NEP Postgraduate Programme 2023

Programme: M.Sc.Microbiology

Programme Degree		M.Sc.
Parenthesis if any (Specialization)		Microbiology
Preamble (Brief Introduction to the programme)		Microbiology is the science in which study of a variety of living organisms which are invisible to the naked eyes.The methods used to study and manipulate these minute and mostly unicellular organism differ from other organism.Microbiologists are paramedical healthcare professionals who helps in maintaining good health and healthy life style of living organisms. Microbiology is used in many aspects of daily life,including food production,biodegradation,manufacture of commercial goods and genetic engineering.
Programme Specific Outcomes (POs)		After completing this programme, Learner will be
	1	Develop capacities to become healthcare professionals for services in the field of hospital clinical laboratories,public health laboratories,blood banking & forensic laboratories.
	2	Demonstrate ability for collaborative research and scientific theories and communication.
	3	Develop abilities including analysis critical reasoning and use their creativity in the related areas to work effectively and efficiently in academics,pharmaceutics,chemical industries R & D.
	4	Design & perform experiments in food industries,environmental areas,medical equipment companies and water plant.
Eligibility Criteria for Programme		A. Any life science graduate with minimum score 50%. B. Science graduate with PGDMLT. C. Any agricultural technology graduate with minimum score 50%.
Intake (For SNDT WU Departments and Conducted Colleges)		60

Postgraduate Programme of Two Years

MSc.Microbiology

SN	Courses	Type of Course	Credits	Marks	Int	Ext
Semester I						
115411	Molecular Immunology(Th)	Major (Core)	4	100	50	50
115412	Bioinstrumentation Techniques & Application(Th)	Major (Core)	4	100	50	50
115423	Bioinstrumentation Techniques & Application(Pr)	Major (Core)	2	50	50	-
115414	Advanced Genetic Engineering(Th)	Major (Core)	4	100	50	50
125411/ 125412	*Microbial Physiology & Development(Th) OR. Bioenergetics & Molecular Enzymology(Th)	Major (Elective)	4	100	50	50
135411	Biostatics & Advanced Research Methodology In Microbiology(Th)	Minor Stream (RM)	4	100	50	50
End of Semester-I			**22**	**550**	**300**	**250**
Semester II						
215411	Advanced Clinical Virology(Th)	Major (Core)	4	100	50	50
215412	Food,Dairy Microbiology & Fermentation Process(Th)	Major (Core)	4	100	50	50
215423	Food,Dairy Microbiology & Fermentation Process(Pr)	Major (Core)	4	100	50	50
215414	Macromolecules & Molecular Enzymology(Th)	Major (Core)	2	50	50	-

225411/ 225412	*Bioprocess Enginnering & Technology(Th) OR Agricultural Microbiology(Th)	Major (Elective)	4	100	50	50
255431	Minor Project	(RP)	4	100	50	50
End of Semester-II			**22**	**550**	**300**	**250**
Exit with PG Diploma in Microbiology						

SECOND YEAR MSc.Microbiology

SN	Courses	Type of Course	Credits	Marks	Int	Ext
	Semester III					
315411	Bioinformatics,Microbial Genetics & Proteomics(Th)	Major (Core)	4	100	50	50
315422	Bioinformatics,Microbial Genetics & Proteomics(Pr)	Major (Core)	4	100	50	50
315413	Enzyme Technology(Th)	Major (Core)	4	100	50	50
315424	Enzyme Technology(Pr)	Major (Core)	2	50	50	-
325411/ 325412	* Microbial Diversity(Th) OR Environmental Microbiology(Th)	Major (Elective)	4	100	50	50
345441	Internship	OJT	4	100	50	50
End of semester-III			**22**	**550**	**300**	**250**

Semester IV						
415411	Recombinant DNA Technology(Th)	Major (Core)	4	100	50	50
415412	Pharmaceutical Microbiology(Th)	Major (Core)	4	100	50	50
415413	Industerial Biotechnology(Th)	Major (Core)	4	100	50	50
425411/ 425412	*Environmental Biotechnology(Th) OR Advanced Medical Microbiology(Th)	Major (Elective)	4	100	50	50
455431	Dissertation(Project)	RP	6	150	100	50
End of Semester-IV						
Exit with PG Degree in Microbiology						

*The elective subjects will be offered only if there are minimum 10 students for the respective selected course.

1.1. MIC.1101 Major (Core)

Course Title	**Molecular Immunology(Th)**
Course Credits	4
Course Outcomes	After going through the course, learners will be able to -
	1.Understand the mechanisms of immune system of body.
	2. Basic understanding of the molecular aspects of Immunology.
	3.Attainment of advanced skills in reading and understanding the primary literature.
	4.The detection, measurement, and characterization of antibodies and their use as research and diagnostic tools.
	5.Molecular mechanisms of the hypersensitivities.
Module 1 (Credit 1): Immune System	

Learning Outcomes	1.Interpret the organs of the immune system. 2.Explain immune system cells. 3.Discusses active immunity and passive immunity. 4.Will be able to discuss immune response mechanisms.
Content Outline	● Organs and cells involved in immune system and immune response. ● Lymphocyte their subpopulation ,their properties and functions. ● Membrane bound receptors of lymph cells. ● Helper T-Cell Suppression ,Lymphocyte trafficking
Module 2 (Credit 1):Antigens and Immunoglobulin	
Learning Outcomes	1.Discuss the concepts of antigen and antibody. 2.Define antigen and describe how antigens affect the adaptive defenses. 3.Discuss the properties of antigens. 4.Explain the structure, properties and functions of antibodies. 5.Understand the importance of haptens and adjuvants.
Content Outline	● Antigens and Immunolglobulin. ● Concept of haptens. ● Conditions of antigenicity. ● Antigens and Immunogenicity ● Super antigens. ● Structure,properties and classes of Immunoglobulin. ● Theories of antibody formation.
Module 3 (Credit 1): Antigen-Antibody Reaction	

Learning Outcomes	1.The antigens and antibodies combine by a process called agglutination. 2.It is the fundamental reaction in the body by which the body is protected from complex foreign molecules, such as pathogens and their chemical toxins. 3.Antigen-antibody binding produces protective outcomes such as cross-linking, neutralization, opsonization, complement activation, immobilization, and cellular cytotoxicity. 4.Once acute inflammation has begun, a number of outcomes may follow. These include healing and repair, suppuration, and chronic inflammation. 5.The outcome depends on the type of tissue involved and the amount of tissue destruction that has occurred, which are in turn related to the cause of the injury.Clinically, acute inflammation is characterized by 5 cardinal signs: rubor (redness), calor (increased heat), tumor (swelling), dolor (pain), and functio laesa (loss of function)
Content Outline	● Antigen-antibody reaction by precipitation ,agglutination and complement fixation. ● Non-specific immuno mechanism ● **I**nflammatory reaction and hormones balance ● Tissue metabolites with bacterial properties.
Module 4 (Credit 1):Expresssion & regulation of Immune Response:	
Learning Outcomes	1.Describe how the immune system is able to discriminate self vs. Non-self 2. Explain how the innate and adaptive immune systems work together to generate an effective immune response against a specific pathogen. 3.Explain how the immune system is able to respond to so many diverse antigens. 4.Lymphocytes in human circulating blood are approximately 80 to 90 percent T cells, and 10 to 20 percent B cells. 5.Recall that the T cells are involved in the cell-mediated immune response, whereas B cells are part of the humoral immune response. 6.Define immunodiagnostics and relate the structure,

	biochemistry and production of Immunoglobulins and antigens to testing. 7.Describe the methods of antibody conjugation, signal outputs, signal amplification and patient sampling commonly used in immunodiagnostic testing. 8.Recognise and evaluate the QC issues pertinent to immunodiagnostic techniques and the interplay between dynamic range, sensitivity and specificity. 9.Identify applications of immunodiagnostics and detail current and future applications. 10.Demonstrate key immunodiagnostic concepts and execute common laboratory assays, which are used in immunodiagnostics.
Content Outline	● Regulation of immune response. ● Activation of B & T lymphocyte. ● MHC registration. ● Mechanism of T cells and NK cells. ● Immunity and Immunoassay. ● Immunodiagnostic and Immunotherapy in virology. ● Serological methods for detection and quantitation of viruses.

References:

1. Essential of Immunology by Riott I. M. 1998. ELBS, Blackwell Scientific Publishers, London.

2. Immunology 2 nd Edition by Kuby J. 1994. W. H. Freeman and Co. New York.

3. Immunology – Understanding of Immune System by Claus D. Elgert. 1996. Wiley – Liss , New

York.

4. Fundamentals of Immunology by William Paul.

5. Cellular and Molecular Immunology. 3 rd Edition by Abbas.

6. Immunobiology: The immune system in Health and Diseases. 3rd edition by Travers.

7. Immunology – A short course. 2 nd Edition by Benjamin.

8. Manual of clinical laboratory and Immunology 6th Edition. 2002 by Noel R. Rose, Chief editor:

Robert G. Hamilton and Barbara Detrick (Eds.), ASM publications.

9. Pocket Guide to Clinical Microbiology. 2 nd Edition. 1998 by Patrick R. Murray. ASM

Publications.

1.2.MIC.1102 Major (Core)

Course Title	**Bioinstrumentation Techniques and Application(Th)**
Course Credits	4
Course Outcomes	After going through the course, learners will be able to – 1.Design and build biomedical instruments that comply with the regulatory standards for medical devices. 2.Describe the key considerations for biological signal generation and measurements. 3.Design and apply signal conditioning within the context of a biomedical device.
Module 1 (Credit 1):Basic Laboratory Instruments	
Learning Outcomes	1. Laminar airflow is used to separate volumes of air, or prevent airborne contaminants from entering an area. 2.Laminar flow hoods are used to exclude contaminants from sensitive processes in science, electronics and medicine. 3.Identify common items as acid, base or neutral. Read a pH strip and identify as acid, base or neutral. Give characteristics of acids, bases and neutral substances. Understand what pH and pOH are measuring. 4.Centrifugation is the process that uses centrifugal force for the separation of two liquids in a mixture. In this process, the denser component of the mixture migrates away from the axis and the lighter component migrates towards the axis. 5.Density gradient centrifugation, known more properly as isopycnic centrifugation, is a technique in which macromolecules move through a density gradient until they find a density equal to their own.
Content Outline	● Basic laboratory instruments. ● Principle and working of pH meter,Laminar air flow and centrifugation. ● Types of centrifugation.

	● Sedimentation velocity. ● Sedimentation equillibrium. ● Density gradient methods and their application.
Module 2 (Credit 1):Chromatographic & Spectroscopy Technique:	
Learning Outcomes	1.Define chromatography. 2.Demonstrate an understanding of the process of chromatography. 3.Describe the steps involved in a chromatography investigation.
Content Outline	● Chromatographic techniques. ● Theory,principle and application of following. ● Paper chromatography ● Thin layer chromatography ● Gel filtration ● Ion exchange ● Affinity ● Gas liquid ● HPLC
Module 3 (Credit 1):Electrophoretic Technique	
Learning Outcomes	1.Identify key features on a gel. 2.Estimate relative DNA fragment length based on the position of bands on a gel. 3.Use a standard curve to accurately and precisely determine fragment length. 4.Explain principles of separation. 5.Explain electroosmotic flow 6.Explain electrophoretic flow 7.Explain the effects of electrophoretic parameters on separation parameters. 8.Demonstrate a good understanding of the electromagnetic spectrum and how this can be applied to the study of chemical molecules.

	9.Describe the principles of spectroscopic methods such as NMR, IR and UV-Vis.
Content Outline	● Electrophoretic and spectroscopic techniques ● Theory,principle and application of electrophoresis. ● Paper electrophoresis. ● Starch gel agarose ● Native and denaturing PAGE ● Isoelectric focusing. ● Techniques ,theory and application of UV,Visible,IR,NMR,Fluoresence,atomic absorption,CD,ORD,Mass and Raman Spectroscopy.
Module 4 (Credit 1):Radioisotopic Techniques	
Learning Outcomes	1.A radionuclide (radioactive nuclide, radioisotope or radioactive isotope) is a nuclide that has excess nuclear energy, making it unstable. 2.These emissions are considered ionizing radiation because they are energetic enough to liberate an electron from another atom. 3.The radioactive decay can produce a stable nuclide or will sometimes produce a new unstable radionuclide which may undergo further decay. 4.Radioactive decay is a random process at the level of single atoms: it is impossible to predict when one particular atom will decay. 5.However, for a collection of atoms of a single nuclide the decay rate, and thus the half-life (t1/2) for that collection, can be calculated from their measured decay constants. The range of the half-lives of radioactive atoms has no known limits and spans a time range of over 55 orders of magnitude.
Content Outline	● Radioisotopic techniques. ● Use of radioisotopic in life science ● Radioactive labelling. ● Principle and application of tracer techniques. ● Detection and measurement of radioactivity using ionization

	chamber. ● Proportional chamber. ● Geiger Muller and Scintillation counter. ● Application of autoradiography and dosimetry.

References:

1. Instrumental Methods of Analysis. 6th Edition by H.H. Willard, L.L. Merritt Jr. and others. 1986. CBS Publishers and Distributors.

2. Instrumental Methods of Chemical Analysis. 1989 by Chatwal G and Anand, S. Himalaya Publishing House, Mumbai.3. A Biologists Guide to Principles and Techniques of Practical Biochemistry. 1975 by Williams, B.L. and Wilson, K.

4. Spectroscopy. Volume 1. Edited by B.B. Straughan and S. Walker. Chapman and Hall Ltd.

5. Gel Electrophoresis of Proteins- A Practical Approach by Hanes.

6. Chromatography: Concepts and Contrasts- 1988 by James Miller. John Wiley and Sons. Inc., New York.

7. Analytical Biochemistry by Holme.

8. Introduction to High Performance Liquid Chromatography by R. J. Hamilton and P. A. Sewell.

9. Spectroscopy by B.P. Straughan and S. Walker.

10. Practical aspects of Gas Chromatography and Mass Spectrometry 1984 by Gordon M. Message, John Wiley and Sons, New York.

11. Gel Chromatography by Tibor Kremmery. Wiley Publications.

12. Isotopes and radiations in Biology by C.C. Thornburn, Butterworth and Co. Ltd., London.

13. The use of radioactive isotopes in the life sciences by J.M.Chapman and G.Ayrey, George Allen and Unwin Ltd., London.

14. Analytical biotechnology edited by Thomas G M Schalkhammer.

15. Principles and techniques of biochemistry and molecular biology by Keith Wilson and Walker.

1.3.MIC.1103 Major (Core)

Course Title	**Bioinstrumentation Techniques and Application(Pr)**
Course Credits	**2**
Course Outcomes	After going through the course, learners will be able to – 1. Discuss the applications of biophysics and principle involved in bioinstruments 2.Describe the methodology involved in biotechniques 3.Describe the applications of bioinstruments 4.Demonstrate knowledge and practical skills of using instruments in biology and medical field 5.Perform techniques involved in molecular biology and diagnosis of diseases 6.Update current knowledge regarding biomedical engineering involving new methods and the instrumentation
Learning Outcomes	1. Explain the electro-analytical techniques and spectroscopic techniques. 2. 2.Describe the application and methodology involved in different types of chromatographic techniques. 3.Explain the principle involved in electrophoresis. 4.Describe various applications of different types of electrophoresis. 5.Explain principle, instrumentation and application of spectroscopic instruments. 6.Demonstrate the usage of CD, ORD, Fluorescence, Mass, NMR, ESR and Atomic absorption spectroscopy. 7.Explain general features of fluid flow, viscosity co-efficient and pipetting techniques. 8.Describe centrifugation & ultracentrifugation techniques

Content Outline	● Studies on pH titration curves of amino acids/ acetic acid and determination of pKa values and Handerson-Hasselbach equation. ● Separation of bacterial lipids/amino acids/sugars/organic acids by TLC or Paper Chromatography. ● Separation of serum protein by horizontal submerged gel electrophoresis. ● Study of UV absorption spectra of macromolecules (protein, nucleic acid, bacterial pigments). ● Quantitative estimation of hydrocarbons/pesticides/organic Solvents /methane by Gas chromatography. ● Demonstration of PCR, DNA sequencer. ● Separation of haemoglobin or blue dextran by gel filtration. ● Paper electrophoresis. ● Density gradient centrifugation.

1.4.MIC.1104 Major (Core)

Course Title	**Advanced Genetic Engineering (Th)**
Course Credits	4
Course Outcomes	After going through the course, learners will be able to -
	1. Understanding the basic steps of gene cloning and the role of enzymes and vectors responsible for gene manipulation, transformation and genetic engineering.□□
	2.Getting detailed knowledge of gene transfer methods and identifying suitable hosts for cloning.
	3.Acquiring theoretical knowledge in the techniques, tools, application and safety measures of genetic engineering.
	4.Describes the genome mapping and sequencing and methods for gene therapy.
	5.Studying the basics of nanotechnology, synthesis, characterization and applications of various nanoparticles in medicine, agriculture and the environment.

Module 1 (Credit 1):Recombination	
Learning Outcomes	1.Recombination process results in genetic diversity at the gene level, reflecting changes in DNA sequences between species. 2.Recombination produces individuals as a result of the fertilisation of haploid male and female gametes. 3.Recombinant DNA technology comprises altering genetic material outside an organism to obtain enhanced and desired characteristics in living organisms or as their products. 4.Homologous recombination also produces new combinations of DNA sequences during meiosis, the process by which eukaryotes make gamete cells, like sperm and egg cells in animals.
Content Outline	● Recombination between hetro duplex DNA. ● Protein involved in recombination ● Role of recA & recBCD. ● Single strand assimilation in bacteria. ● Conjugation in bacteria. ● Transduction generalized & specialized mechanism. ● Transposomes insertion sequences & composite transponse.
Module 2 (Credit 1):Gene Expression	
Learning Outcomes	1.In lac operon, lactose acts as an inducer. If lactose is provided in the medium for the bacteria, the regulatory gene is activated. 2. The inducer will bind to the repressor protein and render it inactive which allows transcription of the operon. Thus, the lac operon is negatively regulated in this case. 3.In a prokaryotic cell, by the time transcription ends, the transcript would already have been used to begin making copies of the encoded protein because the processes of transcription and translation can occur at the same time since both occur in the cytoplasm. 4.Gene expression is the process by which the instructions in our DNA are converted into a functional product, such as a protein. 5.Gene regulation is necessary for making or synthesizing correct

	proteins where they are required. So it maintains the stability of the body. Hence, homeostasis is an outcome of gene regulation.
Content Outline	● Prokaryote:Operon concept. ● Cordinated control structural genes. ● Repressor protein & their functions. ● Operations & other DNA elements of regulations. ● Positive & negative control of an operon. ● Transcriptional activator as positive regulators of gene expression. ● Obstream factors. ● Identifying gene under common regulations.
Module 3 (Credit 1):Isolation,Identification & Characterization of DNA Organisms	
Learning Outcomes	1.Restriction enzyme, a protein produced by bacteria that cleaves DNA at specific sites along the molecule. 2.In the bacterial cell, restriction enzymes cleave foreign DNA, thus eliminating infecting organisms. 3.Explain various DNA modifying enzymes used in genetic engineering. 4.Define the terms plasmid and vector in your own words. 5.Distinguish the types of plasmids covered here based on copy number, host range, and purpose. 6.Describe and explain blue-white selection. 7.Explain or be able to draw out the steps of RE/ligation-based cloning into a plasmid. 8.Phages, formally known as bacteriophages, are viruses that solely kill and selectively target bacteria. 9.They are the most common biological entities in nature, and have been shown to effectively fight and destroy multi-drug resistant bacteria. 10.Describe the natural function of restriction enzymes and explain how they are used in recombinant DNA technology.

Content Outline	• Restriction endonucleases,typeI,II,III. • Recognition sequences. • Properties,nomenclature of classification of type II endonucleases, their activities,restriction & mapping. • Enzymes used in genetic engineering. • DNA sequencing: De oxy method Automated sequencing. • Plasmids: Plasmids ,Vectors properties. • Promotor vectors runway plasmid vectors. • Bacteriophage as essential features organization of genome general structure. • Cloning strategies.
Module 4 (Credit 1):Clonning Vectors in E.Coli & Others Organism	
	1.Transformation is a key step in DNA cloning. 2.It occurs after restriction digest and ligation and transfers newly made plasmids to bacteria. 3.After transformation, bacteria are selected on antibiotic plates. 4.Bacteria with a plasmid are antibiotic-resistant, and each one will form a colony.
	5.Discuss the characteristics of various types of cloning vector(K)[DA] 6.Differentiate cloning vector and expression vectors
Content Outline	• E.Coli expression vectors. • Stability of protein fusion proteins & their applications. • Bacillus: Transformation techniques plasmid and vectors. • Expression.excretion and shuttle vectors. • Streptomyces:Transformation ,plasmid and vectors,expression vectors and phage vectors. • Yeast: Genetic markers and selection system, yeast integrating,replication,episomal vectors,yeast artificial chromosomes,expression vectors.

References:

1. **Benjamin lewin-gene-Vi gene-VIIOxford university press.**
2. **David Frider-Essentials of molecular biology.**
3. **J.Kendrew-Encyclopedia of molecular biologyBlackwell Pub.**
4. **Weaver molecular biology.**
5. **J D Watson,N H Hopkins,JW Roberts, Molecular Biology of the gene.**
6. **J Dannel-Molecular Biology of the cell (2nd edition) Garland Pub.Inc.**
7. **Moyers R A-Molecular Biology & Biotechnology VCH Pub.N Y Inc.**
8. **Elberts BMolecular Biology of the cell Garland Pub.INc.**
9. **Watson J D Recombinant DNA.**
10. **Jyner-Gene targeting practical approach.**
11. **Berry yeast biotechnology.**
12. **Winnakar-From genes to clones.**

1.5.MIC.1105 Major (Elective)

Course Title	**Microbial Physiology & Development(Th)**
Course Credits	4
Course Outcomes	After going through the course, learners will be able to -
	1. Apply the knowledge to understand the microbial physiology and to identify the microorganisms.
	2. Understand the regulation of biochemical pathway and possible process modifications for improved control over microorganisms for microbial product synthesis.
	3.Describe diversity of microorganisms, bacterial cell structure and function, microbial growth and metabolism, and the ways to control their growth by physical and chemical means.
Module 1 (Credit 1):Bacterial Photosynthesis	
Learning Outcomes	1.Describe the function and locations of photosynthetic pigments in eukaryotes and prokaryotes 2.Describe the major products of the light-dependent and light-independent reactions 3.Describe the reactions that produce glucose in a photosynthetic cell 4.Compare and contrast cyclic and noncyclic photophosphorylation
Content Outline	● Photosynthesis:Energy consideration in photosynthesis, light and dark reaction, electron carriers in photosynthesis, Organization of photo system I and II, cyclic and non-cyclic flow of electrons, Z scheme, Hill reaction, photolysis of water. ● Bacterial photosynthesis:scope, electron carriers, Photosynthetic reaction center, cyclic flow of electrons, bacterial photophosphorylation in various groups of phototrophic bacteria, electron donors other than water in anoxygenic photosynthetic bacteria.
Module 2 (Credit 1):Bacterial Respiration	
Learning Outcomes	1.Recognise that respiration is similar to combustion and that heat energy is released.

	2.Recognise that some of the energy released is used to create ATP. Understand that energy in the form of ATP is used to drive reactions in cells. 3.Relate the release of heat energy to keeping an animal warm. 4.During aerobic cellular respiration, glucose reacts with oxygen, forming ATP that can be used by the cell. Carbon dioxide and water are created as byproducts. 5.The end products of aerobic respiration include 6 molecules of carbon dioxide, 6 molecules of water and 30 molecules of ATP. 6.Discuss which components are necessary for the production of energy. 7.Identify the key energy molecule of the body. Understand which type of cellular respiration produces more energy. Build a model representation of ATP and ADP.
	8.Understand that there are two different pathways for anaerobic respiration. 9.State the word equations for the ethanol pathway and the lactate pathway. 10.Describe how an oxygen debt is repaid by an exercising athlete in the lactate pathway. 11.Describe examples of anaerobic respiration in plants and yeast.
Content Outline	● Bacterial Respiration: ● Aerobic Respiration: Mitochondrial electron transport chain, structure and function of ATPase (bacterial and mitochondrial), generation and maintenance of proton motive force, oxidative phosphorylation, inhibitors and un-couplers of electron transport chain and oxidative phosphorylation, Atkinson's energy charge, phosphorylation potential and its significance, Energy generation in all groups of chemolithotrophs. ● Anaerobic Respiration: Concept of anaerobic respiration, oxidized sulfur compounds, and nitrate as electron acceptor with respect to electron transport chain and energy generation, Biochemistry of methanogenesis, Biochemistry of ammonia oxidation, ammonia oxidation by members of Genus Nitroso group, nitrite oxidation by Nitro group of genera.
Module 3 (Credit 1):Bacterial Permeation and Bacterial Sporulation	

	1.So studying the cell wall can help us understand how pathogens evade our defences and how key antibiotics such as penicillin work, which might in turn inform us about how antibiotic resistance might arise and help us to keep our best antibiotics safe from overuse. 2.In bacterial cells, random diffusion is sufficient to allow molecules to reach their desired target sites efficiently because of the small cellular volumes 3.Sporulation occurs in organisms across the tree of life from bacteria and protozoa to plants and fungi and facilitates both survival in response to adverse growth conditions and dispersal to new, more hospitable environments.
Content Outline	● Bacterial Permeation : ● Structure and organization of membrane (Glyco-conjugants and proteins in membrane systems), fluid mosaic model of membrane. ● Methods to study diffusion of solutes in bacteria, passive diffusion, facilitated diffusion, different mechanisms of active diffusion (Proton Motive Force, PTS, role of permeases in transport, different permeases in E. Coli. Transport of amino acids and inorganic ions in microorganisms and their mechanisms. ● Bacterial Sporulation:Sporulating bacteria, molecular architecture of spores, induction and stages of sporulation, Influence of different factors on sporulation. ● Cytological and macromolecular changes during sporulation. Heat resistance and sporulation.
Module 4 (Credit 1):Bacterial Chemolithotrops	
Learning Outcomes	1.The generation of energy (via ATP) and the generation of reducing power (via NADH). Hydrogen oxidizing bacteria (sometimes called Knallgas-bacteria) are bacteria that oxidize hydrogen. 2.The redox reactions performed by these chemolithotrophs act as a bridge between biological and geological processes, and these organisms exploit natural interfaces between fluids of differential redox potential. 3.Describe the role nitrogen fixation plays in distributing atmospheric nitrogen to life on the planet. 4.Identify ways humans and plants use nitrogen.

	5.E haixplain the mutualistic relationship between bacteria and legumes.
Content Outline	● Physiological groups of chemolithotrophs, Oxidation of molecular hydrogen by Hydrogenomonas species. Ferrous and sulfur/sulfide oxidation by Thiobacillus species. ● Biochemistry of biological nitrogen fixation, properties of nitrogenase and its regulation, ammonia assimilation with respect to glutamine synthetase, glutamate dehydrogenase, glutamate synthetase, their properties and regulation.

References:

1. Microbial Physiology and Metabolism by Caldwell D.R. 1995Brown Publishers.

2. Microbial Physiology by Moat A.G. and Foster J. W. 1999. Wiley.

3.Prokaryotic Development by Brun. Y.V. and Shimkets L.J. 2000. ASM Press.

4. Advances in Microbial Physiology. Volumes. Edited by By A.H. Rose. Academic Press, New York.

5. Applied Microbial Physiology by Rhodes.

6. Biosynthesis by Smith.

7. The Bacteria. Volumes by I.C. Gunsalus and Rogery Stanier, Academic Press.

8. Microbial Physiology by Benjamin

9. Bacterial Metabolism by H.W. Doelle

10. Segel Irvin H. (1997) Biochemical Calculations 2nd Ed., John Wiley and Sons, New York.

11. Voet Donald and Voet Judith G. (1995) Biochemistry, 2nd Ed.. John Wiley and sons New York.

12. White Abraham, Handler Philip, Smith Emil, Hill Rober, Lehman J. (1983) Principles of Biochemistry, Edition 6, Tata Mc-Graw Hill Companies, Inc.

13. White David (2000) Physiology and Biochemistry of Prokaryotes. 2nd Ed. Oxford University Press, New York.

14. Zubay Geoffrey (1998) Biochemistry, 4th Ed., W. C. Brown, New York.

1.6.MIC.1106 Major (Elective)

Course Title	**Bioenergetics and Molecular Enzymology(Th)**
Course Credits	4
Course Outcomes	After going through the course, learners will be able to -
	1.Understand the free energy and high energy compounds.
	2.Acquire the knowledge on Biological oxidation.
	3.Outline the major pathways in carbohydrate metabolism
	4.Learn about lipid metabolism and its importance.
	5.Explore on basic reactions and its concepts in protein metabolism.
Module 1 (Credit 1):Carbohydrate catabolic pathway & Microbial Growth on C1 compound	
Learning Outcomes	1.Describe why glycolysis is not oxygen dependent 2.Define and describe the net yield of three-carbon molecules, ATP, and NADH from glycolysis 3.Explain how three-carbon pyruvate molecules are converted into two-carbon acetyl groups that can be funneled into the Krebs cycle. 4.Define and describe the net yield of CO_2, GTP/ATP, $FADH_2$, and NADH from the Krebs cycle 5.Explain how intermediate carbon molecules of the Krebs cycle can be used in a cell 6.Anaplerosis is the act of replenishing TCA cycle intermediates that have been extracted for biosynthesis (in what are called anaplerotic reactions). 7.The TCA cycle is a hub of metabolism, with central importance in both energy production and biosynthesis.
Content Outline	● Carbohydrate catabolic pathways and microbial growth on C1 Compounds: EMP, HMP, ED, Phosphoketolase pathway, TCA cycle, Glyoxylate bypass. ● Anaplerotic sequences, catabolism of different carbohydrates (Fructose, Lactose, Manose, Allose, Gluconate, Manitol, Sorbitol, Arabinose, Xylose), Polyol, glycol and 2,3 butanidiol metabolism, regulation of aerobic and anaerobic carbohydrate metabolism, Microbial growth on C1

	Compounds (Cyanide, Methane, Methanol, methylated amines and carbon monoxide) with reference to microorganisms and biochemical reactions with enzymes involved.
Module 2 (Credit 1):Endogenous metabolism and degradation of aliphaticand aromatic compounds	
Learning Outcomes	1.The aliphatic hydrocarbons are the alkanes, alkenes and alkynes. Hydrocarbons are source of energy to heat and light that engages us in our daily life and activities. They also provide almost every plastic items, the fuel for our vehicles and a major ingredient of the food that we consume.
	3.In aliphatic compounds, reactions of functional groups are often modified very significantly by an adjacent carbonyl group. As would be expected from the discussion in the preceding section, the reactions of certain substituents α and γ to pyridine-like nitrogen atoms in azole rings are similarly influenced
Content Outline	● Endogenous metabolism and degradation of aliphatic and aromatic compounds. ● Functions of endogenous metabolism, types of reserve materials, enzymatic synthesis, degradation and regulation of reserve materials – glycogen, polyphosphates and polyhydroxybutyrate (PHB), PHB production and its futuristic applications. Microbial degradation of aliphatic hydrocarbons (microorganisms involved, mon-terminal, biterminal oxidation of propane, decane, etc.) and aromatic hydrocarbons and aromatic compounds (via catechol, protocatechuate, meta-cleavage of catechol and protocatechuate, dissimilation of catechol and protocatechuate, homogentisate and other related pathways).
Module 3 (Credit 1):Enzyme Properties	
Learning Outcomes	1.Define the term 'enzyme' 2.Explain that enzymes only work on a single substrate. 3.Explain that enzymes function by lowering the activation energy for biochemical reactions. 4.Name and describe at least one way that cells control enzyme activity. 5.Explain that enzymes function by lowering the activation energy

	for biochemical reactions. 6.Name and describe at least one way that cells control enzyme activity. 7.Enzymes are biological catalysts that carry out thousands of chemical reactions, which occur in living cells. 8.Enzymes affect the rate of biochemical reaction and not the direction of the reaction. Enzymes do not start a reaction.
Content Outline	● Properties of Enzymes:Classification of enzymes into six major groups with suitable examples. Numerical classification of enzymes. ● Different structural conformations of enzyme proteins (Primary, secondary, tertiary and quaternary structures). Forces that mentain protein structures. Sources of enzyme. Enzymes as biocatalysts, catalytic power, activation energy, substrate specificity, active site, theories of mechanisms of enzyme action (Induced fit and lock and key). ● Mechanism of action of lysozyme, chymotrypsin and ribonuclease. Monomeric, Oligomeric and multienzyme complex, isozymes and allosteric enzymes. Extremozymes – thermostable, solventogenic and non- aqueous enzymes. Synthetic enzymes, Ribozymes and abzymes
Module 4 (Credit 1):Enzyme Kinetics	
Learning Outcomes	1..Explain working principle of enzymes 2..Express the relationship mechanisms of enzyme activity regulationxplains the definition of allosteric regulation 3.Express regulation of enzymes by covalent modification 4.Express role of enzymatic activity in the regulation of protein synthesis 5.Explain the factors that affect enzyme activity 6.explain the properties of enzyme-catalysed reactions 7.Discusses Michaelis-Menten kinetics 8.Explain the Lineweaver-Burke graphic
Content Outline	● Enzyme kinetics:Importance of enzyme kinetics, factors affecting rates of enzyme mediated reactions (pH, temperature, substrate concentration ,enzyme concentration and reaction time). ● Derivation of Michaelis – Menton equation and its

	significance in enzyme kinetic studies. Lineweaver-Burke plot, Haldane-Briggs relationship, sigmoidal kinetics steady state kinetics and transient phases of enzyme reaction.

References:

1. Understanding Enzymes by Trevor Palmer

2. Enzyme Kinetics by Paul Engel. 1977. John Wiley and Sons. Inc., New York.

3. Enzymes by Dixon and Webb, 3 rd Edition 1979. Academic Press, New York

4. Biochemistry by Stryer 5th Edition WH Freeman 2001

5. Laboratory techniques in Biochemistry and Molecular Biology by Work and Work.

6. Principles of Enzyme Kinetics. 1976. By Athel Cornish – Bowden.Butterworth and Co. 7. Fundamentals of Enzymology. 3rd Edition by Price

8. Biochemistry by Chatwal

9.Methods in Enzymology by Drolittle

10.Biochemistry by Garrett

11. Principles of Biochemistry. 2nd Edition by Horton.

1.7.MIC.1107 Minor Stream (Research Methodology)

Course Title	**Biostatistics and Advanced Research Methodology in Microbiology(Th)**
Course Credits	4
Course Outcomes	After going through the course, learners will be able to -
	1. Develop the ability to apply the methods while working on a research project work.
	2.Describe the appropriate statistical methods required for a particular research design.
	3.Choose the appropriate research design and develop appropriate research hypothesis for a research project.
	4. Develop a appropriate framework for research studies
Module 1 (Credit 1):Introduction of Biostatics	
Learning	1.Recognize, describe, and calculate the measures of

Outcomes	location of data: quartiles and percentiles. 2.Recognize, describe, and calculate the measures of the center of data: mean, median, and mode. 3.Recognize, describe, and calculate the measures of the spread of data: variance, standard deviation, and range.
Content Out line	● Introduction to Biostatistics: Basic definitions and applications. Sampling: Representative sample, sample size, sampling bias and sampling techniques. ● Data collection and presentation : Types of data, methods of collection of primary and secondary data, methods of data presentation, graphical representation by histogram, polygon, ogive curves and pie diagram.
Module 2 (Credit 1):Central Tendancy:Mean,Median and Mode	
Learning Outcomes	1.Calculate the mean, median, and mode of a set of data. 2.Calculate the range of a data set, and recognize it's limitations in fully describing the behavior of a data set. 3.Calculate the standard deviation for a data set, and determine it's units. 4.Fefine regression analysis. 5.Produces simple linear regression equation. 6.Estimates the model using LSE. 7.Rvaluate the regression model. 8.Determines standard error, variance, correlation coeficient of the estimate and interprets them.
Content Outline	● Measures of central tendency: ● Mean, Median, Mode. Measures of variability: Standard deviation, standard error, range, mean deviation and coefficient of variation. Correlation and regression: Positive and negative correlation and calculation of Karl-Pearsons co-efficient of correlation. ● Linear regression and regression equation and multiple linear regression, ANOVA, one and two way classification. Calculation of an unknown variable using regression equation. ● Tests of significance: Small sample test (Chi-square t test, F test), large sample test (Z test) and standard error. Introduction to probability theory and distributions, (concept without deviation) binomial, poison and

	normal (only definitions and problems) Computer oriented statistical techniques. Frequency table of single discrete variable, bubble spot, computation of mean, variance and standard Deviations, t test , correlation coefficient
Module 3 (Credit 1):Advance Research Methodology	
Learning Outcomes	1.Demonstrate the ability to choose methods appropriate to research aims and objectives. 2.Understand the limitations of particular research methods. 3.Develop skills in qualitative and quantitative data analysis and presentation. 4.Develop advanced critical thinking skills. 5.The student knows how to evaluate scientific texts and suggests improvements with respect to clear writing, and precision with respect to the text content.
Content Outline	● Research Methodology :Research institutes, research schemes (minor and major), preparation of research scheme proposals, formats, funding agencies. ● scientific writing: research article, dissertation, review, abstract, synopsis, technical report. Literature search, analysis of scientific report, compilation of data, presentation of experimental data, tabulation, graph, diagrams, histograms, interpretation of tables, graphs, photographs, and diagrams.
Module 4 (Credit 1):Review of Literature & Report Writing	
Learning Outcomes	1.Participants can identify the elements of a literature review and can state in writing the purpose and process of the literature review as they relate to the research process. 2. Participants can search for and access information in multiple formats and use found sources to mine for additional sources 3.ntellectual skills. With this type of learning outcome, the learner will understand concepts, rules or procedures 4.Understand what writing an assignment involves. 5.Identify strengths and weaknesses. 6.nderstand the functions of essays and reports. 7.emonstrate writing skills. 8.Summarize to accurately reflect the body of the report Offer an

	interpretation consistent with the findings in the summary Present recommendations that are consistent with the report's purpose, evidence, and interpretations
Content Outline	• Review of Literature Essential constituents of Literature Review in Microbiology Need for Reviewing Literature What to Review and for what purpose Literature Search Procedure Sources of Literature in Microbiology Planning of Review work Note Taking, Library and documentation • Planning of Research and sampling The planning process Selection of a Problem for Research Hypothesis formation Measurement, Research design and plan Sampling Techniques or Methods Choice of sampling Techniques Sample size Sampling and Non-Sampling errors, Estimation Mean, Estimation of Standard Error and Confidence Interval • Data collection and analysis Types of Data Collection of data Processing of dsata Tabulation Graphical representation Statistical softwares used. • Report/Project writing Types of Reports Planning of Report Writing Documentation Data and Data Analysis Reporting in a Thesis Writing of project, Funding agencies.

References:

1. Statistics in biology, Vol. 1 by Bliss, C.I.K. (1967) Mc Graw Hill, NewYork.

2. Practical Statistics for experimental biologist by Wardlaw, A.C. (1985).

3. Programming in C by E. Ballaguruswamy

4. How Computers work – 2000. By Ron White. Tech. Media

5. How the Internet Work 2000 by Preston Gralla Tech. Media.

6. Statistical Methods in Biology – 2000 by Bailey, N.T. J. English Univ. Press.

7. Biostatistics – 7th Edition by Daniel

8. Fundamental of Biostatistics by Khan

9. Biostatistical Methods by Lachin

10. Statistics for Biologist by Campbell R.C.(1974)Cambridge University Press , UK

11. INTERNET – CDC publication, India.

12. Research Methodology: Methods and Techniques by C. R. Kothari, New Age International Publishers, ISBN:81-224-1522-9

13.Statistical Methods for Research Workers by Fisher R. A., Cosmo Publications, New Delhi ISBN:81-307-0128-6

14.Design and Analysis of Experiments by Montogomery D.C. (2001), John Wiley, ISBN: 0471260088 4. Statistical Methods in Biology – 2000 by Bailey, N.T. J. English Univ. Press. 15. Practical Statistics for experimental biologist by Wardlaw, A.C. (1985).

End of semester-I

2.1.MIC.2101 Major (Core)

Course Title	**Advanced Clinical Virology(Th)**
Course Credits	4
Course Outcomes	After going through the course, learners will be able to -
	1.Understand the architecture of viruses, their classification and the methods used in their study.
	2.Discern the replication strategies of representative viruses from the seven Baltimore classes and comprehend the intricate interaction between viruses and host cells
	3.Comprehend the role of viruses in oncogenesis, and ways of preventing/ treating viral infections.
	4.Know how viruses can be used as tools to study biological processes, as cloning vectorsand for gene transfer.
Module 1 (Credit 1):Classification,Morphology and Cultivation of Viruses	
Learning Outcomes	1.Most viruses probably evolved from different ancestors, the systematic methods that scientists have used to classify prokaryotic and eukaryotic cells are not very useful. 2.Contrast differences in virus architecture and classification. 3.Diagram transmission and replication for medically important viruses.

	4.Distinguish characteristics of normal cells and virus-infected cells. 5.Explain and apply methods used in research and diagnosis of viral diseases.
	6.Isolation of viruses from clinical specimens for which purpose a type of cell culture should be selected which is known for its high sensitivity and in which cell abnormality is readily recognized. 7.Production of vaccines and antigens for serological ...
Content Outline	● Classification and Morphology of Viruses: Brief outline on discovery of viruses. Classification and nomenclature of animal and plant viruses.Cataloging the virus through virus classification schemes of ICTV / ICNV. Morphology and ultrastructure of viruses. Virus related agents, viroids and prions. ● Cultivation and assay of viruses (0.8 Credits) Cultivation of viruses using embryonated eggs, experimental animals and cell cultures (Cell-lines, cell strains and transgenic systems). Purification of viruses by adsorption, precipitation, enzymes, serological methods – haeme agglutination and ELISA. Assay of viruses – Physical and Chemical methods (Electron Microscopy and Protein and Nucleic acids studies). Infectivity Assays (Plaque and end-point) Infectivity of plant viruses. Genetic analysis of viruses by classical genetic methods.
Module 2 (Credit 1):Viral Multiplication	
Learning Outcomes	1.Inside, it releases and replicates its genome while facilitating the manufacture of its proteins by host ribosomes. 2.Virus particles are assembled from these newly synthesized biological molecules and become infectious virions. Finally, the virions are released from the cell to continue the process of infection. 3.Many virus infections result in no disease in the host, while at the other end of the scale a virus infection may result in fatal disease, such as rabies or AIDS. 4.Disease may be manifest as symptoms and/or signs.

Content Outline	● Viral Multiplication:Bacteriophages – Lytic and lysogenic replication Animal viruses - Mechanism of virus adsorption and entry into the host cell DNA and RNA viruses– Mechanism of genome replication Transcription, post transcriptional changes, translation, assembly, exit and maturation of progeny virions.
Module 3 (Credit 1):Viral Pathogenesis	
Learning Outcomes	1.Viral pathogenesis involves several steps that must occur for the virus to infect and cause disease in the host: virus entry into the host, primary virus replication, virus spread within the host, infection of cells with special affinities for the virus (cell tropism), cellular injury, host immune response. 2.Many virus infections result in no disease in the host, while at the other end of the scale a virus infection may result in fatal disease, such as rabies or AIDS. 3.Disease may be manifest as symptoms and/or signs. 4.Productive infections result in the formation of progeny virus and usually cause the destruction of the host cell. 4.In some cases the host cells are not all destroyed, leading to persistent infections in which the surviving cells multiply and continue to produce progeny viruses.
Content Outline	● Pathogenesis of Viruses:Host and virus factors involved in pathogenesis, patterns of infection, pathogenesis of animal viruses Adenovirus, Herpes virus, Picorna virus, Poxvirus and Orthomyxovirus, pathogenesis of plant [TMV] Satellite viruses and their role in plant virus replication. Insect viruses [NPV] Viruses pathogenic to algae and fungi.
Module 4 (Credit 1):Control of Viruses & Emerging Viruses	
Learning Outcomes	1.Direct cell damage and death from viral infection may result from diversion of the cell's energy 2.Shutoff of cell macromolecular synthesis, Competition of viral mRNA for cellular ribosomes,. 3.Competition of viral promoters and transcriptional enhancers for cellular transcriptional factors such as RNA

Content Outline	● Control of Viruses and Emerging Viruses:Control of viral infections through vaccines and chemotherapeutic agents. Viruse neutralization by antibody and interferons

References:

1. Medical virology 10 th edition by Morag C and Tim bury M C 1994.. Churchil Livingstone , London.

2. Introduction to modern virology 4 th Edition by Dimmock N J, Primrose S. B. 1994. Blackwell scientific publications. Oxford.

3. Virology 3rd edition by Conrat H. F. ., Kimball P. C. And Levy J. A. 1994. Prentice Hall, Englewood Cliff, New Jersy.

4. Text Book on Principles of Bacteriology, Virology and Immunology, Topley and Wilson 1995.

5. Molecular Biology, Pathogenesis and Control by S. J. Flint and others. ASM Press, Washington , D. C.

6. Applied Virology. 1984. Edited by Ednord Kurstak. Academic Press Inc.

7. Introduction to Modern Virology by Dimmock.

8. Prion diseases by Gaschup, M. H.

9. Clinical Virology Mannual by Steven, S. , Adinka, R. I.., Young , S. A.

10. Principles of virology. 2000 by Edward Arnold.

11. Virology, Principles and Applications by John Carter. Venetia Saounders, Viley Publications.

12. Principles of virology by A. J. Flint. .ASM Press. Washington D.C.

2.2.MIC.2102 Major (Core)

Course Title	**Food and Dairy Microbiology(Th)**
Course Credits	4
Program Outcomes	After going through the course, learners will be able to -
	1.Understand the beneficial role of microorganisms in food processing and the microbiology of different types of fermented foods – pickles, bread, Idli, Tempeh etc.
	2.Study the different types of microorganisms in milk and their

	activities - fermented dairy products and spoilage and their applications as probiotics
	3.Understand the significance and activities of microorganisms in various food and role of intrinsic and extrinsic factors on microbial growth in foods leading to spoilage, and understand the principles underlying the preservation methods.
	4.Recognize and describe the characteristics of important food borne pathogens and Learn various methods for their isolation, detection and identification
	5.Understand of the basis of food safety regulations and discuss the rationale for the use of standard methods and procedures for the microbiological analysis of food.
Module 1 (Credit 1):Food & Dairy Microbiology	
Learning Outcomes	1.To provide instruction in the general principles of food microbiology. 2. lt is assumed that students wifl have received adequate introduction to microbiology per se. 3.This covers the biology and epidemiology of foodborne microorganisms of public health significance, including bacteria, yeasts, fungi, protozoa and viruses, and food spoilage microorganism. 4.The microbiology of food preservation and food commodities; fermented and microbial foods; principles and methods for the microbiological examination of foods; micro biological quality control, and quality schemes.
Content Outline	● Advanced Food and dairy Microbiology:Genetically modified foods. Probiotic role of lactic acid bacteria and fermented milk products. Biosensors in food, Applications of microbial enzymes in food and dairy industry [Protease, Lipases] ● Microbial anti oxidants, biosurfactants as emulsifiers, microbial polysaccharides as stabilizers and thinkers, flavors (esters, diaacetyl, pyrazines, lactones and terpenes, monosodium glutamate and microbial colors from molds). ● Production and application of Bakers Yeast, Tea, coffee and vinegar fermentation

<table>
<tr><td colspan="2">Module 2 (Credit 1):Food Presevation and Spoilage of Food</td></tr>
<tr><td rowspan="2">Learning Outcomes</td><td>1.Will be able to compare the methods of preservation of animal food. ...

2.Will be able to comprehend the reason for food spoilage. ...

3.Will be able to comprehend the principles of preventing contamination and the removal of microorganisms methods used for food safety</td></tr>
<tr><td>4.To study the types of food spoilage.

5.To discuss the different microflora present in fresh foods.

6.To discuss the principle of food preservation and the different methods of food preservation.</td></tr>
<tr><td>Content Outline</td><td>● Food preservation methods and utilization of dairy waste:
● Food preservation by Radiations (UV , Gamma and microwave)
● Food preservation by low and high Temperature, chemicals and naturally occurring antimicrobials
● Biosensors in food industry. Utilization and disposal of dairy by-product - whey
● Food spoilage and Quality assurance:
● Food borne infections and intoxications; bacterial with examples of infective and toxic types –, Clostridium, Salmonella, Shigella, Staphylococcus, Campylobacter, Listeria.

Mycotoxins in food (Types, structures, producer organism and its toxicity).

● Quality assurance: Microbiological quality standards of food. Government regulatory practices and policies. FDA, EPA, HACCP, ISI</td></tr>
<tr><td colspan="2">Module 3 (Credit 1)</td></tr>
<tr><td rowspan="2">Learning Outcomes</td><td>1.These three products have all gone through fermentation. 2.Fermentation is a process done by microorganisms, such as bacteria and yeast, in an anaerobic environment in which they break down a sugar.

3.This results in carbon dioxide (what gives many fermented products their fizziness) and either alcohol and/or an acid.</td></tr>
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Content Outline	● Introduction, food fermentation, the science and technology. ● Oriental fermented foods (Soya sauce, Natto, Miso), Cerel products, mixed preparations (Idle, Dhokala, Khamang, Papadam and Jilebies), Fermented cassaea flour, fermented pea nut milk, and grape based fermented products- wine (pre fermentating, fermentative and post fermentative practices, general methods of wine preparations) , Fermented vegetables – Saurkraut, Fermented Meat – Sausages.
Module 4 (Credit 1):Industerial Food Fermentation	
Learning Outcomes	1.Explain the process of fermentation in making beer, wine, and liquors. distinguish similarities and differences in yeast fermentation. explain how distillation is used to create a higher alcohol content in liquors.
	2.Characterize different types of beneficial microorganisms that can be incorporated in the development of fermented dairy foods. 3.mplement improvement strategies to develop better starters for dairy industry. 4.Prepare different types of fermented milk products possessing nutritional and therapeutic benefits.
Content Outline	● Taxonomy of lactic acid bacteria present in fermented products,. Acid fermented milks(Acidophilus milk, yoghurt). Slightly acid fermented milks (Cultured butter milk), Acid-alcoholic fermented milk (Kefir). Fermented milk production with extended self life (labneh). Starter cultures for fermented dairy products (Strptococcus thermophillus, Lactobacillus bulgaricus,). ● Metabolism of starter cultures, biochemical changes in fermented milk (Fermentation of lactose to lactic acid, production of aromatic compounds, hydrolysis of proteins and lipids and Vit. B content).Cheese- biological entities in cheese systems (Mlk, microorganisms, enzymes and other additives). Cheese production (Milk quality and composition, steps involed in mfg of cheese, preservation, Classification and nutritional aspects)

References:

1. Food Microbiology. 2nd Edition By Adams

2. Basic Food Microbiology by Banwart George J.

3. Food Microbiology: Fundamentals and Frontiers by Dolle

4. Biotechnology: Food Fermentation Microbiology, Biochemistry and Technology. Volume 2

by Joshi.

5. Fundamentals of Dairy Microbiology by Prajapati.

6. Essentials of Food Microbiology. Edited by John Garbult. Arnold International Students

Edition.

7. Microbiology of Fermented Foods. Volume I and II. By Brian J. Wood.Elsiever Applied

Science Publication.

8. Microbiology of Foods by John C. Ayres. J. OrwinMundt. William E. Sandinee. W. H.

Freeman and Co.

9. Dairy Microbiology by Robinson. Volume II and I.

10. Food Microbiology: Fundamentals and Frontiers. 2nd Edition by Michaell P. Doyle, Larry R.

Beuchat and Thomas I. Montville (Eds.), ASM Publications.

11. Bacterial Pathogenesis A Molecular Approach. 2 nd Edition. 2001 by Abigail A.Salyers and

Dixie D. Whitt. ASM Publications.

12. Advances in Applied Microbiology by D. Pearlman, Academic Press.

13. Microbial biotechnology- principles and applications- by Lee Yuan Kun

14. Biotechnology Vol. III and V edited by H J Rehman and G Reed

15. Applied dairy microbiology edited by Elmer Marth and James Steele.:

2.3.MIC.2103 Major (Core)

Course Title	**Food and Dairy Microbiology(Pr)**
Course Credits	**4**
Course Outcomes	After going through the course, learners will be able to -
	1.Perform methods for isolation, detection and

	identification of microorganisms in milk..
	2. Identify the spoilage microorganisms in fruits & vegetables, bread, mushrooms and analyze methods to control deterioration and spoilage
	3.Identify and analyze the microbes of canned foods.
	4.Perform and analyze the effect of temperature on the spoilage of food products.
Learning Outcomes	1.Recall the history of microorganisms in food. 2.Identify the microorganisms found in food. 3.Explain the factors that affect microbial growth in food. 4.Discuss microbial spoilage of food. 5.Experiment the techniques in control of food spoilage. 6.List foodborne diseases. 7. Differentiate foodborne infection and intoxication. 8.Practice the methods for microbial examination for food. 9.Identify the importance and properties of indicator organisms. 10.Explain the principle of quality control. 11.Discuss the role of HACCP in food safety. 12.Identify the codes of good manufacturing practices
Content Outline	● Production and estimation of lactic acid by Lactobacillus Sp. Or Streptococcus Sp. ● Extraction and estimation of diacetyl. ● Sauerkraut fermentation ● Isolation of food poisoning bacteria/ fungi from contaminated foods, Dairy products ● Extraction and detection of afla toxin for infected foods. ● Preservation of potato/onion by UV radiation ● Production of fermented milk by Lactobacillus acidophilus. ● Rapid analytical techniques in food quality control using microbial Biosensors. ● Production of Youghart.

2.4.MIC.2104 Major (Core)

Course Title	Macromolecules & Molecular Enzymology(Th)
Course Credits	**2**
Course Outcomes	After going through the course, learners will be able to -
	1.Describe structure, functions and the properties of protein .
	2.Explain biosynthesis of nucleic acids, structure of DNA & RNA
	3. Have a deeper insight in to the fundamentals of enzyme structure and function and kinetics of soluble and immobilized enzymes. Discussion on current applications and future potential of enzymes
	4.Ezyme catalysed reactions and enzyme inhibitions and regulatory process, Enzyme activity, Enzyme Units, Specific activity.To perform immobilization of enzymes and understand the wide applications of enzymes and future potential.
	5.Have a complete understanding of rate of reactions and order of reactions, and inhibitions and their kinetics.To gain knowledge on enzyme catalysis and isoenzymes and on multienzyme and multienzyme complexes.
	6.Relate the entropy to law of thermodynamics and Free energy and its relation to chemical equilibria.
Module 1 (Credit 1):Biosynthesis of Protein & Nucleic Acid	
Learning Outcomes	1.Biochemical Identification of the Genetic Material 2.Describe the experiments that demonstrated that DNA is the genetic material. 3. Nucleic Acid Structure 4.Explain how the contributions of Wilkins and Franklin, Watson and Crick, and Chargaff resulted in understanding the structure of DNA. 5.Describe the importance of covalent bonds and hydrogen bonds to the structure of a DNA molecule. 6.Explain the results of the Meselson-Stahl experiment and describe the predicted results if DNA replication

	followed the other possible models. 7.Describe the relationship between the structure of a DNA molecule and the means by which DNA is replicated. 8.Molecular Mechanism of DNA Replication 9.Outline the basic steps involved in DNA replication, including major differences between eukaryotes and bacteria. 10.Explain how eukaryotes overcome the difficulty of replicating the ends of linear chromosomes. 11.Molecular Structure of Eukaryotic Chromosomes 12.Describe the various strategies employed by eukaryotes to compact their genomes into a nucleus. 13.Explain the significance of histone proteins, including their charge and amino-terminal tails.
Content Outline	● Classification,structure and general reaction of protein on amino acids. ● Primary,secondary,tertiary & quaternary structure of protein. ● Sequencing of protein,protein folding. ● Regulation and metabolic disorder of amino acid. ● Sources of organic nitrogen. ● Flow of Nitrogen into the catabolism of amino acids. ● Urea cycle & excretion of nitrogen. ● Biosynthesis & regulation of nucleic acid. ● Structure of DNA & RNA.
Module 2 (Credit 1):Activity of Enzymes and Applied Enzymology	
Learning Outcomes	1.Enzymes are the functional units of cell metabolism. 2.Acting in organized sequences, they catalyze the hundreds of stepwise reactions by which nutrient molecules are degraded, chemical energy is conversed and transformed, and cell macromolecules are made from simple precursors. 3. Enzymes are the proteins that speed up the metabolism in our bodies. 4.The various classification of enzymes and the overview and definition

	of enzymes helps to know catalytic activity in chemical reactions
Content Outline	● Classification & nomenclature of enzymes. ● Theories & mechanism of enzyme action. ● Enzyme kinetics,enzyme inhibition & enzyme parameters. ● Factors affecting enzyme activity & enzyme immobilization by different methods & their applications. ● Uses of enzymes in different industries. ● Uses of purified enzymes in biosensors. ● Enzyme analysis and other application of biosensors.

References:

1.Protein Purification techniques Edt. Simon Roe, Oxford University Press.

2.Cohn & Stump-outline of Biochemistry, Wiley Easter ltd.

3.Harper's review of Biochemistry-Prentice Hall.

4.Plummer-Practical Biochemistry.

5.J.Jayaman-Practical Biochemistry.

6.Luber Stryer-Biochemistry.

7.Voet-Biochemistry.

8. Zuby-Biochemistry 4th edition.

9.Boyer-Concepts in Biochemistry.

10.Adams-Biochemistry of Nucleic acids.

11.Voest-Fundamentals of Biochemistry with CD.

2.5.MIC.2105 Major (Elective)

Course Title	**Bioprocess Engineering & Technology**
Course Credits	4
Course Outcomes	After going through the course, learners will be able to -
	1.Explain how separations, mass transfer, fluid dynamics and biocatalysis principles are applied in bioprocessing.
	2.Assess the performance of bioprocessing operations including cell processing, product extraction and purification and

	troubleshoot operational problems.
	3.Demonstrate an understanding of the socio-economic context of advanced bioprocessing, such as quality control and assurance, regulatory and ethical responsibilities, in assessing complex problems.
	4.Solve open-ended problems by investigating emerging trends in the field and identifying and proposing creative processes.
Module 1 (Credit 1):Introduction to Industrial Bioprocess Engineering	
Learning Outcomes	1.Able to acquire a sound knowledge in mathematics and natural science and apply engineering principles in determining and solving contemporary and complex problems related to bioprocessing. 2.It looks at the processes that take living cells or their components to make products, typically for commercial use – anything from food to biofuels to pharmaceuticals. 3.During batch culture, a typical bacterial growth curve shows five distinct phases of growth: lag phase, the delay before the start of exponential growth; exponential phase, where cell division proceeds at a constant rate; stationary phase, when conditions become unfavorable for growth and bacteria stop replicating.
Content Outline	● Introduction to Industrial Bioprocess Engineering: ● Definition of bioprocess engineering, bioprocess engineer, biotechnology and bioprocess engineering, approach of biologist and engineers towards research, regulatory constraints of bioprocess. ● Batch growth:(growth pattern and kinetics in batch culture, environmental factors affecting growth kinetics), Monod's equation, continuous culture, Chemostat and turbitostat (construction and working), mixed culture in nature, industrial utilization of mixed culture
Module 2 (Credit 1):Introduction of Bioreactors	
	1.Design reactors with mass transfer between two ideally mixed fluid phases, for continuous, fed-batch, batch operation. 2.Design photo-bioreactors with mass transfer between two ideally mixed fluid phases; 3.Handle various expressions for the intrinsic reaction kinetics for all reactors above;

	4.Apply judicious simplifications to a reactor design model for all reactors above, to allow analytical solution; 5.Aalyse differences between reactor types and modes of operation, and exploit these differences for various design goals.
Content Outline	● Bioreactors: ● Design of basic bioreactor, bioreactor configuration, design features, individual parts, baffles, impellers, foam separators, spargers, culture vessel, cooling and heating devices, probes for on-line monitoring computer control of fermentation process, measurement and control of process. ● Ideal batch reactor, ideal continuous flow stirred tank reactor, packed bed reactor bubble column reactor, fluidized bed bioreactor, Trickle bed reactor (Their basic construction, working, and distribution of gases)
Module 3 (Credit 1):Mass Transfer and Sterilization	
	1.Elimination of toxic gases and deodorization of air. 2..Recovery of solvents. 3.Removal of ions from solution, as in demineralization of water. 4.Fractionation by selective adsorption of gases, vapours from gases, vapors from vapors and liquids from liquids
Content Outline	● Mass Transfer and Sterilization: ● Transport phenomena in bioprocess system: Gas liquid mass transfer in cellular systems, basic mass transfer concept, Rate of metabolic oxygen utilization. ● Determination on oxygen transfer rates, determination of Kla, Heat transfer, aeration / agitation and its importance. ● Sterilization of bioreactors, nutrients, air supply, product and effluents, process variable and control, scale up of bioreactor.
Module 4 (Credit 1):Upstream and Downstream Process in Engineering Technology	
Learning Outcomes	1.Design and optimize biomanufacturing processes based on measured bioreaction parameters. 2.Utilize basic principles of Design of Experiment (DoE) for process development.

	3.dentify the main challenges associated with fermentation scale-up and mitigate risks. 4. Understand and explain the bio-separation principles involved in purification of bio-products. 5..Involve suitable unit operations in bioprocess industries. 6.valuate concepts selection of membranes and assess the results of protein purification. 7. Design the method for bio-separation of proteins. 8.Understand the designing processes for the recovery and subsequent purification of atarget therapeutic protein.
Content Outline	● Upstream processes: ● Inoculum development, formulation of production media, sterilization of media, maintenance of stock culture, scale up of the process from shake flask to industrial level. ● Growth of culture in fermenter , choosing cultivation methods , Modifying batch and continuous reactors, immobilization cell systems, active and passive immobilization , solid state fermentation process. ● Down Stream Process: ● Introduction , Recovery of particulates filtration , centrifugation , sedimentation,emerging technologies for cell recovery , product isolation , extraction , solvent extraction , aqueous two phase system , sorption , precipitation , reverse osmosis, ultra filtration. ● Product recovery traits: Commercial enzymes, Intracellular foreign proteins from recombinant E. coli, polysaccharide and biogum recovery, antibiotic, organic acids, ethanol, single cell protein.

References:

1. James E .Bailey and David F Ollis, Biochemical Engineering Fundamentals, McGraw

Hill Publication.

2. Shuler and Fikret Kargi, Bioprocess Engineering basic concepts, 2nd edition , Prentice

Hall Publication.

3. Stanbury PF, Whitekar, A And Hall SJ, Principles of fermentation Technology, Pergamon

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5. Cruger and Cruger , Biotechnology : A text Book of Industrial Microbiology.

6. Fermentation- A practical Approach

7. Bioprocess Technology: Fundamentals and Applications, Stockholm KTH.

8. Biochemical Reactors by Atkinson B., Pion Ltd. London

9. Fermentation Biotechnology: Industrail Perspectives by S. Chand and Co.

10. Biotechnology : A text book of Microbiology by Cruger

11.Biotechnology, Vol. 3 Edited by H.J. Rehm and G.Reed Verlag Chemie 1983.

12. Advances in Biochemical Engineering by T.K. Bhosh, A. Fiechter and N. Blakebrough,

Springer, Verlag Publications, New York.

13. Bioprocess Engineering Kinetics, Mass Transport, Reactorsand Gene Expressions by

Veith, W.F., John Wiley and Sons.

14. Applied Microbiology Series.

15. Industrial Microbiology by L.E. Casida, Wiley Eastern.

16. Bioseperation: Down Stream Processing for Biotechnology by Belter P.A., Cussler E.L.

and Hu W.S., John Wiley and Sons, New York.

17. Seperation Processes in Biotechnology by Asenjo J.A., Eds. Marcel dekker, New York.

18. Bioprocess Engineering Priciples by Doran, Academic Press, London.

2.6.MIC.2106 Major (Elective)

Course Title	**Agricultural Microbiology(Th)**
Course Credits	4
Course Outcomes	After going through the course, learners will be able to -
	1.Know the basic principles of Agricultural Microbiology and have an understanding of the structural characteristics, the functionality and the integration of microorganisms in their natural environment.
	2.Be familiar with the experimental procedures applied in Agricultural Microbiology and be able to interpret the scientific data acquired.

	3.Be able to comprehend the potential of microorganism applications in the food industry and in the agro-biotechnological sector.
	Explain how microorganisms may be detected within various vironments, including how they may be cultivated within the oratory setting, and molecular methods of detection
	Explain how bioinformatics can be used in agricultural crobiology.
Module 1 (Credit 1):Introduction to Biofertilizers	
Learning Outcomes	1.Ability to distinguish the types of biofertilizers. 2.Development of integrated management for best results uses both nitrogenous and phosphatic biofertilizers. 3.Applied to seed/seed material/seedlings/soil/waste matter/crop residues in order to increase the population. 4.Accelerate some biochemical processes. 5.Describe the role nitrogen fixation plays in distributing atmospheric nitrogen to life on the planet. 6.Identify ways humans and plants use nitrogen. 7.Explain the mutualistic relationship between bacteria and legumes.
Content Outline	● Introduction to biofertilizers, Biofertilization processes - Decomposition of organic matter and soil fertility and vermicomposting. Mechanism of phosphate solubilization and phosphate mobilization. ● Nitrogen fixation - Free living and symbiotic nitrogen fixation. Ecto and endomycorrhizae and their importance in agriculture. Biotechnological application in nitrogen fixation.
Module 2 (Credit 1):Microorganism as Biofertilizers	
Learning Outcomes	1.Fertilizers boost crop yields, but their excessive usage has hardened the soil, reduced fertility, strengthened insecticides, polluted air and water, and emitted greenhouse gases, creating health and environmental risks. 2.To promote the use of Biofertilizer technology, i.e., the addition of nutrients through the natural process of nitrogen fixation, solubilizing phosphorus, as well as the stimulation of plant growth by synthesising growth-promoting substances 3.Evaluate mycorrhiza as a plant symbiotes.

	4.In a mycorrhizal association, the fungus colonizes the host plant's roots, either intracellularly as in arbuscular mycorrhizal fungi (AMF or AM) or extracellularly as in ectomycorrhizal fungi. 5.Mycorrhiza are named after their presence in the plant's rhizosphere (root system). This mutualistic association provides the fungus with relatively constant and direct access to carbohydrates, such as glucose and sucrose. 6.Plants grown in sterile soils and growth media often perform poorly without the addition of spores or hyphae of mycorrhizal fungi to colonize the plant roots and aid in the uptake of soil mineral nutrients. 7.Actinorhizal plants have the ability to develop an endosymbiosis with the nitrogen-fixing soil actinomycete Frankia. Frankia is a genus of soil actinomycetes in the family Frankiaceae that fix nitrogen, both under symbiotic and free-living aerobic conditions, while most rhizobia do not. Over 200 strains of Frankia have been isolated from many actinorhizal plant species in the plant families Betulaceae, Casuarinaceae, Coriariaceae, Datiscaceae, Eleagnaceae, Myricaceae, Rhamnaceae, and Rosaceae. 8.In both the free-living and the symbiotic state, nitrogen fixation takes place within the swollen tips of hyphae termed vesicles that are encased in multilayered hopanoid-rich membrane envelopes that provide the necessary O2 protection to prevent nitrogenase inactivation. 9.The strategies used by Frankia spp. To infect actinorhizal plants are quite similar to those used by rhizobia. 10. The establishment of the symbiotic process results in the formation of root nodules in which Frankia provides fixed nitrogen to the host plant in exchange for reduced carbon
Content Outline	● Microorganisms as biofertilizers: ● Biofertilizers and symbiotic associations; Rhizobium - taxonomy, physiology, host-*Rhizobium* interaction, mass cultivation; Associative and non symbiotic association *Azospirillum, Azotobacter*, Cyanobacteria (Nostoc and Anabaena) ● Mycorrhiza and actinorrhiza in plant nutrition and stress tolerance; Interaction of mycorrhiza with *Rhizobium* and *Pseudomonas;* Commercial production of biofertilizers, formulations and BIS specifications; their applications and limitations for Indian agriculture.
Module 3 (Credit 1):Nitrogen Biofertilizers	

Learning Outcomes	1.To improve plant health through nitrogen fixation, growth hormone production, phosphate solubilization, plant disease management and reclamation of better soil health, Azotobacter is one of the best options to be used as biofertilizer for eco-friendly and sustainable crop production 2.Involves small scale and large scale production system. The detailed procedure includes isolation, maintenance, characterization and mass culture production. 3.Azotobacter, Azospirillum, and PSB inoculants can be expected to improve plant growth if the inoculated bacteria are established and grow well in the rhizosphere 4.Inoculation is the process of introducing the appropriate Rhizobium bacteria to the soil in numbers sufficient to ensure successful nodulation. This is done by coating the seed with a liquid or peat-based powder inoculant, or by treating the soil with a granular or liquid inoculant.
Content Outline	● Nitrogenous Biofertilizers:Isolation and purification of Azospirillum and Azotobacter. ● Mass multiplication of Azospirillum and Azotobacter. ● Formulation of inoculum of Azospirillum and Azotobacter. ● Application of inoculants of Azospirillum and Azotobacter. ● Isolation and purification of Rhizobium, mass multiplication and inoculum production of Rhizobium. ● Methods of application of Rhizobium inoculants.
Module 4 (Credit 1):Microorganism as Biopesticids	
Learning Outcomes	1.The organisms used in microbial insecticides are essentially nontoxic and nonpathogenic to wildlife, humans, and other organisms not closely related to the target pest. The safety offered by microbial insecticides is their greatest strength. 2.The toxic action of microbial insecticides is often specific to a single group or species of insects, and this specificity means that most microbial insecticides do not directly affect beneficial insects (including predators or parasites of pests) in treated areas. 3.most microbial insecticides can be used in conjunction with synthetic chemical insecticides because in most cases the microbial product is not deactivated or damaged by residues of conventional insecticides. (Follow label directions concerning any limitations.)

	4.In some cases, the pathogenic microorganisms can become established in a pest population or its habitat and provide control during subsequent pest generations or seasons. 5.They also enhance the root and plant growth by way of encouraging the beneficial soil microflora. By this way they take a part in the increase of the crop yield 6.The competitiveness of biopesticides within the market is taking potential forward steps. 7.The industry is adding eco-friendly products that can be amalgamated within any integrated pest management strategy. Biopesticides in agricultural production make it possible to obtain food free of residues
Content Outline	● Microorganisms as biopesticides: Microbiology of plant surfaces; Principles and mechanism of biological control; biocontrol agents for insect pest and weed control. ● Commercial production of biopesticides with reference to *Bacillus thuringiensis*; integrated pest management; Their applications and limitations for Indian agriculture

Reference Books :

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of Agricultural Sciences, Bangalore, India. □

2.Purohit, S.S., P.R. Kothari and S.K. Mathur, 1993. Basic and Agricultural Biotechnology,

Agro Botanical Pub. India.

3.Subba Rao, N. S. 1988. Biological nitrogen fixation: recent developments, Mohan

Primlani for Oxford and IBH Pub. Co. (P) Ltd., India.

4.Subba Rao, N.S., G.S. Venkataraman and S. Kannaiyan 1993. Biological nitrogen

fixation, ICAR Pub., New Delhi.

5.Somani, L.L., S.C. Bhandari, K.K. Vyas and S.N. Saxena. 1990. Biofertilizers, Scientific

Publishers - Jodhpur.

6.Tilak, K.V.B. 1991. Bacterial Biofertilizers, ICAR Pub., New Delhi.

7.Agrios G. N. 1997. Plant Pathology. Academic Press, San Diego.

8.Cook R. J. & Baker K. F. 1983. The Nature and practice of Biological Control of Plant Pathogens.

9.Amereca Phytopathological Society Press, St. Paul, MN.

10. Forster C. F. & John DA 2000. Environmental Biotechnology. Ellis Horwood Ltd. Publication.

11.Christon J. H. 2001. A Manual of Environmental Microbiology. ASM Publications.

12.Rao, N.S.S. 1999. Soil Microbiology. Oxford & IBH Publishing Co., New Delhi.

13.The nature and properties of soil. Authors- Harry buckman and Nyle C. brady.

14.Introduction to soil Microbiology Internationals. Authors- Martin Alexander.

2.7.MIC.2107 Minor Stream (RP)

Course Title	**Research Project**
Course Credits	4
	● Research project work will be initiated by the students. ● Experimental work will be designed and executed by the student. ● Continuous evaluation of work will be carried out by the instructor.

End of semester-II

Exit with PG Diploma in Microbiology

Assignments,seminar presentation,tutorial ,weekly test and Field visit in all semester.