4.6	The Structure of Photosynthetic Membranes in Bacteria.
4.7	Cell wall and Capsule Biosynthesis. 4.7.1 Peptidoglycan Structure and Synthesis. 4.7.2 Lipopolysaccharide Structure and Synthesis.

4. Course Learning Outcomes/Student's Learning Outcomes (SLO)

Unit 1: Students shall understand kinetics of enzyme catalyzed reactions, they shall be enabled to calculate the Vmax and Km of enzymatic reaction and represent graphically the mechanism of enzyme reactions

Unit 2: Students shall gain knowledge of protein engineering methods to modify enzymes and application of microbial enzymes in various fields

Unit 3: Students will gain an understanding of physiological adaptations of microorganisms' in extreme environment

Unit 4: Students shall develop an understanding of microbial metabolism

Recommended learning resources

- Byung Hong Kim (2008) *Bacterial Physiology and Metabolism*, Cambridge (ISBN-13 978-0-521-71230-9)
- Gray N., Calvin M., and Bhatia SC. (2012). Enzymes Biotechnology. 1st Edition. CBS Publishers, New Delhi. (ISBN; 9788123918297)
- Moat A., Foster J. and Spector M. (2009). Microbial Physiology, 4th Edition, Wiley. (ISBN; 978-81-265-2106-7)
- Palmer T (2004): Enzymology. East-West Press Pvt. Ltd., New Delhi.
- Pandey A., Webb, C., Fernandes, M. and Larroche, C. (2006). Enzyme Technology. SpringerVerlag., New York. (ISBN; 978-0-387-29294-6)
- Price N. and Stevens L. (1999). Fundamentals of Enzymology. 3rd Edition Oxford University Press., London. (ISBN; 9780198502296)
- Ramya.M and Ponmurugan.P (2015) Protein Engineering, Narosa Publishing House. ISBN 798-81-8487-424-2.
- Schaechter M. (2004). The Desk Encyclopedia of Microbiology. Elsevier Academic Press, California USA. (ISBN; 9780080961286)
- Streips U.N. and Yasbin R.E. (2002). Modern Microbial Genetics. 2nd Edition. Wiley-Liss, A John Wiely and sons Inc., publication, New York. (ISBN; 978-0-471-38665-0)
- White D. (2003). The Physiology and Biochemistry of Prokaryotes, 2nd Edition, Oxford University Press. (ISBN: 0-19-512579-7)

MB 2002: BIOINFORMATICS & BIO-NANOTECHNOLOGY

1. Course Code & Title

Course code: Core course II
Course title: Bioinformatics & Bio-nanotechnology
Course type: Core

Course credits: 04

2. Course overview and Course Objectives

The main aspect of this course is to give an understanding of the various omics besides genomics and proteomics and its applications such as drug discovery. It includes the study of databases and the role of bioinformatics in the identification and classification of prokaryotes based on 16s rRNA sequences. Emphasis will be given to the application of bioinformatics and biological databases to problem solving in real research problems. The students will become familiar with the online tools for predictive results for the formulation of research problems. This paper also describes rapidly growing branch of bio-nanotechnology and its applications.

Course Objectives

- To gain knowledge of next generation sequencing methods, to learn genome annotation and mapping methods, to understand proteomics and its applications, transcriptomic, metagenomics, metabolomics and their applications in drug delivery
- To study all the databases, and the use of bioinformatics in the identification and classification of prokaryotes
- To study sequence alignments and the methods of phylogeny and preparation of phylogenetic tree and predicting as well as modeling of protein structure
- To acquire an understanding of nanoscience and application of nanotechnology

3. Course Content

UNIT 1	SCIENCE OF OMICS
	Teaching duration: Lectures 16
1.1	Next generation sequencing method
1.2	Genome: assembling, Closing, Annotation, Mapping (RFLPs, SNPs, AFLPs)
1.3	Proteomics: Interaction, Expression, Functional
1.4	Application of Proteomics: In the field of Medical, Pharmaceutical and Plant Biotechnology
1.5	Transcriptomics: RNA level Gene Expression: DNA Micro array Technology
1.6	Metagenomics: Contribution, Designing a metagenomics project (sequence based and function based)
1.7	Metabolomics
1.8	Drug discovery: Technologies and strategies

UNIT 2	BIOINFORMATICS FOR MICROBIOLOGY
	Teaching duration: Lectures 16

2.1	Biological Databases
2.2	Sequence based classification and identification of prokaryotes 2.2.1 Classification of prokaryotes 2.2.2 Classification of taxonomic hierarchy 2.2.3 Rules for naming of new prokaryote 2.2.4 Benefits of sequence-based identification
2.3	16S rRNA amplicon sequencing for metagenomics 2.3.1 Use of 16s rRNA sequences, generation of data and bioinformatics pipeline, Data analysis, removal of chimeras and DNA from other domains 2.3.2 OTUs. Alignment and association with taxonomic units, 2.3.3 α- (Within Group) and β-Diversity (Between Groups) 2.3.4 Principal coordinates analysis
2.4	Sequencing strategies, data types and analysis of full DNA shotgun sequence data, MG-RAST
2.5	Sequence based typing of prokaryotes: MLST, whole genome-based typing, organisms specific platforms

UNIT 3	**SEQUENCE ALIGNMENTS AND PHYLOGENY** **Teaching duration: Lectures 16**
3.1	Pairwise Sequence Alignment 3.2.1 Sequence Homology versus Sequence Similarity 3.2.2 Sequence Similarity versus Sequence Identity 3.2.3 Methods: Global and Local
3.2	Multiple Sequence Alignment
3.3	3.3.1 Exhaustive Algorithms 3.3.2 Heuristic Algorithms
3.4	Phylogeny: 3.4.1 Methods of Phylogeny: Maximum likelihood, UPGMA, N-J method 3.4.2 Statistical evaluation of obtained phylogenetic tree 3.4.3 Software for phylogenetic analysis: Phylip
3.5	Secondary structure prediction and protein modeling 3.5.1 Computation methods for secondary structure prediction 3.5.2 Homology modeling: fold recognition and threading approaches 3.5.3 Ab-initio structure prediction methods

UNIT 4	BIO-NANOTECHNOLOGY
	Teaching duration: Lectures 16
4.1	An Introduction to Nano World: Nano, The Unit Nanometer, Nanoscience, Nanotechnology
4.2	Types and properties of Nanomaterials
4.3	Nano motors of biological Systems, ATP Synthase: A Nano-turbine
4.4	Physical and Chemical methods for synthesis of nanoparticles.
4.5	Self-assembly techniques for synthesizing nanoparticles
4.6	Applications of nanotechnology 4.6.1 Application of DNA and protein nanostructures in molecular nanotechnology and Nano electronics 4.6.2 Application of carbon nanotubes in biological systems: Biosensors, Gene delivery using CNT instead of vector, Pollution control by CNT 4.6.3 Nano particles and its amalgamation with drugs for drug delivery: Liposomes

Course Learning Outcomes/Student's Learning Outcomes (SLO)

Unit 1: Students shall gain the knowledge of various omics and their importance in biology. Students shall learn about the techniques and strategies of drug discovery

Unit2: Students shall learn the biological databases, classification and identification of prokaryotic microorganisms, they shall know to study metagenomics based on 16s rRNA amplicons

Unit 3: Students shall gain an insight on the sequence alignments and phylogenetic analysis

Unit 4: Students shall understand bio nanotechnology and its applications in cellular processes

Recommended learning resources

- Ghosh, Z., & Mallick, B. (2008). Bioinformatics: Principles and Applications. Oxford University Press. (ISBN:978-0195692303)
- Henrik Christensen (2018) Introduction to Bioinformatics in Microbiology, Springer (ISBN 9783319992808)
- Jamil (2017) Concept in Bioinformatics and genomics, Oxford University press (ISBN: 9780199936991)
- Kanehisa M, Goto S (2000). "KEGG: Kyoto Encyclopedia of Genes and Genomes". Nucleic Acids Res. 28 (1): 27–30.
- Kulkarni S. K., (2015) Nanotechnology: Principles and Practices, 3rd edition, Springer, ISBN 978-3-319-09170-9, ISBN 978-3-319-09171-6 (ebook).
- Lloyd Low (2017) Bioinformatics A Practical Handbook of Next Generation Sequencing and Its Applications, World scientific (SBN 9789813144743)
- National Research Council. (2007). The new science of metagenomics: revealing the secrets of our microbial planet. National Academies Press. (ISBN 978-0-309-10676-4)

- Primrose S. and Twyman R. (2006). Principles of Gene Manipulation & Genomics, 7th edition. Black well Publishing, Malden. (ISBN: 978-1405135443)
- Rastogi, C., Mendiratta, N. and Rastogi P., (2013) Bioinformatics: Methods and applications, 4th Ed. PHI learning Pvt. Ltd.
- Selzer P.M. (2008) Applied Bioinformatics an Introduction, Springer (ISBN: 9783540727996)
- Sharon, M., Sharon, M., Pandey, S., & Oza, G. (2012). Bio-nanotechnology: Concepts and Applications. ANE Books, New Delhi. (ISBN: 978-1439852149)
- Twyman, R. (2004). Principles of proteomics. Taylor & Francis. (ISBN: 978-1859962732)
- Xiong, J., (2009). Essential Bioinformatics, Cambridge University press. (ISBN: 9780521706100)
- Young-Chul Lee and Ju-Young Moon, (2020) Introduction to Bionanotechnology. Springer.

MB 2003: ADVANCES AND CHALLENGES IN IMMUNOLOGY

1. Course Code & Title

Course code: Core course III
Course title: Advances and Challenges in Immunology
Course type: Core
Course credits: 04

2. Course overview and Course Objectives

This paper focuses on principles of immunology, molecular pathogenesis, immune-technology and immunotherapy. It also provides understanding and studying the molecular mechanism of pathogen in causing infections and the response of the host against the pathogens which would enable in developing therapy, vaccine development and the control of transmission.

Course Objectives

Unit 1: To study receptor biology and the interaction of antigens with the immune cells. To learn the immunological responses during transplantation
Unit2: To learn activation of T cells and B cells and the role of helper T cells in activation of immunological responses against antigens
Unit 3: To understand the induction of cancer and oncogenes, to understand tumor biology and the different immunotherapeutic approaches and applications
Unit 4: To gain insight of the challenges like antibiotic drug resistance and the advances in immunology

3. Course Content

UNIT 1	**RECEPTOR BIOLOGY**
	Teaching duration: Lectures 16