Re-Accredited 'B++' 2.86 CGPA by NAAC
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યુનિવર્સિટી કેમ્પસ, ઉધના-મગદલ્લા રોડ, સુરત - ૩૯૫ ૦૦૭, ગુજરાત, ભારત.
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-: પરિપત્ર :-

વિજ્ઞાન વિદ્યાશાખા હેઠળની સંલગ્ન Microbiology વિષયનાં અભ્યાસક્રમ ચલાવતી તમામ કોલેજોનાં આચાર્યશ્રીઓ તથા ડિપાર્ટમેન્ટનાં વડાશ્રીને જણાવવાનું કે, શૈક્ષણિક વર્ષ ૨૦૨૨–૨૩ થી અમલમાં આવનાર NEP - 2020 અનુસાર Microbiology વિષયના M.Sc. સેમેસ્ટર – ૨ ના અભ્યાસક્રમ સંદર્ભે માઈક્રોબાયોલોજી વિષયની અભ્યાસ સમિતિની તા.૦૯/૧૨/૨૦૨૨ની સભાનાં ઠરાવ ક્રમાંકઃ ૨ અન્વયે કરેલ ભલામણ વિજ્ઞાન વિદ્યાશાખાનાં અધ્યક્ષશ્રીએ વિજ્ઞાન વિદ્યાશાખાની મંજૂરની અપેક્ષાએ વિજ્ઞાન વિદ્યાશાખ વતી મંજુર કરી એકેડેમિક કાઉન્સિલને કરેલ ભલામણ એકેડેમિક કાઉન્સિલ તા.૧૪/૧૨/૨૦૨૨ની સભાનાં ઠરાવ ક્રમાંકઃ૪૨ થી સ્વીકારી મંજૂર કરેલ છે. જેની આથી જાણ કરવામાં આવે છે.

માઈક્રોબાયોલોજી વિષયની અભ્યાસ સમિતિની તા.૦૯/૧૨/૨૦૨૨ની સભાનાં ઠરાવ ક્રમાંકઃ૨

:: આથી ઠરાવવામાં આવે છે કે, શૈક્ષણિક વર્ષ ૨૦૨૨–૨૩ થી અમલમાં આવનાર NEP -2020 અનુસાર Microbiology વિષયનાં M.Sc. Sem - 2 નો અભ્યાસક્રમ મંજૂર કરી તે મંજૂર કરવા વિજ્ઞાન વિદ્યાશાખાને ભલામણ કરવામાં આવે છે.

એકેડેમિક કાઉન્સિલની તા.૧૪/૧૨/૨૦૨૨ની ઠરાવ ક્રમાંકઃ ૪૬

:: આથી ઠરાવવામાં આવે છે કે, શૈક્ષણિક વર્ષ ૨૦૨૨–૨૩ થી અમલમાં આવનાર NEP-2020 અનુસાર Microbiology વિષયના M.Sc.સેમેસ્ટર–૨ ના અભ્યાસક્રમ સંદર્ભે માઈક્રોબાયોલોજી વિષયની અભ્યાસ સમિતિની તા.૦૯/૧૨/૨૦૨૨ની સભાનાં ઠરાવ ક્રમાંક : ૨ સંદર્ભે કરેલ ભલામણ વિજ્ઞાન વિદ્યાશાખાના અધ્યક્ષશ્રીએ વિજ્ઞાન વિદ્યાશાખાની મંજૂરની અપેક્ષાએ વિજ્ઞાન વિદ્યાશાખવતી મંજુર કરી એકેડેમિક કાઉન્સિલને કરેલ ભલામણ સ્વીકારી મંજૂર કરવામાં આવે છે.

(બિડાણઃ ઉપર મુજબ)

ક્રમાંક : એસ./Microbiology/ સિલેબસ/પરિપત્ર/૩૦૩૬૯/૨૦૨૨
તા.૧૯–૧૨–૨૦૨૨

કુલસચિવ

પ્રતિ,

૧) વિજ્ઞાન વિદ્યાશાખા હેઠળની સંલગ્ન Microbiology વિષયનો અભ્યાસક્રમ ચલાવતી તમામ કોલેજોનાં આચાર્યશ્રીઓ. તથા ડિપાર્ટમેન્ટનાં વડાશ્રી.....આપશ્રીની કોલેજના સંબંધિત શિક્ષકોને જાણ કરી અમલ કરવા સારૂ.
૨) અધ્યક્ષશ્રી, વિજ્ઞાન વિદ્યાશાખા.
૩) પરીક્ષા નિયામકશ્રી, પરીક્ષા વિભાગ, વીર નર્મદ દ. ગુ. યુનિવર્સિટી, સુરત.
૪) અનુસ્નાતક વિભાગ, વીર નર્મદ દ. ગુ. યુનિવર્સિટી, સુરત.

.....તરફ જાણ તેમજ અમલ સારૂ.

Veer Narmad South Gujarat University,

Surat

M.Sc. (Microbiology) Syllabus

(Effective from December, 2022)

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT
M.Sc. MICROBIOLOGY SEM II
2022-2023

Theory Paper/ Practical	Teaching schedule Hrs/ week	Exam schedule			Total marks	Credit
		Duration (Hrs)	Internal marks	External marks		
Theory papers:						
1: Core I (CC-1) Enzymology and microbial physiology	4	3	30	70	100	4
2: Core II (CC-2) Bioinformatics & Bio-nanotechnology	4	3	30	70	100	4
3: Core III (CE-1) Advances and challenges in immunology	4	3	30	70	100	4
Inter / multi-Disciplinary (AECC) **4: Elective Paper –I** Advances in Pharmaceutical microbiology **Elective Paper –2** Ecology and evolution	4	3	30	70	100	4
Practicals:	12	10-15	50	100	150	6
5. Practical based on Core I, II, III & Elective paper I & II						
6. Skill Based elective paper / swayam/ other MOOC courses GE-1 Biofertilizer production and organic farming GE-2 Cheese and yogurt production	2	0	20	30	50	2

M. Sc. Semester II
MB 2001: ENZYMOLOGY AND MICROBIAL PHYSIOLOGY

1. Course Code & Title

Course code: Core course 1
Course title: Enzymology and Microbial physiology
Course type: Core
Course credits: 04

2. Course overview and Course Objectives

The main aspect of this course is to study the kinetics of enzymes and enzyme inhibition. Students will learn about the general methodology of protein engineering applications of enzymes. Also, this paper will focus on the diverse metabolic processes of microorganisms along with concepts of physiological adaptations in microorganisms.

3. Course Objectives

- To study the structure of enzyme and the models of enzyme substrate reactions
- To learn the kinetics of enzymatic reactions, calculate Vmax and Km of enzyme catalyzed reactions and graphical representation of enzyme kinetics
- To gain an insight of protein engineering, enzyme engineered for new reactions and varied applications of microbial enzymes
- To understand the physiological adaptation of microorganisms in extreme conditions

3. Course Content

UNIT 1	**ENZYME KINETICS**
	Teaching Duration: Lectures 16
1.1	Enzyme 1.1.1The Structure of Enzymes 1.1.2 Models for Monosubstrate Reaction 1.1.3 Models for Bisubstrate Reaction 1.1.4 Monomeric and Oligomeric Enzyme 1.1.5 Multisubstrate Reaction
1.2	Kinetics of Enzyme catalyzed and uncatalyzed reactions
1.3	Kinetics of single substrate enzyme catalyzed reaction 1.3.1 Michaelis-Menten equation, its modification and its significance 1.3.2 Vmax and Km 1.3.2 Lineweaver-Burk plot, Eadie-Hofstee plot, Hanes plot.
1.4	Enzyme inhibition kinetics: 1.4.1 Reversible inhibition: 1.4.2 Competitive inhibition 1.4.3 Non-Competitive inhibition 1.4.4 Un Competitive inhibition 1.4.5 Allosteric inhibition 1.4.6 Substrate inhibition 1.4.7 Partial inhibition 1.4.8 Irreversible inhibition.

1.5	Kinetics of multi-substrate enzyme catalyzed reaction: 1.5.1 Ping-pong reaction 1.5.2 Random-order reactions 1.5.3 Compulsory order reactions

UNIT 2	**PROTEIN ENGINEERING AND APPLICATIONS OF ENZYMES**
	Teaching Duration: Lectures 16
2.1	Enzyme Engineering of industrial enzymes. 2.1.1 Rational design methods 2.1.2 Site directed mutagenesis
2.2	Chemical modifications and unnatural amino acids
2.3	Random methods
2.4	Application of enzymes in Industry. 2.4.1 Milling and Baking: Enzyme in Flour. 2.4.2 Enzymes in Starch production, Sweetener and syrup production, Starch liquefaction and dextrose. 2.4.3 Pectic enzymes in fruit and juice manufacture: Food processing related properties of pectic enzymes. 2.4.4 Textiles and laundry detergents: Enzymes in laundry detergents 2.4.5 Pulp and paper: Enzyme application in pulp and paper processes. 2.4.6 Enzymes and Bioremediation: Enzymology of n-alkane oxidation
2.5	Enzymes engineered for new Reactions-Novel catalysts for organic synthesis, Extremozymes, Synzymes, Artizymes

UNIT 3	**PHYSIOLOGICAL ADAPTATION**
	Teaching Duration: Lectures 16
3.1	Two component regulation 3.1.1 Prototypical Two Component regulatory system
3.2	Spectrum of Functions: 3.2.1 Osmolarity Changes and Porin Regulation 3.2.2 Quorum sensing and staphylococcal virulence 3.2.3 The Phosphorelay and Sporulation Initiation in *Bacillus subtilis* 3.2.4 Chemotaxis and Atypical Output Response
3.3	Physiology, Biochemistry & Genetic Aspects of: 3.3.1 Oxidative Stress Response and Regulation 3.3.2 Heat Shock Response 3.3.3 Nutritional Stress and Starvation Stress Response 3.3.4 pH Stress and Acid Tolerance
3.4	Biochemistry and Physiology of Radiation Resistant Microorganisms

UNIT 4	**MICROBIAL METABOLISM**
	Teaching Duration: Lectures 16
4.1	Assimilation and Dissimilation of Nitrate and Sulphate
4.2	Nitrogen Fixation
4.3	Phototrophic Prokaryotes.
4.4	Purple Photosynthetic Bacteria
4.5	Green Sulphur Bacteria.

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

1.1	The MHC Complex 1.1.1 Structure of MHC molecules 1.1.2 Binding of peptide to MHC molecules 1.1.3 Genomic organization of the MHC 1.1.4 Expression of MHC molecules
1.2	B cell surface receptor for antigen
1.3	T cell surface receptor for antigen
1.4	Transplantation

UNIT 2	**ACTIVATION OF LYMPHOCYTES**
	Teaching duration: Lectures 16
2.1	Activation of T cells 2.1.1 Activation of CD4+ Lymphocyte 2.1.2 Activation of CD8+ T cells
2.2	Activation of B cells 2.2.1 Antigen recognition and antigen induced B cell activation 2.2.2 Helper T cell dependent antibody response to protein antigen 2.2.3 Antibody response to T cell independent antigen
2.4	Primary B and T cells deficiencies

UNIT 3	**CANCER AND IMMUNOTHERAPY**
	Teaching duration: Lectures 16
3.1	Cancer: Origin and Terminology
3.2	Malignant transformation of cells
3.3	Oncogenes and cancer induction
3.4	Tumors of the immune system 3.4.1 Tumor antigens 3.4.2 Tumor invasion of immune system 3.4.3 Cancer Immunotherapy
3.5	Engineered antibodies for therapy
3.6	Immuno- conjugates and its applications

UNIT 4	**Immunological challenges and advances**
	Teaching duration: Lectures 16
4.1	AMR 4.1.1 Evolutionary Biology of Drug Resistance 4.1.2 Mechanisms of Antibacterial Resistance: Shedding Some Light 4.1.3 Antimicrobial resistance: Selection vs. Induction 4.1.4 Colonization and Its Importance for the Emergence of Clinical resistance
4.2	Emerging zoonosis disease 4.2.1 Swine and Avian Influenza Outbreaks in Recent Times 4.2.2 Emerging Animal Coronaviruses: SARS, MERS, SARS-CoV-2
4.3	Stem cell therapy 4.3.1 Stem cell-based therapy for human diseases

4.4	Gut flora transplantation

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

Unit 1: Students shall learn the biology of cell receptors and the importance of molecular interactions in immunological responses

Unit 2: Students shall gain knowledge of the activation of T cells and B cells and the defects leading to immunodeficiency

Unit 3: Students will gain an understanding of tumor antigens and the oncogenes leading to induction of cancer, they shall also learn the strategies of immunotherapies to combat cancer

Unit 4: Students shall become aware of the challenges and the advancement in immunology

Recommended learning resources

- Abbas A.K., Lichtman A.H., Pillai S., (2007) Cellular and Molecular Immunology, 6th Edition, Saunders Elsevier. (ISBN;978-81-312-1034-5)
- Biazzo, Manuele, and Gabriele Deidda. "Fecal microbiota transplantation as new therapeutic avenue for human diseases." *Journal of Clinical Medicine* 11, no. 14 (2022): 4119.
- Delves P.J., Martin S. J., Burton D.R., and Roitt I.M., (2017) Roitt's Essential Immunology, 13th Edition, Willy Blackwell. (ISBN;978-1-118-41577-1)
- Douglas L. Mayers, Antimicrobial Drug Resistance, Volume 1, Mechanisms of Drug Resistance Edited by Douglas L. Mayers, 2009, Humana press, ISBN: 978-1-60327-592-7 e-ISBN: 978-1-59745-180-2 and DOI: 10.1007/978-1-59745-180-2
- Hoang, Duc M., Phuong T. Pham, Trung Q. Bach, Anh TL Ngo, Quyen T. Nguyen, Trang TK Phan, Giang H. Nguyen et al. "Stem cell-based therapy for human diseases." *Signal Transduction and Targeted Therapy* 7, no. 1 (2022): 1-41.
- Kateryna Kon and Mahendra Rai, Antibiotic Resistance Mechanisms and New Antimicrobial Approaches, 2016, Elsevier, ISBN: 978-0-12-803642-6
- Kerry L. LaPlante Cheston B. Cunha, Haley J. Morrill, Louis B. Rice, Eleftherios Mylonakis, Antimicrobial Stewardship: Principles and Practice, 2017, CABI, ISBN-13: 978 1 78064 439 4.
- Kindt T.J., Goldsby R.A., and Osborne B.A., (2007) Kuby Immunology, 6th Edition, W.H.Freeman and Company, New York. (ISBN;0716767643)
- Nash A.A., Dalziel R.G., and Fitzgerald J.R., (2015) Mims' Pathogenesis of Infectious Disease, 6th Edition, Academic Press (Elsevier). (ISBN;978-0-12-397188-3)
- Praful B. Godkar, Darshan P. Godkar, 2021 COVID-19 edition, Textbook of Medical Laboratory Technology - Vol 2 - Revised Reprint 2021 (3rd Edition), ISBN-10: 9789381496190, ISBN-13: 978-9381496190**,** Bhalani Publishing House
- Wang, Jiunn-Wei, Chao-Hung Kuo, Fu-Chen Kuo, Yao-Kuang Wang, Wen-Hung Hsu, Fang-Jung Yu, Huang-Ming Hu, Ping-I. Hsu, Jaw-Yuan Wang, and Deng-Chyang Wu. "Fecal microbiota transplantation: Review and update." *Journal of the Formosan Medical Association* 118 (2019): S23-S31.

Elective Paper –I

MB 2004: ADVANCES IN PHARMACEUTICAL MICROBIOLOGY

1. Course Code & Title

Course code: Elective paper 1
Course title: Advances in pharmaceutical microbiology
Course type: Core
Course credits: 04

2. Course overview and Course Objectives

The main aspect of this course is to study microbiological analysis and quality control in pharmaceutical industries. It includes the learning of good manufacturing practices and its monitoring in pharmaceutical companies. The students would also learn quality check and quality maintenance of pharmaceutical products and microbiological auditing

Course Objectives

- To introduce students to pharmaceuticals and microbiological assays used in pharmaceutics
- To know the good manufacturing practices and the conventional and rapid methods for the monitoring of microbiological quality
- To understand the microbial aspects of pharmaceutical processing and determining the quality assurance and quality control of pharmaceutical products
- To gain knowledge of pharmaceutical products and its sterility, the students shall also learn microbiological auditing

3. Course Content

UNIT 1	**BIOPHARMACEUTICAL: INTRODUCTION AND MICROBIOLOGICAL ASSAY**
	Teaching Duration: Lectures 16
1.1	Introduction to pharmaceuticals: Microorganisms and medicines
1.2	The agar diffusion assay: Its quantitative basis
1.3	The theory and practice of tube assays for growth promoting substances
1.4	The theory and practice of tube assays for growth inhibiting substances
1.5	Standard reference materials

UNIT 2	**MONITORING MICROBIOLOGICAL QUALITY**
	Teaching Duration: Lectures 16
2.1	Principles of good manufacturing practice
2.2	Monitoring microbiological quality – Conventional testing methods
2.3	Monitoring microbiological quality – Application of rapid methods

UNIT 3	MICROBIAL ASPECTS OF PHARMACEUTICAL PROCESSING
	Teaching Duration: Lectures 16
3.1	Microbial spoilage and preservation of pharmaceutical products
3.2	Sterilization control and sterility assurance
3.3	The quality assurance and quality control of pharmaceutical products

UNIT 4	PHARMACEUTICAL STERILE PRODUCTS AND MICROBIOLOGICAL AUDITING
	Teaching Duration: Lectures 16
4.1	Types of sterile products: Injections, non-injectable sterile fluids, ophthalmic preparations, dressing, implants, absorbable hemostats, surgical ligatures and sutures, instruments & equipment
4.2	Vaccines: Seed lot system, production, fermentation, blending, filling, and drying
4.3	In-vitro diagnosis
4.4	Immune sera
4.5	Human immunoglobulin & monoclonal antibodies
4.6	Microbiological auditing

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

Unit 1: Students shall learn microbiological assays used in pharmaceuticals
Unit 2: Students shall acquire knowledge of monitoring the quality of microbiological products
Unit 3: Students shall understand the microbial aspects of spoilage and preservation of products and QA ad QC aspects of pharmaceutical products
Unit 4: Students shall gain learning of the sterility of pharmaceutical products and the relevance of microbiological auditing

Recommended learning resources

- Barredo, J. L., (2005), Microbial Processes and Products. Humana Press, New Jersey, (ISBN: 978-1-59259-847-2)
- Denyer, S. P. and Baird, R. M., (2008), Guide to microbiological control in pharmaceuticals and medical devices. 2nd Edition, CRC Press, Boca Raton, (ISBN: 9781444330632)
- Flickinger, M. C. and Drew, S. W., (1999), Encyclopedia of Bioprocess Technology. Wiley- Interscience, New Jersey, (ISBN: 9780471138228)
- Gad, S. C., (2007), Handbook of Pharmaceutical Biotechnology. Wiley-Interscience, New Jersey, (ISBN: 978-0-470-25958-0)
- Hewitt,W.,(2004). Microbiological Assays for Pharmaceutical Analysis-A rational approach, Indian Edition, CRC, (ISBN: 0-203-58859-2)
- Hugo and Russells, (2007), Pharmaceutical Microbiology, Blackwell Publishing.
- Walsh G., (2007), Pharmaceurcal Biotechnology- Concepts and Applications, Wiley (ISBN: 978-0-470-01244-4)

Elective Paper - 2

MB 2004: ECOLOGY AND EVOLUTION

1. Course Code & Title

Course code: Elective paper 2
Course title: Ecology and Evolution
Course type: Core
Course credits: 04

2. Course overview and Course Objectives

The course concentrates on understanding of origin of life and evolutionary mechanisms. The course provides the ecological concept and details information of applied ecology. The aim of the course is to provide students with a deeper insight into the evolutionary processes and life origin.

Course Objectives

- To study the environment and ecology of living organisms, they shall study the population ecology and growth curves, they shall understand the species interactions and the community structure
- To gain knowledge of ecosystem and applied ecology
- To gain insight of evolutionary theories as well as molecular evolution
- To learn population genetics, behavior and evolution as well as domestication of behavioral changes

3. Course Content

	ENVIRONMENT AND ECOLOGY
UNIT 1	**Teaching Duration: Lectures 16**
1.1	The Environment Physical environment; biotic environment; biotic and abiotic interactions, Habitat and Niche, resource partitioning, character displacement
1.2	Population Ecology Characteristics of a population; population growth curves population regulation Life history strategies (r and K selection); concept of metapopulational – demes and dispersal, interdemic extinctions, age structured populations.
1.3	Species Interactions Types of interactions, interspecific competition, herbivory, carnivory pollination, symbiosis.
1.4	Community Ecology Nature of communities, Community structure and attributes, Levels of species diversity and its measurement; edges and ecotones

	Ecosystem and Applied Ecology
UNIT 2	**Teaching Duration: Lectures 16**

2.1	Ecological Succession Types and mechanisms, Changes involved in succession, Concept of climax.
2.2	Ecosystem Ecology Ecosystem structure; ecosystem function; energy flow and mineral cycling (C, N, and P); Primary production and decomposition Structure and function of some Indian ecosystems: Terrestrial (forest, grassland) and aquatic (fresh water, marine, estuarine)
2.3	Biogeography Major terrestrial biomes, Theory of island biogeography, Biogeographical zones of India.
2.4	Applied Ecology Environmental pollution; global environmental change; biodiversity: status, monitoring and documentation; major drivers of biodiversity change; biodiversity management approaches; Conservation Biology: Principles of conservation, major approaches to management

	Origin of life and history
UNIT 3	**Teaching Duration: Lectures 16**
3.1	Emergence of evolutionary thoughts Lamarck Darwin-concepts of variation, adaptation, struggle, fitness and natural selection; Mendelism; Spontaneity of mutations; The evolutionary synthesis.
3.2	Origin of cells and unicellular evolution Origin of basic biological molecules; Abiotic synthesis of organic monomers and polymers; Concept of Oparin and Haldane; Experiment of Miller (1953); The first cell; Evolution of prokaryotes, Evolution of unicellular eukaryotes;
3.3	Paleontology and Evolutionary History The evolutionary (geological) time scale; Eras, periods and epoch; Major events in the evolutionary time scale; Origins of unicellular and multi cellular organisms; Major groups of plants and animals; Stages in primate evolution including Homo.
3.4	Molecular Evolution Concepts of neutral evolution, molecular divergence and molecular clocks; Molecular tools in phylogeny, classification and identification; Protein and nucleotide sequence analysis; origin of new genes and proteins; Gene duplication and divergence.

	Evolution
UNIT 4	**Teaching Duration: Lectures 16**

.1	The Mechanisms Population genetics – Populations, Gene pool, Gene frequency; Hardy-Weinberg Law; concepts and rate of change in gene frequency through natural selection, migration and random genetic drift; Adaptive radiation; Isolating mechanisms; Speciation; Allopatricity and Sympatricity; Convergent evolution; Sexual selection; Co-evolution
4.2	Brain and Evolution Approaches and methods in study of behavior; Proximate and ultimate causation; Altruism and Evolution-Group selection, Kin selection, Reciprocal altruism; Neural basis of learning, memory, cognition, sleep and arousal; Biological clocks
4.3	Behavior and Evolution Development of behavior; Social communication; Social dominance; Use of space and territoriality; Mating systems, Parental investment and Reproductive success; Parental care; Aggressive behavior;
4.4	Habitat and migration Habitat selection and optimality in foraging; Migration, orientation and navigation; Domestication and behavioral changes

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

Unit 1: Student shall describe the origin and evolutionary mechanism of life forms.

Unit 2: Student will be correlating the evolution processes with behavior biology, paleontology and molecular biology.

Unit 3: Student will be explaining the traditional to modern aspects with practical application in Evolution and ecology.

Unit 4: Student will get the fundamental knowledge about the applied ecology and its application in conservation biology and sustainable development.

Recommended learning resources

- Odum, E. P., & Barrett, G. W. (1971). Fundamentals of ecology (Vol. 3, p. 5). Philadelphia: Saunders.
- Kormondy Edward (2017). Concepts of Ecology, Pearson Education
- Santra, S. C. (2010). Fundamentals of Ecology and Environmental Biology, New Central Book Agency Pvt. Ltd.
- Rana, S. V. S. (2013). Essentials of ecology and environmental science. PHI Learning Pvt. Ltd.
- Krebs, C. J. (1985). Ecology; the experimental analysis of distribution and abundance.
- DK (2019). The Ecology Book Big Ideas Simply Explained), DK publication
- Dash, M. C. (2001). Fundamentals of ecology. Tata McGraw-Hill Education.
- Molles, M. (2015). Ecology: concepts and applications. McGraw-Hill Education.
- Beeby, A., & Brennan, A. M. (2008). First ecology: ecological principles and environmental issues. Oxford University Press. press
- Sharma, P. D., & Sharma, P. D. (2012). Ecology and environment. Rastogi Publications.
- Kumar, P., & Mina, U. (2019). Life Sciences: Fundamentals and Practice I. Pathfinder Publication.
- Jangral R, K. (2020). Handbook of Ecology, Rajat Publication

- Colegrave, N. (2004). Evolution. MARK RIDLEY. Blackwell Publishing. 2003. 751 pages. ISBN 1 4051 0345 0. Price£ 27.50. Genetics Research, 83(1), 65-66.
- Strickberger, M. W. (2000). Evolution. Jones & Bartlett Learning.
- Verma, P. S., & Agarwal, V. K. (2004). Cell Biology, Genetics, Molecular Biology, Evolution and Ecology: Evoloution and Ecology. S. Chand Publishing.
- Raven, P., Johnson, G., Mason, K., Losos, J., & Singer, S. (2013). EBOOK: Biology. McGraw Hill.
- Purves, W. K., Orians, G. H., Heller, H. C., & Sadana, D. (1998). Life: The science of biology. Massachusetts.
- Lisa, A. U., Michael, L. C., Jane, B. R., Steven, A. W., Robert, B. J., Peter, V. M., & Neil, A. C. (2010). Campbell Biology. Benjamin Cummings/Pearson.

MBP-2005
LIST OF PRACTICALS

1. Determination of Km & Vmax of amylase/ cellulase.
2. Determination of effect of pH, temperature, activators and inhibitors on amylase
3. activity.
4. Immobilization of amylase/ cellulase and determine its activity yield.
5. Isolation of respiratory deficient mutants by UV radiation in yeast.
6. Microbes-mediated dye decolourization
7. Detection of anti-HIV and HBsAG sera by ELISA
8. Rapid diagnosis test for Malaria
9. Detection of MDR of bacteria from sewage
10. Microbial synthesis and characterization of metal (gold/ silver/ ZnO) nanoparticles by UV-VIS spectroscopy.
11. MSA and phylogeny
12. Computer assisted oligonucleotide primer designing
13. Protein secondary structure prediction.
14. Homology modelling

ELECTIVE PAPER 1

(Advances in Pharmaceutical microbiology)

01. Sterility testing of pharmaceutical products by direct inoculation & membrane filtration methods as per Indian Pharmacopoeia (IP)
02. Microbiological assay of growth promoting / growth inhibiting substances
03. Microbial limit test

ELECTIVE PAPER 2

(Ecology and Evolution)

01. Molecular Phylogenetic analysis
02. Calculate the Carbon Credit and foot print of given data
03. Study of biodiversity by Quadrant analysis
04. Construction of Winogradsky column
05. Determination of primary productivity in fresh water bodies

Skill Based Elective Paper

GE-1 Biofertilizer and Organic Framing

1. Course code and title

Course code: General Elective 1
Course title: Biofertilizer and organic farming
Course type: Skill based elective paper
Course credits: 02

Course Objectives

This course is design to give a broad outline on bio fertilizers screening, isolation, scaling up and its applications. This course will help to develop low-cost media preparation and impart training of ecofriendly agricultural inputs in bio fertilizers products and organic farming.

UNIT 1	**INTRODUCTION TO BIOFERTILIZER**
	Teaching Duration: Lectures 09
1.1	Biofertilizer for sustainable Agriculture
1.2	Economical and Environmental benefits of Biofertilizer
1.3	Development of microbial biofertilizer industry
1.4	Group of biofertilizers

UNIT 2	**MICROBIAL INOCULANTS FOR ORGANIC FARMING**
	Teaching Duration: Lectures 09
2.1	Introduction to organic farming
2.2	Bacterial inoculants
2.3	Green manuring
2.4	Cyanobacterial inoculants
2.5	Azolla as Bio fertilizer

UNIT 3	**COMPOSTING**
	Teaching Duration: Lectures 09

3.1	Importance of composting
3.2	Optimization of nutrients for agricultural compost
3.3	Methods of spreading compost
3.4	Classification of composting
3.5	Method of operating
3.6	Preparation of consortia

UNIT 4	**ECONOMIC IMPORTANCE OF BIOFERTILIZERS**
	Teaching Duration: Lectures 09
4.1	Benefits from bio fertilizers
4.2	Commercial producers of bio fertilizers
4.3	Progress of bio fertilizers in India
4.4	ECO specifications & quality control of bio fertilizers
4.5	Storage, shelf life, quality control & marketing of bio fertilizers
4.6	Benefits from organic farms

LIST OF PRACTICALS

01. Study of physico- chemical parameters of bio fertilizer
02. Isolation of mycorrhizia
03. Isolation of potassium and phosphate solubilizing microbes
04. Preparation of consortia to enrich organic farm soil

* A visit to a biofertilizer production unit

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

Unit 1: Students shall gain an understanding of biofertilizers and its importance. They shall develop the skill of establishing a biofertilizer unit.

Unit 2: Students shall gain an insight of microbial inoculants and methods of application in organic farms and fields.

Unit 3: Students shall be enabled to prepare a compost from agricultural waste and its use.

Unit 4: Students shall learn about the commercial units for the production of biofertilizers and methods of application It helps in development of integrated management for best results using nitrogenous and phosphate bio fertilizers.

Recommended learning resources

- Dubey, R. C. (1993). A Textbook of Biotechnology. (5 th Edition) S. Chand Publishing. (ISBN: 978-8121926089)
- Dubey, R. C. (2000). Textbook of Microbiology. (4 TH Edition) S. Chand, Limited. (ISBN: 978-8121926201)
- Motsara, M. R., Bhattacharyya, P., & Srivastava, B. (1995). Biofertilizer: Technology, marketing and usage. A sourcebook-cum-glossary.
- Purohit, S. S. (2001). Microbiology: Fundamentals and Applications. Agrobios. (ISBN: 9788177540246)

- Somasundaram, E., Nandhini, D. U., & Meyyappan, M. (2019). Principles of Organic Farming: (With Theory and Practicals). New India Publishing Agency. (ISBN:9781003260844)
- Subba Rao, N. S. (1993). Biofertilizers in agriculture and forestry (3rd rev. ed). International Science Publisher. (ISBN: 1881570290)

Skill Based elective paper

GE-2 Yogurt and Cheese production

1. Course Code & Title

Course code: General Elective 1
Course title: Yogurt and cheese production
Course type: Skill based elective paper
Course credits: 02

2. Course Overview and Course Objectives

After successful completion of course student will be able to know the whole process of cheese and yogurt production and get an idea about the basic process of setting up a small-scale business for the same.

Course Objectives

- To learn details of how to do marketing and product development in dairy industry
- To design setup of industry location, building, equipment etc.
- To learn processing of cheese and yogurt production and other parameters like quality assurance and legislation.
- To understand planning, managing and taking advantage of various government schemes for establishment of medium and small medium scale cheese/yogurt making industry.

3. Course Content

UNIT 1	MARKETS FOR DAIRY PRODUCTS
	Teaching Duration: Lectures 09
1.1	Introduction
1.2	Types of Market
1.3	Overview of Customer Care Concepts
1.4	The Need for A Feasibility Study
1.5	Developing a Marketing & Selling Strategy
1.6	Product Development
1.7	Competitors

UNIT 2	SETTING UP PRODCUTION
	Teaching Duration: Lectures 09
2.1	Selecting the location

2.2	The building
1.3	Services
1.4	Equipment
1.5	Sources of packing and ingredients

UNIT 3	PRODUCTION, QUALITY ASSURANCE & LEGISLATIOB OF CHEESE & YOGURT
	Teaching Duration: Lectures 09
3.1	Cheese Processing
3.2	Yogurt Production
3.3	Quality Assurance of Cheese & Yogurt
3.4	Risk analysis from Production to Consumers
3.5	Process control
3.6	Legislation for Production of Cheese & Yogurt

UNIT 4	PLANNING, MANAGING & GOVERNMENT SCHEME FOR PRODUCTION
	Teaching Duration: Lectures 09
4.1	Production Planning 4.1.1 Planning Raw Materials, Ingredients & Packaging 4.1.2 Planning Work for Staff & Service
4.2	Managing Production 4.2.1 Health & Safety 4.2.2 Production Routines
4.3	Information Of Major Scheme and Program Of Government 4.3.1 Scenario In Food And Agro Sector 4.3.2 Udyam Registration 4.3.3 Pradhan Mantra Mudra Yojana 4.3.4 Regulatory Bodies

LIST OF PRACTICALS

01. Microbiological analysis of cheese
02. Gradation of cheese based on moisture content
03. Determination of moisture content and water activity of cheese

* A visit to food, dairy or milk production unit

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

Unit 1: Students shall learn marketing and Product development strategy

Unit 2: Student shall learn the setting up of industrial building and finding the location. He/she will also learn about equipment services used in the setting up of industries.

Unit 3: Students shall learn processing, quality assurance and legislation of cheese and yogurt production.

Unit 4: Students will gain the knowledge of planning, managing and government schemes for the small-scale business of industrial production.

Recommended learning resources

- Fellows, P., & Axtell, B. (2008). *Setting up and running a small-scale dairy processing business*. CTA. ISBN 978-92-9081-377-4
- Helweg R., (2010). The complete guide to making cheese, butter, yogurt at home., ISBN 10: 1-60138-355-X, ISBN 13: 978-1-60138-355-6
- https://www.msmedithrissur.gov.in/assets/uploads/pageimage/Food.pdf

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