MASTER OF SCIENCE IN MICROBIOLOGY

(Choice Based Credit System)

DEPARTMENT OF MICROBIOLOGY

SRI VENKATESWARA UNIVERSITY:TIRUPATI

Vision

Up gradation of the Knowledge in theory and research activities in order to keep pace with the global scientific progress and to meet the requirements of the society and for the development of the Country.

Mission

The mission of the department of microbiology is to educate and train students in the discipline of microbiology and to expand their scientific knowledge through research.

Programme Specific Outcomes

- Equips capacity to venture into a career in bio based industries as scientists or technologists in the division of production, research and developmental settings.
- Demonstrate the concepts and research approach for their higher career in the field of microbiology and develop their scientific interest.
- Administer skill sets to understand the rationales behind various regulatory/legal bodies governing the R&D in the industry.
- Exhibit in-depth practical oriented knowledge to students in various thrust areas of microbiology, so as to meet the global demands of industry and academia
- Ability to designs aids in developing solutions for complex problems with appropriate consideration to the public health and safety, and the cultural, societal, and environmental considerations.

SRI VENKATESWARA UNIVERSITY::TIRUPATI
COLLEGE OF SCIENCES
CBCS Pattern (With effect from 2019-2020)
M.Sc. Microbiology Course
Department of MICROBIOLOGY

SEMESTER – I

Sl. No.	Course Code	Components of Study	Title of the Course	Contact Hours	No. of Credits	IA Marks	End SEM Exam Marks	Total
1.	MB-101	Core - Theory	Biological Chemistry & Analytical Techniques	04	04	20	80	100
2.	MB-102	Core - Theory	Enzymology & Microbial Physiology & Metabolism	04	04	20	80	100
3.	MB-103	Core - Practical	Biological Chemistry & Analytical Techniques	04	04	-	-	100
4.	MB-104	Core - Practical	Enzymology & Microbial Physiology & Metabolism	04	04	-	-	100
5.	MB-105	Compulsory Foundation **(Related to Subject)**	Introductory Microbiology	04	04	20	80	100
6.	MB-106	Elective Foundation **(Human Values and Ethics)**	Human Values and Professional Ethics – I	04	04	20	80	100
		Total		**24**	**24**			**600**

SEMESTER – II

Sl. No.	Course Code	Components of Study	Title of the Course	Contact Hours	No. of Credits	IA Marks	End SEM Exam Marks	Total
1.	MB-201	Core - Theory	Immunology	04	04	20	80	100
2.	MB-202	Core - Theory	Medical Microbiology	04	04	20	80	100
3.	MB-203	Core - Practical	Immunology	04	04	-	-	100
4.	MB-204	Core - Practical	Medical Microbiology	04	04	-	-	100
5.	MB-205	Compulsory Foundation **(Related to Subject)**	Basics of Virology	04	04	20	80	100
6.	MB-206	Elective Foundation **(Human Values and Ethics)**	Human Values and Professional Ethics –II	04	04	20	80	100
		Total		**24**	**24**			**600**

SEMESTER – III

Sl. No.	Course Code	Components of Study	Title of the Course	Contact Hours	No. of Credits	IA Marks	End SEM Exam Marks	Total
1.	MB-301	Core - Theory	Microbial Genetics and Molecular Biology	04	04	20	80	100
2.	MB-302	Core - Theory	Recombinant DNA Technology & Bioinformatics	04	04	20	80	100
3.	MB-303	Core - Practical	Microbial Genetics and Molecular Biology & Recombinant DNA Technology & Bioinformatics	04	04	-	-	100
4.	MB-304	Core - Practical	a) Agricultural Microbiology b) Food Microbiology	04	04	-	-	100
5.	MB-305	Generic Elective* **(Related to Subject)**	a) Agricultural Microbiology b)Food Microbiology	04	04 04	20 20	80 80	100 100
6.	MB-306	Open Elective* **(For other department)**	a) Applied Microbiology b) Industrial Food Microbiology	04	04	20	80	100
		Total		**24**	**24**			**600**

***Among the Electives a student shall choose one.**

SEMESTER – IV

Sl. No.	Course Code	Components of Study	Title of the Course	Contact Hours	No. of Credits	IA Marks	End SEM Exam Marks	Total
1.	MB-401	Core - Theory	Molecular Cell Biology & Technology	04	04	20	80	100
2.	MB-402	Core - Theory	Environmental Microbiology	04	04	20	80	100
3.	MB-403	Core - Practical	Molecular Cell Biology & Technology & Environmental Microbiology	04	04	-	-	100
4.	MB-404	Core – Practical/ Project Work	Project	04	04	-	-	100
5.	MB-405	Generic Elective* **(Related to Subject)**	a) Agricultural Biotechnology b) Bioprocess Engineering	04	04 04	20 20	80 80	100 100
6.	MB-406	Open Elective* **(For other department)**	a) Fermentation Technology b) Pharmaceutical Microbiology	04	04	20	80	100
		Total		**24**	**24**			**600**
		GRAND TOTAL						**2400**

***Among the Electives a student shall choose one.**

FIRST SEMESTER

MB – 101: BIOLOGICAL CHEMISTRY &ANALYTICAL TECHNIQUES

Course learning Objectives

1. Provides basic foundation on carbohydrates, lipids, thermodynamic principles.
2. Gives detailed knowledge about amino acids and peptides and proteins.
3. Provides in-depth knowledge about nucleic acids and nucleic electrophoresis and centrifugation theory and practice.
4. Understands the principle, Equipment and able to apply various chromatography and spectroscopy methods.

UNIT – I

Principles of thermodynamics, Redox reactions , Free energy, Biosensors, biological uses of radioisotopes, laboratory safety measures in handling isotopes

Carbohydrates : Classification of Carbohydrates; Outline structure and properties of important mono-, di-, and oligosaccharides and their identification and analysis; structure, occurrence and biological importance of structural polysaccharides (cellulose, chitin, agar, alginic acids, pectins, proteoglycans, sialic acids, blood group polysaccharides, bacterial cell wall polysaccharides).

Lipids: Building blocks of lipids. Classification of lipids. Fatty acids-physico-chemical properties, distribution in nature characterization and saponification and iodine number. Nomenclature, outline structures, properties and functions of glycerides, neutral lipids (waxes, fats, oils, phospholipids, sphingolipids and glycolipids). Steroids – plant sterol, ergosterol, stigmasterol, cholesterol.

UNIT-II

Amino acids : Classification, structure, physico-chemical properties, acid-base behaviour of amino acids.
Peptides : Characteristics of peptide bond, peptides of non-protein origin, properties and functions of peptides, determination of amino acid composition and sequence in peptides, chemical synthesis of peptides, peptide profiling.

Proteins : Classification, properties and biological functions of proteins; Structural organization of proteins – primary, secondary, tertiary and quaternary; Ramachandran's plot; proteins denaturation and renaturation ; structure-function relationships of certain proteins – myoglobin, haemoglobin, collagen; chaperones. Protein folding-Anfinsen,s experiment on ribonuclease and Creighton,s studies of BPT1

UNIT-III

Nucleic acids :Structures of purines, pyrimidines, modified bases, Chargaff's rule,nucleosides, nucleotides and polynucleotides; types and structural polymorphism of DNA and RNA; denaturation and renaturation of nucleic acids,melting curves,cot curves, factors influencing denaturation and renaturation,Hybridization.Depolymerization and hydrolysis of nucleic acids by chemical and enzymatic methods. Chemical synthesis of oligonucleotides. Sequencing of Nucleotides.
Centrifugation : Simple theory of preparative and analytical centrifuges and rotors; sedimentation analysis; differential, rate-zonal and equilibrium density gradient centrifugations. Applications – isolation of cells, subcellular organelles, viruses and macromolecules

Electrophoresis (Principles and applications) : Types of electrophoresis – paper, gel (starch, acrylamide and agarose) disc, vertical, horizontal submarine, gradient, 2-dimentional, pulse-field and capillary; isoelectrofocussing; isolation and analysis of gel separated molecules – recovery of molecules from paper/gels.

UNIT-IV

Chromatography : Adsorptin,Partition,Ion Exchange,Gel filtration ,Affinity-Chromatography-Paper,TLC,GLC,HPLC,FPLC.

Spectroscopy : Electromagnetic spectrum of light; simple theory of light absorption by biomolecules; Beer's – Lambert law; transmittance; extinction co-efficient; light sources; monochromators; types of detectors; working principle and applications of visible, UV-visible, IR, Raman, ESR, mass, plasma emission, atomic absorption, and NMR spectrophotometry; fluorimetry and flame photometry; ORD and CD; X-ray diffraction and X-ray crystallography.

Principles and applications of Cell sorting and Flow cytometry (Principles and applications), Biosensors.

Radioisotope techniques - Nature and types of radioactivity, half-life of isotopes; detection and measurement of radioactivity-GM counter, liquid scintillation counter, gamma-ray counter, Cerenkov counting and autoradiography; quenching and quench correction;

Suggested Books:

1. Principles of Biochemistry, Lehninger, 6th edition, 2012 by Nelson and Cox (Worth).
2. Biochemistry, Stryer 8th edition, W.H. Freeman, 2015.
3. Microbial Physiology and Metabolism. 1999, by D.R. Caldwell. 2nd edition. Wm.C. Brown Publ.
4. Microbial Physiology. 2002, 4th ed. By A.G. Moat & J.W. Foster. Wiley-Liss.
5. Foundations in Microbiology. 2015. By K. Talaro & A. Talaro, 9th edition. Wm. C. Brown Publ.
6. Practical biochemistry: Principles and Techniques 2010, 7th ed. by K. Wilson and J. Walker, Cambridge University Press.
7. Modern Experimental Biochemistry. 1993. 2nd ed. by R.F. Boyer. The Benjamin Cummings Publ. Company.
8. Physical Biochemistry: Applications to Biochemistry and Molecular Biology, 1982, 2nd ed. by David Freifelder. W.H. Freeman and company.
9. Introduction to Practical Biochemistry. 2005. by S.K. Sawhney and Randhir Singh (2nd ed). Narosa Publ. House.
10. Biochemical Methods for Agricultural Sciences. 1992 by S. Sadasivam and A. Manikam. Wiley Eastern Ltd.

Course Learning Out comes

1. Be able to identify and analyze carbohydrates lipids.
2. Be familiar with behavior of amino acids, and structure functional relationships of proteins and their profiling.
3. Be able to Isolation centrifugation, Electrophoresis.

CO-PO Attainment in Outcome Based Education -2019

Course Outcome: I Semester

CO-PO Mapping Matrix/Programme Articulation Matrix:

	PO_1 Know ledge	**PO_2** Analysis	**PO_3** Design	**PO_4** Development	**PO_5** Modern Tools	**PO_6** Society	**PO_7** Environment	**PO_8** Ethics	**PO_9** Team work	**PO_{10}** Communication	**PO_{11}** Programme Management	**PO_{12}** Lifelong Learning
CO_1	3	2	2	2	2	2	2	-	-	-	1	1
CO_2	3	2	2	2	2	2	1	-	-	-	1	1
CO_3	3	2	2	2	3	2	2	-	-	-	1	1
CO_4	3	2	2	2	2	2	2	-	-	-	1	1

Outcomes:

Knowledge
Skill
Attitude
Behavior & Values

Level: 1. Slight/Low
2. Moderate
3. Substantial

MB - 102: ENZYMOLOGY & MICROBIAL PHYSIOLOGY & METABOLISM

Course learning Objectives

1. Gives detailed information on cells and organs of the immune system.
2. Give in depth knowledge about Antigen-antibody interaction.
3. Provides the details on immune pathology.
4. Gives central concepts in transplantation and transfusion immunology.

UNIT – I

Nutrition : Elemental nutrient requirements of microbes; nutritional groups of bacteria; autotrophy-photoautotrophy and bacterial photosynthesis; chemoautotrophy and autotrophic metabolism; heterotrophy – photoheterotrophy and chemoheterotrophy, heterotrophic metabolism in bacteria; nutritional mutants and their use in metabolic studies.

Photosynthesis : Oxygenic and anoxygenic photosynthesis, photosynthetic pigments, basic photochemistry of PS I and PS II and photosynthetic electron transport; modes of CO_2 fixation, halobacterial photosynthesis, sulphur, nitrogen and iron assimilating bacteria. Chloroplast mediated electron transport; chemolithotrophic electron transport systems. Biolumenescence.

Uptake and Transport of nutrients in microbes – Structural organization of plasma membrane in relation to transport, types and mechanisms of transport (passive, simple, facilitated, active, chemical modification) with reference to sugars, amino acids and ions; methods for studying of transport, coupling of transport of ions and metabolites to ATP/proton gradient.

Microbial growth: The concept of growth and definition, Cell cycle in microbes and generation time Growth phases of bacteria –survival of microbial cells. Importance of each growth phase. Synchronous cultures – methods of synchronous culturing.

Nature and properties of spores – Physiology and biochemistry of sporulation and germination of spores.

UNIT – II

Carbohydrate metabolism: Pathways underlying the utilization of different sugars (EMP, ED, HMP and phosphoketolase) in microorganisms, gluconeogenesis; synthesis of peptidoglycans and glycoproteins.

Aerobic respiration: TCA cycle – intracellular location and reactions of the cycle, amphibolic nature of the cycle, energetics of the cycle; the glyoxalate cycle. Mechanisms of substrate-level phosphorylation; respiratory electron transport in mitochondria and bacteria along with its components (carriers); mechanism of oxidative phosphorylation, uncouplers, inhibitors;

Anaerobic respiration : nature of fermentation, the relationship of oxygen to growth and fermentation, biochemical mechanisms of lactic acid, ethanol, butanol, citric acid and acetone fermentations, study of fermentations, relationships between fermentation and energy production; nitrate and sulphate respiration

UNIT – III

.**Protein metabolism:** Assimilation of inorganic nitrogen and sulphur, biochemistry of nitrogen fixation; hydrolysis of proteins-exo-and endo-proteinases, outlines of biosynthesis and catabolism of amino acids in microbes (deamination, decarboxylation and transamination reactions). Urea cycle.

Catalytic proteins(enzymes) : Classification, nomenclature, composition and structure of enzymes, kinetics of enzymes derivation, factors influencing enzyme catalyzed reactions, regulation of enzyme activity – activators and inhibitors and mechanism of action of enzymes (chymotrypsin). Regulatory enzymes – allosteric enzymes of michaelis – menter constant, determination of V_{max} and K_{ml} modela explaining allosteric behavior – KMF, MWC models, feed back inhibition in metabolism. Isoenzymes, coenzymes, ribozymes, abzymes

Extra cellular enzymes of Microrganism: Extra cellular enzymes and their Applications.

UNIT – IV

Lipid metabolism: Biosynthesis of triacyl glycerols, phospholipids and glycolipids; oxidation of saturated and unsaturated fatty acids; microbial metabolism of aromatic and aliphatic hydrocarbons

Nucleotide metabolism : biosynthesis of bases, nucleosides and nucleotides including deoxyribonucleotides, regulation of nucleotide synthesis; break down of nucleic acids – exo-and endo-nucleases (RNases and DNases) and phosphodiesterases, salvage pathways; catabolism of purines and pyrimidines

Secondary metabolism: Utilization of secondary metabolites for production of vitamins, toxins (aflatoxin and corynebacterial), hormones (GA), and antibiotics (penicillin and streptomycin).

Suggested Books:

1. Microbial Physiology and Metabolism. 1999, 2nd edition by D.R. Caldwell. Wm.C. Brown Publ.
2. Microbial Physiology. 2002, 4th ed. by A.G. Moat & J.W. Foster. Wiley-Liss.
3. Principles of Biochemistry. Lehinger. 2000.4th edition
4. Foundations in Microbiology. 2015. 9th edition by K. Talaro & A. Talaro, Wm. C. Brown Publ.
5. Microbiology. 2015. By Prescott et al. 6th edition. Wm. C. Brown Publ.
6. Molecular Cell Biology. 2012 – by Lodish et al. 7th edition.

7. General Microbiology, 1999 by Stainer et al., Macmillan Educational Ltd.

Course Learning Out comes

1. Able to describe immunology basics.
2. Able to theoretical principles of invitroselogical tests.
3. Able to explain allergic reactions.
4. Able to explain immunization procedure and immunization programmes.

CO-PO Attainment in Outcome Based Education -2019

CO-PO Mapping Matrix/Programme Articulation Matrix:

	PO_1 Know ledge	**PO_2** Analysis	**PO_3** Design	**PO_4** Development	**PO_5** Modern Tools	**PO_6** Society	**PO_7** Environment	**PO_8** Ethics	**PO_9** Team work	**PO_{10}** Communication	**PO_{11}** Programme Management	**PO_{12}** Lifelong Learning
CO_1	3	2	2	2	2	2	2	-	-	-	1	1
CO_2	3	2	2	2	2	2	2	-	-	-	1	1
CO_3	3	2	2	2	2	2	2	-	-	-	1	1
CO_4	3	2	2	2	2	2	2	-	-	-	1	1

Outcomes:

Knowledge
Skill
Attitude
Behavior & Values

Level: 1. Slight/Low
2. Moderate
3. Substantial

MB-103: PRACTICALS: BIOLOGICAL CHEMISTRY & ANALYTICAL TECHNIQUES

1. Qualitative tests for identification of Carbohydrates, amino acids, nucleic acids
2. Quantitative tests for Protein, glucose, glycine, bilirubin, cholesterol, Inorganic phosphorous
3. Measurement of pH
4. Micrometry for cell size determination
5. Cell counting by Haemocytometer
6. Beer's Law
7. Determination of λ max for coloured solutions
8. Determination of DNA & RNA by UV spectrophotometry
9. Determination of nucleic acid Bases by UV spectrometry
10. Paper chromatography for separation of amino acids / pigments
11. TLC for separation of lipids / amino acids
12. Separation of proteins by SDS-PAGE

MB – 104: PRACTICALS: ENZYMOLOGY & MICROBIAL PHYSIOLOGY & METABOLISM

1. Quantitative estimation of the levels of cellular.
2. Estimation of Amylase enzyme activity (I.U) and calculation of specific enzyme activity.
3. Determine the kinetic enzyme activity.
4. Detection of Peroxidase/Catalase as Isoenzyme.
5. Estimate the acid Phosphophatase activity.

6. Determine Polyphenol activity.
7. Estimation of the lipase activity.
8. Determine the protease activity
9. Spore staining.
10. Biochemical tests: IMVIC; Catalse, Sugar fermentation, oxidation, Fermentation tests H_2S test triple sugar Iron test.
11. Winogradsky's column.
12. Contact slide techniques.
13. Preparation of different media for cultivation of bacteria & fungi.
14. Evaluation of Alcohol effectiveness.
15. Phenol coefficient method.

MB- 105: INTRODUCTORY MICROBIOLOGY

UNIT – I

History and Scope of Microbiology - Discovery of microorganisms and development of microbiology - Contributions of pioneers- Prokaryotic and Eukaryotic microorganisms - Origin and evolution of microorganisms. Distinguishing of different microorganisms-Scope and relevance of Microbiology - Future of Microbiology.

Microbial Structure - Microscopy – principles and applications of light microscope-Bright field- Dark-field, Phase – contrast, Fluorescent, Scanning and Transmission electron microscopes, Confocal microscopy, Scanning tunneling microscope. Preparation of microbiological samples for microscopy-simple and differential staining, special and structural staining. Negative contrast staining for virus samples. Preparation of tissues for thin sectioning (fixation, dehydration, infiltration, embedding and sectioning).

Physical and Chemical methods of sterilization and disinfection : Heat, radiation, pH, atmospheric pressure, filters, various chemical agents, safety precautions. The concept of containment facility.

UNIT – II

Microbiological media : Types of media-natural and synthetic; autotrophic, heterotrophic and prototrophic media; basal, defined, complex, enrichment, selective, differential, maintenance and transport media.

Isolation, cultivation and enumeration of microorganisms : Isolation from different natural sources. Approaches for obtaining pure cultures. Cultivation of aerobes and anaerobes. Continuous, batch, synchronous broth and stock cultures. Enumeration / measurement of growth of microorganisms.

Maintenance and preservation of microbial cultures : Repeated sub-culturing, sterile soil/sand preservation, glycerol-deep freezing, oil overlay, drying methods, freeze-drying.

UNIT-III

Microbial Taxonomy : Classification of microorganisms – introduction – Hackel's three kingdom concept – Whittaker's five kingdom concept – three domain concept of Carl Woese. Basis of microbial classification. Concepts, nomenclature and taxonomic ranks; major characteristics used in Taxonomy – morphological, physiological and metabolic, ecological, numerical taxonomy; genetic and molecular

classification systems; the kingdoms of organisms and phylogenetic trees. Characteristics of prokaryotes and eukaryotic cells.

UNIT – IV

Prokaryotic microorganisms : Brief outlines on discovery, nature, origin, evolution, morphology and structure, composition, reproduction and other characteristics of Bacteria (Eubacteria) Spirochetes, Rickettsias, Chlamydias, Pseudomonads, Acetic acid bacteria, Mycloplasmas, Cyanobacteria, Archaebacteria, Actinomycetes (Actinobacteria).

Note: Viruses are dealt in separate paper with title "Basics of Virology-MB – 302".

Eukaryotic microorganisms:

Fungi: Classification, structure, composition, reproduction and other characteristics of fungal divisions – *Zygomycota, Ascomycota, Basidiomycota* and *Deuteromycota* and slime and water molds. General characteristics and importance of fungi – *Saccharomyces, Candida, Pichia, Pencillium, Neurospora, Rhizopus, Aspergillus, Agaricus, Cryptococcus, Fusarium, Trichoderma, Claviceps.*

Algae : Classification, structure, reproduction and other characteristics of algal divisions. Characteristics of *Chlorella, Senedesmus, Gelidiella* and *Gracellaria.* Economic importance of algae, phytoplantanic microalgae.

Protozoan parasites : Classification, morphology and structure, reproduction and other characteristics of pathogenic protozoa like *Entamoeba, Plasmodium, Leishmania, Cryptosporidium, Trichomonas, Taxoplasma, Trypanosoma, Giardia.*

Suggested Books:

1. Brock Biology of Microorganisms. 1997, 8th ed. Madigan et al., Prentice-Hall International, Inc.
2. Microbiology. 1999. 3rd ed. Prescott et al. Wm. C. Brown Publ.
3. Principles of Microbiology. 1997. 2nd ed. R.A. Atlas. Wm.C. Brown. Publ.
4. Foundations in Microbiology. 1996. 2nd ed. K. Talaro and A. Talaro. Wm. C. Brown Publ.
5. Microbiology. 1996. 5th ed. Pelczar et al. Tata McGram-Hill Publ. Company Ltd.
6. General Microbiology, 1999 by S.B. Sullia, Oxford and IBH Publishers.
7. General Microbiology, 1999 by Stainer et al., Macmillan Educational Ltd.
8. Instant Notes in Microbiology. 1999. J. Nicklin et al. Viva Books Pvt. Ltd.
9. Microorganisms, Biotechnology and Disease : Students Book. 1997 by Pauline Lourie and Susanwells. Cambridge University Press.
10. Introductory Mycology. 1996. 4th ed. Alexopoulos et al., John Wiley and Sons.
11. Introductory Psychology by H.D. Kumar. 2nd ed. 1999. East West Press.

CO-PO Attainment in Outcome Based Education -2019

CO-PO Mapping Matrix/Programme Articulation Matrix:

	PO_1 Know	**PO_2** Analysis	**PO_3** Design	**PO_4** Development	**PO_5** Modern	**PO_6** Society	**PO_7** Environment	**PO_8** Ethics	**PO_9** Team	**PO_{10}** Communication	**PO_{11}** Programme	**PO_{12}** Lifelong

	ledge				Tools				work		Management	Learning
CO_1	3	2	2	2	2	2	2	-	-	-	1	1
CO_2	3	2	2	2	2	2	2	-	-	-	1	1
CO_3	3	2	2	2	2	2	2	-	-	-	1	1
CO_4	3	2	2	2	2	2	2	-	-	-	1	1

Outcomes:

Knowledge
Skill
Attitude
Behavior & Values

Level: 1. Slight/Low
2. Moderate
3. Substantial

Mb-106: HUMAN VALUES AND PROFESSIONAL ETHICS – I

Course learning Objectives

1. Provides concepts on Human Values.
2. Outlines the medical ethics.
3. Given knowledge on business Environmental, Social ethics.

UNIT-I

Definition and Nature of Ethics- Its relation to Religion, Politics, Business, Law, Medicine and Environment. Need and Importance of Professional Ethics- Goals – Ethical Values in various Professions.

UNIT-II

Nature of Values- Good and Bad, Ends and Means, Actual and potential Values, Objective and Subjective Values, Analysis of basic moral concepts- right, ought, duty, obligation, justice, responsibility and freedom, Good behavior and respect for elders, Character and Conduct.

UNIT-III

Individual and society: Ahimsa (Non-Violence), Satya (Truth), Brahmacharya (Celibacy), Asteya (Non possession) and Aparigraha (Non-stealing). Purusharthas (Cardinal virtues)-Dharma (Righteousness), Artha (Wealth), Kama (Fulfillment Bodily Desires), Moksha (Liberation).

UNIT-IV

Bhagavad Gita – (a) Niskama karma. (b) Buddhism – The Four Noble Truths – Arya astanga marga, (c) Jainism – mahavratas and anuvratas. Values Embedded in Various Religions, Relirious Tolerance, Gandhian Ethics.

UNIT-V

Crime and Theories of punishment – (a) Reformative, Retributive and Deterrent. (b) Views on manu and Yajnavalkya.

Suggested Books:

1. John S Mackenjie: A manual of ethics.
2. "The Ethics of Management" by Larue Tone Hosmer, Richard D. Irwin Inc.
3. "Management Ethics – integrity at work" by Joseph A. Petrick and John F. Quinn, Response Books: New Delhi.
4. "Ethics in Management" by S.A. Sherlekar, Himalaya Publishing House.
5. Harold H. Titus: Ethics for Today
6. Maitra, S.K: Hindu Ethics
7. William Lilly: Introduction to Ethics
8. Sinha: A Manual of Ethics
9. Manu: Manu Dharma Sastra or the Institute of Manu: Comprising the Indian System of Duties: Religious and Civil(ed.) G.C. Haughton.
10. Susruta Samhita: Tr. Kaviraj Kunjanlal, Kunjalal Brishagratha, Chowkamba Sanskrit series, Vol. I, II and III, Varnasi, Vol I OO, 16-20, 21-32 and 74-77 only.
11. Caraka Samhita: Tr. Dr. Ram Karan Sarma and Vaidya Bhagavan Dash, Chowkambha Sanskrit Series office, Varanasi I,II,III Vol I PP 183-191.
12. Ethics, Theory and Contemporary Issues, Barbara Mackinnon, Wadsworth/Thomson Learning, 2001.
13. Analyzing Moral Issues, Judith A. Boss, Mayfield Publishing Company, 1999.
14. An Introduction to Applied Ethics (Ed.) John H. Piet and Ayodhya Prasad, Cosmo Publications.
15. Text book for Intermediate logic, Ethics and Human Values, board of Intermediate Education & Telugu Academic Hyderabad.
16. I.C. Sharma Ethical Philosophy of India. Nagin & co Julundhar.

Course learning Outcomes

1. Helps to inculcate human values in their own life.
2. Be able to understand the medical ethics concepts.
3. Beable to explain business, environmental and social ethics.

CO-PO Attainment in Outcome Based Education -2019

CO-PO Mapping Matrix/Programme Articulation Matrix:

	PO_1 Know ledge	**PO_2** Analysis	**PO_3** Design	**PO_4** Development	**PO_5** Modern Tools	**PO_6** Society	**PO_7** Environment	**PO_8** Ethics	**PO_9** Team work	**PO_{10}** Communication	**PO_{11}** Programme Management	**PO_{12}** Lifelong Learning
CO_1	3	2	-	-	2	2	1	3	-	-	-	3
CO_2	3	2	-	-	2	1	1	3	-	-	-	3
CO_3	3	2	-	-	2	1	1	3	-	-	-	3
CO_4	3	2	-	-	2	1	1	3	-	-	-	3

Outcomes:

Knowledge
Skill
Attitude
Behavior & Values

Level: 1. Slight/Low
2. Moderate
3. Substantial

SECOND SEMESTER

MB – 201: IMMUNOLOGY

Course learning Objectives

5. Gives detailed information on cells and organs of the immune system.
6. Give in depth knowledge about Antigen-antibody interaction.
7. Provides the details on immune pathology.
8. Gives central concepts in transplantation and transfusion immunology.

UNIT – I

History: Historical perspective of Immunology, milestones in immunology.

Cells and Organs of the Immune system: Hematopoiesis, Lymphoid cells, stem cells, Mononuclear cells, Granulocytes, Mast cells, Dendritic cells. Lymphoid organs – Primary and Secondary lymphoid organs.

Types of immunity: Innate immunity and adaptive immunity, comparative immunity, Immune dysfunction and its consequences.

Immune responses to infectious diseases: Viral, bacterial, protozoan and other parasitic diseases.

Antigens: types, properties, study of antigenicity, immunogenicity versus antigenicity, factors influencing immunogenicity. Epitopes, haptens, mitogens, superantigens. Viral and bacterial antigens

UNIT – II

Antibodies : Basic and fine structure of Immunoglobulins, classes and biological activities of Immunoglobulins, Antigenic determinants – Iso, allo and idiotypes. Immunoglobulin super family, antibody diversity, organization and expression of immunoglobulin genes. Production of polyclonal antibodies-animals, additives, adjuvants, routes, dose, collection and preservation of antisera, purification of immunoglobulins, quantitative and qualitative analysis of immunoglobulins.

Monoclonal antibodies : Hybridoma technology – principle and production of monoclonal antibodies, advantages and disadvantages over polyclonal antibodies, application of monoclonal antibodies.

Recombinant antibodies : Production and their advantages over conventional antibodies.

Antigen and Antibody interactions : Affinity, Avidity, Cross reactivity.

***In vivo* serological reactions :** Phagocytosis, Opsonization, Neutralization, Protection tests.

***In vitro* serological tests :** Precipitation tests in liquid and semisolid media, single and double immuno diffusion tests. Immuno electrophoresis tests (Rocket, counter current). Agglutinations tests-HA and HI, latex agglutination. Complement fixation tests, Labeled antibody based tests – Enzyme linked immunosorbent assays (ELISA), Western blotting, Radio immuno assay (RIA), Immunoflueorescent and

Immuno specific electron microscopy. Infectivity neutralization test. The relative advantages and disadvantages and their applications in Microbiology.

UNIT – III

Humoral immune response : Primary and secondary immune responses, induction, regulation of the immune effector response.

Cell mediated immune response : Induction and mechanism, antibody-dependent cell mediated cytotoxicity (ADCC).

Immune effector mechanisms : Cytokines, Lymphokines, Chemokines and their classification, properties and functions.

Complement cascade system : Complements nomenclature, classification, complement components, functions, activation, regulation, biological consequences, complement deficiencies.

Hypersensitive and Allergic reactions : Classification, types I, II, III and IV.

Immunopathology : Immunodeficiencies – Primary immunodeficiency (genetic) diseases due to B cell, T-cell and combined defects (Hypogamma globulinemia, SCID, ADA) phagocyte and complement defects. Autoimmune diseases – Autoimmunity, induction, mechanism of tissue damage in autoimmunity. Autoimmune diseases – Organ specific (Autoimmune anemias, Autoimmune thyroid diseases, Diabetes mellitus, Multiple sclerosis), Systemic autoimmune diseases (Rheumatoid arthritis, Systemic lupus erythematousus) and their therapy.

UNIT-IV

Major histocompatability complex (MHC) : Organization and Inheritance of MHC, cellular distribution of MHC molecules, regulations of MHC expression, MHC-immune responsiveness, disease susceptibility, MHC restriction, HLA antigens-Class I, II, III and their functions, Murine antigens and its functions.

Transfusion Immunology : Blood cell components, blood group systems in human and in animals, Rh typing, transfusion reactions, diseases associated with blood transfusion – Haemolytic anemias, Erythroblastosis featalis.

Transplantation Immunology : Transplantation antigens, types of transplants, Graft versus host reactions – immunological basis of graft rejection mechanism, prevention of graft rejection, clinical manifestations of graft rejection, Immunosuppressive therapy of allograft response, clinical transplantation.

Tumor immunology: Cancer and the Immune system, tumor specific antigens, tumors of the immune system, immune response to tumors, cancer immunotherapy.

Vaccinology : Type of immunization procedures, active and passive immunization, designing of vaccines, classical and novel/modern approaches for the production of vaccines, purified macromolecules as vaccines, Recombinant – vector vaccines, DNA vaccines, Synthetic peptide vaccines, Multivalent sub-unit vaccines, uses of vaccines, benefits of vaccination, mass immunization programmes.

Suggested Books:

1. Immunology. 2000. 4th edition. J. Kuby. W.H. Freeman and Company.
2. Immunology. 2003. 5th edition. I. Roitt, J. Brostoff and David Male. Mosby publications.
3. Fundamental Immunology. 1992. 2nd edition. R.M. Coleman, M.F. Lombard and R.E. Sicard. Wm. C. Brown Publishers.
4. Immunology. 1997. 3rd edition. R.M. Hyde. B.I. Waverly Pvt. Ltd.
5. Immunology. 1995. 4th edition. I.R. Tizard. Saunders College Publishing.
6. Immunology – The Science of self and non-self discrimination. 1982. Jon Klein. John Wiley and Sons.
7. Immunology – An illustrated outline. 2013. 5th edition. David Male. Churchill Living Stone.
8. Viruses that affect immune system. 1991. H.Y. Fan, I.S.Y. chen, N. Rosenberg and W. Sugden. American Society for Microbiology.
9. Immunobiology : The immune system in health and disease, 1994. C.A. Janeway, Jr., P. Travers. Current biology Ltd.

Course Learning Out comes

5. Able to describe immunology basics.
6. Able to theoretical principles of invitroselogical tests.
7. Able to explain allergic reactions.
8. Able to explain immunization procedure and immunization programmes.

CO-PO Attainment in Outcome Based Education -2019

CO-PO Mapping Matrix/Programme Articulation Matrix:

	PO_1 Know ledge	**PO_2** Analysis	**PO_3** Design	**PO_4** Development	**PO_5** Modern Tools	**PO_6** Society	**PO_7** Environment	**PO_8** Ethics	**PO_9** Team work	**PO_{10}** Communication	**PO_{11}** Programme Management	**PO_{12}** Lifelong Learning
CO_1	3	2	2	2	2	2	-	-	-	-	-	2
CO_2	3	2	2	2	2	2	-	-	-	-	-	2
CO_3	3	2	2	2	2	2	-	-	-	-	-	2
CO_4	3	2	2	2	2	2	-	-	-	-	-	2

Outcomes:

Knowledge
Skill
Attitude
Behavior & Values

Level: 1. Slight/Low
2. Moderate
3. Substantial

MB –202: MEDICAL MICROBIOLOGY

Course learning Objectives

1. Provides information on infections and pathogenesis.
2. Helps to clean chemotherapy principle.
3. Be able to explain the symptoms of bacterial infections.

4. Be able to explain the symptoms of viral, fungal and parasitic diseases.

UNIT – I

Principles of Medical Microbiology: Historical developments Classification of medically important microorganisms. Normal microbial flora of human body: Origin of normal flora; Infectious diseases.

Infection: Sources of infection for man; vehicles or reservoirs of infection. Exogenous infection: 1) Patients 2) carriers – (Healthy; convalescent; contact; paradoxical and chronic) 3) Infected animals (zoonosis) 4) Soil endogenous infection. Mode of spread of infection: 1) Respiratory 2) skin 3) Wound and burn infection 4) Venereal infections 5) Alimentary tract infection 6) Arthorpod-borne blood infections 7) Laboratory infections. Nosocomial infections: common types of hospital infections, their diagnosis and control.

Pathogenesis: Adhesion in various hosts, cell damage, release of pathogens, Transmissibility, infectivity and Virulence. Opportunistic pathogens and True pathogens. Toxigenicity: Invasiveness, other aggressins (Hyaluronidase), coagulase, fibrinolysins or kinase, depolymerizing enzymes, (mucinase, lipases, proteases, nucleases, collagenase, neuraminidase). Organotropism, variation and virulence.

UNIT – II

Microbial Toxins: Types of microbial toxins, Endotoxins, Exotoxins, LC_{50} of toxins, Effective dose of toxins, Assay of toxins, Mechanism of action of Diphtheria, Cholera, Staphylococcal toxin and Clostridial neurotoxins. Virulence and virulence factors of microbial toxins. Signs and symptoms of microbial intoxication.

Diagnostic methods: Collection, transport and preliminary processing of clinical samples. Clinical, microbiological, immunological and molecular diagnosis of microbial diseases.

Principle of Chemotherapy: Chemotherapeutic agents, Mechanism of action of antimicrobial agents, Synthetic compounds and antibiotics and their assay in body fluids, drug resistance, Mechanisms of drug resistance, MDR. Various methods of drug susceptibility testing. Brief account on available vaccines and schedules, passive prophylactic measures.

UNIT – III

Bacterial diseases: Symptoms, diagnosis , treatment and prevention of the diseases caused by *Staphylococcus, Streptococcus, Pneumococcus, Neisseria, Corynebacterium, Bacillus, Clostridium, Actinomycete, Rickettsiae, Chlamydiae, Mycoplasma, Enterobacteriacea*, *Vibrios*, *Yersinia; Haemophilus; Bordetella, Brucella; Mycobacteria, Spirochetes; Salmonella* species.

UNIT – IV

Viral diseases: Virus-host interactions at cellular and organism levels. Common diseases caused by Poxviruses; Herpes virus; Adeno viruses; Picorna viruses; Orthomyxo viruses; Paramyxo viruses; Arbo viruses, Rhabdo viruses, Hepatitis viruses; Oncogenic viruses; Human Immuno deficiency viruses (HIV/AIDS). Prion diseases – Kuru, CJD disease and GSS syndrome.

Fungal diseases: Diseases caused by dermatophytes, dimorphic fungi and opportunistic fungal pathogens. Description and classification of pathogenic fungi and their laboratory diagnosis.

Parasitic diseases: Disease caused by parasites like *Entamoeba, Plasmodium, Trichomonas, Leishmania* and *Toxoplasma, Giardia, Wuchereria, Dracunculus.*

Suggested Books :

1. Ananthanarayan R, Panikar CKJ (2000). Textbook of Microbiology. 2013. 9th Edition. Orient Longman Ltd.
2. Warren Levinson (2014).Review of Medical Microbiology and Immunology. Mc Graw Hill education
3. Bailey & Scott's (2013). Diagnostic Microbiology (13th Edition), Published by: Mosby.
4. Color atlas and Text book of Diagnostic microbiology (6th Edition), 2005, edited by: Eimer W Koneman, published by: Lippinctt.
5. Subash CP (2000). Text Book of Medical Parasitology, by published by : All India Publishers & Distributors. 1st edition.
6. Jayaran Paniker C.K, Text Book of Medical Parasitology (7th Edition), 2013, by Published by: Jaypee Brothers.
7. Cruichshank *et al.,*(2012). Manual of Clinical Microbiology, 7th ed. by E.H. Lennette et al. ASM Publications.
8. Patrick R. Murray, Ken S. Rosenthal, Michael A. Pfaller (2012), 7th edition. Medical Microbiology. Elsevier saunders.
9. Koen Venema and Ana Paula do Carmo (2015). Probiotics and Prebiotics: Current Research and Future Trends. Caister Academic Press.
10. Sergio Sánchez and Arnold L. Demain (2015). Antibiotics: Current Innovations and Future Trends. Caister Academic Press.

Course Learning Out comes

1. Be able to explain about various infections
2. Be able to understand the diagnostic methods.
3. Be able to explain the symptoms of bacterial infections.
4. Be able to explain the symptoms of viral, fungal and parasitic diseases.

CO-PO Attainment in Outcome Based Education -2019

CO-PO Mapping Matrix/Programme Articulation Matrix:

	PO_1 Know ledge	**PO_2** Analysis	**PO_3** Design	**PO_4** Development	**PO_5** Modern Tools	**PO_6** Society	**PO_7** Environment	**PO_8** Ethics	**PO_9** Team work	**PO_{10}** Communication	**PO_{11}** Programme Management	**PO_{12}** Lifelong Learning
CO_1	3	2	2	2	2	2	-	-	-	-	-	2

CO_2	3	2	2	2	2	2	-	-	-	-	-	2
CO_3	3	2	2	2	2	2	-	-	-	-	-	2
CO_4	3	2	2	2	2	2	-	-	-	-	-	2

Outcomes:

Knowledge
Skill
Attitude
Behavior & Values

Level: 1. Slight/Low
2. Moderate
3. Substantial

MB- 203: Practicals: Immunology

Course learning Objectives

1. Gives hands on experience in Immuno precipitation test.
2. Provides hands on experience on various ELISA methods.
3. Will gain knowledge in immunoglobulin's purification and to perform electrophoresis.

1. Purification of immunoglobulins
2. Electrophoretic separation of normal and immunoserum.
3. Ouchterlony double Immuno diffusion
4. Single radial Immuno diffusion
5. Immuno precipitation test
6. Rocket Immuno electrophoresis
7. Counter current Immuno electrophoresis
8. Isolation & Identification of Rosettee cells.
9. Dot ELISA
10. Sandwich ELISA
11. Antigen Capture ELISA
12. Antibody Capture ELISA
13. ASO titre.
14. Complement fixation test

Course Learning Out comes

1. Able perform various immuno precipitations tests.
2. Be able to perform various types of ELISA methods.
3. Be able to gain practical knowledge about immunoglobulin's and there separation.

MB- 204: Practicals: Medical Microbiology

Course learning Objectives

1. Gives hands on experience on blood related tests
2. Gives knowledge on virus cultivation
3. Provides hands on experience on various diagnostic tests.

1. Widal Test
2. VDRL Test
3. Total counting of RBC & WBC
4. Differential count of WBC
5. Hemoglobin estimation
6. Latex agglutination test
7. Blood typing and Rh determination
8. Identification of pathogenic organisms based on HIV& DOT-BLOT test
9. Hanging drop experiment for bacterial motility.
10. Microbiological staining techniques – Simple, Gram negative, spore, capsular, acid fast and Lactophenol-cotton blue staining.
11. Isolation of bacteriophages from sewage water.
12. Cultivation of viruses in embryonated Chicken eggs: different routes of virus inoculation – Yolk sac, Allontoic and Chorio Allontoic Membrane (CAM).

Course Learning Out comes

1. Be able to perform widal, VDRL and types.
2. Be able to perform various staining procedures.
3. Be able to identify blood cell types.

MB – 205: BASICS OF VIROLOGY

Course learning Objectives

1. Gives basics concepts on Animal & Plant virus cultivation
2. Provides in depth knowledge on properties and purification of Viruses.
3. Gives outlines on nomenclature and classification of viruses.
4. Give in-depth understanding on viral genomes and their replication.

UNIT – I

History of Virology: Discovery of viruses and development of Virology (contribution of pioneers). Nature, origin and evolution of viruses. New emerging viruses.

Isolation and cultivation of viruses: Animal viruses - experimental animals, embryonated eggs, animal cell cultures-primary and secondary cell cultures. Plant viruses - experimental plants and tissue cultures. Infectivity assay methods of viruses- physical, serological and chemical approaches. Assay and maintenance of viruses, qualitative and quantitative analysis of viruses.

UNIT – II

Purification of viruses : Extraction of viruses from tissues, clarification, concentration of viruses in clarified extracts by physical and chemical methods, further purification of viruses by rate zonal / equilibrium density gradient centrifugation, approaches and criteria of virus purity, quantification and preservation of purified virus preparations.

Properties of viruses : Biological characteristics of viruses, host-range, transmission (vector and non-vector), virus stability. Physical-morphology and structure, sedimentation, electrophoretic mobility, buoyant density. Biochemical – chemical composition, nucleic acids, proteins, enzymes, lipids, carbohydrates, polyamines, cations. Antigenic nature of viruses.

Architecture of viruses : Morphology, structure and composition of viruses-Principles of virus structure-Icosahedral, helical and binal symmetry.

UNIT-III

Nomenclature and classification of viruses: Criteria used for naming and classification of viruses. Current ICTV classification of viruses of bacteria, plants, animals, humans, algae, fungi and protozoans. Major characteristics of the virus families / genera / groups.

Sub-viral agents : Characteristics of sub-viral agents – Viroids, Satellite viruses, Satellite nucleic acids and Prions.

UNIT – IV

Viral genomes: Diversity of viral genomes – DNA genome – linear and circular, single stranded and double stranded. RNA genomes – positive and negative, linear and circular, single and double stranded, partite of viral genomes – mono, bi, tri and multipartite genomes.

Replication of viruses: Outlines of replication of viruses – approaches to study replication of viruses, replication strategies of viruses – Baltimore strategies of viral genome replication and expression. Replication of viruses like MS_2, T_4, Lambda, Phi X-174, M_{13}, TMV, cauliflower mosaic virus, geminivirus, parvovirus, polio, HIV, Influenza, reovirus, SV-40 and poxviruses.

Prevention and Control of viruses: The infection control policyaseptic techniques, cleaning and disinfection, protective clothing, isolation; Prevention – sanitation, vector control, vaccines and immunization; Control- chemoprophylaxis, chemotherapy (antiviral drugs, Interferon therapy), efficacy of infection control.

Suggested Books:

1. Virology: 1994. 3rd ed. Frankel-Conrat et al, Prentice-Hall.
2. Fundamental Virology, 1996. 3rd ed. B.N. Fields et al. Lippincott-Raven.
3. Principles of Virology : 2000. by S.J. Flint et al., ASM Press.
4. Introduction to Modern Virology. 1994. 4th ed. Primrose and Dimmock. Blackwell Scientific Publ.
5. Principles of Molecular Virology. 2005. 4th ed. A. Cann. Academic Press.
6. Basic Virology, 1999. By Waginer and M. Hewlett, Blackwell Science Publ.
7. Plant Virology, 4th ed. 2001 by R. Hull (R.E.F. Matthews). Academic Press.
8. Applied Plant Virology. 1985. D.G.A. Walkey. Heinemann Publications.
9. Fields Virology. 1996. B.N. Fields, D.M. Knipe and P.M. Howley. Lippincott-Raven Publishers.
10. Encyclopedia of Virology. 1994. R.G. Webster and Allan Granoff (Eds). Vol I,II,III. Academic Press.

Course learning Outcomes

1. Be able to explain about viruses cultivation method.
2. Be able to describe properties of viruses.
3. Be able to classify the viruses according to ICTV.
4. Be able to conversant with viral genome diversity and control of viruses.

CO-PO Attainment in Outcome Based Education -2019

CO-PO Mapping Matrix/Programme Articulation Matrix:

	PO_1 Know ledge	**PO_2** Analysis	**PO_3** Design	**PO_4** Development	**PO_5** Modern Tools	**PO_6** Society	**PO_7** Environment	**PO_8** Ethics	**PO_9** Team work	**PO_{10}** Communication	**PO_{11}** Programme Management	**PO_{12}** Lifelong Learning
CO_1	3	2	2	2	2	2	-	-	-	-	-	2
CO_2	3	2	2	2	2	2	-	-	-	-	-	2
CO_3	3	2	2	2	2	2	-	-	-	-	-	2
CO_4	3	2	2	2	2	2	-	-	-	-	-	2

Outcomes:

Knowledge
Skill
Attitude
Behavior & Values

Level: 1. Slight/Low
2. Moderate
3. Substantial

MB- 206: - Human Values and Professional Ethics –II

Course learning Objectives

4. Provides concepts on Human Values.
5. Outlines the medical ethics.
6. Given knowledge on business Environmental, Social ethics.

Unit - I

Value Education- Definition - relevance to present day - Concept of Human Values - self introspection - Self esteem. Family values-Components, structure and responsibilities of family- Neutralization of anger - Adjustability - Threats of family life - Status of women in family and society - Caring for needy and elderly - Time allotment for sharing ideas and concerns.

Unit - II

Medical ethics- Views of Charaka, Sushruta and Hippocratus on moral responsibility of medical practitioners. Code of ethics for medical and healthcare professionals. Euthanasia, Ethical obligation to animals, Ethical issues in relation to health care professionals and patients. Social justice in health care,

human cloning, problems of abortion. Ethical issues in genetic engineering and Ethical issues raised by new biological technology or knowledge.

Unit - III

Business ethics- Ethical standards of business-Immoral and illegal practices and their solutions. Characterics of ethical problems in management, ethical theories, causes of unethical behavior, ethical abuses and work ethics.

Unit - IV

Environmental ethics- Ethical theory, man and nature- Ecological crisis, Pest control, Pollution and waste, Climate change, Energy and population, Justice and environmental health.

Unit - V

Social ethics- Organ trade, Human trafficking, Human rights violation and social disparities, Feminist ethics, Surrogacy/pregnancy. Ethics of media- Impact of Newspapers, Television, Movies and Internet.

Suggested Books:

1. John S Mackenjie: A manual of ethics.
2. "The Ethics of Management" by Larue Tone Hosmer, Richard D. Irwin Inc.
3. "Management Ethics - integrity at work' by Joseph A. Petrick and John F. Quinn, Response Books: New Delhi.
4. "Ethics in Management" by S.A. Sherlekar, Himalaya Publishing House.
5. Harold H. Titus: Ethics for Today
6. Maitra, S.K: Hindu Ethics
7. William Lilly : Introduction to Ethics
8. Sinha: A Manual of Ethics
9. Manu: Manava Dharma Sastra or the Institute of Manu: Comprising the Indian System of Duties: Religious and Civil (ed.) G.C.Haughton.
10. Susruta Samhita: Tr.Kaviraj Kunjanlal, Kunjalal Brishagratha, Chowkamba Sanskrit series, Vol I,II and III, Varnasi, Vol I OO, 16-20, 21-32 and 74-77 only.
11. Caraka Samhita :Tr. Dr.Ram Karan Sarma and Vaidya Bhagavan Dash, Chowkambha Sanskrit Series office, Varanasi I, II, III Vol I PP 183-191.
12. Ethics, Theory and Contemporary Issues., Barbara Mackinnon, Wadsworth/Thomson Learning, 2001.
13. Analyzing Moral Issues, Judith A. Boss, Mayfield Publishing Company, 1999.
14. An Introduction to Applied Ethics (Ed.) John H.Piet and Ayodhya Prasad, Cosmo Publications.
15. Text Book for Intermediate First Year Ethics and Human Values, Board of Intermediate Education-Telugu Akademi, Hyderabad.
16. I.C Sharma Ethical Philosophy of India. Nagin&co Julundhar

Course learning Outcomes

1. Helps to inculcate human values in their own life.
2. Be able to understand the medical ethics concepts.
3. Beable to explain business, environmental and social ethics.

CO-PO Attainment in Outcome Based Education -2019

CO-PO Mapping Matrix/Programme Articulation Matrix:

	PO_1 Know ledge	**PO_2** Analysis	**PO_3** Design	**PO_4** Development	**PO_5** Modern Tools	**PO_6** Society	**PO_7** Environment	**PO_8** Ethics	**PO_9** Team work	**PO_{10}** Communication	**PO_{11}** Programme Management	**PO_{12}** Lifelong Learning
CO_1	3	2	-	-	2	2	1	3	-	-	-	3
CO_2	3	2	-	-	2	1	1	3	-	-	-	3
CO_3	3	2	-	-	2	1	1	3	-	-	-	3
CO_4	3	2	-	-	2	1	1	3	-	-	-	3

Outcomes:

Knowledge
Skill
Attitude
Behavior & Values

Level: 1. Slight/Low
2. Moderate
3. Substantial

THIRD SEMISTER

MB – 301: MICROBIAL GENETICS AND MOLECULAR BIOLOGY

Course learning Objectives

1. To give indepth information about industrially important microorganisms.
2. To prove information about recombinant molecular in pharmaceuitical, health , agricultural and industrial sectors.
3. To helps to understand the role of microorganisms in various industries.
4. To gain concepts in Bioremediation.

UNIT – I

Genetic notations, conventions and terminology

Nucleic acids as genetic information carriers – experimental evidences.

Modern concept of gene – Gene structure, co-linearity and polypeptide, one gene – one enzyme, protein polypeptide or product concepts; types of genes.

Genetics of Bacteria and Fungi : *E. coli, Bacillus, Streptomyces, Sacchromyces,* Filamentous fungi *(Neurospora).*

Gene transfer mechanisms in bacteria : Transformation, conjugation, sexduction and transduction (generalized, abortive, contrasduction, specialized,) and gene mapping. Role of Rec gene products.

Genome diversity : Viruses – linear, circular and dividend genomes of RNA and DNA viruses. Prokaryotes – nucleoid and chromosome organization, genome evolution in microbes, phylogenetic trees. Eukaryotes – chromosome organization / structure, histones, nucleosomes, genome complexity, chromosomal banding. Organelle genomes. Genetic mapping of genomes.

Plasmids : bacterial and yeast plasmids, purification, properties, detection, transfer, replication an curing, significance / importance.

Transposal / mobile genetic elements : Prokaryotes – (IS elements, composite and complex transposons), mechanisms of transposition and importance – Eukaryotes (Yeast, Drosophila and Maize) – retrotransposons, retroelements. Exploitation of transposable elements in genetics.

UNIT – II

Mutations: Types, mutagens and molecular mechanisms of mutation, isolation and analysis of mutants, significance of mutants.

Genetic recombination: General of homologous recombination, site specific recombination, transposition; illegitimate recombination and artificial recombination.

Genetics of viruses : Prokaryotic virus (phages) – Benzer's studies on r-II region of T4 and complementation, recombination in bacteriophages (T2), uses of phages in microbial genetics, Eukaryotic viruses-recombination and reassortment, cross-and multiplicity reactivation, complementation, phenotypic mixing, ploidy, DI particles, transduction of genes by retroviruses, evolution of viruses (influenza, HIV, herpesviruses).

UNIT-III

DNA replication : general principles, various modes of replication. Continuous and discontinuous synthesis, relation between cell cycle and DNA synthesis, replication fork and enzymology of DNA replication in prokaryotes and eukaryotes, replication of ssDNA, retroviruses and their unique mode of DNA synthesis, inhibitors of DNA replication.

DNA damage and repair : types of DNA damage-deamination, oxidative damage, alkylation and pyrimidine dimers; repair pathways – mismatch, short patch repair, nucleotide/base, excition repair, recombination repair and SOS system.

Transcription (RNA biosynthesis) : Types of RNA and their role, organization of protein and RNA (rRNA, tRNA, 5 sRNA) encoding transcription units (promoters and regulatory elements) and their transcription in prokaryotes and eukaryotes, polycistronic and monocistronic mRNAs. Types of RNA polymerases. Promoters and other regulatory elements and transcription factors, events of transcription. Maturation and processing of different RNAs : methylation, processing of rRNA; capping, polyadenylation, splicing and editing of mRNA; processing and modification of tRNA. Catalytic RNAs (ribozymes). Inhibitors of transcription. Invitro transcription systems.

UNIT – IV

Translation (Protein biosynthesis) : Central dogma theory and flow of genetic information, genetic code and its elucidation, structure and composition of prokaryotic and eukaryotic ribosomes, structural features of rRNA, mRNA and tRNA in relation to function, steps of protein biosynthesis (activation of amino acids, initiation, elongation, termination) in prokaryotes and eukaryotes; post-translational modification of proteins and their sorting and targeting; regulation of translation; inhibitors of protein biosynthesis; invitro translation systems.

Regulation of gene expression : An overview on levels of regulation, terminology and operon concepts, enzyme induction and repression; positive and negative regulation in *E. coli*- lac and ara operons; regulation by attenuation – his and trp operons; antitermination – N protein and nut sites in Lambda phage. Organization and regulation of nif and nod gene expression in bacteria; gal operon in yeast. Global regulatory responses-heat shock response, stringent response and regulation by small molecules such as cAMP and PPGPP.

DNA binding proteins : Enhancer sequences and control of transcription. Identification of protein – binding sites on DNA, control of transcription by interaction between RNA polymerases and promoter region, use of alternate sigma factors, controlled termination attenuation and antitermination.

Suggested Books:

1. Microbial Genetics by S.R. Maloy et al. 1994
2. Molecular Genetics of Bacteria, 3rd ed. 1998. J.W. Dale. Wiley Publ.
3. Bacterial and Bacteriophage Genetics. 4th ed. 2000. By E.A. Birge. Springer.
4. Principles of Molecular Virology. 4th ed. 2004. By A. Cann. Academic Press.
5. Modern Genetic Analysis by Griffith.
6. Genetics by Gardner.
7. Molecular Cell Biology. 1995, 3rd ed. by Lodish et al. Scientific American books, W.H. Freeman and Company.
8. Molecular Biology. 1995, by David Freifelder, Narosa Publ. House.
9. Text Book of Molecular Biology. 1994, by Sivarama Sastry et al, Macmillan India Ltd.
10. Advanced Molecular Biology : A Concise Reference. 1998, by R.M. Twyman. Viva Books Pvt. Ltd.
11. Instant notes in Molecular Biology, 1998. by P.C. Turner et al. Viva Books Pvt. Ltd.
12. Genes VIII. 1997. by B. Lewin. Oxford University Press. The Biochemistry of nucleic acids. 1992, 11th ed. by Adams et al, Chapman and Hall.
13. Biochemistry. 1995 by L. Stryer. W.H. Freeman and Co.Biochemistry, 1998, 4th ed. by G.L. Zubay. W.C.B. Publ.
14. Microbial Genetics. 1995, by David Freifelder. Narosa Publ. House.
15. Biochemistry and Molecular Biology. 1997, by W.H. Elliott & D.C. Elliott. Oxford University Press.
16. Molecular biology of the Gene. 1998, 5th ed. Watson et al, Addison Wesley Longman.
17. Schaums Outlines – Molecular and Cell Biology. 1996. W.D. Stansfield et al., McGraw-Hill Publ.

Course Learning Out comes

1. Be able to assess “GRAS’.
2. Be able to have clear cut about the production of recombinant molecules.
3. Be conversant with Biofertilizer, Biopesticides and microbial enzymes.
4. Be able to to gain the concepts in waste recycling and industrial efficient.

CO-PO Attainment in Outcome Based Education -2019

CO-PO Mapping Matrix/Programme Articulation Matrix:

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CO_3	3	2	2	2	2	2	-	-	-	-	-	2
CO_4	3	2	2	2	2	2	-	-	-	-	-	2

Outcomes:

Knowledge
Skill
Attitude
Behavior & Values

Level: 1. Slight/Low
2. Moderate
3. Substantial

MB – 302: RECOMBINANT DNA TECHNOLOGY & BIOINFORMATICS

Course learning Objectives

1. To provide knowledge on quality control of food products.
2. To provide indepth knowledge about food poisining and fermentation product.
3. To understand the about fermentation technology concepts.
4. To gain concentrate knowledge on microbials application modern technology.

UNIT – I

Scope and importance of recombinant DNA technology / genetic engineering.

Genetic Engineering tools : Vectors- types, plasmids, transposons, bacterial and animal virus based vectors, bacterial and yeast artificial chromosomes; **enzymes-**restriction endonucleases, different DNA and RNA polymerases ligases, nucleases, kinases, nucleotidyl transferases, alkaline phosphatase; **oligonucleotides-** linkers, homopolymer tails, primers, promoters; **cloning and expression hosts –** *E.coli Bacillus, Agrobacterium,* yeast and plant and animal cell cultures.

Cloning strategies : Generation of DNA molecules, attachment to vectors, delivery of recombinant molecules into host cells, screening and identification of positives clones – antibiotic, nucleic acid and protein based approaches. Construction and screening of cDNA and genomic DNA libraries.

UNIT – II

DNA sequencing : Chemical method of Maxum and Gilbert, Sanger's dideoxy chain termination and primer walking methods. Automated sequencing. Sequence assembly. Genome sequencing and physical mapping of genomes.

Site-directed mutagenesis : Different approaches and its potential in changing genes.

Molecular diagnostics : Preparation of DNA and RNA probes, nucleic acid hybridization, factors influencing hybridization and their applications; PCR-principles, factors affecting PCR, different types of PCR and their applications and limitations; profiling of nucleic acids by DNA fingerprinting, RFLP, RAPD and AFLP.

UNIT – III

Transgenic plants : Construction of plant cell expression vector with desired genes, biological and physical approaches for delivering genes into plant tissues, identification and regeneration of transformed tissues to transgenics. Transgenic plants as bioreactors.

Transgenic animals : Construction of animal cell expression vectors and delivering of genes into cultured animal cells. Production and use of transgenic animals (mice, sheep/goat, cow).

Applications and implications of genetic engineering in biology, agriculture, medicine and industry

UNIT – IV

Microbial genomics and proteomics : DNA microarray – printing of oligo nucleotides and PCR products on glass slides. Whole genome analysis for global pattern of gene expression using fluorescent labeled cDNA or end labeled RNA. Analysis of single nucleotide polymorphisms using DNA chips. **Proteome analysis-**two-dimentional analysis of total cellular proteins, isolation and sequence analysis of individual protein spots by mass spectroscopy. Protein microarray, advantages and disadvantages of DNA and protein microarray.

Introduction – Origin of bioinformatics biological data (genome projects), computer and information technology contributions. An overview of biological databases – NCBI, EMBL, DDBJ, SWISS-PROT, PDB, KEGG.

Sequence alignment – Introduction, significance of sequence alignments and use of dot matrices.

Pair-wise and multiple sequene alignment (MSA) using Clustal programs. Sequence analysis – concepts of sequence analysis and their importance. Concept of Molecular phyloginetics. BLAST – blastn, blastp, tblastx, output analysis matrix BLOSSUM, PAM, e-value. Homology Modeling and Drug discovery. Primer designing. Applications of *Insilio biology*.

Suggested Books:

1. Principles of Gene Manipulation : An introduction to genetic engineering. 1994. 5th ed. Old and Primrose. Blackwell Scientific Publ.
2. Molecular Biotechnology. 1994. Glick and Pasternak. Panima Publ.
3. Recombinant DNA. 1992. 2nd ed. J.D. Watson et al. Freeman and Co.
4. Protein expression : A Practical Approach by S.J. Higgins and B.D. Hames (eds). Oxford University Press.

5. Functional Genomics : A Practical Approach. 2000, by S.P. Hunt and R. Liveey (eds.). Oxford University Press.
6. DNA Microarrays : A Practical Approach by M. Schena (ed.). Oxford University Press.
7. Molecular biology and Biotechnology. 2002. 4th ed. by J.M. Walker and R. Rapley, Panima.
8. Manual of Industrial Microbiology and Biotechnology, second edition., ed. by Demain, A.L., Editor in Chief, 1999, ASM Press.
9. Recombinant DNA and Biotechnology : A guide for Teachers : 2nd ed. H. Kreuzer and A. Massey. ASM Press.
10. Recombinant DNA and Biotechnology : A guide to students : 2nd ed. H. Kreuzer and A. Massey. ASM Press.
11. Basic Biotechnology, 2001. 2nd ed. by C. Ratledge & B. Kristiansen. Cambridge University Press.
12. Molecular Cloning, 2001. Vol. I-III by Sambrook and Russel, CSH Press.
13. Current Protocols in Molecular Biology, 2000. Ausbel et al.
14. Genome analysis. 2000. 4 Vols. CSH Press.

Course Learning Out comes

1. Be able to understand presentation methods.
2. Be able to understand the food infections and microbial sancer.
3. To gain knowledge on Fermentation process.
4. Be able to know the advantages and biofuels and microbial frerapeulic compounds

CO-PO Attainment in Outcome Based Education -2019

CO-PO Mapping Matrix/Programme Articulation Matrix:

	PO_1 Know ledge	**PO_2** Analysis	**PO_3** Design	**PO_4** Development	**PO_5** Modern Tools	**PO_6** Society	**PO_7** Environment	**PO_8** Ethics	**PO_9** Team work	**PO_{10}** Communication	**PO_{11}** Programme Management	**PO_{12}** Lifelong Learning
CO_1	3	2	2	2	2	2	-	-	-	-	-	2
CO_2	3	2	2	2	2	2	-	-	-	-	-	2
CO_3	3	2	2	2	2	2	-	-	-	-	-	2
CO_4	3	2	2	2	2	2	-	-	-	-	-	2

Outcomes:
Knowledge
Skill
Attitude
Behavior & Values

Level: 1. Slight/Low
2. Moderate
3. Substantial

MB-303: PRACTICAL: MICROBIAL GENETICS AND MOLECULAR BIOLOGY & RECOMBINANT DNA TECHNOLOGY & BIOINFORMATIC

Course learning Objectives

1. Gives knowledge on various isolation procesures.
2. Give knowledge about staining methods.

1. Isolation of Genomic DNA from microbes, plant/animal tissues.
2. Isolation of plasmids from Bacteria.
3. Curing of plasmids.
4. Competent cell preparation.
5. Bacterial transformation.
6. Bacterial transduction.
7. Bacterial Conjugation.
8. Mapping of bacterial genes by conjugation / transformation (problems).
9. Side directed mutagenesis
10. AMES test.
11. Screening and isolation of streptomycin mutant resistant bacteria by gradient plate technique.
12. Lethality curve construction.
13. Study of DNA methylation
14. Study of DNA repair
15. Invitro transcription assay
16. Setting of Genetic Engineering laboratory
17. Restriction enzyme analysis of plasmids
18. Recovery of DNA from gels – Electroelution and extraction of DNA from low melting agarose gels.
19. Southern blotting.
20. Western blotting for heterologous gene expression
21. Polymerase chain reaction
22. Induction of enzyme (Beta galactosidase) in Bacteria
23. Calculation of proportion of bases in nucleic acids, number of turns in DNA, length and Mol. Wts. of DNA, Tm values and buoyant densities of DNAs and DNA replication times
24. Conversion of nucleic acids and coding capacities.
25. Calculation of number of phosphoanhydric bonds hydrolysed during protein biosynthesis.
26. Problems related to Bioinformatics

MB: 304: a) Practicals: AGRICULTURAL MICROBIOLOGY

1. Measurement of physic-chemical characteristics of soil.
2. Estimation and enumeration of microorganisms in the soil Rhizosphere (Leguminous & non Leguminous), R/S Ratio.
3. Demonstration of degradation of cellulose by microorganisms in the soil.
4. Isolation of Rhizobium from root nodules and rhizobial nodulation testing.
5. Isolation of Azotobacter from soil.
6. Isolation of VAM fungal populations from soil.
7. Observation of phyllosphere and rhizosphere microbial flora.
8. Estimation of urease activity in soil.
9. Observation of symptoms of diseases of local crops (Fresh or Herbarium).

MB: 304: b) Practicals: FOOD MICROBIOLOGY

1. Determination of lactic acid concentration in commercial curd samples.
2. Microbiological examination of spoiled foods.
3. Enumeration of surface microflora of vegetables.
4. Microbiological examination of milk.
5. Detection of number of bacteria in milk by breeds count.
6. Determination of milk quality by methylene blue reduction test
7. Role of yeasts in bread making
8. Extraction and analysis of aflatoxins
9. Culturing of Mushrooms
10. Visits to Food and Industrial chemical production units

MB: 305 – a) AGRICULTURAL MICROBIOLOGY

Course learning Objectives

1. Gain hands on experience of commercial products using microorganism.

UNIT – I

The developments and scope of Agricultural Microbiology, Contribution of the pioneers.

The Soil: Definition, components, important physical and chemical characteristics, classification outlines.

Microbial diversity in the soil: Qualitative and quantitative nature of bacteria, actinomycetes, fungi, algae, Protozoa and nematodes. Influence of environmental factors on soil microflora. Methods of study, isolation and enumeration of soil microbial flora.

UNIT – II

Soil organic matter: Nature, synthesis significance and decomposition: Microbial degradation of polysaccharides, Proteins and other nitrogenous substances, fats, hydrocarbons and pesticides in soil. Soil humus, its significance and degradation.

Soil enzymes: Nature, isolation, occurrence and ecological significance.

The Rhizosphere – Nature, extent, qualitative and quantitative aspects and activities of rhizosphere microorganisms, nature and ecological role or root exudates, significance of rhizosphere microbial flora on plant growth, plant pathogens and rhizosphere. Plant growth promoting rhizobacteria (PGPR) and siderophore production. Brief account on spermosphere and phyllospheres, their ecology and significance.

UNIT – III

Ecology and biology of non-symbiotic and symbiotic (including stem-nodulating rhizobia) nitrogen fixers, associative symbiosis and their ecological / agronomic significance.The symbiotic relationships – symbiotic nitrogen fixers.Legume - *Rhizobium* interaction, biochemistry and mechanism of nitrogen-fixation; genetics of nitrogen fixation, methods of evaluation of Biological Nitrogen Fixation. Factors

influencing nitrogen fixation.Free-living nitrogen fixing bacteria-*Azotobacter* and *Azospirillum,* response of plants to their inoculation. Nitrogen-fixing Cyanobacteria and their importance in rice cultivation.

Mycorrhizal associations: Morphology, ecology, nature of associations and their ecological significance. VAM – distribution fungi involved, propagation, effect on crop productivity. Biopesticides – *Bacillus thuringiensis,* NPV & CPV, Biofertilizers – microbes used, methods of preparation, application and significance in improving soil fertility and productivity. Cultivation, mass production and inoculation of *Rhizobium, Azotobacter, Azospirillum, Azolla* and *Cyanobacteria*.

UNIT – IV

Principles of Plant Pathology: Brief history and development of plant pathology (contributions of pioneers). Modes of entry of pathogens into host survival and transmission of plant pathogens. Survival of soil-borne plant pathogens. Host-pathogen interactions-virulence factors of pathogens and defense mechanisms of plants against pathogens. Control of plant diseases, by various approaches. Biological control of plant diseases including the use of microbial pesticides, their safety, advantages and disadvantages.

Plant diseases: Symptomology of the plant diseases caused by fungi, bacteria and viruses. Symptoms, etiology, epidemiology / disease cycle and control measures with reference to the following diseases: **Fungal:** damping-off of seedlings, smut of bajra, downy mildew of grapes, powdery mildew of cucurbits, rusts of wheat, groundnut, *Fusarium* wilts, red rot of sugarcane, tikka disease of groundnut, blast disease of rice.

Bacterial: Citrus canker, blight of rice, angular leaf spot of cotton. **Viral and viroid –** rice tungro, sugarcane mosaic/streak, potato leaf roll and spindle tuber; viroid diseases, tomato/tobacco leaf curl, pigeon pea sterility mosaic, peanut bud and stem necrosis, citrus tristeza and yellow mosaic, banana bunchy top. **Phytoplasmal:** Little leaf of brinjal.

Suggested Books:

1. Rangasamy and Bagyaraj, 2nd ed. (2001) Agricultural Microbiology. G.. Printice Hall..
2. Marks S Coyne 1st ed. (1999). Soil Microbiology: An Exploratory Approach, Delmar Publications
3. Subba Rao NS. Soil, 4th ed. (1999) Microbiology (Soil Microorganisms and Plant Growth) 4th ed. Oxford IBH Publications Co. Pvt. Ltd.
4. PaulE. A. and Clark .F.E.(1996). Soil Microbiology and Biochemistry, 2nd ed Academic Press
5. BrownR.G.(1999). Sarup & Sons. Plant Diseases and their control,New Delhi., CRC Press Inc.
6. Prabakaran G , 1st ed. (2004).Introduction to Soil and Agricultural Microbiology.
7. Agrios. G.N. 5th ed. (2005) Plant Pathology,A.P.
8. Rangasami, and A. Mahadevan, 4th ed. 1998 Diseases of Crop Plants in India, Printice-Hall.
9. Mishra,R.R. 1st ed. (2004) Soil Microbiology: CBS Publishers & Distributers .
10. Jan Dirk van Elsas, Jack T.Trevors and Elizabeth M.H. Wellington (2nd ed.) (2006) Modern Soil Microbiology: Marcel Dekker, Inc.

Course Learning Out comes

1. Be able to analyse the substrate product relationship.

MB – 305: b) FOOD MICROBIOLOGY

Course learning Objectives

1. Give elaborate knowledge on Health care products
2. Provide in depth knowledge about microbial antibodies and recombinant products
3. Provide detailed knowledge about organic acids and enzymes
4. Gives in depth knowledge on oxidative transformation.

UNIT – I

Food as substrate for microorganisms : Microorganisms important in food microbiology – Molds, Yeasts and Bacteria- General characteristics-classification and importance. Principles of food preservation. Asepsis-Removal of microorganisms, (anaerobic conditions, high temperatures, low temperatures, drying). Factors influencing microbial growth in food-Extrinsic and intrinsic factors; Chemical preservatives and Food additives. Canning, processing for Heat treatment-D, Z, and F values and working out treatment parameters.

UNIT – II

Contamination and spoilage : Cereals, sugar products, vegetables, fruits, meat and meat products, Milk and Milk products- Fish and sea foods- poultry- spoilage of canned foods. Detection of spoilage and characterization.

Food-borne infections and intoxications : Bacterial and nonbacterial- with examples of infective and toxic types- *Brucella, Bacillus, Clostridium, Escherichia, Salmonella, Staphylococcus, Vibrio, Yersinia;* Nematodes, protozoa, algae, fungi and viruses. Food borne outbreaks-laboratory testing procedures; Prevention Measures- Food sanitation in manufacture and retail trade, Food control agencies and its regulations, Plant sanitation- Employee's Health standards- waste treatment – disposal – quality control.

UNIT – III

Food fermentations : bread, cheese, vinegar, fermented vegetables, fermented dairy products; Experimental and Industrial production methods. Spoilage and defects of fermented dairy products – oriental Fermented foods, their quality standards and control.

UNIT – IV

Food produced by Microbes : Microbial cells as food (single cell proteins)- mushroom cultivation. Bioconversions- production of alcohol-fermented beverages- beer and wine. Genetically modified foods.

Steroid conversion : Industrial Enzymes production- amylases, proteinases, cellulases, aminoacid production- glutamic acid and lysine productions. Hazard analysis and critical control points (HACCP).

Suggested Books :

1. Food Microbiology : Fundamentals and Frontiers. 4th ed. 2012. ed by M.P. Doyle et al., ASM Press..
2. Food Microbiology : 3rd ed. 2007. Adams, M.R. and Moss M.O. Royal Society of Chemistry Publication, Cambridge.
3. Food Microbiology: 4th ed., 1988. Frazier WC and Westhoff Dc. Tata McGraw Hill Publishing Company Ltd., New Delhi.

4. Principles of Fermentation Technology. 2nd Edition : 1999. Stanbury, PF., Whitekar, A and Hall, S.J. Pergamon Press.
5. Basic Food Microbiology : 2nd ed.1989. Banwart, GJ. CBS Publishers and Distributors, Delhi.
6. Food poisoning and Food Hygiene: 7th ed. 2007. Hobbs BC and Roberts D. Edward Arnold (A division of Hodder and Stoughton) London.
7. Dairy Microbiology :3rd ed. 2002. Robinson RK., Elsevier Applied Sciences, London.

Course Learning Out comes

1. Be able to understand the sources of microbes for the production of health care products
2. Be able to understand Microbial products
3. Be able to have detailed idea about organic acids and enzymes
4. Be able to have clear cut idea about dairy products and fermented products

CO-PO Attainment in Outcome Based Education -2019

CO-PO Mapping Matrix/Programme Articulation Matrix:

	PO_1 Know ledge	**PO_2** Analysis	**PO_3** Design	**PO_4** Development	**PO_5** Modern Tools	**PO_6** Society	**PO_7** Environment	**PO_8** Ethics	**PO_9** Team work	**PO_{10}** Communication	**PO_{11}** Programme Management	**PO_{12}** Lifelong Learning
CO_1	3	2	2	2	2	2	-	-	-	-	-	2
CO_2	3	2	2	2	2	2	-	-	-	-	-	2
CO_3	3	2	2	2	2	2	-	-	-	-	-	2
CO_4	3	2	2	2	2	2	-	-	-	-	-	2

Outcomes:

Knowledge
Skill
Attitude
Behavior & Values

Level: 1. Slight/Low
2. Moderate
3. Substantial

MB: 306: a) APPLIED MICROBIOLOGY

Course learning Objectives

1. Gives knowledge on Design and application of biotechnology.
2. Give deep understanding about product recovery.
3. Gives knowledge of industrial products.
4. Provides detailed information on microbial teaching.

UNIT – I

History and scope of Microbiology: Milestones in Microbiology, Nobel laureates in Microbiology, spontaneous theory, Germ theory of disease, scope and application domains of Microbiology.

Types of Microscopes and role of Microscopy in Microbiology: Types of Microscopes-light, Dark field, fluorescence, phase contrast, compound, electron microscopes and their principles and applications related to microbiology.

Taxonomy of Microbes: Nomenclature classification and identification of Microorganisms – Bacteria viruses and other organisms. Phenotypic and Genetic characteristics, epigenetic analysis.

UNIT-II

Morphology and structure of Microbes : Nature of bacteria cell – Bacterial shape, pattern of arrangement and size, structure of cell wall, endospore of bacteria, protoplast, spheroplast and L-form Bacteria, **Viruses** – structure and composition of viruses, enveloped and non-enveloped, symmetry of viruses – helical, cubical and binal, DNA and RNA viruses, segment and non segmented viruses, partite viruses.
Fungi and yeast – Morphology and arrangement of fungal and yeast structures.

Bacterial growth and Nutrition : Nutritional requirement culture media, interaction of bacteria with its physical environment, isolation and preservation of pure culture, Multiplication of bacteria, methods used to determine the bacterial growth, culturing of bacterial cell – synchronous, batch and continuous growth, growth on solid and liquid medium.

Biochemical aspects of Microorganisms: Microbial enzymes and their properties, classification of enzymes and their metabolism. Autotrophic generation of energy – Photosynthesis, chemosynthesis. Heterotrophic generation of energy – Anaerobic respiration, fermentation, aerobic respiration. Catabolism of substrates – Carbohydrates, proteins, nucleic acids, amino acids, fats.

UNIT-III

Microbial genetics : Molecular nature of Microbial genes – genetic elements in Prokaryotes, genetic elements in viruses, Phenotypic changes in Bacteria, transcription, translation, replication of prokaryotes, replication of viruses and bacteriophages, gene transfer in prokaryotes. Regulation of genes and metabolism.

Viruses and sub-viral agents : Structure and composition, symmetry, Taxonomy, virus-Host relationship, cultivation of viruses – animal cell cultures, chick embryo. Oncogenic viruses – Cancer. Viroids, satellite viruses and nucleic acids, prions, Rickettsiae, Mycoplasmas.

Biochemcial and Agricultural Microbiology : Biogeochemical cycles – Carbon, Nitrogen, sulfur and other miscellaneous element cycles. Microbial diseases of crops, Microbial pesticides.

Environmental Microbiology : Biodegradation of wastes and pollutants – sewage treatment and methods of disposal, biodegradation of xenobiotics, petroleum waste oil, pesticides, synthetic polymers. Microbiology of water – aquatic microorganisms, Bacterial indicators of water, purification of water. Microbiology of air – types of air contamination, methods of control of microbial flora of air.

UNIT-IV

Medical Microbiology : Microbiota of human body, determinants of infection, toxigenecity. Host defences – nature host resistance, physical, mechanical and chemical barriers. Microbial disease – respiratory and gastro – intestinal tract disease, contact diseases. Chemotherapeutic agents – antibacterial, antifungal and antiviral agents.

Industrial Microbiology : Fermentation – screening of industrial microorganisms, strain improvement, fermentors and extraction of fermentation products, immobilization of enzymes, production of pharmaceuticals, food products, chemicals, petroleum and bioleaching products.

Food Microbiology: Food spoilage, food products and preservation of food products.

Biotechnology: Molecular cloning, protoplast fusion, Recombinant DNA technology and its applications.

Suggested Books:

1. Applied Microbiology. V.V. Kale and K.P. Bhusari, 2001. Himalaya Publishing house.
2. Applied Microbiology.S.N.Prasad,.2000. Campus Book International.
3. Microbiology. 1999. 3rd ed. Prescott et al. Wm. C. Brown Publ.
4. Principles of Microbiology. 1997. 2nd ed. R.A. Atlas. Wm.C. Brown. Publ.
5. Foundations in Microbiology. 1996. 2nd ed. K. Talaro and A. Talaro. Wm. C. Brown Publ.
6. Microbiology. 1996. 5th ed. Pelczar et al. Tata McGram-Hill Publ. Company Ltd.
7. Immunology. 2000. 4th edition. J. Kuby. W.H. Freeman and Company.
8. Immunology. 1996. 4th edition. I. Roitt, J. Brostoff and David Male. Mosby publications.
9. Microbial Genetics by S.R. Maloy et al. 1994
10. Molecular Genetics of Bacteria, 3rd ed. 1998. J.W. Dale. Wiley Publ.
11. Bacterial and Bacteriophage Genetics. 4th ed. 2000. By E.A. Birge. Springer.
12. Principles of Molecular Virology. 2nd ed. 1997. By A. Cann. Academic Press.
13. Molecular Cell Biology. 1995, 3rd ed. by Lodish et al. Scientific American books, W.H. Freeman and Company.
14. Jawetz, Melnick, & Adelberg's Medical Microbiology. 1998. 21st edition. Geo.F.Brooks, Janet S. Butel Stephen A. Morse. Prentice Hall International Inc.
15. Medical Microbiology : A Guide to Microbial Infections : Pathogenesis, Immunity, Laboratory diagnosis and Control. 1997. 15th edition. David Greenwood, Richard C.B. Slack, John Peutherer. ELST Publishers.
16. Manual of Environmental Microbiology, second edition, by C.J. Hurst, Editor in Chief, 2002. ASM Press.
17. Microbial ecology: Fundamentals and Applications. 1998. Atlas, RM & Barta, R.
18. Environmental Microbiology by Ralph Mitechell.
19. Manual of Industrial Microbiology and Biotechnology, Second edition. 1999. A.L. Demain, Editor in Chief, ASM Press.
20. Biotechnology : A test Book of Industrial Microbiology. Second edition, 2000. Ed. W.Crueger & A.Crueger.Panima Publishing corporation.
21. Industrial Microbiology : An Introduction by M.J. Waites et al. Blackwell Science. 2001.
22. Prescott & Dunn's Industrial Microbiology.Fourth edition, 1999.Edited by Gerald Reed. CBS Publishers and distributors.
23. Food Microbiology : Fundamentals and Frontiers. 2nd ed. 2001. ed by M.P. Doyle et al., ASM Press..
24. Food Microbiology : 1995. Adams, M.R. and Moss M.O. Royal Society of Chemistry Publication, Cambridge.

Course Learning Out comes

1. Be able to gain knowledge on strain improvement.
2. Be able understand the whole broth processing.
3. Gain knowledge on production of industrial products.
4. Be able to understand on efficient trident process.

MB 306: b) INDUSTRIAL FOOD MICROBIOLOGY:

Course learning Objectives

1. Given an idea about humeral and cellular immunity.
2. Provide knowledge on cancer biology and immunology.

3. Give various concepts involved in Health and hygiene.
4. Provide deep insights into sanitary microbiology.

UNIT-I

Food and Microbes: Food as a substrate for microbial growth, sources of food contamination, extrinsic and intrinsic factors influencing microbial growth in food. Biochemical changes in food by microorganisms.

Quality control of food products: Analytical methods and standards for raw, canned and fermented foods.

Food Preservation methods: Principles involved – Asepsis, high and low temperatures, irradiation, drying and food additives. Preservation of vegetables and fruits, milk and milk products, meat and meat products and canned foods.

UNIT – II

Food Poisoning and food infections: Microbial food contamination sources and spoilage of cereals vegetables, fruits, meat, milk, sugar and their products. Fish, sea food, poultry and canned foods. Detection of spoilage and their characterization. Food-borne infections – Bacterial infective and toxic types, *Brucella, Bacillus, Clostridium, Escherichia, Salmonella, Staphylococuus, Vibrio* and *Yersinia.* Non-bacterial – Protozoa, algae, nematodes, fungi and viruses. Food – borne outbreaks – laboratory testing procedures, prevention and control measures.

UNIT-III

Microbes as sources of food: Cheese, bread, Vinegar, fermented Vegetables and dairy products, experimental and industrial production methods, spoilage and defects of fermented dairy products. Fermented foods, their quality and standards. Microbial cells as food – single cell proteins, mushroom and legume inoculants.

UNIT-IV

Industrial enzymes production: Amylases – Fungal and bacterial amylases; proteolytic enzymes – Fungal and bacterial proteases; Pectinases, Invertase and other enzymes. Immobilization of enzymes and microbial cells – methods involved and industrial applications. genetically modified foods – Hazard analysis and critical control points (HACCP).

Suggested Books:

1. Reed G (2004) Industrial Microbiology, by CBS Publishers (AVI Publishing Co.)
2. Davis JE and Demain AL (1999) Manual of industrial Microbiology and Biotechnology 2nd edition by by ASM publications.
3. Doyle *et al*. MP (2001) Food Microbiology Microbiology : Fundamentals and frontiers. 2nd Ed. by ASM Press.
4. Byong H. Lee (2014) Fundamentals of Food Biotechnology, 2nd Edition. Springer
5. Helmut Traitler, Birgit Coleman, Karen Hofmann (2014) Food Industry Design, Technology and Innovation. Springer.

Course Learning Out comes

1. Be able to understand the innate immune centre and adoptive immunity.
2. Be able to understand pathological system of cancer biology
3. Be able to understand the everyday life hygiene

4. Be able to have clear cut idea about microbiological hazards

CO-PO Attainment in Outcome Based Education -2019

CO-PO Mapping Matrix/Programme Articulation Matrix:

	PO_1 Know ledge	**PO_2** Analysis	**PO_3** Design	**PO_4** Development	**PO_5** Modern Tools	**PO_6** Society	**PO_7** Environment	**PO_8** Ethics	**PO_9** Team work	**PO_{10}** Communication	**PO_{11}** Programme Management	**PO_{12}** Lifelong Learning
CO_1	3	2	2	2	2	2	-	-	-	-	-	2
CO_2	3	2	2	2	2	2	-	-	-	-	-	2
CO_3	3	2	2	2	2	2	-	-	-	-	-	2
CO_4	3	2	2	2	2	2	-	-	-	-	-	2

Outcomes:

Knowledge
Skill
Attitude
Behavior & Values

Level: 1. Slight/Low
2. Moderate
3. Substantial

FOURTH SEMISTER

MB – 401: MOLECULAR CELL BIOLOGY &TECHNOLOGY

Course learning Objectives

1. To provide information on signaling mechanisms.
2. To gives detailed information on cancer biology.
3. To provide in depth information about culture media.
4. To gives information on transgenic technology.

UNIT – I

Cell cycles : Bacterial and eukaryotic cell cycles, molecular basis of cell cycle regulation, progress through the cell cycle. Prokaryotic and eukaryotic cell signaling mechanisms : eukaryotic cell-to-cell signaling, endocrine signaling, cyclins. Prokaryotic signaling : Quorum sensing and bacterial pheromones. Intracellular signaling. Signaling pathways. Cell cycle and growth regulation.

UNIT – II

Molecular Biology of tissue transformation and tumerogenesis in plants and animals : Terminology, experimental approaches to study transformation and tumerogenesis. **Plants :** induction of crown gall by *Agrobacterium.* **Animals :** types of tumors, physical, chemical and biological carcinogens, chromosomal changes induced by carcinogens, oncogenes (v-onc, c-onc), antioncogenes and their products, induction of tumors by DNA and RNA viruses, regulation of gene expression by oncogene products; role of oncogene products in signal transduction.

Cancer : Biology of human cancer, Growth of cells, Cell transformation. Oncogenes and Chromosome , Translocation, Amplification of Oncogenes in Tumors, Tumor Suppressor Genes, Role of Oncogenes and Tumor Suppressor Genes in the Pathogenesis of Neoplasms. Oncogene and proto-oncogene functions

UNIT – III

Cell culture media – Components of the medium, physical, chemical and metabolic functions of media. Role of serum and supplements, serum-free media, features and specifications of MEM, DHEM, RPMI and Ham's medium. Role of antibiotics in media. Cell viability and cytotoxicity. Dye exclusion and inclusion tests, colonigenic assay, macromolecular estimation, MTT based assay. **Primary culture** – Mechanical and enzymatic mode of disaggregation. Cell lines – Definite and continuous cell lines, characterization, authentication, maintenance and preservation of cell lines.

UNIT- III

In vitro fertilization – Concept of superovulation, collection, maintenance, and maturation of oocytes, fertilization of oocytes. Cloning – Concept of nuclear transfer, nuclear reprogramming and creation of Dolly. **Transgenic animals** – Retroviral, microinjection, and engineered embryonic stem cell method of transgenesis. Application of transgenic animals – Biopharming, disease models, functional knockouts. **Gene therapy** – *Ex vivo* and *in vivo* gene therapy methods, and their applications. Application of animal cell culture - Vaccine production, specialized cell types. Concepts of tissue engineering – Skin, liver, kidney, blader and heart

Suggested Books :

1. Molecular Cell Biology. 6th ed. 2007 by Lodish et al. Scientific American books, W.H. Freeman and Company.
2. Molecular Biology. 4th ed. 2008, by David Freifelder, Narosa Publ. House.
3. Text Book of Molecular Biology. 1994, by Sivarama Sastry et al, Macmillan India Ltd.
4. Advanced Molecular Biology : A Concise Reference. 1998, by R.M. Twyman. Viva Books Pvt. Ltd.
5. Instant notes in Molecular Biology,2nd ed. 2000. by P.C. Turner et al. Viva Books Pvt. Ltd.
6. Schaums Outlines – Molecular and Cell Biology. 1997. W.D. Stansfield et al., McGraw-Hill Publ.
7. Oncogenes. 1990. G.M. Cooper. Jones and Bartlett Publishers, Boston.

Course Learning Out comes

1. Able to understand the cell cycle proqussion.
2. Able to acquired with carcinogens and oncogenes.
3. Be able to acquaint with cell culture media.
4. Be able to acquaint themselves with gene transgenic animal production technology.

CO-PO Attainment in Outcome Based Education -2019

CO-PO Mapping Matrix/Programme Articulation Matrix:

	PO_1 Know ledge	**PO_2** Analysis	**PO_3** Design	**PO_4** Development	**PO_5** Modern Tools	**PO_6** Society	**PO_7** Environment	**PO_8** Ethics	**PO_9** Team work	**PO_{10}** Communication	**PO_{11}** Programme Management	**PO_{12}** Lifelong Learning
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CO_3	3	2	2	2	2	2	-	-	-	-	-	2
CO_4	3	2	2	2	2	2	-	-	-	-	-	2

Outcomes:

Knowledge
Skill
Attitude
Behavior & Values

Level: 1. Slight/Low
2. Moderate
3. Substantial

MB: 402: ENVIRONMENTAL MICROBIOLOGY

Course learning Objectives

1. To provide overview of microbial ecology.
2. To give in-depth information about soil microbiology.
3. To give knowledge about acquatic microbiology.
4. To provide information about waste treatment methods.

UNIT – I

Brief account of the habitat for microorganisms : soil, water and atmosphere. General description of soil, water, air. Physical and chemical factors influencing the distribution of microbial flora.

Populations and communities interactions : Population interactions (commensalisms, synergism, mutalism, competition, ammensalism, predation, parasitism), microbial population and community dynamics, microbial growth in open and closed environments, the kinetic principles of competition between microbial populations.

Extremophiles – acidophilic, alkalophilic, thermophilic, barophilic and osmophilic microbes – mechanisms and adoption. Halophiles – membrane variation – electron transport – application of thermophiles and extremophiles.

Methods in microbial ecology : Enrichment and isolation methods, microbial activity measurements.

UNIT – II

Soil Microbiology : Diversity of microorganisms (bacteria, fungi, algae, viruses), their distribution and abundance, methods of isolation and estimation, beneficial and antagonistic interactions among microorganisms. Survival of soil-borne pathogens.
Organic matter in soil : Nature, synthesis and decomposition. Humus formation in the soil.

Microbiology and ecological significance of ammonification, nitrification and denitrification : microbes involved, biochemistry of the above processes, factors influencing the processes.

Bio-geo-chemical cycles : Carbon, hydrogen, oxygen, nitrogen, phosphorus, sulphur and iron. Microbiological transformation of phosphorus, sulfur and iron.

UNIT – III

Aerobiology : Microbes and microbial propagules in air. Methods for microbial analysis of air. Brief account of air-borne transmission of microbes – viruses, bacteria and fungi, their diseases forcasting and preventive measures.
Aquatic Microbiology : Water ecosystems – types – fresh water (ponds, lakes, streams) – marine habitats (esturies, mangroves, deepsea, hydrothermal vents, saltpans, coral reefs). Zonations of water ecosystems- upwelling – eutrophication – food chain. Potability of water. Sampling and microbial assessment of water quality. Water purifications – sanitary quality of water. Municipal water treatment, filtration. Disinfection of water by heat, solar energy, UV and gamma radiation, ultra sound, ozone and chlorine. Brief account of major water-borne diseases and their control measures.

UNIT – IV

Waste treatment : Wastes – Solids and liquids and their characterization : Liquid wastes : microbial diversity and treatments- physical, chemical, biological – aerobic – anaerobic-primary-secondary tertiary. Solid waste treatment: saccharification-gassification – composting, utilization of solid wastes – food (SCP, mushroom, yeast) fuel (ethanol, methanol), fertilizers (composting). Liquid waste treatment – trickling – activated sludge-oxidation pond – oxidation ditch. Subterranean microbes and bioremediation. Treatment of industrial fermentation unit effluents.
Positive and negative roles of microbes in environment : Bioremediation, biodegradation of recalcitrant compounds – lignin – pesticides; bioaccumulation of metals and detoxification – biodeterioration – of paper – leather, wood, textiles – metal corrosion – mode of deterioration – organisms involved – its disadvantages – mode of prevention. GMO and their impact.

Suggested Books :

1. Extremophiles, by B.N. Johri, 2000. Springer Verlag., New York.
2. Microbial Diversity, by D. Colwd, 1999. Academic Press.
3. Manual of Environmental Microbiology, second edition, by C.J. Hurst, Editor in Chief, 2002. ASM Press.
4. Microbial ecology: Fundamentals and Applications. 1998. Atlas, RM & Barta, R.
5. Aerobiology. 1997. By Tilak.
6. Environmental Microbiology by Ralph Mitechell.
7. Bioremediation Principles by Eweis.
8. Techniques in Microbial Ecology by Buruage.
9. Soil Microbiology and Plant Growth, 1995 by N.S. Subba Rao.
10. Soil Microbiology by Alexander. 2nd ed. 2011.

11. Environmental Microbiology. 1981 by W.P. Grant and P.E. Long.

Course Learning Out comes

1. Be able to acquatic with microbial commander and their interaction.
2. Be able to know about bio geochemical cycle.
3. Be able to understand the water borne diseases and their control measure.
4. Be able to understand the solid waste management.

CO-PO Attainment in Outcome Based Education -2019

CO-PO Mapping Matrix/Programme Articulation Matrix:

	PO_1 Know ledge	**PO_2** Analysis	**PO_3** Design	**PO_4** Development	**PO_5** Modern Tools	**PO_6** Society	**PO_7** Environment	**PO_8** Ethics	**PO_9** Team work	**PO_{10}** Communication	**PO_{11}** Programme Management	**PO_{12}** Lifelong Learning
CO_1	3	2	2	2	2	2	-	-	-	-	-	2
CO_2	3	2	2	2	2	2	-	-	-	-	-	2
CO_3	3	2	2	2	2	2	-	-	-	-	-	2
CO_4	3	2	2	2	2	2	-	-	-	-	-	2

Outcomes:

Knowledge
Skill
Attitude
Behavior & Values

Level: 1. Slight/Low
2. Moderate
3. Substantial

MB - 403: Practical's: MOLECULAR CELL BIOLOGY& CELL TECHNOLOGY & ENVIRONMENTAL MICROBIOLOGY

Course learning Objectives

1. To provide hands on experience with the techniques used in molecular cell Biology.
2. To give hands on experiments techniques used in Environmental Microbiology.

1. 1.MTT assay
2. 2.Trypan blue dye exclusion test
3. 3.Agrobacterium mediated transformation
4. 4.Culturing of HeLaS3 cells insuspension.
5. Humus estimation in the soil
6. Determination of organic matter of soil
7. Contact slide technique
8. Ammonification in soil
9. Nitrification in soil
10. Denitrification in soil
11. Isolation of antibiotic producing microorganisms from soil
12. Most Probable Number Test for coliforms
13. Quantitative analysis of water for microbial numbers (SPC)
14. Membrane filter method for detection of coliforms in water
15. Effect of heavy metals on the growth of bacteria
16. Microbial interrelationships (Synergism and Antagonism)

Course Learning Out comes

1. Be able to perform techniques in molecular cell biology independently.
2. Be able to perform techniques in environmental microbiology

MB - 404: Project

Course learning Objectives

1.To acquatic themselves to identify and collect scientific Research Problem formula in microbiology.

Practical experience in locating, collecting and interpreting the scientific information for the purpose of M.Sc., Microbiology project work. Students work individually under faculty / scientist supervision in Laboratories, Research labs, National Institutions to perform the procedures and record the results and present the project work at the end of the fourth semester. The project work of the student will be evaluated by seeing the performance of presentation and interpretation of the results.

Course Learning Out comes

1.Be able to design and a research problem analyze the results.

MB-405 (a) : Agricultural Biotechnology

Course learning Objectives

1. To provide in-depth information about plant tissue culture.
2. To give detailed information about plant transformation technology.
3. To give central concepts about metabolic engineering.
4. To provide in-depth knowledge about various organisms for practical applications.

Unit-I

Conventional plant breeding. Introduction to cell and tissue culture. Tissue culture media (composition and preparation). Aseptic techniques. Initiation and maintenance of callus and suspension culture. Organogenesis, somatic embryogenesis. Shoot-tip culture: rapid clonal propagation and production of virus-free plants. Embryo, anther, pollen, ovary, ovule and endosperm culture. Culture for production of haploid plants and homozygous lines. Protoplast isolation, culture and fusion. Selection of hybrid cells and regeneration of hybrid plants. Symmetric and asymmetric hybrids. Cybridisation. Cryopreservation.

Unit-II

Plant transformation technology – Basis of tumor formation and hairy root in plants. Ti and Ri plasmids. Role of virulence genes in transfer of T-DNA from Ti plasmid of *Agrobacterium tumefaciens.* Mechanism of transgene interaction. Transgene stability and gene silencing. Application of plant transformation for productivity and performance: Herbicide resistance – Phosphoinothricin, glyphosate. Insect resistance – Bt genes. Strcture and function of cry proteins – Mechanism of action, critical evaluation of its impact on insect control. Non-bt like protease inhibitors, alpha amylase inhibitor. Virus

resistance – Coat protein – mediated, nucleocapsid gene. Disease resistance – Chitinase, 1,3-beta glucanase, antifungal proteins, thionins, RS proteins. Abiotic stress – Drought and salinity. Post-harvest losses, long shelf-life of fruits and flowers – Use of ACC synthase, polygalacturanase, ACC oxidase. Male sterile lines: barstar and barnase systems.

Unit-III

Metabolic engineering and industrial products – Plant secondary metabolites. Industrial enzymes, biodegradable plastic, polyhydroxybutyrate,, plantibodies, edible vaccines. Molecular marker-aided breeding-RFLP maps, linkage analysis, RAPD markers, STS, microsatellites, SCAR (sequence characterized amplified regions), SSCP (single-strand conformational polymorphism), AFLP, QTL, map-based cloning, molecular marker assisted selection. Role of gene tagging in gene analysis, T-DNA and transposon tagging. Gene knockout for targeted gene replacement. Gene patents.

Unit-IV

Nitrogen fixation and biofertilizers – Diazotrophic microorganisms, nitrogenase enzyme, nitrogen fixation genes. Transfer of *nif* genes to non-diazotrophic microorganisms, *nod* genes structure, function and role in nodulation, Hydrogenase – Hydrogen metabolism. Genetic engineering of hydrogenase genes. Mass production of *Azolla* and cyanobacteria (*Spirulina*) for practical application. Mycorrhizae – Types and importance in agriculture and forestry. Use of algae as a source of food, feed, single cell protein, biofertilizers and other products such as agar agar and alginates.

Course Learning Out come

1. Be able to acquaint themselves with various tissue culture techniques.
2. Be able to understand the plant transformation technology in suitable agriculture.
3. Be able to gain knowledge on Molecular markes aided breeding.
4. Be able to know about genetic engineering methods.

CO-PO Attainment in Outcome Based Education -2019

CO-PO Mapping Matrix/Programme Articulation Matrix:

	PO_1 Know ledge	**PO_2** Analysis	**PO_3** Design	**PO_4** Development	**PO_5** Modern Tools	**PO_6** Society	**PO_7** Environment	**PO_8** Ethics	**PO_9** Team work	**PO_{10}** Communication	**PO_{11}** Programme Management	**PO_{12}** Lifelong Learning
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CO_3	3	2	2	2	2	2	-	-	-	-	-	2
CO_4	3	2	2	2	2	2	-	-	-	-	-	2

Outcomes:

Knowledge
Skill
Attitude
Behavior & Values

Level: 1. Slight/Low
2. Moderate
3. Substantial

MB-405 (b): BIOPROCESS ENGINEERING:

Course learning Objectives

1. Gives detail information on containment facilities.
2. Provides basics on biosafety and regulatory affairs involved in transgenic research.
3. Introducer various bioethics issues.
4. Provides information on patent laws and concepts.

Unit-I

Fermentation Technology – Isolation, screening and maintenance of industrially important microbes. Strain improvement strategies. Fermentation processes: Bioreactor designs; Types of fermentation and fermenters; Concepts of basic modes of fermentation – Batch, fed batch and continuous; Conventional fermentation v/s biotransformation; Solid substrate, surface and submerged fermentation; Fermentation economics; Fermentation media; Fermenter design-mechanically agitated; Pneumatic and hydrodynamic fermenters; Large scale animal and plant cell cultivation and air sterilization; Upstream processing: Media formulation; Sterilization; Aeration and agitation in bioprocess; Measurement and control of bioprocess parameters; Scale up and scale down process.

Unit-II

Downstream processing: Harvesting microbial cells – Membrane filtration system, High speed semi continuous centrifugation – disrupting microbial cells. Gram scale purification of recombinant proteins – Chromatography systems and analytical methods for large scale purification. Inclusion bodies – prevention, solubilization – refolding etc. Stabilization of the proteins. Conversion of agricultural waste (ethanol), cellulose significance in production of glucose from agricultural waste. Conversion of sugar cane baggase – biofuel (bioethanol and biobutanol production). Commercial production of alpha amylase, protease, penicillin, citric acid, lactic acid, lysine, glutamic acid, wine and beer.

Unit-III

Expression vectors and Hosts: General features of expression vectors – vectors for expression of recombinant proteins in E. coli Yeast, and other hosts designated as GRAS (Generally regarded As Safe) organisms. Vectors for cloning and expression in insect and mammalian cells. Codon bias-codon optimization, cloning strategies to have affinity tags and their significance. Strategies for removal of affinity tags- Expression of recombinants as extracellular / surface anchored proteins. Biocatalysts and application. Applications of Metabolic Engineering in *Corynebacterium glutamicum* as model organism. *C.acetobutalycium* pathways for production of biofuels as end products – ethanol, hydrogen. General concepts of metabolic flux analysis.

Unit-IV

Production of recombinant therapeutics: Hepatitis B surface antigen, Epidermal growth factors, insulin, platelet derived growth factor, Granulocyte – macrophage colony stimulating factor – streptokinase –

process optimization and processing. Bio-safety-Regulatory procedures to be followed while producing recombinant therapeutics – Toxicological evaluation – methods and market strategies.

Patenting Biotechnological inventions-Intellectual property rights-patenting procedures-patenting in different counties-patenting DNA sequences, Common types of patent categories with examples from recombinant DNA technology – patenting of multicellular organisms – Fundamental research and patenting.

Course Learning Out comes

1. Be able to differentiate various biosafety levels.
2. Be aqua to understand various regulatory requirements for biologicals and drugs.
3. Be able to understand social and ethical issues.
4. Be able to know the requirements for patentability.

MB-406 (a) : FERMENTATION TECHNOLOGY

Course learning Objectives

1. Gives detailed knowledge on traditional microbial technologies.
2. Privides information on alternates sancer energy and biodegradable polymers.
3. Gives information on skill based technologies mushroom, sincell protein.
4. Provides information on microorganisms role in sustainable agriculture.

Unit – I

Industrial fermenters – types of fermenters, designing, operation uses and their auxiliary equipments, limitations imposed by the fermenters on the ways which microorganisms can be cultivated on an Industrial scale.

Fermentation – simple and complex media, media formulation, carbon sources, nitrogen sources, water, minerals, vitamins and growth factors, precursors, inducers and elicitors, inhibitors, cell permeability modifiers, oxygen, antifoams, animal and plant cell culture media, maintenance cell culture media.

Unit – II

Fermentation processes – Aerobic and anaerobic fermentation processes and their application in the microbial industry, solid-substrate fermentation, slurry fermentation and their applications, whole cell immobilization, behaviour of microbes in different reactors – air lift, fluidized, batch, continuous fed batch condition.

Fermentation media design – Design and usage of various commercial fermentation media – Thermal death kinetics of microorganisms, batch and continuous heat sterilization of liquid media – filter and air. Control of chemical and physical conditions – agitation, heat transfer, mass transfer. Fermenter control and monitoring, operating modes.

UNIT – III

Screening – Primary and secondary screening of microorganisms used in fermentation, detection and assay of fermentation products – physical and clinical assays – titration and gravimetric analysis, turbidity analysis and cell-yield determinations, spectrophotometric assays, chromatographic partition assays, GC assays, Biological assays, diffusion assays, turbidimetric and growth assays, End-point determination assays, metabolic assays, enzymatic assays, stock cultures – working and primary stocks.

UNIT – IV

Scale-up of fermentation, increasing product yields, Dual or multiple fermentation, continuous fermentation and late nutrient additions.

Kinetics of microbial growth and product formation – Kinetic models for microbial growth, phases of cell growth in batch cultures, Microbial growth and non growth associated product formation kinetics – (Primary and secondary). Substrate and product inhibition on cell growth and product formation. Fermentation Economics-Market potential, fermentation and product recovery costs, process appraisal.

Suggested Books :

1. Biotechnology: A text book of Industrial. Ed. W. Cruger & A. Cruger. Second Edition 2000.
2. Principles of Fermentation Technology. 1997. P.E. Stanbury et al., Pergamon Press.
3. Microbial Biotechnology: Fundamentals of Applied Microbiology. 1995. A.N. Glazer et al., Freeman and Company.
4. Fermentation: A Practical approach. 1990. B. McNiel and L.M. Harvey. IRL Press.
5. David A. Mitchell (2006) Solid-State Fermentation BioreactorsFundamentals of Design and Operation. Springer.
6. Hongzhang Chen (2013) Modern Solid State Fermentation Theory and Practice. Springer.
7. Hiroshi Takagi, Hiroshi Kitagaki (2015)Stress Biology of Yeasts and Fungi Applications for Industrial Brewing and Fermentation. Springer.
8. Ashok Pandey, Carlos Ricardo Soccol (2008) Current Developments in Solid-state Fermentation. Springer.

Course Learning Out come

1. Be able to understand about microbial diversity.
2. Be able to understand green technology.
3. Be able to understand the single cells and genetically engimed organims applications.
4. Be able to understand about bio castro agencies and Biofertilizers.

CO-PO Attainment in Outcome Based Education -2019

CO-PO Mapping Matrix/Programme Articulation Matrix:

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CO_3	3	2	2	2	2	2	-	-	-	-	-	2

CO_4	3	2	2	2	2	2	-	-	-	-	-	2

Outcomes:

Knowledge
Skill
Attitude
Behavior & Values

Level: 1. Slight/Low
2. Moderate
3. Substantial

MB – 406 (b): PHARMACEUTICAL MICROBIOLOGY

Course learning Objectives

1. Gives information on public health and communication diseases.
2. Provides depth knowledge on patrogeny prophylasis of various bacteria.
3. Gives information on mycotic and protozoic diseases.
4. Gives detailed information on various virus associated diseases.

UNIT-I

Antibiotics and synthetic antimicrobial agents: Antibiotics and synthetic antimicrobial agents(Aminoglycosides, lactams, tetracyclines, ansamycins, macrolid antibiotics) Antifungal antibiotics, antitumor substances. Peptide antibiotics, Chloramphenicol, Sulphonamides and Quinolinone antimicrobial agents. Chemical disinfectants, antiseptics and preservatives.

Mechanism of action of antibiotics: Mechanism of action of antibiotics (inhibitors of cell wall synthesis, nucleic acid and protein synthesis)Molecular principles of drug targeting.

Drug delivery system in gene therapy, Bacterial resistance to antibiotics, Mode of action of bacterial killing by quinolinones, Bacterial resistance to quionolinones, Mode of action of non – antibiotic antimicrobial agents. Penetrating defenses – How the antimicrobial agents reach the targets (cellular permeability barrier, cellular transport system and drug diffusion).

UNIT-II

Microbial production and Spoilage of pharmaceutical Products

Microbial contamination and spoilage of pharmaceutical products (sterile injectibles, non injectibles, ophthalmic preparations and implants) and their sterilization. Manufacturing procedures and in process control of pharmaceuticals. Other pharmaceuticals produced by microbial fermentations (Streptokinase, Streptodornase).New vaccine technology, DNA vaccines, synthetic peptide vaccines, multivalent subunit vaccines. Vaccine clinical trials.

UNIT-III

Regulatory practices, biosensors and applications in Pharmaceuticals

Financing R&D capital and market outlook. IP, BP, USP. Government regulatory practices and policies, FDA perspective. Reimbursement of drugs and biologicals, legislative perspective. Rational drug design. Immobilization procedures for pharmaceutical applications (liposomes). Macromolecular, cellular and synthetic drug carriers. Biosensors in Pharmaceuticals. Application of microbial enzymes in pharmaceuticals.

UNIT-IV

Quality Assurance and Validation

Good Manufacturing Practices (GMP) and Good Laboratory Practices (GLP) in

pharmaceutical industry.Regulatory aspects of quality control.Quality assurance and quality management in pharmaceuticals ISO, WHO and US certification.Sterilization control and sterility testing (heat sterilization, D value, z value, survival curve, Radiation, gaseous and filter sterilization).Chemical and biological indicators.Design and layout of sterile product manufacturing unit.Designing of Microbiology laboratory,Safety in microbiology laboratory.

Course Learning Out come

1. Be able to understand the epidemology of pathogens.
2. Be able to know the clinical important of Cocci and bacilli and antimicrobial therapy.
3. Be able to identify sancer and pathogenic mechanism of mycotic and protozoan disease.
4. Be able to understand the pathology and laboratory disgnosis of viruses associated with human diseases.