BOARD OF STUDIES (BOS) MEETING
Held on 03-12-2021

The Board of studies in Microbiology meeting was held on 03-12-2021(by circulation) and unanimously resolved to revise the I Semester M.Sc. Microbiology and M.Sc. Industrial Microbiology syllabus for the academic year 2021-2022 onwards. As per the NEP 2020 guidelines.

MEMBERS PRESENT:

1) Prof. Ch. Paramageetham Dept. of Microbiology S.V. University TIRUPATI – 517 502.	Chairperson Board of studies	... Ch. Paramageetham
2) Prof. OVS. Reddy Dept. of Biochemistry S.V. University TIRUPATI – 517 502.	Member	... OVS Reddy
3) Prof. T. Vijaya Dept. of Botany S.V. University TIRUPATI – 517 502.	Member	... [signature]
4) Dr. J. Pramoda Kumari Dept. of Microbiology S.V. University TIRUPATI – 517 502.	Member	... Retired
5) Prof. J. Savitha Dept. of Microbiology Bangalore University BAMGALORE.	Member	... out of country
6) Prof. T. Rathnakumar Dept. of Botany Andhra University VISAKHAPATNAM.	Member	... Retired

Ch. Paramageetham.

A TWO YEAR

MASTER OF SCIENCE IN INDUSTRIAL MICROBIOLOGY

(Choice Based Credit System-semester system)

REVISED SCHEME OF INSTRUCTION & SYLLABUS

As per the action plan of

National Education Policy (NEP)-2020

(Effective from the batch of students admitted from the academic year 2021-2022)

DEPARTMENT OF MICROBIOLOGY

SRI VENKATESWARA UNIVERSITY:TIRUPATI

SRI VENKATESWARA UNIVERSITY::TIRUPATI

DEPARTMENT OF MICROBIOLOGY
M.Sc. INDUSTRIAL MICROBIOLOGY PROGRAMME

SEMESTER – I

Sl. No.	Components of Study	Course code	Title of the course	Credit hours/ week	No. of Credits	IA	SEEM	Total Marks
1	Core-Theory	IMB-101	Introductory Microbiology	6	04	20	80	100
2	Core-Theory	IMB-102	Microbial Physiology	6	04	20	80	100
3	Compulsory Foundation	IMB-103	Biochemistry	6	04	20	80	100
4	Elective Foundation	IMB-104	Biophysics and Biostatistics	6	04	20	80	100
5	Practical-I	IMB-105	Introductory Microbiology & Microbial Physiology	6	04	-	100	100
6	Practical-II	IMB-106	Biochemistry & Biophysics and Biostatistics	6	04	-	100	100
Total				36	24	80	520	600

7	Audit Course** (Self-Study)		**Human and Professional Ethics - I**	0	-	100	-	-

SEMESTER – II

Sl. No.	Components of Study	Course code	Title of the course	Credit hours/ week	No. of Credits	IA	SEEM	Total Marks
1	Core-Theory	IMB-201	Molecular Biology	6	04	20	80	100
2	Core-Theory	IMB-202	Recombinant DNA technology	6	04	20	80	100
3	Compulsory Foundation	IMB-203	Immunology	6	04	20	80	100
4	Elective Foundation	IMB-204	Medical Microbiology	6	04	20	80	100
5	Practical-I	IMB-205	Molecular Biology and Recombinant DNA Technology	6	04	-	100	100
6	Practical-II	IMB-206	Immunology and Medical Microbiology	6	04	-	100	100
Total				36	24	80	520	600
7	Audit Course** (Self-Study)		**Online Courses from MOOS/ NPTEL**	0	-	100	-	-

SEMESTER – III

Sl. No.	Components of Study	Course code	Title of the course	Credit hours/ week	No. of Credits	IA	SEEM	Total Marks
1	Core-Theory	IMB-301	Basics of Industrial Microbiology	6	04	20	80	100
2	Core-Theory	IMB-302	Bioprocessing of Industrial Microorganisms	6	04	20	80	100
3	Generic Elective	IMB-303	a) Pharmaceutical Microbiology b) Downstream Processing	6	04	20	80	100
3	Practical	IMB-304	Basics of Industrial Microbiology and Bioprocessing of Industrial Microbiology	6	04	-	100	100
4	Skill Oriented Course	IMB-305	Industrial Food Microbiology	6	04	20	80	100
5	Open Elective	IMB-306	a) Computational Biology b) Industrial Biotechnology	6	04		100	100
Total				36	24	80	520	600
7	Audit Course** (Self-Study)		**Online Courses from MOOS/ NPTEL**	0	-	100	-	-

SEMESTER – IV

Sl. No.	Components of Study	Course code	Title of the course	Credit hours/ week	No. of Credits	IA	SEEM	Total Marks
1	Core-Theory	IMB-401	Animal and plant cell culture	6	04	20	80	100
2	Core-Theory	IMB-402	Industrial based Microbial clean technology	6	04	20	80	100
3	Generic Elective	IMB-403	a) Industrial production of Microbial product b) Industrial Microbial Technology	6	04	20	80	100
3	Practical	IMB-404	Animal and plant cell culture and Industrial based Microbial clean technology	6	04	-	100	100
4	Project Work	IMB-405	Field Trip/ Industrial Tour Report / Dissertation	6	04	20	80	100
5	Open Elective	IMB-406	a) Bioethics, Biosafety and Intellectual property rights b) Microbial Production of Alcoholic beverages.	6	04		100	100
Total				36	24	80	520	600
7	Audit Course** (Self-Study)		**Online courses from MOOCs / NPTEL**	0	-	100	-	-

- All CORE Papers are Mandatory
- Generic Elective - Choose any one
- Project Work –In house/Research institutes, National laboratories, Central Universities
- Multi-disciplinary course is Mandatory.
- Skill based course Mandatory
- Open Electives are for the Students of other Departments. Minimum One paper should be opted. Extra credits may be earned by opting for more number of open electives depending on the interest of the student through self study
- Interested students may register for MOOC with the approval of the concerned DDC

VISION: To build a global standard in microbiology research and teaching, and to be a guiding light worthy of emulating.

Mission: To provide wholesome experience and knowledge to students to develop into exemplary leaders of the future in academic and outside arena.

- To pursue and promote world-class research and training at the frontiers of microbiology
- To move up through International & national alliances and collaborative initiatives to excel globally in Microbiology and Biotechnology research and education.

CHOICE BASED CREDIT SYSTEM (CBCS):

The CBCS provides an opportunity for the students to choose courses from the prescribed courses comprising core, elective/minor or skill-based courses. The courses can be evaluated following the grading system, which is considered to be better than the conventional marks system. Grading system provides uniformity in the evaluation and computation of the

Cumulative Grade Point Average (CGPA) based on student's performance in examinations which enables the student to move across institutions of higher learning. The uniformity in evaluation system also enables the potential employers in assessing the performance of the candidates

PROGRAM EDUCATIONAL OBJECTIVES

The Program Educational Objectives (PEOs) for the M.Sc. Industrial Microbiology program describe accomplishments that post graduates are expected to attain within two years after post graduation:

PEO-1: To exhibit ability to pursue careers in the industry, agriculture, and applied research where microbial systems are increasingly employed.

PEO-2: To address the increasing need for skilled scientific manpower, contributing to application, advancement and impartment of knowledge in interdisciplinary areas related to industrial Microbiology.

PEO-3: To exhibit excellent professional skills, communication skills and ethical attributes as an effective team member. in a competitive global environment

PEO-4: To demonstrate right mixes of innovative ability, equipped with entrepreneurship abilities contributing to self and national development.

PEO-5: The post graduates will be cognizant and responsive to the societal needs and will possess the initiative and critical acumen required to continuously improve their knowledge through life long learning.

PROGRAMME OUTCOMES

PO-1: Grasp of basic and advanced knowledge on various domains of Microbiology.

PO-2: Ability to integrate technologies through an inter-disciplinary learning habit.

PO-3: Demonstrate an independent thinking ability.

PO-4: Ability to communicate effectively.

PO-5: Equipped with laboratory skills in microbiology.

PO-6: Awareness of the impact of biosolutions in a global, economic, environmental, and societal context.

PO-7: Understanding of professional and ethical responsibility.

PO-8: Ability to design and conduct experiments, as well as to analyze and interpret scientific data.

PO-9: Awareness of contemporary issues that can be mitigated or supported through life science know how and industrial microbiology skills.

PO-10: Recognition of the need for, and an ability to engage in life-long learning.

PROGRAM SPECIFIC OUTCOMES

PSO-1: Equips capacity to venture into a career in bio based industries as scientists or technologists in the division of production, research and developmental settings.

PSO-2: Demonstrate the concepts and research approach for their higher career in the field of microbiology and develop their scientific interest.

PSO-3: Administer skill sets to understand the rationales behind various regulatory/legal bodies governing the R&D in the pharmaceutical industry.

PSO-4: Exhibit in-depth practical oriented knowledge to students in various thrust areas of industrial microbiology, so as to meet the global demands of industry and academia.

PSO-5: 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.

FIRST SEMESTER

IMB - 101: INTRODUCTORY MICROBIOLOGY

Course Learning Objective

1. To provide information on Microscopy and staining materials that helps to observe microorganism.
2. To provide detailed knowledge on Isolation, cultivation and enumeration of microorganisms.

3. To provide in that knowledge about classification and taxonomy of microorganisms.
4. To information on prokaryotic eukaryotic microorganisms.

UNIT – I

History and Scope of Microbiol–gy - Discovery of microorganisms and development of microbiol–gy - Contributions of pioneers- Prokaryotic and Eukaryotic microorgani–ms - Origin and evolution of microorganisms. Distinguishing of different microorganisms-Scope and relevance of Microbiol–g dentture of Microbiology.

Microbial Struct–re - 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 dentify port 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 Taxonom dentify tryical, 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).

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, Neurospo dentify opus, 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.*

Courses Learning Out Comes

1. Be able to know the microbial structure, sterilization disinfection techniques.
2. Be able to know they maintain and preservation of microbial culture.
3. Be able to know nomenclature taxonomic read and major characteristics uses in taxonomy.
4. Be able to know the discovery, classification, structure and importance of Prokaryotic, fungi, algae and protozoa.

Suggested Books:

1. Brock Biology of Microorganisms. 199^{7,} 8th ed. Madigan et al., Prentice-Hall International, Inc.
2. Microbiology. 199$^{9.}$ 3rd ed. Prescott et al. Wm. C. Brown Publ.
3. Principles of Microbiology. 199$^{7.}$ 2nd ed. R.A. Atlas. Wm.C. Brown. Publ.
4. Foundations in Microbiology. 199$^{6.}$ 2nd ed. K. Talaro and A. Talaro. Wm. C. Brown Publ.
5. Microbiology. 199$^{6.}$ 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. 199$^{6.}$ 4th ed. Alexopoulos et al., John Wiley and Sons.
11. Introductory Psychology by H.D. Kuma$^{r.}$ 2nd ed. 1999. East West Press.

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	1	1	-	-	-	1	1
CO_3	3	2	1	2	3	2	2	-	-	-	1	1
CO_4	3	2	2	2	2	2	2	-	-	-	1	1

IMB - 102: MICROBIAL PHYSIOLOGY

Course Learning Objective

1. To provide insights in to nutrition, microbial growth.
2. To know concepts of biogenetics, photosynthesis and carbon metabolisms.
3. To provide in depth information about aerobic and anaerobic respiration and lipid metabolism.
4. To provide detailed information on protein, nucleic acid, secondary metabolisms.

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 bacter dentify tonal mutants and their use in metabolic studies.

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: building of macromolecules from elemental nutrients, supramolecules, cell components and cells; cell cycle in microbes and generation times; batch culture phases and importance of each phase, continuous cultures, synchronous culture, factors influencing the microbial growth.
Nature and properties of spores – Physiology and biochemistry dentify tion and germination of spores.

UNIT – II

The concepts of microbial metabolism, primary and secondary metabolism and their significance.
Bioenergetics: Concepts of free energy and thermodynamic principles in biology, energy transformation, ATP cycle, standard free energy of hydrolysis of phosphate compounds, energy transducers, redox potentials, free energy changes in redox reactions.

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

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

UNIT – III

Aerobic respiration : TCA cycle – intracellular location and reactions of the cycle, amphibolic nature of the cyc dentify tics 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.

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

UNIT – IV

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.

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 (aflotoxin and corynebacterial), hormones (GA), and antibiotics (penicillin and streptomycin).

Microbial toxins and extra cellular enzymes: Exo-and endotoxins: physiology of toxin production; mode of action of toxins and extra cellular enzymes and their importance in pathogen virulence and pathogenesis.

Course Learning Out Comes

1. Be able to know about the nutrition and microbial growth.
2. Be able to know about photosynthesis and carbon.
3. Be able to know in depth details about aerobic and anaerobic respiration.
4. Be able to know in depth about various pathways in protein and nucleotide metabolisms.

Suggested Books:

1. Microbial Physiology and Metabolism. 1995, by D.R. Caldwell. Wm.C. Brown Publ.
2. Microbial Physiology. 199^{9,} 3rd Ed. by A.G. Moat & J.W. Foster. Wiley-Liss.
3. Principles of Biochemistry. Lehinger. 2000.
4. Foundations in Microbiology. 1996. by K. Talaro & A. Talaro, Wm. C. Brown Publ.
5. Microbiology. 2000. By Prescott et al. Wm. C. Brown Publ.
6. Molecular Cell Biology. 2000 – by Lodish et al.
7. General Microbiology, 1999 by Stainer et al., Macmillan Educational Ltd.

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	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	1	2	1	1	-	-	-	1	1
CO_3	3	1	1	2	3	2	2	-	-	-	1	1
CO_4	3	2	2	2	2	2	2	-	-	-	1	1

IMB – 103: BIOCHEMISTRY

Course Learning Objective

1. To provide basic concepts of chemistry in life.
2. To provide in depth information lipids and amino acids.
3. To provide in depth information on proteins and catalytic proteins.
4. To provide in depth information in nucleic acids, hormones and vitamins.

UNIT – I

Basic concepts of Chemistry of life : The major elements of life and their primary characteristics; atomic bonds and molecules – bonding properties of carbon, covalent and non-covalent bonds, Vander waals forces; polarity, hydrophilic and hydrophobic interactions; asymmetry of carbon compounds and cis-trans isomerism; electron transfer and oxidation/reduction; functional groups of organic compounds; hydrogen

ion concentration of biological systems; Brownsted – Lowry acids and bases; ionization and titration of acids; dissociable biological compounds and physiological buffer systems.

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).

UNIT – II

Lipids: Building blocks of lipids. Classification of lipids. Fatty acids-physico-chemical properties, separation, distribution in nature characterization and saponification and iodine number. Nomenclatu dentifyline structures, properties and functions of glycerides, neutral lipids (waxes, fats, oils, phospholipids, sphingolipids and glycolipids. Steroids – plant sterol, ergosterol, stigmasterol, cholesterol. Lipoproteins-classification, composition and importance. Salient features of bacterial lipids.

Amino acids : Classification, structu dentisico-chemical properties, acid-b dentifyiour 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, peptides profiling.

UNIT – III

Proteins : Classification, properties and biological functions of proteins; structural organization of proteins – primary, secondary, tertiary and quaternary; Ramachandran's plot; proteins denaturation and renaturation (ribonuclease); structure-function relationships of certain proteins – myoglobin, hemoglobin, collagen; chaperones.

Catalytic proteins(enzymes) : Classification, nomenclature, composition and structure, enzymes as biocatalysts, outlines of purification and assay of enzymes, kinetics of enzyme catalyzed reactions, factors influencing enzyme catalyzed reactions, regulation of enzyme activity – activators and inhibitors dentify nism of action of enzymes (chymotrypsin). Regulatory enzymes – allosteric enzymes. Isoenzymes, conzymes, ribozymes, abzymes.

UNIT – IV

Nucleic acids : Types and their composition, structures of purines, pyrimidines, modified bases, nucleosides, nucleotides and polynucleotides; properties of bases and functions of nucleotides; types and structural polymorphism of DNA and RNA; denaturation and renaturation of nucleic acids, factors influencing hybridization, cot values.
Hormones and Growth regulators : Classification, outline structures and functions of major animal and plant hormones.
Vitamins : Discovery and outline chemistry of fat soluble (A,D,E and K) and water soluble (riboflavin, pantothenic acid, niacin, pyridoxine, biotin, cobalamine folic acids and ascorbic acid) vitamins and their role in body functions.
Porphyrins and other pigments : Classification, structures and biological functions of porphyrins, brief account of haemoglobin and chlorphylls, cytochromes, xanthophylls and carotenoids of microorganisms.

Course Learning Out Comes

1. Be able to identify and analyze carbohydrates and 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.

Suggested Books:

1. Principles of Biochemistry, Lehninge^{r,} 3rd edition, 2000 by Nelson and Cox (Worth).
2. Biochemistry, Stry^{er} 5th edition, W.H. Freeman, 2001.
3. Microbial Physiology and Metabolism. 1995, by D.R. Caldwell. Wm.C. Brown Publ.

4. Microbial Physiology. 199[9,] 3rd ed. By A.G. Moat & J.W. Foster. Wiley-Liss.
5. Foundations in Microbiology. 1996. By K. Talaro & A. Talaro, Wm. C. Brown Publ.

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CO_1	3	2	2	2	2	2	2	-	-	-	1	1
CO_2	3	2	1	2	2	2	1	-	-	-	1	1
CO_3	3	1	2	2	3	2	2	-	-	-	1	1
CO_4	3	2	2	2	2	2	1	-	-	-	1	1

IMB – 104: BIOPHYSICS & BIOSTATISTICS TECHNIQUES

Course Learning Objective

1. Gives in sights on electrochemical and spectroscopy concepts.
2. Provide in depth knowledge on separation techniques such as centrifugation, electrophoresis and chromatography.
3. Give detailed information on interval date, proportion data and count data.
4. Provide knowledge on statistical basis of biological assays and design of experiments.

UNIT – I

Electrochemcial techniques (Principles and applications): Redox reactions; pH and Clarke oxygen electrodes; biosensors.

Cell sorting and Flow cytometry (Principles and applications):

Radioisotope techniq–es - Nature and types of radioactivity, half-life of isotopes; detection and measurement of radioactivity-GM counter, liquid scintillation counter, gama-ray counter, Cerenkov counting and autoradiography; quenching and quench correction; laboratory safety measures in handling isotopes; biological uses of radioisotopes.

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.

Amino acid and nucleotide sequencers: Basic principle, functioning and applications of amino acid and nucleotide sequencers.

UNIT – II

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 (star dentify mide and agarose) disc, vertical, horizontal submarine, gradient, 2-dimentional, pulse-field and capilla dentifsing; isolation and analysis of gel separated molecules – recovery of molecules from paper/gels; Southern, Northern and West dentifyings.

Chromatography: Principle/simple theory and applications of partition, adsorption, ion-exchange, gel permeation and affinity chromatography based techniques – paper, thin-layer, column, GLC, HPLC, FPLC.

UNIT – III

Introduction: Definition of statistics: population and universe, the sample and population, statistical inference; parameter and statistics.

Interval Data: Mean, mode, median and standard deviation. Concept of probability – classical and frequency definitions; axiones of probability; addition and multiplication theorems (statements only); conditional probability-Baye's theorem (statement only); simple applications. Binomial, Poisson and Normal distributions (definitions and uses only).

Uncertainties in estimation of mean, comparison of means and variances – t, F, and Z tests.
Proportion data: examples of proportion data; (MPN, sterility testing of medicines, animal toxicity, therapeutic trial of drugs and vaccines, animal toxicity, infection and immunization studies) statistical treatment to proportion data. Chi-square test, goodness of fit.

Count data: examples of count data (bacterial cell count, radioactivity count, colony and plaque counts) statistical treatment to count data: Poisson distribution, standard error, confidence limits of counts.

UNIT – IV

Analysis of variance: Analysis of variance: Introduction, procedure and tests for one-way and two-way classified data. Multiple comparisons. Analysis of CRD, RBD and LSD. Factorial experiments- main effects and interaction in a 2^2 design, Duncan's Multiple Range Test.

Correlation and regression, formulae and application. Fitting straight line through a series of points. Fitting of exponential curves. Standard curve and interpolation of unknown Y-values. Multiple linear regression, logistic regression.
Statistical basis of biological assays: Response-Dose metameter. Delusion Assays, Direct and indirect assays. Quantal Responses, Probit, logit, LD_{50}, ED_{50}, PD_{50} – Standard line interpolation assay, parallel assay (4 point, 6 point assays), slope ratio assay.
Design of Experiments – Multiple comparison tests, Dunken's, Tukey's, Scheffic's, Dunnelt's etc.
Probit Analysis
Multiple Regression, Logistic regression
Discriminate Analysis
Clinical trails – Phase I, Phase II etc.
Clinical trails (meaning and importance only).

Course Learning Out Comes

1. Be able to know the principal function and applications of spectroscopy, amino acid nucleotide sequences.
2. Be able to know principle, function and applications of separation techniques.
3. Be able to gain knowledge on basic concepts in statistics.
4. Be able to design the experimental and statistical basics of biological assays.

Suggested Books :

1. Practical biochemistry : Principles and Techniques 199[5,] 4th Ed. by K. Wilson and J. Walker, Cambridge University Press.
2. Modern Experimental Biochemistry. 199[3.] 2nd Ed. by R.F. Boyer. The Benjamin Cummings Publ. Company.
3. Physical Biochemistry : Applications to Biochemistry and Molecular Biology, 198[2,] 2nd Ed. by David Freifelder. W.H. Freeman and company.
4. Introduction to Practical Biochemistry. 2000. by S.K. Sawhney and Randhir Singh (eds). Narosa Publ. House.

5. Biochemical Methods for Agricultural Sciences. 1992 by S. Sadasivam and A. Manikam. Wiley Eastern Ltd.

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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

PRACTICAL:
IMB – 105: INTRODUCTORY MICROBIOLOGY & MICROBIAL PHYSIOLOGY:

1. Microbiological laboratory safety measures
2. Sterilization methods - Wet method, Dry method, Filters. Evaluation of alcohol effectiveness, Phenol coefficient method
3. Preparation of different media for cultivation of bacteria & fungi
4. Plating techniques – streak plate, spread plate methods
5. Enumeration of Bacteria by serial dilution, viable count
6. Qualitative tests for identification of Carbohydrates, amino acids, nucleic acids
7. Quantitative tests for Protein, gluco dentifcine, bilirubin, cholesterol, Inorganic phosphorous
8. Determination of activity of – Peroxidase and Polyphenol oxidase in plant tissues.
9. Purification and study of Acid Phosphatase from potato tubers: Extraction of enzyme; effect of substrate concentration; enzyme concentration; temperature; pH on enzyme activity.
10. Determination of Bacterial growth curve
11. Determination of effect of temperature on bacterial growth
12. Determination of effect of pH on bacterial growth
13. Determination of effect of salt on bacterial growth
14. Determination of growth of fungi
15. Determination of concentration of cyanobacterial pigments
16. Determination of concentration of oligodynamic action
17. Determination of activity of microbial hydrolytic enzymes like amylases, lipases and proteases.
18. Demonstration of aerobic and anaerobic respiration in microbes.
19. Demonstration of Microbial fermentation
20. Demonstration of microbial toxins

PRACTICAL:
IMB – 106: BIOCHEMISTRY & BIOPHYSICS AND BIOSTATISTCS:

1. calculating Mean, Mode Median
2. Problems related to T test & F test & Z test
3. Problems related ANOVA
4. Measurement of pH
5. Micrometry for cell size determination
6. Cell counting by Haemocytometer
7. Beer's Law
8. Determination of λ max for coloured solutions
9. Determination of DNA & RNA by UV spectrophotometry
10. Determination of nucleic acid Bases by UV spectrometry
11. Paper chromatography for separation of amino acids / pigments

12. TLC for separation of lipids / amino acids
13. Dialysis
14. Separation of proteins by SDS-PAGE
15. Separation of DNA by Agarose gel electrophoresis
16. Isolation of chloroplasts by sucrose density gradient centrifugation
17. Determination of concentration of green/yellow pigments by spectrophotometry

SECON SEMESTER

IMB - 201: MOLECULAR BIOLOGY

Course Learning Objective

1. Gives basic concepts in genetics of bacteria and fungi
2. Provides in depth knowledge on genetic recombination
3. Gives overall picture about DNA replication and transcription
4 .Provides in depth information about RNA biosynthesis and gene regulation

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 pyrimid dentifmers; 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.

Course Learning Out Comes

1. Be able to gain knowledge on genome diversity and gene transfer mechanisms,.
2. Be able to gain information on mutations and gene transfer mechanisms
3. Be able to gain in depth-knowledge on DNA and biosynthesis
4. Be able to understand about positive and negative gene regulation

Suggested Books:

1. microbial Genetics by S.R. Maloy et al. 1994
2. Molecular Genetics of Bacteri[a,] 3rd ed. 1998. J.W. Dale. Wiley Publ.
3. Bacterial and Bacteriophage Genetic[s.] 4th ed. 2000. By E.A. Birge. Springer.
4. Principles of Molecular Virolog[y.] 4th ed. 2004. By A. Cann. Academic Press.
5. Modern Genetic Analysis by Griffith.
6. Genetics by Gardner.
7. Molecular Cell Biology. 199[5,] 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, 199[8,] 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. 199[8,] 5th ed. Watson et al, Addison Wesley Longman.
17. Schaums Outlines – Molecular and Cell Biology. 1996. W.D. Stansfield et al., McGraw-Hill Publ.

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

IMB - 202: RECOMBINANT DNA TECHNOLOGY

Course Learning Objective

1. Gives basic concepts in genetic engineering tools
2. Provides in depth knowledge on molecular tools
3. Gives overall picture about transgenics
4. Provides in depth information about proteome and genomes microbiology

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).

UNIT – IV

Microbial genomics and proteomics : DNA microarray – printing of oligonucleotides 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.

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

Course Learning Out Comes

1. Be able to gain knowledge on genetic engineering tools,.
2. Be able to gain details on molecular tools
3. Be able to gain in depth-knowledge on transgenic plants
4. Be able to understand about 'omics"

Suggested Books:

1. Principles of Gene Manipulation: An introduction to genetic engineering. 199[4]. 5th ed. Old and Primrose. Blackwell Scientific Publ.
2. Molecular Biotechnology. 1994. Glick and Pasternak. Panima Publ.
3. Recombinant DNA. 199[2]. 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. 200[2]. 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, 200[1]. 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.

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CO_2	3	2	2	1	2	2	1	-	-	-	1	1
CO_3	3	1	2	2	3	2	2	-	-	-	1	1
CO_4	3	2	2	2	2	1	2	-	-	-	1	1

IMB - 203: IMMUNOLOGY

Course Learning Objective

1. Give 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

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.

UNIT – II

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

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 dou dentimuno 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, Ra dentimuno assay (RIA), Immunoflurescent dentimuno 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 mediates 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 : Immunodefficiencies – Primary immunodeficiency (genetic) diseases due to B cell, T-cell and combined defects (Hypogamma globulinemia, SCID, ADA) phagocyute and complement defects. Autoimmune diseases – Autoimmunity, induction, mechaniss 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 HMC, cellular distribution of HMC molecules, regulations of HMC 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 – Hemolytic anemi dentify osis 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.

Course Learning Out Comes

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

Suggested Books:

1. Immunology. 200$^{0.}$ 4th edition. J. Kuby. W.H. Freeman and Company.
2. Immunology. 199$^{6.}$ 4th edition. I. Roitt, J. Brostoff and David Male. Mosby publications.
3. Fundamental Immunology. 199$^{2.}$ 2nd edition. R.M. Coleman, M.F. Lombard and R.E. Sicard. Wm. C. Brown Publishers.

4. Immunology. 199[7]. 3rd edition. R.M. Hyde. B.I. Waverly Pvt. Ltd.
5. Immunology. 199[5]. 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. 1986. 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.

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CO_1	3	2	2	2	2	1	2	-	-	-	1	1
CO_2	3	2	2	2	2	2	1	-	-	-	1	1
CO_3	3	2	1	2	3	2	2	-	-	-	1	1
CO_4	3	1	2	2	2	2	2	-	-	-	1	1

IMB - 204: MEDICAL MICROBIOLOGY

Course Learning Objective

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.*

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.

Suggested Books :

1. Ananthanarayan R, Panikar CKJ (2000). Textbook of Microbiology. 201$^{3.}$ 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.

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CO_2	3	1	2	2	1	2	1	-	-	-	1	1
CO_3	3	2	2	2	3	2	2	-	-	-	1	1
CO_4	3	2	2	2	2	2	1	-	-	-	1	1

PRACTICALS:

IMB: –205 - Molecular Biology and Recombinant DNA Technology

Course Learning Objective

1. Gives hands on experience in important molecular methods.
2. Provides hands on experience on PCR and Recombinant DNA techniques .
3. Will gain knowledge in biosinformatics and molecular biology information

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

Course Learning Outcomes

1. Able perform DNA and plsmid isolations.
2. Be able to amplify the given gene.
3. Be able to gain practical knowledge about molecular tools.
4. Be able to create a chimeric molecule.
5. Be able to perform bioinformaticstools in genomics.

IMB: –206 - Immunology and Medical Microbiology

Course Learning Objective

1. Gives hands on experience in Immuno precipitation test.
2. Provides hands on experience on various ELISA methods.
3. Will gain knowledge in immunoglobulins.
4. Gives hands on experience on blood related tests.
5. Given knowledge on virus cultivation.
6. Provides hands on experience on various diagnostic tests.

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
15. Widal Test
16. VDRL Test
17. Total counting of RBC & WBC
18. Differential count of WBC
19. Hemoglobin estimation
20. Latex agglutination test
21. Blood typing and Rh determination
22. Identification of pathogenic organisms based on HIV& DOT-BLOT test
23. Hanging drop experiment for bacterial motility.
24. Microbiological staining techniques – Simple, Gram negative, spore, capsular, acid fast and Lactophenol-cotton blue staining.
25. Isolation of bacteriophages from sewage water.
26. Cultivation of viruses in embryonated Chicken eggs: different routes of virus inoculation – Yolk sac, Allontoic and Chorio Allontoic Membrane (CAM).

Course Learning Outcomes

1. Able performs various immune 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.

4. Be able to perform widal, VDRL and types.
5. Be able to perform various staining procedures.
6. Be able to identify blood cell types.

THIRD SEMESTER

IMB - 301: BASICS OF INDUSTRIAL MICROBIOLOGY

Course Learning Objective

1. To give indepth information about industrially important microorganisms.
2. To prove information about recombinant molecular in pharmaceutical, 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

Definition and scope of Industrial Microbiology – Historical development – chronological order of outstanding scientific achievements, concepts and practices of microbiology proceeded to Industrial Microbiology.

UNIT – II

Industrially important microorganisms – Introduction to industrially important microorganisms – Bacteria, fungi, actinomycetes, microalgae, viruses – culture techniques, collection isolation, identification, maintenance of microorganisms. Generally regarded as safe (GRAS) microorganism dentifyeria, Yeasts, Filamentous fungi, Industrial strains, improvement of strains and study of strain stability.

UNIT – III

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-IV

Role of microorganisms in various industries – Food – yeast, mushroom, microalgae and food spoilage organisms. Pharmaceuticals – production of aminoacids, antibiotics, diagnostic proteins, enzymes, hormones, vaccines, vitamins and role of transformed microorganisms in pharmaceuticals. Agriculture – Biofertilizers, biopesticides, biocontrol of microbial pathogens. Industrial enzymes-microbial enzymes, application in food, leather, textile, paper, detergent industries, role of transformed microorganisms in enzymes production. Bioremediation-pesticides, fungicides, preservatives, waste recycling, industrial effluent treatment. Dairy – important microbes in dairy and dairy products. Conventional and recombinants microorganisms involved in the production of ethanol, aminoacids, organic acids – Methanogens and methylotrops.

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 gain the concepts in waste recycling and industrial efficient.

Suggested Books:

1. Industrial Microbiology. 2001. M.J. Waites et al., Blackwell Science.
2. Industrial Microbiology. 1999. L.E. Casida, Jr. New Age International Publ.
3. Industrial Microbiology. B.M. Miller and W. Litsky.
4. Industrial Microbiology. 1984. A.H. Patel. Macmilan India Limited.

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	1	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	1	2	1	2	2	2	-	-	-	1	1

IMB – 302: BIOPROCESSING OF INDUSTRIAL MICROORGANISMS

Course Learning Objective

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

Introduction to Bioprocesses – Historical development and scope of bioprocessing technology, traditional and modern applications of bioprocessing, intergrated bioprocess and various unit operations involved in bioprocessing (upstream and down stream), generalized process flow sheets.

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 – Kintetic 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.

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 idea about dairy products and fermented products.

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.

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	1	2	2	1	2	-	-	-	1	1
CO_2	3	1	2	2	2	2	1	-	-	-	1	1
CO_3	3	2	2	2	3	2	2	-	-	-	1	1
CO_4	3	2	2	1	2	2	2	-	-	-	1	1

IMB – 303: a) PHARMACEUTICAL MICROBIOLOGY

Course Learning Objective

1. To give information on Pharmaceutical of microorganisms
2. To know about Pharmaceutical production of various value added products
3. To provide information on Pharmaceutical Microbiology transformations
4. To provide in depth information on microbial production of recombinant molecules

UNIT – I

Animal Cell Culture: Scope of animal cell culture, principles and methodology of animal cell cultures, physical chemical and metabolic function of the constituents of culture media and reagents, primary, secondary and continuous cell lines, stem cell and embryonic cell isolation and culture, organ culture. Sub culturing, maintenance and preservation of cell cultures.

Transgenesis for improvement of traits and use of animals as bioreactors for production of proteins of pharmaceuticals value, marker assisted selection and genetic improvement of livestock, Germplasm, maintenance and Biodiversity.

Industrial importance of animal cell culture products – viral vaccines for human and animal use, production of interferon, interleukins, retroviruses and adenoviruses and produced for use in gene therapy, large scale production of Bio-Insecticides – Baculoviruses, NPV, GV, cell cultures used for diagnostic assay system, therapeutics.

UNIT – II

Plant cell culture – Embryo culture, meristem culture, callus culure, anther culture, protoplast culture, cell suspension, spore culture, protoplast isolation culture and fusion regeneration and somatic hybridization and regeneration of plants.

Scope of plant cell culture – Major sources of pharmaceuticals, dyes, food colours and flavours, enzymes, polysaccharides, fragrances, insecticides, herbicides, products of secondary metabolites. Production of Shikonim and culturing of Microalgae. Industrial advantages and disadvantages of plant tissue culture – Cell and organ differentiation – Clonal propagation or micropropagation. Application of cell culture for mutant selection, production of secondary

metabolites, transformations, production of transgenic plants for herbicide resistance, insect resistance and disease resistance, nutritional quality improvement, as bioreactors for vaccines.

UNIT – III

Historical review of the involvement of microbiology with pharmaceutical practice, the impact of microorganisms in pharmaceutical device manufacture, microbial contamination control in pharmaceutical manufacturing, implementation of Rapid Microbiological Methods(RMM) for pharmaceutical laboratories, the broader picture of microorganisms and pharmaceutical manufacturing: Challenges, Solutions and Pharmacopoeial guidance.

UNIT – IV

Drug targeting principles: Targeting, Principles and its importance in therapeutics, Methods in drug targeting, advantages and disadvantages in targeting, protein and peptide based drug delivery systems.

The drug development process: Drug Discovery the impact of genomics and related technologies upon drug discovery. Delivery of Biopharmaceuticals-Oral delivery systems – Pulmonary delivery – Nasal, transmucosal and transdermal delivery systems.

Immunopharmacology: The interferon family, cytokines as Biopharmaceuticals. TNF – therapeutic aspects. Haemopoietic growth factors, Growth factors, Hormones of therapeutic interest, Blood products, therapeutic enzymes and Nucleic acid therapeutics.

Course Learning Out Comes

1. Be able to know about microbes and bioreactors
2. Be able to understand the process economics and down stream processing
3. Be able to understand about patenting
4. Be able to gain in depth idea about recombinant therapeutic molecules

Suggested Books:

1. Tim Sandle, (2011)Selection of Microbiological Culture Media and Testing Regimes
2. Sandy Rubio,(2011) Validation of Microbiological Methods by Business Horizons;
3. Masakazu Tsuchiya,(2010)Bacterial Endotoxins Test by bioprocess awards
4. Michael J. Miller,(2013)The Implementation of Rapid Microbiological Methods by European Pharmaceutical company
5. Matts Ramstorp,(2012) Microbiology and Sterility Assurance in Pharmaceuticals and Medical Devices by Madhu Raju Saghee, Tim Sandle and Edward C. Tidswell,UK
6. Sandle, T. (2012). The CDC Handbook: A Guide to Cleaning and Disinfecting Cleanrooms, Grosvenor House Publishing: Surrey, UK
7. Sandle, T. and Saghee, M.R. (2013). Cleanroom Management in Pharmaceuticals and Healthcare, Euromed Communications: Passfield, UK

8. Wulf Crueger and annelies Crueger (2000) Biotechnology : A Text book of Industrial Microbiology (2ed) Panima publishing Mc Graw Hill book
9. Peppler (2003) Microbial techonology. by CRC Press, Canada.
10. Jogdand (2001) Medical Biotechnology, by New Age Publishers, New Delhi
11. Gary Walsh (2013) Pharmaceutical Biotechnology: Concepts and Applications. By wiley.
12. Fowler MW, Warren GS, Murray Moo-Young (2013) Plant Biotechnology: Comprehensive Biotechnology Second Supplement. Elsevier.
13. John M. Davis (2011) Animal Cell Culture: Essential Methods. By Wiley.

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	1	2	2	2	-	-	-	1	1
CO_2	3	1	2	2	2	1	1	-	-	-	1	1
CO_3	3	2	1	2	3	2	2	-	-	-	1	1
CO_4	3	2	2	2	2	2	2	-	-	-	1	1

IMB – 303: b) DOWNSTREAM PROCESSING

Course Learning Objective

1. To gives detailed knowledge about upstream and downstream processing during vitamins, Antibodies, Microbial enzymes and Recombinant and synthetic vaccines.
2. To gives information on various separation processes.
3. To gives information on membrane separation & enrichment operations.
4. To understands the various technologies (such as chromatography, chromate focusing, electrophored C, Dialysis and crystallization methods) used for tradition of downstream processed production.

UNIT – I

Processing – Industrial fermentation – Importance of upstream processing (USP) and Downstream processing (DSP). Role of Downstream processing in industrial fermentation processes, problems and requirements of bioproduct purification. Cell harvesting – broth conditioning, sedimentation, centrifugation, filtration. Cell disruption – mechanical and non-mechanical. Product recovery – Chromatography and dialysis. Distillation and various finishing steps-crystallization, drying. Inclusion bodies and the role of genetic engineering in DSP. Economics of downstream processing.

UNIT – II

Physico – chemical basis of bio-separation processes. Recent development in product isolation – one step purification, reverse microcellular extraction on line membrane separation. Primary separation and recover process – cell disruption methods for intracellular products, removable of insoluble, biomass separation techniques, products flocculation and sedimentation, centrifugation and filtration methods.

UNIT – III

Membrane separations – membrane based separation – micro and ultrafiltration, theory, design and configuration of membrane separation and applications of equipments used.

Enrichment operations – Precipitation methods – salts, organic solvents, polymers, extractive separations, aqueous two-phase extraction, supercritical extraction in situ product removal, integrated bioprocessing.

UNIT – IV

Separation, product resolution, fractionation of downstream processed products by using different technologies – electrophoresis (1D, 2D, gels), chromatography – (Paper, TLC, Absorption, Iox exchange, Gel filtration, Affinity chromatographic separation, GC, HPLC, FPLC, Chromato focusing electrophoretic separations). Dialysis, crystallization, super liquid extraction foam based separation. Study the above process with suitable industrial products.

Course Learning Out Comes

1. Be able to produce and assay the various Industrial products.
2. Be familiar with various physics-chemical methods involved in bio-seperation process.
3. Be acquint themselves with enrichment operations and membrane seperations.
4. Be able to carry out separation and product resolution.

Suggested Books:

1. Basic Biotechnology, 2001. 2nd ed. ed by C. Ratiedge & B. Kristiansen, Cambridge University Press.
2. Manual of Industrial Microbiology and Biotechnology, Second edition. 1999. A.L. Demain, Editor in Chief, ASM Press.
3. Biotechnology : A test Book of Industrial Microbiology. Second edition, 2000. Ed. W.Crueger & A.Crueger.Panima Publishing corporation.
4. Industrial Microbiology : An Introduction by M.J. Waites et al. Blackwell Science. 2001. Prescott & Dunn's Industrial Microbiology. Fourth edition, 1999.Edited by Gerald Reed. CBS Publishers and distributors.

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	1	2	1	2	2	1	-	-	-	1	1
CO_3	3	2	2	2	3	1	2	-	-	-	1	1
CO_4	3	2	2	2	2	2	2	-	-	-	1	1

IMB- 304: PRACTICALS: Basics of Industrial Microbiology and Bioprocessing of Industrial Microbiology

Course Learning Objective

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

1. Isolation, identification and culturing of industrially important microbes – Bacteria, yeast, filamentous fungi from different natural sources.
2. Formulation different simple and complex fermentation media.
3. Production of organic acid from different microbial organism.
4. Production of microbial enzymes and confirmation tests.
5. Estimation of biomass.
6. Estimation of substrate product analysis.
7. Study of growth substrate utilization and product formation – Flask cultures.

Course Learning Out Comes

1. Be isolation, identification and culturing of industrially important microbes.
2. Be formulation different simple and complex fermentation media.
3. Be growth substrate utilization and product formation – flask cultures.

IMB – 305: INDUSTRIAL FOOD MICROBIOLOGY

Course Learning Objective

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

UNIT – I

Food infected by microbes – Types of foods, microorganisms infects various foods. Molds, yeast and bacteria and their important in food microbiology. Extrinsic and Intrinsic factors influencing microbial growth in food. Removal of microorganism from food – Asepsis – Anaerobic conditions, high and low temperatures, drying. Principles of food preservation – chemical preservatives and food additives. Canning, processing for heat treatment and working out treatment parameters.

UNIT – II

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

UNIT – III

Food made by microbes – 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, yeast mushroom, algae, bacterial insecticides, legume inoculants.

UNIT – IV

Microbial enzymes as fermented products – Industrial enzymes production – Amylases – Fungal and bacterial analyses; proteolytic enzymes – Fungal and bacterial proteases; Pectinases, Invertage, other enzymes. Bioconversions – Production of alcohol, fermented beverages – bear and wine, genetically modified foods – Hazard analysis and critical control points (HACCP).

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.

Suggested Books:

1. Food Microbiology: Fundamentals and frontiers. 2001. 2nd Ed. M.P. Doyle et al., ASM Press.
2. Food Microbiology. 1995. M.R. Adams and M.O. Moss. Royal Society of Chemistry Publication, Cambridge.
3. Food Microbiology. 1988. Frazier WC and Westhoff Dc. Tata Mc Graw Hill Publishing Company.
4. Dairy Microbiology. 1990. Robinson R.K. Elsevier Applied Sciences London.
5. Microbial enzymes & Biotechnology. W.M. Fogarty and C.T. Kelly.

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	1	2	-	-	-	1	1

CO_2	3	2	2	1	2	2	1	-	-	-	1	1
CO_3	3	1	2	2	3	2	2	-	-	-	1	1
CO_4	3	2	2	2	2	2	2	-	-	-	1	1

IMB – 306: a) COMPUTATIONAL BIOLOGY

Course Learning Objective

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

Introduction : Definition of statistics : population and universe, the sample and population, statistical inference; parameter and statistics.

Interval Data : Mean, mode, median and standard deviation. Concept of probability – classical and frequency definitions; axiones of probability; addition and multiplication theorems (statements only); conditional probability-Baye's theorem (statement only); simple applications. Binomial, Poisson and Normal distributions (definitions and uses only).

Uncertainties in estimation of mean, comparison of means and variances – t, F, and Z tests.
Proportion data : examples of proportion data; (MPN, sterility testing of medicines, animal toxicity, therapeutic trial of drugs and vaccines, animal toxicity, infection and immunization studies) statistical treatment to proportion data. Chi-square test, goodness of fit.

Count data : examples of count data (bacterial cell count, radioactivity count, colony and plaque counts) statistical treatment to count data: Poisson distribution, standard error, confidence limits of counts.

Analysis of variance : Analysis of variance : Introduction, procedure and tests for one-way and two-way classified data. Multiple comparisons. Analysis of CRD, RBD and LSD. Factorial experiments- main effects and interaction in a 2^2 design, Duncan's Multiple Range Test.

UNIT – II

Correlation and regression, formulae and application. Fitting straight line through a series of points. Fitting of exponential curves. Standard curve and interpolation of unknown Y-values. Multiple linear regression, logistic regression.

Statistical basis of biological assays : Response-Dose metameter. Delusion Assays, Direct and indirect assays. Quantal Responses, Probit, logit, LD_{50}, ED_{50}, PD_{50} – Standard line interpolation assay, parallel assay (4 point, 6 point assays), slope ratio assay.

Design of Experiments – Multiple comparison tests, Dunken's, Tukey's, Scheffic's, Dunnelt's etc.
Probit Analysis

Multiple Regression, Logistic regression
Discriminate Analysis
Clinical trails – Phase I, Phase II etc.
Clinical trails (meaning and importance only).

UNIT – III

Basics of personal computer and its components. Concept of programming Languages. Hardware and Software. The idea of operating systems.

Disk Operating Systems (DOS)- Simple commands to create directories and handle files. DOS based software for creating biological databases-dBASE,

Windows-98 operating system – Starting Windows, Desk Top items, folders and files, explorer, notepad and word pad and their applications. Features of Windows 2000

Microsoft Office - 2000: Introduction and facilities available. Shortcut Bar; customizing toolbars; using common office techniques-starting an office application.

Microsoft Word: Starting a new document, opening existing documents, saving, closing, and printing documents, moving and copying text, proofing the documents, working with multiple documents. Creating and editing work documents; formatting documents; working the tabs, tables and columns; working with long documents; working with graphics; formatting shortcuts; streamlining repetitive work.
Microsoft Excel: Introducing Excel Worksheet, formatting and printing worksheets, workbooks, functions and formulae, excel graphics, creating databases. Solving simple statistical problems and curve fitting using Excel.

Microsoft Power point: Creating presentations, working with slides, showing slide shows, creating an organization charts and graphs, printing a presentation.

UNIT – IV

Internet and Biologist : Internet basics, getting onto the internet, e-mail, file transfer protocols, gopher, the world-wide web, browsing and down loading from sites.

Networking of computers, need and advantages, an overview of International and Indian networks – Virtual Library-I: Searching MEDLINE; Pubmed. Virtual Library II: Science Citation Index and current awareness services; Virtual Library III: Electronic Journal; International and Indian Networks- NICNET, INFLIBNET, AGRIS.

Information Networks: WWW, HTTP, HTML, URLs, EMB net, NCBI net, Virtual tourism.

Databases and Tools: Primary information resources- Protein and genomic information resources- Biological databases; primary, secondary and composite protein sequence databases, structure classification databases, DNA sequence databases, specialized genomic resources; DDBJ, Gen Bank and EMBL public DNA sequence databases; SWISSPROT Database, information retrieval from biological databases; the NCBI data model. Submitting DNA sequences to the Database and updating.

Sequence analysis : Wisconsin GCG, DNASIS, DNASTAR, CLONE MANAGER packages for nucleotide sequence analysis; sequence alignment and database searching; practical aspects of multiple sequence alignment.

Phylogenetic analysis: Phylogenetic models; multiple alignment procedures (CLUSTAL, ALIGN, PHYLIP); tree building methods and trees evaluation; rooting trees, phylogenetics software.

Predictive methods using nucleotide and protein sequences : Detection regulatory elements in the DNA; physical properties of proteins based on sequences, different protein structural motifs RNA binding domains and folding classes; Transcription factors and their DNA binding.

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.

Suggested Books:

1. Biostatistics a foundation for analysis in the field of health sciences by Daniel.2013, 10th edition.
2. Campbell R.C. 1989: Statistics for Biologists, 3rd edition. Cambridge University Press, Cambridge.
3. Statistics made simple – Do it yourself on PC. 2001. By K.V.S. Sarma. Printice Hall of India Publ.
4. An introduction to Biostatistics. 2012. 5th Edition. P.S.S. Sundar Rao and J. Richard, Prentice-Hall of India Pvt. Ltd., New Delhi.
5. Fundamentals of Biostatistics. 1994. First Edition. Irfan A. Khan and Atiya Khanum, Ukaaz Publications.
6. Biostatistics. 2012. First Edition. P.N. Arora and P.K. Malhan, Himalaya Publishing House.
7. Statistics for Biologists. 1980. D.J. Finney.
8. Statistics and Experimental design : An Introduction for Biologists and Biochemists. 1994. 3rd edition. G.M. Clarke. Edward Arnald Publications.
9. Statistical methods. 1989. 8th edition. Snedecor and Cochran, Oxford Press.
10. Elements of Computer Science, 2010. S.K. Sarkar, A.K. Gupta. S. Chand & Company (Chapters – 1,2,9,12,14).
11. Microsoft Office. 1997. Stultz. Office 2000 – The Basics and beyond, 2000. A Lan Neibauer. Tata Mc Graw-Hill Publishing Comp. Part I, II, III, IV, V.
12. Windows-98, 2000, Vickram Crishra. Tata Mc Graw-Hill Publishing.
13. The Internet: Complete Reference, Harley Hahn. 1996. Second Edition. Tata Mc Graw-Hill Publication.
14. Introduction to Bioinformatics, 2001 by T.A. Attwood & D.J. Parry-Smith, Pearson Education Asia Publ.
15. Bioinformatics: A Practical guide to the analysis of genes and proteins. 2004, 3rd edition. Edited by A.D. Baxevanis and B.F.
16. Francis Ouellette. Wiley – Interscience. Computational Methods in Molecular Biology by S.L. Saizberg. 1999.
17. Computer Applications in Biotechnology. 1998. by T. Yosida. Introduction to Bioinformatics by Atwood.
18. Bioinformatics – From Nucleic Acids and Proteins to Cell Metabolism. 1995, by Schomburg and Label VCH Publ.
19. Bioinformatics: Sequence and Genome Analysis. 2004, 2nd edition. By D.W. Mount. CSHL Press.
20. Bioinformatics: Methods and Protocols,. Ed by S. Misener and S.A. Krawetz. Humana Press, 2000.

References:

1. Principles of Biostatistics, 2000. Marcello Pagano; Kimberlee Gauvreau, Published by Duxbury, Thomson Learning, USA.

2. Biostatistical Analysis, 2009, 5th edition. Jorrold H. Zar Published by Pearson Education, Inc., Delhi.
3. Statistical methods for survival data analysis, 2003, 3rd edition. Elisa T. Lee. Published by Wiley Series in probability and mathematical statistics; John Wiley & Sons, Inc. New York.

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	1	2	-	-	-	1	1
CO_2	3	2	2	1	2	2	1	-	-	-	1	1
CO_3	3	1	2	2	3	2	2	-	-	-	1	1
CO_4	3	2	2	2	2	2	2	-	-	-	1	1

IMB – 306: b) INDUSTRIAL BIOTECHNOLOGY

Course Learning Objective

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

Raw materials used as media for industrial fermentations. Development of inocula for industrial fermentations. Isolation, preservation and strain improvement of industrially-important microorganisms. Bioreactor - Designing and appliaction of a biofermentor. Aerobic and anaerobic reactors. Aeration, agitation and sterilization of fermentors. Surface, submerged, batch and continuous fermentations. Scale-up of fermentations.

UNIT - II

Bioprocessing - Recovery of particulates, product isolation, extraction, precipitation, chromatography, centrifugation, membrane separation, electrophoresis, distillation, use of resins super-critical fluid extraction, whole broth processing, online processing integrated product separation, and purification. Single cell protein (SCP) - production from cellulose and sewage. Food from microorganisms – edible mushrooms and cultivation of mushrooms (button).

Commercial production of cheese, yogurt, production of flavoring components.

Biofuels – Methane, hydrogen, alcohol (gasohol).

UNIT - III

Industrial production of (1) antibiotics - streptomycin, penicillin, cephalosporin, and tetracyclin, (2) biomass of *Bacillus megaterium*, *Acinetobacter cerificans*, *Candida utilis* using hydrocarbons, (3) organic acids - citric acid, lactic acid, (4) amino acids - L-lysine, (5) enzymes - amylases, proteases and laccases, stabilization of enzymes, (6) vaccines - rabies, FMD vaccine, hepatitis B, (7) alcohol - ethanol and butanol. Esterification of biofuels, Steroid transformations.

UNIT - IV

Microbial leaching - Organisms of leaching, chemistry of microbial leaching, commercial process.

immobilization of cells - methods, applications, advantages and disadvantages. Recombinant DNA products - interferon.

Fermentation economics - Market potential, some effects of legislation on production of antibiotics and recombinant proteins, plant and equipment, continuous culture, recovery costs, water usage and recycling, effluent treatment.

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

Suggested Books:

1. Principles of fermentation technology (2nd edition) by STANBURY, WHITAKER & HALL.
2. Biotechnology: A Text Book of Industrial microbiology 2nd edition by CRUEGER. & CRUEGER
3. Microbial Technology Vol I by PEPPLER & PEARLMAN (Editors).
4. Microbial Technology Vol II by PEPPLER & PEARLMAN (Editors).
5. Microbial enzymes and bioconversions by ROSE.
6. Microbial Biotechnology: Fundamentals of Applied Microbiology (2nd edition) by GLAZER & NIKAIDO.
7. Prescott & Dunn's Industrial Microbiology 4th edition Editor REED.
8. Biotechnology Vol III. DELLWEG (Editor).
9. Concepts in Biotechnology by BALASUBRAMANIAN, BRYCE, DHARMALINGAM, GREEN & JAYARAMAN.
10. Immobilized cells: Principles and Application by TAMPION & TAMPION.
11. Industrial Microbiology by THOMA.
12. Methods in Food and Dairy Microbiology by DILIELLO.
13. Industrial Microbiology by CASIDA.
14. Industrial Microbiology by MILLER & LITSKY.
15. Microbiology: A Laboratory Manual by CAPPUCCINO & SHERMAN.

CO-PO Mapping Matrix/Programme Articulation Matrix

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CO_1	3	2	2	2	2	2	2	-	-	-	1	1
CO_2	3	2	2	1	2	2	1	-	-	-	1	1
CO_3	3	1	2	2	3	2	2	-	-	-	1	1
CO_4	3	2	2	2	2	1	2	-	-	-	1	1

FOURTH SEMESTER:
IMB - 401: ANIMAL AND PLANT CELL CULTURE

Course Learning Objective

1. To provide hands on experience with the techniques used in plant cells.
2. To give hands on experiments techniques used in Animal cells.

UNIT – I

Animal cell culture – scope of animal cell culture – Industrial importance of animal cell culture products – viral vaccines for human and animal use, production of interferon, interleukins, retroviruses and adenoviruses are produced for use in gene therapy, large scale production of Bio-Insecticides – Baculoviruses, NPV, GV, cell cultures used for diagnostic assay system, therapeutics.

UNIT – II

Production of animal cell culture – primary and secondary cell cultures of different tissues – kidney, embryo, fibroblasts. Cell lines – types of cell lines – Human, Animal insect cell lines. Principles and methodology of animal cell cultures, subculturing, maintenance and preservation of cell cultures, Biology of the cultured cell, culture environment – preparation of media, Tissue and Primary culture – isolation of the tissue, primary culture, cell lines and cell types, cloning and selection of specific cell types, physical and chemical methods of cell separation , induction of differentiation and study of transformed phenotype, other specialized techniques.

UNIT – III

Plant cell culture – scope of plant cell culture – major sources of pharmaceuticals, dyes, food colours and flavours, enzymes, polysaccharides, fragrances, insecticides, herbicides, products of secondary metabolites. Production of Shikonin and culturing of Microalgae. Industrial advantages and disadvantages of plant tissue culture – Cell and organ differentiation – Clonal propagation or micropropagation – production Artificial seeds and Virus free seeds – Somaclonal variation – cross barriers – other uses of tissue culture such as endosperm and nucellus cultures, germplasm storage including cryopreservation – Application of cell culture for mutant selection, production of secondary metabolites, transformations – Plant tissue culture technology – equipment requirements for plant tissue culture – cleaning procedures, laboratory working procedures – Aseptic techniques and use of antibiotics – Environmental factors for tissue growth and development-different type of tissue culture media and their constituents – different cell culture plating techniques .

UNIT-IV

Plant tissue culture types – embryo culture, meristem culture, callus culture, anther culture, protoplast culture, cell suspension, spore culture, protoplast culture, regeneration and somatic hybridization – Protoplasts isolation, culture, purification, viability and regeneration of plants, protoplast fusion and somatic hybridization, cytoplasmic hybrids or cybrids, genetic modification of protoplasts. Gene transfer methods in plants – target cell for transformation, vectors for gene transfer, gene transfer techniques for *Agrobacterium,* selectable and scoreable markers, agroinfection and gene transfer, physical delivery methods or DNA mediated gene transfer methods- PEG stimulated, microinjection, microinjection, micro projectile or particle gun, electroporation. Production of Transgenic plants – transgenic plants for crop improvement, molecular farming, transgenic to study regulated gene and their expression- production of edible vaccines, viral CP mediated and insect resistance transgenic plants.

Course Learning Out Comes

1. Be able to perform techniques in animals and plants.
2. Be able to perform techniques in animals and plants microbiology

Suggested Books :

1. Culture of Animal cells – A manual of Basic technique. Third edition. 1995. R.I. Freshney. A.R. Liss. Inc., New York.

2. Animal cell culture – Practical approach Ed. John R.W. Master. Oxford.
3. Methods in Biology. Vol. 57. Animal cell culture methods. Ed. Jenni. P. Cell Mather and David Barnes. Academic Press.
4. An Introduction to Plant tissue culture. 2000. M.K. Razdan. Oxford & IBH Publishing House.

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	2	2	-	-	-	1	1
CO_2	3	2	2	1	2	2	1	-	-	-	1	1
CO_3	3	1	2	2	3	2	2	-	-	-	1	1
CO_4	3	2	2	2	2	2	2	-	-	-	1	1

IMB - 402: INDUSTRIAL BASED MICROBIAL CLEAN TECHNOLOGY

Course Learning Objective

UNIT – I

Scope of microbial agents in industry - regarding clean environment – waste water and effluent treatment – aerobic biological treatment, carbon oxidizers, filamentous carbon oxidizers, nitrifiers, dinitrifiers. Anaerobic waste-water treatment – hydrolytic bacteria, acetogenic bacteria, methanogenic bacteria.

Compositing of solid organic wastes – *Agaicus bisporus, Bacillus stearothermophilus, Thermus sp., Fungi – Rhizomucor Pusillus.* Ensiling – to preserve the material with a minimum loss of nutritional value, commercial, microbial inoculants, *Pediococcus sp.,Sstreptococcus sp.,* some *Lactobacillus sp*. Biodegradation of Xenobiotics, Bioremediation – basic principle, biodegrade or detoxify contaminating compounds in situ, metal sequester – *Geobacter metallireducens,* radiation resistance bacteria – *Deinococcus radiodurans.*

UNIT – II

Biomining (mineral leaching) – conventional mineral mining – metal ores, *Thiobacillus ferroxidans, Leptosirillum ferroxidans,* Microbial desulphurization of coal – S*ulfolobus acidocaldarium.*

Bioinsecticides – control of insects by use of microbial pathogens - bacteria, fungi, protozoa and viruses – *Bacillus thuringiensis, Pythium, Oligandrum, Ampelomyces quiqualis,* Baculo viruses.

UNIT – III

Biopesticides – Introduction and importance of biopesticides, types of biopesticides, bioinsecticides – biofungicides – biobactericides – bionematicides – bioherbicides. Important bioinsecticides- Bt, NPV, fungal bioinsecticides (Beauveria, Metarhizium, Verticillium, Paecilomyces, Nomuraea. Mass production – formulation – application for the control of insect pests. Important biofungicides – Trichoderma, Gliocladium, *Pseudomonas fluorescens*, mass production – formulation – use in agriculture for the control of crop diseases. Biobactericide - *Agrobacterium radiobacter,* use in control of crown gall disease. Bionematicides- Verticillium, Trichoderma, control of root knot nematodes. Bioherbicides - Phytophthora , Colletotricum, advantage for the use of biopesticides – Problems in commercialization and efficacy – commercial products of biopesticides.

UNIT – IV

Bioremediation – Bioremediation definition, concept – rationale – kinds of pollution – organic, inorganic in soil, water and air – remediation by bacteria, fungi and green plants. Processes of bioaccumulation and biomagnification – microbial remediation by natural attenuation – biostimulation – bioaugmentation –

application of immobilized microbes in soil decontamination.Use of genetically engineered microorganisms and bioremediation – Biodegradation of organic compounds – humification and polymerization reaction – biotransformation of metal and metal compounds – phyto-remediation use of green plants to remove pollutants – Phyto-extraction – induced phyto-extraction and continuous phyto-extraction – phyto-degradation – rhizofiltration – phyto-stabilisation – phytovolatisation of metals – phyto-remediation of organic – bioavailability and uptake – biotransformation and compartmentalization.

Course Learning Out Comes

Suggested Books:

1. Microbial Technology by J.H. Peppler and D. Perlman.
2. Microbial Enzymes & Biotechnology by W.M. Fogarty and C.T. Kelly.
3. Industrial Microbiology, 1999 by L.E. Casida, Jr. New Age International Publ.
4. Industrial Microbiology. 1984. A.H. Patel. Macmilan India Limited.
5. Industrial Microbiology by B.M. Miller and W. Litsky.
6. Microbial Biotechnology – Fundamentals of Applied Microbiology. 1995. by Alexander N.

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	1	2	2	2	1	1	-	-	-	1	1
CO_3	3	2	2	2	3	2	2	-	-	-	1	1
CO_4	3	2	2	1	2	2	2	-	-	-	1	1

IMB - 403: a) INDUSTRIAL PRODUCTION OF MICROBIAL PRODUCTS

Course Learning Objective

UNIT – I

Health care products – Pharmaceuticals-sources of drugs-Microbial based-antibiotics, vitamins, steroids, ergot alkaloids, vaccines, Recombinant therapeutic proteins, DNase, Erythropoietin, Hormones – Cytokines – Interferons, Interleukins I, II, Tissue plasminogen activator (tPA) – Human growth hormone (somatotrophin), Insulin, Tumor necrosis factor (TNF), collagen, Bacteriophages as therapeutic agents.

UNIT – II

Production of Antibiotics from - Penicillin, Cephalosporin, Streptomycin – Vitamins from *Streptomycin sp*., *Bacillus sp*., *Priopionibacterium sp*.- Steroids from *Rhizopus sp*., *Cunning hamella sp*. – Vaccines, BCG, Anthrax, conventional and recombinant vaccines of viral, bacterial – Insulin, *E.coli*. through Recombinant DNA technology.

UNIT – III

Production of organic acids – Lactic acid – *Lactobacillus sp.* , Citric acid – *Aspergillus niger* and Alpha ketoglutaric acid, Gluconi acid – *Aspertillus niger*, *Acetobacter sp*., *Pseudomonas sp*., Fumaric acid – *Rhizopus nigricans,* Itaconic acid – *Aspergillus terreus,* Kojc acid – *Aspergillus sp*., Gibberllic acid – *Gibberella sp.*, *Agaricus sp*., *Phallus sp*., *Boletus sp*., *Grifola sp*. Amino acids – Production of L-Lysine, Glutamic acid.

Production of enzyme – Proteases, Amylases pectic enzymes; Production of solvents – Acetone, Butyl alcohol, glycerol; Production of fuels –Methane, Ethanol, Hydrogen, Hydrocarbons; Recovery of minerals – golden microorganism, Recovery of oil.

UNIT – IV

Microbial oxidative transformationof substrate – Vinegar, *Acetabactor sp., Saccharomyces sp.* Dairy products – production of buffer – *Lactococcus sp.,* Yoghurt – *Streptococcus sp., Lactobacillus sp.,* Cheese

– *Lactococcus sp., Streptococcus sp.* Probiotics – *Lactobacillus sp., Bifidobacterium bifidum Saccharomyces boulardii, Salmonella enteritidis, Lactobacillus salivarius.* Microbial fermented products of meat, fish, plant (Bread sauer kraut, soyabean coffee, cocoa, tea).

Course Learning Out Comes

Suggested Books:

1. Microbial Biotechnology – Fundamentals of Applied Microbiology. 1995. by Alexander N.
2. Microbial Biotechnology; Fundamentals of Applied Microbiology. 1995. A.N. Glazer and H. Nikaido. W.H. Freeman and Company
3. Basic Biotechnology, 2001. 2nd ed. ed by C. Ratiedge & B. Kristiansen, Cambridge University Press.
4. Manual of Industrial Microbiology and Biotechnology, Second edition. 1999. A.L. Demain, Editor in Chief, ASM Press.
5. Biotechnology : A test Book of Industrial Microbiology. Second edition, 2000. Ed. W.Crueger & A.Crueger.Panima Publishing corporation.
6. Industrial Microbiology : An Introduction by M.J. Waites et al. Blackwell Science. 2001.
7. Prescott & Dunn's Industrial Microbiology. Fourth edition, 1999.Edited by Gerald Reed. CBS Publishers and distributors.

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	1	2	2	2	2	-	-	-	1	1
CO_2	3	2	2	2	2	1	1	-	-	-	1	1
CO_3	3	2	2	2	3	2	2	-	-	-	1	1
CO_4	3	1	2	2	2	2	1	-	-	-	1	1

IMB - 403: b) INDUSTRIAL MICROBIAL TECHNOLOGY

Course Learning Objective

UNIT – I

Industrial important microorganisms – isolation of cultures, screening of cultures for their activity, microbial cultures preservation and inoculum development. Fermentation – small-scale liquid fermentations, small-scale solid fermentations, Anaerobic fermentation, continuous culture. Improvement of fermentations, cell and enzyme immobilization, microbial strain improvement by nonrecombinant and recombinant methods, selection of raw materials and development of various media for industrial fermentation processes, small-scale bioreactors, scale-up of Microbial processes.

UNIT – II

Downstream process – Isolation and identification of small molecules, purification and characterization of proteins, Bioprocess simulation, Industrially used microorganisms, molecular biology and genetics – Genetics of *Bacillus sp., Clostridia sp.,* Filamentous fungi, C*orynebacteria sp.*, Streptomyces and non-streptomyces. Actinomycetes, *Saccharomy cervisiae.*

Microbial organisms used in - Recombinant DNA technology for industrial application – Recombinant application of Streptomyces, Thermophiles, Zygosaccharomyces, *E.coli* – Expression of G-protein-couples receptors, over expression of proteins, enzymes, aromatic compounds, biodegradable polymer (polyhydroxy alkanoates).

UNIT – III

Microbial organisms in Environmental clean technology – Bioprospecting, Bioremidiation, Biopesticides, Biomarkers, Bioreporters, Biofilms, Biocorrosion, Microbial biodiversity, release of recombinant microorganisms.

UNIT – IV

Biosynthesis of Microbial secondary metabolites – Antibiotic biosynthesis, streptomycete secondary metabolite biosynthesis, Bacteriocins production. Biosafety, Bioethics and Intellectual property rights, Quality assurance and quality control, Economics of Industrial Microbial technology, future of Industrial microbial technology.

Course Learning Out Comes

Suggested Books:

1. Industrial Microbiology, 1999 by L.E. Casida, Jr. New Age International Publ.
2. Industrial Microbiology. 1984. A.H. Patel. Macmilan India Limited.
3. Industrial Microbiology by B.M. Miller and W. Litsky.
4. Microbial Biotechnology – Fundamentals of Applied Microbiology. 1995. by Alexander N.
5. Manual of Industrial Microbiology and Biotechnology, Second edition. 1999. A.L. Demain, Editor in Chief, ASM Press.
6. Biotechnology : A test Book of Industrial Microbiology. Second edition, 2000. Ed. W.Crueger & A.Crueger.Panima Publishing corporation.
7. Industrial Microbiology : An Introduction by M.J. Waites et al. Blackwell Science. 2001.
8. Prescott & Dunn's Industrial Microbiology. Fourth edition, 1999.Edited by Gerald Reed. CBS Publishers and distributors.
9. Microbial Technology by J.H. Peppler and D. Perlman

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	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	1	2	1	2	-	-	-	1	1
CO_2	3	2	2	2	2	2	1	-	-	-	1	1
CO_3	3	1	2	2	3	2	2	-	-	-	1	1
CO_4	3	2	2	2	2	2	2	-	-	-	1	1

IMB- 404: PRACTICALS: ANIMAL AND PLANT CELL CULTURES AND INDUSTRIAL BASED MICROBIAL CLEAN TECHNOLOGY

1. Antibiotics and study of their role in microbial inhibition.
2. Collection and study of antibiotics sensitivity by invitro.
3. Isolation of Bacteriophages from sewage and soil.
4. Biodegradation of human hairs and animal fur by using the actinomycetes.
5. Set up and demonstrate the ethanol production in the lab.
6. Isolation and identification of polymeric material degrading organisms.
7. Preparation of bread in the lab.
8. Plant tissue culture techniques- meristem, embryo, protoplast
9. Secondary metabolites production from plant cell cultures.
10. Assessment of immune diagnostic kits.

11. Immuno flurocence technique.
12. Immuno blot Analysis of antigens and allergens.
13. *In vitro* analysis for antibacterial properties
14. Antibiotic assay preservative test
15. Bioburden Testing
16. Interferon, interleukin assay.
17. Microbial Limit test (MLT)
18. Bacterial Endotoxins Test

IMB – 405 : Practical : Field Trip / Industriel Tour Report / Project :

Course Learning Objective

1. Give practical experience in locating, collecting and interpretent the scientific, information.

Practical experience in locating, collecting and interpreting the scientific information for the purpose of MSc., Industrial Microbiology field trip/industrial tour report. The student works individually, under faculty/Scientist supervision in laboratories, Research labs, Industries, National Institutes to perform the procedures, 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. Able to design procedures, record research methodology and interpret the research.

IMB- 406: a) BIOETHICS, BIOSAFETY, INTELLECTUAL PROPERTY RIGHTS

Course Learning Objective

UNIT – I

Bioethics – Introduction to Bioethics, solid and ethical issues related industrial genetically manipulated microorganisms (GMM).

UNIT – II

Biosafety – Definition, biosafety consideration, types of containments, personal practices, primary and secondary containment barriers (biosafety levels 1, 2, 3, 4), containment for production activities, practical consideration, possible hazards from industrial production and use of pathogens.

UNIT – III

Biosafety for human health and environment - Use of genetically modified microorganisms and their release in to the environment, special procedures for recombinant DNA based products. Regulatory affairs – regulatory requirements for drugs and biologics.

UNIT – IV

Intellectual property rights – Importance of Intellectual property, history of patent concept, composition of a patent, general patent information – patent laws, patentable subject matter, apply for patent, requirements for patentability, issuance of a patent, infringement of a patent. Obtain patent protection – applying for patent protection, patent prosecution, appeals and interference proceedings, applying for foreign patent protection. Patent laws in US, India and other countries.

Course Learning Out Comes

Suggested Books:

1. Intellectual property rights on Biotechnology. K. Singh BCII, New Delhi.

2. Biotechnologies in developing countries present and future. 1993. A. Sasson. UNESCO Publishers.

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	1	2	1	2	2	1	-	-	-	1	1
CO_3	3	2	2	2	3	1	2	-	-	-	1	1
CO_4	3	2	2	2	2	2	2	-	-	-	1	1

IMB- 406: b) MICROBIAL PRODUCTION OF ALCOHOLIC BEVERAGES.

Course Learning Objective

UNIT – I

History, scope and Industrial important of Beverages. Types of Beverages and their significance in the society. Brewing microbiology – Microorganisms related to Beverages, their isolation, identification and small scale culturing, pure culture techniques, Microbial metabolism and nutrition, genetics of Microbial organisms, magnitude of the brewing industry.

UNIT – II

Elements of the Brewing process – Ingredients – Malt, Adjuncts, water, Hops, yeast, miscellaneous additives. Different process of Bear Brewing – Malting, Brewing, Mashing, Hop addition. Fermentation – Primary, continuous fermentation, aging and finishing. Pure culture of yeast – quality, source, maintenance of pure culture, pure culture propagation, evaluation of yeast produced, microscopic and serological tests, test fermentations, recycled yeast, separation, collection and storage. Microbial contamination. Fermentation requirements – Carbohydrates, nitrogen compounds, inorganic ions, vitamins, polyphenols, Hop compounds, lipids oxygen, yeast.

UNIT – III

Distilled Beverage Alcohol – commercial Important of alcohol, whiskey – Raw materials, mashing and conversion, fermentation, distillation, types of whiskey – Bourbon whiskey, Rye whiskey, corn whiskey, Light whiskey, Tennessee whiskey. Canadian whiskey, scotch whiskey, Irish whiskey, Vodka, Gin, By-product recovery in whiskey synthesis, Rum, Tequila, Cordials and Liqueurs, Congeners.

Wine production – production of grape must, wine fermentation, traditional spontaneous wine fermentation, use of starter cultures, continuous wine fermentation, secondary wine fermentation, post – fermentation treatments.

UNIT – IV

Cider production – apple juice extraction, composition of apple juice, cider fermentation, cider maturation. Vinegar production – Vinegar fermentation, alcohol fermentation, acetic acid fermentation, methods of acetification in vinegar manufacture, traditional surface method trickle generators, submerged methods, finishing processes, process developments.

Course Learning Outcomes

Suggested Books:

1. Molecular Biotechnology: Principles and Applications of recombinant DNA. 1994. by B.R. Glick and J.J. Pastermak. Panima Publ. Corporation.
2. Microbial Biotechnology; Fundamentals of Applied Microbiology. 1995. A.N. Glazer and H. Nikaido. W.H. Freeman and Company.
3. Biotechnology: A test Book of Industrial Microbiology. Second edition, 2000. Ed. W.Crueger & A.Crueger.Panima Publishing corporation.
4. Industrial Microbiology: An Introduction by M.J. Waites et al. Blackwell Science. 2001.
5. Microbial Technology by J.H. Peppler and D. Perlman.
6. Manual of Industrial Microbiology and Biotechnology, Second edition. 1999. A.L. Demain, Editor in Chief, ASM Press

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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	1	2	1	2	2	-	-	-	1	1
CO_4	3	2	2	2	2	2	1	-	-	-	1	1