

ANNAMALAI UNIVERSITY
Division of Microbiology
Faculty of Science
M.Sc., Microbiology Integrated (5 YEARS)

Code	Title	Hours	Credit	Internal mark	External mark	Total
	I year I Sem					
ITAC 11	Language I (Paper I)	3	3	25	75	100
IENC 12	Language II (Paper I)	3	3	25	75	100
ICEC 13	Civics, Environmental and Health Science	3	3	25	75	100
IMBT 14	Introductory Microbiology	5	5	25	75	100
IMBA 15	Ancillary I Paper I Biochemistry	4	4	25	75	100
		18	18	125	375	500
	I Year II Sem					
ITAC 21	Language I (Paper II)	3	3	25	75	100
IENC 22	Language II (Paper II)	3	3	25	75	100
ICAC 23	Computer application	3	3	25	75	100
IMBT 24	General Microbiology	6	6	25	75	100
IMBA 25	Ancillary I Paper II Biochemistry	4	4	25	75	100
IMBP 26	Core practical I Pre lab discussion 1 Hour Practical 5 Hours	6	3	40	60	100
IMBP 27	Ancillary Practical I	5	2	40	60	100
		30	24			
	II Year III Sem					
ITAC 31	Language I (Paper III)	3	3	25	75	100
IENC 32	Language II (Paper III)	3	3	25	75	100
IMBT 33	Microbial taxonomy	6	6	25	75	100
IMBA 35	Ancillary II Paper I Biological science	5	5	25	75	100
IMBP 34	Core practical II Pre lab discussion 1 Hour Practical 5 Hours	6	3	40	60	100
		23	20			
	II Year IV Sem					
ITAC 41	Language I (Paper IV)	3	3	25	75	100
IENC 42	Language II (Paper IV)	3	3	25	75	100
IMBT 43	Microbial physiology	6	6	25	75	100

Code	Title	Hours	Credit	Internal mark	External mark	Total
IMBP 44	Core practical III Pre lab discussion 1 hour Practical 5 hours	6	3	40	60	100
IMBA 45	Ancillary II Paper II Biological Science	5	5	25	75	100
IMBP 46	Ancillary Practical II pre lab 1 hour	6	3	40	60	100
	Practical 5 hour					
		29	23			
	III Year V Sem					
IMBT 51	Medical Microbiology	5	5	25	75	100
IMBT 52	Genetic Engineering	5	5	25	75	100
IMBT 53	Microbial Genetics & Molecular biology	5	5	25	75	100
IMBT 54	Soil & Agricultural Microbiology	5	5	25	75	100
IMBP 55	Core practical IV Pre lab discussion 1 Hour Practical 5 hours	6	3	40	60	100
		26	23			
	III year VI Sem					
IMBT 61	Industrial Microbiology	6	6	25	75	100
IMBT 62	Immunology	6	6	25	75	100
IMBT 63	Environmental Microbial technology	6	6	25	75	100
IMBT 64	Food & Dairy Microbiology	6	6	25	75	100
IMBP 65	Core practical V Pre lab discussion (1Hour) Practical(5 Hours)	6	3	40	60	100
		30	27			
	IV Year VII sem					
IMBT 71	Bioinformatics	5	5	25	75	100
IMBT 72	Microbial diversity & extremophiles	5	5	25	75	100
	Soft skill	4	4	25	75	100
IMBP 73	Core practical VI Pre lab 1 hour Practical 5 hour	6	3	40	60	100
IMBE 74	Optional I Statistical methods	4	4	25	75	100
IMBT 75	Elective -II Bioremediation	4	4	25	75	100
IMBT 76	Soft Skill	4	4	25	75	100
		32	29			

Code	Title	Hours	Credit	Internal mark	External mark	Total
	IV year VIII sem					
IMBT 81	Medical parasitology & Medical mycology	6	6	25	75	100
IMBT 82	Medical diagnostic technology	6	6	25	75	100
IMBP 83	Core practical VII Pre lab 1 hour Practical 5 hours	6	3	40	60	100
IMBE 84	Elective -III Quality control & IPR	4	4	25	75	100
IMBE 85	Elective -IV Microbial metabolites	3	3	25	75	100
		25	22			
	Industrial Training/ Internship for three/ four weeks					
	V Year IX sem					
IMBT 91	Biofuel & Bioenergy	5	5	25	75	100
IMBT 92	Enzymes	5	5	25	75	100
IMBP 93	Core Practical VIII pre lab 1 hour Practical 5 hours	6	3	40	60	100
IMBE 94	Elective -V Genomics and Proteomics	4	4	25	75	100
IMBE 95	Elective-VI Bioinstrumentation & Research methodology	4	4	25	75	100
		24	21			
	V year X Sem					
IMBT 101	Biopharmaceuticals	5	5	25	75	100
IMBT 102	Microbial inoculants & mushroom technology	5	5	25	75	100
IMBP 103	Core Practical IX pre lab 1 hour Practical 5 hours	6	3	40	60	100
IMBE 104	Elective VII Entrepreneurship and management for Microbiology	4	4	25	75	100
IMBT 105	Project		5			
		20	22			
	Total	243	225			

IMBT 14- Introductory Microbiology

Objectives

The course aim to study about the introduction, historical development and application of microbiology.

Unit - I

Introduction, History and scope of Microbiology. Recent developments - Spontaneous generation - Biogenesis. Contributions of Leeuwenhoek, Louis Pasteur, Robert Koch, Elie Metchnikoff, Edward Jenner, Lister and Fleming.

Unit - II

Microscopy: Principles and applications of simple, compound, bright field, dark field, phase contrast, fluorescent and Electron microscope [SEM & TEM].

Unit - III

General characteristics and nature of Archaeobacteria, Eubacteria, Cyanobacteria, Mycoplasmas, Rickettsia, Chlamydia, Spirochaetes, Actinomycetes and Algae.

Unit - IV

Principles of staining: Nature of dyes, types of staining - simple, differential, negative and spore staining. Sterilization methods - Physical (moist heat, dry heat, filtration, pasteurization, tyndalization, radiations) and chemical methods (alcohols, aldehydes, phenols, halogens and hypochlorite).

Unit - V

Media types - simple, defined, enriched and transport media with specific examples for each type. Methods of maintenance and preservation of microbes.

Reference Books:

1. Pelczar, Chan & Kreig (2012). Microbiology 5th edition. Tata McGraw Hill, New Delhi.
2. Dubey, R.C. and Maheswari, D.K. (2011). A Textbook of Microbiology, S. Chand and Company Ltd., New Delhi.
3. Ananthanarayan. R. and Paniker C.K.J Text Book of Microbiology, 8th Edition Orient Longman, 2010
4. Willey, Joanne M. Prescott's Microbiology. 9th Edition: McGraw-Hill Education - Europe, 2014.

IMBT 24 - General Microbiology

Objectives

The aim of the course to learn about the cell structure, differences, media characteristics and chemotherapy.

Unit - I

Difference between prokaryotic and eukaryotic microorganisms. Classification of microorganisms - general principles and nomenclature - Haeckel's three kingdom concept, Whittaker's five kingdom concept. Classification of bacteria according to Bergey's Manual of Systematic Bacteriology (9th edition). Basic understanding of classification of viruses, algae, fungi and protozoa.

Unit -II

Microbial cell : Ultrastructure of bacteria, subcellular structures and cell envelope - slime, capsule, cell wall, pili, flagella, cell inclusions, biosynthesis of bacterial cell wall, cell membrane - Bio membrane, liposomes - membrane transport - diffusion, active and passive transport and osmoregulation.

Unit -III

Nutritional types requirements of bacteria. Isolation of different types of Bacteria - Fungi - Actinomycetes - Cyanobacteria - Protozoa.

Unit - IV

Normal microbial flora of human body. Infections and its types. Pathogenesis and transmission of - *Salmonella*, *Shigella*, Chickenpox, Influenza (Flu), *Aspergillus fumigatus*, *Candida albicans*, Amoebae and Malaria.

Unit - V

Chemotherapy - general characteristics of antimicrobial drugs - Penicillin, Chloramphenicol, Nystatin, cycloheximide and Acycloguanosine (nucleoside).

Reference Books

1. Pelczar, Chan & Kreig (2012). Microbiology 5th edition. Tata McGraw Hill, New Delhi.
2. Dubey RC and Maheswari DK (2011). A Text book of Microbiology. S. Chand &Company Ltd., New Delhi.
3. Ananthanarayan. R. And Paniker C.K.J Text Book of Microbiology, 8th Edition Orient Longman, 2010
4. Willey, Joanne M. *Prescott's Microbiology*. 9th Edition: McGraw-Hill Education - Europe, 2014.

IMBP 26 - Practical I General Microbiology

1. Different methods of sterilization.
2. Preparation of Media:
 - i. Nutrient broth ii. Nutrient agar iii. plates iv. slants v. soft agar
 - vi. Blood agar vii. Selective Media.
3. Determination of growth - growth curve
4. Pure culture technique:
 - i. Streak plate ii. spread plate iii. pour plate methods.
5. Measurement of microbes - micrometry.
6. Enumeration of bacterial / yeast cells-viable count (Plate count), Total count (Haemocytometer count).
7. Motility determination
 - i. Hanging drop method.
8. Staining methods:
 - i. Simple ii. Gram staining iii. Negative staining iv. Spore staining,
 - v. Metachromatic granular staining vi. Lacto phenol cotton blue staining vii. Fungal slide culture.

IMBT 33 - Microbial Taxonomy

Objectives

The emphasis of the course will be on principles of classification, rules and its applications.

Unit - I

An Introduction to Microbial Classification and Taxonomy, Taxonomic Ranks. Techniques used for determination of Microbial Taxonomy & Phylogeny, Systems of Prokaryotic and Eukaryotic Phylogeny

Unit - II

Classification systems in Prokaryotes, Bergey's Manual of Systematic Bacteriology. Prokaryotic groups with unusual characteristics: Cyanobacteria, Green and Purple sulphur bacteria, gliding bacteria, Rickettsia and Chlamydia, Actinomycetes, Archaea- Classification and Significance.

Unit - III

Viruses - Definitions of Virus, Viroids and Prions, Classification systems of Viruses -LHT, Baltimore. General Structure of viruses, Concepts of Lytic and Lysogenic life cycles , Basic Concepts of Virus cultivation

Unit - IV

Eukaryotic Diversity- Three Domains of Life, Endosymbiotic theories, Eukaryotic cell cycle and Cell division - Mitosis and Meiosis Fungi: Distribution and importance. Morphology of fungi -cell wall structure, fungal thallus and filamentous. Cytology of fungi- Mitochondria, Golgi bodies- Endoplasmic reticulum. Recent classification of fungi. Study of yeasts and moulds

Unit - V

Algae: photosynthetic protists- Algal classification with their characteristics features, Type of vegetative forms- heterocyst and non-heterocyst forms. Cytology of algae-pigment and cell inclusions. Distribution and importance. Classification of protozoa. Morphology of protozoa - shapes and size. Cytology of protozoa- Body covering and skeletons, locomotory and internal organelles.

Reference Books

1. Willey, Joanne M. *Prescott's Microbiology*. 9th Edition: McGraw-Hill Education - Europe, 2014
2. *Foundations in Microbiology*, Kathleen Park Talaro, 8th International edition 2011, McGraw Hill.
3. *A Textbook of Biotechnology* R.C. Dubey, 4th edition, First Multicolor Illustrative Edition, Reprint 2007
4. *Brock Biology of Microorganisms*, Michael. T. Madigan, John. M. Martinko, Paul V. Dunlap, David P. Clark- 12th edition, Pearson International edition 2009, Pearson Benjamin Cummings.
5. *Microbiology – An Introduction*, Gerard J. Tortora, Berdell R. Funke, Christine L. Case, 10th ed. 2008, Pearson Education.

IMBP 34 - Practical II Microbial Taxonomy

1. Morphology of Bacteria
Escherichia coli, Staphylococcus aureus, Vibrio cholera.
2. Yeast
Candida albicans, Saccharomyces cerevisiae.
3. Filamentous fungi
Aspergillus, Mucor, penicillium.
4. Protozoa
Plasmodium sp., Paramecium.
5. Algae
Chlorella, Oscillatoria, Nostoc.
6. Viruses
HIV, TMV, T4 Bacteriophage.

IMBT 43 - Microbial Physiology

Objective

The microbial physiology deals with microbial cell structure and function, microbial growth, microbial pigments, carbon assimilation, spore, structure and function.

Unit - I

Biosynthesis of peptidoglycan - outer membrane, teichoic acid - Exopolysaccharides; cytoplasmic membrane, pili, fimbriae, S-layer. Transport mechanisms - active, passive, facilitated diffusions - uni, sym, antiports. Electron carries - artificial electron donors - inhibitors - uncouplers - energy bond - phosphorylation.

Unit - II

Phases of growth curve - measurement of growth - calculations of growth rate - generation time - synchronous growth - induction of synchronous growth, synchrony index - factors affecting growth - pH, temperature, substrate and osmotic condition. Survival at extreme environments - starvation - adaptative mechanisms in thermophilic, alkalophilic, osmophilic and psychrophilic. Bioluminescence - mechanism - advantages.

Unit - III

Autotrophs - cyanobacteria - photosynthetic bacteria and green algae - heterotrophs - bacteria, fungi, myxotrophs. Brief account of photosynthetic and accessory pigments - chlorophyll - fluorescences, phosphorescences - bacteriochlorophyll - rhodopsin - carotenoids - phycobiliproteins;

Unit - IV

Carbohydrates - anabolism - autotrophy - oxygenic - anoxygenic Photosynthesis - autotrophic generation of ATP; fixation of CO₂ - Calvin cycle - C₃ - C₄ pathways. Respiratory metabolism - Embden Mayer Hoff pathway - Enter Doudroff pathway - glyoxalate pathway - Krebs cycle - oxidative and substrate level phosphorylation - reverse TCA cycle - gluconeogenesis - Fermentation of carbohydrates - homo and heterolactic fermentations.

Unit - V

Cell division - endospore - structure - properties - germination. Microbial development, sporulation and morphogenesis. Hyphae vs yeast forms and their significance. Multicellular organization of selected microbes. Dormancy.

References:

1. Caldwell, D.R. (1995). *Microbial Physiology and metabolism*, Wm. C. Brown Publishers, USA
2. Lansing M. Prescott, John P. Harley and Donald A. Klein. (2003). *Microbiology*.(5th edition).McGraw-Hill company, New York.
3. Moat, A.G., Foster, J.W. and Spector, M. P (2002). *Microbial Physiology* (4th Edition).
4. John Wiley & Sons, New York. Pelczar Jr, M.J. Chan, E.C.S. and Kreig, N.R. (1993). *Microbiology*, Mc. Graw Hill. Inc, New York.
5. Salle, A.J. (1996). *Fundamental principles of Bacteriology*(7th edition). Tata McGraw-Hill publishing company limited, NewDelhi.
6. White, D. (1995). *The physiology and biochemistry of Prokaryotes*, Oxford University Press, Oxford, New York.
7. Rabert Poole, K. (2007) *Advances in Microbial Physiology*, Volume 53 Elsevier Science & Technology

IMBP 44 - Practical III Microbial Physiology

1. Growth of Microorganisms on various carbon and Nitrogen sources.
2. Determinations of molar growth yield and ATP.
3. Turbidity measurement
4. Effect of environmental factors such as
 - a. pH
 - b. Temperature
 - c. Carbon sources
 - d. Nitrogen sources
 - e. Pesticides
 - f. Nutrient concentration
5. Growth and development of bacteria.

IMBT 51 - Medical Microbiology

Objectives

This course aims to study about the microorganisms associated with human beings and methods of diagnosis, symptoms caused by them. It also emphasis to learn about the viral disease and anti-microbial drugs and development of drug resistance.

Unit - I

Bacteriology: Normal Microbial flora of human body. Rules for collection and transportation of clinical specimens for microbiological diagnosis. Hospital acquired infections - Epidemiology and control of community infections. Hospital waste disposal.

Unit - II

Morphology, classification, cultural characteristics, Pathogenicity, laboratory diagnosis, Prevention, control and treatment of diseases caused by; *Staphylococci*, *Streptococci*, *Pneumococci*, *Neisseria* (*Gonococci* and *Meningococci*), *Corynebacterium*, *Mycobacterium*, *Clostridium*, *Bacillus*.

Unit - III

Important Gram negative Bacteria causing Human infection - *Vibrio*, *Escherichia coli*, *Proteus*, *Klebsiella*, *Salmonella*, *Shigella*, *Brucella*, Gram negative anaerobes - *Spirochetes*, *Rickettsia*, *Chlamydia*, *Mycoplasma* and *Ureoplasma*, zoonotic diseases and their control.

Unit - IV

Introduction to virology - Properties, Nomenclature, Classification, Morphology and cultivation. General methods in diagnosis and serology, Viroids, Prions, Satellite RNAs and virusoids. Newly emerging disease causing - SARS virus - Swine flu and Dengue virus. Lab diagnosis of viral infections.

Unit - V

Lifecycle, Pathogenicity, diagnosis, prevention and treatment of DNA & RNA viruses - Pox viruses, Herpes viruses, Adenoviruses, Hepatitis viruses: - Picorna, Orthomyxo, Paramyxo, Toga and other Arthropod borne viruses, Rhabdo, Rota and HIV, Oncogenic viruses. Viral vaccines and Antiviral agents.

Reference Books

1. Ananthanarayan. R. and Paniker C.K.J Text Book of Microbiology, Orient Longman, 2010.
2. Greenwood, D. Slack R.B and Peutherer J.F (2012). Medical Microbiology, 18th Edn. Churchill Livingstone, London.
3. Parker. T, M. Leslie and H. Collier, (1990). Principles of Bacteriology, Virology and Immunity (8th Edition). Topley and Wilsons.
4. Morag. C, and M.C. Timbury, (1994) Medical virology (10th Edition), Churchill Livingstone, London.
5. Conrat, H.F.P.C Kimball, and J.A Levy (1994) Virology (3rd edition), Prentice Hall. New Jersey.

IMBT 52 - Genetic Engineering

Unit I

Basic steps in cloning. Restriction Endonucleases - types. Nomenclature and mechanism of action of type II restriction endonucleases, ligases and other enzymes involved in gene cloning.

Unit II

Cloning vectors - properties. Cloning in plasmid (PBR 322), phage λ . Brief account of cosmids, BACs, TACs, Shuffle vectors. Expression vectors.

Unit III

Methods of gene transfer - Calcium Phosphate Co-precipitation, Viral Vectors, lipofection, micro injection. *Agrobacterium* mediated transformation. Host organisms for cloning.

Unit IV

Screening of recombinants - Insertional inactivation (antibiotic resistance, blue white selection) colony hybridization, immunological screening. Cloning strategies, genomic & cDNA cloning.

Unit V

Blotting techniques - Southern, Northern, Western. PCR - basic principle & applications. DNA sequencing - chemical & enzymatic methods. Site - directed mutagenesis – (brief account only). Hazards & safety aspects of genetic engineering.

Reference Books

1. An Introduction To Genetic Engineering (2010) Desmond S. T. Nicholl, Cambridge University Press
2. Molecular Biology Of Genetics (2008) Manorma Singh, Discovery Publishing House.
3. Genetics: A Molecular Approach by Peter J Russell (2009) 3rd edition Benjamin-Cummings Publishing Company.
4. Molecular Biotechnology (2003) Bernard R. Glick and Jack J.Pasternak., 3rd edition by American Society for Microbiology press.
5. Gene Cloning and DNA analysis (2010) T.A.Brown 6th edition. By American Society for Microbiology press.
6. Molecular Biotechnology: Principles and Applications of Recombinant DNA (2010). Glick & Pasteneuk.

IMBT 53 - Microbial Genetics and Molecular biology

Objective

Objective of the course is to give knowledge about molecular biology and genetics of microorganisms.

Unit I

Recombination, Transformation, Transduction - Generalized, Specialized, Conjugation, Hfr triparental mating.

Unit II

Central dogma of Molecular biology, *Escherichia coli*, Chromosome, Plasmids. Concepts of gene - Typical Structure of protein coding genes. Eukaryotic genome - nucleosome & higher order chromatin structure.

Unit III

Replication – Messelson Stahl Experiment. Enzymes & proteins involved in replication. Steps in replication - Initiation, Elongation, Termination. DNA damage & repair - Photo reactivation & Excision.

Unit IV

Transcription, RNA Polymerase Promotor, Steps in transcription, Initiation, elongation & termination, Reverse transcription, post transcriptional processing.

Unit V

Genetic code, steps in translation - Amino acid activation, initiation, chain elongation & termination. Inhibitors of protein synthesis. Post transcriptional modification, Regulation of gene expression. Brief account of *lac* operon

Reference Books

1. Friedberg EC, Walker GC, Siede W. (2006). DNA repair and mutagenesis. ASM press
2. Khalifa Abd El Maksoud Zaied, 2011, Fundamental Microbial Genetics. LAP Lambert Academic Publishing
3. James D. Watson, Tania A. Baker, Stephen P. Bell, and Alexander Gann (2013), Molecular Biology of the Gene, 7th Edition , Pearson Publication
4. Antony JF, Griffiths, Gilbert WM, Lewontin RC and Miller JH (2002). Modern Genetic Analysis, Integrating Genes and Genomes, 2nd edition, WH
5. J E. Krebs, E S. Goldstein, S T. Kilpatrick. (2012). Lewin's Genes XI. Oxford University press
6. Maloy SR, Cronan Jr. JE, Freifelder D (2004). Microbial genetics. Jones and Bartlett publishers.
7. Watson JD, Hopkins NH, Roberts JW, Steitz JA, Weiner AM. (2013). Molecular biology of the gene, 7th edition, Benjamin/Cummings publishing company.

IMBT 54 - Soil & Agricultural Microbiology

Objectives

The aim of the course is to learn about the role of microorganisms, their applications in soil and agriculture.

Unit - I

Development of soil Microbiology - characteristics and classification of soil - Distribution of soil microorganisms in soil fertility - influence of soil and environmental factors on soil microflora. Interaction of microorganism - beneficial and harmful.

Unit - II

Microbial ecology - nature of soil organisms and their interactions - positive and negative interactions - mycorrhizal symbiosis - management of mycorrhizae - inoculum production and use - applied aspects of ecto and endo mycorrhizae. Rhizosphere and spenosphere.

Unit - III

Fate of nitrogen in soil - biological dinitrogen fixation - symbiotic and non-symbiotic significance. Nitrogenase enzyme complex - associative dinitrogen fixation - process - physiology and genetics of dinitrogen fixation - influence of environmental parameters - new developments in nitrogen fixation.

Unit - IV

Plant diseases: symptoms, disease cycle and control measures - Bacterial diseases - Blight of rice, Citrus canker and wilt of potato. Viral diseases - Tungro disease of rice, TMV and CMV. Fungal diseases-rust of wheat, smut of sugarcane, wilt of cotton, tikka leaf spot in groundnut.

Unit - V

Microbial control of insect pests - control of soil borne microbial pathogens and nematodes - interaction of pesticides with soil microorganisms. Effects of microorganisms on pesticides. Effect of plant protection chemicals on soil microorganisms. Microbial herbicides.

Reference Books

1. Mishra R.R., (2004). Soil Microbiology. CBS Publishers & Distributors, New Delhi.
2. Dirk, J. Elsas, V., Trevors, J.T., Wellington, E.M.H. (2006). Modern Soil Microbiology, Marcel Dekker INC, New York, Hong Kong.
3. S A Waksman, Soil Microbiology. Nabu Press, 2011
4. Subba Rao, N.S., (1995). Soil Microorganisms and plant growth. Oxford & IBH Publishing Co., Pvt. Ltd., New Delhi.
5. Atlas Ronald, M., Bartha, and Richard (1997). Microbial Ecology 4th Edition. Benjamin/Cummings Publishing Company, California.

**IMBP 55 - Practical IV (Medical Microbiology, Genetic Engineering,
Molecular biology & Microbial Genetics,
Soil & Agricultural Microbiology)**

1. Acid fast Staining.
2. Capsule Staining.
3. Identification of pathogenic microorganisms from a given sample and biochemical identification for the following bacteria up to species level
 - a. *Staphylococcus aureus*,
 - b. *Escherichia coli*,
 - c. *Klebsiella* sp.,
 - d. *Salomonella typhi*,
 - e. *Proteus f. Pseudomonas*.
4. Isolation and characterization of bacteriophage from natural sources.
5. Cultivation of virus in chick embryo.
6. Genomic DNA isolation
7. Plasmid DNA isolation
8. Restriction digestion
9. Transformation
10. PCR
11. Western Blotting (Demo)
12. Isolation and enumeration of soil microorganisms (fungi, bacteria and actinomycetes).
13. Isolation of free - living nitrogen fixing bacteria from soil - *Azotobacter*.
14. Isolation of Symbiotic nitrogen fixing bacteria from root nodule - *Rhizobium*.
15. Isolation of phosphate solubilizers, ammonifiers and denitrifiers.
16. Study of Mycorrhizae, Cyanobacteria and *Azolla*.

IMBT 61 - Industrial Microbiology

Objectives

To study about the industrially importance microorganisms, fermenter design, fermentation process.

Unit I

Industrially important microorganisms - Isolation, preservation and improvement of strains - handling - development of inoculum for various fermentation processes, upstream processing - media for industrial fermentation - formulation - sterilization.

Unit II

Fermentor design - Body construction, individual parts, heat production - gas liquid exchange - mass transfer - heat transfer - oxygen transfer - stirring and mixing - Newtonian, non-Newtonian fluids - effect of viscosity - scale up - control of temperature, pH, foam, pressure - Sterilization of Bioreactors and nutrients, computer application in fermentation technology.

Unit III

An Introduction to fermentation process - The range of fermentation process, chronological development - component parts of fermentation process - fermentation economics. Fermentation types - submerged and solid state fermentation.

Unit IV

Downstream processing - Recovery of intracellular and extra cellular products - Biomass separation by centrifugation, filtration, flocculation and other recent developments, Cell disintegration - physical, chemical and enzymatic methods. Extraction - solvent, two phase, liquid extraction, whole broth, aqueous multiphase extraction. Purification by different methods, Concentration by precipitation, ultra filtration, reverse osmosis. Drying and crystallization.

Unit V

Microbial production of organic acids - Amino acids, antibiotics - enzymes - vitamins - alcoholic beverages - wine and beer, Fermented foods - bread, cheese.

Reference Books

1. Stanbury, P.F., Whittaker, A. and Hall, S.J., 2009. Principles of fermentation technology, 2nd edition, Pergamon Press.
2. Michael J. Waites, Neil L. Morgan, John S. Rockey, Gary Higton, A., 2001 Industrial Microbiology: An Introduction, 2nd edition, Sinavos Association, Ino Sundeland.
3. Cassida, J.E., 2007. Industrial Microbiology, New Age International
4. Prescott and Dunn, S., 2009. Industrial Microbiology. Agrobios Publishers
5. Pepler, H. J. and Pearlman, D. 2009. Microbial Technology, Vol. 1 and 2, Elsevier press.
6. Belter, P.A., Cussler, E.L. and Hu, W.S., Bio separation, 2011. Downstream processing for Biotechnology, John Wiley and Sons, N.Y.

IMBT 62 - Immunology

Objectives

The aim of the course is to teach the basic concepts of immunology and immunological mechanisms.

Unit - I

Cells of the immune system, T cells, B cells, Macrophages, mast cells, granulocytes, NK cells. Phagocytosis, T cell and B cell receptors and function. Antibody dependent cell mediated cytotoxicity. Blood groups- Blood transfusion-Rh factors- Rh incompatibility

Unit - II

Antigens: Types, Properties, Haptens, Epitopes, Adjuvants, Auto antigens, Blood group antigens. Factors governing antigen - antibody interactions - Affinity, avidity, valance, cross reactivity. Immunoglobulin structure, types, properties and function. Theories of antibody production- Clonal selection theory, Antibody diversity

Unit - III

Types of immunity: Innate and acquired, active and passive - physiology of Immune response - Humoral immunity and cell mediated Immunity: Central and peripheral lymphoid organs - primary lymphoid organs - secondary lymphoid organs- Thymus, Bone marrow, spleen, lymph node- peripheral lymphoid tissue GALT

Unit - IV

The Complement system- classical and alternate pathway. Major histo compatibility complex- class I and class II MHC structure and function. Transplantation immunity - organ transplantation and HLA tissue typing -Immunological tolerance - immunosuppression. Autoimmune disorders and immunology of infectious disease. Hypersensitivity definition and types I to IV (Brief details only)

Unit - V

Antigen - Antibody reactions - Agglutination - Precipitation, Complement fixation - Immunofluorescence, ELISA, RIA. Hybridoma technology and Monoclonal antibodies - applications. Vaccines - DNA vaccines recombinant vaccines - Edible vaccines, multivalent subunit and anti - Idiotype vaccines. Recombinant vaccine

Reference books

1. P.J. Delves, S.J. Martin, D.R. I.M. Roitt (2011). Roitt's Essential Immunology. Blacwell Scientific Publications, Oxford.
2. Rao, C.V (2008). Immunology, A text book, Narosa Publishing House, India.
3. Joshi, K.R and N.O. Osuma (2005). Immunology and Serology, Agrobios Ltd, India.
4. T.J. Kindt, R.A. Goldsby, B.A. Osborne, Janis Kuby 2008. Cuby Immunology III Edn. Panima book company limited. New Delhi.
5. Goldsby, 2004. Immunology. 5th Edn. New Era Books, Bangalore.

IMBT 63 - Environmental Microbial technology

Objectives

To provide a fundamental knowledge about the various scopes in environmental studies.

Unit - I

Environment and Ecosystems-Definitions, biotic and abiotic environment. Environmental segments. Composition and structure of environment. Concept of biosphere, communities and ecosystems. Ecosystem characteristics structure and function. Food chains, food webs and trophic structures. Ecological pyramids.

Unit - II

Eutrophication Water pollution and its control: Need for water management. Sources of water pollution. Measurement of water pollution, Eutrophication: Definition - causes -microbial changes in eutrophic bodies of water induced by various inorganic pollutants. Effects of eutrophication on the quality of water environment - factors influencing eutrophication. Algae in eutrophication, algal blooms, their effects and toxicity, coloured waters, red tides, and cultural eutrophication. Physico-chemical and biological measures to control eutrophication.

Unit - III

Aerobiology-Droplet nuclei, aerosol, assessment of air quality, - solid - liquid-impingement methods - Brief account of air borne transmission of microbes - viruses - bacteria and fungi, their diseases and preventive measures.

Unit IV

Waste treatment techniques -Wastes - types - solid and liquid wastes characterization - solid - liquid; treatments - physical, chemical, biological - aerobic - anaerobic - primary - secondary - tertiary; solid waste treatment - saccharification - gasification - composting. Utilization of solid wastes - food (SCP, mushroom, yeast): fuel (ethanol, methane) fertilizer (composting), liquid waste treatment - trickling filter-activated sludge - oxidation pond - oxidation ditch.

Unit V

Bioremediation & Global environmental problems Microbiology of degradation of xenobiotics in the environment, ecological considerations, decay behavior, bio magnification and degradative plasmids, hydrocarbons, substituted hydrocarbons, oil pollution, surfactants and pesticides. Genetically Modified Organisms released and its environmental impact assessment and ethical issues-Ozone depletion, UV-B, greenhouse effect and acid rain, their impact and biotechnological approaches for management.

Reference Books

1. Bioremediation: Principles and Applications (Biotechnology Research) by R L. Crawford , D L. Crawford 2005.. Cambridge University Press
2. Pollution: Ecology and Biotreatment by Ec Eldowney, S. Hardman D.J. and Waite S. 1993. - Longman Scientific Technical.
3. Wastewater Microbiology: A Handbook for Operators, T. Glymph.(2005) Amer Water Works Assn
4. Environmental Biotechnology. B.C. Bhattacharyya, R Banerjee.(2007) Oxford University Press
5. Biocatalysis and Biodegradation: Microbial transformation of organic compounds. 2001 by Lawrence P. Wacekett, C. Douglas Hershberger. ASM Publications.
6. A Manual of Environmental Microbiology. 2nd Edition. 2007 by Christon J. Hurst (Chief Editor), ASM Publications.

IMBT 64 - Food and Dairy Microbiology

Objectives

The emphasis of the course will be on characteristics and applications, food and dairy microflora and preservation, food quality and control measures.

Unit - I

Importance of food microbiology - types of microorganisms in food - source of contamination (Primary Sources) - factors influencing microbial growth of food (extrinsic and intrinsic) Regulations in food industry-The Food Safety and Standards Authority of India, INFOSAN.

Unit II

Food fermentations: Cheese, bread, wine, beer, fermented vegetables - methods and organisms used. Food and enzymes from microorganisms-single cell protein. Production of amylase, protease and other enzymes from food.

Unit III

Contamination, spoilage and preservation of cereals and cereals products, sugar and sugar products, Vegetables and fruits, meat and meat products - fish and the sea foods, egg and poultry - dairy and fermentative products (ice cream and other products)

Unit IV

Food borne diseases, intoxication and food poisoning - *Staphylococcus*, *Clostridium*, *Escherichia coli* and *Salmonella* infections, Hepatitis, Amoebiasis and Mycotoxins. Encounter of *Aeromonas* in food. EHEC and enteropathogens.

Unit V

Food preservation: Principles - methods of preservation - Physical and chemical methods, food sanitation. Good manufacturing process - hazard analysis, critical control points and personnel hygiene.

Reference Books

1. Adams , M.R. and M.O Moss., 2008. Food Microbiology , the Royal Society of Chemistry, Cambridge.
2. Doyle , M.P. 2005. Handbook of Hygiene Control in the Food Industry. 1nd Edn. Woodhead Publishing
3. Frazier, W.C and Westhoff D.C 2013. Food Microbiology. TATA McGraw Hill Publishing Company Ltd. New Delhi.
4. Jay, J.M.2013. Modern Food Microbiology. 7th Edn. CBS Publishers and Distributors, New Delhi.
5. Stanbury, P.F., Whittaker, A. and Hall, S.J., 2009. Principles of fermentation technology, 2nd edition, Pergamon press.

IMBP 65 - Practical V (Industrial Microbiology, Immunology, Environmental Microbial technology, Food & Dairy Microbiology)

1. Wine production – Alcohol Estimation, Sugar Estimation.
2. Production and Quantification of
 - a. Alcohol
 - b. Citric acid
 - c. Protease
 - d. Amylase
 - e. Lipase
3. Immobilization technique (Sodium alginate method)
4. Immuno electrophoresis
5. ELISA
6. Bacterial examination of water (qualitative and quantitative).
7. Enumeration of microorganism from air. Settle plate technique.
8. Estimation of dissolved oxygen (DO).
9. Estimation of BOD.
10. Estimation of COD.
11. Microbial Spoilage of Vegetables
12. Microbial spoilage of Fruits
13. Isolation of Mycotoxigenic fungi from cereals and oil seeds
14. Examination of Unspoiled canned foods for sterility and quality
15. Spoilage of Sea foods
16. Spoilage of Eggs
17. Effect of sodium chloride on the growth of food
18. Effect of sucrose on the growth of food microflora
19. Role of yeast in Bread making

IMBT 71 – Bioinformatics

Objectives

The aim of the course is to make the students to understand the application of computer technology in biological studies, use of internet and Bionet.

Unit - I

Introduction to bioinformatics, scope of bioinformatics, role of computers in biology. The internet, the world wide web, useful search engines – Boolean searching, search engine algorithms. Finding scientific articles – Pubmed. Running computer software, computer operating systems. Software downloading and installation

Unit - II

The bioinformatics workstation, Unix system, files and directories in Unix, working on a Unix system. Scripting languages – Perl and Python, markup languages – HTML, XML.

Unit - III

Database concepts – Database, database system, database management systems – Hierarchical, Rational and Network, Database security. Biological databases, Types – sequence and structure databases. Genome and organism specific databases. Miscellaneous databases. Data submission, data retrieval with Entrez, DBGET / Link DB and SRS.

Unit - IV

Searching sequence database sequence similarity searches, amino acid substitution matrices, Database searches: FASTA and BLAST, sequence filters, Iterative database searches and PSI – BLAST. Multiple sequence alignment – gene and protein families. Phylogenetics – building phylogenetic trees, Evolution of macromolecular sequences, Sequence annotation.

Unit - V

Obtaining, viewing and analyzing structural data, structural alignment. Classification of protein structures. CATH and SCOP. Protein structure prediction- secondary structure prediction, Territory structure prediction- Homology modelling, protein threading, ab initio protein folding. CADD Molecular docking, Metabolic pathway reconstruction- Kegg

Reference Books

1. Lesk, A.M. Introduction to Bioinformatics. Oxford, 2009.
2. Campbell and Heyer. Discovering Genomics, Proteomics and Bioinformatics. Cold Spring Harbour Laboratory. Press & Benjamin Cummings, 2008.
3. Gibas and Per Jambeck. Developing Bioinformatics Computer Skills. O'Reilly & Associates, 2001.
4. Krane et al. Fundamental concepts of bioinformatics. Benjamin Cummings, 2002.
5. Bergeron BP. Bioinformatics computing 1st ed. Printice Hall, 2002.
6. Baxevanis & Ouellette. Bioinformatics: A practical guide to analysis of genes and proteins. 2nd ed. Wiley – Inter Sci. 2004

IMBT 72 - Microbial diversity and Extremophiles

Objectives

The aim of the course will be on the concept of microbial diversity and characteristics of microorganisms in extreme conditions.

Unit - I

Biodiversity Introduction to microbial biodiversity - distribution, abundance, ecological niche. Types - Bacterial, Archaeal and Eucaryol.

Unit - II

Characteristics and classification of Archaeobacteria. Thermophiles Classification, hyperthermophilic habitats and ecological aspects. Extremely thermophilic Archaeobacteria, thermophile, commercial aspects of thermophiles. Applications of thermozymes. Methanogens: Classification, Habitats, applications.

Unit - III

Alkalophiles and Acidophiles Classification, alkaline environment, soda lakes and deserts, calcium alkalophily Applications. Acidophiles Classification, life at low pH, acidotolerance, applications.

Unit - IV

Halophiles and Basophiles Classification, Dead Sea, discovery basin, cell walls and membranes - Purple membrane, compatible solutes. Osmoadaptation / halotolerance. Applications of halophiles and their extremozymes. Barophiles: Classification, high-pressure habitats, life under pressure, basophile, death under pressure.

Unit - V

Space Microbiology aims and objectives of Space research. Life detection methods - Evidence of metabolism (Gulliver) - Evidence of photosynthesis (autotrophic and heterotrophic) - ATP production - Phosphate uptake - Sulphur uptake. Martian environment (atmosphere, climate and other details).

Reference Books

- 1 Om V. Singh, Extremophiles: Sustainable Resources and Biotechnological Implications, 2012, Wiley-Blackwell
- 2 C Gerday, N Glansdorff, Physiology and Biochemistry of Extremophiles, 2007, ASM Press
- 3 R P Anitori, Extremophiles: Microbiology and Biotechnology , 2012, Caister Academic Press
- 4 H Breidahl, Extremophiles: Life Extr. Environ. 2001, Chelsea House Publications
- 5 F Rainey, A Oren, Extremophiles (Methods in Microbiology), 2006 , Academic Press
- 6 K Horikoshi, G Antranikian, A T. Bull, F T. Robb, K O. Stetter, Extremophiles Handbook, 2011, Springer

IMBP 73 - practical VI (Bioinformatics, Microbial diversity & extremophiles)

1. Isolation of thermophiles from hot water spring [Study at least one enzyme].
2. Studies on halophiles isolated from seawater. [Pigmentation and Salt tolerance]
3. Studies on alkalophiles isolated from lonar water/sea water. [Study at least one enzyme]
4. Biogenic methane production using different wastes.
5. Isolation of *Thiobacillus ferrooxidans* and *Thiobacillus thiooxidans* cultures from metal sulfides, rock coal and acid mine waters.
6. Sequence alignment and searching.
7. Gene prediction.
8. Multiple sequence alignment.
9. Phylogenetic analysis.
10. Protein sequence analysis.
11. Protein structure prediction.
12. Protein structure alignment and comparison.
13. Primer design.
14. SNP finding in DNA sequence.
15. ORF finding in DNA sequence.
16. Visualization tools

IMBT 75 Elective - II Bioremediation

Unit - I

Principles of Bioremediation – Rapid growth and Metabolism- Genetic plasticity – Metabolic pathways for the degradation of xenobiotics, hydrocarbons – Microbial site characterization – Biodegradation potential

Unit - II

Bioprocess design, optimization – Microbial removal rates – inherent problems associated with biotreatment studies. Microbiological methodologies – Standard biotreatability protocols – Quantification of biodegradation; Biocleaning -Chernobyl radioactive contaminated area - Phytoremediation.

Unit - III

Aerobic Bioremediation: Bioremediation of Surface Soils: Fate and transport of contaminants in the Vadose zone – Biodegradation in soil ecosystems – Types of soil treatment systems – Bioreactors. Subsurface Aerobic Bioremediation: in situ Bioremediation – in situ Bioventing – in situ treatments of Harbor Sediments and Lagoons

Unit - IV

Bioremediation in fresh water and marine systems: Bench and Pilot Scale studies – in situ Bioreactor treatment of sediments – in situ treatment in marine ecosystem.

Unit - V

Anoxic/Anaerobic Bioremediation: Anoxic/Anaerobic Processes – Fermentation, Degradation of xenobiotic – Anoxic/Anaerobic bioremediation of hydrocarbons, Phenols, Chlorophenolic compounds, Polycyclic Aromatic Hydrocarbons (PAH), Heterocyclic Compounds, Cyanide, dyes, Radioactive wastes.

Reference Books

1. Microbial Ecology, IV Ed., Atlas, R.M and Bartha,R.,(2000) Addison Wesley Longman Inc.
2. Bioremediation, Baker,K.H. and Herson,D.S., (1994) Mc Graw–Hill Inc, New York.
3. Brock Biology of Microorganisms, Michael.T.Madigan, John.M.Martinko, Paul V. Dunlap, David P. Clark- 12th edition, Pearson International edition 2009, Pearson Benjamin Cummings
4. Bioremediation: Principles and Applications (Biotechnology Research), R L. Crawford, D L. Crawford (2005). Cambridge University Press
5. Waste Management Practices: Municipal, Hazardous, and Industrial, , 2ND Ed, J Pichtel (2014) CRC Press
6. Hazardous Wastes and Solid Wastes, Liu, D.H.F and Liptak,B.G (2000), Lewis Publishers, New York.

IMBT 81 - Medical parasitology and Medical mycology

Objective

This paper is focused for the fungal and Parasitic disease associated with human beings for their etiology, diagnosis and treatment.

Unit - I

Historical introduction to mycology – Morphology - Taxonomy-Classification of fungi - Isolation and Identification of fungi from clinical specimens. Mycotoxins & Mycetism. Antifungal agents - testing methods and quality control.

Unit - II

Superficial mycosis - Tinea, Piedra - dimorphic fungi causing systemic mycosis - Blastomycosis and Histoplasmosis - Cutaneous mycosis-Dermatophytosis. Subcutaneous mycosis - Sporotrichosis, Mycetoma, Rhinosporidiosis, Opportunistic mycosis - Candidiasis, Cryptococcosis and Aspergillosis.

Unit - III

Introduction and classification of parasites, transmission lifecycle, lab diagnosis, preventive measures and treatment for the following Protozoa Entamoeba. Aerobic and Anaerobic Amoebae causing human disease. Toxoplasma, Cryptosporidium and other Protozoan parasites causing infection in man Leishmania, *Trypanosoma*, *Giardia*, *Trichomonas*, *Balantidium*.

Unit - IV

Classification, lifecycle, transmission, Pathogenicity, Lab diagnosis for the following Helminthes – Cestodes - *Taenia Solium*, *T. Saginata*, *Echinococcus granulosus*, *Fasciola hepatica*, *Paragonimus* - schistosomes- *Ascaris lumbricoides*, *Ancylostoma duodenale*, *Trichinella*, *Enterobius* and *Wuchereria bancrofti*.

Unit - V

Laboratory diagnosis of Parasitic infections - Examination of feces - Direct and concentration techniques, serological techniques.

Reference books

1. Chander.J (1996). A text book of Medical mycology. Interprint, New Delhi.
2. Chatraborty. P, (2003). A textbook of Microbiology (2nd edition). New central agency (P) Ltd. Kolkatta.
3. Mehrotra, R.S and K.R aneja (2006). An introduction to mycology. Reprinted and published by New Age International (P) Ltd, New Delhi.
4. Parija S.C (2004). Textbook of Medical Parasitology, Protozoology and Helminthology. (2nd Edition). All India Publishers and distributors, Medical Book Publisher, New Delhi.
5. Challerjee, (1986) Medical Parasitology. Tata mcCraw Hill, New Delhi.
6. Jeyram Paniker, (2004). Textbook of Medical Parasitology (5th edition). JAYPEE brothers, Medical Publishers (P) Ltd. New Delhi.

IMBT 82 - Medical diagnostic technology

Objectives

The emphasis of course is to learn the diagnostic methods and sample collection to diagnose the disease.

Unit - I

Organization of laboratory and safety precautions in laboratory and personal cleanliness and care with regards to infected materials and chemical burns. Quality assurance and disposal of wastes. Maintenance of clinical laboratory instruments. Regulatory agencies NABL

Unit - II

Sample collection, preservation and transportation of various clinical pathology samples. Pathological analysis of clinical specimens

Unit - III

Collection and analysis of Blood, Blood grouping systems, Rh typing, Blood bank operation

Unit - IV

Tissue reception, labeling, fixation for different tissue and section cutting. Preparation of paraffin blocks (Dehydration, clearing, embedding, blocking). Handling and care of microtome sharpening of razors, and section cutting. Preparation of common stains. H & E, congo red, methyl violet, Leishman stain, Giesma, VG, PAS, PASM etc. and staining techniques.

Unit - V

Serology- Serological methods for diagnostic purpose – Agglutination- Widal, VDRL, RPR, ASO, CRP test, latex agglutination test, Precipitation, CFT, ELISA, RIA, CLIA

Reference Books

1. Todd and Sanford, clinical diagnosis by laboratory method.2011, Nabu Press
2. G. Orchard, B Nation Histopathology (Fundamentals of Biomedical Science), 2011, OUP Oxford
3. Culling -Histopathology techniques.
4. Bain, Dacie and Lewis Practical Haematology.2011, Elsevier
5. Ramani Sood.Laboratory technology (Methods and interpretations) 6th Ed.2009 J.P. Bros, New Delhi, .
6. Satish Gupte, -Short text book of medical laboratory for technicians,2012, J.P. Bros, New Delhi.

IMBP 83 - Practical VII (Medical parasitology & Medical mycology, Medical diagnostic technology)

- 1) Skin/nail scrapings for fungi isolation
- 2) Lactophenol cotton blue mount for identification of fungi
- 3) Germ tube test for yeast
- 4) Sugar assimilation test for yeast
- 5) Cultivation of following fungi and their identification in SDA and corn meal Agar
Mucor, Rhizopus, Penicillium, Candida, Aspergillus
- 6) Isolation of ova/cyst in Faeces (Direct and concentration methods).
- 7) Spotters of Anopheles, *Glossina*, Ticks, Mites *Aedes* etc.
- 8) Blood smear examination for Malarial parasites.
- 9) Different methods of blood collection & Preparation of anticoagulant bottles
- 10) Total & Differential WBC count
- 11) Antibiotic sensitivity test-MIC, MBC, Agar dilution, Broth dilution, Disc diffusion.
- 12) Cross matching –Major, Minor
- 13) Antistreptolysin'O test
- 14) CRP
- 15) Rheumatoid factor test
- 16) Fixing and staining of tissues for pathological examination

IMBE 84 Elective - III Quality control and IPR

Unit - I

Bioethics - Definition - Principles of Bio ethics - General issues related to environmental release of genetically modified microorganisms. Ethical issues related to the use of animal as models for microbial diseases- Animal ethics norms in India - Licensing of animal house - Ethical clearance norms for conducting studies on human subjects. Ethical issues related to research in embryonic stem cell cloning.

Unit - II

Biosafety - Introduction. Different levels of biosafety. Guidelines for recombinant DNA research activities in microorganisms. Good Laboratory Practices (GLP). Containments - Types. Basic Laboratory and Maximum Containment microbiology Laboratory research.

Unit - III

Introduction to Intellectual Property - IPR - Definition - Types of IPR: Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications, IP as a factor in R&D; IPs of relevance to Microbiology/ Biotechnology and few Case Studies WTO - Definition - Functions - Forms of IPR Protection.

Unit - IV

Agreements and Treaties-History of GATT & TRIPS Agreement; Madrid Agreement; Hague Agreement; WIPO Treaties; Budapest Treaty; PCT; Indian Patent Act 1970 & recent amendments

Unit - V

Basics of Patents and Concept of Prior Art IPR & edits. Introduction to Patents; Types of patent applications: Ordinary, PCT, Conventional, Divisional and Patent of Addition; Specifications: Provisional and complete; process of patenting, Indian and international agencies involved in IPR & patenting, Global scenario of patents and India's position, patenting of biological material, GLP, GMP.

Reference Books

1. BAREACT, Indian Patent Act 1970 Acts & Rules, Universal Law Publishing Co. Pvt. Ltd., 2007
2. Kankanala C., Genetic Patent Law & Strategy, 1st Edition, Manupatra Information Solution Pvt. Ltd., 2007.
3. Frederic H. Erbisch, Karim M. Maredia (2004). Intellectual Property Rights in Agricultural Biotechnology, CABI Publisher.
4. Mittal D.P. (1999). Indian Patents Law. Taxmann Allied Services (p) Ltd.
5. Christian Lenk, Nils Hoppe, Roberto Andorno (2007). Ethics and Law of Intellectual Property: Current Problems in Politics, Science and Technology, Ashgate Publisher (p) Ltd.
6. Felix Thiele, Richard E. Ashcroft (2005). Bioethics in a Small World. Springer.

7. John Bryant (2005) Bioethics for Scientists. John Wiley and Sons
8. Recombinant DNA safety guidelines (January 1990), Department of Biotechnology, Ministry of Science & Technology, Government of India, New Delhi.
9. Glick, B.R., and Pasternak, (2009), Molecular Biotechnology, 4th Edition, J.J., ASM Press, Washington, DC.

IMBE 85 Elective - IV Microbial metabolites

Unit - I

Metabolites: General account of metabolites, secondary metabolites. Classification, structure and mode of action of secondary metabolites. Plants secondary metabolites: Digitoxine, Salicylic acid, Mycotoxins - Aflatoxin, Ochratoxin, Patulin.

Unit - II

Antimicrobial drugs: Secondary metabolites Antibiotics: History and discovery of antibiotics, Antibiotic resistance, Mechanisms of antibiotic resistance. Structure and mode of action of antibiotics: aminoglycosides (Amikacin), Carbapenems (Imipenim), microlids (Azithromycin), Nitrofurans (nitrofurantoin), Penicillin (Amoxicillin), Quinolones (gatifloxacin/Ciprofloxacin), Sulphonamides (sulfamethoxazole), Tetracyclines (doxycyclines), Chloramphenicol, Flucanazole.

Unit - III

Pigments as secondary metabolites General account of pigments, Chlorophylls, Carotenoids of eukaryotes, phycobilliproteins. Hemoglobin, Myoglobin, Melanin and bile pigments. Microbial pigments: Bacteriochlorophylls, Carotenoids of prokaryotes, rhodopsin and accessory pigments (Pulcherrimin, indigoidin, voalecin) Defensive role of pigments.

Unit - IV

Microbial vitamins Characteristics of fats and water soluble vitamins. Structure, function and chemistry of: Retinol (vitaminA), Riboflavin (vitaminB2), Cyanocobalamine (VitaminB12) and ascorbic acid (vitaminC).

Unit - V

Biopolymers: Polypeptides (collagen, casein and serum albumin), Polynucleotides and polysaccharides (amylose, amylopectin, alginate, cellulose) and other biopolymers like chitin, Xanthan, dextrin, Gellan, Pullulan, curdlan and hyluronic acid. Polyamines: Brief outline and functions of polyamines. Synthesis of linear polyamine-putrescine, cadoverine, spermidine and spermine.

Reference Books

1. Crueger, Biotechnology - A Text Book of Industrial Microbiology 2004, Panima Publishing Corporation
2. MC Flickinger Encyclopedia of Bioprocess Technology: Fermentation, Biocatalysis and Bioseparation, 1999, Wiley and Sons, N, Y.
3. Ashok Pandey, Concise Encyclopedia of Bioresource Technology, 2009, CRC Press
4. Satyanarayana, Biotechnology. 2009, Books and Allied (P) Ltd., Kolkata.
5. Jogdand SN Gene biotechnology. 2009, Himalaya Publishing House, Mumbai.
6. Singh BD, Biotechnology. 2010 Kalyani Publishers, Chennai

IMBT 91 - Biofuel and Bioenergy

Objectives

The emphasis of course is learning the energy sources, utilization of biomass for energy production and as biofuels.

Unit - I

Energy - Renewable and non - renewable energy - Energy plantations - Latex producing plants - nuclear energy - Energy management and use.

Unit - II

Bio gas plants Biogas plant - Types – Construction details - Loading of biogas plants - Biogas requirement for various use - Biogas applications - dual fuel engine.

Unit -III

Alternative feedback for biogas plants. Effective use of Agricultural, Horticultural, Forest and fishery wastes and byproducts as an alternative feed stock for biogas plants – Bio digested slurry - Manure value - Enrichment - Pelletization.

Unit - IV

Utilization of biomass for energy production. Bio mass residues for agriculture, Horticulture, forest and fishery energetic – fast growing biomass species as energy source - solid, liquid, gaseous energy production from biomass and its use.

Unit - V

Biomass briquetting - coir pith groundnut shell etc., Alcohol from sweet sorghum, tapioca, sweet potato - producer gas - Aqua gas, pyrolytic gas from biomass such as maize cob, groundnut husk, cotton stalk, briquettes.

Reference Books

1. V K. Gupta, M Tuohy, C P Kubicek, J Saddler, Feng Xu , Bioenergy Research: Advances and Applications, 2013, Elsevier press.
2. R. S. Khoiyangbam, Biogas Technology: Towards Sustainable Development, 2011, The Energy and Resources Institute, TERI.
3. FW Bai, C G Liu, H Huang, G T Tsao, Biotechnology in China III: Biofuels and Bioenergy: 3 (Advances in Biochemical Engineering/Biotechnology) 2012, Springer press.
4. Chawla, O.P.1986, Advances in Biogas Technology. ICAR Publication, New Delhi.
5. B T Nijaguna, Biogas technology.2002 New Age International Pub.

IMBT 92 - Enzymes

Objectives

The aim of the course is about the classifications, nomenclature and mechanism of the enzyme action.

Unit - I

Enzyme classification and nomenclature of enzymes (IUB); extraction, isolation and purification of enzyme by various methods. Units of enzyme activity- International unit. Mechanism of enzyme action - concept of active site and energetic of enzyme substrate complex formation - specificity of enzyme action;

Unit - II

Kinetics of single substrate reactions - turnover number - Michaelis - Menten's equation K_m , V_{max} two-substrate reactions – mechanisms. Kinetics of allosteric enzymes, Sigmoidal plot

Unit - III

Enzyme inhibitions - Kinetics of competitive, non-competitive & uncompetitive inhibition; nucleophilic and electrophilic attack; role of metal ions in enzyme catalysis.

Unit - IV

Immobilized enzymes - principles & techniques of immobilization - commercial production of enzymes; amylases, proteases, cellulose, artificial enzymes, fermentation, site directed mutagenesis; immobilized enzyme in industrial processes. Industrial uses of enzymes, food, detergents, energy, waste treatment, pharmaceuticals and medicine.

Unit - V

Enzyme regulation- Feedback inhibition, Covalent modification, Allosteric regulation. Structure and function of coenzyme - reactions involving TPP, pyrodoxal phosphate, nicotinamide, flavin nucleotide, coenzyme A and biotin.

Reference Books

1. A Pandey, C Webb, M Fernandes, C Larroche, Enzyme Technology, 2010, Springer press.

2. R A. Copeland, Enzymes: A Practical Introduction to Structure, Mechanism, and Data Analysis, 2000, Wiley-Blackwell.
3. T Palmer, P. L. Bonner, Enzymes: Biochemistry, Biotechnology, Clinical Chemistry, 2007, Horwood Publishing Ltd.
4. D L. Nelson and M M. Cox, Lehninger Principles of Biochemistry, AL. Lehninger, 2013. W. H. Freeman Publishers.
5. Robert K. Murray, David Bender, Kathleen M. Botham and Peter J. Kennelly, Harpers Illustrated Biochemistry 29th Edition, 2012, McGraw-Hill Medical publisher.

IMBP 93 - Practical VIII (Biofuel & Bioenergy, Enzyme technology)

1. Screening for amylase producing microbes from soil
2. Screening for lipase producing microbes from soil
3. Screening for protease producing microbes from soil
4. Isolation of extra cellular enzymes.
5. Isolation of intra cellular enzymes.
6. Isolation of membrane bound enzymes.
7. Purification of enzymes.
8. Assay of enzyme activity amylase
9. Assay for enzyme activity Protease
10. Enzyme kinetics V_{max} Value
11. Enzyme kinetics k_m value
12. Immobilization of enzyme
13. Quantification of biogas from different feedstock.
14. Analysis of nutritive value of biogas slurry.
15. Biomass briquetting – coir pith, groundnut cake, bagasse.

IMBE 94 Elective - V Genomics and Proteomics

Unit - I

Definition of Genomics -Mapping Genome – size-complexity- structure and function of prokaryotic and eukaryotic genome. Physical mapping of genome-Sequencing whole genome- Restriction mapping - FISH - STS mapping - Hybridization assays - Physical mapping without cloning- Mapping by genetic techniques - DNA markers - RFLPs, SSLPs, SNPs - Linkage analysis - Cross breeding and pedigree analysis.

Unit - II

Sequencing methods and Strategies Basic DNA sequencing - Modifications of chain-terminator sequences- Automated DNA sequencing- DNA sequencing by capillary array electrophoresis- shotgun sequencing - Overlapping clone contigs - High throughput sequencing - sequencing strategies- Alternative DNA sequencing - EST sequencing and sequence skimming.

Unit - III

Genome Analysis Overview of sequence analysis- Gene prediction - Tools for genome analysis. Detecting open-reading frames-using homology to find genes- software programs for finding genes- Identifying the function of a new gene - Analyses not based on homology- Genome annotation- Molecular phylogenetics. History of proteomics - from transcriptome to proteome.

Unit - IV

Tools of protein separation, analysis and characterization. Protein digestion techniques. Protein fingerprinting. 2D electrophoresis. Mass spectrometry - ESI and MALDI - TOF, SELDI - TOF (surface enhanced laser desorption time of flight), NMR, X - ray crystallography, phage display, yeast 2+ Hybrid system, surface plasma resonance Applications of proteomics - mining proteomes, protein expression profiling, identifying protein - protein interactions and protein complex, mapping protein modifications.

Unit - V

Metagenomics - Introduction, Methods, Sequence driven approach, Functional metagenomics, Applications, Advantages, Limitations, DGGE Genomics: The Science and Technology behind the human project.

Reference Books

1. Primrose, Principles of Genome Analysis, 2006, Blackwell Science.
2. Dale and Schantz, From Genes to Genomes, 2011, Wiley-Blackwell
3. Brown TA, Genomes 3, 2006 Garland Science.
4. Pennington and Dunn, Proteomics: from protein sequence to function, Garland Science, 2002.
5. Liebler, DC. Introduction to Proteomics. Humana Press, 2002.
6. M Campbell. Discovering Genomics, Proteomics and Bioinformatics, 2008, Pearson Education

IMBE 95 Elective VI Bioinstrumentation and Research methodology

Unit - I

Research Methodology - Meaning and importance. Statement, Constraints, Review of literature - Review and synopsis presentation. Types of research, Research tools, Qualities of a good researcher. Research process, Research designs - Experimental and non-experimental. Preparation of research report. Guidelines for preparing an article. Computers in biological research.

Unit - II

Thesis writing - defining research problem, research design, general format, literature survey, primary source - articles, reviews, abstract, current contents (both text and CCOD), reference card, data analysis, data interpretation, report writing, proof correction.

Unit - III

Light Microscopy - Microscopic optics, components of microscopes. Basic principles and types of Bright field, Dark field, Phase contrast. Fluorescence, Polarization and confocal microscopes and their applications. Immunofluorescence - In situ hybridization. Electron Microscopy - Principle, Techniques and applications of Transmission Electron microscope (TEM) and Scanning Electron Microscope (SEM).

Unit - IV

Spectroscopic methods - UV-Visible, Atomic Absorption and Atomic Emission Spectroscopy. Centrifugation - Principles and types centrifugation Radioactive Analysis: Principles of radioactivity, GM counter & LS counter.

Unit - V

Theory, principles and applications of paper, thin layer, gel filtration, ion exchange, affinity, GC and HPLC methods. Electrophoresis - Principle, types and methods. Horizontal, vertical, PAGE, Agarose electrophoresis, Applications. Pulse Field gel electrophoresis (PFGE) - Principle and applications. Gel documentation and molecular weight analysis.

Reference Books

1. R H. Baltz Demain, A.L. and Davies, J.E. (2010). Manual of Industrial Microbiology & Biotechnology, ASM Press.
2. John G. Webster. (2008). Bioinstrumentation. University of Wisconsin, John Wiley & Sons, Inc.
3. D B. Murphy, M W. Davidson. (2012) Fundamentals of Light Microscopy and Electronic Imaging, Wiley-Blackwell.
4. Westermeier, R (2001). Electroporesis in practice – VCH – Federal Republic of Germany.
5. Wilson, K. and Walker (2000). Principles and Techniques of Practical Biochemistry, Cambridge University Press.
6. Kothari, C.R., 2013. Research methodology Methods and Techniques, New Age International Pvt Ltd Publishers., New Delhi.
7. Anderson, J., Durosn, B.H. and Poole, M. 2011. Thesis and assignment writing, Wiley Eastern Ltd., New Delhi.

IMBT 101 – Biopharmaceuticals

Objectives

The aim of the course will be on the study of Pharmaceutical products.

Unit - I

Antimicrobial drugs, Chemical disinfectants, antiseptics and preservatives. Definition, Types of antimicrobial drugs, (Aminoglycosides, b lactams, tetracyclines, ansamycins, macrolid antibiotics) Antifungal antibiotics, antitumor substances. Peptide antibiotics, Chloramphenicol, Sulphonamides and Quinolinone)

Unit - II

Mechanism of action of antibiotics (inhibitors of cell wall synthesis, nucleic acid and protein synthesis). Molecular principles of drug targeting. Bacterial resistance to antibiotics. Mode of action of non - antibiotic antimicrobial agents. Penetrating defenses - How the antimicrobial agents reach the targets (cellular permeability barrier, cellular transport system and drug diffusion). Macromolecular, cellular and synthetic drug carriers.

Unit - III

Microbial contamination and spoilage of pharmaceutical products (Parenterals & non parenterals, ophthalmic preparations and implants) and their sterilization other pharmaceuticals produced by microbial fermentations (streptokinase, streptodornase). New vaccine technology, DNA vaccines, synthetic peptide vaccines, multivalent subunit vaccines. Vaccine clinical trials.

Unit - IV

Regulatory practices, biosensors and applications in Pharmaceuticals Financing R&D capital and market outlook. IP, BP, USP. Government regulatory practices and policies, FDA perspective. Reimbursement of drugs and biological, legislative perspective. Rational drug design Biosensors in pharmaceuticals. Application of microbial enzymes in pharmaceuticals.

Unit - V

Quality Assurance and Validation, Good Manufacturing Practices (GMP) and Good Laboratory Practices (GLP) in pharmaceutical industry. Regulatory aspects of quality control. Quality assurance and quality management in pharmaceuticals ISO, WHO and US certification. Sterilization control and sterility testing (heat sterilization, D value, Z value, survival curve, Radiation, gaseous and filter sterilization) Chemical and biological indicators. Design and layout of sterile product manufacturing unit

Reference Books

1. S P Denyer, N Hodges, S P. Gorman and B F. Gilmore, Hugo and Russell's Pharmaceutical Microbiology, 2011 Blackwell scientific Publications.
2. A. Bryskier, Antimicrobial Agents: Antibacterial and Antifungals Agents, 2006, American Society for Microbiology.
3. M S. Cooper Quality control in the Pharmaceutical Industry, 2012, Academic Press New York.
4. J.Rehm & G.Reed , Biotechnology, 2012, Wiley India Pvt Ltd.
5. D. N Joseph, Good Manufacturing Practices for Pharmaceuticals: A Plan for Total Quality Control from Manufacturer to Consumer, 2000, CRC Press.

IMBT 102 - Microbial inoculants and Mushroom technology

Objectives

The aim of the course will be on the study of production and distribution of mushrooms and microbial inoculants.

Unit - I

Edible and non-edible mushroom (Historical account, most commonly cultivated mushrooms in the world, distribution and production in various countries).

Unit - II

Cultivation of button mushroom - morphology raising a pure culture & spawn preparation. Preparation of compost & cultivation of *Agaricus bisporus*, *Pleurotus flabellatus*, harvest.

Unit - III

Cultivation of oyster and paddy straw mushroom - preparation of pure culture & spawn cultivation methods, harvest.

Unit - IV

Cyanobacterial Biofertilizers - *Nostoc*, *Anabaena*, *Gloeocapsa* and *Scytonema* as biofertilizers; Symbiotic association with *Azolla*; Multiplication of blue green algae and its effect on agricultural (rice) yields. Bacterial Biofertilizers - Free living forms: *Azotobacter*, *Azospirillum*; Symbiotic forms: *Rhizobium* - Legume Association: *Pseudomonas*, Nonlegume association.

Unit - V

Fungal Biofertilizers - Ectomycorrhizal association with pines: Vesicular arbuscular mycorrhizal association (VAM) - *Glomus* sp; Actinomycetes as Biofertilizers - Actinomycetes associations - *Frankia* sp.

Reference Books

1. S Biswas, M. Datta and S.V. Ngachan Mushrooms: A Manual for Cultivation, 2012, PHI Learning Private Limited.
2. Dhar and Kaul, Biology And Cultivation Or Edible Mushrooms, 2007, Westville Publishing House.
3. Kannaiyan. 2001. Handbook of Edible Mushrooms" TNAU Publication.
4. Rao, N.S., 2007. Biofertilizers in Agriculture. Oxford & IBH Publishing Co., Pvt., Ltd., Bombay.
5. Totawat, K.L., Somani, L.L., Sharma, R.A. and Maloo, S.R., 2008. Biofertilizer Technology. Agrotech Publishing Academy. Udaipur, Rajasthan.
6. Mahendra Rai, Handbook of Microbial Biofertilizers, 2008, CRC Press.

IMBP 103 - Practical IX (Biopharmaceuticals, Microbial inoculants & mushroom technology)

1. Spectrophotometric / Microbiological methods for the determination of Griesofulvin.
2. Bioassay of chloramphenicol by plate assay method or turbidimetric assay method.
3. Treatment of bacterial cells with cetrimide, phenol and detection of Leaky substances such as potassium ions, aminoacids, purines, pyrimidines and pentoses due to cytoplasmic membrane damage.
4. To determine MIC, LD 50 of Beta-lactum/aminoglycoside/ tetracycline/ansamycins.
5. Sterility testing by *Bacillus stearothermophilus*
6. Sampling of pharmaceuticals for microbial contamination and load (syrups, suspensions, creams and ointments, ophthalmic preparations).
7. Determination of D value, Z value for heat sterilization in pharmaceuticals.
8. Determination of antimicrobial activity of a chemical compound (Phenol, resorcinol, thymol, formaldehyde) to that of phenol under Standardized experimental conditions.
9. Cultivation of button mushroom
10. Cultivation of Oyster mushroom
11. Production of microbial inoculants
12. Cultivation of *Azolla*

IMBT 104 Elective VII Entrepreneurship and Management for Microbiology

Unit - I

Evolution of the concept of entrepreneur - Entrepreneurship: Definitions-concept of Entrepreneurship, development - need - role of resource, talent and spirit - process of Entrepreneurship to socio-economic gains.

Unit - II

Institutions and schemes of government of India- Schemes and programmes. Department of science and technology schemes, Nationalized banks - other financial institutions, etc - SIDBI - NSIC - NABARD - IDBI - IFCI - ICICI etc.

Unit - III

Skills for entrepreneurs - communication skills, problem solving skills; Business plan development; Market need - market research, SWOT analysis, identify your competition. Financial plan - obtain financing for your business, insure your business, Marketing - mix-product, distribution, price, promotion, set marketing goals.

Unit - IV

Composting - domestic waste, agricultural and industrial waste, vermi - composting. SCP production - mushroom cultivation.

Unit - V

Biofertilizers and Biopesticides. Production of teaching kits (plasmid DNA isolation, serum electrophoresis) and diagnostic kits (WIDAL test kits, ABO blood grouping kits)

Reference Books

1. P S. Teng, Bioscience Entrepreneurship in Asia: Creating Value with Biology, 2007, World Scientific Publishing Co Pte Ltd
2. Holger Patzelt and Thomas Brenner, Handbook of Bioentrepreneurship, 2008, Springer press
3. David Adams and John Sparrow, Enterprise for Life Scientists: Developing Innovation and Entrepreneurship in the Biosciences, 2008, Scion Publishing Ltd
4. Rao, N.S., 2007. Biofertilizers in Agriculture. Oxford & IBH Publishing Co., Pvt., Ltd., Bombay.
5. Totawat, K.L., Somani, L.L., Sharma, R.A. and Maloo, S.R., 2008. Biofertilizer Technology. Agrotech Publishing Academy. Udaipur, Rajasthan.
6. Subba Rao, N.S., 1995. Biofertilizer in agriculture and forestry. Oxford and IBH, New york.
7. Totawat, K.L., L.L. Somani, R.A. Sharma and S.R. Maloo, 2004. Biofertilizer Technology. Agrotech Publishing Academy, Udaipur, Rajasthan.

