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SHIVAJI UNIVERSITY, KOLHAPUR.

M.Sc. Part-II Microbiology

Sem III & IV

To be implemented from the academic year 2010-11

(i.e. from June 2010) onwards.

Syllabus for M.Sc. - II (Microbiology)

Titles of theory and practical courses in the Semesters

M.Sc. II, Semester III

MIC-301- Biostatics, Bioinformatics and Scientific Writing.

MIC-302- Enzymology and Enzyme Technology

MIC-303- Microbial Technology

MIC-304- Microbial diversity and Extremophiles

MIC-305- Practical Course V

MIC-306- Practical Course VI

M.Sc. II, Semester IV

MIC-401- Food and Dairy Microbiology

MIC-402- Fermentation Technology

MIC-403- Industrial waste management

MIC-404- Recombinant DNA Technology

MIC-405- Practical Course VII

MIC-406- Practical Course VIII

Semester – III

MIC – 301: Biostatistics, Bioinformatics and Scientific Writing

BIOSTATISTICS

UNIT – I

1. Basic concepts: definitions – statistics and biostatistics, population, sample, variable and the various types, statistic and parameter.
2. Collection and presentation of data: primary and secondary data, collection of data – enumeration and measurement, significant digits, rounding of data, accuracy and precision, recording of data. Tabular and diagrammatic presentation – arrays, frequency distribution, bar diagrams, histograms and frequency polygons.
3. Descriptive statistics: measures of central tendency, dispersion, skewness and kurtosis (6)

UNIT - II

1. Probability: definition, elementary properties, types, rules, applications to biological problems, distributions – Binomial, Poisson, Normal, chi-square (χ^2) distribution and test.
2. Inference about populations: sample size, sampling distribution, standard error, estimation of population mean - confidence interval, Student's *t*- distribution and its applications (*t*- test).
3. Sampling methods: principles of sampling, necessity – merits and demerits, random sampling – lottery, geographical arrangement random number; deliberate or non-random sampling, stratified sampling, cluster sampling. (6)

UNIT - III

1. Hypothesis testing: definition of hypothesis, hypotheses - null and alternate hypotheses, general procedure, decision about H_0 – one-tailed and two-tailed tests, type I and type II errors
2. Analysis of Variance (ANOVA): basic concepts, experimental designs – CRD, RBD, factorial experiment, repeated measures, other designs, general method, F – test, multiple comparison tests. (6)

UNIT – IV

1. Correlation: introduction, types, methods of study – scatter diagram, correlation graph, Karl Pearson's coefficient of correlation and its interpretation, test of significance.
2. Regression: introduction, simple linear regression - model, equation, least-squares line, evaluating and using the equation, multiple regression – model, obtaining, evaluating and using the multiple regression equation. (6)

BIOINFORMATICS

UNIT – V

1. Bioinformatics: definition, components, objectives, databases – definition, biological databases, types and examples, database management systems (DBMS)
2. Applications of bioinformatics – I: Data visualisation – sequence and structure of nucleic acids and proteins, database search, visualisation and rendering tools.

3. Applications of bioinformatics – II: Pattern matching and sequence alignment of nucleic acids and proteins – fundamental principles of pairwise sequence alignment, local and global alignment, multiple sequence alignment, computational methods, sequence alignment tools and databases. (6)

UNIT – VI

1. Applications of bioinformatics – III: Modelling and Simulation – components and process of modelling and simulation, algorithms – Monte Carlo, Metropolis, methods and tools used for proteins structure (secondary, motifs, domains and profiles, tertiary, 3-D) modelling and prediction.
2. Applications of bioinformatics – IV:
 - a) Phylogenetic analysis: basic principles and methods of preparation and evaluation of phylogenetic trees and relationships.
 - b) Drug discovery and development: fundamental principles, rational drug design, role of protein interaction resources, chemoinformatics and pharmainformatics resources, pharmacogenomics. (6)

SCIENTIFIC WRITING

UNIT – VII

1. Basic concepts of Scientific writing:
 - a. Language - good English and grammar, use and misuse of words, jargon, abbreviations, literary ornaments
 - b. Main requirements of a scientific document - reader as a target, clarity, brevity, simplicity, accuracy, precision, balance, consistency, impartiality, sincerity, appropriateness, control of interest and objectivity
2. Compilation of experimental record and programme of writing
3. Scientific Document: definition and types – research papers, review papers and articles, conference reports and proceedings, project reports, theses, book reviews. (6)

UNIT – VIII

1. Structure of a scientific paper: the AIMRAD system – writing a paper according to the system, presentation of numerical data, designing effective tables, graphs, diagrams and illustrations, photographs
2. Presenting and publishing research:
 - a. Publishing in journals – printed and electronic journals; selection of a journal, preparation and submission of the manuscript
 - b. Presenting in conferences: oral and poster presentations
3. Legal aspects of scientific authorship: copyright considerations, plagiarism (6)

REFERENCE BOOKS

BIOSTATISTICS

1. Daniel, Wayne (2007) *Biostatistics A foundation for Analysis in the health sciences*, Edition 7, Wiley- India edition.
2. Davis, Charles S.(2002): *Statistical Methods for the Analysis of Repeated Measurements*
3. Finney, D.J. (1971): *Statistical Method in Biological Assays*.
4. Fleiss, Joseph L., Levin Bruce & Paik Myunghee Cho (2003): *Statistical Methods for Rates and Proportions*
5. Irfan Ali Khan and Atiya Khanum, *Fundamentals of Biostatistics*. 2nd Ed. Ukaaz Publications, Hyderabad.
6. Montgomery D.C. – *Design and analysis of experiments*, John Wiley & Sons.
7. Murthy M.N. – *Sampling methods*, Indian Statistical Institute, Kolkata.

BIOINFORMATICS

1. Jean-Michel Claverie and C. Notredame (2003) *Bioinformatics: A Beginner's Guide*, Wiley Dreamtech India (P) Ltd., New Delhi – 110 002
2. Khan, I. A. (2005) *Elementary Bioinformatics*, Pharma Book Syndicate, Hyderabad – 500 095
3. Bergeron, B. (2003) *Bioinformatics Computing*, Prentice-Hall of India Private Limited, New Delhi – 110 001
4. Westhead, D. R., J. H. Parish and R. M. Twyman (2003) *Bioinformatics (Instant Notes Series)*, Viva Books Private Limited, New Delhi, Mumbai, Chennai, Kolkata
5. Narayanan, P. (2005) *Bioinformatics a Primer*, New Age International (P) Limited, Publishers, New Delhi – 110 002
6. Baxevanis, A. D. and Ouellette, B. F. F. (2001) *Bioinformatics: A practical guide to the analysis of genes and proteins*. Second Edition. John Wiley & Sons, New York.
7. Lacroix, Z. and Critchlow, T. (Eds.) 2003. *Bioinformatics. Managing Scientific Data*. Morgan Kaufmann Publishers.
8. Mount, D. W. (2001) *Bioinformatics: sequence and genome analysis*. Cold Spring Harbor Laboratory Press, New York.
9. Zoe L. and Terence C. (2004) *Bioinformatics: Managing Scientific Data*, Morgan Kaufmann Publishers, New Delhi

SCIENTIFIC WRITING :

1. *How to write and publish a Scientific paper* by R.A.Day
2. *Writing Scientific Research Articles – Strategy and Steps* by Margaret Cargill and Patrick O'Connor. Wiley Black well
3. *From Research to Manuscript – A Guide to Scientific Writing* by Michael Jay Katz. Springer.

MIC – 302: Enzymology and Enzyme Technology

UNIT – I

1. History and special properties of enzymes as catalysts
2. IUB system of nomenclature and classification of enzymes
3. Specificity of enzymes types of specificities – substrate and product, bond, group or relative, absolute – stereochemical and spatial specificity, theories to explain specificity – Lock and Key and Induced Fit hypotheses
4. Ogsten's experiment and the concept of the Active Site; monomeric and oligomeric enzymes (6)

UNIT – II

1. Methods employed to identify functional groups in the active site – trapping of the intermediate, use of substrate analogues, modification of amino acid side chains, some common functional groups and amino acids, chemistry of the active site
2. Mechanism of action of chymotrypsin, lysozyme and triose phosphate isomerase
3. Role of co-factors in enzyme action:
 - a. Organic – prosthetic groups, coenzymes and cosubstrates
 - b. Inorganic– role of metal ions in enzyme function, metal activated enzymes and metalloenzymes, ternary complexes (6)

UNIT – III

1. Kinetics of single-substrate enzyme catalysed reactions – Wilhelmy's and Brown's work, Henri and Michaelis-Menten derivations, Briggs and Haldane assumption and derivation, Significance of the M-M equation and K_M
2. Lineweaver-Burk, Eadie-Hofstee, Hanes and Eisenthal and Cornish-Bowden modifications of the M-M equation to derive K_M
3. Kinetics of multisubstrate reactions (6)

UNIT – IV

1. Haldane's relationship for reversible reactions
2. Sigmoid kinetics – Hill and Adair equations for cooperativity
3. Enzyme inhibition: basic concepts, kinetics, examples and significance of reversible and irreversible inhibition (6)

UNIT – V

1. Covalent modification of enzyme structure – irreversible and reversible
2. Ligand induced conformational changes – basic concepts of allosterism and allosteric enzymes, models proposed to explain the mechanism of functioning (MWC and KNF); structural aspects of aspartate: carbamoyltransferase, role of allosteric enzymes in metabolic regulation – feedback inhibition (6)

UNIT - VI

1. Multienzyme systems – basic concepts, types with examples, structural and functional aspects of pyruvate dehydrogenase, fatty acid synthetase, 'Arom' complex and tryptophan synthetase
2. Membrane bound enzymes in metabolic regulation
3. Isoenzymes and their metabolic significance (6)

UNIT – VII

1. Applications of enzymes in medicine:
 - a. In diagnosis – general principles and use of lactate dehydrogenase, creatine kinase, fructose biphosphatase, glucose 6phosphate dehydrogenase, acid and alkaline phosphatase, malate dehydrogenase,
 - b. In therapy – specific applications of few selected enzymes, concept of prodrug and biodrug, Enzymes replacement therapy.
2. Industrial applications of enzymes – catalysts in the manufacturing and other conversion processes, as analytical tools. (6)

UNIT – VIII

1. Immobilisation of enzymes: basic concepts, methods used, properties of IME and their applications in industry, medicine, enzyme electrodes
2. Newer approaches to the application of enzymes – reactions in organic solvents, protein engineering of industrial enzymes – targets and results, rational and random design methods. (6)

REFERENCE BOOKS

1. Understanding Enzymes – Trevor Palmer, Ellis Horwood Publications
2. Fundamentals of Enzymology – N. C. Price and L. Stevens, Oxford University Press
3. Enzyme Technology – Pandey, Webb, Soccol and Larroche. Asiatech Publishers, INC New Delhi .
4. Enzyme Nomenclature – International Union of Biochemists (IUB), Academic Press
5. Enzyme structure and function – A. Fuerst, Freeman, USA
6. Immobilised Enzymes – M. D. Trevan
7. Enzymes – Boyer, Academic Press
8. Advances in Enzymology – Series edited by N. O. Kaplan, Academic Press

MIC – 303
(Microbial Technology)

Unit – I

1. Fermentation equipment and its use :
 - i) Basic functions of a fermenter, body construction, aeration, Agitation, baffles, etc.
 - ii) Design of other fermentation vessels: Airlift fermenter, tower fermenter. Continuous fermenter, fed batch fermenter, waldh of type fermenter.
 - iii) Sterilization of fermentation equipment, air and media.
 - iv) Fermentation broth rheology and power requirements, concepts of Newtonian and non-Newtonian fluids, plastic fluids, effect of rheology on heat and oxygen transfer, Reynold's number, power number, aeration number and apparent viscosity. 6

Unit – II

1. Development of industrial fermentation processes
 - i) Screening.
 - ii) Stock culture maintenance
 - iii) Inoculum preparation development of inocuta for yeast process, bacterial processes and mycelial process.
 - iv) Scale up of fermentation . 6

Unit – III

1. Contamination problems in fermentation industry.
2. Growth and product formation: Concept of primary and secondary metabolites and their control, kinetics of growth and product formation (growth rate, yield coefficient, efficiency), economics. 6

Unit - IV

1. Environmental control of metabolic pathways.
2. Fermentation media- Types of fermentation media, sources of carbon, nitrogen trace elements, growth factors, precursors, buffers, antifoam agents, sterilization of media, screening for fermentation media. 6

Unit – V

1. Genetic Control of Metabolic pathways.
2. Patents – Introduction, composition of patent, background, patent practice and problems. 6

Unit – VI

1. Product recovery and purification – Precipitation, filtration, centrifugation, solvent recover, chromatography, ultra filtration, crystallization and whole broth processing. 6

Unit - VII

1. Saccharification and utilization of cellulosic wastes. 6

Unit - VIII

1. Computer applications in fermentation technology- General applications and specific applications.
2. Fermentation economics – A case study, market potential for product and fermentation, product recovery cost, Entrepreneurship, plan for industry, product selection process, site selection, finance, feasibility, excise and legal aspects. 6

References :

1. Industrial Microbiology by L.E. Casida, John Wiley and Sons INC.
2. Annual reports on fermentation process vol. I and II, by D.Pearlman, Academic press INC.
3. Prescott and Dunn's Industrial Microbiology, 4th edition (1982) by Gerald Reed.
4. Food processing : Biotechnological applications by S.S.Marwaha and J.K.Arora (2000), Asiatech publishers INC.
5. Microbial technology vol. I and II by H.J.Peppler and D.Pearlman. Academic Press INC.
6. Principals of fermentation technology by P.Stanbury and Allan Whitaker, Pergamon Press (1984)
7. Essays in Applied Microbiology by J.R.Norris and M.H.Richmond, John Wiley and Sons, Chicester, New York.

MIC - 304
MICROBIAL DIVERSITY AND EXTREMOPHILES

Unit - I

1. Anoxygenic photosynthetic bacteria –
 - a) general characteristics of purple bacteria.
 - a) general characteristics of green bacteria. 6

Unit - II

1. Oxygenic photosynthetic bacteria –
 - a) General characteristics of Cyanobacteria – external and internal features, physiology and ecology.
 - b) General characteristics of Prochlorales. 6

Unit - III

1. Oxidative transformation of metals –
 - a) Iron oxidation, ammonia oxidation and hydrogen oxidation (habitat and ecological importance of organisms involved), siderophores.
 - b) Magnetotactic bacteria. 6

Unit - IV

1. Archaeobacteria -
 - a) Methanogenic Archaeobacteria (general characteristics) 6

Unit - V

1.
 - a) Extremely Halophilic archaeobacteria - General Characteristics
 - b) Extremely thermophilic archaeobacteria - General Characteristics 6

Unit - VI

1. Microbial diversity in anoxic ecosystems –
 - a) Mechanisms of reduction of iron, sulphur, manganese, nitrate and oxygen. 6

Unit - VII

1.
 - a) General Characteristics of Extremophiles – acidophilic, alkalophilic, barophilic microorganisms.
 - b) Microbial desulphurization of coal, Acid rain. 6

Unit -VIII

1. Subterranean microbes – groundwater contaminatin and microbial transformations, biomagnification, bioaccumulation and bioremediation, Degradation of recalcitrant molecules. 6

Reference:

- 1) Extremophiles (2000) by B. N. Johri, Springer Verlag, New York,
- 2) Microbial diversity by (1999) D. Colwd, Academic Press.
- 3) Bergey's Manual of Systematic Bacterilology (1984), Vols, I and III, Williams and Wilkins, Baltimore Academic Press.
- 4) Microbial Life in Extreme Environments (1978), by D.S. Kushner, Academic Press Inc. New York.
- 5) Microbial Ecology (1979), by J.M. Lynch and N. J. Poole, Blackwell Scientific Publications, Oxford.
- 6) Brock Biology of Microorganisms (2000), 9th Edition, by M.T. Madigan, J.M.Martinko and Jack Parker.
- 7) Biochemistry, Bioengineering and Biotechnology Handbook (1991), by B. Atkinson et al . Macmillan.

PRACTICALS

MIC 305: PRACTICAL COURSE – V

I. BIOSTATISTICS:

1. Measures of central tendency – Mean, median and mode
2. Measures of dispersion – variance and standard deviation
3. Estimation of confidence interval for a normal distribution
4. ANOVA – CRD, RBD
5. Student's t-test and chi-square test on sample data
6. Simple linear regression analysis

II. BIOINFORMATICS:

1. Using PubMed/Medline for biological information
2. Retrieving protein and nucleic acid sequences from databases
3. Single and multiple Sequence alignment using BLAST, Clustal and ClustalW
4. Study of GenBank genomic entries
5. Studying protein 3D structure using RASMOL

III. SCIENTIFIC WRITING:

1. Preparing tables and charts using MS Excel
2. Preparing a PowerPoint presentation

IV. ENZYMOLOGY AND ENZYME TECHNOLOGY:

- A. Studies on the enzyme alpha (α)- amylase:
 1. Quantitative estimation and specific activity
 2. Salt (ammonium sulphate) and solvent (ethyl alcohol) precipitation of enzyme
 3. Partial purification of enzyme by dialysis
 4. Study of the effect of:
 - a. substrate concentration $[S_0]$ – determination of V_{max} and K_M
 - b. pH – determination of optimum pH for activity
 - c. temperature – determination of optimum temperature for activity
 - d. metal ions
 5. Immobilisation by entrapment in alginate gel and determination of loading efficiency
- B. Assay of Invertase, Protease and Lipase

MIC – 306
Practical Course -VI

1. Screening of antibiotic producers – Crowded plate technique.
2. Screening of organic acid producers and amine producers.
3. Screening of amylase producers and protease producers.
4. Screening of vitamin producers.
5. Isolation of Magnetotactic bacteria .
6. Enrichment and isolation of Sulfate reducing bacteria
7. Enrichment and isolation of pesticide resistant bacteria.
8. Enrichment and isolation of phosphate solubilizing microorganisms
9. Bioleaching of copper and iron from copper and iron ores by using *Thiobacilli*
10. Isolation & Characterization of Acidophilic bacteria.
11. Isolation & Characterization of Alkalophilic bacteria.
12. Isolation & Characterization of psychrophilic bacteria
13. Isolation & Characterization of Halophilic bacteria
14. Isolation & Characterization of Halotolerant bacteria
15. Isolation of Anoxygenic bacteria.
16. Study of Cyanobacteria.

Semester IV

MIC – 401

FOOD AND DAIRY MICRBIOLGY

Unit-1

1. Food as a substrate for Microorganisms.
2. General principles underlying microbial spoilage of food.
3. Microbial spoilage of meat, fruits and vegetables.
4. Microbial spoilage of heated canned food. 6

Unit-2

1. General principles of Preservation of food: Asepsis, Removal of microorganisms, Killing of microorganisms, Reducing the growth rate of microorganisms.
2. Methods of food preservation: Thermal processing, cold preservation, Preservation by using chemical preservatives, Food dehydration, Preservation by using Irradiations,
3. Canning of food. 6

Unit-3

1. Fermented foods: Microbiology and biochemistry of
 - a) Fermented cereal foods: Appam, Amboli, Jalebi,
 - b) Fermented cereal legume foods: Idli, Dosa, Dhokla,
 - c) Fermented vegetable products: Sauerkraut, Pickles,
 - d) Fermented milk products: Yoghurt, Cultured butter milk, Acidophilus milk, 6

Unit-4

1. Food born diseases:-Food born intoxications: Botulism and staphylococcal intoxication and Food born infections.
2. Prevention and control of food born diseases. 6

Unit-5

1. Fermented dairy products and their role in controlling food born diseases:
 - a) Types of fermented dairy products,
 - b) Methods of preparations,
 - c) Therapeutic significance and their health properties,
 - d) Mode of action of lactic acid bacteria on enteric pathogens,
 - e) Fermented dairy products and their role in controlling gastro intestinal tract disorders.
2. Cheese production technology:
 - a) Types, production and nutritional aspects,
 - b) Requirements and basic steps,
 - c) Variations in the technologies,
 - d) Spoilage and defects in cheese,
 - e) Assessing the microbiological quality. 6

Unit-6

1. Milk and milk products:
 - a) Definition, composition, Factors affecting composition,
 - b) Nutritive values of milk,
2. Spoilage of milk and milk products:
 - a) Milk as a substrate for microorganisms,
 - b) Microbial contamination of milk- Sources of contamination, types of microorganisms present in milk.
 - c) Biochemical activities during microbial spoilage of milk,
3. Chemical and microbial examination of milk. 6

Unit-7

1. Enzymes in food processing: Need of enzymes. Sources of enzymes.
2. Applications of enzymes in:
 - a) Production of high fructose syrup
 - b) Fruit juice industry
 - c) Baking industry
- d) Oils and fat processing 6

Unit-8

1. Food safety and standards:
 - a) Food safety issues,
 - b) Food adulterations,
 - c) Contaminations with harmful microbes,
 - d) Metallic contamination,
 - e) Food Laws and standards,
 - f) Industrial food safety Laws and standards,
 - g) HACCP
 - h) Indian Food Laws and standards 6

Reference:

- 1) Food processing Biotechnological application (2000) by S.S.Marwaha & K. Arora, Asiatech Publishers INC, New Delhi.
- 2) Food science, Fifth Edition, Norman N. Potter 1996, CBS publishers and distributors.
- 3) The technology of food preservation, Fourth Edition, Norman W. Desrosier (BI Publisher and Distributors, Delhi, 1987)
- 4) Food Microbiology - Adams & Moss
- 5) Dairy Microbiology – Robison
- 6) Outlines of Dairy technology – Sukumar De
- 7) Milk & Milk Products – Clarence
- 8) Food Science (Vth edn) Norman N. Potter, Joseph N. Hotchkiss.

MIC – 402
Fermentation Technology

Unit - I

1. Production of single cell protein- Microorganisms and substrates used, techniques of production, nutritional value of SCP, economics of production, merits and demerits of SCP. 6

Unit - II

1. Microbial insecticides- Candidates for development into microbial insecticides, production of insecticides, evaluating potential hazards to man and environment, effectiveness, safety, economics, advantages and disadvantages. 6

Unit - III

1. Production and applications of microbial polysaccharides- Xanthan gum and Dextran. 6

Unit - IV

1. Typical Fermentation processes – industrial production of :
i) Lactic starter culture for food fermentations
ii) Bacitracin.
iii) Streptomycin.
iv) β -carotene pigments. 6

Unit – V

1. Typical Fermentation processes – industrial production of :
i) Riboflavin.
ii) Gluconic acid
iii) Gibberellin.
iv) Itaconic acid 6

Unit - VI

1. Production of mushrooms – Production steps, harvesting and preservation and nutritive value.
2. Production of bacterial vaccines and antisera. 6

Unit - VII

1. Industrial production of distilled alcoholic beverages – Whisky and Brandy.
2. Microbial production of nucleosides and nucleotides. 6

Unit - VIII

1. Microbial transformations of antibiotics and steroids. 6

References :

1. Industrial Microbiology by L.E. Casida, John Wiley and Sons INC.
2. Annual reports on fermentation process vol. I and II, by D.Pearlman, Academic press INC.
3. Prescott and Dunn's Industrial Microbiology, 4th edition (1982) by Gerald Reed.
4. Food processing : Biotechnological applications by S.S.Marwaha and J.K.Arora (2000), Asiatech publishers INC.
5. Microbial technology vol. I and II by H.J.Peppler and D.Pearlman. Academic Press INC.
6. Methods in Industrial Microbiology by B.Sikyta, Ellis Horwood Ltd. Chichester (1983)
7. Industrial Microbiology by A.H.Patel, MacMillan India Ltd.
8. Principals of fermentation technology by P.Stanbury and Allan Whitaker, Pergamon Press (1984)
9. Advances in Applied Microbiology Vols. 9 and 13, by W.W. Umbreit, Academic Press, New York.
10. Essays in Applied Microbiology by J.R.Norris and M.H.Richmond, John Wiley and Sons, Chicester, New York.
11. Annual reports on fermentation process vol. I by D.Pearlman, Academic Press, 1977
12. Annual reports on fermentation process vol. II by D. Pearlman, Academic press, 1978

MIC 403
Industrial Waste Management

Unit-1

Types and Characterization of industrial wastes:

1. Types of industrial wastes,
2. General characteristics of different industrial wastes, pH, suspended solids, volatile solids, COD, BOD and organic carbon. 6

Unit-2

1. Effects of industrial wastes on aquatic life- Effects of industrial wastes of high BOD, effects of waste with toxicants.
2. Self purification in natural waters :Introduction, Physical process, chemical process, biological process, Eutrophication. 6

Unit-3

1. Microbiology and biochemistry of waste water treatment: Sources of important microorganisms, enrichment, isolation and acclimatization, mass scale production, mixed cultures, preservation, treatability test, Applications and future prospects. 6

Unit-4

Methods of industrial waste treatment: Part-I

Physico-chemical Methods

1. Types of waste water contaminants- suspended solids, dissolved solids and liquids
2. Methods of treatment- Neutralization, oxidation of cyanides, Chromium reduction, reverse osmosis, carbon adsorption, destruction of phenolic compounds. 6

Unit-5

Methods of industrial waste treatment: Part-II

1. Activated sludge process- Process, microbiology, sludge bulking.
2. Trickling filters- Process, Microbiology and applications. 6

Unit-6

Methods of industrial waste treatment: Part-III

1. Lagooning- Aerobic and anaerobic, applications.
2. Anaerobic digestion- Process, microbiology of bio-gas formation, applications.

6

Unit-7

Biomangement of industrial waste:

1. Technological options for treatment- a) Treatment of liquid wastes, b) treatment of solid wastes.
2. Industrial waste treatment: Composition of waste and methods of treatment of wastes from Dairies, Distilleries, paper and pulp industries, fertilizer industries and Pharmaceutical industries.

6

Unit-8

Waste disposal control and regulations : Water pollution control, Regulation and limits for disposal in to lakes, rivers, oceans and land.

6

References:

1. Industrial pollutional control Vol. I. E. Joe. Middlebrooks.
2. The treatment of industrial wastes. 2nd ed. Edmun B. Besselievre, and max Schwartz.
3. Environmental biotechnology, (Industrial pollution management) S.N. Jogdand, Himalaya Publishing house.
4. water and water pollution hand book Vol I, Leonard L. Ciaccio
Waste water treatment M.N. Rao and A. K. Datta
5. Industrial pollution, N. Living Sax, Van Nostrand Reinhold Company
6. Encyclopedia of Environmental science and technology Vol. II, Ram Kumar.
7. Water pollution Microbiology- R. Mitchell.
8. Hand Book of water resourses and pollution control- H.W. Gehm,
J.I. Bregman.

MIC – 404: Recombinant DNA Technology

UNIT – I

Cloning strategies

1. Construction of genomic DNA libraries: in λ cloning vectors, Maniatis' strategy for a representative gene library, genomic libraries in high- capacity vectors, subgenomic libraries
2. Construction of cDNA libraries: properties of cDNA, cDNA libraries, preparation of cDNA for library construction, full-length cDNA cloning
3. PCR as an alternative to genomic and cDNA cloning 6

UNIT – II

Screening strategies

1. Sequence dependent screening: hybridisation, probe design, chromosome walking, PCR
2. Expression cloning: immunological screening, south-western and north-western screening, screening with alternative ligands
3. Functional cloning: functional complementation, 'gain of function' screening
4. Difference cloning: with DNA libraries, by PCR 6

UNIT – III

Cloning in bacteria other than *E. coli*

1. General principles of introducing DNA into other bacteria: maintenance of rDNA in new host, integration of rDNA
2. Cloning in other Gram-negative bacteria: vectors from Inc group (P, Q, W) plasmids, from pBBR1 plasmid
3. Cloning in Gram-positive bacteria: vectors – types, pAM β -1, secretion vectors, vectors for systematic gene inactivation, transcription and translation, controlled expression 6

UNIT – IV

Cloning in Yeasts (*S. cerevisiae*), Fungi and Streptomyces

1. Introduction, fate of DNA plasmid vectors, retro-like vectors, expression of proteins, specialist vectors, identification of genes, determining functions associated with particular genes
2. Cloning in Streptomyces: vectors and techniques, homoeologous recombination 6

UNIT – V

Cloning in animals

1. Overview of gene transfer strategies, DNA mediated transfer, gene transfer by viral transduction
2. Genetic manipulation of animals – mammals, other vertebrates and invertebrates 6

UNIT – VI

Gene transfer to plants

1. Basic principles of plant transgenesis – callus culture, cell suspensions, protoplasts, regeneration of fertile plants, an overview of gene-transfer strategies
2. *Agrobacterium* mediated DNA transfer, direct DNA transfer, *in planta* transformation, chloroplast transformation, plant virus vectors 6

UNIT – VII

Advances in transgenic technology

1. Inducible expression systems, application of site specific recombination
2. Transgenic strategies for gene inhibition
3. Transgenic technology for functional genomics 6

UNIT – VIII

Applications of rDNA Technology

1. Diagnostic tools
2. New drugs and therapies for genetic disorders
3. Combating infectious diseases
4. Protein engineering
5. Metabolic engineering
6. Agronomic and production traits of transgenic plants 6

REFERENCE BOOKS

1. Principles of Gene Manipulation by S. B. Primrose and others. Blackwell Science Publications
2. Recombinant DNA by J. D. Watson and others
3. Genetic Engineering by Chakravarty, CRC Publications
4. Genetic Engineering by Sandhya Mitra
5. Molecular Cloning (Volumes 1, 2, 3) by Sambrook and Russell. Cold Spring Harbor Laboratory Press International Edition
6. Principles of Genetics by E. J. Gardner. John Wiley and Sons, New York

MIC - 405
Practical Course -VII

1. Laboratory production of *B. thuringiensis* insecticide.
2. Fermentative production of citric acid.
3. Fermentative production of gluconic acid
4. Fermentative production of penicillin.
5. Streptomycin bioassay.
6. Immobilization of yeast cells and their use in alcohol production.
7. Preparation of Biocell
8. Development of activated sludge.
9. Chemical analysis of foods - pH, Benzoate, sorbet and colour.
10. Microbiological Examination of milk – MPN test, tests for grading of milk- MBRT test, Resazurin test, DMC.
11. Chemical examination of milk - pH, fat, protein, sugar, and ash)
12. Physical examination of milk - specific gravity and Different solids
13. Platform test in dairy industry and COB Alcohol precipitation, titratable acidity test, quantitative phosphatase test, mastitis test.
14. Microbiology of butter and cheese,
15. Characterization of industrial wastes : pH, Alkalinity, BOD,COD,TOC,DO, Suspended solids, dissolved solids, total solids, total volatile solids, MLSS, MLVSS.
16. Treatability test for industrial effluents.
17. Preparation of plant tissue culture.
18. Isolation of plasmid from *Agrobacterium*.

MIC – 406
Practical Course - VIII

Project work / Industrial Training