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DETAILED SYLLABUS

FOR

DISTANCE EDUCATION

M.Sc. (Microbiology)

(SEMESTER SYSTEM)

M.Sc.Microbiology

COURSE TITLE: M.Sc. (MICROBIOLOGY)
DURATION : 4 SEMESTERS
MODE : SEMESTERS

FIRST SEMESTER

COURSE TITLE	Paper Code	MARKS				
		THEORY		PRACTICAL		TOTAL
		INTERNAL	EXTERNAL	INTERNAL	EXTERNAL	
Biostatistics and Computer Applications	MSCMB/S/110	40	60	40	60	200
Bioenergetics and Molecular Enzymology	MSCMB/S/120	40	60	40	60	200
Bioinstrumentation	MSCMB/S/130	40	60	40	60	200
Food and Dairy Microbiology	MSCMB/S/140	40	60	40	60	200

SECOND SEMESTER

COURSE TITLE	Paper Code	MARKS				
		THEORY		PRACTICAL		TOTAL
		INTERNAL	EXTERNAL	INTERNAL	EXTERNAL	
Recent trends in Virology	MSCMB/S/210	40	60	40	60	200
Molecular Immunology	MSCMB/S/220	40	60	40	60	200
Microbial Physiology	MSCMB/S/230	40	60	40	60	200
Microbial diversity and Extremophiles	MSCMB/S/240	40	60	40	60	200

THIRD SEMESTER

COURSE TITLE	Paper Code	MARKS				
		THEORY		PRACTICAL		TOTAL
		INTERNAL	EXTERNAL	INTERNAL	EXTERNAL	
Enzyme Technology	MSCMB/S/310	40	60	40	60	200
Bioprocess Engineering and Technology	MSCMB/S/320	40	60	40	60	200
Microbial Genetics	MSCMB/S/330	40	60	40	60	200
Environmental Microbial Technology	MSCMB/S/340	40	60	40	60	200

FOURTH SEMESTER

COURSE TITLE	Paper Code	MARKS				
		THEORY		PRACTICAL		PRACTICAL
		INTERNAL		EXTERNAL		
Recombinant DNA Technology	MSCMB/S/410	40	60	40	60	200
Fermentation Technology	MSCMB/S/420	40	60	40	60	200
Bioinformatics, Microbial Genomics and Proteomics	MSCMB/S/430	40	60	40	60	200
Pharmaceutical Microbiology	MSCMB/S/440	40	60	40	60	200

M.Sc.Microbiology
[Semester I]

BIOSTATISTICS AND COMPUTER APPLICATIONS **MSCMB/S/110**

Marks 100

Unit –1 Introduction to Biostatistics

Basic definitions and applications. Sampling: Representative sample, sample size, sampling bias
and sampling techniques. Data collection and presentation: Types of data, methods of collection
of primary and secondary data, methods of data presentation, graphical representation by histogram, polygon, ogive curves and pie diagram.

Unit –2 Measures of central tendency

Measures of central tendency: Mean, Median, Mode.

Measures of variability: Standard deviation, standard error, range, mean deviation and coefficient
of variation. Correlation and regression: Positive and negative correlation and calculation of Karl-
Pearsons co-efficient of correlation. Linear regression and regression equation and multiple linear
regression, ANOVA, one and two way classification.
Calculation of an unknown variable using regression equation.

Unit – 3 Tests of significance

Tests of significance: Small sample test (Chi-square t test, F test), large sample test (Z test) and
standard error.
Introduction to probability theory and distributions, (concept without deviation) binomial, poison
and normal (only definitions and problems)
Computer oriented statistical techniques. Frequency table of single discrete variable, bubble spot,
computation of mean, variance and standard
Deviations, t test, correlation coefficient

Unit- 4 Introduction to computers and computer applications

Introduction to computers: Computer application, basics, organization, PC, mainframes and Super-computers, concept of hardware and software, concept of file, folders and directories, commonly used commands, flow charts and programming techniques. Introduction to Q basic and
C. Introduction in MS Office software concerning Word processing, spreadsheets and presentation software.

Unit - 5 net working concepts

Networking fundamentals, client, server, LAN, WAN, Flp, TelNET, INTERNET, NICNET, WWW, html, e mail, intoduction to MEDLINE, CCOD and PUBMED, for accessing biological information. An introduction to bioinorganic software, C/C++, bioperl, biojava, bioXML, bioORACLE, etc. Introduction to Havard graphics and coral draw.

PRACTICAL

BIOSTATISTICS AND COMPUTER APPLICATIONS **MSCMB/S/120**

Marks: 100

1. Representation of Statistical data by
a) Histograms b) Ogive Curves c) Pie diagrams
2. Determination of Statistical averages/ central tendencies.
a) Arithmetic mean b) Median c) Mode
3. Determination of measures of Dispersion
a) Mean deviation
b) b) Standard deviation and coefficient of variation
c) Quartile deviation
4. Tests of Significance-Application of following
a) Chi- Square test b) t- test c) Standard error
5. Computer operations-getting acquainted with different parts of
Computers. [DOS] and basics of operating a computer.
6. Creating files, folders and directories.
7. Applications of computers in biology using MS-Office.
A] MS-Word B] Excel C] Power Point
8. Creating an e-mail account, sending and receiving mails.
9. An introduction to INTERNET, search engines, websites, browsing and
Downloading.

Unit – 1 Carbohydrate catabolic pathways and microbial growth on C1 Compounds

EMP, HMP, ED, Phosphoketolase pathway, TCA cycle, methylglyoxal bypass. Anaplerotic sequences, catabolism of different carbohydrates, glycerol metabolism, regulation of carbohydrate metabolism, Pasteur effect. Substrate level phosphorylation.
Microbial growth on C1 Compounds (Cyanide, Methane, Methanol, methylated amines and carbon monoxide).

Unit - 2 Bacterial fermentations (biochemical aspects) and Biosynthesis

Alcohol, lactate, mixed acid, butyric acid, acetone-butanol, propionic acid, succinate, methane,
and acetate fermentations. Fermentation of single nitrogenous compounds [amino acids] - alanine, glutamate and glycine.
Biosynthesis of Purines, Pyrimidines and fatty acids.

Unit – 3 Endogenous metabolism and degradation of aliphatic and aromatic compounds.

Functions of endogenous metabolism, types of reserve materials, enzymatic synthesis, degradation and regulation of reserve materials - glycogen, polyphosphates and polyhydroxybutyrate (PHB), PHB production and its futuristic applications.
Microbial degradation of aliphatic hydrocarbons (microorganisms involved, mon-terminal, biterminal
oxidation of propane, decane, etc.) and aromatic hydrocarbons and aromatic compounds (via catechol, protocatechuate, meta-cleavage of catechol and protocatechuate, dissimilation of
catechol and protocatechuate, homogentisate and other related pathways).

Unit – 4 Properties of Enzymes

Classification of enzymes into six major groups with suitable examples. Numerical classification
of enzymes. Different structural conformations of enzyme proteins. Enzymes as biocatalysts, catalytic power, activation energy, substrate specificity, active site, theories of mechanisms of

enzyme action. Mechanism of action of lysozyme, chymotrypsin and ribonuclease. Monomeric, Oligomeric and multienzyme complex, isozymes and allosteric enzymes. Extremozymes - thermostable, solventogenic and non- aqueous enzymes. Ribozymes and abzymes

Unit – 5 Enzyme kinetics

Importance of enzyme kinetics, factors affecting rates of enzyme mediated reactions (pH, temperature, substrate concentration, enzyme concentration and reaction time). Derivation of Michaelis - Menton equation and its significance in enzyme kinetic studies. Lineweaver-Burke
plot, Haldane-Briggs relationship, sigmoidal kinetics steady state kinetics and transient phases of
enzyme reaction.

PRACTICAL

Paper P-II: BIOENERGETICS AND MOLECULAR

ENZYMOLOGY Marks 40

1. Isolation and Identification of Reserve food material (Glycogen / polyphosphates, PHB) of B. megaterium and Azotobacter SP.
2. Quantitative estimation of amino acids by Rosen's method.
3. Quantitative estimation of sugars by Summner's method.
4. Demonstration of endogenous metabolism in B megaterium or E. coli and their survival under starvation conditions
5. Quantitative estimation of proteins by Folin-Lowry / Biuret method.
6. Production of fungal alpha amylase using solid-state fermentation/ production of protease by bacterial species and confirmation by determining the achromic point.
7. Purification of fungal alpha-amylase or bacterial protease by fractionation, chromatographic techniques and electrophoretic separation.
8. Studies on enzyme kinetics of alpha amylase/Protease [Optimization of parameters viz. Substrate, enzyme concentration, reaction temperature, reaction pH, Km, Vmax and metal ions as activators and inhibitors).

Unit –1 Basic laboratory Instruments

Principle and working of pH meter, Laminar-air flow. Centrifugation: Types of centrifuge machines, preparative and analytical centrifuges, differential centrifugation, sedimentation velocity, sedimentation equilibrium, density gradient methods and their applications.

Unit – 2 Chromatographic techniques

Theory, principles and applications of paper, thin layer, gel filtration, ion exchange, affinity, hydrophobic, gas liquid, high pressure/ performance liquid chromatography (HPLC)

Unit – 3 Electrophoretic techniques

Basic principles of electrophoresis, theory and application of paper, starch gel, agarose, native
and denaturing PAGE, isoelectric focusing.

Unit – 4 Spectroscopy

Spectroscopic techniques, theory and applications of Uv, Visible, IR, NMR, Fluorescence, Atomic Absorption, CD, ORD, Mass, Raman Spectroscopy.

Unit – 5 Radioisotopic techniques

Use of radioisotopes in life sciences, radioactive labeling, principle and application of tracer techniques, detection and measurement of radioactivity using ionization chamber, proportional
chamber, Geiger- Muller and Scintillation counters, autoradiography and its applications. Dosimetry.

Unit – 2 Quality assurances in foods

Foodborne infections and intoxications; bacterial with examples of infective and toxic types –, Clostridium, Salmonella, Shigella, Staphylococcus, Campylobacter, Listeria.

Mycotoxins in food with reference to Aspergillus species.
Quality assurance: Microbiological quality standards of food. Government regulatory practices
and policies. FDA, EPA, HACCP, ISI.

Unit –3 Food preservation methods

Radiations - UV, Gamma and microwave
Temperature
Chemical and naturally occurring antimicrobials
Biosensors in food industry.

UNIT – 4 Microbiology of cheese and beverage fermentation.

Microbiology of fermented milk products (acidophilus milk, yoghurt).
Role of microorganisms in beverages – tea and coffee fermentations.
Vinegar Fermentation

Unit - 5 Advanced Food Microbiology

Genetically modified foods. Biosensors in food, Applications of microbial enzymes in dairy industry [Protease, Lipases].
Utilization and disposal of dairy by-product - whey.

PRACTICAL

FOOD AND DAIRY MICROBIOLOGY

Marks 100

1. Production and estimation of lactic acid by Lactobacillus Sp.
Or Streptococcus Sp.
2. Extraction and estimation of diacetyl.
3. Sauerkraut fermentation
4. Isolation of food poisoning bacteria from contaminated foods,
Dairy products
5. Extraction and detection of afla toxin for infected foods.
6. Preservation of potato/onion by UV radiation
7. Production of fermented milk by Lactobacillus acidophilus.
8. Rapid analytical techniques in food quality control using microbial
Biosensors.

[SEMESTER II]

RECENT TRENDS IN VIROLOGY

Marks 100

Unit –1 Classification and Morphology of Viruses

Cataloging the virus through virus classification schemes of ICTV / ICNV. Morphology and ultra-structure of viruses. Virus related agents, viroids and prions.

Unit – 2 Cultivation and assay of viruses

Cultivation of viruses using embryonated eggs, experimental animals and cell cultures (Cell-lines,
cell strains and transgenic systems). Purification of viruses by adsorption, precipitation, enzymes,
serological methods – haeme agglutination and ELISA.
Assay of viruses – Physical and Chemical methods (Electron Microscopy and Protein and Nucleic acids studies.)
Infectivity Assays (Plaque and end-point)
Genetic analysis of viruses by classical genetic methods.

Unit – 3 Viral Multiplication

Mechanism of virus adsorption and entry into the host cell including genome replication and mRNA production by animal viruses, mechanism of RNA synthesis, mechanism of DNA synthesis, transcription mechanism and post transcriptional processing, translation of viral proteins, assembly, exit and maturation of progeny virions, multiplication of bacteriophages.

Unit – 4 Pathogenesis of Viruses

Host and virus factors involved in pathogenesis, patterns of infection, pathogenesis of animal viruses Adenovirus, Herpes virus, Hepatitis virus, Picorna virus, Poxvirus and Orthomyxovirus,
pathogenesis of plant [TMV] and insect viruses [NPV]. Host cell transformation by viruses and
oncogenesis of DNA and RNA viruses.

Unit – 5 Control of Viruses and Emerging Viruses

Control of viral infections through vaccines, interferons and chemotherapeutic agents.
Structure, genomic organization, pathogenesis and control of Human immunodeficiency virus.
Emerging viruses
PRACTICAL

RECENT TRENDS IN VIROLOGY

Marks 40

1. One step growth curve for determination of virus titre.
2. Phage typing of E.coli bacteriophages.
3. Induction of lambda lysogen by UV radiations.
4. Studies on Specialized transduction
5. Isolation of lambda DNA and their characterization.
6. Amplification of lambda DNA by PCR
7. Cultivation and assay of viruses using embryonated eggs and Tissue culture Technique.

Unit – 1 Immune System

Organs and cells involved in immune system and immune response. Lymphocytes, their subpopulation, their properties and functions, membrane bound receptors of lymph cells, helper T

cells, T cells suppression, lymphocyte trafficking.

Unit – 2 Antigens and Immunoglobulins

Concept of haptens, determinants, conditions of antigenicity, antigens and immunogenecity, superantigen.

Immunoglobulins: Structure and properties of immunoglobulin classes. Theories of antibody formation, hybridoma technology for monoclonal antibodies and designer monoclonal antibodies.

Multiple mylomas and structural basis of antibody diversity. Freund's adjuvants and its significance.

Unit – 3 Antigen – Antibody reactions

Antigen-Antibody reaction by precipitation, agglutination and complement fixation.

Non-specific immune mechanism: - Surface defenses, tissue defenses, opsonization, inflamatory
reaction, and hormone balance.

Tissue metabolites with bactericidal properties (lysozyme, nuclein, histone, protamine, basic peptides of tissues – leukins, phagocytins, lecterins, haemocompounds)

Unit – 4 Expressions and Regulation of Immune Response

Regulation of immune response: antigen processing and presentation, generation of humoral and
cell mediated immune response, activation of B and T lymphocytes, cytokines and their role in
immune regulation, T cell regulation, MHC restriction, immunological tolerance. Cell mediated
cytotoxicity: Mechanism of T cells and NK mediated lysis, antibody dependent cell mediated cytotoxicity, and macrophage mediated cytotoxicity.

Complement system: Classical, alternate, lectin pathway of complement activation. Regulation of
complement activation.

Transplantation immunology: MHC, types of grafts, grafts rejection, GVH reactions, mechanism
of graft rejection, and prevention of graft rejection.

Unit - 5: Immunity and Immunoassays

Defense against bacteria, viruses, fungi and parasites. Immunodiagnostics and immunotherapy in
virology – Serological methods for detection and quantitation of viruses including Hepatitis, Influenza, HIV and others.

Immuno-assays: SRID, ELISA, ELISA-PCR, RIA, Western Blotting, Immunofluroscens and their application. Immune deficiencies and autoimmunity.

PRACTICAL

PAPER P-VI MOLECULAR IMMUNOLOGY Marks 40

1. Diagnostic immunologic principles and methods
Precipitation method - Immunodiffusion
- Immunoelectrophoresis
Agglutination method - Widal test
- Haemagglutination
- ELISA method
2. Separation of serum protein by submerged agarose gel electrophoresis.
3. Purification of human immunoglobulins from serum and confirmation of its antigenicity.
4. Identification of S.typhi by serotyping. [Purification of H and O antigens from S.typhi]
5. Clinical diagnosis of Rheumatoid arthritis by purifying immunoglobulins and albumins and confirmation by lattice agglutination test.
6. Estimation of Alkaline phosphatase from patient's serum.
7. Demonstration of Western blotting.

8. Detection of isozymes of Lactate dehydrogenase by PAGE
9. Clinical diagnosis of viral diseases by PCR, ELISA.

Unit – 1 Bacterial photosynthesis

Photosynthetic microorganisms, photosynthetic pigments, and generation of reducing power by
cyclic and non-cyclic photophosphorylation, electron transport chain in photosynthetic bacteria.
Carbon dioxide fixation pathways.

Unit – 2 Bacterial Respiration

Bacterial aerobic respiration, components of electron transport chain, free energy changes and
electron transport, oxidative phosphorylation and theories of ATP formation, inhibition of electron transport chain. Electron transport chain in some heterotrophic and chemolithotrophic
bacteria.
Bacterial anaerobic respiration: Introduction. Nitrate, carbonate and sulfate as electron acceptors.
Electron transport chains in some anaerobic bacteria. Catalase, super oxide dismutase, mechanism
of oxygen toxicity.

Unit – 3 Bacterial Permeation

Structure and organization of membrane
(Glyco-conjugants and proteins in membrane systems), fluid mosaic model of membrane. Methods to study diffusion of solutes in bacteria, passive diffusion, facilitated diffusion, different
mechanisms of active diffusion (Proton Motive Force, PTS, role of permeases in transport, different permeases in E. coli. Transport of aminoacids and inorganic ions in microorganisms and
their mechanisms.

Unit – 4 Bacterial Sporulation

Sporulating bacteria, molecular architecture of spores, induction and stages of sporulation, Influence of different factors on sporulation. Cytological and macromolecular changes during sporulation. Heat resistance and sporulation.

Unit –5 Bacterial Chemolithotrophy

Physiological groups of chemolithotrophs, ammonia oxidation by members of Genus Nitroso group, nitrite oxidation by Nitro group of genera. Oxidation of molecular hydrogen by *Hydrogenomonas* species. Ferrous and sulfur/sulfide oxidation by *Thiobacillus* species.

PRACTICAL

PAPER P-VII MICROBIAL PHYSIOLOGY Marks 40

1. Isolation of Photosynthetic bacteria
2. Glucose uptake by *E. coli / Saccharomyces cerevisiae* [Active and Passive diffusion]
3. Effect of UV, gamma radiations, pH, disinfectants, chemicals and heavy metal ions on spore germination of Bacillus SP.
4. Determination of Iron Oxidation Rate of *Thiobacillus ferrooxidans*.
5. Determination of Sulfur Oxidation Rate of *Thiobacillus thiooxidans.*
6. Microbial degradation, decolorization and adsorption of organic dyes (by free and immobilized cells).
7. Estimation of calcium ions present in sporulating bacteria by EDTA method.
8. Demostration of utilization of sugars by oxidation and fermentation techniques.

Unit - 1 Biodiversity

Introduction to microbial biodiversity – distribution, abundance, ecological niche. Types-Bacterial, Archael and Eucaryal.

Unit – 2 Characteristics and classification of Archaebacteria.

Thermophiles: Classification, hyperthermophilic habitats and ecological aspects. Extremely Thermophilic Archaebacteria, Thermophily, commercial aspects of thermophiles. Applications of
thermozymes.

Methanogens: Classification, Habitats, applications.

Unit – 3 Alkalophiles and Acidophiles

Classification , alkaline environment , soda lakes and deserts , calcium alkalophily Applications .

Acidophiles: Classification, life at low pH, acidotolerence, applications.

Unit – 4 Halophiles and Barophiles

Classification, Dead Sea, discovery basin, cell walls and membranes – Purple membrane, compatible solutes. Osmoadaptation / halotolerence. Applications of halophiles and their extremozymes.

Barophiles: Classification, high-pressure habitats, life under pressure, barophily, death under pressure.

Unit – 5 Space Microbiology

Aims and objectives of Space research. Life detection methods a] Evidence of metabolism (Gulliver) b] Evidence of photosynthesis (autotrophic and heterotrophic) c] ATP production d] Phosphate uptake e] Sulphur uptake . Martian environment (atmosphere, climate and other details).

Antartica as a model for Mars. Search for life on Mars, Viking mission, Viking landers, and Biology box experiment. Gas exchange , Label release and pyrolytic release experiments . Monitoring of astronauts microbial flora: Alterations in the load of medically important microorganisms, changes in mycological autoflora, and changes in bacterial autoflora.

PRACTICAL

PAPER- P-VIII MICROBIAL DIVERSITY AND EXTREMOPHILES

[Semester III]

PAPER TH-IX ENZYME TECHNOLOGY Marks 100

Unit – 1 Extraction and purification of microbial enzymes

Importance of enzyme purification, different sources of enzymes. Extracellular and intracellular
enzymes. Physical and Chemical methods used for cell disintegration. Enzyme fractionation by
precipitation (using Temperature, salt, solvent, pH, etc.), liquid-liquid extraction, ionic exchange,
gel chromatography, affinity chromatography and other special purification methods. Enzyme crystallization techniques. Criteria of purity of enzymes. Pitfalls in working with pure enzymes.

Unit - 2 Enzyme inhibition and Co-factors

Irreversible, reversible, competitive, non-competitive and un-competitive inhibition with suitable
examples and their kinetic studies.

Allosteric inhibition, types of allosteric inhibition and their significance in metabolic regulation & their kinetic study Vitamins and their co-enzymes: structure and functions with suitable examples Metalloenzymes and Metal ions as co-factors and enzyme activators.

Unit - 3 Immobilization of microbial enzymes

Methods viz. adsorption, covalent bonding, entrapment & membrane confinement and their analytical, therapeutic & industrial applications. Properties of immobilized enzymes.

Unit – 4 Enzyme Engineering

Chemical modification and site-directed mutagenesis to study the structure-function relationship

of industrially important enzymes.

Unit – 5 Applications of microbial enzymes

Microbial enzymes in textile, leather, wood industries and detergents. Enzymes in clinical diagnostics.

Enzyme sensors for clinical processes and environmental analyses . Enzymes as therapeutic agents.

PRACTICAL

PAPER -P-IX ENZYME TECHNOLOGY Marks 40

1. Microbial production , Extraction , purification and Confirmation of alpha amylase/ Lipase
2. Determination of efficiency of enzyme purification by measuring specific activity at various stages viz. Salt precipitation, dialysis, electrophoresis etc.
3. Studies on enzyme Activation and Inhibition of extracted alpha amylase /Lipase .Effect of Heavy metal ions, Chelating agents activators and inhibitors
4. Immobilization of cells and enzyme using Sodium alginate and egg albumin and measurement of enzyme activity [amylase/ /Lipase]
5 . Studies on impact of immobilization on enzyme activity in terms of Temperature tolerance and Vmax and Km using various forms Of alpha amylase/Lipase
6. Determination of molecular weight of enzymes using PAGE technique.
7. Preparation of biosensors of urease and determination of its activity.

Unit–1 Bioreactors

Design of a basic fermenter, bioreactor configuration, design features, individual parts, baffles, impellers, foam separators, sparger, culture vessel, cooling and heating devices, probes for online monitoring, computer control of fermentation process, measurement and control of process.

Reactors for specialized applications: Tube reactors, packed bed reactors, fluidized bed reactors, cyclone reactors, trickle flow reactors, their basic construction and types for distribution of gases.

Unit – 2 Mass transfer in reactors

Transport phenomena in fermentation: Gas- liquid exchange and mass transfer, oxygen transfer, critical oxygen concentration, determination of Kla, heat transfer, aeration/agitation, its importance.

Sterilization of Bioreactors, nutrients, air supply, products and effluents, process variables and control, scale-up of bioreactors.

Unit – 3 Fermentation process

Growth of cultures in the fermenter Importance of media in fermentation, media formulation and modification .

Kinetics of growth in batch culture, continuous culture with respect to substrate utilization, specific growth rate, steady state in a chemostat, fed-batch fermentation, yield of biomass, product, calculation for productivity, substrate utilization kinetics.

Fermentation process: Inoculum development. Storage of cultures for repeated fermentations, scaling up of process form shake flask to industrial fermentation.

Unit – 4 Down stream processing

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 - 5 Microbial strain improvement

Isolation, selection and improvement of microbial cultures: Screening and isolation of microorganisms, primary and secondary metabolites, enrichment, specific screening for the desired product.
Strain improvement for the selected organism: mutation and screening of improved cultures, random and strategic screening methods, strategies of strain improvement for primary, secondary
metabolites with relevant examples. Use of recombinant DNA technology, protoplast fusion techniques for strain improvement of primary and secondary metabolites.
Production of recombinant molecules in heterologus system, problems associated with strain improvement programme, improvement of characters other than products and its application in
the industry.
Preservation of cultures after strain improvement programme.

PRACTICAL

PAPER -P-X : BIOPROCESS ENGINEERING AND TECHNOLOGY

Unit – 1 DNA Structure and Mutagenesis

Historical developments in genetics, discovery of DNA and experimental evidence, Structure of
Circular DNA molecule, Primary, Secondary, Tertiary and Quaternary structure of DNA, Watson
and Crick model of double stranded DNA the law of DNA constancy and C value paradox and
topological manipulations.
DNA replication: DNA replication mechanism, enzymes involved in DNA replication and models
of DNA replication.
Molecular basis of spontaneous and induced mutations [physical and chemical mutagenic agents],
types of mutation: point, frameshift, lethal, conditional lethal, inversion and deletion, null mutation, reversion of mutations, intra and intergenic suppression mutations. Environmental mutagenesis, toxicity testing and population genetics.
Systems that safeguard DNA. DNA methylation and DNA repair mechanisms - excision, mismatch,
SOS , photoreactivation, recombination repair and glycocylase system.

Unit – 2 Prokaryotic Transcription and Translation

Organization of transcriptional units and regulation of gene expression Mechanism of transcription of prokaryotes-Structure and function of RNA polymerase, [DNA foot printing], termination and antitermination – N proteins and nut sites in DNA binding proteins, enhancer sequences and control of transcription, RNA processing (Capping, polyadenylation, splicing, introns and exons) Ribonucleoprotein, structure of mRNA, rRNA, tRNA. Direction of protein synthesis, RNA template, direction with experimental proof, tRNA as adaptor, ribosomes and their organization in prokaryotes, polycistronic mRNA in bacteria, initiation of translation in bacteria, small sub-units, its accessory factors, SD sequence in bacteria, initiator tRNA, elongation of translation, translocation and termination mechanisms. Post-translational modification. Salient features of genetic code.

Unit – 3 Regulation of gene expression in prokaryotes

Operon concept, co-ordinated control of structural genes, stringent response, catabolite

repression, instability of bacterial RNA, positive regulation in E.coli [Arabinose operon] and negative regulation in E.coli [lac operon], inducers and repressors, regulation by attenuation by
trp operon.

Unit - 4 Genetic recombination

Genetic recombination processes: Role of rec proteins in homologous recombination. Conjugation: Discovery, F_+, F^- and Hfr cells, types of Hfr; F_+ and F^- and Hfr and F^- genetic crosses. Mechanism of conjugation. Sexduction, conjugational transfer of colicinogenic and resistance transfer factors. Genetic mapping. Plasmid Replication and Incompitability, Control of
copy number.
Transposons – Insertion sequences and composite transposons, phages as transposons, replicative,
non-replicative and conservative transposition. Mutations i.e. deletions, inversions and frameshift
due to transposition. Mechanism of transposition, controlling elements of maize – autonomous and non-autonomous elements. Types of transposons and their properties.

Unit – 5 Phage Genetics

T4 virulent phage: structure, life cycle, genetic map and DNA replication. Lamda temperate phage: Structure, genetic map, lytic and lysogenic cycle, lysogenic repression and phage immunity. [Lambda regulon] applications of phages in microbial genetics.

PRACTICAL

PAPER - P-XI MICROBIAL GENETICS Marks 40

1. Purification of chromosomal / plasmid DNA and study of DNA profile:
* Confirmation of nucleic acid by spectral study.
* Quantitative estimation by diphenylamine test.
* DNA denaturation and determination of Tm and G+C content.
* Agarose gel electrophoresis of DNA.
2. Effect of UV radiations to study the survival pattern of E. coli/yeast. Repair mechanisms in E. coli/yeast (Dark and photoreactivation)
3. Isolation of antibiotic resistant mutants by chemical mutagenesis.
4. Ampicillin selection method for isolation of auxotrophic mutant.
5. Extraction and Purification of RNA from S. cerevisiae.
6. Studies on gene expression in E.coli with reference to lac operon.
7. Study of conjugation in E. coli.
8. Restriction digestion and agarose gel electrophoresis of DNA.
9. Generalized transduction in E. coli using P1 phage.

Unit – 1 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 – 2 Eutrophication

Water pollution and its control: Need for water management. Sources of water pollution. Measurement of water pollution, Eutrophication: Definition, causes of eutrophication, and microbial changes in eutrophic bodies of water induced by various inorganic pollutants. Effects of
eutrophication on the quality of water environment, factors influencing eutrophication. Qualitative characteristics and properties of eutrophic lakes. Measurement of degree of 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 –3 Effluent treatment techniques

Microbiology of wastewater and solid waste treatment: - Waste-types-solid and liquid waste characterization, physical, chemical, biological, aerobic, anaerobic, primary, secondary and tertiary treatments.

Anaerobic processes: Anaerobic digestion, anaerobic filters, and upflow anaerobic sludge.

Treatment schemes for effluents of dairy, distillery, tannery, sugar and antibiotic industries (Types, microbes used, types of Effluent Treatment Plants).

Bioconversion of Solid Waste and utilization as fertilizer.

Bioaccumulation of heavy metal ions from industrial effluents .

Unit – 4 Bioremediation of Xenobiotics

Microbiology of degradation of xenobiotics in the environment, ecological considerations, decay

behaviour, biomagnification and degredative plasmids, hydrocarbons, substituted hydrocarbons,

oil pollution, surfactants and pesticides. Genetically Modified Organisms released and its environmental impact assessment and ethical issues.

Unit – 5 Global environmental problems

Ozone depletion, UV-B, green house effect and acid rain, their impact and biotechnological approaches for management. . Containment of acid mine drainage applying biomining [with reference to copper extraction from low grade ores].

PRACTICAL

PAPER - P-XII ENVIRONMENTAL MICROBIAL TECHNOLOGY

Marks 40

1. Physical analysis of sewage/industrial effluent by measuring total solids, total dissolved solids and total suspended solids.
2. Determination of indices of pollution by measuring BOD/COD of different effluents.
3. Bacterial reduction of nitrate from ground waters
4. Isolation and purification of degradative plasmid of microbes growing in polluted environments.
5. Recovery of toxic metal ions of an industrial effluent by immobilized cells.
6. Utilization of microbial consortium for the treatment of solid waste [Muncipal Solid Waste].
7. Biotransformation of toxic chromium (+ 6) into non-toxic (+ 3) by Pseudomonas species.
8. Tests for the microbial degradation products of aromatic hydrocarbons /aromatic compounds
9. Reduction of distillery spent wash (or any other industrial effluent) BOD by bacterial cultures.
10. Microbial dye decolourization/adsorption.

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[Semester IV]

PAPER TH - XIII RECOMBINANT DNA TECHNOLOGY

Marks 100

Unit – 1 Techniques and enzymes in genetic recombination

Core techniques and essential enzymes used in recombination: restriction endonucleases, type I,

II, III, recognition sequences, properties, nomenclature, classification of type II endonucleases,

their activity. DNA ligase: Properties and specificity, S1 nuclease, BAL 31 nuclease, DNA polymerase, polynucleotide kinase, phosphatase, reverse transcriptase its activity and mode of

action. Chemical synthesis of DNA. Restriction digestion, ligation and transformation.

Unit – 2 Plasmids

Properties, incompatibility, isolation and purification techniques, plasmid vectors and their properties, PBR 322 – its construction and derivatives, single stranded plasmids, promoter probe
vectors, runaway plasmid vectors.

Bacteriophage lambda (λ) as a vector: Essential features, organization of λ genome, general structure, rationale for vector construction, improved λ vectors, λ gt series, λ EMBL vectors, invitro packaging, cosmids, phasmids, filamentous phage vectors, λ zap, λ blue print vectors.

Unit- 3 Specialized cloning strategies

Expression vectors, promoter probe vectors, vectors for library construction, genomic DNA libraries, chromosome walking and jumping, cDNA libraries, short gun cloning, directed cloning,
phage display. Recombinant DNA technology with reference to cloning and production of interferon and insulin. Miscellaneous applications of Genetically engineered micro organisms (GEMS) / genetically modified organisms (GMO's).

Unit – 4 PCR methods and Applications

PCR methods and Applications DNA sequencing methods, Dideoxy and Chemical method. Sequence assembly. Automated sequencing.

Unit – 5 Molecular mapping of genome

Genetic and physical maps, physical mapping and map –based cloning, choice of mapping population, simple sequence repeat loci, southern and fluorescence in situ hybridization for genome analysis, Chromosome microdissection and microcloning, molecular markers in genome
analysis: RFLP, RAPD and AFLP analysis, molecular markers linked to disease resistance genes,
Application of RFLP in forensic, disease prognosis, genetic counseling, pedigree, varietal etc.
animal trafficking and poaching: Germplasm maintenance, taxonomy and Biodiversity.

PRACTICAL

Paper - P-XIII RECOMBINANT DNA TECHNOLOGY Marks 40

1. Isolation of genomic DNA and its confirmation by southern blotting.
2. Isolation of plasmid DNA and its restriction digestion.
3. DNA sequencing by Sangers method / or other method.
4. DNA cloning using plasmid vectors and expression vectors.
5. RFLP analysis.
6. Isolation of poly-A + RNA
7. Amplification of DNA by PCR.

Metabolic pathways and metabolic control mechanisms, industrial production of citric acid, lactic
acid, enzymes (alpha-amylase, lipase, xylase, pectinases, proteases), acetone- butanol, lysine and
glutamic acid.

Unit – 2 Microbial production of therapeutic compounds

Microbial production of therapeutic compounds (β lactam, aminoglycosides, Ansamycins (Rifamycin), peptide antibiotics Quinolinones), biotransformation of steroids, vitamin B12 and riboflavin fermentation.

Unit – 3 Modern trends in microbial production

Modern trends in microbial production of bioplastics (PHB, PHA), bioinsectices (thuricide), biopolymer (dextran, alginate, xanthan, pullulan), Biofertilizers (nitrogen fixer Azotobacter, Phosphate solubilizing microorganisms), Single Cell Protein and production of biological weapons with reference to anthrax.

Unit – 4 Biofuels

Useful features of bio-fuels. The substrate digester and the microorganisms in the process of biogas production (biomethanation). Production of bioethanol from sugar, molasses, starch and
cellulosic materials. Ethanol recovery. Microbial production of hydrogen gas, biodiesel from hydrocarbons.

Unit – 5 Immobilization techniques , IPR and Patents

Some industrial techniques for whole cell and enzyme immobilization. Application and advantages of cell and enzyme immobilization in pharmaceutical, food and fine chemical industries.
Intellectual Property Rights (IPR), Patents, Trademarks, Copyrights, Secrets, Patenting of biological materials, international co operation, obligations with patent applications, implication
of patenting, current issues, hybridoma technology etc. Patenting of higher plants and animals,
transgenic organisms and isolated genes, patenting of genes and DNA sequences, plant breeders
right and farmers rights.

PRACTICAL

PAPER P-XIV FERMENTATION TECHNOLOGY Marks 40

1. Production and characterization of citric acid using A. Niger.
2. Microbial production of glutamic acid.
3. Production of rifamycin using Nocardia strain.
4. Comparison of ethanol production using various Organic wastes /raw
Material [Free cells/ immobilized cells].
5. Production and extraction of thuricide.
6. Laboratory scale production of biofertilizers [Nitrogen fixer/Phosphate
Solubilizers/siderophore producers].
7. Microbial production of dextran by Leuconostoc mesenteroides
8. Microbial production of hydrogen gas by algae/bacteria

Unit – 1 Bioinformatics and its applications

Databases, types, pairwise and multiple alignments. Structure-function relationship. Sequence
assembling using computers. Computer applications in molecular biology, Protein domains and
human genome analysis program (BLAST, FASTA, GCC etc.) Search and retrieval of biological
information and databases sequence, databank. (PDB and gene bank), accessing information
(Network expasy, EMB Net, ICGEB Net).

Unit – 2 Whole genome analysis

Preparation of ordered cosmid libraries, bacterial artificial chromosomal libraries, shotgun libraries and sequencing, conventional sequencing (Sanger, Maxam and Gilbert Methods), automated sequencing.

UNIT - III Sequence analysis

Computational methods, homology algorithms (BLAST) for proteins and nucleic acids, open reading frames, annotations of genes, conserved protein motifs related structure / function (PROSITE, PFAM, Profile Scan). DNA analyses for repeats (Direct and inverted), palindromes,
folding programmes. Use of Internet, public domain databases for nucleic acid and protein sequences (EMBL, GeneBank), database for protein structure (PDB).

UNIT - IV DNA Microarray

Printing or oligonucleotides and PCR products on glass slides, nitrocellulose paper. Whole

genome analysis for Global patterns of gene expression using fluorescent-labelled cDNA or end
labelled RNA probes. Analyses of single nucleotide polymorphism using DNA chips.

UNIT - V Proteome analysis

Two dimensional separation of total cellular proteins, isolation and sequence analysis of individual protein spots by Mass Spectroscopy. Protein microarrary advantages and disadvantages of DNA and protein microarrays

PRACTICAL

PAPER- P-XV BIOINFORMATICS, MICROBIAL GENOMICS AND PROTEOMICS.

Unit – 1 Antibiotics and synthetic antimicrobial agents

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

Unit – 2 Mechanism of action of antibiotics

Mechanism of action of antibiotics (inhibitors of cell wall synthesis, nucleic acid and protein synthesis).
Molecular principles of drug targeting.
Drug delivery system in gene therapy
Bacterial resistance to antibiotics.
Mode of action of bacterial killing by quinolinones.
Bacterial resistance to quionolinones.
Mode of action of non – antibiotic antimicrobial agents.
Penetrating defenses – How the antimicrobial agents reach the targets (cellular permeability barrier, cellular transport system and drug diffusion).

Unit – 3 Microbial production and Spoilage of pharmaceutical Products

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

Unit – 4 Regulatory practices, biosensors and applications in Pharmaceuticals

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

Unit – 5: Quality Assurance and Validation

Good Manufacturing Practices (GMP) and Good Laboratory Practices (GLP) in pharmaceutical industry.
Regulatory aspects of quality control.

Quality assurance and quality management in pharmaceuticals ISO, WHO and US certification.
Sterilization control and sterility testing (heat sterilization, D value, z value, survival curve, Radiation, gaseous and filter sterilization)
Chemical and biological indicators.
Design and layout of sterile product manufacturing unit.
(Designing of Microbiology laboratory)
Safety in microbiology laboratory.
PRACTICAL
PAPER P- XVI PHARMACEUTICAL MICROBIOLOGY Marks 40
1. Spectrophotometric / Microbiological methods for the determination of Griesofulvin.
2. Bioassay of chloremphenicol by plate assay method or turbidiometric 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.