

**SARDAR PATEL UNIVERSITY
VALLABH VIDYANAGAR**



**Programme: MSC (CBCS)
Syllabus with effective from: 2018-19**

**MICROBIOLOGY
Semester IV**

PS04CMIC21: R-DNA Technology

Unit-I

Concept and importance of Genetic Engineering; General strategies and Steps involved in gene cloning: Extraction and purification of DNA and RNA from bacteria, virus, plant and animal cells; physical and enzymatic methods for cutting DNA; DNA ligase and other enzymes involved in gene cloning; Construction genomic and cDNA libraries; Introduction of DNA into host cells; screening and selection methods for recombinant clones.

Unit-II

Cloning vectors- Basic properties and cloning strategies for vectors derived from Plasmids, λ -bacteriophages, M-13 phage, Cosmids, Fosmids, Phagemids, Phasmids, YAC, BAC, HAC/MAC.

Salient features of expression vectors for heterologous expression in E. coli, Yeast, Insect and Mammalian system, factors influencing heterologous gene expression.

Unit-III

DNA sequencing and sequence assembly: Maxam-Gilbert's and Sanger's methods, Shot gun sequencing, Next generation sequencing strategies for large genomes. DNA mapping and DNA fingerprinting: Physical and molecular mapping, Hybridization and PCR based methods of fingerprinting. Site directed mutagenesis: Methods and applications.

Polymerase Chain Reaction: Principle and basic types of PCR; Reverse Transcription and Real Time PCRs.

Unit-IV

Applications of Genetic engineering in improvement of plants, animals and microbes; Gene editing and its applications; Metagenomics and Metabolic engineering; Gene therapy; Restriction and regulations for the release of GMOs; Biosafety and levels of Physical and Biological containment; The Indian Guidelines for release and use of GM organisms.

Reference Books

- Genome 3rd Edition – Brown
- Molecular Biotechnology – Glick
- Principles of Genetic Manipulation – Old and Primrose
- Applied Molecular Genetics – Roger Miesfeld
- Biotechnology – H. K. Das

- Recombinant DNA – Watson et. al.
- Molecular cloning – Sambrook and Russel
- From genes to clones – Ernst Whittaker

PS04CMIC22: Environmental Biotechnology

Unit 1

Waste water treatment- Waste water characterization and its significance: COD, BOD, TOC, TOD, Inorganic constituents, solids, biological components.

Principles and aims of biological wastewater treatment processes: Primary, secondary and tertiary treatment of waste water.

Biochemistry and microbiology of inorganic phosphorus and nitrogen removal from waste water.

Suspended growth processes:

Activated sludge process: Biology of activated sludge, flocculation and sludge settling, problems of sludge settling, modified processes for inorganic nitrogen and phosphorous removal

Oxidation ditches and Waste stabilization ponds.

Fixed film processes: Biofilm formation and slaughting, Trickling filters, Rotating biological contactors, fluidized bed and submerged aerated filters.

Unit 2

Anaerobic digestion: microbiological and biochemical fundamentals, factors influencing anaerobic digestion.

Anaerobic waste water treatment systems: Upflow anaerobic sludge blanket , rotating biological contactors, anaerobic filters. Merits and demerits of anaerobic treatment of waste.

Composting: Objectives, fundamentals, microbiology, factors influencing composting and composting systems, Compost quality and uses, Vermicomposting.

Toxicity testing in waste water treatment plants using microorganisms:

Monitoring environmental processes with biosensors: BOD biosensor, Pesticide biosensor

Unit 3

Biodegradation of organic pollutants: Xenobiotic and recalcitrant organic compounds, mechanisms of biodegradation, factors affecting biodegradation, Acclimation phase in biodegradation. Biodegradation of simple aliphatic, aromatic, polycyclic aromatic hydrocarbons, halogenated hydrocarbons, azo dyes and lignin.

Bioremediation approaches: Intrinsic bioremediation, Biostimulation, Bioaugmentation: Use of genetically modified organisms.. *In situ* and *ex situ* bioremediation technologies with examples.

Bioremediation of heavy metal pollution, Phytoremediation.

Biological treatment of waste gas (polluted air): biofilters, bioscrubbers, membrane bioreactors, biotrickling filters.

Unit 4

Bioleaching of metals: Characteristics of commercially important microbes, mechanisms of bioleaching, factors affecting bioleaching and current biomining processes. Biobeneficiation of gold ores.

Biohydrosulfurization of coal: Removal of organic and inorganic sulfur from coal.

Microbially enhanced oil recovery.

Microbial Insecticides: Bacterial, fungal and viral insecticides in pest management.

Biofertilizers: applications of nitrogen fixing and phosphate solubilising/ mobilizing biofertilizers.

Reference Books:

- Comprehensive Biotechnology Vol-4, Murray Moo Young.
- Biotechnology-Rehm and Reid.
- Waste water microbiology by G. Bitton

- Biodegradation and bioremediation by M.Alexander
- Waste water treatment for pollution control, 2nd edition. Arceivala
- Environmental Biotechnology by H. Jordening and Josef Winter
- Handbook of water and waste water Microbiology by Horan
- Topic related review articles

PS04CMIC23: Lab I (Practicals based on PS04CMIC21 and PS04CMIC22)

PS04EMIC21: Lab II (Practicals based on PS04EMIC2X and PS04EMIC2X)

PS04EMIC22: Dissertation

PS04EMIC23: Microbial Physiology

Unit-I

Bacterial Cell Structure and its type, Bacterial Cell surfaces, Bacterial Cell wall structure function and synthesis, Membrane transport in bacteria-simple, group translocation, ABC transporters, Protein export in bacteria-Type 1,2,3,4, Protein export pathways.

Bacterial capsules structure and importance.

Bacterial organs for locomotion: Flagella: structure, synthesis, function and mechanism of locomotion, Swarming motility, Motility in spirochetes, Gliding motility, Twitching.

Chemotaxis: Molecular mechanism and physiological significance.

Two component signal transduction in prokaryotes

Unit-II

Bacterial differentiation: endospore formation, physiological and genetic aspects of sporulation, Sporulation inducing signals & events in sporulation

Bacterial cell division: molecular mechanisms involved in formation of Z-ring, Cell division machinery.

Yeast cell division: Growth and cell division coordination, Cell division events, molecular basis of cell cycle and control.

Microbial stress responses: Oxygen toxicity, pH, Heat shock, Osmotic pressure, Osmolarity regulation in *E.coli* (Omp system) Phosphate assimilation in *E.coli* (Pho system), Nitrogen fixation in *Klebsiella* & *Rhizobium* (Ntr system).

Metabolism in Autotrophs, Methylophiles and Photoautotrophs

Unit-III

Bioluminescence: process, biochemistry, genetics and significance.

Mechanism of action of antibiotics and mechanisms of drug resistance.

Bacteriocins: Structure, Classification and physiological significance of it.

Microbial reserve compounds: Types, Synthesis and Applications

Siderophores; structure, function and significance

Bacterial biofilms formation steps, dispersion and control strategies

Unit-IV

Quorum sensing process in gram positive and gram negative bacteria.

Microbial fuel cells: Energy generation principle and application.

Microbial production of Hydrogen.

Host Parasite interactions: Structures and functions involved in Host-parasite interactions,

Bacterial damages to host upon infection. Structure and Mechanism of Endotoxin, Exotoxin and Exoenzymes formed by bacteria.

The prokaryotic “immune system”, CRISPR/Cas

References:

- Bacterial signalling, Kramar and Jung
- Microbial Physiology, Moat, Foster and Spector
- The Physiology and Biochemistry of prokaryotes, David White
- Bacterial physiology: A molecular approach, W. E. Sharoud
- Topic related review articles

PS04EMIC24: Food and Dairy Microbiology

Unit I:

Scope of food microbiology

Food as a substrate

- a) Microorganisms important in food microbiology – Bacteria, yeasts and moulds.
- b) Factors influencing microbial growth in food.

Food Spoilage

- a) General principles underlying food spoilage and contamination.
- b) Spoilage of canned food, sugar products, vegetables, fruits, meat and meat products, milk and milk products fish, seafood and poultry

Unit II:

Food poisoning

- a) Indicator food borne pathogens
- b) Bacterial food borne infections and intoxications-*Brucella*, *Campylobacter*, *Clostridium*, *Escherichia* (ETEC/EHEC/EPEC/EAEC), *Salmonella*, *Shigella*, *Listeria*, *Vibrio*, and *Yersinia*.
- c) Non- bacterial food borne infections and intoxications- Nematodes, protozoa, algae, fungi, and viruses.
- d) Culture and non-culture based detection of food pathogens and viruses
- e) General methods for diagnosis of infections, intoxications and preventive measures.

Unit III:

Food preservation

Principles of food preservation – Physical and chemical preservation methods, Bio preservatives

Food fermentations

Starter cultures for fermented foods: Biochemical activities in fermentation of foods.

Oriental fermented foods: Shoyu, Tempoh, Kimchi etc

Fermented milk products: Yogurt, Kefir, Koumiss etc.

Fermented vegetables – Sauerkraut

Bread manufacture

Application of microbial enzymes in food industry

Unit IV:

Genetically modified foods. Biosensors in food

Food research organizations/institutes in India

Recent foodborne outbreaks

Food sanitation – Microbiology of food plant sanitation, water and milk testing

Food laws and quality control – HACCP, Codex alimentarius, PFA, FPO, MFPO, BIS, AGMARK.

Books recommended

1. Food Microbiology, Frazier and Westhoff
2. Food microbiology, Adam and Moss
3. Dairy Microbiology by Robinson. Volume II and I.
4. Fundamental Food Microbiology, Bibek Ray and ArunBhuniya

PS04EMIC25: IPR and Biosafety

UNIT-I

Biotechnology and society: Biotechnology and social responsibility, public acceptance issues in biotechnology, issues of access, ownership, monopoly, traditional knowledge, biodiversity, benefit sharing, environmental sustainability, public vs private funding. Social and ethical issues in biotechnology. Principles of bioethics. Ethical conflicts in biotechnology- interference with nature, unequal distribution of risk and benefits of biotechnology, bioethics vs business ethics.

UNIT-II

Bio- safety: Definition of bio-safety, Biotechnology and bio-safety concerns at the level of individuals, institutions, society, region, country and world.

Bio-safety in laboratory institution: laboratory associated infection and other hazards, assessment of biological hazards and level of biosafety.

Bio safety regulation: handling of recombinant DNA products and process in industry and in institutions.

UNIT-III

IPR I: Introduction to IPR: Forms of IPR and Intellectual property protection. Concept of property with respect to intellectual creativity, Tangible and Intangible property.

WTO: agency controlling trade among nations, WTO with reference to biotechnological affairs, TRIPs. WIPO, EPO.

UNIT-IV

IPR II: Concept related to patents novelty, non-obviousness, utility, anticipation, prior art etc. Type of patents. Indian patent act and foreign patents.

Patentability, Patent application, Revocation of patent, Infringement and Litigation with case studies on patent, Commercialization and Licensing.

References:

1. Fleming, D.A., Hunt, D.L., (2000). Biotechnology and Safety Assessment (3rd Ed) Academic press. ISBN-1555811804, 9781555811808.
2. Thomas, J.A., Fuch, R.L. (1999). Biotechnology and safety assessment (3rd Ed). CRC press, Washington. ISBN: 1560327219, 9781560327219
3. Law and Strategy of biotechnological patents by Sibley. Butterworth publication. (2007) ISBN: 075069440, 9780750694445.
4. Intellectual property rights- Ganguli-Tat McGrawhill. (2001) ISBN-10: 0074638602,
5. Intellectual Property Right- Wattal- Oxford Publication House. (1997) ISBN: 0195905024.
6. Biotechnology - A comprehensive treatise (Vol. 12). Legal economic and ethical dimensions VCH. (2nd ed) ISBN-10 3527304320.
7. Encyclopedia of Bioethics 5 vol set, (2003) ISBN-10: 0028657748.
8. Thomas, J.A., Fuch, R.L. (2002). Biotechnology and safety Assessment (3rd Ed) Academic press.
9. B.D. Singh. Biotechnology expanding horizons.
10. H.K.Das. Text book of biotechnology 3rd edition.

PS04EMIC26: Plant Biotechnology

Unit I

Historical review and scope of plant tissue culture; Plant cell-totipotency. Aseptic techniques; Culture media: preparation and composition. Methods of sterilization, inoculation, incubation and hardening. Cell and organ differentiation; Clonal propagation or micropropagation (artificial seeds, virus free plants); Somaclonal variation; Overcoming crossing barriers : Pre fertilization and post fertilization barriers including in-vitro pollination/fertilization and embryo rescue); Endosperm, nucellus culture, anther culture and ovule culture. Germplasm storage including cryopreservation.

Unit II

Isolation of protoplasts; Purification of protoplasts; Visibility and plating density of protoplasts; Protoplast culture and regeneration of plants; Protoplast fusion and somatic hybridization (techniques of fusion, selection of fused protoplasts, chromosome status of fused protoplasts, uses of somatic hybrids); Cytoplasmic hybrids or Cybrids; Genetic modification of protoplasts.

Unit III

Vectors for gene transfer (based on Ti and Ri plasmids; co integrate, intermediate and helper plasmids; binary vectors; viruses as vectors); gene transfer techniques using *Agrobacterium*; selectable and scorable markers (genes); Agroinfection and gene transfer; Physical delivery methods: Biolistics and electroporation.

Unit IV

Transgenic plants for crop improvement (dicots and monocots including maize, rice, wheat, oats, etc.; resistance to herbicide, insecticide, virus and other diseases; transgenic plants for molecular farming; transgenic plants to regulated gene expression, Chloroplast and Mitochondrion engineering.

Reference Books :

- Plant biotechnology – J Hammond, *et. al.*, Springer Verlag.
- Plant cell and tissue culture for production of food ingredients – T J Fu, G Singh, *et. al.*
- Biotechnology in crop improvement – H S Chawla.
- Practical application of plant molecular biology – R J Henry, Chapman & Hall.
- Elements of biotechnology – P K Gupta.
- An introduction to plant tissue culture – M K Razdan.
- Plant propagation by tissue culture : The technology (Vols. 1 & 2) – Edwin George.
- Handbook of plant cell culture (Vols. 1 to 4) – Evans *et. al.*, Macmillan.
- Plant tissue and cell culture – H E Street, Blackwell Scientific.

- Cell culture and somatic cell genetics of plants (Vols. 1 to 3) – A K Vasil, A. Press.
- Plant cell culture technology – M M Yeoman.
- Plant tissue culture and its biotechnological applications – W Bary, *et. al.*, Springer Verlag.
- Principles of plant biotechnology : An introduction to genetic engineering in plants – S H Mantell, *et. al.*
- Advances in biochemical engineering / Biotechnology – Anderson, *et. al.*
- Applied and fundamental aspects of plant cell tissue and organ culture edited by Reinert& Bajaj Y P S, Springer Verlag.
- Plant cell and tissue culture – S Narayanswamy, Tata Mc Graw Hill Co.
- Text Books: 2.Ignacimuthu, S.J. 1997. Plant Biotechnology. Oxford and IBH Publ