

**SARDAR PATEL UNIVERSITY  
VALLABH VIDYANAGAR**



**Programme: MSC (CBCS)  
Syllabus with effective from: JUNE-2017**

**MICROBIOLOGY  
Semester: II**

**PS02CMIC21: Bioprocess and Biochemical Engineering**

**Unit I**

Introduction to bioprocess technology

Isolation, primary and secondary screening, preservation, maintenance and improvement of industrially important organisms.

Raw materials for fermentation processes

Medium optimization

**Unit II**

Bioreactor design: Laboratory, pilot and large scale reactors. mechanical, pneumatic and hydrodynamic systems. Plug flow reactors, Immobilization and immobilized enzyme reactors.

Sterilization of media and air.

Scale up and Scale down and containment

Mass transfer of oxygen: Agitation and aeration, Determination of  $K_La$ , factors affecting  $K_La$ , fluid rheology. Inoculum development, aseptic inoculation and sampling.

**Unit III**

Bioprocess kinetics: Kinetics of growth and substrate utilization in batch, fed batch and continuous systems.

Control of process parameters: Instrumentation for monitoring bioreactor and fermentation processes, Sensors, Controllers, fermentation control systems and architecture, Incubation and sequence control, advanced control.

**Unit IV**

Downstream processing:

Bioseparation: filtration, centrifugation, sedimentation, flocculation, cell disruption, liquid liquid extraction. purification by chromatographic techniques, reverse osmosis and ultrafiltration, drying, crystallization, storage and packaging.

Fermentation Economics

**References:**

- Principles of Fermentation Technology : Whitekar & Stanbury
- Comprehensive Biotechnology : Murray Moo Young
- Methods in Industrial Microbiology : Sikyta
- Fermentation Microbiology and Biotechnology, El Mansi and Bryc

## PS02CMIC22: Microbial Genetics

### Unit I: Mutation, DNA damage and Repair

Spontaneous mutations (Random v/s Adaptive nature of mutation; Mutation rate and its determination, Types of DNA damage and their consequences (spontaneous and chemical induced deamination, radiation induced DNA damage, loss of nitrogen bases, alkylation, intra and inter strand cross linking) , DNA repair pathways (Mis-match repair in prokaryotes and eukaryotes, Nucleotide excision repair in prokaryotes and in eukaryotes, base excision repair, recombinational repair, SOS pathway, specific repair of oxidative DNA damage, repair of pyrimidine dimers, repair of alkylation induced damage and adaptive response and other specific repair mechanisms).

### Unit II:

**Plasmid Biology** (Types of plasmids, compatibility, regulation of plasmid copy number and plasmid segregation)

**Phage genetics** (T-series, complementation and Fine structure analysis, biology of lambda phages)

**Recombination** (Types, Models of homologous recombination, Molecular mechanism of homologous, Homologous recombination in eukaryotes, mating type switching, Site specific recombination and its biological significance)

**Fungal Genetics** (Tetrad analysis and Mitotic recombination)

### Unit III: Genetic exchange in prokaryotes

**Transformation** (Natural transformation in *Bacillus subtilis*, *Streptococcus pneumonia* and *Haemophilus influenza*). Transformation by inducing artificial competence, Gene linkage and mapping by transformation.

**Transduction** (Generalized transduction in P22, P1, T4 and Mu bacteriophages, homologous recombination with recipient's chromosome, measuring transduction (co-transduction of markers, marker effects, abortive transduction, transduction of plasmids). Applications of generalized transduction, Specialized transduction and its applications.

**Conjugation** (F-factor mediated Conjugation in *E. coli*, Hfr conjugation and chromosomal transfer, F-prime conjugation and merodiploids, Conjugation of fertility inhibited F-like plasmids, Non conjugative mobilizable plasmids, chromosomal mobilization of non-F plasmids, Plasmid based conjugation in other bacteria (*Salmonella*, *Pseudomonas*, *Streptomyces* and *streptococcus*, Interrupted mating and conjugational mapping)

### Unit IV

**Agrobacterium genetics:** Ti plasmid, Interkingdom gene transfer (Key early experiments, vir regulon, protein secretion apparatus, conjugation model of T-DNA transfer, Integration products)

**Restriction modification systems:** Types of RM systems, Role of RM systems, salient features and insights into evolution of diverse types of Restriction endonucleases and Methyl transferases, Regulation of RM systems.

**Transposable elements:** Types of bacterial transposable elements; Structure, genetic organization and mechanism of transposition of Tn5, Tn3, phage Mu, Tn7, IS911, Integrons, Retrotransposons, conjugative and mobilizable transposons, Assays of transposition.

**References:**

- Genes X: Lewin
- Molecular Biology of the Gene-Watson et al.
- Modern Microbial Genetics-Uldis Streips and Ronald Yasbin
- Microbial genetics-Stanley Molay, John Cronan and David Freifelder.
- Molecular Genetics of Bacteria-Snyder and Champness.
- Molecular Genetics-Stent and Calender
- Principles of Genetics- Snustad and Simmons
- Molecular Biology of the Cell-Alberts et al.

## PS02CMIC23: Fundamentals of Immunology

### Unit I

Introduction to immune system: mechanisms of barrier to entry of microbes / pathogens;  
Cells and organs of the immune system involved in innate and adaptive immunity: cells of the immune system, primary and secondary lymphoid organs, Hematopoiesis and its regulation

Innate immunity: receptors of the innate immunity (TLR and sensing of PAMPs, CLR, RLR and CLR); Inflammatory responses

Antigens: antigenicity, and immunogenicity. B and T cell epitopes

### Unit II

Antibody: Structure of immunoglobulin; classes of immunoglobulins, Signal transduction pathways emanating from the BCR,

The Organization and Expression of Lymphocyte Receptor Genes: Hozumi and Tonegawa's Experiment, Multigene organization of Ig Gene, Mechanism of VDJ recombination, B cell receptor expression, allelic exclusion, B cell isotype switching and somatic hypermutation; expression of membrane bound and soluble immunoglobulin; T cell receptor genes and expression

Complement system: Overview of classical, alternative and lectin complement pathways, functions of complement, regulation of complement, complement deficiencies, microbial complement evasion strategies

### Unit III

The Major Histocompatibility Complex and Antigen Presentation: The structure and function of MHC molecules, general organization and inheritance of MHC, self – MHC restriction, endogenous and exogenous pathway of antigen processing and presentation; cross presentation of exogenous antigen, presentation of non peptide antigens

Cytokines: properties, receptors, associated diseases, therapeutic applications, cytokine signaling pathways: JAK-STAT and FAS-FASL signaling pathways

### Unit IV

Basics of Antigen-antibody interactions: Agglutination, precipitation, RIA and ELISA

Cell and antibody mediated effector response: Antibody mediated effector response (Neutralization, opsonization/ phagocytosis, complement fixation, ADCC); Cell mediated effector response (Generation of effector CTL's, Granzyme and Perforin Mediated Cytolysis, Fas-FasL Mediated Cytolysis, NK cell mediated cytotoxicity)

Immunity to infection: Immunity to viruses, Immunity to bacteria and fungi, Immunity to parasites (protozoa and worms).

### References:

1. Owen, J. A., Punt, J., & Stranford, S. A. (2013). *Kuby immunology* (7<sup>th</sup> Edn). New York: WH Freeman.
2. Murphy, K., & Weaver, C. (2016). *Janeway's immunobiology* (9<sup>th</sup> Edn) Garland Science.
3. Male, D., Brostoff, J., Roth, D., & Roitt, I. (2012). *Immunology* (8<sup>th</sup> Edn) *With STUDENT CONSULT Online Access*. Elsevier Health Sciences.

4. Abbas, A. K., Lichtman, A. H., & Pillai, S. (2014). *Cellular and molecular immunology* (6<sup>th</sup> Edn) Elsevier Health Sciences.
5. Relevant review articles / research papers / handouts of latest development in the subject.

**PS02CMIC24: Lab I Practicals based on PS02CMIC21 and PS02CMIC22**

**PS02CMIC25: Lab II Practicals based on PS02CMIC23 and PS02EMIC2X**

## PS02EMIC21: Biostatistics

### Unit - I

Definition of Biostatistics

Data Collection:

Types of Biological Data:

Qualitative (Categorical ) Data: Nominal and Ordinal Data

Quantitative (Numerical) Data: Discrete and Continuous Data

Methods of Collecting Data:

Survey Method: Concept of a statistical population and sample from a population; Methods of drawing sample from the population, Simple Random Sampling (SRS), Stratified Random Sampling, Cluster Sampling; Experimental Method

Presentation:

Construction of frequency distribution (Simple or Discrete and Grouped): Rules for constructing Grouped frequency distribution

Diagrammatic Presentation: Bar Diagram (Chart), Simple, Sub – divided (Component), Percentage, Multiple, Pie Chart

Graphical Presentation: Line Graph, Histogram (For uniform class width only), Frequency Polygon, Frequency Curve, Ogives or Cumulative Frequency Curves

Descriptive Statistics:

Measures of Central Tendency (Averages): Mean or Arithmetic Mean, Median, Mode, Partition Values (For Raw and Grouped Data), Quartiles, Deciles, Percentile, Partition values using graphs (Ogives).

Measures of Dispersion (Variation): Range, Quartile Deviation (Q.D), Inter Quartile Range (IQR), Standard Deviation (SD) and Variance, Coefficient of Variation (C.V), Box – and – Whisker Plot.

Measures of Skewness and Kurtosis: Karl – Pearson's Coeff. of Skewness, Bowley's Coeff. Of Skewness, Kurtosis (Definition Only).

### Unit - II

Probability and Probability Distributions:

Elements of Probability theory: Concept, Classical definition of Probability, Laws of Probabilities (Statements Only), Conditional Probability, Examples

Probability Distributions: Binomial Distribution. Definition, Conditions for applicability of Binomial Distribution, Examples applicable in the field of Biosciences; **Normal Distribution**, Definition (Normal and Standard Normal Distribution), Properties of Normal Distribution, Examples applicable in the field of Biosciences

### Unit - III

Correlation and Regression Analysis:

Correlation: Meaning, Types of Correlation, Positive, Negative, Non – Sense or Spurious, Methods of studying correlation, Scatter Plot (diagram) method, Karl-Pearson's Correlation Coefficient (Product Moment) Method; Properties of Correlation Coefficient

Coefficient of determination and its meaning: Spearman's Rank Correlation Coefficient; Properties of Rank Correlation Coefficient

Regression: Meaning, Properties of Regression Coefficients, Applications in the field of Biosciences

Testing Of Hypothesis: Contingency tables, Goodness of Fit

**Unit - IV**

Large Sample Test: Z - test for (Single) population proportion; Z - test for difference between two population proportions; Z - test for (Single) population mean; Z - test for difference between two population means

Small Sample Test: t – test for (Single) Population Mean, t – test for difference between two population means (Unpaired t-test), t – test for difference between two population means (Paired t-test)

Analysis Of Variance (ANOVA) : One – Way Classification , Two – Way Classification

**References:**

- Fundamentals of statistics by S.C. Gupta
- Principles of Biostatistics by Marcello Pagano and Kimberlee Gaurea
- Biostatistics : A Foundation For Analysis in the Health Sciences by Daniel, Wayne (Seventh Edition), Wiley India Pub.

## PS02EMIC22: Medical Microbiology

### Unit-I Basics in Medical Microbiology

- Sources of infection, Modes of transmission, Factors predisposing to microbial pathogenicity, Types of infectious diseases,
- Prevention and Control of Hospital acquired infections. Immunoprophylaxis: Types of vaccines and schedule of vaccination.
- Recent advances in diagnostic microbiology: Automation, Nucleic acid based detection methods.

### Unit-II Bacteriology

Morphology, Cultural Characteristics, Antigenic structures, Pathogenesis, Laboratory Diagnosis of following bacteria: *Staphylococcus*, *Streptococcus including Pneumococcus*, *Bacillus*, *Corynebacterium*, *Clostridium*, *Mycobacteria*, *Vibrios*, *E. coli*, *Salmonella*, *Shigella*, *Spirochaetes*, *Neisseria*,

### Unit-III Virology

- The Nature and classification of viruses, Morphology: virus structure and Virus replication.
- General properties, diseases caused, lab diagnosis and prevention of
  - Pox, Herpes (HSV), Hepatitis (HAV & HAB), Picorna (Polio virus), Orthomyxo (Influenza), Paramyxo (Mumps and Measles), Rabdo (Rabies), Ebola, Zika and HIV virus.
- Viral vaccines and antiviral agents.

### Unit-IV Parasitology & Mycology

Parasitology: Laboratory techniques in parasitology.

Morphology, life cycle, laboratory diagnosis of following parasites

*Parasites: Entamoeba, Giardia, Leishmania, Plasmodium,*

*Helminths: Taenia, Ascaris, Wuchereria bancrofti, Schistosomes*

Mycology: Morphology, diseases caused and lab diagnosis of:-

- Opportunistic fungi - *Cryptococcus*, *Candida*, *Aspergillus*.
- Fungi causing Cutaneous mycoses- *Dermatophytes*
- Subcutaneous mycoses - *Mycetoma*,
- Systemic mycoses-*Histoplasma*

### References:

1. Textbook of Microbiology by Surinder Kumar
2. Medical Parasitology by R. Karyakarte.
3. P. B. Godkar. Text Books of Medical Laboratory Technology
4. Anathanarayana & Panikar – A Text Book of Medical Microbiology
5. P. Chakraborty- A Text Book of Microbiology
6. Chatterjee, KD – Parasitology
7. Danial Greenwood et al, Medical Microbiology, A guide to Microbial Infections, Pathogenesis, Immunity, Laboratory Diagnosis and control.
8. Jagdish Chander, Textbook of medical mycology.
9. Teri Shores- Understanding Viruses.
10. Biswas SB and Biswas A An Introduction to Viruses.



## **PS02EMIC23: Microtechniques**

### **Unit I**

Light microscopy

Properties of lenses, Optical corrections, Properties and types of objectives, Oculars and Illumination.

Light microscopes: Bright field, dark field, fluorescence, phase contrast, polarizing, differential interference contrast.

Micrometry and photomicrography

### **Unit II**

Basic components of electron microscopes. Thermionic and field emission guns. Types of electron microscopes: TEM, SEM, STEM, ESEM and HVEM

### **Unit III**

Maceration, squash and clearing techniques. Sample preparation for light microscopy. Classification of fixatives, formulas', (Plant and animal samples).

Sample preparation for light microscopy: Fixation, dehydration and infiltration procedures.

Embedding media for light microscopy. Stains and staining procedures- negative and positive staining procedures. Microtomes: Rotary, sliding, cryostat. Histochemical localization of metabolites for light microscopy: Starch, proteins, lipids, total carbohydrates, lignins, polyphenols, nucleic acid, histones, cutin, suberin and waxes. Localization of enzymes: Peroxidase, acid phosphatase and succinic dehydrogenase.

### **Unit IV**

Freeze etching and freeze fracturing.

Sample preparation for Electron microscope: Fixatives, double fixation, dehydration and infiltration procedures, embedding media for electron microscopy. Fixation and embedding of particulate samples like bacteria, virus etc. ultra-microtome and freezing ultramicrotome-semi thin sectioning, ultrathin sectioning, grids, formavar coating, Staining for electron microscopy.

Ultrastructural cytochemistry: Tannin, protein, cell wall polysaccharide, lignin and membrane.

Enzymes: Peroxidase and phosphatase.

Immunocytochemistry.

### **References:**

- Microscopy and Microtechnique: R Marimuthu MJP Publisher, Chennai
- The study of plant structure: Principles and selected methods- T. P. O' Brien and M E McCully.
- Plant Microtechnique- Johansen, DA, McGraw Hill Book Co., New York.
- Botanical Microtechnique and Cytochemistry; Graeme P. Berlyn and Jerome P Micksche.

## PS02EMIC24 - Toxicology

### Unit-1

Definition and scope of toxicology: Eco-toxicology and its environmental significance.

Toxic effects : Basic for general classification & nature. Dose-Response relationship:

Synergism and Antagonism, Determination of ED50 & LD50. Acute and Chronic exposures.

Factors influencing Toxicity. Pharmacodynamics & Chemodynamics, dose conversion between animals and human

Diagnosis of toxic changes in liver and kidneys : Metabolism of drugs: paracetamol and aspirin with their toxic effects on tissues.

### Unit-2

Xenobiotics Metabolism: Absorption & distribution. Phase I reactions. Oxidation, Reduction, Hydrolysis and Hydration. Phase II reaction/Conjugation : Methylation, Glutathione and amino acid conjugation. Detoxification.

Biochemical basis of toxicity : Metabolism of Toxicity : Disturbances of Excitable membrane function. Altered calcium Homeostasis. Covalent binding of cellular macromolecules & Genotoxicity. Tissue specificity of Toxicity.

Toxicity testing : Test protocol, Genetic toxicity testing & Mutagenesis assays : In vitro Test systems – Bacterial Mutation Test, Ames Test, Fluctuation Tests, *In vivo* Mammalian Mutation tests –DNA repair assays, Chromosome damage test, Evaluation of Apoptosis and necrosis

### Unit-3

Pesticide toxicity : Insecticides : Organochlorines, Anti cholinesterases – Organophosphates and Carbamates, Fungicides. Herbicides, Environmental consequences of pesticide toxicity. Biopesticides.

Food Toxicity : Role of diet in cardio-vascular disease and cancer. Toxicology of food additives.

### Unit-4

Metal Toxicity : Toxicology of Arsenic, mercury, lead and cadmium. Environmental factors, affecting metal toxicity effect of light, temperature & pH.

Air pollution : Common air Pollutant & their sources. Air pollution & ozone. Air pollution due to chlorofluorocarbons (CFCs) and asbestos.

### References:

1. Klaassen, C. D (8<sup>th</sup> Eds.). (2013). *Casarett and Doull's toxicology: the basic science of poisons* . New York: McGraw-Hill.
2. John A. Timbrell (4<sup>th</sup> Edn) (2008) Principles of biochemical toxicology. Taylor & Francis Ltd, London,.
3. Smart, R. C., & Hodgson, E. (4<sup>th</sup> Eds.). (2013). Molecular and biochemical toxicology. John Wiley & Sons.
4. Relevant review articles / research papers / handouts of latest development in the subject.