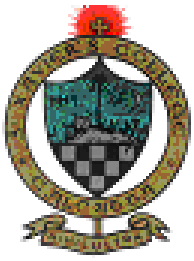

ST. XAVIER'S COLLEGE (AUTONOMOUS)
(UNDER CALCUTTA UNIVERSITY)

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SYLLABUS FOR THREE-YEAR HONOURS COURSE IN MICROBIOLOGY

SYLLABUS FOR THREE-YEAR HONOURS COURSE IN MICROBIOLOGY

Semester I (Modules: 1, 2)

Module -1
(MB31012T)

THEORY

I. Notable Contributions in the Development of Microbiology [AKM]

(a) Spontaneous Generation
(b) Biogenesis
(c) Germ Theory of Disease
(d) Koch's Postulates
(e) Scope of Microbiology and Future Prospects

II. Position of Microbes in the Living World [DD+AKM]

(a) Groups of bacteria as per Bergey's Manual, Volume 2.
(b) Modern approach to the bacterial systematic Tm, G:C ratio, DNA-DNA hybridization, r RNA homology, fingerprinting, numerical taxonomy.
(c) Whittaker's Five Kingdom Concept of living organism (General Characteristics of those five groups)
(d) General Characteristics of Eubacteria and Archaebacteria (major difference with Eubacteria)

III. Microscopy [SSC]

(a) General Principles of optics in relation of microscopy;
(b) Different components of light wave (UV, IR, Visible);
(c) Principles and Applications of Compound Microscope; Light Microscope; Dark Field Microscope; Bright Field Microscope; Phase Contrast Microscope; Fluorescent Microscope; Electron Microscope;
(d) Resolving power, Numerical Aperture, Chromatic Aberration.

Reference

1. Microbiology by Stanier, Ingraham, Painter and Wheelis
2. Microbiology by Prescott,Harley and Klein.

PRACTICAL **(MB31012P) [MM+AB]**

- **Operation** of Light Microscope, Use of Oil immersion Objective
- **Micrometry** – Standardization of microscope
  (a) Microscope measurement of bacterial cell (*B. subtilis*),
  (b) Yeast (*Saccharomyces cerevisiae*),
  (c) Fungal spores (*P. notatum, A. niger*)

Enumeration of Microbes –Yeast by Haemocytometer

Reference:

1. Microbiology by A lab Manual Cappuccino and Sherman.
2. Practical Microbiology by R.C.Dubey.

Module – 2
(MB31022T)

THEORY

I. Stains and Staining Techniques [DD]

(a) Definition of auxochrome; Chromophores; acidic and basic Dyes; Natural dye, mordant and its function.
(b) Classification of stains; Simple and Differential Staining.
(c) Theories of Staining.
(d) Mechanism and Principles of Gram Staining; Acid fast Staining; Endospore Staining; Negative Staining; Capsule Staining; Flagella Staining; Eukaryotic Staining (Single and Double Staining).

II. Microbial Nutrition [KS]

(a) **Nutritional types (definitions and environment)** – Photoautotrophs, Photoorganotrophs, Chemolithotrophs (ammonia, nitrite, sulfur, hydrogen, iron oxidizing bacteria), Chemoorganotrophs.
(b) **Effect of oxygen on growth** – classification on the basis of oxygen requirement and tolerance.
(c) **Bacteriological media** – Types of media: Simple media. Complex media, Selective and differential medium and enrichment media.
(d) Physical factors influencing growth-Temperature, pH, osmotic pressure, Salt concentration

III. **Bacterial Growth [MM]**

(a) Exponential growth and generation time
(b) Kinetics of Growth
(c) The measurement of growth-Measurement of cell mass, Measurement of cell number, Measurement of a cell constituent.
(d) Bacterial growth in batch culture
(e) Bacterial growth in continuous culture
(f) Synchronous culture (definition and brief description)

Reference

1. Microbiology by Stanier, Ingraham , Painter and Wheelis
2. Microbiology by Prescott,Harley and Klein.

PRACTICAL **(MB31022P)**

- **Staining of Microorganisms** -
  (i) Bacteria – preparation of heat-fixed smear and
    (a) Simple staining (*Bacillus subtilis, Staphylococcus aureus*)
    (b) Gram-staining-Gram-positive(*B. subtilis, S aureus, Sarcina lutea*); Gram–negative (*E.coli*)
    (c) Capsule staining (*E. aerogenes*)
    (d) Endospore staining (*B subtilis*)
  (ii) **Fungi** – Lactopheno – Cotton blue staining of Yeast (*Saccharomyces cerivisiae)*: Moulds (*Penicillium motatum, Aspergillus niger)*
- Measurement of bacterial Growth by Turbidometric Measurement.

Reference:

1. Microbiology by A lab Manual Cappuccino and Sherman.
2. Practical Microbiology by R.C.Dubey.

Semester II (Modules: 3 and 4)
Module 3
(MB32032T)

THEORY

I. Stereochemistry [JG]

Representation of molecules in Fischer, flying-wedge, Sawhorse and Newman formulae and their intertranslations, Chirality, elements of symmetry, Plane of symmetry, center of symmetry and axis of symmetry, optical isomerism, enantiomerism and diastereomerism, D/L, R/S, E/Z, syn/anti, cis/trans, meso/dl, threo/erythro, nomenclature, conformational nomenclature-eclipsed/staggered, gauche/anti, dihedral angle, energy barrier of rotation, relative stability of conformers on the basis of steric effect, diople-diopole interactions, H-bonding, conformational analysis of ethane, n-butane, stereochemistry of cyclohexane-chair and boat conformations, conformational analysis of cyclohexane.

II. Physico-Chemical Properties of water [MC]

Arrhenius's concepts, theory of solvent system, Bronsted and Lowry's concepts, HSAB principle, ionization of water, ionic product of water pH, buffer solutions in biological systems, polyprotic acids, acid base neutralization curves, solubility product principle, common ion effect and its applications in separation and identifications of common cations, solvent properties of water, ampholytes, electrostatic and hydrophobic interaction, Vander Waal's interactions, hydrogen bonding.

III. Molecular Spectroscopy – I [RM]

UV-visible absorption spectroscopy: Beer Lambert's law, concept of chromophore, auxochrome, deviations of Beer's law, Applications of UV-visible spectroscopy; Fluorescence spectroscopy, Nuclear Magnetic Resonance spectroscopy: chemical shifts, coupling constants, ring currents, Paramagnetic shifts, spin-spin and spin-lattice relaxation times.

Reference:

1. Basic Stereochemistry of Organic molecules by Subrata Sengupta.
2. Stereochemistry of Carbon Compounds by D. Nasipuri
3. Physical Biochemistry by Freifielder.
4. Biochemistry by Voet and Voet.

PRACTICAL **(MB32032P) [RM+JG]**

Preparation of buffers.
Chemical analysis of biomolecules
Biochemical test (qualitative)

a) Solubility test and detection test for carbohydrates and proteins

Reference:

1. Biochemistry by Palmer

Module – 4
(MB32042T)

THEORY

I. Bacterial Morphology [AKM]

(a) Bacterial cell wall (Gram Positive and Gram Negative), Cell Membrane, Outer Envelopes (Slime layer, Capsule)
(b) Sub cellular structures-Ribosomes, Cytoplasmic Inclusion Bodies (Inorganic and Organic) Exospores, Cysts, (Types and Structure), Endospore (Structure, Formation and Maturation)
(c) Outer Membrane Projections-Flagella, Fimbrae, Pilus (Structure, composition and Functions) AKM
(d) Nuclear Material – Bacterial chromosomes Structure (its differences with the Eukaryotic Chromosome)
(e) Extra Chromosomosal materials-Plasmids and Episomes (F, R, Ti, colicin as examples).

II. Control of Microorganisms in the environment: [AB+MMG]

(a) Definition of Terms related to microbial control with Examples – Sterilization, Disinfection, antisepsis, sanitizer, germicide, bactericide, viricide
(b) Physical method of Sterilization – (mode of action and applications) – Heat (dry heat and moist heat) Low Temperature, Ultrasonication, Radiation, Filtration (HEPA filters, Membrane filters and Collodion filters)
(c) Chemical Method of Sterilization – Alcohol, Acid, Alkali, Halogen Heavy Metal, Phenol and phenol derivatives, formaldehydes, Ethylene oxide, detergents.
(d) Assessment of Chemical Disinfectant – Phenol coefficient Method and Tissue Toxicity Method.

III. Antimicrobial Chemotherapy:

a) The development of Chemotherapy
b) General characteristics OF Antimicrobial drugs
c) Determining the level of antimicrobial activity
d) Antibacterial drugs
e) Antifungal drugs
f) Antiviral drugs
g) Antiprotozoal drugs
h) Factors Influencing Antimicrobial drug effectiveness
i) Drug resistance

Reference:

1. Microbiology by Stanier, Ingraham , Painter and Wheelis
2. Microbiology by Prescott,Harley and Klein.
3. Microbiology by A lab Manual Cappuccino and Sherman.
4. Microbiology by Prescott,Harley and Klein.

PRACTICAL **(MB32042P)** **[MM+AB]**

- **Preparation of Culture Media:**
  (a) Bacterial growth media (Nutrient Broth, NA Slants, Lactose broth),
  (b) Fungal growth media (PDA, Czapekdox agar, YPD)

- **Cultivation of microorganisms:**
  (i) **Bacterial cultivation**
  (a) Streak-plate method (*Bacillus subtilis, Staphylococcus aureus*)
  (b) Pour-plate method (*E.coli*)
  (c) Maintenance of microorganisms (slant culture and stab culture)
  (ii) **Fungal cultivation**
  (a) Yeast (*Saccharomyces cervisiae*)
  Moulds (*Penicillium notatum, Aspergillus niger*)

- **Control of microbes**
  (a) Assay of Antibiotic sensitivity by paper disc method
  (b) Determination of Minimum Inhibitory Concentration (MIC) by serial dilution method
  (c) Determination of Phenol Coefficient.

Reference:

1. Practical Microbiology by R.C.Dubey.

Semester III (Modules: 5 and 6)
Module 5
(MB33052T)

THEORY

I. Carbohydrates [JG]

Classification and properties of carbohydrates, structure of the monosaccharides, cyclic structures of the monosaccharides, anomers, epimers, Haworth projection formula, Mutarotation of carbohydrates, Base catalyzed isomerization of aldoses and ketoses, Glycosides, ether and ester derivatives of carbohydrates, oxidation and reduction reactions of carbohydrates, Killiani-Fischer synthesis, anormeric effect Proof of glucose stereochemistry, Disaccharides and Polysaccharides, cellulose, starch, chitin.

II. Nucleic acids [AB]

(a) DNA & RNA as genetic material.
(b) Purine, Pyrimidine-definition and structure, Nucleosides and nucleotides, structures of DNA and RNA, Double helical Structure.
(c) Different types of DNA- A-DNA, B-DNA, Z-DNA.
(d) Biophysical properties of DNA – hydrolysis, Tm value, hybrid formation, viscosity, Hyperchromic effect, COT curve,
(e) DNA modification and Chemical Carcinogenesis.
(f) General structures of RNA (t-RNA, mRNA, rRNA)

III. Chromosome Structure and Function [AB+JG]

(i) Genome organization in prokaryotes (nucleoid)
(ii) Genome organization in eukaryotes (Chromosome structure-morphology, constrictions, euchromatin, heterochromatin, telomere); Ultrastructure of chromosomes (Nucleosome)
(iii) Experimental evidence for DNA as genetic material (Griffith, Avery Mcleod, Hershey Chase). Experimental evidence for RNA as genetic material (TMV)
(iv) Chromosome banding pattern (G, C, R, Q banding) and significance, Special types of chromosome (Polytene and lampbrush chromosome), Karyotype (Common syndrome due to abnormality in chromosome), Idiogram.
(v) Multigene family
(vi) Exteachromosomal inheritance – Mitochondrial genome, Chloroplast genome
(vii) DNA & RNA staining

IV. Amino acids [JG]

(a) Definition, classification, structure and stereochemistry of amino acids
(b) Physicochemical properties (Ionization and Biuret reaction) of amino acids
(c) Amphoteric molecule, Zwitter ion, pk values
(d) Isoelectric point, electrophoresis
(e) Formol titration of glycine (only reaction and principle)
(f) Reaction with Ninhydrin, FDNB, Dansyl and Dabsyl chlodide, Fluorescamine
(g) Van-slykes reaction
(h) Reaction of carboxyl and ammo groups
(i) Synthesis of glycine
(j) Separation of amino acids by Ion exchange, Gel filtration, Paper chromatography and Thin layer chromatography.
(k) Peptides: peptide bond, biologically important peptides (glutathione, oxytocin-important functions)

V. Proteins [SSC]

Classification (Primary, Secondary, Tertiary, Quaternary-definitions, examples) **Forces that stabilizes structure of proteins:** H-bonds, hydrophobic bond, electrostatic attraction, Vander Waals interaction, dipole-dipole interaction.)

Types of proteins:

(i) Fibrous (α-helix, β-sheet, Collagen) – definition and structure.
(ii) Globular (Haemoglobin, Myoglobin) – definition and structure.
(iii) Simple proteins and conjugated protein – definition and examples.

PRACTICAL **(MB33052P) [KS+SSC]**

- **Chemical analysis of biomolecules**
  Quantitative tests

(a) For amino acids (Ninhydrin test); Separation of amino acids-(Lysine, glycine, tryptophan, proline) by Thin Layer Chromatography.
(b) For lipid (Saponification test triglyceride); Separation of lipids by TLC
(c) Quantitative test for Carbohydrates, Glucose (glucose oxidase method); Protein (Lowry method, Biuret method)
(d) Quantitative test for DNA and RNA:DNA(DPA method) & RNA (orcinol reagent)

Module – 6
(MB33062T)

THEORY

I. Enzymes [SSC]

General properties, Nomenclature and classification, enzyme units, enzyme purification, Co-factors – definition and function with special reference to the representative substances –

(a) Co-enzymes (NAD^+, $NADP^+$, Co-enzyme-A, TPP, Pridoxal phosphate);
(b) Prosthetic groups (FAD^+ - Succinic dehydrogenase);
(c) Metal ions: Zn^{2+}, $Mg2^+$, $Fe^{2+/3+}$, Mn^{2+} - required for enzyme action.

Enzyme kinetics - Themodynamics of enzyme kinetics, Michalelis – Menten equation including derivation, Graphical representation – Lineweaver – Burk Plot, Eadie-Hoffstee plot, Single and Bi substrate reaction (only definition).

Effect of temperature and pH on enzyme activity.

Enzyme inhibition – a) Reversible inhibition – Competitive, Non-Competitive and Uncompetitive Inhibition and their examples and biomedical implications b) Irreversible inhibition – enzyme modification. Regulation of enzyme: Covalent and acid base catalysis.

Regulatory enzymes – Allosteric enzyme and covalent modulation **Feedback inhibition** – Cite Threonine to Isoleucine as example. **Ribozyme –** (catalytic RNA), Abzyme and Isozyme – definitions only.

II. Principles and applications of thermodynamics and Kinetics [JG]

Introduction and scope of thermodynamics, definitions of systems and surroundings, types of systems (closed, isolated and open), extensive properties and intensive properties, concept of temperature, heat and work, sign conventions, first law of thermodynamics, state and path functions, internal energy, isothermal and adiabatic processes, enthalpy, statements of Second Law of thermodynamics, concept of entropy, free energy, transport across membrane (passive diffusion, facilitated diffusion and active transport), chemical potential, gradient of chemical potential as driving force, diffusion, osmosis, osmotic pressure, Donnan equilibrium, diffusion potential, membrane potential. Thermodynamic requirements of reactions – (ΔH, ΔS, ΔG dependence of reactance and products and biomolecular structure) R**eaction Kinetics** – Rate equation, Transition state theory, rate constant, kinetically controlled and thermodynamically controlled reactions, catalyzed reactions, isotope labeling (kinetic and non kinetic). Concepts of rate constant, order and molecularity of a reaction, rate determining step, zero and fractional orders, steady state approximations, temperature dependence on rate constant, Arrhenius equation, activation energy, Enzyme kinetics, Michelis-Menten equation.

III DNA Replication [MM]

History of semi-conservative replication [Meselson and Stahl experiment], structure of DNA positive and negative supercoiling, Twist, Writhe, and Linking number of DNA. Components required for prokaryotic DNA replication, Function of the enzymes like Helicase, Primase, Topoisomerases, DNA polymerase I, II and III, RNase, Ligase. Mechanism of prokaryote replication. Initiation of replication. Bidirectional replication-lagging and leading strands. DNA polymerization and proof reading. Termination of replication.

PRACTICAL **(MB33062P) [SSC+JG+KS]**

(a) **Assay of Enzymes** – Amylase, Protease, Phosphates.
(b) Determination of Km and Vmax of enzymes
(c) Determination of pH optima of enzymes.

Semester 4 (Modules – 7-10)
Module 7
(MB34072T)

THEORY

I. Air Microbiology [MM]

(a) Aerosols, Bioaerosol
(b) Concept of allergy
(c) Different types of microorganisms in air – indoor and outdoor aero microbiology
(d) Microbiological analysis of air – Different air sampling techniques (Impaction, Impingement, Sedimentation, Filtration, Centrifugation, Electrostatic precipitation and Thermal precipitation. Room sterilization-principles and practice (Effect of UV rays, etc.)

II. Food Microbiology [DD]

(a) Microbial Flora of fresh food (Meats, Poultry, Eggs, Fruits and Vegetables, Shellfish and Finfish) and Milk.
(b) Food as substrate for growth of microorganism, concept of water activity.
(c) Microbial Spoilage of food – Fresh food, Fresh milk, Canned food and Stored Grains.
(d) Microbiology of Butter, Cheese, Ice Cream
(e) Microbial Examination of Foods – Quantitative Examination of milk (Agar plate method, Direct microscopic Method, Methylene Blue Reduction test and Resazurin method. Phospate test of pasturised milk.
(f) Preservation of Food – Heat treatment, Pasturization, Appertization, Aseptic Packaging. Low temperature Processing (Chilling and Freezing), Dehydration, Chemical Preservatives (Organic acids, esters and sulphur dioxide), High osmotic Pressure, Antibiotics and Radiation.
(g) Fermented food – Fermented Dairy product (Cheese, Yogurt, kefir, kumiss etc.) and other fermented food (sauerkraut, pickles, green olives and sausages, tea etc.)
(h) Food borne disease – Salmonellosis, Botulism and *E.coli* poisoning, aflatoxin and other toxins.

III. Soil and Agriculture Microbiology [AKM]

(a) Physical and chemical characteristics of various soil types, rhizosphere, Phyllosphere, brief account of microbial interaction (symbiosis, neutralism, commensalisms, competition, ammensalism, synergism, parasitism and predation Microbiology of humus and composit; Biological Nitrogen fixation (Symbiotic and non Symbiotic) Root nodule formation in legumes, Ammonification, Biofertilizers, Biological Pest Control.

(b) Plant pathology

i. Characteristics of pathogenic fungi
ii. Plant pathogenic toxin and their classification
iii. Disease expression in a plant, gene for gene concept
iv. Control of plant disease – physical, chemical, cultural and biological control, IPM
v. **Fungal diseases**
   (a) Oomycetes – Phytopthora (late blight of potato)
   (b) Zygomycetes – Rhizopus (Soft rot of fruits)
   (c) Ascomycetes - Cochliobolus (Leaf spot of rice)
   (d) Basidiomycetes – Puccinia (Black stem rust of wheat)
   Ustilago – (Smut of wheat)
   (e) Deuteromycetes – Pyricularia (Blast of rice)

Fusarium (Wilt of tomato)

vi. **Bacterial Diseases** – Crown gall, Citrus cancer (Symptoms and control)

vii. Plant virus transmission – TMV-RNA, DNA-CMV PSTV, Mollicute – coconut yellow.

viii. Plant nematode – Meloidogyne (Root knot nematode)

(c) Biogeochemical Cycles – Nitrogen, Carbon, Sulphur, Phosphorus cycle. Role of microorganisms in the process.

(d) Heavy metal and metallic toxicity on soil borne organisms and its impact on ecosystem.

IV. Water Microbiology [SSC]

(a) Organisms found in water – Fresh and waste water.

(b) Waterborne diseases and remedy.

(c) **Indicator organism – definition, characterization**. Coliform test-Detection of faecal and non faecal coliform. IMViC Test determination of MPN, Microbiological treatment of sewage and industrial waste water,

(d) **Qualitative and quantitative analysis of water (Identification and enumeration techniques of waterborne microorganism).**

(e) BOD, COD, TOC – determination and implication.

(f) Micobial treatment of wastewater – Single treatment process (Septic tank), Municipal treatment process (primary treatment, secondary treatment, final treatment, advance treatment including trickling filter and oxidation ponds).

PRACTICAL **(MB34072P) [DD+RM]**

(a) **Qualitative and Quantitative Examination** of water, soil, Food, milk, air.

(b) **Water:** Qualitative – Presumptive, Confirmatory and Completed.
Quantitative – Standard plate count.

(c) **Soil:** Qualitative – Rhizosphere & Non-rhizosphere microflora (Isolation of Bacteria, fungi & actinomycetes).
Quantitative – colony counts for the above.
Studies on symbiotic associations of microorganisms. (Rhizobium spp.)

(d) **Food:** Isolation of molds from citrus fruits, Isolation of bacteria from spoiled food.
Preservation of juice using chemicals (sodium benzoate) – {any two}

(e) **Milk: MBRT, DMC,** Lactic acid & Fat conc. in milk.

(f) Microbial Motility test by hanging drop method

Module - 8

THEORY **(MB34082T)**

I. Lipid Metabolism [JG]

Importance of fat, adipose tissue. Fatty acid-types, rancidity of fats. Detailed account of β-oxidation of even-and odd-carbon number saturated and mono and poly unsaturated fatty acids. α and ω oxidation of fatty acids, energy production. Catabolism of Triglycerides and Phospholipids. Lipid peroxidation, Ketone bodies.

II. Amino acid and Protein Metabolism [LR]

(a) Catabolism – Transsmination, deamination, transdeamination.
(b) Transmethylation and decarboxylation.
(c) Urea cycle
(d) Metabolism of glycine, phenylalanine and lysine
(e) Biosynthesis of proteins-Ribosomal

III. Carbohydrate Metabolism [KS]

Aerobic respiration – Glycolysis (EMP pathway), galactose, fructose and glycogen metabolism. TCA-cycle, Glyoxalate cycle: pentose-phophate pathway: Entner-doudoroff pathway

Electron Transport Chain & ATP generation sites. Cori Cycle.
Anaerobic respiration – Utilizing NO_3^-, SO_4^{2-}, Sulphur (S), CO_2 as electron acceptors. Stickland-reaction.
Fermentation – Definition and general concept. Lactic acid, alcohol, mixed acid, butanediol.
Gluconeogenesis, Glyconeogenesis (only definitions)
Biomedical significance (in brief)

IV. Ecology and its applications [AKM]

Population: Definition, metapopulation concept, types, characteristics, survivorship curve, life table, biotic potential, population growth (exponential and logistic), density dependent and density independent population regulation, carrying capacity, evolutionary strategies (r and K selected species)
Concept of stress and strain: different kinds of relationship between organisms
Niche: Definition, concept of habitat and niche, types of niche, niche relationship, evolution of niche.
Limiting factor: Liebigs law of minimum, Shelford's law of tolerance, combined concept of limiting factor.
Ecosystem models, Ecosystem and its functional attributes
Community: Definition, types, characteristics, formation of community, succession and its types, climax concept, ecotone.

PRACTICAL **[DD+RM]**

(MB34082P)

Microbial Characterization based on biochemical tests; Catalase, Oxidase, Nitrate reductase, IMVIC, Urease, Sulfate reduction (TSI), Coagulase test, Decarboxylation, Deamination, Carbohydrate fermentation, Gelatin liquefication.

Module –9
(MB34092T)

THEORY

I. Bioenergetics [KS]

(a) Principles of bioenergetics (Gibbs free energy, Enthalpy, Entropy, Equlibrium constant)
(b) ATP & ADP cycle (oxidation-reduction potential and electromotive force)

II. Photophosphorylation [AB]

General features, light absorption, photochemical event, ATP synthesis.

III. Molecular Spectroscopy – II [RM]

Electron Spin Resonance Spectroscopy, Intensity of ESR signals, Hyperfine interactions, Interaction with n Nuclei, Zero-Field splitting and Kramer's degeneracy, ESR spectrometer, Applications of ESR; Mass Spectrometry, Mass spectrometer, GAS chromatography-Mass spectrometry, Determination of molecular weight, Determination of molecular formulas, fragmentation patterns, McLafferty rearrangement.

IV. Basic Biostatistics [SB]

(a) Concept of Bio-Statistics and its uses.
(b) Exploring data through tables and graphs,
(c) Idea of population and sample.
(d) Study of sample characteristics
- Arithmetic Mean, Median and Mode as measures of location.
- Standard deviation as measure of spread

Statement of the important properties of these measures (no derivation required).
Illustrative examples from the field of Micro-Biology.

(e) Bivariate data Analysis-Correlation coefficient, Regression, Simple measures of association.
Statement of important properties of correlation coefficient (no derivation required).
Illustrative examples from the field of micro-Biology.

PRACTICAL **(MB34092P) [RM+LR]**

Chmromatography: TLC (carbohydrates),
Column chromatography (size exclusion, ion-exchange)
Use of SDS-PAGE

Module – 10
(MB34102T)

THEORY

I. Sequence analysis

Central Dogma of molecular biology, DNA sequencing and data generation, experimental approaches-gene sequence, protein sequence and structural data generation
The term Bioinformatics-range of bioinformatics, nucleic acid, protein, carbohydrate, reaction networks, metabolomics
Genomics- study of the features of prokaryotic and eukaryotic gene for *in silico* studies.
Preliminary aspects of sequence alignment (local and global), pairwise sequence alignment-sequence homology (orthologous, paralogous), similarity, identity, database search, scoring matrices, multiple sequence alignment
Phylogentic analysis

Data generation and Dendrogram analysis

II. Structure analysis

Protein structure prediction-Three dimensional conformation of protein (peptide bonds, dihedral angles, Ramachandran plot, Primary, secondary, super-secondary, tertiary structure, concept of folds and domains)
Protein structure database-PDB searching
Protein structure visualization
Homology modeling—tertiary structure prediction
Protein structure classification -analysis from SCOP, CATH

PRACTICAL **(MB34102P)**
Searching the NCBI genome file—gene length, different annotations, searching for rRNA, tRNA genes—study of prokaryotic genome
Find out similarities between 16SrRNA sequences
Prediction, characterization of secondary structure of macromolecules
Sequence alignment by FASTA and BLAST analysis
Protein structure classification and prediction by SCOP analysis-transmembrane helix, β barrel, coiled coil
Sequence homology and homology modeling, Dendogram analysis

Semester V (Module – 11-14)
Module 11
(MB35112T)

THEORY

I. Molecular Spectroscopy III [RM]

Infrared Spectro scopy, Use of Infrared spectrum, IR spectrometer, Analysis and interpretation of IR data, Infrared spectrometer (FT-IR), Composite problems on Spectroscopy (including Mass, IR, UV and NMR).

II. Analytical techniques in biochemistry and biophysics [RM]

Buffers, criteria for selection of buffers, ultracentrifugation, dialysis, ultrafiltration, Chromatography-Paper, Thin layer and ion-exchange chromatography, deionization of water, HPLC, affinity chromatography, Radiotracer techniques, interaction of radioactivity with matter, Radioimmunoassay (RIA), Mass spectrometry (electron spay and MALDI techniques), Atomic absorption spectroscopy, Atomic emission spectroscopy (application in water analysis, arsenic determination), electrophoresis, types of electrophoresis.

III. Advanced biostatistics [SB]

1. Elements of probability theory.
   - Random Experiment.
   - Classical and statistical definition of probability.
   - Statement of theorems concerning union and intersection of two events.
   - Statement of Boole's inequality.
   - Conditional probability – Statement of the theory of compound probability, theorem of total probability and Bayes' theorem for two events
   - Illustrative examples from the field of Micro-Biology.

2. Concept of random variable and its probability distribution.

3. Concept of tests of significance
   - Z – test
   - T – test
   - Chi-square test for goodness of fit and independence.
   - Illustrative examples from the field of Micro-Biology.

***PRACTICAL* (MB35112P) [SB]**

Z-test, t-test, Chi-square test for goodness of fit and independence.

Module – 12
(MB35122T)

THEORY

I. Virology-I [KS+MMG]

(a) **General Characteristics and Structural Components of virus** (viral proteins, nucleic acids, lipids and carbohydrates)
(b) **Experimental evidence** for DNA as genetic material (Griffith, Avery McLeod, Hershey Chase), Experimental evidence for RNA as genetic material (TMV).
(c) **Differences between Virus and Bacteria** (Physiological and Morphological)
(d) **Classification of animal viruses based on:**
  i. Capsid Symmetry [(Icosahedral (Polyoma), helical (TMV), Complex (Bacteriophage)], Presence of envelope (Herpes virus), Type of nucleic acid present – DNA, (dsDNA, ssDNA), RNA (dsRNA, ssRNA) [ICTV classification]
  ii. Baltimore classification.
  iii. Examples of animal virus (retroviridae, poxviridae, herpesviridae, adenoviridae, orthomyxoviridae, paramyxoviridae).
(e) **Example of plant virus and bacteriophage.**
(f) Assay of animal virus, plant virus and bacteriophage (T-even, T-odd).
(g) **Oncogenic Virus** – SV40, HTLV 1&2, Epstein Barr virus.
(h) **Prions, viroids, virusois.**

II Virology – II [KS]

Lytic cycle of T odd and even bacteriophages and Lysogenic cycle of lambda phage – Choice between Lysis and lysogeny of the Lambda phage induction and SOS response of *E.coli* host, phage typing and lysogenic conversion.
Animal virus – AIDS, Adenovius, Influenza virus etc.

III. Eukaryotic Microbes [AKM]

General Characteristics, Vegetative Structure and Reproductive Structure of the following group of organisms:

(a) Algae – Cyanophyta, Cholorophyta, Bacillariophyta, Phaeophyta, Rhodophyta.
(b) Fungi – Phycomycetes, Ascomycetes, Basidiomycetes, Deuteromycetes.
(c) Protozoa-Giardia, Plasmodium and Entamoeba

PRACTICAL **(MB35122P) [MMG+LR]**

Plaque Assay of Coliphage
Bacterial conjugation, transformation.
Isolation of plant virus and phage

Module – 13
(MB35132T)

THEORY

I. Eukaryotic Cell Biology [SSC+AKM]

(a) Structure of single membrance, double membrance and non membranous organelles. (Location, Structure and Functions).
(b) Ultrastructure of plasma membrane, Transport across cell membrane (Active, Passive and facilitated).
(c) Cell Division (mitosis and meiosis).
(d) Cell Cycle and DNA replication.
(e) Non-living inclusions of the cell.

II. Microbial diseases [AKM]

A) Name of pathogens, disease symptoms and preventative measures.
B) Bacterial – Tuberculosis, Leprosy, Tetanus, Cholera, Gonorrhea, Anthrax.
C) Viral-polio, AIDS.
D) Fungal-Candidiasis.
E) Protozoan-Giardiasis, Malaria, Amoebiasis.
F) Silk worms disease – Fungal (Muscardine), Viral (Grassaric), Protozoal (Pebrine).

PRACTICAL **(MB35132P)**

Study of karyotype and ideograms from root tip.
Effect of physical mutagen like UV, chemical mutagen like benzene hexachloride and others.
Study of meiotic chromosome and understanding the stages from floral bud
Identification of individual stages through permanent slide.
Staining of chromosome with Giemsa/Acridine orange

Module – 14
(MB35142T)

THEORY

I. Transcription [MMG]

a) Initiation, Elongation and termination Mechanisms
b) Levels of regulation
c) Regulation of Transcription Initiation
d) Regulation of Transcription Elongation
e) Regulation of Transcription termination

II . Transcriptional Regulation in Prokaryotes: [MMG]

a) Principles of Transcriptional Regulation: Lactose operon, Tryptophan Operon, Arabinose operon,
b) Regulation by RNA's in bacteria

III. Translation

(a) Messenger RNA
(b) Transfer RNA
(c) The Ribosome
(d) Initiation of Translation
(e) Translation elongation
(f) Termination of translation
(g) Regulation of translation

III. Genetic Code:

a) The code is degenerate
b) Three rules govern the genetic code
c) Suppressor mutations can reside in the same or a different gene.
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PRACTICAL **(MB35142P)**

- Isolation of Genomic DNA from bacteria.
- Isolation of Genomic DNA from plants and blood (Demonstration only).
- Isolation of Plasmid DNA from *E.coli*

Semester VI (Module – 15-18)
Module 15

(MB36152T)

THEORY

I. Immunology [KS]

(a) **Types of immunization –** Active immunization and Passive immunization (Characteristics and functions); Cell mediated immunity - mechanism of immune response; cytokines and lymphokines Humoral immunity-mechanism of immune response
(b) **Immunoglobulin –** Types (IgG, IgM, IgA, IgD, IgE); Structure and function
(c) **Antigen Structure** – (Definition, types); Interferon (Definition, function); Hapten (Definition, function); Adjuvant (Definition, function).
(d) **Antigen Antibody Interaction-**Aggutination, precipitation, Neutralization etc.
(e) **Immune elements** – T-cells (positive and negative selection in thymus), B-cells (selection in bone marrow), Macrophages, NK cells (characteristics and functions), mechanism of phagocytosis
(f) **Clonal selection theory**.
(g) **Complement pathway –three** pathways, MAC formation
(h) **Hypersensitivity** – Definition and types (four types and their mechanism)
(i) **Autoimmunity** – Definition and mechanism of tissue damage caused by it and the autoimmune diseases.
(j) **Production of Monoclonal antibodies** – definition, general techniques of preparation and applications.
(k) **Vaccine and Vaccination** – Definition, types, general roles in immune systems; toxid (Definition, characteristic and function with reference to tetanus toxiod), Vaccination (definition, general procedure and application).

II. **Normal microbial flora of human body** – **[DD]**
Respiratory tract, GI tract, Urinogenital, Skin.

PRACTICAL **(MB36152P)**

(a) Immunoelectrophoresis.
(b) Oucterlony double diffusion technique (titre determination and pattern recognition).
(c) Demonstration of ELISA technique.
(d) Blood grouping and Rh typing.
(e) Handling of pathogenic samples and detection of the pathogen.
(f) Normal Microbial Flora of the throat and skin.
(g) Identification of human Staphylococcal pathogens.

Module – 16
(MB36162T)

THEORY

I. Genetics [AKM]

Post-Mendelian genetics
Variations from Mono + Dihybrid cross
Epistasis – supplementary and complementary genes
Population genetics
Cytoplasmic inheritance
Sex-limited, sex-influenced and sex-linked inheritance

II. Mechanism of Bacterial Pathogenicity [MM+JG]

(a) Entry colonization growth, mechanism of damage of host cell.
(b) Production of endo toxin and exotoxin-definition and general characters.
(c) Mechanism of action of :-
  i. Neurotoxin-Botulium toxin, Tetanus toxin
  ii. Enterotoxin-Cholera toxin, Salmonalla toxin, Klebsiella toxin.
  iii. Cytotoxin.
  iv. Endotoxin – Shigella toxin and Diptheria toxin.

f) Molecular Pathogenesis:
i) Pathogenicity Islands
ii) Transposons
iii) Integrative and Conjugative elements
iv) Integrons
v) Small noncoding RNAs

III. Microbial Genetics – Bacterial Recombination [MMG+SSC]

Transformation, conjugation, transduction, gene mapping, homologous and site-specific recombination.

Fine structure of gene, extra chromosomal inheritance of plasmids and episomes.

Molecular basis of mutation - mutagenic agents (physical chemical and biological). Spontaneous mutation (Luria Delbruck fluctuation test). DNA damage and repair

***PRACTICAL* (MB36162P)**

(a) Demonstration of hemolysis on blood agar.
(b) Phosphate solubilization in bacteria, fungi and actinomycetes.
(c) Transformation
(d) Conjugation

Module – 17
(MB36172T)

THEORY

I. Microbial Fermentation [DD]

Introduction – Equipment and instrumentation of Fermentors – General description of different types – Stirred tank, Bubble column, Air lift, Packed Bed Bioreactor
Idea of upstream processing – medium formulation
Fermentation – static, submerged, agitated, solid phase, batch, feedbatch; continous.
Microbial culture selection by screening method with reference to the antibiotic
Use of immobilized cells and enzymes (Ca alginate beads; polyacrylamide, microfilm) defination and general characteristics
Downstreaming processing.

II. Industrial production [DD+MM]
Industrial Production of Ethyl alcohol using most common and low cost raw materials. Alcoholic beverages (fermented beverages e,g, wine & beer; distilled spirits e.g. whiskey) Preservation of industrial cultures.
[Acetic Acid, Penicillin, streptomycin, Vitamin B12, Lysine, ∝ amylase (inoculum building. Fermentation, separation, assay and purification of products-general discussion), Concept of Primary and Secondary metabolites in microorganisms

II. Recombinant DNA Technology [MMG+AB]
Isolation and purification of nucleic acids and protein, RFLP, RAPD, fingerprinting, Southern Blotting, Dot Blotting, Northern Blotting, Western Blotting techniques.
Cloning Vectors (pBR322, pUC18, YAC), Cloning, PCR techniques, Ti plasmid as transformation vectors
Construction of DNA libraries (Basic ideas and outlines of methods)
[Restriction and Modification enzymes – Enzymes used in recombinant DNA techniques; DNA ligase, Polynucletide kinase, DNA polymerase etc.
Over expression of Recombinant Proteins in bacteria – Insulin, Human Growth Hormone, FSH]
[Applications of RDT In agriculture, Industry and Medicine.]

PRACTICAL **(MB36172P)**

(e) Demonstration of microbial enzymes, mycotoxins, organic acids and antibiotics
(f) Submerged (flask) and solid state fermentation
(g) Estimation of microbial biomass with variation in nutrient level.
(h) Assay of amino acids and vitamins.
(i) Study of microbial exopolysaccharides by cell immobilization.
(j) Isolation and uses of Chitin.
(k) Restriction Enzyme digestion and mapping
(l) PCR techniques
(m) RAPD

Module –18
(MB36513P)

I. Project Paper

(Based on Critical Review Work of scientific literature)