RAJA NARENDRALAL KHAN WOMEN'S COLLEGE (AUTONOMOUS)

Syllabus for M.Sc. in Microbiology

[Choice Based Credit System]

(Courses effective from Academic Year: 2021-2022)

SEMESTER I

GOPE PALACE, PASCHIM MEDINIPUR, WEST BENGAL -721102

Content:

SEMESTER	COURSE	COURSE TITLES		FULL MARKS	Marks		CREDIT
					Int.Asst.	End Sem	
I	MCB 101	FUNDAMENTALS OF MICROBES: PROKARYOTIC MICROORGANISMS AND EUKARYOTIC MICROORGANISMS		50	10	40	4
	MCB 102	FUNDAMENTALS OF MICROBES: VIRUS		50	10	40	4
	MCB 103	BIOCHEMISTRY, BIOPHYSICS AND BIOINSTRUMENTATION		50	10	40	4
	MCB 104	MICROBIAL PHYSIOLOGY AND METABOLISM		50	10	40	4
	MCB 105	105A	STAINING AND IDENTIFICATION	25		25	2
		105B	BIOCHEMICAL TEST AND MICROBIAL GROWTH	25		25	2
	MCB 106	106A	ANALYTICAL BIOCHEMISTRY	25		25	2
		106B	GROUP PROJECT	25		25	2
		Total		300			24

Semester – I

MCB 101: FUNDAMENTALS OF MICROBES: PROKARYOTIC MICROORGANISMS AND EUKARYOTIC MICROORGANISMS

MCB 101.1: Prokaryotic Microorganisms [25 marks]

1. Origin of basic biological molecules; Abiotic synthesis of organic monomers and polymers; Concept of Oparin and Haldane; Experiments of Miller (1953); Cell as a basic unit of living systems; precellular evolution of cell; the evolution of cell from prokaryotes to eukaryotes and from single cells to multicellular organisms.
2. Introduction to microbial taxonomy – Morphological taxonomy, biochemical taxonomy, numerical taxonomy and molecular taxonomy – G +C content, DNA – DNA hybridization, Ribotyping, Plasmid profiles, RFLP, RAPD, STRR & LTRR, REP –PCR, DNA fingerprinting method based on 16SrRNA.
3. General discussion on the occurrence, diversity, characteristic features, significance of various groups of bacteria according to Bergey's Manual of Systematic Bacteriology.
4. Archea: Systematics, diversity, characteristics, significance, potential application. Molecular characteristics of Halophiles, Methanogens, Hyperthermophiles, and Thermoplasm.
5. Culturable and Unculturable bacteria specially viable but non-culturable. Conventional metagenomic approaches and modern methods of studying diversity. Candidate phyla radiation (CPR).
6. General account on uncommon bacterial genera: Rickettsia, Chlamydia, Mycoplasma, sheathed bacteria, stalked and budding bacteria, gliding bacteria including Myxobacteria, and Cyanobacteria

MCB 101.2: Eukaryotic Microorganisms [25 marks]

1. Fungi: Classification and criteria. Molecular tools in fungal analysis.
2. Agriculturally important toxigenic fungi: Biodiversity, Chemical and biological characterization of toxic metabolites, toxigenic fungi in sustainable agriculture with special emphasis on bio-pesticides.

3. Secondary metabolites from fungi: Terpenes, Non-ribosomal peptides, hydrophobins, peptaibols, indole, alkaloids, detailed emphasis on polyketides and fungal pigmentation.

4. Genomics and Biodiversity of yeast: Gene duplication leading to adaptation and biodiversity, functional evolution, case of aerobiosis /anaerobiosis, changes in regulatory circuits for adaptation to new environments and physiology.

5. Mycorrhiza - ecto, endo, and VA mycorrhiza; applications. Yeast as model for human disease. Pathogenic fungi, pathogenecity and virulence factors.

6. Mycotechnology: Fungi in biotechnology. Humanised protein therapeutics. Industrially important enzymes from fungi.

7. Algae: classification, algal pigments, thallus structure, nutrition, ecology, sexual and asexual reproduction and their importance. Culture media of algae.

8. Details about green algae, diatom, euglenoids, brown algae, red algae, pyrrophyta, micro-algae. Occurrence and distribution of macroalgae. Economic importance of algae.

9. Biotechnological application of algae: Importance of algae in production of algal pigments, hydrogen production, important bioactive molecules. Role of algae in sustainable environment. Enhanced biofuel production by algal genetic engineering. Algal farming.

10. Protozoa: classification, structure, nutrition and reproduction. Characteristics of Flagellates, Amoeboids, Sporozoans and Cilliates.

MCB 102: FUNDAMENTALS OF MICROBES: VIRUS [25 marks]

MCB 102.1: Basics of Virology [25 marks]

1. Virus evolution and classification, properties of viruses, virus structure. Sub viral particles: viroids, virusoids, prions, satellite viruses.

2. Cultivation of plant and animal viruses. Purification and maintenance of viruses. Assay of viral particle.

3. Viral replication: Replicative strategies employed by DNA viruses and RNA viruses. Rolling circle and rolling hairpin models. Strategies for gene expression: Initiation, termini maturation,

Ribosome entry, poly (A) tailing, RNA editing, Alternative splicing, Ribosomal shunting (Some viral models e.g.T7, T4, lambda phage, phage φX174 etc).

4. Virus-host interaction. Host response to viral infection: Innate and Adaptive responses, Host inflammasomes. Viruses as vectors for recombinant DNA technology – M13, fd, Baculovirus, Adenovirus, Retrovirus; Oncogenic viruses; oncolysis - VSV.

5. Antiviral agents (chemical and biological) and their mode of actions.

MCB 102.2: Applied virology [25 marks]

1. Bacterial Viruses

Bacteriophage structural organization; life cycle; one step growth curve; transcription; bacteriophage typing; application in bacterial genetics; brief details on M13, Mu, T3, T4 ,and lambda P1. Medical use of virulent phages.

2. Plant viruses

Classification and nomenclature; mechanism of virus entry into plant cells; methods of assay of plant viruses. Effect of viruses on plants; appearance of plants; histology, physiology and cytology of plants; common virus diseases of plants; paddy, cotton, tomato, and sugarcane; viruses of cyanobacteria, algae, fungi; life cycle; type species of plant viruses like TMV, Cauliflower Mosaic Virus and Potato virus X; transmission of plant viruses with vectors (insects, nematodes, fungi) and without vectors (contact, seed and pollens); diagnostic techniques in seeds; seed stocks and diseased plants (seed morphology, seedling symptomatology, indicator plants, serological methods, histochemical tests and fluorescent microscopy); prevention of crop loss due to virus infection –virus –free planting material; Vector control. Biology and mode of transmission of plant viruses.

3. Animal Viruses

Classification and nomenclature of animal human viruses; epidemiology, lifecycle, pathogenecity, diagnosis, prevention and treatment of RNA Viruses Picorna, Orthomyxo, Paramyxo, Toga and other arthropod viruses, Rhabdo, Rota, HIV and other Oncogenic viruses (carcinogenesis and tumor viruses). DNA Viruses Pox, Herpes, Adeno, SV40; Hepatitis Viruses.

Viral Vaccines (conventional vaccines, genetic recombinant vaccines used in national immunization programmes with examples). Details on some important viruses namely Swain – flu, SARS-CoV-2, Shingles (Zoster) and prion disease.

MCB 103: BIOCHEMISTRY, BIOPHYSICS AND BIOINSTRUMENTATION

MCB 103.1: Fundamental Biochemistry [25 marks]

1. Composition, structure and function of biomolecules [carbohydrates, lipids, proteins, nucleic acids (helix -A, B, Z), t-RNA, micro-RNA and vitamins.
2. Chemistry of amino acids, four level proteins structure, Ramachandan plot, domain, folds and motifs of protein. Chemical modification of protein. Denaturation and renaturation of protein structure.
3. Principles of catalysis, enzymes and enzyme kinetics, enzyme regulation, mechanism of enzyme catalysis, isozymes.
4. Structure of model membrane, channels and transport mechanisms, electrical properties of membrane, membrane transport system of bacteria.
5. Protein and DNA sequencing methods.

MCB 103.2: Biophysics and Instrumentation [25 marks]

1. Acid, Bases, Buffers and life processes. General properties of water. Arrhenius's concepts, theory of solvent system, Bronsted and Lowry's concepts, relative strengths of acids, Lux- Flood concept, Lewis concept, Usanovich's concept, HSAB principle, ionization of water, ionic product of water. Concept of pH and 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.
2. Law of thermodynamics, entropy and free energy concept and its biological application.
3. Detection and measurement of different types of radioisotopes normally used in biology, incorporation of radioisotopes in biological tissues and cells, molecular imaging of radioactive material, safety guidelines. Use of stable isotopes in Biological sciences; Autoradiography.
4. Principle and uses of UV/visible, fluorescence, circular dichroism, NMR and ESR Spectroscopy. Centrifugation techniques. Molecular structure determination using X-ray

diffraction and NMR, different types of mass spectrometry. MALDI-TOF, Resolving powers of different microscopes, microscopy of living cells, scanning and transmission microscopes. Principle and application of TLC, ion exchange, affinity, reverse phase, gel filtration. High Performance Liquid Chromatography, Gas Chromatography.

MCB104: Microbial Physiology and Metabolism

MCB104.1: Microbial Physiology [25 marks]

1. Growth and cell division: Measurement of growth, growth physiology, cell division, growth yields, growth kinetics, steady state growth and continuous growth. Control of bacterial growth - physical and chemical agents, preservation methods, stress responses.

2. Cultivation of microbes: aerobic, anaerobic and facultative. Pure culture and its characteristics. Nutritional types, culture media. Measurement of growth (direct and indirect) and factors affecting growth.

3. Physiological Adaptations and Intercellular signaling: Introduction to two component system, regulatory systems during aerobic- anaerobic shifts: Arc, Fnr, Nar, Fhl A regulon, response to phosphate supply: The Pho regulon

- Heat-Shock responses

- pH homeostasis, osmotic homeostasis.

4. Quorum sensing: A and C signaling system, sporulation in *Bacillus subtilis,* control of competence in Bacillus subtilis. Bioluminescent bacteria.

MCB104.2: Microbial Metabolism [25 marks]

1. Metabolic diversity among microbes: Metabolic patterns of photoautotrophs, photoheterotrophs, chemoautotrophs and chemoheterotrophs. Anabolism and catabolism.

2. Pathway and regulation of major metabolism - Glycolysis (EMP pathway), Fermentation, TCA cycle, Glyoxalate cycle, Entner-Daudoroff pathway, Pentose phosphate cycle. Fructose bisphosphate- aldolase pathway; Phosphoketolase pathway. Utilization of sugar other than glucose and complex polysaccharides. Biophysical energy transduction, bioenergetics, electron transport chain and oxidative phosphorylation. Comparison of mitochondrial and bacterial ETC, Uncoupler and inhibitors, chemiosmosis.

3. Metabolism of energy reserve compounds (polyglycans, polyhydroxybutyric acid).

4. Inorganic nitrogen metabolism. Glutamine, lysine and histidine biosynthesis.

5. Biochemistry of N2 fixation. Regulation of nitrogenase activity, concept of nif gene.

6. Photosynthesis in microbes and its mechanism. Photosynthetic bacteria: Classification, pigments, application.

7. Biosynthesis and metabolism of fatty acids, biosynthesis of phospholipids.

8. Purine and pyrimidine biosynthesis (de novo).

9. Oxidative stress, Starvation stress and stringent response.

MCB 105:

MCB 105A: Staining and Identification [25 marks]

1. Preparation of media and cultivation of bacteria, algae, fungi.

2. Qualitative and quantitative enumeration of microorganisms [bacteria and fungi] from soil, water and air.

3. Study of algae: *Diatom, Volvox, Oedogonium, Spirulina, Nostoc, Anabaena*.

4. Study of fungi: *Aspergillus, Candida, Fusarium, Puccinia, Alternaria.*

mcb 105b: Biochemical test and Microbial growth [25 marks]

1. Characterization of bacteria: (i) morphological: shape, Gram stain, endospore stain, capsule stain, acid-fast stain, (ii) cultural: growth in different carbon source (media); (iii) biochemical test: catalase, peroxidase, IMViC, nitrate reduction, fermentation of sugar.

2. Enrichment culture technique for specific bacterial types: endospore forming, Nitrogen fixing (free living and symbiotic), nitrifying, starch degrading, cellulose degrading, casein degrading, phosphate solubilizing. Sulpher-degrading bacteria, metal resistant, plastic degrading and pesticide degrading bacteria.

3. Study of bacterial growth kinetics, effect of inhibitors and stimulators on growth.

MCB 106:

MCB 106A: Analytical Biochemistry [25 marks]

1. Demonstration of analytical instruments (Spectrophotometers, Lyophilizer, HPLC)

2. Estimation of total protein, carbohydrate, DNA and RNA of a bacterial cell.

3. Chromatography: Paper, TLC for sugar / lipid / amino acid.

4. Determination of activity of amylase/ protease. Effect of pH, temperature on enzyme activity.

5. Purification of protein (demonstration only).

6. Determination of MW of protein by PAGE.

7. Study of enzyme by native gel electrophoresis (zymogram).

8. Demonstration of 2D – gel electrophoresis and Gel documentation system.

MCB 106.B: Group project [25 marks]

The Topic for dissertation will be assigned to the students by the concerned guide at the beginning of the 1st Semester and the project work will be within 2000-2500 words and submitted within 60 days.

Project Work pertaining to any Pure Microbiology/ Applied microbiology / Advanced Microbiology / Biophysics/ Bioinformatics/ Inter-disciplinary biological science.

(Work-5, Writing skill-5, Lab note book-5, group discussion/viva-10, each group of project maximum six students. The result/data obtained from the project work should be represented by graph/ chart using Microsoft word).