

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-IV



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	
II	MCB 201	FUNDAMENTALS OF INFECTION AND IMMUNITY :MEDICAL MICROBIOLOGY AND IMMUNOLOGY	50	10	40	4	
	MCB 202	GENETICS AND GENE REGULATION	50	10	40	4	
	MCB 203	BIOMATHEMATICS AND BIOINFORMATICS	50	10	40	4	
	MCB 204	MICROBES IN INFECTION AND ENVIRONMENT (CBCS-I)	50	10	40	4	
	MCB 205	205A	DIAGNOSTIC MICROBIOLOGY AND IMMUNOLOGY	25			2
		205B	BIOMATHEMATICS AND BIOINFORMATICS	25			2
	MCB 206	206A	MICROBIAL GENETICS AND MOLECULAR BIOLOGY	25			2
		206B	VISIT TO INSTITUTE AND PREPARATION OF REPORT	25			2
		TOTAL		300			24
	III	MCB301	CELL BIOLOGY AND GENETIC ENGINEERING	50	10	40	4
MCB 302		AGRICULTURAL AND INDUSTRIAL MICROBIOLOGY	50	10	40	4	
MCB 303		FUNDAMENTALS AND APPLICATION OF FOOD MICROBIOLOGY	50	10	40	4	
MCB 304		ENVIRONMENTAL MICROBIOLOGY (CBCS-II)	50	10	40	4	
MCB 305		MCB 305A	MICROBIAL ANALYSIS OF FOOD	25			2
		MCB 305B	BIOPROCESS TECHNOLOGY	25			2

	MCB 306	MCB 306A	AGRICULTURAL MICROBIOLOGY	25			2
		MCB 306B	REVIEWWORK AND SEMINAR	25			2
				300			24
IV	MCB401	ECOLOGY AND ENVIRONMENTAL MICROBIOLOGY		50	10	40	4
	MCB 402	ADVANCED MICROBIOLOGY		50	10	40	4
	MCB 403	MCB 403A	ENVIRONMENTAL MICROBIOLOGY	25			2
		MCB 403B	COMMUNITY SURVEY AND PREPARATION OF REPORT	25			2
	MCB 404	MCB 404A	INDUSTRY SURVEY	25			2
		MCB 404B	COMPREHENSIVE VIVA	25			2
	MCB 405	PROJECT WORK AND PRESENTATION WITH VIVA-VOCE		100			8
		TOTAL		300			24
		GRAND TOTAL		1200			96

Semester – I

MCB 101: FUNDAMENTALS OF MICROBES: PROKARYOTIC MICROORGANISMS AND EUKARYOTIC MICROORGANISMS [50 Marks]

Total hours: 60

MCB 101.1: Prokaryotic Microorganisms [25 marks]

CREDITS: 4

No. of Hours: 30

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. Archaea: 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

Name of Teacher and class

Dr. Harekrishna Jana, Assistant professor, Dept. of Microbiology, Raja N.L.Khan Women's College, Unit-1,3,4 &6, Total class- 15

Dr. Arijit Jana, Faculty, Dept. of Microbiology, Raja N.L.Khan Women's College, Unit- 2 &5, Total class- 15

MCB 101.2: Eukaryotic Microorganisms [25 marks]

No. of Hours: 30

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, pathogenicity 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, pyrophyta, 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 Ciliates.

Dr. Rashmi Mukherjee, Assistant professor, Dept. of Botany, Raja Narendra Lal Khan Women's College, Unit-1 to 6, Total class-10

Dr. Ms. Dhriti Ghosh, Assistant professor, Dept. of Botany, Raja N.L.Khan Women's College, Unit-7 to 9, Total class-10

**Dr. Arijit Jana, Faculty, Dept. of Microbiology, Raja N.L.Khan Women's College, Unit- 10,
Total class- 10**

MCB 102: FUNDAMENTALS OF MICROBES: VIRUS

[50 Marks]

HOURS: 60

CREDITS: 4

MCB 102.1: Basics of Virology [25 marks]

No. of Hours: 30

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 ϕ X174 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.

Dr. Shatabdi Das, Faculty, Dept. of Microbiology, Raja N.L.Khan Women's College, Unit-1 to 3, Total class-15

Dr. Sucheta Das Maji, Associate professor, Dept. of Biotechnology, Haldia Institute of Technology, Unit-4 to 5, Total class-15

MCB 102.2: Applied virology [25 marks]**No. of Hours: 30****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, pathogenicity, 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.

Dr. Shatabdi Das, Faculty, Dept. of Microbiology, Raja N.L.Khan Women's College, Unit-1, Total class-5

Prof. Ananta kumar Ghosh, Professor, Dept. of Biotechnology, IIT-Kharagpur, Unit-2 to 3, Total class- 25

MCB 103: BIOCHEMISTRY, BIOPHYSICS AND BIOINSTRUMENTATION

[50 Marks]

Total hours: 60

CREDITS: 4

MCB 103.1: Fundamental Biochemistry [25 marks]

No. of Hours: 30

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.

Dr. Samiron Sona Gauri, Scientific officer, IIT- Kharagpur, Unit- 1&5, Total Class-15

Dr. Sansa Dutta, Women Scientist, IIT- Kharagpur, Unit-2,3, &4, Total Class- 15

MCB 103.2: Biophysics and Bioinstrumentation [25 marks]

No. of Hours: 30

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.

Dr. Harekrishna Jana, Assistant professor, Dept. of Microbiology, Raja N.L.Khan Women's College, Unit-1 &2, Total class- 15

Dr. Samiron Sona Gauri, Scintific officer, IIT- Kharagpur, Unit-3 &4, Total class- 15

MCB104: Microbial Physiology and Metabolism

[50 Marks]

MCB104.1: Microbial Physiology [25 marks]

No. of Hours: 30

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.

Dr. Arpita Patra Das, Faculty, Dept. of Microbiology, Raja N.L.Khan Women's College, Unit-1 &2, Total class- 15

Dr. Mh Raihanuddin, Assistant professor. Dept. of Physiology, Raja N.L.Khan Women's College, Unit-3 &4, Total class- 15

Dr. Tapasi Polley, Faculty, Dept. of Microbiology, Raja N.L.Khan Women's College, Unit-2,

MCB104.2: Microbial Metabolism [25 marks]

No. of Hours: 30

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 biphosphate- 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.

Dr. Sansa Dutta, Women Scientist, IIT- Kharagpur, Unit-1 &2, Total Class- 10

Dr. Harekrishna Jana, Assistant professor, Dept. of Microbiology, Raja N.L.Khan Women's College, Unit-6,7 &8, Total class- 10

Dr. Samiron Sona Gauri, Scientific officer, IIT- Kharagpur, Unit-3,4,5 &9, Total class- 10

MCB 105: Staining and Identification, Biochemical test and Microbial growth [50 Marks]

MCB 105A: Staining and Identification [25 marks]

No. of Hours: 60

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]

No. of Hours: 60

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. Sulfur-degrading bacteria, metal resistant, plastic degrading and pesticide degrading bacteria.
3. Study of bacterial growth kinetics, effect of inhibitors and stimulators on growth.

Dr. Harekrishna Jana, Assistant professor, Dept. of Microbiology, Raja N.L.Khan Women's College, Unit- 105A, Total class- 30

Dr. Arpita Patra Das, Faculty, Dept. of Microbiology, Raja N.L.Khan Women's College, Unit-105b, Total class- 30

MCB 106: ANALYTICAL BIOCHEMISTRY AND GROUP PROJECT

[50 Marks]

MCB 106A: Analytical Biochemistry [25 marks]

No. of Hours: 60

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]

No. of Hours: 60

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).

Dr. Harekrishna Jana, Assistant professor, Dept. of Microbiology, Raja N.L.Khan Women's College, Unit- 106A, 106B, Total class- 20

Dr. Arpita Patra Das, Faculty, Dept. of Microbiology, Raja N.L.Khan Women's College, Unit-106B, Total class- 10

Dr. Arijit Jana, Faculty, Dept. of Microbiology, Raja N.L.Khan Women's College, Unit- 106A, 106B, Total class- 30

Semester – II

**MCB 201: FUNDAMENTALS OF INFECTION AND IMMUNITY: MEDICAL MICROBIOLOGY
AND IMMUNOLOGY** **[50 Marks]**

MCB 201.1: Medical Microbiology [25 marks]

No. of Hours: 30

1. Pathogenicity of microorganism: Host parasite relationship, Pathogenesis of viral diseases, bacterial pathogenesis. Virulence and factors associated with virulence. Toxigenicity, host defense against microbial invasion, microbial mechanism for escaping host defenses.
2. Human diseases caused by bacteria: Staphylococcus, Streptococcus, Pneumococcus, Neisseria, Corynebacterium, Bacillus, Clostridium, Shigella, Salmonella, E.coli, Vibrio, Mycobacterium. Meningitis, Tuberculosis, Diphtheria, Leprosy, Cystic fibrosis, Typhoid, Enteritis, Gastritis (*Helicobacter pylorae*), Cholera, Pneumonia. Human-microbe mutualism and disease, manipulation of host cell pathways by bacterial and parasitic pathogens. Different types of secretory pathways of bacteria.
3. Common mycotic infections in human: superficial, subcutaneous, cutaneous, and systemic mycoses.
4. Plant pathogens (bacterial, fungal, algal and mycoplasmal); mechanisms of plant pathogenicity, beneficial association between plant and microorganisms (association of plants with cyanobacteria, actinomycetes and fungi).
5. Antimicrobial Agents and Chemotherapy: Antibiotics - Definition, genera of antibiotics, mode of action of antibiotics, assay of antibiotics, Antibiotics vs probiotics, Antibiotic resistance, MAR(its significance), Methods of action of antibiotics and antibacterial agents. Antimicrobial chemotherapy: Development of chemotherapy, Determining the level of anti microbial activity, Anti microbial/ bacterial drugs, Drug Resistance, Anti viral, fungal, protozoan drugs.

6. Bioterrorism and Bioweapons: Introduction to Bioterrorism and Bioweapons, Pathogenic microorganisms used for these purpose and their properties, Infectious agents and their epidemiology. Case- studies.

Dr. Surajit Das, Assistant professor, Dept. of Bio-Medical Laboratory Science and Management, Vidyasagar University, Unit- 1,2,3,&5. Total class- 20

Dr. Harekrishna Jana, Assistant professor, Dept. of Microbiology, Raja N.L.Khan Women's College, Unit- 4 &6, Total class- 10

MCB 201.2: Immunology [25 marks]

No. of Hours: 30

1. Cells and molecules involved in innate and adaptive immunity, antigens, antigenicity and immunogenicity. B and T cell epitopes.
2. Inflammation; Humoral and cell-mediated immune responses.
3. Structure and function of antibody molecules, generation of antibody diversity, antibody engineering, antigen-antibody interactions.
4. Concept of - a) lymphoid organs, b) primary and secondary immune responses, c) antigen processing and presentation, d) major histocompatibility complex (MHC) antigens, e) Toll-like receptors, f) complement systems, g) Transplantation, h) Hypersensitivity, i) Tolerance and autoimmunity, j) Immunosuppression, and k) congenital and acquired immunodeficiencies.
5. Disease control by vaccination, national vaccination schedules. Types of vaccine: live microorganism, attenuated organism, genetically modified organism, protein, edible, synthetic, naked DNA, recombinant and anti-idiotypic vaccine. Hazards of immunization. Monoclonal antibody - production and application.
6. Epitope design and its application in immune diagnostic tests. Techniques studied in Immunology: Agglutination, Precipitation, Complement fixation, Immunofluorescence, ELISA, RIA, Western blot, FACS. Detection of molecules in living cells, in situ localization by techniques such as FISH and GISH, Immunohistochemical methods. AIDS: HIV testing, vaccine design.

Dr. Sucheta Das Maji, Associate professor, Dept. of Biotechnology, Haldia Institute of Technology, Unit- 1,2,3 &4, Total class- 15

Dr. Atanu Adak, Research Scientist1, Medical College and Hospital, Kolkata, Unit- 5&6, Total class- 15

MCB 202: GENETICS AND GENE REGULATION

[50 Marks]

MCB 202.1: Fundamental of Genetics [25 marks]

No. of Hours: 30

1. Basic principle of Heredity, deviation of Mendelian inheritance, gene interaction, pleiotropy, sex-linked and autosomal- linked traits, dosage compensation. Population genetics.
2. Chromosome structure and organization. Heterochromatization. Extra chromosomal genetic material. Transposons – types and function. C-value paradox.
3. Molecular mechanism of recombination. Linkage and genetic mapping.
4. Bacterial gene transfer and mapping: conjugation, transformation, transduction. Complementation (cis-trans) test. Horizontal gene transfer, epistasis.

Dr. Tilak Das, Faculty, Dept. of Zoology, Raja N.L.Khan Women's College, Unit- 1&4, Total class- 15

Dr. Mh Raihanuddin, Assistant professor. Dept. of Physiology, Raja N.L.Khan Women's College, Unit-2 &3, Total class- 15

MCB 202.2: Gene regulation [25 marks]

No. of Hours: 30

1. Molecular mechanism of DNA replication, transcription and translation. Post transcriptional (capping, polyadenylation, splicing, intron and exons) and post translational modifications.
2. DNA damage and repair: photoreactivity, excision – BER and NER, recombination. SOS repair, mismatch repair, Methyl-directed mismatch repair.
3. Site directed mutagenesis. siRNA, microRNA and RNAi mediated gene silencing.

4. Regulation of prokaryotic gene expression: Basic concept, positive and negative regulation, Operon: lac and trp operon. Lytic & lysogenic regulation in phage and virus.
5. Regulation of gene expression in Eukaryotes. Epigenetics and its role in differentiation.

Dr. Suhird Ranjan Dutta, Faculty, Dept. of Microbiology, Midnapur college, Unit- 3,4&5, Total class- 15

Dr. Samiron Sona Gauri, Scientific officer, IIT- Kharagpur, Unit-1 &2, Total class- 15

MCB 203: BIOMATHEMATICS AND BIOINFORMATICS

[50 Marks]

MCB 203.1: Biomathematics [25 marks]

No. of Hours: 30

1. Definition of sample and population, concept of variable, Central tendencies, Frequency distribution and its graphical representation, Recapitulation of mean, median, mode, standard deviation, standard error.
2. Tests of statistical significance. Simple correlation and regression, t-test, chi-square test, Analysis of variance.
3. Mathematical modeling of bacterial growth curve, fermentation, control of microorganism.

Mr. Puspendu Shit, NET (JRF), Dept. of Zoology and Microbiology, , Raja N.L.Khan Women's College, Unit- 1 &2, Total class- 15

Dr. Harekrishna Jana, Assistant professor, Dept. of Microbiology, Raja N.L.Khan Women's College, Unit- 3, Total class- 15

MCB 203.2: Bioinformatics [25 marks]

No. of Hours: 30

1. Introduction to bioinformatics.
2. Biological sequence database, sequence comparison, pairwise alignment, multiple alignments, database searching, algorithms of FASTA and BLAST, molecular phylogeny.

3. Mutation matrix and its application.
4. Ligand- protein interaction.
5. System biology: Approaches and application

Dr. Amrita Banerjee, Assistant Professor, OIST, Paschim Midnapur, Unit- 3,4,5 Total class- 15

Dr. Sunil Kanti Mondal, Faculty, Dept. of Biotechnology, Burdwan University, Unit- 1&2 Total class- 15

MCB 204: MICROBES IN INFECTION AND ENVIRONMENT (CBCS-I) [50 marks]

No. of Hours: 60

1. Contribution of pioneer worker (Antony van Leeuwenhoek, Louis Pasteur, Robert Koch, Elie Metchnikoff and Edward Jenner) in the field of microbiology. Basic structure and function of microorganisms.
2. Familiarity with the science of microbiology and its significance in everyday life: Microorganisms drive the biogeochemical cycles that sustain all living things, and can be used to ameliorate environmental degradation, in food industry/ biotechnology.
3. Microbial habitats and mechanism of their survival (terrestrial, aquatic, and extreme conditions).
4. Basic concept of infection and its importance in community health. Microbes in infection: Bacteria, Virus, fungi, some common infection diseases.
5. Microbial flora and human health.
6. Basic concept of microbes present in environment. Microbial contribution in society i) biofuel production; ii) changes in global climate; iii) pollutant degradation.

Dr. Arijit Jana, Faculty, Dept. of Microbiology, Raja N.L.Khan Women's College, Unit- 1,2,4 &5, Total class- 30

Dr. Harekrishna Jana, Assistant professor, Dept. of Microbiology, Raja N.L.Khan Women's College, Unit- 3,6, Total class- 30

MCB 205: MEDICAL MICROBIOLOGY AND BIOSTATISTICS

[50 Marks]

No. of Hours: 120

MCB 205A: Diagnostic Microbiology and Immunology [25 marks] No. of Hours: 60

1. Separation and characterization of blood cell.
2. Determination of TC & DC.
3. Quantification of immunoglobulins by ELISA.
4. Precipitation techniques: immunodiffusion, immuno electrophoretic method. Ouchterlony double diffusion technique.
5. Agglutination reactions : Widal, Haemagglutination, Haemagglutination Inhibition
6. Estimation of blood sugar, urea, SGOT & SGPT.
7. Preparation of culture media: Simple tissue culture methods for growing different pathogenic microorganisms and characterization of *E.coli*, *P. aeruginosa*, *S. aureus*, *Salmonella* sp. by biochemical tests.
8. Identification of pathogenic fungi *Aspergillus niger* and *Candida albicans*.
9. Enumeration and identification of microbes associated with urine / pus.
10. Antibiotic sensitivity of microbes associated with urine / pus.

Dr. Harekrishna Jana, Assistant professor, Dept. of Microbiology, Raja N.L.Khan Women's College, Unit- 7,8, 10 Total class- 30

Dr. Arpita Patra Das, Faculty, Dept. of Microbiology, Raja N.L.Khan Women's College, Unit-1to7,9, Total class- 30

MCB 205B: Biomathematics and Bioinformatics [25 marks] No. of Hours: 60

1. Operation of Microsoft word, Microsoft excels, Microsoft Power Point and internet.
2. Preparation of graph of experimental data using MS Excel and other softwares.
3. Computation of mean, median, mode, SD, SE, correlation coefficient, regression and ANOVA using available software.
4. Pair wise alignment, multiple alignments and data-base searching.

**Dr. Arijit Jana, Faculty, Dept. of Microbiology, Raja N.L.Khan Women's College, Unit- 4,
Total class- 25**

**Mr. Puspendu Shit, NET (JRF), Dept. of Zoology and Microbiology, Raja N.L.Khan Women's College,
Unit- 1,2 , Total class- 15**

**Dr. Harekrishna Jana, Assistant professor, Dept. of Microbiology, Raja N.L.Khan Women's
College, Unit- 3, Total class- 20**

MCB 206: Molecular biology and Institute Visit report [50 Marks] No. of Hours: 120

MCB 206A: Microbial genetics and molecular biology [25 marks] No. of Hours: 60

1. Isolation of mutant (UV/ NTG / HNO₂/ Dyes).
2. DNA isolation (plasmid & chromosomal). 3. Agarose gel electrophoresis for DNA.
4. Amplification of DNA / RNA by PCR.
5. Restriction analysis of bacterial DNA.
6. Study of transformation and transduction process.
7. Induction of β -galactosidase in *E. coli*.
8. Demonstration of DGGE.
9. DNA cloning using plasmid vectors and in *E.coli* expression vectors.

MCB 206B: Visit to Institute and preparation of report [25 marks]

Dr. Arijit Jana, Faculty, Dept. of Microbiology, Raja N.L.Khan Women's College, Unit- 2 to 9, Total class- 40

Dr. Harekrishna Jana, Assistant professor, Dept. of Microbiology, Raja N.L.Khan Women's College, Unit- 1 and 206B, Total class- 20

Semester – III

MCB 301: CELL BIOLOGY AND GENETIC ENGINEERING [50 Marks], No. of Hours: 60

MCB 301.1: Cell Biology [25 marks] No. of Hours: 30

1. Structure, function and assembly of cellular and organic components in prokaryotes/eukaryotes.
2. Cell division and cell cycle: mitosis and meiosis, their regulation, steps in cell cycle and control, check points of cell cycle.
3. Programmed cell death (apoptosis), ageing and senescence.
4. Molecular basis of signal transduction in prokaryotes (quorum sensing, Two component sensor system in cell signaling.) and eukaryotes, General principles of cell communication, cell adhesion and role of different adhesion molecules, gap junctions, extracellular matrix, integrins, neurotransmission.
5. Cancer and molecular mechanism of oncogenesis.
6. Concept of animal cell culture, Stem cell and its applications.

Dr. Samiron Sona Gauri, Scientific officer, IIT- Kharagpur, Unit-1,5 &6, Total class- 15

Dr. Anushree Saha, Assistant Professor, Dept. of Botany, Raja N.L.Khan Women's College, Unit- 2.3 and 4, Total class- 15

MCB 301.2: Genetic Engineering [25 marks] No. of Hours: 30

1. Principles and procedures of protein and nucleic acid sequencing, southern, northern and western blotting, polymerase chain reaction, RT –PCR, real time PCR, gel electrophoresis, chemical synthesis of gene. Automated DNA sequencing, pyrosequencing. RFLP and RADP analysis.
2. Techniques: Microarrays, Interaction between DNA-Protein DNA-bimolecules, and protein-protein.
3. Isolation and selection of suitable gene – from known specific proteins, with tissue specific expression, coding for unknown product, transposon tagging, mutant complementation, chromosome walking, exon-trapping
4. Cloning – restriction enzyme and mapping, joining of DNA fragments, construction of chimeric DNA, molecular probes. Construction and screening of genomic and cDNA libraries. Vehicles for gene cloning, Shuttle and Expression vector.
5. Application of genetic engineering - in medicine, agriculture, forensic science, environment.

**Prof. Ananta kumar Ghosh, Professor, Dept. of Biotechnology, IIT-Kharagpur, Unit-1 to 5,
Total class- 30**

MCB302: AGRICULTURAL AND INDUSTRIAL MICROBIOLOGY [50 Marks] No. of Hours: 60

MCB302.1: Agricultural Microbiology [25 marks], No. of Hours: 30

1. Plant-microbe interactions –Endophytic organisms, Common plant pathogenic bacteria, virus and fungus.
2. Beneficial association between plant and microorganisms. Different symbiosis including rhizosphere and phyllosphere microorganisms and their effect.
3. Important roles of soil microbes: nutrient transformations, organic matter cycling, biogeochemical cycles, N₂ cycling.
4. Biofertilizer: Types, production and application (*Rhizobium*, *Azotobacter*, *Azolla*). Liquid biofertilizer.
5. Biopesticides – type , production (BT) and application. *Trichoderma* as biocontrol agent.
6. Microbes in composting: Farmyard manure, Method of composting (aerobic, anaerobic), enrichment of compost with microbial inoculants. Super digested compost, biogas production.
7. Vermiculture: Vermiculture process, Vermicomposting materials, Advantages of vermicompost.
8. Concept of plant tissue culture, micropropagation and protoplast technology.

Dr. Anushree Saha, Assistant Professor, **Dept. of Botany, Raja N.L.Khan Women's College, Unit- 8,**

Total class- 5

Dr. Harekrishna Jana, Assistant professor, **Dept. of Microbiology, Raja N.L.Khan Women's College, Unit- 1 to 7 , Total class- 25**

MCB302.2: Industrial Microbiology [25 marks] No. of Hours: 30

1. Suitability of microbes in industrial processes and their source; Type of fermentations and bioreactors (stirred tank, bubble column, airlift reactor, stirred and air-driven reactors, packed bed, fluidized bed, trickle bed); Monitoring and control of bioreactors; Ideal reactor operation: batch, fed-batch, and continuous operation.
2. Substrates for industrial fermentations; Growth kinetics in batch and continuous fermentation processes; Strain improvement. Fluid flow and mixing: classification of fluids, viscosity, non-Newtonian fluids, Rheological properties of fermentation broth; heat transfer; mass transfer: molecular diffusion, oxygen uptake in cell culture, oxygen transfer in fermentor ($k_L a$), measurement of $k_L a$.
3. Bioprocess engineering: Bioprocess development; Stoichiometry of growth and product formation; energy balances: basic energy concept, energy balance equation for cell culture. homogeneous and heterogeneous reactions.
4. Methods for the recovery and purification of fermentation products (downstream processing); Economic aspects of fermentation processes. Factors depending on scale up process of fermentation.
5. Production aspects (Microbial stains, Substrate, Flow diagrams, Products optimization, and Applications) of the following: Industrial alcohol and alcoholic beverages and glycerol; Organic acids-citric, lactic, acetic, propionic, gluconic acid; Amino acids- glutamic acid, lysine; Enzymes-extracellular amylases and proteases; Vitamins-Vit.B12 and riboflavin; Antibiotics-B-lactam, whole cell and enzyme immobilization and their industrial application
6. Single cell protein; Polysaccharides; Recombinant DNA products: Insulin; Somatostatin; Interferon; Microbial insecticides
7. Solid-state fermentation: process and application

Dr . Santanu Roy, Assistant Professor, **IEST, Shibpur Howrah, Unit- 1 to 4, Total class- 15**

Dr. Arijit Jana, Faculty, Dept. of Microbiology, **Raja N.L.Khan Women's College, Unit- 5 to 7, Total class- 15**

MCB 303 FUNDAMENTALS AND APPLICATION OF FOOD MICROBIOLOGY [50 Marks]

No. of Hours: 60

MCB 303.1: Fundamentals of food microbiology [25 marks] No. of Hours: 30

1. Historical development of food microbiology and significance; Constituents of food (Hydrogen ion concentration, moisture, Water activity, oxidation – reduction potential, nutrient content, inhibitory substance and biological structure); Classification of common food items.
2. Normal microbial flora of common foods (milk, meat, fish, cereals, vegetables and fruits). Factors influencing microbial growth in food - Extrinsic and intrinsic factors
3. Source of microorganism in different foods; Contamination of foods.
4. Spoilage of foods and factors governing the spoilage; Detection of spoilage and characterization.
5. Food preservation methods: physical, synthetic, natural and biological.
6. Food in relation to disease: Food – borne illness: Bacterial; Food borne poisoning, infection, and intoxication: nonbacterial (Food intoxication and food infection).
7. Investigation of food-borne disease outbreak and preventing measures.
8. Current and future implications concerning food safety, hazards and risks.
9. Quality assurance: Microbiological quality standards of food. Government regulatory practices and policies. FDA, EPA, HACCP, ISI.

Dr. Priyanka Ghosh , Jadavpur University, Unit- 1 to 3, Total class- 30

Dr. Tapasi Polley, Faculty, Dept. of Microbiology, Raja N.L.Khan Women's College, Unit-3-9,

MCB 303.2: Application of food Microbiology [25 marks] No. of Hours: 30

1. Microbial food processing: Role of indicating microorganisms like lactic acid and other bacteria, yeast and molds.
2. Fermented food: Production and beneficial effects. Lactic acid, acetic acid, citric acid, bacteriocins and other metabolites, their applications.
3. Oriental fermented foods (preparation, microbes and benefits).
4. Food biotechnology: Genetically modified foods and their acceptability; GM microbial food and food additive production.
5. Food pigments and flavoring agents.
6. Application of microbial enzymes in food production.
7. Microorganisms as food: Single cell protein, algae as food, and mycoprotein from fungi for use as food and feed, mushroom cultivation, Concept of probiotics, prebiotics and synbiotics; different fermented foods (Sauerkraut, Sausages, Bread, Soysauce, Idli, Tempeh, Poi, Dairy products -basic concepts of all briefly).
8. Socio - cultural Importance and therapeutic value of fermented foods.

**Dr. Arijit Jana, Faculty, Dept. of Microbiology, Raja N.L.Khan Women's College, Unit- 1 to 9,
Total class- 30**

MCB 304: ENVIRONMENTAL MICROBIOLOGY (CBCS-II) [50 marks] No. of Hours: 60

1. Microbiology of wastewater and solid waste treatment: - Waste-types-solid and liquid waste characterization, physical, chemical, biological, aerobic, anaerobic, primary, secondary and tertiary treatments.
2. Biomagnifications, Eutrophication, Bioremediation of Xenobiotics (PCB, TNT) and biodegradation of hydrocarbon, bioventing, bioaugmentation.
3. Basic principles of microbiology for production of alternative fuels (Biodiesel).
4. Air pollutants and its control, metal-microbes interaction (biomining).
5. Biofertilizers (compost, vermicompost) and biopesticides (BT), biosafety issue
6. Health hazards and microbial infections, human transmitted diseases.

Dr. Harekrishna Jana, Assistant professor, Dept. of Microbiology, Raja N.L.Khan Women's College, Unit- 1 to 3 , Total class- 30

Dr. Arijit Jana, Faculty, Dept. of Microbiology, Raja N.L.Khan Women's College, Unit- 4 to 6, Total class- 30

MCB 305: BIOPROCESS AND FOOD MICROBIOLOGY [50 marks] No. of Hours: 120

MCB 305A: Microbial analysis of food (25 marks), No. of Hours: 60

1. Conventional and rapid methods of isolation and identification of food spoilage bacteria, fungi by aerobic and anaerobic culture method.
2. Bacteriological analysis of food products; direct microscopic studies and Standard plate count methods.
3. Detection and enumeration of indicator and index organisms for food borne pathogenesis.

4. Microbiological examination of processing plant, equipment, working surfaces etc.
5. Quantifying the thermal death point of microorganisms (D and z values)
4. Reductase test for milk: dye reduction test.
5. Isolation of micro organisms from common food items such as curd, Panmasala and bread.
6. Determination of phosphatase activity of milk.

**Dr. Arpita Patra Das, Faculty, Dept. of Microbiology, Raja N.L.Khan Women's College,
Unit-1to6, Total class- 60**

MCB 305B: Bioprocess Technology [25 marks] No. of Hours: 60

1. Isolation and characterization of microorganisms from fermented foods.
2. Production of alcohol by fermentation from molasses, whey, fruit wastes, malt etc.
3. Preparation of bakers yeast using molasses.
4. Microbial production of amylase (Solid, Liquid & Submerged fermentation).
5. Production of curd and pickles with respect to microbial load and organic acid formation.
6. Production of rice beer by using various types of industrially important yeasts.
7. Mushroom production
8. Production and estimation of citric acid from pineapple waste in solid state fermentation using a selected strain of *Aspergillus*

**Dr. Arpita Patra Das, Faculty, Dept. of Microbiology, Raja N.L.Khan Women's College,
Unit-2to8, Total class- 40**

**Dr. Arijit Jana, Faculty, Dept. of Microbiology, Raja N.L.Khan Women's College, Unit- 1, Total
class- 20**

MCB 306: AGRICULTURAL MICROBIOLOGY AND REVIEW WORK [50 Marks] No. of Hours: 120

MCB 306A: Agricultural Microbiology [25 marks]

No. of Hours: 60

1. Production of vermicompost. Enumeration of microbes and level of N, P, & K before and after composting.
2. Isolation of VAM spores from soil and study of Mycorrhiza.
3. Isolation and cultivation and application of *Rhizobium*, *Azotobacter*.
4. Measurement of N₂ fixing capacity of microbes using gas chromatography / total N₂ estimation by Kjeldahl method.
5. Anatomical and microbial study of legume nodule.
6. Production and estimation of IAA from microorganism.
7. Isolation of fungal pathogen from diseased plant specimen.
8. Study of virus infected plants: study of inclusion bodies in viral infected plants; study of stomatal nature in virus-infected plants; biochemical tests for plant pathogens.
9. Identification of pathological plant specimen (Demonstration of sheet preparation).

Dr. Arijit Jana, Faculty, Dept. of Microbiology, Raja N.L.Khan Women's College, Unit- 2, 5,7&8

Total class- 30

Dr. Harekrishna Jana, Assistant professor, Dept. of Microbiology, Raja N.L.Khan Women's College, Unit- 1,3,4,6 & 9 , Total class- 30

MCB 306B: Review work, project design and seminar [25 marks] No. of Hours: 60

1. Review work [15 marks]
2. Dissertation, Project design [10 marks]

A grant proposal on any relevant topic in biology will have to be prepared by students following the format of National Institute of Health, USA. The students will also be required

to defend the proposal before a panel of experts. Both the written proposal and its defense will be taken into consideration for evaluation.

Dr. Arijit Jana, Faculty, Dept. of Microbiology, Raja N.L.Khan Women's College, Unit-2, Total class- 40

Dr. Harekrishna Jana, Assistant professor, Dept. of Microbiology, Raja N.L.Khan Women's College, Unit- 1, Total class- 20

Semester – IV

MCB 401: Ecology and Environmental Microbiology [50 Marks] No. of Hours: 60

MCB 401.1: Ecology [25 marks] No. of Hours: 30

1. Concept of ecosystem and ecosystem management, trophic structure of the ecosystem; ecotones and edges; ecosystem diversity; classification of ecosystems; stability of ecosystem; examples of ecosystem: A pond; agroecosystem.
2. Energy flow through ecosystem, energy environment. Concept of productivity; energy partitioning in food chain and food webs.
3. Population properties, population growth curve, density dependent and density independent mechanism of population regulation. Concept of habitat and niche, r and k selection.
4. Types of interactions between two species; co-evolution. Biodiversity.
5. Idea of different biomes.
6. Principles of conservation, major approaches to management.

Dr. Partha Pr. Chakraborty, Associate Professor, Dept. of zoology, Raja N.L.Khan Women's College, Unit- 1,2&3, Total class- 15

Dr. Tilak Das, Faculty, Dept. of Zoology, Raja N.L.Khan Women's College, Unit- 4,5&6, Total class- 15

MCB 401.2: Environmental Microbiology [25 marks] No. of Hours: 30

1. Extremophiles : Anaerobes, Halophiles, Acidophiles, Alkaliphiles, Thermophiles, Barophiles; Community structure and organization. Effect of heavy metal and xenobiotic substances on microbes; biological magnification of toxic substances. Microbial deterioration of paper, leather, wood, textile, stone and monument.
2. Aeromicrobiology: Microbes of indoor and outdoor environment, transmission pathways, enumeration, Extramural and intramural, control, bioterrorism. Biosafety.
3. Aquatic microbiology: Significance of microbes in water quality. Test for potability of water. Eutrophication, Microbial treatment of sewage; application of wastewater in land; composting of biosolids and domestic solid waste. Microbes related to fish growth. Common microbial diseases of fish.
4. Marine microbes and their applications.
5. Microorganism and metal pollutants; biodegradation of TNT, PCB; Bioremediation: bioventing, biofiltration, bioaugmentation, problems and advantages.
6. Bioleaching: mineral extraction, oil recovery.

Dr. Harekrishna Jana, Assistant professor, Dept. of Microbiology, Raja N.L.Khan Women's College, Unit- 1 to 6, Total class- 30

MCB 402: Advanced Microbiology

[50 Marks] No. of Hours: 60

MCB 402.1: Natural Therapeutics [25 marks] No. of Hours: 30

1. Molecular principles of drug targeting.
2. Drug delivery system: concept of pharmacokinetics and pharmacodynamics.
3. Antibiotics (antibacterial and antifungal): classification, mode of action
4. Production of therapeutic agents from microbial origin: antibiotics, recombinant proteins, enzymes, vitamins, lactic acid, phenolics, sugar, etc.
5. Mushroom: nutraceuticals, cultivation, toxins.
6. Probiotics: Characteristics of Probiotics organism, application for curing enteric disease and induction of host immunity. Utilization of probiotics in different sectors: humans, fish culture, and poultry etc. Functional properties of probiotics, prebiotics and synbiotics
7. Drug resistance in Bacteria and its effect in the society

Dr. Arpita Patra Das, Faculty, Dept. of Microbiology, Raja N.L.Khan Women's College, Unit- 5&6, Total class- 10

Dr. Arijit Jana, Faculty, Dept. of Microbiology, Raja N.L.Khan Women's College, Unit- 1,2,3,4,7 Total class- 20

MCB 402.2: Advanced bioproducts and Norms [25 marks] No. of Hours: 30

1. Advances and applications of nanotechnology. DNA based nano-structure, organic and inorganic (homo and hetero) nano-particles. Microbial synthesis of nanoparticles, uses of nanoparticles in agriculture and Medicine.
2. Antibacterial and antifungal nanoparticles, toxicity of nanoparticles.
3. Biosensor : General idea.
4. Production of biopolymer (dextran, alginate, pullulan, xanthan gum, PHB) and bioplastic.

5. Steroid biotransformation for preparation of useful drugs.
6. QA and QC in manufacturing and in process control of pharmaceuticals.
7. Concept of intellectual property right (IPR).

Dr. Nimai Bar, Assistant Professor, Dept. of Chemistry, Raja N.L.Khan Women's College, Unit- 1,2,&4, Total class- 15

Dr. Arijit Jana, Faculty, Dept. of Microbiology, Raja N.L.Khan Women's College, Unit- 3,5,6,7 Total class- 15

MCB 403: ENVIRONMENTAL MICROBIOLOGY AND COMMUNITY SURVEY [50 Marks]

MCB 403 A: Environmental Microbiology [25 marks] No. of Hours: 60

1. Testing of water sample to determine microbial load in the different places of urban/ rural locality. Enumeration of total coliform, fecal coliform and *E.coli* present in water through multiple tube fermentation technique (MPN).
2. Determination of Dissolved oxygen (DO) and Biochemical Oxygen Demand (BOD)
3. Identification of enteric bacilli by IMViC Test.
4. Physico-chemical analysis of water – pH, TDS, TSS, EC, COD, phosphate, $\text{NH}_4^+ - \text{N}$, $\text{NO}_3^- - \text{N}$ and total nitrogen, Alkalinity and Hardness of water.
5. Estimation of organic carbon in soil
7. Determination of ammonification, nitrification and denitrification rates in soil and water

MCB 403B: Community survey on Microbial diseases / water hygiene/fermented food and preparation of report [25 marks]

Dr. Harekrishna Jana, Assistant professor, Dept. of Microbiology, Raja N.L.Khan Women's College, Unit- 403A,B Total class- 60

MCB 404: INDUSTRY SURVEY AND GRAND VIVA [50 Marks] **No. of Hours: 120**
MCB 404A: Industry Survey [25 marks] **No. of Hours: 60**
MCB 404B: Comprehensive Viva [25 marks] **No. of Hours: 60**
MCB 405: Project work and presentation with viva-voce. (100 marks) **No. of Hours: 120**
MCB 405A: Project Work- 50
[Students have to complete their training cum dissertation work in different national
Institutes/Laboratories/ Universities / Industries within tenure of 3 months]
MCB 405B: Presentation and Viva [30 +20]

**Dr. Harekrishna Jana, Assistant professor, Dept. of Microbiology, Raja N.L.Khan Women's
College, Unit- 404A,B and 405A, Total class- 30**