University of North Bengal

Syllabus of the entrance test for Ph.D

In

Microbiology

University of North Bengal
Raja Rammohunpur, Darjeeling-734013
West Bengal, India

A. Biomolecules

1. Structure of atoms, molecules and chemical bonds.
2. Composition, structure and function of biomolecules (carbohydrates, lipids, proteins, nucleic acids and vitamins).
3.. Stablizing interactions (Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction, etc.).
4. Principles of biophysical chemistry (pH, buffer, reaction kinetics, thermodynamics, colligative properties).
5.. Bioenergetics, glycolysis, oxidative phosphorylation, coupled reaction, group transfer, biological energy transducers.
6. Principles of catalysis, enzymes and enzyme kinetics, enzyme regulation, mechanism of enzyme catalysis, isozymes
7. Conformation of proteins (Ramachandran plot, secondary structure, domains, motif and folds).
8. Conformation of nucleic acids (helix (A, B, Z), t-RNA, micro-RNA).
9. Stability of proteins and nucleic acids.
10. Metabolism of carbohydrates, lipids, amino acids nucleotides and vitamins.

B. Microbial Growth and Growth Control

1. Measurement of growth: cell number and cell mass.
2. Phases of microbial growth, growth kinetics, concept of primary and secondary metabolites.
3. Different type of growth culture media: Batch, Fed batch, Continuous, Synchronous, Diauxic.
4. Sterilization using heat , radiation, chemical and filter.
5. Antibiotics: Classification, structure, mode of action and antimicrobial spectrum of penicillin,streptomycin,tetracycline,methicillin,Vancomycin,Nalidixic acid, Metronidazole.
6. Antibiotic resistance: mechanism, Overcoming resistance
7. Viral control using chemicals and interferon

C. Metabolism

1. Enzymology:Nomenclature,Classification, Cofactors [coenzymes(Thiamine pyro phosphate,Pyrodoxal phosphate,Coenzyme A),Prosthetic group (FAD,NAD), metal ions ($MG^{2+,}Fe^{2+,}Zn^{2+,}Mo^{2+}$)], Activation energy, transition state, Enzyme Kinetics:Michaelis-Menten equation, Double reciprocal plot, Enzyme reversible inhibition kinetics: Competitive Non competitive, Uncompetitive, Suicide Inactivation by Penicillin during bacterial cell wall biosynthesis. Allosteric enzymes (Aspartate trans carbamoylase), Feed back inhibition Ribozymes, Abzymes
2. Aerobic respiration: Glycolysis, Oxydation of pyruvate, Tricarboxylic acid cycle, Electron transport chain and oxidative phosphorylation, ATP-ADP cycle,Entry of other sugar in aerobic respiration: Galactose,Fructose.

3. Pentose phosphate pathway,Glyoxalate cycle, Glycogenolysis,Glycogenesis,Gluconeogenesis.
4. Anaerobic respiration: Nitrate, Sulfate, carbon dioxide as electron acceptor (Methanogenesis and acetogenesis).
5.Fermentation: Alcoholic, Lactic, stick land reaction, Entner-Doudoroff Pathway, Pasteur effect.
6.Photosynthesis: Oxygenic and Anoxygenic, Chemosynthesis (Amonia,sulfur,Iron)
7.Amino acid biosynthesis : Lysine, Phenyl alanine, Arginine, Glycine, Alanine.
8. Amno acid catabolism: Transamination reaction, Deamination, transmethylation, Decarboxylation, Glucogenic and ketogenic precursors, Urea cycle.
9. Purine and pyrimidine biosynthesis: De novo and salvage pathway, Purine and Pyrimidines degradation: Xanthine and uric acid formation
10. Pathway for fatty acid biosynthesis: Palmitic acid, β- Oxidation of odd and even carbon chain of saturated and unsaturated fatty acids.

D. ***General Microbiology***

1. Microbial phylogeny as revealed by ribosomal RNA sequencing. Whittaker's Five-kingdom and three-kingdom concept of living organisms (General characteristics of those groups); General features of Eubacteria and Archaebacteria (major difference within Eubacteria). Bacterial Taxonomy, Binomial Nomenclature, Difference between Prokaryotes, Eukaryotes and Archaea.
2. Phototrophic bacteria characteristics and ecological niche : Anoxygenic and oxygenic phototrophs, green/purple sulfur/non sulfur bacteria, prochlorophytes, cyanobacteria
3. Chemolithotrophs characteristics and ecological niche: ammonia,nitrite and sulfur chemolithotrophs.
4.Archaea: extreme halophiles,methanogens,hyperthermophiles
5. Algae: General characteristics,growth, Reproduction. Detailed life cycle of Chlamydomonas, Spirogyra
6. Fungi: General characteristics,growth, Reproduction. Detailed life cycle of Aspergillus fumigatus, Rhizopus stolonifer and Sachharomyces cerevisae
5. Protozoa: General characteristics,growth, Reproduction. Detailed life cycle of Plasmodium vivax, Giardia lamblia.
6. Epidemiological terminology: Epedemics,Endemics,Pandemics,Quarentine,Nosocomial infection,Zoonotic infection
7. Normal Microflora of human body: Thoracic, Abdominal, Urogenital and skin
8. General characteristics, mechanism of pathogenesis,transmission,diagnosis and treatment of diseases caused by pathogenic microorganism.
9. Plant Microbe Interaction.
10. Quaram sensing.

E. **Functional anatomy of microbial cell**

1. Overview of cell structure : prokaryotes and eukaryotes
2. Cell wall of prokaryotes : peptidoglycan and other related molecules, outer membrane of gram negative bacteria, capsule, slime layer ,glycocalyx.
3. Cytoplasmic membrane, mesosome and chromatophore
4. Appendages: flagella and motility, pili and fimbriae.
5. Prokaryotic cell surface structure and cell inclusions
6.Prokaryotic ribosome,its difference to eukaryotic ribosome.
7. Arrangement of DNA in prokaryotes.
8. Endospore formation and its characteristics.

F. ***Environmental Microbiology***

1. Bio aerosol ,Suspended particulate matter, microbial sampling technique, technique for room sterilization
2. Microbial analysis of water, indicator organism, Most probable number technique, Biological oxygen demand, Chemical oxygen demand, Eutrophication.
3. General characteristics and adaptation strategies of extremophiles: Oligotrophs, Barotollerent,Barophiles, halotolerent,halophiles,Psychrotolerent, acidophiles,alkali philes, Psychrophiles,Thermotolerent,Thermophiles,Xerotolerent, Osmotolerent microorganisms.
4. Sweage treatment.
5. Biogeochemical cycle :Carbon ,Nitrogen, Sulphur, Phosphorus,Physicochemical charecters of soil,Rhizosphere,Rhizoplane,Phylosphere,Phyloplane,
6. Composting,Biofertilizer,Plant growth promoting rhizobacteria, Endo and Exo Micorhiza
7. Pathogenesis and Control measures of plant diseases: Brown spot of rice, Grey blight of tea, Rice tungro diseases by tungro virus, Powdery mildew of cucurbit.

G.Food and Industrial microbiology

1. Factors affecting growth and survival of microorganism in foods, Intrinsic (substrate limitation,nutrient content, buffering capacity,redox potential,antimicrobials,water activity) and extrinsic (Environmental limitations: relative humidity,temperature, gaseous atmosphere)
2.Microbiology of food (raw,cooked,canned) spoilage: Vegetables,fruits,milk and milk products,fish,meat and meat products.
3. Microbiology of food preservation :Heat processing(Pasteurization,apertization),irradiation (Microwave,UV & ionizing radiation),high pressure processing (Pascalization),Low temperature storage (Chilling, Freezing), Chemical preservatives (Common antioxidants, Organic acid).
4. Food borne diseases: Pathogenesis, Diagnosis and Treatment of Salmonellosis, Shigellosis.
5. Microbiology of traditional food fermentations: Tempe, Yogurt,Idli,Kinema
6. Concept of prebiotic and probiotics.
7. Industrially important microbial culture screening and selection, strain improvement.
8. Description and Function of fermentor,bioreactor.

9. Industrial production,downstream processing, assay and uses of Ethanol,Acetic acid, penicillin, Cyanocobalamine, Diastase.
10. Production of single cell protein and its uses.

H. CellBiology

1. Membrane structure and function :Structure of model membrane, lipid bilayer and membrane protein diffusion, osmosis, ion channels, active transport, membrane pumps, mechanism of sorting and regulation of intracellular transport,electrical properties of membranes.
2. Structural organization and function of intracellular organelles :Cell wall, nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, chloroplast, structure & function of cytoskeleton and its role in motility).
3. Organization of genes and chromosomes : Operon, unique and repetitive DNA, interrupted genes, gene families, structure of chromatin and chromosomes, heterochromatin, euchromatin, transposons.
4. Cell division and cell cycle : Mitosis and meiosis, their regulation, steps in cell cycle, regulation and control of cell cycle
5. Cellular communication Regulation of hematopoiesis, general principles of cell communication, cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix, integrins, neurotransmission and its regulation.
6. Cell signaling Hormones and their receptors, cell surface receptor, signaling through G-protein coupled receptors, signal transduction pathways, second messengers, regulation of signaling pathways, bacterial and plant two-component systems, light signaling in plants, bacterial chemotaxis and quorum sensing.
7.Cancer :Genetic rearrangements in progenitor cells, oncogenes, tumor suppressor genes, cancer and the cell cycle, virus-induced cancer, metastasis, interaction of cancer cells with normal cells, apoptosis, therapeutic interventions of uncontrolled cell growth.

I. Molecular Biology

1. DNA replication, repair and recombination :Unit of replication, enzymes involved, replication origin and replication fork, fidelity of replication, extrachromosomal replicons, DNA damage and repair mechanisms, homologous and site-specific recombination).
2. RNA synthesis and processing : transcription factors and machinery, formation of initiation complex, transcription activator and repressor, RNA polymerases, capping,
3. Protein synthesis and processing :Ribosome, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, genetic code, aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase, and translational proof-reading, translational inhibitors, Post- translational modification of proteins.
4. Control of gene expression at transcription and translation level : regulating the expression of phages, viruses, prokaryotic and eukaryotic genes, role of chromatin in gene expression and gene silencing.

J. Virology and Immunology:

1. Baltimore Classification system, General structures (Envelop and Non Envelop Viruses),Occurance
2. Bacteriophage: T4 ,λ,M13,ØX174: structure, Lysogenic and Lytic Cycle,SOS response in E.coli.Phage titre: Chemical and physical determination
3. Viroids and Proins
4.Plant virus structure, replication and pathogenesis.
5. Animal virus structure, replication and pathogenesis and tumour formation
6. Innate and adaptive immune system Cells and molecules involved in innate and adaptive immunity, antigens, antigenicity and immunogenicity. B and T cell epitopes, structure and function of antibody molecules. generation of antibody diversity, monoclonal antibodies, antibody engineering, antigen-antibody interactions, MHC molecules, antigen processing and presentation, activation and differentiation of B and T cells, B and T cell receptors, humoral and cell-mediated immune responses, primary and secondary immune modulation, the complement system, Toll-like receptors, cell-mediated effector functions, inflammation, hypersensitivity and autoimmunity, immune response during bacterial (tuberculosis), parasitic (malaria) and viral (HIV) infections, congenital and acquired immunodeficiencies, vaccines.

K. Classical Genetics

1.Mendelian principles : Dominance, segregation, independent assortment.
2.Concept of gene : Allele, multiple alleles, pseudoallele, complementation tests
3.Extensions of Mendelian principles : Codominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance and expressivity, phenocopy, linkage and crossing over, sex linkage, sex limited and sex influenced characters.
4.Gene mapping methods : Linkage maps, tetrad analysis, mapping with molecular markers, mapping by using somatic cell hybrids, development of mapping population in plants.
5.Extra chromosomal inheritance : Inheritance of Mitochondrial and chloroplast genes, maternal inheritance.
6.Microbial genetics : Methods of genetic transfers – transformation, conjugation, transduction and sex-duction, mapping genes by interrupted mating, fine structure analysis of genes.
7.Human genetics : Pedigree analysis, lod score for linkage testing, karyotypes, genetic disorders.
8.Quantitative genetics : Polygenic inheritance, heritability and its measurements, QTL mapping.
10.Mutation : Types, causes and detection, mutant types – lethal, conditional, biochemical, loss of function, gain of function, germinal verses somatic mutants, insertional mutagenesis.
11.Structural and numerical alterations of chromosomes : Deletion, duplication, inversion, translocation, ploidy and their genetic implications.
12.Recombination : Homologous and non-homologous recombination including transposition

L. Ecology:

1.The Environment: Physical environment; biotic environment; biotic and abiotic interactions.
2.Habitat and Niche: Concept of habitat and niche; niche width and overlap; fundamental and realized niche; resource partitioning; character displacement.
3.Population Ecology: Characteristics of a population; population growth curves; population regulation; life history strategies (*r* and *K* selection); concept of metapopulation – demes and dispersal, interdemic extinctions, age structured populations.
4.Species Interactions: Types of interactions, interspecific competition, herbivory, carnivory, pollination, symbiosis.
5.Community Ecology: Nature of communities; community structure and attributes; levels of species diversity and its measurement; edges and ecotones.
6.Ecological Succession: Types; mechanisms; changes involved in succession; concept of climax.
7.Ecosystem Ecology: Ecosystem structure; ecosystem function; energy flow and mineral cycling (C,N,P); primary production and decomposition; structure and function of some Indian ecosystems: terrestrial (forest, grassland) and aquatic (fresh water, marine, eustarine).
8.Biogeography: Major terrestrial biomes; theory of island biogeography; biogeographical zones of India.
9.Applied Ecology: Environmental pollution; global environmental change; biodiversity: status, monitoring and documentation; major drivers of biodiversity change; biodiversity management approaches.

M. Evolution:

1.Emergence of evolutionary thoughts :Lamarck; Darwin–concepts of variation, adaptation, struggle, fitness and natural selection; Mendelism; Spontaneity of mutations; The evolutionary synthesis.
2.Origin of cells and unicellular evolution: :Origin of basic biological molecules; Abiotic synthesis of organic monomers and polymers; Concept of Oparin and Haldane; Experiement of Miller (1953); The first cell; Evolution of prokaryotes; Origin of eukaryotic cells; Evolution of unicellular eukaryotes; Anaerobic metabolism, photosynthesis and aerobic metabolism.
3. Evolutionary History: The evolutionary time scale; Eras, periods and epoch; Major events in the evolutionary time scale; Origins of unicellular and multi cellular organisms; Major groups of plants and animals; Stages in primate evolution including Homo.
4. Molecular Evolution: Concepts of neutral evolution, molecular divergence and molecular clocks; Molecular tools in phylogeny, classification and identification; Protein and nucleotide sequence analysis; origin of new genes and proteins; Gene duplication and divergence.
5.The Mechanisms: Population genetics – Populations, Gene pool, Gene frequency; Hardy-Weinberg Law; concepts and rate of change in gene frequency through natural selection, migration and random genetic drift; Adaptive radiation; Isolating mechanisms; Speciation; Allopatricity and Sympatricity; Convergent evolution; Sexual selection; Co-evolution.

N. Methods in Microbiology:

1. Isolation and purification of RNA , DNA (genomic and plasmid) and proteins, different separation methods.
2. Analysis of RNA, DNA and proteins by one and two dimensional gel electrophoresis, Isoelectric focusing gels.
3. Molecular cloning of DNA or RNA fragments in bacterial and eukaryotic systems.
4. Expression of recombinant proteins using bacterial, animal and plant vectors.
5. Isolation of specific nucleic acid sequences
6. Generation of genomic and cDNA libraries in plasmid, phage, cosmid, BAC and YAC vectors.
7. In vitro mutagenesis and deletion techniques, gene knock out in bacterial and eukaryotic organisms.
8. Protein sequencing methods, detection of post translation modification of proteins.
9.DNA sequencing methods, strategies for genome sequencing.
10.Methods for analysis of gene expression at RNA and protein level, large scale expression, such as micro array based techniques
11. Isolation, separation and analysis of carbohydrate and lipid molecules
12. RFLP, RAPD and AFLP techniques
13. Antibody generation, Detection of molecules using ELISA, RIA, western blot, immunoprecipitation, fluocytometry and immunofluorescence microscopy, detection of molecules in living cells, in situ localization by techniques such as FISH and GISH.
14. Molecular analysis using UV/visible, fluorescence, circular dichroism, NMR and ESR spectroscopy Molecular structure determination using X-ray diffraction and NMR, Molecular analysis using light scattering, different types of mass spectrometry and surface plasma resonance methods.
15. Measures of central tendency and dispersal; probability distributions (Binomial, Poisson and normal); Sampling distribution; Difference between parametric and non-parametric statistics; Confidence Interval; Errors; Levels of significance; Regression and Correlation; t-test; Analysis of variance; X2 test;; Basic introduction to Muetrovariate statistics, etc.
16. Visulization of cells and subcellular components by light microscopy, resolving powers of different microscopes, microscopy of living cells, scanning and transmission microscopes, different fixation and staining techniques for EM, freeze-etch and freeze- fracture methods for EM, image processing methods in microscopy.
17. 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.

Syllabus

Course Work-Ph.D programme

Department of Microbiology ,University of North Bengal

Paper	Paper code	Paper Name	Duration	Lectures	Credits	Full Marks
1.	**MBCW01**	**Research Methodology & Design**	First 3Months	10	1	25
2.	**MBCW 02**	**Quantitative Methods**	First 3Months	20	2	50
3.	**MBCW 03**	**Computer Application**	First 3 Months	10	1	25
4.	**MBCW 04**	**Advance Microbiology**	Second 3 Months	40	4	100
		Total	**6 months**	**80**	**8**	**200**

Date:

To
The secretary
Faculty Council for P.G Studies in Science
Univsersity of North Bengal
Rajarammohunpur

Subject: Reframing the Ph.D course work syllabus

Sir,

With respect to the letter reference no. **Ref.No.F.21/3138/FCS/17,dated 27.02.2017** the Ph.D course work syllabus of Department of Microbiology has been reframed and the draft syllabus is attached herewith along with the Departmental committee resolution copy.

It is further for your kind information that there will be no intake of students for Ph.D course work for the session 2016-2017 because already 4 students (session 2014-2015) had completed their course work and are involved in research under myself.

Yours Sincerely,

(Dr.ArindamBhattacharjee)
Head
Department of Microbiology

Paper:MBCW-01

Research Methodology and Design

Defining research Basic and applied research;Essential steps in research ;Defining the research problem;Research/Experimental design;Literature citation ;Research report :components format of thesis and dissertation ,Manuscript/Research article,Review,Monographs,Bibliography and References ;Significance of research ; Bioethics in animal experiments,Safe disposal of microbial and other hazardous wastes,Project proposal.

Paper: MBCW-02

Quantitative Methods

Measures of central tendency and dispersal;Probability distributions-binomial ,poisson and normal;Sampling distribution ;Hypothesis testing-significance testing,T-test,Chi-square test,F-test;ANOVA-one way and two way analyses ; Regression and correlation analyses;Principle component analysis;Discriminant analysis using software.Biohazards,Riskanalysis,Carcinogens,Toxicagents,Biosafetycabinet,Radiation safety ,Chemical safety,Biosafety guidelines and regulation.

Paper:MBCW-03

Computer Application

Biological databank and sequence analysis,Database searching and BLAST,FASTA,Multiple sequence alignments CLUSTALW,Computing evolution –phylogenetic analysis ,Promoters,Restrictionsites,RNA folding patterns,Proteinmotifs,Domains,Pattern recognition softwares ,Primer design,Concept of molecular cloning ,Molecular docking and Drug design.

Paper:MBCW-04

Advance Microbiology

Chemolithotropy and phototrophy,Biological nitrogen fixation,Cellsignaling in Prokaryotes ,Aerobic fermentation ,Respiration ,Bacterial genetics,Development of mutant strains and genetic analysis,Genotypeanalysis,Preservation of important strains,Properties of Phage infected bacterial culture ,Restriction ,Modification and Trangenics. Genome analysis ,Phylogenetic profiling,VNTR,SNTR,SNP,Differential Display ,Analysis of proteomes,Networking,Integrated 2D gel-MS,Purification of proteins,Microarray analysis.

Phase contrast microscopy ;Confocal microscopy;Scanning and Transmission electron microscopy ;Freeze-tech and Freeze-fracture methods for EM,ELISA,FACS,Spectroscopy (NMR,IR,MS etc).Chromatography-TLC,Gas,Column,HPLC;Electrophoresis(DNA and Protein separation techniques),PCR-Nested PCR,Real time PCR and Inverse PCR;Hybridisation ;Blotting Techniques-Western,Southern and Norhtern;Automation in diagnostics,Nanotechniques,Bioprocess,DNAsequencing,Proteinsequencing,Chemical synthesis of DNA and Protein.