

**2016**

**M.Sc. Microbiology Syllabus, 2016  
DEPARTMENT OF BOTANY  
GAUHATI UNIVERSITY**



*With effect from the Academic Session 2016-17*



Paper Code	Name of the paper	Total Marks	Internal assessment	Semester Exam	No. of classes/ week	Credits
MICRO1016	Microbial Diversity, Taxonomy & Systematics	100	20	80	5	6
MICRO1026	Soil & Agricultural Microbiology	100	20	80	5	6
MICRO1036	Physiology & Biochemistry	100	20	80	5	6
MICRO1044	Microbial Diversity, Taxonomy & Systematics and Soil and Agricultural Microbiology	100	20	80	9	4
MICRO1054	Physiology & Biochemistry	100	20	80	9	4
MICRO2016	Microbial Genetics & Molecular biology	100	20	80	5	6
MICRO2026	Bioinstrumentation & Microbial Techniques	100	20	80	5	6
MICRO2036	Immunology	100	20	80	5	6
MICRO2044	Microbial Genetics & Molecular biology	100	20	80	9	4
MICRO2054	Immunology	100	20	80	9	4
MICRO3016	Environmental microbiology	100	20	80	5	6
MICRO3026	Medical microbiology	100	20	80	5	6
MICRO3036	Food & Industrial microbiology	100	20	80	5	6
MICRO3044	Environmental microbiology	100	20	80	9	4
MICRO3054	Medical microbiology & Food & Industrial Microbiology	100	20	80	9	4
MICRO4016	Genetic Engineering, IPR & Biosafety Regulation	100	20	80	5	6
MICRO4026	Biostatistics & Bioinformatics	100	20	80	5	6
MICRO4036	Genetic engineering, Biostatistics & Bioinformatics	100	20	80	9	6
MICRO4046	Dissertation	200	-	-	9	6

**Programme specific outcome:**

**M. Sc. in Microbiology**

- Understand the diversity, life cycle pattern, phylogeny and economic values of microbes of the NE Region.
- Analyse the plant-microbe interaction.
- Understand the role of unculturable microbial flora in environment.
- Train up skill human resources in the field of microbiology.
- Perform procedures as per laboratory standards in the above mentioned areas. Understand the application of microbial resources in agriculture, health care, industry and other environmental issues.

**FIRST SEMESTER**  
**Allotment of Marks and Credits**

Paper(s)	Course work	Internal Assessment	Total	Credit	Class/week
MICRO-1016	80	20	100	6	5
MICRO-1026	80	20	100	6	5
MICRO-1036	80	20	100	6	5
MICRO-1044	80	20	100	4	9
MICRO-1054	80	20	100	4	9

Examination Time: Theory.....3(Three Hours); Practical.....5(Five Hours)

**MICRO-1016**  
**Microbial Diversity, Taxonomy & Systematics**

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**Unit-I**

Concept of microbial species, different groups of microbes, assessment of microbial diversity (microscopic, cultural, molecular), estimates of total number of species, measures and indices of diversity.

**Unit-II**

Recent trends in microbial taxonomy, international code of nomenclature for virus, bacteria and fungi, concept of phylogeny and systematics, presently accepted classifications of virus, bacteria, fungi and micro-algae.

### **Unit-III**

Newer approaches for exploring unculturable microbes: Restriction enzyme based, PCR-based, Microarrays, Metagenomic approach.

### **Unit-IV**

Microbial evolution & biodiversity: origin of life, chemical and cellular evolution, rRNA analysis for tracing microbial evolution, genetic basis of evolution, bacterial, archaeal and eukaryotic diversity.

### **Unit-V**

Structure and functions of slime layers, cilia, flagella, cyst, heterocyst, endospores in bacteria; different types of reproductive structures and spore formation in fungi, dimorphism in fungi, heterothallism and parasexuality in fungi.

### **Unit-VI**

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), Cell division and cell cycle (Mitosis and meiosis, their regulation, steps in cell cycle, regulation and control of cell cycle).

## **MICRO-1026**

### **Soil and Agricultural Microbiology**

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### **Unit-I**

Soil and its properties, Soil microbial population, Sub-surface microbes, Biogeochemical cycling, Microbial interactions: within a single population and between diverse populations (commensalism, neutralism, synergism, mutualism, competition, amensalism and predation), soil and plant microbial habitats and implications for use of legumes, organic farming and biologic pest control.

### **Unit-II**

Microbial interactions with plants (endophytes, mycorrhiza, rhizosphere, symbiotic and associative nitrogen fixation, plant parasitism) and animals (human microbiome, symbiotic relationships, animal parasitism).

### **Unit-III**

Community dynamics, succession within microbial community, succession between biofilm Communities, structure of microbial communities, diversity and stability of microbial community, microbial communities in nature.

### **Unit-IV**

Adaptation to different environmental conditions, quantitative ecology (detection of population, determination of number, biomass and measurement of activity, Microbiology of extreme environments, microorganisms and organic matter decomposition.

### **Unit-V**

Plant pathogenic microorganisms: Disease symptoms, Mode of entry, Disease resistance, Physiology of parasitism, Management of plant diseases, Diseases caused by fungi, bacteria, viruses, algae mycoplasma and nematodes prevalent in north east India.

### **Unit-VI**

Role of microbes in agriculture, horticulture and tissue culturally raised plants, Plant growth promoting rhizobacteria and its role in agriculture, Entomogenous fungi and control of insect pests, Microbial biodeterioration of agricultural produce, biodegradation.

## **MICRO-1036**

### **Physiology and Biochemistry**

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### **Unit-I**

Cell and cellular components, bacterial and fungal cell wall composition; Structure, properties and classification of biomolecules (carbohydrates, proteins, lipids, nucleic acids); composition and architecture of membranes, membrane dynamics, Solute transport (passive diffusion, active transport using P and F type ATPases, Ion mediated transport, transport of ions), liposomes.

### **Unit-II**

Reactions of bio-organic molecules: substitution, addition, elimination, rearrangement, oxidation and reduction; bonding other than covalent, concept of pH of weak acids and weak bases, Henderson-Hasselbalch equation, concept of buffer (types, strength and value).

### **Unit-III**

Bioenergetics: Laws of thermodynamics, entropy, enthalpy, free energy and equilibrium constant, Gibbs free energy equation, determination of free energy of hydrolytic and

biological oxidation reduction reactions. Enzymes and enzyme kinetics, enzyme regulation, mechanism of enzyme catalysis, isozymes, concept of allosterism, abzyme and ribozyme.

#### **Unit-IV**

Microbial metabolisms, respiration, mitochondrial electron transport chain, generation and maintenance of proton motive force, oxidative phosphorylation, inhibitors and un-couplers of electron transport chain and oxidative phosphorylation, Energy generation in all groups of chemolithotrophs; anaerobic respiration, oxidized sulfur compounds, and nitrate as electron acceptor with respect to electron transport chain and energy generation, Biochemistry of methanogens.

#### **Unit-V**

Energy consideration in photosynthesis, light and dark reaction, electron carriers in photosynthesis, organization of photosystem I and II, cyclic and non-cyclic flow of electrons, bacterial photosynthesis: scope, electron carriers, photosynthetic reaction center, cyclic flow of electrons, bacterial photophosphorylation in various groups of phototrophic bacteria, anoxygenic photosynthetic bacteria.

#### **Unit-VI**

Biochemistry of biological nitrogen fixation, properties of nitrogenase and its regulation, ammonia assimilation with respect to glutamine synthetase, glutamate dehydrogenase, glutamate synthetase, their properties and regulation, Biosynthesis of amino acids, Biosynthesis of purine and pyrimidine bases.

## **MICRO-1044**

### **Microbial Diversity, Taxonomy & Systematics, Soil and Agricultural Microbiology**

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1. Isolation, identification and characterization of actinomycetes, yeast, fungi and bacteria, anaerobic microorganisms, thermophilic microorganisms and cyanobacteria from soil.
2. Pure culture and preservation of microbes.
3. Root colonization and AM fungal population.
4. Isolation and characterization of *Rhizobium* from soil and root nodules.
5. Isolation and screening of plant growth promoting rhizobacteria (PGPR) from soil.
6. Counting of bacterial cells and fungal spores and determination of bacterial growth curve.
7. Isolation and identification of endophytes.

8. Simple staining, (Gram & acid fast staining), differential staining, flagella and capsule staining.
9. Effect of physical & chemical factors on microbial growth.
10. Microscopic measurements of microbial spores/cells.
11. Biochemical test for bacterial identification (Triple sugar-Iron Agar, IMViC, H<sub>2</sub>S, Urease, Catalase, Oxidase, Nitrate reductase, Litmus milk and utilization of amino acids).

### **MICRO-1054**

#### **Physiology and Biochemistry**

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1. Preparation of buffers using KH<sub>2</sub>PO<sub>4</sub> and K<sub>2</sub>HPO<sub>4</sub>, acetic acid and sodium acetate, K<sub>2</sub>HPO<sub>4</sub> and H<sub>3</sub>PO<sub>4</sub>.
2. Separation of sugar and amino acids by paper and thin layer chromatography.
3. Estimation of sugar and total carbohydrate, estimation of protein by Lowry, Bradford and UV Spectrophotometry.
4. Extraction and separation of bacterial pigment.
5. Determination of saponification value and iodine number of fat.
6. Determination of molar extinction coefficient of biological molecule.
7. Purification of enzyme from natural source by ammonium sulfate precipitation, organic solvent precipitation, gel filtration.
8. Determination of K<sub>m</sub> and V<sub>m</sub> values of invertase and amylase.
9. Isolation and characterization of (as nitrogen fixers) of *Azospirillum* and detection of IAA.
10. Carbohydrate fermentation by yeast and other fermentative microbes.

**SECOND SEMESTER**  
**Allotment of Marks and Credits**

Paper(s)	Course work	Internal Assessment	Total	Credit	Class/week
MICRO-2016	80	20	100	6	5
MICRO-2026	80	20	100	6	5
MICRO -2036	80	20	100	6	5
MICRO -2044	80	20	100	4	9
MICRO -2054	80	20	100	4	9

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Examination Time: Theory.....3(Three Hours); Practical.....5(Five Hours)

**MICRO-2016**  
**Microbial Genetics & Molecular Biology**

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**Unit-I**

DNA replication, DNA damage and repair mechanisms, Basis of genetic variability, Genetic recombination and methods of genetic transfers – transformation, conjugation, transduction, site-specific recombination.

**Unit-II**

Concept of gene, allele and pseudoallele; organization of genes and chromosomes (Operon, unique and repetitive DNA, interrupted genes, gene families, structure of chromatin and chromosomes, heterochromatin, euchromatin, transposons), Mutation: Types, causes and detection and mutant types. Structural and numerical alterations of chromosomes and their genetic implications.

**Unit-III**

Mendelian and non-Mendelian laws of inheritance, linkage and crossing over, extra chromosomal inheritance, gene mapping (linkage maps and mapping with molecular markers), mapping genes by interrupted mating, Quantitative genetics: Polygenic inheritance, heritability and its measurements, QTL mapping.

**Unit-IV**

Control of gene expression at transcription level (role of promoter, regulator, enhancer and suppressor in gene regulation; Types of histones, histone modifications - Methylation, Acetylation, Phosphorylation and its effect on structure and function of chromatin, role of chromatin in gene expression and gene silencing), gene interaction - epistasis, complementation, pleiotropy, penetrance and expressivity

### **Unit-V**

Control of gene expression at translation level (RNA synthesis and processing), regulatory RNA: antisense RNAs, micro RNAs, RNA interference), protein synthesis and processing, translational proof-reading, translational inhibitors, post-translational modification of proteins.

### **Unit-VI**

Cell signaling (Hormones and their receptors, cell surface receptor, signaling through G-protein coupled receptors and quorum sensing), cellular communication.

## **MICRO-2026**

### **Bioinstrumentation & Microbial Techniques**

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### **Unit-I**

Microscopic techniques, scanning and transmission electron microscopes, different fixation and staining techniques for EM, freeze-etch and freeze-fracture methods for EM, confocal microscope.

### **Unit-II**

Histochemical and Immunotechniques: 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 FISH and GISH techniques.

### **Unit-III**

Working principles and application of chromatography, electrophoresis (agarose and acrylamide – DGGE, Isoelectric focusing), Centrifugation (Ultra centrifugation, Density gradient centrifugation, Differential centrifugation, Isopycnic centrifugation).

### **Unit-IV**

Working principles and application of spectroscopy in biology (UV/Visible spectroscopy, Circular Dichroism, Optical Rotary Dispersion, Fluorescence spectroscopy, Infrared spectroscopy, FTIR, NMR, ESR, Mass spectroscopy) and Biosensors.

### **Unit-V**

Radiography, tracer elements in biology, radioactive isotopes, half life of isotopes, autoradiography, pulse chase experiment, cerenkov radiation, liquid scintillation counting, phosphor imaging, safety guidelines.

**Unit-VI**

DNA sequencing: Principles of Sanger's sequencing, Maxam and Gilburg sequencing, Next Generation Sequencing (Illumina and Solexa).

**MICRO-2036**  
**Immunology**

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**Unit-I**

Concept of immune system; types of Immunity- acquired and innate; cell mediated and humoral immunity; haematopoiesis; cells, tissues and organs of the immune system, complement system.

**Unit-II**

Immunoglobulin- structure, function and classes; introduction to antigens and immunogens; antigenic determinates.

**Unit-III**

Concept of antigen presentation. major histocompatibility complex (MHC). Introduction to HLA. Cytokines, chemokines and their receptors.

**Unit-IV**

Brief introduction to antigen-antibody interactions, Concept of ELISA. Ploclonal and monoclonal antibody, hybridoma technology and its application in healthcare sector.

**Unit-V**

Inflammation, hypersensitivity and autoimmunity; vaccines and immunization.

**Unit-VI**

Immunology of bacterial, viral and parasitic diseases.

**MICRO-2044**  
**Bioinstrumentation & Immunology**

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1. Determination of Sedimentation coefficient at different centrifugation speed.
2. Absorption at different wavelength of nucleic acid and protein using UV-Vis spectrophotometer.
3. Mobility of nucleic acid at different gel concentration and voltage in electrophoresis.
4. Estimation of haemoglobin contents of human blood.
5. Determination blood group.
6. Slide/tube agglutination test for serotyping pathogens.
7. Microbial spore measurement using micrometry techniques.
8. Calibration of pH meter and determination of pH of given sample.

**MICRO-2054**  
**Microbial Genetics & Molecular Biology**

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1. Plasmid DNA extraction and determination of molecular weight of plasmid DNA.
2. PCR amplification of desired gene
3. Restriction digestion and ligation of DNA, Endonuclease mapping of DNA
4. Preparation of competent cells and transformation of plasmid DNA in E. coli.
5. Curing of plasmid using agents such as Ethidium bromide, Acridine orange, Plumbagin and Mitomycin C.

**THIRD SEMESTER**  
**Allotment of Marks and Credits**

Paper(s)	Course work	Internal Assessment	Total	Credit	Class/week
MICRO-3016	80	20	100	6	5
MICRO -3026	80	20	100	6	5
MICRO -3036	80	20	100	6	5
MICRO -3044	80	20	100	4	9
MICRO -3054	80	20	100	4	9

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Examination Time: Theory.....3(Three Hours); Practical.....5(Five Hours)

**MICRO-3016**  
**Environmental Microbiology**

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**Unit-I**

Water microbiology: peculiarities of water as an environmental habitat for microorganisms, taxonomy, physiology, and ecology of aquatic microorganisms, pollution of aquatic systems, eutrophication, oil spills, municipal purification of water, disease transmission in water, waterborne pathogens, low-energy wastewater treatment, strategies and technologies.

**Unit-II**

Bacteriological examination of water: coliform MPN test, membrane filter technique, defined substrate technology for the detection of coliforms and fecal coliforms, film medium for the detection of coliforms in water, food, and on surfaces, detection of bacteriophages, detection of enteric viruses in water, detection of waterborne parasites, kinetics of disinfection, new molecular methods for detection of waterborne pathogens.

**Unit-III**

Microbial transformations and response to contaminants, enrichment and isolation of bacteria that degrade 2,4-dichlorophenoxyacetic acid, adaptation of soil bacteria to metals, biodegradation of phenol compounds, assimilable organic carbon, biochemical oxygen demand, detoxification of inorganic and organic pollutants by microorganisms, and challenges of microbiological degradation of recalcitrant pollutants.

**Unit-IV**

Waste Disposal: organic matter content in sewage and wastewaters, aerobic and anaerobic sewage systems, advanced wastewater treatment, municipal solid wastes-nature, disposal and management, anaerobic breakdown of organic matter in landfills and aquatic sediments, the Stockholm conference.

**Unit-V**

Microbial transformations of radionuclides in the subsurface, microbial deterioration of cultural heritage materials, sorption and transformation of toxic metals by microorganisms, biosensors as environmental monitors, effects of genetically modified plants on soil microorganisms, anaerobic digestion of agricultural residues, bioremediated geomechanical processes, hydrothermal vents and coral reefs, genetically modified micro-organisms (GMOS) in the environment.

**Unit-VI**

Aerobiology: sampling of airborne microorganisms, detection and identification of airmicroflora, aquifer systems, fundamentals and applications, pollution control and waste minimization, microbes and climate change, carbon sequestration.

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**MICRO-3026**  
**Medical Microbiology**

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**Unit-I**

General aspects of medical microbiology, subcellular infectious entities, prokaryotic and eukaryotic microorganisms, host - pathogen interactions, regulation of bacterial virulence, genetics of bacterial pathogenicity, nonspecific and specific defense mechanisms, defects in immune defenses, normal Flora.

**Unit-II**

Antibacterial agents, antifungal agents, antiviral agents, principles of antibiotic therapy, spectrum of action, efficacy, mechanisms of action, pharmacokinetics, side effects, problem of resistance, incidence, significance, resistance mechanisms, evolution of resistance to anti-infective agents, resistance tests, combination therapy, chemoprophylaxis, immunomodulators, multiple drug resistance (MDR).

**Unit-III**

Epidemiology and prevention of infections, upper and lower respiratory tract infections, tuberculosis and mycobacteria, gastrointestinal, liver and biliary tract infections, urinary tract infections, genital infections, infections of the central nervous system.

**Unit-IV**

Control of infectious diseases, principles of hospital infection, sterilisation and disinfection, food, water and public health, antibacterials - the principles, antiviral therapy, antifungal therapy, antiprotozoal and antihelminthic, therapy, non-drug control of infection, immunisation to infectious disease.

### Unit-V

Bacteria as human pathogens, *Bacillus anthracis*, *Clostridium tetani* (Tetanus), *Clostridium botulinum* (Botulism), *Listeria monocytogenes*, *Gardnerella vaginalis*, *Corynebacterium diphtheriae* (Diphtheria), *Actinomyces*, *Mycobacterium tuberculosis* (TB), leprosy bacteria (LB), *Nocardia*, *Salmonella* (gastroenteritis, typhoid fever) *Shigella* (bacterial dysentery), *Escherichia coli*, opportunistic enterobacteriaceae (*Vibrio*, *Aeromonas*, and *Plesiomonas*).

### Unit-VI

Viruses as human pathogens, host-pathogen interactions, diagnosis, therapy host-cell reactions, cell destruction (cytotoxic infection, necrosis), virus replication without cell destruction, tumor transformation, carcinogenic retroviruses (oncoviruses), DNA tumor viruses pathogenesis, defense mechanisms, nonspecific and specific immune defenses, prevention, chemotherapy, laboratory diagnosis, culturing, direct virus detection, virus detection following biochemical, amplification, serodiagnosis .

## MICRO-3036

### Food & Industrial Microbiology

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### Unit-I

Factors affecting the growth and survival of micro-organisms in foods, microbiology of food preservation, food microbiology and public health, food borne diseases, fermented microbial foods, methods for the microbiological examination of foods, controlling the microbiological quality of foods, advance techniques in food microbiology, microbial spoilage and public health.

### Unit-II

Molecular biology and bioinformatics in relation to in industrial microbiology, media and the nutrition of industrial organisms, nutrient requirements, raw materials used in industrial media, plant waste materials as media, sterilization in industrial microbiology, overproduction of metabolites of industrial microorganisms , screening of potent strains and strain, improvement, preservation of microbial gene pool.

### Unit-III

Industrial processes and products, microbial enzymes, fuels and industrial chemicals, health care products, food and beverage fermentations, food additives and supplements, microbial biomass production.

#### Unit-IV

Fermentors types and operation, design of new fermentors on the basis of physiology of the organisms, operational modes of bioreactors; batch, fed-batch and continuous processes; applications, advantages and limitations of each type, effect of type of growth on fermentation, processes: upstream, fermentation and downstream processing, use of fungi in industry including food industry, biosensors and fuel cells, growth and product formation during fermentation: primary and secondary products, metabolites and their control, kinetics of growth and product formation (growth rate, yield coefficient and efficiency).

#### Unit-V

Stimulant beverages: tea, coffee, fermented foods derived from legumes production of organic acids (citric and lactic acids), industrial alcohol (ethanol), immobilized enzymes and immobilized cells, ore leaching (bioleaching) by microorganisms, products of pharmaceutical importance (antibiotics, antitumor agents, vaccines, microbial transformation and steroids and sterols).

#### Unit-VI

Principles of validation process, method validation, concept of ISO certification, preparation of SOPs, validation protocols for methods in quality control, process validation as per WHO Norms.

## MICRO-3044 Environmental Microbiology

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1. Bacteriological examination of water using multiple-tube fermentation test.
2. Determination of air borne microflora
3. Determination of biochemical oxygen demand (BOD) and chemical oxygen demand (COD) of water.
4. Determination of MPN of coliform bacteria.
5. Quantitative analysis of water.
6. Enrichment culture and biodegradation of xenobiotics.
7. Detection of siderophore production by *Azospirillum* and *Pseudomonas*
8. Isolation and characterization of chemolithotrophic microorganisms
9. Growth of microbes in nitrogen free media.
10. Determination of the ability of microbes to degrade cellulose and lignin.
11. Isolation of thermotolerant/thermophilic microbes.

**MICRO-3054**  
**Medical, Food and Industrial Microbiology**

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1. Isolation of antibiotic producing microorganisms and determination of antimicrobial spectrum of isolates.
2. Antibiotic sensitivity test.
3. Microorganisms of skin, mouth, dental caries.
4. Detection of numbers of bacteria in milk by SPC and breed count.
5. Determination of quality of milk sample by methylene blue reductase test.
6. Microbiological examination of food.
7. Role of yeast in bread making.
8. Wine production by the fermentative activities of yeast.
9. Microbiological production of sauerkraut.
10. Computer applications, plotting graphs, statistical analysis using excel, simulation of population growth in batch and continuous culture.

**FOURTH SEMESTER**  
**Allotment of Marks and Credits**

Paper(s)	Course work	Internal Assessment	Total	Credit	Class/week
MICRO-4016	80	20	100	6	5
MICRO -4026	80	20	100	6	5
MICRO -4036	80	20	100	6	5
MICRO -4046	160	40	200	6	5

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Examination Time: Theory.....3(Three Hours); Practical.....5(Five Hours)

**MICRO-4016**  
**Genetic Engineering, IPR and Biosafety Regulation**

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**Unit-I**

Molecular cloning of DNA or RNA fragments in bacterial and eukaryotic systems, expression of recombinant proteins using bacterial, animal and plant vectors, generation of genomic and cDNA libraries, *in vitro* mutagenesis, gene knock out in bacterial and eukaryotic organisms, protein sequencing methods, detection of post translation modification of proteins, DNA sequencing methods, strategies for genome sequencing, methods for analysis of gene expression at RNA and protein level, large scale expression, such as micro array based techniques.

**Unit-II**

Recombinant DNA technology: shot gun cloning, gene library, cDNA cloning; transformation (bacteria, yeast, plants, and animals), characterization, selection and screening of recombinants, phage display systems, heterologous gene expression, vectors: plasmids, cosmid, phages-lambda vectors, single strand vectors, expression vectors, high capacity vectors: PAC, BAC and YAC.

**Unit-III**

Blotting techniques; southern, northern and western hybridization technique, use of radioactive and non-radioactive nucleotides for probe preparation and detection of hybrids, PCR, RT-PCR, qPCR and its applications, DNA microarrays and their use in genomics.

**Unit-IV**

Sequencing techniques; Maxam and Gilbert method, Sanger's di-deoxy method and modifications, automated sequencers, pyrosequencing and recently developed sequencing methods, protein sequencing.

**Unit-V**

Principles of IPR and patent law, patent application procedure, trade mark, copyright, enforcement of IPR, information technology and IPR, computer software and IPR,

biotechnology and IPR, protection of plant varieties, geographical indicators, farmers right, resource rights.

#### **Unit-VI**

Registration, review and approval of rDNA research, general approval procedure for rDNA products and genetically modified microorganisms, genetically engineered microorganisms and their products, release and their impact on the environment and human health, hazard identification and risk management, field tests for genetically modified microorganisms; concept of biosafety, biosafety levels, good microbiological practices, biosafety guidelines, levels of biohazard, biological weapons, biosecurity, components of biosecurity program, bioethical issues.

## **MICRO-4026**

### **Biostatistics & Bioinformatics**

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#### **Unit-I**

Quantitative methods in biology, sampling methods, scales and variables, data organization, tabulation, frequency and probability distributions, graphical representation of distributions, introduction to normal, binomial and poisson distributions and their applications, measures of central tendency, measures of dispersion, skewness, kurtosis.

#### **Unit-II**

Measures of central tendency and dispersal; probability distributions (Binomial, Poisson and normal); laws of probability, independence and randomness; distribution of sample means, standard error and confidence interval, levels of significance; regression and correlation, curve fitting and choice of models; introduction to multivariate analysis: multiple regressions, ordination, principal component analysis.

#### **Unit-III**

Survey design, factorial design, ANOVA and F test, T-tests, non-parametric tests. The concepts of null hypothesis, significance level, type I and type II errors, one tailed and two tailed tests, categorical data and proportion data, chi square test and test for goodness of fit.

#### **Unit-IV**

Computer languages and operating systems, computer simulation of biological systems, writing simple simulation programs for growth models, population interactions and pathway regulation, introduction to bioinformatics, biological databases and data formats, data mining and retrieval systems, nomenclature of nucleotides and amino acids, scope and application of bioinformatics.

### Unit-V

Nucleic acid and protein sequence analysis, assembly and functional annotation. Gene finding, ORF prediction, gene cloning and restriction map digestion, primer designing, sequence alignment methods-pairwise and multiple sequence alignments, scoring matrices, local and global alignment, database search for homologous sequences-BLAST and FASTA, phylogenetic analysis, concept of high-throughput sequencing, analysis and functional annotation.

### Unit-VI

Nucleic acid structures and folding, protein secondary structure analysis, three dimensional structure prediction, ramachandran plot, protein profiles, patterns and fingerprint search, protein-nucleic acid, protein-protein and protein-ligand interactions, protein structural databases (PDB, NDB, MMDB). Introduction to computer-aided drug discovery, approaches, ligand design methods, docking programs.

## MICRO-4034

### Genetic Engineering, Biostatistics & Bioinformatics

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1. Isolation of total DNA, amplification of target sequence with PCR, restriction digestion, and ligation of target sequence with suitable vector, transformation to the host and characterization.
2. Study of expression level of the recombinant product with SDS-PAGE.
3. To workout the mean, median, mode, range, standard deviation, standard error and co-variance of any population data.
4. Application of t-test, F-test and Chi-square test for a given set of data.
5. Drawing of line graphs and histograms from tabulated data.
6. Preparation of skeleton of analysis of variance of the designs - Randomized block design, split-plot and latin square design.
7. Data analysis with appropriate software.
8. Sequence alignment and homologous sequence search.
9. Sequence annotation and gene prediction with the help of bioinformatics tools.
10. Protein modelling and structure prediction.

**MBP-4044**  
**Dissertation**

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**Course outcome:**

**Programme : M. Sc. Microbiology**

MICRO-1016: Microbial Diversity, Taxonomy & Systematics:

- CO1: Understanding of microbial diversity and their occurrence
- CO2: Details of microbial identification and taxonomic studies
- CO3: Analyzing the culturable and non-culturable microorganism using molecular techniques
- CO4: Understanding the three domains of life and microbial evolution
- CO5: Deciphering the microbial extracellular structures and their functions
- CO6: Understanding the intracellular processes of microbes

MICRO-1026: Soil and Agricultural Microbiology:

- CO1: Understanding the soil microbe interactions and their biotransformation processes
- CO2: Understanding the details of plant microbes interaction processes
- CO3: Analyzing the progression of microbial community dynamics
- CO4: Microbial adaptation and succession in different environments
- CO5: Microbial plant pathogenesis and parasitism
- CO6: Plant growth promoting rhizobacteria and its role in agriculture, entomogenous fungi and control of insect pests

MICRO-1036: Physiology and Biochemistry:

- CO1: Comparative analysis of microbial and eukaryotic cellular structures and their function
- CO2: Basics of buffering system and bio-organic reactions
- CO3: Understanding the bioenergetics in relation to thermodynamics
- CO4: Microbial metabolisms, cellular respiration and their biochemistry
- CO5: Photosynthetic microorganism and the type of photosynthesis carried by them
- CO6: Biosynthesis of bio-macromolecules, biological nitrogen fixation and their regulation

MICRO-1044: Microbial Diversity, Taxonomy & Systematics, Soil and Agricultural Microbiology:

- CO1. Isolation, identification and characterization of actinomycetes, yeast, fungi and bacteria, anaerobic microorganisms, thermophilic microorganisms and cyanobacteria from soil
- CO2. Hands on training in microbial pure culture preparation, AM fungi isolation, PGPR, biochemical and various staining techniques

MICRO-1054: Physiology and Biochemistry:

- CO1. Practical experiments on the qualitative and quantitative determination of bio-macromolecules using various techniques
- CO2. Isolation of diazotrophic microbes and determination of IAA

MICRO-2016: Microbial Genetics & Molecular Biology:

- CO1. Understanding the basics of microbial genetics (molecular basis of replication, transcription and translation) and their regulation
- CO2. Basic concepts of genes, operon, gene families, mutations and chromosomal aberrations
- CO3. Concepts of Mendelian, non Mendelian genetics and genetic mapping
- CO4. Regulation of gene expression at different levels
- CO5. Cell signaling and cellular communications

MICRO-2026: Bioinstrumentation & Microbial Techniques:

- CO1. Basics of advance microscopic techniques such as Electron Microscope, freeze-etch and freeze-fracture methods for EM, confocal microscope
- CO2. Histochemical, immunotechniques and in situ localization by FISH and GISH techniques
- CO3. Overview of centrifugation, electrophoresis and chromatographic techniques
- CO4. Principles and application of spectroscopy in biology and biosensors
- CO5. Radioactive analysis of biomacromolecules
- CO6. DNA sequencing techniques

MICRO-2036: Immunology:

- CO1. Concept of immune systems, immunoglobulins and their cellular processes
- CO2. Introduction to antigen-antibody interactions and their application in health care
- CO3. Immunology of bacterial, viral and parasitic diseases

MICRO-2044: Bioinstrumentation & Immunology:

- CO1. Hands on training on the use of spectrophotometer, electrophoresis centrifuge, pH meter etc
- CO2. Practical experiments on blood grouping and serotyping of microorganisms

MICRO-2054: Microbial Genetics & Molecular Biology:

- CO1. Isolation of genetic material from microorganisms, PCR amplification, gel electrophoresis, RE digestion
- CO2. Competent cell preparation, transformation and endonuclease mapping

MICRO-3016: Environmental Microbiology:

- CO1. Microbial ecology, soil, water, air microbiology and waste water treatment strategy.
- CO2. Bacterial examination of water, coliform test, detection of water borne parasites
- CO3. Microbial transformations and response to contaminants, detoxification and xenobiotic compound degradation
- CO4. Sewage treatment, advanced waste water treatment, municipality solid waste management and integrated waste management
- CO5. Bioremediation, genetically modified organisms (GMO), bacterial natural and artificial transformation
- CO6. Understanding of microbes in climate change and carbon sequestration

MICRO-3026: Medical Microbiology:

- CO1. General aspects of medical microbiology, subcellular infectious entities by prokaryotic and eukaryotic microorganisms
- CO2. Antimicrobial, antifungal agents and multiple drug resistance
- CO3. Epidemiology and prevention of infections
- CO4. Principles of hospital infection, sterilisation and disinfection, food, water and public health, antibacterials
- CO5. Bacteria as human pathogens and their virulence mechanisms
- CO6. Viruses as human pathogens, host-pathogen interactions, diagnosis

MICRO-3036: Food & Industrial Microbiology:

- CO1: Factors affecting the growth and survival of micro-organisms in foods, microbiology of food preservation
- CO2. Molecular biology and bioinformatics in relation to in industrial microbiology, media and the nutrition of industrial organisms
- CO3. Industrial processes and fermentation technologies of microbial product formation
- CO4. Overview of stimulant beverages, antibiotics, vaccines and steroids
- CO5. Principles of validation process, method validation, concept of ISO certification

MICRO-3044: Environmental Microbiology:

- CO1. Practical training on COD, BOD, coliform determination, microbial fermentation etc
- CO2. Determination of the ability of microbes to degrade cellulose and lignin

MICRO-3054: Medical, Food and Industrial Microbiology:

- CO1. Isolation of antibiotic producing microorganisms and determination of antimicrobial spectrum of isolates
- CO2. Microbial examination and estimation of food and fermentation products

MICRO-4016: Genetic Engineering, IPR and Biosafety Regulation:

- CO1. Molecular cloning and gene expression strategies
- CO2. Recombinant DNA technology: shot gun cloning, gene library, cDNA cloning
- CO3. Blotting techniques; southern, northern and western hybridization technique
- CO4. Recent advances in DNA and protein sequencing techniques
- CO5. Principles of IPR and patent law, patent application procedure, trade mark, copyright, enforcement of IPR
- CO6. Biosafety regulations related to genetically modified organisms

MICRO-4026: Biostatistics & Bioinformatics:

- CO1. Quantitative methods in biology, sampling methods, scales and variables, data organization
- CO2. Measures of central tendency and dispersal; probability distributions (Binomial, Poisson and normal); laws of probability
- CO3. Survey design, factorial design, ANOVA and F test, T-tests, non-parametric tests
- CO4. Introduction to bioinformatics, biological databases and data formats, data mining and retrieval systems
- CO5. Sequence alignment methods-pairwise and multiple sequence alignments, scoring matrices, local and global alignment
- CO6. Nucleic acid structures and folding, protein secondary structure analysis, three dimensional structure prediction
- CO7. Protein-protein and protein-ligand interactions, protein structural databases (PDB, NDB, MMDB)

MICRO-4034: Genetic Engineering, Biostatistics & Bioinformatics:

- CO1. Practical experiments on cloning of desired gene and expression analysis of recombinant proteins
- CO2. Application of t-test, F-test and Chi-square test for a given set of data
- CO3. Sequence analysis and protein structure modeling using bioinformatic tools

MBP-4044 Dissertation

- CO: Exploration and characterization of microorganisms through hands of training.

**Credits: Total: 24/ Paper**

1 Theory period of one hour per day over a semester

1 Tutorial period of one hour per day over a semester

1 Practical period of three hours per day over a semester

Course work 60; Internal Assessment 15; Credit 6 (Theory)/ 4 (Practical)/5 (Dissertation)