SYLLABUS

for

Choice Based Credit System

(CBCS)

On the basis of

Outcome Based Education

(OBE)

MICROBIOLOGY HONOURS

PATNA WOMEN'S COLLEGE

Autonomous

PATNA UNIVERSITY

3rd Cycle NAAC Accredited at 'A' Grade with CGPA 3.58/4

"*College with Potential for Excellence*" *(CPE) Status Accorded by UGC*

Vision

Rooted in the life, vision and teachings of Jesus Christ and inspired by Mother Veronica, the foundress of the Apostolic Carmel, Patna Women's College strives to become a centre of academic excellence in higher education, social responsibility, and empowerment of women.

Mission Statement

Patna Women's College, the first college for women in Bihar, is committed to the holistic development of women so as to make an effective contribution to the creation of a better society.

To this end, we strive

- To become a center of excellence in higher education for women in an atmosphere of autonomy.
- To excel in teaching-learning, research, and consultancy.
- To provide education that promotes capacity building and holistic development of a person.
- To offer subjects for competency building and motivate/animate a workforce imbued with human values.
- To promote patriotism, communal harmony and cultural integration to maintain a free and peaceful atmosphere on the campus.
- To train the students in creative arts, social service, critical thinking, and leadership in order to make an effective contribution to the creation of a new and value-based society.
- To create women leaders and to make them agents of social change.
- To develop skill oriented and value-based courses, for the all-round development of individuals.
- To promote academic exchange and academia-industry interface.
- To form young women who are 'always wise' and who will dare to 'go ahead and conquer knowledge' through, competence, commitment, delicate conscience, and compassion.

Communicative Microbiology

Note: 1 credit = 15 hours

1. Tutorial group of each theory paper should have a group size of 8 students.
2. Practical paper: 6 credits each (4Theory and 2 Practical).
3. Practical paper will not have tutorials.

Core Courses (6 credits each)

Core Course: A course, which should compulsorily be studied by a candidate as a core requirement is termed as a Core course.

Semester I

1. Introduction to Microbiology
2. Microbial Diversity

Semester II

3. Biochemistry
4. Agricultural Microbiology

Semester III

5. Microbial Physiology and Metabolism
6. Cell Biology
7. Molecular Biology

Semester IV

8. Microbial Genetics
9. Environmental Microbiology
10. Food and Dairy Microbiology

Semester V

11. Industrial Microbiology
12. Immunology

Semester VI

13. Medical Microbiology
14. Recombinant DNA Technology

- At the end of the Second Semester and Fourth Semester the students are required to undergo Hands-on-Training on any specialized area of subject. The purpose of this training is to provide the students with opportunities to apply their

theoretical knowledge acquired in the class room, in the related institute / industrial house, thereby gaining valuable experience in the field of research and development.

Generic Elective Papers (GE) (6 credits each)

Generic Elective (GE) Course: An elective course chosen generally from an unrelated discipline/subject, with an intention to seek exposure is called a Generic Elective.

P.S.: A core course offered in a discipline/subject may be treated as an elective by other discipline/ subject and vice versa and such electives may also be referred to as Generic Elective.

Semester I

1. Introduction and Scope of Microbiology

Semester II

2. Bacteriology and Virology

Semester III

3. Industrial and Food Microbiology

Semester IV

4. Microbes in Environment

Discipline Specific Elective (DSE) (6 credits each)

Discipline Specific Elective (DSE) Course: Elective courses may be offered by the main discipline/subject of study is referred to as Discipline Specific Elective. The University/Institute may also offer discipline related Elective courses of interdisciplinary nature (to be offered by main discipline/subject of study).

Semester V

DSE-1

1. Biostatistics

DSE-2

2. Microbes in Sustainable Agriculture and Development

Semester VI

DSE-3

3. Instrumentation and Biotechniques

DSE-4

4. Project Work / Dissertation

Skill Enhancement Course (SEC) (2Credits)

Skill Enhancement Courses (SEC): These courses may be chosen from a pool of courses designed to provide value-based and/or skill-based knowledge.

Semester III

1. Inter Religious Studies (Value based)

Semester IV

2. Biofertilizers and Biopesticides (Skill based)

Microbiology (Hons.) CBCS Syllabus

Sem	Core Course (14) 6 Credits each	Ability Enhancement Compulsory Course AECC (2) 2 Credits each	Skill Enhancement Course SEC (2) 2 Credits each	Discipline Specific Elective DSE (4) 6 Credits each	Generic Elective GE (4) 6 Credits each
I	**MBIO CC101:** Introduction to Microbiology	English/ Hindi Communication			**MBIO GE101:** Introduction and Scope of Microbiology
	MBIO CC102: Microbial Diversity				
II	**MBIO CC203:** Biochemistry	Environmental Science			**MBIO GE202:** Bacteriology and Virology
	MBIO CC204: Agricultural Microbiology				
III	**MBIO CC305:** Microbial Physiology and Metabolism		**IRS SEC301:** Inter-Religious Studies **(Value based)**		**GE303:** Industrial and Food Microbiology
	MBIO CC306: Cell Biology				

	MBIO CC307: Molecular Biology				
IV	**MBIO CC408:** Microbial Genetics **MBIO C409:** Environmental Microbiology **MBIO CC410:** Food and Dairy Microbiology		**MBIO SEC402:** Biofertilizers and Biopesticides **(Skill based)**		**MBIO GE404:** Microbes in Environment
V	**MBIO CC511:** Industrial Microbiology **MBIO CC512:** Immunology			**MBIO DSE501:** Biostatistics **MBIO DSE502:** Microbes in Sustainable Agriculture and Development	
VI	**MBIO CC613:** Medical Microbiology **MBIO CC614:** Recombinant DNA Technology			**MBIO DSE603:** Instrumentation and Biotechniques **MBIO DSE604:** Project Work / Dissertation	

Course Structure for B.Sc Microbiology(Hons.)

Semester – I	Semester – II
MBIO Core Course 1: Introduction to Microbiology	**MBIO Core Course 3:** Biochemistry
MBIO Core Course 2: Microbial Diversity	**MB Core Course 4:** Agricultural Microbiology
Ability Enhancement Compulsory Course (AECC) -I English/ Hindi Communication	**Ability Enhancement Compulsory Course (AECC)-II** Environmental Science

MBIO Generic Elective (GE) –I: Introduction and Scope of Microbiology	**MBIO Generic Elective (GE) – II:** Bacteriology and Virology

Semester – III	Semester – IV
MBIO Core Course 5: Microbial Physiology and Metabolism	**MBIO Core Course 8:** Microbial Genetics
MBIO Core Course 6: Cell Biology	**MBIO Core Course 9:** Environmental Microbiology
MBIO Core Course 7: Molecular Biology	**MBIO Core Course 10:** Food and Dairy Microbiology
Skill Enhancement Course (SEC) -I Inter-Religious Studies(Value based)	**Skill Enhancement Course (SEC) –II** Biofertilizers and Biopesticides (Skill based)
MBIO Generic Elective (GE) –III: Industrial and Food Microbiology	**MBIO Generic Elective (GE) – IV:** Microbes in Environment

Semester – V	Semester – VI
MBIO Core Course 11: Industrial Microbiology	**MBIO Core Course 13:** Medical Microbiology
MBIO Core Course 12: Immunology	**MBIO Core Course 14:** Recombinant DNA Technology
Discipline Specific Elective(DSE) I: Biostatistics	**Discipline Specific Elective(DSE)III:** Instrumentation and Biotechniques
Discipline Specific Elective(DSE) II: Microbes in Sustainable Agriculture and Development	**Discipline Specific Elective(DSE)IV:** Project Work / Dissertation

Details of Credits for Courses under B.Sc Honours

MICROBIOLOGY

Semester	Course	Theory	Practical	Tutorial	Total Credits
	I. Core Course (14 Papers) – 06 credits each				
I	1. Introduction to Microbiology	4	2	-	6
	2. Microbial Diversity	4	2	-	6
II	3. Biochemistry	4	2	-	6
	4. Agricultural Microbiology	4	2	-	6

III	5. Microbial Physiology and Metabolism	4	2	-	6
	6. Cell biology	4	2	-	6
	7. Molecular Biology.	4	2	-	6
IV	8. Microbial Genetics	4	2	-	6
	9. Environmental Microbiology	4	2	-	6
	10. Food and Dairy Microbiology	4	2	-	6
V	11. Industrial Microbiology	4	2	-	6
	12. Immunology	4	2	-	6
VI	13. Medical Microbiology	4	2	-	6
	14. Recombinant DNA Technology	4	2	-	6

II. Elective Course – 06 credits each

	A. 1. Discipline Specific Elective- DSE (4 Papers)				
V	1. Biostatistics	4	2	-	6
	2. Microbes in Sustainable Agriculture and Development	4	2	-6	
VI	3. Instrumentation and Biotechniques	4	2	-	6
	4. Project work / Dissertation	-	6	-	6
	B. 1. Generic Elective / Interdisciplinary (4 Papers)				
I	1. Introduction and Scope of Microbiology	4	2	-	6
II	2. Bacteriology and Virology	4	2	-	6
III	3. Industrial and Food Microbiology	4	2	-	6
IV	4. Microbes in Environment	4	2	-	6

III. Ability Enhancement Courses – 02 credits each

	1. Ability Enhancement Compulsory				
I	1. English / Hindi Communication	2			2
II	2. Environmental Science	2			2
	II. Skill Enhancement Course (SEC)				
III	1. Inter Religious Studies	2	-	-	2
IV	2. Biofertilizers and Biopesticides	2	-		2
	TOTAL				**140**

Institute should evolve a system/policy about ECA / General Interest / Hobby / Sports / NCC / NSS / related courses on its own.

***wherever there is practical there will be no tutorial and vice-versa.**

B.Sc. (Honours) MICROBIOLOGY

PROGRAM OUTCOMES (POs)

After the completion of B.Sc. Honours Degree Programme, the students will be able to achieve the following outcomes:

PO1: **Professional knowledge:** Acquire comprehensive knowledge of major concepts, theoretical principles and experimental findings of various subjects in pure sciences.

PO2: **Critical thinking and Cognitive skills:** Convey the intricate science information effectively and efficiently, analyze and solve the problems related to plants, animal sciences without relying on assumptions and guesses.

PO3: **Environment and sustainability:** Understand the impact of the scientific solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO4: **Effective Communication:** Demonstrate familiarity with and will be able to analyze both verbally and in writing issues and forms of contemporary art with a clear understanding of historical precedents.

PO5: **Instruments and Experiments:** Acquire the skills in handling scientific instruments, planning and performing in laboratory experiments and drawing logical inferences from the scientific experiments.

PO6: **Research and Analysis:** Demonstrate analytical skill and proficiency in a range of tools and techniques used in research in science and interdisciplinary programmes.

PO7: **Employability and higher Education:** Show proficiency in professional, employability and develop soft skills required for higher education and placements.

PO8: **Ethics:** Imbibe ethical, moral and social values in personal and social life leading to highly cultured and civilized personality in the field of science.

PO9: Science and Society: Apply reasoning acquired by the scientific knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional science practice.

PO10: Interdisciplinary Learning: Integrate academic curriculum with other co-curricular goals, such as career development, life-long learning, develop interdisciplinary learning and opportunity to extend their knowledge across all disciplines.

PO11: Nation Building: Introspect and evolve into dynamic and creative individuals capable of socially productive, constructive actions that positively impact our Nation and the World at large.

Program Specific Outcomes

Upon completion of the programme, the students will attain the ability to:

PSO1: Understand basic concepts of diverse group of microorganisms like eubacteria, archea, fungi, viruses

PSO2: Acquire practical skills of standard microbiological techniques like pure culture technique, preservation and maintenance of microbial culture, assessment of food quality.

PSO3: Produce entrepreneurs who can develop sustainable solutions in mushroom cultivation and small scale biofertilizer production.

PSO4: Skill enhancement in plant tissue culture and basic molecular biology techniques.

PSO5: Practical skills on handling of basic biophysical instruments which will help in future.

PSO6: Pursue career in academics, competitive examinations (FCI, IFS, BIS), biotech industry and other pharma industry.

Microbiology (Honours) Details of CBCS Syllabus

Core Courses (6 credits each)

Core Course: A course, which should compulsorily be studied by a candidate as a core requirement is termed as a Core course.

SEMESTER – I

MBIO CC101: Introduction to Microbiology

COURSE OUTCOME:

After completion of the course, the students will be able to:

CO1. Understand Knowledge about contributions made by prominent scientists in this field

CO2. Comprehend Standard microbiological culture techniques

CO3. Apply Basic instrumentation in microbiology

CO4. Develop Knowledge about growth and nutritional requirement of microorganisms

MBIO CC101 : Introduction to Microbiology (Theory : 4 credits + Practical : 2 credits)		
Unit	**Topics to be covered**	**No. of hours**
1	**History of Development of Microbiology** Development of microbiology as a discipline, Spontaneous generation vs. biogenesis. Contributions of Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming, Role of microorganisms in fermentation, Germ theory of disease, Development of various microbiological techniques and golden era of microbiology, Development of the field of soil microbiology: Contributions of Martinus W. Beijerinck, Sergei N. Winogradsky, Selman A.Waksman, Establishment of fields of medical microbiology and immunology through the work of Paul Ehrlich,, Elie Metchnikoff, Edward Jenner; Scope of Microbiology	20

2	**Microbiological techniques** Pure culture isolation: Streaking, serial dilution and plating methods; cultivation, maintenance and preservation/stocking of pure cultures of bacteria and Fungi; cultivation of anaerobic bacteria, and accessing non-culturable bacteria	10
3	**Microscopy** Bright Field Microscope, Dark Field Microscope, Phase Contrast Microscope, Fluoresence Microscope, Confocal microscopy, Scanning and Transmission Electron Microscope	15
4	**Growth and nutrition** Nutritional requirements in bacteria and nutritional categories; Culture media: components of media, natural and synthetic media, chemically defined media, complex media, selective, differential, indicator, enriched and enrichment media .Physical methods of microbial control: heat, low temperature, high pressure, filtration, desiccation, osmotic pressure, radiation Chemical methods of microbial control: disinfectants, types and mode of action	15
	Practical 1. Microbiology Good Laboratory Practices and Biosafety. 2. To study the principle and applications of important instruments (biological safety cabinets, autoclave, incubator, BOD incubator, hot air oven, light microscope, pH meter) used in the microbiology laboratory. 3. Preparation of culture media for bacterial and fungal cultivation. 4. Sterilization of medium using Autoclave. 5. Sterilization of glassware using Hot Air Oven. 6. Sterilization by radiation and assessment for sterility	30

	7. Staining technique for bacteria and fungi. 8. Isolation of pure cultures of bacteria by streaking method. 9. Preservation of bacterial cultures by various techniques. 10. Estimation of CFU count by spread plate method/pour plate method.	
	TOTAL	**90**

Reading List :

1. Tortora GJ, Funke BR and Case CL. (2008). Microbiology: An Introduction. 9th edition. Pearson Education
2. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms. 14th edition. Pearson International Edition
3. Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited
4. Wiley JM, Sherwood LM and Woolverton CJ. (2013) Prescott's Microbiology. 9th Edition. McGraw Hill International.
5. Atlas RM. (1997). Principles of Microbiology. 2nd edition. WM.T.Brown Publishers.
6. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company.
7. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General Microbiology. 5th edition. McMillan.

SEMESTER– I

MBIO CC102 : Microbial Diversity

COURSE OUTCOME:

After completion of the course, the students will be able to:

CO1. Understand Characteristics features of different groups of microorganisms

CO2. Analysis of types of classification of microorganisms

CO3. Apply General characteristics of acellular and cellular microorganisms (bacteria, Fungi, Algae, viruses, protozoa, archaea)

CO4. Understand the Ultrastructure of bacterial cells and methods of reproduction.

CO5. Develop knowledge of Nature of viruses and different viruses of animals, plants and bacteria (bacteriophages)

MBIO CC102 : Microbial Diversity **PWC (Theory : 4 credits + Practical : 2 credits)'**		
Unit	**Topics to be covered**	**No. of hours**
1	**Systems of classification** Binomial Nomenclature, Whittaker's five kingdom and Carl Woese's three kingdom classification systems and their utility. Difference between prokaryotic and eukaryotic microorganisms Aim and principles of classification, systematics and taxonomy, concept species, taxa, strain; conventional, molecular and recent approaches to polyphasic bacterial taxonomy, evolutionary chronometers, Rrna oligonucleotide sequencing, signature sequences, and protein sequences. Differences between eubacteria and archaebacteria	12
2	**General characteristics of different groups:** Acellular microorganisms (Viruses, Viroids, Prions) and Cellular microorganisms (Bacteria, Archaeal group, Algae, Fungi and Protozoa) with emphasis on distribution and occurrence, morphology, mode of reproduction and economic importance.	18
3	**Bacteria** Cell size, shape and arrangement, glycocalyx, capsule, flagella, endoflagella, fimbriae and pili. Cell-wall: Composition and detailed structure of Gram-positive and Gram-negative cell walls,	15

	Archaebacterial cell wall, Gram and acid fast staining mechanisms, lipopolysaccharide (LPS), sphaeroplasts, protoplasts, and L-forms. Effect of antibiotics and enzymes on the cell wall. Cell Membrane: Structure, function and chemical composition of bacterial and archaeal cell membranes. Cytoplasm: Ribosomes, mesosomes, inclusion bodies, nucleoid, chromosome and plasmids Endospore: Structure, formation, stages of sporulation., Asexual methods of reproduction, logarithmic representation of bacterial populations, phases of growth, calculation of generation time and specific growth rate	
4	**Nature and Properties of Viruses** **(a) Introduction:** Discovery of viruses, nature and definition of viruses, general properties, concept of viroids, virusoids, satellite viruses and Prions. Theories of viral origin Structure of Viruses: Capsid symmetry, enveloped and non-enveloped viruses Isolation, purification and cultivation of viruses Viral taxonomy: Classification and nomenclature of different groups of viruses **(b) Bacteriophages :** Diversity, classification, one step multiplication curve, lytic and lysogenic phages (lambda phage) concept of early and late proteins, regulation of transcription in lambda phage	15
	Practical : 1. Preparation of different media: Nutrient agar, McConkey agar, EMB agar. 2. Demonstration of the presence of microflora in the environment by exposing nutrient agar/ PDA plates to air. 3. Study of Rhizopus, Penicillium, Aspergillus using temporary mounts	30

	4. Study of Cyanobacteria (Nostoc) using slide preparation. 5. Study of Spirogyra and Chlamydomonas, Volvox using temporary Mounts 6. Study of the following protozoans using permanent mounts/photographs: Amoeba, Entamoeba, Paramecium and Plasmodium 7. Study of the structure of important bacterial viruses (X 174, T4,) using electron micrograph. 8. Isolation and enumeration of bacteriophages (PFU) from water/sewage sample	
	TOTAL	**90**

Reading List :

1. Atlas RM. (1997). Principles of Microbiology. 2nd edition. WM.T.Brown Publishers.
2. Black JG. (2008). Microbiology: Principles and Explorations. 7th edition. Prentice Hall
3. Madigan MT, and Martinko JM. (2014). Brock Biology of Micro-organisms. 14th edition. Parker J. Prentice Hall International, Inc.
4. Pelczar Jr MJ, Chan ECS, and Krieg NR. (2004). Microbiology. 5th edition Tata McGraw Hill.
5. Srivastava S and Srivastava PS. (2003). Understanding Bacteria. Kluwer Academic Publishers, Dordrecht
6. Stanier RY, Ingraham JL, Wheelis ML and Painter PR. (2005). General Microbiology. 5th edition McMillan.
7. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9th edition Pearson Education.
8. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.
9. Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited

SEMESTER – II

MBIO CC203 : Biochemistry

COURSE OUTCOME:

After completion of the course, the students will be able to:

CO1. Understand the Concept of Bioenergetics.

CO2. Analysis the Carbohydrates: types, structure and its storage form

CO3. Develop knowledge on Lipids: Types, structure and function

CO4. Learn about Vitamins : types, function, deficiency disease

CO5. Gain Knowledge on Proteins : structure, function, enzyme kinetics and inhibition

MBIO CC203 : Biochemistry **PWC (Theory : 4 credits + Practical : 2 credits)**		
Unit	**Topics to be covered**	**No. of hours**
1	**Bioenergetics** First and second laws of Thermodynamics. Definitions of Gibb's Free Energy, enthalpy, and Entropy and mathematical relationship among them, Standard free energy change and equilibrium constant Coupled reactions and additive nature of standard free energy change, Energy rich compounds: Phosphoenolpyruvate, 1,3- Bisphosphoglycerate, Thioesters, ATP	12
2.	**Carbohydrates** Families of monosaccharides: aldoses and ketoses, trioses, tetroses, pentoses, and hexoses. Stereo isomerism of monosaccharides, epimers, Mutarotation and anomers of glucose. Furanose and pyranose forms of glucose and fructose, Haworth projection formulae for glucose; chair and boat forms of glucose, Sugar derivatives, glucosamine, galactosamine, muramic acid, N-acetyl neuraminic acid, Disaccharides; concept of	12

	reducing and non-reducing sugars, occurrence and Haworth projections of maltose, lactose, and sucrose, Polysaccharides, storage polysaccharides, starch and glycogen. Structural Polysaccharides, cellulose, peptidoglycan and chitin	
3.	**(a) Lipids:** Definition and major classes of storage and structural lipids. Storage lipids. Fatty acids structure and functions. Essential fatty acids. Triacyl glycerols structure, functions and properties. Saponification Structural lipids. Phosphoglycerides: Building blocks, General structure, functions and properties. Structure of phosphatidylethanolamine and phosphatidylcholine, Sphingolipids: building blocks, structure of sphingosine, ceramide. Special mention of sphingomyelins, cerebrosides and gangliosides Lipid functions: cell signals, cofactors, prostaglandins, Introduction of lipid micelles, monolayers, bilayers **(b) Vitamins:** Classification and characteristics with suitable examples, sources and importance	18
4	**(a) Proteins:** Functions of proteins, Primary structures of proteins: Amino acids, the building blocks of proteins. General formula of amino acid and concept of zwitterion. Titration curve of amino acid and its Significance, Classification, biochemical structure and notation of standard protein amino acids Ninhydrin reaction.Natural modifications of amino acids in proteins hydrolysine, cystine and hydroxyproline, Non protein amino acids: Gramicidin, beta-alanine, D-alanine and D- glutamic acid Oligopeptides: Structure and functions of	18

	naturally occurring glutathione and insulin and synthetic aspartame, Secondary structure of proteins: Peptide unit and its salient features. The alpha helix, the beta pleated sheet and their occurrence in proteins, Tertiary and quaternary structures of proteins. Forces holding the polypeptide together. Human haemoglobin structure, Quaternary structures of proteins **(b) Enzymes:** Structure of enzyme: Apoenzyme and cofactors, prosthetic group-TPP, coenzyme NAD,metal cofactors, Classification of enzymes, Mechanism of action of enzymes: active site, transition state complex and activation energy. Lock and key hypothesis, and Induced Fit hypothesis. Significance of hyperbolic, double reciprocal plots of enzyme activity, Km, and allosteric mechanism Definitions of terms – enzyme unit, specific activity and turnover number, Multienzyme complex : pyruvate dehydrogenase; isozyme: lactate dehydrogenase, Effect of pH and temperature on enzyme activity. Enzyme inhibition: competitive- sulfa drugs; non-competitive-heavy metal salts	
	Practical : 1. Properties of water, Concept of pH and buffers, preparation of buffers and Numerical problems to explain the concepts 2. Numerical problems on calculations of Standard Free Energy Change and Equilibrium constant 3. Qualitative/Quantitative tests for carbohydrates, reducing sugars, non reducing sugars	30

	4. Qualitative/Quantitative tests for lipids and proteins 5. Study of protein secondary and tertiary structures with the help of models 6. Study of enzyme kinetics – calculation of Vmax , Km, Kcat values 7. Study effect of temperature, pH and Heavy metals on enzyme activity 8. Estimation of any one vitamin	
	TOTAL	**90**

Reading List :

1. Campbell, MK (2012) Biochemistry, 7th ed., Published by Cengage Learning
2. Campbell, PN and Smith AD (2011) Biochemistry Illustrated, 4th ed., Published by Churchill Livingstone
3. Tymoczko JL, Berg JM and Stryer L (2012) Biochemistry: A short course, 2nd ed., W.H.Freeman
4. Berg JM, Tymoczko JL and Stryer L (2011) Biochemistry, W.H.Freeman and Company
5. Nelson DL and Cox MM (2008) Lehninger Principles of Biochemistry, 5th Edition., W.H. Freeman and Company,
6. Willey MJ, Sherwood, LM & Woolverton C J (2013) Prescott, Harley and Klein's Microbiology by. 9th Ed., McGrawHill
7. Voet,D. and Voet J.G (2004) Biochemistry 3rd edition, John Wiley and Sons,

SEMESTER – II

MBIO CC204 : Agricultural Microbiology (Theory)

COURSE OUTCOME:

After completion of the course, the students will be able to:

CO1. Study on microbial ecology and their interaction with environment.

CO2. Understand Plant microbe's interactions

CO3. Analysis Biofertilizers and biopesticides: their production techniques

CO4. Develop Production of biogas, biomethane and biohydrogen

CO5. Acquire a knowledge of GM Plants

MBIO CC204 : Agricultural Microbiology (Theory) **PWC (Theory : 4 credits + Practical : 2 credits)**		
Unit	**Topics to be covered**	**No. of hours**
1	**(a) Soil Microbiology:** Soil as Microbial Habitat, Soil profile and properties, Soil formation, Diversity and distribution of microorganisms in soil **(b) Mineralization of Organic & Inorganic Matter in Soil:** Mineralization of cellulose, hemicelluloses, lignocelluloses, lignin and humus, phosphate, nitrate, silica, potassium **(c) Microbial Activity in Soil and Green House Gases:** Carbon dioxide, methane, nitrous oxide, nitric oxide – production and control	18
2	**Plant pathogens & Microbial Control of Soil Borne Plant Pathogens :** Plant and their pathogens, Biocontrol mechanisms and ways, Microorganisms used as biocontrol agents against Microbial plant pathogens, Insects, Weeds	15
3	**Biofertilization, Phytostimulation, Bioinsecticides** Plant growth promoting bateria, biofertilizers – symbiotic (Bradyrhizobium, Rhizobium, Frankia), Non Symbiotic (Azospirillum, Azotobacter, Mycorrhizae, MHBs, Phosphate solubilizers, algae), Novel combination of microbes as biofertilizers, PGPRs	15

4	**(a) Secondary Agriculture Biotechnology:** Biotech feed, Silage, Biomanure, biogas, biofuels – advantages and processing parameters **(b) GM crops:** Advantages, social and environmental aspects, Bt crops, golden rice, transgenic plants.	12
	Practical : 1. To study soil profile 2. To perform the rapid soil test for detection of micronutrients 3. Isolation microflora of different types of soils. 4. Isolation of Rhizobium (study as a soil inoculants characteristics and field application) 5. Isolation of Azotobacter (study as a soil inoculants characteristics and field application) 6. Design and functioning of a biogas plant 7. Isolation of cellulose degrading organisms 8. To study of host parasite relationship through section cutting and slide preparation	30
	TOTAL	**90**

Reading List :

1. Agrios GN. (2006). Plant Pathology. 5th edition. Academic press, San Diego,
2. Singh RS. (1998). Plant Diseases Management. 7th edition. Oxford & IBH, New Delhi.
3. Glick BR, Pasternak JJ, and Patten CL (2010) Molecular Biotechnology 4th edition, ASM Press,
4. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA
5. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, Academic Press

6. Barton LL & Northup DE (2011). Microbial Ecology. 1st edition, Wiley Blackwell, USA
7. Campbell RE. (1983). Microbial Ecology. Blackwell Scientific Publication, Oxford, England.
8. Coyne MS. (2001). Soil Microbiology: An Exploratory Approach. Delmar Thomson Learning.
9. Altman A (1998). Agriculture Biotechnology, Ist edition, Marcel decker Inc.
10. Mahendra K. Rai (2005). Hand Book of Microbial Biofertilizers, The Haworth Press, Inc. New York.
11. Reddy, S.M. et. al. (2002). Bioinoculants for Sustainable Agriculture and Forestry, Scientific Publishers.
12. Saleem F and Shakoori AR (2012) Development of Bioinsecticide, Lap Lambert Academic Publishing GmbH KG

SEMESTER – III

MBIO CC305 : Microbial Physiology And Metabolism

COURSE OUTCOME:

After completion of the course, the students will be able to:

CO1. Understand the Growth characteristics of microorganisms inhabiting in extreme environment

CO2. Describe the mechanism of nutrient transport

CO3. Analysis the mechanism of energy generation in autotrophs, chemolithotrophs & heterotrophs

CO4. Acquire knowledge on mechanism of aerobic and anaerobic respiration mode

MBIO CC305 : Microbial Physiology And Metabolism (THEORY) PWC (Theory : 4 credits + Practical : 2 credits)		
Unit	**Topics to be covered**	**No. of hours**
1	**Microbial Growth and Effect of Environment on Microbial Growth**	12

	Definitions of growth, measurement of microbial growth, Batch culture, Continuous culture, generation time and specific growth rate, synchronous growth, diauxic growth curve Microbial growth in response to environment - Temperature (psychrophiles, mesophiles, thermophiles, extremophiles, thermodurics, psychrotrophs), pH (acidophiles, alkaliphiles), solute and water activity (halophiles, xerophiles, osmophilic), Oxygen (aerobic, anaerobic, microaerophilic, facultative aerobe, facultative anaerobe),barophilic. Microbial growth in response to nutrition and energy – Autotroph/ Phototroph, heterotrophy, Chemolithoautotroph, Chemolithoheterotroph, Chemoheterotroph, Chemolithotroph, photolithoautotroph, Photoorganoheterotroph.	
2	**Nutrient uptake and Transport** Passive and facilitated diffusion Primary and secondary active transport, concept of uniport, symport and antiport, Group translocation, Iron uptake	10
3	**Chemoheterotrophic Metabolism :** **(a) Aerobic Respiration :** Concept of aerobic respiration, anaerobic respiration and fermentation Sugar degradation pathways i.e. EMP, ED, Pentose phosphate pathway, TCA cycle, Electron transport chain: components of respiratory chain, comparison of mitochondrial and bacterial ETC, electron transport phosphorylation, uncouplers and inhibitors **(b) Anaerobic respiration and fermentation :** Anaerobic respiration with special reference to dissimilatory nitrate reduction (Denitrification; nitrate/nitrite and nitrate/ammonia respiration; fermentative nitrate reduction)	18

	Fermentation - Alcohol fermentation and Pasteur effect; Lactate fermentation (homofermentative and heterofermentative pathways), concept of linear and branched fermentation pathways	
4	**(a) Chemolithotrophic and Phototrophic Metabolism** Introduction to aerobic and anaerobic chemolithotrophy with an example each. Hydrogen oxidation (definition and reaction) and methanogenesis (definition and reaction) Introduction to phototrophic metabolism - groups of phototrophic microorganisms, anoxygenic vs. oxygenic photosynthesis with reference to photosynthesis in green bacteria, purple bacteria and cyanobacteria **(b) Nitrogen Metabolism-** an overview Introduction to biological nitrogen fixation, Ammonia assimilation, Assimilatory nitrate reduction, dissimilatory nitrate reduction, denitrification	20
	Practical : 1. Study and plot the growth curve of E. coli by turbidometric and standard plate count methods. 2. Effect of temperature on growth of E. coli 3. Effect of pH on growth of E. coli 4. Effect of carbon and nitrogen sources on growth of E.coli 5. Effect of salt on growth of E. coli 6. Demonstration of the thermal death time and decimal reduction time of E. coli.	30

Reading List :

1. Madigan MT, and Martinko JM (2014). Brock Biology of Microorganisms. 14th edition. Prentice Hall International Inc.

2. Moat AG and Foster JW. (2002). Microbial Physiology. 4th edition. John Wiley & Sons
3. Reddy SR and Reddy SM. (2005). Microbial Physiology. Scientific Publishers India
4. Gottschalk G. (1986). Bacterial Metabolism. 2nd edition. Springer Verlag
5. Stanier RY, Ingrahm JI, Wheelis ML and Painter PR. (1987). General Microbiology. 5th edition, McMillan Press.
6. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.

SEMESTER – III

MBIO CC306: Cell Biology (Theory)

COURSE OUTCOME:

After completion of the course, the students will be able to:

CO1. Understand the structure of cell and function of various subcellular organelles

CO2. Demonstrate the protein sorting mechanism in ER, Golgi complex

CO3. Analysis the mechanism of cell signalling, cell cycle, cell division and cell death

CO4. Apply Practical skill of preparation of temporary and permanent slides for mitosis and meiosis.

MBIO CC306 : Cell Biology (Theory) **PWC (Theory : 4 credits + Practical : 2 credits)**		
Unit	**Topics to be covered**	**No. of hours**
1	**Structure and organization of Cell** Cell Organization – Eukaryotic (Plant and animal cells) and prokaryotic Plasma membrane: Structure and transport of small molecules Cell Wall: Eukaryotic cell wall, Extra cellular matrix and	20

	cell matrix interactions, Cell-Cell Interactions - adhesion junctions, tight junctions, gap junctions, and plasmodesmata (only structural aspects) Mitochondria, chloroplasts and peroxisomes Cytoskeleton: Structure and organization of actin filaments, association of actin filaments with plasma membrane, cell surface protrusions, intermediate filaments, microtubules; Nuclear envelope, nuclear pore complex and nuclear lamina Chromatin – Molecular organization, Nucleolus	
2	**Protein Sorting and Transport** Ribosomes, Endoplasmic Reticulum and Golgi Apparatus – Structure, targeting and insertion of proteins in the ER, protein folding, processing and transportation	10
3	**Cell Signalling** Signalling molecules and their receptors Function of cell surface receptors Pathways of intra-cellular receptors – Cyclic AMP pathway, cyclic GMP and MAP kinase pathway	15
4	**Cell Cycle, Cell Death and Cell Renewal** Eukaryotic cell cycle and its regulation, Mitosis and Meiosis Development of cancer, causes and types Programmed cell death, Stem cells Embryonic stem cell, induced pleuripotent stem cells	15
	Practical : 1. Study of representative plant and animal cell by microscopy. 2. Study of the structure of cell organelles through electron micrographs 3. Cytochemical staining of DNA – Feulgen	30

	4. Demonstration of the presence of mitochondria in striated muscle cells/ cheek epithelial cell using staining. 5. Identification and study of cancer cells by photomicrographs. 6. Study of different stages of Mitosis. 7. Study of different stages of Meiosis.	
	TOTAL	**90**

Reading List :

1. Hardin J, Bertoni G and Kleinsmith LJ. (2010). Becker's World of the Cell. 8th edition. Pearson.
2. Karp G. (2010) Cell and Molecular Biology: Concepts and Experiments. 6th edition. John Wiley &Sons. Inc.
3. De Robertis, EDP and De Robertis EMF. (2006). Cell and Molecular Biology. 8th edition. Lipincott Williams and Wilkins, Philadelphia.
4. Cooper, G.M. and Hausman, R.E. (2009). The Cell: A Molecular Approach. 5th.Edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.

SEMESTER – III

MBIO CC307: Molecular Biology (Theory)

COURSE OUTCOME:

After completion of the course, the students will be able to:

CO1. The structure of the genetic material present in an organism i.e., DNA and RNA

CO2. Mechanism of replication, transcription and translation

CO3. The regulation of gene expression occurring in prokaryotes and eukaryotes

CO4. Practical skill in isolation of bacterial DNA and its visualization

MBIO CC307 : Molecular Biology (Theory) PWC (Theory : 4 credits + Practical : 2 credits)		
Unit	**Topics to be covered**	**No. of hours**
1	**Structures of DNA and RNA / Genetic Material** DNA Structure: Miescher to Watson and Crick-historic perspective, DNA structure, Salient features of double helix, Types of DNA, Types of genetic material, denaturation and renaturation, cot curves. DNA topology – linking number, topoisomerases; Organization of DNA Prokaryotes,Viruses, Eukaryotes.RNA Structure, Organelle DNA -- mitochondria and chloroplast DNA.	15
2	**Replication of DNA (Prokaryotes and Eukaryotes):** Bidirectional and unidirectional replication, semi- conservative, semi-discontinuous replication Mechanism of DNA replication: Enzymes and proteins involved in DNA replication –DNA polymerases, DNA ligase, primase, telomerase – for replication of linear ends, Various models of DNA replication including rolling circle, D- loop (mitochondrial), θ (theta) mode of replication and other accessory protein, Mismatch and excision repair	15
3	**Transcription and Translation in Prokaryotes and Eukaryotes** **(a) Transcription:** Definition, difference from replication, promoter - concept and strength of promoter, RNA Polymerase and the transcription unit, Transcription in Eukaryotes: RNA polymerases, general Transcription factors **(b) Post-Transcriptional Processing :** Split genes, concept of introns and exons, RNA splicing, spliceosome machinery, concept of alternative splicing, Polyadenylation and	20

	capping, Processing of rRNA, brief idea of RNA interference (c) Translation (Prokaryotes and Eukaryotes) : Translational machinery, Charging of tRNA, aminoacyl tRNA synthetases, Mechanisms of initiation, elongation and termination of polypeptides in both prokaryotes and eukaryotes, Fidelity of translation, Inhibitors of protein synthesis in prokaryotes and eukaryote	
4	**Regulation of gene Expression in Prokaryotes and Eukaryotes** Regulation of gene expression in prokaryotes, lac ad trp operons. Brief idea of gene regulation in eumkaryoted. Changes in Chromatin Structure - DNA methylation and Histone Acetylation mechanism, transcription and translation level of gene regulation.	10
	Practical : 1. Study of different types of DNA and RNA using micrographs and model / schematic representations 2. Study of semi-conservative replication of DNA through micrographs / schematic Representations 3. Isolation of genomic DNA from E. coli 4. Estimation of DNA using colorimeter (diphenylamine reagent) or UV spectrophotometer (A260 measurement) 5. Resolution and visualization of DNA by Agarose Gel Electrophoresis. 6. Resolution and visualization of proteins by Polyacrylamide Gel Electrophoresis (SDS-PAGE)	30
	TOTAL	**90**

Reading List :

1. Watson JD, Baker TA, Bell SP, Gann A, Levine M and Losick R (2008) Molecular Biology of the Gene, 6th edition, Cold Spring Harbour Lab. Press, Pearson Publication
2. Becker WM, Kleinsmith LJ, Hardin J and Bertoni GP (2009) The World of the Cell, 7th edition, Pearson Benjamin Cummings Publishing, San Francisco
3. De Robertis EDP and De Robertis EMF (2006) Cell and Molecular Biology, 8th edition. Lippincott Williams and Wilkins, Philadelphia
4. Karp G (2010) Cell and Molecular Biology: Concepts and Experiments, 6th edition, John Wiley & Sons. Inc.
5. Sambrook J and Russell DW. (2001). Molecular Cloning: A Laboratory Manual. 4th Edition, Cold
6. Spring Harbour Laboratory press.
7. Krebs J, Goldstein E, Kilpatrick S (2013). Lewin's Essential Genes, 3rd Ed., Jones and Bartlett Learning
8. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-India

SEMESTER – IV

MBIO CC 408: Microbial Genetics

COURSE OUTCOME:

After completion of the course, the students will be able to:

CO1. Understand Genome organization and extrachromosomal DNA in prokaryotes and eukaryotes

CO2. Analysis the Molecular mechanisms that underlie mutations.

CO3. Develop knowledge on Mechanisms of genetic material exchange (transformation, conjugation & transduction)

CO4. Apply Practical skill on study of auxotroph, mutagenic effect of mutagens and plasmid conformations.

MBIO CC408 : Microbial Genetics PWC (Theory : 4 credits + Practical : 2 credits)		
Unit	**Topics to be covered**	**No. of hours**
1	**Genome Organization and Mutations** Genome organization: E. coli, Saccharomyces, Tetrahymena, Mutations and mutagenesis: Definition and types of Mutations; Physical and chemical mutagens; Molecular basis of mutations; Functional mutants (loss and gain of function mutants); Uses of mutations, Reversion and suppression: True revertants; Intra- and inter-genic suppression; Ames test; Mutator genes	15
2	**Plasmids** Types of plasmids – F plasmid, R Plasmids, colicinogenic plasmids, Ti plasmids, linear plasmids, yeast- 2 µ plasmid, Plasmid replication and partitioning, Host range, plasmid-incompatibility, plasmid amplification, Regulation of copy number, curing of plasmids	12
3	**Mechanisms of Genetic Exchange** Transformation - Discovery, mechanism of natural competence, Conjugation - Discovery, mechanism, Hfr and F' strains, Interrupted mating technique and time of entry mapping Transduction - Generalized transduction, specialized transduction, LFT & HFT lysates, Mapping by recombination and co-transduction of markers; Features of T4 genetics , Genetic basis of lytic versus lysogenic switch of phage lambda	18
4	**Transposable elements** Prokaryotic transposable elements – Insertion Sequences, composite and non-composite transposons, Replicative and Non replicative transposition, Mu transposon Eukaryotic transposable elements - Yeast (Ty	15

	retrotransposon), Drosophila (P elements), Maize (Ac/Ds) Uses of transposons and transposition	
	Practical : 1. Preparation of Master and Replica Plate (study of auxotrophs) 2. Study the effect of chemical (HNO2) and physical (UV) mutagens on bacterial cells 3. Study survival curve of bacteria after exposure to ultraviolet (UV) light 4. Isolation of Plasmid DNA from E.coli 5. Study different conformations of plasmid DNA through Agaraose gel electrophoresis. 6. Demonstration of bacterial transformation 7. Study of AMES test	30
	TOTAL	**90**

Reading List :

1. Klug WS, Cummings MR, Spencer, C, Palladino, M (2011). Concepts of Genetics, 10th Ed., Benjamin Cummings
2. Krebs J, Goldstein E, Kilpatrick S (2013). Lewin's Essential Genes, 3rd Ed., Jones and Bartlett Learning
3. Pierce BA (2011) Genetics: A Conceptual Approach, 4th Ed., Macmillan Higher Education Learning
4. Watson JD, Baker TA, Bell SP et al. (2008) Molecular Biology of the Gene, 6th Ed., Benjamin Cummings
5. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-India
6. Russell PJ. (2009). i Genetics- A Molecular Approach. 3rd Ed, Benjamin Cummings
7. Sambrook J and Russell DW. (2001). Molecular Cloning: A Laboratory Manual. 4th Edition, Cold Spring Harbour Laboratory press.
8. Maloy SR, Cronan JE and Friefelder D(2004) Microbial Genetics 2nd EDITION., Jones and Barlett Publishers

SEMESTER – IV

MBIO CC409: Environmental Microbiology

COURSE OUTCOME:

After completion of the course, the students will be able to:

CO1. Develop a better understanding of ecosystem and associated microflora

CO2. Analysis on idea of nutrient cycling with reference to C- cycle, N- cycle and other elements

CO3. Understand the Role of microorganisms in degradation of solid/liquid wastes

CO4. Apply Skills in isolation of Rhizobium & other microflora from rhizosphere & rhizoplane

MBIO CC409 : Environmental Microbiology **PWC (Theory : 4 credits + Practical : 2 credits)**		
Unit	**Topics to be covered**	**No. of hours**
1	**Microorganisms and their Habitats** Structure and function of ecosystems Terrestrial Environment: Soil profile and soil microflora Aquatic Environment: Microflora of fresh water and marine habitat Atmosphere: Aeromicroflora and dispersal of microbes Animal Environment: Microbes in/on human body (Microbiomics) & animal (ruminants) body. Extreme Habitats: Extremophiles: Microbes thriving at high & low temperatures, pH, high hydrostatic & osmotic pressures, salinity, & low nutrient levels. Microbial succession in decomposition of plant organic matter	18
2	**Microbial Interactions** Microbe interactions: Mutualism, synergism, commensalism, competition, amensalism, parasitism, predation Microbe-Plant interaction: Symbiotic and non symbiotic interactions	12

	Microbe-animal interaction: Microbes in ruminants, nematophagus fungi and symbiotic luminescent bacteria	
3	**Biogeochemical Cycling** Carbon cycle: Microbial degradation of cellulose, hemicelluloses, lignin and chitin Nitrogen cycle: Nitrogen fixation, ammonification, nitrification, denitrification and nitrate reduction Phosphorus cycle: Phosphate immobilization and solubilisation Sulphur cycle: Microbes involved in sulphur cycle Other elemental cycles: Iron and manganese	12
4	**Waste Management** (a) Solid Waste management: Sources and types of solid waste, Methods of solid waste disposal (composting and sanitary landfill) Liquid waste management: Composition and strength of sewage (BOD and COD), Primary, secondary (oxidation ponds, trickling filter, activated sludge process and septic tank) and tertiary sewage treatment (b) Principles and degradation of common pesticides, organic (hydrocarbons, oil spills) and inorganic (metals) matter, biosurfactants	18
	Practical : 1. Analysis of soil - pH, moisture content, water holding capacity, percolation, capillary action. 2. Isolation of microbes (bacteria & fungi) from soil (28ºC & 45ºC). 3. Isolation of microbes (bacteria & fungi) from rhizosphere and rhizoplane. 4. Assessment of microbiological quality of water. 5. Determination of BOD of waste water sample. 6. Study the presence of microbial activity by	30

	detecting (qualitatively) enzymes (dehydrogenase, amylase, urease) in soil. 7. Isolation of Rhizobium from root nodules.	
	TOTAL	**90**

Reading List :

1. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA
2. Madigan MT, Martinko JM and Parker J. (2014). Brock Biology of Microorganisms. 14th edition. Pearson/ Benjamin Cummings
3. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, Academic Press
4. Okafor, N (2011). Environmental Microbiology of Aquatic & Waste systems. 1st edition, Springer, New York
5. Singh A, Kuhad, RC & Ward OP (2009). Advances in Applied Bioremediation. Volume 17, Springer-Verlag, Berlin Hedeilberg
6. Barton LL & Northup DE (2011). Microbial Ecology. 1st edition, Wiley Blackwell, USA Campbell RE. (1983). Microbial Ecology. Blackwell Scientific Publication, Oxford, England.
7. Coyne MS. (2001). Soil Microbiology: An Exploratory Approach. Delmar Thomson Learning.
8. Lynch JM & Hobbie JE. (1988). Microorganisms in Action: Concepts & Application in Microbial Ecology. Blackwell Scientific Publication, U.K.
9. Martin A. (1977). An Introduction to Soil Microbiology. 2nd edition. John Wiley & Sons Inc. New York & London.
10. Stolp H. (1988). Microbial Ecology: Organisms Habitats Activities. Cambridge University Press, Cambridge, England.
11. Subba Rao NS. (1999). Soil Microbiology. 4th edition. Oxford & IBH Publishing Co. New Delhi.
12. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.

SEMESTER – V

MBIO CC410: Food and Dairy Microbiology

COURSE OUTCOME:

After completion of the course, the students will be able to:

CO1. Understand the Role of microorganisms in food spoilage

CO2. Analysis the Methods of food preservation

CO3. Develop knowledge on Role of microorganisms in production of fermented foods and probiotics

CO4. Apply Testing of milk quality and microorganism associated with various spoiled foods

MBIO CC410 : Food And Dairy Microbiology **PWC (Theory : 4 credits + Practical : 2 credits)**		
Unit	**Topics to be covered**	**No. of hours**
1	**Foods as a substrate for microorganisms:** Intrinsic and extrinsic factors that affect growth and survival of microbes in foods, natural flora and source of contamination of foods in general.	14
2	**Microbial spoilage of various foods:** Principles, Spoilage of vegetables, fruits, meat, eggs, milk and butter, bread, canned Foods. Cultural and rapid detection methods of food borne pathogens in foods.	16
3	**(a) Principles and methods of food preservation :** Principles, physical methods of food preservation: temperature (low, high, canning, drying), irradiation, hydrostatic pressure, high voltage pulse, microwave processing and aseptic packaging, chemical methods of food preservation: salt, sugar, organic acids, SO2, nitrite and nitrates, ethylene oxide, antibiotics and bacteriocins **(b) Food sanitation and control:** FSSAI and	16

	HACCP, Indices of food sanitary quality and sanitizers	
4	**Fermented foods** Dairy starter cultures, fermented dairy products: yogurt, acidophilus milk, kumiss, kefir, dahi and cheese, other fermented foods: dosa, sauerkraut, soy sauce and tampeh, Probiotics: Health benefits, types of microorganisms used, probiotic foods available in market.	14
	Practical : 1. MBRT of milk samples and their standard plate count. 2. Alkaline phosphatase test to check the efficiency of pasteurization of milk. 3. Isolation of any food borne bacteria from food products. 4. Isolation of spoilage microorganisms from spoiled vegetables/fruits. 5. Isolation of spoilage microorganisms from bread. 6. Preparation of Yogurt/Dahi.	30

Reading List :

1. Adams MR and Moss MO. (1995). Food Microbiology. 4th edition, New Age International (P) Limited Publishers, New Delhi, India.
2. Banwart JM. (1987). Basic Food Microbiology. 1st edition. CBS Publishers and Distributors, Delhi, India.
3. Davidson PM and Brannen AL. (1993). Antimicrobials in Foods. Marcel Dekker, New York.
4. Dillion VM and Board RG. (1996). Natural Antimicrobial Systems and Food Preservation. CAB International, Wallingford, Oxon.
5. Frazier WC and Westhoff DC. (1992). Food Microbiology. 3rd edition. Tata McGraw-Hill Publishing Company Ltd, New Delhi, India.
6. Gould GW. (1995). New Methods of Food Preservation. Blackie Academic and Professional, London.

7. Jay JM, Loessner MJ and Golden DA. (2005). Modern Food Microbiology. 7th edition, CBS Publishers and Distributors, Delhi, India.
8. Lund BM, Baird Parker AC, and Gould GW. (2000). The Microbiological Safety and Quality of Foods. Vol. 1-2, ASPEN Publication, Gaithersberg, MD.
9. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9th edition. Pearson Education.

SEMESTER – V

MBIO CC511: Industrial Microbiology (Theory)

COURSE OUTCOME:

After completion of the course, the students will be able to:

CO1. Understand the Methods of isolation of microorganisms from different sources

CO2. Analysis the Methods of preservation of industrially important microbes

CO3. Apply Knowledge of different types of fermentation process and bioreactors

CO4. Demonstrate the Knowledge of downstream processes and enzyme mobilization techniques

MBIO CC511 : Industrial Microbiology (Theory) **PWC (Theory : 4 credits + Practical : 2 credits)**		
Unit	**Topics to be covered**	**No. of hours**
1	**Isolation of industrially important microbial strains and fermentation media :** Brief history and developments in industrial microbiology; Sources of industrially important microbes and methods for their isolation, preservation and maintenance of industrial strains, strain improvement, Crude and synthetic media; molasses, cornsteep liquor, sulphite waste liquor, whey, yeast extract and protein hydrolysates	18

2	**Types of fermentation processes, bio-reactors and measurement of fermentation parameters** Types of fermentation processes - Solid-state and liquid-state (stationary and submerged) fermentations; batch, fed-batch (eg. baker's yeast) and continuous fermentations Components of a typical bio-reactor, Types of bioreactors- Laboratory, pilot- scale and production fermenters, constantly stirred tank and air-lift fermenters, Measurement and control of fermentation parameters - pH, temperature, dissolved oxygen, foaming and aeration ; Down-stream processing : Cell disruption, filtration, centrifugation, solvent extraction, precipitation, lyophilization and spray drying	20
3	**Microbial production of industrial products (micro-organisms involved, media, fermentation conditions, downstream processing and uses)** Citric acid, ethanol, penicillin, glutamic acid, Vitamin B12, Enzymes (amylase, protease, lipase) Wine, beer	12
4	**Enzyme immobilization** Methods of immobilization, advantages and applications of immobilization, large scale applications of immobilized enzymes (glucose isomerase and penicillin acylase)	10
	Practical : 1. Study different parts of fermenter 2. Microbial fermentations for the production and estimation (qualitative and quantitative) of: (a) Enzymes: Amylase and Cellulase (b) Amino acid: any one eg. Glutamic acid (c) Organic acid: Citric acid (d) Alcohol: Ethanol	30

	3. A visit to any educational institute/industry to see an industrial fermenter, and other downstream processing operations.	
	TOTAL	**90**

Reading List :

1. Patel A.H. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited
2. Okafor N. (2007). Modern Industrial Microbiology and Biotechnology. 1st edition. Bios Scientific Publishers Limited. USA
3. Waites M.J., Morgan N.L., Rockey J.S. and Higton G. (2001). Industrial Microbiology: An Introduction. 1st edition. Wiley – Blackwell
4. Glaze A.N. and Nikaido H. (1995). Microbial Biotechnology: Fundamentals of Applied Microbiology. 1st edition. W.H. Freeman and Company
5. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
6. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi.
7. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.

SEMESTER – V

MBIO CC512: Immunology (Theory)

COURSE OUTCOME:

After completion of the course, the students will be able to:

CO1. Gain Knowledge of various scientific contributions in the field of immunology

CO2. Understand Immune system and its response to pathogenic microorganisms

CO3. Develop Understanding of various immunological disorders

CO4. Apply Knowledge of various immunological techniques

MBIO CC512 : Immunology (Theory) **PWC (Theory : 4 credits + Practical : 2 credits)**		
Unit	**Topics to be covered**	**No. of hours**
1	**(a) Introduction :** Concept of Innate and Adaptive immunity; Contributions of following scientists to the development of field of immunology - Edward Jenner, Karl Landsteiner, Robert Koch, Paul Ehrlich, Elie Metchnikoff, Peter Medawar, MacFarlane Burnet, Neils K Jerne, Rodney Porter and Susumu Tonegawa **(b) Immune Cells and Organs:** Structure, Functions and Properties of: Immune Cells – Stem cell, T cell, B cell, NK cell, Macrophage, Neutrophil, Eosinophil, Basophil, Mast cell, Dendritic cell; and Immune Organs – Bone Marrow, Thymus, Lymph Node, Spleen, GALT, MALT, CALT	10
2	**(a) Antigens:** Characteristics of an antigen (Foreignness, Molecular size and Heterogeneity); Haptens; Epitopes (T & B cell epitopes); T-dependent and T-independent antigens; Adjuvants **(b) Antibodies:** Structure, Types, Functions and Properties of antibodies; Antigenic determinants on antibodies (Isotypic, allotypic, idiotypic); VDJ rearrangements; Monoclonal and Chimeric antibodies **(c) Major Histocompatibility Complex :** Organization of MHC locus (Mice & Human); Structure and Functions of MHC I & II molecules; Antigen processing and presentation (Cytosolic and Endocytic pathways)	22

	(d) Complement System: Components of the Complement system; Activation pathways (Classical, Alternative and Lectin pathways); Biological consequences of complement Activation	
3	**(a) Generation of Immune Response** Primary and Secondary Immune Response; Generation of Humoral Immune Response (Plasma and Memory cells); Generation of Cell Mediated Immune Response (Self MHC restriction, T cell activation, Co- stimulatory signals); Killing Mechanisms by CTL and NK cells, Introduction to tolerance **(b) Immunological Disorders and Tumor Immunity** Types of Autoimmunity and Hypersensitivity with examples; Immunodeficiencies - Animal models (Nude and SCID mice), SCID, DiGeorge syndrome, Chediak- Higashi syndrome, Leukocyte adhesion deficiency, CGD; Types of tumors, tumor Antigens, causes and therapy for cancers.	15
4	**Immunological Techniques:** Principles of Precipitation, Agglutination, Immunodiffusion, Immunoelectrophoresis, ELISA, ELISPOT, Western blotting, Immunofluoresence, Flow cytometry, Immunoelectron microscopy.	8
	Practical : 1. Identification of human blood groups. 2. Perform Total Leukocyte Count of the given blood sample. 3. Perform Differential Leukocyte Count of the given blood sample. 4. Separate serum from the blood sample (demonstration). 5. To study immunodiffusion by Ouchterlony method.	30

	6. To study DOT ELISA. 7. To study immunoelectrophoresis.	
	TOTAL	**90**

Reading List :

1. Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 6th edition Saunders Publication, Philadelphia.
2. Delves P, Martin S, Burton D, Roitt IM. (2006). Roitt's Essential Immunology.11th edition Wiley- Blackwell Scientific Publication, Oxford.
3. Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 6th edition W.H. Freeman and Company, New York.
4. Murphy K, Travers P, Walport M. (2008). Janeway's Immunobiology. 7th edition Garland Science Publishers, New York.
5. Peakman M, and Vergani D. (2009). Basic and Clinical Immunology. 2nd edition Churchill Livingstone Publishers, Edinberg.
6. Richard C and Geiffrey S. (2009). Immunology. 6th edition. Wiley Blackwell Publication.

SEMESTER – VI

MBIO CC613: Medical Microbiology

COURSE OUTCOME:

After completion of the course, the students will be able to:

CO1. Understand the Microbiota of human and host pathogen interaction

CO2. Analysis Disease caused by the pathogenic microorganisms and its diagnosis

CO3. Develop understanding of common bacterial, viral, fungal, parasitic diseases of human being and animals

CO4. Develop Knowledge of various therapeutical measures to combat microbial diseases

MBIO CC613 : Medical Microbiology PWC (Theory : 4 credits + Practical : 2 credits)		
Unit	**Topics to be covered**	**No. of hours**
1	**(a) Normal microflora of the human body and host pathogen interaction:** Normal microflora of the human body: Importance of normal microflora, normal microflora of skin, throat, gastrointestinal tract, urogenital tract Host pathogen interaction: Definitions - Infection, Invasion, Pathogen, Pathogenicity, Virulence, Toxigenicity, Carriers and their types, Opportunistic infections, Nosocomial infections. Transmission of infection, Pathophysiologic effects of LPS **(b) Sample collection, transport and diagnosis** : Collection, transport and culturing of clinical samples, principles of different diagnostic tests (ELISA, Immunofluorescence, Agglutination based tests,Complement fixation, PCR, DNA probes).	18
2	**Bacterial diseases** List of diseases of various organ systems and their causative agents. The following diseases in detail with Symptoms, mode of transmission, prophylaxis and control of Respiratory Diseases: *Streptococcus pyogenes, Haemophilus influenzae, Mycobacterium tuberculosis Gastrointestinal Diseases: Escherichia coli, Salmonella typhi, Vibrio cholerae, Helicobacter pylori Others: Staphylococcus aureus, Bacillus anthracis, Clostridium tetani, Treponema pallidum, Clostridium difficile*	12
3	**(a) Viral diseases:** List of diseases of various organ systems and their causative agents. The following diseases in detail with Symptoms, mode of transmission, prophylaxis and control Polio, Herpes,	20

	Hepatitis, Rabies, Dengue, AIDS, Influenza etc. **(b) Protozoan diseases:** List of diseases of various organ systems and their causative agents. The following diseases in detail with Symptoms, mode of transmission, prophylaxis and control Malaria, Kala-azar **(c) Fungal diseases:** Brief description of each of the following types of mycosis and one representative disease to be studied with respect to transmission, symptoms and prevention.	
4	**Antimicrobial agents: General characteristics and mode of action** Antibacterial agents: Five modes of action with one example each: Inhibitor of nucleic acid synthesis; Inhibitor of cell wall synthesis; Inhibitor of cell membrane function; Inhibitor of protein synthesis; Inhibitor of metabolism Antifungal agents: Mechanism of action of Amphotericin B, Griseofulvin Antiviral agents: Mechanism of action of Amantadine, Acyclovir, Azidothymidine , Antibiotic resistance, MDR, XDR, MRSA, NDM-1	10
	Practical : 1. Identify bacteria (any three of E. coli, Salmonella, Pseudomonas, Staphylococcus, Bacillus) using laboratory strains on the basis of cultural, morphological and biochemical characteristics: IMViC, TSI, nitrate reduction, urease production and catalase tests 2. Study of composition and use of important differential media for identification of bacteria: EMB Agar, McConkey agar, Mannitol salt agar, Deoxycholate citrate agar, TCBS 3. Study of bacterial flora of skin by swab method 4. Perform antibacterial sensitivity by Kirby-Bauer method	30

	5. Determination of minimal inhibitory concentration (MIC) of an antibiotic. 6. Study symptoms of the diseases with the help of photographs: Polio, anthrax, herpes, chicken pox, HPV warts, AIDS (candidiasis), dermatomycoses (ring worms) 7. Study of various stages of malaria parasite in RBCs using permanent mounts. 8. Study of promastigote and amastigote structures of leismania parasites.	

Reading List :

1. Ananthanarayan R. and Paniker C.K.J. (2009) Textbook of Microbiology. 8th edition, University
2. Press Publication
3. Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. (2013) Jawetz, Melnick and
4. Adelberg's Medical Microbiology. 26th edition. McGraw Hill Publication
5. Goering R., Dockrell H., Zuckerman M. and Wakelin D. (2007) Mims' Medical Microbiology. 4th
6. edition. Elsevier
7. Willey JM, Sherwood LM, and Woolverton CJ. (2013) Prescott, Harley and Klein's Microbiology.
8. 9th edition. McGraw Hill Higher Education
9. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms.
10. 14th edition. Pearson International Edition

SEMESTER – VI

MBIO CC614: Recombinant DNA Technology (Theory)

COURSE OUTCOME:

After completion of the course, the students will be able to:

CO1. Understand the Concept of RDT & its application in the production of therapeutic products

CO2. Analysis the Genetic engineering tools for manipulation of DNA

CO3. Develop knowledge on DNA isolation techniques, PCR and gel electrophoresis

CO4. Perform Demonstration of Bacterial Transformation and calculation of transformation efficiency.

MBIO CC614 : Recombinant DNA Technology (Theory) **PWC (Theory : 4 credits + Practical : 2 credits)**		
Unit	**Topics to be covered**	**No. of hours**
1	**(a) Introduction to Genetic Engineering:** Milestones in genetic engineering and biotechnology **(b) Applications of Recombinant DNA Technology:** Products of recombinant DNA technology: Products of human therapeutic interest - insulin, hGH, antisense molecules. Bt transgenic - cotton, brinjal, Gene therapy, recombinant vaccines, protein engineering and site directed mutagensis	16
2	**Molecular Cloning-** **(a) Tools and Strategies:** Cloning Tools; Restriction modification systems: Types I, II and III. Mode of action, nomenclature, applications of Type II restriction enzymes in genetic engineering DNA modifying enzymes and their applications: DNA polymerases. Terminal deoxynucleotidyl, transferase, kinases and phosphatases, and DNA ligases	24

	,Cloning Vectors: Definition and Properties, Plasmid vectors: pBR and pUC series, Bacteriophage lambda and M13 based vectors, Cosmids, BACs, YACs, Use of linkers and adaptors, Expression vectors: E.coli lac and T7 promoter-based vectors, yeast YIp, YEp and YCp vectors, Baculovirus based vectors, mammalian SV40-based expression vectors **(b) Methods in Molecular Cloning:** Transformation of DNA: Chemical method, Electroporation, Gene delivery: Microinjection, electroporation, biolistic method (gene gun), liposome and viralmediated delivery, Agrobacterium - mediated delivery DNA, RNA and Protein analysis: Agarose gel electrophoresis, Southern - and Northern – blotting techniques, dot blot, DNA microarray analysis, SDS-PAGE and Western blotting.	
3	**DNA Amplification and DNA sequencing** PCR: Basics of PCR, RT-PCR, Real-Time PCR Sanger's method of DNA Sequencing: traditional and automated sequencing Primer walking and shotgun sequencing	10
4	**Construction and Screening of Genomic and cDNA libraries** Genomic and cDNA libraries: Preparation and uses, Screening of libraries: Colony hybridization and colony PCR, Chromosome walking and chromosome jumping	10
	Practical : 1. Preparation of competent cells for transformation 2. Demonstration of Bacterial Transformation and calculation of transformation efficiency.	30

	3. Digestion of DNA using restriction enzymes and analysis by agarose gel electrophoresis 4. Ligation of DNA fragments 5. Cloning of DNA insert and Blue white screening of recombinants. 6. Interpretation of sequencing gel electropherograms 7. Designing of primers for DNA amplification 8. Amplification of DNA by PCR	
	TOTAL	**90**

Reading List :

1. Brown TA. (2010). Gene Cloning and DNA Analysis. 6th edition. Blackwell Publishing, Oxford, U.K.
2. Clark DP and Pazdernik NJ. (2009). Biotechnology: Applying the Genetic Revolution. Elsevier Academic Press, USA
3. Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7th edition.Blackwell Publishing, Oxford, U.K.
4. Sambrook J and Russell D. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press
5. Wiley JM, Sherwood LM and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. McGraw Hill Higher Education
6. Brown TA. (2007). Genomes-3. Garland Science Publishers
7. Primrose SB and Twyman RM. (2008). Genomics: Applications in human biology. Blackwell Publishing, Oxford, U.K.

SEMESTER – V

Discipline Specific Elective (DSE) (6 credits each)

Discipline Specific Elective (DSE) Course: Elective courses may be offered by the main discipline/subject of study is referred to as Discipline Specific Elective. The University/Institute may also offer

discipline related Elective courses of interdisciplinary nature (to be offered by main discipline/subject of study).

COURSE OUTCOME:

After completion of the course, the students will be able to:

CO1. Develop basic knowledge of mathematics as applied to biological phenomenon

CO2. Understand the basic concepts of statistics and their importance

CO3. Apply Various statistical techniques to prove the significance of biological experiment

CO4. Demonstrate knowledge on Standard Deviation, Coefficient of Variation, Correlation and regression.

MBIO DSE501 : Biostatistics **PWC (Theory : 4 credits + Practical : 2 credits)**		
Unit	**Topics to be covered**	**No. of hours**
1	(a) Measures of central tendency (mean, median, mode) (b) Measures of dispersion; skewness, kurtosis; Elementary Probability and basic laws; Discrete and Continuous Random variable, Mathematical Expectation; Curve Fitting;	20
2	Correlation and Regression. Emphasis on examples from Biological Sciences; Mean and Variance of Discrete and Continuous Distributions namely Binomial, Poisson, Geometric, Weibull, Logistic and Normal distribution. Fitting of Distributions;	13
3	Statistical methods: Scope of statistics: utility and misuse. Principles of statistical analysis of biological data. Sampling parameters. Difference between sample and Population, Sampling Errors, Censoring, difference between parametric and non-parametric statistics;	12

4	Sampling Distributions, Standard Error, Testing of Hypothesis, Level of Significance and Degree of Freedom; Large Sample Test based on Normal Distribution, Small sample test based on t-test, Z-test and F test; Confidence Interval; Distribution-free test - Chi-square test; Basic introduction to Multivariate statistics, etc.	15
	Practical : 1. Mean, Median, Mode from grouped and ungrouped Data set 2. Standard Deviation and Coefficient of Variation 3. Correlation 4. Regression 5. Analysis of variance 6. Testing of Hypothesis- Normal Distribution, t-test and Chi-Square-test 7. Sampling techniques(simple, stratified and systemic)	30
	TOTAL	**90**

Reading List :

1. H. S. Bear: Understanding Calculus, John Wiley and Sons (Second Edition); 2003.
2. E. Batschelet : Introduction to Mathematics for Life Scientists,Springer Verlag, International
3. Student Edition, Narosa Publishing House, New Delhi (1971, 1975)
4. A. Edmondson and D. Druce : Advanced Biology Statistics, Oxford University Press; 1996.
5. W. Danial : Biostatistics : A foundation for Analysis in Health Sciences, John Wiley and Sons Inc; 2004.

SEMESTER – V

MBIO DSE502: Microbes in Sustainable Agriculture and Development

COURSE OUTCOME:

After completion of the course, the students will be able to:

CO1. Understand the Multifarious roles of microorganisms in the field of sustainable agriculture

CO2. Develop Knowledge of various microbiological process of soil

CO3. Understand the Knowledge of controlling plant pathogens to combat plant diseases

CO4. Demonstrate the Application of biofertilizers and biopesticides in agricultural fields

CO5. Apply Practical skill of mushroom cultivation

MBIO DSE502 : Microbes in Sustainable Agriculture and Development **PWC (Theory : 4 credits + Practical : 2 credits)**		
Unit	**Topics to be covered**	**No. of hours**
1	**(a) Soil Microbiology :** Soil as Microbial Habitat, Soil profile and properties, Soil formation, Diversity and distribution of microorganisms in soil **(b) Mineralization of Organic & Inorganic Matter in Soil:** Mineralization of cellulose, hemicelluloses, lignocelluloses, lignin and humus, phosphate, nitrate, silica, potassium	16
2	**Microbial Control of Soil Borne Plant Pathogens** Plant Pathogens ; Biocontrol mechanisms and ways, Microorganisms used as biocontrol agents against Microbial plant pathogens, Insects, Weeds	14
3	**Biofertilizer and Biopeasticides** Rhizobium, Azotobacter, Azospirillum as biofertilizer : Biocontrol mechanisms and ways, Microorganisms used as biocontrol agents against Microbial plant pathogens, Insects, Weeds	18

4	Mushroom Cultivation : Structure of Mushroom and its type, Spawn, Mushroom Cultivation method	12
	Practical : 1. Study soil profile and Rapid soil test 2. Study microflora of different types of soils 3. Rhizobium as soil inoculants characteristics and field application 4. Azotobacter as soil inoculants characteristics and field application 5. Design and functioning of a biogas plant 6. Isolation of cellulose degrading organisms 7. Mushroom Cultivation	30

Reading List :

1. Brown TA. (2010). Gene Cloning and DNA Analysis. 6th edition. Blackwell Publishing, Oxford, U.K.
2. Clark DP and Pazdernik NJ. (2009). Biotechnology: Applying the Genetic Revolution. Elsevier Academic Press, USA
3. Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K.
4. Sambrook J and Russell D. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press
5. Wiley JM, Sherwood LM and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. McGraw Hill Higher Education
6. Brown TA. (2007). Genomes-3. Garland Science Publishers
7. Primrose SB and Twyman RM. (2008). Genomics: Applications in human biology. Blackwell Publishing, Oxford, U.K.

SEMESTER – VI

MBIO DSE603: Instrumentation and Biotechniques

COURSE OUTCOME:

After completion of the course, the students will be able to:

CO1. Understand the Instruments and its techniques to study microbes and its biomolecules

CO2. Develop depth Knowledge of observing microbial world through microscopy technique

CO3. Analysis the Biomolecule separation techniques: chromatography, gel electrophoresis, spectrophotometry

CO4. Apply Demonstration of column packing in any form of column chromatography

MBIO DSE603 : Instrumentation and Biotechniques **PWC (Theory : 4 credits + Practical : 2 credits)**		
Unit	**Topics to be covered**	**No. of hours**
1	**Microscopy** Brightfield and darkfield microscopy, Fluorescence Microscopy, Phase contrast Microscopy, Confocal Microscopy, Electron Microscopy (Scanning and Transmission Electron Microscopy) and Micrometry.	15
2	**(a) Chromatography :** Principles and applications of paper chromatography (including Descending and 2-D), Thin layer chromatography. Column packing and fraction collection. Gel filtration chromatography, ion exchange chromatography and affinity chromatography, GLC, HPLC. **(b) Spectrophotometry:** Principle and use of study of absorption spectra of biomolecules. Analysis of biomolecules using UV and visible range. Colorimetry and turbidometry.	15

3	**Electrophoresis** Principle and applications of native polyacrylamide gel electrophoresis, SDS- polyacrylamide gel electrophoresis, 2D gel electrophoresis, Isoelectric focusing, Zymogram preparation and Agarose gel electrophoresis.	15
4	**Centrifugation and pH Meter** Preparative and analytical centrifugation, fixed angle and swinging bucket rotors. RCF and sedimentation coefficient, differential centrifugation, density gradient centrifugation and ultracentrifugation; pH Meter	15
	Practical : 1. Study of fluorescent micrographs to visualize bacterial cells. 2. Ray diagrams of phase contrast microscopy and Electron microscopy. 3. Separation of mixtures by paper / thin layer chromatography. 4. Demonstration of column packing in any form of column chromatography. 5. Separation of protein mixtures by any form of chromatography. 6. Separation of protein mixtures by Polyacrylamide Gel Electrophoresis (PAGE). 7. Separation of components of a given mixture using a laboratory scale centrifuge. 8. Understanding density gradient centrifugation with the help of pictures. 9. Estimation of Sugar by Spectrophotometer 10. Measurement of pH of Different Samples	30
	TOTAL	**90**

Reading List :

1. Wilson K and Walker J. (2010). Principles and Techniques of Biochemistry and Molecular Biology. 7th Ed., Cambridge University Press.

2. Nelson DL and Cox MM. (2008). Lehninger Principles of Biochemistry, 5th Ed., W.H. Freeman and Company.
3. Willey MJ, Sherwood LM & Woolverton C J. (2013). Prescott, Harley and Klein's Microbiology. 9thEd., McGraw Hill.
4. Karp G. (2010) Cell and Molecular Biology: Concepts and Experiments. 6th edition. John Wiley & Sons. Inc.
5. De Robertis EDP and De Robertis EMF. (2006). Cell and Molecular Biology. 8th edition. Lipincott Williams and Wilkins, Philadelphia.
6. Cooper G.M. and Hausman R.E. (2009). The Cell: A Molecular Approach. 5th Edition. ASM Press & Sunderland, Washington D.C., Sinauer Associates, MA.
7. Nigam A and Ayyagari A. 2007. Lab Manual in Biochemistry, Immunology and Biotechnology. Tata McGraw Hill.

SEMESTER – VI

MBIO DSE604 : Project Work/Dissertation (6 Credits)

COURSE OUTCOME:

After completion of the course, the students will be able to:

CO1. Apply Experimental approach of various scientific phenomena

CO2. Enhance knowledge on research aptitude and designing experiments independently

CO3. Develop knowledge on Augmenting reading habit of research/review articles

CO4. Skilled knowledge on project work

MBIO DSE604 : Project Work / Dissertation (6 Credits) PWC		
Unit	**Topics to be covered**	**No. of hours**
1	**Optional Dissertation or project work in place of one Discipline Specific Elective paper (6 credits) in 6th Semester.**	

	Dissertation/Project: An elective course designed to acquire special/advanced knowledge, such as supplement study/support study to a project work, and a candidate studies such a course on his own with an advisory support by a teacher/faculty member is called dissertation/project. **Project work/Dissertation** is considered as a special course involving application of knowledge involving / analyzing /exploring a real life situation / difficult problem. A Project/Dissertation work would be of 6 credits. A Project/Dissertation work may be given in lieu of a discipline specific elective paper	
	TOTAL	**90**

Generic Elective Papers (GE) (6 credits each)

Generic Elective (GE) Course: An elective course chosen generally from an unrelated discipline/subject, with an intention to seek exposure is called a Generic Elective.

P.S.: A core course offered in a discipline/subject may be treated as an elective by other discipline/ subject and vice versa and such electives may also be referred to as Generic Elective.

SEMESTER – I

MBIO GE101: Introduction and Scope of Microbiology

COURSE OUTCOME:

After completion of the course, the students will be able to:

CO1. Understand the General characteristics of acellular (viruses) and cellular microorganisms (bacteria, fungi, algae, protozoa, archaea)

CO2. Classify bacteria into different groups and methods of reproduction.

CO3. Develop depth knowledge of the chemical nature of viruses and different types animals, plants and bacteria (bacteriophages)

CO4. Study the principle and applications of important instruments autoclave, incubator, hot air oven, light microscope, pH meter) used in the microbiology laboratory

MBIO GE101 : Introduction and Scope of Microbiology PWC (Theory : 4 credits + Practical : 2 credits)		
Unit	**Topics to be covered**	**No. of hours**
1	**History of Development of Microbiology** Development of microbiology as a discipline, Spontaneous generation vs. biogenesis. Contributions of Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming Role of microorganisms in fermentation, Germ theory of disease, Development of various microbiological techniques and golden era of microbiology, Development of the field of soil microbiology: Contributions of Martinus W. Beijerinck, Sergei N. Winogradsky, Selman A.Waksman, Establishment of fields of medical microbiology and immunology through the work of Paul Ehrlich, Elie Metchnikoff, Edward Jenner	12
2	**Diversity of Microorganisms** Systems of classification : Binomial nomenclature, Whittaker's five kingdom and Carl Woese's three kingdom classification systems and their utility General characteristics of different groups: Acellular microorganisms (Viruses, Viroids, Prions) and Cellular microorganisms (Prokarya: Archaea and Bacteria, Eukarya : Algae, Fungi and Protozoa) giving definitions and citing examples	15
3	**(a) Microscopy :** Bright Field Microscope, Dark Field Microscope, Phase Contrast Microscope, Fluoresence Microscope,	18

	Transmission Electron Microscope, Scanning Electron Microscope **(b) Sterilization :** Moist Heat, Autoclave, Dry Heat, Hot Air Oven, Tyndallization, Filteration	
4	**(a) Industrial Microbiology:** Definition of fermentation, primary and secondary metabolites, types of fermentations and fermenters and microbes producing important industrial products through fermentation **(b) Food and Dairy Microbiology :** Microorganisms as food (SCP), microorganisms in food fermentations (dairy and non dairy based fermented food products) and probiotics. Microorganisms in food spoilage and food borne infections **(c) Medical Microbiology:** definition, scope and application	15
	Practical : 1. Microbiology Laboratory Management and Biosafety. 2. To study the principle and applications of important instruments autoclave, incubator, hot air oven, light microscope, pH meter) used in the microbiology laboratory 3. Sterilization of medium using Autoclave. 4. Sterilization of glassware using Hot Air Oven 5. Study of different shapes of bacteria using permanent slides 6. Study of Rhizopus and Penicillium using permanent mounts	30
	TOTAL	**90**

Reading List :

1. Tortora GJ, Funke BR and Case CL. (2008). Microbiology: An Introduction. 9th edition. Pearson Education

2. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms. 14th edition. Pearson International Edition
3. Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited
4. Wiley JM, Sherwood LM and Woolverton CJ. (2013) Prescott's Microbiology. 9th Edition. McGraw Hill International.
5. Atlas RM. (1997). Principles of Microbiology. 2nd edition. WM.T.Brown Publishers.
6. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company.
7. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General Microbiology. 5th edition. McMillan

SEMESTER – II

MBIO GE202: Bacteriology and Virology

COURSE OUTCOME:

After completion of the course, the students will be able to:

CO1. Understand the Ultrastructure of bacterial cells and their appendages.

CO2. Demonstrate the Methods of reproduction in bacteria.

CO3. Analysis Viruses: types (Plant virus, Animal virus and bacteriophage)

CO4. Study the morphological structures of viruses (DNA and RNA) and their important characters using electron micrographs

MBIO GE202 : Bacteriology and Virology **PWC (Theory : 4 credits + Practical : 2 credits)**		
Unit	**Topics to be covered**	**No. of hours**
1	**Cell organization** Cell size, shape and arrangements, capsule, flagella and pili, Composition and detailed	12

	structure of gram- positive and gram- negative cell wall and archaeal cell wall, Structure, chemical composition and functions of bacterial and archaeal cell membranes, Ribosomes, inclusions, nucleoid, plasmids, structure, formation and stages of sporulation	
2	**Bacterial growth and control** Culture media: Components of media, Synthetic or defined media, Complex media, enriched media, selective media, differential media, enrichment culture media Pure culture isolation: Streaking, serial dilution and plating methods, cultivation, maintenance and stocking of pure cultures, cultivation of anaerobic bacteria Growth: Binary fission, phases of growth	12
3	**Bacterial Systematics and Taxonomy** Taxonomy, nomenclature, systematics, types of classifications Morphology, ecological significance and economic importance of the following groups: Archaea: methanogens, thermophiles and halophiles Eubacteria: Gram negative and Gram positive Gram negative: Non-proteobacteria– Deinococcus, Chlamydiae, Spirochetes Alpha proteobacteria- Rickettsia, Rhizobium, Agrobacterium Gamma proteobacteria –Escherichia, Shigella, Pseudomonas Gram positive: Low G+C: Mycoplasma, Bacillus, Clostridium, Staphylococcus High G+C: Streptomyces, Frankia.	16
4	**(a) Introduction to Viruses :** Properties of viruses; general nature and important features	20

	Subviral particles; viroids, prions and their importance Isolation and cultivation of viruses **(b) Structure, and multiplication of viruses:** Morphological characters: Capsid symmetry and different shapes of viruses with examples, Viral multiplication in the Cell: Lytic and lysogenic cycle Description of important viruses: salient features of the viruses infecting differenthosts - Bacteriophages (T4 & Lambda); Plant (TMV & Cauliflower Mosaic Virus), Human (HIV & Hepatitis viruses) **(c) Role of Viruses in Disease and its prevention :** Viruses as pathogens: Role of viruses in causing diseases ; Prevention and control of viruses: Viral vaccines, interferons and antiviral compounds	
	Practical : 1. Preparation of different media: Nutrient agar, Nutrient broth 2. To perform simple staining 3. To Gram's staining of the bacterial smear 4. Isolation of pure cultures of bacteria by streaking method 5. Enumeration of colony forming units (CFU) count by spread plate method/pour plate 6. Study the morphological structures of viruses (DNA and RNA) and their important characters using electron micrographs	30
	TOTAL	**90**

Reading List :

1. Atlas RM. (1997). Principles of Microbiology. 2nd edition. WM.T.Brown Publishers
2. Madigan MT, Martinko JM, Dunlap PV and Clark DP (2014). Brock Biology of Micro-organisms. 14th edition. Pearson Education, Inc.

3. Stanier RY, Ingraham JL, Wheelis ML and Painter PR. (2005). General Microbiology. 5th edition. McMillan
4. Carter J and Saunders V(2007). Virology; principles and Applications. John Wiley and Sons
5. Flint SJ, Enquist, LW, Krug, RM, Racaniello, VR Skalka, AM (2004) Principles of Virology, Molecular Biology, Pathogenesis and Control.2nd edition.ASM Press
6. Shors Teri (2013) Understanding Viruses 2nd edition Jones and Bartlett Learning Burlington USA
7. Pelczar Jr MJ, Chan ECS, and Krieg NR. (2004). Microbiology. 5th edition Tata McGraw Hill.
8. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9th edition Pearson Education.
9. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.
10. Dimmock, NJ, Easton, AL, Leppard, KN (2007). Introduction to Modern Virology. 6th edition, Blackwell Publishing Ltd.
11. Cann AJ (2012) Principles of Molecular Virology, Academic Press

SEMESTER – III

MBIO GE303: Industrial And Food Microbiology

COURSE OUTCOME:

After completion of the course, the students will be able to:

CO1. Demonstrate the Use of microorganisms in fermentation industry

CO2. Understand the Different parameters essential for large scale production of industrial products

CO3. Develop depth knowledge on different methods of food preservation and food sanitation

CO4. Apply Laboratory skills in producing alcohol and enzymes using bacteria/yeast

MBIO GE303 : Industrial And Food Microbiology PWC (Theory : 4 credits + Practical : 2 credits)		
Unit	**Topics to be covered**	**No. of hours**
1	**Introduction to Industrial microbiology** Brief history and developments in industrial microbiology, brief 8dea of fermenters and fermentation processes- (laboratory, pilot scale and production fermenters, components of typical continuously stirred tank bioreactors, solod state, liquid state, batch, fed batch and contuinuous). Application of industrial microbiology in the production of products like antibiotics, alcohol, SCP, organic acids, enzymes, mushrooms and genetically modified products.	15
2	**Isolation of Industrial Strains and Fermentation Medium** Primary and secondary screening Preservation and maintenance of industrial strains Ingredients used in fermentation medium - molasses, corn steep liquor, whey & Yeast extract Measurement and control of fermentation parameters-pH, temperature, dissolvedoxygen, foaming and aeration.	10
3	**(a) Food as a substrate for microbial growth:** Intrinsic and extrinsic parameters that affect microbial growth in food Microbial spoilage of food - milk, egg, canned foods, meat. **(b) Dairy products, probiotics:** Fermented dairy products - yogurt, acidophilus milk, kefir, dahi and cheese, Probiotics definition, examples and benefits	18
4	**Principles and methods of food preservation and food sanitation** Physical methods - high temperature, low temperature, irradiation, aseptic packaging ; Chemical methods - salt, sugar, benzoates, citric	17

	acid, ethylene oxide, nitrate and nitrite ; Food sanitation and control – HACCP ; Food intoxication by Clostridium botulinum and Staphylococcus aureus Food infection by Salmonella and E.coli	
	Practical : 1. To study the microflora of Dahi by Gram's staining 2. Microbial fermentation for the production and estimation of citric acid 3. Microbial fermentation for the production and estimation of ethanol 4. Determination of the microbiological quality of milk sample by MBRT 5. Isolation of fungi from spoilt bread/ fruits/ vegetables 6. Study of the process of mushroom cultivation.	30
	TOTAL	**90**

Reading List :

1. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd Edition. Panima Publishing Company, New Delhi
2. Patel AH. (1996). Industrial Microbiology .1st Edition. MacMillan India Limited Publishing Company Ltd. New Delhi, India
3. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An introduction.9th Edition. Pearson Education
4. Willey JM, Sherwood LM AND Woolverton CJ (2013), Prescott, Harley and Klein's Microbiology.9th Edition. McGraw Hill Higher education
5. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
6. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.

7. Adams MR and Moss MO. (1995). Food Microbiology. 4th edition, New Age International (P) Limited Publishers, New Delhi, India.
8. Banwart JM. (1987). Basic Food Microbiology. 1st edition. CBS Publishers and Distributors, Delhi, India.
9. Frazier WC and Westhoff DC. (1992). Food Microbiology. 3rd edition. Tata McGraw-Hill Publishing Company Ltd, New Delhi, India.
10. Jay JM, Loessner MJ and Golden DA. (2005). Modern Food Microbiology. 7th edition, CBS Publishers and Distributors, Delhi, India.

SEMESTER – IV

MBIO GE404: Microbes in Environment

COURSE OUTCOME:

After completion of the course, the students will be able to:

CO1. Understand ecosystem and associated microflora

CO2. Develop understanding of microbial interactions with other organisms and among themselves

CO3. Demonstrate an idea of nutrient cycling with reference to carbon, nitrogen & other elements

CO4. Apply Skills in isolation of microbes from soil and potent enzymatic (cellulase, amylase) activity

MBIO GE404 : Microbes in Environment **PWC (Theory : 4 credits + Practical : 2 credits)**		
Unit	**Topics to be covered**	**No. of hours**
1	**Microorganisms and their Habitats** Structure and function of ecosystems Terrestrial Environment: Soil profile and soil microflora Aquatic Environment: Microflora of fresh water and marine habitats	12

	Atmosphere: Aeromicroflora and dispersal of microbes Animal Environment: Microbes in/on human body (Microbiomics) & animal (ruminants) body. Extreme Habitats: Extremophiles: Microbes thriving at high & low temperatures, pH, high hydrostatic& osmotic pressures, salinity, & low nutrient levels.	
2	**Microbial Interactions** Microbe interactions: Mutualism, synergism, commensalism, competition, amensalism, parasitism, predation Microbe-Plant interaction: Symbiotic and non symbiotic interactions Microbe-animal interaction: Microbes in ruminants, nematophagus fungi and symbiotic luminescent bacteria	16
3	**Biogeochemical Cycling** Carbon cycle: Microbial degradation of cellulose, hemicelluloses, lignin and chitin Nitrogen cycle: Nitrogen fixation, ammonification, nitrification, denitrification and nitrate reduction Phosphorus cycle: Phosphate immobilization and solubilisation Sulphur cycle: Microbes involved in sulphur cycle Other elemental cycles: Iron and manganese	12
4	**(a) Waste Management:** Solid Waste management: Sources and types of solid waste, Methods of solid waste disposal (composting and sanitary landfill) Liquid waste management: Composition and strength of sewage (BOD and COD), Primary, secondary (oxidation ponds, trickling filter, activated sludge process and septic tank) and tertiary sewage treatment	20

	(b) Microbial Bioremediation: Principles and degradation of common pesticides, hydrocarbons (oil spills) **(c) Water Potability:** Treatment and safety of drinking (potable) water, methods to detect potability of water samples: (a)standard qualitative procedure: presumptive test/MPN test, confirmed and completed tests for faecal coliforms (b) Membrane filter technique and (c) Presence/absence tests	
	Practical : 1. To perform the rapid soil test for detection of phosphate, ammonia etc 2. Isolation of microbes (bacteria & fungi) from soil (28ºC & 45ºC). 3. Isolation of microbes (bacteria & fungi) from rhizosphere 4. Assessment of microbiological quality of water. 5. Study the presence of microbial activity by detecting (qualitatively) enzymes (cellulase, amylase etc) in soil. 6. Isolation of Rhizobium from root nodules.	30
	TOTAL	**90**

Reading List :

1. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA
2. Madigan MT, Martinko JM and Parker J. (2014). Brock Biology of Microorganisms. 14th edition. Pearson/ Benjamin Cummings
3. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, Academic Press
4. Okafor, N (2011). Environmental Microbiology of Aquatic & Waste systems. 1st edition, Springer, New York
5. Singh A, Kuhad, RC & Ward OP (2009). Advances in Applied

Bioremediation. Volume 17, Springer Verlag, Berlin Hedeilberg

6. Barton LL & Northup DE (2011). Microbial Ecology. 1st edition, Wiley Blackwell, USA Campbell RE. (1983). Microbial Ecology. Blackwell Scientific Publication, Oxford, England.
7. Coyne MS. (2001). Soil Microbiology: An Exploratory Approach. Delmar Thomson Learning.
8. Lynch JM & Hobbie JE. (1988). Microorganisms in Action: Concepts & Application in Microbial Ecology. Blackwell Scientific Publication, U.K.
9. Martin A. (1977). An Introduction to Soil Microbiology. 2nd edition. John Wiley & Sons Inc. New York & London.
10. Stolp H. (1988). Microbial Ecology: Organisms Habitats Activities. Cambridge University Press, Cambridge, England.
11. Subba Rao NS. (1999). Soil Microbiology. 4th edition. Oxford & IBH Publishing Co. New Delhi.
12. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.

Skill Enhancement Course (SEC)(2Credits)

Skill Enhancement Courses (SEC): These courses may be chosen from a pool of courses designed to provide value-based and/or skill-based knowledge.

SEMESTER – III

IRSSEC301 : Inter-Religious Studies (Value Based)

IRSSEC301 : Inter-Religious Studies (Value Based) **PWC (02credits)**		
Unit	**Topics to be covered**	**No. of hours**
1	Nature and Need of Inter-Religious study, Scope of Comparative Religion.	05
2	Salient Features of Hinduism, Jainism and Buddhism, Salient Features of Christiany, Islam and Sikkhism.	10

3	Similarities and Differences among Religions, Conflicting Truth claims of different religions and inter-religious Harmony.	10
4	Religious Tolerance, Secularism.	05
	TOTAL	**30**

Reading List :

1. Chaudhary, C. Neeraj (1979). "Hinduism",B.I.Publication,New Delhi.
2. Devraj,N.K.,(1917)-"Hinduism and Christanity"Asian Publishing House.
3. Gordh, Geo rge, -''Christian Faith and its Cultural Exoperssion'', Printed in USA.
4. Hick, John,- ''Philosophy of Religion'', Prentice Hall of India.
5. Hopfe, M.Lewis(1983)- ''Religion of the World'', Macmillan Publishing Co. Inc, New York
6. Masih,Y. (1990)- ''Comparitive study of Relgion'',Motilal Banarasidass.
7. Sethi,S. Arijit, Pummer, Reinhard, (1979)-''Comparitive Religion'', Vikas Publishing House pvt. ltd, Delhi.
8. Singh, B.N.,(1994)-''Vishwa Dharma Darshan ki Samasyain'', Ratna Printing Works.
9. Tiwari, Nath Kedar,(1983)-''Comparative Religion'', Motilal Banarasidass.
10. Ward, CHS (1998) – 'Early Buddhism", Caxton Publication, Delhi.

SEMESTER – IV

MBIO SEC402: Biofertilizers and Biopesticides

COURSE OUTCOME:

After completion of the course, the students will be able to:

CO1. Understand N2 fixation, phosphate solubilization & mycorrhizal interaction in maintaining soil fertility

CO2. Developed skill on potent microorganism to be used as biopesticides

CO3. Analysis Viral diseases, their causal agent, symptoms, prevention and control measures

CO4. Develop depth knowledge on Bioinsecticides

MBIO SEC402 : Biofertilizers and Biopesticides PWC (Theory : 2 credits)		
Unit	**Topics to be covered**	**No. of hours**
1	**Biofertilizers** General account of the microbes used as biofertilizers for various crop plants and their advantages over chemical fertilizers. Symbiotic N2 fixers: Rhizobium - Isolation, characteristics, types, inoculum production and field application, legume/pulses plants Frankia - Isolation, characteristics, Alder, Casurina plants, non-leguminous crop symbiosis. Cyanobacteria, Azolla - Isolation, characterization, mass multiplication, Role in rice cultivation, Crop response, field application.	8
2	**Non - Symbiotic Nitrogen Fixers** Free living Azospirillum, Azotobacter - free isolation, characteristics, mass inoculums, production and field application	4
3	**(a) Phosphate Solubilizers :** Phosphate solubilizing microbes - Isolation, characterization, mass inoculum production, field application **(b) Mycorrhizal Biofertilizers :** Importance of mycorrizal inoculum, types of mycorrhizae and associated plants, Mass inoculums production of VAM, field applications of Ectomycorrhizae and VAM	8
4	**(a) Bioinsecticides :** General account of microbes used as bioinsecticides and their	10

	advantages over synthetic pesticides, Bacillus thuringiensis, production, Field applications, Viruses – cultivation and field applications. **(b) Role of Viruses in Disease and its prevention :** Viruses as pathogens: Role of viruses in causing diseases Prevention and control of viruses: Viral vaccines, interferons and antiviral compounds	
	TOTAL	**30**

Reading List :

1. Kannaiyan, S. (2003). Bioetchnology of Biofertilizers, CHIPS, Texas.
2. Mahendra K. Rai (2005). Hand book of Microbial biofertilizers, The Haworth Press, Inc. New York.
3. Reddy, S.M. et. al. (2002). Bioinoculants for sustainable agriculture and forestry, Scientific Publishers.
4. Subba Rao N.S (1995) Soil microorganisms and plant growth Oxford and IBH publishing co. Pvt. Ltd. NewDelhi.
5. Saleem F and Shakoori AR (2012) Development of Bioinsecticide, Lap Lambert Academic Publishing GmbH KG
6. Aggarwal SK (2005) Advanced Environmental Biotechnology, APH publication.

SEMESTER – I

Ability Enhancement Compulsory Courses (AECC)

COURSE OUTCOME:

After completion of the course, the students will be able to:

CO1. Communicate effectively using the techniques in the area of spoken as well as written communication.

CO2. Hone their LSRW skills within their communication.

CO3. Design and answer job interview questions

CO4. Demonstrate the ability to craft professional messages that are clear yet courteous.

Ability Enhancement Compulsory Courses (AECC)

English (2 Credits)

"AECC" courses are the courses based upon the content that leads to Knowledge enhancement; i. English/Hindi communication, ii. Environmental Science

SEMESTER – I

ENG AEC101 : English Communication **PWC (Theory :2 credits)**		
Unit	**Topics to be covered**	**No. of hours**
1	Communication (a) Definition of Communication (b) Stages of Communication (c) Barriers of Communication (d) Verbal and Non-verbal Communication (e) Skills of Communication – Listening, Reading, Writing, Speaking	5
2	Listening Skill (a) Meaning and Importance of Listening (b) Principles of Good listening	5
3	Writing Skills (a) Notice, Agenda, Minutes of the meeting (b) Report writing, Circulars (c) Writing Resume (d) Building vocabulary	15
4	Speaking Skill (a) Interview	5

	(b) Meeting (c) Situational Conversation	
	TOTAL	**30**

Suggested Readings:

1. Scot, O.; Contemporary *Business Communication*. Biztantra, New Delhi.
2. Lesikar, R.V. & Flatley, M.E.; *Basic Business Communication Skills for Empowering the Internet Generation*, Tata McGraw Hill Publishing Company Ltd. New Delhi.
3. Ludlow, R. & Panton, F.; *The Essence of Effective Communications*, Prentice Hall Of India Pvt. Ltd., New Delhi.
4. R. C. Bhatia, *Business Communication*, Ane Books Pvt Ltd, New Delhi

SEMESTER – I

HINAECC101 – हिन्दी-व्याकरण और सम्प्रेषण

परिणाम:

1. विभिन्न प्रतियोगी परीक्षाओं के लिए तैयार करना।
2. सम्प्रेषण-क्षमता की वृद्धि करना।
3. कार्यालयी-पत्र लेखन की क्षमता विकसित करना।
4. हिन्दी के व्याकरणिक एवं सैद्धांतिक स्वरूप की जानकारी हासिल करना।

HIN AEC101 हिन्दी व्याकरण और सम्प्रेषण **PWC** **(Theory: 2 credits)**		
Unit	**Topics to be covered**	**No. of hours**
1	**हिन्दी व्याकरण और रचना :** संज्ञा, सर्वनाम, विशेषण, क्रिया, अव्यय, उपसर्ग, प्रत्यय, समास, सन्धि, पर्यायवाची शब्द, विलोम शब्द, अनेक शब्दों के लिए एक शब्द, मुहावरे एवं लोकोक्तियाँ, पल्लवन, संक्षेपण, शब्द शुद्धि, वाक्य शुद्धि, विविध प्रकार के पत्र-लेखन	15

2	**सम्प्रेषणः भाषिक सम्प्रेषण :** स्वरूप और सिद्धांत, संप्रेषण की अवधारणा और महत्व, संप्रेषण की प्रक्रिया, संप्रेषण के विभिन्न मॉडल, संप्रेषण की चुनौतियाँ	05
3	**सम्प्रेषण के प्रकार :** मौखिक और लिखित, वैयक्तिक और सामाजिक, व्यावसायिक, भ्रामक संप्रेषण, संप्रेषण बाधाएँ और रणनीति	05
4	**सम्प्रेषण के माध्यम :** एकालाप, संवाद, सामूहिक चर्चा, प्रभावी संप्रेक्षण	05
	TOTAL	**30**

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