SCHEME OF EXAMINATION
AND
COURSE OF STUDY

IN

INDUSTRIAL MICROBIOLOGY

B.Sc. I, II, III YEAR
(w. e. f.July 2019)

DEPARMENT OF BOTANY & MICORBIOLOGY
GURUKULA KANGRI VISHWAVIDYALAYA, HARIDWAR – 249404
August 2019

INDUSTRIAL MICROBIOLOGY
B.Sc. I, II & III YEAR
(w. e. f. 2019-20)

COURSE STRUCTURE

S.No.	Subject Code	Subject Title	Period		Evaluation Scheme				Subject Total
					Sessional			ESE	
			L	P	Credit	CT	TA		
Semester I									
DSC 1	BIM-C101	Fundamentals of Microbiology	4	-	4	20	10	70	100
	BIM-C151	Lab course CC-01		4	2	15	15	70	100
Semester II									
DSC 2	BIM-C201	Microbial Technology	4	-	4	20	10	70	100
	BIM-C251	Lab course CC-02		4	2	15	15	70	100
					12				**400**
Semester III									
DSC 3	BIM-C301	Microbial Physiology & Metabolism	4	-	4	20	10	70	100
SEC 1	BIM-S301	Food Fermentation Techniques	4		4	20	10	70	100
	BIM-S302	Tools and Techniques							
	BIM-C351	Lab course CC-03		4	2	15	15	70	100
Semester IV									
DSC 4	BIM-C401	Industrial Microbiology	4	-	4	20	10	70	100
SEC 2	BIM-S401	Biofertilizers	4		4	20	10	70	100
	BIM-S402	Microbial Diagnosis in Health Clinics							
	BIM-C451	Lab course CC-04		4	2	15	15	70	100
					20				**600**
Semester V									
DSE 1	BIM-E501	Control of Microbial Diseases	4	-	4	20	10	70	100
	BIM-E502	Food Borne Diseases and Food Preservation							
	BIM-E503	Environmental Microbiology							
SEC 3	BIM-S501	Pharmaceutical Microbiology	4		4	20	10	70	100
	BIM-S502	Microbiological Analysis of Air and Water							
	BIM-C551	Lab course – 05		4	2	15	15	70	100
Semester VI									
DSE 2	BIM-E601	Immunology	4	-	4	20	10	70	100
	BIM-E602	Recombinant DNA Technology							
	BIM-E603	Molecular Genetics							
SEC 4	BIM-S601	Medical Microbiology	4		4	20	10	70	100
	BIM-S602	Agricultural Microbiology							
	BIM-S603	Project Work							
	BIM-C651	Lab course – 06		4	2	15	15	70	100
					20				**600**
		Credit Total			**52**			**Grand Total**	**1600**

B.Sc. I Year **Semester – I**

BIM -C101
DSC-1 FUNDAMENTALS OF MICROBIOLOGY

MM : 100 Sessional : 30
Time : 3 hrs ESE : 70
L Credit Pass Marks : 40
4 4
Total Hours: 60

NOTE: Questions of theory paper are to be set under three sections i.e., A, B, and C. **Tenobjective/multiple choice questions** (MCQs) uniformly distributed from the entire syllabus are to be set for section A. In Section B, the student has to answer any **five** questions out of **tenshort answer questions** (100 words) uniformly distributed from the entire syllabus. **Eightlong answer questions/descriptive** questions uniformly distributed from the entire syllabus are to be set for section C and the student has to answer any four questions. Section A, B, and C will be of 10, 20, and 40 marks respectively. The previous year paper/model paper can be used as a guideline and the following syllabus should be strictly followed while setting the question paper.

UNIT–I

Vedic Microbiology: Agnihotra-a vedic technology for environment purification, Origin of earth with reference to Veda, different terms used for microbes, distribution of microorganisms, microbes and diseases, different methods for control of microorganisms as described in Vedas. **(04 Lectures)**

UNIT-II

Historical account of microbiology, spontaneous generation vs biogenesis, golden age of microbiology, contributions made by Anton von Leeuwenhoek, Louis Pasteur, Robert Koch and Edward Jenner, Joseph Lister, Alexander Fleming; germ theory of disease. **(12 lecture)**

UNIT III

General features of various groups of microorganisms: bacteria, cyanobacteria, archaea, mycoplasma, viruses (Morphology and Multiplication of T4 Bacteriophage), protozoa and fungi, Bacterial cells (size and arrangement), ultrastructure of bacterial cells. **(16 Lectures)**

UNIT-IV

Culturable and non-culturable microorganisms (metagenomics): broad outline classification of different microorganisms, bacterial nomenclature, modern trends in bacterial taxonomy, Whittaker's five kingdom classification, three domain system of classification. **(12 Lectures)**

UNIT-V

Staining Vs Dye,special stain, various methods of staining (Gram stain, differential stain, endospore, capsule, flagella and negative stain).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. **(16 Lectures)**

DCS 1 SEMESTER I BIM-C151 (LAB COURSE)

1. Principles and applications of microbiology laboratory instruments (Autoclave, Laminar Air Flow, Incubator, Hot Air Oven, and Light Microscope).
2. Perform Gram staining of bacteria.
3. Perform Endospore staining of bacteria.
4. Perform Capsule staining by negative staining technique of bacteria.
5. Perform Flagella staining of bacteria.
6. Perform Negative staining of bacteria.
7. Isolation of microorganisms from soil by pour plate method.
8. Isolation of microorganisms from air.
9. Effect of osmotic pressure.
10. Effect of radiation.
11. Cultivation of bacteriophages.
12. To prepare the Nutrient Agar Medium.
13. To prepare the Potato Dextrose Agar Medium.

Suggested Reading

1. Dubey R.C**.** and Maheshwari, D.K. *A Textbook of Microbiology*. 3rd ed., S. Chand & Co, Ram Nagar, New Delhi, p. 1034. ISBN 81-219-2620-3
2. Dubey, R.C. and Maheshwari, D.K. *Practical Microbiology*. 2nd ed., S. Chand & Co. P Ltd, New Delhi, p. 413. ISBN: 81:219-2559-2
3. Dubey, R.C**.** *Advanced Biotechnology*. S. Chand & Co. P Ltd, New Delhi, p. 1161; ISBN: 81:219-4290-X.
4. Cappachino. Microbiology- A laboratory Manual, Pearson Education India ISBN: 978-9332535190
5. Powar and Daginawala. General Microbiology Vol1 and Vol2, Himalaya Publishing House,**ISBN-13:** 978-9350240892

6. B.Sc. I Year **Semester – II**

BIM -C201
DSC-2 MICROBIAL TECHNOLOGY

MM : 100 Sessional : 30
Time : 3 hrs ESE : 70
L Credit Pass Marks : 40
4 4
Total Hours: 60

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UNIT – I

Cultivation of bacteria: aerobic and anaerobic; Culture media: types and preparation; various technique used for isolation of microorganisms from soil, water and air; pure cultures techniques; cultural characteristic;Preservation techniques.**(10 Lectures)**

UNIT – II

History of evolutionary trend of fermentor from ancient to modern period/era; shake flask, bioreactor, construction material;Design of fermentors; aeration and agitation, control of pH, temperature, foaming agents, biosensor.**(12 Lectures)**

UNIT -III

Fermentation media and its preparation: sterilization of apparatus and production media;Inoculum preparation; downstream processing;Types of fermentation: batch, fedbatch, continuous, dual or multiple, surface and submerged fermentation.**(15 Lectures)**

UNIT -IV

Agricultural microbiology: Plant growth promoting rhizobacteria (PGPR); N_2- fixers and phosphate solubilizers; production of bioinoculants; cyanobacteria, bacteria and fungi, **(11 Lectures)**

UNIT -V

Biopesticides: concept of biopesticides;advantages of biopesticides; microorganisms used for preparation of biopesticides;Mass production of microbial pesticides in general: bacterial and fungal.**(12 Lectures)**

Suggested Reading

1. Dubey R.C**.** and Maheshwari, D.K. *A Textbook of Microbiology*. 3rd ed., S. Chand & Co, Ram Nagar, New Delhi, p. 1034. ISBN 81-219-2620-3
2. Dubey, R.C. and Maheshwari, D.K. *Practical Microbiology*. 2nd ed., S. Chand & Co. P Ltd, New Delhi, p. 413. ISBN: 81:219-2559-2
3. Casida, L.E.J.R. Industrial Microbiology, New Age International Publisher,
4. A.H.Patel, Industrial Microbiology, Laxmi Publication, **ISBN-10:** 9385750267
5. Prescott and Dunns.Industrial Microbiology, CBS Publishers and Distributers, ISBN-10**:** 8123910010
6. Dubey, R.C**.** *Advanced Biotechnology*. S. Chand & Co. P Ltd, New Delhi, p. 1161; ISBN: 81:219-4290-X.

DSC 2 SEMESTER II BIM-C251 (LAB COURSE)

1. Cultivation of anaerobic bacteria.
2. Isolation of bacteria from soil by serial dilution method.
3. Isolation of Phosphate solubilising bacteria.
4. Isolation of aquatic fungi by bait technique.
5. Effect of pH on growth of microorganisms.
6. Effect of temperature on growth of microorganism.
7. Determination of oxygen requirement of given bacteria.
8. Demonstration of fermentation by yeast.
9. Isolation of cyanobacteria from paddy field.
10. Isolation of root nodulating bacteria from leguminous plant.
11. isolation of bacteria inhibiting Phytopathogenic fungi

B.Sc. II Year **Semester – III**

BIM -C301
DSC-3 MICROBIAL PHYSIOLOGY AND METABOLISM

MM : 100 Sessional : 30
Time : 3 hrs ESE : 70
L Credit Pass Marks : 40
4 4
Total Hours: 60

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UNIT-I

Bacterial growth: Growth Curve; synchronous growth; microbial growth kinetics in batch cultures; growth measurement: by cell mass, cell count and cell turbidity; growth influencing factors.**(12 Lectures)**

UNIT II

Characteristics, nomenclature, classification and application of enzymes;Factors influencing enzymatic activity;Mechanism of enzyme action;Allosteric enzymes.**(10 Lectures)**

UNIT-III

General concepts of respiration and fermentation: aerobic and anaerobic respiration, fermentation; alcoholic fermentation, lactic acid fermentation.**(10 Lectures)**

UNIT-IV

Microbial metabolism: general strategy of metabolism, anabolism, catabolism, primary metabolic pathway, secondary metabolic pathway, metabolism of carbohydrates (glycolysis, TCA cycle).**(14 Lectures)**

UNIT-V

Nitrogen fixation in symbiotic and free-living microorganisms, root nodule formation, leghaemoglobin, nitrogenase enzyme;Photosynthetic bacteria and their classification.**(14 Lectures)**

Suggested Reading

1. Dubey R.C. and Maheshwari, D.K. *A Textbook of Microbiology*. 3rd ed., S. Chand & Co, Ram Nagar, New Delhi, p. 1034. ISBN 81-219-2620-3
2. Dubey, R.C. and Maheshwari, D.K. *Practical Microbiology*. 2nd ed., S. Chand & Co. P Ltd, New Delhi, p. 413. ISBN: 81:219-2559-2
3. Roger Y. Stanier, John L. Ingraham. General Micobiology, Palgrave Macmillan, **ISBN-13:** 978-0333763643
4. Powar and Daginawala. General Microbiology Vol1 and Vol2, Himalaya Publishing House,**ISBN-13:** 978-9350240892
5. M.T.Madigan, J.M.Mahinko Jack Parkar Brock: Biology of Microorganisms, Pearson Education ISBN 978-9332586864

B.Sc. II Year **Semester – III**

BIM -S301
SEC-1 FOOD FRERMENTATION TECHNIQUES

MM : 100 Sessional : 30
Time : 3 hrs ESE : 70
L Credit Pass Marks : 40
4 4
Total Hours: 60

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UNIT-I

Fermented Foods:Definition, types, advantages and health benefits.**(10 Lectures)**

UNIT- II

Milk Based Fermented Foods:Dahi/Yogurt, Buttermilk (Chach), Shrikhand and cheese: Preparation of inoculum and production process. **(16 Lectures)**

UNIT-III

Grain Based Fermented Foods: Soy sauce, Tempe, Bread, Jalebi, Miso, Tofu, Idli and Dosa: Microorganisms used and production process. **(16 Lectures)**

UNIT–IV

Vegetable Based Fermented Foods: Pickels, Saeurkraut: Microorganisms and production process. **(08 Lectures)**

UNIT–V

Probiotic Foods;Definition, types, microorganisms and health benefits in supply of vitamins, Immunomodulation, Control of phytopathogenic bacteria *in vivo***(10 Lectures)**

Suggested Reading

1. Dubey R.C**.** and Maheshwari, D.K. *A Textbook of Microbiology*. 3rd ed., S. Chand & Co, Ram Nagar, New Delhi, p. 1034. ISBN 81-219-2620-3
2. Dubey, R.C. and Maheshwari, D.K. *Practical Microbiology*. 2nd ed., S. Chand & Co. P Ltd, New Delhi, p. 413. ISBN: 81:219-2559-2
3. Doyle et al., Food Microbiology: Fundamentals and Frontier, American Society of Microbiology
4. William C Frazier, Food Microbiology, MacGraw Hills Education.
5. Adam and Moss, Food Microbiology, Royal Society of Chemistry
6. Dubey, R.C**.** *Advanced Biotechnology*. S. Chand & Co. P Ltd, New Delhi, p. 1161; ISBN: 81:219-4290-X.

B.Sc. II Year **Semester – III**

BIM -S302
SEC-1 TOOLS AND TECHNIQUES

MM : 100 Sessional : 30
Time : 3 hrs ESE : 70
L Credit Pass Marks : 40
4 4
Total Hours: 60

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UNIT–I

Industrial microbiology-definition and scope, history of industrial microbiology, industrial microbiology in present scenario, development of industrial microbiology in India.**(06 Lectures)**

UNIT-II

Basic knowledge of different instruments and their application in microbiology such as microscope (compound, SEM & TEM), micrometry, scanning microscope, hot air oven, autoclave, laminar air flow and BOD incubator.**(10 Lectures)**

UNIT–III

Isolation of industrially important microorganisms, Primary screening (crowded plate technique, auxanography technique, enrichment culture technique, differential culture technique), Importance of screening.**(14 Lectures)**

UNIT–IV

Aseptic technique: contamination, sterilization (heating, steam sterilization, tyndallization, dry heat, chemicals, radiation sterilization, filter sterilization), sterilization of air.**(14 Lectures)**

UNIT–V

Chromatography techniques: paper chromatography, thin layer chromatography, adsorption column chromatography, gas liquid chromatography, gel permeation, ion exchange and affinity chromatography, gel electrophoresis.**(16 Lectures)**

Suggested Reading

1. Dubey R.C**.** and Maheshwari, D.K. *A Textbook of Microbiology*. 3rd ed., S. Chand & Co, Ram Nagar, New Delhi, p. 1034. ISBN 81-219-2620-3
2. Prescott's Microbiology, 10th Edition, McGraw Hill Publication
3. Dubey, R.C. and Maheshwari, D.K. *Practical Microbiology*. 2nd ed., S. Chand & Co. P Ltd, New Delhi, p. 413. ISBN: 81:219-2559-2
4. Dubey, R.C**.** *Advanced Biotechnology*. S. Chand & Co. P Ltd, New Delhi, p. 1161; ISBN: 81:219-4290-X.

DSC 3 SEC 1 SEMESTER III BIM-C351 (LAB COURSE)

1. Determination of growth curve of bacteria.
2. Bacterial population count by turbidimetry method
3. Amylase production test.
4. Cellulase production test.
5. Demonstration of carbohydrate metabolism.
6. Demonstration of enzyme activity in given mocroorganism.
7. Detection of number of bacteria in milk by standard plate count technique.
8. Determination of quality of milk sample by MBRT (methylene blue reductase test).
9. Laboratory preparation of sauerkraut.
10. Different tools in microbiology lab (Autoclave, Laminar Air Flow, Incubator, Hot Air Oven, and Light Microrscope).
11. Effect of ultraviolet radiation on bacterial growth.
12. Effect of dyes on bacterial growth.
13. Separation of leaf pigments through paper chromatography on bacterial growth.

B.Sc. II Year **Semester – IV**

BIM -C401
DSC-4 INDUSTRIAL MICROBIOLOGY

MM : 100 Sessional : 30
Time : 3 hrs ESE : 70
L Credit Pass Marks : 40
4 4
Total Hours: 60

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UNIT - I

Principal of exploitation of microorganism and their products, screening of microorganism, primary and secondary screening, strain development strategies, immobilization methods: adsorption, covalent linkages; advantages and disadvantages.**(14 Lectures)**

UNIT – II

Alcoholic products: production and recovery of industrial alcohol, beer, wine, whiskey, rum, and brandy; commercial production of vinegar; Yeast and Baker's yeast**(10 Lectures)**

UNIT – III

Antibiotics: Fermentation and recovery process of penicillin, streptomycin and tetracycline. **(10 Lectures)**

UNIT - IV

Enzymes and Amino acids: Microbial production and applications of amylases, lipase and protease; Amino acids: production of L-glutamic acid and L-lysine.**(14 Lectures)**

UNIT - V

Vitamin B-12; Vitamin B2 (riboflavin), Vitamin C;Organic acids: Lactic acid and citric acid (fermentation and recovery).**(08 Lectures)**

Suggested Reading

1. Dubey, R.C**.** *Advanced Biotechnology*. S. Chand & Co. P Ltd, New Delhi, p. 1161; ISBN: 81:219-4290-X.
2. Casida, L.E.J.R. Industrial Microbiology, New Age International Publisher,
3. A.H.Patel, Industrial Microbiology, Laxmi Publication, **ISBN-10:** 9385750267
4. Prescott and Dunns.Industrial Microbiology, CBS Publishers and Distributers, ISBN-10**:** 8123910010

B.Sc. II Year **Semester – IV**

BIM -S401
SEC-2 BIOFERTILIZERS

MM : 100 Sessional : 30
Time : 3 hrs ESE : 70
L Credit Pass Marks : 40
4 4
Total Hours: 60

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UNIT–I

Biofertilizers; General account of the microbes used as biofertilizers for various crop plants and their advantages over chemical fertilizers. Symbiotic Nitrogen fixers: *Rhizobium* - Isolation, characteristics, types, Inoculum production and Mass cultivation; Field applications; Carrier materials**(16 Lectures)**

UNIT-II

Non - symbiotic Nitrogen Fixers; Free living *Azospirillum*, *Azotobacter*- isolation, characteristics, mass inoculum, production and field application.**(08 Lectures)**

UNIT–III

Phosphate Solubilizers; Phosphate solubilizing microbes - isolation, characterization, mass inoculum production, field application.**(08 Lectures)**

UNIT–IV

MycorrhizalBiofertilizers: Importance of mycorrhizal inoculum, types of mycorrhizae and associated plants, Inoculum production and Mass production of VAM; field applications of Ectomycorrhizae and VAM.

(16 Lectures)

UNIT –V

Cyanobacteria: *Nostoc/ Anabena*; cultivation methods (tray and pit methods) ;applications in field. *Azolla*:isolation, characterization, mass multiplication, role in rice cultivation, crop response, field Application**(12 Lectures)**

Suggested Reading

1. Dubey R.C**.** and Maheshwari, D.K. *A Textbook of Microbiology*. 3rd ed., S. Chand & Co, Ram Nagar, New Delhi, p. 1034. ISBN 81-219-2620-3
2. N.S. SubbhaRao, Soil Microbiology, Science Publishers.
3. M.K.Rai, Handbook of Microbial Fertilizers, Internation Book Distributing Co.
4. Dubey, R.C**.** *Advanced Biotechnology*. S. Chand & Co. P Ltd, New Delhi, p. 1161; ISBN: 81:219-4290-X.
5. Rangaswami,G. Agriculture Microbiolgy, Prentice Hall Indian Learning Ltd
6. Dubey, R.C. and Maheshwari, D.K. *Practical Microbiology*. 2nd ed., S. Chand & Co. P Ltd, New Delhi, p. 413. ISBN: 81:219-2559-2

B.Sc. II Year **Semester – IV**

BIM -S402
SEC-2 MICROBIAL DIAGNOSIS IN HEALTH CLINICS

MM : 100 Sessional : 30
Time : 3 hrs ESE : 70
L Credit Pass Marks : 40
4 4
Total Hours: 60

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UNIT–I

Major human diseases caused by bacteria, viruses, fungi and protozoans;Importance of diagnosis of human diseases;bacterial, viral, fungal and protozoan;Criteria used in diagnosis of human clinical samples for diagnosis.**(12 Lectures)**

UNIT -II

Collection of Clinical Samples;andprecautions required. Method of transport of clinical samples to laboratory and storage.**(06 Lectures)**

UNIT –III

Direct Microscopic Examination and Culture; Examination of sample by staining, Preparation and use of culture media, Distinct colony properties of various bacterial pathogens.**(12 Lectures)**

UNIT –IV

Serological and Molecular Methods;Serological Methods - Agglutination, ELISA, immunofluorescence, Nucleic acid based methods - PCR, Nucleic acid probes. **(14 Lectures)**

UNIT –V

Testing for Antibiotic Sensitivity in Bacteria; Importance, Determination of resistance/sensitivity of bacteria using disc diffusion method, Determination of minimal inhibitory concentration (MIC) of an antibiotic by serial double dilution method. **(16 Lectures)**

Suggested Reading

1. Dubey R.C**.** and Maheshwari, D.K. *A Textbook of Microbiology*. 3rd ed., S. Chand & Co, Ram Nagar, New Delhi, p. 1034. ISBN 81-219-2620-3
2. Dubey, R.C**.** *Advanced Biotechnology*. S. Chand & Co. P Ltd, New Delhi, p. 1161; ISBN: 81:219-4290-X.
3. CKJ Paniker. Test Book of Microbiology, Orient Longman

DSC 4 SEC 2 SEMESTER IV BIM-C451(LAB COURSE)

1. Isolation of antibiotic producing microorganisms from soil.
2. Laboratory production of alcohol from Grape Juice/Sugarcane Juice.
3. Demonstration of vinegar production in laboratory.
4. Bioassay of vitamin $B_{12.}$
5. Fat hydrolysis (lipase activity) by a given bacterial culture.
6. Demonstration of fermentation by yeast.
7. Isolation of *Azotobacter* from garden soil.
8. Isolation of VAM (Vascular ArbuscularMycorrihizal spore from soil.
9. Isolation of phosphate solubilising microorganisms from soil.
10. Antibiotic sensitivity of UTI causing bacteria.
11. Slide agglutination reaction of unknown bacterial culture.
12. Demonstration of antigen-antibody reaction.

Suggested Reading

1. Dubey, R.C. and Maheshwari, D.K. *Practical Microbiology*. 2nd ed., S. Chand & Co. P Ltd, New Delhi, p. 413. ISBN: 81:219-2559-2

B.Sc. III Year **Semester – V**

BIM –E-501
DSE-1 CONTROL OF MICROBIAL DISEASES

MM : 100 Sessional : 30
Time : 3 hrs ESE : 70
L Credit Pass Marks : 40
4 4
Total Hours: 60

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UNIT - I

Human Diseases: Infectious and non infectious diseases, microbial and non microbial diseases, Deficiency diseases, occupational diseases, Incubation period, mortality rate, nosocomial infections. **(06 Lectures)**

UNIT - II

Microbial diseases Respiratory microbial diseases, gastrointestinal microbial diseases, skin diseases, eye diseases, urinary tract diseases, Sexually transmitted diseases: Types, route of infection, clinical systems and general prevention methods, study of recent outbreaks of human diseases (SARS/ Swine flu/ Ebola) – causes, spread and control, Mosquito borne disease – Types and prevention. **(16 Lectures)**

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UNIT - III

Therapeutics of Microbial diseases: Treatment using antibiotics: beta lactam antibiotics (penicillin, cephalosporins), quinolones, polypeptides and aminoglycosides**.** Judicious use of antibiotics, importance of completing antibiotic regimen, Concept of DOTS, emergence of antibiotic resistance, current issues of MDR/XDR microbial strains. Treatment using antiviral agents: Amantadine, Acyclovir, Azidothymidine. Concept of HAART.**(16 Lectures)**

UNIT - IV

Prevention of Microbial Diseases: General preventive measures, Importance of personal hygiene, environmental sanitation and methods to prevent the spread of infectious agents transmitted by direct contact, food, water and insect vectors. **(16 Lectures)**

UNIT - V

Vaccines: Importance, types, vaccines available against microbial diseases, vaccination schedule (compulsory and preventive) in the Indian context. **(06 Lectures)**

Suggested Reading

1. Dubey R.C. and Maheshwari, D.K. *A Textbook of Microbiology*. 3rd ed., S. Chand & Co, Ram Nagar, New Delhi, p. 1034. ISBN 81-219-2620-3
2. Mackie and McCartney. Practical Medical Microbiology, Elsevier
3. CKJ Paniker. Test Book of Microbiology, Orient Longman
4. D.R.Arora. Medical Mycology, CBS Publisher and Distributors

B.Sc. III Year **Semester – V**

BIM -E502

DSE-1FOOD BORNE DISEASES AND FOOD PRESERVATION

MM : 100 Sessional : 30
Time : 3 hrs ESE : 70
L Credit Pass Marks : 40
4 4
Total Hours: 60

NOTE: Questions of theory paper are to be set under three sections i.e., A, B, and C. **Tenobjective/multiple choice questions** (MCQs) uniformly distributed from the entire syllabus are to be set for section A. In Section B, the student has to answer any **five** questions out of **tenshort answer questions** (100 words) uniformly distributed from the entire syllabus. **Eightlong answer questions/descriptive** questions uniformly distributed from the entire syllabus are to be set for section C and the student has to answer any four questions. Section A, B, and C will be of 10, 20, and 40 marks respectively. The previous year paper/model paper can be used as a guideline and the following syllabus should be strictly followed while setting the question paper.

UNIT – I

Food spoilage: microbes in food, extrinsic and intrinsic factors affecting microbial growth in foods, microbial spoilage of foods, microbial spoilage of specific food – milk and milk products, fruits and vegetables, meat products, canned foods. **(15 Lectures)**

UNIT – II

Food preservation methods: aseptic handling, temperature treatment, dehydration, lyophilization, osmotic pressure, radiations canning, chemical preservatives (salt and sugars, organic acids, propylene oxide, wood smoke and antibiotics).**(09 Lectures)**

UNIT - III

Food-borne diseases (Bacteria and Virus): food poisoning (food intoxication and food infections);Bacterial food poisoning (*Clostridium* and *Staphylococcus);* Viral infections:Rotavirus, Hepatitis A & C **(12 Lectures)**

UNIT – IV

Food-borne diseases (Fungus and protozoans):fungal food poisoning (*Aspergillus* and *Penicillium*), health hazards of mycotoxins; Protozonal infections; *Entamoebahistolytica, Teniasolium, Fasciola hepatica***(12 Lectures)**

UNIT - V

Methods for microbiological examination of food and quality control: indicator organisms for assuring the suitability of food product, methods of microbiological examination, direct culture technique, enumeration methods (plate count and MPN), alternative methods (dye reduction tests), electrical methods, quality criteria, sampling schemes.**(12 Lectures)**

Suggested Reading

1. Doyle et al., Food Microbiology: Fundamentals and Frontier, American Society of Microbiology
2. William C Frazier, Food Microbiology, MacGraw Hills Education.
3. Adam and Moss, Food Microbiology, Royal Society of Chemistry
4. Dubey R.C. and Maheshwari, D.K. *A Textbook of Microbiology*. 3rd ed., S. Chand & Co, Ram Nagar, New Delhi, p. 1034. ISBN 81-219-2620-3
5. Mackie and McCartney. Practical Medical Microbiology, Elsevier
6. CKJ Paniker. Test Book of Microbiology, Orient Longman

B.Sc. III Year **Semester – V**

BIM -E503

DSE-1 ENVIRONMENTAL MICROBIOLOGY

MM : 100 Sessional : 30
Time : 3 hrs ESE : 70
L Credit Pass Marks : 40
4 4
Total Hours: 60

NOTE: Questions of theory paper are to be set under three sections i.e., A, B, and C. **Tenobjective/multiple choice questions** (MCQs) uniformly distributed from the entire syllabus are to be set for section A. In Section B, the student has to answer any **five** questions out of **tenshort answer questions** (100 words) uniformly distributed from the entire syllabus. **Eightlong answer questions/descriptive** questions uniformly distributed from the entire syllabus are to be set for section C and the student has to answer any four questions. Section A, B, and C will be of 10, 20, and 40 marks respectively. The previous year paper/model paper can be used as a guideline and the following syllabus should be strictly followed while setting the question paper.

UNIT - I

Microorganisms in different habitats: brief account of heterogeneous group of microorganisms, different habitats such as soil, water, air; factors affecting microbial population in nature.**(10 Lectures)**

UNIT - II

Water microbiology: type of water (atmospheric, surface and stored), parameters of aquatic environment (temperature, light, pressure, pH, turbidity and organic constituents);Microflora of aquatic environmental (fresh water and marine microbiology;deep sea-vent, volcano and soda lake.**(15 Lectures)**

UNIT - III

Microbiology of domestic and waste water: sewage/waste water (physical, chemical and microbiological analysis), BOD and COD;Wastewater treatment (primary, secondary and tertiary treatment), **(10 Lectures)**

UNIT – IV

Solid waste management: solid waste processing (landfills, composting and anaerobic sludge digestion), Effect of solid waste on public health;Microbial pathogens in municipal solid waste;Regulation for disposal of biohazardous materials.**(12 Lectures)**

UNIT - V

Bioremediation and Biodegradation: concept of bioremediation, types of bioremediation, Microbial degradation of Xenobiotics ;Bioindicators of pollution.**(13 Lectures)**

Suggested Reading

1. N.S. SubbhaRao, Soil Microbiology, Science Publisher, ISBN: 9781578080700
2. Dubey, R.C**.** *Advanced Biotechnology*. S. Chand & Co. P Ltd, New Delhi, p. 1161; ISBN: 81:219-4290-X.
3. P.D. Sharma, Microbiology, Rastogi Publication ISBN:978-8171339358.
4. Dubey R.C**.** and Maheshwari, D.K. *A Textbook of Microbiology*. 3rd ed., S. Chand & Co, Ram Nagar, New Delhi, p. 1034. ISBN 81-219-2620-3

B.Sc. III Year **Semester – V**

BIM -S501

SEC-3 PHARMACEUTICAL MICROBIOLOGY

MM : 100 Sessional : 30
Time : 3 hrs ESE : 70
L Credit Pass Marks : 40
4 4
Total Hours: 60

NOTE: Questions of theory paper are to be set under three sections i.e., A, B, and C. **Tenobjective/multiple choice questions** (MCQs) uniformly distributed from the entire syllabus are to be set for section A. In Section B, the student has to answer any **five** questions out of **tenshort answer questions** (100 words) uniformly distributed from the entire syllabus. **Eightlong answer questions/descriptive** questions uniformly distributed from the entire syllabus are to be set for section C and the student has to answer any four questions. Section A, B, and C will be of 10, 20, and 40 marks respectively. The previous year paper/model paper can be used as a guideline and the following syllabus should be strictly followed while setting the question paper.

UNIT - I

Pharmaceutical premises: selection of area for a pharmaceutical premise, different components of a premise, Govt. norms for a premise.**(08 Lectures)**

UNIT - II

Good manufacturing practices (GMP) and its organization, good laboratory practice (GLP), cGMP; Operation of quality control (QC) and quality assurance (QA) units.**(12 Lectures)**

UNIT - III

Sterile area and its maintenance, environmental monitoring, types of environmental monitoring, methods of sterilization in pharma, disinfectants and antiseptics, evaluation of disinfectants.**(16 Lectures)**

UNIT - IV

Routine tests: antibiotic assay, microbial limit test (MLT), pyrogen tests (in rabbit, *in vitro*, endotoxin tests), preservative efficacy test.**(10 Lectures)**

UNIT - V

Safety in microbial laboratory: Biosafety cabinets ; Occurrence of laboratory infections: tuberculosis and serum Hepatitis in lab workers; Routes of infection in laboratory (infection through mouth, skin, respiratory tract)

(14 Lectures)

Suggested Reading

1. Dubey R.C**.** and Maheshwari, D.K. *A Textbook of Microbiology*. 3rd ed., S. Chand & Co, Ram Nagar, New Delhi, p. 1034. ISBN 81-219-2620-3
2. SS Purohit and AK Saluja. Pharmaceutical Microbiology, Agrobios (India), ISBN-13-9788177541939
3. CKJ Paniker. Test Book of Microbiology, Orient Longman

B.Sc. III Year **Semester – V**

BIM -S502

SEC-3 MICROBIOLOGICAL ANALYSIS OF AIR AND WATER

MM : 100 Sessional : 30
Time : 3 hrs ESE : 70
L Credit Pass Marks : 40
4 4
Total Hours: 60

NOTE: Questions of theory paper are to be set under three sections i.e., A, B, and C. **Tenobjective/multiple choice questions** (MCQs) uniformly distributed from the entire syllabus are to be set for section A. In Section B, the student has to answer any **five** questions out of **tenshort answer questions** (100 words) uniformly distributed from the entire syllabus. **Eightlong answer questions/descriptive** questions uniformly distributed from the entire syllabus are to be set for section C and the student has to answer any four questions. Section A, B, and C will be of 10, 20, and 40 marks respectively. The previous year paper/model paper can be used as a guideline and the following syllabus should be strictly followed while setting the question paper.

UNIT - I

Aeromicrobiology: Bioaerosols, Air borne microorganisms (bacteria, Viruses, fungi) and their impact on human health and environment, significance in food and pharma industries and operation theatres, allergens.**(16 Lectures)**

UNIT - II

Air Sample Collection and Analysis: Bioaerosol sampling, air samplers, methods of analysis, CFU, culture media for bacteria and fungi, Identification characteristics.**(14 Lectures)**

UNIT - III

Control Measures: Fate of bioaerosols, inactivation mechanisms – UV light, HEPA filters, desiccation, Incineration. **(08 Lectures)**

UNIT - IV

Microbiological Analysis of Water: Sample Collection, Treatment and safety of drinking (potable) water, methods to detect potability of water samples: (a) standard qualitative procedure: presumptive/MPN tests, confirmed and completed tests for faecal coliforms (b) Membrane filter technique and (c) Presence/absence tests.**(16 Lectures)**

UNIT - V

Control Measures: Precipitation, chemical disinfection, filtration, high temperature, UV light. **(06 Lectures)**

Suggested Reading

1. N.S. SubbhaRao, Soil Microbiology, Science Publisher, ISBN: 9781578080700
2. Dubey, R.C**.** *Advanced Biotechnology*. S. Chand & Co. P Ltd, New Delhi, p. 1161; ISBN: 81:219-4290-X.
3. P.D. Sharma, Microbiology, Rastogi Publication ISBN:978-8171339358.
4. Dubey R.C**.** and Maheshwari, D.K. *A Textbook of Microbiology*. 3rd ed., S. Chand & Co, Ram Nagar, New Delhi, p. 1034. ISBN 81-219-2620-3

DSE 1/SEC 3 SEMESTER V BIM-E551(LAB COURSE)

1. Demonstration of the bacterial flora of the skin.
2. Estimation of urine bacteria by pour-plate method.
3. Isolation of microorganisms from gastrointestinal tract.
4. Isolation of microorganism from upper respiratory tract.
5. Determination of quality of milk by MBRT (methylene blue reductase test).
6. Demonstration of microbial production of curd.
7. Microbial production of Asav/wine.
8. Determination of biological oxygen demand (BOD) of water.
9. Determination of chemical oxygen demand (COD) of water.
10. Water analysis for total bacterial population by standard plate count.
11. Sterility testing of injectibles.
12. Microbial limit tests.
13. Bacterial examination of water by multiple-tube fermentation test or multiple tube tests.

B.Sc. III Year **Semester – VI**

BIM -E601
DSE-2 IMMUNOLOGY

MM : 100 Sessional : 30
Time : 3 hrs ESE : 70
L Credit Pass Marks : 40
4 4
Total Hours: 60

NOTE: Questions of theory paper are to be set under three sections i.e., A, B, and C. **Tenobjective/multiple choice questions** (MCQs) uniformly distributed from the entire syllabus are to be set for section A. In Section B, the student has to answer any **five** questions out of **tenshort answer questions** (100 words) uniformly distributed from the entire syllabus. **Eightlong answer questions/descriptive** questions uniformly distributed from the entire syllabus are to be set for section C and the student has to answer any four questions. Section A, B, and C will be of 10, 20, and 40 marks respectively. The previous year paper/model paper can be used as a guideline and the following syllabus should be strictly followed while setting the question paper.

UNIT - I

Introduction; Concept of Innate and Adaptive immunity; Contributions of following scientists to the development of field of immunology - Edward Jenner, Karl Landsteiner, Paul Ehrlich, Elie Metchnikoff; Functions 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. **(14 Lectures)**

UNIT - II

Antigens and antibodies; Characteristics of an antigen (Foreignness, Molecular size and Heterogeneity); Haptens; Epitopes (T & B cell epitopes); T-dependent and T-independent antigens; Adjuvants; Structure, Types, Functions and Properties of antibodies; Antigenic determinants on antibodies (Isotypic, allotypic, idiotypic); VDJ rearrangements; Monoclonal and Chimeric antibodies. **(12 Lectures)**

UNIT - III

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); Complement System-Components of the Complement system; Activation pathways (Classical, Alternative and Lectin pathways); Biological consequences of complement Activation. **(14 Lectures)**

UNIT - IV

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. **(12 Lectures)**

UNIT - V

Immunological Techniques; Principles of Precipitation, Agglutination, Immunodiffusion, Immunoelectrophoresis, ELISA, Western blotting, Immunofluoresence, Flow cytometry.**(08 Lectures)**

Suggested Reading

1. Janis Kubey, Immunology, W.H.Freeman
2. Peter J Delves, S.J. Martins, D.R. Burtons, Roitts Essential Immunology, Wiley Blackwell
3. C.V.Rao , An Introduction to Immunology, Alpha Science International Ltd , **ISBN** 978-1842650356

B.Sc. III Year **Semester – VI**

BIM -E602

DSE-2 RECOMBINANT DNA TECHNOLOGY

MM : 100 Sessional : 30
Time : 3 hrs ESE : 70
L Credit 44 Pass Marks : 40

Total Hours: 60

NOTE: Questions of theory paper are to be set under three sections i.e., A, B, and C. **Tenobjective/multiple choice questions** (MCQs) uniformly distributed from the entire syllabus are to be set for section A. In Section B, the student has to answer any **five** questions out of **tenshort answer questions** (100 words) uniformly distributed from the entire syllabus. **Eightlong answer questions/descriptive** questions uniformly distributed from the entire syllabus are to be set for section C and the student has to answer any four questions. Section A, B, and C will be of 10, 20, and 40 marks respectively. The previous year paper/model paper can be used as a guideline and the following syllabus should be strictly followed while setting the question paper.

UNIT- I

Introduction to Genetic Engineering: Milestones in genetic engineering and biotechnology **Molecular Cloning- 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 deoxynucleotidyltransferase, kinases and phosphatases, and DNA ligases Cloning Vectors: Definition and Properties Plasmid vectors: pBR, Cosmids, Expression vectors. **(16 Lectures)**

UNIT- II

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, DNA Western blotting.**(14 Lectures)**

UNIT- III

DNA Amplification and DNA sequencing PCR: Basics of PCR, Real-Time PCR, Sanger's method of DNA Sequencing: traditional and automated sequencing. **(09 Lectures)**

UNIT- IV

Construction and Screening of Genomic and cDNA libraries: Genomic and cDNA libraries: Preparation and uses, Screening of libraries: Colony hybridization and colony PCR. **(09 Lectures)**

UNIT - V

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 mutagenesis. **(12 Lectures)**

Suggested Reading

1. Bruce Alberts. Molecular Biology of the Cells, W.W. Norton and Company, ISBN: 9780815344643
2. Dubey, R.C**.** *Advanced Biotechnology*. S. Chand & Co. P Ltd, New Delhi, p. 1161; ISBN: 81:219-4290-X.
3. Harvey, Lodish. Molecular Cell Biology, W.H.Freeman
4. Dubey, R.C. and Maheshwari, D.K. *Practical Microbiology*. 2nd ed., S. Chand & Co. P Ltd, New Delhi, p. 413. ISBN: 81:219-2559-2

B.Sc. III Year **Semester – VI**

BIM –E603
DSE-2 MOLECULAR GENETICS

MM : 100 Sessional : 30
Time : 3 hrs ESE : 70
L Credit Pass Marks : 40
4 4
Total Hours: 60

NOTE: Questions of theory paper are to be set under three sections i.e., A, B, and C. **Tenobjective/multiple choice questions** (MCQs) uniformly distributed from the entire syllabus are to be set for section A. In Section B, the student has to answer any **five** questions out of **tenshort answer questions** (100 words) uniformly distributed from the entire syllabus. **Eightlong answer questions/descriptive** questions uniformly distributed from the entire syllabus are to be set for section C and the student has to answer any four questions. Section A, B, and C will be of 10, 20, and 40 marks respectively. The previous year paper/model paper can be used as a guideline and the following syllabus should be strictly followed while setting the question paper.

UNIT - I

Genetic Material: DNA structure, Salient features of double helix, Types of DNA, denaturation and renaturation, topoisomerases in general; Organization of DNA in Prokaryotes and Eukaryotes, RNA Types and Structure; Replication of DNA**:-**Mechanism of DNA replication: Enzymes and proteins involved in DNA replication- DNA polymerases, DNA ligase, primase.**(15 Lectures)**

UNIT - II

Transcription: Definition, promoter - concept and strength of promoter. Transcriptional Machinery and Mechanism of transcription.Translation**-**Genetic code, Translational machinery, Charging of tRNA, aminoacyltRNAsynthetases, Mechanisms of initiation, elongation and termination of polypeptides.**(15 Lectures)**

UNIT - III

Regulation of gene Expression Principles of transcriptional regulation, Operon-operator theory with examples from *lac* and *trp*operons; Mutations**-**: Definition and types of Mutations; Physical and chemical mutagens; Uses of mutations,.**(15 Lectures)**

UNIT - IV

Mechanisms of Genetic Exchange: Transformation - Discovery, mechanism of natural competence Conjugation – Discovery and mechanisms, Hfr and F' strains; Transduction - Generalized transduction, specialized transduction.**(06 Lectures)**

UNIT – V

Plasmids and Transposable Elements: Property and functions of plasmids, Types of plasmids. Prokaryotic transposable elements – Insertion Sequences, composite and non-composite transposons, Replicative and Non replicative transposition, Importance of transposons and transposition.**(09 Lectures)**

Suggested Reading

1. David Friefelder, Microbial Genetics, Narosa Publishing House.
2. Gardner, Principle of Genetics, Wiley
3. Dubey, R.C**.** *Advanced Biotechnology*. S. Chand & Co. P Ltd, New Delhi, p. 1161; ISBN: 81:219-4290-X.
4. Lehninger, Nelson and Cox. Principles of Biochemistry, WH Freeman; 7th ed, ISBN:978-1319108243

B.Sc. III Year **Semester – VI**

BIM –S-601
DSE-1 MEDICAL MICROBIOLOGY

MM : 100 Sessional : 30
Time : 3 hrs ESE : 70
L Credit Pass Marks : 40
4 4
Total Hours: 60

NOTE: Questions of theory paper are to be set under three sections i.e., A, B, and C. **Tenobjective/multiple choice questions** (MCQs) uniformly distributed from the entire syllabus are to be set for section A. In Section B, the student has to answer any **five** questions out of **tenshort answer questions** (100 words) uniformly distributed from the entire syllabus. **Eightlong answer questions/descriptive** questions uniformly distributed from the entire syllabus are to be set for section C and the student has to answer any four questions. Section A, B, and C will be of 10, 20, and 40 marks respectively. The previous year paper/model paper can be used as a guideline and the following syllabus should be strictly followed while setting the question paper.

UNIT–I

Normal microflora of the human body: importance of normal microflora, normal microflora of skin, throat, gastrointestinal tract, and respiratory tract; **Immunology:** concept of innate and adaptive immunity, T-cell and B-cell, Antigen- Antibody reactions(Precipitation , Agglutination, and ELISA). **(14 Lectures)**

UNIT -II

Bacterial diseases: symptoms, mode of transmission, prophylaxis, treatment and control of: Respiratory Diseases: *Streptococcus pyogenes*, *Mycobacterium tuberculosis;* Gastrointestinal Diseases: *Escherichia coli*, *Salmonella typhi*, *Vibrio cholerae*, Others: *Staphylococcus aureus,* **(12 Lectures)**

UNIT –III

Viral diseases: Symptoms, mode of transmission, prophylaxis and control of Polio, Herpes, Hepatitis-B, Rabies, Dengue and AIDS **(12 Lectures)**

UNIT–IV

Fungal diseases: Brief description of each of the following types of mycoses and one representative disease to be studied with respect to transmission, symptoms and prevention Cutaneous mycoses: Tineapedis (Athlete's foot); Systemic mycoses: Histoplasmosis; Opportunistic mycoses: Candidiasis. **(12 Lectures)**

UNIT–V

Prevention of Microbial Diseases: General preventive measures, Importance of personal hygiene, environmental sanitation and methods to prevent the spread of infectious agents **Vaccines:** Importance, types of vaccines, vaccination schedule in Indian context. **(10 Lectures)**

Suggested Reading

1. Dubey R.C. and Maheshwari, D.K. *A Textbook of Microbiology*. 3rd ed., S. Chand & Co, Ram Nagar, New Delhi, p. 1034. ISBN 81-219-2620-3
2. Mackie and McCartney. Practical Medical Microbiology, Elsevier
3. CKJ Paniker. Test Book of Microbiology, Orient Longman
4. D.R.Arora. Medical Mycology, CBS Publisher and Distributors

B.Sc. III Year **Semester – VI**

BIM -S602

SEC-4: AGRICULTURAL MICROBIOLOGY

MM : 100 Sessional : 30
Time : 3 hrs ESE : 70
L Credit Pass Marks : 40
4 4
Total Hours: 60

NOTE: Questions of theory paper are to be set under three sections i.e., A, B, and C. **Tenobjective/multiple choice questions** (MCQs) uniformly distributed from the entire syllabus are to be set for section A. In Section B, the student has to answer any **five** questions out of **tenshort answer questions** (100 words) uniformly distributed from the entire syllabus. **Eightlong answer questions/descriptive** questions uniformly distributed from the entire syllabus are to be set for section C and the student has to answer any four questions. Section A, B, and C will be of 10, 20, and 40 marks respectively. The previous year paper/model paper can be used as a guideline and the following syllabus should be strictly followed while setting the question paper.

UNIT - I

Soil Microbiology: Soil as microbial habitat, soil profile and properties, soil formation, diversity and distribution of microorganisms in soil; mineralization of organic & inorganic matter in soil-mineralization of cellulose, hemicelluloses, lignocelluloses, lignin and humus, phosphate, nitrate, silica, potassium. **(16 Lectures)**

UNIT - II

Microbial Control of Soil Borne Plant Pathogens(Biopesticides) : Biological control; biocontrol mechanisms and ways, microorganisms used as biocontrol agents against plant pathogens, insects, weeds, commercial biofungicides**(14 Lectures)**

UNIT - III

Biofertilizers& PGPRs: 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. **(16 Lectures)**

UNIT - IV

Secondary Agriculture Biotechnology: Biomanure, biogas, biofuels – advantages and processing parameters. **(08 Lectures)**

UNIT - V

GM crops: Advantages, social and environmental aspects, Bt crops, golden rice.**(06 Lectures)**

Suggested Reading

1. Dubey R.C. and Maheshwari, D.K. *A Textbook of Microbiology*. 3rd ed., S. Chand & Co, Ram Nagar, New Delhi, p. 1034. ISBN 81-219-2620-3
2. Singh and Purohot, Microbial Ecology, AGROBIOS
3. Atlas. Microbial Ecology, Pearson Education ISBN13: 9788129707710

B.Sc. III Year **Semester – VI**

BIM -S603

SEC-4: PROJECT WORK

DSE 2/SEC 4 SEMESTER VI BIM-E651 (LAB COURSE)

1. Blood group determination by slide agglutination method.
2. Demonstration of bacterial plasmid isolation.
3. Demonstration of Genetic recombination in bacteria.
4. UV induced auxotropic mutant production, isolation replica plate technique.
5. Determination of nitrate production in nitrite broth soil cultures.
6. Isolation of *Fusarium* sp. From soil.
7. Isolation of *Macrophomina phaseolina* from soil.
8. Isolation of Rhizobia from root nodule.
9. Isolation of *Azotobacter*.
10. Isolation of antibiotic resistant bacteria by gradient plate technique.
11. Estimation of DNA by Diphenylamine Method.
12. Predict the microorganism on the basis of reaction on TSI slant
13. Perform citrate utilisation test.
14. Determination of titre by slide agglutination method.