

COURSE BREAKUP
MASTERS AND DOCTORAL PROGRAMME IN MICROBIOLOGY

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DEPARTMENT OF MICROBIOLOGY
COLLEGE BASIC SCIENCE AND HUMANITIES
ORISSA UNIVERSITY OF AGRICULTURE AND TECHNOLOGY
BHUBANESWAR-3, ODISHA

MASTERS PROGRAMME IN MICROBIOLOGY

SEMESTER- I

Course code	Title	Credit Hour			Compulsory Non-Credit
		Major	Minor	Supporting	
MICRO 501	Principles of Microbiology	3+1			
MICRO 502	Microbial Physiology and Metabolism	3+1			
MICRO 503	Microbial Genetic	2+1			
MICRO 506	Food and Dairy Microbiology		2+1		
PGS 501	Library & Information Services				0+1
PGS 503	Intellectual Property and its Management				1+0
PGS 504	Basic Concepts in Lab. Techniques				0+1
	<i>Total Credit Hour</i>	8+3	2+1	0	1+2

SEMESTER- II

Course code	Title	Credit Hour			Compulsory Non-Credit
		Major	Minor	Supporting	
MICRO 504	Soil Microbiology	2+1			
MICRO 505	Microbial Biotechnology		2+1		
MICRO 509	Industrial Microbiology			2+1	
MICRO 510	Biofertilizer Technology			1+1	
MICRO 512	Clinical Microbiology		2+1		
PGS 502	Technical Writing & Communications Skills				0+1
PGS 506	Disaster Management Skills				1+0
	<i>Total Credit Hour</i>	2+1	4+2	3+2	1+1

SEMESTER- III

Course code	Title	Credit Hour			Compulsory Non-Credit
		Major	Minor	Supporting	
MICRO 507	Virus and Bacteriophages	2+1			
MICRO 508	Environmental Microbiology		2+1		
MICRO 511	Cyanobacterial /Algal Biotechnology			2+0	
MICRO 513	Immunology	2+1			
MICRO 599	Minor Research	0+8			
	<i>Total Credit Hour</i>	4+10	2+1	2+0	0

SEMESTER- IV

Course code	Title	Credit Hour			Compulsory Non-Credit
		Major	Minor	Supporting	
MICRO 591	Seminar	1+0			
MICRO 599	Research	0+12			
	<i>Total Credit Hour</i>	1+12			

SEMESTER-I

PRINCIPLES OF MICROBIOLOGY

Course Code: MICRO-501 (3+1)

Course Title: PRINCIPLES OF MICROBIOLOGY

Semester: 1St

Faculty: Dr. (Mrs.) Pratima Ray

Course objective: To impart knowledge on Sterilization principles, physical and chemical methods of sterilization, basic principles and use of microscope and Isolation of bacteria, fungi, algae, actinomycetes and protozoa.

Lecture	Details
1,2	Discoveries in microbiology
3,4	Concepts of origin of life.
5	Abiogenesis and biogenesis
6	Contribution of Louis Pasteur, Robert Koch, Alexander Flemming, S.A. Waksman.
7,8	Scope and importance of microbiology
9,10	Structure and function of bacteria
11	Structure and function of cyanobacteria
12	Structure and function of fungi
13,14	Classification of prokaryotes
15,16	Basic concepts used in bacterial classification
17	Evolutionary relationship among prokaryotes
18,19	Phylogenetic and numerical taxonomy
20	Archea
21	Actinomycetes
22	Mycoplasma
23	Chlamydia
24	Rickettsia
25,26	Gracilaricutes, Firmicutes, Taenaricute and Mendosicutes
27	Reproduction in bacteria
28	Chromatography and its types :Thin layer and Gas liquid chromatography

29,30	Electrophoresis
31,32	Centrifugation and its types

Exp. No.	Practical classes	Experiment details
1	2	Preparation of growth media liquid, solid, semi-solid media, selective, enrichment and common media for growth of micro-organisms.
2	2	Methods of isolation, enumeration, purification and maintenance of microorganisms from different environments air, water, soil, milk and food by pour plate, spread plate and streak plate method.
3	1	Staining technique- gram's staining
4	1	acid fast staining
5	1	spore staining, capsule staining
6	1	negative and simple staining
7	1	Anaerobic culture of bacteria, micrometry
8	1	Hanging drop technique for study of bacterial motility
9	4	Identification of bacteria by biochemical tests
10	1	Identification of fungi
11	1	Preservation technique for bacteria and fungi

PRINCIPLES OF MICROBIOLOGY

Course code: MICRO-501 (3+1)

Course title: PRINCIPLES OF MICROBIOLOGY

Semester: 1st

Faculty: Dr. Deviprasad Samantaray

Course objective: To impart knowledge on principles of sterilization, cultivation and preservation of microbes using various culture media, study of microbes through imaging technology and application of photometry.

Lecture	Subject details
1,2,3	Sterilization principles, different methods of sterilization and its applications
4,5	Culture media, types and its applications
6,7	Staining principles, different types of staining and its applications
8, 9	Isolation of bacteria, fungi, algae, actinomycetes and protozoa
10	Preservation of bacterial and fungal cultures
11, 12, 13,14	Principles of microscopy, types and applications of microscope
15	Spectrophotometer and its applications
16	Colorimeter and its applications

Suggested books:

1. Microbiology: Michael J. Pelczar, JR., E.C.S. Chan & Noel R. Krieg, McGraw-Hill Education.
2. Prescott's Microbiology: Joanne M. Willey, Linda M. Sherwood & Christopher J. Woolverton, McGraw-Hill Education.
3. Microbiology: Daniel lim, Kendall Hunt Publishing.
4. Brock Biology of Microorganisms: Michael T. Madigan, John M. Martinko & Kelly S. Bender, Pearson.
5. Biophysical Chemistry Principles and Techniques: Avinash Upadhyay, Kakoli Upadhyay & Nirmalendu Nath, Himalaya Publishing House.

MICROBIAL PHYSIOLOGY AND METABOLISM

Course Code : MICRO-502 (3+1)

Course Title : MICROBIAL PHYSIOLOGY AND METABOLISM

Semester : 1st

Faculty : Dr. B.B. Mishra

Course objective: To impart knowledge on Principles of bioenergetics, Fermentative metabolism and Biosynthesis of building blocks and macro-molecules.

Lecture	Subject details
1,2	Principles of bioenergetics
3,4,5,6	Enzyme and its kinetics, regulation of enzyme activity
7,8,9,10,11,12	Bacterial photosynthesis
13,14,15	Energy production (EMP,PP,ED,TCA)
16,17,18	Utilization of reserve materials: starch, glycogen, lipid
19,20	Respiratory chain and electron transport system
21,22	Electron transport under anaerobic condition
23,24	Biosynthesis of building blocks and macro-molecules
25,26	Amino acids and protein synthesis
27,28	Nucleotides and nucleic acids
29,30,31	Carbohydrates
32,33	Peptidoglycans
34,35,36	Fatty acids
37,38	Phospholipids and isoprenoids
39,40	Regulation of metabolism

MICROBIAL PHYSIOLOGY AND METABOLISM

Course code: MICRO-502 (3+1)

Course title: MICROBIAL PHYSIOLOGY AND METABOLISM

Semester: 1st

Faculty: Dr. Deviprasad Samantaray

Course objective: To impart knowledge on nutritional requirement, nutrient transport and growth of microbes.

Lecture	Subject details
1	Introduction and scope of microbial physiology
2,3	Nutritional diversity of microbes
4,5	Nutrient transport in microbes
6	Microbial growth
7	Determination of microbial growth
8	Diauxic growth, continuous and fedbatch culture

Exp. No.	Practical classes	Experiment details
1	2	To study different growth phases of the supplied bacteria.
2	1	Calculations of generation time and growth rate of the bacteria from the experimental data.
3	2	To study the effect of pH on growth of microbes.
4	2	To study the effect of temperature on growth of microbes.
5	2	To study the effect of salt concentration on growth of microbes.
6	2	To study the effect of sugar on growth of microbes.
7	2	To study the effect of N ₂ sources on growth of microbes.
8	2	Estimation of protein by Bardford & Biurette method
9	1	To detect prescence of catalase & oxidase in the supplied bacteria.

Suggested books:

1. Prescott's Microbiology: Joanne M. Willey, Linda M. Sherwood & Christopher J. Woolverton, McGraw-Hill Education.
2. Microbiology: Daniel lim, Kendall Hunt Publishing.
3. Brock Biology of Microorganisms: Michael T. Madigan, John M. Martinko & Kelly S. Bender, Pearson.
4. Principles of Biochemistry: David Lee Nelson & Michael M. Cox, Macmillan Learning.
5. Bacterial Growth and Division: Stephen Cooper, Academic Press.
6. Moat's Microbial Physiology: Michael P. Spector, John W. Foster & Jonathon P. Audia, and Wiley-Blackwell.

MICROBIAL GENETICS

Course Code: MICRO-503 (2+1)

Course Title: MICROBIAL GENETICS Semester: 1st

Faculty: Dr (Mrs.) Saubhagya Manjari Samantaray

Course objective: To impart knowledge on prokaryotic and eukaryotic genome, regarding mutation and DNA repair mechanism, genetic exchange and regulation of gene expression.

Lecture	Details
1,2	Prokaryotic and eukaryotic genome
3,4	Viral genome and replication of viral DNA
5,6,7	Replication of eukaryotic and prokaryotic genome
8,9,10	Spontaneous and induced mutation
11,12	Molecular basis of mutation
12,13,14,15	DNA repair mechanism
16,17	Gene mapping by recombination and complementation
18	Transformation
19	Conjugation
20,21	Transduction and horizontal transfer of genetic transformation
22,23	Host restriction and modification
24,25	Transposable elements
26	Regulation of gene expression
27,28,29	Lac operon and Trp operon
30,31	Genetic basis of cancer and cell death

Exp. No.	Practical Classes	Experiment details
01	01	Inactivation of micro-organisms by different mutagens, production, isolation and characterization of mutants
02	03	Transformation
03	03	Conjugation
04	01	DNA isolation (Prokaryotes)
05	01	Plasmid isolation(Prokaryotes)
06	01	DNA isolation (Eukaryotes)
07	01	Plasmid isolation(Eukaryotes)
08	01	Gel electrophoresis

Suggested books:

1. Molecular Biology: Freifelder D.
2. Molecular Biology of Gene: Watson J.D.
3. Biochemistry of Nucleic acid: Davidson J.N.
4. Molecular Biotechnology: Primrose
5. Genetics: Stricberger
6. Fundaments of Biochemistry: Voet & Voet

FOOD AND DAIRY MICROBIOLOGY

Course Code : MICRO-506 (2+1)

Course Title : FOOD AND DAIRY MICROBIOLOGY

Semester : 1st

Faculty : Dr. (Mrs.) P.Ray and Dr. D. P. smantaray

Course objective: To impart knowledge on food borne pathogens, food borne illness, food safety, food biotechnology, microbial spoilage of various types of foods, preservation (biological and chemical), fermented food and advanced technique in detecting food borne pathogens and their toxins.

Lecture	Subject details
1,2	Introduction and scope of food microbiology
3	Perspective on food safety and food biotechnology
4,5,6,7	Common microorganisms in food
8	Factors of special significance in food microbiology
9	Spores and their significance
10	Indicator organisms and microbiological criteria
11,12	Microbial spoilage of meat and fish
13,14,15	Microbial spoilage of milk, fruits and vegetables
16,17,18	Food poisoning and food borne pathogen and bacterial diseases
19,20,21	Fermented foods (dairy, vegetable and meat products)
22,23	Preservatives and preservation methods
24,25	Bacteriocin and their applications
26	Biologically based preservative system
27	Probiotic bacteria and its significance
28,29,30	Advanced techniques for detecting food borne pathogens and their toxins
31,32	Critical control point system in controlling microbiological hazards in food

Exp. No.	Practical classes	Experiment details
1	2	Microbiological analysis of baby food and canned food
2	2	Microbiological analysis of milk and dairy products
3	2	Microbiological analysis of eggs
4	2	Microbiological analysis of meat
5	2	Microbiological analysis of vegetables
6	2	Microbiological analysis of fruits
7	2	Microbiological analysis of cereals
8	2	Microbiological analysis of surface, containers and water

Suggested books:

1. Food Microbiology: Frazier
2. Food Microbiology- Adams and Moss
3. Textbook of Microobiology: Prescott
4. Lab manual for milk quality control testing: Davis

BASIC CONCEPTS IN LABORATORY TECHNIQUES

Course code: PGS-504 (0+1)

Course title: BASIC CONCEPTS IN LABORATORY TECHNIQUES

Semester: 1st

Faculty: Dr. Deviprasad Samantaray

Course objective: To impart practical knowledge on safety measures for microbiological laboratory, use of some common instrument, preparation of solutions with different strength, sampling and isolation of microbes.

Lecture	Subject details
1	Microbiological laboratory safety rules
2	Handling of chemical substances
3,4,5	Use and handling of some common microbiological instruments
6	Washing, drying and sterilization of glasswares
7,8	Preparation of solutions with different strengths
9,10	Preparation of buffers of different strengths and pH values
11	Methods of sterilization of inoculation chamber
12,13	Preparation of culture media and methods of sterilization
14,15,16	Sampling and isolation of different microbes

Suggested books:

1. Microbiology, Michael J. Pelczar, JR., E.C.S. Chan & Noel R. Krieg, McGraw-Hill Education.
2. Biophysical Chemistry Principles and Techniques: Avinash Upadhyay, Kakoli Upadhyay & Nirmalendu Nath, Himalaya Publishing House.
3. CRC Handbook of Laboratory Safety: A. Keith Furr, CRC Press.
4. A Handbook on Laboratory Solutions: M.H.Gabb & W.E.Latcham, Chemical Publishing Co INC., USA.
5. Collins and Lyne's Microbiological Methods, 8Ed, Chris Collins, John Grange, Patricia Lyne, Joseph Falkinham III, CRC Press.

SEMESTER-II

SOIL MICROBIOLOGY

Course Code: MICRO-504 (2+1)

Course Title: SOIL

MICROBIOLOGY Semester: 2nd

Faculty: Dr (Mrs.) Pratima Ray

Course objective: To impart knowledge on soil microorganisms and its role in Biogeochemical cycle and its effect on biodegradation of pesticides

Lecture	Details
1	Discoveries in soil microbiology
2,3	Distribution of microorganisms in soil
4,5	Qualitative and quantitative estimation of microorganisms in soil
6	Soil microbial biomass
7	Influence of environmental factors on soil micro flora moisture, pH, temperature, organic matter
8	Organic matter decomposition
9	Humus formation
10,11	Carbon cycle
12,13,14	Nitrogen cycle
15	Microbial transformation of phosphorus
16,17	Microbial transformation of Sulphur
18	Microbial transformation of iron
19	Microbial transformation of manganese
20	Degradation of cellulose
21	Degradation of hemicelluloses
22	Degradation of lignin
23	Degradation of pectin
24	Degradation of chitin
25	Inter-relationships between plants and microorganisms
26	Rhizosphere concepts

27	Mycorrhiza
28	Soil enzyme activities and importance
29,30	Microbial pesticides
31	Biodegradation of pesticides
32	Effect of pesticides on soil micro flora

Exp. No.	Practical Classes	Experiment details
1	3	Determination of microbial population
2	3	Soil microbial biomass
3	3	Decomposition studies in soil
4	1	Ammonification
5	2	Nitrification,
6	2	N ₂ fixation
7	1	Sulphur oxidation
8	1	Phosphorus solubilization

Suggested books:

1. Soil Microbiology - Suba Rao
2. Soil Microbiology - Alexander Martin
3. Soil Microbiology - Mark, Coyne
4. Soil Microbiology - Paul, E.Eiego
5. Soil biotechnology - Iyech, martin

MICROBIAL BIOTECHNOLOGY

Course Code : MICRO-505 (2+1)

Course Title : MICROBIAL BIOTECHNOLOGY

Semeste : 2nd

Faculty : Dr. (Mrs.) Saubhagya Manjari Samantaray

Course objective: To impart knowledge on r-DNA technology, vectors, markers, blot technique, DNA sequencing, DNA fingerprinting, PCR, Drug designing and biosensors.

Lecture	Details
1,2	Isolation, screening and genetic improvement of industrially important microorganisms
3,4	Restriction enzymes
5,6,7,8	Cloning vectors
9,10	Expression vectors
11	Isolation and purification of genomic DNA
12	Isolation and purification of plasmid
13,14	c-DNA synthesis, selection and screening of recombinant clones
15	Southern blotting and insertional inactivation
16,17	Northern blotting, marker and reporter genes
18,19	Western blotting and colony hybridization
20	Hybridoma technology
21	Vaccine development and hormone production
22	Steroid transformation
23,24	Immobilization of enzymes or cells
25,26	DNA sequencing and RFLP
27,28	Drug designing and RAPD
29,30	PCR and Micro arrays
31,32	Biosensors and DNA fingerprinting

Exp. No.	Practical Classes	Experiment details
01	02	Isolation and purification of protein by SDS
02	02	Isolation and purification of protein by PAGE
03	02	Isolation of DNA (Prokaryotes)
04	02	Isolation of plasmid (Prokaryotes)
05	02	Isolation of DNA (Eukaryotes)
06	02	Isolation of plasmid (Eukaryotes)
07	01	PCR
08	01	ELISA
09	02	Gel electrophoresis

Suggested books:

1. Molecular Biology: Freifelder D.
2. Molecular Biology of Gene: Watson J.D.
3. Biochemistry of Nucleic acid: Davidson J.N.
4. Molecular Biotechnology: Primrose
5. Genetics: Stricberger
6. Fundamentals of Biochemistry: Voet & Voet

INDUSTRIAL MICROBIOLOGY

Course code: MICRO-509 (2+1)

Course title: INDUSTRIAL MICROBIOLOGY

Semester: 2nd

Faculty: Dr. Deviprasad Samantaray

Course objective: To impart knowledge on fermentation process and production of different industrial product through submerged and solid state fermentation process.

Lecture	Subject details
1	History and development of industrial microbiology
2,3	Contribution of microbial genetics to industry
4,5,6	Strain development
7,8,9	Fermentor and Bioreactor
10,11	Fermentation process
12,13,14	Downstream processing
15,16,17	Industrial production of ethyl alcohol, wine and beer
18,19,20	Citric acid, lactic acid and lysine
21,22,23,	Glutamic acid, penicillin and streptomycin
24,25,26,	Single cell protein, vinegar and riboflavin
27,28,29	Single cell oil, amylase and cellulose

Exp. No.	Practical Classes	Experiment details
1	2	To isolate amylase producing bacteria from a given soil sample.
2	2	To isolate cellulase producing bacteria from a given soil sample.
3	2	To isolate proteinase producing bacteria from a given soil sample.
4	2	To isolate pectinase producing bacteria from a given soil sample.
5	2	To isolate lipase producing bacteria from a given soil sample.
6	2	To isolate gelatinase producing bacteria from a given soil sample.
7	2	To isolate citric acid producing bacteria from a given soil sample.
8	1	To immobilize bacterial cell for the production of enzymes.
9	2	Qualitative test for ethanol production by <i>S. cerevisiae</i> .

Suggested books:

1. Industrial Microbiology: L.E.Casida, John Wiley & Sons INC.
2. Industrial Microbiology: A.H.Patel, Laxmi Publications.
3. Prescott & Dunn's Industrial Microbiology: Samuel Cate Prescott, Cecil Gordon Dunn & Gerald Reed, CBS Publishers.
4. Biotechnology: A Textbook of Industrial Microbiology: Wulf Crueger, Anneliese Crueger & T.D.Brock, Sinauer Associates INC, USA.
5. Industrial Microbiology: An Introduction: M. J.Waites, Neil L. Morgan & John S. Rockey, Wiley-Blackwell.
6. Principles of Fermentation Technology: P.F.Stanbury, A.Whitaker & S.J.Hall, Elsevier.

BIO-FERTILIZER TECHNOLOGY

Course Code : MICRO-510 (1+1)

Course Title : BIO-FERTILIZER TECHNOLOGY

Semester : 2nd

Faculty : Dr. B.B. Mishra

Course objective: To impart knowledge on different agriculturally important beneficial microorganisms.

Lecture	Subject details
1	Different agriculturally important beneficial microorganisms
2,3	Free living, symbiotic, associative and endophytic nitrogen fixers
4	Cyanobacteria
5,6	Nodule formation, competitiveness and quantification of nitrogen fixed
7	Plant growth promoting bacteria
8	Phosphate solubilizing bacteria and fungi, mycorrhiza
9	Bio-control microbial inoculants
10	Recycling of organic wastes and composting
11	Bioremediation
12	Selection, establishment and competitiveness
13	Crop productivity and soil & plant health
14	Mass scale production
15	Quality control of bio-inoculants and bio-fertilizer inoculation
16	Microbial communities in the soil

Exp. No.	Practical classes	Experiment details
1	2	Isolation of symbiotic, asymbiotic and associative nitrogen fixing bacteria
2	2	Determination of phosphate solubilizing activity of bacteria
3	2	Determination of nitrogen fixing ability of bacteria
4	2	Determination of indole acetic acid (IAA) production of bacteria
5	2	Determination of siderophore production of bacteria
6	2	Determination of HCN production of bacteria
7	2	Bio-inoculant production by using different carriers materials
8	2	Quality control of formulated bio-inoculant

Suggested books:

1. Soil Microbiology: M. Alexander
2. Modern Soil Microbiology: J.D. Van Elsas, J.T. Trevors & E.M.H. Wellington
3. Principles and Applications of Soil Microbiology 2nd Edition: D.M. Sylvia, J.J. Fuhrmann, P.T. Hartly & D. Zuberer
4. Methods for Evaluating Biological Nitrogen Fixation: F.J. Bergerson

CLINICAL MICROBIOLOGY

Course Code : MICRO-512 (2+1)

Course Title : CLINICAL MICROBIOLOGY

Semester : 2nd

Faculty : Dr. (Mrs.) P.Ray, Dr. D. P. smantaray and Dr. (Mrs.) Saubhagya Manjari Samantaray

Course objective: To impart knowledge on various human pathogens (bacteria, viruses, fungi, etc.) diseases caused by them, control of microorganisms by physical, chemical, antibiotics and chemotherapeutic agents. The students are also oriented with modern approaches for diagnosis of various infectious diseases. Isolation of pathogens from infected stool, urine, blood, sputum on different medium.

Lecture	Subject details
1,2	Distribution, occurrence and role of normal flora of human body
3,4	Host-microbe interaction
5,6	Microbial enzymes and toxins
7,8	Modern approaches for diagnosis of various infectious diseases
9	Control of microorganisms by various physical and chemical agents
10	Antibiotics and other chemotherapeutic agents
11	Methods used for the study of epidemiology and control of infectious disease
12-22	Important diseases caused by bacteria (<i>Staphylococcus</i> , <i>Streptococcus</i> , <i>E.coli</i> , <i>Salmonella</i> , <i>Shigella</i> , <i>Proteus</i> , <i>Vibrio</i> , <i>Clostridium</i> , <i>Bacillus</i> , <i>M.leprae</i> , <i>M.tuberculosis</i>)
23-29	Viral diseases (measles, mumps, hepatitis, polio, AIDS, influenza, small pox, chicken pox)
30,31,32	Disease caused by Rickettsia, Chlamydia and Mycoplasma

Exp. No.	Practical classes	Experiment details
1	3	Isolation of microorganism using different media
2	3	Identification of different pathogens from urine
3	3	Identification of different pathogens from stool
4	3	Identification of different pathogens from pus
5	3	Identification of different pathogens from Sputum
6	3	Identification of different pathogens from blood

Suggested books:

1. Manual of Clinical Microbiology: Murray
2. Clinical Microbiology: Greenwood
3. Bacterial Disease: Wilson and Topley

SEMESTER-III VIRUS AND BACTERIOPHAGES

Course Code : MICRO-507 (2+1)

Course Title : VIRUS AND BACTERIOPHAGES

Semester : 3rd

Faculty : Dr (Mrs.) Pratima Ray

Course objective: To impart knowledge on structure, cultivation, classification, reproduction and properties of virus.

Lecture	Details
1	Discovery of viruses
2,3	Nature and general properties of viruses
4	Classification of viruses
5	Methods in virology
6	Purification and characterization of viruses
7	Morphology of viruses
8	Chemical composition of viruses
9,10	Cultivation of virus
11,12	Assay of virus
13,14	Replication of Virus
15	Viral genetics and variation
16,17,	Serological properties of viruses
18,19	Sub-viral pathogens
20	Historical developments and classification of bacteriophages
21	Structure of bacteriophages
22,23	Life cycles of different DNA bacteriophages
24	Life cycles of different RNA bacteriophages
25	Oncogenic viruses
26,27	Viral oncogenesis
28,29	Viral cell interaction
30,31	Interferon
32	Intracellular control of virus infection

Exp. No.	Practical classes	Experiment details
1	5	Cultivation of virus
2	3	Inoculation of chick embryo
3	2	Estimation of titre value by haemagglutination
4	1	Estimation of titre value by haemagglutination inhibition test
5	1	Preparation of phage stocks
6	2	filtration of phages and bacteria
7	2	Study of infected plant parts and disease caused by viruses

Suggested books:

1. Introduction to modern virology -Dimmock
2. Text book of microbiology - Narayam.A and Panikar
3. Introduction to Viruses - Biswas and Biswas
4. Medical microbiology - Greenwood
5. Virology - Voyles

ENVIRONMENTAL MICROBIOLOGY

Course code: MICRO-508 (2+1)

Course title: ENVIRONMENTAL MICROBIOLOGY

Semester: 3rd

Faculty: Dr. Deviprasad Samantaray

Course objective: To impart knowledge on microbial interaction, extremophilic microbes & their molecular adaptation, bioremediation, bioenergy and biopolymer production by microbes.

Lecture	Subject details
1	Scope of environmental microbiology
2, 3,4	Microbial interaction
5,6,7,8,9	Extremophiles and their molecular adaptation
10,11,12	Bioremediation
13,14,15,16	Xenobiotics and recalcitrant
17,18,19	Microbes in mineral recovery
20,21	Bioenergy-Methanogenesis
22	Hydrogen production
23	Microbial fuel cell
24	Bioterrorism
25,26	Biopolymer production
27	Environmental pollution and waste management
28	Waste water treatment

Exp. No.	Practical Classes	Experiment details
1	1	Estimation of dissolve oxygen level in the supplied water sample.
2	1	Estimation of BOD level in the supplied water sample.
3	1	Estimation of COD level in the supplied water sample.
4	2	To perform protability of the supplied water sample by MPN test.
5	2	Estimation of microbial load of the supplied sewage and waste sample.
6	2	Isolation and characterization of psycrophile from the supplied sample.

7	2	Isolation and characterization of thermophile from the supplied sample.
8	2	Isolation and characterization of alkalophile from the supplied sample.
9	2	Isolation and characterization of acidophile from the supplied sample.
10	2	Isolation and characterization of halophile from the supplied sample.

Suggested books:

1. Microbial Ecology: Fundamentals and Applications: R. M. Atlas & R. Bartha, Benjamin Cummings.
2. Environmental Science: W. P. Cunningham & M. A. Cunningham, McGraw-Hill Education.
3. Environmental Biotechnology: Basic Concepts and Applications: I. S. Thakur, I. K. International Publishing House.
4. Environmental Biotechnology: Concepts and Applications: H. J. Jordening & J. Winter, Wiley-Blackwell.
5. Microbial Ecology: R.Campbell, Blackwell Scientific Publications.
6. Environmental Microbiology: R. Mitchell, CB.

CYAN OBACTERIAL AND ALGAL BIOTECHNOLOGY

Course Code : MICRO-511 (2+0)

Course Title : CYANOBACTERIAL AND ALGAL BIOTECHNOLOGY

Semester : 3rd

Faculty : Dr. (Mrs.) Saubhagya Manjari Samantaray

Course objective: To impart knowledge on Cyanobacteria and algae regarding their occurrence, origin, evolution, pigments, carbon metabolism, photo synthesis, culture and cultivation methods, cyanobacteria in aqua culture, the production of neutraceutical, nitrogen metabolism etc.

Lecture	Details
1,2	Occurrence and distribution of cyanobacteria and algae
3,4,4,6	Thallus structure and reproduction
7,8	Life cycles
9	Origin and evolution of cyanobacteria
10,11	Role of algae in development of land plants
12,13	Algal pigment
14	carbon metabolism
15,16	Algal culture and cultivation
17,18	Sea weeds cultivation
19,20	Cyanobacterial and algal fuel, as neutraceuticals
21,22	Sea weeds biotechnology
23	UV absorbing pigments and role in sustainable aquaculture
24,25	Algae is a primary colonizer, carbon sequestration
26,27	Cellular differentiation and nitrogen metabolism
28,29	Algae as pollution indicator, eutrification agent and role in bioremediation
30	Cyanobacterial and algal toxins
31,32	cyanobacteria and selected microalgae in agriculture as soil conditioner, reclamation of problem soil and biofertilizer

Suggested books:

1. Phycology: Principles, Processes & Applications: Ahluwali AS
2. Algae: Anatomy, Biochemistry & Biotechnology: Barsanti & Gualtieri P
3. The Biology of Cyanobacteria: Carr NG & Whitton BA
4. The Cyanobacteria Molecular Molecular Biology, Genomics & Evolution: Herrero & Flores E
5. Introductory Phycology: Kumar HD
6. Algal Culturing Techniques: Robert A Andersen
7. Biotechnology and Utilization of Algae: Venkataraman LV & Becker EW

IMMUNOLOGY

Course Code : MICRO-513 (2+1)

Course Title : IMMUNOLOGY

Semester : 3rd

Faculty : Dr. Ashis kumar Mohanty

Course objective: To impart knowledge on basic immunology (the role of immune system and antigen and antibody MHC and complement). The course is also oriented to acquire information on tumour immunology, auto immune disease, hypersensitivity and different types of invitro immunological diagnostic methods and their applications

Lecture	Subject details
1	Innate and adaptive immunity
2,3	Active and passive immunity
4	B and T lymphocytes, NK cells
5	Phagocytosis and its mechanism
6,7,8	Immunological organs
9	Antigens and haptens
10,11,12	Structure, function and diversity of antibody
13,14	Hybridoma and monoclonal antibody
15,16	Organization of MHC. Structure and cellular distribution of HLA antigens
17,18,19	Components of complement and pathways of complement activation
20	Primary and secondary immune response
21	Humoral immune response
22	Cell mediated immune responses
23	Immunological tolerance
24,25	Hypersensitivity: types and mechanism
26	Tumor immunology
27	Auto immune diseases
28,29,30	Immunological principles of various reactions and techniques
30	ELISA
31,32	Immuno electrophoresis and rocket immune electrophoresis

Exp. No.	Practical classes	Experiment details
1	3	Demonstration of agglutination test (slide and tube)
2	3	Precipitation test
3	2	ELISA
4	2	DOT ELISA
5	2	Immunodiffusion
6	2	Immuno-electrophoresis
7	2	Rocket electrophoresis

Suggested books:

1. Immunology: Kuby
2. Immunology: Roitt
3. Immunology: Tyzard
4. Manual of Clinical laboratory immunology: Rose

DOCTORAL PROGRAMME IN MICROBIOLOGY
SEMESTER-I

Course code	Title	Credit Hour			Compulsory Non-Credit
		Major	Minor	Supporting	
MICRO 601	Advances in Fermentation	2+1			
MICRO 602	Advanced Microbial Physiology	2+0			
MICRO 606	Food and Dairy Microbiology		3+0		
MICRO 605	Advanced Immunology			3+0	
PGS 601	Library and Information Services				0+1
PGS 603	Intellectual Property Right				1+0
PGS 604	Basic Concepts in Lab. Technique				0+2
	<i>Total Credit Hour</i>	4+1	3+0	3+0	1+3

SEMESTER-II

Course code	Title	Credit Hour			Compulsory Non-Credit
		Major	Minor	Supporting	
MICRO 603	Regulation of Microbial Biosynthesis	2+0			
MICRO 604	Current Topic in Soil Microbiology	2+0			
MICRO 607	Recent Trends in Environmental Microbiology			2+0	
MICRO 610	Microbial Biotechnology	3+0			
PGS 602	Technical Writing and Communication Skills				0+1
PGS 606	Disaster Management				1+0
	<i>Total Credit Hour</i>	7+0		2+0	1+1

SEMESTER-III

Course code	Title	Credit Hour			Compulsory Non-Credit
		Major	Minor	Supporting	
MICRO 609	Plant-Microbe Interaction	3+0			
MICRO 608	Research Methodology		2+0		
MICRO 611	Virus & Bacteriophages		3+0		
MICRO 691	Doctoral Seminar				
MICRO 699	Doctoral Research				
	<i>Total Credit Hour</i>	3+0	5+0		

Course code	Title	Credit Hour			Compulsory Non-Credit
		Major	Minor	Supporting	

SEMESTER-IV

MICRO-699	Doctoral Research	0+12			
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SEMESTER-V

MICRO-699	Doctoral Research	0+12			
MICRO 691	Doctoral Seminar	1+0			

SEMESTER-VI

MICRO-692	Doctoral Seminar-II	1+0			
MICRO-699	Doctoral Research	0+12			

SEMESTER-I

ADVANCES IN FERMENTATION

Course Code : MICRO-601 (2+1)

Course Title : Advances in fermentation

Semester : 1st

Faculty : Dr (Mrs.) Pratima Ray

Course objective: To impart knowledge on fermentation, fermentation media, industrial microorganisms and fermentation products.

Lecture	Details
1,2,3,4	An overview of fermentation process
5	Current status of fermentation industry
6,7,8	Design of fermenter and bioreactor
9,10	High performance bioreactors
11	Media for microbial fermentation process
12	Criteria of media formulation
13,14,15	Downstream processing for recovery of different industrial product
16	Steroid transformation

Exp. No.	Practical classes	Experiment details
1	2	Isolation and identification of industrially important bacteria
2	2	Isolation and identification of industrially important fungi
3	2	Microbial production of alcohol
4	2	Microbial production of antibiotics
5	2	Microbial production of enzymes
6	2	Microbial production of citric acid
7	2	Microbial production of lactic acid
8	2	Bioremediation of industrial effluents

ADVANCES IN FERMENTATION

Course code: MICRO-601 (2+1)

Course title: ADVANCES IN FERMENTATION **Semester:** 1st

Faculty: Dr. Deviprasad Samantaray

Course objective: To impart knowledge on fermentation process and production of different industrial product through submerged and solid state fermentation process.

Lecture	Subject details
1,2	Media formulation for microbial fermentation process
3,4,5	Downstream processing
6	Primary and secondary metabolites
7,8,9	Industrial production of ethyl alcohol, wine and beer
10,11,12	Penicillin and lysine
13,14	Riboflavin and lactic acid
15,16	Single cell oil and single cell protein

Suggested books:

1. Industrial Microbiology: L.E.Casida, John Wiley & Sons INC.
2. Industrial Microbiology: A.H.Patel, Laxmi Publications.
3. Prescott & Dunn's Industrial Microbiology: Samuel Cate Prescott, Cecil Gordon Dunn & Gerald Reed, CBS Publishers.
4. Biotechnology: A Textbook of Industrial Microbiology: Wulf Crueger, Anneliese Crueger & T.D.Brock, Sinauer Associates INC, USA.
5. Industrial Microbiology: An Introduction: M. J.Waites, Neil L. Morgan & John S. Rockey, Wiley-Blackwell.
6. Principles of Fermentation Technology: P.F.Stanbury, A.Whitaker & S.J.Hall, Elsevier.

ADVANCED MICROBIAL PHYSIOLOGY

Course code: MICRO-602 (2+0)

Course title: ADVANCED MICROBIAL PHYSIOLOGY

Semester: 1st

Faculty: Dr. B.B. Mishra

Course Objective: To impart knowledge on Bacteria, Slime molds, yeasts: Origin, evolution, structure, function, molecular aspects, Physiological aspects of Nitrogen fixation & Fermentative metabolism.

Lecture	Subject details
1,2,3	Bacteria, Slime molds, yeasts: origin, evolution, structure, function, molecular aspects
4	Nutritional diversity in microbes
5	Principle of bioenergetics
6	Enzymes and enzyme kinetics
7	Regulation of enzyme activity
8	Physiological aspects of nitrogen fixation
9	Bacterial photosynthesis
10,11,12	Energy production (EMP,PP,ED,TCA)
13,14	Utilization of reserve materials: starch, glycogen, lipid
15	Respiratory chain and electron transport system
16	Electron transport under anaerobic condition
17	Fermentative metabolism
18,19	Biosynthesis of building blocks and macro-molecules
20	Aminoacids and protein synthesis
21,22	Nucleotides and nucleic acids
23	Carbohydrates
24,25	Peptidoglycans and fatty acids
26	Phospholipids and isoprenoids
27	Regulation of metabolism

28,29	Bioluminescence, bacterial virulence and heat shock response
30,31	Extracellular protein secretion in bacteria and quorum sensing
32	Current molecular microbiology

Suggested books:

1. Prescott's Microbiology: Joanne M. Willey, Linda M. Sherwood & Christopher J. Woolverton, McGraw-Hill Education.
2. Microbiology: Daniel lim, Kendall Hunt Publishing.
3. Brock Biology of Microorganisms: Michael T. Madigan, John M. Martinko & Kelly S. Bender, Pearson.
4. Principles of Biochemistry: David Lee Nelson & Michael M. Cox, Macmillan Learning.
5. Bacterial Growth and Division: Stephen Cooper, Academic Press.
6. Moat's Microbial Physiology: Michael P. Spector, John W. Foster & Jonathon P. Audia, and Wiley-Blackwell.

FOOD AND DAIRY MICROBIOLOGY

Course code: MICRO-606 (3+0)

Course title: FOOD AND DAIRY MICROBIOLOGY

Semester: 1st

Faculty: Dr. Saubhagya Manjari Samantaray

Course objective: To impart knowledge on food borne pathogens, food borne illness, food safety, food biotechnology, microbial spoilage of various types of foods, preservation (biological and chemical), fermented food and advanced technique in detecting food borne pathogens and their toxins.

Lecture	Subject details
1,2,3	Perspective on food safety and food biotechnology
4,5,6	Factors of special significance in food microbiology
7, 8	Principles influencing microbial growth in foods
9, 10	Spores and their significance
11, 12, 13	Indicator micro-organisms and microbiological criteria
14, 15, 16, 17, 18	Microbial spoilage of food, meat, fish, milk, fruits, vegetables and their products
19, 20, 21, 22	Food poisoning and food borne pathogenic bacterial diseases
23	Food fermentation
24, 25,26, 27	Fermented dairy, vegetables and meat products
32, 33, 34, 35,36, 37	Preservatives and preservation methods- physical methods, chemical preservatives and natural antimicrobial compounds
38, 39	Bacteriocins and their applications
40, 41, 42	Biologically based preservation system and probiotic bacteria
43, 44, 45	Advanced techniques in detecting food borne pathogens toxins
46,47, 48	Critical control point systems in controlling microbial hazards in foods

Suggested Books:

1. Food Microbiology: Doyle.
2. Food Microbiology: Frazier.
3. Food Microbiology: Adams and Moss
4. Modern Food Microbiology: Jav I.M.
5. Food Microbiology: Neelam Khetarpaul.
6. International Food Safety Handbook: K. V. Heijden.
7. Text Book of Microbiology: Prescott (TMH).
8. Outlines of Dairy Technology: Sukumar De (Oxford).
9. Milk and Milk Products (4th edition): C. H. Eckles (TMH).
10. Introductory Microbiology: R. P. Singh (C.B.D. Publication).
11. Laboratory Manual for Milk Quality Control Testing: J. G. Davis.

ADVANCED IMMUNOLOGY

Course code: MICRO-605 (3+0)

Course title: ADVANCED

IMMUNOLOGY Semester: 1st

Faculty: Dr. (Mrs.) P.Ray, Dr. D. P. smantaray and Dr. (Mrs.) Saubhagya Manjari Samantaray

Course objective: To impart knowledge on basic immunology (the role of immune system and antigen and antibody, MHC and complement). The course is also oriented to acquire information on tumor immunology, auto immune diseases, hypersensitivity and different types of *in vitro* immunological diagnostic methods and their applications.

Lecture	Subject details
1,2,3,4,5	Immunological organs (thymus, bone marrow, lymph nodes, spleen, MALT and GALT)
6,7	Cells involved in immune response
8,9	Non-specific immune mechanism
10,11,12,13	Antigens, Immunoglobulins and its diversity
14	Immune response to bacterial infection and innate immunity
15	Acquired immunity
16,17,18	Complement system
19,20	Acute phase proteins and Macrophage
21,22,23	Cytokines and interferons
24,25,26	Histocompatibility complex
27,28,29,30,31,32	Hypersensitivity
33,34,35	Auto immune diseases
36,37	Tumour immunology
38,39	Immune complex diseases
42,43	Precipitation method, immunodiffusion and agglutination method
44,45,46	ELISA (separation of serum by electrophoresis, separation and characterization of lymphocytes)
47,48	Handling laboratory animals and raising antibody

Suggested books:

7. Immunology: Kuby
8. Immunology: Roitt
9. Immunology: Tizard
10. Manual of clinical laboratory immunology: Rose
11. Journals and internet

SEMESTER-II

REGULATION OF MICROBIAL BIOSYNTHESIS

Course Code : MICRO-603 (2+0)

Course Title : REGULATION OF MICROBIAL BIOSYNTHESIS **Semester :** 2nd

Faculty : Dr. (Mrs.) P.Ray, Dr. D. P. smantaray and Dr. (Mrs.) Saubhagya Manjari Samantaray

Course objective: To impart knowledge on regulation of microbial biosynthesis of various inducible and biosynthetic pathways, fermentative and respiratory pathways and lytic and lysogenic aspects.

Lecture	Subject details
1,2,3	Regulation of initiation, termination and anti-termination of transcription
4,5,6	Global regulation and differentiation by sigma factor
7,8	Regulatory control in bacteria- inducible and biosynthetic pathways
9,10,11,12,13	Oxidative stress control, fermentative and respiratory and regulatory pathway
14	Regulation of cell cycle
15,16	Lytic and lysogenic aspect

Suggested books:

1. Fundamentals of Biochemistry: Lehninger
2. Microbial Physiology: Spector
3. Molecular Genetics: Freifeder
4. Journals and Periodicals

REGULATION OF MICROBIAL BIOSYNTHESIS

Course Code : MICRO-603 (2+0)

Course Title : REGULATION OF MICROBIAL BIOSYNTHESIS

Semester : 2nd

Faculty : Dr. (Mrs.) Saubhagya Manjari Samantray

Course objective: To impart knowledge on regulation of microbial biosynthesis of various inducible and biosynthetic pathways, fermentative and respiratory pathways and lytic and lysogenic aspects.

Lecture	Subject details
1,2,3	Ribosomal RNA and ribosomal protein regulation under stress condition
4,5,6	Specific regulatory system
7,8	SOS regulatory control
9,10	Antisense RNA regulation of gene expression
11,12	Global nitrogen control
13,14,15	Regulation of nitrogen fixation

Suggested books:

1. Fundamentals of Biochemistry: Lehninger
2. Microbial Physiology: Spector
3. Molecular Genetics: Freifeder
4. Journals and Periodicals

CURRENT TOPICS IN SOIL MICROBIOLOGY

Course Code: MICRO-604 (2+1)

Course Title: CURRENT TOPICS IN SOIL MICROBIOLOGY

Semester: 2nd

Faculty: Dr (Mrs.) Pratima Ray

Course objective: To impart knowledge on latest trends in soil microbiology like diversities, biological control and bioremediation etc.

Lecture	Details
1,2,3,4,5	Molecular ecology
6,7,8,9,10	Biodiversity of soil microorganisms
11,12	Survival and dispersal of microorganisms
13	Microbial successions
14,15,16,17,18,19,20,21	Transformation of Organic matter
22,23,24	Bioremediation of polluted soils
25,26,27,28	Biological control
29,30,31,32	Other topics of current interest

Suggested books:

1. Soil Microbiology - Suba Rao
2. Soil Microbiology - Alexander Martin
3. Soil Microbiology - Mark, Coyne
4. Soil Microbiology - Paul, E.Eiego
5. Soil biotechnology - Iyech, martin

RECENT TRENDS IN ENVIRONMENTAL MICROBIOLOGY

Course code: MICRO-607 (2+0)

Course title: ENVIRONMENTAL MICROBIOLOGY

Semester: 2nd

Faculty: Dr. Deviprasad Samantaray

Course objective: To impart knowledge on microbial interaction, extremophilic microbes & their molecular adaptation, bioremediation, bioenergy and biopolymer production by microbes.

Lecture	Subject details
1	Overview of distribution of microbes
2, 3,4,5,6	Extremophiles and their molecular adaptation
7,8,9	Microbial interaction
10,11,12	Bioremediation
13,14,15,16	Xenobiotics and recalcitrant
17,18,19	Microbes in mineral recovery
20,21,22	Bioenergy-Methanogenesis and ethanol production
23,24	Hydrogen production and microbial fuel cell
25,26,27	Bioterrorism and biopolymer production
28,29	Global warming
30	Nano-technology in pollution control

Suggested books:

1. Microbial Ecology: Fundamentals and Applications: R. M. Atlas & R. Bartha, Benjamin Cummings.
2. Environmental Science: W. P. Cunningham & M. A. Cunningham, McGraw-Hill Education.
3. Environmental Biotechnology: Basic Concepts and Applications: I. S. Thakur, I. K. International Publishing House.
4. Environmental Biotechnology: Concepts and Applications: H. J. Jordening & J. Winter, Wiley-Blackwell.
5. Microbial Ecology: R. Campbell, Blackwell Scientific Publications.
6. Environmental Microbiology: R. Mitchell, CB.

MICROBIAL BIOTECHNOLOGY

Course Code : MICRO-610 (3+0)

Course Title : MICROBIAL BIOTECHNOLOGY

Semester : 2nd

Faculty : Dr. (Mrs.) Saubhagya Manjari Samantaray Department of Bioinformatics

Course objective: To impart knowledge on application of rDNA technology, in various fields like agriculture, medicine, oil recovery, pollution control and bioleaching, DNA sequencing, drug designing, DNA fingerprinting, PCR, RFLP, RAPD.

Lecture	Subject details
1,2,3	Isolation, screening and genetic improvements of industrially important microorganisms
4,5	Restriction enzymes
6,7,8,9	Cloning vectors
10	Isolation and purification of genomic DNA
11	Isolation and screening of plasmid DNA
12,13	cDNA synthesis and cloning in E.coli
14,15	Screening and selection of recombinant clones, insertional inactivation
16,17	Marker and reporter genes
18,19,20,21	Blotting techniques
22,23	Application of rDNA technology in agriculture
24,25	Application of rDNA technology in medicine
26	Application of rDNA technology in oil recovery
27,28,29	Application of rDNA technology in pollution control and bioleaching
30,31,32	DNA sequencing and automated sequencing
33	Drug designing
34	DNA finger printing
35	PCR
36	RFLP
37	RAPD

38	Microarray technology
39,40	Introduction to bioinformatics, database types
41,42	Online proteomics and genomics tools
43,44	Multiple alignment and BLAST

Suggested books:

1. Molecular Biology: Freifelder D.
2. Molecular Biology of Gene: Watson J.D.
3. Biochemistry of Nucleic acid: Davidson J.N.
4. Molecular Biotechnology: Primrose
5. Genetics: Stricberger
6. Fundamentals of Biochemistry: Voet & Voet
7. Bioinformatics 2000: Higgins and Taylor

SEMESTER-III

PLANT-MICROBE INTERACTIONS

Course code: MICRO-609 (3+0)

Course title: PLANT-MICROBE INTERACTIONS

Semester: 3rd

Faculty: Dr. Deviprasad Samantaray

Course objective: To impart knowledge on different interfaces of interactions and quorum sensing phenomenon in microbes.

Lecture	Subject details
1	Different interfaces of interactions
2,3	Plant-microbe interaction
4,5	Microbe-microbe interaction
6,7	Soil-plant-microbe interaction
8,9,10	Symbiotic association of microbes
11,12,13	Quorum sensing phenomenon in bacteria

Suggested books:

1. Microbial Ecology: Fundamentals and Applications: R. M. Atlas & R. Bartha, Benjamin Cummings.
2. Environmental Science: W. P. Cunningham & M. A. Cunningham, McGraw-Hill Education.
3. Microbial Ecology: R. Campbell, Blackwell Scientific Publications.
4. Environmental Microbiology: R. Mitchell, CB.

PLANT-MICROBE INTERACTION

Course Code : MICRO-609 (3+0)

Course Title : PLANT-MICROBE INTERACTION

Semester : 3rd

Faculty : Dr. (Mrs.) P.Ray, Dr. D. P. smantaray and Dr. (Mrs.) Saubhagya Manjari Samantaray

Course objective: To impart thorough knowledge on interactions of plants and microbes, and elementary idea transgenic microbes and plants; microbial inoculants

Lecture	Subject details
1	Biosensors
2,3	Bioluminescence
4,5	Plants and their interactions including transgenic microbes and plants
6,7,8	Treatments of biological wastes
10,11,12	Microbial inoculants
13,14,15,16	Enzymes for waste treatment

Suggested books:

Journals and Periodicals

RESEARCH METHODOLOGY

Course code: MICRO-608 (2+0)

Course title: RESEARCH METHODOLOGY

Semester: 3rd

Faculty: Dr. B.B. Mishra

Course objective: To impart knowledge on scientific methods related to research and biostatistics.

Lecture	Subject details
1,2	Scientific methods
3,4	Making of hypothesis
5,6	Testing the null hypothesis
7,8	Setting up the experiments with negative control, minimum number of replicates per treatments and minimum number of observation per group
9,10	Empirical observations, valid conclusion
11,12	Research methodology in survey work
13	Census study and sample study (Simulated data analysis)
14,15	Use of primary & secondary data and sample studies in research
16,17	Common statistical designs in nutritional assessment (Simulated data analysis)
18,19,20	Criteria for nutritional assessments (Simulated data analysis)
21,22,23	Nutritional requirements (Simulated data analysis)
24,25	Embryological and histo-pathological work (Simulated data analysis)
26,27	Enzyme assay
28,29	Use of radio isotopes in nutrition research
30,31	X-ray in nutritional investigations
32	Reference collection and writing paper and thesis

Suggested books:

1. Introductory Biostatistics: B.N. Mishra & M.K. Mishra
2. Statistics: Gupta

VIRUS AND BACTERIOPHAGES

Course Code : MICRO-611 (3+0)

Course Title : VIRUS AND BACTERIOPHAGES

Semester : 3rd

Faculty : Dr (Mrs.) Pratima Ray

Course objective: To impart knowledge on structure, reproduction and properties of virus.

Lecture	Details
1	Discovery of viruses
2,3	Nature and general properties of viruses
4	Classification of viruses
5	Methods in virology
6	Purification and characterization of viruses
7	Morphology of viruses
8	Chemical composition of viruses
9,10	Cultivation of virus
11,12	Assay of virus
13,14	Replication of Virus
15	Viral genetics and variation
16,17	Serological properties of viruses
18,19	Sub-viral pathogens
20	Historical developments and classification of bacteriophages
21	Structure of bacteriophages
22,23	Life cycles of different DNA bacteriophages
24	Life cycles of different RNA bacteriophages
25	Oncogenic viruses
26,27	Viral oncogenesis
28,29	Viral cell interaction
30,31	Interferon
32	Intracellular control of virus infection

Suggested books:

1. Introduction to modern virology: Dimmock
2. Text book of microbiology: Narayam.A and Panikar
3. Introduction to Viruses: Biswas and Biswas
4. Medical microbiology: Greenwood
5. Virology: Voyles