DAV University, Jalandhar
Department of Microbiology

Proposed Syllabus for
M.Sc. (Hons.) Microbiology
(Semester I – IV)

2013-2014

DAV UNIVERSITY, JALANDHAR

Scheme of Courses (Program ID 40)

Master of Microbiology

Semester 1

S.No	Course Code	Course Title	L	T	P	Cr	% Weightage				E
							A	B	C	D	
1	MIC501	Microbial Diversity	4	0	0	4	25	25	25	25	**100**
2	MIC502	Environmental and Industrial Microbiology	4	0	0	4	25	25	25	25	**100**
3	MIC503	Immunology	4	0	0	4	25	25	25	25	**100**
4	MIC504	Virology I	4	0	0	4	25	25	25	25	**100**
5	BCH502	Microbial Biochemistry	4	0	0	4	25	25	25	25	**100**
6	MIC505	Microbial Diversity Lab	0	0	2	1	-	-	-	-	**25**
7	MIC506	Environmental and Industrial Microbiology Lab	0	0	2	1	-	-	-	-	**25**
8	MIC507	Immunology Lab	0	0	2	1	-	-	-	-	**25**
9	MIC508	Virology I Lab	0	0	2	1	-	-	-	-	**25**
10	BCH504	Microbial Biochemistry Lab	0	0	2	1	-	-	-	-	**25**
11	MIC551	MSc Seminar I	2	0	0	2	-	-	-	-	**50**
			20	**0**	**10**	**27**					**675**

A: Continuous Assessment: Based on Objective Type Tests
B: Mid-Term Test-1: Based on Objective Type & Subjective Type Test
C: Mid-Term Test-2: Based on Objective Type & Subjective Type Test
D: End-Term Exam (Final): Based on Objective Type Tests
E: Total Marks

L: Lectures T: Tutorial P: Practical Cr: Credits

DAV UNIVERSITY, JALANDHAR

Scheme of Courses

Master of Microbiology

Semester 2

S.No	Course Code	Course Title	L	T	P	Cr	% Weightage				E
							A	B	C	D	
1	MIC509	Clinical Microbiology	4	0	0	4	25	25	25	25	**100**
2	MIC511	Virology II	2	0	0	2	25	25	25	25	**50**
3	BTY551	Recombinant DNA Technology	4	0	0	4	25	25	25	25	**100**
4	BCH507	Advanced Enzymology	2	0	0	2	25	25	25	25	**50**
5	BOT517	Plant Physiology	4	0	0	4	25	25	25	25	**100**
6	MIC510	Clinical Microbiology Lab	0	0	3	2	-	-	-	-	**50**
7	BTY555	Recombinant DNA Technology Lab	0	0	3	2	-	-	-	-	**50**
8	BCH508	Advanced Enzymology Lab	0	0	2	1	-	-	-	-	**25**
9	BOT518	Plant Physiology Lab	0	0	3	2	-	-	-	-	**50**
10	MIC552	MSc Seminar II	1	0	0	1	-	-	-	-	**25**
			16	**0**	**11**	**24**					**600**

A: Continuous Assessment: Based on Objective Type Tests
B: Mid-Term Test-1: Based on Objective Type & Subjective Type Test
C: Mid-Term Test-2: Based on Objective Type & Subjective Type Test
D: End-Term Exam (Final): Based on Objective Type Tests
E: Total Marks

L: Lectures T: Tutorial P: Practical Cr: Credits

Scheme of Courses

Master of Microbiology

Semester 3

S.No	Course Code	Course Title	L	T	P	Cr	% Weightage				E
							A	B	C	D	
1	ZOO502	Animal Physiology	4	1	0	4	25	25	25	25	**100**
2	MIC601	Microbial Genetics	4	1	0	4	25	25	25	25	**100**
3	BTY502	Molecular Biology	4	1	0	4	25	25	25	25	**100**
4	BCH501	Bioanalytical Techniques	4	1	0	4	25	25	25	25	**100**
5	ZOO507	Animal Physiology Lab	0	0	3	2	-	-	-	-	**25**
6	MIC602	Microbial Genetics Lab	0	0	3	2	-	-	-	-	**50**
7	BTY506	Molecular Biology Lab	0	0	3	2	-	-	-	-	**50**
8	BCH503	Bioanalytical Techniques Lab	0	0	3	2	-	-	-	-	**50**
			16	**4**	**11**	**24**					**600**

A: Continuous Assessment: Based on Objective Type Tests
B: Mid-Term Test-1: Based on Objective Type & Subjective Type Test
C: Mid-Term Test-2: Based on Objective Type & Subjective Type Test
D: End-Term Exam (Final): Based on Objective Type Tests
E: Total Marks

L: Lectures T: Tutorial P: Practical Cr: Credits

Scheme of Courses

Master of Microbiology

Semester 4

S.No	Course Code	Course Title	L	T	P	Cr	% Weightage				E
							A	B	C	D	
1	BTY553	Biostatistics	4	1	0	4	25	25	25	25	**100**
2	BTY652	Genomics, Proteomics and Metabolomics	4	1	0	4	25	25	25	25	**100**
3	MIC652	MSc Seminar IV	2	0	0	2	-	-	-	-	**50**
4	MIC654	Project	0	0	0	8	-	-	-	-	**200**
5	BTY557	Biostatistics Lab	0	0	3	2	-	-	-	-	**50**
6	BTY656	Genomics, Proteomics and Metabolomics Lab	0	0	3	2	-	-	-	-	**50**
7	MIC653	Educational Tour	0	0	0	2	-	-	-	-	**50**
			10	**2**	**6**	**24**					**600**

A: Continuous Assessment: Based on Objective Type Tests
B: Mid-Term Test-1: Based on Objective Type & Subjective Type Test
C: Mid-Term Test-2: Based on Objective Type & Subjective Type Test
D: End-Term Exam (Final): Based on Objective Type Tests
E: Total Marks

L: Lectures T: Tutorial P: Practical Cr: Credits

Course Title: Microbial Diversity
Course Code: MIC501

L	T	P	Credits	Marks
4	0	0	4	100

Course Objective: This course is to learn microbial diversity and ecology.

Unit A

Microbial Evolution and Systematics – Early earth, origin and diversification of life, endosymbiotic origins of eukaryotes, phenotypic analysis, genotypic analysis, species concept in microbiology, classification and nomenclature in microbiology. 8 hours

Unit B

Bacteria (Proteobacteria) – Phylogeny of bacteria, phototrophic, chemolithotrophic, and methanotrophic *Proteobacteria*, aerobic and facultatively aerobic chemoorganotrophic *Proteobacteria*, morphologically unusual *Proteobacteria*, *Delta*--- and *Epsilonproteobacteria.*

6 hours

Other Bacteria – Firmicutes, mollicutes and actinobacteria, cyanobacteria, prochlorophytes, Chlamydia, planctomycetes, verrumicrobia, flavobacteria 6 hours
And acidobacteria, cytophaga, green sulfur bacteria, spirochetes, deinococci, green non---sulfur bacteria, hyperthermophilic bacteria. 6 hours

Unit C

Archaea **–** Diversity of Archaea, Euryarchaeota, Crenarchaeota, Evolution and life at higher temperatures. 8 hours
Eukaryotic Microbes – Eukaryotic cell structure and function, eukaryotic microbial diversity, protists, fungi, red and green algae 6 hours

Unit D

Methods in Microbial Ecology– Culture---dependent and culture–independent
Analyses of microbial communities, measuring microbial activities in nature. 6 hours

Major Microbial Habitats and Diversity – microbial ecology, the microbial environment, terrestrial and aquatic environments 6 hours

Nutrient Cycles, Biodegradation and Bioremediation –Carbon cycle, syntrophy and methanogenesis, nitrogen cycle, sulfur cycle, iron cycle, phosphorus, calcium and silica cycles, microbial leaching, mercury transformations, petroleum and xenobiotics biodegradation and bioremediation. 8 hours

60 hours

Reference books

1. Microbiology. Pelczar, M. J., Chan, E. C. S. and Krieg, N. R. Tata McGraw Hill Publishing Company Limited. 5th edition. 1993.
2. General microbiology. Roger Y. Stainer, John L. Ingraham, Mark L. Wheelis and Page R. Painter. Macmillan Press Ltd. 5th edition. 1987.

3. Microbiology-An Introduction. Tortora, G.J., Funke, B. R. and Case, C. L. Benjamin Cummings, Carson, USA. 7th edition. 2001
4. Brock Biology of Microorganisms. Madigan and John M. Martinko, Paul V. Dunlap, David P. Clark. Benjamin Cummings, 12th edition. 2008.

Course Title: Environmental and Industrial Microbiology
Course Code: MIC502

L	T	P	Credits	Marks
4	0	0	4	100

Course Objective: This course is to learn environmental and industrial microbiology. Waste water microbiology and aeromicrobiology are covered in this course.

Unit A: Industrial Microbiology

Primary and secondary metabolites; Major industrial products – Foods: Single Cell Protein, Mushrooms, Cheese and Yogurt, Spirulina, Fermented Meat, Sauerkraut, Pickles, Coffee Beans, Chocolate, Olives, Soy sauce; Flavoring agents and Food Supplement: Vinegar, Nucleotides, Amino Acids, Vitamins; Beverage Containing Alcohol: Wine, Beer, Distilled Beverages; Organic Acids: Citric acid, Itaconic acid ; Enzymes and Microbial Transformation; Inhibitors; Genetically Engineered Microorganisms : Human insulin, Human Growth Hormones and Vaccines.
15 hours

Unit B: Wastewater Microbiology

Water Microorganisms: Marine Microbiology, Fresh Water Microbiology ; Sewage Treatment : Ecological impact of raw sewage on receiving water, Public health impact of raw sewage discharge; Primary waste water treatment, Secondary treatment: Activated Sludge Process, Trickling Filters, Oxidation Ponds, Rotating Biological Contractors; Microbial treatment problems; Tertiary waste water treatment, Drinking Water Treatment ; Microbial Analysis of Water: Total coliform bacteria analysis, Membrane-Filter Technique, Colorimetric and Fluorogenic Analysis, IMViC Test. Commercial blends of microorganisms/enzymes in wastewater treatment.
15 hours

Unit C: Microbial Waste Management

Waste as a Resource: Organic Compost, Vermicomposting, Biogas Production; Landfills; Pesticides: Alternatives to use of persistant pesticides; Bioremediation: Biodegradative organisms, Methodology of bioremediation, Advantages of bioremediation, Problem associated with bioremediation, Future of bioremediation; Acid mine drainage; Microbial Leaching: Copper Leaching, Uranium Leaching; Biodegradation: Biodegradation of Petroleum and Xenobiotics, Biofilteration: Biofilters, Microorganisms, Biofilter Media, Mechanism of Biofilteration.

15 hours

Unit D: Aeromicrobiology

Important airborne pathogens: Plant, animal and human pathogens; Important airborne toxins; Bioaerosols : Nature of bioaerosols; Aeromicrobiological pathways; Microbial survival in air; Extramural aeromicrobiology; Intramural aeromicrobiology; Bioaerosols control; Control of microorganisms by physical agents: High temperature, Low temperature, Filtration, Desiccation, Osmotic pressure, Radiations; Control of microorganisms by chemical means: Phenol, Phenolics, Bisphenols, Biguanides, Halogens, Alcohols, Heavy metals and their compounds.

15 hours

60 hours

Reference books

1. Pelczar, M. J., Chan, E. C. S. and Krieg, N. R. (1993). Microbiology-Concepts and Applications. McGraw Hill Inc, New Delhi.
2. Perry, J.J. and Staley, J.T. (1997). Microbiology- Dynamics and Diversity. Harcourt College Publishing, Florida, USA.
3. Taussig, M. J. (1984). Microbiology (2^{nd} ed.). Blackwell Scientific Publications, Oxford, London.
4. Tortora, G.J., Funke, B. R. and Case, C. L. (2001). Microbiology-An Introduction (7^{th} ed.). Benjamin Cummings, Carson, USA.

Course Title: Immunology
Course Code: MIC503

L	T	P	Credits	Marks
4	0	0	4	100

Course Objective: This course is to learn basic and advanced immunology.

Unit-A

History of immunology.
Three fundamental concepts in immunology: Specificity, discrimination of self from non-self and memory.
Lymphocytes : B lymphocyte, T lymphocyte
Antibodies : structure , classes and function 10 hours

Unit-B

Immune cell receptors: Detailed structure and development of B cell (Ig) and T cell (TcR) receptors;
Structure of CD4, CD8, MHC-I, MHC-II molecules, cellular adhesion molecules (ICAM, VCAM, MadCAM, selectins, integrins); Pattern Recognition Receptors (PRRs) and Toll-like receptors (TLR); 8 hours
Markers of suppressor / regulatory T cells - CD4+ CD25+
Genetic organization: Organization of the genes for B and T cell receptors.
Genetic organization of MHC-I and MHC-II complex, Peptide loading and expression of MHC-I and MHC-II molecules.
Molecular mechanisms responsible for generating diversity of antibodies and T cell receptors.;
Hybridoma technology and monoclonal antibodies. 12 hour

Unit-C

Immune response and signaling: Humoral and cell-mediated immune response; Innate immune response and pattern recognition; Recent advances in innate immune response especially NK-DC interactions; 6 hours
Major cytokines and their role in immune mechanisms: TNF, IFN, IL-1, IL-2, IL-4, 1L-6, IL-10,IL-12, IL-17, TGFβ; Cell signaling through MAP kinases and NF-κB. 4 hours
Tolerance and autoimmunity and their mechanism; Mechanisms of autoimmunity; Autoimmune components of diabetes mellitus (DM), multiple sclerosis (MS), experimental autoimmune encephalitis (EAE); Infections leading to autoimmune diseases. 6 hours

Unit-D

Immunological disorders and hypersensitivity: Deficiencies / defects of T cells, B cells, complement and phagocytic cells; 4 hours
Comparative study of Type I-V hypersensitivities with examples. 4 hours
Transplantation and tumor immunology: Alloreactive response; Graft rejection ; HLA-matching; 3 hours
Transgenic animals for xenotransplantation; Tumor antigens, immune response to tumors and immunotherapy of tumors. 3 hours

60 hours

Reference books

1. Kuby Immunology. Thomas J. Kindt, Richard A. Goldsby, Barbara A. Osborne. W.H. Freeman and Co. Publishers. 6th Edition. 2007.
2. Janeway's Immunobiology. Kenneth Murphy, Paul Trevers, Mark Walpart. Garland Science Publishers. 2012.
3. Roitt's Essential Immunology. Ivan M. Roitt and Peter J. Delves. 10^{th} Ed. Blackwell Publishing Ltd. 2001.
4. Fundamental Immunology. William E. Paul. 6^{th} edition. Lippincott Williams & Wilkins, a Wolters Kluwer business. 2008.

Course Title: Virology I
Course Code: MIC504

L	T	P	Credits	Marks
4	0	0	4	100

Course Objective: This course is to learn basic and advanced plant virology and bacteriophages.

Unit-A History and development of plant virology, cryptograms, and classification of plant viruses and viroids

Brief history of virology highlighting the significant contributions of scientists to the development of plant virology; significance of plant virology and modern classification of plant viruses and viroids according to ICTV; and cryptograms of various plant viruses and virus groups. 15 hours

Unit-B Propagation, purification, characterization and identification and genomics of plant viruses

General methods of propagation of plant viruses; purification of plant viruses using centrifugation, chromatography and electrophoresis techniques, their assay and comparison of the sensitivity of assay methods; methods employed in identification of plant viruses and structural and functional genomics. 15 hours

Unit-C

Symptoms of plant virus diseases, transmission of plant viruses, viral and viroid diseases and their control

General discussion on symptoms caused by viruses and viroids in diseased economically important trees and agricultural crops, and their control including development of virus disease resistant transgenetics. 15 hours

Unit-D

Replication and expression of viral genomes

Mechanism of genome replication, expression and virus multiplication of RNA and DNA plant viruses

Microbial viruses and virus-like pathogens

Diversity, classification, characteristics and applications of bacteriophages, and general account on algal, fungal and protozoan viruses, viroids, virophages and prions. 15 hours

60 hours

Reference books

1. Principles of Virology: Molecular Biology, Pathogenesis and Control of Animal Viruses by S.J. Flint, L.W. Enquist, V.R. Racaniello, and A.M. Skalka 2nd edition, ASM Press, Washington, DC, 2004.

2. Introduction to Modern Virology EPZ by Nigel Dimmock, Andrew Easton and Keith Leppard, 5th edition, Blackwell Publishing, 2005

3. Basic Virology by Edward K. Wanger, Martinez Hewiett, David Bloom and David Camerini, 3rd edition, Blackwell Publishing, 2007.

4. Principles of Molecular Virology by Alan J. Cann, 3rd edition, Elsevier Academic Press, 2001.

5. Plant Virology by Roger Hull, 4th edition, Academic press, 2002.

Course Title: Microbial Diversity Lab
Course Code: MIC505

L	T	P	Credits	Marks
0	0	2	1	25

1. Bright-Field Light Microscope and Microscopic Measurement of Organisms
2. The Hanging Drop Slide and Bacterial Motility
3. Winogradsky column preparation
4. Isolation of free living nitrogen fixing bacteria from soil sample
5. Isolation of antibiotic producing streptomycetes from soil sample
6. Bacterial growth curve of isolated bacteria
7. Gram staining of isolated bacteria
8. Acid-Fast staining
9. Endospore staining
10. Capsule staining

30 hours

Course Title: Environmental and Industrial Microbiology Lab
Course Code: MIC506

L	T	P	Credits	Marks
0	0	2	1	25

1. To study different principle and working of instruments used to perform microbiological experiments.
2. To study the Gram positive and Gram negative staining of Bacteria.
3. To determine the quality of milk samples using Methylene Blue.
4. To study microbial techniques: Media requirement, Inoculation and Streaking of plate.
5. To study the growth period in given strain of bacteria.
6. To prepare Potato Dextrose Agar (PDA) medium for routine cultivation of fungi.
7. To study aeromicroflora at different locations of DAV University, Jalandhar.
8. To isolate the microorganisms from soil by Pour Plate Technique.
9. To determine the coliform bacteria in given water sample using MPN Test viz. Preliminary test, Confirmatory Test and Complete Test.
10. To determine the motility of bacteria by Hanging Drop Method.
11. To demonstrate the bacterial growth in response to oxygen availability.
12. To study the mutagenicity of water samples using Ames Assay.
13. To study the mutagenicity of soil samples using Ames Assay.
14. To study the antibiotic activity of bacteria using Paper Disc Assay.
15. To study antibacterial activity of plant extract.
16. To study antifungal activity of plant extract.

30 hours

Course Title: Immunology Lab
Course Code: MIC507

L	T	P	Credits	Marks
0	0	2	1	25

1. Agglutination of bacteria
2. SDS-PAGE electrophoresis
3. Separation of IgG by ammonium sulfate precipitation
4. Reduction of IgG with mercaptoethanol to four chain
5. Papain digestion of IgG
6. Pepsin digestion of IgG
7. Gel precipitation
8. ELISA
9. Western Blotting
10. Separation of white blood cells from blood
11. Total leukocyte count and differential leukocyte count
12. Blood typing

30 hours

Course Title: Virology I Lab
Course Code: MIC508

L	T	P	Credits	Marks
0	0	2	1	25

1. Susceptibility to bacteriophage T4, T5.
2. Isolation of phage resistant bacteria.
3. One step growth curve of bacteriophage T4
4. Transduction by bacteriophage P1
5. Isolation of phage DNA
6. Amplification of phage gene by PCR
7. Diagnosis of plant virus by ELISA
8. Diagnosis of plant virus by PCR

30 hours

Course Title: Clinical Microbiology
Course Code: MIC509

L	T	P	Credits	Marks
4	0	0	4	100

Course Objective: This course is to learn clinical microbiology. This course covers host parasite relationship and pathogenic bacteria and pathogenic fungi.

Unit A

Normal microbial flora.

Immune response to infection. The immuneresponsive cells, T cell responses.

Host parasite relationship. Pathogen, Microbial pathogenicity, Strategy for survival, Overcoming the host immune system, Virulence factors. 12 hours

Unit B

Sterilization and disinfection.

Antibacterial and antiviral agents.

Antimicrobial resistance.

Priciples of laboratory diagnostics of infectious diseases. 12 hours

Unit C

Pathogenic bacteria. Staphylococci, Streptococci, Enterococci,

Pathogenic bacteria : Clostridium, Bacteroids, Neissaria, Enterobacteriaceae,

Pathogenic bacteria : Vibrio, Pseudomonas, Haemophilus, Bordotella,

Pathogenic bacteria : Mycoplasma, Legionella, Spirochetes,

Pathogenic bacteria : Mycobacteria, Actinomyces, Nocardia,

Pathogenic bacteria : Chlamydia, Rickettsia, Coxiella, Bartonella, 18 hours

Unit D

Pathogenic fungi, Pathogenesis, immunity and chemotherapy of fungal infection

Sporothrix, Candida, Aspergillus, Cryptococcus, Histoplasma, Pneumocystis

Local and systemic infections. Skin and wound infection, Bone and joint infection.

Upper respiratory tract infections, Lower respiratory tract infection, Enteric infections and food poisoning, Urinary tract infection. 18 hours

60 hours

Reference books

1. Microbiology. Pelczar, M. J., Chan, E. C. S. and Krieg, N. R. Tata McGraw Hill Publishing Company Limited. 5th edition. 1993.
2. General microbiology. Roger Y. Stainer, John L. Ingraham, Mark L. Wheelis and Page R. Painter. Macmillan Press Ltd. 5th edition. 1987.
3. Microbiology-An Introduction. Tortora, G.J., Funke, B. R. and Case, C. L. Benjamin Cummings, Carson, USA. 7th edition. 2001
4. Brock Biology of Microorganisms. Madigan and John M. Martinko, Paul V. Dunlap, David P. Clark. Benjamin Cummings, 12th edition. 2008.
5. Sherris medical microbiology. Kenneth J. Ryan and C George Ray. Macgrew Hill. 4th edition. 2004.

6. Jawetz, Melnick, & Adelberg's Medical Microbiology. Geo F. Brooks, Karen C. Carroll, Janet S. Butel and Morse. Mcgraw Hill. 24th edition. 2007.

Course Title: Clinical Microbiology Lab
Course Code: MIC510

L	T	P	Credits	Marks
0	0	3	2	50

1. Preparation of media. Blood agar, Chocolate agar.
2. Test of hemolysis. α, β hemolysis.
3. Test of motility on agar plate and under microscope.
4. Catalase test.
5. Acid fast staining
6. Giemsa staining
7. Siderophore production detection by chromo azurol sulfate agar.
8. Isolation of pure culture and preservation techniques

45 hours

Course Title: Virology II
Course Code: MIC511

L	T	P	Credits	Marks
2	0	0	2	50

Course Objective: This course is to learn basic and advanced animal virology.

1. Classification, Morphology and Chemistry of Viruses: Virus evolution and classification, properties of viruses, virus structure. 4 **hours**
2. Working with viruses: Techniques for visualisation and enumeration of viral particles, measuring biological activity of viruses, assays for virus estimation and manipulation, characterization of viral products expressed in infected cells, Diagnostic virology, Physical and chemical manipulation of viruses. **5 hours**
3. Virus replication Strategies: Principal events involved in replication: Adsorption, penetration, uncoating nucleic acid and protein synthesis, intracellular trafficking, assembly, maturation and release, viral-host interaction, Host response to viral infection. **5 hours**
4. Replication patterns of specific viruses: Replicative strategies employed by animal DNA viruses. Replicative strategies employed by animal RNA viruses. Identification of virus prototypes associated with different virus replication schemes; Details on important viruses namely Herpesvirus, Poliovirus, Influenza virus, VSV, SV40 and Adeno Virus, Poxviruses, Hepatitis Viruses, coronaviruses, Retroviruses. Subviral pathogens: HDV, Prions, Viroids. **5 hours**
5. Pathogenesis of viral infection: Stages of infection, Patterns of some viral diseases-epidemiology, transmission, infection, symptoms, risk, transformation and oncogenesis, emerging viruses. **4 hours**
6. Anti-viral strategies-prevention and control of viral diseases: Host specific and nonspecific defense mechanisms involved in resistance to and recovery from virus infections. Role of interferon in viral infections. Contributions of various host defence mechanisms in viral infections; Viral Chemotherapy: Nucleoside analogs, reverse transcriptase inhibitors, protease inhibitors, History of vaccines especially smallpox and polio. New methods: subunit vaccines, anti-idiotype and DNA vaccines. **7 hours**

30 hours

Reference books

6. Principles of Virology: Molecular Biology, Pathogenesis and Control of Animal Viruses by S.J. Flint, L.W. Enquist, V.R. Racaniello, and A.M. Skalka 2nd edition, ASM Press, Washington, DC, 2004.
7. Introduction to Modern Virology EPZ by Nigel Dimmock, Andrew Easton and Keith Leppard, 5th edition, Blackwell Publishing, 2005
8. Basic Virology by Edward K. Wanger, Martinez Hewiett, David Bloom and David Camerini, 3rd edition, Blackwell Publishing, 2007.
9. Principles of Molecular Virology by Alan J. Cann, 3rd edition, Elsevier Academic Press, 2001.
10. Plant Virology by Roger Hull, 4th edition, Academic press, 2002.

Course Title: Microbial Genetics
Course Code: MIC601

L	T	P	Credits	Marks
4	1	0	4	100

Course Objective: This course is to learn microbial genetics. This course covers transcription, translation, gene transfer, gene organization and mutation.

Unit-A

Structure of nucleic acids. Replication of DNA.

Chromosome replication and cell division. DNA repair (Mismatch repair, excision repair, recombination, SOS repair.)

Gene expression (Transcription, translation, posttranslational events) 12 hours

Unit-B

Mutation, variation and evolution. Types of mutation. Mechanism of mutation (spontaneous mutation, chemical mutagen, UV irradiation)

Phenotype, Phenotype restoration (reversion, suppression, complementation)

Isolation and identification of mutants (mutation and selection, replica plating, penicillin enrichment, molecular methods) 12 hours

Unit-C

Gene organization. Transcriptional control (terminators, attenuators, anti-terminators, Induction and repression)

Translational control, codon usage

Plasmids, Plasmid replication and stability. 12 hours

Unit-D

Gene transfer: Transformation, Conjugation (F plasmid), Transduction (general and specialized)

Insertion sequence, Transposons, Mechanism of transposition,

Strain development, Generation of variation, Overproduction of primary metabolite, Overproduction of secondary metabolite 12 hours

Genetic methods for investigating bacteria (complementation, cross feeding, reporter genes)

Bacterial virulence, Detection of virulence genes, specific mutagenesis

Gene mapping (conjugational analysis, co-transformation, co-transduction), Gene sequencing, Genome sequencing

Physical and genetic map, Analysis of gene expression 12 hours

60 hours

Reference books

1. Molecular genetics of bacteria. Jeremy W. Dale and Simon F Park. John Wiley and Sons Ltd. 4th edition. 2008.
2. Microbial genetics. Stanley R. Maloy, John E. Cronan and David Freifelder. Jones and Bartlett Publishers. 2nd edition. 1994.
3. Brock Biology of Microorganisms. Madigan and John M. Martinko, Paul V. Dunlap, David P. Clark. Benjamin Cummings, 12th edition. 2008.

Course Title: Microbial Genetics Lab
Course Code: MIC602

L	T	P	Credits	Marks
0	0	3	2	50

1. Preparation of competent cells by chemical method
2. Preparation of competent cells for electroporation
3. Transformation of *Escherichia coli*
4. Plasmid DNA extraction
5. Genomic DNA extraction
6. Transduction of *Escherichia coli* by P1 phage
7. Conjugation mating in *Escherichia coli*
8. PCR amplification of gene from *Escherichia coli* genomic DNA
9. Restriction digestion of DNA
10. Ligation of DNA fragments
11. Blue-white selection cloning of DNA

45 hours

M.Sc. Seminar I

Course Code: MIC551

L	T	P	Credits	Marks
2	0	0	2	50

Seminar Objective:

During the course students will come to know about the general understanding of the most common problems, recent advances in microbiology research. Each student shall be allotted a topic by the instructor. Student will have to understand the topic, collect literature and prepare the presentation. Through this the students will develop habit of reading newer topics, will become inquisitive and develop confidence of presentation and discussion before audience.

The students shall submit a project report on the allotted topic, which shall be evaluated by the concerned internal faculty. He/She then would present a seminar on the concerned topic. The students will be encouraged to explore all available literature as well as the internet to prepare the seminar report and present the same using informative slides made using Power Point or projectors.

Seminar Contents:

Students will present their work on a selected topic with the following headings:

- Title
- Objectives
- Review of Literature
- Materials and Methods
- Results
- Conclusion/recommendations

Examination Scheme:

Literature study/ Fabrication/ Presentation	50
Written Report	25
Question answer session	25
Total	100

M.Sc. Seminar II

Course Code: MIC552

L	T	P	Credits	Marks
1	0	0	1	25

Seminar Objective:

During the course students will come to know about the general understanding of the most common problems, recent advances in microbiology research. Each student shall be allotted a topic by the instructor. Student will have to understand the topic, collect literature and prepare the presentation. Through this the students will develop habit of reading newer topics, will become inquisitive and develop confidence of presentation and discussion before audience.

The students shall submit a project report on the allotted topic, which shall be evaluated by the concerned internal faculty. He/She then would present a seminar on the concerned topic. The students will be encouraged to explore all available literature as well as the internet to prepare the seminar report and present the same using informative slides made using Power Point or projectors.

Seminar Contents:

Students will present their work on a selected topic with the following headings:

- Title
- Objectives
- Review of Literature
- Materials and Methods
- Results
- Conclusion/recommendations

Examination Scheme:

Literature study/ Fabrication/ Presentation	50
Written Report	25
Question answer session	25
Total	100

M.Sc. Seminar IV

Course Code: MIC652

L	T	P	Credits	Marks
2	0	0	2	50

Seminar Objective:

During the course students will come to know about the general understanding of the most common problems, recent advances in microbiology research. Each student shall be allotted a topic by the instructor. Student will have to understand the topic, collect literature and prepare the presentation. Through this the students will develop habit of reading newer topics, will become inquisitive and develop confidence of presentation and discussion before audience.

The students shall submit a project report on the allotted topic, which shall be evaluated by the concerned internal faculty. He/She then would present a seminar on the concerned topic. The students will be encouraged to explore all available literature as well as the internet to prepare the seminar report and present the same using informative slides made using Power Point or projectors.

Seminar Contents:

Students will present their work on a selected topic with the following headings:

- Title
- Objectives
- Review of Literature
- Materials and Methods
- Results
- Conclusion/recommendations

Examination Scheme:

Literature study/ Fabrication/ Presentation	50
Written Report	25
Question answer session	25
Total	100

Project

Course Code: MIC654 **Credit Units: 8**

Guidelines for Training Project:

Research experience is as close to a professional problem-solving activity as anything in the curriculum. It provides exposure to research methodology and an opportunity to work closely with a faculty guide. It usually requires the use of advanced concepts, a variety of experimental techniques, and state-of-art instrumentation. Research is genuine exploration of the unknown that leads to new knowledge which often warrants publication. But whether or not the results of research project are publishable, the project should be communicated in the form of a research report written by the student.

Sufficient time should be allowed for satisfactory completion of reports, taking into account that initial drafts should be criticized by the faculty guide and corrected by the student at each stage.

The file is the principal means by which the work carried out will be assessed and therefore great care should be taken in its preparation.

In general, the File should be comprehensive and include:

- A short account of the activities that were undertaken as part of the project
- A statement about the extent to which the project has achieved its stated goals.
- Assessment about the outcomes of the experimentation processes engaged in as part of the project;
- Any activities planned but not yet completed as part of the project, or as future initiative directly resulting from the project;
- Any problems that have arisen that may be useful to document for future reference.

Report Layout

The report should contain the following components:

- **Title or Cover Page**
  The title page should contain the following information: Project Title; Student' name; Course; Year; Supervisor' name

- **Acknowledgements** (optional)
  Acknowledgement to any advisory or financial assistance received in the course of work may be given

- **Abstract**
  A good abstract should be straight to the point; not too descriptive but fully informative. First paragraph should state what was accomplished with regard to the objectives. The abstract does not have to be an entire summary of the project, but rather a concise summary of the scope and results of the project

- **Table of Contents**
  Title and subtitles are to correspond exactly with those in the text

- **Introduction**
  Here brief introduction to the problem that is the central to the project and an outline of the structure of the rest of the report should be provided. The introduction should aim to catch the imagination of the reader, so excessive details should be avoided.

- **Materials and Methods**
  This section should aim at experimental designs, materials used. Methodology should be mentioned in details including modification if any.

- **Results and Discussion**
  Present results, discuss and compare these with those from other workers etc. In writing these section, emphasis should be given on what has been performed and was achieved in the course of the work, rather than discuss in detail what is readily available in the text books. Avoid abrupt

changes in the contents from section to section and maintain a lucid flow throughout the thesis. An opening and closing paragraph ins every chapter should be included in a smooth flow.
Note that in writing the various sections, all figures and tables should as far as possible be next to the associated text, in the same orientation as the main text, numbered, and given appropriate titles or captions. All major equations should also be numbered and unless it is really necessary never write in "point" form.

- **Conclusion**
  A conclusion should be the final section in which the outcome of the work is mentioned briefly.
  Future Prospects
- **Appendices**
  The appendix contains material which is of interest to the reader but not an integral part of the thesis and any problem that have arisen that may be useful to document for future reference.
  References
  This should include papers and books referred to in the body of the report. These should be ordered alphabetically on the authors surname. The titles of the journals preferably should not be abbreviated; if they are, abbreviations must comply with an internationally recognized system.

Examples
For research article
Voravuthikunchai, SP, Lortheeranuwat, A, Ninrprom, T. Popaya, W, Pongpaichit Sanjay, Supawita T.(2002) Antibacterial activity of Thai medicinal plant against enterohaemorrhagic *E.coli* 157:H7.Clin Microbiol Infect, 8(SUPPL 1):116-117

For Book
Kowalski, M.(1976) Transduction of effectiveness in Rhizobium Meliloti. SYMBIOTIC NITROGEN FIXATION PLANTS (editor P.S. Nutman IBP), 7:63-67

ASSESSMENT OF THE PROJECT FILE
Essentially, marking will be based on the following criteria: the quality of the report, the technical merit of the project and the project execution.
Technical merit attempts to assess the quality and depth of the intellectual efforts put into project.
The file should fulfil the following assessment objectives:

Range of Research Methods used to Obtain Information
Execution of Research
Data Analysis
Analyse Quantitative/Qualitative information
Control quality
Draw Conclusions

Assessment Scheme:

Continuous Evaluation: 40% (Based on punctuality, regularity of work, adherence to plan and methodology, refinements/mid-course corrections etc. as reflected in the Project File)

Final Evaluation: 60%(Based on the documentation in the file, Final report layout, analysis and results, achievements of objectives, presentations/viva)

Paper: Plant Physiology

Code: BOT517

L	T	P	Credits	Marks
4	0	0	4	100

Objective:
To acquaint the students about various physiological processes at cellular and organ level in plants.

Teaching Methodology:
Class room Lectures, practicals, models, charts, power point presentations.

Learning outcomes
The students will come to know the how a plant cell responds to various biotic and abiotic stresses, defense mechanism in plants, events of seed and fruit development, and the various physiological roles of plant hormones.

Instruction for candidates:

- The question paper for end-semester examination will have a weightage of 25%. It will consist of 100 objective questions of equal marks. All questions will be compulsory.
- Two preannounced test will be conducted having a weightage of 25% each. Each preannounced test will consist of 20 objective type, 5 short questions/problems on the UGC-NET (objective type) pattern as well as one long answer type question. The student is expected to provide reasoning/solution/working for the answer. The candidates will attempt all question. Choice will be given only in long answer type. The question paper is expected to contain problems to the extent of 40% of total marks.
- Four objective/MCQ type surprise test will be taken. Two best out of four objective/MCQ type surprise test will be considered towards final each of 12.5% weightage to the final. Each surprise test will include 20-25 questions.
- The books indicated as text-book(s) are suggestive However, any other book may be followed.

UNIT-I

Membranes: Recent concepts of structure and composition of membrane; Various classes of pumps; Ion channels; regulation of Transport; Mechanism of sorting; and their significance;

Electrical properties of membranes. **(6 Lectures)**

Photosynthesis: Energy pathways in photosynthesis; Composition and characterization of photosystem-I and -II; molecular basis of electron flow through cyclic, non-cyclic and pseudo-cyclic photophosphorylations, Biochemical events and regulation of CO2 fixation (C3, C4 and CAM); Mechanism of and regulation of photorespiration; RUBISCO as an example of model enzyme for semi-autonomy at the molecular level.

(10 Lectures)

UNIT-II

Stress physiology: Plant responses to abiotic stresses, mechanisms of abiotic stress tolerance, water deficit and drought tolerance, salinity stress, metal toxicity, freezing and heat stress.

(6 Lectures)

Oxidative and nitrosative stress and antioxidative strategies: Nitrosative and oxidative stress - causes and effects, nitric oxide biosynthesis and metabolism, NO mediated signaling, markers of nitrosative stress, NO crosstalk with other hormones, antioxidant mechanisms. **(5 Lectures)**

Secondary metabolites and their biotechnological aspects: Natural products (secondary metabolites), their range and ecophysiological functions. Overview of terpenoidal, alkaloidal, and phenolic metabolites, their biosynthesis and functions. **(3 Lectures)**

UNIT-III

Plant Respiration: Detailed mechanism; Glycolysis and TCA cycle Mitochondria as biological oxidators; Chemiosmatic regeneration of ATP; CN- resistant respiration and metabolic inhibitors regulating the respiration.

(5 Lectures)

Physiology of seed development, maturation, dormancy and germination: Hormonal regulation of seed development, events associated with seed maturation, factors regulating seed dormancy, mechanisms of mobilization of food reserves during seed germination.

(5 Lectures)

Fruit development and ripening: Stages of fruit development and their regulation, biochemical and related events during fruit ripening in climacteric and non-climacteric fruits, physiology and biochemistry of fruit abscission, post-harvest changes, production of transgenic fruits.

(6 Lectures)

UNIT-IV

Sensory physiology: Phytochromes and cryptochromes; Biochemical and biophysical mechanisms of sense of touch, electric self-defense, taste, light, explosion, sleeping and

rhythms; neurotransmitters in plants. **(4 Lectures)**

Plant Hormones: Physiological effects and molecular mechanism of action of auxins, gibberellins, cytokinins, ethylene, abscissic acid, jasmonic acid, brassinosteroids, polyamines, salicylic acid. **(10 Lectures)**

Suggested Readings

1. Wilkins M.B. Advanced Plant Physiology, Pitman, New York, 1984.
2. Bonner B. and Varner J.E. Plant Biochemistry, Academic Press, London, 1976.
3. Taiz L. and Zeiger E. Plant Physiology. The Benjamin/Cumming Publishing Company, California, 1998.
4. Stryer L. Biochemistry (4th Edition), W.H., Freeman and Co., New York, 1995.
5. Voet D. and Voet, J.G. Biochemistry, John Wiley and Sons Inc., New York, 1995.
6. Srivastava, A.K. Plant Growth and Development, Associated Press, 2002.

Paper: Plant Physiology Lab

Code: BOT518

L	T	P	Credits	Marks
0	0	3	2	50

1. Determination of Chlorophyll a and Chlorophyll b ratio in C3 and C4 plants.
2. Spectroscopic determination of Chlorophyll a, Chlorophyll b, Carotenoids and
3. Anthocyanin under varied environmental conditions.
4. Effect of environment factors on seed germination.
5. Experimental study of hormonal effects in plant material
6. Experimental study of stress physiology.

45 hours

DAV UNIVERSITY, JALANDHAR

Course Title: Recombinant DNA technology

Course Code:BTY551

L	T	P	Credits	Marks
4	0	0	4	100

Course objective: The basic objective of the paper is to present the principles of gene manipulation and its associated technologies. How developments in gene manipulation have revolutionized medicine, agriculture and health.

1. Introduction and scope of Recombinant DNA Technology. **2 hour**
2. DNA modifying enzymes- Terminal deoxynucleotidyl transferase, Polynucleotide kinase, Alkaline phosphatase, Nucleases, Methylases, Ligases- *E. coli* and T4 DNA ligases, Linker, Adaptor, Homopolymer tailing, Restriction Endonucleases. **8 hours**
3. Isolation and Purification of nucleic acid: Basic techniques and considerations criteria of purity, isolation and purification of phage DNA plasmid, chromosomal DNA, RNA and mRNA. **4 hours**
4. Cloning and expression vector: Characteristics of cloning and expression vectors; plasmid, phage and cosmid vectors, multipurpose cloning vectors, shuttle vectors; bacterial, yeast, plant and mammalian expression vectors. **10 hours**
5. Cloning and expression hosts: Characteristics of cloning and expression host, bacterial, yeast, plant and mammalian host systems for cloning and expression of genes. **4 hours**
6. DNA Cloning Strategies: Preparation of genomic and cDNA libraries, criteria for selection of cloning vectors - plasmid, bacteriophage and cosmid, transformation and transfection, electroporation, screening of gene library and selection of clone. **6 hours**
7. Nucleic acid Blotting and Hybridization: Southern and northern blotting and hybridization techniques, radioactive and non-radioactive labeling of probe, western blotting. **4 hours**
8. Expression of cloned genes :Expression of cloned genes in *E. coli*, *Bacillus subtilis*, s*treptomyces*, yeast and mammalian cells, detection and analysis of proteins expression from cloned genes. **8 hours**

9. Protein-Protein interactions-Phage display (*in vivo*, *in vitro* and *in planta*, Yeast two hybrid system, Yeast three hybrid system. Bicomplementation and Florescence Resonance Energy Transfer (FRET). **3 hours**
10. Polymerase chain reaction and site directed mutagenesis: Principle and application of polymerase chain reaction, random mutagenesis, site-directed mutagenesis and protein engineering. **4 hours**
11. Impact of rDNA on human genetics: Mapping & cloning of human disease genes, DNA based diagnosis, gene targetting, human genome project history and scope. **4 hours**
12. Applications of r-DNA technology in industry, agriculture and forensic science. **3 hours**

Books:

1. Gene cloning and DNA analysis – An Introduction (2006) 5th edition, T.A. Brown, Blackwell publisher.
2. Genetic Engineering. An Introduction to gene analysis and exploitation in eukaryotes (1998), S.M. Kingsman and A.J. Kingsman, Blackwell Scientific Publications, Oxford.
3. Molecular Cloning : A Laboratory Manual (2000), J. sambrook, E.F. Fritsch and T.Maniatis, Cold Spring Harbor Laboratory Press, New York.
4. Molecular Biotechnology-Principles and Applications of Recombinant DNA (2003) 3rd edition, Bernard R Glick and Jack J pasternak. ASM press, Washington.
5. Principles of Genetic Engineering (2009), Mousumi Debnath, pointer publisher, Jaipur.

Principles of gene manipulation and Genomics (2006) 7th edition, S.B Primose and R.M Twyman, Blackwell publishing.

Course Title: Recombinant DNA technology-LAB

Course Code:BTY555

L	T	P	Credits	Marks
0	0	3	2	50

- Preparation and purification of pUC plasmid.
- Preparation and purification of genomic DNA
- Restriction digestion of plasmid and genomic DNA and gel electrophoresis.
- Gene cloning
- Bacterial transformation
- Southern blotting and hybridization with non-radioactive probes.
- Amplification of DNA with PCR Temperature cycler.

Course Title: Molecular Biology

Course Code:BTY502

L	T	P	Credits	Marks
4	1	0	4	100

Course Objective: A comprehensive knowledge of molecular aspects of biological function at the molecular level, particular emphasis on the structure and regulation of genes, as well as, the structure and synthesis of proteins and applications of these concepts in human medicine and health, agriculture, study evolution and other areas.

1. Introduction to molecular biology, basic techniques in molecular biology. DNA and its various forms, super coiling of DNA, DNA melting, repetitive sequences, cot and rot curves, C value paradox, DNA protein interaction, DNA super coiling. Prokaryotic & eukaryotic DNA replication, enzymes and accessory proteins involved in DNA replication, replication origin & replication fork, fidelity of replication, extrachromosomal replicons, DNA damage and repair mechanisms, gene amplification, mobile genetic elements, homologous and site specific recombination. **12 hours**
2. Prokaryotic and eukaryotic transcription, RNA polymerase, transcription factors, regulatory elements, transcriptional activator, repressor & mechanism of transcription regulation, post-transcriptional processing of mRNA, rRNA & tRNA. **12 hours**
3. Protein synthesis and processing: Ribosome structure, genetic code, prokaryotic & eukaryotic translation, the translation machinery, mechanism and regulation of translation & translation proof-reading, translational inhibitors, Post-translational modification of proteins and intracellular protein targeting, import into nucleus, mitochondria and peroxisome. **10 hours**
4. Control of gene expression at transcription and translation level (regulating the expression of phages, viruses, prokaryotic and eukaryotic genes, role of chromatin in gene expression and gene silencing). Cell signaling: signal transduction pathways and their regulation. **10 hours**
5. Genome sequencing: Genome sizes, organelle genomes, genomic libraries, YAC, BAC libraries, and strategies for sequencing genome, packaging, transfection and recovery of clones, application of sequence information for identification of defective genes. **8 hours**

6. Photoregulation and phytochrome regulation of nuclear and chloroplastic gene expression. Molecular mechanism of nitrogen fixation. Molecular biology of various stresses, viz. abiotic stresses like drought, salt, heavy metals and tempreture; and biotic stresses like bacterial, fungal and viral disease. Signal transduction and its molecular basis, molecular mechanism of plant hormone action mitochondrial control of fertility, structure, organization and regulation of nuclear gene concerning storage proteins and starch synthesis. **8 hours**

Books:

1. Molecular cell biology (2008) by Harvey F. Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger, Matthew P. Scott, Anthony Bretscher (W.H.Freeman).
2. Genes IX (2008) by Benjamin Lewin (Jones and Bartlett Publishers).
3. Molecular cloning: A laboratory manual (2000) by J. Sambrook, E.F.Fritish and T. Maniatis (Cold Spring Harbor Laboratory Press,New York).

Course Title: Molecular Biology-LAB

Course Code:BTY506

L	T	P	Credits	Marks
0	0	2	1	25

- Isolation of genomic DNA from bacteria.
- Isolation of genomic DNA from plant.
- Isolation of total RNA from tissue.
- Demonstration of DNA protein interaction.
- Quantitation of nucleic acids and proteins.
- Gel electrophoresis:
    - Nucleic acid
    - Protein

DAV UNIVERSITY, JALANDHAR

Course Title: Biostatistics

Course Code:BTY553

L	T	P	Credits	Marks
4	1	0	4	100

Course objective: The course aims to develop expertise in the application of statistical methods applied to biological data obtained in experimental findings.

1. Brief description and tabulation of data and its graphical representation. Measures of Central Tendency (Mean, Median, Mode), Measures of dispersion (Range, Mean Deviation, Standard Deviation, Quartile Deviation), combined mean and variance, covariance, Graphs (Bar Chart, Pie Chart, Box Plot, Histogram, Ogive, scatter plot) Probability: Experimental probability, probability when outcomes are equally likely, subjective probabilities. **12 hours**
2. Probability (Addition and Multiplication Theorem), Bayes theorem, Binomial, Poisson and Normal distribution. Correlation and linear regression **8 hours**
3. Random variables and distributions, Discrete and continuous random variables, Cumulative distribution function, Probability mass function and probability, Density function, Expectation of random variable– experimental Approach and theoretical approach. **10 hours**
4. Formulation of Hypothesis (One-tailed & Two-tailed), Type I and Type II errors, power of a test, Significance of a test, P-value testing, Hypothesis Testing (students T-test, Chi-square test). Analysis of variance (ANOVA) one and two way. Pearson correlation test. **8 hours**
5. Biological experimental designs- CRD, RBD, factorial designs, latin square designs. **6 hours**
6. Application of statistics biological experimental design: Data collection and explanation and conclusion case studies. **8 hours**
7. Sampling theory and different techniques,Applications of statistical methods using statistical software , SAS. **8 hours**

Books:

- Biostatistics: A foundation for analysis in the Health Sciences, W.W Daniel. Publisher: John Wiley and Sons.
- Biostatistics, P.N Arora and P.K Malhan. Publisher: Himalaya Publishing House.

- Introduction to Biostatistics, Ronald N. Forthfer and Eun Sun Lee .Publisher: Elsevier.
- Biostatistics: A foundation for analysis in the Health Sciences, W.W Daniel. Publisher: John Wiley and Sons.
- Statistical Methodology, S.P Gupta. Publisher: S.Chand & Co.
- Biostatistics: A manual of Statistical Methodology for use in Health, Nutrition and Anthropology, K. Visweswara Rao. Publisher: Jaypee Brothers.

Course Title: Biostatistics – LAB

Course Code:BTY557

L	T	P	Credits	Marks
0	0	3	2	50

- Experiments based on measures of central tendency.
- Experiments based on measures of dispersion.
- Experiments based on analysis of data obtained in lab for different biological experiments
- Questions based on various distributions like Binomial, Poisson, Bernoulli.
- Practical on question of probability.
- Practical based on hypothesis testing.
- Biological experimental designs- CRD, RBD, factorial designs, latin square designs.

Course Title: Genomics, Proteomics and Metabolomics

Course Code:BTY652

L	T	P	Credits	Marks
4	1	0	4	100

Course Objective: The aim of the course is to provide students practical and bioinformatical skills in genomics, transcriptomics, proteomics and metabolomics, knowledge and the notion about how the methods are applied in real-life scientific research.

1. Introduction to –omes and –omics. Gene, Genome and Genomics. **2 hour**
2. Whole genome analysis: Preparation of genomic library in vectors, ordered cosmid libraries, BAC libraries, shotgun libraries. Genome analysis for global patterns of gene expression using fluorescent-labelled cDNA or end-labelled RNA probes. **6 hours**
3. FISH, Sequencing: Conventional sequencing (Sanger, Maxam and Gilbert methods), automated sequencing, analysis of sequence information FISH. Analysis of single nucleotide polymorphism using DNA chips. **4 hours**
4. Transcriptomics. Microarray, EST, SAGE. Bioinformatical methods in ranscriptomics.

   Application of transcriptomics. Genome sequencing projects (technology of sequencing and assembly, bioinformatics of genome annotation, current status of genome sequencing projects) Genomic browsers and databases Orthology prediction (comparative genomics), Search for transcription factor binding sites (TFBS), Computational prediction of miRNA target genes *De novo* prediction of regulatory motifs in genome, Single nucleotide polymorphisms (SNP) in medical genetics and basic research. **10 hours**
5. Next generation sequencing using new technologies. Alignment of pairs of sequences of DNA and proteins. Multiple sequence alignment. Searching databases for similar sequences. Phylogeny: Different approaches to tree construction. Analyze sequences and its role in understanding the evolution of organisms and genes. **6 hours**
6. **Proteomics.** Aims, strategies and methods. Bioinformatics tools in proteomics. Application of proteomics. Protein microarrays. Proteomics technologies: 2D-electrophoresis, MALDI-TOF mass spectrometry, yeast 2-hybrid system. Protein-

protein interactions: experimental and computational methods, databases. **8 hours**

7. Types of data and databases, quality of annotation. Protein structure prediction. The proteome. High throughput proteomics and its use to the biologists. **4 hours**
8. Novel approaches to protein expression analysis: Scope of functional proteomics. Proteome analysis: 2DE based strategy. Alternatives to 2DE for protein expression analysis. **5 hours**
9. Application of proteome analysis to drug development and toxicology: Basic principle and making use of the data. **4 hours**
10. Protien-DNA interactions. Cancer profiling using DNA microarrays. Proteomics as tool for plant genetics and breeding. **5 hours**
11. Introduction to metabolomics. Technologies in metabolomics. Nutrigenomics. Nuclear Magnetic Resonance Spectroscopy and Mass Spectrometry in metabolomics.

    Metabolic pathways resources: KEGG, Biocarta. Nutrigenomics and metabolic health. Solved problems and future challenges. **6 hours**

Books:

1. A primer of genome science (2009) by Gibson G. and Muse S. V., (Sinauer Associates, Inc. Sunderland, MA).
2. Knowledge discovery in proteomics (2006) by Igor Jurisica, Dennis Wigle (Chapman & Hall / CRC).
3. Proteomics: From protein sequence to function (2002) edited by Pennington SR, Dunn M. J. (Viva Books Pvt. Ltd).
4. Informatics in proteomics (2005) edited by Srivastava Sudhir (Taylor & Francis Group / CRC).
5. Genomics and proteomics engineering in medicine and biology (2007) edited by Akay M. (Wiley-Interscience John Wiley & Sons, Inc. Publication, USA).
6. Essentials of genomics and bioinformatics (2002) by Christoph W. Sensen (Wiley-VCH, Weinheim).
7. Current protocols in bioinformatics (2004) by Baxevanis A.D., Davison, D.B., Page, R.D.M. & Petsko, G.A (John Wiley & Sons, Inc. Publications, New York).

Course Title: Genomics, Proteomics and Metabolomics-LAB

Course Code: BTY656

L	T	P	Credits	Marks
0	0	3	2	50

- Site directed mutagenesis. Deleting a DNA sequence from a plasmid and introduction into *E. coli.*
- Functional validation of gene expression.
- Analysis of mutants using Southern blot and PCR analysis.
- Introduction to DNA sequencing.

Course Title: Animal Physiology
Course Code: ZOO502

L	T	P	Credits	Marks
4	1	0	4	100

Course Objective: The students will learn physiological aspects of body processes at system, organ, tissue and cellular level as well as their regulation.

Unit A 17 hours

- **Nutrition**: Sources, functions and deficiency disorders of micro- and macro-nutrients.
  Digestion: Functional structure of digestive glands- salivary glands, pancreas, liver, gastric and intestinal wall glands- neural and hormonal regulation of secretion of digestive juices. Digestion of food nutrients in different parts of the alimentary canal in animals. Absorption of food- the molecular structure of the absorptive surface. Assimilation of food, egestion. The peristaltic movements, their regulation and significance. Energy balance, BMR
- **Respiration:** Types of respiration, comparison of respiration in different species-anatomical considerations, breathing mechanisms, alveolar ventilation and gaseous exchange in lungs- the respiratory membrane, transport of gases by the blood, oxygen-haemoglobin dissociation curve. Transport, dissociation and liberation of CO_2, chloride shift, cellular respiration and oxidation. Respiratory pigments and their oxygen carrying capacity. Neural and chemical regulation of respiration and respiratory quotient. Respiration during exercise and at high altitude

Unit B 15 hours

- **Blood and Circulation**: Blood corpuscles, haemopoiesis and formed elements, plasma functions, blood volume and its regulation, blood groups, haemoglobin, immunity, blood coagulation, haemostasis. Physiological and comparative anatomy of heart, blood vessels and lymphatic system. Cardiac musculature- specialized tissue and conduction system of the heart- myogenic and neurogenic heart- as a pump, ECG and its significance. Cardiac cycle, heart beat, heart sounds, cardiac output, blood pressure and their neural and chemical regulation. .
- **Excretion:** Functional anatomy of kidney-the nephron and its functions, the mechanism of urine formation and its concentration- the countercurrent theory,electrolyte balance Acid-base balance. The feedback and hormonal control of renal functions.Micturition. Comparative physiology of excretion of nitrogenous waste products.
- **Osmoregulation:** Mechanisms of water and salt balance in aquatic (freshwater, brackish and marine), migratory and terrestrial animals and its hormonal regulation.

Unit C 18 hours

- **Musculature**: Types of muscles, Fine structure of skeletal muscle fibre and its chemical composition, molecular mechanism of muscle contraction (sliding-filament theory). Electric organs in fishes.
- **Neurophysiology:** Neural structure- its types, neuroglia and blood-brain barrier. Resting potential, generation of action potential and its propagation-role of Na+-K+ and Ca++pumps, conduction of nerve impulse, myelination and saltatory conduction, neurotransmitters and mechanism of synaptic

transmission, summation of excitatory and inhibitory nerve impulses and their computation. Properties of a reflex and its types. Gross neuroanatomy of the brain and spinal cord, central and peripheral nervous system, neural control of muscle tone and posture. Electrophysiological methods: Single neuron recording, patch-clamp recording, EEG- Brain activity recording, lesion and stimulation of brain, pharmacological testing, PET, MRI, fMRI, CAT.

- **Special Senses:** Physiology of vision- molecular and cellular structure of retina, colour blindness and other vision defects, Hearing and equilibrium and senses of smell, taste and touch.

Unit-D 10 hours

- **Endocrine Regulation**: Structure and functions of pituitary gland, thyroid, parathyroid, adrenals, Islets of Langerhans and their neuroendocrine regulation- the feedback mechanism. Chemical nature of hormones. Autocrine, paracrine and juxtacrine regulation. Mechanism of hormone action. Stress physiology.
- **Reproduction**: Reproductive patterns in animals, Hypothalamo-hypophyseal gonadal regulation. Structure and hormonal functions of gonads, Gametogenesis, hormonal regulation of ovulation, fertilization and implantation, pregnancy, parturition and lactation.

Reference books:

1. Wood DW. Principles of Animal Physiology. Hodder Arnold. 3rd edition.
2. Wison JA. Principles of Animal Physiology. Prentice Hall College Div. 2nd edition. 1979.
3. Prosser CL, Bishop DW. Comparative Animal Physiology. Philadelphia Saunders.1950.
4. Singh HR and Kumar N. Animal Physiology and Biochemistry. Vishal Publishing Co.
5. Schmidt-Nielsen K. Animal Physiology: Adaptations and Environment. Cambridge University Press; 5 edition. 1997.
6. Randall D, Eckert R, Burggren W, French K. Eckert Animal physiology: Mechanisms and Adaptations. WH Freeman & Co. 1997.
7. Guyton, A.X., Text Book of Medical Physiology, 7th edition, Saunders Company, 1986.
8. Best, J.P., Best and Taylor's physiological basis of medical practice,11th ed., William and Wilkins, 1985.
9. Hoar, W.S., General and comparative physiology, Adaptation and Environment ,3rd ed., Cambridge University Press, 1983.
10. Rhoades, R.A., Tanner, G.A., Medical Physiology, 2nd ed., Lippincott Williams and Wilkins, 2003.

Course Title: Animal Physiology Lab
Course Code: ZOO507

L	T	P	Credits	Marks
0	0	1	2	50

- Demonstration of activity of digestive enzymes (Amylase, Protease, Lipase).
- Haematological Tests-PVC, DLC, TLC, RBC and WBC count, Haemoglobin estimation.
- Measurement of blood pressure and pulse, bleeding and clotting time in human. Preparation of human blood film. Study of different types of blood cells, TLC, DLC
- Demonstration of pneumostastic recording of respiratory movements.
- Demonstration of oxygen uptake by pipette manometer.
- To study the effect of exercise on cardiovascular and respiratory system.
- To study the effect of insulin on blood glucose level of rat.
- To prepare the vaginal smears of mice and identify the stage of estrous cycle.
- To study the histology of different organs and endocrine glands.

Note: Practicals related to Animal Physiology Lab are in accordance with UGC guidelines and have been approved by Dissection Monitoring Committee.

Course Title: Microbial Biochemistry
Course Code: BCH502

L	T	P	Credits	Marks
4	0	0	4	100

Course Objectives: The course introduces students to biochemical concepts relevant to microbial physiology and metabolism.

Unit A (15 hours)

Types of microorganisms, general characteristics of main groups of microorganisms. Criteria used in classification of microorganisms – cytology, genetics, host specialization, serology, different phases of growth.

Unit B (15 hours)

Nutrition, physiology and growth of microbial cells.

Gram-positive and Gram-negative organisms. Structure and function of peptidoglycan in gram-positive and gram-negative organisms. Functions of polymeric components in outer membrane and acidic polymers in gram-negative organisms.

Special features of bacterial metabolism.

Unit C (15 hours)

Food spoilage, fermentation, food-borne infection.

Role of microorganisms in domestic and industrial sewage.

Microbiological standards.

Unit D (15 hours)

Virus structure, virus proteins, virus classification and methods of assay.

Replication of RNA viruses – negative strand (VSV), positive strand (polio), retroviruses (to include all events in the infectious cycle)

Replication of DNA viruses (Adenovirus or SV40)

Virus-host interaction

Vaccines and prevention – smallpox/polio/AIDS

Recommended Books:

1. White, D., Dummond, J., and Fuqua, C. (2009) The Physiology and Biochemistry of Prokaryotes. Oxford University Press, 4th edition.

2. Nelson, D.L. and Cox, M.M. (2009). Lehninger`s Principles of Biochemistry, W.H. Freeman and Company, New York.

3. Stanier R. Y., Adelberg E. A., Ingraham J. L., (1976) General Microbiology, 4th edition, Macmillan Press, London.

4. Madigan, MT, Martinko, JM, Stahl, DA and Clark, DP. (2011) Biology of microorganisms, 13th edition. Benjamin Cummings, USA.

Course Title: Microbial Biochemistry Laboratory
Course Code: BCH504

L	T	P	Credits	Marks
0	0	2	1	25

Experiments:

1. Preparation and sterilization of culture media

2. Simple staining, gram staining, endospore staining and capsule staining.

3. Preparation of bacterial growth curve.

4. Estimation of viable cells in a bacterial suspension.

5. Determination on minimum inhibitory concentration (MIC) of antibiotic.

6. Isolation of microorganisms from air and soil

7. Bacteriological analysis of water – (1) presumptive test, (2) confirmed test, (3) completed test.

8. Biochemical tests of bacteria: - indole production. Tests for catalase, protease, amylase and oxidase. Starch hydrolysis test. Methyl red test.

Course Title: Advanced Enzymology
Course Code: BCH507

L	T	P	Credits	Marks
2	0	0	2	50

Course Objective: The course is an advanced treatment of enzymology and covers specialized techniques used to investigate enzyme mechanism, various types of enzyme reactions and enzyme kinetics.

Unit A (7 hours)

Enzyme diversity: concept of convergent and divergent evolution of enzymes, kinetics of multi substrate enzyme catalyzed reactions: classification, kinetics of multisubstrate reactions, derivation of rate of expression for ordered, ping-pong and Bi-Bi reaction mechanisms, investigation of reaction mechanism by using initial velocity, inhibition and isotope exchange studies.

Unit B (8 hours)

Methods of measuring enzymatic rate constants and their magnitude: Rapid mixing and sampling techniques, relaxation methods, absolute concentration of enzymes, sigmoidal kinetics: cooperativity phenomenon for protein ligand binding, symmetric & sequential models for action of allosteric enzymes and their significance, Hill and Scatchard plots.

Unit C (10 hours)

Identification of active site of enzymes: by trapping of enzyme-substrate complex, use of substrate analogues, enzyme modification by chemical procedures affecting amino acid side chains, treatment with proteases and site-directed mutagenesis, by studying the effect of changing pH. A brief account of investigation of three dimensional structure of active site, structures & mechanisms of selected enzymes: the dehydrogenases, the proteases, ribonuclease and lysozyme.

Unit D (5 hours)

Enzyme turnover: kinetics of turnover, methods for measuring rates of enzymes turnover, correlation between rates of turnover and the structure and functions of enzymes, mechanism of enzyme degradation, significance of enzyme turnover.

Books Recommended:

1. T. Palmer and P. Bonner, Enzymes: Biochemistry, Biotechnology and Clinical Chemistry, 2nd Ed.(2008), Affiliated East-West press Pvt. Ltd. New Delhi

2. Nicholas C. Price and Lewis Stevens, Fundamentals of Enzymology, 3rd Ed. Oxford Science publications

3. Alan Fersht, Enzyme Structure and Mechanisms, W. M. Freeman & Company New York.

Course Title: Advanced Enzymology Laboratory

L	T	P	Credits	Marks
0	0	2	1	25

Course Code: BCH508

Experiments:

1. Assay of enzyme activity

2. Isolation and purification of urease

3. Time course of enzymatic reaction

4. Influence of substrate concentration on the rate of enzymatic reaction

5. Effect of pH and temperature on the rate of enzyme reaction

6. Specificity of enzyme action

7. Inhibition of enzyme activity. Determination of Ki values

8. Molecular weight determination of enzyme by gel filtration

9. Isozyme detection

10. Immobilization studies:

(a) Preparation of urease entrapped in alginate beads and determination of percent entrapment

(b) Study of the kinetics of the rate of urea hydrolysis by urease entrapped alginate beads

(c) Study of reusability and storage stability of urease entrapped alginate beads

(d) Immobilization of urease by covalent attachment to solid support.

L	T	P	Credits	Marks
4	1	0	4	100

Course Title: Bioanalytical Techniques
Course Code: BCH501

Course Objective: The course introduces students all the major bioanalytical techniques relevant to students of biochemistry. It covers the theoretical aspects of various techniques, along with their instrumentation and applications.

Unit A (20 hours)

Spectroscopy – Concepts of spectroscopy, Visible and UV spectroscopy, Laws of photometry. Beer-Lambert's law, Principles and applications of colorimetry, Fluorescence Spectroscopy.

Chromatography – Principles of partition chromatography, paper, thin layer, ion exchange and affinity chromatography, gel permeation chromatography, HPLC and FPLC

Unit B (20 hours)

Centrifugation – Principles of centrifugation, concepts of RCF, different types of instruments and rotors, preparative, differential and density gradient centrifugation, analytical ultra-centrifugation, determination of molecular weights and other applications, subcellular fractionation.

Mass Spectrometry – Principle of MS, ionization modes, equipment, MS of proteins/peptides, interface of MS with other methods – MS/MS, LC/MS, and GC/MS, peptide mapping, post-translation modification analysis of proteins, protein sequencing by MS.

Unit C (10 hours)

Electrophoretic techniques – Principles of electrophoretic separation. Continuous, zonal and capillary electrophoresis, different types of electrophoresis including paper, cellulose, acetate/nitrate and gel. Electroporation, pulse field gel electrophoresis.

Immunochemical techniques – Making antibodies, Immunoassay formats, Immunomicroscopy, Lateral flow devices, Epitope mapping, Immunoblotting, Fluorescent activated cell sorting (FACS), Cell and tissue staining techniques, Immunocapture, polymerase chain reaction (PCR) Immunoaffinity chromatography (IAC), Antibody-based biosensors, Therapeutic antibodies

Unit D (10 hours)

Bioinformatics – Overview, Sequence databases – DNA, protein, genome, EST and SNP databases, BLAST programs, ClustalW, Tertiary protein structure databases, PDB, Rasmol, Pymol and Swiss-PDB viewer, Homology modeling.

Recommended books:

1. Physical Biochemistry – Principles and Applications – 2nd Edition – David Sheehan, Wiley-Blackwell (2009).
2. Analytical Biochemistry – 3rd Edition – David Holme and Hazel Peck, Pearson Education Ltd. (1998)

Course Title: Bioanalytical Techniques Laboratory

L	T	P	Credits	Marks
0	0	3	2	50

Course Code: BCH503

Experiments:

1. Titration of a weak acid using a pH meter, preparation of buffers

2. Verification of Beer-Lambert's law and determination of absorption coefficients

3. Paper chromatography – Separation of amino acids and carbohydrates in a mixture

4. Thin layer chromatography of fatty acids

5. Column chromatography – Separation of a mixture of proteins and salt using Sephadex column

6. Electrophoresis