SYLLABUS FOR TWO YEAR FULL TIME MASTER IN MICROBIOLOGY 2021-2023

SCHOOL OF LIFE & ALLIED SCIENCE
ITM UNIVERSITY, RAIPUR

Programme: M.Sc. in Microbiology **Session 2021-23**

Programme Educational Objectives:

1. The student shall become a professional microbiologist.

2. The student shall become a researcher in the field of microbiology.

3. The student shall become an entrepreneur or a consultant or a freelancer in the area of microbiology.

Programme Outcome:

A student shall have:

1. An ability to apply the fundamental knowledge of microbial physiology, microbial genetics & molecular biology in the area of microbiology.
2. An ability to design and conduct experiments, as well as analyse and interpret the results.
3. An ability to learn and develop skills to analyse microbiology related problems, especially of those related to the environmental, social, political, ethical, health and safety, manufacturability and sustainability.
4. An ability to function in multidisciplinary teams.
5. An ability to identify, formulate and solve problems in the area of microbiology.
6. An understanding of professional and ethical responsibility in the field of microbiology.
7. An ability to communicate effectively in scientific reasoning and data analysis in both written and oral forms.
8. The broad education necessary to understand the impact of solutions in a global, economic, environmental and societal context.
9. A recognition of the microbial diseases for integrated management and an ability to engage in lifelong learning in the area of biochemistry.
10. A knowledge of contemporary issues related to food, agricultural, environmental and health.
11. An ability to use the techniques, skills and modern professional tools necessary for professional practice and for research.
12. An ability to apply the relevant knowledge and managerial skills to manage the project of multidisciplinary nature.

Program Specific Objectives:

1. Students shall be able to identify, characterize & solve the problems of infectious diseases in the area of medical microbiology.

2. Students shall be able to conduct the fermentation technology experiments as well as to analyse & interpret the results.

3. Students shall be able to use the analytical techniques for disease diagnosis & analysis of biomolecules.

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COURSE STRUCTURE FOR M.Sc. MICROBIOLOGY (2021-2023)

SEMESTER – I

Sl No.	Category	Subject Code	Subject Name	Hours Per week		C	Examination Scheme				
				L	P		Theory Marks		Practical Marks		Total
							CCE	ESE	CCE	ESE	
1	Core Course	MSMBT101CO	Virology	5	-	4	30	70	-	-	100
2	Core Course	MSMBT102CO	Biomolecules	5	-	4	30	70	-	-	100
3	Core Course	MSMBT103CO	Immunology	5	-	4	30	70	-	-	100
4	Discipline Specific Elective-1 (Any one)	MSMBT101DSE	Cell Biology & Enzymology	5	-	4	30	70	-	-	100
		MSMBT102DSE	Pharmaceutical Microbiology	5	-	4	30	70	-	-	100
5	Core Course Practical	MSMBP101CO	Virology Practical	-	3	2	-	-	15	35	50
6	Core Course Practical	MSMBP102CO	Biomolecules Practical	-	3	2	-	-	15	35	50
7	Core Course Practical	MSMBP103CO	Immunology Practical	-	3	2	-	-	15	35	50
8	Discipline Specific Elective-1 Practical (Any one)	MSMBP101DSE	Cell Biology & Enzymology Practical	-	3	2	-	-	15	35	50
		MSMBP102DSE	Pharmaceutical Microbiology Practical	-	3	2	-	-	15	35	50
Total Credit						**24**					**600**

L:Lecture, P:Practical, CCE: Continuous Comprehensive Evaluation, ESE: End Semester Examination

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SEMESTER II

Sl No.	Category	Subject Code	Subject Name	Hours Per week		C	Examination Scheme				
				L	P		Theory Marks		Practical Marks		Total
							CCE	ESE	CCE	ESE	
1	Core Course	MSMBT204CO	Analytical Techniques	5	-	4	30	70	-	-	100
2	Core Course	MSMBT205CO	Microbial Physiology & Metabolism	5	-	4	30	70	-	-	100
3	Core Course	MSMBT206CO	Molecular & Microbial Genetics	5	-	4	30	70	-	-	100
4	Discipline Specific Elective-2 (Any one)	MSMBT203DSE	Biostatistics & Approach to Review Writing/Presentation & Data Representation	5	-	4	30	70	-	-	100
		MSMBT204DSE	Bioethics, Biosafety & IPR	5	-	4	30	70	-	-	100
5	Core Course Practical	MSMBP204CO	Analytical Techniques Practical	-	3	2	-	-	15	35	50
6	Core Course Practical	MSMBP205CO	Microbial Physiology & Metabolism Practical	-	3	2	-	-	15	35	50
7	Core Course Practical	MSMBP206CO	Molecular & Microbial Genetics Practical	-	3	2	-	-	15	35	50
8	Discipline Specific Elective-2 Practical (Any one)	MSMBP203DSE	Biostatistics & Approach to Review Writing/Presentation & Data Representation Practical	-	3	2	-	-	15	35	50
		MSMBP204DSE	Bioethics, Biosafety & IPR Practical	-	3	2	-	-	15	35	50
9	Skill Enhancement Course	MSMBP201SEC	Seminar	-	3	2	-	-	15	35	50
Total Credit						**26**					**650**

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SEMESTER III

Sl No.	Category	Subject Code	Subject Name	Hours Per week		C	Examination Scheme				
				L	P		Theory Marks		Practical Marks		Total
							CCE	ESE	CCE	ESE	
1	Core Course	MSMBT307CO	Molecular Biology	5	-	4	30	70	-	-	100
2	Core Course	MSMBT308CO	Medical Microbiology	5	-	4	30	70	-	-	100
3	Core Course	MSMBT309CO	Fermentation Technology and Industrial Microbiology	5	-	4	30	70	-	-	100
4	Discipline Specific Elective-3 (Any one)	MSMBT305DSE	Food, Agriculture & Environmental Microbiology	5	-	4	30	70	-	-	100
		MSMBT306DSE	Bioinformatics	5	-	4	30	70	-	-	100
5	Core Course Practical	MSMBP307CO	Molecular Biology	-	3	2	-	-	15	35	50
6	Core Course Practical	MSMBP308CO	Medical Microbiology Practical	-	3	2	-	-	15	35	50
7	Core Course Practical	MSMBP309CO	Fermentation Technology and Industrial Microbiology Practical	-	3	2	-	-	15	35	50
8	Discipline Specific Elective-3 Practical (Any one)	MSMBP305DSE	Food, Agriculture & Environmental Microbiology Practical	-	3	2	-	-	15	35	50
		MSMBP306DSE	Bioinformatics Practical	-	3	2	-	-	15	35	50
9	Skill Enhancement Course	MSMBP302SEC	Seminar	-	3	2	-	-	15	35	50
10	Ability Enhancement Course	MSMBP301AEC	Summer Training Report	-	-	2	-	-	-	50	50
Total Credit						**28**					**700**

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SEMESTER IV

Sl No.	Category	Subject Code	Subject Name	Hours Per week		C	Examination Scheme				
				L	P		Theory Marks		Practical Marks		Total
							CCE	ESE	CCE	ESE	
1	Core Course	MSMBP4010CO	Dissertation & Viva	-	-	24	60	140	-	-	200
2	Generic Elective-1 (Optional)	MSMBT401GE	SWAYAM-Microbiology (MOOCs course)*	-	-	4	-	-	-	-	50
Total Credit						**28**					**250**

***MOOCs courses to be selected / opted from SWAYAM portal https://swayam.gov.in/ in consultation with the coordinator**

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ASSESSMENT PROCEDURE FOR AWARDING MARKS

Appearance in End Semester Examination is mandatory for all courses including Theory, Laboratory and Dissertation.

All the Theory, Laboratory and other courses as per the curriculum will be assessed for the award of credit based on

1. Continuous Comprehensive Evaluation (CCE)

2. End Semester Examination (ESE)

S.No	Category of Course		Continuous Comprehensive Evaluation	End Semester Examination
1	Theory Courses	Core Course	30	70
		Discipline Specific Elective	30	70
		Generic Elective	30	70
		Skill Enhancement Course	15	35
2	Practical Courses	Core Course	15	35
		Discipline Specific Elective	15	35

1. Continuous Comprehensive Evaluation (CCE)

I. Theory courses

Category	Marks
Class Test I	5
Class Test II	5
Class Test III	5
Assignment	5
Attendance	5
Class Participation	5
Total Marks	**30**

II. Practical courses

Category	Marks
Record Note Book	5

Viva Voce	5
Class participation	5
Total Marks	**15**

III. Dissertation Report

Monthly report Evaluation	15 Marks
Thesis Evaluation	45 Marks
Total Marks	**60**

2. End Semester Examination

I. Theory course: It will comprise of a 70 Marks Written Paper for each subject at the End of Each Semester (June/December).

II. Practical course: Each subject will be assessed 35 marks for the practical's in each subject. The practical examination will be conducted before/after the ESE individually for the subjects.

III. Dissertation: It will comprise of the following-
Presentation - 70 Marks
Viva Voce - 70 Marks

Assessment of online courses: Students may be permitted to earn extra credit through online courses (which are provided with a certificate from known sources such as NPTEL and other MOOC based platforms with the approval of Departmental Committee and subject to a maximum of four additional credits.

Passing Marks: 45 % in each subject (Both in CCE and ESE separately)

Criteria for passing M.Sc.

	Continuous Assessment Minimum	**End Semester Minimum**	**Overall Passing**
Theory	45% (14 out of 30 marks)	45% (32 out of 70 marks)	50% (in CCE and ESE together)
Practical	45% (07 out of 15 marks)	45% (16 out of 35 marks)	50% (in CCE and ESE together)
Project	45% (27 out of 60 marks)	45% (63 out of 140 marks)	50% (in CCE and ESE together)

SEMESTER I

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Name of the subject: Virology	Subject Code: MSMBT101CO
Total Marks for Evaluation: 100	No. of Contact Hours: 60, Credits:4

Course Objectives: The module is designed to provide introduction & detailed information onthe classification, structure and replication in viruses.

Course Outcomes:

CO1-Explain the history and development of viruses, the rationale behind the Baltimore classification system of viruses as well as types and major characteristics of viruses.

CO2- Describe properties of viruses and isolation, cultivation, assay and maintenances of viruses.

CO3- Explain viral genome, its replication and viral gene expression as well as virus – host interaction

CO4- Explain transmission of viruses, viral vectors, viral diseases and diagnosis of viral diseases.

CO5- Explain the treatment and vaccination available against viral infection.

Unit	Topic/Sub-Topic	Contact Hours
1	History of Viruses History and Discovery of Viruses, Nature, origin and evolution of viruses, New emerging and re-emerging, viruses, viruses in human welfare. Nomenclature, classification and structure of viruses – criteria used for naming, classification of viruses, recent ICTV classification of viruses infecting animals, humans, plants, bacteria,algae, fungi. Major characteristics of different virus families/genera/groups-Hepadnaviridae,Poxviridae, Baculoviridae, Adenoviridae, Herpesviridae, Ortho and Paramyxoviridae, Retroviridae, Reoviridae, Parvoviridae, Rhadboviridae, Picornaviridae, Flaviviridae, Potyviridae, Tobamoviridae, Bromoviridae, Bunyaviridae, Geminiviridae, Caulimoviridae. Algal, Fungal and Bacterial viruses Phycodnaviridae, Cyanophages,Partitiviridae and Totiviridae. Subviral agents-sat viruses, Sat nucleic acids,Viroids, Prions	15
2	Properties of Viruses Biological properties of viruses – host range, transmission- vector, non-vector;Physical properties of viruses–morphology, structure, sedimentation, electrophoretic mobility, buoyant density; Biochemical characteristics chemical composition of viruses, proteins, nucleic acids, envelope, enzymes, lipids, carbohydrates, polyamines, cations, Antigenic nature of viruses. Isolation, cultivation, assay and maintenances of viruses – Animal, Plant and Bacterial Viruses: bioassay tissue culture – organ culture, primary and secondary Cell cultures, suspension and monolayer cell cultures, cell strains, cell lines, embryonated eggs; experimental plant tissue cultures.	10

3	Viral Replication and genome expression Viral genomes- structure and complexity of Viral genomes, diversity among viral genomes – DNA and RNA genomes- linear, circular, double and single stranded; positive and negative sense of RNA genomes, mono, bi tri and multipartite of genomes. Replication of viruses – an overview of viral replication cycles, replication strategies of DNA, RNA viruses and regulation of viral genome expression- Baltimore strategies. Virus – host interactions – cytopathic effects of viral infections, inclusion bodies, chromosomal aberrations; Response of host cells to viral infection – interference, Immunological responses of the host.	15
4	Transmission of viruses Transmission of viruses –Vertical (Direct) transmission –contact, mechanical, transplacental, sexual, fecal, seed and pollen. Horizontal (Indirect) transmission- aerosols, fomites, water, food, graft, dodder. Vector-arthropod, non-arthropods, virus and vector relationship. Multiple infections – viral zoonosis.	10
5	Diagnosis of viral diseases – chemical symptoms, diagnosis, molecular methods used in viral diagnosis, prevention and control of viruses: prevention – sanitation, vector control, vaccines and immunization control– chemoprophylaxis, chemotherapy –antiviral drugs,interferon therapy, efficacy of infection control.	10

RECOMMENDED BOOKS

1. Principles of Virology:S.J. Flint et al., ASM press, 2nd Ed., 2004.
2. Introduction to Modern Virology: Dimmock et al., Blackwell Sci. Publ, 5th Ed., 2001.
3. Principles of Molecular Virology, A. Cann, Academic Press, 3rd Ed., 2001.
4. Plant Virology, R. Hull, Academic Press,4thEd., 2001.
5. Fundamental Virology,D.M. Knipe and P.M. Howley, 4th Ed., 2001.
6. Plant viruses, M. V. Nayudu, Prentice Hall Publication, 2006.

Name of the subject: Virology Practical	**Subject Code: MSMBP101CO**
Total Marks for Evaluation: 50	**No. of Contact Hours: 30, Credits:2**

Course Objectives: The module is designed to provide basic information about cultivation of viruses in laboratory and studying their virulence.

Course Outcomes:

CO1- Illustrate One step growth curve for determination of virus titre.
CO2- Demonstrate Phage typing of E. coli bacteriophages.
CO3- Demonstrate Induction of lambda lysogen by UV radiations.
CO4- Describe in detail about Specialized transduction
CO5- Describe Isolation of lambda DNA and their characterization
CO6- Describe lambda DNA amplification by PCR

CO7-Describe cultivation and assay of viruses using embryonated eggs and Tissue culture Technique.

S.No.	List of Experiments	Contact Hours
1	One step growth curve for determination of virus titre.	6
2	Phage typing of E. coli bacteriophages.	6
3	Induction of lambda lysogen by UV radiations.	3
4	Studies on Specialized transduction	3
5	Isolation of lambda DNA and their characterization	6
6	Amplification of lambda DNA by PCR	3
7	Cultivation and assay of viruses using embryonated eggs and Tissue culture Technique.	3

RECOMMENDED BOOKS

1. Clinical virology Manual, Steven, S., Adinka, R.L., Young, S.A.
2. Laboratory Exercises in Microbiology, Harley Prescott, Tata McGrawHill, 2nd Ed., 2010.

Name of the subject: Biomolecules	**Subject Code: MSMBT102CO**
Total Marks for Evaluation: 100	**No. of Contact Hours: 60, Credits:4**

Course Objectives: The module is designed to provide introduction & detailed information onthe basics of biomolecules.

Course Outcomes:

CO1- Discuss the classification, properties and functions of carbohydrates and lipids.
CO2- Explain the classification, structure and functions of amino acids and proteins.
CO3- Describe the structure and functions of DNA, RNA, water soluble vitamins and chlorophylls.
CO4- Discuss biological oxidation and oxidative phosphorylation.
CO5- Describe the mineral metabolism and role of trace elements on microbial enzymes.

Unit	Topic/Sub-Topic	Contact hours
1	Carbohydrates- Classification, chemistry properties, and function – mono, di, oligo and polysaccharides.bacterial cell wall polysaccharides.Conjugated polysaccharides– glycoproteins, muriens and lipopolysaccharides. Lipids – classification, chemistry, properties and function – free fatty acids, triglycerides, phospholipids, glycolipids & waxes. Conjugated lipids – lipoproteins.Major steroids of biological importance – prostaglandins.	15
2	Amino acids and proteins Classification, structure and Function. Essential amino acids &amphoteric nature of amino acids and reactions and functions of carboxyl and amino	15

	groups and side chains. Peptide structure. Ramachandran's plot. Methods for isolation and characterization of proteins. Structural levels of proteins – primary, secondary, tertiary and quaternary, denaturation of proteins. Hydrolysis of proteins. Protein sequencing using various methods.	
3	Nucleic acids Structure, function and their properties. Structural polymorphism Of DNA, RNA. Structural Characteristics of RNA.Sources. Chemistry and biochemical functions of water- soluble vitamins. Chemistry of Porphyrins–Heme,Cytochromes, Chlorophylls,xanthophylls, Bacteriochlorophylls &algal pigments, Carotenoids.	12
4	Biological oxidation, Biological redox carriers, membranes electrontransport, oxidative phosphorylationand mechanism. Bacterial photosynthesis photosynthetic electron transport.	8
5	Mineral metabolism–phosphorus, potassium, calcium and Trace elements – molybdenum, zinc manganese, cobalt and copper. Influence of mineral on the production of toxins. Role of trace elements on microbial enzymes.	10

RECOMMENDED BOOKS

1. Lehninger Principles of Biochemistry, Nelson DL and Cox MM, W.H. Freeman and Company 5th Ed., 2008.

2. Biochemistry – Stryer, W. H. Freeman & Co. – New York 8th Ed., 2015.

Name of the subject: Biomolecules Practical	**Subject Code: MSMBP102CO**
Total Marks for Evaluation: 50	**No. of Contact Hours: 30, Credits:2**

Course Objectives: The module is designed to provide introduction to basics of reagent preparation and quantification of biomolecules.

Course Outcomes:

CO1- Practice various buffer preparation.
CO2- Calculate normality and molarity of different solutions.
CO3- Interpret Titration curve for amino acids and their pKa value.
CO4- Calculate acid value,saponification value andiodine number of lipidssamples.
CO5- Calculate amount ofprotein in given sample.
CO6- Calculate amount ofDNA and RNA in givensample.

S.No.	List of Experiments	Contact Hours
1	Preparation of buffers	6
2	Determination/calculation of normality and molarity of solutions	3
3	Titration curve for amino acids and determination of pKa value	3
4	Determination of acid value, saponification value and iodine number	6

	of lipid samples	
5	Determination of protein in given sample	6
6	Quantification of DNA and RNA	6

RECOMMENDED BOOKS

1. Laboratory Experiments for Organic, Inorganic and Biochemistry, Bettelheim and Landsberg, Harcourt Inc, 8th Ed., 2012.
2. Biotechnology: Procedures and experiments handbook, S Harisha, Infinity Science Press. 2005.
3. Biotechnology: A laboratory course, Becker, Caldwell and Zachgo, 2nd Ed.,1996.

Name of the subject: Immunology	**Subject Code: MSMBT103CO**
Total Marks for Evaluation: 100	**No. of Contact Hours: 60, Credits:4**

Course Objectives: The module is designed to provide introduction & detailed information onthe principles of bodies defence mechanism.

Course Outcomes:

CO1-Discuss cells and organs of the immune system, innate and adaptive immunity and various immunological techniques.
CO2- Explain the nature of antigens, types of antibodies and complement system.
CO3- Discuss humoral and cell-mediated immunity and immune response to various infectious diseases.
CO4- Explain major histocompatibility complex, tumour immunology and different immunodeficiency diseases.
CO5- Discuss the development and production of vaccines and immunotherapy of infectious diseases.

Unit	Topic/Sub-Topic	Contact Hours
1	History and scope of immunology Cells involved in immune system-T-lymphocytes, B- lymphocytes, monocytes, macrophages, APC, Neutrophils, mast cells. Types of immunity – Adaptive immunity, innate immunity. Thymus, bone marrow, spleen, lymph nodes. lymphoid organs. Antigen-Antibody reactions - Ag-Ab binding, agglutination, blood groups, immunofluorescence, and important immunological diagnostic tests - ELISA, RIA, immune blot, Immunodiffusion, Immunoelectrophoretic, Complement fixation test (CFT).	10
2	Nature of antigens; antibody structure, classification of antibodies, functions of IgG, IgA, IgM, IgD and IgE; primary and secondary immune response; serological analysis of antibodies – isotypes, allotypes and idiotypes.	15

	Antibody diversity, antigen receptors on B and T lymphocytes. Phagocytosis, opsination, Opsonins and polyclonal and (monoclonal antibody production) (Hybridoma techniques) Applications of monoclonal antibodies in biomedical research, clinical diagnosis and treatment. The complement system - components of classical and alternative complement pathways, complement receptors, biological, consequences of complement activation	
3	Humoral and cell-mediated immunity, ontogeny of B and T lymphocytes, generation of memory B cells and affinity maturation. T and B cell interactions,cytokines, lymphocyte-mediated cytotoxicity (CTL). Antibody-dependent cell- mediated cytotoxicity. Reactions of immunity antitoxins, neutralization of toxin with antitoxin Immune response to infectious diseases: viral infections, bacterial infections, and protozoan diseases.	10
4	Graft versus host reactions: Major Histocompatibility Complex (MHC). Human leucocyte antigen (HLA) restriction, Hypersensitive reactions – Auto immunity, transplantation immunity, Tumor immunology, immunological tolerance and immunosuppression. Immunodeficiency diseases - Primary immunodeficiency (genetic) diseases due to B-cell and T-cell and combined defects (hypogammaglobulinemia, thymic aplasia, SCID). Secondary immunodeficiency (acquired).	15
5	Vaccines – development and production, vaccine expression system. Production of DNA vaccines. Immunotherapy of infectious diseases; Principles of immunization; vaccinoprophylaxis, vaccinotherapy, serotherapy.	10

RECOMMENDED BOOKS

1. Cellular and Molecular Immunology, Abul K. Abbas et al., 9th Ed., 2017.
2. Essential Immunology, Roitt, Brostoff, Male, Harcourt Brace & Company,8th Ed., 2012.
3. Immunology, J. Kuby, Richard A. Goldsby, Thomas J. Kindt, Barbara A. Osborne, Freeman & Company Mosby publishers, 2009.
4. Immunobiology – The immune system in Health disease, Janeway and Travers, 1994.

Name of the subject: Immunology Practical	**Subject Code: MSMBP103CO**
Total Marks for Evaluation: 50	**No. of Contact Hours: 30, Credits:2**

Course Objectives: The module is designed to provide introduction & detailed information on some basic immunodiagnostic techniques and quantification of blood proteins.

Course Outcomes:

CO1- Analyse enteric fever or typhoid through WIDAL method.
CO2- Practice variousImmunodiffusiontechniques (DID & RIA).
CO3- Calculate WBC and RBC count.

CO4- Interpret HBsAG, HIV, HCV & other serological procedures.
CO5- Examine Bacterial Agglutination.
CO6- Interpret Latex Agglutination.
CO7- Practice SDS page of serum proteins.
CO8- Examine serum proteins by Bradford method / CBB method.

S.No.	List of Experiments	Contact Hours
1.	WIDAL Test	4
2.	Immunodiffusion techniques (DID & RIA)	4
3.	WBC & RBC count	4
4.	HBsAG, HIV, HCV & other serological tests	4
5.	Bacterial Agglutination Test	4
6.	Latex Agglutination Test	4
7.	SDS page of serum proteins	4
8.	Estimation of serum proteins by (Bradford method / CBB method)	2

RECOMMENDED BOOKS

1. Practical Immunology, Hay and Westwood, BlackwellScience, 4th Ed., 2002.

Name of the subject: Cell Biology and Enzymology	**Subject Code: MSMBT101DSE**
Total Marks for Evaluation: 100	**No. of Contact Hours: 60, Credits:4**

Course Objective: The module is designed to provide introduction & detailed information onthe cell components and emphasis on enzymology.

Course Outcomes:
CO1- Describe the structure, function and biogenesis of chloroplast and mitochondria and physico-chemical properties of the bacteria.
CO2- Discuss about signal transduction in eukaryotes.
CO3- Explain the classification, nomenclature, assay of enzymes and its kinetics.
CO4- Discuss enzyme inhibitors, isoenzymes, regulatory and allosteric enzymes.
CO5- Explain the methods of isolation, purification, recovery and yield of enzymes.

Unit	Topic/Sub-Topic	Contact Hours

1	Organellar Biology: Structure, Function and biogenesis of chloroplast and mitochondria, mesosomes, lysosomes and cytoskeleton system. Photosynthesis in bacteria and plants: Organizations, apparatus, electron donors and acceptors, energetic. Physico-chemical properties of bacteria – intracellular osmotic pressure, permeability of the bacterial cell. Nutrient transport-simple diffusion, active, passive and facilitated diffusion. Purple green photosynthetic bacteria, Oxygenic and anoxygenic photosynthesis, structure of synthetic pigments, primary photochemistry of PS I and PS II, electron transport, CO_2 fixation, halo bacterial photosynthesis.	15
2	Signal transduction in eukaryotes: Protein kinases, phosphorylation cascades, Ras pathway, MAP kinase pathway, etc. Cyclic nucleotides, G proteins. Mechanisms of protein translocation across membranes in prokaryotes and eukaryotes, coated vesicles, membrane receptors.	15
3	Outlines of enzyme classification, nomenclature, assay of enzymes and kinetics of enzyme catalysedreactions – Michaelis – Mentonequation, determination of Km, V max and k cat values. Factors affecting enzyme reaction – pH, temperature, radiation, enzyme and substrate concentrations, activators, coenzymes and metalloenzymes. Ribozymes and abzymes.	10
4	Enzyme inhibitors, competitive and non-competitive inhibition. Active site determination. Mechanism of action of ribonuclease, lysozyme and chymotrypsin. Isoenzymes, regulatory enzymes-covalent modification, zymogen activation. Allosteric enzymes-ATCase. Glutamine synthetase, Haemoglobin and myoglobin	10
5	Enzyme purification: Methods of isolation, purification, recovery and yield of enzymes. Criteria of testing purity of enzyme preparations. Methods of enzyme immobilization, comparison of kinetics of immobilized enzyme and free enzymes, Application of immobilized exams.	10

RECOMMENDED BOOKS

1. Cell and Molecular Biology, E.B.P. De Robertis, Lippincott Williams & Wilkins, 2006.
2. Molecular Cell Biology, Lodish& Baltimore, 1986.
3. Fundamentals of Enzymology, Nicholas C. Price, Lewis Stevens, Oxford University Press, 1989.
4. Enzymes, Biochemistry, Biotechnology, Clinical Chemistry, Trevor Palmer, Harward Publishing Limited, 2001.
5. Principles of Biochemistry, Lehninger, Nelson and Cox, 2017.

Name of the subject: Cell Biology and Enzymology Practical	**Subject Code: MSMBP101DSE**
Total Marks for Evaluation: 50	**No. of Contact Hours: 30, Credits:2**

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Course Objectives: The module is designed to provide practical information on enzymatic production, purification, immobilization and determination of enzymatic activity.

Course Outcomes:

CO1- Explain the techniques of microbial enzymatic production.
CO2- Demonstrate the techniques of enzyme purification in a step by step manner.
CO3- Analysis of inhibition and activation of enzymes by using various molecules.
CO4-Analyze immobilization and activity of different enzymes.
CO5-Analyze the optimum physical parameters for enzyme function.
CO6-Analyze the molecular weight of protein by using different techniques.

S.No.	List of Experiments	Contact Hours
1.	Microbial production, Extraction, purification and Confirmation of alpha amylase/ Lipase	5
2.	Determination of efficiency of enzyme purification by measuring specific activity at various stages viz. Salt precipitation, dialysis, electrophoresis etc.	5
3.	Studies on enzyme Activation and Inhibition of extracted alpha amylase /Lipase. Effect of Heavy metal ions, Chelating agents' activators and inhibitors	5
4.	Immobilization of cells and enzyme using Sodium alginate and egg albumin and measurement of enzyme activity [amylase/ Lipase]	5
5.	Studies on impact of immobilization on enzyme activity in terms of Temperature tolerance and Vmax and Km using various forms of alpha amylase/Lipase	5
6.	Determination of molecular weight of enzymes using PAGE technique.	5

RECOMMENDED BOOKS

1. Methods in Enzymology. - Enzyme purification and related techniques, William B. Jakoby, Academic Press, New York,Volume 22.
2. Laboratory techniques in Biochemistry and Molecular Biology, Work and Work.

Name of the subject: Pharmaceutical Microbiology	**Subject Code: MSMBT102DSE**
Total Marks for Evaluation: 100	**No. of Contact Hours: 60, Credits:4**

Course Objective: The module is designed to provide introduction & detailed information on production and mechanism of antibiotic action and learn about ethics of antibiotic production.

Course Outcomes:

CO1- Describe antibiotics, synthetic antimicrobial agents and chemical disinfectants, antiseptics andpreservatives.

CO2- Discuss the mechanism of action of antibiotics and non-antibiotic antimicrobial agents.
CO3- Explain microbial contamination and spoilage of pharmaceutical products, DNA vaccines, synthetic peptide vaccines, multivalent subunit vaccines.
CO4- Interpret the financing R&D capital and market outlook.
CO5- Develop the good manufacturing practices and good laboratory practices in the pharmaceuticalindustry.

Unit	Topic/Sub-Topic	Contact Hours
1	Antibiotics and synthetic antimicrobial agents Antibiotics and synthetic antimicrobial agents (Aminoglycosides, β lactams, tetracyclines, ansamycins, macrolide antibiotics) Antifungal antibiotics, antitumor substances. Peptide antibiotics, Chloramphenicol, Sulphonamides and Quinolinone antimicrobial agents. Chemical disinfectants, antiseptics and preservatives.	12
2	Mechanism of action of antibiotics (inhibitors of cell wall synthesis, nucleic acid and protein synthesis). Molecular principles of drug targeting. Drug delivery system in gene therapy Bacterial resistance to antibiotics. Mode of action of bacterial killing by quinolinones. Bacterial resistance to quinolinones. Mode of action of non – antibiotic antimicrobial agents. Penetrating defences – How the antimicrobial agents reach the targets (cellular permeability barrier, cellular transport system and drug diffusion).	15
3	Microbial contamination and spoilage of pharmaceutical products (sterile injectables, non-injectables, ophthalmic preparations and implants) and their sterilization. Manufacturing procedures and in process control of pharmaceuticals. Other pharmaceuticals produced by microbial fermentations (streptokinase, streptodornase). New vaccine technology, DNA vaccines, synthetic peptide vaccines, multivalent subunit vaccines. Vaccine clinical trials.	15
4	Financing R&D capital and market outlook. IP, BP, USP. Government regulatory practices and policies, FDA perspective. Reimbursement of drugs and biologicals, legislative perspective. Rational drug design. Immobilization procedures for pharmaceutical applications (liposomes). Macromolecular, cellular and synthetic drug carriers. Biosensors in pharmaceuticals. Application of microbial enzymes in pharmaceuticals.	9
5	Good Manufacturing Practices (GMP) and Good Laboratory Practices (GLP) in pharmaceutical industry. Regulatory aspects of quality control. Quality assurance and quality management in pharmaceuticals ISO, WHO and US certification. Sterilization control and sterility testing (heat sterilization, D value, z value, survival curve, Radiation, gaseous and filter sterilization)Chemical and biological indicators. Design and layout of sterile product manufacturing unit. (Designing of Microbiology laboratory) Safety in microbiology laboratory.	9

RECOMMENDED BOOKS

1. Pharmaceutical Microbiology, W.B. Hugo & A.D. Russell, Blackwell scientificPublications, 6th Ed.,

2. Quality control in the Pharmaceutical Industry, Murray S. Cooper, Academic Press New York, Vol.2.
3. Pharmaceutical Biotechnology, S. P. Vyas & V. K. Dixit, CBS Publishers & Distributors, New Delhi.

Name of the subject: Pharmaceutical Microbiology Practical	**Subject Code: MSMBP102DSE**
Total Marks for Evaluation: 50	**No. of Contact Hours: 30, Credits:2**

Course Objectives: The module is designed to provide introduction & detailed information on some basic assays to analyse the effectivity of some antibiotics and study their antimicrobial activity.

Course Outcomes:

CO1- Examine thespectrophotometric/microbial methods for the determination of Griseofulvin.
CO2- Interpret bio-assay of chloramphenicol by plate assay method or turbidimetric assay method.
CO3- Calculate MIC and LD50 ofBeta-lactam/ aminoglycoside/tetracycline/ annamycin.
CO4- Interpret D value, Z value forheat sterilization inpharmaceuticals.
CO5- Analyse antimicrobial activityof a chemical compound to that ofphenol under standardized experimental conditions.
CO6- Test sterility by Bacillus stearothermophilus.

S.No.	List of Experiments	Contact Hours
1.	Spectrophotometric / Microbiological methods for the determination of Griseofulvin.	6
2.	Bio-assay of chloramphenicol by plate assay method or turbidimetric Assay method.	6
3.	To determine MIC, LD50 of Beta-lactam /aminoglycoside /tetracycline / annamycin.	6
4.	Determination of D value, Z value for heat sterilization in pharmaceuticals.	4
5.	Determination of antimicrobial activity of a chemical compound (Phenol, resorcinol, thymol, formaldehyde) to that of phenol under Standardized experimental conditions.	4
6.	Sterility testing by Bacillus stearothermophilus.	4

RECOMMENDED BOOKS

1. Pharmaceutical microbiology (Including Practicals), CharakantKokare, NiraliPrakashan
2. Practical Microbiology, Dubey and Maheshwari, S Chand Publications

SEMESTER II

Programme: M.Sc. in Microbiology **Session 2021-23**

Name of the subject: Analytical Techniques	**Subject Code: MSMBT204CO**
Total Marks for Evaluation: 100	**No. of Contact Hours: 60, Credits:4**

Course Objectives: The module is designed to provide introduction & detailed information onthe instrumentation of analytical instruments.

Course Outcomes:
CO1-Explain the principle and application of Spectroscopy.
CO2- Apply the principle, methodology and applications of Centrifugation techniques.
CO3-Apply the principle, methodology and applications of Electrophoresis techniques.
CO4- Apply the principle, methodology and applications of Chromatography techniques.
CO5-Apply the principle, methodology and applications of Agglutination techniques& PCR.

Unit	Topic/Sub Topic	Contact Hours
1	Microscopy Principles of light, phase, fluorescent & electron microscopes; Microtomy– sectioning. Microscopic techniques: Basic principles and applications of phase–contrast microscopy, fluorescent microscopy and electron microscopy scanning and transmission microscopy Spectroscopic techniques: Laws of absorption and absorption spectrum. Principle, instrumentation and applications of UV visible spectrophotometry and spectrofluorimetric. Basic principles of turbidimetry and nephelometry. Principle, instrumentation and applications of luminometry. Atomic spectroscopy– principle and applications of atomic flame and flameless spectrophotometry. Use of lasers for spectroscopy. MALOF TOF.	15
2	Centrifugation and radioisotope techniques: Ultracentrifuges– Analytical ultracentrifuge– instrumentation and applications. Preparative ultracentrifuge– types, instrumentation and applications of preparative rotors. Analysis of subcellular fractions and determination of relative molecular mass– sedimentation velocity and sedimentation equilibrium. Units of radioactivity. Detection and measurement of radioactivity–solid and liquid scintillation counting, scintillation cocktails and sample preparation. Cerenkov counting. Autoradiography. Applications of radioisotopes in biology. Radiation hazards.	15

3	Electrophoresis and Electrochemical techniques: Electrophoresis: General principles. Support media. Electrophoresis of proteins– SDS--PAGE, native gels, gradient gels, isoelectric focusing, 2--DPAGE.Cellulose acetate electrophoresis.Detection,estimation and recovery of proteins in gels. Electrophoresis of nucleic acids– agarose gel electrophoresis, DNA sequencing gels, pulsed field gel electrophoresis. Membrane blotting and hybridization of nucleic acids–Southern, Western, dot--blot and fluorescent in situ hybridization. RFLP-- technique and applications.	10
4	Chromatography: Principle, instrumentation and applications of thin layer and gas chromatography.Column chromatography--packing, loading,eluting and detection.Ion--exchange chromatographypreparationofresins, procedure and applications. Chromatofocusing.Molecular exclusion chromatography--principle, gel preparation, operation and applications. Affinity chromatography– principle, materials, procedure and applications. Special forms of affinity chromatography– immune affinity,metal chelate, dye- ligand and covalent chromatography. HPLC– principle, materials,instrumentation and applications. Capillary electrochromatography.	10
5	PCR technique: PCR– basic principle,RT--PCR, quantitative PCR and insitu PCR. Diagnostic and laboratory applications of PCR.Comet assay. Monitoring of oncogenes and antioncogenes. Mutagenecity testing– Ame's test.DNA finger printing,DNA foot printing. Agglutination and precipitation techniques: Immuno- electrophoresis, RIA, immunoblotting, Avidin- biotin mediated immuno assay. Immunohistochemistry-immunofluorescence, immunoferritin technique.Fluorescent immunoassay. Cytokines assay: ELISA and ELISPOT.	10

RECOMMENDED BOOKS

1. Instrumental Methods of Chemical Analysis, Chatwal & Anand, 2018.
2. Practical Biochemistry and Molecular Biology: Principles and techniques, Wilson & Walker, 2018.
3. Physical Biochemistry: Application to Biochemistry and Molecular biology, Freifelder, 2nd Ed., 1982.
4. Biochemical methods, Sadasivam & Manickam, 2nd Ed., 2007.
5. Biophysical Chemistry: Principles and techniques, Upadhyay & Nath, 2009.

Name of the subject: Analytical Techniques Practical	**Subject Code: MSMBP204CO**
Total Marks for Evaluation: 50	**No. of Contact Hours: 30, Credits:2**

Course Objective: This module is a general introduction to different types of techniques involved in quantification of some biomolecules like glucose, vitamins, haemoglobin, chlorophyll and

lipids.

Course Outcomes:
CO1- Analyse the value of Blood Urea Nitrogen.
CO2- Analyse the value of glucose by different types of techniques.
CO3- Analyse the value of vitamins by using various techniques.
CO4- Analyse the value of haemoglobin by different methods.
CO5- Analyse clinical significance of various enzymes by different techniques.
CO6- Experiment theworking principle ofchromatography forestimation of chlorophyll pigment.
CO7- Experiment the working principle of colorimetry for lycopene test in various foods.
CO8- Analyse the value of lipid degradation by various techniques.

S.No.	List of Experiments	Contact Hours
1	Estimation of Blood Urea Nitrogen (BUN)	6
2	Estimation of Glucose	3
3	Estimation of Ascorbic acid (Vitamins C)	3
4	Estimation of Hemoglobin	3
5	Lactate Dehydrogenase (LDH)/Serum Glutamate Pyruvate Transaminase (SGPT)	4
6	Chlorophyll estimation –Paper chromatography	4
7	Lycopene test using a colorimeter in Tomato / watermelon	4
8	Estimation of Lipid per oxidation	3

RECOMMENDED BOOKS
1. Laboratory experiments for General, Organic and Biochemistry, Bettelheim and Landsberg,
4th Ed., 2000.

Name of the subject: Microbial Physiology & Metabolism	**Subject Code: MSMBT205CO**
Total Marks for Evaluation: 100	**No. of Contact Hours: 60, Credits:4**

Course Objectives: The module is designed to provide introduction & detailed information onthe basics of nutritional types and metabolism.

Course Outcomes:
CO1- Apply the principles of the energy-yielding and consuming reactions, the transport systems andthe mechanisms of energy conservation in microbialmetabolism.
CO2- Illustrate the metabolism of carbohydrates and the mechanism of fermentation in microbes.
CO3- Illustrate the metabolism of proteins and amino acids and their regulation in microbes.

CO4- Illustrate the metabolism, catabolism and regulation of lipid and nucleotide inmicrobes.
CO5- Synthesize the vitamins, hormones, toxins and antibiotics by using secondary metabolites.

Unit	Topic/Sub-Topic	Contact Hours
1	Nutritional types- Autotrophic bacteria, chemosynthetic and photo synthetic microorganisms. Heterotrophic bacteria – saprophytes, parasites and mixotrophs. Respiration in bacteria – aerobic and anaerobic types of respiration, obligate aerobes, facultative anaerobes and obligate anaerobes. Toxic effect of oxygen on anaerobes. Bioluminescence in microorganisms. Energy yields. Microbial growth: The concept of growth and definition, Cell cycle in microbes and generation time	10
2	Carbohydrate metabolism in microbes- Synthesis of carbohydrates inphotosynthetic, chemosynthetic and heterophic microbes.Fermentation of carbohydrates by microorganisms – Embden-Meyerhof- Pranas pathway, Entner- Doudoroff (ED) pathway, C2 -C4 split pathway. Kreb's cycle, glyoxylate cycle, hexose monophosphate shunt (HMP), gluconeogenesis, anaplerotic reactions, synthesis of peptidoglycans and glycoproteins. Anaerobic respiration - Fermentation, Biochemical mechanisms of lactic acid, ethanol, butanol and citric acid fermentations. Nitrate and sulphate respiration.	15
3	Metabolism of amino acids Biosynthesis of amino acids and their regulation with emphasis on tryptophan and histidine by microorganisms Protein metabolism - Assimilation of inorganic nitrogen and sulphur, Biochemistry of nitrogen fixation. Urea cycle. Signal transduction with reference to nitrogen metabolism. Catabolism of amino acids, transamination, decarboxylation and oxidative deamination. Porphyrin biosynthesis and catabolism.	10
4	Lipid Metabolism Biosynthesis of triacyl glycerols, phospholipids and sphingolipids. Oxidation of saturated and unsaturated fatty acids. Microbial metabolism of aromatic and aliphatic hydrocarbons (camphor, 2,4-D and toluene) with emphasis on the role of monooxygenase and dioxygenase in the ring cleavage (ortho, meta and gentisate cleavage) and reductive biosynthesis. Nucleotide Metabolism: Biosynthesis of purine and pyrimidine nucleotides, biosynthesis of deoxyribonucleotides. Regulation of nucleotide synthesis. Catabolism of purines and pyrimidines	15
5	Secondary metabolism: Utilization of secondary metabolites for production of vitamins, toxins (aflatoxins and corynebacterial), hormones (GA) and antibiotics (Penicillin and streptomycin)	10

RECOMMENDED BOOKS

1. Microbial physiology, Moat and Foster, 4th Ed., 2002.
2. An introduction to bacterial physiology, Price and Stevens, 1999.
3. An introduction to bacterial physiology, Oginsky and Umbreit, 1959.
4. Principles of Biochemistry, Lehninger, Nelson and Cox ,2017.
5. Biochemistry – Stryer, W. H. Freeman & Co. – New York, 8th Ed., 2015.
6. Textbook of Microbiology, M. Burrows, 19th Ed., 2017.
7. Microbial physiology and Metabolism, D. R. Caldwell, 2nd Ed., 1999.

Name of the subject: Microbial Physiology & Metabolism Practical	**Subject Code: MSMBP205CO**
Total Marks for Evaluation: 50	**No. of Contact Hours: 30, Credits:2**

Course Objective: This module is a designed to give a practical knowledge of morphological and biochemical characters of photosynthetic bacteria and learn the techniques of microbial immobilization and their advantages.

Course Outcomes:

CO1- Demonstrate the isolation method of photosynthetic bacteria from mixed cultures.
CO2- Explain the mechanism of nutrient uptake by bacteria.
CO3- Analyse the effect of physical and chemical sources on bacterial reproduction.
CO4- Practice bioremediation reaction with the help of microbes.
CO5- Analyse immobilization reaction by microbes.
CO6- Calculate the value of calcium absorption in sporulating bacteria by EDTA method.
CO7- Identify an unknown bacterium by performing various biochemical tests.

S.No.	List of Experiments	Contact Hours
1	Isolation of Photosynthetic bacteria	6
2	Glucose uptake by E. coli / Saccharomyces cerevisiae [Active and Passive diffusion]	3
3	Effect of UV, gamma radiations, pH, disinfectants, chemicals and heavy metal ions on spore germination of Bacillus SP.	6
4	Determination of Iron and Sulphur Oxidation Rate of Thiobacillus ferrooxidans.	3
5	Microbial degradation, decolorization and adsorption of organic dyes (by free and immobilized cells).	6
6	Estimation of calcium ions present in sporulating bacteria by EDTA method.	3
7	Demonstration of utilization of sugars by oxidation and fermentation techniques.	3

RECOMMENDED BOOKS

1. Laboratory experiments for General, Organic and Biochemistry, Bettelheim and Landsberg,
4th Ed., 2000.

Name of the subject: Molecular & Microbial Genetics	**Subject Code: MSMBT206CO**
Total Marks for Evaluation: 100	**No. of Contact Hours: 60, Credits:4**

Course Objectives: The module is designed to provide introduction & detailed information onthe various genetic phenomenon in microbes.

Course Outcomes:

CO1- Construct a molecular organization of the genome.
CO2- Analyse the properties of plasmid which could be used in industries.
CO3- Distinguish the causes of various mutations.
CO4- Formulate the bacterial genetic in genotype and phenotype changes of modifying species andbacteriophage as well.
CO5- Explain the basis of bacterial chromosome mapping and recombination in bacteriophages.

Unit	Topic/Sub-Topic	Contact Hours
1	Molecular organization of chromosomes in Prokaryotes and Eukaryotes. Centromeres and telomeres. Recombination at molecular level, heteroduplex analysis. Fine Structure analysis. Organisation of genomes – Repeated sequences- C value – cot curves" Multigene families; Molecular markers(RFLP and RAPD) Polymorphisms. Yeast & Drosophila as model organisms. Complementation and functional allelism.	15
2	Plasmids – Types, plasmid DNA Properties. Sex plasmid F and its derivatives, drug resistance (R) plasmids. The Ti plasmid of Agrobacterium. Hybridization in yeast, control of mating type lociin yeast. Transposable elements – transposition. Types of bacterial transposons, duplication of target sequence at an insertion site. Deletion and inversion caused by transposons. Transposable elements in yeast and drosophila.Retroposons.	15
3	Mutations – Terminology, types of mutations, Molecular basis of mutations, isolation & analysis of mutants. Mutagenesis – base analogue mutagens, chemical mutagens, intercalating substances, mutator genes. Site directed mutagenesis, mutational hot spots, Reversion, second site revertant, frame shift mutations, carcinogens, screening of mutants.UV damage of DNA and repair.	10
4	Bacterial genetics – Inheritance of characteristics and variability. Phenotypic changes due to	10

	environmental alterations. Genotypic changes. Bacterial recombination. Bacterial conjugation. Transduction – Generalized and specialized transductions. Bacterial transformation. Tetrad analysis in eukaryotic microbes – Neurospora and yeast.	
5	Mapping of bacterial chromosome by interrupted mating and transduction. Recombination in bacteriophages. Benzers study on rII loci of T4 bacteriophages. Complementation test.	10

RECOMMENDED BOOKS

1. Cell and Molecular Biology, E.B.P. De Robertis, Lippincott Williams & Wilkins, 8th Ed. 2006.
2. Molecular Cell Biology, Lodish& Baltimore, 5th Ed., 2015.
3. Molecular Biology of the Gene, Watson Roberts, SteitxWainer, The Benjamin/Cummings Publishing Company Inc., 7th Ed., 2013.
4. Microbial Genetics, Stanley R. Maloy, John E Cronan Jr., David Freifelder Jones and Bartleh, Publishers Inc., 2nd Ed., 1994.
5. Genes – VII, Benjamin Lewin, 2000.
6. Molecular Genetics of Bacteria, J.W. Dale, Wiley Publ, 3rd Ed., 1998.
7. Bacterial and Bacteriophage genetics, E.A. Birge Springer, 1998.

Name of the subject: Molecular & Microbial Genetics Practical	**Subject Code: MSMBP206CO**
Total Marks for Evaluation: 50	**No. of Contact Hours: 30, Credits:2**

Course Objectives: The module is designed to provide introduction & detailed information on spectrometric, centrifugation and electrophoretic methods in analytical instruments.

Course Outcomes:

CO1- Apply the basic principle of isolation of DNA from bacteria.
CO2- Apply the principle of gel electrophoresis for nucleic acids.
CO3- Explain the basic principle of transformation in bacteria.
CO4-Analyze the effect of UV radiations on microbial viability.
CO5- Apply the basic principle of isolation of RNA from microbes.
CO6- Calculate the amount of nucleic acid by diphenylamine test.

S.No.	List of Experiments	Contact Hours
1.	Extraction of genomic DNA from bacteria	6
2.	Agarose gel electrophoresis of isolated DNA	6
3.	Study of transformation in bacteria	6

4.	Effect of UV radiations to study the survival pattern of E. coli/yeast.	3
5.	Extraction and Purification of RNA from S. cerevisiae.	6
6.	Quantitative estimation of DNA by diphenylamine test.	3

RECOMMENDED BOOKS

1. Biotechnology: Procedures and experiments handbook, S Harisha, Infinity Science Press, 2005.
2. Biotechnology: A laboratory course, Becker, Caldwell and Zachgo, 2nd Ed., 1996.

Name of the subject: Biostatistics & Approach to Review Writing/Presentation & Data Representation	**Subject Code: MSMBT203DSE**
Total Marks for Evaluation: 100	**No. of Contact Hours: 60, Credits:4**

Course Objectives: The module is designed to provide introduction to Graphs. It also givesinsight about Data and result interpretation. The student will be taught how to design a research project and finally how to present his research work.

Course Outcomes:

CO1- Practice the methods of chi square analysis of various biological data.
CO2- Calculate the methods of student t test, z test and ANOVA in data obtained from various biological sources.
CO3- Calculate the methods of correlation and regression in data obtained from various biological
sources.
CO4-Analyze the concept of research methodology
CO5- Discuss the process of writing a thesis or report for publishing in journals or magazines.

Unit	Topic/Sub Topic	Contact Hours
1	Data Presentation: Graphs:Histogram, Bar Charts: Simple and Multiple, Pie Chart, Problems and Interpretations of each.Tables: Simple Table; Two Way and Multiway Table; Problems elaborating each. Exact Sampling Distribution: Chi Square Test. Definition: Applications of Chi Square Test. Chi Square Test for population variance. Chi Square Test for Goodness of Fit. Chi Square Test for independence of attributes (2x2 contingency table only). Yates Correction method. (Problems on Chi--Square with Yates method. correction need to be covered in practical session). Note on degrees of freedom. Problems on each.	10
2	Exact Sampling Distribution II: Parametric Test: t-test. Definition: Simple t--Test for mean and variance. Independent t--Test for Mean and Variance. Paired t-- Test for mean and variance. Problems on each.Z--test. Definition--Test for significance of difference forsample mean and Population Mean. Z--Test for significance of difference for sample variance and Population	15

	Variance. Z-- Test forsignificance of difference for sample means of two group. Z-- Test for significance of difference for sample variance of two group. Problems on each. ANOVA, One WayANOVA,Two Way ANOVA, Problems on each. Non-Parametric Test: Test of Randomness, Median Test, Sign Test, Mann--Whitney--Wilcoxon U Test, Problems	
3	Correlation and Regression: Definition of Correlation forBivariate Distribution.Types of Correlations, Positive Correlation,Negative Correlation,No Correlation.Methods for Identifying Types and Degree of correlation, ScatterDiagram,Karl Pearson's Correlation Coefficient,Problems,Interpretations of Results, Rank Correlation, Limitations of correlations, Regression for Bivariate Distribution,Line of regression, Regression Curves, Regression Coefficients,Properties of regression coefficients.	15
4	Methodology and Literature collection: Introduction to Research Methodology-Meaning of Research, Objective of Research, Significance, Type of Research: Basic, Applied, Research Approaches,Research Methods versus Methodology, Research and Scientific method, Criterions of good Research, Problems /Bottlenecks faced by Researchers. Defining theResearch Problem. Literature collection--Need of review of literature, Review process and Review Reading, Discriminative Reading, Consulting Source material. Literature citation--Different Systems of citing Reference: --Name–Year System citation in the text, Name –Year System–List of Reference, Citing Reference in the text, Alphabet– Number System, Journal Abbreviation.	10
5	Scientific Writing: Interpretation and Report Writing. Meaning of Interpretation, Techniques of interpretation, Precaution of interpretation. Significance of Report Writing. Step in Report Writing. Types of Report Writing. Component of a Research Report--Title, Authors, Abstract, Summary, Synopsis, Key Words, Introduction, MM, Result, Discussion, Acknowledgements, Appendixes, references, Plagiarism. Use of Table/Figures in Report Writing--Need, Introduction and Placement of Table/figure, Numbering, Box Heading, Caption photographs. Formatting and Typing– Introduction, Margins, Spacing, Alignment, Fonts, etc., Format of Thesis.	10

RECOMMENDED BOOKS

1. Fundamentals of Biostatistics, Bernard Rosner, 5th Ed., Duxbury Thomson Learning, 8th Ed., 2015.
2. Introductory Biostatistics, Chap T. Lee, Wiley, 1st Ed., 2003.

Name of the subject: Biostatistics & Approach to Review Writing/Presentation & Data Representation Practical	**Subject Code: MSMBP203DSE**
Total Marks for Evaluation: 50	**No. of Contact Hours: 30, Credits:2**

Programme: M.Sc. in Microbiology **Session 2021-23**

Course Objective: This module provides a basic information on collection, sampling, calculations, interpretations and presentations of various biological data.

Course Outcomes:
CO1- Prepare stem and leaf, box and Whiskers plots for various data.
CO2- Explain various sampling techniques.
CO3- Calculate mean, median, mode with the help of online softwares.
CO4- Calculate correlation coefficient by using online softwares.
CO5- Estimate confidence intervals by using online softwares.
CO6- Prepare scatterplot with the help of online softwares.
CO7- Calculate hypothesis testing using chi square and student t test for concluding the significance of data.

S.No.	List of Experiments	Contact Hours
1	Stem and Leaf, Box and Whisker's plots	6
2	Simple random sampling – all possible samples	6
3	Calculation Mean, Median and Mode Using Microsoft Excel	6
4	Calculation Pearson's Correlation Coefficient Using Microsoft Excel	3
5	Determination Confidence Intervals Using Microsoft Excel	3
6	Building a Scatterplot and to Add a Trend Line Using Microsoft Excel	3
7	Test for significance- Chi square and student t test	3

RECOMMENDED BOOKS
1. Software based practicals

Name of the subject: Bioethics, Biosafety & IPR	**Subject Code: MSMBT204DSE**
Total Marks for Evaluation: 100	**No. of Contact Hours: 60, Credits:4**

Course Objectives: The module is designed to provide introduction to bioethics and biosafety involved in plant and animal biotechnology and learning the concepts of patenting and intellectual property rights.

Course Outcomes:
CO1-Define the concept of bioethics in releasing various biological products for human use.
CO2-Apply the principles of biosafety involved in dealing with Microbes.
CO3-Memorize the various levels of biosafety guidelines.
CO4-Describe the intellectual property rights and its implementation.
CO5-Explain the process of filing a patent.

Unit	Topic/Sub Topic	Contact

		Hours
1	Bioethics: Introduction to ethics and bioethics, framework for ethical decision making. Ethical, legal and socioeconomic aspects of gene therapy, germ line, somatic, embryonic and adult stem cell research. Ethical implications of GM crops, GMO's, human genome project, human cloning, designer babies, biopiracy and biowarfare. Eugenics and its possible approaches. Animal right activities -Blue cross in India-society for prevention of cruelty against animals. Ethical limits of Animal use. Green peace -Human Rights and Responsibilities.	15
2	Biosafety: Introduction –biosafety issues in biotechnology -historical background. Biological Safety Cabinets, Primary Containment for Biohazards. Biosafety Levels-Levels of Specific Microorganisms, Infectious Agents and Infected Animals.	10
3	Biosafety Guidelines: Guidelines and regulations (National and International including Cartagena Protocol) –operation of biosafety guidelines and regulations of Government of India; Definition of GMOs & LMOs. Roles of Institutional Biosafety Committee, RCGM, GEAC etc. for GMO applications in food and agriculture. Environmental release of =GMOs -Risk -Analysis, Assessment, management and communication.	10
4	Intellectual Property Rights: Introduction to IPR, Types of IP -Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge and Geographical Indications. Importance of IPR –patentable and non-patentable, patenting life, legal protection of Biotechnological inventions. Agreements and Treaties -History of GATT & TRIPS Agreement; Madrid Agreement; Hague Agreement; WIPO Treaties; Budapest Treaty; PCT; Indian Patent Act 1970 & recent amendments. IPR and WTO regime -Consumer protection and plant genetic resources.	15
5	Patents and Patent Laws: Objectives of the patent system -Basic, principles and general requirements of patent law. Biotechnological inventions and patent law -Legal development -Patentable subjects and protection in Biotechnology. Patent Filing Procedures -National & PCT filing procedure, Time frame and cost, Status of the patent applications, Precautions while patenting, disclosure/ nondisclosure, financial assistance for patenting, introduction to existing schemes. Patent licensing and agreement. Patent infringement -meaning, scope, litigation, case studies.	10

RECOMMENDED BOOKS

1. Manual of Laboratory Safety (Chemical, Radioactive, and Biosafety with Biocides), Rashid
and Sood, Jaypee Publishers.
2. Empirical Bioethics: Theoretical and Practical Perspectives, Jonathan Ives, Michael Dunn, Alan Cribb, Cambridge University Press.

Name of the subject: Bioethics, Biosafety & IPR Practical	**Subject Code: MSMBP204DSE**
Total Marks for Evaluation: 50	**No. of Contact Hours: 30, Credits:2**

Course Objective: This module is a general introduction to study the different types of laboratory practices, good manufacturing practices and filing the patents for a novel product.

Course Outcomes:
CO1- Demonstrate the good laboratory practices.
CO2- Demonstrate the good manufacturing practices.
CO3- Appraise the ethical issues in animal management.
CO4- Distinguish thevarious patenting processes.
CO5- Analyse ethicalaspects related to biological, biomedical, health care and biotechnology research.
CO6- Demonstrate the basic of ethics involved in xenotransplantation.

S.No.	List of Experiments	Contact Hours
1	Study of good laboratory practices	6
2	Study of good manufacturing practices	6
3	Study of ethical issues in animal management	6
4	Study of patenting processes	6
5	Study of ethics involved in stem cell research	3
6	Study of ethics involved in xenotransplantation	3

RECOMMENDED BOOKS
1. Manual of Laboratory Safety (Chemical, Radioactive, and Biosafety with Biocides), Rashid
and Sood, Jaypee Publishers.
2. Empirical Bioethics: Theoretical and Practical Perspectives, Jonathan Ives, Michael Dunn, Alan Cribb, Cambridge University Press.

Name of the subject: Seminar	**Subject Code: MSMBP201SEC**
Total Marks for Evaluation: 50	**No. of Contact Hours: 30, Credits:2**

Course Objectives: The module is designed to make a student skilled in making presentations and presentation ability.

CO1- Practice scientific readings & presentation skills.
CO2- Outline how to make a poster for seminar and conferences.
CO3- Practice persuasive speech, present information in a compelling, well-structured, and logical sequence.
CO4- Express oral and written communication skills.

Programme: M.Sc. in Microbiology **Session 2021-23**

SEMESTER III

Name of the subject: Molecular Biology	Subject Code: MSMBT307CO
Total Marks for Evaluation: 100	No. of Contact Hours: 60, Credits:4

Course Objective: The module is designed to provide introduction the molecular mechanismsof life together with its advancements.

Course Outcome:
CO1-Explain the cell cycle and signalling mechanisms.
CO2-Compare the transcription process protein synthesis among various species of prokaryotes and eukaryotes.
CO3-Analyse the process of translation and post translational modifications.
CO4- Evaluate the gene regulatory mechanisms in a eukaryotic cell.
CO5- Apply the recombinant DNA methods in designing new recombinants.

Unit	Topic/ Sub Topic	Contact Hours
1	Cell cycle and regulation of cell cycle, divisional control, regulatory proteins, cyclin/cdk complexes,check points, cell cycle arrest Cellular communication: General principle, types of receptors, relay of signal and intracellular signal proteins, calcium messenger system and signalling via c AMP	10
2	Mechanisms of Transcription – Prokaryotic transcription; promoters, properties of bacterial RNA polymerase, steps: initiation, elongation and termination. Eukaryotic transcription, promoters, enhancers factors and properties of RNA polymerase I, II and III. Reverse transcription. Inhibitors of transcription. Post transcriptional processing – Maturation of rRNA, mRNA and tRNA; RNA	15

	splicing, introns and exons, consensus sequence function. Poly A tail, 5' capping.	
3	Structure, functional domain and subunit assembly, cell free protein synthesis, direction of protein synthesis (Dintzis experiment), adaptor role of tRNA, formation of initiation complex, chain elongation, translocation &termination and the role of respective factors involved therein. Inhibitors of protein biosynthesis. Comparison of protein biosynthesis in prokaryotes with eukaryotes. Post translational processing: Proteolytic cleavage, covalent modifications, glycosylation of proteins, disulphide bond formation, ER bound ribosome, co-andpost-translational protein synthesis, PRE and PRO proteins, Signal hypothesis.	15
4	Regulation of Transcription and Translation – Positive and negative control, Repressor & Inducer, concept of operon, lac-, ara-, trp operons, attenuation, catabolite repression, autogenous regulation, lytic cycle of bacteriophage; stringent response of rRNA synthesis. Hormonal control, transcription factors, steroid receptors. DNA binding motifs in pro- and eukaryotes – Helix turn, helix, zinc fingers, leucine zippers/ b zip, helix loop helix motifs.	10
5	Recombinant DNA Technology Recombinant DNA methods – Features of commonly used vectors, strategies for cloning in various vectors and identification of bacterial colonies containing recombinant plasmids and bacteriophage vectors. Restriction enzymes DNA sequencing, Rapid DNA sequencing methods; Maxam-Gilbert technique, Sanger's Dideoxy nucleotide sequencing, gene walking, RNA sequencing. Applications of recombinant technology – Production of insulin, drug, vaccines, diagnostic probe of genetic diseases, Gene therapy.	10

RECOMMENDED BOOKS

1. Molecular Biology of the Cell, Alberts, NCBI Publication, 5th Ed., 2007.
2. Principles of Biochemistry, Lehninger WH Freeman, 7th Ed., 2017.
3. Biochemistry of Signal Transduction and Regulation, Gerhard Krauss Wiley, VCH, 5th Ed., 2014.
4. Molecular Cell Biology, Lodish, WH Freeman & Company, 8th Ed., 2016.
5. The cell, Cooper, ASM Press, 2nd Ed., 2011.

Name of the subject: Molecular Biology Practical	**Subject Code: MSMBP307CO**
Total Marks for Evaluation: 50	**No. of Contact Hours: 30, Credits:2**

Course Objectives: The module is designed to provide detailed knowledge about isolation, transformation and quantification of nucleic acids.

Course Outcomes:

CO1- Practice the process of extraction of genomic DNA from bacteria.
CO2- Practice the process of extraction of plasmid DNA from bacteria.

CO3- Practice the process of extraction of genomic DNA from leaves.
CO4- Examine the process of transformation in bacteria.
CO5- Apply the techniques of gene cloning in bacteria.
CO6- Apply the technique of differential staining in bacterial chromosomes.
CO7- Apply the process of agarose gel electrophoresis in separation of DNA.
CO8- Apply the technique of DNA quantification by spectrometry.

S.No.	List of Experiments	Contact Hours
1	Extraction of genomic DNA from bacteria	6
2	Extraction of plasmid DNA from bacteria	6
3	Extraction of genomic DNA from leaves	3
4	Transformation in bacteria	3
5	Gene cloning in bacteria	3
6	Differential staining in bacterial DNA	3
7	Agarose gel electrophoresis of DNA	3
8	Quantitative estimation of DNA	3

RECOMMENDED BOOKS

1.Biotechnology: Procedures and experiments handbook, S Harisha, Infinity Science Press 2005.
2. Biotechnology: A laboratory course, Becker, Caldwell and Zachgo, 2nd Ed.,1996.

Name of the subject: Medical Microbiology	**Subject Code: MSMBT308CO**
Total Marks for Evaluation: 100	**No. of Contact Hours: 60, Credits:4**

Course Objectives: The module is designed to provide introduction & detailed information of the pathogenicity, diagnosis and treatment of microbial diseases.

Course Outcomes:
CO1-Analyse about the normal micro flora of human body and their pathogenicity.
CO2-Appraise the level of diseases caused by pathogenic fungal and protozoal species.
CO3-Discuss about the disease transmission vectors and their role in spreading the disease.
CO4-Apply the study of virology and epidemiology of some viruses in practical life.
CO5-Discriminate the antibiotics and antifungal drugs going to be applied on the patients.

Unit	Topic/Sub-Topic	Contact Hours
1	Normal microbial flora of human body, host microbe interactions.	10

	Infection and infection process- routes of transmission of microbes in the body. Description and pathology of diseases caused by bacteria; Streptococcus, Pneumococcus, Gonococcus, Enterobacteriaceae, E. coli, Salmonella, Shigella, Pseudomonas, Klebsiella, Proteus, Vibrio cholera. Brucella, Haemophilus, influenzae; pathogenic anaerobes, Tetanus, Clostridia, Corynebacterium, Mycobacteria, Spirochaetes.	
2	Description and pathology of diseases caused by Aspergillus, Penicillium, Mucomycosis, Blastomycosis Microsporosis, Rhinosporidium, Epidermophyscosis Description and pathology of diseases caused by hemoflagellates; Leishmania donavani, L. tropica, Trypanosoma gambiense; intestinal flagellates; Trichomonas, Giardia, Entamoeba histolytica, malarial parasites, Helminths; Ascaris lumbricoides, Hook worm, pinworm, Filarial parasites.	15
3	Laboratory diagnosis of Common infective syndromes and parasitic manifestations; Methods of transmission and role of vectors- biology of vectors. (1) House fly (2) Mosquitoes (3) sand fly.	10
4	Viral diseases: Description, pathology and lab diagnosis of diseases caused by pox viruses; herpes virus (chicken pox- zoster); orthomyxovirus and paramyxo viruses, adenoviruses, other respiratory viruses (Influenza, Rhino) Viruses affecting nervous system: (Polio, Rabies, Enteroviruses, Reoviruses, hepatitis, HIV. Interferon: Nomenclature, types and classifications. Induction of interferons, types of inducers.	15
5	Need and significance of epidemiological studies. Epidemiological investigations to identify a disease, Principles of chemotherapy, Mode of antibiotics. - Penicillin, streptomycin, sulphonamides and Polymyxins. Antifungal drugs (Nystatin), Antiviral agents. (Ribavirin) Problems of drug resistance and drug sensitivity. Drug resistance in bacteria.	10

RECOMMENDED BOOKS

1.Medical Microbiology, MIMS, Play Fair, Roitt& Mosby Publishers, 5th Ed., 2012.
2. Medical Virology, D.O. White & F.J. Fenner, Academic press, 4th Ed., 1994.
3. Textbook of Microbiology, Ananthanarayan, C.K.J. Panikar, Oreint Longman Ltd., 6th Ed., 2000.
4. Practical Medical Microbiology, Mackie & Mc. Cauetrey, 14th Ed., 1996.

Name of the subject: Medical Microbiology Practical	**Subject Code: MSMBP308CO**
Total Marks for Evaluation: 50	**No. of Contact Hours: 30, Credits:2**

Course Objectives: The module is designed to provide practical knowledge on cultivation of clinical pathogenic samples, blood collection techniques and isolation of antibiotic producing microbes

Course Outcomes:

CO1-Analyze the various pathogens from clinical specimens.

CO2-Analyze the diseased and normal urine samples.

CO3-Analyze the value of blood glucose by biochemical method.
CO4- Identify antibiotic producing microorganism by crowded plate technique.
CO5- Identify E. coli on the basis of morphological, cultural characteristics & biochemical reactions.
CO6- Practice various blood collection techniques.
CO7-Analyze the antimicrobial activities of some antibiotics.
CO8- Calculate the bleeding and clotting time by Duke's method.

S.No.	List of Experiments	Contact Hours
1.	Isolation, cultivation and identification of pathogen from clinical specimens (Blood, Serum, Urine, Pus)	3
2	Urine analysis by strip method	6
3	Estimation of blood glucose by O-Toulidine method.	3
4	Isolation of antibiotic producing organisms by crowded plate technique	3
5	Isolation cultivation & identification of E. coli	3
6	Blood collection techniques	6
7	Antimicrobial activities of selected antibiotics by disc diffusion method	3
8	Estimation of bleeding time & clotting time	3

RECOMMENDED BOOKS

1.Essentials of Clinical Diagnostics, Sunil K Sen, CBS publisher, 9th Ed., 2005.
2. Practical Medical Microbiology, Mackie & McCartney, Elsevier, 14th Ed., 1996.

Name of the subject: Fermentation Technology & Industrial Microbiology	**Subject Code: MSMBT309CO**
Total Marks for Evaluation: 100	**No. of Contact Hours: 60, Credits:4**

Course Objectives: The module is designed to provide introduction & detailed information onthe basics of fermentation process and industrial production.

Course Outcomes:

CO1- Outline in detail the various requirements of large-scale industrial fermentation processes.
CO2- Outline the growth kinetics in batch and continuous cultures, industrial sterilization methods,design of fermenters, recovery and purification of fermentation products and fermentationeconomics.
CO3-Explain the process of isolation, selection and improvement of microbial cultures

CO4- Summarize the characteristics of enzyme probe biosensors, biofilms, biosurfactants, the industrial production of ethyl alcohol, beer and wine, and processes of microbial leaching of Copper and Uranium
CO5- Apply the principle of recombinant DNA technology and protoplast fusion techniques for strain improvement

Unit	Topic/Sub-Topic	Contact Hours
1	An introduction to fermentation processes – The range of fermentation processes. Microorganisms used in industrial microbiological processes – the isolation, preservation and strain improvement of industrially important microorganisms, screening methods, isolation of autotrophic mutants. Media and materials required for industrial microbiological processes – Anti- foams.	10
2	Microbial growth kinetics, batch culture, continuous culture, fed batch culture and Dual or multiple fermentations. Inoculum development for large- scale processes. Design of fermenter: Construction and maintenance of aseptic conditions. Control of various parameters. Construction and maintenance of aseptic conditions. Control of various parameters. Sterilization of media. Types of fermenters. Computer application in fermentation technology. Recovery and purification of fermentation products. Fermentationeconomics.	15
3	Isolation, selection and improvement of microbial cultures: Screening and isolation of microorganisms, primary and secondary metabolites, enrichment, specific screening for the desired product. Strain improvement for the selected organism: mutation and screening of improved cultures, random and strategic screening methods, strategies of strain improvement for primary, secondary metabolites with relevant examples.	15
4	Production of ethyl alcohol, beer & wine. Enzyme probe biosensors, biochips, biofilms, biosurfactants, Biotransformation, Petroleum Microbiology. Microbial leaching- role of microorganisms in the recovery of minerals (uranium, copper) from ores. Microbial products from genetically modified (cloned) organisms ex: insulin. Microbial groups involved in biogas production, design of digester.	10
5	Use of recombinant DNA technology, protoplast fusion techniques for strain improvement of primary and secondary metabolites. Production of recombinant molecules in heterologous system, problems associated with strain improvement programme, improvement of characters other than products and its application in the industry. Preservation of cultures after strain improvement programme.	10

RECOMMENDED BOOKS

1.Principles of Fermentation Technology, Stanbury, P.F., Whitekar, A. and Hall, S.J., 1995.
2. Fermentation Biotechnology: Industrial Perspectives, Chand.
3. Biotechnology- A textbook of Industrial Microbiology, Creuger and Creuger, Sinaeur Associates.
4. Industrial Microbiology, L.E. Casida, Wiley Eastern.

Name of the subject: Fermentation Technology & Industrial Microbiology Practical	**Subject Code: MSMBP309CO**
Total Marks for Evaluation: 50	**No. of Contact Hours: 30, Credits:2**

Programme: M.Sc. in Microbiology **Session 2021-23**

Course Objectives: The module is designed to provide introduction & detailed information onthe basics of fermentation process and industrial production of some food item

Course Outcomes:
CO1- Practice the production of citric acid by using microbes.
CO2- Practice the microbial production of glutamic acid.
CO3- Practice the production of various antibiotics by using a specific strain.
CO4- Demonstrate the method of alcohol production by various organic raw materials.
CO5- Demonstrate the laboratory scale production of some biofertilizers.
CO6- Produce hydrogen gas with the help of some microbes.

S.No.	List of Experiments	Contact Hours
1.	Production and characterization of citric acid using A. Niger	6
2.	Microbial production of glutamic acid	3
3.	Production of rifamycin using Nocardia strain	3
4.	Comparison of ethanol production using various Organic wastes /raw Material [Free cells/ immobilized cells].	6
5.	Laboratory scale production of biofertilizers [Nitrogen fixer/Phosphate Solubilizers/siderophore producers]	6
6.	Microbial production of hydrogen gas by algae/bacteria	6

RECOMMENDED BOOKS

1.Experiments in Microbiology, Plant pathology, Tissue Culture and Microbial Biotechnology, K
R Aneja, New age publisher, 5th Ed., 2015.
2. Manual of industrial Microbiology and Biotechnology, Davis J.E. and Demain A.L., ASM publications, 2nd Ed.,

Name of the subject: Food, Agriculture & Environmental Microbiology	**Subject Code: MSMBT305DSE**
Total Marks for Evaluation: 100	**No. of Contact Hours: 60, Credits:4**

Course Objectives: The module is designed to provide introduction & detailed information on the microbiology of food, soil and water and their applications.

Course Outcomes:

Programme: M.Sc. in Microbiology **Session 2021-23**

CO1- Analyse the characteristics of important pathogens & spoilage microorganisms in foods.
CO2- Identify ways to control the growth of microorganisms in food & dairy industries.
CO3- Discriminate the role of microorganisms in the field of environmental microbiology.
CO4- Apply the role of microorganisms in the field of agricultural microbiology.
CO5- Distinguish between the airborne and waterborne microbes.

Unit	Topic/Sub-Topic	Contact Hours
1	Microbiology of foods – Microbial flora of fresh foods, grains, fruits, vegetables, milk, meat, eggs and fish and their infestation by bacteria, fungi and viruses. Microbiological examination of foods- microscopic techniques and cultural techniques. Direct microscopic examination, total colony counts and differential enumeration. Identification of specific groups – Bacteria, Viruses, Fungi and Protozoa. Microbial spoilage of milk, food, types of spoilage organisms, food poisoning, bacterial toxins.	15
2	Food processing & preservation: Methods of food preservation. Aseptic handling, pasteurization of milk, refrigeration and freezing, dehydration, osmotic pressure, chemicals-organic acids, nitrates, nitrites and cresols, Radiation-UV light, gamma radiation Fermented Foods: Preparation of yogurt, cheese, soyabean, single cell proteins. Yeast, algae and fungal biomass production.	15
3	Soil Environment- Microorganisms, soil structure, soil profile, Physico-chemical conditions, Microbial composition, sampling techniques, role of Microorganisms in organic matter decomposition (cellulose, Hemicellulose, Lignin) Bio-geo chemical cycles – Carbon cycle, Nitrogen cycle – Nitrogen fixation, nitrification, de-nitrification, sulphur, iron and phosphorus cycles. Rhizosphere – microorganisms and bio chelators.	10
4	Biofertilizers – Introduction, biofertilizers using nitrogen fixing microbes –phosphate solubilization- Rhizobium, Azotobacter, Azospirillum, Azolla; Anabaena Symbiosis, blue green algae, Mycorrhiza, Biopesticides – toxins from Bacillus thuringiensis, Pseudomonassyringae, Biological Control – Use of Baculovirus, NPV virus, protozoa & fungi in biological control.	10
5	Aquatic environment: Fresh water microorganisms, Salt water, oceans, estuaries, microorganism (their zonation and characteristics). Faecal pollution of waters – water borne diseases, indicator organisms. IMVIC test, sanitary examination of water. Atmospheric Environment: Dispersal of airborne microorganisms. Air Sampling principles and techniques. Air spora: Concepts and components, indoor and outdoor air spora. Diurnal periodicity patterns. Seasonal periodicity patterns. Vertical profiles.	10

RECOMMENDED BOOKS

1. Food Microbiology: Fundamentals & Frontiers, M.P. Dayle et al, ASM press, 2nd Ed., 2001.
2. Food Microbiology, Frazier W.C. and West haff D.C., Tata Mc. Graw Hill Publishing Company Limited, New Delhi, 1988.
3. Basic Food Microbiology, Banwart, G.J., CBS Publishers and Distributors, Delhi, 1989.
4. Agricultural Microbiology, G. Rangaswamy and Bagyaraj, Prentice Hall India,1992.
5. Bio-fertilizers in Agriculture and Forestry, N.S. Subba Rao, 1995.
6. Soil Microbiology and Plant Growth, N.S. Subba Rao, 1995.
7. Environmental Microbiology, Ralph Mitechell, 2nd Ed., 2010.
8. Bioremediation principles, Eweis, 1998.

Name of the subject: Food, Agriculture &Environmental Microbiology Practical	**Subject Code: MSMBP305DSE**
Total Marks for Evaluation: 50	**No. of Contact Hours: 30, Credits:2**

Course Objectives: The module is designed to provide practical knowledge of biochemical analysis of some food products including toxic substances, bioremediation techniques and treatment of sewage and industrial wastes

Course Outcomes:

CO1- Analysis of some natural food product by biochemical method.
CO2- Calculate citric acid by titrimetric method.
CO3-Analyze the glucose consumed by yeast while culturing them with different sugars.
CO4- Illustrate the preparation method of food items with the help of microbes.
CO5- Examine utilization of microbial consortium for the treatment of solid waste.
CO6- Experiment of working principle of bioremediation technique for heavy metals.
CO7-Analyze bacteria from contaminated foods.
CO8- Calculate physical parameters of waste water.

S.No.	List of Experiments	Contact Hours
1.	Identification of pH of natural food	3
2.	Estimation of citric acid by titrimetric method	3
3.	Estimation of glucose in food products by DNS & Yeast growth curve	4
4.	Preparation of bread using yeast	6
5.	Utilization of microbial consortium for the treatment of solid	5

	waste	
6.	Biotransformation of toxic chromium (+ 6) into non-toxic (+ 3) by Pseudomonas species.	3
7.	Isolation of food poisoning bacteria from contaminated foods, Dairy products	3
8.	Physical analysis of sewage/industrial effluent by measuring total solids, total dissolved solids and total suspended solids.	3

RECOMMENDED BOOKS

1.Experiments in Microbiology, Plant pathology, Tissue Culture and Microbial Biotechnology, K
R Aneja, New age publisher, 5th Ed., 2015.
2. A Manual of Environmental Microbiology, Christon J. Hurst (Chief Editor), ASM Publications,
2nd Ed., 2001.

Name of the subject: Bioinformatics	**Subject Code: MSMBT306DSE**
Total Marks for Evaluation: 100	**No. of Contact Hours: 60, Credits:4**

Course Objectives: The module is designed to provide introduction & detailed information on storing, retrieving, analysing biological data in silico.

Course Outcomes:

CO1- Explain the different resources or tools available for bioinformatics.
CO2- Analyze sequence similarity and alignment using the bioinformatic tools.
CO3- Practice phylogenetic analysis.
CO4- Predict protein structure by using different database.
CO5- Explain cheminformatics, its history and evolution.

Unit	Topic/ Sub Topic	Contact Hours
1	Introduction and Bioinformatics Resources: Knowledge of various databases and bioinformatics tools available at these resources, the major content of the databases, Nucleic acid sequence databases: GenBank, EMBL, DDBJ, Protein sequence databases: SWISS- PROT, TrEMBL, PIR, PDB, Genome Databases at NCBI, EBI, TIGR, SANGER, Other Databases of Patterns/Motifs/System Biology (Gene and protein network database and resources), Various file formats for bio-molecular sequences: GenBank, fasta, gcg, etc.	10
2	Basic concepts of sequence similarity, identity and homology, definitions of homologues, orthologues, paralogues.Scoring matrices: basic concept of a scoring matrix, PAM and BLOSUM series. Sequence-based Database	15

	Searches: BLAST and FASTA algorithms, various versions of basic BLAST and FASTA. Pairwise and Multiple sequence alignments: basic concepts of sequence alignment, Needleman &Wuncsh, Smith & Waterman algorithms for pairwise alignments, Progressive and hierarchical algorithms for MSA. Use of pairwise alignments and Multiple sequence alignment for analysis of Nucleic acid and protein sequences and interpretation of results.	
3	Phylogeny: Phylogenetic analysis, Definition and description of phylogenetic trees and various types of trees, Method of construction of Phylogenetic trees [distance-based method (UPGMA, NJ), character-based methods (Maximum Parsimony and Maximum Likelihood method0, disk covering methods],Computational approaches for gene identification, ORF and Human Genome Project.	10
4	Protein Structure Prediction; Homology modelling, prediction of protein structure from sequences, functional sites, Protein folding problem, protein folding classes, protein identification and characterization; AACompIdent, TagIdent, PepIdent and MultiIdent; PROSEARCH, Pep Sea, Pep MAPPER, FindPept, Predicting transmembrane helices, Primary structure analysis and prediction, Secondary structure analysis and prediction, motifs, profiles, patterns and fingerprints search.Methods of sequence based protein prediction	15
5	Introduction to cheminformatics, Evolution of cheminformatics, History of chemical information science. Use of cheminformatics, Prospectus of cheminformatics, History of medicinal chemistry.	10

RECOMMENDED BOOKS

1. Essential Bioinformatics (Paperback), JinXiong, Cambridge University Press.
2. Bioinformatics: Methods & Protocols, Stephen Misener and Stephen A. Krawetz, Humana Press.
3. Essentials of Bioinformatics, Irfan Ali khan and Atiya Khanum, Publisher: Ukaaz Publications.
4. Bioinformatics: Sequence and Genome Analysis (Hardcover), David W. Mount, Cold Spring Harbor Laboratory Press.

Name of the subject: Bioinformatics Practical	**Subject Code: MSMBP206DSE**
Total Marks for Evaluation: 50	**No. of Contact Hours: 30, Credits:2**

Course Objectives: The module is designed to provide a detailed knowledge of online databases available and functioning of all the software to study the bio molecules of life.

Course Outcomes:

CO1- Demonstrate various collection of biomolecules.
CO2- Compute basics of sequence alignment and analysis.
CO3- Illustrate data visualization software to effectively communicate results.
CO4- Interpret the representation of evolutionary relationships among organisms.
CO5-Analyse biological macromolecular structures and structure prediction methods.

CO6- Outline common methods and applications for analysis of gene or protein expression.

S.No.	List of Experiments	Contact Hours
1	Use of Databases	5
2	Sequence retrieval and format conversion	5
3	BLAST based logical searches	5
4	Building Phylogenetic trees	5
5	DNA and protein structure predictions	5
6	Proteins-protein interactions and prediction of Go: biological process	5

RECOMMENDED BOOKS

1. Bioinformatics: Methods & Protocols By Stephen Misener and Stephen A. Krawetz, Humana Press.

Name of the subject: Seminar	**Subject Code: MSMBT302SEC**
Total Marks for Evaluation: 50	**No. of Contact Hours:30, Credits:2**

Course Objectives: The module is designed to make a student skilled in making presentations and presentation ability.

Course Outcomes:
CO1-Practice scientific readings & presentation skills.
CO2-Outline how to make a poster for seminar and conferences.
CO3- Practice persuasive speech, present information in a compelling, well-structured, and logical sequence.
CO4-Express oral and written communication skills.

Name of the subject: Summer Training Report	**Subject Code: MSMBP301AEC**
Total Marks for Evaluation: 50	**No. of Contact Hours: --90, Credits:2**

Course Objectives: The module is designed to make a student industry skilled by going through a rigorous 1/2 months of summer training.

Course Outcomes:
CO1- Practice the latest techniques in research and development laboratories.
CO2- Apply the working principles of basic and high throughput instruments.
CO3- Practice persuasive speech, present information in a compelling, well-structured, and logical sequence.
CO4- Demonstrate hands on practical skills.

SEMESTER IV

Name of the subject: Dissertation & Viva	**Subject Code: MSMBT4010CO**
Total Marks for Evaluation: 200	**No. of Contact Hours: -- Credits:24**

Course Objectives: The module is designed to provide intensive lab orientation and six months long internship to create a research-oriented attitude in students.

Course Outcomes:
CO1:Analyse the importance of doing a hands-on research project.
CO2: Outline how to review a literature and finalize a topic of research.
CO3:Illustrate the process of compiling a thesis.
CO4: Summarize the importance of hands on training in research and development.

Name of the subject: SWAYAM-Microbiology	**Subject Code: MSMBT401GE**
Total Marks for Evaluation: 50	**No. of Contact Hours: -- Credits:4**

Course Objectives: The module is designed to provide 4-12 weeks long online courses including virtual lab orientation provided by a government online platform (SWAYAM) to create a research-oriented attitude in students.

Course Outcomes:
CO1-Show the ability to strictly follow the course information.
CO2-Develop participation and engagement by creating learner-centred communities using group projects.
CO3-Solve the weekly assignments and assessments given based on critical thinking.
CO4- Develop time management, intrinsic motivation and commitment to the course.
CO5- Develop self-directed learning environment and enhancement of computer and language.