Kavayitri Bahinabai Chaudhari

North Maharashtra University, Jalgaon

Structure of Syllabus

Program B.Sc.

T. Y. B. Sc. (Microbiology)

Choice Based Credit System (CBCS)

2020-21

T.Y.B.Sc. Microbiology

Preamble

The degree course of Bachelor of Science (Choice Based Credit System) in Microbiology has been designed with a multi-faceted approach so as to meet the ever-growing challenges in the field of Pathology, Immunology, Genetics, Biochemistry, Pharmaceuticals, Food and Dairy industry, Agriculture and Nanotechnology. The beneficiaries of this course are entitled to get enriched with a wide range of theoretical and practical knowledge in the above fields. The aim is to inculcate interest in the subject and apply the knowledge gained for society, employment, business, as well as research. The subjects incorporated shall be updated with the novel technologies and innovative methods to go hand in hand with the developing demands of Life Sciences. The course is empowered with skills focussed to gain proficiency in handling equipment and learning the norms and precautions essential in a Microbiology Laboratory. The B.Sc. course shall build graduates that shall apply the knowledge gained for collection and interpretation of data in research. They shall also be acquainted with skills for presentation of data in a standard scientific style. The course has the greatest asset to envisage the beneficiaries with the practical and theoretical skills needed in the subject once they qualify the degree and face the open challenges of Microbiology in the world. The upcoming global challenges have been taken into consideration with priority during the designing of the course. This shall attract students to opt the subject so as foresee a sound knowledge in the subject and satisfy their curiosities. The motive is to lay a strong foundation for the student in the subject that shall help him grow and reach his targets in the global educational hub.

The candidates opting for the course shall get enough opportunities to select courses of his/her choice. This will bestow full justice to their interests. Restructuring of the syllabus has been done to suffice the needs of a choice-based credit system that shall strengthen the student's intellectual status at large.

Board of Studies in Life Science has taken efforts to fulfil the components of Teaching-Learning-Evaluation process to a maximum extent during the compilation of the syllabi. The syllabus is vividly endowed with course objectives and learning outcomes for every subject. The guidelines laid down by University Grants Commission (UGC), New Delhi for the CBCS have been given due justice during the restructuring of the syllabi.

Hence, Board of Studies in Life Sciences in its meeting accepted the revised syllabus for T. Y. B. Sc. (Microbiology) based on Choice Based Credit System (CBCS) of UGC guidelines.The path for a bright future of Microbiology has been emphasized to build up with a hope to achieve the goals in the form of fruitful program outcomes in the coming days.

There are 08 core courses which encompass all important aspects of the discipline of Microbiology and are all compulsory courses. 04 choice-based Discipline Specific Elective (DSE) courses are designed which give the students a chance to apply their knowledge of Microbiology to study societal problems. The students have a freedom to select the courses of

their choice while Skill based Elective Courses (SEC) are also included to develop skills in areas which are related to employability in diagnostics, health, food and pharmaceutical industries, agriculture and environment.

Programme Outcome (PO):

As an outcome, the graduate students are expected to gain the following competencies upon completion of this program B. Sc.

- Students will understand the concepts and significance in the field of Biochemistry / Biotechnology / Microbiology that can be used for solving the real time problems.
- Students will acquire skills and ability in their field and find professional opportunities in industry, agriculture and higher studies.
- Students will have improved personal qualities and transferable skills to help them to groom as responsible citizens.

Program Specific Objectives (PSO):

- Microbiology graduates will apply their knowledge and skills gained through the program to achieve success in their academic and/or professional development.
- Our graduates can apply this knowledge for pursuing postgraduate education.
- The program shall promote them to choose varied career paths in various disciplines of the subject.
- Our candidates will develop a sense of societal and ethical responsibility pertaining to health, agriculture, dairy, genetic engineering, and fermentation industry.
- The knowledge shall promote our graduates to stand independently amidst the growing technological innovations in the subject.
- Students will have an expertise in isolation techniques and diagnostic tests.
- Students will have a wide perspective on fermentation technology, GMP, GLP and IPR.
- Students will have familiarity with metabolism functional in bacteria.
- Students will understand contemporary environmental issues and shall be motivated to provide solutions for solving them.

Learning Objectives (LO):

- To acquaint the students with various disciplines of Microbiology.

- To articulate foundation and pillar level knowledge of Microbiology for the beneficiaries to apply them for advanced studies in the subject.
- To develop practical skills with a sound theoretical background.
- To apply the knowledge gained for higher education, research and profession of their choice.
- To analyse their interests among the various disciplines and implement them in their professional endeavours.

Programme Structure:

The programme includes 8 Discipline Specific Core Courses (DSC) of 3 credits each, 4 each for the two semesters (Semester V and VI). There shall be inclusion of 02 Skill Enhancement Course (SEC) of 3 credits each, one for each Semester. The course has incorporated 4 Discipline Specific Elective Course (DSE) of 3 credits each, two for each Semester. The student shall have liberty to choose one of the two courses. There shall be 6 Discipline specific Core Practical courses of 2 credits each; 3 courses for each semester.

Eligibility:

Students completing Second Year CBCS (Semester III and IV) of B.Sc. (44 credits) in Microbiology shall be eligible for admission to T. Y. B. Sc. degree course having CBCS pattern. However, the candidate must pass all subjects of first year.

Course Fee: As per University norms.

Duration: The duration of B. Sc. (Microbiology) degree program shall consist of three years.

Medium of instruction: The medium of instruction for the course shall be English.

Credit to contact hour/Duration of Lecture: 45 Lectures of 60 minutes or 54 Lectures of 50 minutes shall be conducted for 08 Discipline Specific Core courses, 02 Skill Enhancement Courses and 02 Discipline Specific Elective courses of 3 credits each. Each theory and practical course must be completed in 45 and 60 lectures, respectively of 60 minutes duration. The score allotted for 06 Discipline Specific Core practical courses is 2 credits for each course.

Attendance:

The candidates appearing for the final year examinations of B.Sc. Microbiology need to fulfill a regular attendance record in theory and practical of not less than 80 %. Failing to fulfill the criteria the student shall not be eligible for appearing for the T. Y. B. Sc. (CBCS) examination.

Exam Pattern

- Each theory and practical course will be of 100 marks comprising of 40 marks internal (College assessment) and 60 marks external examination (University assessment).
- Theory examination (60 marks) will be of three hours duration for each theory course. There shall be 5 questions each carrying equal marks (12 marks each) while the tentative pattern of question papers shall be as follows;
- Question 1 (12 marks): 9 sub-questions, each of 2 marks; answerable in 2 -3 line and based on entire syllabus, attempt any 6 out of 9 questions.
- Question 2, 3 and 4 (12 marks each): based from Unit I, II, and III, respectively, each question has 3 sub-questions of 6 marks each and answer only 2 sub-questions from each Q2, Q3, and Q4 in brief.
- Question 5 (12 marks): answer only 3 out of 5 in brief, based from all 3 units, Each 4 marks.

Internal examination (40 marks each semester):

Internal assessment (College assessment) of the student by respective teacher will be comprehensive and continuous, based on written test. The written test shall comprise of both objective and subjective type questions.

Practical Examination:

Practical examination shall be conducted by the respective college at the end of the semester. Practical examination will be of minimum 5-6 hours duration and shall be conducted as per schedule (10 am to 5 pm on schedule date or can be scheduled 10 am -1 pm / 2 – 5 pm for 2 consecutive days) in case of microbiology practical where incubation condition, allied aspect is essential. There shall be 5 marks for laboratory logbook and well written journal, 10 marks for *viva-voce* and minimum three experiments (major and minor). Certified journal is

compulsory to appear for practical examination. There shall be one expert and two examiners (external and internal) per batch for the practical examination.

Scheme

Scheme for T. Y. B. Sc. program under the Faculty of Science and Technology includes in continuation with the First and Second Year's two semesters namely Semester V and VI. Each semester shall include four Core courses; one Skill based course, one Elective course, three Core practicals and one non-credit Elective Audit course.

Scheme for B.Sc. Program under Faculty of Science and Technology

Sr. No.	Year → / Course ↓	First Year				Second Year				Third Year				Total Credit Value
		Sem I		Sem II		Sem III		Sem IV		Sem V		Sem VI		
1	Core Courses (16)	Credits each	Courses	Credits each	Courses	Credits each	Courses	Credits each	Courses	Credits each	Courses	Credits each	Courses	
	i. Theory	4	4	4	4	4	3	4	3	3	4	3	4	4x14=56 3x8=24
	ii. Practical	2	4	2	4	2	3	2	3	2	3	2	3	2x4=28 2x6=12
2	Ability Enhancement Compulsory Course (AECC) (2)	2	1	2	1	2	1	2	1					2x2x2x2 =08
3	Skill Enhancement Course (SEC) (4)					2	1	2	1	3	1	3	1	2x2=04 3x2=06
4	Discipline Specific Elective (DSE) (6)									3	1	3	1	3x2=06
5	Elective Audit									No credit	Any 1	No credit	Any 1	--
6	Total Credit Value	26		26		22		22		24		24		**144**

	(Credit x No. of courses)							

Structure of Curriculum of T. Y. B. Sc. (Microbiology) Semester V

Discipline	Course Type	Course Code	Course Title	Credits	Hours/ Week (Clock Hours)	Total Teaching hours	Marks	
							CA	UA
DSC	Core I	MB-501	Microbial Genetics	3	3	45	40	60
	Core II	MB-502	Bioprocess Technology	3	3	45	40	60
	Core III	MB-503	Metabolism	3	3	45	40	60
	Core IV	MB-504	Basic Immunology	3	3	45	40	60
SEC	Skill Based	MB-505	Medical Microbiology I	3	3	45	40	60
DSE	Elective Course (Anyone)	MB-506A	Food Microbiology	3	3	45	40	60
		MB-506B	Pharmaceutical Quality Control and Quality Assurance					
DSC	Core (Practical)	MB-507	Methods in Medical Microbiology-I	2	4 (per batch)	60	40	60
		MB-508	Methods in Industrial Microbiology-I	2	4 (per batch)	60	40	60
		MB-509	Methods in Applied Microbiology-I	2	4 (per batch)	60	40	60
AU	Elective Audit Course (Anyone)	AC-501A	NCC	No credit	2	30	100	--
		AC-501B	NSS					
		AC-501C	Sports					

DSC: Discipline Specific Core Courses/Core Practical

SEC: Skill Enhancement Course

DSE: Discipline Specific Elective Course

AU : Audit course

CA : College assessment (Internal examination)

UA : University assessment (External examination)

NCC: National Cadet Corps

NSS: National Service Scheme

Structure of Curriculum of T.Y.B.Sc. (Microbiology) Semester VI

Discipline	Course Type	Course Code	Course Title	Credits	Hours/ Week (Clock Hours)	Total Teaching hours	Marks	
							CA	UA
DSC	Core I	MB-601	Molecular Biology	3	3	45	40	60
	Core II	MB-602	Fermentations	3	3	45	40	60
	Core III	MB-603	Enzymology	3	3	45	40	60
	Core IV	MB-604	Advanced Immunology	3	3	45	40	60
SEC	Skill Based	MB-605	Medical Microbiology-II	3	3	45	40	60
DSE	Elective Course (Anyone)	MB-606A	Agricultural Microbiology	3	3	45	40	60
		MB-606B	Regulatory Practices & IPR					
DSC	Core (Practical)	MB-607	Methods in Medical Microbiology-II	2	4 (per batch)	60	40	60
		MB-608	Methods in Industrial Microbiology-II	2	4 (per batch)	60	40	60
		MB-609	Methods in Applied Microbiology-II	2	4 (per batch)	60	40	60
AU	Elective Audit Course (Anyone)	AC-601A	Soft Skill	No credit	2	30	100	--
		AC-601B	Yoga					
		AC-601C	Practising cleanliness					

DSC: Discipline Specific Core Courses/Core Practical

SEC: Skill Enhancement Course

DSE: Discipline Specific Elective Course

AU : Audit course

CA : College assessment (Internal examination)

UA : University assessment (External examination)

Skill Enhancement Course (SEC):

To increase the potentiality of Microbiology students in industries and to make them more employable in pharmaceutical industries or medical Microbiology fields and go for higher studies. This course will improve skills of required for them to boost their industrial and research career.

Discipline Specific Elective Course (DSE)

Elective course will give students choice to study the course of their interest that include the food, pharmaceutical and agricultural microbiology. This shall give them a real choice in selecting the course of their interest. In the 5th semester, student can choose either Food Microbiology or Pharmaceutical Quality Control and Quality Assurance. Whereas in the 6th semester they have choice between Agricultural Microbiology or Regulatory Practices & IPR. Student who has selected Food Microbiology for the 5th semester, compulsorily must take Agricultural Microbiology in 6th semester while one who has selected Pharmaceutical Quality Control and Quality Assurance shall opt for Regulatory Practices & IPR in the 6th semester.

Audit Course (AU):
The syllabi for audit courses will be common for all courses and shall be available separately.

Equivalence of the courses for T. Y. B. Sc. (Microbiology)

Old Syllabus (June 2016) (Semester pattern 60:40) courses		**Equivalent New Syllabus (June 2020) CBCS pattern (Semester pattern 60:40) courses**	
Course Code	**Paper**	**Course Code**	**Paper**
Semester V			
MB-351	Microbial Genetics	**MB-501**	Microbial Genetics
MB-352	Fermentation Technology	**MB-502**	Bioprocess Technology
MB-353	Microbial Metabolism	**MB-503**	Metabolism
MB-354	Medical Microbiology	**MB-505**	Medical Microbiology-I
MB-355	Immunology	**MB-504**	Basic Immunology
MB-356	Applied Microbiology	**MB-506 (A)**	Food Microbiology
MB-357	Techniques in Diagnostic Microbiology-I	**MB-507**	Methods in Medical Microbiology-I

MB-358	Techniques in Industrial Microbiology-I	**MB-508**	Methods in Industrial Microbiology-I
MB-359	Techniques in Applied Microbiology-I	**MB-509**	Methods in Applied Microbiology-I
Semester VI			
MB-361	Molecular Biology	**MB-601**	Molecular Biology
MB-362	Pharmaceutical Microbiology	**MB-602**	Fermentations
MB-363	Enzymology	**MB-603**	Enzymology
MB-364	Clinical Microbiology	**MB-605**	Medical Microbiology-II
MB-365	Diagnostic Immunology	**MB-604**	Advanced Immunology
MB-366	Environmental Microbiology	**MB-606 (A)**	Agricultural Microbiology
MB-367	Techniques in Diagnostic Microbiology-II	**MB-607**	Methods in Medical Microbiology-II
MB-368	Techniques in Industrial Microbiology-II	**MB-608**	Methods in Industrial Microbiology-II
MB-369	Techniques in Applied Microbiology-I	**MB-609**	Methods in Applied Microbiology-II

T.Y.B.Sc. (CBCS) Syllabus Semester - V

Discipline Specific Core (DSC) Course		
MB 501- Microbial Genetics		
Total Hours:45		**Credits:3**
Course Objectives • To introduce the concepts in Microbial Genetics. • To acquaint with molecular techniques. • To update applied knowledge in the field of microbial genetics.		
Learning Outcomes After successful completion of this course, students are expected to: • Acquaint with the concepts of Gene transfer and its Central Dogma. • Able to learn the principles and applications of various molecular techniques. • Students shall have the basic knowledge of operon and r-DNA technology.		
Unit	**Topics**	**Lectures**
UNIT-1	**Central Dogma**	**15**
➢	Introduction to the concept of Central Dogma of molecular biology	
	Primary and Secondary structure of DNA	
	Denaturation and Renaturation of DNA, Cot Curve	
➢	Replication of DNA	
	Modes of Replication: Conservative, Semiconservative, Dispersive	
	Meselson and Stahl Experiment	
	Mechanism of Bacterial DNA Replication: • Initiation: Unwinding, Primer • Elongation: DNA Polymerase I and III, Replication fork • Termination	
	Models of Replication: Theta, Rolling Circle, Linear Eukaryotic	
	The fidelity of DNA Replication.	
➢	Transcription in Bacteria	
	Components of Transcription: Template, Transcription Unit, Substrate for Transcription, Transcription apparatus, Bacterial RNA polymerase	
	• Initiation: Bacterial Promoters • Elongation • Termination: Rho dependent and Rho independent	
➢	Translation in Bacteria	
	Binding of Amino Acids to Transfer RNA (Activation of Amino acid and Charging of t-RNA)	
	• Initiation: Initiation factors, Shine-Dalgarno Consensus Sequence, Subunits of ribosomes	

	• Elongation: A. P. E sites • Termination: Release factors	
UNIT 2	**Viral Genetics**	**15**
➢	Classification of viruses based on genome	
➢	Salient features of viral genome • Unusual bases: TMV and T4 • Overlapping genes: Hepatitis B virus • Alternate Splicing: Retrovirus • Terminal redundancy: T4 • Terminal Cohesive ends: Lambda • Segmented Genome: Influenza Virus • Non-segmented Genome: Picorna virus	
➢	Structure of Double Stranded DNA phages: T4 and Lambda.	
➢	Lytic Cycle	
	Lysogenic Cycle	
➢	Bacteriophage mutants: • Plaque morphology • Conditional lethal (Ts and Am) mutants • Deletion Mutants	
UNIT 3	**Gene Transfer and Repair Mechanisms**	**15**
➢	Gene Transfer by Transformation: • Development of Competence (Gram Positive & Gram Negative) • Mechanism in Gram Positive and Gram Negative bacteria	
➢	Gene Transfer by Conjugation: • F^+, Hfr and F^1 strains • F plasmid • Conjugation in F^+ and Hfr cells	
➢	Gene Transfer by Transduction: • Generalised Transduction • Specialised Transduction • Abortive Transduction	
➢	Transposition: • Transposable elements that move via DNA intermediates: IS Composite & TnA family of transposons • Mechanism of DNA mediated transposition	
➢	• Transposable elements that move via RNA intermediates: Retrotransposons • Mechanism of retro-	

	transposition	
➢	DNA Repair mechanisms: • DNA damage • Direct Reversal of DNA damage • Base Excision Repair by base flipping • Nucleotide Excision Repair • Recombination repair • Translesion DNA synthesis (TLS) • SOS Repair	

Suggested Reading:

1. Gunther S. Stent, (1978), Molecular Genetics: An Introductory Narrative, 2nd Edn. W.H. Freeman & Co.
2. Hayes, W. (1964), The Genetics of Bacteria and their Viruses, CBS Pub. New Delhi.
3. Gardner, Simmons, Snustad. (2006), Principles of Genetics, 8th Ed. John Wiley & Sons. Inc. New York.
4. Primrose, S. B. (2002). Principles of Gene Manipulation 6th Edn Oxford: Blackwell Scientific Publications.
5. Strickberger, M.W. (1985), Genetics, 3rd Edition Macmillan Pub. Co. NY.
6. Uldis N. Streips, Ronald E. Yashbin (2002) Modern Microbial Genetics, 2nd Edition, Wiley-Liss, Inc.
7. Watson et al., (2004) Molecular Biology of Genes, International Edition, Benjamin Cummings Publishers.
8. Jeremy W. Dale and Simon F. Park (2004) Molecular Genetics of Bacteria, 4th Edition, John Wiley and Sons, Ltd.
9. David Freifelder, (1987) Molecular Biology, 2nd Edition. Jones & Bartlett Publication.

Websites

- https://www.biointeractive.org/classroom-resources/central-dogma-and-genetic-medicine
- https://courses.lumenlearning.com/microbiology/chapter/the-viral-life-cycle/

Discipline Specific Core (DSC) Course		
MB 502- Bioprocess Technology		
Total Hours:45		**Credits:3**

Course Objectives

- To introduce with concepts related to bioreactors and their types.
- To acquaint with concepts strain improvement and scale up.
- To understand the processes involved in fermentation.

Learning Outcomes

After successful completion of this course, students are expected to:

- Know a bioreactor, its parts, types and working.
- Get knowledge about the significant processes in a bioreactor like strain improvement, inoculum development sterilization and scale-up.

Unit	Topics	Lectures
UNIT-1	**Bioreactor Engineering**	**15**
➢	Types of bioreactor (Air-lift fermenter and Bubble column bioreactor.	
➢	Types of - Impeller, Sparger and Baffle arrangements.	
➢	Probes (O_2 and pH), Control of Temperature and Foam.	
➢	On-line, In-situ, Measurements within fermenter.	
UNIT-2--	**Industrial Sterilization, Strain Improvement and Scale Up**	**15**
➢	Need of aseptic conditions in fermentation process.	
➢	Fermentation media sterilization – Batch and Continuous.	
➢	Sterilization of air by Filtration.	
➢	Methods of strain improvement based on: • Modification of permeability • Mutation • r-DNA technology	
➢	Criteria for scale-up, Scale-up of industrial process.	
UNIT-3	**The Development of Inoculum for Industrial Fermentations**	**15**
➢	Introduction and criteria for the transfer of inoculum	
➢	The development of inoculum for yeast processes: • Brewing • Bakers' yeast	
➢	The development of Inoculum for bacterial processes.	
➢	The development of Inoculum for mycelial processes: • Sporulation on solidified media • Sporulation on solid media • Sporulation in submerged culture • The use of the spore inoculum. • Inoculum development for vegetative fungi.	
➢	The effect of inoculum on the morphology of filamentous organisms in submerged culture.	

➢	The aseptic inoculation of fermenters: • Inoculation from a laboratory fermenter or a spore suspension vessel. • Inoculation from a fermenter.	

Suggested Reading

1. Stanbury, P. F., Whitaker, A., Hall, S. J, (1997), Principles of fermentation Technology, Aditya Book Pvt. Ltd., New Delhi.
2. Demanin Arnold L. and Davies Julian E., (1999) Manual of Industrial Microbiology and Biotechnology, 2nd ed. Panima, ASM Press.
3. Bu'lock, J. and Kristiansen, B, (1987), Basic Biotechnology, Academic Press, London.
4. Rehm, Ii J. and Reed, G, (1983), Biotechnology vol.111, Verlag Chenue, Florida.
5. Casida, L. E., (1991), Industrial Microbiology, Wiley Eastern, New Delhi.
6. Peppler, H. J., Perlman, D., (1979), Microbial Technology, vol. I & II, Academic Press.
7. Prescott, S. C. And Dunn, C. G, (1987), Industrial Microbiology, 3rd Ed., McGraw Hill, New York.
8. Ratledge, C. and Kristiansen, B., (2001), Basic Biotechnology, Cambridge University Press.
9. Patel, A. H., (1984), Industrial Microbiology, MacMillan India Ltd., New Delhi.
10. Doelle, H. W., Mitchell, D. V. and Rolz, C E., (1992), Solid Substrate Cultivation, Elsevier Science Publishers Ltd.. England.
11. Crueger W and Crueger A., (2000) Biotechnology: A textbook of Industrial Microbiology, 2nd ed. Panima Publishing corporation, New Delhi.
12. Jogdand S. N. (2006) Industrial Biotechnology, Himalaya Publishing House, Mumbai.

Discipline Specific Core (DSC) Course		
MB 503- Metabolism		
Total Hours:45		**Credits:3**

Course Objectives

- To acquaint with the principles of Bioenergetics.
- To understand the concept of thermodynamics and Electron Transport Chain.
- To define the types of anabolic and catabolic pathways and the mechanisms involved therein.

Learning Outcomes

After successful completion of this course, students are expected to:

- Get well versed with the catabolic and anabolic pathways.
- Understand the concept of ETC and principles of thermodynamics.
- Apply the principles of metabolism in various bacteria.

Unit	Topics	Lectures
UNIT-1	**Bioenergetics and Biological oxidation**	**15**
➢	Laws of thermodynamics	
➢	Concept of free energy, entropy and enthalpy	
➢	High energy compounds	
➢	ATP-ADP Cycle	
➢	Redox potential	
➢	Electron transport chain (ETC)	
➢	Inhibitors of electron transport chain	
➢	Oxidative Phosphorylation: Concept and Mechanism	
➢	Inhibitors and Uncouplers of oxidative phosphorylation	
➢	Mitochondrial ATP synthase complex	
➢	Shuttle pathways (Malate aspartate and Glycerol phosphate shuttles)	
➢	Reverse electron transport chain (RETC)	
UNIT 2	**Anabolic pathways**	**15**
➢	Gluconeogenesis	
➢	Cori cycle	
➢	Polysaccharides: Glycogen and Peptidoglycan biosynthesis	
➢	Fatty acid biosynthesis	
➢	FAS Complex: Structure and Significance	
➢	Ketone bodies: Concept and Synthesis	
➢	Purine and Pyrimidine nucleotide biosynthesis (de Novo and Salvage pathway)	
UNIT 3	**Catabolic Pathways**	**15**
➢	Transamination	
➢	Concept of anaplerosis	
➢	HMP Shunt	

➢	Uronic acid Pathway	
➢	Catabolism of Polysaccharides: Starch and glycogen	
➢	Fatty acid oxidation	
➢	PDH Complex: Reactions and Regulation	
➢	Overview of catabolism of proteins	
➢	Deamination (Oxidative and Non-oxidative)	
➢	Urea cycle	

Suggested Reading:

1. Nelson, D. L., and Cox, M. M. (2009), Lehninger's Principles of Biochemistry. New York: WH Freeman.
2. Moat, A., and Foster, J., (1988), Microbial Physiology. Wiley Interscience Publications, New York.
3. Stamen R. Y., Ingraham, J. L., Wheelis, M. L., and Painter, P. R., (1990), General Microbiology, MacMillan Edu. Ltd., London.
4. Berg, J. M., Tymoczko, J. L., and Stryer, L. (2008), Biochemistry (Loose-Leaf). Macmillan.
5. Satyanarayana U., and Chakrapani U., (2006), Biochemistry, Books and Allied (P) Ltd. Kolkata.
6. Zubay, G. L., Parson, W. W., and Vance, D. E. (1995), Principles of Biochemistry. WCB Publishers, Oxford, England.

Discipline Specific Core (DSC) Course		
MB 504 - Basic Immunology		
Total Hours:45		**Credits:3**

Course Objectives

- To study the concepts related to antigen and antibody.
- To study the various immune cells and organs functional in a body.
- To get knowledge about MHC and Antigen Presentation.

Learning Outcomes

After successful completion of this course, students are expected to:

- Get acquainted with Antigenicity and Immunogenicity.
- Know the role of immune cells and organs and the functional mechanisms of each.
- Understand the structure and role of MHC and APC.

Unit	Topics	Lectures
UNIT-1	**History of Immunology**	**20**
➢	Historical developments in the field of immunology	
➢	Contributions of: Edward Jenner, Karl Landsteiner, Robert Koch, Paul Ehrlich, Elie Metchnikoff, Peter Medawar, MacFarlane Burnet, Neils K Jerne, Rodney Porter and Susumu Tonegawa	
➢	Antigen and Antibodies.	
➢	Characteristics of an antigen (Foreignness, Molecular size and Heterogeneity)	
➢	Antigenicity versus Immunogenicity	
➢	Haptens, Epitopes (T & B cell epitopes)	
➢	T-dependent and T-independent antigens	
➢	Adjuvants, Carriers, Antigenic determinants on antibodies (Isotypic, allotypic, idiotypic)	
➢	Genetic basis of antibody formation (organization of heavy and light chain genes) VDJ rearrangements	
➢	Theories of antibody formation (Burnet's clonal selection theory)	
➢	Monoclonal and Chimeric antibodies	
UNIT-2	**Immune Cells and Organs**	**10**
➢	Hematopoesis: Concept of Stem cells.	
➢	Structure, functions and properties of: T cell, B cell, NK cell, Macrophage, Neutrophil, Eosinophil, Basophil, Mast cell& dendritic cell	
➢	Organs of immune system: Bone Marrow, Thymus, Lymph Node, Spleen, GALT, MALT and CALT	
UNIT-3	**Major Histocompatibility Complex and antigen presentation**	**15**
➢	Definition of MHC	
➢	Organization of MHC locus (Mice & Human)	
➢	Structure and Functions of MHC Class I & II molecules	

➢	Antigen processing and presentation: need and significance	
➢	Antigen presentation pathways (Cytosolic and Endocytic pathways) & Cross presentation	

Suggested Reading:

1. Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 6th edition Saunders Publication, Philadelphia.
2. Ananthnarayan, P., Paniker, C. K. J., (1990). Textbook of Microbiology, Orient Longma n, Madras.
3. Banker, D (1980), Modern Practice in Immunization, 3rd Ed., Popular Prakashan Pvt. Ltd., Bombay.
4. Coleman, R. M, Lombard M F, Sicard, R. E., (1989). Fundamental Immunology, 2nd E d., W. C. Brown Publishers, USA.
5. Delves P, Martin S, Burton D, Roitt IM. (2006). Roitt's Essential Immunology. 11th Edn Wiley-Blackwell Scientific Publication, Oxford.
6. Glazier, A. M., Nikaido, H., (1995), Microbial Biotechnology, W. H. Freeman and Co., New York.
7. Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 6th* edition W.H. Freeman and Company, New York.
8. Murphy K, Travers P, Walport M. (2008). Janeway's Immunobiology. 7th edition Garland Science Publishers, New York.
9. Peakman M, and Vergani D. (2009). Basic and Clinical Immunology. 2nd edition Churchill Livingstone Publishers, Edinberg.
10. Richard C and Geiffrey S. (2009). Immunology. 6th edition. Wiley Blackwell Publication.

Skill Enhancement Course (SEC)		
MB 505- Medical Microbiology-I		
Total Hours:45		**Credits:3**

Course Objectives

- To introduce the concepts in Medical Microbiology.
- To enrich knowledge about various diseases with respect to diagnosis, prevention, control and role of chemotherapy.
- To understand the human anatomy with functions.

Learning Outcomes

After successful completion of this course, students are expected to:

- Get a clear vision about various aspects of infectious diseases.
- Understand the principles of immunological phenomena associated with the infectious diseases.
- Carry out fundamental or applied research in the field of Medical Microbiology.

Unit	Topics	Lectures
UNIT-1	**Basic concepts in Medical Microbiology**	**15**
➢	Commensal and Pathogenic Human Microflora and microbiome - normal microflora of the human body, dual nature of normal flora with respect to disease, normal flora of major human body systems (respiratory tract, gastrointestinal tract, genitourinary system, skin) and Concept of human microbiome	
➢	Classification of disease – infectious, communicable, contagious, nosocomial, iatrogenic& zoonotic diseases	
➢	Chain of infection -Portal of entry and exit of pathogen	
➢	Stages of infectious diseases and virulence factors	
➢	Transmission of disease – Modes of transmission	
➢	Collection of clinical samples and Laboratory diagnosis: precautions required for sample collection (oral cavity, throat, skin, blood, urine, faeces)	
➢	Prophylaxis of disease	
➢	Treatment, Prevention and Control of disease	
➢	Epidemiology of disease	
➢	General concept and applications of public health microbiology.	
UNIT-2	**Anatomy and functions of Human System**	**15**
➢	Respiratory System	
➢	Gastrointestinal System	
➢	Excretion system	
➢	Central Nervous System – CNS and PNS	
➢	Reproductive system	
➢	Special Senses - Eye and ear (in brief)	
➢	Skin	

UNIT-3	**Chemotherapeutic agents- General characteristics and mode of action**	**15**
➢	Classes of antimicrobial agents, spectrum of activity and Criteria for evaluation of chemotherapeutic agents.	
➢	Antibacterial agents: Five modes of action with one example each: • Inhibitor of nucleic acid synthesis: Quinolones. • Inhibitor of cell wall synthesis: β-lactams (Penicillin) and polypeptides (Bacitracin). • Inhibitor of cell membrane function: Polymyxins. • Inhibitor of protein synthesis: Tetracyclines, Chloramphenicol. • Inhibitor of metabolism: Sulfonamides.	
➢	Antifungal agents: inhibition of plasma membrane- Amphotericin B, Griseofulvin.	
➢	Antiviral agents: inhibition of viral replication – Amantadine	
➢	Antiprotozoal drug - hydroxychloroquine	
➢	Antitoxin and Interferon as therapeutic drugs	
➢	Antibiotic resistance and its mechanism of resistance- MDR, XDR, MRSA & NDM-1.	

Suggested Reading:

1. Ananthnarayan, P., Paniker, C. K. J., (2009), Textbook of Microbiology 8th Edn, Universities Press, Hyderabad.
2. Atlas, R. M. (1995), Microorganisms in our world, Mosby Yearbook Inc.
3. Chakraborty P (2013), A textbook of Microbiology, New Central Book Agency, Delhi.
4. Davis, B. D., Dulbecco, R, Eisen, H. N., Ginsberg, R. S., (1990), Microbiology, 4th Ed., Harper and Row Publishers, Singapore.
5. Dey, N. C. and Dey, T. K., (1999) Medical Bacteriology and Microbiology, 16th Edn, Allied Agency, Calcutta.
6. Prescott, L. M., Hartley, J. P. and Klein, D. A., (1993), Microbiology, 2nd Ed., W. M. C. Brown Publ, England.
7. Tortora, G. J., Funke, B. R. and Case, C. L., (2004), Microbiology, 8th Edn., Person Education (Low Price edition), Delhi.
8. Nagoba BS and Pichare Asha (2012), Medical Microbiology: Prep Manual for Under Graduates, Elsevier.

Web sites

- http://www.who.ch.- World Health Organization
- http://www.ncbi.nlm.nih.gov/PubMed- PubMed -Medline on the Web.
- http://www.cdc.gov- US Centers for Disease Control (Atlanta)
- http://www.who.int/emc/-WHO Communicable Disease Surveillance and Response

Discipline Specific Elective (DSE) Course		
MB 506 (A) - Food Microbiology		
Total Hours:45		**Credits:3**
Course Objectives • To understand concepts in milk microbiology. • To complement the students with the basic knowledge of food microbiology. • To acquaint the students with food preservation techniques.		
Learning Outcomes After successful completion of this course, students are expected to: • Know the concepts related to popular milk products, milk examination and spoilage. • Comprehend knowledge regarding fermented food products, food spoilage and infection. • Understand diverse strategies for food preservation.		
Unit	**Topics**	**Lectures**
UNIT-1	**Food and Milk Microbiology**	**15**
➢	Milk - Definition, composition and types.	
➢	Microbiological examination of food and milk: Standard plate count, Breed count, Test for mastitis, MBRT test Resazurin test & Brucella ring test.	
➢	Milk products: Fermented milk: Advantage Examples: Dahi / Yoghurt, buttermilk	
➢	Cheese: Types, general production process, microbiological changes during ripening, defects and spoilage.	
➢	Microbial quality of milk • Milk microorganisms: acid/ gas producers, proteolytic, lipolytic, pathogenic etc. • Defects: Colour and Flavour, Sweet curdling, Stormy fermentation& Ropiness.	
UNIT-2	**Fermented products and food spoilage**	15
➢	Fermented foods: Bread and Idli.	
➢	Food infection: sources, mechanism of infection and prevention.	
➢	Microbial food poisoning with respect to toxins, their effects, properties of toxins and treatment: *Staphylococcus aureus, Bacillus cereus, Clostridium botulinum Salmonella* and *Vibrio parahaemolyticus.*	
➢	Aflatoxins: Structure, detection, mode of action and detoxification.	
➢	Fermented vegetables: Sauerkraut and Soy Sauce	
➢	Concept of prebiotics and probiotics and their significance.	
UNIT 3	**Food Preservation Techniques**	**15**
➢	Factors influencing on food preservation.	
➢	Temperature dependent control:	

	• Low temperature: Chilling and freezing • High temperature • Pasteurization: Principle and Types	
➢	Chemical preservatives: Sulphur dioxide, Nitrites and nitrates& Organic acids (Acetic and Lactic acids)	
➢	Antibiotics (Natamycin)	
➢	Canning: Concept and Method.	
➢	Control of Water activity: Dehydration	
➢	Use of radiations: Microwave, UV and Ionizing.	

Suggested Reading:

1. Adams, M. R., Moss, M. O, (1995), Food Microbiology, New Age International, New D elhi.
2. Singh B. D. (2014), Biotechnology: exploring horizons, Kalyani publishers, Ludhiana.
3. Banwart, G. J., (1987), Basic Food Microbiology, CBS Publ., New Delhi.
4. Bilgrami, K. S, Dube, H. G., (1994), Textbook of Modern Plant pathology, Vikas Publ., New Delhi.
5. Frazier, W. C, Westhoff, D C., (1988), Food Microbiology, Tata McGraw Hill, New Delh i.
6. James M. Jay, Martin J. Loessner, David A. (2012), Modern Food Microbiology, 7th Edition(Food Science Texts Series).
7. Winton, A. L, Winton, K. B, (1998), Milk and Milk Products, Agro-botanical Publ, Bikan er.
8. Ray B (2005), Fundamental Food Microbiology, CRC press, London.

Discipline Specific Elective (DSE) Course		
MB 506 (B)- Pharmaceutical Quality Control & Quality Assurance		
Total Hours:45		**Credits:3**

Course Objectives

- To develop practical skills involved in interpretation of biological materials and data.
- To promote development of entrepreneurship and build up Professionals in Pharmaceutical Analysis, teaching and R&D work.
- Develop a scientific attitude to make students open minded, critical and curious about scope, functioning and the future of pharmaceutical Microbiology.

Learning Outcomes

After successful completion of this course, students are expected to:

- Understand microbial spoilage and preservation of pharmaceutical formulations during production and in products.
- Get hands-on knowledge of various methods / processes required in pharmaceutical quality control and assurance.
- Acquire knowledge of GMP practice, CGMP, FDA, GLP and Pharmacopeia.

Unit	Topics	Lectures
UNIT-1	**Microbial production and Spoilage of pharmaceutical products**	**15**
➢	Designing of Microbiology laboratory – Guidelines, Layout Design and layout of sterile product manufacturing unit.	
➢	Microbial contamination and spoilage of pharmaceutical products (sterile injectables, non-injectables, ophthalmic preparations and implants) and their sterilization.	
➢	Other pharmaceuticals produced by microbial fermentations Biopharmaceuticals viz. streptokinase& streptodornase.	
UNIT-2	**Quality control of pharmaceuticals**	**15**
➢	Importance and functions of quality control.	
➢	Methods for quality assessment, Sterilization control and sterility testing: • Heat sterilization • D value, Z value • Survival curve • Radiation • Gaseous sterilization • Filter Sterilization • Ames test • Sterility test • Toxicity test	
UNIT 3	**GMP, GLP and Quality Assurance**	**15**
➢	Good Manufacturing Practices (GMP) and Good Laboratory Practices (GLP) in pharmaceutical industry.	
➢	Regulatory aspects of Quality control, Quality assurance and Quality.	

	Management in Pharmaceuticals.	
➢	A comparison of Quality Control and Quality Assurance.	
➢	Sampling and specification of raw materials and finished Products.	
➢	Validation: Sterile manufacturing unit and Biosafety levels.	
➢	Validation and calibration of Laminar Air Flow, Autoclave, Balance, pH meter and Centrifuge.	
➢	Chemical and biological indicators.	

Suggested Reading:

1. Hugo W. B. & Russell A. D. (2009), Pharmaceutical Microbiology –6th Edn. Blackwell scientific Publications.
2. Analytical Microbiology–Edt by Frederick Kavanagh Volume I & II. (1972), Academic Press New York.
3. Quinolone antimicrobial agents – Edt. Hooper, David C; Rubinstein, Ethan (2003), ASM Press, 3rd edition
4. Quality control in the Pharmaceutical Industry - Murray S. Cooper Vol.2. (1979), Academic Press Washington DC. New York.
5. Biotechnology – Edt. By H. J. Rehm & G. Reed, Vol 4 (1983), VCH Publications, Federal Republic of Germany.
6. Vyas S. P. & Dixit V.K. (2010), Pharmaceutical Biotechnology by CBS Publishers, New Delhi.
7. Willig Sydney H., Tuckerman Murray M., Hitchings IV William S. (1982), Good Manufacturing Practices for Pharmaceuticals II Edition, Mercel Dekker NC New York.
8. Handbook of Pharmaceutical Analysis Edt. Lena Ohannesian and Antony J. Streeter (2002), Marcel Dekker, Inc. New York

Discipline Specific Core (DSC) Practical Course

MB 507 - Methods in Medical Microbiology – I

Total hours: 60		**Credits: 2**

Course Objectives:

- To acquaint with microbial isolation techniques from various clinical samples.
- Gain knowledge about diagnostic tests for diseases.
- To train to determine potency of antibiotics using various standard methods.

Learning outcomes

After successful completion of this course, students are expected to:

- Achieve skill in pure culture techniques.
- Learn principles underlying diagnostic tests and handle kits for diagnosis of diseases.
- Know various stages involved in malarial and diarrhoeal infections.

Sr. No	Topic	Lectures/ Hours
1.	Isolation and identification of *Proteus* sp. from urine sample.	04
2.	Isolation and identification of *E. coli* from stool sample.	04
3.	Isolation and identification of *Salmonella* from blood sample.	04
4.	Preparation of O and H antigen of *Salmonella.*	04
5.	Widal Test.	04
6.	Determination of Minimum Inhibitory Concentration (MIC) of an antibiotic.	04
7.	Antimicrobial Sensitivity Test: Stoke's method.	04
8.	Antimicrobial Sensitivity Test: Kirby-Bauer method.	04
9.	Detection of Malarial parasite by a suitable test.	04
10.	Determine the influence of various sugar/nitrogen concentrations on growth of bacteria.	04
11.	Study of various stages of malarial parasite in RBCs using permanent slides.	04
12.	Demonstration of Universal Precautions for handling blood and other body fluids.	04

Suggested Reading:

1. Harley, J.P. and Prescott, L. M (1996), Laboratory Exercises in Microbiology, 3rd Ed, WCB / McGraw Hill Inc.
2. Jayaraman, J (1981), Laboratory Manual in Biochemistry, Wiley Eastern Ltd., New Delhi.
3. Mackie TJ and McCartney JE (1989), Practical Medical Microbiology, 13th Collee, J. E., Duguid, J. P., Fraser, A. G, Marmion, B. P., Churchill Livingstone International Student Ed.
4. Parija Subhash Chandra (2008), Textbook of Microbiology, Ahuja Publishing House, New Delhi, ISBN: 81 89443-06-2
5. Willey JM, Sherwood LM, and Woolverton CJ. (2013), Prescott, Harley and Klein's

Microbiology. 9th edition. McGraw Hill Higher Education
6. Deshmukh A.M. (1997), 1st Ed., Handbook of Media, Stains and reagents in Microbiology Pama Publications.
7. Reddy M. G., Reddy M. N., Saigopal D. V. R. And Mallaiah K. V. (2008), Laboratory experiments in Microbiology, Himalaya Publishing House, Mumbai

Discipline Specific Core (DSC) Practical Course

MB-508: Methods in Industrial Microbiology-I

Total hours: 60		**Credits: 02**

Course Objectives

- To acquaint the learner with various fermentation processes.
- To apply the concept of these processes for commercially valuable products.
- To correlate this knowledge with the industrial fermentation process.

Learning Outcomes

After successful completion of this course students are expected to:

- Understand the operations in fermentation processes
- Inculcate the salient features of quality management and regulatory processes.
- Use computer for data generation and maintenance.

Sr.No.	Topic	Lectures/ Hours
1.	Production and estimation of alcoholic beverages from fruit juice.	04
2.	Screening and Isolation of lipase producing organisms from soil/compost.	04
3.	Sterility testing of injectables by membrane filter technique	04
4.	Isolation of probiotics/ lactic acid bacteria.	04
5.	Determine Thermal Death Time (TDT) of given bacteria.	04
6.	Determine Thermal Death Point (TDP) of given bacteria.	04
7.	Separation and identification of amino acid/ sugar by Thin Layer Chromatography/paper chromatography.	04
8.	Measurement of fungal growth by biomass (mycelia dry weight) method.	04
9.	Total fungal spore count using Neubauer's chamber.	04
10.	Design and use of typical fermentation medium using raw material-Molasses / agro waste.	04
11.	Bio-burden estimation of pharmaceutical finished product.	04
12.	Presentation of data in an appropriate form (graphs/ tables using MS Excel).	04

Suggested Reading:

1. Aneja, K. R. (1996), Experiments in Microbiology, Plant pathology, Tissue culture and Mushroom cultivation, 2nd Ed., Wishwa Prakashan, New Delhi (New Age International, Pvt. Ltd.).
2. Dubey R.C. and Maheshwari D.K. (2004), Practical Microbiology, S. Chand and Co. Delhi.
3. Gunashekharan P, Introduction to Microbial Techniques
4. Harley, J.P. and Prescott, L. M (1996), Laboratory Exercises in Microbiology, 3rd Ed, WCB / McGraw Hill Inc.
5. Jayaraman, J (1981), Laboratory Manual in Biochemistry, Wiley Eastern Ltd., New Delhi.

6. Mackie TJ and McCartney JE (1989), Practical Medical Microbiology, 13rd Edn Collee, J. E., Duguid, J. P., Fraser, A. G, Marmion, B. P., Churchy Livingstone International Student Ed.
7. Parija S. C., (2007), Textbook of Practical Microbiology, Ahuja Publishing House New Delhi.
8. Plummer, D. T. (1992), An Introduction to Practical Biochemistry, Tata McGraw Hill Publisher, New Delhi.
9. Sharma Kanika, Manual of Microbiology Tools and techniques, 2nd Ed. (2007), Ane's Book India, New Delhi

Discipline Specific Core (DSC) Practical Course

MB-509: Methods in Applied Microbiology-I

Total hours: 60		**Credits: 02**

Course Objectives

- To learn the isolation of agriculturally important microorganisms causing food poisoning & microbes responsible for food fermentation.
- To understand the principle and methods of microbiological examination of milk and sewage.
- To acquaint the students with the concept of BOD and nanoparticles.

Learning Outcomes

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

- Isolate and identify agriculturally important microbes like *Azotobacter* and cellulolytic microbes.
- Detect food poisoning causing microbes and perform the tests to determine quality control of dairy product (milk).
- Synthesize nanoparticles by biological method/s and characterize them using UV-Visible Spectrophotometry.

S.N.	Topic	Lectures/Hours
1.	Isolation and identification of *Azotobacter* from rhizosphere sample.	04
2.	Isolation of cellulose degrading bacteria from decaying wood sample.	04
3.	Isolation of lignin degrading bacteria.	04
4.	Isolation of bacteriophage from sewage (Plaque assay).	04
5.	Determination of Dissolved oxygen and Biological Oxygen Demand (BOD) of sewage water effluent.	04
6.	Isolation and identification of food poisoning causing *S. aureus/ Bacillus cereus/ Clostridium botulinum* from spoiled food sample.	04
7.	Study of stormy fermentation.	04
8.	Analysis of milk sample by MBRT test	04
9.	Analysis of milk sample by Resazurin test.	04
10.	Isolation and characterization of food fermenting microorganisms from idli batter/Curd.	04
11.	Demonstration of mushroom cultivation.	04
12.	Synthesis of silver nanoparticles by using Fungi / BGA / Bacteria and determination of $\lambda_{max.}$	04

Suggested Reading:

1. Aneja, K. R. (1996), Experiments in Microbiology, Plant pathology, Tissue culture and Mushroom cultivation, 2nd Ed., Wishwa Prakashan, New Delhi (New Age International, Pvt. Ltd.).
2. Dubey R.C. and Maheshwari D.K. (2004), Practical Microbiology, S. Chand and Co. Delhi.

3. Gunasekaran P, Introduction to Microbial Techniques
4. Harley, J.P. and Prescott, L. M (1996), Laboratory Exercises in Microbiology, 3rd Ed, WCB / McGraw Hill Inc.
5. Jayaraman, J (1981), Laboratory Manual in Biochemistry, Wiley Eastern Ltd., New Delhi.
6. Mackie TJ and McCartney JE (1989), Practical Medical Microbiology, 13rd Edn Collee, J. E., Duguid, J. P., Fraser, A. G, Marmion, B. P., Churchy Livingstone International Student Ed.
7. Parija S. C., (2007), Textbook of Practical Microbiology, Ahuja Publishing House New Delhi.
8. Plummer, D. T. (1992), An Introduction to Practical Biochemistry, Tata McGraw Hill Publisher, New Delhi. Sharma Kanika, Manual of Microbiology Tools and techniques, 2nd Ed. (2007), Ane's Book India, New Delhi

T.Y.B.Sc. (CBCS) Syllabus Semester - VI

Discipline Specific Core (DSC) Course		
MB 601- Molecular Biology		
Total Hours:45		**Credits:3**
Course Objectives • To get acquainted with the molecular regulatory mechanisms in bacteria. • To understand the principles underlying techniques used in molecular Biology. • To study the principle and applications of recombinant DNA technology.		
Learning Outcomes After successful completion of this course, students are expected to: • Get well versed with the regulatory mechanisms of Lactose and Tryptophan operon. • Understand the principles and applications of advanced molecular techniques. • Know the methodology involved in engineering of genes and its practical applications.		
Unit	**Topics**	**Lectures**
UNIT-1	**Gene Regulation**	**15**
	Diauxic Growth Phenomenon	
	Modes of Regulation	
	Mechanism of Regulation: Induction and Repression	
	Concept of Operon	
	Lactose Operon: Positive and Negative Regulation	
	Lac Mutants	
	Tryptophan Operon: Repressible System& Attenuation	
UNIT -2	**Techniques in Molecular Biology**	**15**
	Principle and Applications of:	
➢	• Blotting techniques: Dot and Slot blotting, Southern, Northern & Western Blotting.	
	• Autoradiography	
	• Gene Sequencing: Sanger's method, Maxam-Gilbert method, Ribotyping, Automated DNA sequencing & Shotgun Sequencing	
	• DNA Fingerprinting	
	• Polymerase Chain Reaction (PCR)	
➢	Construction of Genome Library& c-DNA Library	
➢	Gene Mapping: Co-transformation & Interrupted Mating Experiment.	
UNIT-3	**r-DNA Technology**	**15**
➢	Restriction Enzymes: Type I, II, III; Role of Type II Enzymes in genetic engineering	
➢	DNA Polymerases, Terminal deoxynucleotidyl transferases, Kinases, Phosphatases & DNA Ligase	
➢	Cloning Vectors: Definition and Properties	

	• Plasmid Vectors: pBR322, pUC • Lambda Vector • Cosmids, BACs & YACs	
➢	Use of Linkers and Adaptors	
➢	Generation of recombinant DNA molecule: • Cutting and joining the DNA molecules • Methods to transfer recombinant DNA into host cells • Methods of screening the cells containing the recombinant DNA • Identification of clones using probes	
➢	Applications of r-DNA technology in • Health and Medicine: Production of insulin, interferon & Hepatitis vaccine • Agriculture: Herbicide Resistant crops & Bt cotton. • Environment: Bioremediation of pollutants.	

Suggested Reading:

1. Bruce A. (2008), Molecular Biology of the Cell, 5th Edition. Publisher: Garland Science, New York.
2. Gunther S. Stent, (1978), Molecular Genetics: An Introductory Narrative, 2nd Edn. W.H. Freeman & Co.
3. James D. Watson, Tania A. Baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Losick, (2013), Molecular Biology of the Gene, 7th Edn. Pearson Publishers.
4. Jeremy Dale and Malcom von Schantz (2002) From Genes to Genomes, John Wiley and Sons Ltd.
5. Jocelyn E. Krebs, Elliott S. Goldstein, Stephen T. Kilpatrick, (2012) Lewin's GENES XI, 11th Edition. Jones & Bartlett Learning.
6. Lodish H. et al. (2012), Molecular Cell Biology, 7th Edn W. H. Freeman & Company. New York.
7. Streips Uldis N.and Yashbin Ronald E. (2002), Modern Microbial Genetics, 2nd Edition, Wiley-Liss, Inc.
8. Watson *et al*., (2004), Molecular Biology of Genes, International Edition, Benjamin Cummings Publishers.
9. Jeremy W. Dale and Simon F. Park (2004), Molecular Genetics of Bacteria, 4th Edition, John Wiley and Sons, Ltd.

Websites

- https://www2.le.ac.uk/projects/vgec/highereducation/topics/recombinanttechniques
- https://www.mybiosource.com/learn/recombinant-DNA-Technology/
- http://www2.csudh.edu/nsturm/CHEMXL153/RegulationofGeneExpression.htmhttp://www2.csudh.edu/nsturm/CHEMXL153/RegulationofGeneExpression.htm

Discipline Specific Core (DSC) Course

MB 602- Fermentations

Total Hours:45		Credits:3

Course Objectives

- To introduce fermentation processes and their types.
- To provide knowledge about the chronological development in fermentation.
- To acquire knowledge about large scale production of commercially valuable products.

Learning Outcomes

After successful completion of this course, students are expected to:

- Understand fermentation processes involved in the production of various products.
- Get acquainted with the needs of a fermentation industry.
- Know about the large-scale production of various valuable products.

Unit	Topics	Lectures
UNIT-1	**An Introduction to Fermentation Process**	**15**
➢	History and Introduction to fermentation process.	
➢	Overview few fermentation processes and products: • Microbial cells (biomass) • Microbial enzymes • Microbial metabolites • Recombinant products	
➢	The chronological development in the fermentation industry	
➢	The component parts of fermenter and fermentation parameters (Typical fermentation process)	
UNIT-2	**Large-Scale Production of the following with respect to organisms involved, inoculums preparation, fermentation media, fermentation process, flow chart andrecovery**	**15**
➢	Antibiotics: Streptomycin and Penicillin	
➢	Amino acids: L- Lysine and L- Glutamic acid	
➢	Enzyme: Amylase	
➢	Vitamin: Cyanocobalamin	
➢	Production of vaccine & Immune sera.	
UNIT-3	**Large-Scale Production of the following with respect to organisms involved, inoculums preparation, fermentation media, fermentation process, flow chart and recovery**	**15**
➢	Organic acids: Citric acid, Vinegar and Lactic acid	
➢	Organic solvent: Ethanol	
➢	Beverage: Beer & Wine	

Suggested Reading:

1. Bu'lock, J. and Kristiansen, B, (1987), Basic Biotechnology, Academic Press, London.
2. Casida, L. E., (1991), Industrial Microbiology, Wiley Eastern, New Delhi.
3. Crueger W and Crueger A., (2000), Biotechnology: A textbook of Industrial microbiology, 2nd ed. Panima Publishing Corporation, New Delhi.
4. Demanin Arnold L. and Davies Julian E., (1999), Manual of Industrial Microbiology and

Biotechnology, 2nd ed. Panima, ASM Press.
5. Doelle, H. W., Mitchell, D. V. and Rolz, C E., (1992), Solid Substrate Cultivation, Elsevier Science Publishers Ltd.. England.
6. Jogdand S. N. (2006), Industrial Biotechnology, Himalaya Publishing House, Mumbai
7. Patel, A. H., (1984), Industrial Microbiology, MacMillan India Ltd., New Delhi.
8. Peppler, H. J., Perlman, D., (1979), Microbial Technology, vol. I & II, Academic Press.
9. Prescott, S. C. And Dunn, C. G, (1987), Industrial Microbiology, 3rd Ed., McGraw Hill, New York.
10. Ratledge, C. and Kristiansen, B., (2001), Basic Biotechnology, Cambridge University Press.
11. Rehm, Ii J. and Reed, G, (1983), Biotechnology vol.111, Verlag Chenue, Florida.
12. Stanbury, P. F., Whitaker, A., Hall, S. J, (1997), Principles of fermentation Technology, Aditya Book Pvt. Ltd., New Delhi.
13. Vyas, S. P. and Dixit, V. K., (1998), Pharmaceutical Biotechnology, CBS Publisher, New Delhi.

Discipline Specific Core (DSC) Course		
MB 603- Enzymology		
Total Hours:45		**Credits:3**
Course Objectives • To understand regulation of enzyme action. • To get acquainted with enzyme technology. • To get knowledge about techniques involved in enzyme purification**.**		
Learning Outcomes After successful completion of this course, students are expected to: • Know the role of coenzymes in enzyme action. • Understand the regulation of enzymatic reactions pertaining to allosteric proteins and covalent modification. • Acquire knowledge about purification of enzymes by various methods, immobilization of enzymes and enzyme engineering techniques.		
Unit	**Topics**	**Lectures**
UNIT-1	**Enzymes and Cofactors**	**15**
➢	Role of Cofactors in metabolism	
➢	Occurrence, Structure and Biochemical functions of the following: • Nicotinic acid: NAD and NADP • Riboflavin: FMN and FAD • Thiamine: TPP • Pantothenic acid: Coenzyme A • Biotin: Biocytin • Folic acid: THF • Pyridoxine: Pyridoxal Phosphate	
UNIT -2	**Enzyme Regulation**	**15**
➢	Allosteric enzyme: Concept, Properties, Positive and Negative Cooperativity, Example-ATCase	
➢	Isoenzyme: Concept and example -LDH	
➢	Enzyme Inhibition: • Reversible Inhibition: Competitive. Uncompetitive, Non-competitive with examples • Irreversible Inhibition	
➢	Covalent modification: Glycogen Phosphorylase	
➢	Proteolytic modification of Zymogens	
UNIT-3	**Enzyme Technology**	**15**
➢	Methods of Enzyme Purification based on various properties:	
➢	Molecular size: Molecular Exclusion Chromatography	
➢	Solubility: Isoelectric Precipitation& Salt precipitation	
➢	Electric Charge: SDS-PAGE electrophoresis	

➢	Adsorption: Affinity chromatography	
➢	Enzyme assay: Spectrophotometric Assay	
➢	Immobilization of Enzyme: Concept, Methods and Applications	
➢	Enzyme Engineering: Objectives, Principle, Methodology & Applications	

Suggested Reading:

1. Lehninger, A I., (1982), Principles of Biochemistry, Butterworth Publishers, New York.
2. Microbiology, 5th Ed., MacMillan Edu. Ltd., London
3. Moat, A., Foster, J., (1988), Microbial Physiology, 2nd Ed., Wiley Interscience Publications, New York.
4. Palmer T., (1985). Understanding Enzymes. 2nd Ed., Ellis Horwood Ltd., Chichester. Price, N. C, Stevens, L, (1989), Fundamentals of Enzymology, 2nd Ed., Oxford Sci. Publ., Oxford.
5. Rose, A. H., (1983), Chemical Microbiology, 3rd Ed., Butterworth Publishers.
6. Satyanarayana U., (1999), Biochemistry, Books and Allied (P) Ltd. Calcutta
7. Stamen R. Y., Ingraham, J. L., Wheelis, M. L., Painter, P. R., (1990),
8. Stryer, L., (1988), Biochemistry, W H Freeman and Co., New York.
9. Zubay, G. L (1996), Biochemistry, 4th edition, Wm. C. Brown publishers.

Discipline Specific Core (DSC) Course		
MB 604: Advanced Immunology		
Total Hours:45		**Credits:3**
Course Objectives • To understand various protective mechanisms underlying the human immune system, immunological disorders and tumours. • To study the principles underlying various immunological techniques. • To debate the immuno-prophylactic measures against various novel viral infections.		
Learning Outcomes After successful completion of this course, students are expected to: • Be well versed with protective immunity and tolerance in the body. • Gain knowledge about the serological tests and their applications. • Know the path that may help to overcome the challenges in the synthesis of novel vaccines.		
Unit	**Topics**	**Lectures**
UNIT-1	**Protective Mechanisms**	**15**
➢	• B-cell activation: Proliferation, Differentiation, Memory B cells& Plasma cells • T cells: Effector T cell activation, Differentiation& Memory T cells • Killing Mechanisms by CTL and NK cells • Introduction to tolerance • Interaction between immune cells • Role of lymphokines	
➢	Other protective mechanisms: • Inflammation • Complement: Classical and Alternative cascade • Biological consequences of complement Activation	
➢	Interferon: • Introduction, Mechanism and Significance • Tumor Necrosis Factor (TNF) • Phagocytosis	
UNIT -2	**Immunological Disorders and Tumour Immunity**	**10**
➢	Types of Autoimmunity	
➢	Hypersensitivity with examples	
➢	Immunodeficiencies - Animal models (Nude and SCID mice), SCID & DiGeorge syndrome	
➢	Types of tumors Tumor Antigens: TSTA & TATA	
➢	Causes and therapy for cancers (generalized)	
UNIT-3	**Immunological Techniques**	**10**
➢	Basics of antigen-antibody interaction: affinity, avidity & interaction forces	

➢	Principles of Precipitation, Agglutination, Immunodiffusion& precipitation curve	
➢	Immunoelectrophoresis	
➢	ELISA: Direct and Indirect& ELISPOT assay	
➢	Western blotting	
➢	Immunofluorescence	
➢	Flow cytometry	
UNIT-4	**Immunoprophylaxis**	**10**
➢	Vaccines: • Historical developments • Characteristics of ideal vaccine • Types of vaccines with one example	
➢	Vaccine development against emerging infectious agents: • SARS • HIV • Novel Corona virus (COVID-19)	
➢	Quality control of vaccines and sera	
➢	Immunization schedule in India	

Suggested Reading:

1. Abbas AK, Lichtman AH, Pillai S. (2007), Cellular and Molecular Immunology. 6th edition Saunders Publication, Philadelphia.
2. Ananthnarayan, P., Paniker, C. K. J., (1990), Textbook of Micro-biology, Orient Longman, Madras.
3. Banker, D (1980), Modern Practice in Immunization, 3rd Ed., Popular Prakashan Pvt. Ltd., Bombay.
4. Coleman, R. M, Lombard M F, Sicard, R. E., (1989), Fundamental Immunology, 2nd Ed., W. C. Brown Publishers, USA.
5. Delves P, Martin S, Burton D, Roitt IM. (2006), Roitt's Essential Immunol.11thEd. Wiley-Blackwell Scientific Publication, Oxford.
6. Glazier, A. M., Nikaido, H., (1995), Microbial Biotechnology, W. H. Freeman and Co., New York.
7. Goldsby RA, Kindt TJ, Osborne BA. (2007), Kuby's Immunology. 6th edition W.H. Freeman and Company, New York.
8. Murphy K, Travers P, Walport M. (2008), Janeway's Immunobiology. 7th Ed., Garland Science Publishers, New York.
9. Peakman M, and Vergani D. (2009), Basic and Clinical Immunology. 2nd Ed., Churchill Livingstone Publishers, Edinberg.
10. Richard C and Geiffrey S. (2009), Immunology. 6th edition. Wiley Blackwell Publication

Skilled Enhancement Course (SEC)

MB 605-Medical Microbiology - II

Total Hours:45		**Credits:3**

Course Objectives

- To create awareness about the infectious diseases.
- To create theoretical base for practical approaches.
- To study prognosis of bacterial, viral and other diseases.

Learning Outcomes

After successful completion of this course, students are expected to:

- Become aware about the various types of diseases and their sources.
- Justify the variation between viral, bacterial and other diseases.
- Explain prognosis of diseases and understand the role of medical microbiology in public health.

Unit	Topics	Lectures
UNIT-1	**Viral infections and diseases**	**15**
➢	Study of diseases with respect to causative agent, infectious dose, portal of entry, pathogenicity, epidemiology, laboratory diagnosis, prophylaxis, treatment, prevention and control of the following: • AIDS • Picornavirus disease –Poliomyelitis • Rhabdovirus disease – Rabies • Hepadnavirus diseases –Hepatitis A, B and C • Corona virus disease	
UNIT -2	**Bacterial Infections and diseases**	**15**
➢	Study of diseases with respect to - causative agent, infectious dose, portal of entry, pathogenicity, epidemiology, laboratory diagnosis, prophylaxis, treatment prevention and control of the following: • Respiratory disease: Tuberculosis • Gastrointestinal diseases: Typhoid & Cholera • Bacterial disease affecting the brain and nervous system: Tetanus • Sexually transmitted bacterial disease: Syphilis	
UNIT-3	**Fungal and Protozoal diseases**	**15**
➢	Study of diseases with respect to causative agent, portal of entry, pathogenicity, laboratory diagnosis, prophylaxis, treatment, prevention and control of the following: Cutaneous mycoses: Dermatophytosis, Tinea Pedis (Athlete's foot) Systemic mycoses: Histoplasmosis Opportunistic mycoses: Candidiasis	
➢	Protozoal diseases: Malaria & Amoebic dysentery	

Suggested Reading:

1. Ananthnarayan, P., Paniker, C. K. J., (2009), Ed 8th Textbook of Microbiology, Universities press, Hyderabad.
2. Atlas, R. M. (1995), Microorganisms in our world, Mosby Year Book Inc.
3. Chakraborty P (2013), A text book of Microbiology, New Central Book Agency, Delhi.
4. Davis, B. D., Dulbecco, R, Eisen, H. N., Ginsberg, R. S., (1990), Microbiology, 4th Ed., Harper and Row Publishers, Singapore.
5. Dey, N. C. and Dey, T. K., (1999), Medical Bacteriology and Microbiology, 16th Ed, Allied Agency, Calcutta.
6. Nagoba BS and Pichare Asha (2012), Medical Microbiology: Prep Manual for Under Graduates, Elsevier
7. Prescott, L. M., Hartley, J. P. and Klein, D. A., (1993), Microbiology, 2nd Ed., W. M. C. Brown Publishers, England.
8. Tortora, G. J., Funke, B. R. and Case, C. L., (2004), Microbiology, 8th Ed., Person Education (Low Price edition), Delhi.

Web sites

- http://www.who.ch.: World Health Organization
- http://www.ncbi.nlm.nih.gov/PubMed:PubMed -Medline on the Web.
- http://www.cdc.gov: US Centre for Disease Control (Atlanta)
- http://www.who.int/emc/ : WHO Communicable Disease Surveillance and Response

Discipline Specific Elective (DSE) Course		
MB 606 (A) - Agricultural Microbiology		
Total Hours:45		**Credits:3**

Course Objectives

- To understand concepts in plant pathology.
- To acquaint the students with basic knowledge of plant disease control.
- To complement the students with the concepts in Agricultural Microbiology.

Learning Outcomes

After successful completion of this course, students are expected to:

- Understand classification of plant pathology with regional plant diseases.
- Know the concepts related to methods of plant disease control.
- Comprehend knowledge regarding Agricultural Microbiology.

Unit	Topics	Lectures
UNIT-1	**Plant Microbe Interactions**	**15**
➢	Rhizosphere: concept, microorganisms, significance and Rhizosphere engineering	
➢	Classification of plant diseases based on symptoms, crop and parts affected	
➢	Terminology: Host, Alternate and Collateral host, Resistance, Susceptibility and Tolerance	
➢	Disease Triangle (Host, environment and pathogen), concept of Disease cycle	
➢	Study of plant diseases with respect to causative agent, host, symptoms and control: • Wilt of cotton • Citrus canker • Downy mildew of grapes • Whip smut of sugarcane • Tikka disease of groundnut • Banana Bunchy Top Viral disease (BBTV)	
UNIT -2	**Methods of plant disease control**	
➢	Mechanism: Exclusion, Eradication, Reduction of inoculum, Protection and Resistant varieties	
➢	Chemical control: fungicides, bactericides etc.	
➢	Biological control: microbial herbicides& insecticides	
➢	Cultural methods: Tillage, Deep ploughing and Spacing	
➢	Integrated pest management: Inspection, Identification, Threshold, Employment control and Evaluation	
➢	Modern approaches • Application of viral proteins in controlling plant viral diseases • Antisense RNA technology in plant disease control	

	• RNA interference (RNAi) in controlling plant pathogens • Mycoviruses for controlling fungal pathogens	
UNIT-3	**Agricultural and environmental microbiology**	**15**
➢	Transgenic plants: • Method: Gene construction, vector (Ti/Ri plasmid), mechanism& importance • Example: Development of insect resistant plants (Bt cotton), Biochemical production of Hirudin-A polypeptide& Phytase enzyme	
➢	Waste: source, types and management • Liquid waste: primary, secondary and tertiary treatments. • Solid waste: Composting: necessity, microbiology, methods, advantages and disadvantages	
➢	Biogas: feedstock, process (hydrolysis, acidogenesis, Methanogenesis), factors affecting biogas production	
➢	Bioremediation: importance, types, methods, example of xenobiotic degradation	

Suggested Reading:

1. Dubey R. C. and Maheshwari D. K. (2006), A textbook of microbiology, S Chand, New Delhi.
2. Das H. K. (2005), Textbook of biotechnology, Wiley Dream tech India Pvt. Ltd.
3. Kuderia, V. P., (1998), Water Pollution, Pragati Prakashan, Meerut.
4. Martin Alexander (1977), Introduction to Soil Microbiology, 2nd Ed., John Wiley & Sons.
5. Mitchell, R. (1974), Introduction to Environmental MicrobiologyPrentice Hall, New Je rsey.
6. Pathak, V. N, Khatri, N.K., Pathak, M., (1996), Fundamentals of Plant Pathology, Agro - botanical Publ., Bikaner.
7. Powar, C. B., Daginwalla, H. F., (1990), General MicrobiologyVol. I & II, Himalaya P ublishing House, Mumbai.
8. Rao, M. N. and Rao, H. V N, (1989), Air Pollution, Tata McGraw Hill Publ, Company, Ltd., New Delhi.
9. Salle, A. J., (1990), Fundamentals of Microbiology, Tata McGraw Hill, New Delhi.
10. Satyanarayana U. (2005), Biotechnology, Books and Allied (P) Ltd. Kolkata.
11. Thakur I S (2011), Environmental Biotechnology: Basic concepts and applications, IK International, New Delhi.

Discipline Specific Elective (DSE) Course		
MB 606 (B)- Regulatory Practices and IPR		
Total Hours:45		**Credits:3**
Course Objectives • To promote development of entrepreneurship and know the importance and scope of the IPR in Microbiology. • To get acquainted with regulatory practices undertaken at commercial level. • Develop a scientific attitude to make students open minded, critical and curious about scope, functioning and the future of Commercial Microbiology.		
Learning Outcomes After successful completion of this course, students are expected to: • Understand role of regulatory practices in Pharmaceutical Industry and become aware of the patents norms. • Have knowledge pertaining to Intellectual Property Rights and their protection. • Be endowed with the legislature to be followed during the generation of genetically modified plant and animals.		
Unit	**Topics**	**Lectures**
UNIT-1	**Regulatory practices in pharmaceutical industry**	**15**
➢	General organization of pharmaceutical industry	
➢	Regulatory agencies: ISO, WHO and US certification. IP, BP and USP	
➢	Government regulatory practices and policies, role and functioning of FDA, legislative perspective	
UNIT-2	**Intellectual Property Rights and Protection**	**20**
➢	Concept of Patents	
➢	GATT and TRIP, Concept of Patents, Copyrights, Trademarks; Patenting – need for patents	
➢	Patenting of Biological materials, Regulatory issues and Challenges to food product	
➢	Patent process, protection of knowledge, knowledge consortia and databases	
➢	Plant Variety Protection Act	
➢	Procedure for patent application, International harmonization of patent laws	
➢	Patenting of life forms - plant, animals, microbes, gene, process and products	
➢	Plant Breeders Rights - International conventions on biological diversity	
UNIT 4	**Biosafety and Society**	**10**
➢	Transgenic plants, Commercial status and public acceptance	
➢	Bio-safety guidelines for research involving GMO’s	
➢	Benefits and risks, Socio-economic impact and ecological considerations of GMO’s	

➢	Gene flow	

Suggested Reading:

1. Anant Padmanabhan (2012), Intellectual Property Rights: Infringement and Remedies, LexisNexis-Butterworths.
2. Gasser, C.C. and Eraley, R.T. (1989), Genetically engineering plants for crops improvements Science 1293-1296.
3. Gupta P.K. (2003), Biotechnology and Genomics, Rastogi Publications Meerut.
4. Karmach, C.L. (eds) (1991), Biotechnology Regulations Handbook, Centre for energy and environmental management, Fanifac Stn. Vingnia. 68.
5. Kshitij Kumar Singh (2015), Biotechnology and IPR, DOI https://doi.org/10.1007/978-81-322-2059-6ISBN 978-81-322-2058-9.
6. Monney, H.A.and Bernandi, G (ed) 1993 Introduction of genetically modified organisms into the environment, Wiley, New York.
7. Stewant-tull, D.E.S. & Sussman, M (Eds.) (1994), The release of Genetically Modified Microorganisms, REGEM 2, Plenum Press, New York.
8. Bills, D. and Kind, Shain-Daw (Ed.) (1990), Biotechnology and Food safety Butterworth-Heinemann Boston, London.

Sussman, M., Collmi, C.H., Shimnen, A.A. and Stewart-tull D.E. (1994).

Websites:

- https://ipr.icegate.gov.in/IPR
- https://www.wipo.int/about-ip/en/
- http://library.jgu.edu.in/content/intellectual-property-rights
- https://www.hilarispublisher.com/open-access/regulatory-practice-in-pharmaceutical-industry

Discipline Specific Core (DSC) Practical Course

MB 607 - Methods Medical Microbiology – II

Total Hours: 60		**Credits: 2**

Course Objective:

- To study pure culture techniques involved in the isolation of pathogens from clinical samples.
- To investigate the normal flora of skin and mouth.
- To handle diagnostic tests involved in detection of STDs.

Learning Outcomes

After successful completion of course, students are expected to:

- Perform pure culture techniques and apply them for pathogenic bacteria.
- Inculcate the technique involved in collection of mouth and skin samples using swabs for diagnostic purpose.

Perform diagnostic tests for Syphilis and AIDS.

Sr. No	**Topic**	**Lectures/ Hours**
1.	Isolation and identification of *Staphylococcus* from pus sample.	04
2.	Isolation and identification of *Pseudomonas* from pus sample.	04
3.	Isolation and identification of *Candida* from skin/mouth.	04
4.	Isolation of Normal Microbial Flora of Skin.	04
5.	Potassium hydroxide wet mount preparation for presumptive diagnosis of fungal infection.	04
6.	Isolation of Normal Microbial Flora of Mouth.	04
7.	Cultivation of Anaerobic bacteria by suitable method.	04
8.	Enzyme-linked immunosorbent assay (ELISA)	04
9.	Venereal disease research laboratory (VDRL)	04
10.	Demonstration of precipitation reaction based on immunodiffusion.	04
11.	Study of various stages of *Entamoeba histolytica* using permanent slides.	04
12.	Visit to Pathology Laboratory/Blood Bank.	04

Suggested Reading:

1. Harley, J.P. and Prescott, L. M (1996), Laboratory Exercises in Microbiology, 3rd Ed, WCB / McGraw Hill Inc.
2. Jayaraman, J (1981), Laboratory Manual in Biochemistry, Wiley Eastern Ltd., New Delhi.
3. Mackie TJ and McCartney JE (1989), Practical Medical Microbiology, 13rd Edn Collee, J. E., Duguid, J. P., Fraser, A. G, Marmion, B. P., Churchy Livingstone International Student Ed.
4. Parija Subhash Chandra (2008), Text Book of Microbiology, Ahuja Publishing

House, New Delhi, ISBN:: 81 89443-06-2
5. Willey JM, Sherwood LM, and Woolverton CJ. (2013), Prescott, Harley and Klein's Microbiology. 9th edition. McGraw Hill Higher Education
6. Deshmukh A.M. (1997), 1st Edn., Handbook of Media, Stains and reag ents in Microbiology Pama Publications.
7. Reddy M. G., Reddy M. N., Saigopal D. V. R. And Mallaiah K. V. (2008), Laboratory experiments in Microbiology, Himalaya Publishing House, Mumbai

DSC Discipline Specific Core Practical

MB-608: Methods Industrial Microbiology-II

Total hours: 60		**Credits: 02**

Course Objectives

- To analyse the potency of an antibiotic by suitable bioassay.
- To study the stoichiometric evaluation of enzyme activity.
- To handle the techniques involved in enzyme immobilization.

Learning Outcomes

After successful completion of this course, students are expected to:

- Design bioprocesses for commercially valuable products.
- Learn techniques for validation of instruments used in fermentation industry.
- Investigate the role of immobilization in enzyme activity and apply it for various purposes.

Sr.No.	**Topic**	**Lectures/ Hours**
1.	Production and estimation of citric acid by fermentation.	04
2.	Microbiological assay of Penicillin / Streptomycin by paper disc or agar -well plate method.	04
3.	U.V. Survival curve.	04
4.	Isolation of antibiotic resistant bacteria by gradient plate technique.	04
5.	Screening of amylase producing organism from rhizosphere.	04
6.	Production of amylase at shake flask level in laboratory.	04
7.	Determination of protein content of crude amylase enzyme.	04
8.	Determination of enzyme activity and specific activity of crude enzyme amylase.	04
9.	Immobilization of yeast cells/enzyme and detection of immobilization activity.	04
10.	Validation of autoclave / laminar air flow system.	04
11.	Microbiological assay of commercial vitamin.	04
12.	**Activity:** Visit to Food / Milk Processing/ Pharmaceutical / Fermentation Industry / Research organization.	04

Suggested Reading:

1. Aneja, K. R. (1996), Experiments in Microbiology, Plant pathology, Tissue culture and Mushroom cultivation, 2nd Ed., Wishwa Prakashan, New Delhi (New Age International, Pvt. Ltd.).
2. Dubey R.C. and Maheshwari D.K. (2004), Practical Microbiology, S.Chand and Co. Delhi.
3. Gunashekharan P, Introduction to Microbial Techniques_____
4. Harley, J.P. and Prescott, L. M (1996), Laboratory Exercises in Microbiology, 3rd Ed, WCB / McGraw Hill Inc.
5. Jayaraman, J (1981), Laboratory Manual in Biochemistry, Wiley Eastern Ltd., New Delhi.

6. Mackie and McCartney (1989), Practical Medical Microbiology, 13rd \ Collee, J. E., Duguid, J. P., Fraser, A. G, Marmion, B. P., Churchy Livingstone International Student Ed.
7. Parija S. C., (2007), Textbook of Practical Microbiology, Ahuja Publishing House New Delhi.
8. Plummer, D. T. (1992), An Introduction to Practical Biochemistry, Tata McGraw Hill Publisher, New Delhi.
9. Sharma Kanika, Manual of Microbiology Tools and techniques, 2nd Ed. (2007), Ane's Book India, New Delhi

DSC Discipline Specific Core Practical

MB-609: Methods in Applied Microbiology-II

Total hours: 60		**Credits: 02**

Course Objectives

- To isolate and screen microbes involved in bioremediation processes
- To analyse the wastewater / liquid effluent and emphasize on safety handling of hazardous materials.
- To aware the students about bioenergy, bio fertilizers, biocontrol agents etc**.**

Learning Outcomes

After successful completion of this course, students are expected to:

- Isolate and screen microbes involved in bioremediation processes like dyes and lignin degradation.
- Isolate and identify rhizospheric microbes which are important for crops
- Analyse the quality of wastewater / liquid effluent and make charts of safety handling of hazardous materials and MSDS.

Sr.No.	**Topic**	**Lectures/ Hours**
1.	Isolation of azo/aryl dye degrading bacteria from polluted soil sample by solid phase decolourization method.	04
2.	Isolation of phosphate solubilizing microorganism from rhizosphere soil.	04
3.	Demonstration of Koch's postulates in plants.	04
4.	Analysis of wastewater of distillery/dairy/Pharma. industry- Determination of TS, TDS and COD.	04
5.	Isolation and primary screening of bacteria/fungi from soil sample for lignin dephenolization activity.	04
6.	Isolation and identification of *Rhizobium* sp. from root nodules.	04
7.	Isolation and identification of *Azotobacter* sp. from root nodules.	04
8.	Demonstration safety handling of hazards chemicals and awareness of Material Safety Data Sheet (MSDS).	04
9.	Demonstration of biogas production.	04
10.	Evaluation of efficacy of biofertilizer (*Azotobacter/ Rhizobium/ Trichoderma* sp.) by pot assay.	04
11.	Dilution methods for liquid/solid/semisolid food samples.	04
12.	Evaluation of antifungal activity of bacterial biocontrol agent.	04

Suggested Reading

1. Anuradha De (2014), Practical and Applied Microbiology, 5th Edition, National Book Depot, Mumbai.
2. Dubey R.C. and Maheshwari D.K. (2004), Practical Microbiology, S.Chand and Co. Delhi.
3. Dubey Akhilesh, Mishra Neeraj, Singh, Deb Neha, Abhinav and Verma, Shivendra. (2010), Isolation of dye degrading microorganism. Electronic Journal of Environmental, Agricultural and Food Chemistry.
4. Parija S. C., (2007), Textbook of Practical Microbiology, Ahuja Publishing House New Delhi.

5. Reddy M. G., Reddy M. N., Saigopal D. V. R. and Mallaiah K. V. (2008), Laboratory experiments in Microbiology, Himalaya Publishing House, Mumbai.
6. Roy D C et al, (2018), Biodegradation of Crystal Violet dye by bacteria isolated from textile industry effluents, PeerJ.; Vol. 6, doi: 10.7717/peerj.5015.
7. Sharma Kanika, Manual of Microbiology Tools and techniques, 2nd Ed. (2007), Ane's Book India, New Delhi.

Skills acquired and Job prospects for the Microbiology students

Microbiology is one of the most significant subjects exhibiting its impact in human health, industrial production of antibiotics, vaccines, enzymes, fine chemicals, energy sector and social sector like waste treatment etc. Degree program in Microbiology teaches students how microorganisms are part of human life and how they are useful in various applications. A significant attraction of the course is the ability to combine in-depth scientific knowledge with practical laboratory skills and the career opportunity in all sectors.

After successful completion of three years degree course in Microbiology, student will be well versed with laboratory skills and transferable skills essential for working in industrial sector, working in laboratories and higher studies.

Laboratory Skills:

- Laboratory safety practices
- Skillful handling of microbial cultures and aseptic techniques
- Skillful handling of fermenters and its parts
- Molecular kit based and protocol-based analysis
- Advanced techniques like- Chromatography, Electrophoresis, Spectrometry
- Some medical diagnostic techniques like Widal test, microbial analysis of food and dairy products.
- Analysis and interpretation of results and logical thinking

Transferable Skills:

During the course student will develop skills other than laboratory skills that are transferable across the number of career areas. These are:

- Analytical skill, Observational skill
- Planning and Time management
- Mathematical and IT skills
- Creative thinking, Problem solving
- Report writing skill, Presentation skill

Job Opportunities:

Private Sector:

Microbiology can work in quality control, quality assurance and R & D divisions of companies like-Biotech companies, Pharmaceutical companies, Chemical manufacturing companies, Food and Beverages (includes brewing), Health and Beauty Care, Medical Instrument companies, Agricultural companies, Research Companies and Laboratories etc.

Public Sector:

Blood Service, Cancer research institutes, Environmental Pollution Control, Forensic Science, Hospitals, National Blood Services, Overseas Development, Public Health Entities, Public Health Laboratories, Agriculture and fisheries etc.

Job profiles:

Microbiologist, Biologist, Biomedical Scientist, Biotechnologist, Chemical Examiners, Chemist, Clinical Scientist, Food Scientist, Forensic Scientist, Laboratory Technician, Biochemist, Research Associates, Research Officers, Research Scientist etc. wherever microbiology is dealt with.

Opportunities in higher studies

After successful completion of B.Sc. in Microbiology, student may continue further studies like M.Sc. in Microbiology / Biotechnology / Biochemistry and pursue higher studies. Even students can pursue other courses where graduation is essential.

--x--