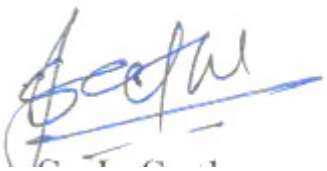
SAVITRIBAI PHULE PUNE UNIVERSITY

B. Sc. Degree Course in
MICROBIOLOGY

SYLLABUS FOR THIRD YEAR
(To be implemented from Academic Year 2015-16)



GENERAL INFORMATION

Eligibility at third year B. Sc. Microbiology:
Student shall clear all First Year B. Sc. Microbiology courses and satisfactorily keep terms of Second Year of B. Sc. with Microbiology as one of the subjects.

Course Structure: T. Y. B. Sc. Microbiology course includes 12 theory papers and 3 practical courses. Six theory papers will be taught in semester III and the remaining six in semester IV. Practical are conducted over semesters III and IV. The examination will be held semester-wise for theory paper whereas the examination for three practical courses will be held at the end of the semester IV.

Work-load:
Theory Papers: Four Periods / Week per Paper (Total 48 / Paper per Semester)
Practical Course: Four Hours / Week per course (Total 96 / Course per Semester). Practical is to be conducted as four hours each day on three consecutive days / Batch.

Standard of Passing:
i. In order to pass in the Second Year and Third Year theory examination, the candidate has to obtain 20 marks out of 50 in each course of each semester. (Minimum 16 marks must be obtained in the University Theory Examination).
ii. In order to pass in practical examination, the candidate has to obtain 40 marks out of 100 in each course. (Minimum 32 marks must be obtained in the University Examination.)

Award of Class:
The class will be awarded to the student on the aggregate marks obtained during the second and third year in the Principle subject only. The award of the class shall be as follows:

1. Aggregate 70% and above First Class with Distinction
2. Aggregate 60% and more but less than 70% First Class
3. Aggregate 55% and more but less than 60% Higher Second Class
4. Aggregate 50% and more but less than 55% Second Class
5. Aggregate 40% and more but less than 50% Pass Class
6. Below 40% Fail

ATKT Rules:
While going from F. Y. B. Sc. to S. Y. B. Sc. at least 8 courses (out of total 12) should be cleared; however all F. Y. B. Sc. courses should be cleared while going to T. Y. B. Sc.
While going from S. Y. B. Sc. to T. Y. B. Sc., at least 12 courses (out of 20) should be cleared (Practical Course at S. Y. B. Sc. will be equivalent to 2 courses).

University Terms:
University authorities declare dates for commencement and conclusion of the first and second terms. Terms can be kept by only duly admitted students. The term shall be granted only on minimum 80 percent attendance at theory and practical course and satisfactory performance during the term.

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

Qualification of Teachers: With minimum undergraduate and postgraduate degree in Microbiology (B. Sc. and M. Sc. Microbiology) and qualified as per UGC regulations.

Equivalences for the New Courses (w. e. f. from 2015-16)
with Old Courses (from 2010-11) in Microbiology
T. Y. B. Sc. Microbiology

Semester III				Semester IV				Practical Courses			
New Course		Old Course		New Course		Old Course		New Course		Old Course	
Paper	**Course Title**	**Paper**	**Course Title**	**Paper**	**Course Title**	**Paper**	**Course Title**	**Paper**	**Course Title**	**Paper**	**Course Title**
MB 331	Medical Microbiology - I	MB 331	Medical Microbiology - I	MB 341	Medical Microbiology - II	MB 341	Medical Microbiology - II	MB 347 Practical course – I Applied Microbiology		MB 347 Practical course – I Applied Microbiology	
MB 332	Genetics & Molecular Biology - I	MB 332	Genetics and Molecular Biology - I	MB 342	Genetics & Molecular Biology - II	MB 342	Genetics and Molecular Biology - II				
MB 333	Enzymology	MB 333	Enzymology	MB 343	Metabolism	MB 343	Metabolism	MB 348 Practical course – II Biochemistry & Molecular Biology		MB 348 Practical course – II Biochemistry & Genetics	
MB 334	Immunology - I	MB 334	Immunology - I	MB 344	Immunology - II	MB 344	Immunology - II				
MB 335	Fermentation Technology -I	MB 335	Fermentation Technology -I	MB 345	Fermentation Technology - II	MB 345	Fermentation Technology - II	MB 349 Practical course – III Diagnostic Microbiology & Immunology		MB 349 Practical course – III Diagnostic Microbiology & Immunology	
MB 336	Food & Dairy Microbiology	MB 336	Food & dairy Microbiology	MB 346	Agricultural & Environmental Microbiology	MB 346	Soil & Agricultural Microbiology				

Course Structure

T. Y. B. Sc. Microbiology

Theory Courses							
Semester III				Semester IV			
Paper	**Course Title**	**Internal Exam Marks**	**University Exam Marks**	**Paper**	**Course Title**	**Internal Exam Marks**	**University Exam Marks**
MB 331	Medical Microbiology - I	10	40	MB 341	Medical Microbiology - II	10	40
MB 332	Genetics & Molecular Biology - I	10	40	MB 342	Genetics & Molecular Biology - II	10	40
MB 333	Enzymology	10	40	MB 343	Metabolism	10	40
MB 334	Immunology - I	10	40	MB 344	Immunology - II	10	40
MB 335	Fermentation Technology - I	10	40	MB 345	Fermentation Technology - II	10	40
MB 336	Food & Dairy Microbiology	10	40	MB 346	Agricultural & Environmental Microbiology	10	40

Practical Courses			
Paper	**Course Title**	**Internal Exam Marks**	**University Exam Marks**
MB 347	Practical course – I Applied Microbiology	20	80
MB 348	Practical course – II Biochemistry & Molecular Biology	20	80
MB 349	Practical course – III Diagnostic Microbiology & Immunology	20	80

MB – 331: MEDICAL MICROBIOLOGY - I

Sr. No.	Topic	No. of Lectures
I	**Introduction to infectious diseases of following human body systems: (Brief anatomy and physiology, Diseases, Pathogens and Symptoms)** a. Respiratory system b. Gastrointestinal system c. Kidney and Liver d. Genital system e. Central nervous system	**10**
II	**Epidemiology:** a. Definition, scope and applications b. Incidence and prevalence rates, mortality and morbidity rates c. Disease distribution based on time, place and person d. Case control and cohort studies – study design and application e. Principle and methods – Clinical trials of drugs and vaccines (Randomized control trials Concurrent parallel and cross-over trials) f. Epidemiology of infectious diseases i. Sources and reservoirs of infection ii. Modes of transmission of infections iii. Disease prevention and control measures	**10**
III	**Study of following groups of bacterial pathogens: (with respect to - Classification and Biochemical characters, Antigenic structure, Viability characteristics, Pathogenicity, Pathogenesis, Symptoms, Laboratory diagnosis, Epidemiology, Prophylaxis and Chemotherapy):** i. Enteric pathogens (*E. coli*, *Shigella*, *Salmonella*, *Campylobacter*, *Vibrio*) ii. Pneumococci and *Neiserria* iii. Pyogenic organisms – *Staphylococcus, Streptococcus, Pseudomonas* iv. Spirochetes – *Treponema, Leptospira* v. *Clostridium tetani* and *Clostridium perfringens* vi. *Bacillus anthracis* vii. *Acinetobacter* spp. viii. *Mycobacterium tuberculosis and Mycobacterium leprae* ix. Rickettsia	**28**

MB – 341: MEDICAL MICROBIOLOGY - II

Sr. No.	Topic	No. of Lectures
I	**Chemotherapy:** **1.** Introduction to chemotherapy **2.** Desirable parameters of chemotherapeutic agent (Selective toxicity, Bioavailability of Drug, MIC, MBC, LD-50 value, routes of drug administration) **3.** Mode of action of antimicrobial agents on:	**20**

	a. Bacteria: i. Cell wall (Beta lactams [1st to 6th Generation- e.g. Meropenem, Imipenem Piperacillin], Tazobactam, Cycloserine, Bacitracin) ii. Cell membrane (Polymyxin, Monensin) iii. Protein synthesis (Streptomycin, Tetracycline) iv. Nucleic acids (Nalidixic acid, Rifamycin, Quinolones) v. Enzyme inhibitors (Trimethoprim) **b. Fungi:** (Griseofulvin, Nystatin, Amphotericin B, Anidulafungin, Voriconazole) **c. Viruses:** (Acyclovir, Zidovudine, Oseltamivir) **d. Protozoa:** (Metronidazole, Mepacrine) **4. Resistance to antibiotics:** i. Development of antibiotic resistance (e.g. ESBL, VRE, MRSA) ii. Reasons and Mechanisms of drug resistance iii. Antibiotics misuse	
II	**a. Introduction to cultivation of viruses:** **b. Study of following groups of viral pathogens (with respect to – Virion characteristics, Viability characteristics, Pathogenicity, Pathogenesis, Symptoms, Laboratory diagnosis including serological diagnosis, Epidemiology, Prophylaxis and Chemotherapy):** i. HIV ii. Polio virus iii. Hemorrhagic viruses (Dengue, Ebola) iv. Hepatitis A and Hepatitis B viruses v. Influenza virus (human, swine and bird) vi. FMD virus and Rinderpest virus vii. Japanese encephalitis virus viii. Rota virus ix. Rhabdoviruses (Rabies) x. Herpes Virus (simplex, zoster) xi. Oncogenic viruses (DNA, RNA)	**2** **16**
III	**Study of following groups of parasites** (with respect to – Classification, Life cycle, Morphological characteristics, Viability characteristics, Pathogenicity, Pathogenesis, Symptoms, Laboratory diagnosis (Serological diagnosis wherever applicable), Epidemiology, Prophylaxis and Chemotherapy): a. *Plasmodium* b. *Entamoeba* c. *Giardia*	**5**
IV	**Study of following groups of *Candida* and Non-C*andida* fungal pathogens** (with respect to – Morphological and cultural characteristics, Classification, Pathogenicity, Pathogenesis, Symptoms, Laboratory diagnosis, Epidemiology, Prophylaxis and Chemotherapy)	**5**

References:

1. Tortora, G.J., Funke, B.R., Case, C.L, 1992. Microbiology: An introduction 5th Edition, Benjamin Pub. Co. NY
2. Roitt, P.I: Mims, C.J. Medical Microbiology

3. Chakraborty, P., 2003 A textbook of Microbiology, 2nd Edition New Central Book Agency, India.
4. Medical Microbiology edited by Samuel Baron. Fourth edition. (University of Texas Medical Branch of Galvesion)
5. Sherris, John C, Ed, Medical Microbiology: an Introduction to infectious diseases. Elsevier Publication IInd edition.
6. Virulence mechanisms of bacterial pathogens (Second edition) by Roth, Bolin, Brogden Minion and Michael.
7. Ganti, A. Sastry.1975. Veterinary Pathology. Seventh Edition. Revised by P. Rama Rao.
8. Davis B.D., Delbacco, 1990 Microbiology 4th edition, J.B. Lippincott Co. NY
9. Wolfgang K. Joklik, 1992, Zinsser Microbiology 20th Edition, McGraw-Hill Professional Publishing.
10. Dey, N.C and Dey, TK. 1988, Medical Bacteriology, Allied Agency, Calcutta, 17th Edition
11. Ananthnarayana, R. and C.E, Jayaram Panikar, 1996 Text book of microbiology, 5th edition, Orient Longman.
12. Park and Park, Preventive and Social medicine. 2013, Publisher: Banarsidas Bhanot, Jabalpur
13. David Greenwood, 1995, Antimicrobial Chemotherapy, 3rd Edition, Oxford University Press.
14. Franklin, T.J and Snow, G. A. 2012, Biochemistry of Antimicrobial Action. Springer Science & Business Media
15. Mukherjee, K.L 1988 Medical Laboratory Technology, Vol III, 10th Edition, Tata Mc. Graw-Hill Pub Co

MB – 332: GENETICS AND MOLECULAR BIOLOGY - I

Sr. No.	Topic	No. of Lectures
I	**Gene Linkage and crossing over:** a. Mendelian laws, b. Recombination in eukaryotes Double Strand Break (DSB) model c. Gene linkage and cross over d. Chromosome mapping, Recombination frequency, Map unit e. Mapping Chromosome by Tetrad analysis f. Mapping Chromosome by Para sexual cycle	10
II	**DNA Replication:** a. Single replicon b. Bidirectional movement of replication fork. Ori C, c. Prepriming and Priming reaction. d. DNA polymerases, DNA synthesis of leading, lagging strand e. Okazaki fragments. f. Termination- Ter sequence, Tus protein g. Mismatched repair	7
III	**Prokaryotic and Eukaryotic Transcription:** a. Structure of Promotors b. Structure and role of RNA polymerases. c. Initiation, elongation and termination d. Post transcriptional modification e. Regulation of transcription f. Introduction to RNA splicing	11
IV	**Prokaryotic and Eukaryotic Translation:** a. Role of m-RNA, t-RNA and Ribosomes in translation b. Synthesis of amino acyl tRNA c. Initiation, elongation, translocation and termination of protein d. Regulation of translation	8
V	**Guidelines for gene manipulation:** a. History of recombinant DNA technology - Potential uses and biohazards b. Safety guidelines for recombinant DNA technology laboratory set up	4
VI	**Techniques used in recombinant DNA technology:** a. Isolation and purification of genomic DNA b. Agarose gel electrophoresis c. Blotting- Southern, Northern and Western	8

MB – 342: GENETICS AND MOLECULAR BIOLOGY - II

Sr. No.	Topic	No. of Lectures
I	**Gene transfer by transformation:** a. Development of competence in Gram positive and Gram negative bacteria. b. Process of transformation in Gram positive and Gram negative bacteria.	5

	c. Factors affecting transformation. d. Mapping of chromosome by co-transformation.	
II	**Gene transfer by transduction:** a. Process of generalized transduction. b. Process of specialized transduction. c. Mapping by Co-transduction.	**4**
III	**Gene transfer by conjugation:** a. Properties of F plasmid, b. F^+, F^-, Hfr and F′ strains c. Process of conjugation between F^+ and F^- and Hfr and F^- d. Mapping of conjugant's by interruptedmating experiment.	**5**
IV	**DNA damage and repair:** a. DNA damage by hydrolysis, deamination, alkylation oxidation and radiation b. Base excision repair and nucleotide excision repair c. Recombinational repair d. Photoreactivation **e.** Translesion DNA synthesis	**8**
V	**Recombination and Mutants in Bacteriophages** a. Bacteriophage mutants i. Plaque morphology ii. Conditional lethal (Ts and Am) mutants iii. Deletion Mutants b. Deletion Mapping using bacteriophage deletion mutants c. Benzer`s spot tests d. Genetic Complementation i. Cis-trans test of genetic function ii. Intercistronic (rII locus of T4 phage) iii. Intracistronic (β galactosidase)	**10**
VI	**Tools of Recombinant DNA technology:** a. Vectors used: Plasmids, Viral DNA, cosmids, phagemids, PACs, BACs, YACs, Expression vectors b. Restriction Enzymes c. Insertion of foreign DNA in hosts d. Genomic and c DNA library e. Concept of a clone and probe	**8**
VII	**Generation of recombinant DNA molecule:** a. Cutting and joining the DNA molecules. b. Methods to transfer recombinant DNA into host cells. c. Methods of screening the cells containing the recombinant DNA. d. Identification of clones using probes	**8**

References:

1. Bruce A. (2008), Molecular Biology of the Cell, 5th Edn. Publisher: Garland Science, New York.
2. David Freidfelder, (1987).Molecular Biology, 2nd Edn. Jones & Bartlett Pub.
3. Gardner, Simmons, Snustad. (2006), Principles of Genetics, 8th Edn.John Wiley & Sons. Inc. New York.
4. Gunther S. Stent, (1978), Molecular Genetics: An Introductory Narrative, 2nd Edn. W.H. Freeman & Co.

5. Hayes, W. (1964), The Genetics of Bacteria and their Viruses, CBS Pub. New Delhi.
6. 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.
7. Jocelyn E. Krebs, Elliott S. Goldstein, Stephen T. Kilpatrick, (2012) Lewin's GENES XI , 11th Edn. Jones &Bartlett Learning
8. Lodish H. et al. (2012), Molecular Cell Biology, 7th Edn. W. H. Freeman & Company. New York.
9. Primrose, S. B. (2002).Principles of Gene Manipulation6th Edn. Oxford: Blackwell Scientific Publications
10. Russel Peter. (2009), iGenetics: A Molecular Approach, 3rd Edn. Publisher Benjamin Cummings
11. Russel, Peter, (1990), Essential Genetics, 7thEdn. Blackwell Science Pub.
12. Stanier, R. Y. (1987), General Microbiology, 5th Edition, Macmillan Pub. Co. NY
13. Strickberger, M.W. (1985), Genetics, 3rd Edition Macmillan Pub. Co. NY.

MB – 333: ENZYMOLOGY

Sr. No.	Topic	No. of Lectures
I	**Enzymes:** a. Structure of enzymes: Methods to determine amino acid residues at active site (Physical and chemical methods)	5
	b. Role of cofactors in metabolism: Occurrence, Structure and Biochemical functions of the following: i. Nicotinic Acid (Niacin) and the Pyrimidine nucleotides. ii. Riboflavin (Vitamin B_2) and the Flavin nucleotides iii. Thiamine (Vitamin B_1) and Thiamine Pyrophosphate iv. Pantothenic acid and coenzyme A v. Pyridoxal phosphate (Vitamin B_6) vi. Metal ions	6
II	**Enzyme assays:** a. Principles of enzyme assays: Sampling methods and continuous assay b. Enzymes assays with examples by: i. Spectrophotometric methods ii. Spectroflurometric methods iii. Radioisotope assay	4
III	**Principles and Methods of Enzyme purification:** a. Methods of cell fractionation b. Principles and methods of enzyme purification: i. Based on molecular size ii. Based on charge iii. Based on solubility differences iv. Based on specific binding property and selective adsorption c. Criteria for purity: SDS-PAGE, ultracentrifugation, and construction of purification chart d. Characterization of enzymes: i. Determination of Molecular weight based on: Ultracentrifugation, SDS-PAGE, gel filtration ii. Stability of enzyme activity at pH and temperature	12
IV	**Enzyme Kinetics:** a. Concept and use of initial velocity b. Michaelis Menton equation for the initial velocity of single substrate enzyme catalyzed reaction. Brigg's Haldane modification of Michaelis Menton equation. Michaelis Menton plot. Definition with significance of Km, Ks, Vmax c. Different plots for plotting Kinetic data: i. Lineweaver and Burk plot ii. Hanes plot iii. Eadie Hofstee plot iv. Eisanthal, Cornish-Bowden plot d. Concepts and types of Enzyme Inhibitions	10
V	**Metabolic Regulations:** i. Enzyme compartmentalization at cellular level ii. Allosteric enzymes iii. Feedback mechanisms	9

	iv. Covalently modified regulatory enzymes (e.g. Glycogen phosphorylase) v. Proteolytic activation of zymogens vi. Isozymes - concept and examples vii. Multienzyme complex e.g. Pyruvate dehydrogenase complex(PDH)	
VI	**Immobilization of enzymes:** Concept, methods of immobilization and applications	**2**

MB – 343: METABOLISM

Sr. No.	Topic	No. of Lectures
I	**Membrane transport mechanisms:** i. Passive transport - Diffusion, Osmosis, Facilitated transport ii. Active transport - Active transport systems in bacteria iii. Group translocation of sugars in bacteria iv. Ionophores: Mechanism and examples	**6**
II	**Bioenergetics:** i. Laws of thermodynamics ii. Concepts of free energy, entropy, high energy compounds: Pyrophosphate, enolic phosphates, acyl phosphates, thioester compounds, and guanidinium compounds iii. Mitochondrial electron transport chain: components, arrangement of different components in the inner membrane, structure and function of ATP synthatase, inhibitors and uncouplers of ETC and oxidative phosphorylation, energetics of mitochondrial electron transfer chain	**16**
III	**Biosynthesis and Degradation:** a. Chemistry, concept of polymerization of macromolecules: Polysaccharides. (Starch, glycogen and peptidoglycan) and Lipids (Fatty acids, triglycerides and phospholipids) b. Degradation of macromolecules – Polysaccharides (starch, glycogenand cellulose), Lipids (fatty acids oxidation) and Proteins (urea cycle)	**18**
IV	**Bacterial Photosynthesis:** i. Habitat and examples of photosynthetic bacteria ii. Photosynthetic apparatus iii. Oxygenic and Anoxygenic mechanisms iv. Calvin cycle and its regulation	**8**

References:

1. Nelson D. L. and Cox M. M. (2002) *Lehninger's Principles of Biochemistry*, Mac Millan Worth Pub. Co. New Delhi
2. Segel Irvin H. (1997). *Biochemical Calculations*. 2nd Ed. John Wiley and Sons, New York.
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4. Conn Eric, Stumpf Paul K., Bruuening George, Doi Roy H., (1987) *Outlines of Biochemistry* 5th Ed , John Wiley and Sons, New Delhi.

5. Palmer Trevor (2001) *Enzymes: Biochemistry, Biotechnology and Clinical chemistry*, Horwood Pub. Co. Chinchester, England.
6. White David (2000) *Physiology and Biochemistry of Prokaryotes.* 2nd Ed. Oxford University Press, New York.
7. David A. Hall & Krishna Rao (1999) Photosynthesis (Studies in Biology) 6th Edition, Cambridge University Press, London

MB – 334: IMMUNOLOGY – I

Sr. No.	Topic	No. of Lectures
I	**Immunity:** Definition and Classification	**2**
II	**Formation of blood cells:** Erythrocytic, myelocytic, monocytic and lymphocytic lineages and differentiation process, lymphocyte types and subsets	**2**
III	**Organs of immune system:** a. Primary lymphoid organs (Thymus and Bursa): Thymus – structure, thymic education (positive and negative selection) b. Secondary lymphoid organs – structure and function of spleen and lymph node, mucous associated lymphoid tissue; response of secondary lymphoid organs to antigen, lymphatic system and lymph circulation	 **3** **3**
IV	**Innate immunity: Non specific mechanisms of defense** a. **First line of defense** – Physical, chemical and biological barriers b. **Second line of defense**: i. Humoral components: Defensins, pattern recognition proteins (PRP) and pathogen associated molecular patterns (PAMPs), complement, kinins, acute phase reactants. ii. Cellular components: Phagocytic cells – PMNL, macrophages (reticulo-endothelial cell system) and dendritic cells iii. Functions: Phagocytosis (oxygen dependent and independent systems), Complement activation (Classical, Alternative and lectin pathway), Coagulation system, Inflammation (cardinal signs, mediators, vascular and cellular changes, role of Toll-like receptors)	 **1** **2** **2** **6**
V	**Antigen:** a. Concepts and factors affecting immunogenecity b. Antigenic determinants, haptens and cross-reactivity, Carriers, Adjuvants c. Types of antigens: Thymus-dependent and thymus-independent antigens, Synthetic antigens, Soluble and particulate antigens, Autoantigens, Isoantigens	 **2** **2** **2**
VI	**Immunoglobulins:** a. Structure of basic unit, chemical and biological properties b. Characteristic of domain structure, functions of light and heavy chain domains c. Antigenic nature of immunoglobulin molecules d. Molecular basis of antibody diversity (kappa chain, lambda chain and heavy chain diversity)	 **2** **1** **1** **2**
VII	**Adaptive / Acquired Immunity (Third line of defense):** **1. Humoral Immune Response** a. Primary and secondary response kinetics, significance in vaccination programs b. Antigen processing and presentation (MHC class I and class II restriction pathways), cell-cell interactions and adhesion molecules,	 **3** **6**

	response to super-antigens, role of cytokines in activation and differentiation of B-cells	
	2. Cell Mediated Immune Response a. Activation and differentiation of T cells b. Mechanism of CTL mediated cytotoxicity, ADCC c. Significance of CMI	**3**
VIII	**Transplantation and Immunity** a. Types of Grafts, b. Allograft rejection mechanisms c. Prevention of allograft rejection	**3**

MB – 344: IMMUNOLOGY – II

Sr. No.	Topic	No. of Lectures
I	**Major Histocompatibility Complex:** a. Structure of MHC in man and mouse b. Structure and functions of MHC class–I and class–II molecules c. Polymorphism of MHC molecules d. MHC antigen typing (microcytoxicity and mixed lymphocyte reaction)	**6**
II	**Cytokines:** Types, General characters and role in immune activation - Interferons, Interleukins and TNFs	**3**
III	**Antigen- Antibody Interactions** **Principles** of interactions: Antibody affinity and avidity, ratio of antigen antibody, lattice hypothesis and two stage theory, antigen-antibody reaction kinetics (dialysis equilibrium experiment) **Visualization** of antigen antibody complexes a. Precipitation reactions: in fluid and in gel, immunoelectrophoresis b. Agglutination reactions: hemagglutination, bacterial agglutination, passive agglutination and agglutination-inhibition c. Immunofluorescence techniques: direct and indirect, FACS d. ELISA, biotin-avidin system, e. RIA f. Jerne's hemolytic plaque assay, ELISpot assay	**12**
IV	**Immunohematology** a. Systems of blood group antigens b. ABO system - Biochemistry of blood group substances, Bombay blood group, Inheritance of ABH antigens c. Rh system d. Laboratory methods of blood group typing, Coomb's test e. Medico-legal applications of blood groups f. Blood banking practices, transfusion reactions	**10**
V	**Public health immunology** a. Types of vaccines and antisera b. Immunization schedules: principles, schedules in developing and developed countries	**2** **2**
VI	**Hypersensitivity**	

	a. Immediate and delayed type hypersensitivity b. Gell and Coomb's classification of hypersensitivity – mechanism with examples for type I, II, III and IV c. Autoimmunity – Types, Immunopathological mechanisms, Theories of origin of autoimmunity, Pathophysiology (mechanism of symptom generation) of Myasthenia gravis and Rheumatoid arthritis, Therapeutic immunosuppression for autoimmunity	**2** **4** **4**
VII	**Hybridoma Technology and Monoclonal Antibodies** **a.** Preparation, HAT selection and propagation of hybridomas secreting monoclonal antibodies **b.** Applications of monoclonal antibodies	**2** **1**

References:

1. Abul K. Abbas and Andrew H. Lichtman. *Basic Immunology- Functions and Disorders of Immune System.* 2nd Ed. 2004. Saunders. Elsevier Inc. PA. USA.
2. Aderem, A., and Underhill, D.M.: *Mechanisms of phagocytosis in macrophages***.** *Annu. Rev. Immunol.* 1999, **17**:593–623.
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9. Ganz, T.: *Defensins: antimicrobial peptides of innate immunity***.** *Nat. Rev. Immunol.* 2003, **3**:710–720.
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11. Guyton A. C. and Hall J. E. (1996) *Text Book of Medical Physiology*, Goel Book Agency, Bangalore.
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21. Zeev Pancer and Max D. Cooper, (2006), *The Evolution of Adaptive Immunity*, Ann. Rev. Immunol., **24:** 497–518

MB – 335: FERMENTATION TECHNOLOGY – I

Sr. No.	Topic	No. of Lectures
I	**Strain Improvement:** a. Objective of strain improvement b. Methods for strain improvement: i. selection of different types of mutants ii. application of rDNA technology	9
II	**Media optimization:** a. Classical approach – One factor at a time, Full factorial design b. Placket & Burman design c. Response Surface Methodology (RSM)	4
III	**Sterilization of Media:** a. Methods of sterilization b. Batch sterilization and Continuous sterilization c. Concept and derivation of Del factor	4
IV	**Scale-up and Scale-down:** a. Objective of scale-up b. Levels of fermentation (laboratory, pilot-plant and production levels) c. Criteria of scale-up for critical parameters (aeration and agitation, broth rheology and sterilization) d. Scale-down	5
V	**Principles and methods of downstream processing:** a. Cell disruption b. Filtration c. Centrifugation d. Liquid-liquid extraction e. Distillation f. Ion exchange chromatography g. Drying	9
VI	**Quality assurance (QA) of fermentation product:** a. Detection and Quantification of the product by physicochemical, biological and enzymatic methods b. Sterility testing c. Pyrogen testing – Endotoxin detection d. Ames test and modified Ames test e. Toxicity testing f. Shelf life determination	12
VII	**Fermentation economics:** Contribution of various expense heads to a process (Recurring and non recurring expenditures) citing any suitable example. Introduction to Intellectual Property Rights (IPR) - Types of IPR	3 2

MB – 345: FERMENTATION TECHNOLOGY – II

Sr. No.	Topic	No. of Lectures
I	**Introduction to Solid State Fermentation and Submerged Fermentation**	**2**
II	**Large scale production of:**	
	a. Primary Metabolites: i. Vitamins (B12 and Riboflavin) ii. Amino acid - Glutamic acid, Lysine iii. Organic acids (Citric acid, Vinegar and Lactic acid) **b. Secondary metabolites:** i. Ethanol and alcoholic Beverages (Beer and Wine) ii. Antibiotics (Penicillin and Streptomycin)	 **4** **4** **6** **6** **5**
	c. Enzymes (Amylase, Esterases and Proteases)	**6**
	d. Microbial transformation of steroids	**2**
	e. Biomass based products: i. Yeast: Baker's and Distiller's yeast ii. Mushroom production	 **3** **2**
	f. Milk products: Cheese and Yogurt	**3**
	g. Vaccines (Polio, Tetanus and Rabies)	**3**
	h. Immune sera	**2**

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MB – 336: FOOD AND DAIRY MICROBIOLOGY

Sr. No.	Topic	No. of Lectures
I	**DAIRY MICROBIOLOGY**	
	3. Dairy Development in India: Role of National Dairy Development Board (NDDB), National Dairy Research Institute (NDRI), Military dairy farm, Indian Dairy Corporation (IDC), Dairy Co-operatives, Milk Grid, Operation Flood.	**2**
	4. Milk Chemistry and Constituents: a. Definition and Composition of milk b. Types of Milk (skimmed, toned and homogenized). c. Concept of clean milk d. Factors affecting quality and quantity of milk. e. Nutritive value of milk f. Physico-Chemical properties of milk.	**5**
	5. Microbiology of milk: a. Common micro-organisms found in milk b. Fermentation and spoilage of milk c. Milk borne diseases	**8**
	6. Preservation of Milk by Pasteurization & its storage: a. Methods of Pasteurization – LTH, HTST, UHT b. Storage specifications after pasteurization c. Phosphatase test and its significance	**3**
	7. Microbial analysis of milk: a. Dye reduction test (using methylene blue and resazurin) b. Total bacterial count. c. Brucella ring test and tests for mastitis. d. Somatic cell count	**4**
II	**FOOD MICROBIOLOGY**	
	1. Classification of Foods based on stability: Perishable, Semi-perishable & stable	**1**
	2. Food spoilage: a. Chemical and physical properties of food affecting microbial growth b. Sources of food spoilage micro-organisms c. Spoilage of i. Meat and Poultry products ii. Bread iii. Fruits and Vegetables iv. Eggs v. Sea foods vi. Canned foods	**5**
	c. Food preservation: a. Principles of food preservation b. Thermal destruction of bacteria - use of low temperature and high temperature. c. Determination of TDP, TDT, D, F, and Z values d. Use of chemicals and antibiotics in food preservation e. Canning	**5**

	f. Dehydration g. Use of radiations h. Principles of Hazard Analysis and Critical Control Points (HACCP)- i. Introduction to Tetrapack technology	
	4. Microbial food poisoning and food infection: a. Food poisoning by: i. *Staphylococcus aureus* ii. *Campylobacter* iii. *Clostridium botulinum* iv. *Aspergillus flavus* b. Food infection by : i. *Salmonella typhimurium* ii. *Vibrio parahemolyticus*	**4**
	5. Fermented foods: a. Definition and Types b. Significance of fermented foods (probiotic characteristics of lactic acid bacteria) c. Fermentation of *Idli* batter, butter	**4**
	6. Applications of genetically modified microorganisms: a. Starter cultures b. Genetically modified foods i. Food grade Bio-preservatives ii. Recombinant Dairy enzymes / Proteins	**5**
	7. Food Sanitation and regulation	**2**

MB – 346: AGRICULTURAL AND ENVIRONMENTAL MICROBIOLOGY

Sr. No.	Topic	No. of Lectures
I	**Agriculture Technology:** **1. Plant growth improvement with respect to:** a. Disease resistance b. Environmental tolerance **2. Methods of plant disease control** a. Chemical control b. Eradication c. Biological control (employing bacterial and fungal cultures) d. Integrated pest management e. Development of insect resistant plants (BT crops) f. Application of viral proteins in controlling plant viral diseases g. Antisense RNA technology in plant disease control h. RNA interference (RNAi) in controlling plant pathogens i. Mycoviruses acting against fungal plant pathogens	**14**
II	**Biochemistry and production of bio-fertilizers with respect to:** a. Nitrogen Fixation i. Nonsymbiotic Nitrogen fixation : Diazotrophy, role of	**8**

	nitrogenase and hydrogenase, mechanism of nitrogen fixation ii. Symbiotic Nitrogen fixation : Establishment of symbiosis, Nodule development, mechanism of nitrogen fixation in root nodules iii. *Nod* genes, *Nif* genes, Nif gene cloning, b. Phosphate solubilization c. Potassium mobilization d. Iron chelation	
III	**Bioremediation and Waste Water Treatment:** **1. Bioremediation:** Definition, Role of plants & Microbes in Bioremediation of: a. Hydrocarbons b. Industrial Wastes: (Dyes, Paper & Pulp, Heavy metals, Dairy, Distillery , Tannery c. Xenobiotics **2. Bioaugmentation:** a. Definition b. Use of microbial cultures and enzymes for bioaugmentation c. Applications **3.** Genetically Modified Microorganisms in Bioremediation **4.** Biosorption	**12**
IV	**Bioleaching:** a. Microorganisms used b. Bioleaching process c. Bioleaching of - Copper, Iron, Manganese, Gold, Silver d. Advantages of Bioleaching	**6**
V	**Introduction to Nanobiotechnology:** Synthesis of Nanoparticles using microorganisms and its' applications	**2**
VI	**Microbial Biosensors and Biochips in Environmental Monitoring:** a. Definition, components, types, advantages & limitations b. Application of Biosensors and Biochips	**3**
VII	**Biofuel cells and Biodegradable plastic:**	**2**
VIII	**Bioterrorism**	**1**

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MB – 347: PRACTICAL COURSE – I
APPLIED MICROBIOLOGY

Sr. No.	Topic	No. of Practical
I	Screening and isolation of pesticide degrading microorganisms from soil.	**2**
II	Isolation and identification of lactic cultures up to genus level	**2**
III	Laboratory scale fermentation, estimation, product recovery and yield calculation of ethanol / organic acid (any one)	**2**
IV	Quality assurance tests: a. Antibiotic and growth factor assay (agar gel diffusion technique) b. Sterility testing of non-biocidal injectables	 **2** **1**
V	MIC and MBC of Antibacterial compounds	**2**
VI	Tests for Milk and Dairy products a. Phosphatase test b. MBRT test c. Test for mastitis d. Milk fat estimation e. Standard Plate Count (for milk / milk product e.g. milk powder) f. Direct Microscopic count g. Somatic cell count	**4**
VII	Enrichment, Isolation, Preparation and Application of Bioinoculants (e.g. *Azo-Rhizo* / Blue Green Algae (cyanobacteria), phosphate solubilizer - anyone)	**2**
VIII	Isolation and identification of *Xanthomonas* spp. from infected sample	**1**
IX	Isolation and identification of *Aspergillus* spp. from onions infected with Black Mould	**1**
X	Antifungal activity of Lactic acid bacteria.	**1**
XI	Microscopic examination of Fungi causing Rust and Smut infections in Plants (Demonstration)	**1**
XII	Dye removal from wastes by dead microbial Biomass	**1**
XIII	Biosynthesis of nanoparticles	**1**
XIV	Visit to a Dairy / Fermentation industry / Agriculture college and preparation of visit report	**1**

MB – 348: PRACTICAL COURSE – II
BIOCHEMISTRY AND MOLECULAR BIOLOGY

Sr. No.	Topic	No. of Practical
I	Determination of absorption spectra and molar extinction co-efficient (by colorimetry/ spectrophotometry)	**1**
II	Clinical Biochemistry - Estimations of: a. blood sugar b. blood urea c. serum cholesterol d. serum proteins and albumin	**4**
III	Qualitative analytical tests for proteins and carbohydrates	**2**
IV	Preparation of buffers	**1**
V	Paper chromatography	**1**
VI	Quantitative biochemical techniques: a. Estimation of total carbohydrates by Phenol-sulfuric acid method b. Estimation of reducing sugar by DNSA method c. Estimation of proteins by Folin Lowry method	**3**
VII	Enzyme production: a. Screening of amylase producing organisms b. Production of amylase using these isolates c. Precipitation of amylase from fermentation broth d. d. Determination of specific activity of crude and purified amylase	**5**
VIII	Isolation and enumeration of bacteriophages and study of phage morphology	**2**
IX	Genomic (bacterial) DNA isolation and detection	**1**
X	Isolation of plasmid DNA and gel electrophoresis (demonstration)	**2**
XI	Transformation of *E. coli* and selection of recombinants	**1**
XII	Visit to a research institute involved in biochemical / biotechnology research and preparation of visit report	**1**

MB – 349: PRACTICAL COURSE – III
DIAGNOSTIC MICROBIOLOGY AND IMMUNOLOGY

Sr. No.	Topic	No. of Practical
I	**Clinical microbiology:** a. Physical, Chemical and Microscopic examination of Clinical samples – urine, stool, pus, sputum b. Isolation, identification of following pathogens from clinical samples: *E. coli*, *Salmonella* spp., *Pseudomonas spp., Proteus* spp., *Klebsiella* spp., *Shigella* spp., *Staphylococcus spp, Streptococcus* spp. (for identification use of keys as well as Bergey's Manual is recommended) Antibiotic sensitivity testing of the isolates (for Gram negative and Gram Positive) c. Study of growth characters of isolated pathogens on following media: Mannitol Salt Agar, Wilson Blair agar, Salmonella Shigella agar, Glucose azide medium, Cetrimide agar, TSI agar	**3** **8** **1**
II	**Demonstration of permanent slides of following parasites:** a. *Entamoeba histolytica* b. *Ascaris* spp. c. *Plasmodium* spp. d. *Mycobacterium(tuberculosis and leprae*)	**1**
III	**Epidemiological survey:** Development of hypothesis, Data collection, organization, statistical analysis, graphical representation using computers and interpretation, Preparation of report	**2**
IV	**Hemogram:** a. Estimation of hemoglobin (Acid hematin and Cyan-methemoglobin method) b. ESR and PCV determination, c. White blood cell differential count from peripheral blood d. Counting of RBCs and WBCs using counting chamber e. Calculation of hematological indices	**3**
V	**Immunohematology:** Blood group typing by slide test and tube test for ABO and Rh systems, Cross-matching, Coomb's test	**2**
VI	**Agglutination tests**: Widal test, RPR test	**1**
VII	**Immunoprecipitation:** Double diffusion (Ouchterlony) technique	**1**
VIII	**Demonstrations of:** a. Serum protein separation by electrophoresis b. ELISA (Antigen/ Antibody detection) c. iii. egg inoculation technique	**1**
IX	Visit to blood bank and preparation of visit report	**1**