

PONDICHERRY UNIVERSITY



B.Sc. APPLIED MICROBIOLOGY (Choice Based Credit System)

REGULATIONS AND SYLLABUS

From 2017-18 onwards

PONDICHERRY UNIVERSITY

B.Sc. Applied Microbiology

REGULATIONS

(Effective from the academic year 2017-18)

AIM OF THE COURSE

The B.Sc. Applied Microbiology course aims to impart the students with basic principles of Microbiology and their applications to humankind.

ELIGIBILITY FOR ADMISSION

Candidates for admission to B.Sc. Applied Microbiology shall be required to have passed H.Sc., (+2) or its equivalent with Botany/Zoology/Biology as one of the subjects of study.

DURATION OF THE COURSE

Prescribed studies in B.Sc. Applied Microbiology shall be of six consecutive semesters (three years). The maximum duration allowed for each student to acquire prescribed number of credits in order to complete the Programme of Study shall be twelve consecutive semesters (six years).

AGE LIMIT

The rules as applicable to other Under Graduate courses as prevailing in Pondicherry University.

MEDIUM OF INSTRUCTION

The medium of instruction shall be English

PATTERN OF EXAMINATION

- ❖ The End-Semester examination for each course in a B.Sc. Applied Microbiology shall be conducted by the Pondicherry University for a maximum of 75 marks and Internal Continuous Assessment for 25 marks.
- ❖ Internal Assessment for all theory courses shall be done on the basis of at least two Internal Assessment tests (15 marks), term papers/assignments/seminars/case demonstrations/presentations/write-ups/*viva voce* etc. (5 marks) and attendance (5 marks).

The following weightage shall be given to attendance:

95% - 100% (5 marks)

90% - 94% (4 marks)

85% - 89% (3 marks)

80% - 84% (2 marks)

75% - 79% (1 mark)

- ❖ For Skill Enhancement Course of Semester VI (SEC- 4 /APMB-361) Microbes and Their Applications (Credit Seminar) course's End-Semester examination (75 marks) shall be internally conducted and evaluated by the Department of Microbiology.
- ❖ The Practical End-Semester examination for each course in a Programme of Study shall be conducted by the Pondicherry University for a maximum of 35 marks and Internal Continuous Assessment for 15 marks.
- ❖ Internal Assessment for all Practical courses involving Laboratory/Field work/Project work shall be done on the basis of one Internal Assessment test (5 marks), practical observation/ demonstration/*viva voce*/model making or presenting (5 marks) and attendance (5 marks).
- ❖ End-semester examination shall be conducted for all courses offered. The duration of the end-semester examination shall be 3 hours.
- ❖ Every student has to pay examination fee per Credit basis as fixed by the University.
- ❖ A schedule of end-semester examinations will be prepared and displayed by the University much in advance.
- ❖ No student with less than 75 % in any particular course shall be permitted to attend the end-semester examination and shall be given grade FA-failure due to lack of attendance. However, an overall condonation of 10 % is permitted for valid reasons (NCC, NSS, Swachh Bharat) or medical reasons. A student who has been awarded FA shall repeat the course when offered. The Principal/Head of the Department shall ensure that the candidate is informed about the lack of attendance before the commencement of end-semester examination and confirm that such candidates are not permitted to write the examination.
- ❖ To pass a course the student must secure minimum of 40 out of 100 marks (40 %) in the internal and in the end-semester examination.

- ❖ A student who has earned the required number of 120 credits by clearing all the required courses shall be declared as pass even if he/she could not clear optional courses which were taken in excess of the required number of courses.
- ❖ Result Passing Board for each Programme of Study shall be constituted by the Pondicherry University from time to time.
- ❖ Revaluation and re totaling of the answer scripts shall be allowed within the stipulated period of time as decided by the Controller of Examinations (COE) after paying the required amount of fee.

SUPPLEMENTARY EXAMINATION

- ❖ A failed student who meets the attendance requirement may be permitted to register for the next end-semester examination in the following semester itself.
- ❖ Students who have failed due to insufficient attendance and /or less than 40 % Internal Assessment marks should repeat the course as and when offered.

DISTRIBUTION OF MARKS

THEORY

Total: 100 Marks

End-Semester University Examination: 75 marks

Continuous Internal Assessment: 25 marks

[comprises of Internal assessment tests - 15 marks; term papers/assignments/seminars/case demonstrations/ presentations/write-ups/*viva voce* - 5 marks; Attendance - 5 marks]

- Requirement for minimum pass in Continuous Internal Assessment: 10 marks (40 %) out of 25 Marks
- Requirement for minimum pass in Term End University Examination: 30 marks (40 %) out of 75 Marks

For Skill Enhancement Course of Semester VI (SEC- 4 /APMB-361) Microbes and Their Applications (Credit Seminar) course's End-Semester examination (75 marks) shall be internally conducted and evaluated by the Department of Microbiology.

PRACTICALS

Total: 50 Marks

End-Semester University Practical Examination: 35 marks

Continuous Internal Assessment: 15 marks

[one Internal Assessment test (5 marks), practical observation/ demonstration/*viva voce*/model making or presenting (5 marks) and attendance (5 marks)].

- Requirement for minimum pass in Continuous Internal Assessment: 6 marks (40 %) out of 15 Marks
- Requirement for minimum pass in Term End University Examination: 14 marks (40 %) out of 35 Marks

QUESTION PAPER PATTERN FOR THEORY AND PRACTICALS

Theory External Examination (75 marks)

Time: 3 hours

Max. Marks: 75

Part – A 10 X 1 = 10 Marks

(2 questions from each unit)

Part – B 5 X 7 = 35 Marks

(Short answer type – either or choice, one question from each unit)

Part – C 3 X 10 = 30 Marks

(Essay answer type - 3 out of 5 Questions have to be answered, 1 question from each unit)

Practical External Examination (35 marks)

Time: 3 hours

Max. Marks: 35

I. Question 1 (20 Marks)

II. Question 2 Spotters (5 Marks)

III. Record (10 Marks)

(Submission of practical record for the End Semester Practical Examination is mandatory).

**Course Structure for B.Sc. Applied Microbiology
Implemented from 2017-18 onwards**

COURSE	SUBJECT CODE [#]	TITLE OF THE PAPER	CREDIT ALLOTTED		Hours per week	
			Lecture	Tutorial/lab	Theory	Practicals
SEMESTER - I			20 CREDITS			
MIL – 1	LBEN/LHIN/LMAL/LSAN/LTAM/LTEL 111	Language – I	03		5	
ENGLISH – 1	ENGL 112	English – I	03		5	
DSC – 1A	APMB 111	Fundamentals of Microbiology	03		4	
DSC – 2A	APMB 112	Cell Biology	03		4	
DSC – 3A	APMB 113	Fundamentals of Biochemistry (Biochemistry - I)	03		4	
DSC – 4A	APMB 111P	<i>Practicals - I Fundamentals of Microbiology</i>		01		2
DSC – 5A	APMB 112P	<i>Practicals - II Cell Biology</i>		01		2
DSC – 6A	APMB 113P	<i>Practicals - III Fundamentals of Biochemistry</i>		01		2
AECC – 1	PADM 113	Public Administration	02		2	
SEMESTER - II			20 CREDITS			
MIL – 2	LBEN/LHIN/LMAL/LSAN/LTAM/LTEL 121	Language – II	03		5	
ENGLISH – 2	ENGL 122	English – II	03		5	
DSC – 1B	APMB 121	Molecular Biology	03		4	
DSC – 2B	APMB 122	Immunology	03		4	
DSC – 3B	APMB 123	Clinical Biochemistry (Biochemistry - II)	03		4	
DSC – 4B	APMB 121P	<i>Practicals - IV Molecular Biology</i>		01		2
DSC – 5B	APMB 122P	<i>Practicals - V Immunology</i>		01		2
DSC – 6B	APMB 123P	<i>Practicals - VI Clinical Biochemistry</i>		01		2
AECC – 2	ENVS 123	Environmental studies	02		2	

COURSE	SUBJECT CODE [#]	TITLE OF THE PAPER	CREDIT ALLOTTED		Hours per week	
			Lecture	Tutorial/lab	Theory	Practicals
SEMESTER - III		20 CREDITS				
MIL – 3	LBEN/LHIN/LMAL/ LSAN/LTAM/LTEL 231	Language – III	03		5	
ENGLISH – 3	ENGL 232	English – III	03		5	
DSC – 1C	APMB 231	Bacterial Physiology and Metabolism	03		4	
DSC – 2C	APMB 232	Recombinant DNA Technology	03		4	
DSC – 3C	APMB 233	Economic and Medical Entomology (Biological Science - I)	03		4	
DSC – 4C	APMB 231P	<i>Practicals - VII Bacterial Physiology and Metabolism</i>		01		2
DSC – 5C	APMB 232P	<i>Practicals - VIII Recombinant DNA Technology</i>		01		2
DSC – 6C	APMB 233P	<i>Practicals - IX Economic and Medical Entomology</i>		01		2
SEC – 1	APMB 234	Public Health Microbiology	02		2	
SEMESTER - IV		20 CREDITS				
MIL – 4	LBEN/LHIN/LMAL/ LSAN/LTAM/LTEL 241	Language – IV	03		5	
ENGLISH – 4	ENGL 242	English – IV	03		5	
DSC – 1D	APMB 241	Virology	03		4	
DSC – 2D	APMB 242	Medical Bacteriology	03		4	
DSC – 3D	APMB 243	Plant Pathology (Biological Science - II)	03		4	
DSC – 4D	APMB 241P	<i>Practicals - X Virology</i>		01		2
DSC – 5D	APMB 242P	<i>Practicals - XI Medical Bacteriology</i>		01		2
DSC – 6D	APMB 243P	<i>Practicals - XII Plant Pathology</i>		01		2
SEC – 2	APMB 244	Mushroom and <i>Spirulina</i> cultivation	02		2	

COURSE	SUBJECT CODE [#]	TITLE OF THE PAPER	CREDIT ALLOTTED		Hours per week	
			Lecture	Tutorial/lab	Theory	Practicals
SEMESTER - V		20 CREDITS				
SEC – 3	APMB 351	Management of Microbiology laboratory	02		4	
*DSE – 1A *DSE – 2A *DSE – 3A	APMB 352	Microbial Diversity and Bacterial Phylogeny	04		5	
	APMB 353	Medical Mycology and Parasitology	04		5	
	APMB 354	Pharmaceutical Microbiology	04		5	
	APMB 355	Industrial Microbiology	04		5	
	APMB 356	Biostatistics and Computer Applications	04		5	
	APMB 352P	<i>Practicals - XIII Microbial Diversity and Bacterial Phylogeny</i>		01		2
	APMB 353P	<i>Practicals - XIV Medical Mycology and Parasitology</i>		01		2
	APMB 354P	<i>Practicals - XV Pharmaceutical Microbiology</i>		01		2
	APMB 355P	<i>Practicals - XVI Industrial Microbiology</i>		01		2
	APMB 356P	<i>Practicals - XVII Biostatistics and Computer Applications</i>		01		2
GE – 1	APMB 357	Bioinformatics	03		5	
SEMESTER - VI		20 CREDITS				
SEC – 4	APMB 361	Microbes and their Applications (Credit seminar)	02		4	
*DSE – 1B *DSE – 2B *DSE – 3B	APMB 362	Food and Dairy Microbiology	04		5	
	APMB 363	Microbial Ecology and Environmental Microbiology	04		5	
	APMB 364	Soil and Agricultural Microbiology	04		5	
	APMB 365	Haematology and Blood Banking	04		5	
	APMB 366	Microbial Production of Pigments, Flavour and Aroma compounds	04		5	
	APMB 362P	<i>Practicals - XVIII Food and Dairy Microbiology</i>		01		2
	APMB 363P	<i>Practicals - XIX Microbial Ecology and Environmental Microbiology</i>		01		2
	APMB 364P	<i>Practicals - XX Soil and Agricultural Microbiology</i>		01		2
	APMB 365P	<i>Practicals - XXI Haematology and Blood Banking</i>		01		2
APMB 366P	<i>Practicals - XXII Microbial Production of Pigments, Flavour and Aroma compounds</i>		01		2	
GE – 2	APMB 367	Microbial Genomics	03		5	

Total number of Credits - 120

[#] Applied MicroBiology; the first numeral stands for year of collegiate education; second numeral stands for number of the semester; third numeral is for serial number of the course: P - denotes practical course

*Among five papers, student have the choice of selecting any three papers (theory with practical course)

Abbreviations used : DSC- Discipline Specific Core course; AECC - Ability Enhancement Compulsory Course; SEC - Skill Enhancement Course;

GE - Generic Elective course; DSE - Discipline Specific Elective course; MIL - Modern Indian languages

SEMESTER – I

DSC - 1A

APMB 111

FUNDAMENTALS OF MICROBIOLOGY

(3 credits)

Unit - I

History and scope of microbiology, spontaneous generation – biogenesis theory – contributions of Leeuwenhoek, Louis Pasteur, Robert Koch, Edward Jenner, Paul Ehrlich and Fleming.

Unit - II

Microscope – principles and application – simple and compound microscope – dark field – phase contrast, fluorescent microscope, SEM and TEM. Types of staining – simple, differential (Gram's, AFB), special – capsular staining (negative), spore, LPCB, KOH mount.

Unit - III

Ultrastructure of bacteria, cell envelope, cell wall – Gram positive and Gram negative bacterial cell wall, slime, flagella, capsule, pili.

Unit - IV

Sterilization and disinfection – principles – methods of sterilization – physical methods – dry heat – moist heat – radiation – filtration (membrane and HEPA) – chemical sterilization – chemical agents – mode of action. Preservation and maintenance of culture

Unit - V

Culture and media preparation – solid and liquid. Types of media – semi synthetic, synthetic, enriched, enrichment, selective and differential media. Pure culture techniques – tube dilution, pour, spread, streak plate. Anaerobic cultivation of bacteria.

Text Books

1. Willey J.M., Sherwood L.M. and Woolverton C.J. (2013) Prescott's Microbiology, 9th Edn. McGraw-Hill Higher Education.
2. Madigan M.T., Bender K.S., Buckley D.H., Sattley W.M. and Stahl D.A. (2017) Brock Biology of Microorganisms, 15th Edn. (Global Edn.) Pearson Education.

Reference Books

1. Talaro K.P. and Chess B. (2012) Foundations in Microbiology, 8th Edn. The McGraw Hill Companies.
2. Tortora G.J., Funke B.R. and Chase C.L. (2013) Microbiology: An Introduction, 11th Edn. Pearson-Benjamin Cummings.
3. Brown A. and Smith H. (2015) Benson's Microbiological Applications: Laboratory Manual in General Microbiology, 13th Edn. McGraw-Hill Companies.

DSC – 4A

APMB 111P

Practicals – I: FUNDAMENTALS OF MICROBIOLOGY

(1 credit)

1. Handling of instruments and laboratory safety measures.
2. Handling and maintenance of compound microscope.
3. Cleaning of glasswares and preparation of cleaning solutions.
4. Staining techniques a. simple, b. differential staining (Gram's and Ziehl-Neelsen), c. special staining (spore and capsular staining methods) and wet-mount.
5. Hanging drop technique – motility.
6. Handling of laboratory instruments a. autoclave b. hot air oven c. laminar air flow d. pH meter.
7. Media preparation: a. liquid media – peptone water, nutrient broth; b. solid media – nutrient agar (agar slant, agar plate); c. enriched medium – blood agar; d. differential medium – MacConkey agar; e. enrichment medium – selenite F broth; f. selective medium – EMB, MSA.

SEMESTER – I

DSC – 2A

APMB 112

CELL BIOLOGY

(3 credits)

Unit - I

History of cell biology, cell as basic unit of life, cell theory, protoplasm theory and organismal theory, broad classification of cell types, Bacteria, Archaea (prokaryotic) and Eukaryotic cells and their similarities and differences.

Unit - II

Structure and functions of cell wall: bacterial cell wall – plant cell wall and fungal cell wall, plasma membrane – exocytosis, endocytosis, phagocytosis – vesicles and their importance in transport. Cytoskeleton structure – microtubules, microfilaments, intermediate filament.

Unit - III

Structure and functions of cell organelles – endoplasmic reticulum (rough endoplasmic reticulum and smooth endoplasmic reticulum), golgi apparatus, lysosomes, microbodies (peroxisomes and glyoxysomes), vacuoles, ribosomes, centriole and basal bodies.

Unit - IV

Mitochondria – organization of respiratory chain, chloroplasts – photophosphorylation, nucleus, nucleolus, nuclear membrane and organization of chromosomes, cell cycle and its check points, cell division (mitosis and meiosis).

Unit - V

Cell communication – overview – types of cell signaling – signal molecules – signal amplification – receptor types – quorum sensing.

Text Books

1. Verma P.S. and Agarwal V.K. (2016) Cell Biology (Cytology, Biomolecules, Molecular Biology), Paperback, S. Chand and Company Ltd.
2. Hardin J. and Bertoni G. (2017) Becker's World of the Cell, 9th Edn (Global Edition). Pearson Education Ltd.

Reference Books

1. Cooper G.M. and Hausman R.E. (2016) The Cell – A Molecular Approach, 7th Edn. Sinauer Associates Inc.
2. Mason K.A., Losos J.B. and Singer S.R. (2017) Raven Johnson's Biology, 11th Edn. McGraw-Hill Education.
3. Karp G. (2010) Cell and Molecular Biology – Concepts and Experiments, 6th Edn. John Wiley and Sons.

DSC – 5A

APMB 112P

Practicals – II: CELL BIOLOGY

(1 credit)

1. Study of plant and animal cell types basic structure using micrographs or model.
2. Study of bacterial cell structure, shape and arrangement using micrographs or model.
3. Blood as liquid tissue – demonstrating the different types of blood cells.
4. Cytoplasmic streaming in eukaryotic cells.
5. Stomatal cell type in plant tissues.
6. Mitosis demonstrated using onion root tip method
7. Studying the different cellular organelles of the eukaryotic and prokaryotic cells with animation and micrographs.
8. Demonstration of quorum sensing in bacteria using animation or micrographs.

SEMESTER – I

DSC – 3A

APMB 113

FUNDAMENTALS OF BIOCHEMISTRY

(3 credits)

(Biochemistry - I)

Unit - I

Chemistry of carbohydrates: definition and classification of carbohydrates, linear and ring forms (Haworth formula) for monosaccharides – disaccharides and glycosidic bond. Physical properties – mutarotation and kiliani cyanohydrin synthesis. Chemical properties – oxidation, reduction, osazone formation. Polysaccharides (homo and hetero): starch and cellulose – occurrence, structure, physical and chemical properties – reducing and non reducing sugar.

Unit - II

Chemistry of amino acids: standard and non-standard amino acids and their properties, amphoteric nature, isoelectric point, isoelectric pH and Zwitter ion – Ramachandran plot for amino acids. Reaction with ninhydrin, 1-fluoro-2, 4-dinitrobenzene (FDNB) and Siegfried's carbamino reaction.

Unit - III

Chemistry of proteins: classifications – shape and size, solubility, physical properties and functional properties. Primary, secondary, tertiary and quaternary structure of protein – protein folding – molecular chaperones. N-terminal determination – Edman and dansyl chloride method. C-terminal determination – Van-Slyke reaction, phosgene reaction – protein assays – column chromatography and electrophoresis.

Unit - IV

Chemistry of lipids: definition, classification and functions. Occurrence, chemistry and biological functions – simple lipids: tertiary compound lipids (e.g. phospholipids), derived lipids: steroids (e.g. cholesterol). Saturated and unsaturated fatty acids physical property – emulsification. Chemical properties – saponification, rancidity, definition of acid number, saponification number, iodine number and Reichert-Meissl number. Bile acid and bile salt functions.

Unit - V

Chemistry of nucleic acids: definition, sugar pucker – nucleoside, nucleotide and polynucleotide. Double helical model of DNA – super coil forms and linking numbers of DNA. Structure of RNA's – occurrence, chemistry and biological functions. Differences between DNA and RNA, properties – quantification of nucleic acids – thermal denaturation – cot curve and cot value, T_m , hypo and hyperchromicity.

Text Books

1. Satynarayana T. (2005) Biochemistry, Books and Allied Pvt. Ltd.
2. Moore J.T. and Langley R. (2008) Biochemistry for Dummies, Wiley Publishing Company.

Reference Books

1. Nelson D.L and Cox M.M. (2017) Lehninger Principles of Biochemistry, 7th Edn. Intl. Edition, WH Freeman and Company.
2. Voet D. and Voet J.G. (2011) Biochemistry, 4th Edn. John Wiley and Sons Ltd.
3. Campbell M.K., Farrell S.O. and McDougal O.M. (2018) Biochemistry, 9th Edn. Brooks /Cole Cenage Learning.

DSC - 6A

APMB 113P

**Practicals – III: FUNDAMENTALS OF
BIOCHEMISTRY**

(1 credit)

1. Estimation of HCl using Na_2CO_3 as link and NaOH as primary standard.
2. Estimation of iron in ferrous ammonium sulphate using potassium permanganate as link solution and oxalic acid as primary standard.
3. Estimation of glucose by Benedict's test.
4. Estimation of glycine by formal titration.
5. Estimation of ascorbic acid.
6. Preparation of starch from potatoes.
7. Qualitative analysis of protein.
8. Qualitative analysis of fats.
9. Preparation of ovalbumin from egg.

SEMESTER – II

DSC – 1B

APMB 121

MOLECULAR BIOLOGY

(3 credits)

Unit - I

History of molecular biology, DNA and RNA as genetic materials, experiments of Griffith, Avery, Macleod and McCarty. Hershey and Chase, Lederberg and Tatum, Chargaff's principles, primary and secondary structure of DNA and RNA. Alternative forms of DNA double helices – types of RNA.

Unit - II

DNA replication in prokaryotes: Replicons – models of DNA replication – origin and termination of replication – rolling circle replication – proof for semi conservative replication (Meselson and Stahl Experiment) – enzymes and proteins involved in DNA replication (nucleases, polymerases, ligases, helicases, gyrases, single strand binding protein, replisome and primosome) – mechanism of semi discontinuous replication.

Unit - III

Steps involved in transcription of prokaryotes, promoters, transcription factors, RNA polymerases I, II and III – ribosomal RNA transcription and processing – genetic code, deciphering the genetic code, characteristics of genetic code, Wobble hypothesis, central dogma of life and reversal of central dogma.

Unit - IV

Steps involved in translation of prokaryotes – role of proteasomes in protein degradation – mechanism of action of antibiotics on protein synthesis (puromycin, chloramphenicol and streptomycin). Regulation of gene expression in prokaryotes – polycistronic mRNA and operons (*lac* operon and *trp* operon and attenuation mechanism).

Unit - V

Mutation: spontaneous and induced mutations – UV and X - rays – mechanism of action of base analogues, alkylating agents, intercalating agents and teratogens – reversion suppressor mutations and mutation rate – repair of damaged DNA – excision repair, SOS, photoreactivation – CRISPR and their role in genome stability.

Text Books

1. Verma P.S. and Agarwal V.K. (2016) Cell Biology (Cytology, Biomolecules, Molecular Biology), Paperback, S. Chand and Company Ltd.
2. McLennan A., Bates A., Turner P. and White M. (2012) Bios Instant Notes Molecular Biology, 4th Edn. Taylor & Francis.

Reference Books

1. Watson J.D., Baker T.A., Bell S.P., Gann A., Levine M., Losick R. and Harrison S.H. (2014) Molecular Biology of Gene, 7th Edn. Pearson Benjamin-Cummings.
2. Cox M.M., Doudna J.A. and O'Donnell M. (2012) Molecular biology: Principles and Practice, WH Freeman and Company.
3. Lodish H., Berk A., Kaiser C.A., Krieger M., Bretscher A., Ploegh H., Amon A. and Martin K.C. (2016) Molecular Cell Biology, 8th Edn. WH Freeman and Company.

DSC – 4B

APMB 121P

Practicals– IV: MOLECULAR BIOLOGY

(1 credit)

1. Introduction to molecular biology laboratory techniques and development skills.
2. Elaboration of DNA and RNA structure and forms using micrograph or animation.
3. Working on Agarose gel electrophoresis.
4. DNA isolation from *E .coli*.
5. DNA estimation – spectrophotometric method.
6. UV irradiation – Percent survival curve.
7. Transformation (demonstration).
8. Isolation of plasmids (demonstration).
9. Isolation of RNA from cells (demonstration).
10. Identification of bacterial phylogeny using 16S rRNA gene sequencing (demonstration).

SEMESTER – II

DSC – 2B

APMB 122

IMMUNOLOGY

(3 credits)

Unit - I

History of immunology, host parasitic relationships, microbial infections – types – sources of infection – steps involved in infection – transmission of infection, virulence – toxigenicity and invasiveness, host resistance. Innate immunity and acquired immunity.

Unit - II

Structure, functions and properties of immune cells: stem cell, T cell, B cell, NK cell, macrophage, neutrophil, eosinophil, basophil, mast cell, dendritic cell and immune organs – bone marrow, thymus, lymph node, spleen, GALT, MALT, CALT.

Unit - III

Antigens– types, properties, haptens, adjuvants, vaccines – types – toxoids – antitoxins. Immunoglobulins – structure, types and properties. Theories of antibody production. Hybridoma Technology, complement structure, properties, function of complement components and pathways.

Unit - IV

Antigen and antibody reactions: *In-vitro* methods – agglutination, precipitation, complement fixation, immunofluorescence, enzyme linked immuno sorbent assay (ELISA), radioimmunoassay. *In-vivo* methods: skin tests – immune complex tissue demonstrations.

Unit - V

Hypersensitivity reactions: antibody mediated – type I anaphylaxis – type II antibody dependent cell cytotoxicity – type III – immune complex reactions – type IV – delayed type hypersensitivity reactions. Cell mediated immune responses – lymphokines, cytokines.

Text Books

1. Owen J., Punt J. and Stranford S. (2013) Kuby Immunology, 7th Edn. Macmillan Education, India.
2. Shetti N. (2005) Immunology: Introductory Text book, 2nd Edn. New Age International Limited.

Reference Books

1. Lydyard P., Whelan A. and Fanger M. (2011) Bios Instant notes in Immunology, 3rd Edn. Garland Science publishers.
2. Delves P.J., Martin S.J., Burton D.R. and Roitt I.M. (2011) Roitt's Essential Immunology, 12th Edn. Wiley publishers.
3. Brooks G., Carrol K.C., Butel J. and Morse S. (2012) Jawetz Melnick and Adelberg Medical Microbiology, 26th Edn. Lange Medical Publications.

DSC –5B

APMB 122P

Practical –V: IMMUNOLOGY

(1 credit)

1. Identification of human blood groups – forward and reverse grouping.
2. Separation of serum from blood sample (demonstration).
3. Separation of plasma from blood (demonstration).
4. Differential leukocyte count of the given blood sample.
5. Precipitation reaction: Ouchterlony double immunodiffusion test.
6. Radial immunodiffusion.
7. Counter immunoelectrophoresis (CIE).
8. Rocket electrophoresis.
9. Rapid plasma reagin (RPR) test.
10. Agglutination Test – Widal test.
11. Antistreptolysin O (ASLO) test.
12. ELISA (demonstration).

SEMESTER – II

DSC – 3B

APMB 123

CLINICAL BIOCHEMISTRY

(3 credits)

(Biochemistry - II)

Unit - I

Basic concepts of clinical biochemistry: A brief review of units and abbreviations used in expressing concentrations and standard solutions. Biological samples – specimen collection – anticoagulant – preservatives for blood and urine – transport of specimens.

Unit - II

Disorders related to carbohydrate metabolism: diabetes mellitus – definition – WHO criteria – classification of diabetes mellitus – signs, symptoms and complications – GTT–galactosemia, galactosuria, fructosuria.

Unit - III

Disorders related to amino acid and lipid metabolism: Inborn errors of metabolism – phenylketonuria, alkaptonuria, albinism and tyrosinosis. Exogenous and endogenous transport of lipids – chylomicron transport, VLDL transport – reverse cholesterol transport – atherosclerosis – fatty liver – risk and anti risk factors.

Unit - IV

Liver function test: detoxification and excretory functions – protein changes in liver disease- differential diagnosis of jaundice – hemolytic hepatic and obstructive jaundice – Bilirubin metabolism, bile pigment levels in blood and urine – gastric function test – fractional test meal analysis and its interpretation. GI hormones – gastrin, secretin, CCK and gastric inhibitory peptide.

Unit - V

Diagnostic enzymology: plasma enzymes – functional and non-functional enzymes – isoenzymes – enzyme patterns in acute pancreatitis, liver diseases and myocardial infarction.

Text Books

1. Ahmed N. (2010) Clinical Biochemistry. Oxford University Press.
2. Vasudevan D.M. (2008) Textbook of Biochemistry for Medical Students, 5th Edn, Jaypee publishers.

Reference Books

1. Rodwell V.W., Bender D.A., Botham K.M., Kennelly P.J. and Weil P.A. (2015) Harper's Biochemistry, 30th Edn. McGraw Hill Education.
2. Sathya Narayana U. (1999) Biochemistry, 2nd Edn. Kolkata, Allied Publishers.
3. Mallikarjuna Rao N. (2002) Medical Biochemistry, 2nd Edn. New Age Publishers.

DSC – 6B

APMB 123P

Practicals – VI: CLINICAL BIOCHEMISTRY

(1 credit)

1. Blood sugar analysis.
2. Blood urea analysis.
3. Serum – creatinine estimation.
4. Serum – uric acid estimation.
5. Serum – cholesterol estimation.
6. Serum – bilirubin estimation.
7. Estimation of total protein.
8. Determination of A/G ratio.
9. Urine analysis.
10. Estimation of SGOT and SGPT.

SEMESTER – III

DSC – 1C

APMB 231 BACTERIAL PHYSIOLOGY AND METABOLISM (3 credits)

Unit - I

Nutritional classification – importance of various macro, micro elements and growth factors in bacterial growth – bacterial growth curve – measurement of microbial growth – gravimetry, turbidometry and nephelometry. Continuous culture – synchronous culture – sporulation.

Unit-II

Transport of nutrients – uptake of nutrient – passive diffusion – facilitated diffusion – active transport (periplasmic binding protein and ABC transport) simple transport (uniport, symport and antiport) – group translocation and protein export system. Role of osmoregulatory proteins – permeomics.

Unit - III

Biosynthesis of cell structures from glucose (cell wall, capsule, flagella structure and synthesis, cell inclusions) – biochemistry of nitrogen fixation – nitrogenase enzyme – nitrogen assimilation – sulfate assimilation – anaplerotic reactions in the catabolic pathways.

Unit - IV

Photosynthesis – characteristics and metabolism of autotrophs, anoxygenic photosynthetic bacteria and cyanobacteria – CO₂ fixation and mechanism of photosynthesis – chemolithotrophs – hydrogen bacteria – nitrifying bacteria, sulphur bacteria and iron bacteria – methanogens – methylotrophs.

Unit - V

Central catabolic pathways – glycolysis, hexose monophosphate pathway, Entner Doudoroff pathway, tricarboxylic acid cycle – electron transport system–components – adenosine tri phosphate structure and their generation types – fermentations – types – anaerobic respirations.

Text Books

1. Drummond J.T., White D. and Fuqua C. (2012) The Physiology and Biochemistry of Prokaryotes, 4th Edn. Oxford University Press.
2. Kim B.H. and Gadd G.M. (2008) Bacterial Physiology and Metabolism, Cambridge University Press.

Reference Books

1. Schaechter M. (Ed.) (2009) Physiology In: Encyclopedia of Microbiology, 3rd Edn. Academic Press.
3. Moat A.G., Foster J.W. and Spector M.P. (2002) Microbial Physiology, 4th Edn. Wiley-Liss Publishers.
2. Rosenberg E., Delong E.F., Lory S., Stackebrandt E. and Thompson F. (2013) The Prokaryotes: Prokaryotic Communities and Ecophysiology, 4th Edn. Springer Reference.

DSC – 4C

APMB 231P Practicals – VII: BACTERIAL PHYSIOLOGY AND METABOLISM

(1 credit)

1. Determination of growth curve of bacteria.
2. Bacterial population count by turbidity method.
3. Estimation of fungal growth by gravimetric estimation.
4. Effect of temperature on bacterial growth.
5. Effect of pH on bacterial growth.
6. Biochemical characterization of bacterial cultures: catalase, urease, cytochrome oxidase and sugar fermentation, citrate utilization, gelatin liquefaction, sulfide indole motility test.
7. Nitrification and denitrification by bacteria.
8. Biolog/API based biochemical tests (demonstration).

SEMESTER – III

DSC – 2C

APMB 232

RECOMBINANT DNA TECHNOLOGY

(3 credits)

Unit - I

Introduction to recombinant DNA technology – tools for rDNA technology – DNA manipulative enzymes: restriction enzymes, ligases, polynucleotide kinase, phosphatase, cutting of DNA molecules – joining of DNA molecules – homopolymer tails, linkers, adapters.

Unit - II

Gene cloning vectors: salient features, plasmids – properties, types, pBR322 and pUC18, bacteriophage vectors – λ , λ ZAP, λ gt11, cosmids, artificial chromosomes – BAC, YAC, MAC. Cloning bovine somatostatin gene in *E. coli*.

Unit - III

Transformation of r-DNA into target host organisms: calcium chloride mediated gene transfer, *Agrobacterium* mediated DNA transfer, electroporation, microinjection, liposome fusion, particle gun bombardment. Screening and selection of recombinant host cells: blue/white screening.

Unit - IV

Construction of gene libraries: genomic and cDNA libraries. Blotting techniques, polymerase chain reaction (PCR) and its applications.

Unit - V

Applications of rDNA technology in industry, medicine, agriculture and pharmacy. Social impact of recombinant DNA technology.

Text Books

1. Primrose S.B. and Twyman R.M. (2006) Principle of Gene Manipulation and Genomics, 7th Edn. Blackwell Publishing.
2. Nicholl D.S.T (2008) An Introduction to Genetic Engineering, 3rd Edn. Cambridge University Press.

Reference Books

1. Brown T.A. (2016) Gene Cloning and DNA Analysis – An Introduction, 7th Edn. Wiley-Blackwell.
2. Glick B.R. and Patten C.L. (2017) Molecular Biotechnology. Principles and Application of Recombinant DNA, 5th Edn. ASM Press, Washington.
3. Watson J.D., Gann A., Baker T.A., Levine M., Bell S.P. and Losick R. (2014) Molecular Biology of Gene, 7th Edn. Pearson publishers.

DSC – 5C

APMB 232P

Practicals-VIII: RECOMBINANT DNA TECHNOLOGY

(1 credit)

1. Agarose gel electrophoresis.
2. Isolation of total bacterial DNA.
3. Isolation of yeast DNA.
4. Isolation of DNA from red blood cells.
5. Isolation of plasmid DNA.
6. Restriction digestion.
7. Ligation.
8. Production of competent *E. coli* cells.
9. Transformation of bacteria and isolation of transformants.

SEMESTER – III

DSC – 3C

APMB 233

ECONOMIC AND MEDICAL ENTOMOLOGY (Biological Science-I)

(3 credits)

Unit - I

Classification of insects according to Order – Pests of crops: any three pests for each crop, their life cycle and control measures: food crops – rice, sorghum; pulses – red gram, green gram, black gram; cash crops – sugarcane; fibre – cotton; oilseeds – groundnut, coconut; vegetables – brinjal, tomato, ladies' finger; spices; condiments and beverages – cardamom, chilly, tea, coffee; fruit trees – mango, citrus, grapes.

Unit - II

Pests of stored products, their life cycle and control: beetles – red grain beetle; rice weevil, paddy bore beetle, pulse beetle, carpet beetle; moths – paddy grain moth, rice meal worm. termites and their control – insect vectors of plant diseases and their control.

Unit - III

Beneficial insects: honeybee, silkworm, lac insects – their biology, life cycle and uses to humankind. Insect predators, parasites and parasitoids that destroy crop pests and other harmful insects of human live stocks.

Unit - IV

Principles of insect pest management using physical mechanical, biological, chemical and legal methods. Classification of pesticides and their formulations, both inorganic and organic – mode of their action. Biocides and their efficacy – a brief outline – precautions in handling pesticides and environmental pollution – biological control agents used in agriculture.

Unit - V

Vector borne human diseases – mechanisms of transmission – types of vectors and their identification. (tsetse flies, black flies, sand flies, ticks, mites, lice, bed bugs, fleas, mosquitos) – vector borne disease, mode of infection and control – lyme disease – typhus – Rickettsia – Rocky mountain spotted fever – Equine infectious anemia – Chagas disease.

Text Books

1. David B.V. and Ramamurthy V.V. (2016) Elements of Economic Entomology, Paperback, 8th Edn. Brillion Publishing.
2. Shukla A. (2009) A Handbook Economic Entomology, Daya Publishing House.

Reference Books

1. Prasad T.V. (2015) Handbook of Entomology, 3rd Edn. New Vishal Publications.
2. Riley W.A. (2017) Handbook of Medical Entomology (Classic Reprint), Forgotten Books.
2. Dhooria M.S. (2008) Ane's Encyclopedic Dictionary of General and Applied Entomology, Ane's Books India, Co published by Springer, Netherlands.

DSC – 6C

APMB 233P Practicals – IX: ECONOMIC AND MEDICAL ENTOMOLOGY

(1 credit)

1. Collection, preservation and display of insects (representing any 15 insect orders).
2. External morphology of an insect (e.g. grasshopper).
3. Demonstration of Insects metamorphosis.
4. Life cycle of honey bee; beehive and their parts.
5. Rearing of mulberry silkworms.
6. Collection, observation and importance of crop pests.
7. Collection, observation and importance of storage pests.
8. Collection of medically important pests and understanding their role in human diseases.

SEMESTER – III

SEC– 1

APMB 234

PUBLIC HEALTH MICROBIOLOGY

(2 credits)

Unit - I

Introduction to public health: definition, scope, concept and importance of public health microbiology – roles of microbiologist in public health – microbial association of water, air and soil.

Unit - II

Air borne infections: air and its composition – indoor air – outdoor air – air borne diseases (bacterial, fungal and viral) – methods of enumeration of microorganisms in air – air sanitation.

Unit - III

Water borne infections: kinds of water – water borne diseases (viral, bacterial, protozoan) – methods of enumeration of microorganisms in water – indicator organism – water treatment, control of water borne diseases.

Unit - IV

Food borne diseases: definition and importance of food hygiene – types (spoilage of meat and its products, milk and dairy product, fish and fish products and eggs) – role of microorganisms in food spoilage and poisoning – food borne diseases – types of food borne diseases – food poisoning – food borne infection.

Unit - V

Hospital acquired infection: Prophylactic immunization – disposal of infective hospital and laboratory materials – monitoring of sanitation in community – techniques used for the diagnosis of hospital acquired infection.

Text books

1. Ghimire P. and Parajuli K. (2005) A Text Book of Microbiology, Vidhyarthi Pustak Bhandar Publication, Kathmandu.
2. Brownson, R.C., Baker, E.A., Leet T.L. and Follespie K.N. (2003) Evidence Based Public Health, Oxford University Press.

Reference books

1. Engelkirk P.G. and Duben-Engelkirk J. (2015) Burton's Microbiology for the Health Sciences, 10th Edn. Wolters Kluwer Health.
2. Park K. (2017) Parks Text Book of Preventive and Social Medicine, Banarsidas Bhanot Publishers.
3. Jay J.M., Loessner M.J. and Golden D.A. (2005) Modern Food Microbiology, 7th Edn. Springer.

SEMESTER – IV

DSC – 1D VIROLOGY

APMB 241

(3 credits)

Unit - I

General properties – structural – classification – cultivation – isolation and identification of animal viruses, plant viruses, bacterial, algal and fungal viruses and insect viruses.

Unit - II

Eukaryotic DNA virus replication, eukaryotic RNA virus replication. Viral propagation – chick embryo and cell lines. Purification and assay. Laboratory diagnosis of viral diseases. Viral vaccines, interferons and antiviral drugs.

Unit - III

Morphology, classification, characteristics pathogenicity, laboratory diagnosis, prevention and control of infections produced by the following group of viruses. Adeno virus, Pox virus, Herpes virus, Papiloma virus, viral Hepatitis, Ebola and Zika viruses.

Unit – IV

Morphology, classification, characteristics pathogenicity, laboratory diagnosis, prevention and control of infections produced by the following group of viruses. Polio, HIV, Picorna viruses, Influenza and Rhabdo viruses. Teven and Todd phages, virioids and prions.

Unit - V

Arbo viruses: Flavi viruses – Yellow fever viruses – Dengue virus – Chickungunya virus – Japanese encephalitis virus.

Text Books

1. Singh V. (2010) Text book of Virology, 1st Edn. IBDC publishers.
2. Oarsman S.N.J., van Zyl G.U., Nutt L., Anderson M.I. and Preiser W. (2012) Virology Illustrated colour text, 1st Edn. Elsevier Health Sciences.

Reference Books

1. Carter J. and Saunders V. (2013) Virology: Principles and Applications (paperback) 2nd Edn. Wiley-Blackwell Publishers.
2. Dimmock, N.J., Easton A.L. and Leppard, K.N. (2007). Introduction to Modern Virology. 6th Edn. Blackwell Publishing Ltd.
3. Flint, S.J., Enquist, L.W., Krug, R.M., Racaniello V.R. and Skalka A.M. (2004). Principles of Virology, Molecular Biology, Pathogenesis and Control, 2nd Edn. ASM press Washington DC.

1. Isolation of bacteriophage from sewage sample.
2. Preparation of bacteriophage stock.
3. Titration of bacteriophage.
4. One step growth of bacteriophage.
5. Plaque assay.
6. Chick embryo inoculation.
7. Study of plant viral symptoms (demonstration).
8. Study of disease symptoms caused by viroids (demonstration).
9. Animal inoculation (demonstration).

SEMESTER – IV

DSC – 2D

APMB 242

MEDICAL BACTERIOLOGY

(3 credits)

Unit - I

Infection: definition, sources of infection, types of infections, methods of transmission of infections. General attributes and virulence factors of bacteria causing infections.

Unit - II

Collection and transport of specimens for microbiological examination. Clinical diagnosis of sexually transmitted diseases, urinary tract infections and hospital acquired infections. Methods of disposal of hospital waste.

Unit - III

Morphology, classification, cultural characteristics, pathogenicity, laboratory diagnosis and prevention of infections caused by the following organisms: *Staphylococcus aureus*, *Streptococcus pyogenes*, *Streptococcus pneumoniae*, *Neisseria meningitidis*, *Neisseria gonorrhoeae*, *Corynebacterium diphtheriae*, *Clostridium tetani*, *Clostridium botulinum*.

Unit – IV

Morphology, cultural characteristics, pathogenicity, laboratory diagnosis and prevention of infections caused by the following organisms: *Escherichia coli*, *Shigella*, *Salmonella*, *Vibrio cholerae*, *Pseudomonas*, *Mycobacterium tuberculosis*, *Mycobacterium leprae*.

Unit - V

Morphology, cultural characteristics, pathogenicity, laboratory diagnosis and prevention of infections caused by the following organisms: Zoonotic bacterial diseases such as plague, anthrax, leptospirosis, brucellosis.

Text Books

1. Collee, J.C., Fraser A.C., Marmion B.P. and Simmons A. (2007) Mackie & McCartney Practical Medical Microbiology, 14th Edn. Elsevier Health Sciences.
2. Ananthanarayan R. and Kapil A. (2013) Ananthanarayan & Panicker's Text book of Microbiology, 9th Edn. Paperback, Orient BlackSwan.

Reference Books

1. Forbes B.A., Sham D.E. and Weissfeld A.S. (2007) Bailey and Scotts Diagnostic Microbiology 12th Edn, Mosby Publications.
2. Brooks G., Carroll K.C., Butel J. and Morse S. (2012) Jawetz Melnick and Adelberg Medical Microbiology, 26th Edn. Lange Medical Publications.
3. Greenwood D., Slack R.C.B., Barer M.R. and Irving W.L. (2012) Medical Microbiology, 18th Edn. Elsevier Churchill Livingstone.

DSC – 5D

APMB 242P

Practicals XI: MEDICAL BACTERIOLOGY

(1 credit)

1. General requirements of collection, transport of clinical specimens, direct examination, staining of specimens, methods of enriched, selective, and enrichment culture techniques used to isolate organisms from clinical specimens.
2. Simple, differential and special staining of clinical material.
3. Isolation of microflora from human throat.
4. Differential test of *Staphylococcus* by examining growth on agar plates.
5. Antimicrobial sensitivity Testing.
6. Quantitative urine culture.
7. Isolation and identification of bacterial pathogens from clinical specimens.
8. Biochemical reactions of the isolated and identified bacterial pathogens.
9. Identification of ectoparasites – mosquitoes, fleas, lice, mites, ticks, etc. (spotters only).

SEMESTER – IV

DSC – 3D

APMB 243

PLANT PATHOLOGY
(Biological Science - II)

(3 credits)

Unit - I

Concept of plant disease – definitions of disease, disease cycle and pathogenicity, symptoms associated with microbial plant diseases, types of plant pathogens, economic losses and social impact of plant diseases. Significant contributions by scientists in the field of plant pathology.

Unit- II

Infection, invasion, colonization, dissemination of pathogens and perennation. Concepts of monocyclic, polycyclic and polyetic diseases, disease triangle and disease pyramid, forecasting of plant diseases and its relevance in Indian context.

Unit - III

Virulence factors of pathogens: enzymes, toxins (host specific and nonspecific) growth regulators, virulence factors in viruses (replicase, coat protein, silencing suppressors) in disease development. Effects of pathogens on host physiological processes (photosynthesis, respiration, cell membrane permeability, translocation of water and nutrients, plant growth and reproduction).

Unit - IV

Concept of resistance (*r*) gene and avirulence (*avr*) gene; gene for gene hypothesis, types of plant resistance – Concepts of constitutive defense mechanisms in plants, inducible structural defenses – inducible biochemical defenses hypersensitive response (HR), systemic acquired resistance (SAR), phytoalexins, pathogenesis related (PR) proteins, plantibodies, phenolics, quinones, oxidative bursts.

Unit - V

Basic principles of the disease management – study of important plant diseases with emphasis on its etiological agent, symptoms, epidemiology, life cycle and management: fungal diseases – diseases of phytopathogenic bacteria – phytoplasmas – viruses and viroids.

Text Books

1. Ravichandra N.G. (2013) Fundamentals of Plant Pathology, PHI Learning Pvt Ltd.
2. Vidyasekharan P. (2010) Principles of Plant Pathology. CBS Publishers & Distributor's.

Reference Books

1. Vidhyasekaran P. (2004) Concise Encyclopedia of Plant Pathology. CRC Press.
2. Sharma J.N., Karthikeyan G. and Sh. Mohinder Singh (2007) Fundamentals of Plant pathology. ICAR E-course.
3. Agrios G.N. (2005) Plant Pathology, 5th Edn. Elsevier Academic Press.

DSC – 6D

APMB 243P

Practicals – XII: PLANT PATHOLOGY

(1 credit)

1. Demonstration of Koch's postulates in fungal, bacterial and viral plant pathogens.
2. Preparing a plant pathology herbarium
3. Study of important diseases of crop plants by cutting cross sections and microscopic examination fungal conspicuous structures from infected plant materials – (a) *Albugo* and *Puccinia*.
4. Study of important diseases of crop plants by cutting cross sections and microscopic examination fungal conspicuous structures from infected plant materials – (a) *Ustilago* and *Colletotrichum*.
5. Study of important diseases of crop plants by cutting cross sections and microscopic examination fungal conspicuous structures from infected plant materials – (a) *Fusarium* (b) *Verticillium* (c) *Rhizoctonia*
6. Examination of citrus canker symptoms and isolation of the causal organism.
7. Isolation of pectinolytic phytopathogens and testing their pectinolytic activity.
8. Isolation of antagonists bacterial population from soils.
9. Detecting and measuring extracellular enzymes of fungi and bacteria

SEMESTER – IV

SEC– 2

APMB 244 MUSHROOM AND SPIRULINA CULTIVATION (2 credits)

Unit - I

Edible and non-edible mushroom – historical account, most commonly cultivated mushrooms in the world, distribution and production in various countries.

Unit - II

Cultivation of button, oyster and paddy straw mushroom – raising a pure culture – spawn preparation and mass cultivation – harvest pests and diseases in mushroom

Unit – III

Economics of mushroom cultivation – precautions in mushroom cultivation – precaution to be taken while selecting the area, spawn preparation, spawn run, during cropping harvesting etc. Mushroom recipes (western and Indian recipes, pickles, powders, jams etc.

Unit – IV

Introduction to SCP production – historical use and rediscovery of *Spirulina* importance – morphology, taxonomy and habitat of *Spirulina* – biochemical composition including proximate composition – amino acids – unsaturated fatty acids – minerals and vitamins. Human health benefits of *Spirulina*.

Unit - V

Natural production – laboratory cultivation – small scale commercial production – commercial and mass cultivation (tank construction, culture medium, strain selection, scaling up of the process) – importance of light and pH in *Spirulina* cultivation – harvesting, drying and packing.

Text Books

1. Changs T. and Hayanes W.A. (Ed.) (1978) Biology and Cultivation of Edible Mushrooms. Academic Press. N.Y.
2. Habib M.A.B., Parvin M., Huntington T.C. and Hasan M.R. (2008) A review on culture, production and use of *Spirulina* as food for humans and feeds for domestic animals and fish. FAO Fishers and Aquaculture Circular No. 1034, FAO, Rome, Italy.

Reference books

1. Biswas S., Datta M. and Ngachan S.V. (2012) Mushrooms: A Manual for Cultivation, PHI.
2. Selvendran D. (2015) Large Scale Algal Biomass (*Spirulina*) Production in India. In: D. Das (Ed.) Algal Biorefinery: An Integrated Approach, Springer.
3. Zadrazil F. and Grabbe K. (1983) Edible Mushroom, Biotechnology Vol. 3, Weinheim: Verlag Chemie, Berlin.

SEMESTER – V

SEC– 3

APMB 351 MANAGEMENT OF MICROBIOLOGY LABORATORY (2 credits)

Unit - I

Rules and regulations to be followed in a microbiology laboratory – maintenance of records – familiarizing with common chemicals, instruments and equipments of microbiology laboratory.

Unit - II

Laboratory management : human resources – logistics and supply – test performance – data management – resource tapping – instruments – water and sources of light and electricity – room – table and benches and space in the laboratory.

Unit - III

Laboratory quality control assessment: Internal quality control and external quality control.

Unit - IV

Maintenance of type strains or reference strain of microbes: culture collection centres – preservation and maintenance of cultures.

Unit - V

Laboratory waste disposal system: national and international guidelines for the disposal of waste. Basic concepts of bio-safety and its universal precautions.

Text books

1. Cappuccino J.G. and Sherman N. (2014) Microbiology a laboratory manual. 10th Edn. Pearson.
2. Gile, T.J. and Scungio D. (2014) Complete guide to Laboratory safety, 4th Edn. HCPPro a division of BLR.

Reference books

1. Emmert E. (2013). Biosafety guidelines for handling microorganisms in the teaching laboratory: development and rationale. Journal of Microbiology & Biology Education 14: 78–83.

SEMESTER – V

DSE – 1A

APMB 352 MICROBIAL DIVERSITY AND BACTERIAL PHYLOGENY (4 credits)

Unit -I

Microbial Big Tree of Life – The domain Archaea – Bacteria –Eukaryotes – Eukaryotic tree of life – Endosymbiosis theory and the role of horizontal gene transfer in shaping of domains – Different types of microbial diversity – Importance of microbial diversity – Methods of examining microbial diversity.

Unit-II

Eukaryotic diversity and Bacterial phylogeny – Fungal diversity – Protist (algae and protozoa) diversity – Viral diversity – their importance and role in shaping human community. History of bacterial classification – Concept of bacterial phylogeny – Phylogenetic markers – Polyphasic taxonomy – Overall view of bacterial phyla – Bergeys Manual of Systematic Bacteriology (2nd Edn.).

Unit-III

Archaea and Gram negatives:– An overview of their ecological occurrence, morphological diversity, structural, metabolic and genetic diversity, their importance and classification of Archaeal phyla – Gram negative bacteria including cyanobacteria – Deeply branching phyla – Proteobacteria – their classes.

Unit-IV

Gram Positives and heterogeneous members: Overall view of – ecological occurrence, morphological diversity, structural, metabolic and genetic diversity, their importance and classification of phyla Firmicutes – Actinobacteria – Bacteroidetes – Spirochetes – Tenericutes (Mollicutes) – Acidobacteria – Planctomycetes – Verrucomicrobia – Chlamydia.

Unit-V

Uncultivated majorities: The Great Plate count anomaly – novel bacterial cultivation strategies – cultivation independent methods of assessing bacterial diversity – Candidatus status of the bacteria – Candidate phyla radiation – their importance.

Text Books

1. Brown J.W. (2015) Principles of Microbial Diversity, ASM Press.
2. Madigan M.T., Bender K.S., Buckley D.H., Sattley W.M. and Stahl D.A. (2017) Brock Biology of Microorganisms, 15th Edn. (Global Edn.) Pearson Education.

Reference Books

1. Epstein S.S. (2009) *Uncultivated microorganisms*, Springer-Verlag Publishers.
2. Rosenberg E., DeLong E., Lory S., Stackebrandt E. and Thompson F. (Ed.) (2013) *The Prokaryotes* (Total of eleven reference book series), Springer-Verlag publishers.
3. Bertrand J.C., Caumette P., Lebaron P., Matheron R., Normand P. and Sime-Ngando T. (Eds.) (2015) *Environmental Microbiology: Fundamentals and Applications*, Springer Publishers.

DSE – 6A

APMB 352P

**Practicals – XIII: MICROBIAL DIVERSITY
AND BACTERIAL PHYLOGENY**

(1 credit)

1. Microscopic observation of bacteria, fungi, algae, protozoa.
2. Isolation and observation on a Gram positive bacteria.
3. Isolation and observation of a Gram negative bacteria.
4. Observation of morphologically distinct cyanobacteria.
5. Observation of morphologically distinct algal populations.
6. Observation of fungi and their types – spores.
7. Comparative observation of fungi and actinobacteria.
8. Isolation and observation of an Archaea.
9. Demonstrating the great plate count anomaly.
10. Visit to microbial rich environments like solar saltern, lakes and demonstrate the presence of distinct and conspicuous microorganisms.

SEMESTER – V

DSE – 2A

APMB 353 MEDICAL MYCOLOGY AND PARASITOLOGY (4 credits)

Unit - I

General properties of fungi – morphology, taxonomy, nomenclature and classification of fungi – virulence factors of fungi causing infection.

Unit -II

Collection, transport and processing of clinical specimens for detection of superficial, subcutaneous and systemic sycoses. Dermatophytes – *Trichophyton* – *Microsporum* – epidermophyton – dermatophytosis, superficial mycoses – Tinea versicolor, Tinea nigra, Black piedra , White piedra.

Unit -III

Subcutaneous mycoses – mycetoma, dimorphic fungi causing systemic mycoses – *Histoplasma capsulatum* – *Blastomyces dermatitidis* – *Coccidioides immitis* – *Paracoccidioides brasiliensis*. Opportunistic mycoses – Candidiasis, Cryptococcosis, Aspergillosis, Zygomycosis.

Unit –IV

Introduction to medical parasitology – morphology, classification, characteristics, pathogenesis, laboratory diagnosis, prevention and control of the following agents. *Entamoeba histolytica*, *Giardia lamblia*, *Trichomonas vaginalis*, *Trypanosoma brucei*, *Trypanosoma cruzi*.

Unit –V

Morphology, classification, characteristics, pathogenesis, laboratory diagnosis, prevention and control of the following agents. *Leishmania donovani*, *Leishmania tropica*, *Plasmodium falciparum*, *Balantidium coli*, *Taenia saginata*, *Taenia solium*, *Echinococcus granulosus*, *Ancylostoma duodenale*, *Ascaris lumbricoides* and *Wuchereria bancrofti*.

Text Books

1. Chander J. (2009) Text Book of Medical Mycology, 3rd Edn. Mehta Publishers.
2. Ananthanarayan R. and Kapil A. (2013) Ananthanarayan & Panicker's Text book of Microbiology, 9th Edn. Paperback, Orient BlackSwan.
3. Parija S. C. (2013) Text Book of Medical Parasitology – Protozoology and Helminthology, 4th Edn. All India Publishers and Distributors, New Delhi.

Reference Books

1. Reiss E. Shadomy H.J. and Lyon G.M. (2011) Fundamental Medical Mycology, Wiley-Blackwell.
2. Brooks G., Carrol K.C., Butel J. and Morse S. (2012) Jawetz Melnick and Adelberg Medical Microbiology, 26th Edn. Lange Medical Publications.
3. Chatterjee K.D. (2009) Parasitology: Protozoology and Helminthology, 13th Edn. CBS Publishers & Distributors Pvt. Limited.

DSE – 7A

APMB 353P

**Practicals – XIV: MEDICAL MYCOLOGY AND
PARASITOLOGY**

(1 credit)

1. KOH preparation for skin scrapings for fungi.
2. Lactophenol preparation for fungi – *Aspergillus*, *Rhizopus* and *Mucor*.
3. Germ tube test for *Candida albicans*.
4. Wet mount preparation for *Candida* and *Cryptococcus*.
5. Sugar fermentation and sugar assimilation test for yeasts.
6. Cultivation of fungi and yeast on SDA or corn meal agar.
7. Slide culture technique.
8. Saline wet mount examinations of stool for parasites.
9. Iodine mount examinations of stool for parasites.
10. LPCB mount examinations of stool for parasites.
11. Stool culture for amoeba and hookworm.
12. Floatation sedimentation techniques for stool examination.
13. Staining of peripheral blood smear for malarial parasite.

SEMESTER – V

DSE – 3A

APMB 354

PHARMACEUTICAL MICROBIOLOGY

(4 credits)

Unit - I

Introduction – Overview of products, classification of pharmacologic agents based on chemistry and source. Phytopharmaceuticals: screening tests for phytoconstituents – alkaloids and terpenoids. Three examples of commercial natural products from marine and terrestrial organisms.

Unit - II

Drug development: Biology guided fractionation methods: *in vitro* assay systems based on enzymes, tissue, and organ or growth inhibition. Animal models: transgenic animals, cell lines. Antimicrobial activity studies (antibacterial, antiviral, antifungal and antiparasitic activities).

Unit - III

Gene therapy: general introduction, *ex vivo* and *in vivo* gene therapy, potential targets for gene therapy, inherited disorders. Vaccine design and production, classification, genetically recombinant vaccines, advantages and disadvantages – examples – hepatitis B vaccines, cholera vaccines, edible vaccines, DNA vaccines – principles and mechanism.

Unit - IV

Immunologicals: Antisera – hyper immune gamma globulin – monoclonal antibodies – uses. Recombinant proteins: strategies and genetic manipulations for overproduction of biomolecules – insulin production, production of interferons.

Unit - V

Other biomolecules: probiotics and nutraceuticals – economic and legal considerations in pharmaceutical biotechnology: FDA guidelines – preclinical trials, acute, sub-acute, chronic and teratogenic studies. Clinical trials – Phases I, II, III and IV. ICMR guidelines for design and conduct of clinical trials, licensing and drug control.

Text Books

1. Denyer S.P., Hodges N.A. and Gorman S.P. (2004) Hugo and Russell's Pharmaceutical Microbiology, 7th Edn. Blackwell Publishers.
2. Mehra P.S. (2011) A text book of Pharmaceutical Microbiology, IK International Publishing House.

Reference Books

1. Baird R.M., Hodges N.A. and Denyer S.P. (2005) Handbook of Microbiological Quality control in Pharmaceutical and Medical Devices, Taylor and Francis Inc.
2. Saghee M.R., Sandle T. and Tidswell E.C. (2011) Microbiology and Sterility Assurance in Pharmaceuticals and Medical devices, Business Horizons publishers.
3. Hanlon G. and Sandle T. (2015) Industrial Pharmaceutical Microbiology: Standards and Controls, Euromed Communications.

DSE – 8A

APMB 354P

**Practicals –XV: PHARMACEUTICAL
MICROBIOLOGY**

(1 credit)

1. Preparation of medicinal plant extracts.
2. Sterility testing of vaccines and injections.
3. Antibacterial activity of antibiotic preparations.
4. Antifungal tests.
5. Estimation of thiamine, riboflavin, ascorbic acid content of multivitamin formulations.
6. MIC- by broth and agar dilution method.
7. Phenol co-efficient test.
8. Proteolytic digestion of antibodies.
9. Analysis of digested fragments.
10. Visit to a vaccine production unit and observe the unit operation procedures.

SEMESTER – V

DSE – 4A

APMB 355

INDUSTRIAL MICROBIOLOGY

(4 credits)

Unit - I

General concepts of industrial microbiology, principles of exploitation of microorganisms of their products, screening, strain development, immobilization methods, fermentation media, raw materials used in media production, antifoaming agents, industrial sterilization.

Unit - II

Fermentation equipment and its uses, types of fermentation – single, batch, continuous, multiple, surface, submerged, and solid state fermentation.

Unit - III

Food fermentations and food produced by microbes: bread, cheese, malt beverages, vinegar, fermented dairy products and oriental fermented foods. Microbial cells as food – single cell proteins.

Unit - IV

Industrial products derived from microbes: industrial enzymes – amylase, protease, cellulase. Amino acids production: glutamic acid and lysine. Production of antibiotics: penicillin, streptomycin.

Unit - V

Industrial products derived from microbes: Vitamins – riboflavin, cyanocobalamin. Vaccines: genetic recombinant vaccines. Organic acids: citric acid, acetic acid. Steroid conversion. Production of alcoholic beverages: beer and wine, biofuels: ethanol, methane, biogas. Disposal of industrial waste.

Text Books

1. Waites M.J. Morgan N.L., Rockey J.S. and Higton G. (2011) Industrial Microbiology. An Introduction, Paperback, WB Publishers.
2. Patel A.H. (2016) Industrial Microbiology, 2nd Edn. Laxmi Publications.

Reference Books

1. Baltz R.H., Demain A.L. and Davies J.E. (2010) Manual of Industrial Microbiology and Biotechnology, ASM Press.
2. Flickinger M.C. and Drew S.W. (1999) Encyclopedia of Bioprocess Technology: Fermentation, Biocatalysis and Bioseparation, (Vol 1-5), Wiley publishers.
3. Stanbury P.T., Whitaker A. and Hall S. (2016) Principles of Fermentation Technology, Butterworth-Heinemann.

DSE – 9A

APMB 355P

**Practicals – XVI: INDUSTRIAL
MICROBIOLOGY**

(1 Credit)

1. Wine production.
2. Isolation of lactic acid bacteria from curd.
3. Isolation of lipolytic organisms from butter or cheese.
4. Immobilized bacterial cells for production of hydrolytic enzymes.
5. Enzyme production and assay – cellulase, protease and amylase.
6. Alcohol production.
7. Immobilization of yeast.
8. Visit and observe an industry unit pertaining to microbiological products manufacturing.

SEMESTER – V

DSE – 5A

APMB 356 BIOSTATISTICS AND COMPUTER APPLICATIONS (4 credits)

Unit - I

Biostatistics : definition – nature and scope of statistics and limitations – collection of data – sampling and sampling design – classification and tabulation – frequency distribution for discrete and continuous data – diagrammatic representation (bar diagram and pie chart – graphical representations (histogram, frequency polygon and ogives).

Unit - II

Measures of central tendency: mean, median, mode, geometric mean, harmonic mean, measures of dispersion, range, mean deviation, quartile deviation and standard deviation, standard error.

Unit - III

Introduction to computers: computer application, basics, organization, PC, mainframes and super-computers, concept of hardware and software, concept of file, folders and directories, commonly used commands, flow charts and programming techniques.

Unit - IV

Introduction in MS Office software concerning word processing, spreadsheets for biostatistics and presentation software. New technologies in IT– electronic commerce – hypermedia – data warehouses and marts – data mining online analytical processing – geographic information systems. Application of IT – computer in business and industry – computers in home – computers in education and training – computer in entertaining science, medicine and engineering.

Unit - V

Networking fundamentals, client, server, LAN, WAN, TelNET, INTERNET, NICNET, WWW, html, e mail, introduction to MEDLINE, CCOD and PUBMED, for accessing biological information.

Text Books

1. Balakrishnan N. (2003) Statistical Methods and Practice – Recent Advances, Narosa Publishing House Private Limited.
2. Preston Gralla (2000) How the Internet Work, Tech. Media.

Reference Books

1. Wardlaw A.C. (2000) Practical Statistics for experimental biologists, 2nd Edn. Wiley publishers
2. Gupta S.P. (2009) Statistical Methods, 28th Edn. Sultan Chand and Sons.
3. Gurumani N. (2005) An introduction to Biostatistics, MJP Publishers, Chennai.

1. Representation of Statistical data by
 - a) Histograms b) Ogive Curves c) Pie diagrams.
2. Determination of Statistical averages/ central tendencies.
 - a) Arithmetic mean b) Median c) Mode.
3. Determination of measures of Dispersion
 - a) Mean deviation
 - b) Standard deviation
 - c) Quartile deviation.
4. Computer operations-getting acquainted with different parts of Computers. [DOS] and basics of operating a computer.
5. Creating files, folders and directories.
6. Applications of computers in biology using MS-Office.
 - A] MS-Word B] Excel C] Power Point.
7. Creating an e-mail account, sending and receiving e mails.
8. An introduction to INTERNET, search engines, websites, browsing and downloading.

SEMESTER – V

GE – 1

APMB 357

BIOINFORMATICS

(3 credits)

Unit - I

Analysis of DNA and protein sequences – codon distributions, frequency statistics, pattern and motif searches – randomization.

Unit - II

Sequence alignments: Scoring matrices – PAM and BLOSUM – local and global alignment concepts – dynamic programming methodology – Needleman and Wunsch algorithm, Smith – Waterman algorithm – statistics of alignment score – multiple sequence alignment – progressive alignment – database searches for homologous sequences – FASTA and BLAST versions.

Unit - III

Evolutionary analysis: distances – clustering methods – rooted and unrooted tree representations – bootstrapping strategies.

Unit - IV

Fragment assembly – genome sequence assembly. Gene finding methods: content and signal methods, gene prediction – analysis and prediction of regulatory regions.

Unit - V

Neural network – concepts and secondary structure prediction – probabilistic models: Markov chain – random walk – hidden Markov models – gene identification and other applications.

Text Books

1. Lesk M.A. (2008) Introduction to Bioinformatics, 3rd International Student Edition, Oxford Publication.
2. Claverie J.M. and Notredame C. (2007) Bioinformatics for Dummies, 2nd Edn. Wiley Publishers.

Reference Books

1. Rastogi S.C., Mendiratta, N. and Rastogi P. (2007) Bioinformatics – Concepts, Skills, Applications, 2nd Edn. Prentice Hall India Publication.
2. Hodgman T.C., French A. and Westhead D.R. (2010) Bios Instant Notes Bioinformatics, Taylor & Francis.
3. Mount D.W. (2005) Bioinformatics: Sequence and Genome analysis, 2nd Edn. Paperback, CBS Publishers.

SEMESTER – VI

SEC-4

APMB 361 MICROBES AND THEIR APPLICATIONS (Credit Seminar)

(2 credits)

Unit – I

Identifying suitable topic in fundamentals of microbiology or applications of microbiology to human kind and society.

Unit – II

Literature survey and collection.

Unit – III

Preparation of a report – abstract preparation for seminar presentation.

Unit – IV

Presentation of the seminar in powerpoint format.

Unit – V

Discussion on the topic and evaluation of the seminar report.

Reference

1. Microbiology Senior Seminar (MB490) syllabus Fall and Spring every year
<https://microbiology.ncsu.edu/HH/MICROBIOLOGY%20SENIOR%20SEMINAR-%20online%20info.pdf>

SEMESTER – VI

DSE – 1B

APMB 362

FOOD AND DAIRY MICROBIOLOGY

(4 credits)

Unit - I

Food as a substrate for microorganisms – microorganisms important in food microbiology: molds, yeasts and bacteria – factors affecting the growth of microorganisms in food, feed and fodder.

Unit - II

Principles of food preservation: general principles and application methods – asepsis, removal of microorganisms, anaerobic conditions, high temperature, low temperature, drying and food additives.

Unit - III

Spoilage of food: vegetables, eggs, milk and milk products, meat and meat products, fish and sea foods and canned foods.

Unit - IV

Fermented foods: pickled cucumber, sauerkraut, bread, cheese, vinegar, fermented dairy products – spoilage of fermented dairy products.

Unit - V

Food borne infections and intoxications: bacterial and non-bacterial – Investigation of food borne disease – microbiology in food sanitation – sewage and waste treatment and disposal – good manufacturing practices – hazard analysis – quality control – employee health standards.

Text Books

1. Frazier W.C. and Westhoff D.C. (2008) Food Microbiology, 4th Edn. Tata McGraw Hill Publishing Co., New Delhi.
2. Bamforth C.W. (2005) Food, Fermentation and Microorganisms, Blackwell Science.

Reference Books

1. Doyle M.P. and Buchanan R.L. (Ed.) (2013) Food Microbiology: Fundamentals and Frontiers, 4th Edn. ASM press.
2. Jay J.M., Loessner M.J. and Golden D.A. (2005) Modern Food Microbiology, 7th Edn. Springer Publishers.
3. Robinson R.K. (2002) Dairy Microbiology: Milk and Milk Products, 3rd Edn. Wiley Publishers.

DSE – 6B

APMB 362P

**Practicals – XVIII: FOOD AND DAIRY
MICROBIOLOGY**

(1 credit)

1. Bacterial counts of food samples.
2. Quantitative analysis of milk by standard plate count method.
3. Isolation and counting of fecal bacteria in water.
4. Test of quality of milk by methylene blue dye reduction test.
5. Detection of mastitis through milk test.
6. Isolation of microorganisms from curd.
7. Isolation of bacteria and fungi from spoiled food.
8. Microbial populations in fruit juices, soft drinks and ice cream.
9. Isolation of lipolytic organisms from butter.
10. Visit to a microbiology based Food industry and observe the unit operation procedures.

SEMESTER – VI

DSE – 2B

APMB 363 MICROBIAL ECOLOGY AND ENVIRONMENTAL MICROBIOLOGY

(4 credits)

Unit - I

Environment ecosystems, food chain – niche, soil, water and air environment. Microbial interactions – symbiosis, neutralism, commensalism, synergism, mutualism, ammensalism, competition, parasitism and predation.

Unit - II

Aerobiology – microbes in aerosol. Allergens – assessment of quality of air – air borne diseases caused by bacteria, fungi and viruses – symptoms and preventive measures.

Unit - III

Microbiology of water – determination of water quality – bacteriological examination of water – indicator organisms – water borne pathogens. Microbiology of sewage – chemical and biochemical characteristics of sewage – sewage treatment and disposal of wastes.

Unit - IV

Biodegradation of oil, biodeterioration of materials – paint, paper, wood, leather and metal – mode of deterioration – organism involved – disadvantage and mode of prevention.

Unit - V

Water pollution – BOD – COD. Bioremediation, composting, bioamelioration – biofilm formation – impact on the environment. Environmental protection laws.

Text Books

1. Atlas R.N. and Bartha R. (1992). Microbial Ecology: Fundamentals and Applications, 3rd Edn. Redwood City, CA Benjamin/Cummings.
2. Pepper I.L. and Gerba C.P. (2004) Environmental Microbiology: A Laboratory manual, 2nd Edn. Academic Press.

Reference Books

1. Pepper I., Gerba C. and Gentry T. (Ed.) (2014) Environmental Microbiology, Academic Press.
2. Madsen E.L. (2008) Environmental Microbiology: From Genomes to Biogeochemistry, Blackwell publishers.
3. Barton L.E. and Northup D.E. (2011) Microbial Ecology, Wiley-Blackwell.

DSE – 7B

APMB 363P

**Practicals –XIX: MICROBIAL ECOLOGY AND
ENVIRONMENTAL MICROBIOLOGY**

(1 credit)

1. Bacteriological examination of water by multiple tube fermentation tests.
2. Water analysis for total bacterial population by standard plate count method.
3. Isolation of cellulolytic organism for various soil.
4. Determination of salinity of water.
5. Estimation of oxygen by Winkler's method.
6. Estimation of BOD of water.
7. Estimation of COD of water.
8. Isolation of bacteriophage from the sewage.
9. Isolation of microorganism from air by open plate method.
10. Determination of total bacterial population in water by standard plate count method.
11. Visit and observe unique ecosystems and understanding the role of microorganisms.

SEMESTER – VI

DSE – 3B

APMB 364 SOIL AND AGRICULTURAL MICROBIOLOGY (4 credits)

Unit-I

Introduction to soil microorganisms – bacteria (cyanobacteria and actinobacteria), algae, fungi, protozoans, nematodes and viruses – Role of microbes in soil fertility.

Unit-II

Microbial associations in phytosphere: rhizosphere – phyllosphere – spermosphere. Mycorrhiza – types and importance to agriculture – organic matter decomposition – humus formation.

Unit-III

Biogeochemical cycles – carbon, nitrogen, phosphorus, sulphur cycles; nitrogen fixers – root nodule formation – nitrogenase, hydrogenase – biochemistry of nitrogen fixation.

Unit-IV

Biofertilizers – definition, importance – types and their application methods – Steps in mass production of bacterial biofertilizers – quality guidelines for biofertilizers. Mass production of blue green algae, *Azolla* and mycorrhiza. Plant response to biofertilizers application.

Unit -V

Plant growth promoting rhizobacteria – Biological control of phytopathogens – Mechanism of control – *Trichoderma* sp. and *Pseudomonas fluorescens* as biocontrol agents – Disease suppressive soils – Biopesticide and their importance: Bacterial, fungal and viral.

Text Books

1. Sylvia D.M., Fuhrmann, J.J., Hartel P.J. and Zuberer D.A. (2005) Principles and Applications of Soil Microbiology, 2nd Edn. Pearson, Prentice Hall.
2. Subba Rao N.S. (2001) Soil Microorganisms and plant growth, Oxford and IBH Publishing Co. Pvt. Ltd.

Reference Books

1. Glick B.R. (2015) Beneficial Plant Bacterial Interactions, Springer.
2. Paul E.A. (Ed.) (2015) Soil Microbiology, Ecology and Biochemistry, 4th Edn, Academic Press.
3. Madigan M.T., Bender K.S., Buckley D.H., Sattley W.M. and Stahl D.A. (2017) Brock Biology of Microorganisms, 15th Edn. (Global Edn.) Pearson Education.

DSE – 8B

APMB 364P

**Practicals –XX: SOIL AND AGRICULTURAL
MICROBIOLOGY**

(1 credit)

1. Isolation of bacteria, fungi and actinobacteria from soils.
2. Isolation of nitrogen fixing bacteria from root nodules of legumes.
3. Enumeration of rhizosphere to non rhizosphere population of bacteria.
4. Isolation of antagonistic *Pseudomonas* from soil.
5. Microscopic observations of root colonization by VAM fungi.
6. Isolation of *Azospirillum* sp. from the roots of grasses.
7. Isolation of phyllosphere microflora.
8. Isolation of P solubilizing microorganisms.
9. Observation of *Anabaena* from *Azolla* plants.
10. Demonstration on different biofertilizers types, formulation and application methods.
11. Visit to biofertilizers and biopesticides unit to understand about the Unit operation procedures.

SEMESTER – VI

DSE – 4B

APMB 365

HAEMATOLOGY AND BLOOD BANKING

(4 credits)

Unit - I

Blood: definition, characters, composition. Collection of blood – capillary blood: from adults and infants, examinations employed. Venous blood: from adults and infants, examinations employed – Anticoagulants: definition – type: Wintrob's, EDTA, heparin, citrate, concentration, examinations, advantages and disadvantages.

Unit - II

Counting of blood cells: Neubauer counting chamber – total RBC count: diluting fluids, normal values – total WBC count: diluting fluids, normal values differential leucocyte count: granulocyte and agranulocytes, morphology and function, staining technique – Platelet count: morphological characters and functions, haemoglobin: composition and normal values, haemoglobin estimation.

Unit - III

Coagulation mechanism: factors, bleeding time, clotting time. Haematological indices: packed cell volume. Erythrocyte sedimentation: principle – determination: Wintrob's, Westergren method – advantages and disadvantages – factors affecting the process.

Unit - IV

Preparation of stains and staining techniques: Wright stain, Leishman's stain, Giemsa's stain, Fields stain, peroxidase stain. Examination of blood smear – peripheral smear report – size, colour and shape. Blood parasites: malarial parasite and microfilaria.

Unit - V

ABO Grouping: History, slide and tube technique, Rh typing: slide and tube technique, Coombs test: direct and indirect method, donor screening – cross matching, collection of blood, preservation and storage.

Text Books

1. Maheswari N. (2008) Clinical Pathology, Haematology and Blood Banking (for DMLT students), 2nd Edn. Jaypee Brothers Medical Publishers.
2. Hoffbrand A.V. and Moss P.A.H. (2015) Hoffbrand's Essential Haematology, 7th Edn. Wiley.

Reference books

1. Greer J.P., Foerster J., Lukens J.N., Rodgers G.M., Paraskevas F. and Glader B.E. (Ed.) (2013). Wintrob's Clinical Hematology, 13th Edn. Wolters Kluwer.
2. Hillyer C., Silberstein L., Ness P., Anderson K. and Roback J. (2006) Blood banking and Transfusion medicine, 2nd Edn. Elsevier Press.
3. Godkar P.B. and Godkar D.P. (2013) Textbook Medical Laboratory Technology Vol-I and II, Bhalani Publishing House.

DSE – 9B

APMB 365P

**Practicals – XXI: HAEMATOLOGY AND
BLOOD BANKING**

(1 credit)

1. Collection of blood – finger prick, venous blood.
2. Hb estimation, RBC count, estimation of packed cell volume, total WBC count and absolute eosinophil count.
3. Staining of blood smears and differential count of WBC.
4. Platelet count by various methods.
5. Erythrocyte sedimentation rate by various methods.
6. Preparation of reagents for coagulant studies.
7. Preparation of anticoagulant fluids.
8. Coomb's test.
9. Screening of HbS Ag.

DSE – 10B

APMB 366P

**Practicals – XXII: MICROBIAL PRODUCTION
OF PIGMENTS, FLAVOUR AND
AROMA COMPOUNDS**

(1 credit)

1. Observation of *Dunaliella* sp.– a beta carotene producing algae.
2. Isolation of *Monascus* sp. from soil.
3. Mass production of pigment using *Monascus* fungal culture.
4. Isolation of pigment producing bacteria/actinobacteria.
5. Mass multiplication of the pigment producer and pigment extraction
6. Production and estimation (HPLC) of vanillin from precursor using microbial cultures.
7. Microbial production of xylitol from xylose and their estimation using HPLC
8. Microbial biocatalysis of precursor to vitamin C and their estimation using HPLC
9. Usage of yeast for the biocatalysis of flavour and aroma compounds

SEMESTER – VI

GE -2

APMB 367

MICROBIAL GENOMICS

(3 credits)

Unit-I

Introduction to microbial genomics – sequencing genomes – first generation DNA sequencing – shot gun sequencing – second generation DNA sequencing – third and fourth generation DNA sequencing

Unit-II

Biological sequences as information – DNA, RNA and protein as informative molecules – general characteristics of microbial genomes – genome assembly – genome annotation – identification of an open reading frame in a genome.

Unit-III

Microbial genomes size and content – small genomes and large genomes – genomes of organelles – symbionts and organelles – eukaryotic microbial genomes an introduction: genomes of microbial parasites – the yeast genome.

Unit-IV

Functional genomics: microarrays and transcriptomes – gene chips and gene expression and its applications – RNA sequence analysis – methods in proteomics – comparative genomics and proteomics – the interactome.

Unit-V

Culture independent studies of microorganisms – metagenomics: principles and applications – steps in construction of a metagenomes – examples of metagenomic studies – metagenomics as a tool to reveal the vast microbial diversity.

Text Books

1. Madigan M.T., Bender K.S., Buckley D.H., Sattley W.M. and Stahl D.A. (2017) Brock Biology of Microorganisms, 15th Edn. (Global Edn.) Pearson Education.
2. Sanders E.R. and Miller J.H. (2010) I Microbiologist: A discovery based course in Microbial Ecology and Molecular Evolution, ASM press.

Reference Books

1. Fraser C.M., Read T. and Nelson K.E. (2004) Microbial Genomes, Springer.
2. Highlander S.K., Rodriguez-Valera F. and White B.A. (2015) Encyclopedia of Metagenomics: Environmental Metagenomics, Springer Science.
3. Dale J.W. and von Schantz M. (2007) From Genes to Genomes: Concepts and Applications of DNA Technology, 2nd Edn. Wiley publishers.