GONDWANA UNIVERSITY

GADCHIROLI

CHOICE BASE CREDIT SYSTEM (CBCS)

SYLLABUS FOR

B.Sc.

THREE-YEARS DEGREE COURSE

IN

MICROBIOLOGY

From

Academic Year

2017-2018

Preface

The Graduate and Master program in "Microbiology" is a scientific-biological study course, based on fundamental research with special focus on microbiology at its full diversity. This covers phylogeny, physiology, cell and molecular biology of organisms from all three domains of life. The program "Microbiology" at the Gondwana-University is directed towards the education of excellent, competitive graduates with a great spectrum of methodology, interdisciplinary focus and international qualification for the assignment in research, and in companies. The close connection to the local job market allows an optimal change to occupation. Here, the potential of biology and in particular of molecular biology with focus on microbiology is increasingly used as platform for the networking of other disciplines. The combination and development of technology platforms of various institutes (e.g. proteome, transcriptome, metabolome analyses, chemical, biochemical, physical and cell biological analytics, fermentation) under, “Enabling Technologies" allows a strong focusing on research during the Master study program.

The Graduate and Master Study program "Microbiology" builds consecutively on a biological education and is focused on research. The study program is especially dedicated to the integration and consolidation of knowledge in microbiology. The job market for microbiologists is still excellent.

Dr. Abhay B. Solunke

Chairman of Board of Studies in Microbiology

Gondwana University, Gadchiroli. (Maharashtra)

Preamble

The B.Sc. Microbiology courses are running in Gondwana University, Gadchiroli from its beginning followed the semester pattern and now Gondwana University, Gadchiroli, has adopted the CBCS (Choice Base Credit System) pattern that would be divided B.Sc. into three years- year I, year II and year III. Each part would consist of two semesters. Each semester would comprise of four theory papers including practicals. The new course will commence from the academic session 2017-18. The syllabus has been prepared keeping in view the unique requirements of B.Sc. Microbiology students. The contents have been drawn to accommodate the widening horizons of the Microbiology discipline. It reflects the changing needs of the students, pertaining to the fields of Chemistry, Statistics and Computational skills. The detailed syllabus for each paper is appended with a list of suggested readings.

Each practical batch should not have more than 16 students. Any number exceeding 20 will be divided into two equal batches. This is because microbiology practicals require individual attention for imparting correct and adequate hands – on training to the students. One short educational trip will be conducted to industry/national/research institutes in the 5th semester to keep the students abreast with latest developments in the field of microbiology.

Approved by: Board of Studies in Microbiology, in meeting held on 29-03-2016 & 15-05-2017.

Dr. Abhay B. Solunke

Chairman

Shri Govindrao Munghate Arts & Science College, Kurkheda

Members Present:

1. Dr. P.H. Kumbhare Guru Nanak College, Ballarshah.
2. Dr. S.V. Kasbekar Sindhu Mahavidyalaya, Nagpur.
3. Dr. V.U. Thool Sardar Patel Mahavidyalaya, Chandrapur.
4. Dr. M. Kulkarni Chintamani Mahavidyalaya, Pomburna.

Table

Semester No.	Paper No.	Course Code	Title of Paper	Theory	Internal assesment	Total Marks
		B.Sc. First Year				
I	**I**		Fundamentals of Microbiology	**50**	**10**	**60**
	II		Microbial Techniques	**50**	**10**	**60**
	III		Practical's based on theory paper I & II	**30**		**30**
			Total			**150**
II	**IV**		General Biochemistry	**50**	**10**	**60**
	V		Applied Microbiology	**50**	**10**	**60**
	VI		Practical's based on theory paper V &VI	**30**		**50**
			Total			**150**
		B.Sc. Second Year				
III	**VII**		Microbial Physiology And Metabolism	**50**	**10**	**60**
	VIII		Food, Soil Microbiology and Microbial Ecology	**50**	**10**	**60**
	IX		Practical's based on theory paper VII & VIII	**30**		**50**
			Total			**150**
IV	**X**		Immunology	**50**	**10**	**60**
	XI		Medical Microbiology	**50**	**10**	**60**
	XII		Practical's based on theory paper X & XI	**30**		**50**
			Total			**150**
		B.Sc. Third Year				
V	**XIII**		Microbial Technology	**50**	**10**	**60**
	XIV		Microbial Genetics	**50**	**10**	**60**
	XV		Practical's based on theory paper XIII & XIV	**30**		**50**
			Total			**150**
VI	**XVI**		Molecular Biology	**50**	**10**	**60**
	XVII		Analytical Microbiology	**50**	**10**	**60**
	XVIII		Practical's based on theory paper XVI & XVII	**30**		**50**
			Total			**150**
Internal Assessment: Based on Assignment, Seminar, Unit Test & overall attendance and performance of the student						

General Overview:

Total Credits for all semesters in B.Sc. Programme will be of 132.

The semester wise credit points earned by the learner from undergraduate programme shall be as follows:

Programme	Sem I	Sem II	Sem III	Sem IV	Sem V	Sem VI	Total Credits
Under Graduate	26	26	20	20	20	20	132

Credit Base Evaluation System:

Scheme of examination:

It is divided into two points: Internal assessment and external assessment (Semester end Examination Conducted by University).

Internal Assessment:

Internal assessment includes Seminars, case studies, Quizzes, Viva, Unit test, etc.

The semester end examination for each course with practical will be as follows:

One theory course of two papers: 100 marks (external Assessment- University examination)

20 Marks for (Internal assessment).

Total 120

One practical course 30 marks

(Practical Examination for odd semester will be at college level and for even semester at university level with external examiner)

1) Time duration of each Theory Paper will be of Three (3) Hrs.
2) There shall be 5 questions of 08 marks each.
3) The theory course will be divided into 4 units.
4) All questions will be compulsory and with internal choice.
3) Time Duration for Practical examination will be 4 hours for two consecutive days.

The marks will be given for all examinations and they will be converted into grade points. The final grade card will have marks, credits, grades, grade points, SGPA & CGPA.

Format for the Internal Assessment

Sr. No.	Evaluation Type	Marks	Marks Obtained
1	Assignments	05	
2	Class Test	10	
3	Active Participation in routine class activities / seminars, etc.	05	

Passing:

For each course there is a passing with minimum **35%**(internal and external together)

Allowed to keep terms (ATKT)

1) A student shall be allowed to keep term for semester II irrespective of grades obtained in each course of semester I.
2) A student shall be allowed to keep term for semester II if he/she passes (Grade E or above in each course) each semester I & semester II **OR** He/she passes two course in each semester.
3) A student shall be allowed to keep term for semester IV irrespective of grades obtained in each course of semester II & can appear for semester IV examination.

4) A student shall be allowed to keep term for semester V if he/she passes semester I, II, III & IV. **OR** He/she has passes Semester I & Semester Ii and pass in at least 2 courses each of semester III & IV.
5) A student shall be allowed to keep term for Sem VI irrespective of grades obtained in each course of semester V.
There will be supplementary examination conducted for external evaluation (Semester end) by University.

QUESTION PAPER PATTERN

Question .1	**Long Question OR Short Questions (2 of 5marks each)**	**Unit I OR Unit I**	**10 Marks**
Question .2	**Long Question OR Short Questions (2 of 5marks each)**	**Unit II OR Unit II**	**10 Marks**
Question .3	**Long Question OR Short Questions (2 of 5marks each)**	**Unit III OR Unit III**	**10 Marks**
Question .4	**Long Question OR Short Questions (2 of 5marks each)**	**Unit IV OR Unit IV**	**10 Marks**
Question .5	**Short Notes any Ten (10) out of Twelve (12) One Mark each (3 questions from each unit)**	**On All four Units.**	**10 Marks**

Scheme for Choice Based Credit System in B.Sc.

Sem	Core Courses (12)	Ability enhancement Compulsory Course(AECC) [2]	Skill enhancement Course(SEC) [2]	Discipline Specific Elective (DSE) (6)
I	DSC-1A	(English/Hindi/MIL Communication)/ Environmental Science		
	DSC-2A			
	DSC-3A			
II	DSC-1B	Environmental Science/ (English/Hindi/MIL Communication)		
	DSC-2B			
	DSC-3B			
III	DSC-1C		SEC-1	
	DSC-2C			
	DSC-3C			
IV	DSC-1D		SEC-2	
	DSC-2D			
	DSC-3D			
V			SEC-3	DSE-1A
				DSE-2A
				DSE-3A
VI			SEC-4	DSE-1B
				DSE-2B
				DSE-3B

Total Credits is 132

Scheme for Choice Based Credit System in B.Sc.

Sem	Core Courses (12) of 6 credits each. Two papers for each core course. Total credits 72	Ability enhancement Compulsory Course (AECC) (4+4=8 Credits)	Skill enhancement Course(SEC) [2credits] One paper from pool of papers. Total crdits 4X2=8 credits	Discipline Specific Elective (DSE) (6) of 6 credits each. Two papers of each discipline from poll of papers. Total credits 6X6=36 credits.
1	Core Course e.g. Course-I: Physics(Th+Pr) Course-II: Chemistry (Th+Pr) Course-III: Microbiology(Th+Pr)	AECC I (English) AECC II (Marathi/Supl. English /Hindi/ Other language)		
2	Core Course e.g. Course-IV: Physics(Th+Pr) Course-v: Chemistry (Th+Pr) Course-VI: Microbiology(Th+Pr)	AECC III (English) AECC IV (Marathi/Supl. English /Hindi/ Other language)		
3	Core Course e.g. Course-VII: Physics(Th+Pr) Course-VIII: Chemistry (Th+Pr) Course-IX: Microbiology(Th+Pr)		SEC-I Environmental Studies Compulsory	
4	Core Course e.g. Course-X: Physics(Th+Pr) Course-XI: Chemistry (Th+Pr) Course-XII: Microbiology(Th+Pr)		SEC-II Foundation Course to be chosen by student	
5			SEC-III Foundation Course to be chosen by student	DSE-I (Phy. Elective) [Th+Pr] DSE-II (Chem. Elective) [Th+Pr] DSE-IIIA (Microbiology Elective) [Th+Pr]
6			SEC-IV Foundation Course to be chosen by student	DSE-IV(Phy. Elective) [Th+Pr] DSE-V (Chem. Elective) [Th+Pr] DSE-VI (Microbiology Elective) [Th+Pr]

SEMESTER-I

B. Sc. I Year

Semester-I		
Course Code ……..	**Paper-I**	**Marks: 50**
Credits: 2		**Total Hours: 48**
FUNDAMENTALS OF MICROBIOLOGY		
Objective: To make the students to understand the fundamentals of Microbial world.		
Unit No.	**Content**	**Hrs.**
1	**History & Developments in Microbiology**	**12**
	Development of microbiology as a discipline, with special reference to the work of following scientists: Antony von Leeuwenhoek, Louis Pasteur, Robert Koch, Martinus W. Beijerinck, Sergei N. Winogradsky, Selman A. Waksman, Elie Metchnikoff, M.S. Swaminathan, A.M. Chakroborty, H.G.Khorana	
	Theory of Abiogenesis and Biogenesis: Aristotle's notion about spontaneous generation; The experiments of F. Redii, John Needham, Spallanzani, Shwann & Schultze, Shroder & Von Dusch, Louis Pasteur, John Tyndall.	
	Germ theory of disease: Koch's postulates & River's postulates	
	Scope of Microbiology: Branches of Microbiology, Impact of Microbiology and the future.	
2	**Study of Prokaryotic Cell**	**12**
	Difference between Eukaryotic and Prokaryotic cell. **Structure and functions of bacterial cell components:** (a) Cell wall; (b) Cytoplasmic membrane;(c) Capsule & Slime layer;(d) Flagella;(e) Nuclear material;(f) Reserve food material; (g) Plasmids;(h) Mesosomes; (i)70S Ribosome; (j) Gas vacuole. **Spore**: Structure, stages in sporulation.	
3	**Microbial Taxonomy**	**12**
	Aim, principles and parts of taxonomy: General criteria used for bacterial classification. Concept of taxa, genus, species, strain, family, order, division, kingdom. **Various approaches of bacterial taxonomy**: (Artificial, natural & evolutionary) Two (Linnean), Three(Haeckel), Four (Stainer-Von Neil) and Five kingdom(Whittaker) concept. **Methods of bacterial classification:** Intuitive, Numerical Taxonomy, Genetic relatedness (DNA base composition, DNA homology, r-RNA homology & sequencing). **Outline of classification of bacteria and archaea** as per 8th edition of Bergy's Manual of determinative and Systematic bacteriology.	
4	**Viruses, Archaebacteria and Fungi**	**12**
	Viruses: History and General characteristics of viruses. 2. Classification of Viruses (LHT). 3. Structure of viruses. 4. Life cycle of viruses, Lytic Cycle of T4 Phage, Lysogenic cycle of Lambda phage 5. Methods of cultivation of viruses.	
	Archaebacteria: General characteristics, Unique characters, Groups of Archaebacteria (Methanogens, Halophiles, Thermophiles), Economic and Evolutionary importance of *Archaebacteria*.	
	Fungi: General characteristics, methods of reproduction and economic importance of Molds and *Yeast*.	

B.Sc. I

Semester-I		
Course Code ……..	**Paper-II**	**Marks: 50**
Credits: 2		**Total Hours: 48**
MICROBIAL TECHNIQUES		
Objective: To make the students to understand the fundamentals on microbes and their study techniques.		
Unit No.	**Content**	**Hrs.**
1	**Microscopy:** Definition of Magnification, Focal length, Focal point, Angular aperture and Numerical aperture, Resolving power. **Objectives** (Low power, High power, Oil immersion lens), **Ocular** lens and functions. **Condensers**: Abbes, Cardioids, Parabolic and their functions. **Principle, construction, working and applications of**, Bright field microscopy, Dark Field microscopy, Phase Contrast microscopy and Electron microscopy (TEM and SEM).	**12**
2	**Stains and Staining Techniques**	**12**
	Definition of stain, auxochrome, chromophores, Dyes, Acidic and Basic dyes; Indicator Dyes; Classification of stains, Theories of staining, Principle Mechanism and applications of Gram staining, Acid fast staining, Negative staining, Capsule staining, Flagella staining and Endospore staining.	
3	**Cultivation of Bacteria**	**12**
	Microbial Nutrition Basic nutritional requirements, nutritional categories of microorganism based on carbon and energy source. **Culture media**: Components of media and their role. **Types of media**: Liquid, semisolid and solid with example, Natural, synthetic and non-synthetic media, complex media, selective, differential, indicator media, enriched and enrichment media. **Methods of isolation of pure culture**: Streak plate, Pour plate and spread plate methods, Spiral Plate Method. Cultivation of anaerobic bacteria. **Methods of preservation of pure cultures**: Agar slant, Lyophilization, Freeze drying, Oil Sealing. Systematic study of pure culture, Stock culture collection centres in India and Abroad.	
4	**Sterilization & Disinfection**	**12**
	Definitions: Sterilization, Disinfection, Antiseptic, Germicide, Microbiostasis & Microbicidal agents , Sanitization	
	Physical agents–Microbial death concept. (**a)** Temperature–Dry heat, moist heat, Incineration (b**)** Radiation–Ionizing and Nonionizing radiations.(**c)** Filtration and types of filters.	
	Chemical agents- (**a)** Phenol & Phenolic compounds **(b)** Alcohols (**c)** Halogens (**d)** Heavy metals and their compounds (**e)** Aldehydes (**f)** Gaseous agents (**g)** Quaternary ammonium compounds. (**h)** Detergents. **Characteristics of an ideal disinfectant**. Phenol coefficient, Checking of Efficacy of Sterilization.	

Practical B. Sc. I
Semester –I
{Based on Paper -I & II}

TOTAL HOURS: 48 **CREDITS: 2** **Marks: 30**

1. Microbiology Good Laboratory Practices and Biosafety.
2. *Preparation of Cotton Plug, Cleaning of Glassware's.
3. * Study of principle and applications of important instruments, (Anaerobic Jar, Autoclave, Incubator, Hot air oven, Microscope, Colony counter, Membrane filter assembly, pH meter, Laminar Air Flow, Spectrophotometer).
4. Staining Techniques
   *(a) Monochrome / Simple staining
   (b) Negative Staining
   *(c) Gram Staining
   (d) Flagella Staining
5. Special Staining Procedures
   (a)Cell Wall Staining (Chance's Method)
   *(b) Endospore staining
6. Preparation of Culture Media: Saline, Peptone Water, Nutrient Broth, Nutrient agar, MacConkey agar, Starch Agar, Milk agar, PD- agar, Baired-Parker Agar.

*7. Demonstration of presence of Microbes and their colony characters present in Air, Skin, Soil, Teeth, and Water.

*8. Isolation of pure culture by Streak plate and Spread plate methods.

*9. Enumeration of bacteria by standard plate count method.

*10. Study of Motility by Hanging Drop technique

11. Cultivation and Staining of Fungi.

*12. Antibiotic sensitivity test by Kirby-Bauer disc diffusion method

13. Oligodynamic action of heavy metals.

Note: i) Minimum 4 major and 4 minor experiments are compulsory
ii) Underlined experiments are considered to be major experiments
iii) Experiments with asterisks are compulsory
iv) Duration of practical examination will be 8 hours i.e. 4 hours each for two consecutive days

Distribution of marks for practical examination:

One major experiment …….	5 marks
Two minor experiments 5 × 2 =	10 marks
Spotting	5 marks
Viva-Voce	5 marks
Practical Record	5 marks
Total …….	**30 marks**

SEMESTER-II

B.Sc. I

Semester II		
Course Code ……..	**Paper-IV**	**Marks: 50**
Credits: 2		**Total Hours :48**
GENERAL BIOCHEMISTRY		
Objective: To make the students to understand the fundamentals of Chemical Microbiology.		

Unit No.	Content	Hrs.
1	**Biochemical principles** I. Concepts of Atom, Molecule, pH, Acids, Bases, Buffer, Solvent, Solute, Types of solutions (hypotonic, hypertonic, isotonic) and redox potential II. Types of Isomers and their importance in biology. III. Types of bonds and their importance: Electrovalent, covalent, non-covalent, Ester, Phospho-diester, Thio-ester, Peptide, Glycosides.	12
2	**Amino Acids & Proteins** **Amino Acids:** Definition, General structure and features of amino acids, amphoteric nature, List of 20 amino acids with structure. **Classification of amino acids:** based on R-group, Uncommon amino acids and their functions. **Proteins**: Definition. Classification of Proteins, Primary, secondary, tertiary, quaternary structures of proteins (outline). Biological significance of proteins.	12
3	**Carbohydrates & Lipids** **Carbohydrates**: a] Definition and Classification. b] Monosaccharides, Triose, Tetrose, Pentose, Hexose (Examples and structures). c] Disaccharides: Glycoside Linkage (Lactose, Maltose and Sucrose). d] Oligosaccharides: Trisaccharides (Structure of raffinose). **e] Polysaccharides**: Homo and heteropolysaccharides, structure of (Starch, Cellulose, Hyaluronic acid). Biological significance of carbohydrates. **Lipids:** Definition and Classification. Types of Lipids: Simple lipids-Triglycerides. Conjugated Lipids- Phospholipids, Phosphatidic acid, and Cholesterol. Biological importance of Lipids.	12
4	**Nucleic Acids** Nitrogenous base composition of nucleic acids, Structure of Purines, Pyrimidines, Pentose sugars (Ribose, Deoxyribose), Phosphodiester bond, Nucleosides and Nucleotides, Nomenclature of Nucleosides and nucleotides. Basic Structure of DNA (Watson-Crick model). **RNA :** Structure of m-RNA, t-RNA, r-RNA	12

B.Sc. I year

Semester II		
Course Code ……..	**Paper-V**	**Marks: 50**
Credits: 2		**Total Hours :48**
APPLIED MICROBIOLOGY		
Objective: To make the students to understand and aware the fundamentals of National Mission on environmental cleanliness, health and hygiene.		
Unit No.	**Content**	**Hrs.**
1	**Air Microbiology:** a. Definition and composition of air. b. Sources of microorganisms in air. c. Enumeration of microorganisms in air: Solid and liquid impingement technique (Lemon sampler, Anderson sampler) d.control of microorganisms in air, Room sterilization techniques (radiation, fumigation, laminar air flow) e. droplet, aerosol, droplet nuclei and droplet infection, air borne diseases(list with causative organisms)	**12**
2	**Water Microbiology:** a. Definition, Types of water sources, Types of waters, b. Sources and types of microorganisms in water c. Significance of microorganisms in water, Pure (safe/potable) & polluted water d. Indicators of excretal pollution. d. Collection and handling of water sample for analysis f. Bacteriological analysis of water for coliforms(MTDT, MPN) g. Identification of faecal and non-faecal coliforms by (IMViC and Eijkmann test) h. Water treatment using RSF i. Chlorination of water (mechanism), different methods j. Water borne diseases(List with causative organisms)	**12**
3	**Sewage Microbiology** a. Definition and types of sewage, composition and strength of sewage (BOD, COD, ThOD), b. Microbiology of sewage, c. General municipal sewage treatment method, d. Preliminary, Primary and Secondary sewage treatment methods. e. Water reclamation.	**12**
4	**Milk Microbiology** a. Definition and composition of milk, sources of contamination of milk. b. Desirable and undesirable changes in milk. c. Milk borne diseases (List with causative organisms). d. Bacteriological examination of milk by SPC, DMC, Reductase test (MBRT), checking of pasteurization of milk by phosphatase test. e. Milk products- Cheese, yoghurt (production)	**12**

Practicals B. Sc. I
Semester –II
{Based on Theory Paper -IV & V}

TOTAL HOURS: 48 **CREDITS: 2** **Marks: 30**

1. *Qualitative estimation of carbohydrate.
2. *Qualitative estimation of proteins.
3. *Qualitative estimation of lipids.
4. *Estimation of protein by Lowry method
5. *Estimation of sugar by DNS method.
6. *Estimation of DNA by Diphenylamine method
7. *Estimation of RNA by Orcinal method
8. Partial purification of protein by fractional precipitation.
9. Determination of acid value of fat.
10. *Bacteriological examination of water for potability (MTDT)
    i) Presumptive (MPN) test ii)Confirmatory test iii) completed test;
11. *Identification of Coliforms by IMViC test.
12. *Determination of quality of Milk by Methylene blue reduction test.
13. *Checking of Pasteurization of milk by phosphatase test.
14. *Determination of BOD/DO of water
15. Determination of residual chlorine of water
16. Isolation and study of Air micro flora

Note: i) Minimum 4 major and 4 minor experiments are compulsory
ii) Underlined experiments are considered to be major experiments
iii) Experiments with asterisks are compulsory
iv) Duration of practical examination will be 8 hours i.e. 4 hours each for two consecutive days

Distribution of marks for practical examination:

One major experiment …….	6 marks
Two minor experiments 3 × 2 =	6 marks
Spotting	3 marks
Viva-Voce	2 marks
Practical Record	3 marks
Total ……..	**20 marks**

Internal Assessment will carry 10 mark

Books Recommended for Theory& Practical of B.Sc.I, SEM I & II

1. General Microbiology by Hans G. Schlegel.
2. General Microbiology by R.Y. Stayner.
3. Fundamentals of Microbiology by Crabtree, & Martin Frobisher.
4. Fundamentals of Bacteriology by A.J. Salle
5. A text of Microbiology by Dubey RC and Maheswari DK (2012).
6. Geeta Sumbali and Mehrotra RS (2009). Principles of Microbiology.
7. General Microbiology volume 1 and 2 by Powar CB and Daginawala H F.
8. Microbiology by Pelczar TR M J Chan ECS and Kreig N R.
9. Robert F Boyd (1984). General microbiology.
10. Microbiology by Prescott L M, J P Harley and D A Klein.
11. Introduction to Microbiology by Ingraham J.L. and Ingrahm C.A
12. History of Microbiology & Microbiological Methods by A.B. Solunke, V.S. Hamde, R.S. Awasthi & P.R. Thorat.
13. General Microbiology by Hans G. Schlegel.
14. Air Microbiology an environment & Health Prospective by S.C. Aithal, P.S. Wakte & A.V. Manwar.
15. Water Microbiology by S.C. Aithal, & N. Kulkarni.
16. General Microbiology by R.Y. Stayner.
17. A text of Microbiology by Dubey RC and Maheswari DK.
18. Manual of Methods for Pure Culture Study by A.B. Solunke, V.S. Hamde, R.S. Awasthi & P.S. Wakte.
19. Text Book of Microbial Chemistry and Physiology by P.H.Kumbhare & U.V.Thool Rajani Prakashan, Nagpur.
20. Text Book of Applied Microbiology by P.H.Kumbhare & U.V.Thool, Rajani Prakashan, Nagpur.
21. General Virology by Luria S.E.
22. A textbook of Fungi and Viruses by Dubey H.C.
23. Alcamo Fundamentals of Microbiology
24. Experiments in Microbiology by Aneja K.R.
25. Introduction to Microbial Techniques by Gunasekaran,
26. Elementary Microbiology by Modi H.A.
27. Handbook of Media, Stain and Reagents in Microbiology by Deshmukh A.M.,
28. Biology of Microorganisms by Brock T.D. and Madigan M.T.
29. Biochemistry by J.L. Jain
30. Biochemistry by Zubay
31. Principles of Biochemistry by Nelson David L and Cox Michael M. Lehninger.
32. Disinfectants and Disinfection by A.G. Young
33. Filtration by F.E. Vey
34. Biological Stains by H.J. Conn.

SEMESTER-III

B.Sc. II

Semester III		
Course Code……	**Paper-VII**	**Marks: 50**
Credits: 2		**Total Hours :48**
MICROBIAL PHYSIOLOGY AND METABOLISM		
Objective: To make the students to understand the fundamentals of physiological and metabolic pathways.		
Unit No.	**Content**	**Hrs.**
1	**Growth**	**12**
	a) Concept of Growth; b) Bacterial Growth Curve; c) Phases of Growth d) generation time, mathematical expression, growth rate constant e) Diauxic Growth f) Synchronous Growth (methods) g) Continuous Culture (methods) h) **Measurement of bacterial Growth:** Breed's method, Hemocytometer, Coulter counter, Plate count, membrane filter count i) Physical conditions required for growth i) Oxygen requirement ii) pH iii) temperature iv) Miscellaneous.	
2	**Enzymes**	**12**
	a) History in brief. Definition, General properties, physicochemical nature of enzymes, Nomenclature and Classification Based on IUB system and EC. b) Enzymes as catalysts i. Activation energy ii. Mechanism of enzyme action c) The active site d) Enzyme specificity: i. Absolute, Broad, Group & Stereo chemical specificity. e) Enzyme-Substrate Interactions (Emil Fischer Hypothesis & Daniel Koshland's Model) f) **Enzyme kinetics**: i. Michaelis–Menten equation ii. Line Weaver-Burk Plot g) **Immobilized enzyme**: techniques and applications (in brief) h) **Factors affecting enzyme activity**: pH, temperature and substrate concentration.	
3	**Microbial Metabolism**	**12**
	Definition of Metabolism, Anabolism, Catabolism and Amphibolism. EMP pathway (detail) HMP pathway (outline), ED Pathway (outline), PK pathway (outline) TCA cycle (detail), Metabolic mill β -oxidation of fatty acid Bioluminescence – Occurrence, mechanism & applications.	
4	**Pathways of Microbial Fermentations**	**12**
	Definition, Basic Concept and Biochemistry of a) **Alcohol Fermentation**: i. Ethanol fermentation by Yeasts b) **Lactate Fermentation**: i. Homo and Hetero Fermentative Pathways c) Mixed Acid and Butanediol Fermentation d)Acetone-Butanol Fermentation	

B.Sc. II

Semester III		
Course Code ……..	**Paper-VIII**	**Marks: 50**
Credits: 2		**Total Hours :48**
FOOD, SOIL MICROBIOLOGY AND MICROBIAL ECOLOGY		
Objective: To make the students to understand the fundamentals of Microbial Ecology.		
Unit No.	**Content**	**Hrs.**
1	**Food Microbiology** Definition and types of food, Sources of contamination in food, Microbial examinations of food, Significance of microorganisms in food, Spoilage and its types (Different types of spoilages with suitable examples) Preservation of food (different methods), food borne diseases, food infections and food poisoning (Botulism, *Staphylococcal* intoxication and Salmonellosis)	**12**
2	**Soil Microbiology** Definition and composition of soil, types of soil, significance of microorganisms in soil, soil as a culture medium, microbiological examination of soil. **Elemental transformations:** Carbon cycle; Nitrogen cycle; Sulphur cycle; Phosphorus cycle.	**12**
3	**Microbial associations and Ecology** Positive and Negative Microbial associations, mutualism, Symbiosis, Syntrophism, Synergism, Commensalism, Parasitism, Competition, Antibiosis. Rhizosphere, Philosopher, Miycorrhizae (types and examples) Concept of Population, community, Microbial succession and adaptation.	**12**
4	**Environmental Biotechnology** **a.** Microbial leaching - bioleaching of copper and Uranium. b. Microbial enhanced oil recovery (MEOR). c. Bioremediation, Acid mine drainage, desulfurization of coal d. Biogas plant, construction and working mechanism e. Biodegradation of (a) Cellulose (b) Pesticides (xenobiotics)	**12**

Practical B. Sc. II
Semester III
{based on Paper -VII & VIII}

Total Hours: 48 **CREDITS: 2** **Marks: 30**

1. * Demonstration of enzymes activity:_Catalase, Lecithinase (lipase), Amylase, Caseinase (protease), Urease.
2. *Isolation and study of *Rhizobium* from root nodules.
3. *Isolation and study of *Azotobacter* from soil
4. Demonstration of Synergism.
5. Demonstration of Antibiosis
6. Demonstration of Syntrophism.
7. Isolation and Study of Rhizospheric microflora.
8. *Demonstration of: Ammonification, Nitrification, Nitrate reduction.
9. Bacteriological examination of food by SPC, YMPC.
10. Demonstration of cellulose degradation.
11. Study of Phosphate solubilization by mycorhizae.
12. *Production of amylase enzyme and its assay
13. Preparation of Rhizobium Biofertilizer.

Note: i) Minimum 4 major and 4 minor experiments are compulsory
ii) Underlined experiments are considered to be major experiments
iii) Experiments with asterisks are compulsory
iv) Duration of practical examination will be 8 hours i.e. 4 hours each for two consecutive days

Distribution of marks for practical examination:

One major experiment …….	8 marks
Two minor experiments 3 × 2 =	6 marks
Viva-Voce	4 marks
Practical Record	4 marks
Total …….	**20 marks**

Internal Assessment will carry 10 marks

SEMESTER-IV

B.Sc. II

Semester-IV		
Course Code ……	**Paper-X**	**Marks: 50**
Credits: 2		**Total Hours :48**
IMMUNOLOGY		
Objective: To make the students to understand the fundamentals of Immunology.		
Unit No.	**Content**	**Hrs.**
1	**Structure and functions of Immune system.**	**12**
	Lymphoid system: Primary and Secondary lymphoid organs (Thymus, bone marrow, lymph node, Spleen), Lymphoid tissues (Malt/GALT, Payers patch, tonsils, appendix), Lymphoid cells (B cells, T cells, other immune competent cells **Immunity**- definition and classification with suitable examples, active and passive immunity I**mmune response**- Humoral (primary & secondary) and cellular.	
2	**Antigen & Antibody**	**12**
	Antigen: Definition, general properties, antigen specificity, bacterial antigens with reference to *S. typhi*. **Antibody**: Definition, general structure of immunoglobulin, classification, structure and properties of immunoglobulin classes. Theories of antibody production.	
3	**Antigen Antibody Reactions**	**12**
	Mechanism and applications of the following reaction with suitable examples- Agglutination, precipitation (Ring, Tube and Immunodiffusion), Flocculation test, complement fixation, virus neutralization, toxin Neutralization reaction, Enzyme linked immunosorbent assay.	
4	**Hypersensitivity and Allergy**	**12**
	Hypersensitivity: Definition and Classification (Gell-Coomb's). **Mechanism of Hypersensitivity reaction:** i) Type I: Reaginic (Anaphylaxis), ii) Type II: Cytolytic and cytotoxic (Erythroblastosis fetalis) iii) Type III: Immune complex disease (Arthus reaction,) iv)Type IV: Delayed Hypersensitivity (Contact dermatitis) **Autoimmunity**: causes of autoimmunity, autoimmune disorders (Rheumatoid arthritis)	

B.Sc. II

Semester-IV		
Course Code ……	**Paper-XI**	**Marks: 50**
Credits: 2		**Total Hrs :48**
MEDICAL MICROBIOLOGY		
Objective: To make the students to understand the fundamentals of the diseases, causative agents and their prevention.		
Unit No.	**Content**	**Hrs.**
1	**Infection and Disease** **Infection:** Definition, types of infections, infection process(pathogenesis) **Disease:** Disease, types of diseases, Stages of Infectious disease. **Control of communicable diseases**: different methods. **Normal flora of human body**	**12**
2	**Dynamics of Disease Transmission** **Causative/etiological agents of various diseases**, bacterial, viral, fungal, protozoan, rickettsial, waterborne, foodborne, airborne (list only). **Sources/reservoir of infections**- endogenous sources, exogenous sources, case, carriers, animals, insect, non-living sources. **Portals of exit, Portals of entry.** **Modes of transmission**- Contact, Vehicle, Vector, airborne, Trans-placental, Laboratory, Hospital. **Susceptibility of host.**	12
3	**Microbial Mechanism of Pathogenicity** **Pathogenicity and Virulence**, difference **Variation of virulence**, Exaltation, Attenuation, methods of attenuation. **Virulence determining factors** **Infectivity** – MID, MLD, ID50, LD50 **Invasiveness**, factors responsible (aggresins) **Toxigenicity** – Exotoxin, Endotoxin, comparison, enterotoxin. **Vaccine & toxoid**, types	12
4	**Bacterial Viral and other diseases** **Aetiology, epidemiology, characteristics, pathogenesis, symptoms, laboratory diagnosis, treatment of the followings** a) Diphtheria b) Tuberculosis. c) Cholera d) Typhoid e) AIDS f) Polio g) Hepatitis A & B. h) Syphilis i) Candidiasis. j) Malaria	12

Practical B. Sc. II
(Semester IV)
{based on Paper -X & XI}

Total Hours: 48 **CREDITS: 2** **Marks: 30**

1. *Study of morphology, cultural and biochemical characteristics of,
   a) *S. aureus*. b) *S.* typhi c) *V. cholerae d) E. coli*
2. To study normal flora of skin and oral cavity.
3. Detection of Malarial parasite from blood sample.
4. Detection of Chikungunia and Dengue fever.
5. Acid Fast staining of *M. tuberculosis* from sputum
6. Total Leucocyte Counting
7. *Detection of Blood group and Rh factor
8. *Haemoglobin % estimation
9. *Detection of Typhoid and Paratyphoid fever by slide/tube Widal test
10. Detection of Rheumatoid arthritis *(***RA***)*
11. *Detection of Syphilis by VDRL test (RPR)
12. *Determination of blood sugar by GOD-POD method,
13. Estimation of blood urea by Diacetyl monoxime method (DAM)
14. Demonstration of HBs Ag by Hepacard test
15. *Estimation of Antigen by Single Radial Immune Diffusion(RIA).
16. Detection of AIDS by ELISA test.

Note: i) Minimum 4 major and 4 minor experiments are compulsory
ii) Underlined experiments are considered to be major experiments
iii) Experiments with asterisks are compulsory
iv) Duration of practical examination will be 8 hours i.e. 4 hours each for two consecutive days

Distribution of marks for practical examination:

One major experiment …….	8 marks
Two minor experiments 3 × 2 =	6 marks
Viva-Voce	4 marks
Practical Record	4 marks

Total …….. 20 marks

Internal Assessment will carry 10 marks

Books Recommended for Theory& Practical of B.Sc. II Year

1. Basic Immunology by Joshi & Osarano.
2. Medical Microbiology by A.H. Modi.
3. Text book of Immunology by B.S. Nagoba & D.V. Vedpathak.
4. Medical Microbiology by Anantharayanan 7C.K. Jayaram Panikar.
5. Immunology by E. Roitt.
6. Medical Microbiology by T.C. Dey & N.C. Dey.
7. Textbook of Medical Bacteriology by Fairbrother.
8. Medical Microbiology by Chakrborthy.
9. Food Microbiology by Frazier.
10. Soil Microbiology by Alexander
11. Soil Microbiology by Subbarao
12. A Manual of Environmental Microbiology by Christon.
13. Soil Microbiology by S.A. Waksman
14. Microbial Ecology by T.D. Brock
15. Enzymology by Boyer
16. Molecular and Cellular enzymology by J.Y. Khan & G. Herve
17. Principles of Immunology by Karsner & Ecker
18. Immunology of Fungal Infections by G.D. Brown.
19. Fundamentals of Immunology by Williams &Paul
20. Text Book of Microbial Taxonomy, Ecology and Diversity by P.H.Kumbhare and V.U.Thool Rajani Prakashan, Nagpur.
21. Text Book of Enzymology and Metabolism by P.H.Kumbhare and V.U.Thool, Rajani Prakashan, Nagpur.
22. Text Book of Industrial and Food Microbiology by P.H.Kumbhare and V.U.Thool, Rajani Prakashan, Nagpur.
23. Text Book of Medical Microbiology by P.H.Kumbhare and V.U.Thool, Rajani Prakashan, Nagpur.
24. Text Book of Immunology by P.H.Kumbhare and V.U.Thool, Rajani Prakashan, Nagpur.
25. Fundamentals of Food Microbiology by A. Bhunia
26. Soil Microbiology & Biochemistry by E.A. Paul
27. Bacterial Cell to Cell Communication by D.R. Demuth
28. Modern Food Microbiology by James M. Jay.
29. Secondary Metabolites in Soil Ecology by Ajit Verma
30. Molecular Mechanism of Plant and Microbe Coexistance by C. Nautiyal.
31. Bacterial Metabolism by Doelle
32. Bacterial Metabolism by Gottschalk
33. Chemical Microbiology by Rose

SEMESTER-V

Semester-V		
Course Code ……..	**Paper-XIII**	**Marks: 50**
Credits: 2		**Total Hours :48**
MICROBIAL TECHNOLOGY		
Objective: To make the students to understand the fundamentals of Industrial processes and mechanisms for the product formation.		
Unit No.	**Content**	**Hrs**
1	**Industrial Microbiology**	**S**
	Definition, Scope and Development of Industrial Microbiology, Bioreactor / Fermentor (Definition, Characteristics of Ideal, Design and Different parts of fermentor). **Types of Fermentor**: laboratory fermentor, pilot plant fermentor, industrial fermentor, Horton sphere. Batch, continuous, Rotory drum disk fermentor, Tubular, fed batch, fludised bed reactor, tower fermentor (In brief). Computer application in fermentation technology.	
	Fermentations: Definition and Types- Batch And Continuous, Aerobic and Anaerobic, Solid and Liquid state, Surface and Submerged culture, Single, Dual / Multiple culture.	
	Fermentation media: Composition, Raw materials, screening of media, antifoam, buffer.	
	GMP(Good manufacturing Practices)	
2	**Microbes in Industrial Microbiology**	**12**
	1. Industrially important microorganisms & their products (List) 2. Screening: Primary and Secondary 3. Strain improvement 4. Stock culture and its maintenance (serial subculture, overlaying with mineral oil, lyophilisation, liquid nitrogen, soil stock).	
3	**Upstream and Downstream Processing**	**12**
	Upstream process, different stages in brief **Downstream process** - Recovery & Purification of fermentation products: . Cell removal by: precipitation, filtration & centrifugation . Cell disruption: physical & chemical method . Solvent recovery process . Chromatography: Types and significance in industrial recovery . Drying & crystallization . Packing of product .Testing of sterility, pyrogen, carcinogenicity, toxicity and allergens.	
4	**Important Fermentation products**	**12**
	Strains involved in fermentation, Fermentation Media, fermentation condition, Metabolic pathway involved, Product recovery operations and Uses of; – • Beverages (Beer, Wine) • Organic acid (Citric acid) • Antibiotics(Penicillin) • Amino acids(Lysine) • Enzymes (Amylase) • Biomass – Baker's Yeast • Fermented food – Idli	

B.Sc. III

Semester-V		
Course Code ……..	**Paper-XIV**	**Marks: 50**
Credits: 2	**MICROBIAL GENETICS**	**Total Hours :48**
Objective: To make the students understand the fundamentals of techniques of Genetics and Genetic engineering and the methods involved. To make the students to understand the genetics of microbes.		
Unit No.	**Content**	**Hrs**
1	**Microbial DNA** 1. Forms of bacterial DNA (A, B, Cruciform, H, & Z.) 2. Evidences of DNA as genetic material (Griffith Experiment, Avery et al experiments, and Hershey and Chase experiments) 3. Prokaryotic DNA replication: General Concept of DNA replication, Semiconservative Mode, Rolling circle model. Replicon model and precursors of DNA replication. Details of elongation (Beta Clamp and progressive polymerase) 4. Discovery of RNA as viral genetic material(Gierer and Schramm experiment(TMV)	**12**
2	**Bacterial Mutation** a. Spontaneous versus induced mutations. b. Molecular basis of mutation-Types of mutation-base pair substitution, frame shift mutation, point, non-sense, missense, silent. c. Mutagenic agents-Physical and chemical. d.Mutation rate, Ames test. e.Spontaneous mutations-Fluctuation Test f.DNA repair–i)Photo reactivation ii) Dark Repair Mechanism	**12**
3	**Bacterial Recombination** General Perspective of Genetic:(a)Recombination(with Holliday Model as example). (b)Homologous Recombination in *E.coli*(Initiation, Synapsis, Branch Migration and resolution).(c)Site Specific Recombination(Integrative and Excessive Recombination).(d) Illegitimate Recombination (Non-Homologous Recombination) **(a)Transformation:** Introduction and History; Mechanism of transformation; Competence, Binding, Penetration, Synapsis and Integration. (b)**Conjugation**: Discovery of conjugation in bacteria; Properties of F plasmid/Sex factor; Hfr strains and their formation; Mechanism of Conjugation; F' factor and Sexduction. (c)**Transduction:** Introduction and discovery; Generalized and Specialized transduction; Abortive transduction; (d)**Transposition**: Transposable Elements in Prokaryotes; Insertion sequences, Transposons.	**12**
4	**Structure of Prokaryotic Chromosomes and Methods in Genetics**	**12**
	E. coli- The model genetic organism, Structural organization of *E. coli* chromosome - Folded Fiber model. **Plasmids:** Definition, Properties, Types and Applications. Methods of screening nucleic acids using mass spectrometry DNA Sequencing Apparatus Methods for Evaluating ribonucleotide sequence Methods of Immobilization of Nucleic acids.	

Practical's B.Sc. III
(Semester V)
{Practical's based on Paper -XIII & XIV}

Total Hours: 48 **CREDITS: 2** **Marks: 30**

1. Primary screening of antibiotic producers, amylase producers, and organic acid producers.
2. Preparation of fermented food – Idli.
3. *Production of Penicillin by Fermentation and its Bioassay.
4. *Production of Wine by Fermentation and its estimation by Titrable acidity.
5. *Production of Ethanol by Fermentation and its estimation by Titration.
6. Production of Citric acid by Surface/submerged fermentation and its estimation by titrable acidity.
7. Extraction and Purification of RNA from Yeast.
8. Replica Plate method.
9. *Isolation of bacterial plasmid DNA
10. *Extraction of genomic DNA from E. coli and isolation by Agarose gel electrophoresis
11. *Digestion of DNA using restriction enzyme and analysis by agarose gel elctrophoresis
12. *Ligation of restricted DNA fragment
13. Demonstration of Transformation
14. Demonstration of Conjugation

Note: i) Minimum 4 major and 4 minor experiments are compulsory
ii) Underlined experiments are considered to be major experiments
iii) Experiments with asterisks are compulsory
iv) Duration of practical examination will be 8 hours i.e. 4 hours each for two consecutive days

Distribution of marks for practical examination:

One major experiment …….	8 marks
Two minor experiments 3 × 2 =	6 marks
Viva-Voce	4 marks
Practical Record	4 marks

Total …….. 20 marks

Internal Assessment will carry 10 marks

SEMESTER-VI

B.Sc. III

Semester-VI			
Course Code……	**Paper No. XVI**	**Marks: 50**	
Credits: 2	**Molecular Biology**	**Total Hrs :48**	
Objective: To make the students to understand the fundamentals of Molecular biology.			
Unit No.	**Content**		**Hrs.**
1	**Mutagenesis and DNA Repair** **Mutagenesis of DNA by**, **Mis-pairing** of Bases due to Tautomerism, Deamination, Depurination and Damage due to Oxidative Metabolism **Repair of DNA** by: i. Photo-reactivation ii. Nucleotide Excision Repair (NER) iii. Base Excision Repair (BER); iv. Mismatch Excision Repair (MER).		**12**
2	**Regulation of Gene expression in Prokaryotes** a) Regulation of Transcription (Repressors, Activators, Sigma factor and Attenuation) b) Regulation of Translation (During Initiation, Elongation and Termination) c) The lac Operon of *E. coli* d) The trp Operon of *E. coli*		**12**
3	**Gene Expression:** Definitions of Gene, Muton, recon, Cistron, Split genes and gene within gene. a) Characteristics of Genetic code(Triplet code, comma free, non-overlapping, degenerate, start and stop signals and wobble hypothesis) b) Structure of RNA Polymerase (RNAP) and Process of transcription c) Structure of Ribosomes and Process of Translation d) Bacterial Transcriptional and Translational Cycle		**12**
4	**Molecular Techniques and their Applications** a) Introduction, Definition and Purpose of Cloning; b) Tools for Molecular Cloning i. **ENZYMES**: Restriction endonucleases, DNA ligases, alkaline phosphatase, DNA Modifying enzymes. ii. **VECTORS**: Plasmids-pBR322, Bacteriophage-Phage λ, Cosmids b) Isolation of Bacterial DNA – Gene gun, hybridization, Reverse transcriptase c) **Methods of gene transfer:** i. Transformation; ii. Electroporation; iii. Liposome fusion; iv. Transduction i) Screening of recombinants: methods, i. Insertion inactivation ii. Immunochemical methods; iii. Colony hybridization j) **Applications**: i. Expression of Bt toxin in tobacco plant ii. Expression of human insulin gene in *E.coli*		**12**

B.Sc. III

Semester-VI		
Course Code……..	**Paper XVII**	**Marks: 50**
Credits: 2	**Analytical Microbiology**	**Total Hrs :48**
Objective: To make the students to understand the fundamentals of analytical tools and techniques.		

Unit No.	Content	Hrs.
1	**BASIC ANALYTICAL TECHNIQUES IN MICROIOLOGY**	12
	Colorimetry and Spectrophotometry: Principles and applications. Introduction to IR and NMR and their applications. Atomic spectroscopy: Principles and applications of Atomic Absorption/Emission Spectrometer. Mass Spectrometry; Raman Spectrometry	
2	**CHROMATOGRAPHY**	12
	Chromatography: Theories and Principles. Paper Chromatography. Thin layer Chromatography. Affinity and Ion Exchange Chromatography. Partition and size Exclusion Chromatography. Gas Chromatography and High Performance Liquid Chromatography.	
3	**ELECTROPHORESIS & CENTRIFUGATION**	12
	Electrophoresis: Theories and Principles. Paper Electrophoresis. Gel Electrophoresis: PAGE, AGE and PFGE. **Centrifugation:** Basic principles, concept of RCF, Sedimentation coefficient **Types of centrifuges:** clinical, high speed and ultracentrifuge- application, Density gradient centrifugation.	
4	**MODERN ANALYTICAL TECHNIQUES**	12
	Applications of Radioisotopes in biosciences: Radioactive and stable isotopes, rate of radioactivity decay, units of radioactivity. Radioisotope methods, types of radioactive decay - Half life and radioactivity- GM counter– Scintillation counter – Autoradiography Blotting techniques. RFLP & RAPD. **PCR Technology**: Principle and Applications. **Introduction to Biosensor**: Definition and applications.	

Practical's B.Sc. III (Semester VI)
{Practical's based on Paper -XVI & XVII} USMBP18

Total Hours: 48 CREDITS: 2 Marks: 30

1. *Preparation of commonly used Buffers.
2. *Demonstration of Paper Electrophoresis
3. *Separation of Sugars by Paper Chromatography
4. *Separation of Amino acids by Paper Chromatography
5. *Thin Layer chromatography of Sugars.
6. *Thin Layer chromatography of Amino acids.
7. Isolation of Lac Mutants of *E.coli*.
8. Isolation of lambda Phage DNA.
9. Demonstration of Beer's -Lambert law by colorimetry/spectro-phophotometry
10. *Isolation of Antibiotic resistant mutants by Physical/Chemical agents.
11. Ampicillin selection method for isolation of auxotrophic mutants.
12 DNA amplification by PCR (Demonstration)
14. Cloning of GFP gene

Note: 1. Underlined experiments are treated as major experiments.
2. Students should perform at least 4 major and 4 minor experiments
3. Practicals with asteric mark are compulsory.
4. An educational tour (visit to Pharmaceutical, Dairy industry, Research institute) is compulsory in V or VI semester
5. For project a suitable microbial investigation involving laboratory work or survey work may be given to the group of 2-3 students at the beginning of semester
6. Report on project / review work preferably printed should be submitted duly certified by in charge teacher and head of the department

Distribution of marks during practical examinations of B.Sc. Semester VI

1. One major experiment- 06
2. Two minor experiment- 2 X 3 = 06
3. Project (lab or review work) 04
4. Viva voce- 02
5. Practical record- 02 --

Total 20

Internal Assessment will carry 10 marks

Duration of Practical examination will be 8 hrs., 4 hrs. Each for two consecutive days

Books Recommended for Theory& Practical of B.Sc. III Year

1. Essentials of Molecular Biology by D. Freidfelder
2. Molecular biology by J.D. Watson.
3. Biophysical Chemistry by Chatwal & Anand.
4. Microbial Genetics by D. Freidfelder
5. Microbial Technology by Vol. I & II by A.H. Peppler.
6. Microbial Technology of TCA by A. B. Solunke, V.S. Hamde, P.S. Wakte
7. Principles of Genetics by R.H. Tamarin.
8. Molecular Biology and Genetic engineering by Narayanan.
9. Fundamentals of Bacterial Genetics by Nancy Trum and J. Trumphy.
10. Industrial Microbiology by A.H. Patel
11. Industrial Microbiology by Prescott & Dunn.
12. Modern Industrial Microbiology & Biotechnology by Nduka Okafoe.
13. The Book of Citric Acid by A.B. Solunke
14. Industrial Microbiology: An Introduction by Wastes, Morgan, Rockey and Highten.
15. Text Book of, Microbial Genetics by P.H.Kumbhare & V.U.Thool Rajani Prakashan, Nagpur
16. Biotechnology by P. Prave
17. Industrial Microbiology by Casida.
18. Text Book of Bioinstrumentation by P.H.Kumbhare & Dr. Megha Kulkarni, Rajani Prakashan, Nagpur.
19. DNA Chromatography by Doughlas
20. Ion Chromatography by J. Weiss
21. Encyclopedia of Bioprocessing Technology by M.C. Flickinger & S.W. Drew.
22. Textbook of Microbiology, Molecular Biology and Bioinstrumentation by R.M. Bhute and S.V. Kasbekar.
23. Microbiology for Analytical Chemists by R.K. Dart