GUJARAT UNIVERSITY
Syllabus for Third Year B. Sc. Microbiology
Semester V and Semester VI
Effective from June-2019

1. A student selecting Microbiology as the special subject in Third Year B. Sc. will be offered following papers in Semester-V and Semester-VI.

   A. Semester-V

   I. Four theory papers of core course MI-301, MI-302, MI-303 and MI-304, each of 100 marks.

   II. One theory paper of subject elective course MI-305 of 100 marks.

   III. One practical paper MI-306 of 200 marks.

   B. Semester-VI

   I. Four theory papers of Core Course MI-307, MI-308, MI-309 and MI-310, each of 100 marks.

   II. One theory paper of subject elective course MI-311 of 100 marks.

   III. One practical paper MI-312 of 200 marks.

2. Each theory paper at the external examination shall be of 2½ hours duration and carry 70 marks. The external practical examination carrying 140 marks shall be conducted for three consecutive days, each of four hours duration.
3. Internal assessment will be of 30 marks for each theory paper and 60 marks for practical paper.
4. Distribution of lectures for individual paper is as follows.

   A For each theory paper of core course, there shall be 4 lectures per week, each of 55 minutes duration (4 X 4 = 16 lectures/week)

   B. For theory paper of subject elective course there shall be 3 lectures per week, each of 55 minutes duration (1 X 3 = 03 lectures/week)

   C For practical paper there shall be 4 periods each of 55 minutes duration, for three consecutive days (4 X 3 = 12 periods per week for one batch).

5. Ideally one batch for practical periods shall consist of 20 students; however maximally 25 students can be accommodated.
6. Every theory paper is divided into four units and from each unit one question shall be set for examination. The type of question/sub-question and its marks shall be set on the basis of question paper format decided by the Gujarat University from time to time.
7. The teaching shall be based upon listed reference books.
8. The numeric on the right depicts the number of lectures allotted to a particular topic.
9. The syllabus for each paper is outlined as follows

SEMESTER - VI
COURSE MI-307
Genetic Engineering

Unit I Tools of rDNA technology

1. Fundamentals: rDNA technology, genetic engineering, cloning (1 hr)
2. Enzymes: Restriction endonucleases, Reverse transcriptase, Terminal transferase, Alkaline phosphatase, DNA ligases (3 hr)
3. Cloning vectors (4 hr)
   A. Criteria for selection of cloning vector
   B. Types of vector: plasmid vector (pBR322), phage vector (λ), cosmid, shuttle vector - yEP and Ti plasmid
4. Genetic probes, primers and reporter genes (Green Fluorescent Protein) (1 hr)
5. Host cell for cloning: properties of good host, prokaryotic and eukaryotic host cells (1 hr)

Unit II Techniques for genetic engineering

Principle, method and applications of following techniques

1. Gene editing: Site directed Mutagenesis (2 hr)
2. Gene amplification: Polymerase Chain Reaction (2 hr)
3. Gene detection by hybridization: Southern blotting (2 hr)
4. Gene sequencing: Sanger's dideoxy chain termination method (2 hr)
5. Gene expression: DNA microarray (2 hr)

Unit III rDNA technology

1. Obtaining desired DNA fragment: Isolation from donor cell – shot gun cloning and construction of genomic library, construction of cDNA library, chemical synthesis of DNA (4 hr)
2. Preparation of rDNA: Protocol for joining isolated DNA fragment with cloning vector (2 hr)
3. Transfer of rDNA in to suitable host cell: Transformation, Gene gun, Microinjection, Protoplast Fusion, and Electroporation. (2 hr)
4. Selection of recombinant clone: Colony hybridization technique, Use of marker genes, X- gal dye and reporter gene (2 hr)

Unit IV Applications of rDNA technology

1. Medical applications: Recombinant vaccine (Hepatitis-B), Recombinant protein (Insulin) (4 hr)
2. Agricultural applications: Transgenic plants resistant to microbial pathogens & insect pests (4 hr)
3. Environmental applications: Environmental genomics - metagenomics (1 hr)
4. Social impacts of rDNA technology (ELSI) (1 hr)

Reference Books:

1. **Prescott, Harley, and Klein's Microbiology,** J. M. Willey, L. M. Sherwood, C. J. Woolverton**,** 7th Edition (2008), McGraw Hill Higher Education- USA

2. **Principles of Microbiology,** R. M. Atlas, 2nd Edition (Indian Edition) (2015), McGraw Hill Education (India) Private Limited –New Delhi

3. **Biotechnology: The Biological Principles**, Trevan M. D., Boffey S., Goulding K. H. and Stanbury S. (1987) Tata – McGraw Hill, New Delhi – India.

4. **Biotechnology,** U. Satyanarayana, 1st Edition (Reprinted 2008), Books and Allied (P) Ltd. Kolkata

SEMESTER - VI
COURSE MI-308
Virology and Mycology

Unit I Introduction to viruses and sub-viral entities

1. General characteristics and structural organization of virus (3 hr)
2. Classification of viruses: ICNV and Cryptogram system of viral classification (2 hr)
3. Cultivation of viruses: (3 hr)
   A. Cultivation in animal
   B. Cultivation in embryonated eggs
   C. In vitro culture: cell lines, primary and secondary cell lines, continuous cell lines, cytopathic effects
4. Sub-viral entities: viroids, virusoids, prions, introduction to persistent, latent and slow viruses, oncogenic viruses (2 hr)

Unit II Bacteriophages, plant viruses and animal viruses

1. Lytic cycle (T4 Phage) (3 hr)
   A. One step growth curve experiment, burst size
   B. Phage adsorption and penetration, intracellular development, early and late events, replication of phage chromosome, phage morphogenesis (assembly) and release
2. Single stranded DNA and RNA phages: ΦX174 and MS2. (1 hr)
3. Lysogenic cycle (lambda phage): Mechanism of establishment, induction, and replication. (2 hr)
4. Plant Viruses: Introduction and replication of plant viruses (TMV) (1 hr)
5. Animal viruses: Introduction and replication (adsorption, penetration, uncoating, replication, synthesis and assembly, and release) of animal viruses in general (HIV) (3 hr)

Unit III Introduction to fungi

1. General characters: Somatic structure, ultra-structure of fungal cell, hyphal modifications, asexual and sexual spores (4 hr)
2. Cultivation of fungi (3 hr)
   A. Principles of fungal nutrition
   B. Cultivation media & methods, slide culture technique, prevention of bacterial contamination
3. Economic importance of fungi (3 hr)
   A. Primary and secondary metabolites of fungi and their importance
   B. Overview of plant and animal fungal diseases

Unit III Reproduction and classification of fungi

1. Fungal classification: Criteria used for classification, recent classification system (2 hr)

2. Brief outline of following classes of fungi:
   Salient features, reproduction and economic importance in general

   A. Myxomycetes (2 hr)

   B. Eumycetes (6 hr)
      i. Chytridiomycetes
      ii. Phycomycetes (Phycomycotina)
      iii. Ascomycetes (Ascomycotina)
      iv. Basidiomycetes (Basiomycotina)
      v. Deutromycetes (Deuteromycotina)

Reference Books:

1. **Introductory Mycology**, Alexopoulos C J, Mims C W, Blackwell M, (1996) 4th edition, Blackwell Publishing.

2. **Introduction to Fungi**, Webster J, R W S Weber (2007) 3rd edition, Cambridge University Press.

3. **Principles of Microbiology,** R. M. Atlas, 2nd Edition (Indian Edition) (2015), McGraw Hill Education (India) Private Limited –New Delhi

4. **Prescott, Harley, and Klein's Microbiology,** J. M. Willey, L. M. Sherwood, C. J. Woolverton**,** 7th Edition (2008), McGraw Hill Higher Education- USA

5. **Basic Virology**, Wagner E K, Hewlett N J, Bloom D C and Camerini D (2008) 3rd edition Blackwell Publishing Ltd UK.

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SEMESTER - VI
COURSE MI-309
Medical Microbiology

Unit I Relationship between human body and microbe

1. Normal microbiota (normal flora) of the human body (4 hr)
   A. Importance, origin and establishment
   B. Microbiota of various body parts
   C. Gnotobiotic life and gnotobiosis

2. Host-parasite relationship (6 hr)
   A. Concept of host-parasite relationship and factors affecting it
   B. Microbial pathogenicity:
   C. Overview of bacterial and viral pathogenicity
   D. Factors affecting the process of infection
   E. Pathogenicity: (a) Invasiveness: role of structures and secretions of bacteria
      (b) Toxigenicity: Protein and LPS toxins -properties and mode of action

Unit II Epidemiology of infectious disease and vaccines

1. Epidemiology (6 hr)
   A. Concepts of epidemiology
   B. Epidemiological types of infection
   C. Techniques used to study epidemiology
   D. Epidemiological markers
   E. Infectious disease cycle
   F. Nosocomial infections: sources, transmission and control

2. Vaccines (4 hr)
   A. Concept immunoprophylaxis
   B. Types of vaccine
   C. Schedule of vaccination (followed in India)
   D. Hazards of vaccination

Unit III Clinical Microbiology

1. Specimen: types of specimen, methods of collection, storage and transportation (2 hr)

2. Methods used for diagnosis and identification of pathogens (8 hr)
   A. Microscopy
   B. Growth and biochemical characteristics
   C. Clinical immunology
   D. Pathological changes in blood and body fluids and tissues
   E. Significance of computer and possible uses of biosensors

Unit IV Infectious diseases of human being

Study of following diseases with respect to etiological agent, symptoms, transmission, diagnosis and control.

1. Airborne diseases: Tuberculosis, Swine flu (2 hr)
2. Food and waterborne diseases: Typhoid, Hepatitis A (2 hr)
3. Contagious diseases: Syphilis, AIDS (2 hr)
4. Insect borne diseases: Malaria, Dengue (2 hr)
5. Zoonoses: Rabies, Anthrax (2 hr)

Reference Books:

1. **Principles of Microbiology,** R. M. Atlas, 2nd Edition (Indian Edition) (2015), McGraw Hill Education (India) Private Limited –New Delhi
2. **Prescott, Harley, and Klein's Microbiology,** J. M. Willey, L. M. Sherwood, C. J. Woolverton**,** 7th Edition (2008), McGraw Hill Higher Education- USA
3. **Baker and Silverton's Introduction to Medical Laboratory Technology,** Baker F J, Silverton R E, Pallister C J, (1998), 7th edition, Butterworths-Heinemann, Oxford, UK

SEMESTER - V
COURSE MI-310
Bioprocess Technology

Unit I Fermenter operation and scale up

1. Modes of operation: surface culture fermentation, submerged fermentation (batch, fed-batch and continuous fermentations), solid substrate fermentation (4 hr)

2. Operating parameters and their control: aseptic operation, mass transfer of oxygen, foam, pH, temperature (2 hr)

3. Safety procedures (2 hr)
   A. Containment
   B. Clean room environment

4. Introduction to scale up (2 hr)

Unit II Downstream processing

1. Introduction (1 hr)

2. Removal of microbial cells and suspended solids (3 hr)
   A. Foam separation
   B. Precipitation
   C. Filtration
   D. Centrifugation

3. Cell disruption methods (2 hr)
   A. Physico-mechanical methods
   B. Chemical methods

4. Product concentration and purification (2 hr)
   A. Liquid-liquid extraction
   B. Membrane processes

5. Finishing stages (1 hr)
   A. Drying
   B. Crystallization

6. Effluent treatment (1 hr)

Unit III Product analysis and fermentation economics

1. Detection and assay of fermentation products (6 hr)
   A. Physical assays: Titration and gravimetric analysis, turbidity and cell yield determination
   B. Chemical assays: Chromatography, Spectrophotometry
   C. Biological assays: Microbial assay

2. Microbial quality assurance (2 hr)
   A. Sterility testing
   B. Pyrogen testing (LAL test)

3. Introduction to fermentation economics (2 hr)

Unit IV Typical fermentation processes

1. Enzyme: Amylase (2 hr)
2. Antibiotic: Penicillin (2 hr)
3. Organic acid: Citric acid (2 hr)
4. Biofuel/solvent: Ethanol (2 hr)
5. Amino acid: Lysine (2 hr)

Reference Books:

1. **Principles of Fermentation Technology,** Stanbury P F, Whitaker A and Hall SJ, (1995) 2nd edition, Pergamon Press, London, UK.
2. **Industrial Microbiology: An Introduction,** Waites, M J and Morgan N L, (2002) Blackwell Science.
3. **Biotechnology: A Textbook of Industrial Microbiology,** Crueger W and Crueger A, (2000) 2nd edition, Panima Publishing Corporation, New Delhi, India.
4. **Fermentation Microbiology and Biotechnology,** El-Mansi E M T, Bryce CFA, Dahhou B, Sanchez S, Demain AL, Allman AR (eds), (2011) 3rd edition, CRC Press; Taylor and Francis Group, Boca Raton.
5. **Industrial Microbiology,** Casida LE, Jr. (1968), Wiley Eastern Ltd, New Delhi, India.

SEMESTER - VI
COURSE MI-311.1

Biotechnology

Unit -1 Introduction to biotechnology

1. Introduction & historical background of biotechnology (1 hr)
2. Old and new biotechnology (2 hr)
3. Biotechnology: an interdisciplinary & multidisciplinary science (2 hr)
4. Scope and importance of biotechnology (major areas of biotechnology) (2 hr)
5. Biotechnology in Gujarat & India: Education and Research (1 hr)

Unit: 2 Instrumental methods

Principle, method, and applications of following methods

1. UV-Vis spectroscopy (1 hr)
2. Centrifugation and its types in brief (2 hr)
3. Chromatography: Paper, TLC, HPLC (2 hr)
4. Electrophoresis: SDS-PAGE and Agarose gel electrophoresis (2 hr)
5. Biosensors (1 hr)

Unit: 3 Cellular & molecular techniques

Principle, method and applications of following techniques

1. Animal cell culture: primary & secondary cell culture, continuous cell lines (2 hr)
2. Plant tissue culture: Introduction to PTC, callus culture (2 hr)
3. Northern blotting (2 hr)
4. CRISPR CAS 9 (2 hr)

Unit: 4 Areas of application of biotechnology

1. Plant biotechnology: transgenic plants-herbicide resistant plants & golden rice (2 hr)
2. Animal biotechnology (2 hr)
   A. Transgenic animals- features of animal suitable for gene transfer
   B. Transgenic cow for lectoferrin production
   C. Transgenic sheep for wool production
3. Microbial biotechnology: baker's yeast production (2 hr)
4. Enzyme biotechnology: analytical, industrial and therapeutic applications (1 hr)
5. Intellectual property rights: Introduction to IPR, patents in biotechnology (1 hr)

Reference Books:

1. **Basic Biotechnology,** Colin Ratledge and Bjorn Kristiansen (2006) Cambridge University Press, 3rd edition.

2. B. Sc. Edition **Biotechnology,** B.D. Singh 5th Edition (Reprinted 2015), Kalyani Publishers, Ludhiana, Punjab

3. **Principles and Techniques of Biochemistry and Molecular Biology**, Wilson K and Walker J (2005) (6th Edn), Cambridge

4. **Biotechnology: The Biological Principles**, Trevan M. D., Boffey S., Goulding K. H. and Stanbury S. (1987) Tata – McGraw Hill, New Delhi – India.

5. **Biotechnology,** U. Satyanarayana, 1st Edition (Reprinted 2008), Books and Allied (P) Ltd. Kolkata

6. **Introduction to biotechnology,** Ashim K. Chakravarty, (2013) Higher Education Division– Oxford University Press, Oxford-UK

7. **CRISPR-Cas: A Laboratory Manual,** edited by Jennifer Doudna and Prashant Mali, (2016) Cold Spring Harbour Laboratory, NY, USA

SEMESTER-VI
COURSE MI-312
Microbiology Practicals
(Practicals based on the theory papers MI-307 to MI-311.1)

1. Separation of amino acids by paper chromatography.
2. Separation of amino acids by thin layer chromatography.
3. Immobilization of cells by calcium-alginate entrapment method and activity check by methylene blue reduction test. (Demonstration only).
4. Use of enzyme as analytical tool: Glucose estimation by GOD-POD method.
5. Isolation of bacteriophage from sewage.
6. Isolation and cultivation of yeasts.
7. Cultivation of and microscopic examination of molds by slide culture technique.
8. Study of plant diseases caused by Virus and Fungi — Mosaic, red rot, rust, smut, wilt, leaf curl, powdery mildew, downy mildew.
9. Isolation, cultivation and identification of gram-negative bacteria—*Escherichia coli, Enterobacter aerogenes, Proteus vulgaris, Pseudomonas aeruginosa, Salmonella typhi, Salmonella paratyphi* A, *Salmonella paratyphi* B.
10. Characterization of Gram-negative bacteria based on biochemical reactions using rapid identification kit. (Demonstration only).
11. Study of antibiogram (using multidisc).
12. Physical and chemical analysis of urine.
13. Estimation of blood urea by diacetyl monoxime method (DAM).
14. Study of permanent slides
    A Insect vectors: Female anopheles mosquito, head louse, tick, flea, mite.
    B. Microorganisms: Actinomycetes, yeast, bacteroids, acid-fast bacilli, spirochetes, *Streptococcus pneumoniae, Clostridium tetani* and *Plasmodium vivax*
15. Fermentative production of amylase and its activity check.
16. Bioassay of penicillin/ampicillin using *Bacillus subtilis*.
17. Sterility testing of pharmaceutical product.

Scheme for Practical Examination

No.	Exercise	Marks
1	Isolation and identification of Gram negative bacteria	**30**
2	Bioprocess technology	**30**
3	General exercise A. Separation of amino acids by paper chromatography B. Separation of amino acids by thin layer chromatography C. Estimation of glucose by GOD-POD method D. Estimation of blood urea by DAM method E. Physical and chemical analysis of urine F. Determination of antibiogram G. Isolation of bacteriophage from sewage	**30**
4	Spotting	**20**
5	Viva	**20**
6	Journal and slides	**10**
	Total	**140**