SOLAPUR UNIVERSITY
SOLAPUR

M.Sc. Part II Semester III & Semester IV

Microbiology

CBCS True Spirit
Syllabus
(With effect from June 2017)
1. **Title of the Course: M. Sc. DEGREE COURSE FOR MICROBIOLOGY**

2. **Introduction:** This course provides a broad overview of microbiology and produces expert hands that would have sufficient knowledge and expertise to solve the urgent problems of the region by using microbiology. The course structure is biological centric where students basically learn microbiology and are taught necessary basic subjects for that purpose.

In addition to disciplines like Virology, Immunology, Genetics, Molecular Biology, Enzymology, Biostatistics, Bioinformatics, Scientific Writing, Computer Science, Industrial Microbiology and waste management etc., topics introduced in the course of two year are in the field of microbiology.

3) **Objectives of the course:** A prime objective to maintain updated curriculum and providing therein inputs to take care of fast paced developments in the knowledge of Microbiology in relation to international context, a two year program is formulated for M.Sc. Microbiology to develop competent microbiologist to achieve desirable placements in the country and abroad. The program obliges students to read original publications and envisages significant inputs in the laboratory work, communication skills, creativity, planning, execution and critical evaluation of the studies undertaken.

- Beyond simulating, learning, understanding the techniques, the course also addresses the underlying recurring problems of disciplines in today scientific and changing business world.
- To develop awareness & knowledge of different organization requirement and subject knowledge through varied subjects and training methodology in students.
- To train the students to take up wide variety of roles like researchers, scientists, consultants, entrepreneurs, academicians, industry leaders and policy.

- To provide an intensive and in-depth learning to the students in field of microbiology.
- Beyond simulating, learning, understanding the techniques, the course also addresses the underlying recurring problems of disciplines in today scientific and changing business world.
- To develop awareness & knowledge of different organization requirement and subject knowledge through varied subjects and training methodology in students.
- To train the students to take up wide variety of roles like researchers, scientists, consultants, entrepreneurs, academicians, industry leaders and policy.
4) **Advantages of the Course:** • Microbiology has tremendous job potential. The successful students will be able to establish trading, industrial and consultancy organizations in pharmaceuticals, paper, fermentation, food processing & preservation, agriculture, environment protection and also their own industry for micro propagation of commercially important plants in vitro, transgenic plants, vaccine production, clinical pathology, genetic counseling, human karyotyping etc.

• Multinational companies dealing with production of tissue cultured and genetically modified plants, food products, leather, dairy, beverages, pharmaceutical, chemical Industries, agribusiness, Environment protection.

• Medical & Scientific Research Organizations.

• Universities in India & aboard.

5) **Eligibility of Course:**

Eligibility: A Candidate possessing Bachelor Degree with Microbiology /. Or life sciences as a principal subject (Microbiology), and who have passed the entrance examination conducted by the Solapur University shall be held eligible for admission to M. Sc. Course in Microbiology. Students from other University with B.Sc. General Degree in life sciences and who have passed the entrance examination conducted by the University are also eligible.

• Admission: Merit list based on average of B.Sc. aggregate and entrance exam conducted by University. For other university student merit list only on basis of entrance examination conducted by University.

6) **Duration:** The duration for this program is of 2 years with semester pattern (04 Semesters)

7) **Medium of Instruction:** English

8) **Structure of the Course:**

• Structure of M.Sc. course in faculty of Science has total of 4 semesters for 2 years.

• M. Sc. I comprise of total two semesters and M. Sc. II comprises of total two semesters.

• Semester I includes four theory papers (3 Hard Core and 1 Soft Core) and practical course as per theory papers.

• Semester II & III includes four theory papers (2 Hard Core, 1 Soft Core and 1 Open Elective) and practical course as per theory papers.

• Semester IV includes four theory papers (3 Hard Core and 1 Soft Core) and a Major project substituting the practical course
• Each theory paper comprising of 5 units which are distributed in total 60 lecture hours having weightage of 4 credits.

• Practical papers are to be conducted at the end of their respective semester.

• Final year Major project work should begin in III semester and the completed thesis should be submitted at the end of the IV semester.

• Student would have to present his/her project work during the project report submission which would be evaluated by the internal as well as the external examiners.

• As per the credit system, the assessment of Theory paper of 100 marks weightage will be as: 70 marks theory assessment by University examination (UA) and 30 marks internal assessment by the college (CA). For internal assessment of candidate, periodical tests/seminars/ viva/oral / quiz etc. may be suitably adopted.

• As per the credit system, the assessment of practical paper of 100 marks weightage will be as: 70 marks practical assessment by University examination (UA) and 30 marks internal assessment by the college (CA).

• In each semester students has to give compulsorily 16 tutorials (4 tutorials per theory paper) with weightage of 25 marks (1 credit)

M.Sc.II (Sem. III&IV)

The internal assessment will be based on Unit tests, Home assignment, viva, practical, Project Work etc as given below. Practical examination of 200 marks for 4 practical courses shall be conducted at the end of III rd & IVth semester. The practical examination of 200 marks shall consist of 140 marks for University practical assessment and 60 marks for college internal assessment for each semester.

For University practical examination, there shall be appointment of four examiners two examiners shall be external and two shall be internal appointed by the University. The internal practical assessment shall be done as per scheme given below.

5. Scheme of evaluation:

As per the norms of the Credit System of evaluation, out of 100 Marks, the candidates have to appear for College internal assessment of 30 marks and external evaluation (University Assessment) of 70 marks. Assessment scheme is given below.

Semester - III: Theory: (100 marks)
University Examination (70 Marks): Number of Theory papers: 4 Papers, out of which Three papers MIC 301 MIC 302 MIC 303 are compulsory & paper no four (MIC 304) is Choice Based.

Internal Continuous Assessment (30 Marks):
Scheme of Marking: 20 Marks: Internal Test
10 Marks: Home assignment/Tutorials / Group discussion/ Viva/Field visit./

Seminar: 25 Marks

Semester - IV:
Theory: (100 marks)
University Examination (70 Marks): Number of Theory papers: 4, out of which Three papers MIC 401 MIC 402 MIC 403 are compulsory & paper no four (MIC 404) is Choice Based.

Internal Continuous Assessment (30 Marks):
Scheme of Marking: 20 Marks: Internal Test
10 Marks: Home assignment/Tutorials/ Group discussion/ Viva/ Field visit.

Practical Examination: University Examination (200 Marks):
No of Practical courses: 4 Practicals each course with 50 marks
The university practical examination shall be of four days per batch per semester (at least of five hours duration each day. Each candidate must produce a certificate from the Head of the Department in his/her college, stating that he/she has completed, in a satisfactory manner, a practical course on the lines laid down from time to time by Academic Council on the recommendations of Board of Studies and that the laboratory journals have been properly maintained. Every candidate must have recorded his/her observations in the laboratory journal and a written report on each exercise performed. Every journal is to be checked and signed periodically by a member of teaching staff and certified by the Head of the Department at the end of each semester. Candidates are to produce their journals at the time of semester practical examination. There shall be 20 (Twenty) marks for each journal of semesters I, II, III each and 10 (Ten) marks for journal of semester IV. Students shall have to undertake an academic tour for the period of 5 to 8 days to visit places of academic interest like industries, research institutions, R & D departments during semesters II and IV each. The students should submit the tour report at the time of practical examination. The tour report should be duly certified by Head of the department. There shall be 10 (Ten) marks for the tour report.
Internal Continuous Assessment (60 Marks): Internal Test on any four practical, 30 Marks.
Viva, attendance, attitude tour report etc. 30 Marks

4. Project Work*/Industrial Training** (50 Marks)

The overall structure of the course to be implemented from 2017 onwards is as follow

<table>
<thead>
<tr>
<th>Semister III</th>
<th>M.Sc. MICROBIOLOGY.C B C S w.e.f.2017-18 (REVISED)</th>
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<tbody>
<tr>
<td>Code</td>
<td>Title of the Paper</td>
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<tr>
<td>MSc II</td>
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<tr>
<td>HCT3.1</td>
<td>Molecular Biology and Genetic Engineering</td>
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<tr>
<td>HCT3.2</td>
<td>Bioprocess Technology and Fermentation Technology</td>
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<tr>
<td>Soft Core (Any one)</td>
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<tr>
<td>SCT3.3A</td>
<td>Immunology and Immunotechnology</td>
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<tr>
<td>SCT3.3 B</td>
<td>Bioenergetics and Molecular Enzymology</td>
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<td>Open Elective (Anyone)</td>
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<tr>
<td>OET3.4A</td>
<td>Agricultural Microbiology</td>
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<tr>
<td>OET3.4B</td>
<td>Environment and Waste Management Technology</td>
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<tr>
<td>HCT4.1</td>
<td>Pharmaceutical Microbiology</td>
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<td>HCT4.2</td>
<td>Food and Dairy Microbiology</td>
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<tr>
<td>HCT4.3</td>
<td>Principles of Bioinstrumentation and Techniques</td>
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<td>Soft Core (Any one)</td>
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<td>SCT4.1A</td>
<td>Health care and Diagnostic Microbiology</td>
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<tr>
<td>SCTI4.1B</td>
<td>Recombinant DNA Technology</td>
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<td>Practical</td>
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<td>Practical Course for HCT4.1,4.2,4.3</td>
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<td>Practical Course on SCT4.1A</td>
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<td>Project/In plant training</td>
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<td>Total for I,II, III IV Semester</td>
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M.Sc. MICROBIOLOGY (SEM.III) (CBCS)

HCT 301: Molecular Biology and Genetic Engineering

UNIT – I 10L

1. **Methods of studying DNA:** Southern blotting, Northern blotting, labeling- radioactive and non-radioactive labeling, and Isopycnic separation.

2. **DNA sequencing:** Direct sequencing, indirect sequencing, Maxam and Gilbert method, Sanger’s Method, RNA sequencing, PCR sequencing.

3. **Nucleic acid hybridization:** Design and construction of probes, nick translation, chemical synthesis, hybridization, liquid hybridization, solid hybridization, determination of stringency conditions. Applications of nucleic acid hybridization.

UNIT – II 10L

1. **Mutations** – Nature and types, mutagenic agents- physical, chemical and biological. Phage mediated mutagenesis, site directed mutagenesis. Fluctuation test and replica plate technique, isolation of mutants, mutagenecity and carcinogenecity testing (Ames test, inductive test and muta test).

2. **Gene transfer in bacteria** transformation, transduction, conjugation, transfection, protoplast fusion, electroporation, restriction and modification of DNA, recombination enzymes involved.

UNIT-III 10L

1. Molecular biology of Oncogenesis, Neoplastic transformation, theories of Oncogenesis


3. Law of DNA constancy and redundancy, dosage compensation, genetic load, C-value paradox, Cot curves and DNA reassociation constant.

UNIT – IV 10L

**General Strategy of gene cloning**

1. Vectors in Genetic engineering

a. **Plasmid vectors** – Use of natural plasmids as vectors, artificial plasmid vectors, pSC101, R1, pBR322, pUC18, Ti plasmid vectors.

B. **Bacteriophage vectors** – Insertion vectors, replacement vectors, Cosmid vectors, phagemid vectors, shuttle vectors, M13 based vectors.

2. **Restriction endonucleases** – Type I, II and III, restriction mapping, RFLP and RAPD
3. Constructions of recombinant DNA- selection of DNA fragment for cloning, cDNA synthesis, chemical synthesis, gene synthesizers, ligation with RES, homopolymer tailing, blunt end ligation, linkers, monitoring restriction and ligation.

4. Insertion of recombinant DNA – Host selection, transformation, transfection electroporation, lipofection

5. Screening of recombinants

6. DNA libraries – Genome libraries and cDNA libraries.

UNIT V

Protein engineering & metabolic engineering:
Metabolic engineering-Essence of metabolic engineering, examples of pathway manipulations, metabolic engineering in practice, metabolic flux analysis and its applications, synthesis low molecular weight compounds

2. Applications of Genetic engineering & legal aspects in genetic engineering.

References:
HCT 302: Bioprocess technology and Fermentation Technology

Unit-I 10L

1. **Bioreactor Design and Operation.**
   a) Design aspects, the dimensional ratio of the outer shell and operational aspects such as working volume, baffles and impellers. The configuration (placement) of impellers in vessel and different types of impellers.
   b) Different types of fermenters.
   c) Facilitation for maintaining all parameters during fermentation. Aeration, Agitation.
   d) Sterilization of fermenter and other mechanical system of fermentor

2. **Monitoring of process variables.**
   a) Fermentation broth rheology and power requirement for agitation. Concept of Newtonian and Non-Newtonian fluids, effect of broth rheology on heat, nutrient and oxygen transfer, Reynolds number, power number, Aeration number, working out examples with different softwares.
   b) Use of various types of sensors and biosensors for maintaining environmental parameter (pressure, pH, temperature, DO, DCO2)
   c) Operational modes bioreactor, batch, feed batch, continuous.
   d) Automation in fermentation industry.

Unit-II 10 L

1. **Growth and product formation concept during fermentation.**
   a) Concept of primary and secondary metabolites and their control, kinetics of growth and product formation.
   b) Control of metabolic pathways, environmental and genetic control.
   c) Effect of type of growth on fermentation.
   d) Mycelial pellet form, mycelial filamentous form, free cells, cell producing exopolymers, affects mass transfer of nutrients, oxygen and heat: as cell proliferation.
2. Development of microbial processing.
a) Fermentation media and microbial growth, media composition, types of media, sterilization of media, screening of media
b) Growth & development of microorganisms, synchronous and synchronized, growth yield, effect of limiting factors.
c) Screening, strain improvement, scale up, inoculums preparation, stock culture maintenance, contamination problems

Unit-III

Downstream processing and Quality control.
a) Product recovery and purification. Centrifugation, Filtration, Precipitation, Solvent extraction, Chromatography, Ultra Filtration, Crystallization and whole broth processing.
b) Quality control in fermentation industry. Assay testing, Sterility testing, Pyrogenicity testing, Toxicity and Allergy, Carcinogenicity testing.

Unit-IV

Industrial production of:
1) Streptomycin, Amylase, Vitamin B12, L-Lysine,
2) Microbial transformation of antibiotics and steroids.
3) Microbial production of nucleosides, nucleotides, pigments.
4) Production and applications of biopolymers, Xanthan gum, dextran, pullulan, mannan, curdlan and Alginate.
5) Production of Mushroom, production steps, harvesting and preservation, nutritive value
6) Industrial production of distilled alcoholic beverages. Whisky and Brandy.

Unit-V

Biosafety, Bioethics and IPR
a) Guidelines for safety in microbiological processes, Good manufacturing practices, biosafety levels of infectious agents.
b) Regulatory practices, process validation, Quality assurance.
c) Bioethics: concept, case study, stem cells, GM foods and Nanobiotechnology.
References:
2. Fermentations - A practical approach. IRL.
5. Biotechnology - A Text Book of Industrial Microbiology by Cruger.
6. Fermentation Biotechnology: Industrial Perspectives by Chand.
11. Applied Microbiology Series.
12. Industrial Microbiology by L.E. Casida, Wiley Eastern

SCT 303: SCT A: Immunonology & Immunotechnolgy

UNIT – I

1. Immunity: Innate and acquired immunity, Cells of immune response, Structure, types and functions of lymphoid organs, lymphatic system

2. Biology of immune cells:B cells – development, maturation and their surface molecules, T cell structure, development, maturation, and differentiation and their surface molecules, Subsets of T-cells. NK cells, Antigen presenting cells,
3. Clinical Immunology

Immune response to infectious diseases, viral, bacterial, protozoan and parasitic infections, Immunodeficiency disorders – Phagocytic deficiencies, humoral deficiencies, cell mediated deficiencies and combined deficiencies, complement deficiencies, Autoimmunity, Rheumatic diseases: Systemic lupus erythematosus, Rheumatoid arthritis, Multiple myeloma.

UNIT – II

1. Major histocompatibility systems:
The H2 and HLA complex, H-2 haplotypes of mouse strains, MHC and antigen presentation, structure of class I and class II molecules, polymorphism of MHC molecules, MHC and disease association, methods of HLA typing.

2. Cytokines:
Cytokines – general properties, structure and function (Tumor Necrosis Factor, Interleukins, Interferon etc.), cytokines in disease, immunoregulatory role of cytokines.

UNIT – III

1. T-Cell Receptor
Structure and function of T cell receptor (TCR), T cell accessory membrane molecules (CD and adhesion molecules), and signal transduction by TCR/CD3.

2. Regulation of Immune Response:
Antigen as regulatory mechanism, network theory, internal images and anti-images, role of cytokines in regulation of immune response, mechanism of tolerance induction, regulation of complement system, Immunomodulation – by Biological Response Modifiers (BRMs) and by cytokines


UNIT – IV

Experimental Immunology
In vitro systems- Principles and kinetics of antigen antibody reactions, detection and quantitation of cytokines, FACS, western blotting, cell culture systems, haemolytic plaque
assay. In vivo systems – Experimental animals in immunology research, models for autoimmunity and other immunopathological conditions. Experimental systems for: Cell mediated immune responses, Transplantation and adoptive transfer, Cell to cell interactions, Functional assays of cytokines.

UNIT – V

1. **Immune system evolution:** Evolution of immune system in invertebrates and vertebrates, occurrence of immune system components in invertebrate and vertebrates, evolution of immunoglobulin heavy and light chain classes and subclass.

2. **Tumor Immunology:** Cellular adaptations and properties of cancer cells, escape mechanisms of tumor from host defense, immune response to tumor – role of cells of immune system, Immunosurveillance theory, tumor antigens, cancer immunotherapy, immuno-diagnosis of tumors (detection of tumor markers, e.g. alpha fetoprotein, carcino-embryonic antigen etc.)

**References:**

**SCT 303 B. Bioenergetics and Molecular Enzymology**

**Unit : I**

Carbohydrate catabolic pathways and microbial growth on C1 Compounds EMP, HMP,

**Unit :II**

Bacterial fermentations (biochemical aspects) and Biosynthesis Alcohol, lactate, mixed acid, butyric acid, acetone-butanol, propionic acid, succinate, methane, and acetate fermentations. Fermentation of single nitrogenous compounds [amino acids] – alanine, glutamate and glycine. Biosynthesis of Purines, Pyrimidines and fatty acids.

**Unit:III**

Endogenous metabolism and degradation of aliphatic and aromatic compounds. Functions of endogenous metabolism, types of reserve materials, enzymatic synthesis, degradation and regulation of reserve materials - glycogen, polyphosphates and polyhydroxybutyrate (PHB), PHB production and its futuristic applications. Microbial degradation of aliphatic hydrocarbons (microorganisms involved, mon-terminal, biterminal oxidation of propane, decane, etc.) and aromatic hydrocarbons and aromatic compounds (via catechol, protocatechuate, meta-cleavage of catechol and protocatechuate, dissimilation of catechol and protocatechuate, homogentisate and other related pathways).

**Unit :IV**


**Unit :V**

Enzyme kinetics Importance of enzyme kinetics, factors affecting rates of enzyme mediated reactions (pH, temperature, substrate concentration, enzyme concentration and reaction time). Derivation of Michaelis - Menton equation and its significance in enzyme kinetic studies. Lineweaver-Burke plot, Haldane-Briggs relationship, sigmoidal kinetics steady state kinetics and transient phases of enzyme reaction.
References:
1. Understanding Enzymes by Trevor Palmer
5. Laboratory techniques in Biochemistry and Molecular Biology by Work and Work.
8. Biochemistry by Chatwal
9. Methods in Enzymology by Drolittle
10. Biochemistry by Garrett
14. Understanding Enzymes by Trevor Palmer
17. Understanding Enzymes by Trevor Palmer

OET 3.4: A: Agricultural Microbiology

UNIT –I 10L
Soil environment: Physicochemical and biological properties of soil, soil microorganisms, soil enzymes, organic matter decomposition, microorganisms and soil fertility, biogeochemical cycles-C, N, S and P. Methods used in soil chemistry and microbiological studies, microbial products influencing plant growth

UNIT –II 10L
Rhizosphere and Phyllosphere – Rhizospheric effect, nitrogen fixation in rhizosphere, root exudates, influence of rhizosphere on crop productivity, biological control within microbial communities of the rhizosphere, plant growth promoting rhizobacteria, siderophores, role
of antibiotics and siderophore in biocontrol of plant pathogens, phyllosphere and microorganisms. 

Frankia Induced Nodulation in Actinorrhizal Plants, Rhizobium-cultivated and wild legume plant root nodulation and significance

UNIT –III  

Recycling of Agriculture and animal waste
Composting - different methods, anaerobic digestion, merits and the demerits of the processes, saccharification of cellulosic wastes

2) Plant Tissue Culture – Types, formulation of growth media, techniques and applications.

UNIT –IV  

Biofertilizers
1. Historical development, concept, scope, merits and limitations of Biofertilize Systematic study of major groups of microorganisms as biofertilizers, Nitrogen fixing bacteria, Phosphate solubilizing microbes, blue green algae and mycorrhizae.
2. Production of biofertilizers, screening, selection of potential strains Laboratory and large scale production of bacterial, algal and fungal biofertilizers
3. Methods of application and evaluation of biofertilizers.

UNIT –V  

BIOPESTICIDES
1. Biological control, its importance in crop pests and disease management, merits and demerits of biological control, history, distribution of biopesticides, role and status of biopesticides in pest control.
2. Pest control for crop protection by using biocontrol agents like bacteria (spore formers and non-spore formers) with special reference to B.thuringiensis and B. sphericus, mosquito control by fungi (culcinomyces, langenidium and coelomomyces), NPV of Heliothis sp.
3. Toxin produced by bacteria and fungi, their chemistry, mode of action, pest control and safety.
4. Commercial production of B.thuringiensis, NPV, fungal pathogens, their formulations and applications.
7. Biopesticides, their use and significance in the developing era of ecological approaches of insect control and plant protection.

**REFERENCES**
4. Rangaswamy and Bagyraj. Agriculture Microbiology.
5. Smith S E and Read D J. Mycorhizal symbiosis. 2nd Ed.
11. Burges H D: Microbial Control of Pests and Plant Disease
13. Soil and soil microorganisms – Subbarao

**OET 3.4 B: Environment and Waste Management Technology**

**UNIT –I**


2. **Eutrophication Water pollution and its control:** Need for water management. Sources of water pollution. Measurement of water pollution, Eutrophication: Definition, causes of eutrophication, and microbial changes in eutrophic bodies of water induced by various inorganic pollutants. Effects of eutrophication on the quality of water environment, factors influencing eutrophication. Qualitative characteristics and properties of eutrophic lakes. Measurement of
degree of eutrophication. Algae in eutrophication, algal blooms, their effects and toxicity, coloured waters, red tides, and cultural eutrophication

UNIT –II

2. Microbiology and biochemistry of waste water treatment:
   a. Introduction, types of biological treatments, impact of pollutants on bio- treatment, bio-augmentation, basic concepts of waste water treatment
   b. Microorganisms in waste water treatment: source of organisms, enrichment and acclimatization, isolation, treatability tests, mass scale production, mixed cultures.
   c. genetically engineered microorganisms, preservation, applications and future prospects

UNIT –III
Working of treatment systems and their analysis:
   a. Reaction and kinetics, mass balance analysis, reactor types, hydraulic characters of reactor, selection of reactor type
   b. Critical operation parameters like DO, HRT, Mean Cell Residence Time (MCRT), F/M ratio, tank volume, flow rate, BOD, COD, temperature. Malfunctioning of treatment systems due to shock loading, hydraulic loading and remedial measures adapted.

UNIT –IV
1. Waste disposal control and regulations:
   a. Water pollution control, regulation and limits for disposal into Lakes, rivers, oceans and land.
   b. Environmental Impact Assessment (EIA), Environmental Audit (EA)

UNIT –V
1. Novel Methods of Pollution Control : Vermicomposting, treatment using aquatic plants, root zone process
2. Eutrophication, El Nino, global warming, acid rains and significance
3. Enzymes and Pollution – Monooxingenases, aminotransferases, bioenergetic enzymes, other metabolic enzymes, enzymatic Rectifications.

REFERENCES:
3. Industrial pollution Control, Vol. 1, E. Joe, Middle Brooks.
6. Treatment of Industrial Effluents- A.G. callely, C.F. Foster and D.A. Stafford

Practical Course HCP 3.1  
50 MARKS
Practicals based on HCT 301: Molecular Biology and Genetic Engineering
1. Detection of polygene chromosomes chromosomal bands in chironomonas larval salivary gland cells
2. Determination of Genetic transformation in Bacteria
3. Study of transformation, transfection, conjugation, transduction, electroporation and protoplast fusion in bacteria
4. Isolation of restriction endonucleases from bacteria
5. Estimation of mutation rate in bacteria, site directed mutagenesis
6. Fluctuation test
7. Isolation of thiamine requiring mutants of E.coli using replica plate technique

Practical Course HCP 3.2  
50 marks
(Based on Bioprocess technology and Fermentation Technology)
1. Bioassy of streptomycin, lovastatin Chloramphenicol and dounurubicin by plate assay method or turbidimetric assay method
2. Treatment of bacterial cells with cetrimide, phenol and detection of Leaky substances such as potassium ions, aminoacids, purines, pyrimidines and pentoses due to cytoplasmic membrane damage.
3. To determine MIC, LD_{50} of Beta-lactum/aminoglycoside/tetracycline/ansamycins
4. Sterility testing by Bacillus stearothermophilus.
Practical Course SCP 3.1 Based on SCT 303 A: 50 marks
1. Antibiotic sensitivity tests by Kirby-Bauer method.
2. Antibiotic sensitivity tests by Stocks comparative diffusion method
3. Determination of MIC (Minimal inhibitory concentration) by tube, disc and plate method.
4. Isolation and Identification of pathogen belonging to Enterobacteriaceae at species level
5. Demonstration on animal inoculation by various routes.

Practical Course SCP 3.2 (Practicals based on SCT 303 B): 50 marks
1. Isolation and Identification of Reserve food material (Glycogen / polyphosphates, PHB) of B. megaterium and Azotobacter SP.
2. Quantitative estimation of amino acids by Rosen’s method.
4. Demonstration of endogenous metabolism in B megaterium or E. coli and their survival under starvation conditions
6. Production of fungal alpha amylase using solid-state fermentation/ production of protease by bacterial species and confirmation by determining the achromatic point.
7. Purification of fungal alpha-amylase or bacterial protease by fractionation, chromatographic techniques and electrophoretic separation.
8. Studies on enzyme kinetics of alpha amylase/Protease [Optimization of parameters viz. Substrate, enzyme concentration, reaction temperature, reaction pH, Km, Vmax and metal ions as activators and inhibitors).

Practical Course OEP 3.1(Practicals based on OET 303 A): 50 marks
1. Detection of IAA by Azospirillium / Pseudomonas.
2. Detection of siderophore production by Pseudomonas.
3. Laboratory production of Bacillus thuringiensis Insecticide and testing of its efficiency.
5. Production of biogas by using different Agricultural wastes and testing of its efficiency.
6. Enrichment, acclimatization and Isolation of organisms from wastes containing recalcitrant, xenobiotic compounds.
7. Preparation of Activated Sludge.
8. Biofuel energy—electricity

**Practical Course OEP 3.1 (Practicals based on OET 303 B): 50 marks**

1. Physical analysis of sewage/industrial effluent by measuring total solids, total dissolved solids and total suspended solids.

2. Determination of indices of pollution by measuring BOD/COD of different effluents.

3. Bacterial reduction of nitrate from ground waters

4. Isolation and purification of degradative plasmid of microbes growing in polluted environments.

5. Recovery of toxic metal ions of an industrial effluent by immobilized cells.

6. Utilization of microbial consortium for the treatment of solid waste [Municipal Solid Waste].

7. Biotransformation of toxic chromium (+6) into non-toxic (+3) by Pseudomonas species.

8. Tests for the microbial degradation products of aromatic hydrocarbons/ aromatic compounds

9. Reduction of distillery spent wash (or any other industrial effluent) BOD by bacterial cultures.

10. Microbial dye decolourization/adsorption.
HCT4.1. Pharmaceutical Microbiology

Unit – I

Antibiotic and Synthetic Antimicrobial Agents
Antibiotics and synthetic antimicrobial agents (Aminoglycosides, β lactams, tetracyclines, ansamycins, macrolid antibiotics) Antifungal antibiotics, antitumor substances Peptide antibiotics, Chloramphenicol, Sulphonamides and Quinolinone antimicrobial agents. Chemical disinfectants, antiseptics and preservatives

Unit – II

Mechanism of Action of Antibiotics:
Mechanism of action of antibiotics (inhibitors of cell wall synthesis, nucleic acid and protein synthesis) Molecular Principles of drug targeting Drug delivery system in gene therapy Bacterial resistance to antibiotics Mode of action of bacterial killing by Quinolinone Bacterial resistance to Quinolinone Mode of action of non-antibiotics antimicrobial agents Penetrating defenses- How the antimicrobial agents reach the targets (cellular permeability barrier, cellular transport system and drug diffusion).

Unit – III

Microbial Production and Spoilage of Pharmaceutical Products
Microbial contamination and spoilage of pharmaceutical products (sterile injectibles, non injectibles, ophthalmic preparations and implants) and their sterilization Manufacturing procedures and in process control of pharmaceuticals Other pharmaceuticals produced by microbial fermentations (streptokinase, streptodornase). New vaccine technology, DNA vaccines, synthetic peptide vaccines, multivalent subunit vaccines. Vaccine clinical trials.

Unit –IV

Regulatory Practices, Biosensors and Applications in Pharmaceuticals
Unit –V

Quality Assurance and Validation

Good Manufacturing Practices (GMP) and Good Laboratory Practices (GLP) in pharmaceutical industry Regulatory aspects of quality control. Quality assurance and quality management in pharmaceuticals ISO, WHO and US certification.

Sterilization control and sterility testing (heat sterilization, D value, Z value, survival curve, Radiation, gaseous and filter sterilization) Chemical and biological indicators.

Design and layout of sterile product manufacturing unit (Designing of Microbiology laboratory)

Safety in Microbiology laboratory

References

2. Analytical Microbiology – Edt. By Frederick Kavanagh Volume I and II.
HCT4.2  Food and Dairy Microbiology

Unit-I 10L
1. General principles underlying spoilage of foods & Food as substrates for microorganisms.
2. Microbiology and food spoilage: Microbiology and spoilage of i) meat and meat products, ii) fish and poultry, iii) fruits and vegetables, iv) sugar and sugar products, and canned foods.
3. Microbial food poisoning and infections, investigation of food born outbreaks, prevention and control

Unit-II 10L
1. General principles underlying food preservation and different methods of food preservation, process of canning.
2. Microbial flavors in food and dairy industry.

Unit-III 10L
1. Microbiology of Milk and milk products: Composition and nutritive value of milk.
2. Spoilage of milk and milk products: Khoa, paneer, cream, basundi, ice creams,

Unit-IV 10L
1. Fermented milk products: Types, Production and Defects in: a) Cultured butter milk, dahi, butter and cheese, paneer, chakka, shrikhand, creams, basundi and ice creams b) Kefir, kumiss, yoghurt, Bulgarian sour milk,
2. Fermented food products Types, Production and Defects in: a) Jilebi, punjabi warri, dhokla, b) lime and mango pickles.

Unit-V 10L
1. Chemical and microbiological examination of food & milk, grading of food & milk.
2. Food adulterations and contaminations of foods with harmful microorganisms.
3. Food laws and standards, Indian and international food safety laws andstandards.
BIS Laboratory Services, BIS product certification and licensing, BIS Quality Systems certification.

4. Quality and safety assurance in food and dairy industry, Sanitation and regulation in food and dairy industry, food and dairy arithmetic standardization of products & costing.

REFERENCES:

4) Food Microbiology: Frazier.
5) Food Microbiology: James De and De.

HCT4.3. Bioinstrumentation: Techniques and Applications 50 Lectures

UNIT I: 10 L

UNIT II: 10 L
Principle Methodology and applications: Gel filtration, ion exchange and affinity chromatography, Thin layer and gas chromatography, High performance liquid chromatography, FPLC, Centrifugation: Basic principal and application, differential – density gradient and ultra centrifugation.

UNIT III: 10 L
Principle of biophysical method for analyzing biopolymer structure: X ray diffraction Fluorescence, UV ORD/CD Visible IR, NMR and ESR spectroscopy, Atomic absorption and plasma emission spectroscopy, MS and MALDI –TOF 15 Lectures

UNIT IV: 10 L
Electrophoresis, Principle and application of Native, SDS Agarose and 2D gel Electrophoresis. Blotting techniques – Southern blotting, Northern blotting, Western blotting.
UNIT V:  


Electron microscopy: Basic components of electron microscopes. Thermionic and field emission electron guns. Types of electron microscopes: TEM, SEM, STEM, ESEM and HVEM

Preparation of biological samples for light and electron microscopy: Sectioning, maceration, squash and clearing technique. Freeze etching and freeze fracturing.

Stains for light and electron microscopy.:Staining procedures and Photomicrography

References:

1. Shrama BK, Instrumental method of chemical analysis
2. DA Skoog. Instrumental methods of analysis
3. Plummer, An introduction to practical Biochemistry
4. Chatwal and Anand, Instrumentation Boyer, Modern experimental Biology
5. Biochemistry by Lubert Stryer
6. Plummer, An introduction to practical Biochemistry
7. Boyer, Modern experimental Biology
12. Introduction to Protein Structure – Branden and Tooze, Garland Publishing Co

SCT4.1A: Health Care and Diagnostic Microbiology

UNIT – I

1. Determinants of microbial pathogenicity

Infection, Transmission of infection, infection process, Bacterial pathogenicity, Regulation of bacterial virulence factors, Bacterial virulence factors.
2. **Virulence factors**: mechanisms of adhesion, colonization and invasion of host tissues by bacterial pathogens

Microbial toxins: Mode of action and assay (in vivo and in vitro) of diphtheria, cholera, tetanus toxins and endotoxins of gram negative bacteria

Mechanism of bacterial resistance to host and humoral defenses

**UNIT – II**

1. **Microbiology of pharmacological industries**

Study of major group of Pharmacologically active molecules of plant, animal and microbial origins

Physical and Chemical properties, metabolic activity, identification of drug target / receptors, elucidation of the mechanisms of drug action, Drug interactions, toxicity and adverse reactions, toxicity testing, assays for mutagenicity, carcinogenicity, pyrogenicity and allergy testing, Extraction, Purification and Characterization of bioactive molecules

1) Extraction: Hot and cold extraction methods, solvent extraction
2) Purification: Analytical and preparative techniques
3) Characterization: Physical and chemical characterization methods for alkaloids, steroids, flavanoids, terpenoids, saponins, proteins peptides and amino acids etc. Steps towards commercialization of a drug, Regulation of drugs, FDA.

**UNIT – III**

1. **Antimicrobial agents and chemotherapy**

1. Antimicrobial assays in liquid media - factors affecting assay techniques
2. Antimicrobial assays in agar media - gradient plate technique, disc/well diffusion techniques, and factors affecting diffusion tests.
3. Susceptibility testing for anti-mycobacterials, anti-fungal, anti-parasitic, antiviral agents.
4. Laboratory evaluation of new antibiotics:
   a) In vitro screening, experimental animal infection, animal models for activity.
   b) Toxicity, tolerability, carcinogenecity, teratogenecity, and allergy testing.
5. Correlation between in vitro and in vivo sensitivity testing and clinical outcome

6. Lines of evidence to indicate the target of antimicrobial agents, methods for study of the mode of action and resistance to antimicrobial agents:

UNIT-IV

10L

1. Mechanism of action of antibiotics

a) Affecting cell wall: Cycloserine, Vancomycin, Cerulenin, beta-lactams.
b) Affecting cell membrane: Polymyxins, Valinomycins, Monesin
c) Inhibitors of Nucleic acid and synthesis: Azaserine, DON, Bleomycin, Mitomycin C, Acridines, Chloroquin, Hydrophenyl azopyrimidine, Nalidixic acid
d) Inhibitors of protein synthesis - Chloromaphenicol, Erythromycin, Fusidic acid, Cycloheximide.
e) Synthetic antimicrobials: Nitrofurans, INH
f) Antifungal agents
g) Antiviral agents
h) Antiprotozoal agents

UNIT V 10L

1. Methods used in Diagnostic Microbiology

Use of various Antigen-antibody detection methods/technologies used in medical diagnostics – Agglutination, Precipitation, Complement fixation test (CFT), PCR, real-time PCR, PCR Sequencing, Enzyme Linked Immunosorbant Assay (ELISA), Radioimmunoassay (RIA), Florescence In Situ Hybridization (FISH), Immunohistochemistry (IHC), Flow cytometry

2. Quality control in Microbiology laboratory

Role of microbiology laboratory, Specimen handling, laboratory records, safety regulation, basic procedure of diagnostic microbiology laboratory, Rapid methods for identification of microorganisms, Principles, working and applications of instruments in medical microbiology.

References


10. Salyers AA, Whitte DD, Bacterial Pathogenesis, 2nd Ed. American Society

**SCT 4.1 B Recombinant DNA Technology**

**Unit :I**

Techniques and enzymes in genetic recombination Core techniques and essential enzymes used in recombination: restriction endonucleases, type I, II, III, recognition sequences, properties, nomenclature, classification of type II endonucleases, their activity. DNA ligase: Properties and specificity, S1 nuclease, BAL 31 nuclease, DNA polymerase, polynucleotide kinase, phosphatase, reverse transcriptase its activity and mode of action. Chemical synthesis of DNA. Restriction digestion, ligation and transformation.

**Unit: II**

10L

**Unit- III**

Specialized cloning strategies Expression vectors, promoter probe vectors, vectors for library construction, genomic DNA libraries, chromosome walking and jumping, cDNA libraries, short gun cloning, directed cloning, phage display. Recombinant DNA technology with reference to cloning and production of interferon and insulin. Miscellaneous applications of Genetically engineered micro organisms (GEMS) / genetically modified organisms (GMO’s).

**Unit :IV**

PCR methods and Applications PCR methods and Applications DNA sequencing methods, Dideoxy and Chemical method. Sequence assembly. Automated sequencing.

**Unit:V**

Molecular mapping of genome Genetic and physical maps, physical mapping and map – based cloning, choice of mapping population, simple sequence repeat loci, southern and fluorescence in situ hybridization for genome analysis, Chromosome microdissection and microcloning, molecular markers in genome analysis: RFLP, RAPD and AFLP analysis, molecular markers linked to disease resistance genes, Application of RFLP in forensic, disease prognosis, genetic counseling, pedigree, varietal etc. animal trafficking and poaching: Germplasm maintenance, taxonomy and Biodiversity.

**References**

10. From genes to clones by Winnaker.

**HCP 4.1, 4.2, 4.3 Practical Course for HCT4.1, 4.2, 4.3**

**HCP 4.1 on HCT4.1: Pharmaceutical Microbiology**

1. Spectrophotometric / Microbiological methods for the determination of Griseofulvin.
2. Bioassay of Chloramphenicol by plate assay method or turbidiometric assay method.
3. Treatment of bacterial cells with cetrimide, phenol and detection of Leaky substances such as potassium ions, aminoacids, purines, pyrimidines and pentoses due to cytoplasmic membrane damage.
4. To determine MIC, LD$_{50}$ of Beta-lactum/aminoglycoside/tetracycline/ansamycins
5. Sterility testing by Bacillus stearothermophilus
6. Sampling of pharmaceuticals for microbial contamination and load (syrups, suspensions, creams and ointments, ophthmalic preparations).
7. Determination of D value, Z value for heat sterilization in pharmaceuticals. Determination of antimicrobial activity of a chemical compound (Phenol, resorcinol, thymol, formaldehyde) to that of phenol under standardized experimental conditions

**HCP 4.2 on HCT4.2: Food and Dairy Microbiology.**

1. Detection of adulteration in common foods
2. Detection of afla toxin in food and feed.
3. Chemical analysis of foods-pH, benzoate, sorbates and colour.


5. Physical analysis - sp. gravity, different solids, tests for grading of milk.

6. Platform tests in dairy industry- COB, alcohol precipitation, titrable acidity test, quantitative phosphatase, mastitis and BRT tests.

7. Production lactose and casein from milk.

8. Microbiology of butter, cheese and idli batter

**HCP 4.3 on HCT4.3. Bioinstrumentation: Techniques and Applications**

1. Chromatographic Separation of amino acids, sugars, dyes, and plant materials using paper by paper Chromatographic techniques

2. Chromatographic Separation of amino acids, sugars, dyes, and plant materials using thin layer Chromatographic techniques.

3. Chromatographic Separation of amino acids, sugars, dyes, and plant materials using column Chromatographic techniques.

4. Electrophoretic separation of proteins and nucleic acids by agarose gel electrophoresis

5. Electrophoretic separation of proteins and nucleic acids by polyacrylamide gel electrophoresis.

6. Electrophoresis of polysaccharide and glycoprotein, lipoproteins etc.

7. Studies on the principles of light spectroscopy – Beer and Lambert’s laws, extinction coefficient and molar extinction coefficient.

8. UV – visible spectrophotometry & atomic absorption spectroscopy.

9. Immunochemical techniques: Immunodiffusion, immunoelectrophoresis, radioimmunoassay, enzyme linked immunosorbent assay, immunoblotting, immunohistochemistry

**SCP1.1 Practical Course on SCT4.1 A 50 marks**

**Health Care and Diagnostic Microbiology**

1. T and B rosette tests

2. Isolation and cultivation of lymphocytes.
3. Animal tissues organ explants.
4. Studies on immunomodulation potential of plant material
5. Complement fixation test
6. Precipitation of Immunoglobulin by ammonium sulphate method
7. Serological tests-CRP, RA, ASO, SLE, Coomb’s and Australia antigen test

**SCP1.1B Practical Course on SCT4.1B**

**RECOMBINANT DNA TECHNOLOGY**

1. Isolation of genomic DNA and its confirmation by southern blotting.
2. Isolation of plasmid DNA and its restriction digestion.
3. DNA sequencing by Sangers method / or other method.
4. DNA cloning using plasmid vectors and expression vectors.
5. RFLP analysis.
6. Isolation of poly-A + RNA
7. Amplification of DNA by PCR.

**SCP1.2 Project Work*/Industrial Training** *(In lieu of SCP1.2)*

*Student is to undertake a research project (as part of the semester IV in lieu of practical course which is to be started in the beginning of semester III so as to give enough time for duly completion of project. In the first half of project dissertation, student is to write about scientific writing and presentation including basic concepts of preparation of scientific document, its presentation and publication and in the second half student should prepare dissertation as a report of project in the format of research methodology (Introduction, Aims and Objectives, Material and Methods, Results and Discussions, Conclusion and Bibliography) and the prepared dissertation of the project shall be submitted to the department 10 (ten) days before the commencement of semester IV examination and it is to be produced by the department at the time of semester IV practical examination.

For the research project work out of fifty marks, 35 marks shall be given by university examiners through assessment of dissertation at the time of semester IV practical examination. The remaining 15 marks shall be given by research guide or internal examiner as an internal evaluation during research project work in progress. The method
and process of internal evaluation is to be formulated by the research guide and Department.

**Industrial training cum industrial project**

**The guide of student should locate the industry and depute the student in the industry for the period of one month. Student should complete his/ Her industrial training cum industrial project in the vacation period after semester II Student should study microbiological aspects in industry and submit its report in the form of dissertation dully signed by industry authority, concerned guide and Head of the Department of microbiology.**