Course Title	Course Code	Credit
Introduction to Microbiology and Microbial Diversity	MICUGMCC1101	4 (Theory 3, Practical 1)

Course Objectives
The learning objectives of this course are as follows: • *To know the history and development of Microbiology as a discipline.* • *To know the Systems of classification.* • *To give an idea of the diversity of microbial life with emphasis on how we interact with microbes that are responsible for infections as well as those that do not normally cause disease.* • *To give an idea of general characteristics and economic importance, applications, or harmful effects of diverse microorganisms.*
Course Outcomes
By studying this course • *Students will have complete knowledge of the history of the development of Microbiology as an independent discipline. They will be aware of the diverse scopes of microbiology.* • *Students will learn the systems of classification of diverse microorganisms.* • *They will be able to describe the general characteristics, economic or ecological importance, and harmful effects of different groups of microorganisms.*

Theory

Unit 1 History of Development and Scope of Microbiology

Development of microbiology as a discipline; spontaneous generation vs. Biogenesis. Contributions of Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming. Role of microorganisms in fermentation, germ theory of disease, Development of various microbiological techniques and golden era of microbiology. Development of the field of soil microbiology: Contributions of Martinus W. Beijerinck, Sergei N. Winogradsky, Selman A. Waksman. Establishment of fields of medical microbiology and immunology through the work of Paul Ehrlich, Elie Metchnikoff, Edward Jenner. An overview of Scope of Microbiology.

Unit 2 Diversity of Microbial World

A. Systems of classification

Binomial Nomenclature, Whittaker's five kingdom and Carl Woese's three domain classification systems and their utility. Difference between prokaryotic and eukaryotic microorganisms.

B. General characteristics of different groups:

Acellular microorganisms (Viruses, Viroids, Prions); **Cellular** microorganisms (Bacteria, Algae, Fungi and Protozoa) with emphasis on distribution and occurrence, morphology, mode of reproduction and economic importance.

Algae: General characteristics of algae including occurrence, thallus organization, algal cell ultra-structure, pigments, flagella, eyes potfood reserves and vegetative, asexual and sexual reproduction. Different types of life cycles in algae with suitable examples: Haplobiontic, Haplontic, Diplontic, Diplobiontic and Diplo-haplontic lifecycles. Applications of algae in agriculture, industry, environment and food.

Fungi: General characteristics of fungi including habitat, distribution, nutritional requirements, fungal cell ultrastructure, thallus organization and aggregation, fungal wall structure, asexual reproduction, sexual reproduction, heterokaryosis, heterothallism and parasexual mechanism. Economic importance of fungi with examples in agriculture, environment, Industry, medicine, food, biodeterioration and mycotoxins.

Protozoa: General characteristics with special reference to *Amoeba*, *Paramecium*, *Plasmodium*,

Leishmania and *Giardia*

Practical

1. Microbiology Good Laboratory Practices and Biosafety.
2. To study the principle and applications of important instruments (biological safety cabinets, autoclave, incubator, BOD incubator, hot air oven, light microscope, pH meter) used in the microbiology laboratory.
3. Simple staining and observation of a coccus and bacillus bacteria.
4. Demonstration of the structure of different viruses from photographs.
5. Study of *Rhizopus*, *Penicillium*, *Aspergillus, Puccinia teliospore, Candida albicans* using permanent mounts.
6. Study of *Spirogyra* and *Chlamydomonas*, *Volvox* using permanent mounts.
7. Study of the following protozoans using permanent mounts/photographs: *Amoeba*, *Entamoeba*, *Paramecium* and *Plasmodium*.

Suggested Readings

1. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2019). Brock Biology of Microorganisms. 15th edition. Pearson International Edition
2. Wiley JM, Sherwood LM and Woolverton CJ. (2017) Prescott's Microbiology. 10th Edition. McGraw Hill International.
3. Tortora GJ, Funke BR and Case CL. (2008). Microbiology: An Introduction. 9th edition. Pearson Education
4. Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited

5. Atlas RM. (1997). Principles of Microbiology. 2nd edition. W.M.T. Brown Publishers.

5. Pelczar MJ, Chan ECS and Krieg NR.(1993). Microbiology.5th edition. McGrawHill Book Company.

Course Title	Course Code	Credit
Biomolecules	MICUGMCC1102	4 (Theory 3, Practical 1)

Course Objectives

This course is designed to give the students

- *The understanding of acids, bases and buffers and their relevance in living systems.*
- *The information about the structure and function of various biomolecules such as carbohydrate, protein (including their role as biocatalysts) and nucleic acids.*
- *The knowledge about enzymes and catalysis.*
- *Use of various techniques involved in biochemical analysis.*

Course Outcomes

After completion of the course, a student will be able to achieve these outcomes:

- *The students will learn about the chemical structures of carbohydrates, and their structural and metabolic role in cellular systems.*
- *The students will learn about structure and function of lipids, circulating lipids and inflammatory lipid mediators etc.*
- *They will also learn about primary, secondary, tertiary, quaternary structure of proteins.*
- *The students will understand about the structure and function of nucleosides and nucleotides.*
- *The students will learn about the enzymes and various enzymatic mechanisms in the biological system.*
- *Students will learn the application of various techniques used in biochemical analysis.*

Theory

Unit 1: Water and Buffer

Physical properties of water, structure of water molecules, Ionization of water, Bronsted – Lowry concept of acid and bases, Concept of pH of weak acids and weak bases, Henderson-Hasselbalch equation, concept of buffer, strength of buffer, buffer value, important biological buffers (with the help of numerical problems). Forces involved in biomolecular interactions with examples: Van der Waals interactions, electrostatic interactions, hydrogen bond and hydrophobic interaction.

Unit 2. Stereochemistry

General concepts on: Plane of symmetry, centre and axis of symmetry; Concepts of chirality; optical isomerism; geometrical isomerism; DL, RS nomenclature; Projection formula (Fischer & Howarth); Isomers: anomers, epimers; Stereochemistry of cyclohexane: idea of axial & equatorial bonds (related to chair form conformation). Configuration versus conformation.

Unit 3: Carbohydrates

Structure and Biological importance of Monosaccharides, Disaccharides, Polysaccharides and Glycoconjugates.

Unit 4: Lipids

Structure and Significance: Physiologically important saturated and unsaturated fatty acids, Tri-acylglycerols, Phospholipids, Glycolipids, Steroids

Unit 5: Proteins

Amino acids: Structure, Classification and General Properties of α-amino acids; Physiological importance of essential and non-essential α-amino acids. Proteins: Bonds stabilizing protein structure; Levels of organization in proteins; Denaturation; Introduction to simple and conjugate proteins.

Unit 6: Nucleic Acids

Structure: Purines and pyrimidines, Nucleosides, Nucleotides, Nucleic acids; Cot Curves: Base pairing, Denaturation and Renaturation of DNA. Types of DNA and RNA, Complementarity of DNA, Hypo- Hyperchromaticity of DNA

Unit 7: Enzymes
Nomenclature and classification; Cofactors; Specificity of enzyme action;Isozymes; Mechanism of enzyme action; Enzyme kinetics; Factors affecting rate of enzyme-catalyzed reactions; Derivation of Michaelis-Menten equation, Concept of Km and Vmax, Lineweaver-Burk plot; Multi-substrate reactions; Enzyme inhibition; Allosteric enzymes and their kinetics; Regulation of enzyme action.

Unit 8. Vitamins
Classification and characteristics with suitable examples, sources and importance

Practical

1. Concept of molarity, normality, percentage, dilutions, pH and buffers.
2. Preparation of buffers and Numerical problems to explain the concepts.
3. Qualitative tests of functional groups in carbohydrates, proteins and lipids.
4. Paper chromatography of amino acids.
5. Protein estimation.

Suggested Readings

1. Cox, M.M and Nelson, D.L. (2008). Lehninger's Principles of Biochemistry, VEdition, W.H. Freeman and Co., New York.
2. Berg, J.M., Tymoczko, J.L. and Stryer, L. (2007). Biochemistry, VI Edition,W.H. Freeman and Co., New York.
3. Murray, R.K., Bender, D.A., Botham, K.M., Kennelly, P.J., Rodwell, V.W. and Well, P.A. (2009). Harper's Illustrated Biochemistry, XXVIII Edition,International Edition, The McGraw- Hill Companies Inc.
4. Hames, B.D. and Hooper, N.M. (2000). Instant Notes in Biochemistry, IIEdition, BIOS Scientific Publishers Ltd., U.K.
5. Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R. (2008). Molecular Biology of the Gene, VI Edition, Cold Spring Harbor Lab.Press, Pearson Pub.
6. Voet,D. and Voet J.G (2004) Biochemistry 3rd edition, John Wiley and Sons

Course Title	Course Code	Credit
Biology for Sustainable Development	MICUGSEC1101	3

Course Objectives
The learning objectives of this course are as follows: • This course intends to develop awareness about the importance of sustainable development in the modern world • Implementation and achievement of sustainable development goals • To understand the significance of sustainable development in ecological context • To harness various biological concepts in achieving sustainable development goals
Course Outcomes
By studying this course, students will be able to: • Learn the concept of sustainable development in modern world • Understand the implications of biology in achieving sustainable development goals • Traditional and modern techniques in organic farming, soil and water conservation • Recent developments on biodegradable and bio-based alternatives for commercial use • Understanding the concepts of bioenergy and its potential • Implications of biowaste and recycle management for sustainable development

Unit 1: Sustainable development: Concept of sustainable development; Brief introduction to sustainable development goals; Role of Biology in sustainable development.

Unit 2: Organic farming: Green manuring and organic fertilizers, Recycling of biodegradable municipal, agricultural and Industrial wastes – bio compost making methods, types and method of vermicomposting – field Application.

Unit 3: Bioenergy: Biotech feed, Silage, Bio manure, biogas, biofuels – advantages and processing parameters, Next-generation biofuels, concept of waste-to-energy conversion, various aspects of bioenergy technology.

Unit 4: Soil and water conservation: Advanced green technologies, biologicals and bioreactor-based waste water treatment strategies. Application of algae in soil conservation. Role of plants in rehabilitation of agricultural lands. Bioremediation and phytoremediation techniques for sustainable development.

Unit 5: Biodegradable and bio-based alternatives: Biodegradable polymers and bioplastics, eco-friendly and sustainable packaging techniques, concept of bio-based alternatives and revival of pre-plastic era.

Unit 6: Biowaste and recycling management: Concept and types of biowaste, environmental effects of biowaste and biomedical waste. Impact of biowaste management in bioeconomy, concept of zero-waste management and its implication in sustainable biowaste recycling.

Suggested readings

1. Mamta Bansal, Basics of Organic Farming, CBS Publishers and distributers, ISBN: 9789386478351.
2. Baskar Gurunathan (Editor), Renganathan Sahadevan (Editor), Zainul Akmar Zakaria (Editor), Biofuels and Bioenergy: Opportunities and Challenges, Elsevier 1st ed. 0323852696
3. Amrat Sinore, Endalikachew Kissi, Abebayehu Aticho, The effects of biological soil conservation practices and community perception toward these practices in the Lemo District of Southern Ethiopia, International Soil and Water Conservation Research, Volume 6, Issue 2, 2018, Pages 123-130, ISSN 2095-6339, https://doi.org/10.1016/j.iswcr.2018.01.004.

Course Title	Course Code	Credit
Bacteriology	MICUGMCC1203	4 (Theory 3, Practical 1)

Course Objectives

The learning objectives of this course are as follows:

- *To give an idea of bacterial cellular ultrastructural details so that students can correlate the structures with function, and ecological significance at later stages.*
- *To give detailed idea of bacterial systematics.*
- *General characteristics of eubacteria and archaebacteria, and their economic and ecological significance.*

Course Outcomes

By studying this course, students will be able to:

- *Describe the morphological features, cell arrangement and structural components of bacterial cell*
- *Will have gained knowledge about cell wall structure and extracellular appendages*
- *Will have gathered detailed information regarding bacterial cell division and endospore formation.*
- *Will be able to classify bacteria based on observed characteristics.*
- *Will have gathered detailed information regarding general characteristics of eubacteria and archaebacteria, and their economic and ecological significance*

Theory

Unit 1: Cell organization

Cell size, shape and arrangement, glycocalyx, capsule, flagella, endoflagella, fimbriae and pili. Cell-wall: Composition and detailed structure of Gram-positive and Gram-negative cell walls, Archaebacterial cell wall, Gram and acid-fast staining mechanisms, lipopolysaccharide (LPS), sphaeroplasts, protoplasts, and L-forms. Effect of antibiotics and enzymes on the cell wall. Cell Membrane: Structure, function and chemical composition of bacterial and archaeal cell membranes. Cytoplasm: Ribosomes, mesosomes, inclusion bodies, nucleoid, chromosome and plasmids Endospore: Structure, formation, stages of sporulation.

Unit 2: Bacterial Systematics

Aim and principles of classification, systematics and taxonomy, concept of species, taxa, strain; conventional, molecular and recent approaches to polyphasic bacterial taxonomy, evolutionary chronometers, rRNA oligonucleotide sequencing, signature sequences, and protein sequences. Evolutionary differences between eubacteria and archaebacteria.

Unit 3: Important archaeal and eubacterial groups

A. Archaebacteria:

General characteristics, phylogenetic overview, genera belonging to Nanoarchaeota (*Nanoarchaeum*), Crenarchaeota (*Sulfolobus*, *Thermoproteus*) and Euryarchaeota [Methanogens (*Methanobacterium*, *Methanocaldococcus*), thermophiles (*Thermococcus*, *Pyrococcus*, *Thermoplasma*), and Halophiles (*Halobacterium*, *Halococcus*)]

B. Eubacteria: Morphology, metabolism, ecological significance and economic importance of Non-Proteobacterial and Proteobacterial classes of Gram negative bacteria; Low G+ C (Firmicutes) and High G+C (Actinobacteria) members of Gram-positive bacteria.

C. Cyanobacteria: Morphology, metabolism, ecological significance, and economic importance.

Practical

1. Preparation of different media: synthetic media BG-11, DM medium, Complex media-Nutrient agar, McConkey agar, EMB agar.

2. Study of bacterial cell shape and size by simple staining.
3. Gram's staining
4. Acid-fast staining-permanent slide only.
5. Capsule staining
6. Endospore staining.
7. Motility by hanging drop method.
8. Antibiotic sensitivity test of any bacteria by agar-cup method.

Suggested Readings

1. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2019). Brock Biology of Microorganisms. 15th edition. Pearson International Edition
2. Wiley JM, Sherwood LM and Woolverton CJ. (2017) Prescott's Microbiology. 10th Edition. McGraw Hill International.
3. Atlas RM. (1997). Principles of Microbiology. 2nd edition. WM.T. Brown Publishers.
4. Black JG. (2008). Microbiology: Principles and Explorations. 7th edition. Prentice Hall
5. Pelczar Jr MJ, Chan ECS, and Krieg NR. (2004). Microbiology.5th edition Tata McGraw Hill.
6. Srivastava S and Srivastava PS. (2003). Understanding Bacteria. Kluwer Academic Publishers, Dordrecht
7. Stanier RY, Ingraham JL, Wheelis ML and Painter PR. (2005). General Microbiology. 5th edition McMillan.
8. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9thedition Pearson Education.

Course Title	Course Code	Credit
Microbial Techniques	MICUGMCC1204	4 (Theory 3, Practical 1)

Course Objectives
The learning objectives of this course are as follows: • *To give an idea about the nutritional requirements of microorganisms; composition and applications of different types of culture media; and methods of controlling microbial growth.* • *Different techniques to isolate and study pure cultures* • *To give basic ideas of the techniques used to study complex microbial communities.*
Course Outcomes
By studying this course, students will be able to: • *Formulate media to isolate and grow specific groups of microorganisms.* • *Isolate pure cultures from different types of samples.* • *Will have some idea how to study non-culturable bacteria.* • *Will be able to characterize isolated microorganisms based on microscopic studies.*

Theory

Unit 1: Nutrition, Media, and Control of Microbial Growth
Nutritional requirements in bacteria and nutritional categories; Culture media: components of media, natural and synthetic media, chemically defined media, complex media, selective, differential, indicator, enriched and enrichment media. Physical methods of microbial control: heat, low temperature, high pressure, filtration, desiccation, osmotic pressure, radiation. Chemical methods of microbial control: disinfectants, types and mode of action.

Unit 2: Bacteriological techniques
Pure culture isolation: Streaking, serial dilution and plating methods; cultivation, maintenance and preservation/stocking of pure cultures; cultivation of anaerobic bacteria, and accessing non-culturable bacteria. Selective Single-cell isolation methods: laser Tweezers, Flow cytometry, Microfluidics, and High-Throughput Methods.

Unit 3: Basics of Staining and Microscopy
Classification/types of stains; acidic and basic dyes, simple and differential staining, negative staining. Mordants and Chromophores; Principles of Light microscopy: brightfield and darkfield, Phase contrast microscopy.

Unit 4: Basic Ideas and Applications of Advanced Microbiological Methods
Fluorescence microscopy in microbial study: applications of different fluorescent dyes; Viability Staining; Fluorescent Proteins as Cell Tags and Reporter Genes; Fluorescence in Situ Hybridization (FISH). Culture-independent analyses of Microbial communities: 16S-based metagenomics.

Practical

1. Preparation of culture media for bacterial cultivation.
2. Sterilization of medium using Autoclave and assessment for sterility.
3. Sterilization of glassware using Hot Air Oven and assessment for sterility.
4. Sterilization of heat-labile material by membrane filtration and assessment for sterility.
5. Isolation of pure cultures of bacteria by streaking method.
6. Preservation of bacterial cultures by various techniques.
7. Estimation of CFU count by spread plate method/pour plate method.
8. Demonstration of the presence of microflora in the environment by exposing nutrient agar plates to air.

Suggested Readings

1. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2019). Brock Biology of Microorganisms. 15th edition. Pearson International Edition
2. Wiley JM, Sherwood LM and Woolverton CJ. (2017) Prescott's Microbiology. 10th Edition. McGraw Hill International.
3. Tortora GJ, Funke BR and Case CL. (2008). Microbiology: An Introduction. 9th edition. Pearson Education
4. Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited
5. Atlas RM. (1997). Principles of Microbiology. 2nd edition. W.M.T. Brown Publishers.
5. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology.5th edition. McGrawHill Book Company.

Course Title	Course Code	Credit
Biostatistics	MICUGMDC1202	3

Course Objectives
The learning objectives of this course are as follows: • *To introduce students to the basic concepts of statistics, probability and probability distributions.* • *To teach them the different probability distributions and their application in statistical analysis* • *To familiarize them with various tests of fit analysis methods.* • *To introduce the concept of database, in-silico tools for biological sciences* • *To expose them about the various stages of drug development.*
Course Outcomes
After completion of the course the students would be • *Well versed with sampling methods for biological sciences and their statistical analysis.* • *Able to analyse of data for test of fit analysis* • *Able to access the various biological databases and retrieve the information* • *Enabled to analyse the data using different in-silico tools.*

Unit 1: Descriptive Statistics

Data in Biology: Development in biostatistics, samples and populations, techniques of sampling (random and stratified), sampling and non-sampling errors, variables in biology, univariate and bivariate frequency distributions

Measures of Central Tendency: means, mode, median.

Measures of Dispersion: Range, standard deviation, coefficient of variance and covariance.

Measures of Skewness: Pearson's coefficients of skewness; Measures of Kurtosis.

Unit 2: Probability and Probability Distributions

Probability: Basic concepts, addition and multiplication rules of probability, conditional probability

Probability Distributions: Probability mass function, probability density function and distribution function. Binomial distribution, Poisson distribution, normal distribution and exponential distribution along with their properties and relationships.

Unit 3: Correlation and Linear Regression

Correlation Analysis: Scatter diagrams, Pearson's and Spearman's coefficients of correlation, coefficient of determination.

Regression Analysis: Method of least squares, equations of lines of regression and their applications in biostatistics.

Unit 4: Hypothesis Testing

Sampling distributions and standard error, null and alternate hypothesis, basic concept and illustrations of type I and type II errors, concept of confidence interval estimation.

Student's t-distribution: test for single mean, difference of means and paired t- test, chi-square distribution.

Unit 5: Statistical software

Study of different statistical software, data analysis using different software.

Suggested Readings

1. A. Edmondson and D. Druce : Advanced Biology Statistics, Oxford University Press; 1996.
2. W. Danial : Biostatistics : A foundation for Analysis in Health Sciences, John Wiley and Sons Inc; 2004.

Course Title	Course Code	Credit
Economic Biology	MICUGSEC1202	4 (Theory 3, Practical 1)

Course Objectives

The learning objectives of this course are as follows:

- *To inculcate self-reliant skills from biology perspectives.*
- *To enhance commercial viability of biological knowledge in real-time world.*
- *To generate human resources that can establish small-scale industries that can generate job opportunities for the lowest of the lows in society.*
- *To develop "aatmanirbhar Bharat" and producing bioentrepreneurs for sustainable development of the society as a whole.*

Course Outcomes

By studying this course, students will be able to:

- *Develop knowledge in wide range of traditional and modern applications of biology in commercial perspective.*
- *Gain knowledge in apiculture and sericulture, both of which are commercially viable skills that can be established as a small-scale startup programme.*
- *Gain knowledge of aquaculture that will help the students to initiate startup in fisheries related to food or ornamental aquariums.*
- *Establish home-grown mushroom cultivation that is a rich source of protein and vitamins. Mushroom cultivation is among the trending small-scale startup ideas that require minimum financial capital but have significant monetizing potential.*
- *Gain skills in horticulture, establish nurseries of economically important plant saplings including ornamental and medicinal plants. There is also high demand for professional garden maintenance companies in modern residential and commercial complexes.*
- *Knowledge of applications of microbes in consumer-based industries can help generate skills of producing unique flavors and aroma in various food items. It also opens up options of producing intellectual properties that may have monetizing potential.*

Unit 1: Apiculture

Artificial Bee rearing (Apiary), Beehives – Newton and Langstroth. Bee Pasturage; Selection of Bee Species for Apiculture; Bee Keeping Equipment; Methods of Extraction of Honey (Indigenous and Modern). Bee Diseases and Enemies Control and Preventive measures. Products of Apiculture Industry and its Uses (Honey, Bees Wax, Propolis), Pollen etc.

Unit 2: Sericulture

Sericulture: Definition, history and present status; Silk route Types of silkworms, Distribution and Races. Exotic and indigenous races; Mulberry and non-mulberry Sericulture. Selection of mulberry variety and establishment of mulberry garden Rearing house and rearing appliances; Disinfectants: Formalin, bleaching powder, Silkworm rearing technology: Early age and Late age rearing. Types of mountages; Spinning, harvesting and storage of cocoons.

Unit 3: Aquaculture

Principles, definition and scope; Water-quality criteria for Aquaculture: Role of temperature, pH, salinity, dissolved oxygen, ammonia, nitrite, nitrate, phosphate

Fish Nutrition: Regulation of food intake, environmental factors and feed intake, digestive physiology and nutrient digestibility in fishes, Fish growth estimation, Feed content estimation and food formulation

Difference between major and minor carps with examples; Composite fish farming: General concepts, advantages and disadvantages; Induced breeding: method and advantages; Integrated fish farming.

Unit 4: Mushroom Culture Technology

Types of edible mushrooms available in India – *Volvariella volvacea, Pleurotus sajor-caju, Calocybe indica,*

Agaricus bisporus. Mushroom cultivation Infrastructure: substrates (locally available) Polythene bag, vessels, Inoculation hook, inoculation loop, low-cost stove, sieves, culture rack, mushroom unit (Thatched house) water sprayer, tray, small polythene bag. Pure culture: Medium, sterilization, preparation of spawn, multiplication. Mushroom bed preparation - paddy straw, sugarcane trash, maize straw, banana leaves. Factors affecting the mushroom bed preparation - Low-cost technology, Composting technology in mushroom production.

Unit 5: Horticulture

Definition, objectives and scope and building up of infrastructure for nursery, planning and seasonal activities - Planting - direct seeding and transplants. **Vegetative propagation:** Air-layering, cutting, selection of cutting, collecting season, treatment of cutting, rooting medium and planting of cuttings - Hardening of plants – green house - mist chamber, shed root, shade house and glass house. Transplanting of seedlings - Study of cultivation of different vegetables: cabbage, brinjal, lady's finger, onion, garlic, tomatoes, and carrots - Storage and marketing procedures.

Unit 6: Microbes in industry

Microbes in food, dairy, pharma and industry. Microbial Standards for Different Foods and Water – BIS standards for common foods and drinking water.

Suggested Readings

1. Harrigan WF (1998) Laboratory Methods in Food Microbiology, 3rd ed. Academic Press
2. Saleem F and Shakoori AR (2012) Development of Bioinsecticide, Lap Lambert Academic Publishing GmbH KG
3. Mahendra K. Rai (2005). Hand book of Microbial biofertilizers, The Haworth Press, Inc. New York.
4. Handbook of Practical Sericulture: S.R. Ullal and M.N. Narasimhanna CSB, Bangalore.
5. Silkworm Rearing and Disease of Silkworm, 1956, Ptd. By Director of Ptg., Stn.& Pub. Govt. Press, Bangalore
6. Bisht D.S., *Apiculture*, ICAR Publication.
7. Singh S., *Beekeeping in India*, Indian council of Agricultural Research, NewDelhi.
8. Edmond Musser & Andres, Fundamentals of Horticulture, McGraw Hill Book Co., New Delhi.
9. Tewari, Pankaj Kapoor, S.C., (1988). Mushroom cultivation, Mittal Publications, Delhi.
10. Nita Bahl (1984-1988) Hand book of Mushrooms, II Edition, Vol. I & Vol. II.
11. Handbook of Fisheries and Aquaculture, Indian Council of Agricultural Research, ICAR, (2006), DIPA, New Delhi, INDIA