SARVAJANIK UNIVERSITY

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Faculty of Science

SHREE RAMKRISHNA INSTITUTE OF COMPUTER EDUCATION AND APPLIED SCIENCES, SURAT

B.Sc. Microbiology

Syllabus

(Effective from 2021)

M.T.B College Campus, B/h P.T.Science College, Opp. Chowpati,
Athwalines, Surat-395001 Gujarat, India
Contact: 7228018498, 728018499. Email: info@srki.ac.in

B.Sc. Microbiology	
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A. About B.Sc. Microbiology Programme

The Department of Microbiology of SRKI at Sarvajanik University runs **a full time three-year program of six semesters,** leading to award of Bachelor of Science (B.Sc.) degree in Microbiology. The curriculum is designed to train the students in basic and advanced areas of Microbiology, keeping in mind the latest advances in the field. Particular emphasis is laid on the practical aspects of the field. Students are taught how to plan experiments, perform them carefully, analyze the data accurately, and present the results both, qualitatively and quantitatively. The students are offered basic and advanced level courses in Microbial Diversity, Microbial Physiology, Virology, Immunology, Enzymology, Environmental Microbiology, Molecular biology, Recombinant DNA technology, Industrial Microbiology, Food Microbiology etc. During the programme students were also exposing to industrial and relevant field visit.

B. Programme Objective

- The objective of the B.Sc. Microbiology is to equip the students to gain fundamental knowledge and analytical skills at an advanced level in the field of microbiology.

- The program emphasizes to apply knowledge acquired about prokaryotic and eukaryotic cellular processes, interaction of microorganisms among themselves, with physical and chemical agents and higher order organisms in environment and biological systems to various conditions.

- The laboratory training in addition to theory is included so that the students will acquire the skills to qualify for the positions in industry, clinical laboratory or for further education in a Master program.

C. Eligibility

- The candidate must have passed 10+2 or an equivalent examination with Biology as one of the subjects. **OR** Vocational course in Home Science **OR** Diploma in Pharmacy. **OR** The candidate who has passed equivalent exam from other subjects or boards need to avail eligibility certificate for this programme from the Board of Equivalence (BoE) of the Sarvajanik University.

D. B.Sc. Microbiology Course Structure

Sem	Course Type	Course Code	Paper Title	Hour/Week		Credit
				Th	Pr	
1	Core course	DSC-1	Introduction to microbiology & Microscopy	4	4	4+2
		DSC-2	Cell structure & Anatomy	4	4	4+2
	Elective	DSE-1	Biochemistry & Enzymology	2	-	2
		TDE-1	Transdisciplinary Elective	2	-	2
	PAECC	PAECC-1	Professional Communication	2	-	2
	Life Skills	Life Skills-1	Life Skills / NCC / NSS	2	-	2
2	Core course	DSC-3	Nutrition & Growth of microorganisms	4	4	4+2
		DSC-4	Microbial Diversity	4	4	4+2
	Elective	DSE-2	Microbial Ecology	4	-	4
		TDE-2	Transdisciplinary Elective	2	-	2
	PAECC	PAECC-2	Environmental Science (UGC)	2	-	2
	Life Skills	Life Skills-2	Life Skills / NCC / NSS	2	-	2
3	Core course	DSC-5	Control of microorganisms	4	4	4+2
		DSC-6	Microbial Taxonomy	4	4	4+2
	SEC	SEC-1	Applied Environmental Microbiology	4	4	4+2
	Elective	DSE-3	Food & Dairy Microbiology	2	-	2
		TDE-3	Transdisciplinary Elective	2	-	2
	Life Skills	Life Skills-3	Life Skills / NCC / NSS	2	-	2
4	Core course	DSC-7	Environmental Biotechnology	4	4	4+2
		DSC-8	Microbial Physiology & metabolism	4	4	4+2
	SEC	SEC-2	Biofertilizers, Biopesticides & Mushroom cultivation	4	4	4+2
	Elective	DSE-4	Nanosciences & Nano technology	2	-	2
		TDE-4	Transdisciplinary Elective	2	-	2
	Life Skills	Life Skills-4	Life Skills / NCC / NSS	2	-	2
5	Core Course	DSC-9	Molecular Biology	4	4	4+2
		DSC-10	Fundamentals of Immunology	4	4	4+2
	SEC	SEC-3	Instrumentation & Techniques	4	4	4+2
	Elective	DSE-5	Haematology & Blood banking	2	-	2
		TDE-5	Transdisciplinary Elective	2	-	2
	Life Skills	Life Skills-5	Life Skills / NCC / NSS	2	-	2
6	Core Course	DSC-11	Microbial Technology	4	4	4+2
		DSC-12	Health & Epidemiology	4	4	4+2
	SEC	SEC-4	Essential skills in computing	4	4	4+2
	Elective	DSE-6	Recombinant DNA Technology	2	-	2
		TDE-6	Transdisciplinary Elective	2	-	2
	Life Skills	Life Skills-6	Life Skills / NCC / NSS	2	-	2
					Total Credit	136

Note: DSC – Discipline Specific Core, DSE – Discipline Specific Elective, PAECC – Professional Ability Enhancement Compulsory Course, SEC - Skill Enhancement Course, TDE - Transdisciplinary Elective

E. Evaluation Scheme

B.Sc. Microbiology				
Evaluation	**Criteria**	**Theory**	**Practical**	
			Sem – I & II	**Sem – III to VI**
Internal	Continuous & Comprehensive Evaluation (CCE)	40	30	40
	Attendance	10	10	10
	Assignment	20	--	
	Internal Practical Test and Viva - Voce	--	30	50
External	External Evaluation	30	30	50
	Total	100	100	150

F. Syllabus

Name of faculty: Sciences	**Department: Microbiology**
Program: B.Sc. Microbiology Sem 3	**Type:** DSC-5
Subject: Control of Microorganisms	
Credit: 04	**Total learning hours:** 60
Course description: The control of microbial growth is necessary in many practical situations, thus significant advances in agriculture, medicine, and food science have been made through study of this area of microbiology. Control of microorganisms is essential so as to prevent the transmission of diseases & infection, stop decomposition and spoilage, and prevent unwanted microbial contamination. Therefore, controlling microbial growth is important in medical field, pharmaceutical and biotechnology industries, academic research, and food industry. Ever since microbes were shown to cause diseases, different techniques have been invented to control their spread.	
Student learning outcome: • Compare between disinfectants, antiseptics, and sterilants. • Describe the principles of controlling the presence of microorganisms through physical and chemical agents, that can eliminate or suppress microbial life. • The basis of chemotherapeutic control. • Mode of action of narrow and broad-spectrum antibiotics on gram-positive and gram-negative bacteria. • Mechanism for development of antibiotic resistance and microbial susceptibility. • Methods for determination of microbial susceptibility.	

Unit-1: Fundamentals of Microbial Control **(Duration:06 Hrs)**

1.1 Principles of Microbial Control

1.2 Microbial Death Pattern

1.3 Conditions Influencing Antimicrobial Action

1.4 Mode of Action of Antimicrobial Agents

Unit-2: Physical Agents of Microbial Control **(Duration:09 Hrs)**

1.1 Heat

1.2 Low Temperature

1.3 Radiation

1.4 Sonic and Ultrasonic Waves, Filtration & Osmotic Pressure

Unit-3: Chemical Agents of Microbial Control - I **(Duration: 08 Hrs)**

3.1 Choosing a Microbicidal Chemical
3.2 Evaluating the Effectiveness of Chemical Agents
3.3 Mechanisms of Action of Chemical Agents
3.4 Acids & Alkalis
3.5 Alcohols
3.6 Soaps & Detergents

Unit-4: Chemical Agents of Microbial Control - II **(Duration: 09 Hrs)**

4.1 Heavy metals
4.2 Halogens
4.3 Phenols
4.4 Oxidizing Agents
4.5 Alkylating Agents
4.6 Dyes

Unit-5: Chemotherapeutic Agents & Chemotherapy **(Duration: 07 Hrs)**

5.1 History of Chemotherapy
5.2 Characteristics of Antibiotics as Chemotherapeutic Agents
5.3 Antifungal Chemotherapeutic Agents
5.1 Antiparasitic Chemotherapeutic Agents
5.2 Antiviral Chemotherapeutic Agents

Unit-6: Antibacterial Chemotherapeutic Agents - I **(Duration: 07 Hrs)**

6.1 Mechanisms of Antibacterial Drug Action & Its Spectrum
6.2 Bacterial Cell Wall Inhibiting Antibiotics
6.3 Cell Membrane Disrupting Antibiotics

Unit-7: Antibacterial Chemotherapeutic Agents - II **(Duration: 07 Hrs)**

7.1 Nucleic Acid Synthesis Inhibiting Antibiotics
7.2 Protein Synthesis Inhibiting Antibiotics
7.3 Metabolic Pathways Inhibiting Antibiotics
7.4 Antimetabolites

Unit-8: Development of Antibiotic Resistance & Microbial Susceptibility

(Duration: 07 Hrs)

1.1 Resistance of Microorganisms to Antibiotic

1.2 Mechanisms for Development of Antibiotic Resistance

1.3 Determination of Microbial Sensitivities to Antimicrobial Agents

Reference Books:

- Black, J. G., (2014). Microbiology, 9th edition. (ISBN: 978-1-118-74316-4)
- Talaro, K.P., and Chess B., (2015). Foundations In Microbiology, 9th edition. (ISBN: 978–0–07–352260–9)
- Wiley, J., & Sherwood, L., (2015). Prescott, Harley, and Klein's Microbiology, 9th edition. (ISBN: 978-0-07-340240-6)
- Pelczar, Chan and Krieg, (2001). Microbiology-Concepts and Application, 5th edition. (ISBN: 978-0-07-462320-6)

Further Reading:

- Tortora G.J., and Funke B.R. (2016). Microbiology an Introduction, 12th Ed., Benjamin Cummings. (ISBN: 9780321929150)
- Cowan M. K. and Talaro K. P., (2014). Microbiology-A systems Approach, 4th edition Mc Graw Hill Higher Education. (ISBN: 978-0073402437)
- Wiley, J., & Sherwood, L. (2013). Prescott, Harley, and Klein's Microbiology, 8th Ed., McGraw-Hill Science/Engineering/Math, (ISBN: 9780071313674)
- Powar and Daginawala. (2019). General Microbiology Vol-I, 2nd Ed. Himalaya Publishing House, Mumbai. (ISBN: 978-93-5024-089-2)
- Purohit, S.S. (2006). Microbiology-Fundamentals and Applications-7th Edition, Agrobios Publications, Delhi. (ISBN: 978-8177542592)
- Atlas. R.M. (1995). Principles of Microbiology, 2nd Edition. Wm. C. Brown Publishers. (ISBN: 9780815108894)

List of Practicals

1) Effect of antiseptic and disinfectant on bacterial growth by disc method
2) Effect of Heavy metal on growth of bacteria – Oligo dynamic action
3) Effect of UV rays on growth of bacteria
4) Evaluation of Disinfectant by Phenol-coefficient method
5) Antibiotic susceptibility test by Kirby-bauer method.

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Name of faculty: Science	**Department: Microbiology**
Program: B. Sc. Microbiology Sem 3	**Type:** DSC-6
Subject: Microbial Taxonomy	
Credit: 04	**Total learning hours:** 60
Course description: Course aimed to deliver insights about tools, techniques, strategies and methodologies to classify the microorganisms. Course will also provide detailed knowledge of bacterial and archaeal groups and comprehensive knowledge of protozoa, fungi, algae and virus.	
Student learning outcome: By the end of this course, student will • Acquire the knowledge about the basis of microbial classification. • Develop the understanding about three domains of life • Explore detailed features and characteristics of bacteria • Learn archaeal taxonomy, metabolism and features of archaea. • Understand the classification, major features of important members of protist, fungi, algae and viruses.	

Unit-1: Principles of Microbial Taxonomy **(Duration: 08 Hrs)**

1.1 Introduction to Microbial Taxonomy

1.2 Taxonomic Ranks

1.3 Classical and Molecular Characteristics

1.4 Phylogenetic tree

1.5 Concept of Microbial species

1.6 Microbial Phylogeny: Three Domains of Life

Unit-2: Taxonomy of Bacteria: Proteobacteria **(Duration:08 Hrs)**

2.1 Bergey's Manual of Systematic Bacteriology

2.2 Class *Alphaproteobacteria*: Purple Phototrophic Bacteria and Order *Rhizobiales*

2.3 Class *Betaproteobacteria*: Order *Neisseriales* and Order *Nitrosomonadales*

2.4 Class *Gammaproteobacteria*: Order *Enterobacteriales*

2.5 Class Deltaproteobacteria: Order Bdellovibrionales

2.6 Class *Epsilonproteobacteria*

Unit-3: Taxonomy of Bacteria: Deeply Branching, Photosynthetic and Non-proteal Gram negative bacteria **(Duration: 07 Hrs)**

3.1 Deeply Branching Bacteria*: Deinococcus* and *Thermus*

3.2 Photosynthetic Bacteria : Cyanobacteria

3.3 *Chlamydias*

3.4 *Spirochaetes*

3.5 *Bacteroides* and *Flavobacterium*

Unit-4: Taxonomy of Bacteria: Low and High G+C Gram positive Bacteria **(Duration: 07 Hrs)**

4.1 Nonsporulating *Firmicutes*: *Staphylococcus*, *Micrococcus* and *Lactobacillus*

4.2 Endospore-Forming *Firmicutes*: *Bacillus* and *Clostridium*

4.3 *Mollicutes*: *Mycoplasma*

4.4 *Actinobacteria*: *Coryneform* Bacteria, *Mycobacterium* and *Actinomycetes*

Unit-5: Taxonomy of Archea **(Duration: 07 Hrs)**

5.1 Archaeal Taxonomy

5.2 Archeal Metabolism

5.3 Phylum *Crenarchaeota*

5.4 Phylum *Thaumarchaeota*

5.5 Phylum *Euryarchaeota*

Unit-6: Taxonomy of Protozoa and Algae **(Duration: 07 Hrs)**

6.1 Classification of Protozoa

6.2 Algal Nomenclature and basis of algal classification

6.3 Classification of algae

6.4 *Chlorophyta*, *Rhodophyta*, *Phaeophyta*, *Chrysophyta*

Unit-7: Taxonomy of Fungi **(Duration: 08 Hrs)**

7.1 Classification of fungi and their general characteristics

7.2 *Chytridiomycota*

7.3 *Zygomycota*

7.4 *Glomeromycota*

7.5 *Ascomycota*

7.6 *Basidiomycota*

7.7 *Microsporidia*

Unit-8: Taxonomy of Virus **(Duration: 08 Hrs)**

8.1 Classification of Virus

8.2 RNA Virus: General characteristics and important groups

8.3 DNA Virus: General characteristics and important groups

8.4 Emerging viruses

Reference Book:

- Bauman, Robert W.. Microbiology: With Diseases by Body System, 3rd Edition, United Kingdom : Benjamin Cummings, 2012. (ISBN: 9780321712714)
- Black, Jacquelyn G.., Black, Laura J.. Microbiology: Principles and Explorations. 10th Edition, United Kingdom : Wiley, 2015. (ISBN: 9781118743164)
- Michael T. Madigan, Thomas D. Brock, John M. Martinko, David P. Clark, Brock Biology of Microorganisms, 13th Edition, Germany: Benjamin Cummings, 2012. (ISBN: 9780321649638)
- Sharma, O. P.. Algae. India: Tata McGraw Hill, 2011. (ISBN: 9780070681941)
- Sherwood, Linda., Woolverton, Christopher J.., Willey, Joanne M.. Prescott's Microbiology, 10th Edition, Singapore: McGraw-Hill Education, 2017. (ISBN: 9789813151260)

Further Reading:

- Garrity, George M.. Bergey's Manual of Systematic Bacteriology: The archaea and the deeply branching and phototrophic bacteria. United States: Springer, 2001. (ISBN: 9780387987712)
- Garrity, George M.. Bergey's Manual of Systematic Bacteriology: The proteobacteria. Part A. Introductory essays. United States: Springer, 2001. (ISBN: 9780387241432)
- Garrity, George M.. Bergey's Manual of Systematic Bacteriology: The proteobacteria. Part B. The Gammaproteobacteria. United States: Springer, 2001. (ISBN: 9780387241449)

- Garrity, George M.. Bergey's Manual of Systematic Bacteriology: The proteobacteria. Part C. The Alpha-, Beta-, Delta-, and Epsilonproteobacteria. United States: Springer, 2005. (ISBN: 9780387241456)
- Gunsalus, Robert P.., Perry, Jerome J.., Lory, Stephen., Staley, James T.. Microbial Life, 2nd Edition, United Kingdom: Sinauer Associates, 2007. (ISBN: 9780878936854)
- Ludwig, Wolfgang., Garrity, George., Krieg, Noel R.., Schleifer, Karl-Heinz., Boone, David R.., Jones, Dorothy., Rainey, Fred A.., Castenholz, Richard W.., Bergey, David Hendricks. Bergey's Manual of Systematic Bacteriology: Volume 3: The Firmicutes. Germany: Springer New York, 2001. (ISBN: 9780387684895)

List of Practicals

1) Study of various biochemical tests for identification of bacteria
2) Study of extracellular enzymatic activity : Amylase, Caseinase, Gelatinase, Lipase, DNAase
3) Study of intracellular enzymatic activity: Deaminase, Ornithine Decarboxylase, Catalase, Dehydrogenase (Resazurin indicator), Oxidase.
4) Study of pure cultures of bacteria: Gram positive and Gram negative bacteria. (Gram positive bacteria: *Bacillus subtilis, Bacillus cereus, Bacillus megaterium, Staphylococcus aureus, Staphylococcus epidermidis,* Gram Negative bacteria: *Escherichia coli, Enterobacter aerogenes, Proteus vulgaris, Pseudomonas aeruginosa, Serratia marcescens*)
5) Isolation and identification of actinomycetes from soil.
6) Study of permanent slides of Parasite/ Protozoa (*Entamoeba histolytica*, *Leishmania donovani, Giardia lamblia/ Giardia intestinalis, Filarial worms, Trypanosoma gambiense*).

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Name of faculty: Science	**Department:** Environmental Science
Program: B. Sc. Sem 3	**Type:** SEC-1
Subject: Applied Environmental Microbiology	
Credit: 04+ 02	**Total learning hours:** 60
Student learning outcome: • Basic understanding of microbiology of air, water and soil • Knowing microbial hazards of environmental origin • Knowing treatment of drinking water • Having basic concept of indicator microorganisms • Learning sampling and cultural methods for the detection of microorganisms in environmental samples	

Unit-1: Soil Microbiology

1.1 Historical perspective and modern environmental microbiology

1.2 Soil as a microbial environment

1.3 Microorganisms in surface soils

1.4 Distribution of microorganisms in soil

1.5 Microorganisms in subsurface environment

Unit-2 :Aeromicrobiology

2.1 Important airborne pathogens and toxins

2.2 Aerosols and their nature

2.3 Bioaerosol control

2.4 Biosafety in laboratory

Unit-3: Aquatic Microbiology

3.1 Introduction to aquatic microbiology

3.2 Microbial habitats in the Aquatic Environments

3.3 Aquatic Environments

3.4 Aquatic microbes as future foods

Unit-4: Environmentally Transmitted Pathogens

4.1 Environmentally transmitted bacteria

4.2 Parasitology

4.3 Environmentally transmitted viruses

4.4 Transport of pathogens in environment

Unit-5: Indicator Microorganisms

5.1 Coliforms

5.2 Fecal Streptococci

5.3 Other potential indicator organisms

5.4 Standards and criteria for indicators

Unit-6: Drinking Water Treatment

6.1 Water treatment processes

6.2 Water treatment requirements

6.3 Water distribution systems

6.4 Microbial growth in distribution systems

Unit-7 :Environmental Sample Collection and Processing

7.1 Sampling of soils and sediments

7.2 Sampling strategies and methods for water

7.3 Devices for collection of air samples

7.4 Detection of microorganisms on fomites

Unit-8 :Cultural Methods for Detection of Microorganisms

8.1 Cultural methods for bacteria

8.2 Culture media for bacteria

8.3 Cultural methods for fungi

8.4 Cultural methods for algae and cyanobacteria

References Books

- Pepper IL, Gerba CP, Gentry TJ, Maier RM, editors. Environmental microbiology. Academic press; 2011 Oct 13. 978-0123705198

List of Practicals

1. Heterotrophic plate count of soils
2. Study of microorganisms present in ambient air by settling plate method
3. Enumeration of coliforms by MPN method

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Name of faculty: Science	**Department: Microbiology**
Program: B.Sc. Microbiology Sem 3	**Type:** DSC-3
Subject: Food and Dairy Microbiology	
Credit: 02	**Total learning hours: 30**

Course description:

This paper covers the principles of food fermentation and the role of beneficial microbes; the role of microorganisms and food spoilage; pathogenic microorganisms, infection and intoxication, the principles to control microbial growth; as well as food safety and quality management. Provide students with theoretical knowledge and practical abilities required to work in the food industry, research centers, and food-related national and international organizations.

Student learning outcome:

- Important pathogens and spoilage microorganisms in foods and the conditions, under which they will grow, conditions under which the important pathogens are commonly inactivated, killed or made harmless in food.
- Principles involving food preservation and understand the role and significance of microbial inactivation, adaptation and environmental factors on growth and response of microorganisms in various environments.
- Principles of food science to control and assure the quality of food products and safety standards to be followed in a food and Dairy industry.

Unit-1:Introduction and scope of Food Microbiology (Duration: 02 Hrs)

1.1 Definition of food

1.2 Basic Food categories and its group

1.3 Food as a substrate for microorganisms

Unit-2: Principles of food preservation-I (Duration:04 Hrs)

2.1 Introduction to Principles of food preservation

2.2 Asepsis, Removal of microorganisms and Anaerobic condition for preservation

2.3 Preservation by use of high temperature and

2.4 Preservation by use of low-temperature

Unit-3:Principles of food preservation-II (Duration:03 Hrs)

3.1 Preservation by drying

3.2 Preservation by drying radiation

3.3 Preservation by food Additives

Unit-4:Microbial spoilage of foods **(Duration: 06 Hrs)**

4.1 Contamination and Spoilage of food

4.2 Spoilage of Cereals and Cereal Products

4.3 Spoilage of Vegetables and fruits

4.4 Spoilage of canned foods

4.5 **F**ood in relation to Disease: Food borne Illness

4.6 Food-borne poisoning, Infection and Intoxication

Unit-5:Use of Microorganisms As Food And Food Suppliments
(Duration:04 Hrs)

5.1 Single cell protein

5.2 List of fermented foods

5.3 Production of breads

Unit-6: Dairy microbiology **(Duration:06 Hrs)**

6.1 Definition, types of Milk and its Classification

6.2 Indian standards for market milk

6.3 Milk Components and its nutritive value

6.4 Types of Microorganisms present in Raw Milk

6.5 Contamination, Spoilage and Preservation of milk and milk products

6.6 Fermented Dairy Products: Fermented milks and Cheese

Unit-7: Advances in Dairy Technology **(Duration:03 Hrs)**

7.1 Self-life predicting methods for milk

7.2 Microbial control by new non thermal methods

7.3 Concept of Probiotics

Unit-8: Microbial standards for food safety and quality management
(Duration: 02 Hrs)

8.1 Indicators of Food Microbial Quality and safety

8.2 Hazard Analysis and Critical Control Points (HACCP)

Reference Books:

- Doyle M.P. and Buchanan R.L. (2013), Food Microbiology:Fundamentals and Frontiers, American Society for Microbiology; 4th Ed.
- Dubey, R.C. (2010). Textbook of Biotechnology, S. Chand. Multicolor 1st Ed.
- Frazier, W. C. and Westhoff, D. C., (2014). Food Microbiology, 5th Ed., Tata Mc-Graw Hill, India.
- James M. Jay (2000) Modern Food Microbiology.6th Ed., AN ASPEN PUBLICATION® Aspen Publishers, Inc. Gaithersburg, Maryland.
- Manoranjan, K. (2002). Food Analysis and Quality Control,1st Ed., Agrotech Publishing Academy.
- Microorganisms in Foods 7: Microbiological Testing in Food Safety Management**,** by International Commission for the Microbiological Specifications of Foods (ICMSF), Springer; 1st ed. (2012) (ISBN-13 : 978-1461352211).
- Modi H.A. (2009),Dairy Microbiology, pointer publishers, ISBN-13 : 978-8179102893
- Robinson, R. K. (Ed.). (2005). *Dairy microbiology handbook: the microbiology of milk and milk products*. John Wiley & Sons.
- Singh B.D. (2010),Biotechnology expanding Horizons, kalyani publishers, ISBN-13 : 978-8127261535
- Sukumar De. (2013). Outlines of Dairy Technology, Oxford university. (ISBN:978-0-19561194-6
- Wiley, J., Sherwood, L. & Woolverton C., (2017). Prescott, Harley, and Klein's Microbiology, 10th Ed., McGraw-Hill Science/Engineering/Math.

Further Reading:

- Adams, M. R., & Moss, M. O. (2003). *Food microbiology*. PANIMA PUBLISHING CORPORATION; 2nd Ed.(ISBN-13 : 978-8186535370)
- Marth, E. H., & Steele, J. (Eds.). (2001). *Applied dairy microbiology*. CRC Press.
- Pelczar, M. J., & Chan, E. C. S. (1998). *Microbiology,* 5Ed., Tata-McGraw-Hill.
- Purohit, S. S., (2006). *Microbiology: Fundamentals and Applications*, 7Ed., Agrobios (India).

- Spreer, E. (2017). *Milk and dairy product technology*. Routledge.
- Walstra, P., Walstra, P., Wouters, J. T., & Geurts, T. J. (2005). *Dairy science and technology*. CRC press.