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,
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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: Science	**Department**: Environmental Science
Program: B.Sc. Microbiology Sem 4	**Type:** DSC-7
Subject: Environmental Biotechnology	
Credit: 04+02	**Total learning hours:** 30
Student learning outcome: ● The major outcome to study the environmental biotechnology is to understand the current applications of biotechnology to environmental quality evaluation, monitoring and remediation of contaminated environments. ● Sustainable environmental biotechnology advances are helping to make manufacturing processes cleaner and more efficient by reducing toxic chemical pollution and greenhouse gas emissions.	

Unit-1: Introduction and Scope of Environmental Biotechnology (Duration: 07 Hrs)

1.1 Definition, introduction and scope of environmental biotechnology

1.2 Need and issues of environmental biotechnology

1.3 Challenges of Environmental Biotechnology

1.4 Abatement of pollution and Environmental clean-up technologies

Unit-2: Introduction and tools for genetic engineering (Duration: 07 Hrs)

2.1 DNA modifying enzymes: Nuclease, Alkaline Phosphatase, DNA polymerase, Reverse Transcriptase, Polynucleotide Kinase, Methylase and DNA ligase

2.2 Methods of Gene cloning and Gene transformation

2.3 Linkers, adaptors, homopolymer tailing, Site directed mutagenesis

2.4 PCR: Process, Methodology and Types, Reverse Transcriptase PCR, Real Time PCR

Unit-3: Different types of gene cloning vectors (Duration: 07 Hrs)

3.1 Cloning vectors: Types and Properties, Essential components of gene cloning vectors, Selectable and screenable markers

3.2 Plasmids, Bacteriophages, M13 mp vectors, PUC19 and Bluescript vectors

3.3 Insertion and Replacement Vectors, TA cloning vectors, YACs and BACs

3.4 Expression vectors, plant based vectors, Ti and Ri plasmids as vectors

Unit-4: Gene library and Genome editing techniques (Duration: 07 Hrs)

4.1 Isolation of mRNA and total RNA, reverse transcriptase and cDNA synthesis

4.2 Introduction to miRNA and siRNA

4.3 Gene knock in and Gene knock out

4.4 Genome Editing: CRISPER-CAS, TALENs, ZFNs

4.5Applications of genetic engineering techniques in environmental biotechnology

Unit-5: Biomass and Bioenergy (Duration: 07 Hrs)

5.1 Biomass as a source of energy: Composition and types of biomass

5.2 Biomass conversion: Thermo-chemical conversion, Bioconversion

5.3 Bioenergy – Petroleum plants, Bioethanol

5.4 Gaseous fuels – Biogas, Biohydrogen and Microbial Fuel cells

Unit-6: Bioremediation technologies (Duration: 07 Hrs)

6.1 Bioremediation: Introduction and Types

6.2 Bioaugmentation and Biofilteration

6.3 Bioremediation of hydrocarbons

6.4 Bioremediation of industrial wastes

6.5 Bioremediation of recalcitrant and xenobiotic compounds

Unit-7: Phytoremediation and rhizoremediation technologies (Duration :07 Hrs)

7.1 Phytoremediation – Introduction, Types and Mechanisms

7.2 Advantages, Disadvantages and Applications of phytoremediation

7.3 Rhizoremediation – Introduction, Types and Mechanisms

7.4 Concept of Phytoextraction and rhizofilteration

Unit-8: Applications of Environmental Biotechnology and sustainable technologies

(Duration: 07 Hrs)

8.1 Bioleaching: Types, Processes and Examples

8.2 Bioplastics, Bioscrubbers, Biopesticides and Biofertilizers

8.3Environmental Nanotechnology – Principles and Environmental applications

8.4 Biosensors: Types, Working and Applications

References Books

- Indu Shekhar Thakur (I K International Publishing) Environmental Biotechnology: Basic Concepts and Applications , 2nd Edition. ISBN: 9789380578477.
- N. Arumugam and V. Kumaresan (Saras Publications) Environmental Biotechnology, 2nd Edition. ISBN: 9789384826031.
- Pradipta Kumar Mohapatra (Dreamtech Press, New Delhi). Textbook of Environmental Biotechnology. ISBN: 9789389633054.
- Viswanath Buddolla. (Narosa Publication). Environmental Biotechnology - Concepts and Applications. ISBN: 9788184875478.
- K. Chaterjee (Prentice Hall India Learning) Introduction to Environmental Biotechnology. ISBN: 9788120342989.

List of Practicals

1. Isolation of symbotic, nonsymbiotic and anaerobic nitrogen fixing bacteria from rhizosphere
2. Isolation of genomic DNA from bacterial, yeast and plant samples
3. Isolation of plasmid DNA
4. Study of biosorption of heavy metal by fungal biomass
5. Synthesis of AgNPs by using sodium citrate
6. Isolation and enrichment of Uric Acid Utilizing Bacteria
7. Study of seed viability and seed germination assay in presence of environmental pollutants.

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Name of Faculty: Science	**Department**: Biotechnology
Program: B.Sc. Sem 04	**Type:** DSC-8
Subject: Microbial Physiology and Metabolism	
Credit: 04 + 02	**Total learning hours:** 60
Course description: The objectives of this course are to provide students with the theory and practical experience Physiology and Metabolism aspect of Microorganisms which facilitate investigation of molecular biology and evolution-related concepts.	
Student learning outcome: At the end of the course, students will be able to: ● Understand basics of microbial growth and cell cycle, modes of microbial reproduction. ● Know the role and effect of various factors- environmental, physical and chemical on growth of microorganisms and also learn ways and means of cultivating microorganisms in in vitro conditions. ● Explain methods and techniques for controlling microbial growth. ● Learn about the response of microorganisms towards various stresses to sustain and survive during exposure to these stresses. ● At the end of the course, the student has an understanding on the metabolism and mechanism of various biomolecules. ● The student through this course will be able to explain the principle of energy yielding and consuming reactions, various anabolic and catabolic pathways, transport systems and the mechanisms of energy conservation in microbial metabolism.	

Unit-1: Microbial Growth **(Duration: 09 Hrs)**

1.1. Reproductive Strategies in Bacteria and Archaea

1.2. Bacterial Cell Cycle and its Regulation

1.3. Bacterial Cell division (Gram Positive Bacillus and Gram Negative Rods)

1.4. Growth Curve Studies

1.5. Bacterial Differentiation (Bacillus Endospore formation)

Unit-2: Microbial Nutrition **(Duration :08 Hrs)**

2.1 Effect of Environmental Factors on Growth of Microorganisms

2.2 Microorganisms in Natural Environments

2.3 Cultivation of Microorganisms in Laboratory

2.4 Measurement of Microbial Population

Unit-3: Control of Microorganisms **(Duration: 07 Hrs)**

3.1. Principles of Microbial Control

3.2. Pattern of Microbial Death

3.3. Mechanical Methods for Microbial Control

3.4. Physical Methods for Microbial Control

3.5. Chemical Methods for Microbial Control

Unit-4: Response to stress **(Duration :07 Hrs)**

4.1. Osmotic Stress

4.2. Oxidative Stress

4.3. Thermal Stress

4.4. pH Stress and Acid Tolerance

4.5. Nutrient Stress and Starvation

Unit-5 : Carbohydrate Metabolism **(Duration: 09 Hrs)**

5.1 Concept of Metabolism and Bioenergetics

5.2 Aerobic (PP Pathway) & Anaerobic Glycolysis (Sequence of Reactions, Regulation)

5.3 ED Pathway

5.4 Pyruvate Metabolism, Citric acid Cycle & its Regulation

5.5 Glycogenesis, Glycogenolysis (Sequence of Reactions & Regulation)

Unit-6 :Lipid Metabolism **(Duration :08 Hrs)**

6.1 Outline of Lipid Synthesis

6.2 Catabolism of Fatty acid: Beta oxidation

6.3 Oxidation of Unsaturated Fatty Acids

6.4 Oxidation of Odd Chain Fatty Acids, Cholesterol & Ketone Bodies.

Unit-7:Amino acid Metabolism **(Duration: 07 Hrs)**

7.1 Essential & Non Essential Amino Acids, Brief Outline of Amino Acid Synthesis

7.2 Catabolism of Amino acids, Transamination

7.3 Metabolic Breakdown of Individual Amino Acids – Glucogenic & Ketogenic Amino Acids, Amino Acids As Biosynthetic Precursors

Unit-8: Nucleotide Metabolism **(Duration :05 Hrs)**

8.1 Biosynthesis of Purine & Pyrimidine (*De novo* & Salvage Pathway);

8.2 Degradation of Purine & Pyrimidine

Reference Books

- John P. Harley, Donald A. Klein, Microbiology- Lansing Prescott, 10th Edition, Mcgraw Hill Publication. ISBN-13-978-1259281594
- Albert Moat, John Foster, Micheal Spector, Microbial Physiology, 4th Edition, A John Wiley & Sons, Inc., Publication ISBN 0-471-39483-1
- Stryer, L., "Biochemistry", 4th Edition, W.H. Freeman & Co., 2000.
- Murray, R.K., etal "Harper's Biochemistry", 23rd Edition, Prentice Hall International, 1993.
- Voet D and Voet JG. 2011. Biochemistry. 4th Ed. John Wiley and Sons, Inc. NY, USA

List of Practicals

1. To culture bacteria in solid and liquid media
2. To study bacterial growth curve.
3. Study of Biochemical test for characterization of Bacteria.

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Name of faculty: Science	**Department: Microbiology**
Program: B.Sc. Microbiology Sem 4	**Type:** SEC -2
Subject: Biofertilizer, Biopesticide and Mushroom cultivation	
Credit: 04 + 02	**Total learning hours:** 60

Course description:

This paper covers the Definition, scope and importance of types of biofertilizers. Biochemistry of nitrogen fixation and Phosphate solubilization –mechanism and formulation of Biofertilizer. Biological control Microbial control, Production of biopesticide based on Fungi and bacteria.
Paper is also designed to teach to the students, practical information about wild and cultivated mushrooms, cultivation techniques, post - harvest management, pest and disease problems and the economics and marketing strategies which help the students to learn a means of self-employment and income generation.

Student learning outcome: Upon successful completion of this course students will have learned

- Understanding of importance and practical aspects of production of biofertilizers.
- Role of biopesticides/bioinsecticides in the agriculture field.
- Nutritional value and commercial use of mushrooms for human consumption.
- Practical cultivation of mushrooms, management of diseases affecting mushrooms, mushroom harvesting and various avenues for using it into an entrepreneurship.

Unit-1: Biofertilizers: Microbial Inoculants **(Duration: 08 Hrs)**

1.1 Bacterial and Cyanobacterial Inoculants

1.2 Azolla and Mycorhizal fungi as Biofertilizer

1.3 Green Manuring

1.4 Frankia Induced Nodulation

1.5 Benefits of Biofertilizers and it's Commercial producers

1.6 Indian Status for Biofertilizers

Unit-2: Formulation of Biofertilizers **(Duration:08 Hrs)**

2.1 Mass production of Biofertilizers

2.2 Application of Biofertilizers

2.3 Economics of Biofertilizers

2.4 Coast and Availability of Biofertilizers

Unit-3: Biopesticide **(Duration:08 Hrs)**

3.1 Biological Control of Plant pathogen

3.2 Biological control of Insect pests

3.3 Biological control of weeds

Unit-4: Microbial Production of Insecticides **(Duration:08 Hrs)**

4.1 Biological Control of Insects

4.2 Production of biological insecticides

4.3 Bioassay of biological insecticides

4.4 Formulation and use of bioinsecticides

4.5 Safety Testing and Development of new Bioinsecticides

Unit-5: Introduction to Mushrooms **(Duration:08 Hrs)**

5.1 History of Mushroom Cultivation

5.2 Morphology of Mushrooms

5.3 Food Value of Mushrooms

5.4 Application of Mushrooms

5.5 Present status of the mushroom industry in India

Unit-6: Biology of Mushrooms **(Duration:10 Hrs)**

6.1 The Biology of Mushrooms

6.2 The Mushroom Life Cycle

6.3 Classification of Mushrooms

6.4 Genetic Improvement of Mushrooms

Unit-7: Cultivation Technology of mushrooms **(Duration:06 Hrs)**

7.1 Cultivation technique of button Mushrooms

7.2 Cultivation Technology Oyster Mushrooms

7.3 Cultivation Technology of Paddy Straw Mushroom

7.4 Cultivation Technology of Milky Mushroom

Unit-8: Post Cultivation Process **(Duration: 04 Hrs)**

8.1 Packaging and quality control

8.2 Preservation and processing

8.3 Mushroom houses: Maintaining and monitoring House

8.4 Production cycle

8.5 Export marketing of mushroom

8.6 Waste management and recycling

Reference Books:

- Bahl, N. (1984). Handbook on mushrooms, oxford &IBH publishing co. Pvt. Ltd. 2nd Eddition. (https://archive.org/details/in.ernet.dli.2015.219901/page/n19/mode/2up)
- Dubey R.C., (2012), A Textbook of Biotechnology, 4th Edition, S Chand and Company Ltd., 81-219-2608-4
- Kadhila-Muandingi, N. P., Mubiana, F. S., & Halueendo, K. L. (2012). Mushroom Cultivation: a beginners guide. *University of Namibia, Namibia*.
- Kainth, G. S. (1996). *Export potential of Indian agriculture*. Regency publication. ISBN-8186030212 (https://www.google.co.in/books/edition/Export_Potential_of_Indian_Agriculture/95TrPISDUXEC?hl=en&gbpv=1)
- Kashangura C, (2004), Manual For Mushroom Cultivation
- Okafor, N., & Okeke, B. C. (2017). *Modern industrial microbiology and biotechnology*. CRC Press. ISBN: 978-1-57808-434-0
- Sandhu S., (2013) Biofertilizer Technology, Black print India Inc.,ISBN- 978-93-82036-22-7
- Stamets, P., & Chilton, J. S. (1983). The mushroom cultivator. *First Washington*.
- Thapa C. D., MUSHROOM CULTURE

Further Reading:

- Brahma Mishra, (2012) "Fertilizer Technology and Management", IK International Publishing House Pvt. Ltd.
- FAO, "Fertilizers and their use", (2015) 4th Edition, Scientific Publisher, New Delhi.
- Meena, V. S., Mishra, P. K., Bisht, J. K., & Pattanayak, A. (Eds.). (2017). *Agriculturally important microbes for sustainable agriculture: volume 2: applications in crop production and protection*. Springer.
- Paul, E. (Ed.). (2014). *Soil microbiology, ecology and biochemistry*. Academic press.
- Suman, B. C., & Sharma, V. P. (2007). Mushroom cultivation in India. Daya Books. ISBN:9789351300212

List of Practicals

1) Isolation of symbiotic nitrogen fixing bacteria from root nodules of leguminous plant.
2) Isolation of non-symbiotic nitrogen fixing bacteria from soil
3) Isolation and purification of Azospirillum.
4) Isolation of Phosphate solubilizing microorganisms from rhizosphere.
5) Study of plant (Red rot of sugar cane) pathogenic fungi.

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Name of faculty: Science	**Department:** Allied
Program: B.Sc. Microbiology Sem 4	**Type:** DSE-4
Subject: Nanoscience and Nanotechnology	
Credit: 02	**Total learning hours:** 30
Course description: Nanoscience is the study of structures and molecules on the scale of nanometers and the technology which utilizes it in practical applications is called nanotechnology. Today, engineers and researchers are finding a wide variety of methods to deliberately make nanoscale materials to take the advantages of their enhanced properties such as higher strength, lighter weight, high chemical reactivity, etc. also the nanotechnology offers more advances in disease treatments, in imaging and diagnostics equipment, in energy efficient products such as fuel and solar cells, etc. so in order to move towards the advanced materials and devices, students should have the knowledge of nanoscience.	
Student learning outcome: After learning the course,students should be able : • To understand the difference between bulk and nanoscale materials. • To understand the basics of nanoscale science. • To understand the synthesizing technique and difficulties to synthesize the nanomaterials so they can get interest in the search of new composition techniques of nanomaterials. • To understand the various applications of nanoscience and nanotechnology.	

Unit-1 : Fundamentals of Nanoscience and Nanotechnology (Duration: 03 Hrs)

1.1 Introduction to the world of Nanoscience

1.2 Nano and Nature: Nanoscopic colors, Bioluminescence, Tribiology.

1.3 Introduction to hydrophilic and hydrophobic materials.

1.4 Time line of Nanotechnology in different centuries.

Unit-2: Nano scale Science (The big world of Nano scale) (Duration :04 Hrs)

2.1 Interconversion of Units.

2.2 Introduction to surface area to volume ratio and aspect ratio.

2.3 Difference between surface area to volume ratio of bulk materials and nano materials (sphere, rods, cubes)

2.4 Difference in aspect ratio of bulk wire and nanowire.

2.5 Nanomaterial and wavelength of light.

Unit-3: Classification of Nano structured materials (Duration: 04 Hrs)

3.1 Small things can make a big difference.

3.2 Classification of nanostructured materials (3D, 2D, 1D, 0D).

3.3 Relationship between dimension and shape of nanomaterials (Quantum dots, Quantum wires,

carbon nanotubes, Fullerenes).

3.4 Effect of size on electronic and optical properties.

Unit-4: Fundamental of atomic structure and Bonding **(Duration: 03 Hrs)**

4.1 Bohr's atomic structure.

4.2 Bohr's atomic radii, comparative size of nanomaterials and atomic size, electronic configuration.

4.3 Types of energy levels

4.4 Bonding and electronic structures of solids.

Unit-5: Concept of solid state physics and crystal structure **(Duration :04 Hrs)**

5.1 Introduction.

5.2 Planes in the crystals and crystallographic directions.

5.3 Types of crystal structures.

5.4 Reciprocal lattice

Unit-6: Synthesis techniques **(Duration: 04 Hrs)**

6.1 Introduction

6.2 Top-Down fabrication methods(concepts with examples only)

6.3 Bottom-Up fabrication methods(concepts with examples only)

6.4 Chemical,Biological and Self-assembly methods of synthesis

Unit-7: Properties of Nano materials **(Duration: 04 Hrs)**

7.1 Introduction

7.2 Mechanical & Optical properties

7.3 Electrical & Magnetic properties

7.4 Structural and Thermal properties

Unit-8: Applications and Future perspective of Nanoscience and Nanotechnology.
(Duration: 04 Hrs)

8.1 Introduction

8.2 Cosmetics & Domestic appliances

8.3 Nanobiotechnology and Medical fields

8.4 Environmental development

8.5 Food and Agriculture

Reference Books:

- Nanoscience and Nanotechnology Fundanentals to Frontiers, M.S. Ramachandra Rao, Shubra Singh2013, Wiley
- Nanotechnology Principles and practicals, S.K. Kulkarni, 2017, Capital Publishing Company
- Bio-nanotechnology: concepts and applications, Madhuri Sharon ,Maheshwar Sharon, 2013, CRC Press
- Introduction to nanoscience and nanotechnology, Boca Raton, G.L. Hornyak, H.F. Tibbals, J. Dutta , J. Moore, CRC Press
- A textbook of Nanoscience and Nanotechnology, B.S. Murty, 2012, Orient Blackswan Private Limited - New Delhi
- Environmental Nanotechnology, M. H. Fulekar, Bhawana Pathak, 2018, CRC Press
- A textbook of Nanoscience and Nanotechnology, T. Pradeep, 2012, Tata McGraw Hill Education Private Limited.