SARVAJANIK UNIVERSITY

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Faculty of Science

SHREE RAMKRISHNA INSTITUTE OF COMPUTER EDUCATION AND APPLIED SCIENCES, SURAT

M.Sc. Microbiology

Syllabus

(Effective from 2021)

M.T.B College Campus, B/h P.T.Science College, Opp. Chowpati,
Athwalines, Surat-395001 Gujarat, India
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M.Sc. Microbiology	
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A. About M.Sc. Microbiology Programme

The M.Sc. Microbiology programme offered by Sarvajanik University is of two years' duration and is divided into four semesters. The various courses of the programme are designed to include classroom teaching and lectures, laboratory work, project work, viva, seminars, assignments and field trips. Three categories of courses are being offered in this programme: Core courses, Skill enhancement courses and Elective course. A separate research-based course that leads to a dissertation is also one of the Core Courses offer in the final semester. The student presents his/ her research orally at the end of the semester, and this is coupled to a *viva-voce*. This not only equips the student for a career in research/ industry, but also fosters self-confidence and self-reliance in the student as he/she learns to work and think independently. Thirty percent of the total marks for each course will be awarded through Internal Assessment. 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.

B. Programme Objective

- Through the stimulus of scholarly progression and intellectual development the programme aims to equip students with excellence in education and skills, thus enabling the student to pursue a career of his/her choice.
- By cultivating talents and promoting all round personality development through multi-dimensional education a spirit of self-confidence and self-reliance will be infused in the student.
- The student will be instilled with values of professional ethics and be made ready to contribute to society as responsible individuals.

C. Eligibility

- A candidate must have passed Bachelor's degree in Microbiology / Medical Technology/Biotechnology/Environmental Science / Industrial Microbiology /Bioscience / General Science/ Life-Science / Botany/Plant Science/Zoology/Animal Science/ Biology /Agriculture/Fisheries/Forestry /others.

- 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. M.Sc. Microbiology Course Structure

Sem	Course Type	Course Code	Paper Title	Hours/Week		Credit
				Th	Pr	
1	Core course	DSC-1	Principles of Microbiology & Microbial Diversity	4	4	4+2
		DSC-2	Agriculture & Environmental Microbiology	4	4	4+2
	SEC	SEC-1	Molecular biology & Genetic Engineering	4	4	4+2
	Elective	DSE-1		4	4	4+2
2	Core course	DSC-3	Microbial Physiology & Metabolism	4	4	4+2
		DSC-4	Immunology and molecular pathogenesis	4	4	4+2
	SEC	SEC-2	Instrumentation and analytical techniques	4	4	4+2
	Elective	DSE-2		4	4	4+2
3	Core course	DSC-5	Economic Microbiology	4	4	4+2
		DSC-6	Enzyme Technology & Protein Engineering	4	4	4+2
	SEC	SEC-3	Pharmaceutical Microbiology & Drug Development	4	4	4+2
	Elective	DSE-3		4	4	4+2
4	Core course	DSC-7	Dissertation	32		16
		DSC-8	Seminar Presentation			4
		DSC-9	Review of published research paper/Article			4
					Total Credit	96
Note: DSC – Discipline Specific Core, DSE - – Discipline Specific Elective, SEC - Skill Enhancement Course						

Semester	DSE (Any one to be opt)
1	1. Food Chemistry 2. Energy and Environment 3. Laboratory safety and management 4. Bioethics & Biosafety
2	1. Forensic Chemistry & Toxicology 2. Bioinformatics & Other “OMICS” 3. IPR 4. Biostatistics.
3	1. Forensic biology and DNA typing 2. Research Methodology 3. Bioentrepreneurship 4. Application of Green Chemistry

E. Evaluation Scheme

M.Sc. Microbiology					
Evaluation	**Criteria**	**Theory**	**Practical**	**Dissertation**	**Seminar/ Review of published research paper**
Internal	Continuous & Comprehensive Evaluation (CCE)	40	60	140	60
	Attendance	10	10	10	10
	Assignment	20	----	----	----
	Internal Practical Test and Viva – Voce /	----	70	----	----
	Internal assessment	----	----	50	30
External	External Evaluation	30	60	100	50
	Total	100	200	300	150

F. Syllabus

Semester 1

Principles of Microbiology & Microbial Diversity

Name of faculty: Science	**Department:** Microbiology
Program: M. Sc Microbiology Sem-I	**Type:** DSC-1
Subject: Principles of Microbiology & Microbial Diversity	
Credit: 4+2	**Total learning hours:** 60
Course description: This course introduces students of diverse fields of biological science, to the fundamentals of microbiology. It furnishes the knowledge about historical aspects, structural, technical and applied aspects, as well as phylogenetic aspects related with microorganisms. Furthermore, it also provides in-depth information about diverse groups of microorganisms including those living in extreme conditions.	
Student learning outcome: On completion of this subject, students will learn about • Structure and microscopic observation of various microorganisms, how microbes can grow and how they can be controlled. • Classification of microorganisms, phylogenetic groups of microbes. • Properties, reproduction and cultivation of viruses, fungi, algae and protozoa. • How microbes survive under extreme conditions.	

Unit-1: Introduction to Microbiology & Staining &Microscopic Techniques
(Duration: 09 Hrs)

1.1 Historical breakthrough of microbiology
1.2 Brief survey of microorganisms
1.3 Biology of Procaryotic & Eucaryotic Cell
1.4 Staining & Microscopy

Unit-2: Fundamentals of Bacterial Growth & it's Control (Duration: 10 Hrs)

2.1 Bacterial Growth: Growth Curve, Reproduction & Growth measurement
2.2 Techniques of cultivation & isolation of microorganisms.
2.3 Physical and Chemical Methods for control of microorganisms.
2.4 Antimicrobial agents & Development of Resistance
2.5 Maintenance & preservation of pure cultures

Unit-3: Microbial Taxonomy (Duration: 06 Hrs)

3.1 Classification of Prokaryotic organisms & the Concept of Bacterial Speciation
3.2 Bacterial Nomenclature
3.3 Culture Collections: An Essential Resource for Microbiology
3.4 Prokaryotic domain

3.5 Classification and identification of prokaryotic organisms
3.6 Numerical and polyphasic taxonomy

Unit-4: Bacterial Systematics **(Duration: 07 Hrs)**

4.1 Bergey's Manual: Past and Current Status
4.2 Phylogenetic groups of Bacteria: Proteobacteria, Firmicutes, Actinobacteria
4.3 Phylogenetic groups of Archaea

Unit-5: Virology **(Duration: 07 Hrs)**

5.1 Properties, Structure & Morphology of Viruses.
5.2 Viral Replication Cycle: Lytic and Lysogenic
5.3 Baltimore Classification of Viruses
5.4 Virus Cultivation & Assay

Unit-6: Mycology **(Duration: 07 Hrs)**

6.1 Properties & Structure of Fungi
6.2 Nutritional Requirements
6.3 Fungal Reproduction
6.4 Nomenclature & Classification of Fungi

Unit-7: Phycology & Protozoology **(Duration: 08 Hrs)**

7.1 Properties & Types of Algae
7.2 Algal Reproduction & Diversity
7.3 Algal Photosynthesis
7.4 Properties and Classification of Protozoa
7.5 General Morphology and Reproduction of Protozoa

Unit-8: Extremophiles **(Duration: 11 Hrs)**

8.1 Molecular Physiology, Adaptation & Applications of:
- 8.1.1 Hyperthermophiles
- 8.1.2 Psychrophiles
- 8.1.3 Barophiles
- 8.1.4 Halophiles
- 8.1.5 Acidophiles
- 8.1.6 Alkalophiles

Reference Book:

- Ronald M. Atlas. Principles of Microbiology. 2nd Ed. Mc GrawHill Edu. ISBN: 978-93-392-1987-1
- ALCAMO. Fundamentals of Microbiology. 6th Ed. Jones & Bartlett Publishers. ISBN: 0-7637-1067-9
- David white. The Physiology & Biochemistry of Prokaryotes. 2nd Ed. Oxford University Press. ISBN: 0-19-512579-7

- Bergey's Manual of Systematic Bacteriology. 2nd Ed. Vol I. Springer. ISBN: 0-387-98771-1
- Teri Shors. Understanding Viruses. 3rd Ed. Jones & Bartlett Learning. ISBN: 9781-2840-25927
- Fields. Virology. 5th Ed. Vol I. ISBN: 0-7817-6060-7
- J. Webster & R. Weber. Introduction to Fungi. 3rd Ed. Cambridge University Press. ISBN: 978-0-521-72700-6
- Geeta Sumbali. The Fungi. 2nd Ed. Narosa Publishers. ISBN: 978-81-8487-037-4
- J.W. Deacon. Modern Mycology. 3rd Ed. Blackwell Science. ISBN: 0-632-03077-1
- Graham, Graham & Wilcox. Algae. 2nd Ed. Benjamin Cummings. ISBN: 0-321-55965-7
- Michael J. Pelczar, JR. E.C.S. Chen & Noel R. Krieg. Microbiology. 5th Ed. Tata McGraw Hill Publishing Company Ltd. ISBN: 978-0-07-462320-6
- Willey, Sherwood and Woolverton. Prescott's Microbiology 9th Ed. Mc Graw Hill Education ISSN: 978-981-4581-56-1.

Further Reading

- R.L. Kotpal. Protozoa. ISBN: 81-7133-879-8
- Calkins, Gary N. Protozoology. New York Lea & Febiger. ISBN: 9780260805966
- K. Horikoshi & W.D. Grant. Extremophiles. Wiley-Liss. ISBN: 0-471-02618-2
- D.L. Hawksworth. Biodiversity: Measurement and Estimation. Chapman & Hall. ISBN: 041275220-4
- Oladele Ogunseitan. Microbial Diversity. Blackwell Publishers. ISBN: 0-632-04708-9

List of Practical

1) Determine the generation time and specific growth rate of bacterial culture.
2) One step growth curve of bacteria.
3) Isolation & cultivation of fungi from different natural sources.
4) Isolation & cultivation of algae from environmental samples.
5) Isolation of protozoa from soil.

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Agriculture & Environmental Microbiology

Name of faculty: Science	**Department:** Microbiology
Program: M.Sc. Microbiology Sem-I	**Type:** DSC-2
Subject: Agriculture & Environmental Microbiology	
Credit: 4+2	**Total learning hours:** 60

Course description:

This course will provide complete knowledge about importance of microbial community within agriculture and environmental parameters. With detail explanation about use of microbes to solve related problems, including treatment pollution contaminated soil and water, like bioremediation, biodegradation for better environment. This paper will also explain plant growth promotion, improvement in nutrient availability, control of plant pathogens, knowledge about drinking water and wastewater treatment. Paper will critically discuss the need for agricultural and environmental microbiology with their expanded uses and limitations, clarifying appliance of microorganisms in varied fields of agricultural and environmental microbiology.

Student learning outcome:

- Importance and use of microbes in agriculture and environmental fields
- How to solve agriculture and environment related problems with related applications of different microbes
- How to substitute chemical fertilizers and pesticides with microbial origin sources
- Improvement in plant growth, quality of drinking water, wastewater and reuse of wastewater, to fulfil demand of water in society .

Unit-1: Soil Microbiology **(Duration: 08 Hrs)**

1.1 Microorganism in soil environment
1.2 Decomposition of organic matter and Biochemical cycles
1.3 Mining Microbiology

Unit-2: Agriculture Microbiology **(Duration: 08 Hrs)**

2.1 Microbial Biofertilizers & Rhizobial inoculants
2.2 Ectomycorrhizal fungi & Arbuscular mycorrhizal fungi
2.3 Endophytes for sustainable agriculture
2.4 Production of Microbial Insecticides
2.4 Biopesticides

Unit-3: Plant pathology **(Duration: 06 Hrs)**

3.1 Plant diseases: Types and control measures
3.2 Role of Nanoparticles in Plants
3.3 Toxicity of Nanomaterials to Plants

Unit-4: Biodegradation **(Duration: 08 Hrs)**

4.1 Growth linked Biodegradation: Acclimation, Detoxication, Activation, Kinetics
4.2 Bioavaibility and Cometabolism
4.3 Inoculation

Unit-5: Bioremediation **(Duration: 08 Hrs)**

5.1 Management and Remediation of soils problem
5.2 Bioremediation Technologies: *In Situ* & *Ex Situ*
5.3 Bioremediation of metals and Inorganic pollutants

Unit-6: Treatment of pollutants **(Duration: 08 Hrs)**

6.1 Pesticides
6.2 Textile Effluent
6.3 Nuclear waste
6.4 Food and dairy waste
6.5 Sugar and distillery waste
6.6 Pharmaceuticals and Hospital waste treatment

Unit-7: Water and Waste Water Treatment **(Duration: 08 Hrs)**

7.1 Drinking Water
7.2 Constituent of waste water
7.3 Biological treatment of waste water
7.4 Waste water Reclamation and Reuse
7.5 Public health and environmental issues in water Reuse

Unit-8: Aquatic Microbiology **(Duration: 06 Hrs)**

8.1 Algal Blooms
8.2 Microbial Mats
8.3 Biofilms

Reference Book:

- Bhoopander Giri,Ram Prasad,Qiang Sheng, Wu, Ajit Varma. Biofertilizers for sustainable Agriculture and Environment.Springer.(2019).ISBN 978-3-030-18932-7, ISBN 978-3-030-18933-4 (E book)
- G.Rangaswami and D.J.Bagyaraj. Agriculture Microbiology 2nd edition .Prentice Hall of India private Limited New Delhi 110001 (2009) ISBN 9788120306684.
- Manzer H. Siddiqui · Mohamed H. Al-Whaibi Firoz Mohammad Nanotechnology and Plant Sciences Nanoparticles and Their Impact on Plants..(2015) ISBN 978-3-319-14502-0 (eBook) ISBN. Springer Cham Heidelberg New York Dordrecht London 978-3-319-14501-3
- Martin Alexander. Biodegradation and Bioremediation 2nd Edition Academic press An Imprint of Elsevier.ISBN 13:978-0-12-049861-1 ; ISBN-10:12-049861-8

- Metcalf and Eddy Waste Water Engineering Treatment and Reuse. McGraw Hill Education (India) 4th edition (2003).ISBN 13:978-0-07-049539-5; ISBN 10:0-07-049539-4
- Mukesh Doble and Anil Kumar . Biotreatment of Industrial Effluents Butterworth-Heinemann An Imprint of Elsevier . (2005) ISBN 978-0-7506-7838-4
- Pradipta Kumar Mohapaatra. Textbook of Environmental Biotechnology I.K. International Publishing House Pvt ltd. (2006) ISBN 81-88237-54-X
- T.M.Schmidt and M.Schaechter .Topics in Ecology and Environmental Microbiology Edited by Academic Press (2012).ISBN;978-0-12-383878-0

Further Reading:

- Eve Riser –Roberts Remediation of Petroleum Contaminated Soils .Biological, Physical and Chemical Processes . Lewis Publihers .1998 ISBN 0-87371-858-5
- Soli J Arceivala Shyam R Asolekar .WasteWater Treatment for Pollution Control and Reuse 3rd edition Mc Graw Hill Education India Pvt Ltd (2007).ISBN (13):978-0-07-0620995

List of Practical

1) Spectrophotometric analysis of Bioremediation of polycyclic aromatic Hydrocarbons by bacteria
2) Determination of Biochemical oxygen demand (BOD)
3) Determination of Total Suspended Solids TSS and TDS
4) Isolation of Cyanobacteria from soil/water from paddy field
5) Bio-oxidation and determination of oxidation rate: Fe, Cu, S (Any one)

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Molecular Biology & Genetic Engineering

Name of faculty: Science	**Department:** Microbiology
Program: M.Sc. Microbiology Sem-I	**Type:** SEC-1
Subject: Molecular Biology & Genetic Engineering	
Credit: 4+2	**Total learning hours:** 60
Course description: The subject offers the in-depth knowledge of the concepts, tools, techniques and process related to Molecular biology and recombinant DNA technology.	
Student learning outcome: ● Understand central dogma of life and compare the molecular biological processes among prokaryotic and eukaryotic cell. ● Understand steps of gene cloning ● Explain the quantification, decoding, cloning and modification of gene and genome ● Explain the features of various types of Enzymes and gene cloning vectors ● Application of genetic engineering to various field	

Unit 1: Introduction to Molecular Biology: DNA and RNA (Duration: 08 Hrs)

1.1 The Molecular Nature of Genes
1.2 Semiconservative nature of replication: Bacterial Replication
1.3 Eukaryotic and Archaeal DNA Replication; Breakage and Repair of DNA Strands
1.4 An Early RNA World, The Structure of RNA, Classes of RNA, Synthesis of an RNA Molecule from a DNA Template; Bacterial Transcription; Eukaryotic and Archaeal Transcription
1.5 RNA Molecules and RNA Processing: capping, elongation, and termination, RNA processing, RNA editing, splicing, and polyadenylation, structure and function of different types of RNAs, RNA transport.

Unit 2: Protein synthesis and Post Transcriptional Modifications (Duration: 08 Hrs)

2.1 Protein synthesis and processing: Ribosome, formation of initiation complex, initiation factors and their regulation, Elongation and elongation factors, Termination.
2.2 Genetic code
2.3 Aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase, and translational proof-reading, translational inhibitors,
2.4 Post- translational modification of proteins.

Unit-3: Gene Regulation (Duration: 06 Hrs)

3.1 Control of gene expression at transcription and translation level for prokaryotes;
3.2 Regulating the expression of phages, viruses
3.3 Control of gene expression at transcription and translation level for eukaryotes

Unit-4: Introduction and Molecular Tools for Genetic Engineering (Duration: 08 Hrs)

4.1 General requirements for performing a genetic engineering experiment;

4.2 Enzymes used in Recombinant DNA technology: restriction endonucleases and methylases; DNA ligase, Klenow enzyme, T4 DNA polymerase, polynucleotide kinase, alkaline phosphatase; DNA ligase; linkers; adaptors; homopolymeric tailing;

4.3 labelling of DNA: nick translation, random priming, radioactive and non-radioactive probes,

4.4 hybridization techniques: northern, southern, south-western and far-western and colony hybridization, fluorescence in situ hybridization

Unit-5: Vectors for Gene Cloning (Duration: 08 Hrs)

5.1 Vector used in Gene cloning: Plasmid, Bacteriophage, M13,

5.2 Yeast cloning vector

5.3 Giant vector BAC, HAC PAC

5.4 Vector for Plant Ti plasmid

5.5 Vector of animal cell

Unit-6: Gene Cloning Strategies and PCR Techniques (Duration: 08 Hrs)

6.1 Joining of DNA fragment

6.2 Introduction of DNA in host cell

6.3 Construction of Genomic and cDNA library

6.4 Techniques for selection, screening and characterization of transformants

6.5 Isolation and amplification of specific nucleic acid sequences,

6.6 PCR, RT PCR and qRT PCR variant of PCR, Factors affecting PCR amplification.

Unit-7: Tools for Analysing Gene Expression (Duration: 07 Hrs)

7.1 Methods for analysis of gene expression at RNA and protein level

7.2 Large scale expression, such as micro array-based techniques

7.3 *In vitro* mutagenesis and deletion techniques

7.4 Gene knock out in bacterial and eukaryotic organisms

Unit-8: Applications of Recombinant DNA Technology (Duration: 07 Hrs)

8.1 DNA Fingerprinting & DNA Forensics

8.2 Gene Therapy

8.3 Recombinant products: hormones and vaccines

8.4 Transgenesis in plants Gene transfer to plants, Plants as bioreactor

8.5 Transgenic animals: Retroviral vector method, Cre-*lox P* recombination system

8.6 Safety regulations related to genetic engineering

Reference Book:

- Brown, T. A. (2020). Gene cloning and DNA analysis: an introduction. John Wiley & Sons, ISBN 9781405181730.
- Smita Rastogi and Neelam Pathak, (2009) Genetic Engineering, Oxford University Press; Illustrated edition, ISBN 0195696573.
- Lewin, B. (2008). genes IX. 2008. Jones Barlett Publ. ISBN 0763740632

- Molecular Biology, Robert F. Weaver, McGraw-Hill Higher Education, ISBN 0073525324.
- Primrose, S. B., & Twyman, R. (2009). Principles of genome analysis and genomics. John Wiley & Sons, ISBN 9781405101202
- Watson, J. D. (2004). Molecular biology of the gene. Pearson Education India, ISBN 9332585474
- Glick, B. R., & Patten, C. L. (2017). Molecular biotechnology: principles and applications of recombinant DNA (Vol. 34). John Wiley & Sons, ISBN- 1555812244.

Further Reading

- Chandar, N., & Viselli, S. (2012). Cell and molecular biology. Lippincott Williams & Wilkins, ISBN 978781792103.
- Chaudhuri, K. (2013). Recombinant DNA technology. The Energy and Resources Institute (TERI), ISBN 9788179933206.
- Malathi, V. (2013). Essentials of molecular biology. Pearson, ISBN-10 8131773213
- Mitra, S. (1996). Genetic engineering: principles and practice. McGraw-Hill Education, ISBN 978-9339203535.
- Nicholl, D. S. (2008). An introduction to genetic engineering. Cambridge University Press, ISBN 9780521850063.
- Pal, J. K., & Ghaskadbi, S. S. (2009). Fundamentals of Molecular Biology. Oxford University Press, ISBN 9780195697810.
- Pierce, B. A. (2012). Genetics: a conceptual approach. Macmillan, ISBN 9781319297145.
- Principle of Genetics, Tamrine, Tata McGraw Hill
- Rastogi, S. C. (2006). Cell and molecular biology. New Age International, ISBN 8122414877.
- Recombinant Dna Technology and Genetic Engineering Paperback, K Rajagopa, McGraw Hill Education
- Reece, R. J. (2004). Analysis of genes and genomes (pp. 88-95). Hoboken, NJ: John Wiley & Sons, ISBN 9780071077798.
- Verma, P. S., & Agarwal, V. K. (2004). Cell Biology, Genetics, Molecular Biology, Evolution and Ecology: Evoloution and Ecology. S. Chand Publishing, ISBN 9788121924429.

List of Practical

1) Isolation of Genomic DNA from bacteria and fungi.
2) Isolation of plasmid.
3) RFLP
4) DNA amplification by PCR
5) Study of Transformation in *E. coli* / Yeast
6) RNA isolation from yeast

Food Chemistry

Name of faculty: Science	**Department:** Chemistry
Program: M. Sc. Sem-I	**Type:** DSE-1
Subject: Food Chemistry	
Credit: 04(T) + 02 (P)	**Total learning hours:** 60

Course description:

This course presents concise and relevant information on the composition of foods and the reactions they undergo during processing and storage. The course will deal with the chemistry of the principal components of foods, their properties and interactions. This will provide basic information regarding the food analysis also.

Student learning outcome:

At the end of the course students will be able to:

- Explain the importance of water for stability and quality of foods.
- Understand the relationship between nutrition and human well being
- Know the major and minor components of foods
- Know composition and properties of food
- Explain the basic structures of food constituents
- Understand the basic chemical reaction food constituents undergo during processing
- Identify additives added to foods for different purposes

Unit 1 Water in Food **(06 Hrs)**

1.1 Moisture in foods, definition of water in food, Water as a nutrient

1.2 Types of water and their specific function

1.1 Sorption phenomenon

1.2 Water activity and food stability

1.3 Water activity and packaging

1.6 Water activity and spoilage

Unit 2 Carbohydrates **(10 Hrs)**

2.1 Definition, classification and physical properties

2.2 Nutritive roles of carbohydrate

2.3 Sweetness of sugars, relation of structure to sweetness

2.4 Important carbohydrates in food

(glucose, sucrose, starch, agar, glycogen, cellulose, pectin, gums and resins)

2.5 Carbohydrates: digestion, absorption, metabolism (glycolysis, citric acid cycle, glycogenesis, Glycogenolysis, Gluconeogenesis, hexose monophosphate pathway)

2.6 Retro gradation and staling

2.7 Modified celluloses and starches

2.8 Pectic substances and dietary fibre

2.9 Nonenzymatic browning and Mailard reaction

Unit 3 Lipids **(08 Hrs)**

3.1 Characteristics and classification

3.2 Physical properties-melting point, softening point, specific gravity, refractive index, smoke, flash and fire point, turbidity point

3.1 Chemical properties- reichert meissel value, polenske value, iodine value, peroxide value, saponification value

3.4 Effect of frying on fats

3.5 Changes in fats and oils- rancidity, lipolysis, flavor reversion

3.6 Auto-oxidation, factor affecting rate of oxidation and its prevention, Methods of measuring lipid oxidation- solid fat index, peroxide value, thiobarbituric acid test, anisidine value, Kreis test, oxirane test

3.7 Technology of edible fats and oils- Refining, Hydrogenation and Interesterification

Unit 4 Proteins **(08 Hrs)**

4.1 Protein classification and structure

4.2 Nature of food proteins (plant and animal proteins)

4.3 Denaturation of protein and its implications

4.4 Functional properties of proteins (organoleptic, solubility, viscosity, binding gelation/ texturization , emulsification , foaming)

4.5 Supplementary value of food proteins

4.6 Modification of food protein in processing and storage and its implications

4.7 Reaction of protein in food (Reaction with lipids, sulphites enzymatic hydrolysis, plastein reaction)

Unit 5 Minerals **(04 Hrs)**

5.1 Mineral functions, sources

5.2 Solubility and bioavailability of minerals

5.3 Nutritional aspects of minerals

5.4 Fortification: Iron sources used in fortification

Unit 6 Vitamin **(06 Hrs)**

6.1 Classification, stability, toxicity and sources

6.2 Distribution in foods, loss during processing

6.3 Mechanism of degradation

6.4 Functions and deficiency diseases caused by following vitamins:

6.4.1 Fats soluble vitamins – Vitamin A, D, E and K

6.4.2 Water soluble vitamins – Vitamin C and B-complex

Unit 7 Food additives **(08 Hrs)**

7.1 Definition, need and classification of food additives

7.2 Permitted food additives and their role

7.2.1 Preservatives-Natural and Artificial (Class-I and class-II preservatives)

7.2.2 Antioxidants, Chelating agents, Colouring agents

7.2.3 Curing agents, Emulsions

7.2.4 Flavors and flavor enhancers

7.2.5 Non-nutritive sweeteners

7.2.6 pH control agents

7.2.7 Stabilizer and thickeners

7.2.8 Humectants, Anti-caking agents

7.2.9 Firming agent, Clarifying agent, Flour bleaching agents

Unit 8 Food Analysis **(10 Hrs)**

8.1 Analysis of Chemical Additives in foods

8.1.1 Division of colour additives

8.1.2 Chromatographic identification of colours, quantitative estimation of added dyes in foods (Titanium Trichloride Method)

8.2 Chemical preservatives and synthetic sweetening agents (Organic-ether extractable and non- ether extractable)

8.2.1 Analysis of SO_2 & Sodium Benzoate (Chemical Methods), Sorbic Acid (Chromatography)

8.3 Types of Antioxidants used in Foods

8.3.1 Analysis of Butylated Hydroxy Toluene (BHT) (Spectrophotometry)

8.4 Moisture analysis in food

8.5 Common adulterants in food

8.6 Pesticide analysis of food products

Reference:

1. Fennema's food chemistry, Damodaran, S., Parkin, K. L., & Fennema, O. R., 2007, CRC press.
2. Food science, Potter, N. N., & Hotchkiss, J. H., 2012, Springer Science & Business Media.
3. Principles of food chemistry, DeMan, J. M., Finley, J. W., Hurst, W. J., & Lee, C. Y. 2018, Springer.
4. Food chemistry, Aurand, L. W., Woods, A. E., & Wells, M. R., 1987, Springer, Dordrecht.
5. Food Chemistry, Meyer, L. H., 1982, AVI Publising Company.
6. Foods facts and principles, N. Shakuntala Manay, M. Shdakshara Swamy, 2008, New age International Publisher, New Delhi.
7. Introduction to Chemical Analysis of Foods, S. Suzanna & Nielsen, CBS Publishers & Distributor.
8. Food chemistry, Belitz, H. D., Grosch, W., & Schieberle, P., 2004, Springer, Berlin, Heidelberg.

Laboratory Practical

1. Separation of Amino Acids using Thin Layer Chromatography.
2. Estimation of Vitamin C by Iodometric Titration.
3. Preparation of Lineweaver Burk Plot for Amylaze Enzyme.
4. Qualitative Analysis of Carbohydrates.
5. Determination of pH, Turbidity and TDS of water sample.
6. Determination of D.O. and Conductivity of water sample.
7. Preparation of p-Nitro Chloro benzene from Acetanilide.
8. Preparation of Eosin from Phthalic Acid.
9. Determination of Zn^{+2}/ Cu^{+2} by Complexometric titration.
10. Gravimetric estimation of Ni as Ni (Dimethyl Glyoxime)$_2$ /Ba as $BaSO_4$.
11. Determination of COD of water sample by redox titration.

12. Analysis of fats/oils – Any two of the following:

Acid value, Iodine number, Reichert Meissel number and Saponification value of fats

13. Determination of riboflavin from curry leaves (fluorimetric method).
14. Determination of salt content in commercial table butter.
15. Determination of Moisture in food sample.

References:

1. Standard Methods for Examination of Water & Wastewater, Andrew D. Eaton, Lenore S. Clesceri, Eugene W. Rice, Arnold Greenberg, 23rd Edition, 2017, published by APHA, AWWA, WEF.
2. Official Methods of Analysis, Dr. William Harwitz, Dr. George W Latimer, 18th Edition, 2005, published by Association of Officiating Analytical Chemists (AOAC).
3. Analytical Techniques in Agriculture, Biotechnology and Environmental Engineerin; A. Nag; 1st Edition, 2006, Prentice Hall of India.
4. Laboratory Manual in Biochemistry – J. Jayaraman, 2011, New Age Publication.
5. Manual of analysis of fruits and vegetable products, Central food technological research institute, Mysore, S. Ranganna, 1977, Tata McGraw Hill publishing company Ltd, New Delhi.
6. Biochemical Methods, S. Sadasivam, and A. Manikam, 2nd Edition, 1996, New Age International(p) Ltd. Publishers and Tamil Nadu Agricultural University (Coimbatore).
7. Laboratory techniques in food analysis, D. Pearson, 1973, John Wiley & Sons, New York.
8. Analytical Chemistry, H. Kaur, 1st Edition, 2013, Pragati Prakashan.

Energy and Environment

Course Title	Energy and Environment
Course credit	04+02
Course Hrs	60
Course Objective	The students are expected to understand the importance of energy conservation and become capable to identify the technologies for effective utilization of renewable energy sources.
Course Objective	After learning the subject, students will be able to understand, • Importance of renewable energy sources. • Application of different renewable energy sources. • Impact of energy on ecology, society and environment. • Energy Policy of India and our energy future. • The need, importance and scope of non-conventional and alternative energy.
Course content	**Unit-1: Introduction:** Energy, Units of energy, Law of conservation of energy, Scenario of renewable and non-renewable energy sources, Needs of renewable energy, advantages and limitations of renewable energy, present energy scenario of conventional and RE sources. **Unit-2: Solar Energy:** Sun as source of energy: solar energy potential in India, National solar mission, solar radiation and its spectral characteristics, solar radiation outside the Earth's atmosphere and at the Earth's surface, flat plate and concentrating collectors, solar thermal power generation, fundamentals of solar photo voltaic conversion. **Unit-3: Wind Energy:** Wind power and its sources, modern wind energy-modern wind turbines, wind energy estimation, types of wind energy systems, site selection, details of wind turbine generator. **Unit-4: Bio Energy:** Types of biogas plants, biogas generation, factors affecting biogas generation, advantages and disadvantages of biomass energy, biomass

	gasification, types of gasification. **Unit-5: Ocean thermal energy:** Ocean thermal energy conversion principal, energy from tides, tidal power plants, single and double basin plants, site requirements, advantages and limitations. **Unit-6: Energy, environment and society:** Impact of energy use on the environment, fossil fuel burning and related issues of air pollution, global warming, greenhouse effect, nuclear energy and related issues of radioactive waste, social inequalities related to energy production, distribution and use. **Unit-7: Energy, ecology and environment:** Energy -production, transformation and utilization, associated environmental impacts: Nuclear accidents, pollution, construction of dams, over consumption of energy and its impact on the environment, economy and global change. **Unit-8: Energy policy and our energy future:** Energy statistics in India and world, importance of energy conservation, India's Energy Strategy(National Energy Policy), energy audit definition, energy management system, types of energy audit, Fuel and energy substitution in future.
Reference Books	1. Solar Energy: Principles of Thermal collection and storage, S.P.Sukhatme and J.K.Nayak, McGraw-Hill Education. 2. Elliott, D. 1997. Sustainable Technology, Energy, Society and Environment. New York, Routledge Press. 3. Sathyajith Mathew.2006.Wind energy: fundamental, resources analysis and economics. Springer Berlin Heidelberg, The Netherland ISBN: 139783540309055. 4. M.V.R. Koteswara. Rao, "Energy Resources: Conventional & Non-conventional" BSP Publications,2006. 5. Craig. J.R.,Vaughan, D.J.,Skinner.B.J.1996. Resources of the Earth: Origin, use and environmental impact.(2nd edition). Prentice hall, New Jersey.

	6. Godfrey Boyle, "Renewable Energy Power for A Sustainable Future," Oxford University Press.
Practical/ Demonstration of Equipments	1. Determination of calorific value by Bomb Calorimeter. 2. Solar radiation measurement methods using Pyrheliometer and Pyranometer. 3. VI – characteristics of solar PV system 4. VI – characteristics of Thermister.

Laboratory safety and Management

Name of Faculty: Science	**Department:** Environmental Science
Program: M. Sc.	**Type of Subject:**Theory
Subject: Laboratory safety and Management	
Semester-1 (DSE)	

Student Learning Outcomes (SLOs):

- Be aware of the factors that can lead to an accident.
- Discuss toxicology, industrial hygiene, source models, dispersion models, , fires and fire prevention, explosions and explosion prevention, electrostatics, pressure relief systems, runaway reactions, and risk analysis as they apply to chemical process safety, and be able to solve corresponding problems.
- Discuss the nature of the accident process and methods used in accident investigation, inherently safer design strategies, and the various strategies and governmental regulations relevant to process safety management.

References and Textbooks: (With Author, Edition, Publishers, ISBN)

1. Industrial Hygiene & Chemical Safety - M.H.Fulekar: I. K.International Publishing House, New Delhi.

2. Industrial Hygiene Reference And Study Guide- Allan K. Fleeger, Dean Lillquist, AIHA, 01-May-2006

3. Personal Protective Equipment -Guide to Ports/Dock Workers - M.H.Fulekar : Government of India's Publication

4. Fundamentals of Industrial Hygiene-Barbara A. Plog, Patricia J. Quinlan, National Safety Council Press, 2002

5. Occupational safety management and engineering, Willie Hammer, Dennis Price, Prentice Hall, 2001

6. Industrial Safety and Health Management, C. Ray Asfahl, David W. Rieske, Prentice Hall, 31-Jul-2009

7. Fundamentals of Occupational Safety and Health, Mark A. Friend, James P. Kohn, Government Institutes, 16-Aug-2010

8. Handbook of occupational safety and health, Louis J. DiBerardinis, John Wiley, 1999

9. Occupational Hygiene. Blackwell Science, Harrington, J.M. & K. Gardiner. 1995, Oxford.

10. Industrial Hygiene Evaluation Methods. Micheal S. Bisesi. CRC Press, 28-Aug-2003

Unit-1: Introduction of Industrial Hygiene (7 Lecture)

1.1 Definition, scope and applications

1.2 Occupational Environmental Stress: Physical & Chemical

1.3 Airborne chemicals: Dust or aerosols (respirable and non respirable, inhalable and total dust), gases, fumes, vapours, mist and smoke.

1.4 Concept of threshold limiting values

UNIT-2: Biosafety (7 Lecture)

2.1 Introduction; Historical Backround

2.2 Introduction to Biological Safety Cabinets and types

2.3 Primary Containment for Biohazards and Biosafety Levels of Specific Microorganisms

2.4 Recommended Biosafety Levels for Infectious Agents and Infected Animals

UNIT-3 Safety Precautions (7 Lecture)

3.1 Precautions: Process and operations involving explosives, flammables, toxic substances, dusts, vapors, cloud formation & combating.

3.2 Safety precautions for transportation for hazardous chemicals; Handling and storage of hazardous chemicals.

3.3 Respiratory personal protective equipment (RPPE) & non respiratory personal protective equipment (NRPPE): head protection , ear protection , face and eye protection , hand protection, foot protection and body protection.

UNIT-4 Fire and Explosion (7 Lecture)

4.1 Fire phenomena, classification of fire and extinguishers.

4.2 Statutory and other standards.

4.3 Fire prevention & protection system.

4.4 Explosion phenomena, explosion control devices, fire awareness.

UNIT-5 Electrical Safety: (7 Lecture)

5.1 Electricity and Hazardous, Indian standards.

5.2 Effects of electrical parameters on human body.

5.3 Safety measures for electric works.

UNIT-6 Noise and Vibration: (7 Lecture)

6.1 Noise: generation, types and permissible limit

6.2 measurement and evaluation of noise

6.3 control methods: control of source, isolation, sound proofing and practicing aspects of control of noise

6.4 vibration: generation, types and control

Unit-7 Hazards & Risk identification, Assessment and control techniques: (7 Lecture)

7.1 Hazards, Risks & detection techniques, Preliminary hazard analysis(PHA) & hazard analysis(HAZAN)

7.2 Failure mode effect analysis(FMEA), Hazard and operability(HAZOP) study.

7.3 Hazard ranking (DOW & MOND index), Fault tree analysis, Event tree analysis(ETA)

7.4 Major accident hazard control, onsite and off-site emergency plans.

Unit-8 Storage hazards **(7 lecture)**

8.1 safety measures for storage of flammable liquids/solvents, acid and alkali, chlorine and ammonia

8.2 safety of storing gas cylinders, color coding, marking and ensuring safe connection of cylinder

8.3 design of storage shed or go-down, retention basin, catch pot or dump vessel. Safe placement of containers.

Practicals:

1. Preparation of Material Safety Data Sheet for some common chemicals.
2. To neutralize the given sample using NaOH / HCL/ CaCO3
3. Determination of CO2 from the atmosphere by volumetric method in a workplace Environment.
4. Estimate Noise Levels at different locations.

Bioethics & Biosafety

Name of Faculty: Science	**Department:** Biotechnology
Program: M. Sc. Sem-I	**Type:** DSE-1
Subject: Bioethics & Biosafety	
Credit: 04	**Total Learning Hours:** 60
Course Description: This course introduces students to basic concepts of Bioethics & Biosafety. It will also inculcate the importance, need & applications of these areas in the students of any applied science branch. It will provide information about rules, regulations, laws, acts & protocols regarding bioethics & biosafety to be followed in different fields of science.	
Student Learning Outcome: After completion of the course, students will be: 1)Student will be able to appreciate the importance of Bioethics & Biosafety 2)Student will be able to implement necessary bioethics rules & regulations wherever needed in practice 3) Student will be able to identify the need of safety & will to execute it in practical life.	

Unit 1 Introduction (07 Hours)

1.1 History & Definitions of Ethics & bioethics

1.2 History & Definitions of Safety & Biosafety

1.3 Applications of Bioethics

1.4 Applications of Biosafety

1.5 Environment Ethics

Unit 2 Ethical, Legal, Social Issues – I (09 Hours)

2.1 Prenatal Diagnosis & Genetic manipulation

2.2 Biotechnology

2.3 Genetically modified Organism: Foods & Crops

2.4 Stem Cell Research

2.5 Organ transplantation & Xenotransplantation

Unit 3 Ethical, Legal, Social Issues – Ii (09 Hours)

3.1 Biodiversity & Resource management

3.2 Human & animal Cloning

3.3 Animal Testing & Animals in Research

3.4 Testing of Drugs on Human Volunteers

3.5 Assisted Reproductive Technologies (ART)

Unit 4 Hazardous Materials – Handling & Disposal (07 Hours)

4.1 Hazards & Biohazards (biological agents) with their types/ categories

4.2 Disposal of chemical wastes & hazardous wastes

4.3 Material Safety Datasheet (MSDs)

4.4 Controlling the exposure to hazardous substances

4.5 Duties, immunization & first aid of employees

Unit 5 Risk Assessment & Containment (07 Hours)

5.1 Risk Assessment

5.2 Containment Levels

5.3 Containment in Animal lab

5.4 Containment in Plant tissue culture Lab

5.5 Containment in Microbiological lab

Unit 6 Biosafety (07 Hours)

6.1 Risk Assessment of Planned introduction & Biotechnology products

6.2 Planned introduction & Field trials of GM plants

6.3 Planned introduction of GE organisms

6.4 Biosafety during industrial production

6.5 Risk & Safety management in ART & stem cell research

Unit 7 Regulations & Guidelines – I (07 Hours)

7.1 NIH guidelines

7.2 ICH International Community Harmonization guidelines

7.3 Regulatory Framework for GE Plants in India

7.4 Indian Biosafety guidelines

7.5 Laboratory Biosafety Manual of WHO

Unit 8 Regulations & Guidelines – Ii (07 Hours)

8.1 Cartagena Protocol

8.2 ART regulation Bill

8.3 National Regulatory Bodies for Biosafety in India

8.4 Ethical Guidelines for Biomedical research involving human subjects

8.5 National Guidelines for Stem Cell Research

Reference Books

- Bioethics & Biosafety by M K Sateesh, I K International Pub. Ltd
- Biotechnology Expanding Horizons by B D Singh, Kalyani Pub.

Web Resources

- Biosafety resource book by FAO http://www.fao.org/3/i1905e/i1905e00.htm
- Biosafety Manual by WHO https://www.who.int/csr/resources/publications/biosafety/Biosafety7.pdf
- ICMR Bioethics Unit https://ethics.ncdirindia.org/

Practical

1) Case study on Bioethics

2) Project on Analysis of Biosafety measures / First aid of any Institute/lab/ Industrial unit

3) Visit to an industry to study safety measures