

SANKALCHAND PATEL UNIVERSITY, VISNAGAR

Faculty of Science and Humanities



Structure, Teaching Scheme and Syllabus of B.Sc. (Honours) Microbiology as per NEP 2020

Program Code: SC102

With effect from:2023-24

Graduate attributes (Generic learning outcomes)

Program Out Comes:

PO1: *Complex problem-solving*: The graduates should be able to demonstrate the capability to solve different kinds of problems in familiar and non-familiar contexts and apply the learning to real-life situations.

PO2: *Critical thinking*: The graduates should be able to demonstrate the capability to:

- apply analytic thought to a body of knowledge, including the analysis and evaluation of policies, and practices, as well as evidence, arguments, claims, beliefs, and the reliability and relevance of evidence,
- identify relevant assumptions or implications; and formulate coherent arguments,
- identify logical flaws and holes in the arguments of others,
- analyze and synthesize data from a variety of sources and draw valid conclusions and support them with evidence and examples.

PO3: *Creativity*: The graduates should be able to demonstrate the ability to:

- create, perform, or think in different and diverse ways about the same objects or scenarios,
- deal with problems and situations that do not have simple solutions,
- innovate and perform tasks in a better manner,
- view a problem or a situation from multiple perspectives,
- think ‘out of the box’ and generate solutions to complex problems in unfamiliar contexts,
- adopt innovative, imaginative, lateral thinking, interpersonal skills and emotional intelligence.

PO4: *Communication Skills*: The graduates should be able to demonstrate the skills that enable them to:

- listen carefully, read texts and research papers analytically and present complex information in a clear and concise manner to different groups/audiences,
- express thoughts and ideas effectively in writing and orally and communicate with others using appropriate media,
- confidently share views and express herself/himself,
- construct logical arguments using correct technical language related to a field of learning, work/vocation, or an area of professional practice, and convey ideas, thoughts, and arguments using language that is respectful and sensitive to gender and other minority groups.

PO5: *Analytical reasoning/thinking*: The graduates should be able to demonstrate the capability to:

- evaluate the reliability and relevance of evidence;
- identify logical flaws in the arguments of others;
- analyze and synthesize data from a variety of sources; draw valid conclusions and support them with evidence and examples, and address opposing viewpoints.

PO6: *Research-related skills:* The graduates should be able to demonstrate:

- a keen sense of observation, inquiry, and capability for asking relevant/ appropriate questions,
- the ability to problematize, synthesize, and articulate issues and design research proposals,
- the ability to define problems, formulate appropriate and relevant research questions, formulate hypotheses, test hypotheses using quantitative and qualitative data, establish hypotheses, make inferences based on the analysis and interpretation of data, and predict cause-and-effect relationships,
- the capacity to develop appropriate methodology and tools for data collection,
- the appropriate use of statistical and other analytical tools and techniques,
- the ability to plan, execute and report the results of an experiment or investigation.

PO7: *Coordinating/collaborating with others:* The graduates should be able to demonstrate the ability to:

- work effectively and respectfully with diverse teams,
- facilitate cooperative or coordinated effort on the part of a group,
- act together as a group or a team in the interests of a common cause and work efficiently as a member of a team.

PO8: *Leadership readiness/qualities:* The graduates should be able to demonstrate the capability for:

- mapping out the tasks of a team or an organization and setting direction.
- formulating an inspiring vision and building a team that can help achieve the vision, motivating and inspiring team members to engage with that vision.
- using management skills to guide people to the right destination.

PO9: *Learning how to learn skills:* The graduates should be able to demonstrate the ability to:

- acquire new knowledge and skills, including ‘learning how to learn skills, that are necessary for pursuing learning activities throughout life, through self-paced and self-directed learning aimed at personal development, meeting economic, social, and cultural objectives, and adapting to changing trades and demands of the workplace, including adapting to the changes in work processes in the context of the fourth industrial revolution, through knowledge/ skill development/reskilling,

- work independently, identify appropriate resources required for further learning,
- acquire organizational skills and time management to set self-defined goals and targets with timelines.
- inculcate a healthy attitude to be a lifelong learner

PO10: *Digital and technological skills:* The graduates should be able to demonstrate the capability to:

- use ICT in a variety of learning and work situations,
- access, evaluate, and use a variety of relevant information sources, and use appropriate software for analysis of data

PO11: *Multicultural competence and inclusive spirit:* The graduates should be able to demonstrate:

- the acquisition of knowledge of the values and beliefs of multiple cultures and a global perspective to honour diversity,
- capability to effectively engage in a multicultural group/society and interact respectfully with diverse groups,
- capability to lead a diverse team to accomplish common group tasks and goals.
- gender sensitivity and adopting a gender-neutral approach, as also empathy for the less advantaged and the differently-abled including those with learning disabilities.

PO12: *Value inculcation:* The graduates should be able to demonstrate the acquisition of knowledge and attitude that are required to:

- embrace and practice constitutional, humanistic, ethical, and moral values in life, including universal human values of truth, righteous conduct, peace, love, nonviolence, scientific temper, citizenship values,
- practice responsible global citizenship required for responding to contemporary global challenges, enabling learners to become aware of and understand global issues and to become active promoters of more peaceful, tolerant, inclusive, secure, and sustainable societies,
- formulate a position/argument about an ethical issue from multiple perspectives
- identify ethical issues related to work, and follow ethical practices, including avoiding unethical behavior such as fabrication, falsification or misrepresentation of data, or committing plagiarism, and adhering to intellectual property rights,
- recognize environmental and sustainability issues, and participate in actions to promote sustainable development.
- adopt an objective, unbiased, and truthful actions in all aspects of work,
- instill integrity and identify ethical issues related to work, and follow ethical practices.

PO13: *Autonomy, responsibility, and accountability:* The graduates should be able to demonstrate the ability to:

- apply knowledge, understanding, and/or skills with an appropriate degree of independence relevant to the level of the qualification,
- work independently, identify appropriate resources required for a project, and manage a project through to completion,

- exercise responsibility and demonstrate accountability in applying knowledge and/or skills in work and/or learning contexts appropriate for the level of the qualification, including ensuring safety and security at workplaces.

PO14: *Environmental awareness and action:* The graduates should be able to demonstrate and required to take appropriate actions for:

- mitigating the effects of environmental degradation, climate change, and pollution
- effective waste management, conservation of biological diversity, management of biological resources and biodiversity, forest and wildlife conservation, and sustainable development and living.

PO15: *Community engagement and service:* The graduates should be able to demonstrate the capability to participate in community-engaged services/ activities for promoting the well-being of society.

PO16: *Empathy:* The graduates should be able to demonstrate the ability to identify with or understand the perspective, experiences, or points of view of another individual or group, and to identify and understand other people's emotions.

Program Specification Outcomes (PSOs):

PSO1: Students will develop basic as well as advance skill to observe, isolate, identify and cultivate microorganisms.

PSO2: Students will develop theoretical and practical skills of tools and techniques used to study

Semester- III

Branch Name:	B.Sc. Microbiology
Program Code:	SC102
Course Name:	Food and Dairy Microbiology
Course Code:	13-MIM205-2C
Pre-requisite Course:	Basics of Microbiology

Course Objectives:

- To understand natural flora and source of contamination of foods in general
- To understand Microbial Spoilage of various Foods and Foodborne diseases
- To understand methods of Food Preservation
- To understand Fermented dairy products

Teaching and Examination Scheme:

Teaching Scheme (Hours per week)				Evaluation Scheme (Marks)				
Lecture (L)	Tutorial (T)	Practical (P)	Credit	Theory (Marks)		Practical (Marks)		Total (Marks)
				University Assessment	Continuous Assessment	University Assessment	Continuous Assessment	
3	-	2	4	50	25	--	25	100

Subject Contents:

Unit	Content	Total Hours	Weightage
1	A) Foods as a Substrate for Microorganisms Intrinsic and extrinsic factors that affect growth and survival of microbes in foods, natural flora and source of contamination of foods in general B) Microbial Spoilage of various Foods ✓ Principles, Spoilage of vegetables, fruits, meat, eggs, milk, bread, canned Foods C) Food borne diseases (causative agents, foods involved, symptoms and preventive measures) ✓ Food borne intoxications: <i>Staphylococcus aureus</i> & <i>Clostridium botulinum</i> . ✓ Food borne infections: <i>Escherichia coli</i> , Salmonellosis, Shigellosis,	15	34%
2	Principles and Methods of Food Preservation Principles, physical methods of food Preservation : temperature (low, high, canning, drying), irradiation, hydrostatic pressure, high voltage pulse, microwave Processing and aseptic packaging Chemical methods of food preservation: salt, sugar, organic acids, SO ₂ , nitrite and nitrates, ethylene oxide, antibiotics	15	33%
3	Fermented Foods Concept of Starter culture in Dairy Industry. Fermented dairy products: yogurt, acidophilus milk, kumiss, kefir, dahi and cheese Other fermented foods : dosa, sauerkraut, soy sauce and tempeh Probiotics: Health benefits, types of microorganisms used, probiotic foods available in market. An introduction to prebiotic, postbiotics and synbiotic	15	33%

List of Experiments:

1. MBRT of milk samples and their standard plate count.
2. Alkaline phosphatase test to check the efficiency of pasteurization of milk.
3. Isolation of any food borne bacteria from food products.
4. Isolation of spoilage microorganisms from spoiled vegetables/fruits.
5. Preparation of Yogurt/Dahi.

Textbooks:

1. Frazier WC and Westhoff DC. (1992). Food Microbiology. 3rd edition .Tata Mc Graw-Hill Publishing Company Ltd, New Delhi, India
2. Michael Pelczar, text book of microbiology, 5thed.

Reference Books:

1. Adams MR and Moss MO.(1995). Food Microbiology. 4th edition, New Age International (P) Limited Publishers, New Delhi, India.
2. BanwartJM.(1987).Basic Food Microbiology. 1stedition.CBS Publishers and Distributors, Delhi ,India.
3. Davidson PM and Brannen AL.(1993).Antimicrobials in Foods. Marcel Dekker, New York.
4. Dillion VM and Board RG.(1996).Natural Antimicrobial Systems and Food Preservation.CAB International, Wallingford, Oxon.
5. Gould GW. (1995).New Methods of Food Preservation. Blackie Academic and Professional, London.
6. Jay JM, Loessner MJ and Golden DA.(2005).Modern Food Microbiology. 7th edition , CBS Publishers and Distributors, Delhi, India.
7. Lund BM, Baird Parker AC, and Gould GW.(2000).The Microbiological Safety and Quality of Foods.Vol.1-2,ASPENPublication,Gaithersberg, MD.
8. Tortora GJ ,FunkeBR, and Case CL.(2008). Microbiology: An Introduction .9th edition. Pearson Education.

List of Open-Source Software/learning website:

<https://www.youtube.com/watch?v=shWayTlt4hk>
<http://digimat.in/nptel/courses/video/126105013/L04.html>
digimat.in/nptel/courses/video/126104003/L18.html
<https://www.youtube.com/watch?v=0vmXakqsEOs>

Course Learning Outcomes (CLO): On completion of this course, the students will be able to:

CLO	Description	Bloom's Taxonomy Level
CLO1	Enlist and explain factors affect growth and survival of microbes in foods.	1 Remembering 2 Understanding
CLO2	Discuss causes of microbial Spoilage of various Foods and Food borne infections and isolate microbes responsible for spoilage.	1 Remembering 2 Understanding
CLO3	Learn various Physical and Chemical methods of food preservation and apply it.	2 Understanding 3 Applying
CLO4	Acquire and apply the knowledge various Fermented foods and starter culture.	1 Remembering 2 Understanding 3 Applying
CLO5	Understand the concept and advantages of fermented food and Probiotics and analyze its importance in the society.	1 Remembering 2 Understanding 4 Analyzing
CLO6	Understanding the concept and formation of Starter culture , fermented food and Probiotics which helps in dairy industry and other food industries.	5 Evaluating 6 Creating

Mapping of CLO s with POs & PSOs

[illegible]

Branch Name:	B.Sc. Microbiology
Program Code:	SC102
Course Name:	Molecular Biology
Course Code:	13-MIM206-2C
Pre-requisite Course:	Basics of cell biology and biochemistry

Course Objectives:

- To understand the core and fundamental processes that are operated at the level of gene in unicellular and multicellular systems.
- To understand the basics of DNA & RNA, Genetic Material, DNA Replication, Transcription and Translation are the processes.
- To gain the thinking skills that needs to understand before going for advanced genetic techniques.

Teaching and Examination Scheme:

Teaching Scheme (Hours per week)				Evaluation Scheme (Marks)				
Lecture (L)	Tutorial (T)	Practical (P)	Credit	Theory (Marks)		Practical (Marks)		Total (Marks)
				University Assessment	Continuous Assessment	University Assessment	Continuous Assessment	
3	-	2	4	50	25	--	25	100

Subject Contents:

Unit	Content	Lectures	Weightage
1	A) Structures of DNA and RNA /Genetic Material - DNA Structure: Miescher to Watson and Crick-historic perspective - DNA structure, Salient features of double helix, Forms of DNA, Types of RNA - Experiments proving DNA as Genetic Material (B) Replication of DNA - Bidirectional and unidirectional replication, - Mechanism of DNA replication: Enzymes and proteins involved in DNA replication–DNA polymerases, DNA ligase, primase, telomerase–for replication of linear end. - Various models of DNA replication including rolling circle, Θ(theta) mode of replication, Yoshikawa Model of DNA Replication	13	30 %
2	Transcription - Transcription: Definition, - Promoter- concept and strength of promoter - RNA Polymerase and the transcription unit, general Transcription factors - Post-Transcriptional Processing - Split genes, concept of introns and exons, RNA splicing, spliceosome machinery, - Concept of alternative splicing, Polyadenylation and capping, Processing of rRNA, RNA interference: siRNA, miRNA and its significance	14	30 %
3	Translation and Gene regulation Genetic Code	18	40 %

	• Translational machinery, Charging of t-RNA, aminoacyl t-RNA synthetases, Mechanisms of initiation, elongation, and termination of polypeptides in prokaryotes and eukaryotes. • Post Translational modification in protein. • Antibiotics that affect the process of Translation in Prokaryotes Regulation of gene expression • Regulation of gene expression in prokaryotes: lac operon, trp operon and Immunity operon of bacteriophage Lambda.		
--	---	--	--

List of Experiments:

1. To isolate Genomic DNA from Fungi.
2. To isolate Genomic DNA from Bacteria.
3. To perform qualitative analysis of DNA by Agarose Gel Electrophoresis
4. To estimate RNA by orcinol method
5. To estimate DNA by DPA method
6. To discuss and schematically demonstrate the semi-conservative nature of DNA replication
7. To discuss and demonstrate the experimental evidence of DNA as a genetic material.

Textbooks:

1. Lehninger: Principles of Biochemistry.
2. Gardner EJ, Simmons M J, Snustad DP (2008). Principles of Genetics.8th Ed. Wiley-India

Reference Books:

1. Watson JD, Baker TA, Bell SP, Gann A, Levine M and Losick R (2008) Molecular Biology of the Gene, 6th edition, Cold Spring Harbour Lab. Press, Pearson Publication
2. Becker WM, Kleinsmith LJ, Hardin J and Bertoni GP (2009) The World of the Cell, 7th edition, Pearson Benjamin Cummings Publishing, San Francisco
3. De Robertis EDP and De Robertis EMF (2006) Cell and Molecular Biology, 8th edition. Lippincott Williams and Wilkins, Philadelphia
4. Karp G (2010) Cell and Molecular Biology: Concepts and Experiments, 6th edition, John Wiley & Sons. Inc.
5. Sambrook J and Russell D W. (2001). Molecular Cloning :A Laboratory Manual 4th Edition, Cold Spring Harbour Laboratory press.
6. Krebs J, Goldstein E, Kilpatrick S. (2013). Lewin's Essential Genes, 3rd Ed., Jones and Bartlett

List of Open-Source Software/learning website:

<https://www.youtube.com/watch?v=sQgwDgJX2ZQ>
<https://www.visiblebody.com/blog/dna-and-rna-basics-replication-transcription-and-translation>
[digimat.in/nptel/courses/video/102106096/L08.html](http://www.digimat.in/nptel/courses/video/102106096/L08.html)
<http://www.digimat.in/nptel/courses/video/121106008/L20.html>

Course Learning Outcomes (CLO): On completion of this course, the students will be able to:

CLO	Description	Bloom's Taxonomy Level
CLO1	Gain a core knowledge base in the fundamental theory and practice of modern Biochemistry and Molecular Biology	1 Remembering 2 Understanding
CLO2	Comprehend the central dogma of molecular biology, and the essential details of some basic biological processes such as replication, transcription, translation in eukaryotes and prokaryotes and compare them.	1 Remembering 2 Understanding 4 Analyzing
CLO3	Assess the importance of various biochemical processes, and their regulation.	2 Understanding 3 Applying 4 Analysing
CLO4	Discuss various basic mechanism in controlling replication transcription and translation	1 Remembering 2 Understanding 4 Analyzing
CLO5	Evaluate mechanism of splicing and protein modification which controls the central dogma.	2 Understanding 5 Evaluating

CLO6	Gain insight into the most significant molecular and cell-based methods used today to expand and apply our understanding of biology for formation of various Recombinant products.	2 Understanding 3 Applying 6 Creating
------	--	---

Mapping of CLO s with POs & PSOs

Course Learning Outcomes	Program Outcomes (POs)																Program Specific Outcome (PSOs)	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	PSO1	PSO2
CLO1	1	1	1		1	1												1
CLO2	1	3	1		1	1									2			2
CLO3	1	3	1		2	2			2						1			3
CLO4	2	3	1		3	3			3									2
CLO5	2	3	3		3	3			3						3			3
CLO6	3	3	3		3	3			3									3

3: High, 2: Medium, 1: Low

Branch Name:	B.Sc. Microbiology
Program Code:	SC102
Course Name:	Inheritance Biology
Course Code:	13-MIM207-2C
Pre-requisite Course:	Basics of cell

Course Objectives:

- This course is designed to acquire basic knowledge inheritance and to enable students to brush up the concepts of classical genetics.
- To understand sex determination and differentiation.
- To give insight of mutation, DNA repair and human cytogenetics.

Teaching and Examination Scheme:

Teaching Scheme (Hours per week)				Evaluation Scheme (Marks)				
Lecture (L)	Tutorial (T)	Practical (P)	Credit	Theory (Marks)		Practical (Marks)		Total (Marks)
				University Assessment	Continuous Assessment	University Assessment	Continuous Assessment	
3	-	2	4	50	25	--	25	100

Subject Contents:

Unit	Content	Total Hours	Weightage
1	Mendel's work, laws of heredity, Back & Test cross, Complete and Incomplete dominance Linkage: History, Kinds of Linkage, linkage groups, Concept of linkage map, genetic distance Vs physical distance, Determination of linkage map. Types of Crossing over, mechanism of Meiotic Crossing over Introduction of mapping by tetrad analysis, cytological detection of Crossing over, significance of Crossing over. Allelic Variation & Gene function: Multiple allele, Genetic interaction: Epistasis interactions, Non-Epistatic interactions, Pleiotropism	15	33 %
2	Sex linkage in Drosophila/ Neurospora, Sex-Limited and Sex Influenced Traits Determination of sex and sex differentiation: • Genetical controlled of sex determination mechanism • Metabolically and hormonally controlled sex determination mechanism • Environmentally controlled sex determination Sex differentiation. Non-Mendelian/ Cytoplasmic inheritance Eugenics and eugenics, Euphenics	15	33 %
3	Human cytogenetics: Human karyotype, Banding techniques, Inborn metabolic disorders, inherited disorders- Allosomal (Klinefelters syndrome and Turners Syndrome), Autosomal (Down syndrome and Cri-Du chat Syndrome), Pedigree analysis. Mutations: Types-Spontaneous and Induce, Mutagen-Physical and Chemical, Mutation at Molecular level(Gene Mutation) , Chromosomal variation in Number & Structure DNA repair mechanism: Direct and indirect mechanism, Photoreactivation, SOS mechanism.	15	34 %

List of Experiments:

1. Isolation antibiotic mutant by replica plate method
2. Isolation antibiotic mutant by gradient plate method

3. Isolation of Lac- mutant
4. Isolation of pigment mutant.
5. UV survival curve of *E. coli*.
6. Ame's test (demonstration)

Textbooks:

- Cell biology & Genetics: Verma and Agrawal

Reference Books:

- Genetics: principles and analysis. 4 th edition 1998, Denial L. Hartl, Elizabeth tones. Principles of genetics: E.J. Gardner.
- Genes 9: Benjamin Levi
- Lehninger Principles of Biochemistry, 5th Edition, Nelson DL and Cox MM (2008)., W.H. Freeman and Company,
- Microbiology Powar and Dagainawala

List of Open-Source Software/learning website:

<https://knowgenetics.org/mendelian-genetics/>
[https://bioprinciples.biosci.gatech.edu/module-4-genes-and-genomes/4-2-4-mendelian genetics/](https://bioprinciples.biosci.gatech.edu/module-4-genes-and-genomes/4-2-4-mendelian%20genetics/)
<https://www.youtube.com/watch?v=NWqgZUnJdAY>
<https://www.biologyonline.com/dictionary/mutation>
https://onlinecourses.nptel.ac.in/noc22_bt07/preview
https://onlinecourses.swayam2.ac.in/cec21_bt05/preview

Course Learning Outcomes (CLO): On completion of this course, the students will be able to:

CLO	Description	Bloom's Taxonomy Level
CLO1	Discuss the Mendelian work and understand mechanism of heredity.	2 Understanding
CLO2	List and explain the types of genetic interactions.	1 Remembering
CLO3	Enabling students to understand types, advantages and disadvantages mutagens.	2 Understanding
CLO4	Development of capacity to understand sex determination and how there is differentiation.	3 Applying, 2 Understanding
CLO5	Learn about chromosomal variations, evaluate syndromes associated with it, identify and compare the numerical and structural variations and its application	3 Applying 4Analyzing 5 Evaluating,
CLO6	Understand the DNA repair mechanisms and its applications Discuss the mechanisms involved in crossing over predict outcomes of it.	2 Understanding 3 Applying 6 Creating

Mapping of CLO s with POs & PSOs

Course Learning Outcomes	Program Outcomes (POs)																Program Specific Outcome (PSOs)	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	PSO1	PSO2
CLO1	1	3	2			3									2			
CLO2	1	2				3									2		2	
CLO3	1	3	1			3									2			
CLO4	2	3	2		3	3									3			
CLO5	2	3	3		3	3									3		1	2
CLO6	3	3	3		3	3									3			3

3: High, 2: Medium, 1: Low

Branch Name:	B.Sc. Microbiology
Program Code:	SC102
Course Name:	Bioinstrumentation
Course Code:	13-MDC235-2C
Pre-requisite Course:	Basics Biology up to 12 th Science.

Course Objectives:

- To understand various types of spectroscopies.
- To understand the functions of various types of chromatography
- To understand the fundamental aspects of Electrophoresis and Centrifugation.

Teaching and Examination Scheme:

Teaching Scheme (Hours per week)				Evaluation Scheme (Marks)				
Lecture (L)	Tutorial (T)	Practical (P)	Credit	Theory (Marks)		Practical (Marks)		Total (Marks)
				University Assessment	Continuous Assessment	University Assessment	Continuous Assessment	
3	-	2	4	50	25	--	25	100

Subject Contents:

Unit	Content	Total Hour	Weightage
1	Spectroscopy • Interaction of EM radiation with matter : Overview of Electromagnetic spectrum; physical phenomenon : Absorption, Resonance fluorescence, Emission, Refraction, Diffraction, Scattering, Raman Scattering, Resonance Raman Scattering, Beer-Lambert's Laws. • UV-Vis spectrophotometer: Principle, Instrumentation, working and Application • Atomic spectroscopy: Principles and application of Atomic Absorption/Emission Spectrometer	11	25 %
2	Chromatography • Chromatography: Basic Theory of Chromatography, Partition theory and solvent extraction theory • Introduction to key terms: retention time, retardation factor (R_f), elution • Partition and adsorption chromatography • Different techniques of chromatography: Principle, stationary and Mobile phase, operation ,Detection/elution of solute, Application - Planner • Chromatography, (Paper Chromatography, TLC) , GC, Ion exchange chromatography, Gel exclusion chromatography, Affinity chromatography, HPLC and FPLC	16	35 %
3	Electrophoresis : • Theory & principle of electrophoresis • Agarose electrophoresis of nucleic acid • Electrophoresis of protein- polyacrylamide gel (native and SDS-PAGE), Iso-electric focusing of protein • Overview of 2D Gel Electrophoresis Centrifugation: • Theory of centrifugation and sedimentation, • Use and design of different types of rotors • Types of centrifuges: Preparative and analytical centrifugation • Density gradient centrifugation (zonal and isopycnic), differential Centrifugation, Application of centrifugation for preparative and analytical purpose.	18	40 %

List of Experiments:

1. Principles of Colorimetry: (i) Verification of Beer's law (ii) To determine maximum absorption spectra of coloured solution.
2. Solvent-solvent extraction of plant pigments.
3. Use of paper chromatography for separation of plant pigments
4. Separation of Amino acids by paper chromatography.
5. TLC of Amino acids
6. Demonstration of Ion-exchange chromatography
7. Demonstration of Gel-exclusion chromatography
8. Preparation of the sub-cellular fractions by centrifugation
9. Native gel electrophoresis of proteins.

Textbooks:

- Biophysical chemistry: Principle and techniques by Upadhyay & Nath

Reference Books:

- Principles and techniques of biochemistry & molecular biology by Keith Wilson & John Walker
- Instrumental methods of analysis by B. Sivasankar
- Instrumental methods of analysis by Willard, Merritt, Dean & Settle
- Instrumental analysis by D.A. Skoog, Holler & Crouch
- Physical Biochemistry by David Freifelder
- Instrumental Methods of Chemical Analysis by Chatwal G and Anand, S.
- Chemical analysis and Instrumentation by B.k.Sharma

List of Open-Source Software/learning website:

<https://www.youtube.com/watch?v=FX-NiPVsYPM>

<http://www.digimat.in/nptel/courses/video/104105084/L01.html>

www.digimat.in/nptel/courses/video/104105084/L51.html

<http://www.digimat.in/nptel/courses/video/104105084/L41.html>

Course Learning Outcomes (CLO): On completion of this course, the students will be able to:

CLO	Description	Bloom's Taxonomy Level
CLO1	Describe basics of spectroscopy	1 Remembering, 2 Understanding
CLO2	Explain available knowledge on Chromatography theory	2 Understanding 4 Analyze
CLO3	Illustrate the various types of chromatography and perform the separation of plant pigment and amino acid by paper and thin layer chromatography.	3 Applying
CLO4	Learn, understand and perform basic techniques of Electrophoresis and centrifugation	3 Applying, 2 Understanding
CLO5	Analyze the nucleic acid and proteins by Electrophoresis	4 Analyzing 5 Evaluating
CLO6	Discuss the application of the techniques in various research so that they can apply the knowledge gained	6 Creating

Mapping of CLO s with POs & PSOs

Course Learning Outcomes	Program Outcomes (POs)																Program Specific Outcome (PSOs)	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	PSO1	PSO2
CLO1	1	2			1	1												2
CLO2	1	3				3			1				1					2
CLO3	1	3				1			2									2
CLO4	1	3				2			1									2
CLO5	1	3			1	2			2				2				1	2
CLO6	1	3			1	3			3				3				1	3

3: High, 2: Medium, 1: Low

Branch Name:	B.Sc. Microbiology
Program Code:	SC102
Course Name:	Fungi, Lichens and Plant Pathology
Course Code:	13-MDC237-2C
Pre-requisite Course:	Basics Biology up to 12th Science.

Course Objectives:

- To understand Living systems are based on various biochemical reactions.
- To understand the functions of various biochemical reactions that is basically based on biomolecules like, carbohydrates, lipids, proteins and nucleic acids.
- To understand the fundamental aspects of such bio molecules by opting for such course.

Teaching and Examination Scheme:

Teaching Scheme (Hours per week)				Evaluation Scheme (Marks)				
Lecture (L)	Tutorial (T)	Practical (P)	Credit	Theory (Marks)		Practical (Marks)		Total (Marks)
				University Assessment	Continuous Assessment	University Assessment	Continuous Assessment	
3	-	2	4	50	25	--	25	100

Subject Contents:

Unit	Content	Total Hour	Weightage
1	General characteristics; Affinities with plants. Thallus organization; Cell wall composition; Nutrition; Classification (Ainsworth). • Phycomycetes: Zygomycetidae: Characteristic features. Thallus organisation; Reproduction; Life cycle and classification with reference to <i>Rhizopus</i> . • Ascomycetes: General characteristics (asexual and sexual fruiting bodies); Life cycle and classification with reference to <i>Claviceps</i> . • Basidiomycetes: General characteristics; Life cycle and Classification with reference to <i>Agaricus</i>	15	33 %
2	Allied Fungi: General characteristics; Status of Slime molds, Classification; Occurrence; Types of plasmodia; Types of fruiting bodies. • Lichens: Occurrence; General characteristics; Classification; Study of thallus (morphological and anatomical), Reproduction; Economic importance. • Mycorrhiza: Ectomycorrhiza, Endomycorrhiza and their significance. • Applied Mycology: Application of fungi in food industry (Flavour & texture, Fermentation, Baking, Organic acids, Enzymes, Mycoproteins); Medicines (Pharmaceutical preparations); Agriculture (Bio fertilizers).	15	33 %
3	Terms and concepts; General symptoms. • Geographical distribution of diseases. Host-Pathogen relationships. • Pathogen, Symptoms, Dissemination, Disease cycle and control measures of following plant diseases: Bacterial diseases – Citrus canker. Fungal diseases – White rust of crucifers, Black rust of wheat.	15	34 %

List of Experiments:

1. ***Rhizopus***: study of asexual stage from temporary mounts and sexual structures through permanent slides/photographs/charts.
2. ***Claviceps***: study of asexual stage from temporary mounts. Study of Sexual stage from permanent slides/photographs/charts.
3. ***Agaricus***: Specimens of button stage and full grown mushroom; sectioning of gills of

Agaricus. Permanent slides/photographs/charts.

4. **Lichens**: Study of growth forms of lichens (crustose, foliose and fruticose) on different substrates. Study of thallus and reproductive structure (apothecium) through Permanent slides/photographs/charts/specimen.

5. **Mycorrhizae**: Ectomycorrhiza and Endomycorrhiza (Photographs).

6. **Phytopathology**: Study of Plant diseases: Citrus Canker, White rust of crucifers and Black rust of wheat.

Textbooks:

- Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi and Their Allies, Macmillan Publishers India Ltd.
- Sharma, P.D. (2011). Plant Pathology, Rastogi Publication, Meerut, India.

Reference Books:

- Agrios, G.N. (1997) Plant Pathology, 4th edition, Academic Press, U.K.
- Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley & Sons (Asia) Singapore. 4th edition.
- Webster, J. and Weber, R. (2007). Introduction to Fungi, Cambridge University Press, Cambridge. 3rd edition.

List of Open-Source Software/learning website:

<https://www.youtube.com/watch?v=HtNZQ7KmN2M>

<https://www.youtube.com/watch?v=dRfH0zBjAUo>

<https://www.youtube.com/watch?v=TKOv2XWxoeY>

<https://www.youtube.com/watch?v=Bq65kdCCnGU>

Course Learning Outcomes (CLO): On completion of this course, the students will be able to:

CLO	Description	Bloom's Taxonomy Level
CLO1	Identify true fungi and demonstrate the principles and application of plant pathology in the control of plant disease.	1 Remembering, 2 Understanding 4 Analyze
CLO2	Demonstrate skills in laboratory, field and glasshouse work related to mycology and plant pathology.	2 Understanding 4 Analyzing
CLO3	Illustrate the structure of Lichen.	3 Applying
CLO4	Develop an understanding of microbes, fungi and lichens and appreciate their adaptive strategies.	3 Applying, 2 Understanding
CLO5	Identify the common plant diseases according to geographical locations and devise control measures.	4 Analyzing 5 Evaluating
CLO6	Discuss the mechanisms involved in plant pathogenesis.	6 Creating

Mapping of CLO s with POs & PSOs

Course Learning Outcomes	Program Outcomes (POs)																Program Specific Outcome (PSOs)	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	PSO1	PSO2
CLO1	1	2			1	1											3	3
CLO2	1	3				3			1				1				2	3
CLO3	1	3				1			2								1	2
CLO4	1	3				2			1								1	2
CLO5	1	3			1	2			2				2				3	2
CLO6	1	3			1	3			3				3				3	3

3: High, 2: Medium, 1: Low

Branch Name:	B.Sc. Microbiology
Program Code:	SC102
Course Name:	Grammar and Communication Skill-1
Course Code:	13-AEC203-2C
Pre-requisite Course:	Basics English Grammar Basics English up to F.Y.B.Sc.

Course Objectives:

- To inculcate human values among the students through poems and prose.
- To create an interest in literature and to develop language skills.
- The students will become familiar with formal vocabulary that is common in academic texts.

Teaching and Examination Scheme:

Teaching Scheme (Hours per week)				Evaluation Scheme (Marks)				
Lecture (L)	Tutorial (T)	Practical (P)	Credit	Theory (Marks)		Practical (Marks)		Total (Marks)
				University Assessment	Continuous Assessment	University Assessment	Continuous Assessment	
2	-	--	2	25	25	--	--	50

Subject Contents:

Unit	Content	Total Hours	Weightage
1	VOCABULARY&GRAMMARLINK Phrasal Verbs, Antonyms, Synonyms, Misspelled Words , Part Of Speech:- Noun, Pronoun, Verb, Adverb, Articles :- A, An ,The etc.	9	30%
2	SPEAKING Dialogues Writing:- 1.A dialogue between a doctor and a patient 2.A dialogue between a teacher and a student about studies 3.A dialogue between a country child and a town child 4.A dialogue between mother and daughter about studies 5.A dialogue between a shopkeeper and a customer 6.A dialogue between a traffic warden and a taxi driver 7.A dialogue between the two friends about the choice of profession	6	20%
3	READING&WRITING Letter writing (Personal & Business Letters) and invitations, Telegrams and notices, Paragraph Writing. Translation:- Translate the Accident/Incident Paragraphs given by your teacher from the English News Papers (Teacher has to give small paragraphs at least 5 to 6 paragraphs or more than that for the entire semester based on especially from the pages no. 3 & 4 of The Times of India)	6	20%
4	TEXT Glimpses of Life-An Anthology of Short Stories (Orient Black Swan) Lesson 3 to 7	9	30%

Textbooks:

Glimpses of Life-An Anthology of Short Stories (Orient Black Swan)
Easy to learn English grammar by Dr.Jayesh Patel

Reference Books:

1. Very Useful Verbs book (Enka Publication)
2. Contemporary English Grammar Structure & Composition
3. Murphy R. Intermediate English Grammar(New Delhi: Cambridge University)
4. The Art of Public Speaking by Vijay Kumar.

List of Open-Source Software/learning website:

- englishpage.com
- epaper.timesofindia.com
- epaperindianexpress.com
- <https://www.youtube.com/watch?v=QdAgyD4xhY>

Course Learning Outcomes (CLO): On completion of this course, the students will be able to:

CLO	Description	Bloom's Taxonomy Level
CLO1	Describe how public speaking can be used to advocate or create change	1 Remembering
CLO2	Explain the goals and benefits of public speaking	2 Understanding
CLO3	Use parallel structures correctly and effectively.	3 Applying
CLO4	Identify strategies for researching and supporting a speech	4 Analyzing
CLO5	Recognize when to use visual aids	3 Applying
CLO6	Describe how public speaking can be used to advocate or create change	6 Creating

Mapping of CLO s with POs & PSOs

Course Learning Outcomes	Program Outcomes (POs)																Program Specific Outcome (PSOs)	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	PSO1	PSO2
CLO1	2					3					2					3		
CLO2		1			2		1			3		1			2			
CLO3			3					2					2			2		
CLO4		2					2					2						
CLO5					2					2					2			
CLO6	1					1					1					2		

3: High, 2: Medium, 1: Low

Branch Name:	B.Sc. Microbiology
Program Code:	SC102
Course Name:	Green Chemistry
Course Code:	13-SEC212-2C
Pre-requisite Course:	

Course Objectives:

- To meet the growing demand of Specialization and Advanced Courses in applied science.
- To make student understand about different terms use in green chemistry.
- To learn about the basic concepts about green chemistry.

Teaching and Examination Scheme:

Teaching Scheme (Hours per week)				Evaluation Scheme (Marks)				
Lecture (L)	Tutorial (T)	Practical (P)	Credit	Theory (Marks)		Practical (Marks)		Total (Marks)
				University Assessment	Continuous Assessment	University Assessment	Continuous Assessment	
2	-	-	2	25	25	-	-	50

Subject Contents:

Unit	Content	Lectures	Weightage
1	Introduction to Green Chemistry Basic Principles of Green Chemistry ; Challenges --pollution control and pollution, Green methods, green products, recycling of waste, International organizations promoting green chemistry, Importance of PTC, Ionic Liquids, Ultrasound assisted reactions.	15	50%
2	Designing Green Synthesis Choice of starting materials, choice of reagents, choice of catalysts, Bio catalysts, polymer supported catalysts, choice of solvents, Synthesis involving basic principles of green chemistry, Ultrasound assisted reactions: Esterification, saponification, substitution reactions, Alkylation, oxidation, reduction, coupling reaction, Cannizaro reaction, Strecker synthesis, Knoevenagel Reaction, Reformatsky reaction.	15	50%

Reference Books:

- 1.V.K. Ahluwalia & M.R. Kidwai: New Trends in Green Chemistry, Anamalaya Publishers (2005).
2. P.T. Anastas & J.K. Warner: Oxford Green Chemistry- Theory and Practical, University Press (1998).
3. A.S. Matlack: Introduction to Green Chemistry, Marcel Dekker (2001).

List of Open-Source Software/learning website:

<http://onlinelibrary.wiley.com>

https://en.wikipedia.org/wiki/Main_Page

Course Learning Outcomes (CLO): On completion of this course, the students will be able to:

CLO	Description	Bloom's Taxonomy Level
CLO1	Learn and understand basic principles of green chemistry	1 Remembering 2 Understanding
CLO2	Learn and understand pollution control and waste management.	1 Remembering 2 Understanding
CLO3	Understand the importance of green products and learn choice appropriate assemblies for synthesis.	1 Remembering 2 Understanding
CLO4	Learn different types of green reactions.	2 Understanding 3 Applying

Mapping of CLO s with POs & PSOs

Course Learning Outcomes	Program Outcomes (POs)																Program Specific Outcome (PSOs)	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	PSO1	PSO2
CLO1	2																	
CLO2		1			2							2						
CLO3								1										
CLO4			1								1							

3: High, 2: Medium, 1: Low

Branch Name:	B.Sc. Microbiology
Program Code:	SC102
Course Name:	Food Fermentation Techniques
Course Code:	13-SEC213-2C
Pre-requisite Course:	Basics of Microbiology

Course Objectives:

- To understand types & health benefits of Fermented Foods
- To understand Milk, Grain & Vegetable Based Fermented foods
- To understand Fermented Meat and Fish
- To understand Probiotics Foods

Teaching and Examination Scheme:

Teaching Scheme (Hours per week)				Evaluation Scheme (Marks)				
Lecture (L)	Tutorial (T)	Practical (P)	Credit	Theory (Marks)		Practical (Marks)		Total (Marks)
				University Assessment	Continuous Assessment	University Assessment	Continuous Assessment	
2	-	-	2	25	25	-	-	50

Subject Contents:

Unit	Content	Lectures	Weightage
1	A) Fermented Foods Definition, types, advantages and health benefits (B) Milk Based Fermented Foods Dahi, Yogurt, Buttermilk (Chach) and cheese: Preparation of inoculums, types of microorganisms and production process (C) Grain Based Fermented Foods Soy sauce, Bread, Idli and Dosa: Microorganisms and production process	18	60 %
2	A) Vegetable Based Fermented Foods Pickles, Sauerkraut: Microorganisms and production process (B) Fermented Meat and Fish Types, microorganisms involved, fermentation process (C) Probiotics Foods :Definition types, microorganisms and health benefits.	12	40 %

Textbooks:

- Frazier WC and Westhoff DC. (1992). Food Microbiology. 3rd edition .Tata Mc Graw-Hill Publishing Company Ltd, New Delhi, India
- Michael Pelczar, text book of microbiology, 5th ed.

Reference Books:

- Hui Y H, Meunier-Goddik L, Josephsen J, Nip WK, Stanfield PS (2004) Handbook of food and fermentation technology, CRC Press
- Holzapfel W (2014) Advances in Fermented Foods and Beverages, Woodhead Publishing.
- Yadav JS, Grover, S and Batish VK (1993) A comprehensive dairy microbiology, Metropolitan
- Jay JM, Loessner MJ, Golden DA (2005) Modern Food Microbiology, 7th edition. Springer

List of Open-Source Software/learning website:

<https://www.youtube.com/watch?v=shWayTlt4hk>
<http://digimat.in/nptel/courses/video/126105013/L04.html>
digimat.in/nptel/courses/video/126104003/L18.html
<https://www.youtube.com/watch?v=0vmXakqsEOs>

Course Learning Outcomes (CLO): On completion of this course, the students will be able to:

CLO	Description	Bloom's Taxonomy Level
CLO1	Discuss the types & health benefits of Fermented Foods	1 Remembering 2 Understanding
CLO2	Enlist various microbes used in fermentation of various foods.	1 Remembering 2 Understanding
CLO3	Understand the concept and advantages of Milk Based Fermented foods	2 Understanding 3 Applying
CLO4	Acquire and apply the knowledge Grain & Vegetable Based Fermented foods.	1 Remembering 2 Understanding 3 Applying
CLO5	Understand the concept and advantages of fermented food and Probiotics and analyze its importance in the society.	1 Remembering 2 Understanding 4 Analyzing
CLO6	Understanding the concept and formation of fermented food and Probiotics Foods	5 Evaluating 6 Creating

Mapping of CLO s with POs & PSOs

Course Learning Outcomes	Program Outcomes (POs)																Program Specific Outcome (PSOs)	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	PSO1	PSO2
CLO1						2												3
CLO2						2											1	3
CLO3			2			3											1	3
CLO4		2	2			3											2	3
CLO5					3	3											2	3
CLO6		2	3		3	3											2	3

3: High, 2: Medium, 1: Low

Branch Name:	B.Sc. Microbiology
Program Code:	SC102
Course Name:	DNA Damage and Repair
Course Code:	13-SEC214-2C
Pre-requisite Course:	Basic molecular biology

Course Objectives:

- To provide the knowledge of the causes of DNA damage
- To understand effects of DNA damage
- To understand repair mechanism to maintain the integrity of the treasure of life “DNA”.

Teaching and Examination Scheme:

Teaching Scheme (Hours per week)				Evaluation Scheme (Marks)				
Lecture (L)	Tutorial (T)	Practical (P)	Credit	Theory (Marks)		Practical (Marks)		Total (Marks)
				University Assessment	Continuous Assessment	University Assessment	Continuous Assessment	
2	-	-	2	25	25	-	-	50

Subject Contents:

Unit	Content	Lectures	Weightage
1	Chromosomal Alterations: Structural Alterations, Numerical Alterations Types of Mutations: On the basis of DNA damage: causes and types of DNA damage:	15	50%
2	DNA repair mechanisms: Mismatch DNA repair, nucleotide excision repair, base excision repair, direct DNA repair, SOS response, Photo reactivation, translesion synthesis, recombinational repair, nonhomologous end joining.	15	50%

Textbooks:

Lehninger: Principles of Biochemistry
Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition.
McGraw Hill Higher Education

Reference Books:

- Molecular Biology of Cell: B. Alberts et. al.
- Genes X B. Lewin
- Instant notes on Molecular Biology Turner
- Nelson, D.L., Cox, M.M. (2004) Lehninger Principles of Biochemistry, 4th Edition

List of Open-Source Software/learning website:

https://www.youtube.com/watch?v=SrEou0y9L_A

<https://www.youtube.com/watch?v=sX6LncNjTFU>

Course Learning Outcomes (CLO): On completion of this course, the students will be able to:

CLO	Description	Bloom's Taxonomy Level
CLO1	Students will be able to describe types of Mutations.	1 Remembering
CLO2	Understanding the DNA damage and repair mechanism	2 Understanding
CLO3	Students could be able to use recombination method.	3 Applying
CLO4	Analysing DNA damage and repair mechanism for find genetic diseases.	1 Remembering 4 Analysing
CLO5	Understanding gene expression, regulation, causes of DNA damage and repair mechanisms to select specific treatments for solving of genetic diseases.	2 Understanding 4 Analysing 5 Evaluating
CLO6	Creating things, which can protect DNA from damaging by various environmental factors.	6 Creating

Mapping of CLO s with POs & PSOs

Course Learning Outcomes	Program Outcomes (POs)																Program Specific Outcome (PSOs)	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	PSO1	PSO2
CLO1	2		1			3				3								2
CLO2	2		2			3				2								2
CLO3	2		1		1	3				3								3
CLO4	2		1		2	3				2								3
CLO5	2		1			3				3								3
CLO6	2		2			3				3								3

3: High, 2: Medium, 1: Low

Branch Name:	B.Sc. Microbiology
Program Code:	SC102
Course Name:	Vedic Mathematics
Course Code:	13-IKS102-2C
Pre-requisite Course:	

Course Objectives:

- To understand the basic concept of Subtraction by Mental Calculation.
- To understand the concept of Multiplication by Mental Calculation.
- To be able to understand the Mental Calculation and Questions of Reasoning.

Teaching and Examination Scheme:

Teaching Scheme (Hours per week)				Evaluation Scheme (Marks)				
Lecture (L)	Tutorial (T)	Practical (P)	Credit	Theory (Marks)		Practical (Marks)		Total (Marks)
				University Assessment	Continuous Assessment	University Assessment	Continuous Assessment	
-	-	4	2	-	-	25	25	50

Subject Contents:

Unit	Content	Total Hours	Weightage
1	Complement, Subtraction and Multiplication by specific numbers. • Complement of number • Starting Complements from the Middle of the Sum. • Leaving Complements in the middle of the Sum. • Some special and general case of subtraction. • Multiplication by 11 & 12 & 9 Key Words: Subtraction, Complement, Multiplication.	30	50%
2	Multiplication and Working Base Multiplication • Base Multiplication. • Multiplication of Numbers more than the Base. • Multiplication of One more and one less than the base number. • Working Base Multiplication. • Multiplication of 2, 3, 4 Digit number. Key Words: Multiplication, Base, Working base.	30	50%

Reference Books:

- Vedic Mathematics for All Ages by Vandana Singhal: Motilal Banarsidass Publisher private limited- Delhi, 2008.
- Vedic Mathematics by Bharti KrishnaTirthji Maharaj : Motilal Banarsidass Publisher private limited- Delhi, 1965.

List of Open-Source Software/learning website:

1. https://www.youtube.com/watch?v=eyLsbv8E4Kg&list=PLVLoWQFkZbhUFSIAjbWPVv_mIAAX8BBD1
2. <https://www.youtube.com/watch?v=X98-JRMZrk&pp=ygUzc3VidHJhY3Rpb24gYW5kIG11bHRpcGxpY2F0aW9uIGJ5IHZlZGljIG1hdGhlcWF0a>

Mapping of CLO s with POs & PSOs

Course Learning Outcomes	Program Outcomes (POs)																Program Specific Outcome (PSOs)	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	PSO1	PSO2
CLO1	2	2	3	3		2	3	1		1	1	3	1					
CLO2	2	3		2	2	2	2	3	2		2	1		1	1	1		
CLO3		2	3			2	2		1	3		3	3					
CLO4	3	3					3	2	3		2	1	1	2	1	2		
CLO5	3	2	2	2	3	2	2			2	1	2						
CLO6	2	1	2	1	2	1		2			2		1	3	2			

3: High, 2: Medium, 1: Low