FACULTY OF SCIENCE

COURSE STRUCTURE

(Choice Based Credit System)

B. SC. LIFE SCIENCES (BIOCHEMISTRY, MICROBIOLOGY BIOTECHNOLOGY,)

Effective from Academic Year: 2023-2024

Faculty Name: SCIENCE

Programme Name: B. Sc. LIFE SCIENCES (Biochemistry/Microbiology/Biotechnology)

Semester: I

Academic Batch: 2023-24

Course Group	Board of Studies / Faculty Ownership	Course Code	Course Name	Cr	Teaching Scheme				Assessment/ Evaluation Type		External Exam Duration (Hrs.)		INT(T) Max./ Passing	EXT(T) Max./ Passing	INT(P) Max./ Passing	EXT(P) Max./ Passing	Grand Total Max./ Passing
					T	P	Tu	Cont. Hrs	T	P	T	P					
Discipline Specific Course-1	Biological Sciences		Molecules of Life	4	3	1		5	✓	✓	2	2	50/18	50/17	25/9	25/9	150/53
Discipline Specific Course-2	Biological Sciences		General Microbiology	4	3	1		5	✓	✓	2	2	50/18	50/17	25/9	25/9	150/53
Discipline Specific Course-3	Biological Sciences		Cell Biology	4	3	1		5	✓	✓	2	2	50/18	50/17	25/9	25/9	150/53
Generic Elective	Chemical Sciences		Chemistry-I	4	3	1		5	✓	✓	2	2	50/18	50/17	25/9	25/9	150/53
Ability Enhancement Course	Humanities		English	2	2			2	✓		2		50/18	50/17			100/35
Skill Enhancement Course	Biological Sciences		Microbial Techniques	2		2		2		✓		2			50/18	50/17	100/35
Value Addition Course (any one)	Arts		National Service Scheme (NSS)	2		2		2		✓		2			50/18	50/17	100/35
			National Cadet Corps (NCC)	2		2		2		✓		2			50/18	50/17	100/35
			Sports	2		2		2		✓		2			50/18	50/17	100/35
				22													

 # T = Theory, P = Practical, Tu = Tutorial

Name & Sign [Chairman - Board of Studies]: DR. SHILPA GUPTE

Name & Sign [Dean / Director]: DR. BASUDEB BAKSHI

Faculty Name: SCIENCE

Programme Name: B. Sc. LIFE SCIENCES (Biochemistry/Microbiology/Biotechnology)

Semester: II

Academic Batch: 2023-24

Course Group	Board of Studies / Faculty Ownership	Course Code	Course Name	Cr	Teaching Scheme				Assessment/ Evaluation Type		External Exam Duration (Hrs.)		INT(T) Max./ Passing	EXT(T) Max./ Passing	INT(P) Max./ Passing	EXT(P) Max./ Passing	Grand Total Max./ Passing
					T	P	Tu	Cont. Hrs	T	P	T	P					
Discipline Specific Course-1	Biological Sciences		Enzymology	4	3	1		5	✓	✓	2	2	50/18	50/17	25/9	25/9	150/53
Discipline Specific Course-2	Biological Sciences		Microbial Physiology	4	3	1		5	✓	✓	2	2	50/18	50/17	25/9	25/9	150/53
Discipline Specific Course-3	Biological Sciences		Inheritance Biology	4	3	1		5	✓	✓	2	2	50/18	50/17	25/9	25/9	150/53
Generic Elective	Chemical Sciences		Chemistry-II	4	3	1		5	✓	✓	2	2	50/18	50/17	25/9	25/9	150/53
Ability Enhancement Course	Interdisciplinary		Environmental Studies	2	2			2	✓		2		50/18	50/17			100/35
Skill Enhancement Course	Biological Sciences		Organic Farming	2	2			2	✓		2		50/18	50/17			100/35
Value Addition Course	FCML		Liberal Arts	2		2		2		✓		2			50/18	50/17	100/35
				22													

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Name & Sign [Dean / Director]: DR. BASUDEB BAKSHI

Faculty Name: SCIENCE

Programme Name: B. Sc. LIFE SCIENCES (Biochemistry/Microbiology/Biotechnology)

Semester: III

Academic Batch: 2023-24

Course Group	Board of Studies / Faculty Ownership	Course Code	Course Name	Cr	Teaching Scheme				Assessment/ Evaluation Type		External Exam Duration (Hrs.)		INT(T) Max./ Passing	EXT(T) Max./ Passing	INT(P) Max./ Passing	EXT(P) Max./ Passing	Grand Total Max./ Passing
					T	P	Tu	Cont. Hrs	T	P	T	P					
Discipline Specific Course-1	Biological Sciences		Techniques in Biochemistry	4	3	1		5	✓	✓	2	2	50/18	50/17	25/9	25/9	150/53
Discipline Specific Course-2	Biological Sciences		Microbial Ecology & Diversity	4	3	1		5	✓	✓	2	2	50/18	50/17	25/9	25/9	150/53
Discipline Specific Course-3	Biological Sciences		Developmental Biology	4	3	1		5	✓	✓	2	2	50/18	50/17	25/9	25/9	150/53
Generic Elective	Biological Sciences		DNA Structure Function and Repair	4	3	1		5	✓	✓	2	2	50/18	50/17	25/9	25/9	150/53
Ability Enhancement Course	Biological Sciences		Environmental Pollution	2	2			2	✓		2		50/18	50/17			100/35
Skill Enhancement Course	Biological Sciences		Bioinstrumentation-I	2	2			2	✓		2		50/18	50/17			100/35
Value Addition Course	FCML		Indian Constitution	2	2			2	✓		2		50/18	50/17			100/35
				22													

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Name & Sign [Dean / Director]: DR. BASUDEB BAKSHI

Faculty Name: SCIENCE

Programme Name: B. Sc. LIFE SCIENCES (Biochemistry/Microbiology/Biotechnology)

Semester: IV

Academic Batch: 2023-24

Course Group	Board of Studies / Faculty Ownership	Course Code	Course Name	Cr	Teaching Scheme				Assessment/ Evaluation Type		External Exam Duration (Hrs.)		INT(T) Max./ Passing	EXT(T) Max./ Passing	INT(P) Max./ Passing	EXT(P) Max./ Passing	Grand Total Max./ Passing
					T	P	Tu	Cont. Hrs	T	P	T	P					
Discipline Specific Course-1	Biological Sciences		Metabolism of Carbohydrates & Lipids	4	3	1		5	✓	✓	2	2	50/18	50/17	25/9	25/9	150/53
Discipline Specific Course-2	Biological Sciences		Microbial Genetics	4	3	1		5	✓	✓	2	2	50/18	50/17	25/9	25/9	150/53
Discipline Specific Course-3	Biological Sciences		Phytochemistry and Pharmacognosy	4	3	1		5	✓	✓	2	2	50/18	50/17	25/9	25/9	150/53
Generic Elective	Biological Sciences		Gene Expression and Regulation	4	3	1		5	✓	✓	2	2	50/18	50/17	25/9	25/9	150/53
Ability Enhancement Course	Biological Sciences		Fundamentals of Biostatistics	2	2			2	✓		2		50/18	50/17			100/35
Skill Enhancement Course	Biological Sciences		Bioinstrumentation-II	2	2			2	✓		2		50/18	50/17			100/35
Value Addition Course	Interdisciplinary		Wildlife Conservation	2	2			2	✓		2		50/18	50/17			100/35
				22													

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Name & Sign [Chairman - Board of Studies]: DR. SHILPA GUPTE

Name & Sign [Dean / Director]: DR. BASUDEB BAKSHI

Faculty Name: SCIENCE

Programme Name: B. Sc. LIFE SCIENCES (Biochemistry/Microbiology/Biotechnology)

Semester: V

Academic Batch: 2023-24

Course Group	Board of Studies / Faculty Ownership	Course Code	Course Name	Cr	Teaching Scheme				Assessment/ Evaluation Type		External Exam Duration (Hrs.)		INT(T) Max./ Passing	EXT(T) Max./ Passing	INT(P) Max./ Passing	EXT(P) Max./ Passing	Grand Total Max./ Passing
					T	P	Tu	Cont. Hrs	T	P	T	P					
Discipline Specific Course-1	Biological Sciences		Metabolism of Amino acids & Nucleotides	4	3	1		5	✓	✓	2	2	50/18	50/17	25/9	25/9	150/53
Discipline Specific Course-2	Biological Sciences		Environmental Microbiology	4	3	1		5	✓	✓	2	2	50/18	50/17	25/9	25/9	150/53
Discipline Specific Course-3	Biological Sciences		Basic Pharmacology	4	3	1		5	✓	✓	2	2	50/18	50/17	25/9	25/9	150/53
Discipline Specific Elective	Biological Sciences		Clinical Biochemistry	4	3	1		5	✓	✓	2	2	50/18	50/17	25/9	25/9	150/53
Generic Elective	Biological Sciences		Genetic Engineering	4	3	1		5	✓	✓	2	2	50/18	50/17	25/9	25/9	150/53
Skill Enhancement Course	Biological Sciences		Introduction to Bioinformatics	2	2			2	✓		2		50/18	50/17			100/35
				22													

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Name & Sign [Dean / Director]: DR. BASUDEB BAKSHI

Faculty Name: SCIENCE

Programme Name: B. Sc. LIFE SCIENCES (Biochemistry/Microbiology/Biotechnology)

Semester: VI

Academic Batch: 2023-24

Course Group	Board of Studies / Faculty Ownership	Course Code	Course Name	Cr	Teaching Scheme				Assessment/ Evaluation Type		External Exam Duration (Hrs.)		INT(T) Max./ Passing	EXT(T) Max./ Passing	INT(P) Max./ Passing	EXT(P) Max./ Passing	Grand Total Max./ Passing
					T	P	Tu	Cont. Hrs	T	P	T	P					
Discipline Specific Course-1	Biological Sciences		Membrane Biology & Bioenergetics	4	3	1		5	✓	✓	2	2	50/18	50/17	25/9	25/9	150/53
Discipline Specific Course-2	Biological Sciences		Biopharmaceuticals and Bio therapeutics	4	3	1		5	✓	✓	2	2	50/18	50/17	25/9	25/9	150/53
Discipline Specific Course-3	Biological Sciences		Animal Biotechnology	4	3	1		5	✓	✓	2	2	50/18	50/17	25/9	25/9	150/53
Discipline Specific Elective	Biological Sciences		Human Genetics	4	3	1		5	✓	✓	2	2	50/18	50/17	25/9	25/9	150/53
Generic Elective	Biological Sciences		Basic Immunology	4	3	1		5	✓	✓	2	2	50/18	50/17	25/9	25/9	150/53
Skill Enhancement Course	Biological Sciences		Entrepreneurship Development	2	2			2	✓		2		50/18	50/17			100/35
				22													

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Name & Sign [Dean / Director]: DR. BASUDEB BAKSHI

FACULTY OF SCIENCE

Effective from Academic Batch: 2023-24

Programme: **B.Sc. Life Sciences**

Semester: **I**

Course Code: To be Given by University

Course Title: **Molecules of life**

Course Group: **Discipline Specific Course - 1**

Course Objectives:

The objectives of this course are:

a). To provide insight into fundamentals of structures and functions of biomolecules. Student will able to understand basic structure of enzymes and mechanism of action.

b). It also helps to understand the properties of carbohydrates, proteins, lipids, cholesterol, DNA, RNA, glycoproteins and glycolipids and their importance in biological systems.

c). To develop skills to determine amino acid and nucleotide sequences of proteins and DNA respectively.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		Practical		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
3		2	4	50/18	50/17	25/9	25/9	150/53

Detailed Syllabus:		
Sr.	Contents	Hours

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1	**Introduction to Bio molecules** • Nature of biological material and general properties of biomolecules. Carbohydrate: Introduction, occurrence, physiological importance, classification of carbohydrates, monosaccharide, disaccharide, oligosaccharides and polysaccharides. • Physiological properties of carbohydrates, asymmetric centre in monosaccharides, Optical isomerism, stereoisomerism, epimers, mutarotation, diasterioisomerism configuration in sugar, cyclic structure anomeric carbon atom, fisher's projection formula, Haworths representation. • Chemical properties of carbohydrates, oxidation and reduction of sugars, action of mineral acids, hydrogen cyanide, and hydrazine on sugars due to hydroxyl groups, reducing action of sugars. • Polysaccharides: occurrence, structure and physiological importance of starch, glycogen, cellulose, hemicellulose, dextrin, pectin, agar, hyalouronic acid, heparin and chondrotin sulphate.	**12**
2	**Amino acids and proteins** • Structure and classification of amino acids, rare aminoacids of proteins, non-protein, aminoacids, Essential aminoacids, amphoteric nature of protein, titration curve of glycine. Physical properties of amino acids- stereospecificity and optical activity. • Chemical properties of amino acids, chemistry of peptide linkage. Classification of proteins, solubility criteria: salting in and out of protein. Denaturation of proteins. Structure of proteins with examples (Primary, secondary, tertiary, quaternary). Determination of sequence of proteins.	**11**
3	**Lipids** • Definition, classification of lipids, fatty acids, essential fatty acids triacylglycerol, properties of triacylglycerol, phospholipids, glycolipids, sphingolipids, sterols, there properties, structures, functions. Lipoproteins.	**11**
4	**Nucleotides and nucleic acid** • Structure of nitrogen bases and sugars, structure of nucleosides and nucleotides, Ribose, Deoxyribose and their conformation. - Structure and properties of DNA, forms of DNA. **Enzymes** • Nomenclature and classification, chemical nature and properties of enzymes, factor affecting enzyme activity, active site, enzyme inhibition, enzyme specificity, Coenzymes.	**11**

List of Practicals / Tutorials:

1	**Identification of biomolecules: Carbohydrate (Molisch's test), Protein (Biuret) & lipid (Saponification**	**30**
2	Qualitative analysis of carbohydrates: Molisch's test, Iodine test, Benedict's test,	

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Fehling's test, Cole's test, Barfoed's test, Saliwanoff's test, Rapid furfural test, Osazone test, Mucic acid test, Inversion test.

3 Qualitative analysis of proteins: Precipitation test, Mercuric nitrate test, Lead acetate test, Sulphosalicyllic test, Potassium ferricyanide test, Tannic acid test, Alcohol test, Heller's test, Ammonium sulphate test.

4 Qualitative analysis of amino acids: Colour reactions, Biuret test, Ninhydrin test, Millon's test, Arginine test (Sakaguchi test), Xanthoproteic test, Hopkin's Cole test, Ehrlich test, Nitroprusside test.

5 Qualitative analysis of fat: Test for oil, Solubility test, Dichromate test, Emulsion test, Absorption test, Glycerol test, Acid value of oil, Saponofication test, Iodine test, Borax test, and Liebermann-Burchard test.

6 Estimation of protein by Biuret method.

7 Estimation of carbohydrate by DNS method.

8 Estimation of DNA by DPA method.

Reference Books:

1 Biochemistry by Lubert Stryer, W. H. Freeman and Company. 4th /6th edition, 2000/2004 Hardback, ISBN 0716720094

2 Fundamentals of Biochemistry: Life at the Molecular Level, by D. Voet, J. G. Voet, and C. Pratt, 3rd Edition, John Wiley and Co John Wiley & Sons, Inc., New York, , 2008 ISBN **:** 0471214957; 9780471214953

3 Principles of Biochemistry by Albert Lehninger, W.H. Freeman & Company; 3rd edition (February 2000), ISBN-10: 1572591536

4 Harper's Biochemistry: Harper, 27th Edition, McGraw-Hill Publishing Co; Robert K. Murray, Daryl K. Granner, Victor W. Rodwell, 2006 ISBN-10: 0071461973

5 Outlines of Biochemistry by Conn E E , Stumps P E and and Doi, R.H., John Wiley and sons, Singapore, 5th Edition – 2001

6 Principles of Biochemistry by Horton,Morgan, Secrimgeour,Perry, Rawn , pearson International edition – 4th edition ISBN 978-1-4058-2573-3

7 Harper's Biochemistry: R. K. Murray and others. Appleton and Lange, Stanford. ISBN: 0838536905 25 edition (pb) 2000

8 Plummer, D.T. (1987). 3rd ed. An introduction of Practical Biochemistry. McGraw Hill Book Co.

Supplementary learning Material:

1 SWAYAM (https://swayam.gov.in/)

2 NPTEL (https://nptel.ac.in/)

3 e-PATHSHALA (https://epathshala.nic.in/)

4 DIKSHA (https://diksha.gov.in/)

Pedagogy:

1. Audio -visual aids, power point presentation, videos, animation, models etc.
2. Continuous assessment based on quiz, assignment, seminar.
3. Sample collection/ data collection etc
4. Laboratory experiments
5. Demonstration
6. Student feed back
7. Peer led learning

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Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
50	20	10	10	5	5	

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes (CO):		
Sr.	**Course Outcome Statements**	**%weightage**
CO-1	Understand chemical and physical characters of biomolecules to be known to the students.	**25**
CO-2	Learn the structure, classification and functions of Carbohydrates, Lipid and Protein.	**25**
CO-3	Different protein structure, their physical chemical properties	**25**
CO-4	Learn the structure, classification and functions of Nucleic acid and enzyme.	**25**

Curriculum Revision:

Version: 1.0
Drafted on (Month-Year): May 2023
Last Reviewed on (Month-Year): June 2023
Next Review on (Month-Year): April 2024

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FACULTY OF SCIENCE

Effective from Academic Batch: 2023-24

Programme: **B.Sc. Life Sciences**

Semester: **I**

Course Code: To be Given by University

Course Title: **General Microbiology**

Course Group: **Discipline Specific Course - 2**

Course Objectives:

The objectives of this course are:

a). To give students comprehensive knowledge of the historical aspects and development of Microbiology.

b). To make the students to understand the different aspects to the classification of Prokaryotes.

c). Students will understand the in-depth knowledge on the structure and functions of prokaryotic And eukaryotic cells.

d). Student will learn properties of viruses and exhaustive knowledge of fungi. Further it gives insight into hands on training of basic microbial techniques which will give the student a strong base in scope of microbiology.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		Practical		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
3		2	4	50/18	50/17	25/9	25/9	150/53

Detailed Syllabus:

Sr.	Contents	Hours
1	**Historical foundation of Microbiology** • Establishment of microbiology as a discipline: Spontaneous generation *vs* biogenesis, Contributions of Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming. Role of microorganisms in fermentation, Germ theory of disease, Development of various microbiological techniques and golden era of microbiology. • Development of the field of soil microbiology: Contributions of Martinus W. Beijerinck, Sergei N. Winogradsky, Selman A.Waksman. Establishment of fields of medical microbiology and immunology through the work of Paul Ehrlich, Elie Metchnikoff, Edward Jenner.	12

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2	**Classification and Prokaryotic cell structure** • Binomial Nomenclature, Whittaker's five kingdom and Carl Woese's three kingdom classification systems and their utility. Classification in brief as per Bergey's Manual of Systematic Bacteriology. • Overview of prokaryotic cell structure, prokaryotic cell membranes, prokaryotic cytoplasm, cytoplasmic inclusion bodies, cell wall, ribosome, and capsule. Bacterial endospores, exospores, and cyst. Bacterial motility. Bacterial chromosome, nuclear material, plasmid and episomes.	**11**
3	**Eukaryotic cell structure and function** • Overview of eukaryotic cell structure, Eukaryotic membranes, Cytoplasmic matrix, Organelles of the biosynthetic-secretory and endocytic pathways, Ribosomes, Mitochondria, Chloroplast, Nucleus, Structures external to the plasma membrane, Comparison of prokaryotic and eukaryotic cells.	**11**
4	**Viruses, Other Acellular Agents and Fungi** • Introduction to viruses, General properties of viruses, Viral reproduction, Cultivation of viruses, Virus purification and assays, Principles of virus taxonomy, Viroids and Virusoids, Prions. Lytic and lysogenic cycles. • Introduction of fungi, Distribution, Structure, Nutrition and metabolism, Reproduction, Characteristics of fungal divisions and Economic significance.	**11**

List of Practicals / Tutorials:

1	Preparation and sterilization of culture media for bacterial cultivation
2	Study of different shapes of bacteria using permanent slides/ pictographs
3	Simple staining: Monochrome staining and Differential: Gram's staining
4	Determination of motility of bacteria by (i) Hanging drop method (ii) Agar stab method
5	Isolation of bacteria [Streak plate, spread plate, pour plate, serial dilution]
6	Determination of CFU count.
7	Study of the following fungi by preparing temporary mounts: *Rhizopus* and *Aspergillus*.

Reference Books:

1	Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company.
2	Dubey RC and Maheswari DK. A Text book of Microbiology. (2005).S. Chand & Company Ltd., New Delhi.
3	Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9th edition. Pearson Education.
4	Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General Microbiology. 5th edition. McMillan.
5	Atlas RM. (1997). Principles of Microbiology. 2nd edition. WM.T.Brown Publishers. 3. Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition.
6	Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. 7th edition. McGraw Hill Higher Education.
7	Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education limited.
8	Madigan MT, Martinko JM and Parker J. (2009). Brock Biology of Microorganisms. 12th edition. Pearson/Benjamin Cummings.

Supplementary learning Material:	
1	SWAYAM (https://swayam.gov.in/)

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2	NPTEL (https://nptel.ac.in/)
3	e-PATHSHALA (https://epathshala.nic.in/)
4	DIKSHA (https://diksha.gov.in/)

Pedagogy:

1. Audio -visual aids, power point presentation, videos, animation, models etc.
2. Continuous assessment based on quiz, assignment, seminar.
3. Industrial visit / sample collection/ data collection etc
4. Laboratory experiments
5. Demonstration
6. Student feed back
7. Peer led learning

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
50	20	10	10	5	5	

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	Acquire knowledge about history and scope of Microbiology.	**25**
CO-2	Understand various methods of microbial classification.	**25**
CO-3	Differentiate prokaryotic and eukaryotic cell structure and functions.	**25**
CO-4	Learn about viruses and nutritional requirements and modes of reproduction in fungi.	**25**

Curriculum Revision:	
Version:	1.0
Drafted on (Month-Year):	May 2023
Last Reviewed on (Month-Year):	June 2023
Next Review on (Month-Year):	April 2024

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FACULTY OF SCIENCE

Effective from Academic Batch: 2023-24

Programme: B.Sc. Life Sciences

Semester: I

Course Code: To be given by university

Course Title: Cell Biology

Course Group: Discipline Specific Core -3

Course Objectives:

The objectives of this course are to enable students to…

a) Understand structure and function of prokaryotic and eukaryotic cells.
b) Learn structure and functions of cell and its organelles.
c) Gain knowledge of synthesis and function of proteins, membrane structure and functions of cell.
d) Provide knowledge of cellular communication, division of cell and chromosomal separation in different stages of cell cycle.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
3	0	2	4	50/18	50/17	25/9	25/9	150/53

* **J**: Jury; **V**: Viva; **P**: Practical

Detailed Syllabus:		
Sr.	**Contents**	**Hours**
1	**Cell Structure and Function:** Discovery, Origin of Cell and Cell theory, Cell as basic unit of life (Plant and Animal Cell structure, Comparison between plant and animal cells), Difference between Prokaryotic and Eukaryotic cells. Structure and its function of Plasma membrane (Three dimensional), Chemical composition of biological membranes, Membrane models, Fluid mosaic membrane model. Cell wall, distribution, chemical composition, functions, and variations in prokaryotic and eukaryotic cells (primary and secondary wall), Glycocalyx, Cell-cell interactions/ Junctions, pit connections in plants and animals.	12

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2	**Cytoskeleton structure and functions:** Overview of the Major Functions of Cytoskeleton. Microtubules: Structure, Composition and functions, Composition, Assembly and Disassembly, Structure, composition and functions of Centrioles and Basal bodies, Microtubules in Cilia and Flagella. Microfilaments and Intermediate filaments: Structure and Composition; Endoplasmic reticulum: Structure, function including role in protein segregation. Golgi complex: Structure, biogenesis and functions including role in protein secretion.	**11**
3	**Structure of Nucleus** Nuclear membrane, nuclear pore, nucleolus, chromatin, structure of nucleic acids. Mitochondria – Ultra structure and function; Biogenesis of mitochondrial Genomes, Chloroplast – Ultra structure and function, Genome biogenesis. Ribosomes detailed structure and its function with involvement in protein synthesis. Vacuoles, Lysosomes structure and functions.	**11**
4	**Cell cycle and Cell division** The key roles of mitosis and meiosis during the life cycle. Types of cell divisions. Different Stages of mitosis and meiosis, highlighting similarities and differences. Significance of Mitosis and Meiosis. Overview of the Cell cycle and its control. Programmed Cell Death: Apoptosis-intrinsic and extrinsic apoptotic pathways, necrosis, necroptosis, and autophagy.	**11**

Reference Books:

1. Cell Biology by C.B. Powar. (Reprinted-2004) Himalaya Publishing House, Mumbai.
2. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology by P.S. Verma and V.K. Agarwal (Reprinted -2007) Pub. S. Chand& Company Ltd. Ram Nagar, New Delhi-110055.
3. De Roberts E. D. P. and De Roberts E. M. F. 2010. Cell and Molecular Biology. Walters Kluwer, 8th edition.
4. Albert B., Johnson A., Lewis J., Raff M., Roberts K. and Walter P. 2014. Molecular biology of the cell. 6th edition, Garland Science, Taylor & Francis Group. ISBN: 0-8153-3218-1.
5. Geoffrey M. Cooper and Robert E. Hassman. 2018. The Cell: A molecular approach. Sinauer Associates Inc, 8th edition, ISBN:0-87893-214-3.

List of Practicals / Tutorials: **30**

1. Structure of cell organelles adopting preparations/charts/models
   Mitochondria; Chloroplast; Ribosomes; Endoplasmic reticulum; Nucleus
2. Squash preparation of onion flower buds for the study of meiosis stages.
3. Squash preparation of onion root tip for the study of mitosis stages.
4. Vital staining of mitochondria.
5. Trypan blue exclusion test for cell viability.
6. Measurement of the size of cells using micrometry.
7. Preparation of Buccal smear and Identification of Barr Body.
8. Localization of chloroplast.

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Supplementary learning Material:

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2. NPTEL (https://nptel.ac.in/)
3. e-PATHSHALA (https://epathshala.nic.in/)
4. DIKSHA (https://diksha.gov.in/)

Pedagogy:

1. Audio -visual aids, power point presentation, videos, animation, models etc.
2. Continuous assessment based on quiz, assignment, seminar.
3. Industrial visit
4. Laboratory experiments
5. Demonstration
6. Student feed back
7. Peer led learning

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying. **N**: Analysing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
20	20	20	10	10	20	

Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	Students will understand the structure and function of various cellular organelles and its significance.	**25**
CO-2	Students will learn how cellular components work together to carry out life functions.	**25**
CO-3	Students will be acquiring a better understating on how cellular processes enable organism to meet their basic needs.	**25**
CO-4	Students will get knowledge of program cell death and the cellular components underlying mitotic cell division.	**25**

Curriculum Revision:

Version:	1.0
Drafted on (Month-Year):	May - 2023
Last Reviewed on (Month-Year):	June - 2023
Next Review on (Month-Year):	April - 2024

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FACULTY OF SCIENCE

Effective from Academic Batch: 2023-24

Programme: **B.Sc. Life Sciences**

Semester: **I**

Course Code: To be Given by University

Course Title: **Chemistry–I**

Course Group: **Generic Elective**

Course Objectives:

The objectives of this course are:

a). To educate the students to develop the knowledge of the fundamental principles of chemistry and to enable understanding of the nomenclature, structural, isomerism, stereochemistry of organic compounds.

b). Student will understand acid-base concept and solution behaviour. It provides the fundamental knowledge of the properties of transition metals and basics of coordination chemistry.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		Practical		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
3		2	4	50/18	50/17	25/9	25/9	150/53

Detailed Syllabus:

Sr.	Contents	Hours
1	IUPAC nomenclature Introduction of organic compound and their classification. Physical Properties and systemic IUPAC nomenclature of different class of organic compounds including alkanes, alkenes, alkynes, cycloalkanes, bicyclic, spiro, aromatic and heterocyclic compounds.	12
2	**Stereochemistry** Elements of symmetrycentre, plane and axis of symmetry. Isomers and classification of isomers. Configuration, conformational isomers. Separation of enantiomers. Absolute configuration (R and S). Conversion of projection formulas. Stereochemistry of compounds containing two asymmetric carbon atoms. Conformations around a C-C bond in acyclic compounds. Structure of cycloalkanes, Cyclohexane conformations. Stereochemistry of disubstituted cyclohexanes.	11

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3	**Ionic equilibrium in aqueous solutions** Acids & Bases, Arrhenius theory of Acids and Bases, The Lowry – Bronsted Concept, Strength of Acids and Bases, The Lewis concept, pH Scale, pH and Buffers Structure and physical properties of water, Self-Ionization of water, Hydrolysis, Buffer Solutions, Indicator, Sparingly Soluble Salts, Common ion effect, Selective Precipitation, acid-base titration and use of indicators, mathematical treatment of acid-base titrations.	**11**
4	**Fundamental concept of coordination chemistry** Position of d-block elements in the periodic table, Electronic configuration and Classification of d-block elements in 3d, 4d, 5d and 6d series. Definition of coordination compounds Werner's theory, Co-ordination number, Classification of ligands, Nomenclature of co-ordination compounds, Chelate, chelating ligand and Chelation, Uses of Chelates.	**11**

List of Practicals / Tutorials: **30**

1. Volumetric analysis: Determination of concentration of Strong acid [HCl] and weak acids [oxalic acid/Acetic acid] by titrating against strong base [NaOH].
2. Volumetric analysis: Determination of concentration of transition metal salts (Cu, Ni, Zn) by titrating against EDTA.
3. Qualitative Analysis : Identification of Organic substance:Salicylic acid, Cinnamic acid, Benzoic acid, α-Naphthol, β-Naphthol, o-nitroaniline, m-nitroaniline, p-nitroaniline, Naphthalene, m-dinitrobenzene, Anthracene.

Reference Books:

1	Morrison R. T. & Boyd R. N., *Organic chemistry* (6th edition).
2	IUPAC nomenclature by Robert M. Silverstein.
3	Stereochemistry by P. S. Kalsi.
4	A text book of organic chemistry by Arun Bahl& B. S. Bahl, 16th Edition
5	Principles of Physical chemistry by B. R. Puri, L. R. Sharma and M. S. Pathania, 41th Ed.
6	Biophysical chemistry, Principles and Techniques by Upadhyay, Upadhyay and Nath.
7	Cotton, F.A. & Wilkinson, G. *Basic Inorganic Chemistry,* Wiley
8	Elements of Physical Chemistry by S. Glasstone and D. Lewis

Supplementary learning Material:

1. SWAYAM (https://swayam.gov.in/)
2. NPTEL (https://nptel.ac.in/)
3. e-PATHSHALA (https://epathshala.nic.in/)
4. DIKSHA (https://diksha.gov.in/)

Pedagogy:

1.Audio -visual aids, power point presentation, videos, animation, models etc.
2. Continuous assessment based on quiz, assignment, seminar.
3. Industrial visit

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4. Laboratory experiments
5. Demonstration
6. Student feed back
7. Peer led learning

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
50	20	10	10	5	5	

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	Understand the fundamental principles of organic chemistry that include chemical bonding	**25**
CO-2	Learn nomenclature, structural of various classes of compounds	**25**
CO-3	Develop concept of isomerism, stereochemistry, Chirality	**25**
CO-4	Acquire concept of Acidity, Alkalinity, applications of indicator	**25**

Curriculum Revision:

Version: 1.0
Drafted on (Month-Year): May 2023
Last Reviewed on (Month-Year): June 2023
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FACULTY OF SCIENCE

Effective from Academic Batch: 2023-24

Programme: **B.Sc. Life Sciences**

Semester: **I**

Course Code: To be Given by University

Course Title: **English**

Course Group: **Ability Enhancement Course**

Course Objectives:

The objectives of this course are**:**

a). English is now used almost exclusively as the language of science. By learning a single language, scientists around the world gain access to the vast scientific literature and can communicate with other scientists anywhere in the world.

b). Students will learn about various scientific terms and will be able to enhance skills. Verbal and Non-verbal communication, writing skills, reviewing will be remedy for the students to get better and better subjectively.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		Practical		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
2			2	50/18	50/17			100/35

Detailed Syllabus:		
Sr.	**Contents**	**Hours**
1	**Vocabulary and Presentation Skill Development** • Listening Skills, Speaking Skills, Reading Skills and Writing Skills (LSRW) • Defining the Purpose & how to make an effective presentation (MS PowerPoint) • Outline preparation • Review / Content / Précis writing.	**15**
2	**Introduction and Language of Communication** • Theory of Communication, Types and Modes of Communication • Verbal and Non-verbal (Spoken and Written) • Personal, Social and Business Barriers and Strategies; Intra-personal, Inter-personal and Group communication, Expressing opinions	**15**

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Reference Books:

1. Fluency in English - Part II, Oxford University Press, 2006.
2. Business English, Pearson, 2008.
3. Language, Literature and Creativity, Orient Blackswan, 2013.
4. Language through Literature (forthcoming) ed. Dr. Gauri Mishra, Dr Ranjana Kaul, Dr Brati Biswas

Supplementary learning Material:

1. SWAYAM (https://swayam.gov.in/)
2. NPTEL (https://nptel.ac.in/)
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4. DIKSHA (https://diksha.gov.in/)

Pedagogy:

1.Audio -visual aids, power point presentation, videos, animation, models etc.
2. Continuous assessment based on quiz, assignment, seminar.
3.Group Discussion
4. Student feed back
5. Peer led learning

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
50	20	10	10	5	5	

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	Understand the preparation of Well-organized presentation slides	**50**
CO-2	Improve presenting skill	**50**

Curriculum Revision:

Version:	1.0
Drafted on (Month-Year):	May 2023
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FACULTY OF SCIENCE

Effective from Academic Batch: 2023-24

Programme: **B.Sc. Life Sciences (BC/MI/BT)**

Semester: **I**

Course Code: To be Given by University

Course Title: **Microbial Techniques**

Course Group: **Skill Enhancement Course**

Course Objectives:
The objectives of this course are:

a) Ability to apply the tools and techniques of Microbiology in conducting research.

b) Acquire basic skills in aseptic techniques, microscopy.

c) Learn different staining techniques, microbial cultivation, and enumeration techniques.

d) Prepare the student for advance studies in the subject of Microbiology.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		Practical		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
		2	2			50/18	50/17	100/35

Detailed Syllabus:		
Sr.	**Contents**	**Hours**
1	**Introduction to laboratory equipment:** (Principle and Applications) Microscope, Autoclave, Hot air oven, Incubator, pH meter, biological safety cabinet. Cleaning and sterilization of glassware. Sterilization techniques – Chemical, UV, autoclaving, and membrane filtration. Basic microbe handling techniques. Cryo-stock and glycerol stock preparation, maintenance, and Preservation of Bacteria. **Special Staining Techniques:** Endospore staining, Acid fast staining, Capsule staining, Metachromatic granules staining, cell wall staining.	**15**

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2	**Media preparation and cultivation of microbes** Liquid media- Peptone water, Nutrient broth; Solid media- Nutrient agar (Agar slant, Agar plate); Enriched Medium- Blood agar; Differential medium - Mac Conkey agar; Enrichment Medium - Selenite F broth; Selective medium- EMB, MSA. Isolation and cultivation of bacteria. Preparation of culture media for cultivation of yeast and fungi (spoiled bread/fruits/vegetable). Isolation of bacterial flora of skin by swab method. Determination of microbiological quality of milk sample by MBRT..	**15**

Reference Books:

1. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company.
2. Murphy, D.B. Fundamental of Light Microscopy & Electron Imaging.1st Edition.Wiley-Liss.(2001).
3. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General Microbiology. 5th edition. McMillan.

Supplementary learning Material:

1. SWAYAM (https://swayam.gov.in/)
2. NPTEL (https://nptel.ac.in/)
3. e-PATHSHALA (https://epathshala.nic.in/)
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Pedagogy:

1.Audio -visual aids, power point presentation, videos, animation, models etc.
2. Continuous assessment based on quiz, assignment, seminar.
3.Group Discussion
4. Student feed back
5.. Peer led learning

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
50	20	10	10	5	5	

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	Students will familiarize with various lab equipments relevant to microbiological work. They will learn different types of staining to observe microbes and their cell components.	**50**
CO-2	Students will learn to prepare different media, cultivation method and their applications.	**50**

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Curriculum Revision:

Version:	1.0
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FACULTY OF SCIENCE

Effective from Academic Batch: 2023-24

Programme: **B.Sc. Life Sciences**

Semester: **II**

Course Code: To be Given by University

Course Title: **Enzymology**

Course Group: **Discipline Specific Course – 1**

Course Objectives:
The objectives of this course are to enable students….

a). To understand the Enzyme and their classification, structure of enzyme and their action & purification.
b). The course will teach the enzyme kinetics, mechanisms of enzyme catalysis and Methods to study enzymes and its mechanisms of regulations using suitable examples of enzymes in the cell.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		Practical		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
3		2	4	50/18	50/17	25/9	25/9	150/53

Detailed Syllabus:		
Sr.	**Contents**	**Hours**
1	**An Introduction to enzymes:** What are enzymes, brief history of enzymes, concepts of coenzymes, cofactors, holoenzymes, apoenzyme, activators, inhibitors, regulatory enzymes. Specificity of enzyme (active site) and models for enzyme specificity (Lock and key, induced-fit and transition-state stabilization hypothesis). Enzyme classification: IUB enzyme classification.	**12**

2	**Methods for isolation and purification of enzymes:-** Methods for homogenization of tissue, Method for protein purification depend on size (centrifugation, gel filtration, dialysis and ultrafiltration), Method for protein purification depend on polarity (ion-exchange chromatography, electrophoresis, isoelectric focusing, hydrophobic interaction chromatography), Method for protein purification depend on changes in solubility (change in pH, change in ionic strength, decrease in dielectric constant), Method for protein purification depend on possession of specific binding sites or structural features (affinity chromatography, affinity elution, dye-ligand chromatography, immunoadsorption chromatography and covalent chromatography).	**11**
3	**Enzyme kinetics:-** Concept of activation energy for uncatalyzed and catalyzed (chemical and enzyme) reaction. Type of reaction (zero-order, first-order and second order). Unisubstrate enzyme kinetics; factors affecting the rate of enzyme catalyzed reactions forms and derivation of Michaelis-Menten equation; significance of $V_{max,}$ $K_m$and different plots (Lineweaver-Burk, Eadie-Hofstee and Hanes plots). Enzyme inhibition – type of inhibition (reversible and irreversible), competitive, non-competitive, uncompetitive, mixed, partial, substrate, and allosteric.	**11**
4	**Mechanism of Enzyme Action and immobilization of enzymes:** Enzyme mechanisms: Factors affecting catalytic efficiency, Mechanism of Lysozyme, Chymotrypsin, Carboxypeptidase, Aspartate Transcarbomylase. Allosteric enzymes and sigmoidal kinetics: Protein ligand binding, Co-operativity, MWC & KNF models, Immobilized enzymes:- Methods of immobilization, use of immobilized enzymes, advantage and disadvantage of immobilized enzymes. Industrial applications of enzymes.	**11**

List of Practicals / Tutorials:

1 Estimation of reducing sugar by DNS method

2 Determination of invertase activity

3 Effect of enzyme concentration on enzyme catalyzed reaction

4 Effect of pH on enzyme catalyzed reaction

5 Effect of temperature on enzyme catalyzed reaction

6 Effect of time on enzyme catalyzed reaction

7 Effect of substrate concentration on enzyme catalyzed reaction and determination of Km and Vmax of enzyme

8 Demonstration of immobilization of enzyme/whole cell using appropriate method

30

Reference Books:

1	Fundamentals of enzymology: Nicholason Price & Stevens **ISBN – 0-19850-229-X**.
2	Enzymes: Biochemistry, Biotechnology and Clinical Chemistry: Trevor Palmer, Philip L. Bonner, 2nd edition Horwood Publishing Limited, **ISBN – 978-1-904275-27-5**.
3	Biochemistry: DonaldVoet, Judith G. Voet, 4th Edition, John Wiley & Sons, Inc., New York, 2008 **ISBN –13 978-0470-57095-1.**.
4	Fundamentals of Biochemistry:Life at the Molecular Level, D Voet, J.G Voet and C. W. Pratt. 5th Edition John Wiley and Sons, Inc, New York, **ISBN –978-1-118-91840-1**.
5	Biochemistry: Jeremy M. Berg, John L. Tymoczko, Gregory J. Gatto, Jr., LubertStryer8th Edition. W. H. Freeman and Company; ISBN–13: 978-1-4641-2610-9.
6	Textbook of Medical Biochemistry: Chatterjee M.N and Rana Shinde. 8th Edition, Jaypee Brothers Medical Publisher PVT Ltd. **ISBN – 978-93-5025-484-4**.
7	Lehninger Principles of Biochemistry: David L. Nelson, Michael M. Cox,7th Edition. W. H. Freeman and Company. **ISBN – 13: 978-1-4641-2611-6**.
8	Harpers's Biochemistry: Robert Murray, Victor Rodwell, David Bender, Kathleen M. Botham, P. Anthony Weil, Peter J. Kennelly, 28th Edition.Mc Graw Hill Publishing Company. **ISBN – 978-0-07-170197-6**.
9	Practical Enzymology: Prof. Dr. Hans Bisswanger 2nd Edition (2011, Wiley-Blackwell) **ISBN–978-3-527-32076-9.**

Supplementary learning Material:	
1	SWAYAM (https://swayam.gov.in/)
2	COURSERA (https://www.coursera.org/)
3	NPTEL (https://nptel.ac.in/)
4	e-PATHSHALA (https://epathshala.nic.in/)
5	DIKSHA (https://diksha.gov.in/)

Pedagogy:

1. Audio -visual aids, power point presentation, videos, animation, models etc.
2. Continuous assessment based on quiz, assignment, seminar.
3. Industrial visit / sample collection etc
4. Laboratory experiments
5. Problem solving
6. Demonstration
7. Student feed back

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
50	20	10	10	5	5	

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	Understand the fundamental concept of enzymes and their specificity of action and classification.	**25**
CO-2	Understand Enzyme purification strategies from variety of sources and to study the purity of enzymes..	**25**
CO-3	Understand the enzyme kinetics with respect to presence of Substrate, inhibitors and activators and significance of Km, Vmax & Kcat, enzyme efficiency.	**25**
CO-4	Understand the mechanisms of different enzyme actions. Understands the relevance of Isoenzymes and its physiological significance, enzyme immobilization techniques and industrial application of enzymes.	**25**

Curriculum Revision:

Version: 1.0
Drafted on (Month-Year): May 2023
Last Reviewed on (Month-Year): June 2023
Next Review on (Month-Year): April 2024

CVM UNIVERSITY
Aegis: Charutar Vidya Mandal (Estd.1945)

FACULTY OF SCIENCE

Effective from Academic Batch: 2023-24

Programme: **B.Sc. Life Sciences**

Semester: **II**

Course Code: **To be Given by University**

Course Title: **Microbial Physiology**

Course Group: **Discipline Specific Course – 2**

Course Objectives:

The objectives of this course are:

a). To educate the students to develop a clear understanding of the fundamental concepts of microbial physiology and metabolism occurring inside microbes.

b). The students will understand nutritional classification of microbes.

c). Students will understand pure culture techniques and methods of culturing, preservation and maintenance of microorganisms.

d).This course will aid students to acquire skills and competence in microbiological laboratory practices.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		Practical		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
3		2	4	50/18	50/17	25/9	25/9	150/53

Detailed Syllabus:

Sr.	Contents	Hours
1	Microbial Nutrition Nutritional types: Requirement of nutrients for microbes and classification of microorganisms based on carbon, energy and electron sources viz. Autotroph/Phototroph, heterotrophy, Chemolithoautotroph, Chemolithoheterotroph, Chemoheterotroph, Chemolithotroph, photolithoautotroph, Photoorganoheterotroph. Primary and secondary active transport; Passive and facilitated diffusion. Effect of oxygen on growth, classification on the basis of oxygen requirement and tolerance (aerobic, anaerobic, microaerophilic, facultative aerobe, facultative anaerobe).	12

2	**Media type, control and Preservation** • Role of macro and micro-nutrients. Components of media: Natural, Synthetic, Complex, Selective media, Differential Media, Enriched and enrichment media. Methods for culturing aerobic and anaerobic bacteria; Colony and broth culture characteristics. • Physical methods of microbial control: heat, low temperature, high pressure, filtration, desiccation, osmotic pressure, radiation. Chemical methods of microbial control: disinfectants, types and mode of action. Maintenance and preservation techniques for microorganisms (Sub culturing, Oil overlay, Sand cultures, Storage at low temperature, Lyophilisation, Liquid Nitrogen).	**11**
3	**Microbial Growth** • Growth in Microbes (growth phases, generation time, growth curve and specific growth rate). Measurement of cell mass and cell number; Factors affecting microbial growth; Continuous and batch cultures; details of synchronous and Diauxic growth curve. Physical factors influencing growth: Temperature; pH; Atmospheric Pressure; Salt Concentration. Chemical factors: heavy metal (copper), surfactants. Control of Microorganisms: patterns of microbial death, control of microorganism growth by antiseptics.	**11**
4	**Microbial Photosynthesis** • Concept of photosynthesis and associated pigments in microbes; photosynthetic apparatus in pro and eukaryotes; anoxygenic and oxygenic photosynthesis; light and dark reaction; photorespiration and its significance; Effect of light, temperature; pH and CO_2 concentration on photosynthesis; measurement of net photosynthetic yield. Electron transport chain in photosynthetic bacteria.	**11**

List of Practicals / Tutorials:

1	Introduction of media and its constituents for microbial growth.	**30**
2	Different methods for isolation and maintenance of microorganisms.	
3	Isolation of microbes using differential media.	
4	To study and plot the growth curve of *E. coli* using spectrophotometric method and to calculate specific growth rate and generation time.	
5	To study and plot the growth curve of *Aspergillus niger* by radial growth measurements.	
6	To study the effect of temperature of *Aspergillus niger* by dry weight method.	
7	Demonstration of the thermal death time and decimal reduction time of *E. coli*.	
8	Isolation of Photosynthetic bacteria.	
9	Preservation of bacterial cultures.	

Reference Books:

1	Moat A.G. and Foster S.W. Microbial Physiology (4th Ed.) (2004). John Wiley and Sons, New York.
2	Gerald Karp. Cell Biology (3rd Ed.) (2003). McGraw Hill Book Company, New York.

3	Stanier R. Y, Ingrahm J. I, Wheelis M. L and Painter P. R. General Microbiology. (5th Ed.) (1987). McMillan Press. UK.
4	Dubey R. C and Maheswari D. K. A Text book of Microbiology. (2005).S. Chand & Company Ltd., New Delhi.
5	Nelson D. L. & Cox M. M. Lehninger's Principles of Biochemistry, 4th edition. (2005). W. H. Freeman & Co. NY.
6	Pelczar Jr, M. J, Chan E. C. S., Krieg N R, Microbiology, (5th Ed.), (2001). McGraw Hill Book Company, NY.
7	Madigan M. T, Martinko J. M and Parker J. (2003). Brock Biology of Microorganisms. 10th edition. Pearson/Benjamin Cummings.
8	Reddy S. R. and Reddy S. M. (2005). Microbial Physiology. Scientific Publishers India.

Supplementary learning Material:	
1	SWAYAM (https://swayam.gov.in/)
2	NPTEL (https://nptel.ac.in/)
3	e-PATHSHALA (https://epathshala.nic.in/)
4	DIKSHA (https://diksha.gov.in/)

Pedagogy:
1. Audio -visual aids, power point presentation, videos, animation, models etc.
2. Continuous assessment based on quiz, assignment, seminar.
3. Industrial visit / sample collection/ data collection etc
4. Laboratory experiments
5. Demonstration
6. Student feed back
7. Peer led learning

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
50	20	10	10	5	5	

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes (CO):

Sr.	**Course Outcome Statements**	**%weightage**
CO-1	Design synthetic media for screening of specific culture.	**25**
CO-2	Describe and differentiate type of growth requirement for specific microbial culture.	**25**
CO-3	Describe and evaluate the growth of microorganisms and factors affecting it.	**25**
CO-4	Describe the microbial photosynthesis and depict the role of pigments associated with microbes.	**25**

Curriculum Revision:	
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CVM UNIVERSITY
Aegis: Charutar Vidya Mandal (Estd.1945)

FACULTY OF SCIENCE

Effective from Academic Batch: 2023-24

Programme: **B.Sc. Life Sciences**

Semester: **II**

Course Code: **To be given by university**

Course Title: **Inheritance Biology**

Course Group: **Discipline specific course -3**

Course Objectives:

The objectives of this course are to enable students to

a) To provide a comprehensive study to develop the knowledge of Classical and modern Mendelian genetics, success of Mendel's experiment, Chromosomal theory of inheritance.
b) The course will provide a foundation of the Allelic and non-allelic gene interaction along with the genetic linkage and crossing over
c) It also outlines the factors and the determination of sex in various species as well as aberration of chromosome with population genetics.
d) The course will prepare students for learning the mechanism of muscle contraction, Structure and types of neuron cells,

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
3	0	2	4	50/18	50/17	25/9	25/9	150/53

* **J**: Jury; **V**: Viva; **P**: Practical

Detailed Syllabus:		
Sr.	**Contents**	**Hours**
1	**Fundamentals of Genetics:** Historical developments in the field of genetics, Mendel's experimental organism and its significance, Mendel's experimental design, monohybrid, di-hybrid and tri hybrid crosses, Law of segregation & Principle of independent assortment, Test and back crosses. Chromosomal theory of inheritance (Sutton-Boveri). Applications of Mendel's Principles (Punnett square method, Forked-line method, Probability method)	**11**

2	**Interaction of Genes:** Allelic interactions: Concept of dominance, recessiveness, Concept of pseudo-alleles, Co-dominance, Incomplete dominance, Pleiotropy, Penetrance, Expressivity (Example of each), lethal allele. Non allelic interactions: Epistasis (dominant & recessive), Duplicate gene action (15:1), Complementary gene action (9:7), Supplementary gene action (9:3:4), Inhibitory gene action (13:3), Masking gene action (12:3:1), Polymeric gene action (9:6:1), Additive gene action (1:4:6:4:1)	**11**
3	**Genetic linkage, Crossing over and Chromosomal aberrations:-** Introduction, Chromosome theory of Linkage, Coupling and Repulsion phase, Types of Linkage, Linkage groups and Linkage maps. Recombination of genes in a chromosome crossing over, Molecular mechanism of crossing over. Genetic disorders, Alteration in chromosome structure - Deletions, duplications, inversions and translocations Alterations in chromosome number - Ploidy-Aneuploidy and Euploidy.	**11**
4	**UNIT IV: Sex determination and Sex linkage:** Difference between Autosomes and Allosomes, Structure of X and Y chromosomes, Mechanisms of sex determination, Environmental factors and Chromosome theory of Sex determination: XX- XY, XX-XO, XO-XX, ZZ-ZW, ZO-ZZ system, Genic balance theory of Bridges, sex determination, Sex determination in animals (Drosophila, Reptiles and Mammals,) and Plants, Barr bodies, Genetic balance theory (X/A index), Fragile-X- syndrome and chromosome, sex influenced dominance, sex limited gene expression, and sex linked inheritance.	**12**

Reference Books:

1 Principles of Genetics (2010) 5th ed. And 6th ed., Snustad, D.P. and Simmons, M.J., John Wiley & Sons Asia, ISBN:978-0-470-39842-5.
2 Genetics (2000), P.S.Verma and V.K. Agarwal, S. Chand and Company. (ISBN:81-219-0262-2), New Delhi.
3 Genetics. P. K. Gupta, Rastogi Publications. ISBN: 81-7133-779-1. Shivaji Road Meerut, India.
4 Fundamentals of Genetics. (2004), B.D. Singh, Kalyani Publishers. (ISBN: 81-272-1331-4).1.
5 Principles of Genetics by Gardener, John Wiley & Sons, New York, USA, (ISBN 9971-51-346-3).

List of Practical

1 Problems in different topics of Genetics - Introduction to Mendelian genetics. **30**
(I) Mendel's law of inheritance
a) Law of Dominance. b) Law of segregation. c) Law of Independent assortment.
(II) Back Cross & Test Cross
a) Monohybrid back cross and test cross b) Dihybrid back crosses and test cross.
2 Problem related to Interaction of genes:-
(a) Incomplete dominance (b) Co-dominance (c) Problems related to monohybrid cross (d) Problems related to dihybrid crosses. (e) Problem related to sex linked inheritance (f) Linkage (g) Crossing over
3 Variation in chromosomes structure and number - by charts
4 Problems related to sex determination.

5	Pedigree charts of some common characters like blood group and color blindness
6	Mitotic Chromosome preparation and Karyotyping

Supplementary learning Material:	
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Pedagogy:
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4. Laboratory experiments
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R	**U**	**A**	**N**	**E**	**C**	
20	20	20	10	10	20	

Course Outcomes (CO):

Sr.	**Course Outcome Statements**	**%weightage**
CO-1	Learn Mendelian Genetics, Mendel's law of segregation, Independent assortment, pedigree	**25**
CO-2	Will get knowledge of Gene interaction at different level, dominant and recessive gene.	**25**
CO-3	Acquire the knowledge of sex determination in mammals, plants and animals, structure of X and Y Chromosomes.	**25**
CO-4	Develop concept of chromosomal aberrations, Hardy Weinberg law, and evolutionary genetics	**25**

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FACULTY OF SCIENCE

Effective from Academic Batch: 2023-24

Programme: **B.Sc. Life Sciences**

Semester: **II**

Course Code: To be Given by University

Course Title: **Chemistry-II**

Course Group: **Generic Elective**

Course Objectives:

The objectives of this course are to enable students…..

a). To educate the students to develop the knowledge of the basics of quantitative analysis.

b). Understanding of the standardization and student can apply theoretical knowledge to prepare solutions and basic chemical analysis methods.

c). Student will understand clearly reaction kinetics and thermodynamic parameters of reaction and their application in biological system.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		Practical		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
3		2	4	50/18	50/17	25/9	25/9	150/53

Detailed Syllabus:

Sr.	Contents	Hours
1	General Introduction of analytical chemistry Introduction, Qualitative and Quantitative analysis, Types of titrations. Requirements for titrimetric analysis. Concentration systems: molarity, formality, normality, wt%, ppm, milliequalence and millimoles-problems. Primary and Secondary standards, criteria for primary standards. Preparation of standard solutions, standardization of solutions. Limitation of volumetric analysis, endpoint and equivalence point. Introduction to Instrumental and Chemical Methods of analysis, Applications of Chemical Analytical Chemistry, Sampling of Solid, Liquid and Gas, Stages of Analysis, Interferences, Selection of Methods, limitations of Analytical Methods.	12
2	Thermodynamics Terminology of thermodynamics, First law of thermodynamics, internal energy, enthalpy of a system, heat capacity, spontaneous process, Second law of thermodynamics, concept of entropy, entropy of mixing, standard entropies, criteria for reversible and irreversible process, Gibbs-Helmholtz equation, Third law of thermodynamics, determination of absolute entropies of elements and compounds. Applications of first and second law of thermodynamics in living cells.	11
3	Chemical Kinetics Introduction, Rate of reaction, Rate constant, Half life time, Determination of Half life time of reaction, Order of reaction Derivation of First law, second order rate reaction constant for (a=b) and (a≠b). Derivation of third order. Mathematical problems. Catalysis characteristics of catalysis, Types of catalysis, homogeneous and heterogeneous catalysis, enzymecatalyzed reaction and derivation mechanism.	11
4	Physical properties of liquids **Surface tension:** surface energy, factors affecting surface tension, interfacial tension, surface active agents, measurements of surface tensions. **Viscosity:** units of viscosity, factors affecting viscosity, measurement of viscosity, application of viscometer, significance of viscosity in biological system.	11

List of Practicals / Tutorials:

1	Preparation of normal/molar solutions of acids and bases.	
2	Preparation and standardization of primary and secondary standard solution.	
3	Volumetric analysis of Weak Acid/ Strong Base.	
4	To determine the amount of carbonate and bicarbonate in a given mixture by titrating it against sulphuric acid/ hydrochloric acid.	
5	To determine the concentration of a solution for the given liquid by determination of surface-tension of a liquid by drop-volume method at various concentration.	**30**
6	To determine the viscosity of the given liquid with the help of Ostwald's viscometer.	
7	To determine the percentage composition of the given solution by Ostwald's viscometer.	
8	To determine the molecular weight of given polymer using Ostwald's viscometer.	
9	Determination of Pka value of amino acid (glycine).	
10	Potentiometric titration of Acid / Base.	

Reference Books:

1 Quantitative analysis by R. A Day, Jr. & A. L. Underwood 6th Edition, Printice Hall of India Private Limited New Delhi. 2005. ISBN: 61-203-0793-3, 9788120307933.

2 Basic concept of Analytical Chemistry by S. M. Khopkar, New age International Publishers, 2004. ISBN 81-224-2092-3.

3 Vogel's Text book of Quantitative Chemical Analysis by J. Mendhan, R. C. Denney, M. Thomas, B. Sivasankar. 6th Ed. Pearson 2009. ISBN: 978-81-317-2325-8.

4 Biophysical chemistry, Principles and Techniques by Upadhyay, Upadhyay and Nath, Himalaya Publishing House, 2019. ISBN978-98-5142-227-3

5 Principles of Physical chemistry by B. R. Puri, L. R. Sharma and M. S. Pathania, 41th Ed. Vishal Publishing Co. 2012. ISBN: 81-88646-00-8

6 Lehninger's principles of biochemistry by David Nelson and Michel Cox. 5th Ed. W. H. Freeman Company, New York. 2005. ISBN: 978-0-23022699-9.

7 An advance course in practical Chemistry by Ghoshal, Mahapatra, Nad. New central book agency, Kolkata, 2004. ISBN: 81-7381-302-7.

Supplementary learning Material:

1. https://camtools.cam.ac.uk/access/content/group/6041b37a-7fa4-4a47-808b-b20db3a36122/Module%202/Practice%20Questions/mod2/index.htm
2. SWAYAM (https://swayam.gov.in/)
3. NPTEL (https://nptel.ac.in/)
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Pedagogy:

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2. Continuous assessment based on quiz, assignment, seminar.
3. Industrial visit
4. Laboratory experiments
5. Demonstration
6. Student feed back
7. Peer led learning

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
50	20	10	10	5	5	

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	Preparations of solution and to learn concentration units.	**25**
CO-2	To understand some of the basics of analytical chemistry.	**25**
CO-3	To learn fundamentals of thermodynamic chemistry and chemical kinetics.	**25**
CO-4	Develop concept of physical properties of solutions.	**25**

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FACULTY OF SCIENCE

Effective from Academic Batch: 2023-24

Programme: **B.Sc. Life Sciences**

Semester: **II**

Course Code: To be Given by University

Course Title: **Environmental Studies**

Course Group: **Ability Enhancement Course**

Course Objectives:

The objectives of this course are to enable students to…

a.) To develop clear understanding of various aspects of environment this includes ecosystem, biodiversity, and conservation of biodiversity, Indian hotspots, endangered flora and fauna of India.

b.) It also develops an attitude of concern for the environment and acquiring skills to help the concerned individuals in identifying and solving environmental problems.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		Practical		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
2			2	50/18	50/17			100/35

Detailed Syllabus:

Sr.	Contents	Hours
1	**Introduction to environmental studies:** Multidisciplinary nature of environmental studies; components of environment: atmosphere, hydrosphere, lithosphere, and biosphere. • Scope and importance; Concept of sustainability and sustainable development; Brief history of environmentalism.	02

2	**Natural Resources:** Land resources: Minerals, soil, agricultural crops, natural forest products, medicinal plants, and forest-based industries and livelihoods; Land cover, land use change, land degradation, soil erosion, and desertification; Causes of deforestation; Impacts of mining and dam building on environment, forests, biodiversity, and tribal communities. Water resources: Natural and man-made sources; Uses of water; Over exploitation of surface and ground water resources; Floods, droughts, and international & interstate conflicts over water. Energy resources: Renewable and non-renewable energy sources; Use of alternate energy sources; Growing energy needs; Energy contents of coal, petroleum, natural gas and biogas; Agro residues as a biomass energy source. • Case studies: Contemporary Indian issues related to mining, dams, forests, energy, etc (e.g., National Solar Mission, Cauvery River water conflict, Sardar Sarovar dam, Chipko movement, Appiko movement, Tarun Bharat Sangh, etc)	**10**
3	**Global Environmental Issues and Policies** Causes of Climate change, Global warming, Ozone layer depletion, and Acid rain, Impacts on human communities, biodiversity, global economy, and agriculture. International agreements and programmes: Earth Summit, UNFCCC, Montreal and Kyoto protocols, Convention on Biological Diversity (CBD), Ramsar convention, The Chemical Weapons Convention (CWC), UNEP, CITES, etc. Sustainable Development Goals: India's National Action Plan on Climate Change and its major missions. Environment legislation in India: Wildlife Protection Act, 1972; Water (Prevention and Control of Pollution) Act, 1974; Forest (Conservation) Act 1980; Air (Prevention & Control of Pollution) Act, 1981; Environment Protection Act, 1986; Scheduled Tribes and other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006.	**10**
4	**Human Communities and the Environment:** Human population growth: Impacts on environment, human health, and welfare; Carbon footprint. Resettlement and rehabilitation of developmental projects affected persons and communities, relevant case studies. Environmental movements: Chipko movement, Appiko movement, Silent valley movement, Bishnois of Rajasthan, Narmada Bachao Andolan, etc. Environmental justice: National Green Tribunal and its importance. Environmental philosophy: Environmental ethics; Role of various religions and cultural practices in environmental conservation. Environmental communication and public awareness: case studies (e.g., CNG vehicles in Delhi, Swachh Bharat Abhiyan, National Environment Awareness Campaign (NEAC), National Green Corps (NGC) "Eco-club" programme, etc.)	**08**

Reference Books:

1	Ecology - Principles and Applications by J.L. Chapman & M.J. Reiss. (2008) (2nd Ed.) Cambridge University Press, U.K. (ISBN: 978-0-521-68920-5)
2	Ecology and Environment by P.D. Sharma. (2010). (10th Ed.) Rastogi Publications, Meerut (India). (ISBN: 978-81-7133-905-1)
3	Elements of Ecology by Thomas Smith & Robert Smith. (2007) (6th Ed.) Dorling Kindersley Press. (South Asia). (ISBN: 81-317-1557-4)
4	Fundamentals of Ecology by Eugene Odum& Gray Barrett. (2009) (5th Ed.) Cengage Learning & Nelson Education Press. (ISBN: 978-81-315-0020-0)
5	Groom, Martha J., Gary K. Meffe, and Carl Ronald Carroll. Principles of Conservation Biology. Sunderland: Sinauer Associates, 2006.
6	Raven, P.H., Hassenzahl, D.M. & Berg, L.R. 2012. Environment. 8th edition. John Wiley & Sons.
7	Rosencranz, A., Divan, S., & Noble, M. L. 2001. Environmental law and policy in India. Tripathi 1992.
8	Singh, J.S., Singh, S.P. and Gupta, S.R. 2014. Ecology, Environmental Science and Conservation. S. Chand Publishing, New Delhi.

Supplementary learning Material:	
1	SWAYAM (https://swayam.gov.in/)
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4	DIKSHA (https://diksha.gov.in/)

Pedagogy:
1. Audio -visual aids, power point presentation, videos, animation, models etc.
2. Continuous assessment based on quiz, assignment, seminar.
3. Field trip / Industrial visit / sample collection/ data collection etc
4. Case study
5. Group Discussion
6. Student feed back
7. Peer led learning

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
50	20	10	10	5	5	

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	Students will gain of in-depth knowledge on natural processes and resources that sustain life and govern economy.	**10**
CO-2	Students will acquire critical thinking for environmental protection, and sustainable development.	**30**

CO-3	Students will develop attitude for active participation in solving current environmental problems and preventing the future ones.	**30**
CO-4	Students will adopt sustainability as a practice in life, society, and industry.	**30**

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CVM UNIVERSITY
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FACULTY OF SCIENCE

Effective from Academic Batch: 2023-24

Programme: **B.Sc. Life Sciences**

Semester: **II**

Course Code: **To be given by university**

Course Title: **Organic Farming**

Course Group: **Skill Enhancement Course (SEC)**

Course Objectives:
The objectives of this course are to enable students to…

a) Learn significance of the holistic concept organic farming
b) Acquaint students with cultural production practices typically employed in organic farming.
c) Examine challenges and trends in the production, processing, and marketing of organic farm products.
d) Introduce students to the large body of literature relating to organic agriculture practices.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
2			2	50/18	50/17			100/35

* **J**: Jury; **V**: Viva; **P**: Practical

Detailed Syllabus:

Sr.	Contents	Hours
1	History of alternative agricultural Development, Effects of Green revolution organic farming. Need, concepts, definition, characteristics, and components of organic farming. Relevance to modern agriculture, different eco-friendly farming system, biological farming Natural farming, biodynamic farming, permaculture, regenerative agriculture, and Zero Budget farming. Organic nutrient sources and their fortification, organic manures, methods of composting. Green manures: bio fertiliser types, methods of application, benefits and limitations.	15

2	Nutrient use in organic farming-scope and limitations. Nutrient management in organic farming. Organic ecosystem and their concepts. Choice of crops and varieties in organic farming, crop rotations, need and benefits, multiple cropping. Fundamentals of insect, disease and weed management under organic mode of production-cultural-biological methods-nonchemical pest & disease management. Initiatives taken by the central and state governments, NGOs, and other organizations for promotion of organic agriculture in India	**15**

Reference Books:

1. Tiwari, V.N., Gupta, D.K., Maloo, S.R and Somani, L.L. 2010. Natural, organic, biological, ecological, and biodynamic farming. Agrotech Publishing Academy, Udaipur. 420p.
2. Mukund Joshi and Prabhakarasetty, T.K. 2006. Sustainability through organic farming. Kalyani publishers, New Delhi. 349p.
3. Balasubramanian, R., Balakishnan, K and Siva Subramanian, K. 2013. Principles and practices of organic farming. Satish Serial Publishing House. 453p.
4. Arun K. Sharma. 2002. A Handbook of organic farming. Agrobios, India. 627p.

Supplementary learning Material:	
1	SWAYAM (https://swayam.gov.in/)
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Pedagogy:

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6. Student feed back
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R	**U**	**A**	**N**	**E**	**C**	
20	20	20	10	10	20	

Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	Students will get knowledge of the historical, biological, and ecological basis for organic farming including crop and livestock management.	**50**

CO-2	Students will develop critical thinking with a systems approach to agriculture using case studies as working examples of farming systems.	**50**

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