2024

LEARNING OUTCOMES BASED CURRICULUM FRAMEWORK

MOUNT CARMEL COLLEGE, AUTONOMOUS, BENGALURU

PGBIOTECH

INTRODUCTION:

A nation's journey is largely scripted by the quality of its human resources. India, home to world's largest young population, needs to strengthen the human capital in terms of knowledge and skills so that the dream of Viksit Bharat by 2047 is achievable. This needs a curriculum framework which emphasises on Learning Outcomes so that higher education is empowering the students with the right set of Knowledge, Attitude and Skills.

UGC's Learning Outcomes based Curriculum Framework (LOCF) aims at holistic experience for students which focuses on both knowledge acquisition and application of knowledge. LOCF also seeks to empower the students with the necessary skills in a Tech-driven Knowledge economy – critical thinking, problem-solving, analytical reasoning, cognitive skills and lifelong self-learning.

Based on the LOCG given by UGC, Mount Carmel College, Autonomous proposes the following template which will be adopted by all the Departments for curriculum revision and adoption of outcome-based approach.

GRADUATE ATTRIBUTES

Mount Carmel College, Autonomous offers graduate and postgraduate programs which empower graduates with the following attributes:

- In-depth knowledge and ability to apply this in real world situations
- Critical, creative and evidence-based thinking to be problems-solvers
- Excellent communication skills to convey thoughts and ideas appropriately & innovatively
- Agile learners who can keep pace with a rapidly transforming digitalized world
- Ability to take up leadership roles and work in multi-cultural teams
- A desire to see themselves as continuous learners and seek new knowledge and skills
- To be responsible citizens with sound ethical values and concern for the community

QUALIFICATION DESCRIPTORS

The students who complete three years of full-time study of an undergraduate programme of study will be awarded a Bachelor's Degree (BA/B.Sc./B.Com/BBA/BCA/B.Voc); Students who complete four years of full-time study of an undergraduate programme will be awarded a Bachelor's Degree Honours. The Graduates of the degree program will demonstrate:

- An in-depth understanding in the chosen discipline, comprising theoretical and practical perspectives, and a basic understanding of emerging areas of study and practice.
- Ability to apply knowledge to comprehend the dynamics of the work-place, society and world in order to find efficient and ethical solutions to problems.
- Basic quantitative and digital skills for undertaking analysis, interpreting results and arriving at logical conclusions.
- Comprehensive knowledge about current topics and basic skills required to comprehend contemporary issues.

FRAMEWORK FOR OUTCOME BASED CURRICULUM FOR A PROGRAM

VISION OF THE DEPARTMENT

Our vision is to produce competent and technically proficient Biotechnologists who can employ the processes and applications, profoundly influence research and development in the sectors of agriculture, industry, health care and environment protection and provide sustainable competitive edge to present society.

PROGRAM LEARNING OUTCOMES (What students will learn after completing the degree)	
PLO1	To Familiarize with the concepts in associated subjects in Biotechnology such as Genetics, Microbiology, Molecular Biology, Immunology , Analytical techniques, Biochemistry etc
PLO2	To identify, understand and analyze and problems related to biotechnology and finding valid conclusions with basic knowledge in related subjects
PLO3	To gain In-depth knowledge in the chemical structure and function of biomolecules, metabolism in the cell, knowledge of the concepts of molecular genetics and biosynthesis of proteins, and a good theoretical and practical insight into methods used to obtain this knowledge.
PLO4	To inculcate research aptitude in students through practical experience of laboratory experiments and mandatory in house project work
PLO5	To get a solid foundation for future work in both academia and industry through theoretical and practical competence within the broad field of Biotechnology, both in the molecular level as well as with its applications
PLO 6	To create insight into the potential and limitations of Biotechnology and its role in society and people's responsibility for how it is used among the various inter related disciplines.
PLO 7	To use critical analysis and problem solving skills ; to develop, plan and implement innovative solutions within a diverse range of biotechnology industry sectors

SYLLABUS BLUEPRINT

Program Title	MSc Biotechnology
Course Title	CELL BIOLOGY
Nature of Course	Discipline Specific Course (DSC)
Semester	I
Total Hours	45
Credits	3

Objective of the Course:

To understand the structures and purposes of basic components of prokaryotic and eukaryotic cells, especially membranes, and organelles and how these cellular components are used to generate and utilize energy in cells.

Course Learning Outcomes:

COURSE LEARNING OUTCOMES (What students will learn after completing the degree based on Bloom's Taxonomy)	
CLO1	The students will be able to understand how the biomolecules transport mechanism across the membranes.
CLO2	The students are able to analyse the structural features of organelles in cellular level, also about molecular sorting and vesicular traffic.
CLO3	Students will be able to learn the maintenance of structural integrity of cells and intra cellular particle movements.
CLO4	Students are familiarize with the structural level organization of chromosomes
CLO5	Students will be able to learn the impact of cell division and its control measurements
CLO6	Students are able to connect with cell signalling and signal transduction process with receptors inside and outside the cell.

MAPPING OF COURSE LEARNING OUTCOMES TO PROGRAM LEARNING OUTCOMES							
	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7
CLO1	✓						
CLO2							
CLO3		✓		✓		✓	
CLO4		✓		✓			
CLO5			✓		✓		✓
CLO6	✓				✓		

(Put a tick mark to indicate the mapping)

Course Content:

Module	Content	Hours
1 Cell Wall and Cell Membrane	Cell wall-ultra structure and function. Cell Junctions, Cell adhesion and extra cellular matrix (ECM) Cell Junctions: Types, molecular basis and functions. Cell-Cell adhesion - Cadherins, Selectins, their mechanisms and functions. ECM: Glycosaminoglycans (GAG), Collagens, Elastin, Fibronectin, Basal- lamina, their structure and functions. Cell Membrane: Structure and organization, functions, Membrane transport systems: Principles of membrane transport; Types of carrier proteins and active membrane transport (Na+ and K+ pump, Ca++ pump, H+ pump); Ion channels - Family of membrane transport proteins.	9
2 Cell organelles	Structure and functions of ER, Golgi complex, lysosomes, peroxisomes, nucleus, ribosomes, mitochondria, chloroplast, and vacuoles. **Protein sorting**: Transport of molecules between nucleus and cytosol; Transport of proteins to cellular organelles (ER, Mitochondria, Chloroplast etc). **Intra-vesicular traffic**: Transport vehicles, SNAREs, Clathrin coat assembly; Transport from ER to Golgi and then to lysosomes; endocytosis and exocytosis.	14
3 Cytoskeletal structures and motor proteins	Microtubules, microfilaments and intermediate filaments. Molecular Motors: Kinesin, dynein and myosin. Physiology of ciliary movement, sliding filament hypothesis	6
4 Chromosomes	Structure and Organization, Multiple strand, single strand and nucleosome model. Giant chromosomes -polytene chromosome and lamp brush chromosome.	4
5 Cell cycle and its control	Cell cycle and control of cell cycle –Cyclins and CDKs, Mitosis and meiosis, Regulation of cell cycle: Cyclins and CDKs- their types and pathways. G1/S Check point	6

	and of G2/M Checkpoint Cell senescence, necrosis and apoptosis: Intrinsic and extrinsic pathway.	
6.**Cell signalling**	Cell signalling- Autocrine, endocrine and paracrine, cell to cell interactions. Signal transduction. (Ion channel linked receptor, G protein linked receptor and Enzyme linked receptors).	6

References:

1. Vesely, P. (2004). Molecular biology of the cell. By Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts and Peter Walter. Garland Science Inc., New York.
2. Cooper, G. M., & Hausman, R. E. (2016). The Cell: A Molecular Approach.
3. Karp, G., Iwasa, J., & Marshall, W. (2020). Karp's Cell and Molecular Biology. John Wiley & Sons.
4. De Robertis, E. D., & De Robertis, E. M. (1981). Essentials of cell and molecular biology.

Online Resources:

1. https://www.pubmed.ncbi.nlm.nih.gov/
2. https://www.ncbi.nlm.nih.gov/

Teaching Pedagogy:

- Case studies on topics for in depth exploration of realities (cases)and presenting investigative analyses.
- Assignments in order to create authentic and simplified learning environments with respect to complex topics
- Group discussion and quiz to encourage debates and stimulate teacher and students interaction.
- Slide presentation and model based demonstrations to promote critical thinking and help students to practically apply their skills.

Evaluation Pattern:

Continuous Internal Assessment		Test 1	30 marks scaled down to 20
		Test 2	NA
		Seminar/Presentation	10 marks reduced to 5
		Project	10 marks reduced to 5
Semester End Examination		SEE	70 marks
TOTAL			100 marks

SYLLABUS BLUEPRINT

Program Title	MSc Biotechnology
Course Title	GENERAL MICROBIOLOGY
Nature of Course	Discipline specific course (DSC)
Semester	I
Total Hours	45
Credits	3

Objective of the Course:

This course is designed to help students understand and examine the microbial strains and to classify them, study structural organisations and functions. It describes diversity of microorganisms, bacterial cell structure and function, microbial growth and metabolism, and the ways to control their growth by physical and chemical means.

Course Learning Outcomes:

COURSE LEARNING OUTCOMES (What students will learn after completing the degree based on Bloom's Taxonomy)	
CLO1	To understand and examine the microbial strains and to classify them.
CLO2	To understand and examine the microbial strains and to classify them.
CLO3	To relate various factors affecting the microbial growth and functions.
CLO4	To understand the Biochemical pathways and metabolic processes of microorganisms.
CLO5	To value the role of microorganisms in Ecology and Biogeochemical cycles.
CLO6	To understand and examine the different diseases caused by microorganisms.
CLO7	To demonstrate the applications of different methods in Microbiology

MAPPING OF COURSE LEARNING OUTCOMES TO PROGRAM LEARNING OUTCOMES							
	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7
CLO1	✔						
CLO2							
CLO3		✔		✔		✔	

CLO4		✔		✔			
CLO5	✔		✔		✔		
CLO6	✔				✔		
CLO7							

(Put a tick mark to indicate the mapping)

Course Content:

Module	Content	Hours
1.Microbial Taxonomy	Different types of classifications of microorganisms- Bacteria - Bergey's manual of systematic classification; Traceability of Microbial Strains Virus; Fungi; Viroids; Prions	7
2.Prokaryotic and Eukaryotic microorganisms	Virus - Structure, Growth cycle, Assay. Bacteria - Overview of structure, Structure of cell wall, Cell membrane, Internal Structures – DNA, plasmids, Ribosomes, cytoskeleton, inclusions; external structure – fimbriae, pili, S-layer, glycocalyx, flagella;Structure of Cyanobacteria – Anaebena. Structure of proteobacteria - Rhizobium Introduction. Protozoa (Plasmodium) and Fungi (Yeast) Algae (Chlorella) Slime molds (Physarum)- structure and reproduction.	12
3.Microbial Growth and nutrition and control	Growth and cell division, factors affecting bacterial growth-physical and chemical factors, sporulation in bacteria. Physical-Pasteurization, radiation, heat and chemical-phenols. Halogens etc	5
4.Metabolic pathways specific to microbes	Different types of fermentation- Homo and Heterolactic fermentation, ED pathway, phosphoketolase pathway, glyoxylate cycle. Synthesis of peptidoglycan	5
5.Microbial Ecology	Ecology of microorganisms- symbiotic relationships, Microorganisms in Nitrogen cycle, carbon cycle, phosphorus cycle, iron cycle.	6
6.Disease causing microorganisms	Bacterial –Staphylococcal infections, Typhoid, TB; Fungal – Keratitis, Dermatitis, Viral – AIDS, Measles, Hepatitis and their diagnosis.	4
7.Methods in Microbiology	Composition of culture media and its types-special purpose and Selective media. Differential, Enrichment and microbial assay media. Pure culture, Isolation of microbes	6

	using Winogradsky coloumn.	
TOTAL HOURS	**45**	

References:

1. Willey, J. M., Sherwood, L. M., & Woolverton, C. J. (2014). *Prescott's microbiology*. McGraw-Hill.
2. Black, J. G., & Black, L. J. (2018). *Microbiology: principles and explorations*. John Wiley & Sons.
3. Bergey, D. H. (1994). *Bergey's manual of determinative bacteriology*. Lippincott Williams & Wilkins.
4. Atlas, R. M. (2004). *Handbook of microbiological media*. CRC press.
5. Caldwell, D. R. (1995). Microbial physiology and metabolism. Wm. C. *C. Brown*.
6. Dale, J. W., & Park, S. F. (2013). *Molecular genetics of bacteria*. John Wiley & Sons.

Online Resources:

1. https://www.pubmed.ncbi.nlm.nih.gov/
2. https://www.ncbi.nlm.nih.gov/

Teaching Pedagogy:

- Case studies on topics for in depth exploration of realities (cases)and presenting investigative analyses.
- Assignments in order to create authentic and simplified learning environments with respect to complex topics
- Group discussion and quiz to encourage debates and stimulate teacher and students interaction.
- Slide presentation and model based demonstrations to promote critical thinking and help students to practically apply their skills.

Evaluation Pattern:

Continuous Internal Assessment		Test 1	30 marks scaled down to 20
		Test 2	NA
		Seminar/Presentation	10 marks reduced to 5
		Project	10 marks reduced to 5
Semester End Examination		SEE	70 marks
TOTAL			100 marks

SYLLABUS BLUEPRINT

Program Title	MSc Biotechnology
Course Title	MOLECULAR GENETICS
Nature of Course	Discipline specific course (DSC)
Semester	I
Total Hours	45
Credits	3

Objective of the Course:

To offer a blend of classical genetics and modern genetic concepts

Course Learning Outcomes:

COURSE LEARNING OUTCOMES (What students will learn after completing the degree based on Bloom's Taxonomy)	
CLO1	The student will be able to analyse genetic inheritance of phenotypes and understand the genetic inheritance of sexual phenotypes also.
CLO2	The student will gain knowledge about genes are organised in prokaryotes and eukaryotes cells. The pattern of arrangement of DNA in chromosome
CLO3	The students will have an understanding of bacterial means of genetic material exchange and modification.
CLO4	The student will be able to learn the impact of genetic recombination at molecular level.
CLO5	The student will develop an analytical skill to connect phenotypic features with transposition of genes.
CLO6	The student will able to approach logical explanation for questions related to mutation
CL07	This will enable the students to understand and design experiments for detection of different types of mutations

MAPPING OF COURSE LEARNING OUTCOMES TO PROGRAM LEARNING OUTCOMES							
	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7
CLO1	✓						
CLO2							
CLO3		✓		✓		✓	

CLO4		✔		✔			
CLO5			✔		✔		✔
CLO6	✔				✔		
CLO7							

(Put a tick mark to indicate the mapping)

Course Content:

Module	Content	Hours
1.Principles in Genetics and Molecular basis of sex determination and dosage compensation	Mendel's laws of Inheritance, Mendellian and Non-Mendellian inheritance patterns, Hardy-Weinberg Equilibrium, Sex determination in Drosophila and mammals, Secondary sex determination in mammals, Dosage Compensation in Drosophila and mammals.	11
2.Genome organization	Organization of E.coli genome. Mapping of and mapping of E.coli chromosome. Common features of the genome of prokaryotes and eukaryotes (esp Human genome), bacteriophage genome, Mapping of T$ phage genome using mutants. Topological manipulation of DNA. C-value paradox, concept of gene families.	7
3.Bacterial genetics	Transformation, Conjugation and Transduction	3
4.Genetic Recombination	Homologous and Non-Homologous recombination, Different models of Genetic Recombination (Single and Double stranded breaks). Role of Rec A, Rec BCD, Ruv ABC in recombination. Conservative Site-Specific Recombination in Lambda phage	8
5.Transposable genetic elements	Introduction to Bacteria, Yeast, Drosophila, Maize Transposons. Replicative and Non-replicative transposition. Role of transposase and Resolvase. Controlling elements in transposition. Retro-transposons.	6
6.Mutation	Molecular basis of Mutation: Spontaneous and Induced, physical and chemical mutagenesis. Role in evolution, adaptive mutations in bacteria and viruses.	5
7.Detection of Mutagens & mutations	Ame's test, different approaches for the detection of unknown point mutations, DGGE, HET, SSCP, PTT, CFLP	5
TOTAL HOURS	**45**	

References:

1. Carey, N. (2012). The epigenetics revolution: How modern biology is rewriting our understanding of genetics, disease, and inheritance. Columbia University Press.
2. Brown, T. A. (2018). Genomes 4. CRC Press LLC.
3. Lewin, B. (2006). Essential genes. Pearson Education.
4. Meneely, P. (2020). Genetic Analysis: Genes, Genomes, and Networks in Eukaryotes. Oxford University Press.
5. Snyder, L., Champness, W., & Champness, W. (2007). Molecular genetics of bacteria (Vol. 3). Washington, DC: Asm Press.
6. Strachan, T., & Read, A. P. (1999). Human molecular genetics 2/; Tom Strachan and Andrew P. Read.
7. Snustad, D. P., & Simmons, M. J. (2015). Principles of genetics. John Wiley & Sons.
8. Griffiths, A. J. (2005). An introduction to genetic analysis. Macmillan.

Online Resources:

1. https://www.pubmed.ncbi.nlm.nih.gov/
2. https://www.ncbi.nlm.nih.gov/

Teaching Pedagogy:

- Case studies on topics for in depth exploration of realities (cases)and presenting investigative analyses.
- Assignments in order to create authentic and simplified learning environments with respect to complex topics
- Group discussion and quiz to encourage debates and stimulate teacher and students interaction.
- Slide presentation and model based demonstrations to promote critical thinking and help students to practically apply their skills.

Evaluation Pattern:

Continuous Internal Assessment		Test 1	30 marks scaled down to 20
		Test 2	NA
		Seminar/Presentation	10 marks reduced to 5
		Project	10 marks reduced to 5
Semester End Examination		SEE	70 marks
TOTAL			100 marks

SYLLABUS BLUEPRINT

Program Title	MSc Biotechnology
Course Title	BIOMOLECULES AND ANALYTICAL TECHNIQUES
Nature of Course	Discipline Specific Course(DSC)
Semester	I
Total Hours	52
Credits	4

Objective of the Course:

The module aims to provide practical experience in basic techniques in Biomolecular technologies and to provide an understanding of the theoretical basis of the techniques.

Course Learning Outcomes:

COURSE LEARNING OUTCOMES (What students will learn after completing the degree based on Bloom's Taxonomy)	
CLO1	Students will have an understating of the structural organisation of proteins and the relevance of each amino acid in it.
CLO2	Students will get an idea about the diverse form carbohydrate existing in the nature and their function
CLO3	Students will be able to understand the different forms lipids existing in the nature and their function
CLO4	Students will be able to analyse the structural and functional organisation of enzymes, explore their action mechanism, and their requirement in day-to-day functions in living systems
CLO5	Students will get an insight about the structure of the nucleotides and the kind of bonds they can form during different reaction
CLO6	Students will gain knowledge in the mechanisms of advanced techniques used in isolation and purification of biomolecules
CLO7	Study the principles, working and applications of instruments used for characterization of biomolecules

MAPPING OF COURSE LEARNING OUTCOMES TO PROGRAM LEARNING OUTCOMES							
	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7
CLO1	✔						
CLO2							
CLO3		✔		✔		✔	
CLO4		✔		✔			
CLO5			✔		✔		✔
CLO6	✔				✔		
CLO7			✔				

(Put a tick mark to indicate the mapping)

Course Content:

Module	Content	Hours
1.Amino acids and Proteins	Classification , Properties Chemical reactions Optical Properties of amino acids and proteins Structural organization of proteins	6
2.Carbohydrates	Classification, structure, Properties, Chemical reactions, Derived sugars, Polysaccharides	5
3.Lipids	Classification (simple, compound and derived lipids), Properties, Chemical reactions, Role of lipids in biological functions	5
4.Enzymes	Classification, nomenclature, coenzymes Kinetics of Enzyme catalysed reaction – Michaelis- Menten equation, significance of Km and Vmax, Factors affecting enzyme activity, Lineweaver -Burk plot, Mechanism of enzyme action –Lock and key theory and Induced fit hypothesis, Enzyme inhibition – reversible and irreversible inhibitions. Allosteric regulation.	6
5.Purines and pyrimidines	Structure of nitrogenous bases, nucleosides, and nucleotides.	3
6.Isolation and Separation of Biomolecules (proteins)	General scheme for purification of proteins. Methods for lysis of plant, animal and microbial cells. Use of detergents in isolation	18

	of membrane proteins. Centrifugation: Principles, instrumentation and applications. Types of centrifugation-density gradient centrifugation, isopycnic and rate zonal centrifugation, Basic principles: Adsorption chromatography, Partition chromatography (Paper, TLC, ion-exchange, gel filtration, affinity). Applications of chromatography.	
7.Electrophoresis and spectroscopy and spectrophotometry	Principles, instrumentation, methods and applications of electrophoresis. (Poly acrylamide/ Agarose gel electrophoresis, use of SDS) Electromagnetic radiation and interaction with matter, Principles and applications of UV and visible spectrophotometer.	9
TOTAL HOURS	**45**	

References:

1. H.H. Willard, L.L. Merritt Jr et al., (1986) Instrumental Methods of Analysis, 6th Edition. CBS Publishers and Distributors.
2. Chatwal G and Anand, S. (1989) Instrumental Methods of Chemical Analysis. Himalaya Publishing House, Mumbai.
3. Nadeau, J. L. (2017). Introduction to experimental biophysics: biological methods for physical scientists. CRC Press.
4. Robinson, J. W. (1991). Practical handbook of spectroscopy. CRC press.
5. Glick, D. (Ed.). (2009). Methods of biochemical analysis. John Wiley & Sons.
6. Harisha, S. (2005). An introduction to practical biotechnology. Firewall Media.
7. Upadhyay, A., Upadhyay, K., & Nath, N. (2003). Biophysical Chemistry Principles & Techniques Handbook.

Online Resources:

1. https://www.pubmed.ncbi.nlm.nih.gov/
2. https://www.ncbi.nlm.nih.gov/

Teaching Pedagogy:

- Assignment
- Slide presentation
- Quiz
- Group discussion
- Case study

Evaluation Pattern:

Continuous Internal Assessment		Test 1	30 marks scaled down to 20
		Test 2	NA
		Seminar/Presentation	10 marks reduced to 5
		Project	10 marks reduced to 5
Semester End Examination		SEE	70 marks
TOTAL			100 marks

SYLLABUS BLUEPRINT

Program Title	MSc Biotechnology
Course Title	BASIC BIOINFORMATICS
Nature of Course	Allied course
Semester	I
Total Hours	26
Credits	2

Objective of the Course:

This course is designed to provide a broad overview of biostatistics methods as well as its applications commonly used for Biotechnological experiments.

Course Learning Outcomes:

COURSE LEARNING OUTCOMES (What students will learn after completing the degree based on Bloom's Taxonomy)	
CLO1	To understand important Biological Databases and to articulate the biological data.
CLO2	To analyse and evaluate various computational methods to analyse protein sequences.
CLO3	To apply the concepts learnt to the methods of Phylogenetic analysis.
CLO4	To create a link between bioinformatics and prediction of protein structure using various computational tools.

MAPPING OF COURSE LEARNING OUTCOMES TO PROGRAM LEARNING OUTCOMES							
	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7
CLO1	✔						
CLO2							
CLO3		✔		✔		✔	
CLO4		✔		✔			

(Put a tick mark to indicate the mapping)

Course Content:

Module	Content	Hours
1. Biological Databases	NCBI, EMBL, DDBJ, PIR, SWISSPROT PDB, CATH, BLOCKS, TIGR, KEGG	**6**
2. Computational sequence analysis	Needleman Wunsch Algorithm, Smith Waterman aligorithm, PAM, BLOSUM, Gap, Gap penalty, Pairwise Alignment, Multiple Alignment, BLAST, FASTA, ORF finder	**8**
3. Phylogenetic Analysis	Tree construction – Distance Method	**2**
4. Protein Structure Prediction	Protein sequencing; Secondary structure prediction tools and methods, tertiary structure prediction tools and methods; Structure alignment, validation, refinement MALDI -TOF	**4**
TOTAL HOURS	**26**	

References:

1. Baxevanis, A. D., Bader, G. D., & Wishart, D. S. (Eds.). (2020). Bioinformatics. John Wiley & Sons.
2. Higgins, D., & Taylor, W. (Eds.). (2000). Bioinformatics: Sequence, Structure and Databanks: A Practical Approach (Vol. 236). OUP Oxford.
3. Peruski, L. F., & Peruski, A. H. (1997). The Internet and the new biology: tools for genomic and molecular research..
4. Tzfira, T. (2002). Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins.
5. Higgins, D., & Taylor, W. (Eds.). (2000). Bioinformatics: Sequence, Structure and Databanks: A Practical Approach (Vol. 236). OUP Oxford.

Online Resources:

1. https://www.pubmed.ncbi.nlm.nih.gov/
2. https://www.ncbi.nlm.nih.gov/

Teaching Pedagogy:

- Case studies on topics for in depth exploration of realities (cases)and presenting investigative analyses.
- Assignments in order to create authentic and simplified learning environments with respect to complex topics
- Group discussion and quiz to encourage debates and stimulate teacher and students interaction.
- Slide presentation and model based demonstrations to promote critical thinking and help students to practically apply their skills.

Evaluation Pattern:

Continuous Internal Assessment		Test 1	30 marks scaled down to 10
		Test 2	NA
		Seminar/Presentation	10 marks reduced to 5
		Project	NA
Semester End Examination		SEE	50 marks reduced to 35
TOTAL			50 marks

SYLLABUS BLUEPRINT

Program Title	M.Sc Biotechnology
Course Title	BIOSTATISTICS
Nature of Course	Allied Course
Semester	I
Total Hours	26
Credits	2

Objective of the Course:

Enable the students to understand, analyze and interpret descriptive statistics and visual representations. Learn the concepts of probability and probability distributions. Apply hypothesis testing to draw conclusions about populations in the context of biological systems and interpret P values.

Course Learning Outcomes:

COURSE LEARNING OUTCOMES (What students will learn after completing the degree based on Bloom's Taxonomy)	
CLO1	Understand, create and analyze diagrammatic and graphical displays to summarised data. Evaluate and interpret measures of center and spread of data
CLO2	Evaluate, interpret and communicate the simple correlation and simple linear regression
CLO3	Apply basic concepts of probability to evaluate, interpret and communicate event probabilities. Apply appropriate probability distribution based on experimental conditions and assumptions to evaluate probability
CLO4	Understand and identify the population and sample from a study, distinguish between probability and non probability sampling methods
CLO5	Understand and apply appropriate tests of hypothesis in the context of biological systems and interpret P values

Course Content:

Module	Content	Hours
1	**Univariate Data Analysis**	**07hrs**
	Types of data, summarization of data through frequency distributions, bar diagrams and histograms.	
	Measures of central tendency – mean, median, mode.	
	Measures of dispersion – range, variance, standard deviation, coefficient of variation.	
II	**Bivariate Data Analysis**	**03 hrs**
	Scatter plot, Karl Pearson's correlation, fitting linear regression.	
III	**Probability and Theoretical Distributions**	**06 hrs**
	Probability - Basic terminology, classical definition, conditional probability, independence	
	Random variables – discrete and continuous.	
	Binomial, Poisson and normal distributions-important properties and problems	
IV	**Sampling**	**02** hrs
	Meaning. Probability and non -probability sampling techniques discussion through examples.	
	Types of sampling - simple random sampling, stratified random sampling, systematic sampling and cluster sampling.	
V	**Testing of Hypothesis**	**08** hrs
	Random samples, parameter and statistic, types of hypothesis: null, alternative, simple, composite, one-sided, two-sided, types of errors, critical and acceptance regions.	
	Large sample test for proportion, equality of proportions, t-test for single mean and equality of means, chi-square test for independence of attributes, ANOVA for one-way classified data.	

References:

1. N. Gurumani (2005), An Introduction to Biostatistics, Second Edition, MJP publishers
2. Veer Bala Rastogi (2008), Fundamentals of Biostatistics, Ane Books India
3. B L Verma, G D Shukla, R N Srivastava (1993), Biostatistics Perspectives in Health Care, Research and Practice, First Edition, CBS Publishers and Distributers,
4. Jerrold H Zar (1999), Biostatistical Analysis, Fourth Edition, Pearson Education

Online Resources:

1. https://www.unilus.ac.zm/lms/e-books/books/Basic_Sciences/Behavioural%20sciences%20and%20public%20health/Fundamentals%20of%20Biostatistics%20%287th%20Edition%29.pdf.
2. https://books.google.co.in/books?id=9gAXEoxDq04C&printsec=copyright&redir_esc=y#v=onepage&q&f=false.

Teaching Pedagogy:

- Classroom teaching using ICT tools
- Teaching through Microsoft Excel
- Assignments

Evaluation Pattern:

Continuous Internal Assessment	Test 1	30 marks scaled down to 10
	Seminar/Presentation	5 marks
Semester End Examination	SEE	50 marks
TOTAL		50 marks

SYLLABUS BLUEPRINT

Program Title	MSc Biotechnology
Course Title	BIOCHEMISTRY
Nature of Course	DSC
Semester	II
Total Hours	45
Credits	3

Objective of the Course:
Through the application of biochemical pathways, students will study not only concepts, principles, and various metabolic procedures that occur in the organism they will also understand the vital role of biochemistry in medicine and how biochemistry principles are applied in everyday professional practices

Course Learning Outcomes:

COURSE LEARNING OUTCOMES (What students will learn after completing the degree based on Bloom's Taxonomy)	
CLO1	To understand and explain the Bioenergetics concepts of energy production and transmission in a living system.
CLO2	To examine the basis of Protein metabolism in living system.
CLO3	To understand the concepts of Carbohydrate production and its use in the living system.
CLO4	To evaluate the process of Lipids production and its importance in the living system.
CLO5	To study the concepts and importance of photosynthesis in plants and other living systems.
CLO6	To understand and explain the mechanism of synthesis of nitrogen bases.

MAPPING OF COURSE LEARNING OUTCOMES TO PROGRAM LEARNING OUTCOMES							
	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7
CLO1	✔						
CLO2							
CLO3		✔		✔		✔	
CLO4		✔		✔			
CLO5			✔		✔		✔
CLO6	✔				✔		

(Put a tick mark to indicate the mapping)

Course Content:

Module	Content	Hours
1.Bioenergetics	Bioenergetics: Laws of thermodynamics, enthalpy, entropy, and the free energy change, standard free energy change. ETC,Respiratory chain The principal redox carriers, chemi osmotic hypothesis. Substrate level phosphorylation and Oxidative phosphorylation, Transmembrane pH and potential gradients. ATP synthesis and utilization ATP and Other energy rich compounds, Functions of ATP.	6
2.Protein & Amino acids	Protein breakdown/proteolysis, Disposal of N_2 in the urea cycle Biosynthesis, degradation and regulation of essential amino acids (Aromatic amino acids in detail) Central glutamine and glutamic acid pathways	10
3.Carbohydrates	Metabolism and regulation of glycogenesis, Glycogenolysis, Glycolysis, fermentation reactions, Gluconeogenesis, Krebs cycle, HMP shunt and its significance. Anaplerosis. Starch synthesis.	8
4.Lipids	Fatty acid synthesis and its regulation beta oxidation of saturated and unsaturated fatty acids (mention odd chain), Omega oxidation. Metabolism of ketone bodies. Synthesis of phospholipids, Synthesis of cholesterol.	10
5.Photosynthesis	Introduction to photosynthesis. Light Reactions, Dark reactions (Calvin Cycle), Photorespiration, C_4 Plants, CAM Plants.	7
6.**Metabolism of purines and pyrimidines**	De novo and salvage pathways	4
TOTAL HOURS	**45**	

References:

1. Berg, J. M., Tymoczko, J. L., & Stryer, L. (2007). Biochemistry (Loose-Leaf). Macmillan.
2. Flotte, T. R., & Berns, K. I. (Eds.). (1969). Laboratory techniques in biochemistry and molecular biology (Vol. 31). Elsevier.
3. Horton, D. (2012). Advances in carbohydrate chemistry and biochemistry (Vol. 68). Academic Press.
4. Voet, D., & Voet, J. G. (2010). Biochemistry. John Wiley & Sons.
5. Glick, D. (Ed.). (2009). Methods of biochemical analysis. John Wiley & Sons.
6. Lehninger, A. L., Nelson, D. L., & Cox, M. M. (2005). Lehninger principles of biochemistry. Macmillan.

Online Resources:

1. https://www.pubmed.ncbi.nlm.nih.gov/
2. https://www.ncbi.nlm.nih.gov/

Teaching Pedagogy:

- Case studies on topics for in depth exploration of realities (cases)and presenting investigative analyses.
- Assignments in order to create authentic and simplified learning environments with respect to complex topics
- Group discussion and quiz to encourage debates and stimulate teacher and students interaction.
- Slide presentation and model based demonstrations to promote critical thinking and help students to practically apply their skills.

Evaluation Pattern:

Continuous Internal Assessment		Test 1	30 marks scaled down to 20
		Test 2	NA
		Seminar/Presentation	10 marks reduced to 5
		Project	10 marks reduced to 5
Semester End Examination		SEE	70 marks
TOTAL			100 marks

SYLLABUS BLUEPRINT

Program Title	MSc Biotechnology
Course Title	MOLECULAR BIOLOGY
Nature of Course	DSC
Semester	II
Total Hours	45
Credits	3

Objective of the Course:

To clarify various molecular biological concepts that revolves around the DNA

Course Learning Outcomes:

COURSE LEARNING OUTCOMES (What students will learn after completing the degree based on Bloom's Taxonomy)	
CLO1	Students will get an insight about some of the important discoveries and inventions in Molecular Biology
CLO2	The student will obtain knowledge about the structure, function and types of nucleic acids in a cell.
CLO3	The students will have an understanding about the various modes of DNA replication possible in a cell.
CLO4	The student will be able to approach analytical questions related to transcription of a gene and post transcriptional modifications
CLO5	The student will be able to connect the importance of synthesis of proteins by translation.
CLO6	The student will be able to learn the impact of DNA mutation on diseased conditions and the importance of DNA repair system in a cell. They will also be able to think logically the regulation of gene expression in various cellular conditions in prokaryotes and eukaryotes.
CLO7	Students will be able to understand different techniques of hybridisation and their applications in appropriate situations
CLO8	Study the Oncogenes and mechanism of metastasis, Tumour suppressor genes

MAPPING OF COURSE LEARNING OUTCOMES TO PROGRAM LEARNING OUTCOMES							
	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7
CLO1	✔						

CLO2							
CLO3		✔		✔		✔	
CLO4		✔		✔			
CLO5			✔		✔		✔
CLO6	✔				✔		
CLO7							✔
CLO8			✔				

(Put a tick mark to indicate the mapping)

Course Content:

Module	Content	Hours
1.Introduction	History, Discovery of Nucleic Acids, Biochemical evidence of DNA and RNA as genetic material	**1**
2.Structure and Function of Nucleic Acids	Structure of DNA and RNA, Different forms of DNA (A-DNA, B-DNA, Z-DNA). Types of RNA and their functions. Base modification in RNA.	**7**
3.DNA Replication	DNA replication (3 types), Mechanism of DNA Replication, Regulation in Prokaryotes and Eukaryotes.	**7**
4.Transcription	Types, Structure and function of RNA polymerases Transcription in Prokaryotes and Eukaryotes (Transcription factors, inhibitors of transcription), Post Transcriptional modifications.	**8**
5.Translation	Genetic code, tRNAs, ribosomes, Protein synthesis in Prokaryotes and Eukaryotes, Post translational modifications.	**7**
6.DNA damage and Repair **& Regulation of Gene expression**	Alterations of DNA molecule, Biochemical mechanisms (Photoreactivation, Mismatch, Excision, Recombination and SOS repair) General aspects of regulation, operon model. Prokaryotes:- lac operon , trp operon. Levels of eukaryotic gene regulation. Transcription control by methylation, miRNA and siRNA	**12**
7.Hybridization techniques with Applications	Hybridization and Blotting techniques – Southern , Northern and WesternBlotting	**2**
8. Introduction to cancer biology and	Oncogenes and mechanism of metastasis, Tumour suppressor genes	**1**
TOTAL HOURS	**45**	

References:

1. Alberts, Bruce, Dennis Bray, Karen Hopkin, Alexander D. Johnson, Julian Lewis, Martin Raff, Keith Roberts, and Peter Walter (2015).. Essential cell biology. Garland Science
2. Bruce, A. (1983). Molecular biology of the cell. Garland publishing.
3. Carlberg, C., & Molnár, F. (2016). Mechanisms of gene regulation , Dordrecht, The Netherlands: Springer.
4. Lewin, B., Krebs, J., Kilpatrick, S. T., & Goldstein, E. S. (2014). Lewin's Genes XI, vol. 11. Burlington, Massachusetts: Jones & Bartlett Learning.
5. Dunn, A., Johnstone, R. W., & Stillman, B. (2019). Joseph F. Sambrook (1939–2019). Nature Structural & Molecular Biology, 26(10), 846-847.
6. Carson, S., Miller, H. B., Srougi, M. C., & Witherow, D. S. (2019). Molecular biology techniques: a classroom laboratory manual. Academic Press.
7. Berg, J. M., & Tymoczko, J. L. (2018). Stryer biochemie (Vol. 8). Heidelberg: Springer Spektrum.

Online Resources:

1. https://www.pubmed.ncbi.nlm.nih.gov/
2. https://www.ncbi.nlm.nih.gov/

Teaching Pedagogy:

- Case studies on topics for in depth exploration of realities (cases)and presenting investigative analyses.
- Assignments in order to create authentic and simplified learning environments with respect to complex topics
- Group discussion and quiz to encourage debates and stimulate teacher and students interaction.
- Slide presentation and model based demonstrations to promote critical thinking and help students to practically apply their skills.

Evaluation Pattern:

Continuous Internal Assessment		Test 1	30 marks scaled down to 20
		Test 2	NA
		Seminar/Presentation	10 marks reduced to 5
		Project	10 marks reduced to 5
Semester End Examination		SEE	70 marks
TOTAL			100 marks

SYLLABUS BLUEPRINT

Program Title	MSc Biotechnology
Course Title	IMMUNOLOGY
Nature of Course	DSC
Semester	II
Total Hours	45
Credits	3

Objective of the Course:

The objective of this course is to learn about the structural features of the components of the immune system as well as their functions, with the primary emphasis on the mechanisms involved in immune system development and responsiveness.

Course Learning Outcomes:

COURSE LEARNING OUTCOMES (What students will learn after completing the degree based on Bloom's Taxonomy)	
CLO1	Helps to demonstrate the basic knowledge of immunological processes at a cellular and molecular level. Define central immunological principles and concepts
CLO2	Elucidate the genetic basis for immunological diversity and the generation of adaptive immune responses.
CLO3	Provide students with the basic knowledge about the functioning of the immune system, inflammation, immune response against infectious agents.
CLO4	Outline key events and cellular players in antigen antibody interaction, and how the nature of the antigen antibody reaction will shape resulting effector responses.
CLO5	Understand and explain the basis of immunological tolerance, autoimmunity and transplantation.
CLO6	Understand and explain the basis of allergy and allergic diseases processes governing graft rejection and therapeutic modalities for immunosuppression in transplantation.
CLO7	Describe immune mechanisms related to vaccine function and Assess the efficacy and efficiency of currently available vaccines.

MAPPING OF COURSE LEARNING OUTCOMES TO PROGRAM LEARNING OUTCOMES							
	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7
CLO1	✔						
CLO2							
CLO3		✔		✔		✔	
CLO4		✔		✔			
CLO5			✔		✔		✔
CLO6	✔				✔		
CLO7							✔

(Put a tick mark to indicate the mapping)

Course Content:

Module	Content	Hours
1.Components of Immune System	Immune response : innate and acquired immunity, Cells and Organs of the immune system	07
2.Antigens and Antibody	Antigen: properties of antigens, types, immunogens, haptens and adjuvants. Epitope: concept of epitope; B-cell and T-cell epitopes. Antibody: Basic structure, different classes and subclasses of immunoglobulins-structure and functions, effector functions of antibodies, antigenic determinants. Organization of immunoglobulins: multigene segments, VJ and VDJ recombination, P and N additions, class switching, affinity maturation. Monoclonal antibody: production and its applications	08
3.Complement system	Components of Complement system, activation pathways, regulation of complement system, biological consequences of complement activation	05
4.Antigen-Antibody reaction and methods of disease diagnosis	Antigen-antibody reaction: Forces responsible for interactions: ag-ab affinity and avidity cross reactivity, precipitation and agglutination reactions. Methodologies: immuno-diffusion, immuno-electrophoresis,	06

	ELISA-different types: Sandwich, direct, competitive and indirect methods, Western Blotting, Agglutination Inhibition tests, Immunofluorescence- fluorochromes, direct and indirect methods	
5.MHC	Classification, Structure and function, MHC evolution and allelic diversity, MHC polymorphism	07
6.Hyper sensitivity	Allergens, allergy and allergic reactions- Type1 Immediate, Type 2- Ab dependent , Type-3- immune complex, Type 4-cell mediated, Type -5 - stimulatory	07
7.Vaccines	Types of vaccines and their immune response (live attenuated and killed vaccines, sub-unit vaccines, recombinant vaccines, idiotypic vaccines, DNA vaccines). Common immunization program	05
TOTAL HOURS	**45**	

References:

1. Roitt I.M., Delves P. Roitt's Essential Immunology. (2001). 10th edn. London: Blackwell Science
2. Goldsby RA, Kindt TJ, Osborne BA, Kuby J. (2003). New York: Freeman
3. C. V. Rao. (2005) Immunology A Textbook. Edition, Narosa Publishing House Pvt. Limited
4. Delves, P. J., Martin, S. J., Burton, D. R., & Roitt, I. M. (2017). Roitt's essential immunology. John Wiley & Sons.
5. S Gangal, S.Sontakke (2013).Textbook of Basic and clinicalImmunology.Universities Press, (India) Pvt. Ltd

Online Resources:

1. https://www.pubmed.ncbi.nlm.nih.gov/
2. https://www.ncbi.nlm.nih.gov/

Teaching Pedagogy:

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- Slide presentation and model based demonstrations to promote critical thinking and help students to practically apply their skills.

Evaluation Pattern:

Continuous Internal Assessment		Test 1	30 marks scaled down to 20
		Test 2	NA
		Seminar/Presentation	10 marks reduced to 5
		Project	10 marks reduced to 5
Semester End Examination		SEE	70 marks
TOTAL			100 marks

SYLLABUS BLUEPRINT

Program Title	MSc Biotechnology
Course Title	BIOPHYSICS
Nature of Course	DSC
Semester	II
Total Hours	52
Credits	4

Objective of the Course:

To study selected biological phenomena using physical principles by introducing the use of physical methods in the study of biological systems, including macromolecules, membranes, nerves, muscle, photosynthetic systems and visual systems.

Course Learning Outcomes:

COURSE LEARNING OUTCOMES (What students will learn after completing the degree based on Bloom's Taxonomy)	
CLO1	To understand and explain the Bioenergetics concepts of energy production and transmission in a living system.
CLO2	To examine the basis of Protein metabolism in living system.
CLO3	To understand the concepts of Carbohydrate production and its use in the living system.
CLO4	To evaluate the process of Lipids production and its importance in the living system.
CLO5	To study the concepts and importance of photosynthesis in plants and other living systems.
CLO6	To understand and explain the mechanism of synthesis of nitrogen bases.
CLO7	To understand the role of Analytical methods in analysis of biomolecules

MAPPING OF COURSE LEARNING OUTCOMES TO PROGRAM LEARNING OUTCOMES							
	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7
CLO1	✓						
CLO2							
CLO3		✓		✓		✓	
CLO4		✓		✓			
CLO5			✓		✓		✓
CLO6	✓				✓		
CLO7				✓			

(Put a tick mark to indicate the mapping)

Course Content:

Module	Content	Hours
1.Physical characteristics of life and Principles of bond formation	Surface tension, diffusion, osmotic pressure. Sedimentation Mechanism of bond formation : Chemical and physical forces involved in bond formation – covalent, ionic, etc. vanderwaal's forces	7
2.Isotopes and radioactivity	Radioactivity, decay laws, radio isotopes, half-life, Non-radioactive labels, Assay of radioactive materials, Applications of radioisotopes in biological sciences. Nature and measurement of radio activity Detection using fluorescent probes and chromogenic compounds	8
3. Protein structure determination	Primary, secondary, tertiary and quaternary structure and their characteristics Determination of amino acid residues, Ramachandran's plot, NMR, X-ray crystallography, Mass spectroscopy conformational analysis	10
4. Protein folding And Protein- Ligand interactions	Thermodynamics of protein folding and protein stability Ligand binding sites in immunoglobulin Substrate binding sites in serine proteases, Haem binding sites Nucleotide binding sites	8

	Binding sites for phosphoryl groups	
5. Structural basis for protein mechanism	Skeletal muscle a model system	3
6. Electrical Behavior of Cell membrane and Electrophysiology	Structure , potential and transport (active and passive) Na and K pump, Ca^{++}ATPase pump Different electrical signals in cell. Resting membrane potential–ionic basis. Action potential- ionic basis, Patch clamp and Voltage clamp studies.	7
7. Analytical methods in analysis of biomolecules	Fractional precipitation, Ultra filtration, Freeze drying Cryo electron microscopy Ultracentrifugation GLC, HPLC Capillary electrophoresis. Pulse field gel electrophoresis, Isoelectric focusing Atomic absorption spectroscopy, Spectrofluorimetry.	9
TOTAL HOURS	**52**	

References:

1. Glaser, R. (2012). Biophysics: an introduction. Springer Science & Business Media.
2. Dillon, P. F. (2012). Biophysics: a physiological approach. Cambridge University Press.
3. Kumar, P. (2016). Fundamentals and Techniques of Biophysics and Molecular biology. Pathfinder Publication unit of PAPL.
4. Rettinger, J., Schwarz, S., & Schwarz, W. (2022). Electrophysiology. Springer International Publishing.
5. Dave, H. D., Shook, M., & Varacallo, M. (2019). Anatomy, skeletal muscle.
6. Upadhyay, A., Upadhyay, K., & Nath, N. (2003). Biophysical Chemistry Principles & Techniques Handbook.

Online Resources:

1. https://www.pubmed.ncbi.nlm.nih.gov/
2. https://www.ncbi.nlm.nih.gov/

Teaching Pedagogy:

- Case studies on topics for in depth exploration of realities (cases)and presenting investigative analyses.
- Assignments in order to create authentic and simplified learning environments with respect to complex topics
- Group discussion and quiz to encourage debates and stimulate teacher and students interaction.
- Slide presentation and model based demonstrations to promote critical thinking and help students to practically apply their skills.

Evaluation Pattern:

Continuous Internal Assessment		Test 1	30 marks scaled down to 20
		Test 2	NA
		Seminar/Presentation	10 marks reduced to 5
		Project	10 marks reduced to 5
Semester End Examination		SEE	70 marks
TOTAL			100 marks

SYLLABUS BLUEPRINT

Program Title	M.Sc Biotechnology
Course Title	Nanotechnology in Biological Sciences
Nature of Course	Allied course
Semester	II
Total Hours	26
Credits	02

Objective of the Course:

- To become familiar with the background and fundamentals of nanotechnology
- To familiarize students with different nanomaterial synthesis method and their underlined principles.
- To enhance students ability to troubleshoot and address challenges that may arise during nanomaterial synthesis
- To provide the knowledge in preparation of nanomaterials and various instruments.

Course Learning Outcomes:

COURSE LEARNING OUTCOMES (What students will learn after completing the degree based on Bloom's Taxonomy)	
CLO1	Understand the background and fundamentals of nanotechnology
CLO2	Students gets hands on training on synthesis of different nanostructures and various instruments.
CLO3	Understanding principles and mechanism various nanomaterial synthesis methods.

CLO4	Acquire the knowledge on data analysis and interpretation
CLO5	Ability to select appropriate synthesis techniques based on the desired nanomaterial properties and applications

Course Content:

Module	Content	Hours
I	Background of Nanotechnology: Introduction Nano and Nanometer- Historical aspects of Nanotechnology, Nanotechnology in nature, Theory, Definitions and Scaling, Properties at nanoscale - optical, electronic and magnetic. Nanomaterial's**:** 0D materials, 1D material, 2D materials, 3D materials, Top down and Bottom up approach for synthesis- Ball milling, probe sonication, sol-gel, hydrothermal. Green synthesis, biological synthesis.	06
II	Applications: Agriculture: Plant disease diagnostics, Seed germination, Crop protection - nano fertilizer, and smart delivery systems, Food Industry: Food processing, food sensors, intelligent packaging, edible coatings. Medicine and Healthcare technology: cancer treatment, drug delivery, bio imaging and nano robots. The Ethics of Nanotechnology-Potential Benefits, Potential Dangers.	05
III	Lab Component- List of Experiments • Green synthesis of Silver (Ag) Nanoparticles using Azadirachta indica • Honey mediated synthesis of silver (Ag) nanoparticles. • Fluorescent Nano-Biomass Dots (Glycine max) using probe sonication technique. • Synthesis of Silver (Ag) Nanoparticles using chemical reduction method. • Zinc Oxide (ZnO) nanoparticle synthesis precipitation method. • Preparation of Magnesium oxide (MgO) by reduction method. • Synthesis of Stannic Oxide (SnO2) Nanowire by Hydrothermal technique. • Preparation of Zinc oxide (ZnO) nanoparticle synthesis by ball milling technique. • To Study the lattice and Structural parameters for the XRD Data.	15

	• To Study the particle size distribution using Image J software (TEM analysis) • Demo experiments: Analysis of nano structured material using Atomic force Microscope(AFM) • Demo experiments: Nanomaterial preparation using Chemical vapour deposition	

References:

1. T. Pradeep (2017), NANO: The Essentials: Understanding Nanoscience and Nanotechnology book, Publisher, McGraw Hill Education, Delhi
2. WM Breck (2016), Nanotechnology Volume 1,2 CBS Publishers & Distributors Pvt ltd

Online Resources:

1.http://www.istl.org/11-winter/internet1.html

Teaching Pedagogy:

- Case studies on topics for in depth exploration of realities (cases)and presenting investigative analyses.
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- Group discussion and quiz to encourage debates and stimulate teacher and students interaction.
- Slide presentation and model based demonstrations to promote critical thinking and help students to practically apply their skills.

Evaluation Pattern:

Continuous Internal Assessment	Test 1	30 marks scaled down to 10
	Test 2	30 marks scaled down to 10
	Seminar/Presentation	10 marks
	Project	10 marks
Semester End Examination	SEE	60 marks
TOTAL		100 marks

SYLLABUS BLUEPRINT

Program Title	MSc Biotechnology
Course Title	ADVANCED BIOINFORMATICS
Nature of Course	Allied Course
Semester	II
Total Hours	26
Credits	2

Objective of the Course:

To provide an insight into the inherent structure of biological information and development of computational approaches to study and predict protein structure to further understanding of structure-function relationship.

Course Learning Outcomes:

COURSE LEARNING OUTCOMES (What students will learn after completing the degree based on Bloom's Taxonomy)	
CLO1	To understand the inherent structure of protein molecules through Molecular Visualization.
CLO2	To analyse and evaluate the computational approaches towards predicting the protein structure using Molecular Docking.
CLO3	To apply the concepts learnt to understand the structure-function relationships.
CLO4	To create a link between the concepts of molecular visualization tools and their research and industrial applications.

MAPPING OF COURSE LEARNING OUTCOMES TO PROGRAM LEARNING OUTCOMES

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7
CLO1	✔						
CLO2					✔		
CLO3		✔		✔		✔	
CLO4			✔				

(Put a tick mark to indicate the mapping)

Course Content:

Module	Content	Hours
1. Molecular Visualization	Rasmol, Swiss PDB Viewer	**6**
2. Molecular Docking	Determination of active sites and hot spots, Receptor-Ligand interactions, Pharmacophore, Tools used for docking (AUTODOCK).	**8**
3. QSAR	Quantitative structure – active relationship models	**6**
4. Molecular Visualization	Rasmol, Swiss PDB Viewer	**6**
TOTAL HOURS	**26**	

References:

1. Wilkins, M. R. (Ed.). (1997). Proteome research: new frontiers in functional genomics. Springer Science & Business Media.
2. Cantor, C. R., & Smith, C. L. (2004). Genomics: the science and technology behind the human genome project. John Wiley & Sons.
3. Franks, F. (Ed.). (1993). Protein biotechnology: isolation, characterization, and stabilization. Springer Science & Business Media.
4. Cleland, J. L., & Craik, C. S. (Eds.). (1996). Protein engineering: principles and practice. New York: Wiley-Liss.

Online Resources:

1. https://www.pubmed.ncbi.nlm.nih.gov/
2. https://www.ncbi.nlm.nih.gov/

Teaching Pedagogy:

- Case studies on topics for in depth exploration of realities (cases)and presenting investigative analyses.
- Assignments in order to create authentic and simplified learning environments with respect to complex topics
- Group discussion and quiz to encourage debates and stimulate teacher and students interaction.
- Slide presentation and model based demonstrations to promote critical thinking and help students to practically apply their skills.

Evaluation Pattern:

Continuous Internal Assessment		Test 1	30 marks scaled down to 10
		Test 2	NA
		Seminar/Presentation	10 marks reduced to 5
		Project	NA
Semester End Examination		SEE	50 marks reduced to 35
TOTAL			50 marks

SYLLABUS BLUEPRINT

Program Title	MSc Biotechnology
Course Title	COMMUNITY DEVELOPMENT PROGRAMME
Nature of Course	CDP
Semester	II
Total Hours	30 hours
Credits	1
MARKS	50

Community Development Program

The students of MSc Biotechnology involve themselves in various types of CDP activities. Some of the initiatives are: creating social awareness about pollution (noise/ chemical/waste dumping) in common crowded places like railway/bus station (by circulating flyers with risk factors associated and solutions to minimize the threat), educating children belonging to underprivileged communities for example “Nammadi mane foundation” as well as children with special needs as in foundations like “Tamahar” and “Ishanya India Foundation”, entertaining and helping people belonging to the geriatric community such as “Akkare Seva” and “Sri Rama elders Ashram”, initiating food drives for needy people in the above mentioned organisations. These initiatives are with the motive of improving the social, economic, and environmental situations of the community the students are belonging.

SYLLABUS BLUEPRINT

Program Title	MSc Biotechnology
Course Title	ANIMAL BIOTECHNOLOGY
Nature of Course	DSC
Semester	III
Total Hours	45
Credits	3

Objective of the Course:

To help understand the culture techniques of animal cells and exploit it in the field of tissue culture, enhance the genetic engineering skills with respect to animals and to study the applications of animal tissue culture and transgenic technology

Course Learning Outcomes:

COURSE LEARNING OUTCOMES (What students will learn after completing the degree based on Bloom's Taxonomy)	
CLO1	Gain knowledge about the practicalskills to culture animal cells and tissues and Familiarize with the tissue culture lab facilities
CLO2	·Equip with the knowledge on physiological and nutritional requirements of cell types and Analyse the properties of normal and tumorigenic cells Competence and skill development instudying and characterizing cancer cells
CLO3	Understand that aseptic technique is a fundamental and important laboratory skill in the field of animal tissue culture
CLO4	Gain knowledge about the genetic studies on cultured cells and applications ofCell Hybridization in Formal Genetics
CLO5	Learn the invitro culturing and manipulation techniques in assisted conception and Gain competent knowledge on the concepts of assisted reproductive technology
CLO6	Analyze the micromanipulation techniques to carry out somatic cell nuclear Transfer and Competence and skill development in studying the applications of cloning technology in research and development
CL07	To help understand methods of developing transgenic animals and genetic engineering skills with respect to animals and their industrial applications

MAPPING OF COURSE LEARNING OUTCOMES TO PROGRAM LEARNING OUTCOMES							
	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7
CLO1	✔						
CLO2			✔				
CLO3		✔		✔		✔	
CLO4		✔		✔			
CLO5			✔		✔		✔
CLO6	✔				✔		
CLO7							✔

(Put a tick mark to indicate the mapping)

Course Content:

Module	Content	Hours
1.Animal Tissue Culture Requirements	Introduction Laboratory design, Equipments used Media: Natural, Defined media for cells and tissues-composition and preparation	6
2.Types of cultures and stem cell biology	Adherent, suspension, primary, secondary and Cell lines (finite, continuous). Organ culture, (Examples - CHO, BHK, HeLa, Properties and Culture characteristics) Embryonic and adult stem cells, potencylevelsand applications of stem cells.	11
3.Sterilization techniques	Heat based sterilization-Steam, Dry heat, Flaming, Incineration, Tyndallization Chemical sterilization-Ethylene oxide, Nitrogen dioxide, Glutaraldehyde and formaldehyde, Hydrogen peroxide Radiation sterilization-Non-ionizing radiation sterilization, Ionizing radiation sterilization -Sterile filtration	5
4.Cell hybridization	Somatic cell hybridization methods and applications of somatic cell hybrids	4
5.Assisted Reproductive technology and Embryo biotechniques in animals	In vitro maturation of oocytes, In vitro fertilization and Cryopreservation Multiple ovulation, Estrus synchronization, Embryo collection, evaluation and transfer	7

6.Cloning	Micromanipulation techniques, examples of cloned animals and applications of Somatic cell cloning	5
7. Transgenic technology in animals	Methods of transgenesis (DNA microinjection, Retroviral and Embryonic stem cell methods) with examples of transgenic animals developed for improved desired domestic characteristics (milk, meat, egg, wool, silk), biomedical models and large scale production of therapeutic proteins	7
TOTAL HOURS	**45**	

References:

1. M. M. Ranga. Animal biotechnology (2010) ; Edition, 3, reprint ; Publisher, Agrobios (India)
2. B. Singh, M. S. Chauhan. (2013). Textbook of Animal Biotechnology. Publisher TERI
3. R. Sasidhara (2003). Animal Biotechnology. MJP Publishers
4. Sudha Ganga (2007). Principles and Practice of Animal Tissue Culture Biotechnology. l. Publisher, Universities Press
5. Freshney, R.I. (2010) Culture of Animal Cells A Manual of Basic Technique and Specialized Applications. 6th Edition, John Wiley & Sons Ltd., Hoboken

Online Resources:

1. https://www.pubmed.ncbi.nlm.nih.gov/
2. https://www.ncbi.nlm.nih.gov/

Teaching Pedagogy:

- Case studies on topics for in depth exploration of realities (cases)and presenting investigative analyses.
- Assignments in order to create authentic and simplified learning environments with respect to complex topics
- Group discussion and quiz to encourage debates and stimulate teacher and students interaction.
- Slide presentation and model based demonstrations to promote critical thinking and help students to practically apply their skills.

Evaluation Pattern:

Continuous Internal Assessment		Test 1	30 marks scaled down to 20
		Test 2	NA
		Seminar/Presentation	10 marks reduced to 5
		Project	10 marks reduced to 5
Semester End Examination		SEE	70 marks
TOTAL			100 marks

SYLLABUS BLUEPRINT

Program Title	MSc Biotechnology
Course Title	PLANT BIOTECHNOLOGY
Nature of Course	DSC
Semester	III
Total Hours	45
Credits	3

Objective of the Course:

The program includes an introductory section on plant biotechnology and its applications for agriculture and industry

Course Learning Outcomes:

COURSE LEARNING OUTCOMES (What students will learn after completing the degree based on Bloom's Taxonomy)	
CLO1	Provides the students with basic knowledge of instrumentation for sterilization procedures and media preparations.
CLO2	Students are able to learn theoretical knowledge about different cultures which they will extend in practicals.
CLO3	The student is able to connect the making of plant clones and production of secondary metabolites.
CLO4	The students are able to analyze developmental pathways
CLO5	The students are acquiring knowledge of genetic organization and model systems in plants
CLO6	The student is able to approach cloning and transfection methods in plants to obtain transgenics and apply the knowledge in designing their project work.
CL07	The students will be familiarize with the applications of transgenic plants in different fields

MAPPING OF COURSE LEARNING OUTCOMES TO PROGRAM LEARNING OUTCOMES							
	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7
CLO1	✔						
CLO2							

CLO3		✔		✔		✔	
CLO4		✔		✔			
CLO5			✔		✔		✔
CLO6	✔				✔		
CLO7							✔

(Put a tick mark to indicate the mapping)

Course Content:

Module	Content	Hours
1.Laboratory organization and media preparation	Instrumentation and laboratory set up. Sterilization methods (media sterilization, explant sterilization and maintenance of aseptic environment), Media preparation: Media components Procedure: inoculation, incubation, hardening.	07
2.Different types of culture and Applications of in vitro culture	Callus, Organ and Meristem culture. Haploid culture- anther and ovule culture. Protoplast isolation and fusion. Applications. Somatic hybridization and production of cybrids.	08
3.Micropropagation	Techniques of micro propagation, Methods and Stages. Cell suspension culture and production of secondary metabolites. (Shikonin)	04
4. Plant regeneration	Somatic embryogenesis and organogenesis	04
5. Plant molecular Biology	Model systems: Arabidopsis and Rice; Organisation of plant genomes: Unique DNA sequences, types of repetitive DNA. Plant chloroplast and mitochondrial genomes. Use of plant molecular markers in agriculture.	05
6.Gene transfer in plants	Marker genes: reporter genes and selectable markers. Current status of plant viruses: Potential DNA (Caulimoviruses and Gemini viruses) / RNA (BMV, TMV, PVX) vector systems. Genetic transformation methods in plants with one specific example for each: Ti plasmid (binary and co-integrate vectors) vector systems, protocols for transformation and mechanisms of transformation.	10

	Direct DNA Transfer to plant – Target cells for transformation, Particle Gun Method and Electroporation.	
7. Transgenic plants for quality improvement	Transgenic plants for quality- Resistance to biotic stress: Insect resistance (Bt genes from B. thuringiensis, ipt gene from A. tumefacience, cholesterol oxidase gene from Strptomyces fungus) Disease resistance (Antimicrobial proteins, Engineering toxin insensitivity, Phytoalexins) Virus resistance (Coat-protein mediated cross protection, Non structural protein mediated resistance, Antisense and sense mediated resistance), Resistance to abiotic stress: Proline, Glycine betain, Mannitol. Herbicide resistance Longer life of flower, flower colour and shape, male sterility. Transgenic plants as bioreactors- vitamins, antibodies, polymers and edible vaccines	07
TOTAL HOURS	**45**	

References:

1. Grierson, D., & Covey, S. N. (2012). Plant molecular biology. Springer Science & Business Media.
2. Chawla, H. S. (2011). Introduction to plant biotechnology (3/e). CRC Press.
3. Gamborg, O., & Phillips, G. C. (Eds.). (2013). Plant cell, tissue and organ culture: fundamental methods. Springer Science & Business Media.
4. Slater, A., Scott, N., & Fowler, M. (2008). Plant biotechnology: the genetic manipulation of plants. OUP Oxford.

Online Resources:

1. https://www.pubmed.ncbi.nlm.nih.gov/
2. https://www.ncbi.nlm.nih.gov/

Teaching Pedagogy:

- Case studies on topics for in depth exploration of realities (cases)and presenting investigative analyses.
- Assignments in order to create authentic and simplified learning environments with respect to complex topics

- Group discussion and quiz to encourage debates and stimulate teacher and students interaction.
- Slide presentation and model based demonstrations to promote critical thinking and help students to practically apply their skills.

Evaluation Pattern:

Continuous Internal Assessment		Test 1	30 marks scaled down to 20
		Test 2	NA
		Seminar/Presentation	10 marks reduced to 5
		Project	10 marks reduced to 5
Semester End Examination		SEE	70 marks
TOTAL			100 marks

SYLLABUS BLUEPRINT

Program Title	MSc Biotechnology
Course Title	GENETIC ENGINEERING
Nature of Course	DSC
Semester	III
Total Hours	45
Credits	3

Objective of the Course:

To teach techniques commonly used to study, clone and express genes

Course Learning Outcomes:

COURSE LEARNING OUTCOMES (What students will learn after completing the degree based on Bloom's Taxonomy)	
CLO1	Students will get an idea about the importance of genetic engineering and will get familiarise with different methods of gene transfer
CLO2	Students will get knowledge about the enzymes that are frequently used in genetic engineering
CLO3	Students will be informed about different types of vectors that can be used for gene cloning and they will be able to decide the relevance of each type of vector

CLO4	Students will be able to understand the basic procedure for cloning and the different types of DNA - library
CLO5	Students will develop an analytical skill on different crucial techniques frequently used in genetic engineering like PCR and next generation Sequencing
CLO6	Students will develop an understanding about the technologies recently being used in the industries
CL07	Students will get an idea about the importance of genetic engineering and will get familiarise with different methods of gene transfer
CL08	Students will get knowledge about the enzymes that are frequently used in genetic engineering

MAPPING OF COURSE LEARNING OUTCOMES TO PROGRAM LEARNING OUTCOMES

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7
CLO1	✓						
CLO							
CLO3		✓		✓		✓	
CLO4		✓		✓			
CLO5			✓		✓		✓
CLO6	✓				✓		
CLO7							✓
CLO8	✓						

(Put a tick mark to indicate the mapping)

Course Content:

Module	Content	Hours
1. Introduction to genetic engineering - Isolation of DNA, RNA and Methods of DNA transfer	Definition, aims and objectives of recombinant DNA technology. History of development of Insulin as a commercial Product of Genetic engineering Isolation of RNA from Eukaryotes. Transformation (Heatshock), Transfection, Microinjection, Electroporation, Microprojectile, Liposome- Fusion methods, Transformation and transfection efficiency.	**04**
2.Tools of r-DNA Technology	Enzymes involved in r-DNA techniques: Restriction Endo nucleases, Exo nucleases	

	(lambda, Exonuclease III), DNA Ligase, Use of Restriction Linkers, Homo Polymer Tails and terminal transferase, DNA Polymerases (Pol I, Klenow, Taq Polymerase), DNases (I and II), RNases (A,P, L, H), Kinase, Alkaline phosphatase (CIAP), Reverse Transcriptase.	**05**
4. Vectors	Different types of vectors - Cloning Vectors: Plasmid (pBR322, pUC series), Phage based Vectors(lambda and M13), Cosmids, Phagemids (pBluescript) Expression vectors (pET), Cassette Vectors (rfA), Shuttle Vectors (pPIC): Artificial chromosomes, YAC, BAC: Plant vectors, Animal viruses as vectors SV40,Vaccinia Virus: Insect virus vectors Baculovirus, Agrobacterium mediated plant cell infection Promotors; lac, trp, lambda, hybrid tac etc.	**10**
5.Cloning Strategies	Basic Cloning Procedures- Vector preparation; Insert preparation- restriction digest, PCR with adaptor primer. Ligation, Transformation. Selection process for transformed cells, Final screening of Recombinant cells, Shot Gun Cloning; cDNA Cloning Strategies (cDNA cloning , cDNA Library synthesis), In vitro Transcription and Translation Techniques (Rabbit Reticulocytes, Wheat Germ) Screening a library (DNA hybridization, immunological assays and Protein activity).	**8**
7. Techniques	PCR and its types - RT PCR – Reverse transcriptase PCR, Nested PCR, Multiplex PCR, Arbitrary Primed PCR, Touch Down PCR, Real time PCR DNA sequencing – • Maxam–Gilbert sequencing • Sangers Sequencing Next gen Sequencing • 454 Pyrosequencing • Illumina, • ABI SOLiD Mapping (Physical) • Restriction mapping • Fluorescent in situ hybridization (FISH) • Sequence tagged site (STS) mapping Chromosome Walking, Micro array,	**10**

	In vitro Mutagenesis Site-directed Mutagenesis (SDM) Yeast two hybrid system	
8. Genome editing techniques	Cre-Lox P and FLP-FRT SYSTEMS, Knockout animals CRISPR- Cas system, CRISPR-Cas9 mediated Gene Editing, TALENs (Transcription activator-like effector nucleases) mediated Gene Editing, Zinc finger nuclease	**08**
	Total hours	**45**

References:

1. Doudna, J. A., Sternberg, S. H., & Bennett, E. (2017). A Crack in Creation. Audible Studios on Brilliance Audio.
2. Brown, T. A. (2015). Gene Cloning and DNA Analysis: An Introduction. Wiley & Sons, Incorporated, John.
3. Twyman, R., & Primrose, S. B. (2013). Principles of Gene Manipulation and Genomics. Wiley & Sons, Incorporated, John.
4. D, W. J. (2004). Molecular Biology of the Gene. Pearson Education, Limited.
5. Watson, J. D. (2007). Recombinant DNA: genes and genomes: a short course. Macmillan.

Online Resources:

1. https://www.pubmed.ncbi.nlm.nih.gov/
2. https://www.ncbi.nlm.nih.gov/

Teaching Pedagogy:

- Case studies on topics for in depth exploration of realities (cases)and presenting investigative analyses.
- Assignments in order to create authentic and simplified learning environments with respect to complex topics
- Group discussion and quiz to encourage debates and stimulate teacher and students interaction.
- Slide presentation and model based demonstrations to promote critical thinking and help students to practically apply their skills.

Evaluation Pattern:

Continuous Internal Assessment		Test 1	30 marks scaled down to 20
		Test 2	NA
		Seminar/Presentation	10 marks reduced to 5
		Project	10 marks reduced to 5
Semester End Examination		SEE	70 marks
TOTAL			100 marks

SYLLABUS BLUEPRINT

Program Title	MSc Biotechnology
Course Title	ENVIRONMENTAL BIOTECHNOLOGY
Nature of Course	DISCIPLINE SPECIFIC ELECTIVE
Semester	III
Total Hours	45
Credits	4

Objective of the Course:

To provide an understanding of the scientific principles (atmospheric, hydrological, geomorphological and ecological) that underpins current environmental issues and describes existing and emerging technologies that are important in the area of environmental biotechnology.

Course Learning Outcomes:

COURSE LEARNING OUTCOMES (What students will learn after completing the degree based on Bloom's Taxonomy)	
CLO1	Gain knowledge understanding of the scientific principles (atmospheric, hydrological, geomorphological and ecological) that underpin current environmental issues and describes existing and emerging technologies that are important in the area of environmental biotechnology
CLO2	Analyze the types of environmental monitoring to create a baseline for the impact of industrial pollutants in the air, land and water Gain knowledge on the biomolecular computer based approach for environmental issues including pollution
CLO3	Competence and skill development in the methods for monitoring environmental pollution
CLO4	Learn the importance and impact of biodiversity on human life, health and environment Apply the practice of Wildlife conservation, an attempt to protect endangered animal and plant species, along with their natural habitat Evaluate the reasons for loss of biodiversity and and its significant impacts on human health and the spread of disease
CLO5	Analyse the factors posing threat to the environment and Knowledge on the basic steps in Environmental risk assessment

CLO6	Gain competent knowledge on the current Water conservation and Management strategies Suggest biotechnological solutions to address environmental issues including pollution, mineral resource mining, renewable energy and water recycling
CL07	Analyse the Novel Methods for Environment protection and apply the practice of protecting the natural environment on individual, organization controlled or governmental levels, for the benefit of both the environment and humans

MAPPING OF COURSE LEARNING OUTCOMES TO PROGRAM LEARNING OUTCOMES

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7
CLO1	✓						
CLO2							
CLO3		✓		✓		✓	
CLO4		✓		✓			
CLO5			✓		✓		✓
CLO6	✓				✓		
CLO7							✓

(Put a tick mark to indicate the mapping)

Course Content:

Module	Content	Hours
1.Introduction	Definition & objective of Environmental Biotechnology. Environment: basic concepts and issues.	**3**
2. Environmental Monitoring	Sampling (Air, Water, Soil). Bioindicators (Terrestrial & Aquatic), Biosensors, Biochips – A step towards biomolecular computer – possible future applications.	**7**
3. Methods of monitoring Pollution;	Biological methods; Detection methods for DO, BOD, Pathogen monitoring by heterotrophic plate count; Multiple tube method; Membrane filtration methods; Other emerging techniques such as enzyme detection, Gene	**10**

	probe technology etc. Chemical methods- Detection methods for COD, pH, alkalinity, TSS, TDS, Total organic carbon, Biosensors for pollution	
4. Bio diversity and its conservation:	Introduction-Definition: Genetic species and ecosystem diversity, Bio-geographical classification of India, Hot-spots of biodiversity, Biodiversity-loss and conservation Threats to biodiversity : habitat loss, poaching of wildlife, man –wild life conflicts, Endangered and endemic species of India Global environmental problems, Biodiversity-loss and conservation-Global and National approach, Treaties – Kyoto protocol, Montreal protocol Earth summits, Environmental priorities in India	**10**
5. Environmental Risk analysis	Definition of Environmental risk, risk assessment and risk management, Environmental Risk characterization Basic steps in Environmental risk assessment - hazard identification, dose-response assessment, exposure assessment.	**9**
6. Water conservation and Management-	Rain water harvesting, watershed management, Ganga Action Plan, Water (prevention and control of pollution) act	**6**
7. Novel Methods for Environment protection	Vermitechnology, Waste Water Treatment Using Aquatic Plants, Root Zone Treatment. Biodegradable and Ecofriendly Products	**7**
TOTAL HOURS	**45**	

References:

1. Evans, J. C. Furlong (2002). Environmental Biotechnology.Theory and Application
2. John T, Cookson Jr. (1985). Bioremediation Engineering: Design and application. McGraw Hill, Inc
3. A. H. Scragg , Alan Scragg.(2005). Environmental Biotechnology. Oxford University Press
4. Foster C.F. John ware D.A. (1987). Environmental Biotechnology, Ellis, Honwood Ltd
5. Casida Jr, L.E. (2007). Industrial Microbiology, NewAge International (P) Ltd
6. Bhattacharya, B.C. and Banerjee, R (2007). Environmental Biotechnology, OxfordUniversityPress

Online Resources:

1. https://www.pubmed.ncbi.nlm.nih.gov/
2. https://www.ncbi.nlm.nih.gov/

Teaching Pedagogy:

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- Group discussion and quiz to encourage debates and stimulate teacher and students interaction.
- Slide presentation and model based demonstrations to promote critical thinking and help students to practically apply their skills.

Evaluation Pattern:

Continuous Internal Assessment		Test 1	30 marks scaled down to 20
		Test 2	NA
		Seminar/Presentation	10 marks reduced to 5
		Project	10 marks reduced to 5
Semester End Examination		SEE	70 marks
TOTAL			100 marks

SYLLABUS BLUEPRINT

Program Title	MSc Biotechnology
Course Title	FOOD BIOTECHNOLOGY
Nature of Course	DISCIPLINE SPECIFIC ELECTIVE
Semester	III
Total Hours	45
Credits	4

Objective of the Course:

Teach fundamental principles and unifying concepts in the food biotechnology, beginning with introducing biological concepts and end with specific areas of interest.

Course Learning Outcomes:

COURSE LEARNING OUTCOMES (What students will learn after completing the degree based on Bloom's Taxonomy)	
CLO1	Students will be able to highlight the concept of functional foods and different fermented foods
CLO2	Students are familiarizing with the production and use of enzymes in food processing
CLO3	The students are able to learn the commercial value of different types of microbial proteins used as food supplements
CLO4	The students will be analyzing the advanced methods in food analysis
CLO5	Students will be able to connect with improving the nutritional quality of different foods.
CLO6	Students will be able to interpret the role of microorganisms in various food formulations
CL07	Students will be able to infer the newer developments in food industries.

MAPPING OF COURSE LEARNING OUTCOMES TO PROGRAM LEARNING OUTCOMES							
	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7
CLO1	✔						
CLO2							
CLO3		✔		✔		✔	
CLO4		✔		✔			
CLO5			✔		✔		✔
CLO6	✔				✔		
CLO7							✔

(Put a tick mark to indicate the mapping)

Course Content:

Module	Content	Hours
1.Food Biotechnology and Relevance of Fermentation	Food Biotechnology-Definition, introduction, historical background, scope and importance. Fermentation technology - Origin, scope, and development of fermented products,	7

	Primary feed stock, raw materials and conversions, Fermented food and microbial starters, Commercial potential, Food fermentation industries, their magnitude, R & D innovations.	
2.Enzyme in Food Biotechnology	Enzyme Technology - Production of enzymes - Amylase, Protease, Lipase, Lactase and pectinases, Use of enzymes in food & beverage industry.	4
3.Production of microbial protein	SCP, SCO: substrates, nutritional value, harvesting Mushroom culture, Different types of mushrooms.	5
4.Advanced techniques of food analysis	Sampling techniques and theory and practice of chemical and physical methods of food analysis for determination of food composition	7
5.Food additives	Pigments in food, food flavours, food additives and toxicants. Natural sweeteners and artificial sweeteners and their role in controlling diseases and deficiencies, Nutraceuticals, and Functional Foods	5
6.Food Microbiology and Food Preservation	Microbial growth pattern, Microbial examination of food, Types of microorganism normally associated with food-mold, yeast, and bacteria. Microorganisms in natural food products. Biochemical changes caused by micro-organisms, deterioration of various types of food product. Standards for different foods. Food borne intoxicants and mycotoxins Factors determining shelf life, Food Preservation Using Irradiation, Food Preservation Using Irradiation heat**,** High Pressure Processing, ultrasound in food technology, Natural preservatives.	15
7.Application of biotechnology in food industries	Food fermentation-Alcoholic beverages, cheese making, fermented soya based foods, vinegar. Acidulants-citric acid, lactic acid, tartaric acid. Vitamins-Vitamin, riboflavin, vitamin B12, Amino acids-lysine, methoinine, glutamate. Sweetners-glucose syrup, High Fructose Corn Syrup (HFCS), invert sugar.	9
TOTAL HOURS	**45**	

References:

1. Whitehurst, R. J., & Van Oort, M. (Eds.). (2010). Enzymes in food technology (Vol. 388). Singapore: Wiley-Blackwell.
2. Buldini, P. L., Ricci, L., & Sharma, J. L. (2002). Recent applications of sample preparation techniques in food analysis. Journal of Chromatography A, 975(1), 47-70.
3. Branen, A. L., Davidson, P. M., Salminen, S., & Thorngate, J. (Eds.). (2001). Food additives. CRC Press.
4. Campbell-Platt, G. (1994). Fermented foods—a world perspective. Food research international, 27(3), 253-257.
5. Armenante, P. M., & Kirpekar, A. C. (1997). Sterilization in the pharmaceutical and biotechnology industry. In Handbook of Downstream Processing. Dordrecht: Springer Netherlands.

Online Resources:

1. https://www.pubmed.ncbi.nlm.nih.gov/
2. https://www.ncbi.nlm.nih.gov/

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- Slide presentation and model based demonstrations to promote critical thinking and help students to practically apply their skills.

Evaluation Pattern:

Continuous Internal Assessment		Test 1	30 marks scaled down to 20
		Test 2	NA
		Seminar/Presentation	10 marks reduced to 5
		Project	10 marks reduced to 5
Semester End Examination		SEE	70 marks
TOTAL			100 marks

SYLLABUS BLUEPRINT

Program Title	MSc Biotechnology
Course Title	DEVELOPMENTAL BIOLOGY
Nature of Course	Allied Course
Semester	III
Total Hours	30
Credits	2

Objective of the Course:

The objective of this program is to acquire an increased level of understanding of modern concepts and methodologies employed in genetic and developmental biological work and to develop insight into the complexities of cell structure and function, the molecular events that mediate cellular processes, their dynamic properties in living cells and how this contributes to the functioning of the whole organism and its development.

Course Learning Outcomes:

COURSE LEARNING OUTCOMES (What students will learn after completing the degree based on Bloom's Taxonomy)	
CLO1	Students will be aware of the history and terminologies of developmental biology.
CLO2	Students will be able to analyse the stages of animal development
CLO3	Students will be able to connect the cellular and molecular mechanisms underlying human and animal development
CLO4	Students will be acquiring deep knowledge in the process of fertilization and development of gametes
CLO5	The students will be familiarize and demonstrate a broad understanding of the key cellular and molecular mechanisms underlying human and animal development
CLO6	Students will be able to apply the concept of genetic and environmental impact to an understanding of congenital abnormalities and predisposition to adult disease

MAPPING OF COURSE LEARNING OUTCOMES TO PROGRAM LEARNING OUTCOMES							
	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7
CLO1	✔						

CLO2							
CLO3		✔		✔		✔	
CLO4		✔		✔			
CLO5			✔		✔		✔
CLO6	✔				✔		

(Put a tick mark to indicate the mapping)

Course Content:

Module	Content	Hours
1.Introduction to Developmental biology	Comparative Embryology Evolutionary Embryology Medical Embryology and Teratology	1
2.Principles of Development	Life Cycles and Developmental Patterns	2
3.Differential gene expression	Differential Gene Transcription Methylation Pattern and the Control of Transcription	4
4.Fertilization: Beginning a new organism	Structure of the Gametes Recognition of Egg and Sperm Gamete Fusion and the Prevention of Polyspermy The Activation of Egg Metabolism Fusion of the Genetic Material Rearrangement of the Egg Cytoplasm	8
5.The early development of vertebrates	Early Mammalian Development Formation of the Neural Tube, Neural Crest and CNS Mesoderm Development Endoderm Development	8
6.Differentiation and development of Invertebrate and vertebrate model systems	Segmentation in Drosophila Vulval Development in C. elegans Melanophore Development in Zebra Fish	7
TOTAL HOURS	**30**	

References:

1. Gilbert, S. F. (2000). An introduction to early developmental processes. In Developmental Biology. 6th edition. Sinauer Associates.
2. Wolpert, L. (2011). Developmental biology: A very short introduction. OUP Oxford.
3. Slack, J. M., & Dale, L. (2021). Essential developmental biology. John Wiley & Sons.

Online Resources:

1. https://www.pubmed.ncbi.nlm.nih.gov/
2. https://www.ncbi.nlm.nih.gov/

Teaching Pedagogy:

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Evaluation Pattern:

Continuous Internal Assessment		Test 1	30 marks scaled down to 10
		Test 2	NA
		Seminar/Presentation	10 marks reduced to 5
		Project	NA
Semester End Examination		SEE	50 marks reduced to 35
TOTAL			50 marks

SYLLABUS BLUEPRINT

Program Title	MSc Biotechnology
Course Title	Internship Report
Nature of Course	INTERNSHIP
Semester	III
Total Hours	30 days
Credits	2
MARKS	50

Internship Program

Students of MSc Biotechnology get exposure to experimental learning in external laboratory facilities in specified subjects during the Internship Program. Students get exposed to standard procedures in microbiology, molecular biology and biochemistry and along with advanced techniques in rDNA technology, plant and animal cell culture, bioinformatics along with biodegradation procedures. They can get this exposure in various research labs either in renowned universities, diagnostic lab facilities associated with hospitals, or research institutes. Credora, Mediomix, Jain Hospital, Azyme Institute, Dextrose Lab, Agricultural University, NIMAHNS, Scire Science, St. Johns Medical College and MMS University are some of the facilities where our students have been able to complete their Internship Program. The exposure to external lab facilities will be a learning opportunity to widen the knowledge and prepare them for a better career.

SYLLABUS BLUEPRINT

Program Title	MSc Biotechnology
Course Title	BIO PROCESS ENGINEERING & ENZYMOLOGY
Nature of Course	DSC
Semester	IV
Total Hours	45
Credits	3

Objective of the Course:

The programme is tailored to build strong fundamentals on core concepts such as reactor design, process control, etc. The programme will help students acquire state-of- the-art knowledge in topics such as metabolic engineering, synthetic biology, modelling of biological systems, plant cell bioprocessing, etc.

Course Learning Outcomes:

COURSE LEARNING OUTCOMES (What students will learn after completing the degree based on Bloom's Taxonomy)	
CLO1	Students are familiarizing with the concepts in bioprocess and also acquire knowledge about the industrially relevant strains sterilization techniques.
CLO2	Students will be able to describe the basic configuration and parts of a fermentor.
CLO3	Student will be able to apply the basics of microbial kinetics in batch, fed-batch and continuous mode of operation.
CLO4	Students will be developing a fundamental understanding process and product optimization, also be able to produce, analyse and interpret data from bioprocesses
CLO5	Students are able to understand the basic laws and terminologies in enzymology and also able to connect with enzymatic assays.
CLO6	Students are able to approach the catalytic mechanisms in detail and the impact of coenzymes and cofactors in enzyme catalyzed reactions

MAPPING OF COURSE LEARNING OUTCOMES TO PROGRAM LEARNING OUTCOMES							
	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7
CLO1	✔						
CLO2							
CLO3		✔		✔		✔	
CLO4		✔		✔			
CLO5			✔		✔		✔
CLO6	✔				✔		

(Put a tick mark to indicate the mapping)

Course Content:

Module	Content	Hours
1.Introduction to Bioprocess Engineering, Media and sterilization	Concept of Bioprocess engineering, Advantages of bioprocess over chemical process Isolation and improvement of industrially important strains. Design of fermentation media, inoculum development. Sterilization-	4

	Thermal death kinetics, sterilization of medium, air and fermentors.	
2.Fermenters	Design of fermentor-criteria for ideal fermenter aeration, agitation, valves, baffles, heat exchanges. Types of Fermenter– tower fermenter, cylindro-conical vessels, air –lift fermenter, deep-jet fermenter, the cyclone column. Animal cell culture fermenter-stirred fermenter, hollow fiber chambers, packed glass bead reactors. Membrane bioreactors Cell immobilization techniques.	6
3.Types of fermentation processes	Submerged fermentation, surface or solid substrate fermentation, batch fermentation, continuous fermentation, and kinetics of fermentation processes .Online acquisition: Bioprocess control and monitoring of variables such as temperature, agitation, pressure, pH, PID control, Use of computers in bioprocess control systems.	5
4.Upstream and Downstream processing	Scale- up and scale- down process Separation of cells: foam separation, flocculation, filtration, centrifugation (Basket and bowl centrifugation), Cell lysis methods: physical and chemical methods. Large scale separation techniques - distillation, chromatography techniques, membrane filtration, ultra filtration, reverse osmosis, crystallization, spray drying drum drying, freeze drying. Biosensors-construction and application	8
5.Introduction to enzymology, Isolation and assay of enzymes	Enzyme nomenclature & classification, general properties of enzymes- active site and specificity of enzymes. Extraction and purification of enzyme, enzymes as analytical reagents , Principle of enzymatic analysis (end point, kinetic and immunoassay methods)	4
6.Theories of enzyme catalysis, Co enzymes and co factors	Mechanism of catalysis (acid-base, electrostatic, covalent) Isozymes, reactions catalyzed by enzymes without cofactors (ribonuclease), mechanism of action of co-enzymes (NAD^+) metalloenzymes (example which need Mg^{2+}), monomeric enzymes (serine protease) and oligomeric enzyme(LDH).	7
	Total hours	**45**

References:

1. Stanbury, P. F., Whitaker, A., & Hall, S. J. (2013). Principles of fermentation technology. Elsevier.
2. Kalaichelvan, P. T., & Pandi, I. A. (2019). Bioprocess technology. MJP Publishers
3. Doran, P. M. (1995). Bioprocess engineering principles. Elsevier.
4. Bhatt, S. M. (2022). Enzymology and enzyme technology. S. Chand Publishing.
5. Palmer, T., & Bonner, P. L. (2007). Enzymes: biochemistry, biotechnology, clinical chemistry. Elsevier.
6. Michael, L. S., & Kargi, F. (2002). Bioprocess engineering: basic concepts.

Online Resources:

1. https://www.pubmed.ncbi.nlm.nih.gov/
2. https://www.ncbi.nlm.nih.gov/

Teaching Pedagogy:

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Evaluation Pattern:

Continuous Internal Assessment		Test 1	30 marks scaled down to 20
		Test 2	NA
		Seminar/Presentation	10 marks reduced to 5
		Project	10 marks reduced to 5
Semester End Examination		SEE	70 marks
TOTAL			100 marks

SYLLABUS BLUEPRINT

Program Title	MSc Biotechnology
Course Title	MEDICAL BIOTECHNOLOGY, BIOETHICS AND BIOSAFETY
Nature of Course	DSC
Semester	IV
Total Hours	52
Credits	4

Objective of the Course:

To learn the principle in the development of diagnostics, therapeutic interventions, drug delivery systems, Practical application of bioethics concepts and ethical evaluation of Biotechnological innovations.

Course Learning Outcomes:

COURSE LEARNING OUTCOMES (What students will learn after completing the degree based on Bloom's Taxonomy)	
CLO1	Gain knowledge about the practical skills to carry out DNA assays and Familiarize with the methods of DNA analysis and its importance in disease diagnosis
CLO2	Analyse the types of human disorders,Competence and skill development in probe based diagnosis of diseases
CLO3	Gain knowledge about the tissue compatibility and graft rejection And applications of regenerative medicine
CLO4	Analyse the role of drug delivery systems in nanomedicine, Competence and skill development in drug designing and pharmacokinetics
CLO5	Learn the principles and scope of bioethics and biosafety, Understand the legal, social, economic, health and environmental impacts of biotechnology research
CLO6	To help understand the types of IPR and critical in helping new ventures transform their innovation potential and creativity into market value and competitiveness
CL07	Skill development in ethical evalution of diagnostics and therapeutics

MAPPING OF COURSE LEARNING OUTCOMES TO PROGRAM LEARNING OUTCOMES							
	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7
CLO1	✔						
CLO2							
CLO3		✔		✔		✔	
CLO4		✔		✔			
CLO5			✔		✔		✔
CLO6	✔				✔		
CLO7							✔

(Put a tick mark to indicate the mapping)

Course Content:

Module	Content	Hours
1.Methods of DNA assay and DNA profiling	Methods of DNA assay (DNA probes, Nucleic acid hybridization,), Karyotype analysis, FISH, CGH DNA fingerprinting (RFLPs, SNPs, methodologies of genotyping –RAPD, AFLP and SNP typing-molecular beacons, OLA),familial relationships(Mitochondrial DNA-maternal lineage) , applications	**1.Methods of DNA assay and DNA profiling**
2.Detection and diagnosis of Human disorders	General introduction to Biochemical disorders, Immune disorders and Genetic disorders. Probes for diagnosis of infectious diseases (AIDS and HPV) Diagnosis of genetic diseases (Cystic fibrosis, sickle cell anemia, diabetes) Prenatal diagnosis of inborn errors of metabolism.	**2.Detection and diagnosis of Human disorders**
3.Regenerative Medicine, Medical Products and Gene Therapy	Cell and Tissue transplantation(importance of HLA typing, tests-Micro cytotoxicity and MLR, examples for cell and tissue transplantations-pancreatic cells, kidney, bone marrow), tissue engineering(scaffolds and cells-SCLP, materials for scaffolds), Stem cell technology (adult and embryonic stem cells) Medical products-Human protein replacements (Insulin, Factor VIII),	**3.Regenerative Medicine, Medical Products and Gene Therapy**

	Therapeutic agents (TPA, Interferons) through recombinant production, Artificial blood Introduction to gene therapy-Ex vivo gene therapy (ADA, familial hypercholesterolemia), In vivo gene therapy (cancer), Antigene and anti-sense therapy (cancer).	
4.Nano Biotechnology	Introduction to Nano Biotechnology, Drug designing and delivery using Microspheres and nanoparticles.	**4.Nano Biotechnology**
5.Biosafety	Overview of legal, social, economic, health and environmental impacts of biotechnology research. Biosafety regulations for labs, green house, field trials, biosafety committees, guidelines for research in transgenic organisms, Importance of Public education in transgenic technology research, animal containment and categories of invasiveness, Ethical issues associated with GM food, Labelling of GM food and GM crops, , Hazardous materials used in biotechnology- handling and disposal, Radiation safety measues. Good Manufacturing Practices (GMP) and Good Lab Practices (GLP)	**5.Biosafety**
6.Intellectual property rights	Forms of IPRs, Patenting and the procedures involved in the applications for patents and granting of the patent, patent search, patent cooperation treaty (PCT). Examples of patents in Biotechnology, plant breeder's rights	**6.Intellectual property rights**
7.Bioethics in Diagnosis and therapeutics	Importance of detection of pre-symptomatic disease in health care, Prenatal diagnosis and its ethical implications, Fetal sex determination and its implications in India. Ethical issues in stem cell research, testing of drugs in human volunteers (clinical trials), use of animals in research, organ transplantation and xenotransplantation.	**7.Bioethics in Diagnosis and therapeutics**
	Total hours	**52**

References:

1. Firdos Alam Khan. (2014). Biotechnology and Medical Sciences, CRC Press
2. Firdos Alam khan. (2013). Medical Biotechnology. Academic Press
3. Leonard V. Crowley (2012). An Introduction to human diseases: Pathology and Pathophysiology correlations
4. Sateesh MK (2008). Bioethics & Biosafety. IK International publications

Online Resources:

1. https://www.pubmed.ncbi.nlm.nih.gov/
2. https://www.ncbi.nlm.nih.gov/

Teaching Pedagogy:

- Case studies on topics for in depth exploration of realities (cases)and presenting investigative analyses.
- Assignments in order to create authentic and simplified learning environments with respect to complex topics
- Group discussion and quiz to encourage debates and stimulate teacher and students interaction.
- Slide presentation and model based demonstrations to promote critical thinking and help students to practically apply their skills.

Evaluation Pattern:

Continuous Internal Assessment		Test 1	30 marks scaled down to 20
		Test 2	NA
		Seminar/Presentation	10 marks reduced to 5
		Project	10 marks reduced to 5
Semester End Examination		SEE	70 marks
TOTAL			100 marks

SYLLABUS BLUEPRINT

Program Title	MSc Biotechnology
Course Title	CLINICAL BIOTECHNOLOGY
Nature of Course	Discipline Specific elective
Semester	IV
Total Hours	52
Credits	4

Objective of the Course:

To study scientific research and development in the pharmaceutical, diagnostic and biotechnological industries and clinical application in the therapeutic and diagnostic fields.
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Course Learning Outcomes:

COURSE LEARNING OUTCOMES (What students will learn after completing the degree based on Bloom's Taxonomy)	
CLO1	Understanding about the nature of clinical conditions, diagnosis and treatment
CLO2	Analyse the types of human disorders,Competence and skill development in diagnosis of diseases
CLO3	To develop an ability to use skills and modern technological tools necessary
CLO4	Explore the area of Stem cell technology as it represents an exciting area in medicine because of its potential to regenerate and repair damaged tissue and gain an insight into the the Future of Regenerative Medicine
CLO5	Equip students with the knowledge of genetic and molecular basis of conditions
CLO6	Gain knowledge about the practical skills to carry out gene transfer and methods of DNA injection and its importance in therapeutics
CL07	Explore the concepts of bioethical evaluation in medical genetics

MAPPING OF COURSE LEARNING OUTCOMES TO PROGRAM LEARNING OUTCOMES							
	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7
CLO1	✔						

CLO2							
CLO3		✓		✓		✓	
CLO4		✓		✓			
CLO5			✓		✓		✓
CLO6	✓				✓		
CLO7							✓

(Put a tick mark to indicate the mapping)

Course Content:

Module	Content	Hours
1.Introduction to Clinical Biotechnology	Brief introduction to diseases, investigations and solutions.	2
2. Representative diseases of Bacteria, Viruses, Fungi, Protozoa	Bacteria: Representative diseases to be studied in detail are - typhoid, tuberculosis. Viruses: Representative diseases to be studied in detail are - viral hepatitis, AIDS and viral cancers. Fungi: Diseases to be taken up in following categories: superficial, subcutaneous, mycoses. Protozoa: Diseases to be discussed are - amoebiasis, toxoplasmosis.	10
3. Investigation of epidemics	Methods of culturing and assaying: bacterial - serial dilutions direct and indirect count methods, viral plaque assay, and parasitic assay – serodiagnostic methods	5
4. Stem Cell Biology	Types of stem cells , Molecular basis of Pluripotentency, Stem cell niches, Stem cell renewal, Cell cycles regulators in stem cells Applications- • Neurons Stem Cells and Potential Therapies with specific application in Spinal cord injury. • Stem Cell Therapy in Cardiomyocyte Regeneration in Heart Disease	8
5.Identifying human disease genes	General gene therapy strategies, Targeted mutation correction, Targeted inhibition of gene expression.	7
6 .Gene therapy, Gene blocking therapies and Gene replacement therapy	Gene therapy for non-inheritable diseases with one example. Gene Knockouts, Gene disruption-p53	13

	Adenovirus, Naked DNA or direct injection or particle bombardment (with one example each), In-utero fetal gene therapy Prion diseases and effective gene therapy	
7.Controversial issues in medical genetics	In vitro fertilization, Prenatal sexing, Surrogate therapy, Germline gene therapy, Human transgenesis, Genetic counselling	**7**
	Total hours	**52**

References:

1. R. S. Satoskar & Bhandarkar (2013) Pharmacology and Pharmacotherapeutics. Revised 23rd Edition, Bombay Popular Prakasam Publishers
2. Rang H & MM Dale (2003). Pharmacology, Fifth Edition, Churchill-Livingstone
3. Goodman and Gilman's (2013). The Pharmacological Basis of Therapeutics 12th Edition, MacMillan Publishing Company
4. Ho et al. (2020). Biotechnology and Biopharmaceuticals Transferring Proteins and Genes. Textbook of infectious diseases 2nd Edition by Sahadulla, MI
5. Zakrzewski, W., Dobrzyński, M., Szymonowicz, M., & Rybak, Z. (2019). Stem cells: past, present, and future. Stem cell research & therapy, 10(1), 1-22.
6. Jones, H. D. (2021). Gene silencing or gene editing: the pros and cons. In RNAi for plant improvement and protection (pp. 47-53). Wallingford UK: CABI.

Online Resources:

1. https://www.pubmed.ncbi.nlm.nih.gov/
2. https://www.ncbi.nlm.nih.gov/

Teaching Pedagogy:

- Case studies on topics for in depth exploration of realities (cases)and presenting investigative analyses.
- Assignments in order to create authentic and simplified learning environments with respect to complex topics
- Group discussion and quiz to encourage debates and stimulate teacher and students interaction.
- Slide presentation and model based demonstrations to promote critical thinking and help students to practically apply their skills.

Evaluation Pattern:

Continuous Internal Assessment		Test 1	30 marks scaled down to 20
		Test 2	NA
		Seminar/Presentation	10 marks reduced to 5
		Project	10 marks reduced to 5
Semester End Examination		SEE	70 marks
TOTAL			100 marks

SYLLABUS BLUEPRINT

Program Title	MSc Biotechnology
Course Title	CANCER BIOLOGY
Nature of Course	Discipline Specific elective
Semester	IV
Total Hours	52
Credits	4

Objective of the Course:

The subject will address the key molecular, genetic and cellular characteristics of cancer.

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. **Course Learning Outcomes:**

COURSE LEARNING OUTCOMES (What students will learn after completing the degree based on Bloom's Taxonomy)	
CLO1	Students will get familiarized about the fundamental aspects of molecular aspects of cancer.
CLO2	Students will learn various causes of cancer.
CLO3	This unit will help the students in understanding the role of various oncogenes in cancer and proliferation.
CLO4	Students will be able to understand the role of different types of growth factors and receptors in promoting cancerous condition.
CLO5	Students will be able to understand metastasis of cancerous cells.
CLO6	Students will learn the about the treatment of cancer and may be able to apply knowledge in development of useful drugs.

MAPPING OF COURSE LEARNING OUTCOMES TO PROGRAM LEARNING OUTCOMES							
	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7
CLO1	✓						
CLO2							
CLO3		✓		✓		✓	
CLO4		✓		✓			
CLO5			✓		✓		✓
CLO6	✓				✓		

(Put a tick mark to indicate the mapping)

Course Content:

Module	Content	Hours
1.Fundamentals of Cancer Biology	Regulation of Cell cycle, Mutations that cause changes in signal molecules, effects on receptor, signal switches, tumor suppressor genes, Modulation of cell cycle-in cancer, Different forms of cancers, Diet and cancer, Telomerases and their role in cancer.	2
2.Principles of Carcinogenesis	Chemical Carcinogenesis, Metabolism of Carcinogenesis, Natural History of Carcinogenesis, Targets of Chemical Carcinogenesis, Principles of Physical Carcinogenesis, X-Ray radiation – Mechanism of radiation Carcinogenesis.	10
3. Molecular Cell Biology of Cancer	Oncogenes, Oncogenes/proto oncogenes activity, Identification of Oncogenes, Retroviruses and Oncogenes, DNA viruses and cancer.	5
4.Oncogenic Growth factors/growth factor receptors	Detection of Oncogenes, Growth factor and Growth factor receptors and the related signal molecules that are Oncogenes. Growth factors related to transformations.	8
5.Principles of Cancer Metastasis	Clinical significances of invasion, heterogeneity of metastatic phenotype, Metastatic cascade, Basement membrane disruption, Three step theory of invasion, Proteinases and tumour cell invasion.	7

6.New Molecules for Cancer Therapy	Different forms of therapy, Chemotherapy, Radiation Therapy, Detection of Cancers, Prediction of aggressiveness of Cancer, Advances in Cancer detection.	13
	Total hours	**52**

References:

1. DeVita Jr, V. T., Lawrence, T., & Rosenberg, S. A. (2012). Cancer: Principles & practice of oncology: Annual advances in oncology. Lippincott Williams & Wilkins.
2. Gabriel, J. A. (Ed.). (2007). The biology of cancer. John Wiley & Sons.
3. Pecorino, L. (2021). Molecular biology of cancer: mechanisms, targets, and therapeutics. Oxford university press.
4. Pecorino, L. (2021). Molecular biology of cancer: mechanisms, targets, and therapeutics. Oxford university press.
5. Dellaire, G., Berman, J. N., & Arceci, R. J. (Eds.). (2013). Cancer genomics: from bench to personalized medicine. Academic Press.
6. DeVita Jr, V. T., Lawrence, T., & Rosenberg, S. A. (2012). Cancer: Principles & practice of oncology: Annual advances in oncology. Lippincott Williams & Wilkins.

Online Resources:

1. https://www.pubmed.ncbi.nlm.nih.gov/
2. https://www.ncbi.nlm.nih.gov/

Teaching Pedagogy:

- Case studies on topics for in depth exploration of realities (cases)and presenting investigative analyses.
- Assignments in order to create authentic and simplified learning environments with respect to complex topics
- Group discussion and quiz to encourage debates and stimulate teacher and students interaction.
- Slide presentation and model based demonstrations to promote critical thinking and help students to practically apply their skills.

Evaluation Pattern:

Continuous Internal Assessment		Test 1	30 marks scaled down to 20
		Test 2	NA
		Seminar/Presentation	10 marks reduced to 5
		Project	10 marks reduced to 5
Semester End Examination		SEE	70 marks
TOTAL			100 marks

SYLLABUS BLUEPRINT

Program Title	MSc Biotechnology
Course Title	INDUSTRIAL BIOTECHNOLOGY
Nature of Course	Open Elective (OE)
Semester	III
Total Hours	30
Credits	2

Objective of the Course:

To impart the knowledge on Historical overview of industrial Biotechnology, production of some commercially important modern Bio products, Industrial Enzymes, Products of plant and animal cell cultures and Production of recombinant proteins..

Course Learning Outcomes:

COURSE LEARNING OUTCOMES (What students will learn after completing the degree based on Bloom's Taxonomy)	
CLO1	To throw light on nonconventional fuels and their environment friendly advantage
CLO2	To familiarize the biochemical pathway and possible process mechanisms to utilize microorganisms for microbial product synthesis
CLO3	To Understand the basic concept of biopolymers and bioplastic.
CLO4	To understand the mechanism of purposeful transformation of raw materials into a consumable food products
CLO5	It will provide an overview of the key enzymes currently used in large scale industrial processes.
CLO6	To throw light on nonconventional fuels and their environment friendly advantage

MAPPING OF COURSE LEARNING OUTCOMES TO PROGRAM LEARNING OUTCOMES							
	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7
CLO1	✔						
CLO2							
CLO3		✔		✔		✔	

CLO4		✔		✔			
CLO5			✔		✔		✔
CLO6	✔				✔		

(Put a tick mark to indicate the mapping)

Course Content:

Module	Content	Hours
1.Introduction	Introduction to Industrial biotechnology	1
2.Alternate fuels	Fuels from agricultural wastes (cellulose / lignin) Biodiesels (plant/algae/ microbial source)	6
3. Microbial Products	Alcoholic beverages (wine, beer), Organic acids (Citric acid, lactic acid), Antibiotics -Penicillin Nutraceutical products –vitamin B12. Secondary metabolite – Capsaicin	7
4.Bioplastics	Bioplastics uses (PHA, PHB).	3
5.Fermented Foods	Microbial Foods –Cheese, Baker's Yeast, Single cell proteins (SCP) eg: Spirulina, Single cell Oils (SCO) eg: Polyunsaturated fatty acids (PUFAs)	6
6.Enzyme Biotechnology	Industrially important enzyme (amylase, acid and alkaline phosphatase). Applications of Industrial enzymes in food, pharmaceutical, detergent industry.	7
TOTAL HOURS	**30**	

References:

1. Pandey, A., Negi, S., Soccol, C.R., (2016). Current Developments in Biotechnology and Bioengineering: Production, isolation and purification of industrial products", Elsevier
2. Okafor, N. (2007). Modern Industrial Microbiology and Biotechnology. CRC Press
3. Presscott and Dunn's. (1987). Industrial Microbiology. CBS Publisher
4. Casida Jr, L. E. (1968). Industrial Microbiology. Wiley

Online Resources:

1. https://www.pubmed.ncbi.nlm.nih.gov/
2. https://www.ncbi.nlm.nih.gov/

Teaching Pedagogy:

- Case studies on topics for in depth exploration of realities (cases)and presenting investigative analyses.
- Assignments in order to create authentic and simplified learning environments with respect to complex topics

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- Slide presentation and model based demonstrations to promote critical thinking and help students to practically apply their skills.

Evaluation Pattern:

Continuous Internal Assessment		Test 1	30 marks scaled down to 10
		Test 2	NA
		Seminar/Presentation	10 marks reduced to 5
		Project	NA
Semester End Examination		SEE	50 marks reduced to 35
TOTAL			50 marks