



॥ तमसो मा ज्योतिर्गमय ॥

VISION

To provide equal opportunities for value based global education for creating an Enlightened Society

MISSION

To establish and facilitate educational institutions in the region for providing affordable value based global education to all who aspire to study and to create opportunities to educators, social workers and philanthropists to serve society



**SARVAJANIK
UNIVERSITY**

INCLUSIVE | INTEGRATED | INNOVATIVE

creating an enlightened society...

UNIVERSITY OFFICE

Dr. R. K. Desai Marg, Athwalines,
Surat-395001, Gujarat, India.

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CURRICULUM FOR

“MASTER OF SCIENCE (BIOTECHNOLOGY)”

M.Sc. (Biotechnology)

SEM – 1

SEM – 2

w.e.f. Academic Year 2026-27

Constituent Institute:
Shree Ramkrishna Institute of
Computer Education and Applied
Sciences (SRKI)



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SARVAJANIK UNIVERSITY

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Course Curriculum MASTER OF SCIENCE (Biotechnology) Sem-1 and 2

The Course Curriculum of Master of Science (Biotechnology) was proposed and drafted by **Academic and Curriculum Committee of Biotechnology** under the Faculty of Science in the meeting held on **24-06-2026** and recommended to '**BOARD OF STUDIES**' for approval.

Dr. Jay Bergi
**Chairman, Academic
& Curriculum Committee
Science**

Place of the meeting
Sarvajani University Office


Sign

The proposed Course Curriculum was approved by **Board of Studies; Science** under the Faculty of Science in the meeting held on **21-08-2026** and was recommended to the '**FACULTY**' for approval.

Dr. Jay Bergi
**Chairman,
Board of Studies- Science**

Place of the meeting
Sarvajani University Office


Sign

The Course Curriculum approved by the **Faculty of Science** in the meeting held on **21-08-2026** and was recommended to '**ACADEMIC COUNCIL**' for approval.

Dr. Jay Bergi
**Chairman &
Dean, Faculty of
Science**

Place of the meeting
Sarvajani University Office


Sign

The Course Curriculum approved by the '**Academic Council of Sarvajani University**' in the meeting held on **16-09-2026**.

Mr. Ashish Desai
Member Secretary,
**Academic Council
& I/c. Registrar,
Sarvajani University**

Place of the meeting
Sarvajani University Office


Sign

- The approved curriculum of Master of Science (Biotechnology) is with effect from the Academic year **2026–27**



SARVAJANIK UNIVERSITY
FACULTY OF SCIENCE
Master of Science (Biotechnology) Sem-I and II



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Faculty of Science

M. Sc. (Biotechnology)

DETAILED CURRICULUM
(W.E.F. 2026-27)



SARVAJANIK UNIVERSITY
FACULTY OF SCIENCE
Master of Science (Biotechnology) Sem-I and II

Credit Framework for 2 Years Postgraduate Program (As per KCG SOP) wef 2026-27
Faculty of Science, Sarvajani University

Semester	DSC						DSE		Skill Enhancement		Total Credits
	DSC No. of Papers	Theory		Lab		Total DSC Credits					
		Theory Hours	Theory Credits	Lab Hrs	Lab Credits		No. of Papers	Credits	No. of Papers	Credits	
1	4	3+3+3+3	3+3+3+3	2+2+2+2	1+1+1+1	16	1	4	1	2	22
2	4	3+3+3+3	3+3+3+3	2+2+2+2	1+1+1+1	16	1	4	1	2	22
3	4	3+3+3+3	3+3+3+3	2+2+2+2	1+1+1+1	16	1	4	1	2	22
4	Dissrt.			48	16	16	1	4	1	2	22
Total after 2yrs	12 + 1					64	4	16	4	8	88



SARVAJANIK UNIVERSITY
FACULTY OF SCIENCE
Master of Science (Biotechnology) Sem-I and II

Teaching Scheme for M.Sc. (Organic Chemistry) Semester – I to II						
Semester	Course Category	Credits	Theory (Hrs/Week)	Theory (Total)	Laboratory (Hrs/Week)	Laboratory (Total)
I	Discipline Specific Core-1	4	3	45	2	30
	Discipline Specific Core-2	4	3	45	2	30
	Discipline Specific Core-3	4	3	45	2	30
	Discipline Specific Core-4	4	3	45	2	30
	Discipline Specific Elective-1	4	3	45	2	30
	Skill Enhancement Courses-1	2	2	30	-	-
	Total	22	17	255	10	150
II	Discipline Specific Core-5	4	3	45	2	30
	Discipline Specific Core-6	4	3	45	2	30
	Discipline Specific Core-7	4	3	45	2	30
	Discipline Specific Core-8	4	3	45	2	30
	Discipline Specific Elective-2	4	3	45	2	30
	Skill Enhancement Courses-2	2	2	30	-	-
	Total	22	17	255	10	150



SARVAJANIK UNIVERSITY
FACULTY OF SCIENCE
Master of Science (Biotechnology) Sem-I and II

Evaluation Scheme for M.Sc. (Organic Chemistry) Semester – I to II							
Semester	Course Category	Continuous and Comprehensive Evaluation (CCE)			Total CCE	Semester End Examination (SEE)	Grand Total
		CCE	Assignment	Attendance			
I	Discipline Specific Core-1	30	10	10	50	50	100
	Discipline Specific Core-2	30	10	10	50	50	100
	Discipline Specific Core-3	30	10	10	50	50	100
	Discipline Specific Core-4	30	10	10	50	50	100
	Discipline Specific Elective-1	30	10	10	50	50	100
	Skill Enhancement Courses-1	15	5	5	25	25	50
II	Discipline Specific Core-5	30	10	10	50	50	100
	Discipline Specific Core-6	30	10	10	50	50	100
	Discipline Specific Core-7	30	10	10	50	50	100
	Discipline Specific Core-8	30	10	10	50	50	100
	Discipline Specific Elective-2	30	10	10	50	50	100
	Skill Enhancement Courses-2	15	5	5	25	25	50



SARVAJANIK UNIVERSITY
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Faculty of Science

M.Sc. (Biotechnology)

SEM - 7

DETAILED CURRICULUM
(W.E.F. 2026-27)



SARVAJANIK UNIVERSITY
FACULTY OF SCIENCE
Master of Science (Biotechnology) Sem-I and II

Name of College: Shree Ramkrishna Institute of Computer Education and Applied Sciences						
Faculty	Science		Program	M.Sc. Biotechnology		
Course Type	DSC		Version	2.0		
Semester	01		Effective From	June, 2026		
Course Code	MSBT21103	Course Name	Genomics, Proteomics and Other Omics (TH)			
Teaching Scheme				Examination Scheme		
Credits	Lecture (L)	Tutorial (T)	Practical (P)	Continuous Assessments (CA)	Term end examinations (TEE)	Total
3	3 hrs	0	0	40	35	75

Name of College: Shree Ramkrishna Institute of Computer Education and Applied Sciences						
Faculty	Science		Program	M.Sc. Biotechnology		
Course Type	DSC		Version	2.0		
Semester	01		Effective From	June, 2026		
Course Code	MSBT21104	Course Name	Genomics, Proteomics and Other Omics (PR)			
Teaching Scheme				Examination Scheme		
Credits	Lecture (L)	Tutorial (T)	Practical (P)	Continuous Assessments (CA)	Term end examinations (TEE)	Total
1	0	0	2 hrs	10	15	25



SARVAJANIK UNIVERSITY
FACULTY OF SCIENCE
Master of Science (Biotechnology) Sem-I and II

Name of faculty: Science	Department: Biotechnology
Program: M.Sc. Biotechnology	Type: Theory
Subject: Genomics, Proteomics and Other Omics	Semester: 7
Credit: 04	Total learning hours: 45 hrs
Course description: This course provides a comprehensive understanding of genomics and related omics technologies, including genome organization, sequencing methods, functional genomics, comparative genomics, proteomics, metabolomics, and protein interaction studies. It enables students to understand the principles and applications of modern DNA sequencing technologies and gene annotation approaches. The course also develops knowledge of gene expression analysis, protein function, metabolic profiling, and evolutionary relationships among organisms. Students are trained to apply and analyze omics data for understanding biological systems and solving research problems. Overall, it equips learners with theoretical knowledge and analytical skills required for careers in biotechnology, biomedical research, and bioinformatics-driven industries.	
Student learning outcome: 1. Explain key concepts of genomics, genome organization, and omics technologies. 2. Compare DNA sequencing technologies and genome analysis methods. 3. Apply omics tools for gene expression and functional studies. 4. Analyze genomic and proteomic data for biological interpretation. 5. Evaluate applications and limitations of omics technologies. 6. Design basic experimental approaches using omics tools.	

UNIT I: Introduction to Genomics and Structural genomics (07 hrs)

- 1.1 Definition and scope of genomics
- 1.2 Organization of prokaryotic and eukaryotic genomes, coding and non-coding DNA, repetitive DNA sequences
- 1.3 Genome size and complexity (C-value paradox)
- 1.4 Structural genomics: genome mapping, sequencing, assembly and annotation

Unit II DNA Sequencing technologies and Application (08 hrs)

- 2.1 First-generation sequencing: Sanger sequencing, Maxam-Gilbert sequencing
- 2.2 Second-generation sequencing (NGS): Roche 454 sequencing, Illumina sequencing
- 2.3 Third-generation sequencing technologies: Ion torrent, Nanopore sequencing
- 2.4 Assembly of Genomic Information, Prediction of Genes: Extrinsic and Intrinsic method

UNIT III: Functional Genomics (07 hrs)

- 3.1 Introduction and principles of Functional Genomics
- 3.2 Gene expression analysis: DNA microarrays and transcriptome analysis
- 3.3 Epigenetic regulation: DNA methylation, histone modifications and epigenetic control of gene expression
- 3.4 Forward versus Reverse genetics, Gene function analysis using gene knockout, RNAi, and mutagenesis



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Master of Science (Biotechnology) Sem-I and II

UNIT IV: Comparative Genomics

(08 hrs)

- 4.1 Introduction to Comparative Genomics, genome comparison, orthologs and paralogs, evolutionary relationships.
- 4.2 Comparative genomics of bacteria
- 4.3 Comparative genomics of Eukaryotes
- 4.4 Applications of Comparative Genomics

UNIT V: Proteomics and Metabolomics

(08 hrs)

- 5.1 Introduction to proteomics and proteome complexity
- 5.2 Structural and functional proteomics
- 5.3 Protein separation techniques: two-dimensional gel electrophoresis
- 5.4 Protein identification and analysis: mass spectrometry and protein microarrays
- 5.5 Introduction to metabolomics and metabolic profiling

Unit VI: Protein Interaction and Omics Applications

(07 hrs)

- 6.1 Yeast two-hybrid system, phage display, immunoprecipitation
- 6.2 Protein Engineering and Applications
- 6.3 Recombinant proteins and therapeutic proteins
- 6.4 Applications and future prospects of omics technologies

References

1. Primrose S & Twyman R, Principles of Gene Manipulation and Genomics, 7th ed, Blackwell, 2006 6. ISBN 978-1405135443
2. Danial C. Liebler, Introduction to proteomics-Tools for new biology, Humana press, <https://doi.org/10.1007/978-1-59259-130-5>
3. Wilson & Walker's, Principles and Techniques of Biochemistry and Molecular Biology, Eighth Edition, ISBN 978-1-108-71698-7
4. Peter J. Russell, Reed College, iGenetics: A Molecular Approach, 3rd Edition, Pearson Publishers, ISBN 9780321569769
5. Jolls. O and Jornvali H (eds) 2000: Proteomics in functional genomics, Birkhauser verilog, Basel, Switzerland. ISBN 978-3034884587
6. Pennington, S. and Dunn M. Proteomics from protein sequence to function. New Delhi: Viva Books Private Limited; 2002. ISBN 978-8176492904

PRACTICALS

Practical 1: Isolation and quantification of genomic DNA.

Practical 2: PCR and agarose gel electrophoresis.

Practical 3: Restriction digestion and agarose gel electrophoresis.

Practical 4: Protein estimation and SDS-PAGE analysis.

Practical 5: GMO detection and screening using qPCR

Explanation of sequencing technique using chromatogram interpretation.



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Master of Science (Biotechnology) Sem-I and II

Name of College: Shree Ramkrishna Institute of Computer Education and Applied Sciences						
Faculty	Science		Program	M.Sc. Biotechnology		
Course Type	DSC		Version	2.0		
Semester	01		Effective From	June, 2026		
Course Code	MSBT21105	Course Name	Principles of Bioprocess Technology (TH)			
Teaching Scheme				Examination Scheme		
Credits	Lecture (L)	Tutorial (T)	Practical (P)	Continuous Assessments (CA)	Term end examinations (TEE)	Total
3	3 hrs	0	0	40	35	75

Name of College: Shree Ramkrishna Institute of Computer Education and Applied Sciences						
Faculty	Science		Program	M.Sc. Biotechnology		
Course Type	DSC		Version	2.0		
Semester	01		Effective From	June, 2026		
Course Code	MSBT21106	Course Name	Principles of Bioprocess Technology (PR)			
Teaching Scheme				Examination Scheme		
Credits	Lecture (L)	Tutorial (T)	Practical (P)	Continuous Assessments (CA)	Term end examinations (TEE)	Total
1	0	0	2 hrs	10	15	25



SARVAJANIK UNIVERSITY
FACULTY OF SCIENCE
Master of Science (Biotechnology) Sem-I and II

Name of Faculty: Science	Department: Biotechnology
Program: M.Sc. Biotechnology	Type: Major
Subject: Principle of Bioprocess Technology	
Credit: 03+01	Total learning hours: 45 (Th)+ 30 (Pr)
Course description: This course introduces the fundamentals of industrial bioprocessing from upstream to downstream operations, focusing on application-oriented engineering principles in biological systems. It emphasizes process monitoring, control, validation, and modern trends such as PAT, QbD, and Industry 4.0 to prepare students for real-world biopharmaceutical applications.	
Student Learning Outcome: 1. Explain industrial bioprocess workflows and unit operations. 2. Analyze factors affecting fermentation and product yield. 3. Apply principles of mass and heat transfer in bioprocess systems. 4. Interpret process control strategies and instrumentation data. 5. Understand downstream processing techniques and cost implications. 6. Evaluate validation, regulatory, and quality requirements in biopharma industries.	

UNIT 1: Fundamentals of Bioprocess and Sterilization

(7 hrs)

1.1 Historical Development of Bioprocess Technology, Interdisciplinary Approach to Bioprocessing, Outlines of Integrated Bioprocess, Unit Operations in Bioprocess

1.2 Sterilization of Process Equipments: Equipment Sterilization: Vessel, Air filters, Medium Filters, Valve and Pippings, Elimination of Condensate

1.3 Monitoring and validation of sterilization, Batch Sterilization, Continuous Sterilization, degradation of Heat labile components

1.4 Trouble shooting/ Problem Solving, Sterility Audit, Automation

UNIT 2: Mass Transfer in Bioprocess Systems

(8 hrs)

2.1 Mass Transfer by Diffusion

2.2 Theories of Diffusional Mass Transfer: Penetration Theory, Surface Renewal Theory

2.3 Mass Transfer by Convection: Gas-Liquid Mass Transfer, Measurement of kLa



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2.4 Oxygen Transfer Methodology in Fermenters: Specific Oxygen Uptake Rate, Critical Oxygen Concentration

2.5 Factor affecting Oxygen Transfer Rate: Bubble Size, Gas Hold-up, Gas Velocity, Types of Gas Sparger, Types of Agitator, Power Input to Agitators, Temperature, Pressure, Antifoaming Agents, Cells, Surface Active Solutes

UNIT 3: Heat Transfer in Bioprocesses

(8 hrs)

3.1 Importance of Heat Transfer in Biological Reactors

3.2 Heat transfer mechanisms: Conduction, convection , Heat Transfer by Radiation

3.3 Heat Transfer Equipments: Process Equipment for Heat Transfer, Double Pipe Heat Exchanger, Shell and Tube Heat Exchanger, Condenser

3.4 Case study: Cooling failure in industrial fermenter

UNIT 4: Instrumentation and Control of Bioprocess

(7 hrs)

4.1 Fundamentals of process control: Basic Control System

4.2 Control Loops: Open, Close and Additional Forms of Control

4.3 Measurement Elements: Temperature, Pressure, Level, Flow, pH, DO, CO₂, NADH, Cell Density, Viscosity

4.4 Analytical Instrumentation: Microprocessor Based Control System, SCADA systems and real-time monitoring, PAT tools and data integrity (ALCOA+)

UNIT 5: Cleaning of Process Equipment: Design and Practice

(8 hrs)

5.1 Hygienic Plant Design, Cleaning Reagents, Cleaning Methods, CIP

5.2 Pharmaceutical Water: Grade Water, Dead legs, Slope

5.3 Pharmaceutical Water Treatment System: Treatment Equipment, Softeners, Deionizer

5.4 Plant Steam Systems, Clean Steam Systems, Chilled Water Systems, Cooling Towers



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UNIT 6: Validation and Bioprocess Economics

(7 hrs)

6.1 Validation: Team, Time line, Criteria, Protocols

6.2 Installation Qualification, Operation Qualification, Performance Qualification

6.3 Plant Design and Economics, Cost of Production, Break-Even Analysis

6.4 Project Economics, Depreciation, Case Study: Project Economics for Citric Acid Manufacturer

Practicals:

1. Determination of Oxygen Transfer Rate (OTR) in a model system.
2. Determination of Thermal Death Point (TDP) and Thermal Death Time (TDT).
3. Calibration and performance analysis of bioprocess sensors (pH/DO).
4. Study of microbial growth kinetics in batch culture.
5. Study of the components and function of laboratory scale Bioreactor.

References:

1. Bailey, J. E. & Ollis, D. F. *Biochemical Engineering Fundamentals* (2nd ed.). McGraw-Hill..
2. Bhatia, S. C.. *Biochemical Engineering*. Lotus Press.
3. Lydersen, B. K., D'Elia, N. A., & Nelson, K. L. (Eds.). *Bioprocess Engineering: Systems, Equipment and Facilities*. John Wiley & Sons.
4. Rao, D. G. *Introduction to Biochemical Engineering*. Tata McGraw-Hill.
5. Shuler, M. L. & Kargi, F. *Bioprocess Engineering: Basic Concepts* (3rd ed.). Prentice Hall.



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Name of College: Shree Ramkrishna Institute of Computer Education and Applied Sciences						
Faculty	Science		Program	M.Sc. Biotechnology		
Course Type	DSC		Version	2.0		
Semester	01		Effective From	June, 2026		
Course Code	MSBT21107	Course Name	IVF, ART and Stem Cells (TH)			
Teaching Scheme				Examination Scheme		
Credits	Lecture (L)	Tutorial (T)	Practical (P)	Continuous Assessments (CA)	Term end examinations (TEE)	Total
3	3 hrs	0	0	40	35	75

Name of College: Shree Ramkrishna Institute of Computer Education and Applied Sciences						
Faculty	Science		Program	M.Sc. Biotechnology		
Course Type	DSC		Version	2.0		
Semester	01		Effective From	June, 2026		
Course Code	MSBT21108	Course Name	IVF, ART and Stem Cells (PR)			
Teaching Scheme				Examination Scheme		
Credits	Lecture (L)	Tutorial (T)	Practical (P)	Continuous Assessments (CA)	Term end examinations (TEE)	Total
1	0	0	2 hrs	10	15	25



SARVAJANIK UNIVERSITY
FACULTY OF SCIENCE
Master of Science (Biotechnology) Sem-I and II

Name of faculty: Science	Department: Biotechnology
Program: M.Sc. Biotechnology	Type: Theory + Practical
Subject: IVF, ART and Stem Cells	
Credits: 03 + 01	Total learning hours: 45
Course Description: The course is designed to introduce students to the set up of the Assisted Reproductive Technology Centers, the basic requirements for establishing the center, the documentation and management systems for smooth functioning at the center. The course also deals with the basic techniques for handling gametes. This course will make students aware & scientifically informed about fundamental concepts of Stem cell biology till molecular levels. It will provide adequate knowledge about recent strategies & applications in the field of treatment of cancers & about stem cell therapies.	
Student Learning Outcome: Students will: 1. Define ART, IVF and Stem cells technology. 2. Understand the need and criteria for the ART-IVF center set up. 3. Apply knowledge of handling and aseptic technique for embryo culture, sperm processing, cryopreservation and other relevant techniques related to IVF. 4. Evaluate the need and applications of IVF and stem cells. 5. Analyze the challenges and complications in IVF. 6. Compare conventional and recent trends in IVF and Stem Cells.	

Unit 1: Introduction to Assisted Reproductive Technologies (ART)

(05 Hours)

- 1.1 Significance and Historical Background of Art and IVF
- 1.2 Reproductive Biology and Human Fertility
- 1.3 Causes and Types of Infertility
- 1.4 Overview of Assisted Reproductive Technologies
- 1.5 Fertility Assessment and Patient Evaluation

Unit-2 Emerging ART Techniques and Fertility Preservation

(06 Hours)

- 2.1 Artificial Insemination and Intrauterine Insemination (IUI)
- 2.2 Fertility Preservation Techniques
- 2.3 Donor Programs in Assisted Reproduction
- 2.4 Cryopreservation of Gametes, Embryos and Reproductive Tissues
- 2.5 Genetic Screening and Reproductive Decision-Making

Unit-3 Fundamentals of In Vitro Fertilization (IVF)

(08 Hours)

- 3.1 IVF Laboratory Infrastructure and Equipment
- 3.2 Media and Reagents for IVF Laboratories
- 3.3 Ovarian Stimulation and Oocyte Retrieval
- 3.4 Sperm Preparation and Fertilization Techniques
- 3.5 Embryo Culture and Development
- 3.6 Embryo Transfer and Treatment Outcomes



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Unit-4 Advanced IVF Practices and Clinical Applications

(08 Hours)

- 4.1 Intracytoplasmic Sperm Injection (ICSI)
- 4.2 Blastocyst Culture and Embryo Selection
- 4.3 Quality Control and Quality Assurance in IVF Laboratories
- 4.4 Challenges and Complications in IVF
- 4.5 Assisted Reproductive Technology Act, 2021 with ART Rules, 2022

Unit-5 Introduction to Stem Cells

(10 Hours)

- 5.1 Stem Cells: Definition, Properties
- 5.2 Stem Cells Niches
- 5.3 Signal Transduction in Stem Cells
- 5.4 Model Organisms in Stem Cell Research (*Arabidopsis Thaliana*, *Platyhelminthes*, Zebrafish, Deer Antler Stem Cells)

Unit-6 Culture of Stem Cells

(08 Hours)

- 6.1 Embryonic Stem Cells and Extraembryonic Stem Cells
- 6.2 Derivation and Culture of Embryonic Stem Cells (mESC And hESC)
- 6.3 Culture of Amniocytes
- 6.4 Induced Pluripotent Stem Cells
- 6.5 Applications of Stem Cells

Practicals:

- 1. Demonstration of Stem cell Expansion.
- 2. Visit to IVF Center/ Stem Cell Bank
- 3. Demonstration of Sperm Preparation
- 4. Case study/ Review Article on ART/Stem Cell.

References:

- 1. Textbook Of Assisted Reproductive Techniques Volume 1: Lab Perspectives By David Gardner, Ariel Weissman, Colin M Howles, Zeev Shoham, CRC Press, 5th Edition ISBN: 9781498740098
- 2. Textbook Of Assisted Reproductive Techniques Volume 2: Clinical Perspectives by David Gardner, Ariel Weissman, Colin M Howles, Zeev Shoham, CRC Press, 5th Edition ISBN:978-1498740180
- 3. Talwar, Lt Pankaj. Step by Step: Protocols in Clinical Embryology and ART. JP Medical Ltd, 2012. ISBN: 9789350257654
- 4. IVF Techniques For the Beginners – Kuldeep Jain & Pankal Talwar, Jaypee Brothers Medical Pub.ISBN: 978-9350903599
- 5. A Practical Guide To Setting Up An Ivf Lab, Embryo Culture Systems & Running The Unit – Alex C Varghese, Peter Sjoblom & K Jayaprakasan, Jaypee brothers' medical Pub ISBN:9789350905166
- 6. Calegari, F., & Waskow, C. (Eds.). (2014). *Stem Cells: From Basic Research to Therapy, Volume 1: Basic Stem Cell Biology, Tissue Formation during Development, and Model Organisms*. CRC Press. ISBN 978-1-4822-0776-7
- 7. Calegari, F., & Waskow, C. (Eds.). (2014). *Stem Cells: From Basic Research to Therapy, Volume Two: Tissue Homeostasis and Regeneration during Adulthood, Applications, Legislation and Ethics* (Vol. 1144). CRC Press. ISBN: 978-1-4822-1984-5
- 8. Lanza, R., Gearhart, J., Hogan, B., Melton, D., Pedersen, R., Thomas, E. D., & Thomson, J. A. (Eds.). (2005). *Essentials of stem cell biology*. Elsevier. ISBN: 978-0-12-374729-7
- 9. Sell, S. (Ed.). (2004). *Stem cells handbook* (Vol. 1). Totowa, NJ: Humana Press. E-ISBN 1-59259-411-5



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Name of College: Shree Ramkrishna Institute of Computer Education and Applied Sciences						
Faculty	Science		Program	M.Sc. Biotechnology		
Course Type	DSC		Version	2.0		
Semester	01		Effective From	June, 2026		
Course Code	MSBT21109	Course Name	Dairy and Food Technology (TH)			
Teaching Scheme				Examination Scheme		
Credits	Lecture (L)	Tutorial (T)	Practical (P)	Continuous Assessments (CA)	Term end examinations (TEE)	Total
3	3 hrs	0	0	40	35	75

Name of College: Shree Ramkrishna Institute of Computer Education and Applied Sciences						
Faculty	Science		Program	M.Sc. Biotechnology		
Course Type	DSC		Version	2.0		
Semester	01		Effective From	June, 2026		
Course Code	MSBT21110	Course Name	Dairy and Food Technology (PR)			
Teaching Scheme				Examination Scheme		
Credits	Lecture (L)	Tutorial (T)	Practical (P)	Continuous Assessments (CA)	Term end examinations (TEE)	Total
1	0	0	2 hrs	10	15	25



SARVAJANIK UNIVERSITY
FACULTY OF SCIENCE
Master of Science (Biotechnology) Sem-I and II

Dairy and Food Technology

Unit 1: Introduction to food microbiology and food spoilage **(08 hours)**

- 1.1 Food as a substrate for microorganisms
- 1.2 Contamination and Spoilage of food:
 - 1.2.1 Bread
 - 1.2.2 Vegetables and fruits
 - 1.2.3 Heated canned foods
- 1.3 Food borne disease outbreaks
- 1.4 Detection of food-borne pathogens

Unit 2: Preservation of food **(08 hours)**

- 2.1 Asepsis
- 2.2 Removal of microorganisms
- 2.3 Heat treatments employed in processing foods
- 2.4 Temperatures employed in low-temperature storage
- 2.5 Methods of drying
- 2.6 Added preservatives
- 2.7 Developed preservatives
- 2.8 Preservation by radiation

Unit 3: Dairy Microbiology **(07 hours)**

- 3.1 Kinds of milk
- 3.2 Composition and structure of milk
- 3.3 Methods of testing and grading of milk
- 3.4 Source of microorganisms in milk
- 3.5 Contamination and Spoilage of milk and milk products
- 3.6 Preservation of milk and milk products

Unit 4: Dairy technology **(08 hours)**

- 4.1 Basic steps in milk processing
- 4.2 Manufacturing of fluid milk products
- 4.3 Concentrated fat products
- 4.4 Condensed fluid milk products
- 4.5 Dry milk products
- 4.6 Fermented / Cultured dairy products
- 4.7 Cheese and cheese products
- 4.8 Ice cream and frozen desserts

Unit 5: Fermented food and microorganisms as food **(07 hours)**

- 5.1 List of fermented foods
- 5.2 Production of breads
- 5.3 Production of alcoholic beverages
- 5.4 Single cell protein
- 5.5 Microorganisms as food and food amendments
- 5.6 Mushroom Culture



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Unit 6: Testing of food and dairy

(07 hours)

- 6.1 Types of samples
- 6.2 Best methods of sampling
- 6.3 Testing of raw and pasteurised milk
- 6.4 Testing for APC
- 6.5 Testing for *coliforms*
- 6.6 Qualitative assays for *Salmonella* and *Listeria*
- 6.7 Testing methods for *S. aureus*

References:

1. Frazier, W. C., and Westhoff, D. C., (2006). Food Microbiology, 4Ed., Tata Mc-Graw Hill, India.
2. Wiley, J., Sherwood, L. and Woolverton, C.J. (2014). Prescott's Microbiology, 9th Ed., McGraw-Hill.
3. Chandan, R. C. (2015). Dairy processing and quality assurance: an overview. Blackwell.
4. Pelczar, M. J., Chan, E. C. S. and Kreig, N. (1998). Microbiology, 5th Ed., Tata-McGraw-Hill.
5. Purohit, S. S., (2006). Microbiology: Fundamentals and Applications, 7Ed., Agrobios(India).
6. Dubey, R.C. (2010). Textbook of Biotechnology, S. Chand.

Practicals:

1. Determination of microbial quality of milk by RRT
2. Determination of pasteurization of milk by phosphatase test
3. Characterization for the presence of *Listeria*
4. Determination of the presence of fecal coliforms in milk



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Name of College: Shree Ramkrishna Institute of Computer Education and Applied Sciences						
Faculty	Science		Program	M.Sc. Biotechnology		
Course Type	DSE		Version	2.0		
Semester	01		Effective From	June, 2026		
Course Code	MSBT22101	Course Name	Biotechnology Laboratory Skills (TH)			
Teaching Scheme				Examination Scheme		
Credits	Lecture (L)	Tutorial (T)	Practical (P)	Continuous Assessments (CA)	Term end examinations (TEE)	Total
3	3 hrs	0	0	40	35	75

Name of College: Shree Ramkrishna Institute of Computer Education and Applied Sciences						
Faculty	Science		Program	M.Sc. Biotechnology		
Course Type	DSE		Version	2.0		
Semester	01		Effective From	June, 2026		
Course Code	MSBT22102	Course Name	Biotechnology Laboratory Skills (PR)			
Teaching Scheme				Examination Scheme		
Credits	Lecture (L)	Tutorial (T)	Practical (P)	Continuous Assessments (CA)	Term end examinations (TEE)	Total
1	0	0	2 hrs	10	15	25



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Biotechnology Laboratory Skills

Name of Faculty: Science	Department: Biotechnology
Program: M.Sc. Biotechnology	Type: DSE
Subject: Biotechnology Laboratory Skills	Semester: 1
Credits: 03 + 01 = 04	
Course Description: This course prepares students for minimum essential skills in biotechnology laboratory of an industry / research organization.	
Student Learning Outcomes (SLOs): At the end of the course, students will be able to: 1. Define and have overview of skills and essential procedures of a biotechnology laboratory. 2. Understand the safety and SOPs in biotechnology laboratory. 3. Apply different DNA, RNA and protein handling skills to the laboratory. 4. Compare and selectively use different analytical skills. 5. Evaluate advantages and disadvantages of advanced molecular biology skills. 6. Analyse how to go ahead with modern research protocols.	

Unit 1: Best practices of biotechnology laboratory (07 hours)

- 1.1 Laboratory safety
- 1.2 Laboratory notebook
- 1.3 Laboratory equipment
- 1.4 Good laboratory practice
- 1.5 Good manufacturing practice
- 1.6 How to write an SOP

Unit 2: DNA techniques (08 hours)

- 2.1 Minipreps of plasmid DNA
- 2.2 Manipulation of DNA
- 2.3 Resolution and Recovery of Large DNA Fragments
- 2.4 Resolution and Recovery of Small DNA Fragments
- 2.5 Blotting and Hybridization of DNA
- 2.6 Synthesis and Purification of Oligonucleotides

Unit 3: Protein techniques (08 hours)

- 3.1 Protein quantitation
- 3.2 Protein mass spectroscopy
- 3.3 Protein electrophoresis and other types of PAGE
- 3.4 Protein chromatography
- 3.5 Protein analysis using bioinformatics
- 3.6 Quality control in protein production



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Unit 4: PCR and related skills (07 hours)

- 4.1 Thermal cyclers
- 4.2 Types of PCR
- 4.3 PCR optimization
- 4.4 Techniques based on PCR
- 4.5 Real world applications of PCR

Unit 5: Specialized techniques (07 hours)

- 5.1 Preparation of RNA from Eukaryotic and Prokaryotic Cells
- 5.2 Mutagenesis of Cloned DNA
- 5.3 Purification of Recombinant Proteins by Epitope Tagging
- 5.4 *In vitro* and *in vivo* reporter assays
- 5.5 Labeling and Colorimetric Detection of Non-isotopic Probes

Unit 6: Analytical techniques (08 hours)

- 6.1 Imaging live cells and tissues
- 6.2 Measuring cellular dynamics
- 6.3 The electron microscope
- 6.4 Types, care and safety aspects of centrifuges
- 6.5 Preparative centrifugation
- 6.6 UV and visible light spectroscopy
- 6.7 Infrared and Raman spectroscopy

References:

1. Wilson, K., Hofmann, A., Walker, J. M., & Clokie, S. (Eds.). (2018). *Wilson and Walker's principles and techniques of biochemistry and molecular biology*. Cambridge university press.
2. Brown, J. K. (2018). *Biotechnology: A laboratory skills course* (2nd ed.). Bio-Rad Laboratories.
3. Ausubel, F. M., Brent, R., Kingston, R. E., Moore, D. D., Seidman, J. G., Smith, J. A., & Struhl, K. (Eds.). (1987–). *Current Protocols in Molecular Biology*. John Wiley & Sons.

Practicals:

1. Demonstration of staining and destaining techniques for protein SDS-PAGE
2. Nucleic acid amplification by PCR
3. Resolution and recovery of DNA from agarose gel
4. Use of bioinformatics tools for the multiple sequence alignment and structure prediction of proteins



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Name of College: Shree Ramkrishna Institute of Computer Education and Applied Sciences						
Faculty	Science		Program	M.Sc. All		
Course Type	SEC		Version	2.0		
Semester	01		Effective From	June, 2026		
Course Code	MSBT23102	Course Name	Research Methodology - 1			
Teaching Scheme				Examination Scheme		
Credits	Lecture (L)	Tutorial (T)	Practical (P)	Continuous Assessments (CA)	Term end examinations (TEE)	Total
2	2 hrs	0	0 hrs	25	25	50



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Faculty: Science	Department: Env. Sc. and Biotech.
Program: M.Sc.	Type: SEC
Subject: Research Methodology - I	Credits: 2
Semester: I	

References:

1. Ghosh, B. N. (1982). *Scientific method and social research*. Sterling Publishers.
2. Kothari, C. R. (2004). *Research methodology: Methods and techniques*. New Age International.

Unit 1: Conceptual Foundation

(06 hours)

- 1.1 Constituents and theoretical perspectives
- 1.2 Approaches to inquiry
- 1.3 Strategies and process
- 1.4 Hypothesis: its types and sources
- 1.5 Nature, sources and types of data
- 1.6 Measurement scales of variables

Unit 2: Philosophy of Scientific research

(08 hours)

- 2.1 Positivist philosophy of science and its criticism
- 2.2 Karl Popper and Thomas Kunh's philosophy of science
- 2.3 Definition, need and purpose of research
- 2.4 Conceptual framework of research
- 2.5 Basic and applied research
- 2.6 General characteristics of modern research
- 2.7 Criteria for selecting a topic and Scientific method

Unit 3: Planning of research

(08 hours)

- 3.1 Criteria of scientific research
- 3.2 Purpose and development of theory
- 3.3 Scope of research in biology
- 3.4 Stages and process of research
- 3.5 Sources of data
- 3.6 Sample design
- 3.7 Survey research
- 3.8 Experimental research



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Unit 4: Methods of research

(08 hours)

- 4.1 Planning and process of observation
- 4.2 Types of observation
- 4.3 Questionnaire method
- 4.4 Pre-testing and distribution of questionnaires
- 4.5 Interviewing method
- 4.6 Parts and planning of experimental research
- 4.7 Laboratory vs Field experiment
- 4.8 Experiment design



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Name of College: Shree Ramkrishna Institute of Computer Education and Applied Sciences						
Faculty	Science		Program	M.Sc. Biotechnology		
Course Type	DSC		Version	2.0		
Semester	02		Effective From	June, 2026		
Course Code	MSBT21205	Course Name	CRO and CMDO (TH)			
Teaching Scheme				Examination Scheme		
Credits	Lecture (L)	Tutorial (T)	Practical (P)	Continuous Assessments (CA)	Term end examinations (TEE)	Total
3	3 hrs	0	0	40	35	75

Name of College: Shree Ramkrishna Institute of Computer Education and Applied Sciences						
Faculty	Science		Program	M.Sc. Biotechnology		
Course Type	DSC		Version	2.0		
Semester	02		Effective From	June, 2026		
Course Code	MSBT21206	Course Name	CRO and CMDO (PR)			
Teaching Scheme				Examination Scheme		
Credits	Lecture (L)	Tutorial (T)	Practical (P)	Continuous Assessments (CA)	Term end examinations (TEE)	Total
1	0	0	2 hrs	10	15	25



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CRO and CDMO

Name of Faculty: Science	Department: Biotechnology
Program: M.Sc. Biotechnology	Type: DSC
Subject: CRO and CDMO	Semester: II
Credit: 03+01	Total learning hours: 45(Th)+30 (Pr)
Course description: The course provides students with a comprehensive understanding of the rapidly growing Contract Research Organization (CRO) and Contract Development and Manufacturing Organization (CDMO) sectors within the biotechnology and biopharmaceutical industry. The course explores the business models, operational frameworks, regulatory requirements, and strategic importance of outsourcing in modern biotechnology enterprises.	
Student Learning Outcome: 1. Explain CRO and CDMO business models and global market dynamics. 2. Analyze outsourcing strategies and sponsor-partner relationships. 3. Understand operational workflows in research, development, and manufacturing services. 4. Interpret regulatory requirements and quality systems in outsourced environments. 5. Apply business development, contract, and project management principles. 6. Evaluate emerging trends and career opportunities in the CRO/CDMO sector.	

Unit 1: CRO Industry Overview, Market Drivers and Research Outsourcing (7 hrs)

- 1.1 Introduction to pharmaceutical biotechnology and biopharmaceutical products, CRO industry as a component of the pharmaceutical and biotechnology ecosystem
- 1.2 Market Drivers: Increasing R&D expenditure worldwide, Growing number of clinical trials worldwide, Growing outsourcing of R&D activities
- 1.3 Rising technological advancement
- 1.4 Porter 5 forces Analysis of Indian CRO Sector

Unit 2: CRO Service Areas, Drug Development Support and Emerging Research Technologies (8 hrs)

- 2.1 CRO service areas and service type trends, Discovery and chemical research services in CRO sector
- 2.2 Clinical development services and clinical trial management services, Clinical CRO services, Bioequivalence and bioavailability CRO services
- 2.3 Genomics, proteomics, pharmacogenomics, toxicogenomics, glycomics, and chemical genomics in drug discovery and development
- 2.4 Role of bioinformatics, next-generation sequencing, molecular profiling, and biomarker identification in modern drug development



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Unit 3: CRO Growth Restraints, Regulatory Complexity, and Biosimilar Development (7 hrs)

- 3.1 Industry–academia collaboration gap in CRO sector, Regulatory complexity and approval delays
- 3.2 Data integrity issues in CRO operations, Historical perception of clinical trials in India, Patient Recruitment and Retention, Guinea Pig Syndrome, Patient Data Confidentiality
- 3.3 Regulatory framework for biosimilars, Biosimilars and drug product approval
- 3.4 Comparability, scale-up and post-approval changes in biopharmaceutical products

Unit 4: Contract Manufacturing Arrangements, Quality Agreements and CGMP Responsibilities (8 hrs)

- 4.1 Defining contract manufacturing in pharmaceutical and biopharmaceutical industries
- 4.2 Responsibilities of parties involved in contract manufacturing, Role of owner and contract facility
- 4.3 Quality agreements: purpose, scope, and essential elements, Documenting CGMP activities in quality agreements, CGMP responsibilities of owners and contract facilities, analytical testing laboratories
- 4.4 Case Study: Common Problem in Contract Manufacturing Arrangements

Unit 5: Assessment of Indian CDMO Market (7 hrs)

- 5.1 Overview of CDMO Services & Global CDMO Market
- 5.2 Key growth drivers for the CDMO Industry
- 5.3 Risk and Challenges for the Indian CDMO Industry
- 5.4 Overview of recent trends in Indian CDMO Industry

Unit 6: India as an Emerging Biologics CDMO Hub (8 hrs)

- 6.1 Advanced Modality Pivots and Continuous Biomanufacturing: A Case Study on Gennova Biopharmaceuticals (Pune, Maharashtra)
- 6.2 Reason for India emerging as the key player in CDMO segment
- 6.3 Overview of Competitor analysis in CDMO industry
- 6.4 Case Study: Competitive landscape of Indian CDMO Segment



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References:

1. Study on CRO Sector in India. Department of Pharmaceuticals, Government of India.
2. Contract Manufacturing Arrangements for Drugs: Quality Agreements – Guidance for Industry. U.S. Food and Drug Administration.
3. Assessment of Indian Pharmaceutical and CDMO market .CRISIL Report-May 2022
4. Crommelin DJA, Sindelar RD, Meibohm B. Pharmaceutical Biotechnology. Springer.
5. Developing Countries Vaccine Manufacturers Network (DCVMN) Industrial Profile & Process Frameworks: Gennova Biopharmaceuticals Limited (Pune Cluster).

Practicals:

1. Preparation and Presentation of a Contract Research Organization (CRO) Service Proposal.
2. Development of a Scale-Up Risk Assessment and Mitigation Plan for a Biologic Product.
3. Case Study Evaluation of CRO/CDMO Operations and Regulatory Compliance.
4. Preparation of an Audit Checklist and CAPA Plan for CRO/CDMO Facility Inspection.



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Name of College: Shree Ramkrishna Institute of Computer Education and Applied Sciences						
Faculty	Science		Program	M.Sc. Biotechnology		
Course Type	DSC		Version	2.0		
Semester	02		Effective From	June, 2026		
Course Code	MSBT21207	Course Name	Aquaculture and Livestock Biotechnology (TH)			
Teaching Scheme				Examination Scheme		
Credits	Lecture (L)	Tutorial (T)	Practical (P)	Continuous Assessments (CA)	Term end examinations (TEE)	Total
3	3 hrs	0	0	40	35	75

Name of College: Shree Ramkrishna Institute of Computer Education and Applied Sciences						
Faculty	Science		Program	M.Sc. Biotechnology		
Course Type	DSC		Version	2.0		
Semester	02		Effective From	June, 2026		
Course Code	MSBT21208	Course Name	Aquaculture and Livestock Biotechnology (PR)			
Teaching Scheme				Examination Scheme		
Credits	Lecture (L)	Tutorial (T)	Practical (P)	Continuous Assessments (CA)	Term end examinations (TEE)	Total
1	0	0	2 hrs	10	15	25



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Master of Science (Biotechnology) Sem-I and II

Name of faculty: Science	Department: Biotechnology
Program: M.Sc. Biotechnology	Type: Theory + Practical
Subject: Biotechnology Business: Aquaculture and Livestock Biotechnology	
Credits: 03 + 01	Total learning hours: 45
Course Description: The course aims to: 1. Introduce students to India's aquaculture and livestock sectors and their contribution to the bioeconomy. 2. Understand biotechnology-enabled production systems used in fisheries, dairy, poultry and livestock industries. 3. Familiarize students with commercial production technologies and value-added products. 4. To develop understanding related to nutrition, disease management and breed improvement. 5. Promote sustainable and environmentally responsible biotechnology concepts.	
Student Learning Outcome: Upon successful completion of the course, students will be able to: 1. Define and explain the structure and economic significance of aquaculture and livestock industries. 2. Understand value addition and commercialization opportunities. 3. Apply and identify career and startup opportunities in aquaculture and livestock biotechnology. 4. Compare conventional and recent trends in livestock. 5. Evaluate biotechnology applications in feed, nutrition and production management. 6. Analyze sustainability issues and environmental challenges with livestock management.	

Unit 1: Introduction to Aquaculture

(05 Hours)

- 1.1 Objectives and Advantages of Aquaculture
- 1.2 Scope and Advantages of livestock
- 1.3 Status of Aquaculture- India and Global Scenario
- 1.4 Status of Livestock - India and Global Scenario
- 1.5 Economic Importance of Aquaculture and Livestock

Unit-2: Prawn Culture and Processing

(09 hours)

- 2.1 Prawn Culture Methods
- 2.2 Constraints in Shrimp and Prawn Culture
- 2.3 Harvesting
- 2.4 Post Harvest Technology
- 2.5 Processing for Preservation

Unit-3 Biotechnology in Aquaculture

(09 Hours)

- 3.1 Fish Genome Manipulation
- 3.2 Transgenic Fish
- 3.3 Fish Hybridization
- 3.4 Induced Breeding and Hatcheries
- 3.5 Hormonal Manipulation in Aquaculture



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Unit-4 Feed Formulation and Disease Management in Aquaculture

(07 Hours)

- 4.1 Types of Food and Feedstuffs
- 4.2 Feed Formulation Tools and Techniques
- 4.3 Food Supplements, Prebiotics, Probiotics and Synbiotics
- 4.4 Types of Diseases (Nutritional, Protozoal, Fungal, Bacterial, Viral)
- 4.5 Vaccines

Unit-5 Livestock Biology

(10 Hours)

- 5.1 Diseases and Vaccines
- 5.2 Breeds of Cattle
- 5.3 Breeds of Poultry
- 5.4 Mating Behaviour, Artificial Insemination and Embryo Transfer in Cattle
- 5.5 Feed Management in Livestock
- 5.6 Methods of Identification in Cattles
- 5.7 Genetic Conservation and Role of Biotechnology in Livestock and Cattle Industry

Unit-6 Government schemes

(05 Hours)

- 6.1 Rashtriya GOKUL Mission
- 6.2 Pradhan Mantri Formalisation of Micro Food Processing Enterprises Scheme (PMMSY)
- 6.3 National Programme for Dairy Development (NPDD)
- 6.4 Animal Husbandry Infrastructure Development Fund (AHIDF) and Dairy Processing and Infrastructure Development Fund (DIDF)
- 6.5 National Livestock Mission NLM

Practicals:

- 1. Visit to fish hatchery, dairy farm, poultry farm, shrimp culture farm, fish/shrimp processing unit / animal hospital
- 2. To perform analysis of Microbial diseases in Aquaculture.
- 3. To perform Proximate analysis of fish feed. (Protein, Carbohydrate, Lipid, Moisture, Ash)
- 4. To perform Livestock Breed identification through RT-PCR.

References & Text Books:

- 1. The Role of Biotechnology in Improvement of Livestock: Animal Health and Biotechnology by Muhammad Abubakar (Editor), Ali Saeed (Editor), Oguz Kul (Editor)
- 2. Economic importance of zoology-Dr. G. S. Shukla and Dr. V.B. Upadhyay
- 3. Essentials of Poultry Science Mihir Suthar

Government and Industry Resources:

- National Fisheries Development Board (NFDB)
- Department of Fisheries, Government of India
- National Dairy Development Board (NDDB)
- Department of Animal Husbandry and Dairying
- Department of Biotechnology (DBT)



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Name of College: Shree Ramkrishna Institute of Computer Education and Applied Sciences						
Faculty	Science		Program	M.Sc. Biotechnology		
Course Type	DSC		Version	2.0		
Semester	02		Effective From	June, 2026		
Course Code	MSBT21209	Course Name	Vaccine and MAb Manufacturing (TH)			
Teaching Scheme				Examination Scheme		
Credits	Lecture (L)	Tutorial (T)	Practical (P)	Continuous Assessments (CA)	Term end examinations (TEE)	Total
3	3 hrs	0	0	40	35	75

Name of College: Shree Ramkrishna Institute of Computer Education and Applied Sciences						
Faculty	Science		Program	M.Sc. Biotechnology		
Course Type	DSC		Version	2.0		
Semester	02		Effective From	June, 2026		
Course Code	MSBT21210	Course Name	Vaccine and MAb Manufacturing (PR)			
Teaching Scheme				Examination Scheme		
Credits	Lecture (L)	Tutorial (T)	Practical (P)	Continuous Assessments (CA)	Term end examinations (TEE)	Total
1	0	0	2 hrs	10	15	25



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Name of Faculty: Science	Department: Biotechnology
Program: M.Sc. Biotechnology	Type: DSC
Subject: Vaccine and MAb Manufacturing	
Credits: 03 + 01 = 04	

Unit 1: Production Facilities

(08 hours)

- 1.1 GMP-compliant plant design
- 1.2 Basic concepts for production plants
- 1.3 Clean and plant utilities
- 1.4 Equipment cleaning
- 1.5 Clean rooms
- 1.6 Automation

Unit 2: Manufacturing Process

(07 hours)

- 2.1 Process schematic and evaluation
- 2.2 Cell Bank
- 2.3 Fermentation

Unit 3: Purification

(08 hours)

- 3.1 Basic principles
- 3.2 Technologies for cell separation and product isolation
- 3.3 Technologies for final purification
- 3.4 Overview of purification
- 3.5 Formulation and filling
- 3.6 Labelling and Packaging

Unit 4: Vaccine types and manufacturing

(09 hours)

- 4.1 Understanding Six Types of Vaccine Technologies
- 4.2 Vaccine process overview
- 4.3 Vaccine Process Technologies
- 4.4 Viral Vaccine: Process overview
- 4.5 Viral Vaccine: Influenza vaccines
- 4.6 Virus-like Particles Vaccine: Generic Process
- 4.7 Typical Polysaccharide Conjugated Vaccine Process
- 4.8 Typical Viral Vectors Process
- 4.9 mRNA Vaccine Manufacturing



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Unit 5: Advances in monoclonal antibody manufacturing

(06 hours)

- 5.1 Therapeutic antibody discovery technologies
- 5.2 NK cell-mediated antibody dependent cellular cytotoxicity (ADCC)
- 5.3 Antibodies against viral disease: COVID-19
- 5.4 Single use STR systems
- 5.5 Single use bag systems
- 5.6 Microcarrier technology for the anchorage-dependent cells

Unit 6: Case studies

(07 hours)

- 6.1 Rotavac
- 6.2 Covaxin
- 6.3 iNOVACC
- 6.4 ZYCOV-D
- 6.5 EasySix
- 6.6 CANMAb
- 6.7 Reditux

References:

1. Behme, S. (2022). *Manufacturing of pharmaceutical proteins: From technology to economy* (3rd ed.). Wiley-Blackwell.



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Name of College: Shree Ramkrishna Institute of Computer Education and Applied Sciences						
Faculty	Science		Program	M.Sc. Biotechnology		
Course Type	DSC		Version	2.0		
Semester	02		Effective From	June, 2026		
Course Code	MSBT21211	Course Name	Agriculture Biotechnology (TH)			
Teaching Scheme				Examination Scheme		
Credits	Lecture (L)	Tutorial (T)	Practical (P)	Continuous Assessments (CA)	Term end examinations (TEE)	Total
3	3 hrs	0	0	40	35	75

Name of College: Shree Ramkrishna Institute of Computer Education and Applied Sciences						
Faculty	Science		Program	M.Sc. Biotechnology		
Course Type	DSC		Version	2.0		
Semester	02		Effective From	June, 2026		
Course Code	MSBT21212	Course Name	Agriculture Biotechnology (PR)			
Teaching Scheme				Examination Scheme		
Credits	Lecture (L)	Tutorial (T)	Practical (P)	Continuous Assessments (CA)	Term end examinations (TEE)	Total
1	0	0	2 hrs	10	15	25



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Name of faculty: Science	Department: Biotechnology
Program: M.Sc. Biotechnology	Type: Theory
Subject: Agriculture Biotechnology	
Credit: 04	Total learning hours: 45 [Th] + 30 [PR]
Course description: This course introduces the basic principles and applications of agricultural biotechnology in modern crop improvement. It covers plant transformation, genetic engineering, molecular markers, and advanced breeding techniques used for developing improved crop varieties. Students will learn about plant responses to biotic and abiotic stresses and the molecular approaches used to enhance stress tolerance. The course also explains modern technologies such as CRISPR-Cas, RNA interference, and genetically modified crops along with biosafety regulations. It provides an overview of biofertilizers, mushroom cultivation, sustainable agricultural practices, and agricultural entrepreneurship. The course emphasizes the role of biotechnology in improving crop productivity, food security, and sustainable agriculture while developing awareness of current research systems and innovations in the agricultural sector.	
Student learning outcome: 1. Explain the basic concepts and importance of agricultural biotechnology in crop improvement and food security. 2. Describe plant transformation methods, genetic engineering techniques, and their applications in agriculture. 3. Identify molecular markers and modern breeding technologies used for crop improvement. 4. Explain the molecular mechanisms involved in plant responses to biotic and abiotic stresses. 5. Evaluate the applications of CRISPR, RNA interference, GM crops, and biosafety regulations. 6. Recognize the role of biofertilizers, mushroom cultivation, and biotechnology-based entrepreneurship in sustainable agriculture.	

UNIT I: Foundations of Agricultural Biotechnology & Research Systems

(07 hrs)

- 1.1 Evolution of Agricultural Biotechnology and Major Milestones in Crop Improvement (Green Revolution, Hybrid Crops, Transgenic Crops, Gene-Edited Crops)
- 1.2 National Agricultural Research System (NARS) in India
- 1.3 CGIAR and global agricultural research organizations
- 1.4 Role of biotechnology in food security and sustainable agriculture

UNIT II: Plant Transformation and Genetic Engineering

(08 hrs)

- 2.1 Biology of *Agrobacterium tumefaciens*, Ti plasmid, virulence (vir) operon
- 2.2 Principles of stable transformation protocols (*Agrobacterium*-mediated gene transfer vs. Biolistics/Particle bombardment).
- 2.3 Binary vectors, function of selectable markers (antibiotic/herbicide resistance) and reporter genes (GUS, GFP).
- 2.4 Floral dip transformation, chloroplast transformation, marker-free transgenic generation, and transient expression via agroinfiltration



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UNIT III: Crop Stress Biology and Molecular Defense Mechanisms **(08 hrs)**

- 3.1 Biotic Stress: Plant-pathogen interactions, Bt toxins, Pathogenesis-Related (PR) proteins, and protease inhibitors.
- 3.2 Herbicide Resistance Mechanisms: Glyphosate tolerance (EPSPS'engineering) and glufosinate tolerance (Bar gene).
- 3.3 Abiotic stress: drought, salinity, temperature stress and Flooding stress: hypoxia and anoxia.
- 3.4 Delaying fruit ripening (ACC synthase/oxidase inhibition, polygalacturonase silencing), male sterility using the Barnase-Barstar system.

UNIT IV: Molecular Markers and Plant Breeding Technologies **(08 hrs)**

- 4.1 Overview of Molecular Markers: RFLP, RAPD, AFLP and their applications
- 4.2 PCR-based markers: SSR, ISSR, SCAR, CAPS, SNP
- 4.3 Marker-assisted selection (MAS)
- 4.4 TILLING as a Reverse genetics tool for discovering natural or induced mutations, QTL mapping

UNIT V: Modern Crop Improvement Technologies **(07 hrs)**

- 5.1 Applications of Genetic Engineering in Crop Improvement (Yield, Nutrition and Stress Tolerance)
- 5.2 Heterosis (hybrid vigor) and apomixis
- 5.3 CRISPR-Cas based crop improvement
- 5.4 RNA interference (RNAi) in plants
- 5.5 GM crops: environmental and food safety issues
- 5.6 Biosafety Regulations and Regulatory Framework for Agricultural Biotechnology

UNIT VI: Agricultural Entrepreneurship and Sustainable Biotechnology **(07 hrs)**

- 6.1 Biofertilizers: Rhizobium, Azospirillum, mycorrhizae
- 6.2 Phosphate solubilizing microbes
- 6.3 Mushroom biology: types and cultivation basics
- 6.4 Basic post-harvest handling of mushrooms
- 6.5 Sustainable agriculture and green manure
- 6.6 Agri-Biotechnology Entrepreneurship: Biofertilizer Production, Mushroom Enterprise and Agri-Startup Opportunities



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References and Textbooks:

1. Adrian Slater, Nigel Scott and Mark Fowler, Plant Biotechnology: The genetic manipulation of plants, 2nd Edition, Oxford University Press, 2003
2. Introduction to Plant Biotechnology. 2nd edition. By H. S. Chawla. Oxford & IBH publishing Co. Pvt. Ltd. New Delhi.
3. Plant Biotechnology and Genetics: Principles, Techniques and Applications, Edited by C. Neal Stewart JR. John Wiley and Sons Publications 2008
4. Marker Assisted Plant Breeding: Principles and practices, B.D Singh and A.K Singh, Springer 2015
5. Plant Biotechnology Vol-I, Plant Genetic Engineering, Edited by Don Grierson, Blackie Academic and Professional 1991
6. Salisbury, P.B. & Ross, C.W. (1992). Plant Physiology. Wadsworth Publishing, California.
7. Lincoln Taiz and Eduardo Zaiger (4th Edition), Plant Physiology, Sinauer Associates Inc. Publishers.
8. Krishnamoorthy, 1999. Hand Book of Mushroom Cultivation. TNAU Publications, Coimbatore, TN, India.
9. Biswas, S, Datta, M and Nagachan, S.V. 2012. Mushrooms- A manual for cultivation. PHI Learning Private Limited, New Delhi
10. SubbaRao, N. S., 1998, Biofertilizers in agriculture and forestry. India Book House Ltd. New Delhi.

Practicals:

1. Quantitative analysis of important phytochemicals from suitable plant source.
2. Rapid *in vitro* screening tests for abiotic stress tolerance (e.g., PEG-induced drought stress or NaCl-induced salinity stress) monitoring seed germination and viability.
3. Estimation of antioxidants and antioxidant enzymes namely Superoxide dismutase, Ascorbate peroxidase / Catalase from plant leaf.
4. Isolation of DNA from suitable plant source and quality check using gel electrophoresis.



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Name of College: Shree Ramkrishna Institute of Computer Education and Applied Sciences						
Faculty	Science		Program	M.Sc. Biotechnology		
Course Type	DSE		Version	2.0		
Semester	02		Effective From	June, 2026		
Course Code	MSBT22201	Course Name	Identification and Characterization Skills (TH)			
Teaching Scheme				Examination Scheme		
Credits	Lecture (L)	Tutorial (T)	Practical (P)	Continuous Assessments (CA)	Term end examinations (TEE)	Total
3	3 hrs	0	0	40	35	75

Name of College: Shree Ramkrishna Institute of Computer Education and Applied Sciences						
Faculty	Science		Program	M.Sc. Biotechnology		
Course Type	DSE		Version	2.0		
Semester	02		Effective From	June, 2026		
Course Code	MSBT22202	Course Name	Identification and Characterization Skills (PR)			
Teaching Scheme				Examination Scheme		
Credits	Lecture (L)	Tutorial (T)	Practical (P)	Continuous Assessments (CA)	Term end examinations (TEE)	Total
1	0	0	2 hrs	10	15	25



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FACULTY OF SCIENCE
Master of Science (Biotechnology) Sem-I and II

Name of College: Shree Ramkrishna Institute of Computer Education and Applied Sciences						
Faculty	Science		Program	M.Sc. All		
Course Type	SEC		Version	2.0		
Semester	02		Effective From	June, 2026		
Course Code	MSBT23203	Course Name	Research Methodology - 2			
Teaching Scheme				Examination Scheme		
Credits	Lecture (L)	Tutorial (T)	Practical (P)	Continuous Assessments (CA)	Term end examinations (TEE)	Total
2	2 hrs	0	0 hrs	25	25	50



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FACULTY OF SCIENCE
Master of Science (Biotechnology) Sem-I and II

Faculty: Science	Department: Env. Sc. and Biotech.
Program: M.Sc.	Type: SEC
Subject: Research Methodology-2	Credits: 2
Semester: 2	

References:

1. Ghosh, B. N. (1982). *Scientific method and social research*. Sterling Publishers.
2. Kothari, C. R. (2004). *Research methodology: Methods and techniques*. New Age International.

Unit 1: Conceptual Foundation

(06 hours)

- 1.1 Constituents and theoretical perspectives
- 1.2 Approaches to inquiry
- 1.3 Strategies and process
- 1.4 Hypothesis: its types and sources
- 1.5 Nature, sources and types of data
- 1.6 Measurement scales of variables

Unit 2: Philosophy of Scientific research

(08 hours)

- 2.1 Positivist philosophy of science and its criticism
- 2.2 Karl Popper and Thomas Kunh's philosophy of science
- 2.3 Definition, need and purpose of research
- 2.4 Conceptual framework of research
- 2.5 Basic and applied research
- 2.6 General characteristics of modern research
- 2.7 Criteria for selecting a topic and Scientific method



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Unit 3: Planning of research

(08 hours)

- 3.1 Criteria of scientific research
- 3.2 Purpose and development of theory
- 3.3 Scope of research in biology
- 3.4 Stages and process of research
- 3.5 Sources of data
- 3.6 Sample design
- 3.7 Survey research
- 3.8 Experimental research

Unit 4: Methods of research

(08 hours)

- 4.1 Planning and process of observation
- 4.2 Types of observation
- 4.3 Questionnaire method
- 4.4 Pre-testing and distribution of questionnaires
- 4.5 Interviewing method
- 4.6 Parts and planning of experimental research
- 4.7 Laboratory vs Field experiment
- 4.8 Experiment design

