

**KADI SARVA  
VISHWAVIDYALAYA,  
GANDHINAGAR**



**M.Sc. BIOTECHNOLOGY**

**SYLLABUS**

**W.E.F. JULY 2017**

Kadi Sarva Vishwavidyalaya, Gandhinagar  
CBCS Syllabus of M.Sc. Biotechnology  
**Course Structure for M.Sc. Biotechnology Programme**

**SEMESTER- 1**

Sem.	Paper	Title	Hours / week	Credits	Exam hours	Mid Term marks	External marks	Total marks
1	BTCT 101	Molecular Biology	4	4	3	Max.:30 Min: 12	Max.:70 Min: 28	100
1	BTCT 102	Principles of Biochemistry and Enzymology	4	4	3	Max.:30 Min: 12	Max.:70 Min: 28	100
1	BTCT 103	Bioinstrumentation	4	4	3	Max.:30 Min: 12	Max.:70 Min: 28	100
1	BTCT 104	Cell Biology and Cellular Physiology	4	4	3	Max.:30 Min: 12	Max.:70 Min: 28	100
1	BTCP 105	Practicals related to theory papers in the semester	8	8	12	----	Max.: 200 Min: 80	Max.: 200 Min:80
<b>Total credits</b>				24				

**SEMESTER- 2**

2	BTCT 201	Genetic Engineering	4	4	3	Max.:30 Min: 12	Max.:70 Min: 28	100
2	BTCT 202	Systematics of Microbial Life	4	4	3	Max.:30 Min: 12	Max.:70 Min: 28	100
2	BTCT 203	Research Methodology and Technical Writing in Biotechnology	4	4	3	Max.:30 Min: 12	Max.:70 Min: 28	100
2	BTCT 204	Bioprocess Engineering	4	4	3	Max.:30 Min: 12	Max.:70 Min: 28	100
2	BTCP 205	Practicals related to core theory papers in the semester	8	8	12	----	Max.: 200 Min: 80	Max.: 200 Min: 80
<b>Total credits</b>				24				

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**SEMESTER-3**

Sem.	Paper	Title	Hours/ week	Credits	Exam hours	Mid Term marks	External marks	Total marks
3	BTCT 301	Pharmaceutical Biotechnology	4	4	3	Max.:30 Min: 12	Max.:70 Min: 28	100
3	BTCT 302	Immunology	4	4	3	Max.:30 Min: 12	Max.:70 Min: 28	100
3	BTCT 303	Microbial Technology	4	4	3	Max.:30 Min: 12	Max.:70 Min: 28	100
3	BTCT 304	Plant Biotechnology and Animal Cell Science	4	4	3	Max.:30 Min: 12	Max.:70 Min: 28	100
3	BTCP 305	Practicals related to theory papers in the semester	16	8	12	----	Max.: 200 Min: 80	Max.: 200 Min:80
3	BTET 306A	Biostatistics	2	2	2	Max.:15 Min: 6	Max.:35 Min: 14	50
3	BTET 306B	Genomics	2	2	2	Max.:15 Min: 6	Max.:35 Min: 14	50
		<b>Total credits</b>		26				650

**SEMESTER- 4**

4	BTCT 401	Bioinformatics	4	4	3	Max.:30 Min: 12	Max.:70 Min: 28	100
4	BTCT 402	Environmental Biotechnology	4	4	3	Max.:30 Min: 12	Max.:70 Min: 28	100
4	BTCP 403	Practicals related to theory papers in the semester	8	4	6	----	Max.: 100 Min: 40	Max.:100 Min: 40
4	BTDI 404	Dissertation/ Industrial Training for 8 weeks	-	12	-	-	Max.:300 Min: 120	Max.300 Min: 120
4	BTET 405A	Biotechnology Business Management	2	2	2	Max.:15 Min: 6	Max.:35 Min: 14	50
4	BTET 405B	Proteomics	2	2	2	Max.:15 Min: 6	Max.:35 Min: 14	50
		<b>Total credits</b>		26				650

% - Weightage of marks in percentage, Hrs- Number of teaching hours per week. BTCT- Biotechnology Core Theory, BTCP- Biotechnology Core Practical, BTET- Biotechnology Elective Theory, BTDI – Biotechnology Dissertation/ Industrial Training

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**General instructions**

1. The medium of instruction will be English for theory and practical courses.
2. There will be 4 lectures, each of 55 minutes duration / week / theory paper / semester.
3. There will be “four” units in each core theory paper. There will be 48 hrs. of theory teaching / paper / semester. Each theory paper / semester will be of 100 marks. There will be 30 marks for midterm evaluation and 70 marks for external evaluation.
4. There will be “two” units in each elective theory paper. There will be 24 hrs. of theory teaching / paper / semester. Each theory paper / semester will be of 50 marks. There will be 15 marks for midterm evaluation and 35 marks for external evaluation.
5. In semesters 1, 2 and 3, there will be 16 practical hours/ week / paper / batch. Each practical paper / semester will be of 200 marks. There is no midterm evaluation for practical work.
6. In semester 4, there will be 8 practical hours/ week / paper / batch and the practical paper in semester 4 will be of 100 marks. There is no midterm evaluation for practical work.
7. Dissertation and Industrial Training in semester 4 shall be evaluated for 300 marks. Work carried out and written report carry 200 marks, presentation carries 100marks.

**Unit wise marks distribution and the question paper scheme of End Term Core Theory Papers**

<b>Section A</b>	<b>Questions from each Unit</b>	<b>Questions to be answered</b>	<b>Marks</b>
Unit 1	Five MCQ, Two 5M questions, Four 3M questions	MCQ-5 5M questions -1 3M questions – 4	<b>35 Marks</b>
Unit 2	Five MCQ, Two 5M questions, Four 3M questions	MCQ-5 5M questions -1 3M questions –(Minimum-1 & Maximum-4)	
<b>Section B</b>	<b>Questions from each Unit</b>	<b>Questions to be answered</b>	<b>Marks</b>
Unit 3	Five MCQ, Two 5M questions, Four 3M questions	MCQ-5 5M questions -1 3M questions –(Minimum-1 & Maximum-4)	<b>35 Marks</b>
Unit 4	Five MCQ, Two 5M questions, Four 3M questions	MCQ-5 5M questions -1 3M questions –(Minimum-1 & Maximum-4)	
		<b>Total</b>	<b>70 Marks</b>

**Unit wise marks distribution and the question paper scheme for End Term Elective Theory Paper**

<b>Section A</b>	<b>Questions from each Unit</b>	<b>Questions to be answered</b>	<b>Marks</b>
Unit 1	Five MCQ, Two 5M questions, Four 3M questions	MCQ-5 5M questions -1 3M questions –(Minimum-1 & Maximum-4)	<b>35 Marks</b>
Unit 2	Five MCQ, Two 5M questions, Four 3M questions	MCQ-5 5M questions -1 3M questions –(Minimum-1 & Maximum-4)	
		<b>Total</b>	<b>35 Marks</b>

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**M.Sc. Biotechnology, I Year Course Description:** This course is designed to enable students to acquire understanding of fundamentals of Biotechnology and applications of various Biotechnological resources and techniques. It also provides opportunities for utilizing Biotechnology products for the benefit of mankind. The course also provides practical training on Biotechnological resources, techniques and processes for creation of trained manpower for adsorption in upcoming Biotechnology Industry.

<b>Paper</b>	<b>Title of Paper</b>	<b>Credits</b>
<b>Core</b>	<b>SEMESTER-1</b>	
BTCT 101	Molecular Biology	4
BTCT 102	Principles of Biochemistry and Enzymology	4
BTCT 103	Bioinstrumentation	4
BTCT 104	Cell Biology and Cellular Physiology	4
BTCP 105	Practical work related to core theory papers in the semester	8
	<b>SEMESTER-2</b>	
<b>Core</b>		
BTCT 201	Genetic Engineering	4
BTCT 202	Systematics of Microbial Life	4
BTCT 203	Research Methodology and Technical Writing in Biotechnology	4
BTCT 204	Bioprocess Engineering	4
BTCP 205	Practical work related to core theory papers in the semester	8
	<b>SEMESTER-3</b>	
<b>Core</b>		
BTCT 301	Pharmaceutical Biotechnology	4
BTCT 302	Immunology	4
BTCT 303	Microbial Technology	4
BTCT 304	Plant Biotechnology and Animal Cell Science	4
BTCP 305	Practicals related to theory papers in the semester	8
<b>Elective</b>		
BTET 306A	Biostatistics	2
<b>OR</b>		
BTET 306B	Genomics	2
	<b>SEMESTER-4</b>	
<b>Core</b>		
BTCT 401	Bioinformatics	4
BTCT 402	Environmental Biotechnology	4
BTCP 403	Practical's related to core theory papers in the semester	4
BTDI 404	Dissertation/ Industrial Training	12
<b>Elective</b>		
BTET 405A	Biotechnology Business Management	2
<b>OR</b>		
BTET 405B	Proteomics	2
	<b>Total Credits</b>	<b>100</b>

BTCT- Biotechnology Core Theory, BTCP- Biotechnology Core Practical, BTET- Biotechnology Elective Theory, BTDI – Biotechnology Dissertation/ Industrial Training

# Kadi Sarva Vishwavidyalaya, Gandhinagar

## CBCS Syllabus of M.Sc. Biotechnology

Semester-1

### BTCT 101- Molecular Biology

#### Teaching and Evaluation Scheme:

Subject Code	Subject Title	Credits	Theory		Total Marks	
			Hrs.	Max Marks		
				Mid Term		End Term
BTCT 101	Molecular Biology	4	48	30	70	100

#### Course Content

#### Section A

**Unit 1** **No. of Lectures: 12** **Weightage: 25%**

Genetic material & Recombination: Genetics, Overview of Mendelian Genetics, Central Dogma of life, Genetic Material – Properties, DNA is genetic material - Experimental proof, RNA is genetic material - Experimental proof, Transduction, Conjugation & Overview of transposons.

Replication: Proposed models for Mechanism of DNA replication – Semiconservative and conservative and experimental proof for semi conservative mode of replication. Enzymes & accessory proteins involved in DNA replication. Okazaki's experiments, Replication process in prokaryotes & Eukaryotes- Rolling circle mode of replication, Theta replication, D loops. End replication problem in eukaryotes, Telomerase.

**Unit 2** **No. of Lectures: 12** **Weightage: 25%**

Genome organization: Genomic organization in prokaryotes, Packaging of DNA as nucleosomes and higher order of packaging in eukaryotes, C-value paradox. Euchromatin, Heterochromatin, Bar bodies. Chromosomes types based on centromere location, Special type of chromosomes: lamp brush and giant chromosomes. DNA damage by radiations and chemicals. DNA Repair - Light Repair & Dark Repair – Excision Repair, Mismatch Repair, Recombination Repair, SOS Repair.

#### Section B

**Unit 3** **No. of Lectures: 12** **Weightage: 25%**

Promoters & Other Regulatory Sequences: Transcription- Definition, Cis and Trans elements, Importance of DNA binding Proteins, Transcription factors, Promoters and enhancers. Transcription: RNA polymerase and Mechanism of Transcription in prokaryotes & Eukaryotes, Processing of mRNA- 5' capping, 3' polyadenylation, splicing.

**Unit 4** **No. of Lectures: 12** **Weightage: 25%**

Translation: Definition, role of tRNA & ribosomes, Mechanism of translation in Prokaryotes & Eukaryotes, Post translational modification of proteins such as phosphorylation, adenylation, acylation and glycosylation. Regulation of gene expression: Operon concept-lac operon – positive and negative regulation, trp operon- negative regulation & Attenuation.

#### References

S.N.	Title	Author
1	Instant notes on Molecular Biology- 4 Ed.	Turner <i>et. al.</i>
2	Fundamental Bacterial Genetics	Nancy Trun & Janie Trempy
<b>Suggested Reading</b>		
1	Molecular Biology of Cell:	B. Alberts <i>et. al.</i>
2	Molecular Biology of the Gene	J. D. Watson <i>et. Al.</i>
3	Genes XI	B. Lewin
4	Principles of Genetics	Snustard

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## CBCS Syllabus of M.Sc. Biotechnology

Semester-1

### BTCT 102- Principles of Biochemistry and Enzymology

#### Teaching and Evaluation Scheme:

Subject Code	Subject Title	Credits	Theory			Total Marks
			Hrs.	Max Marks		
				Mid Term	End Term	
BTCT 102	Principles of Biochemistry and Enzymology	4	48	30	70	100

#### Course Content

##### Section A

<b>Unit 1</b>	<b>No. of Lectures: 12</b>	<b>Weightage: 25%</b>
<p><b>Carbohydrate metabolism:</b> Classification and biological importance of Sugar. Aerobic and anaerobic glycolytic pathways. TCA cycle and various fates of Glucose 6 Phosphate in a cell - Gluconeogenesis, glycogen synthesis and breakdown. ATP Cycle, High energy compounds; Electron transport chain order and organization of carriers, proton gradient, respiratory controls and oxidative phosphorylation, ATP- synthetase complex. ED and PPP pathways.</p> <p><b>Nucleic acid metabolism:</b> Brief over view of central dogma. Structure of nucleoside, nucleotides, purines and pyrimidines. Biosynthesis and regulation of purines and pyrimidines. Structure and Function of Ribonucleotide reductase.</p>		

<b>Unit 2</b>	<b>No. of Lectures: 12</b>	<b>Weightage: 25%</b>
<p><b>Lipid metabolism:</b> Classification of lipids.  <math>\alpha</math>, <math>\beta</math> and <math>\delta</math> oxidation of fatty acids, metabolism of fatty acids with even and odd carbon atoms, saturated and unsaturated fatty acids. Metabolism and synthesis of phospholipids, glycolipids and sphingolipids; Ketone bodies –formation and degradation, Mobilization of fats.</p> <p><b>Proteins and Amino acids metabolism:</b> Proteins structure: Classification of amino acids; Primary, secondary, tertiary and quaternary structure of proteins. Properties of amino acids, Biosynthesis and degradation of amino acid. Urea cycle. Nitrogen balance, Regulation of amino acid metabolism in microbial system.</p>		

##### Section B

<b>Unit 3</b>	<b>No. of Lectures: 12</b>	<b>Weightage: 25%</b>
<p>Introduction to Enzymes, nomenclature and classification of enzymes. Enzymes as biocatalysts, catalytic power, activation energy, substrate specificity, active site, theories of mechanisms of enzyme action. Factor affecting enzyme activity and catalysis: pH, substrate and enzyme concentration, temperature, coenzyme and cofactors, Isolation &amp; purification of enzymes. Methods of enzyme assay.</p> <p><b>Enzyme Kinetics:</b> Derivation of Michaelis - Menton equation and its significance in enzyme kinetic studies. Line weaver-Burke plot, Haldane-Briggs relationship, sigmoidal kinetics steady state kinetics and transient phases of enzyme reaction. Significance of <math>K_m</math>, <math>V_{max}</math> &amp; <math>K_{cat}</math>. Introduction to allosteric enzymes and isozymes.</p>		

<b>Unit 4</b>	<b>No. of Lectures: 12</b>	<b>Weightage: 25%</b>
<p><b>Multi-enzyme system, Co-cooperativity.</b>  <b>Types of Enzyme inhibition and Mechanism of regulation of enzymes.</b>  <b>Enzyme Technology:</b> Immobilization of enzymes and their application.</p>		

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**References**

<b>S.N.</b>	<b>Name of Book</b>	<b>Authors</b>
1	Lehninger's Principles of Biochemistry	D. L. Nelson and M. M. Cox
2	Biochemistry	L. Stryer
3	Biochemistry	D. Voet and J. G. Voet.
4	Biochemistry: Chemical Reactions of the Living Cells (Vol. I & II)	D. Metzler
5	Biochemistry	Jain & Jain
6	Fundamentals of Enzymology	N.C. Price and L. Stevens
7	Enzyme Structure and Mechanism	A. Fersht
8	Understanding Enzymes	T. Palmer
9	Enzymology	T. Devsena



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## CBCS Syllabus of M.Sc. Biotechnology

Semester-1

### BTCT 103- Bioinstrumentation

#### Teaching and Evaluation Scheme:

Subject Code	Subject Title	Credits	Theory			Total Marks
			Hrs.	Max Marks		
				Mid Term	End Term	
<b>BTCT 103</b>	<b>Bioinstrumentation</b>	<b>4</b>	<b>48</b>	<b>30</b>	<b>70</b>	<b>100</b>

#### Course Content

#### Section A

<b>Unit 1</b>	<b>No. of Lectures: 12</b>	<b>Weightage: 25%</b>
<p><b>Use of analytical microscopy in elucidating the structure-function relationship in microbes:</b> Electron microscopy, phase contrast and fluorescence microscopy &amp; scanning tunneling microscopy. Introduction to Osmosis, diffusion, Fick's law of diffusion and Donnan Equilibrium.</p> <p><b>Centrifugation techniques:</b> Principle of sedimentation, Sedimentation rate, types of centrifuges, Centrifugation techniques: Rate Zonal; High speed; Isopycnic; Ultra; preparative; Gradient Centrifugation techniques.</p>		

<b>Unit 2</b>	<b>No. of Lectures: 12</b>	<b>Weightage: 25%</b>
<p><b>Chromatographic techniques:</b> Principle, methodology and applications of Paper, Thin layer gel – filtration, ion –exchange and affinity chromatography; and gas chromatography; High performance liquid chromatography.</p> <p><b>Electrophoresis:</b> Principles, Factors affecting electrophoresis, types of Electrophoresis- Zone; Gel, Isoelectric; DISC; Immuno &amp; Pulsed Field Gel Electrophoresis</p>		

#### Section B

<b>Unit 3</b>	<b>No. of Lectures: 12</b>	<b>Weightage: 25%</b>
<p><b>Basic concepts of Electromagnetic radiation</b> – wave length, frequency, wave number, velocity. Properties of U.V and IR rays, fluorescence, Phosphorescence. Principles, instrumentation and applications of Visible, UV, IR, AA Spectroscopy.</p>		

<b>Unit 4</b>	<b>No. of Lectures: 12</b>	<b>Weightage: 25%</b>
<p>Principles, instrumentation and applications of NMR, ESR, and Mass spectroscopy. Fluorescence spectroscopy, Raman spectroscopy, CD, ORD, Characterization of macromolecules using X-ray diffraction analysis.</p> <p><b>Principles and applications of Radio isotope techniques:</b> Detection and measurement of radioactivity, Geiger Muller counters, Scintillation counting, Autoradiography and RIA; Applications of isotopes in biological studies.</p>		

#### References

S.N.	Name of Book	Authors
1	Principle & techniques of biochemistry & molecular biology	Keith Wilson & John Walker
2	Instrumental methods of analysis	B. Sivasankar
3	Biophysical chemistry: Principle and techniques	Upadhyay & Nath
4	Instrumental methods of analysis	Willard, Merritt, Dean & Settle
5	Instrumental analysis	D.A. Skoog, Holler & Crouch
6	Physical Biochemistry	David Freifelder

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## CBCS Syllabus of M.Sc. Biotechnology

Semester-1

### BTCT 104- Cell Biology and Cellular Physiology

#### Teaching and Evaluation Scheme:

Subject Code	Subject Title	Credits	Theory			Total Marks
			Hrs.	Max Marks		
				Mid Term	End Term	
<b>BTCT 104</b>	<b>Cell Biology and Cellular Physiology</b>	<b>4</b>	<b>48</b>	<b>30</b>	<b>70</b>	<b>100</b>

#### Course Content

#### Section A

<b>Unit 1</b>	<b>No. of Lectures: 12</b>	<b>Weightage: 25%</b>
<b>Overview of structure and functions of cellular organelles in Prokaryotes and Eukaryotes:</b> Molecular Organization and functions of - Endoplasmic reticulum, Golgi complex, Lysosomes, Microbodies: Peroxisomes, Ribosomes, Mitochondria, Nucleus, Chloroplast.		
<b>Organization of Cytoskeleton:</b> Membrane Cytoskeleton interactions, Microtubule and its dynamics, motor proteins, Microfilament and its functions, Intermediate filaments and their functions , Cell division and overview of cell cycle.		
<b>Bio-membranes:</b> Structures and Transport process		

<b>Unit 2</b>	<b>No. of Lectures: 12</b>	<b>Weightage: 25%</b>
<b>Microbial growth:</b> Definition, Mathematical expression of growth, Growth curve, Methods for measurement of microbial growth, Effect of environment on microorganisms.		
<b>Sterilization:</b> various sterilization methods, Microbial contamination control and sterility testing. Applications in biotechnology		

#### Section B

<b>Unit 3</b>	<b>No. of Lectures: 12</b>	<b>Weightage: 25%</b>
<b>Microbial metabolic diversity:</b> Photosynthesis: Photosynthetic pigments, oxygenic & anoxygenic Photosynthesis, , Nitrogen fixation: Biological nitrogen fixation, Nitrogen fixation process, Nitrogenase enzyme, Regulation of nitrogen fixation.		
<b>Methanogenesis, Acetogenesis &amp; Microbial respiration:</b> Bacterial anaerobic and Aerobic respirations, Methanogenesis, Acetogenesis.		
<b>Microbial diversity:</b> Nutritional Diversity , Extremophiles		

<b>Unit 4</b>	<b>No. of Lectures: 12</b>	<b>Weightage: 25%</b>
<b>Culture collection:</b> Maintenance of cultures, Biochemical characterization.		
<b>Antimicrobial agents:</b> Antibacterial, Antiviral, Antifungal agents, Mode of action and resistance to antibiotics		

#### References

S.N.	Name of Book	Authors
1	Principle & techniques of biochemistry & molecular biology	Keith Wilson & John Walker
2	Instrumental methods of analysis	B. Sivasankar
3	Biophysical chemistry: Principle and techniques	Upadhyay & Nath
4	Instrumental methods of analysis	Willard, Merritt, Dean & Settle
5	Instrumental analysis	D.A. Skoog, Holler & Crouch
6	Physical Biochemistry	David Freifelder

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## CBCS Syllabus of M.Sc. Biotechnology

Semester-1

### BTCP 105 Practicals

#### Teaching and Evaluation Scheme:

Subject Code	Subject Title	Credits	Practical				Total Marks	
			Hrs/week	Max Marks				
				Experiments & writing	Spots	Viva		Journal
<b>BTCP 105</b>	<b>Practicals</b>	<b>8</b>	<b>16</b>	<b>120</b>	<b>40</b>	<b>20</b>	<b>20</b>	<b>200</b>

#### COURSE CONTENT:

1. Good laboratory practices and management.
2. Introduction to Instruments that are routine used in the laboratory.
3. Basics of weights, measurements and preparation of standard solutions.
4. Isolation of DNA from Animal source.
5. Isolation of the DNA from a plant source.
6. Estimation of DNA by Diphenyl amine method.
7. Visualization of the DNA samples by Agarose gel electrophoresis.
8. Isolation of proteins from plant source.
9. Estimation of proteins by Brad Ford's method/ U.V. Spectrophotometric method.
10. Protein estimation by Folin- Lowry's method.
11. Protein estimation by Biuret method.
12. Carbohydrate estimation by Anthrone method
13. Estimation of reducing sugar by DNSA method.
14. Isolation of casein from milk.
15. Isolation of lactose from milk.
16. Isolation of Urease enzyme from plant source.
17. Assay of Urease activity.
18. Enzyme Kinetics Studies (Amylase).
19. Determination of standard substrate curve.
20. Effect of substrate concentration on enzyme activity.
21. Effect of pH on enzyme activity.
22. Effect of Temperature on enzyme activity.
23. Effect of Incubation time on enzyme activity.
24. Thin layer chromatography of fatty acids/lipids
25. Identification of carbohydrates by ascending paper chromatography technique.
26. Identification of carbohydrates by radial or circular paper chromatography.
27. Separation of amino acids by Paper electrophoresis
28. Separation of proteins by SDSPAGE
29. Effect of hypertonic, hypotonic and isotonic environment of human RBC.
30. Isoelectric point determination of amino acid – Glycine.
31. Microscopic examination of bacteria and yeast by different staining methods.
32. Monochrome staining
33. Negative staining
34. Gram's staining
35. Acid fast staining
36. Spore staining
37. Capsule staining

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38. Isolation, cultivation & identification of molds
39. Preparation of sterile liquid and solid media for growth of microorganisms.
40. Isolation and maintenance of organisms from soil by plating, streaking and serial dilution methods, slant and stab culture.
41. Purification of cultures, maintenance and preservation of pure cultures.
42. Bacterial growth curve & factors affecting it.
43. Isolation and detection of Mitochondria from leaves.
44. Isolation and detection of Chloroplast from leaves.
45. Different stages of Mitosis and Meiosis.

### References:

An introduction to Practical Biochemistry	David T.Plummer
Biochemical Methods	S. Sadasivan & A. Manickam
Practical Biotechnology	R.S.Guad, G. D. Gupta, S.B.Gokhale
Methods In Enzymology	Shelby L Berger & Alan R. Kimmel
Experimental Microbiology	R. J.Patel
Laboratory exercises in Microbiology	Harley Prescott
Laboratory manual in Biochemistry.	Jaynarayan

# Kadi Sarva Vishwavidyalaya, Gandhinagar

## CBCS Syllabus of M.Sc. Biotechnology

Semester-2

### BTCT- 201- Genetic Engineering

#### Teaching and Evaluation Scheme:

Subject Code	Subject Title	Credits	Theory			Total Marks
			Hrs.	Max Marks		
				Mid Term	End Term	
<b>BTCT 201</b>	<b>Genetic Engineering</b>	<b>4</b>	<b>48</b>	<b>30</b>	<b>70</b>	<b>100</b>

#### Section A

<b>Unit 1</b>	<b>No. of Lectures: 12</b>	<b>Weightage: 25%</b>
Genetic Engineering, Chimera, Recombinant DNA, Invitro gene manipulation and its tools. Restriction endonucleases, Modification methylases and other enzymes to modify the DNA. Vectors – plasmids, bacteriophages, cosmids, phagemids, artificial chromosome vectors (YAC, BAC), Animal virus derived vectors - SV40 and retroviral vectors, Vectors in yeast and cloning in Plants.		

<b>Unit 2</b>	<b>No. of Lectures: 12</b>	<b>Weightage: 25%</b>
Molecular cloning, – isolation of DNA, Genomic DNA libraries, Shot gun gene cloning, cDNA libraries, full length cDNA cloning, Transformation of recombinant DNA, screening of recombinants, Southern, Northern and Western blotting,		

#### Section B

<b>Unit 3</b>	<b>No. of Lectures: 12</b>	<b>Weightage: 25%</b>
Polymerase chain reaction and its applications, Sequencing of DNA – Maxam and Gilberts method, Sanger’s method and other advances in sequencing, overview of chemical synthesis of oligonucleotides		

<b>Unit 4</b>	<b>No. of Lectures: 12</b>	<b>Weightage: 25%</b>
Mutation, Mutagens and Mutagenesis, techniques of in vitro mutagenesis, Site-directed mutagenesis. Applications of genetic engineering: Transgenic microbes; Strain construction, production of recombinant pharmaceuticals.		

#### References

S.N.	Title	Author
1	A text book of Biotechnology	R.C. Dubey
2	Genetic Engineering:	Smita Rastogi
<b>Suggested Reading</b>		
1	Principles of Gene Manipulation	R.W.Old , Twyman M. & S.B.Primrose
2	Concepts In Biotechnology	Balasubramanian D <i>et al</i>
3	Genetic Engineering	Sandya Mitra
4	Gene Biotechnology	S.N. Jogdand

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## CBCS Syllabus of M.Sc. Biotechnology

Semester-2

### BTCT 202- Systematics of Microbial Life

#### Teaching and Evaluation Scheme:

Subject Code	Subject Title	Credits	Theory			Total Marks
			Hrs.	Max Marks		
				Mid Term	End Term	
BTCT 202	Systematics of Microbial Life	4	48	30	70	100

#### Course Content:

#### Section A

<b>Unit 1</b>	<b>No. of Lectures: 12</b>	<b>Weightage: 25%</b>
<p><b>History of Science:</b> Prebiological chemical evolution, proteinoids and protocells; Species concept, theory. Kingdom to Species, The five Kingdoms, Three domain concept of Carl Woese; Endosymbiont. Scope, History and development and Scope of Biotechnology. Contributions of Pioneers.</p> <p><b>Microbial biodiversity</b> Species, Genomic and Ecologic diversity and classification of microorganisms. Distinguishing characteristics between prokaryotes and eukaryotes. Prions. Extremophiles.</p> <p><b>Taxonomy and Phylogeny</b> – Classical and Basic concepts in Taxonomy and Phylogeny, Morphological and molecular Taxonomy; Phylogenetic analysis, Phylogenetic trees.</p>		

<b>Unit 2</b>	<b>No. of Lectures: 12</b>	<b>Weightage: 25%</b>
<p><b>Disinfection / Sterilization:</b> Physical and chemical agents, radiation &amp; filtration. Indicator organism's for sterilization methods. Cultivation techniques, preservation and maintenance of Microbial cultures.</p> <p><b>Bacterial systematics:</b> Bergey's Manual of Systematic Bacteriology. Distribution, General features, characters, and replication, Systematics and Economic Importance of various groups of bacteria. <i>Proteobacteria</i>, <i>Firmicutes</i>. Actinobacteria, Mycoplasma,, Spirochetes, Rickettsiae,</p>		

#### Section B

<b>Unit 3</b>	<b>No. of Lectures: 12</b>	<b>Weightage: 25%</b>
<p><b>Viruses:</b> General characters, Structure and replication, nomenclature and classification of DNA and RNA viruses. Plant Viruses, Animal Viruses, Bacteriophages. Virus Diagnosis and cultivation. Economic Importance.</p> <p><b>Archaeobacteria and other extremophiles.</b> Characteristics, diversity, significance and potential applications of Archaeobacteria, Alkalophiles and Acidophiles Halophiles and Barophile.</p>		

<b>Unit 4</b>	<b>No. of Lectures: 12</b>	<b>Weightage: 25%</b>
<p><b>Algal diversity and importance:</b> Distribution, morphology, taxonomy and lifecycle. Economic Importance of algae (algal pigments, biofuels, hydrogen production, important bioactive molecules).</p> <p><b>Fungi:</b> General characters, Distribution, Morphology, Structure, nutrition and life cycle, Classification and Economic Importance. Associations: Lichens, Mycorrhiza. Yeast: genomics, diversity, and economic application.</p> <p><b>Protozoa:</b> General characters, Morphology, Structure, nutrition and life cycle, Classification, Economic Importance</p>		

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**References**

<b>S.N.</b>	<b>Name of Book</b>	<b>Authors</b>
1	General Microbiology	R.Y. Stanier, John L. Ingraham and Mark L. Wheelis
2	Principles of Microbiology	Ronald M. Atlas, Me Graw Hill
3	Microbiology	Michael J. Pcleczar, Chan and Krieg, Mac Graw Hill.
4	Brocks Biology of Microorganisms 8th Edition	Michael T. Madigan, John M. Martinko. Jack Parker.
5	Microbiology Principle & Applications	J.J. Black, John Wiley, Prentice Hall
6	An Introduction to Fungi	H.C. Dube : Vikas Publishing House Pvt. Ltd.
7	Introductory Mycology	C.J. Alexopoulos
8	Structure & reproduction of the Algae	F.E. Fristsch

# Kadi Sarva Vishwavidyalaya, Gandhinagar

## CBCS Syllabus of M.Sc. Biotechnology

Semester-2

### BTCT: 203- Research Methodology and Technical Writing in Biotechnology

#### Teaching and Evaluation Scheme:

Subject Code	Subject Title	Credits	Theory			Total Marks
			Hrs.	Max Marks		
				Mid Term	End Term	
BTCT 203	Research Methodology and Technical Writing in Biotechnology	4	48	30	70	100

#### Course Content

##### Section A

<b>Unit 1</b>	<b>No. of Lectures: 12</b>	<b>Weightage: 25%</b>
<b>Current trends in biotechnological research:</b> Introduction, Types of research		
<b>Research Process:</b> Identification of the problem, Defining the problem.		
<b>Literature search:</b> Information sources		

<b>Unit 2</b>	<b>No. of Lectures: 12</b>	<b>Weightage: 25%</b>
<b>Design of the experiment:</b> Variables in the experiments, evolution and application of research designs, observations, measurements, error measurements, error analysis.		
<b>Progress of research:</b> Evaluation of results, comparison with existing methodologies, validation of findings		

##### Section B

<b>Unit 3</b>	<b>No. of Lectures: 12</b>	<b>Weightage: 25%</b>
<b>Scientific communication :</b> Types of reports; Scientific writing skills, Elements of a Scientific paper including Abstract, Introduction, Materials & Methods, Results, Discussion, References; Drafting titles and framing abstracts, Plagiarism		

<b>Unit 4</b>	<b>No. of Lectures: 12</b>	<b>Weightage: 25%</b>
<b>Technical Writing :</b> Guidelines for effective writing, Paragraph writing, Writing style of application, Personal Resume, Official letter and Memo including Requests, Complains, asking quotation etc.		

#### References

S.N.	Name of Book	Authors
1	Research Methodology	CR Kothari
2	Study and Communication Skills for the Biosciences	Stuart Johnson & Jon Scott



# Kadi Sarva Vishwavidyalaya, Gandhinagar

## CBCS Syllabus of M.Sc. Biotechnology

Semester-2

### BTCT 204- Bioprocess Engineering

#### Teaching and Evaluation Scheme:

Subject Code	Subject Title	Credits	Theory			Total Marks
			Hrs.	Max Marks		
				Mid Term	End Term	
<b>BTCT 204</b>	<b>Bioprocess Engineering</b>	<b>4</b>	<b>48</b>	<b>30</b>	<b>70</b>	<b>100</b>

#### Course Content

#### Section A

<b>Unit 1</b>	<b>No. of Lectures: 12</b>	<b>Weightage: 25%</b>
<p><b>Introduction to Fermentation &amp; Bioprocess Technology.</b> Growth phases of microorganism, primary secondary metabolite. Effects of environmental factors on growth. Growth kinetics: Microbial growth cycle and measurement of growth. Primary and secondary screening, Preservation of industrially important microorganisms. Strain improvement techniques. Fermentation substrates used in media formulation. Optimization of media. Inoculum development Scale up of bioprocesses.</p>		

<b>Unit 2</b>	<b>No. of Lectures: 12</b>	<b>Weightage: 25%</b>
<p><b>Elements of biochemical engineering, Fermenter and Bioreactor design; Solid state / Submerged cultivation;</b> Batch, fed batch and continuous cultivation. Sterilization techniques for media, reactor and air. Agitation and aeration and mass transfer of oxygen in different types of Bioreactors.</p>		

#### Section B

<b>Unit 3</b>	<b>No. of Lectures: 12</b>	<b>Weightage: 25%</b>
<p><b>Measurement and Control of Process parameters in Fermenter. Automation:</b> two position and proportionate control, biosensors, microprocessor based control systems. Cell separation and Cell disintegration techniques.</p>		

<b>Unit 4</b>	<b>No. of Lectures: 12</b>	<b>Weightage: 25%</b>
<p>Product enrichment and purification techniques.  <b>Enzyme technology:</b> Use of immobilized enzymes in bioreactor and its applications. Bioprocess economics.</p>		

#### References

S.N.	Name of Book	Authors
1	Principles of Fermentation Technology	A. Whitekar, P. F. Stanbury & S. J. Hall
2	Comprehensive Biotechnology	M. Moo-Young (Ed)
3	Methods in Industrial Microbiology:	G. Sikyta
4	Industrial Microbiology:	L. E. Casida
5	Biochemical Engineering Fundamentals	J. E. Bailey & D. F. Ollis
6	Microbial Technology	H .J. Peppler & D. Perlman (Ed)
7	Prescott & Dunn's Industrial Microbiology	G. Reed
8	Fermentation Technology	H A Modi
9	Industrial Microbiology	A H. Patel
10	Textbook of Biotechnology	W. Crueger and A. Crueger
11	Industrial Microbiology: An Introduction	M Waites, N Morgan, J Rockey and G Higton

# Kadi Sarva Vishwavidyalaya, Gandhinagar

## CBCS Syllabus of M.Sc. Biotechnology

Semester-2

### BTCP 205 Practicals

#### Teaching and Evaluation Scheme:

Subject Code	Subject Title	Credits	Practical				Total Marks	
			Hrs/ week	Max Marks				
				Experiments & writing	Spots	Viva		Journal
<b>BTCP 205</b>	<b>Practicals</b>	<b>8</b>	<b>16</b>	<b>120</b>	<b>40</b>	<b>20</b>	<b>20</b>	<b>200</b>

#### COURSE CONTENT:

1. Isolation of RNA from yeast
2. Estimation of RNA by orcinol method.
3. Isolation of DNA from *E. coli*.
4. Isolation of plasmid DNA from *E. coli* culture.
5. Restriction digestion of DNA.
6. Ligation of DNA fragments.
7. Visualization of DNA samples by Agarose gel electrophoresis.
8. Transformation and selection of recombinants.
9. Isolation of Amylase producing microorganisms from soil.
10. Isolation of Protease producing microorganisms from soil.
11. Isolation of Lipase producing microorganisms from soil.
12. Screening of antibiotic producing microorganisms from soil.
13. Screening of organic acid producing microorganisms from soil.
14. Citric acid estimation by titrometric method.
15. Estimation of Reducing and Non-reducing sugar by Cole's method.
16. Fermentative production of Citric acid. -
17. Gel entrapment of yeast cells & determination of invertase activity of immobilized yeast cells.
18. To search and collect Microbes occurring in nature and to examine the collected samples exhibiting viruses, bacteria and molds.
19. To Isolate microbes from Mangrove ecosystem
20. To Isolate thermophilic microbes from Gujarat sites
21. To Isolate halophilic and alkalophilic microbes from Gujarat sites
22. To write a review article
23. How to include the references in a paper
24. How to write a Title and to find out keywords in a scientific communication
25. How to write an abstract
26. How to write a thesis
27. How to write an Introduction for an article
28. How to write a short note on any Topic
29. How to describe a Diagram on any Topic
30. How to point out the mistakes in the scientific communication

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**References:**

<b>S.N.</b>	<b>Title</b>	<b>Author</b>
1	An introduction to Practical Biochemistry	David T.Plummer
2	Biochemical Methods	S. Sadasivan & A. Manickam
3	Practical Biotechnology	R.S.Guad, G. D. Gupta, S.B.Gokhale
4	Methods In Enzymology	Shelby L Berger & Alan R. Kimmel
5	Experimental Microbiology	R. J.Patel
6	Laboratory exercises in Microbiology	Harley Prescott
7	Laboratory manual in Biochemistry.	Jaynarayan

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## CBCS Syllabus of M.Sc. Biotechnology

Semester 3

### BTCT – 301 PHARMACEUTICAL BIOTECHNOLOGY

#### Teaching and Evaluation Scheme:

Subject Code	Subject Title	Credits	Theory			Total Marks
			Hrs.	Max Marks		
				Mid Term	End Term	
<b>BTCT 301</b>	<b>Pharmaceutical Biotechnology</b>	<b>4</b>	<b>48</b>	<b>30</b>	<b>70</b>	<b>100</b>

#### COURSE CONTENT

##### Section A

<b>Unit 1</b>	<b>Weightage:25%</b>	<b>Lectures:12</b>
History of the pharmaceutical industry, Biopharmaceuticals and introduction to animal, plant and microbial based pharmaceutical products. Expression hosts, recombinant microbes as expression hosts for biopharmaceuticals, Molecular Pharming		

<b>Unit 2</b>	<b>Weightage:25%</b>	<b>Lectures:12</b>
Concept and approaches for gene therapy, ex vivo and in vivo gene therapy, Potential target diseases for gene therapy (inherited disorders and cancer) Antigen and antisense therapy Vaccine: genetically improved vaccines, synthetic peptide based vaccines, nucleic acid vaccines Xenotransplantation in pharmaceutical biotechnology.		

##### Section B

<b>Unit 3</b>	<b>Weightage:25%</b>	<b>Lectures:12</b>
Dosage forms, Formulations and delivery routes for Biopharmaceutical: Oral delivery systems, pulmonary delivery, Nasal, Trans mucosal and transdermal delivery systems, Pharmacogenetics and its impact on drug therapy		

<b>Unit 4</b>	<b>Weightage:25%</b>	<b>Lectures:12</b>
Introduction to Different Pharmacopoeia, GMP Guidelines for manufacturing facilities, Regulatory market Inspections and their requirements, Quality Control analysis, QA and Documentation, SOP, Market complain analysis. USFDA WHO		

#### REFERENCES:

Sr. No.	Name of Book	Authors
1	Hugo and Russel's Pharmaceutical Microbiology:	Hugo and Russel's
2	Biopharmaceuticals Biochemistry and Biotechnology	Gary Walsh
3	Pharmaceutical Biotechnology: Drug Discovery & Clinical Applications:	O. Kayser& R.H. Muller
4	Biopharmaceuticals:	Jogdand, S.N
5	Molecular Biotechnology Therapeutic applications and Strategies	M. Sunil and P.D Salil
6	Pharmaceutical Biotechnology	S. P.Vyas and D.V. Kohli
7	Comprehensive Biotechnology	K G Ramawat&ShailyGoyal
8	Pharmaceutical Biotechnology Fundamentals & Applications	DJ Crommelin RD Sindler&Meibohm
9	Medical Biotechnology	P. Nallari& V V Rao

# Kadi Sarva Vishwavidyalaya, Gandhinagar

## CBCS Syllabus of M.Sc. Biotechnology

Semester-3

### BTCT302-IMMUNOLOGY

#### Teaching and Evaluation Scheme:

Subject Code	Subject Title	Credits	Theory			Total Marks
			Hrs.	Max Marks		
				Mid Term	End Term	
BTCT 302	Immunology	4	48	30	70	100

#### COURSE CONTENTS:

**Unit 1** **Weightage:25%** **Lectures:12**  
**Adaptive immunity and innate immunity. Inflammation:** Definition, Characteristics of inflammation, causes and mechanism of inflammation  
**Cells of immune system:** Hematopoiesis, and structure and functions of immune cells, ADCC  
**Organs of immune system:** Primary and secondary lymphoid organs.  
**Antigens and antibodies:** Properties of immunogens, haptens, epitopes, structure and classes of immunoglobulins, monoclonal antibodies and abzymes.  
**Complement:** Definition, Classical, alternative and lectin pathway of complement system. Complement deficiency diseases. **Cytokines:** properties, receptors, associated diseases, therapeutic applications.

**Unit 2** **Weightage:25%** **Lectures:12**  
**Antibody diversity:** Antibody diversity definition, Organization of Ig genes, mechanism of gene rearrangement, generation of diversity; expression, synthesis and class switching.  
**Generation, activation and differentiation of B cells:** B cell maturation, activation and proliferation.  
**T-cell receptor, T-cell maturation, activation and differentiation:** TCR-complex, peptide binding, thymic selection, activation and differentiation of T cells.  
**Major histocompatibility complex:** Definition, types, structure, organization of MHC genes and inheritance, Self MHC restriction.  
**Antigen processing and presentation:** Cytosolic and endocytic pathway for antigen processing

#### Section B

**Unit 3** **Weightage:25%** **Lectures:12**  
**Antigen and antibody interaction:** Precipitation and agglutination reactions.  
**Transplantation immunology:** Transplantation definition, transplantation types, mechanism of graft rejection, HLA matching, Mixed lymphocyte reaction.  
**Hypersensitivity reactions:** Classification and types of hypersensitivity reactions.  
**Vaccines:** Definition, Passive Immunization and Active immunization, Classification of vaccines, Herd immunity.  
**Tumor immunology:** Definition of benign and malignant tumor, oncogenes, Process of metastasis, Tumor Antigen (**TATA, TSTA**)

**Unit 4** **Weightage:25%** **Lectures:12**  
**Immune tolerance and autoimmunity:** Establishment and failure of tolerance,  
**a. Organ specific diseases** (Addison's disease, Autoimmune hemolytic anaemia, Good pastures syndrome, Graves' disease, Hashimotos thyroiditis, Insulin dependent diabetes mellitus, Myasthenia gravis, Glomerularnephritis and Pernicious anaemia)  
**b. Systemic diseases:** Multiple sclerosis, Rheumatoidarthritis, Systemic lupus erythramatosis.  
**c. Immunodeficiency diseases.** a. SCID, b. WAS c. Di George Syndrome, d. Ataxia telangiectasia, e. Chediak Higashi Syndrome, f. Chronic granulamatous diseases.

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## CBCS Syllabus of M.Sc. Biotechnology

Semester-3

### BTCT303: MICROBIAL TECHNOLOGY

#### Teaching and Evaluation Scheme:

Subject Code	Subject Title	Credits	Theory			Total Marks
			Hrs.	Max Marks		
				Mid Term	End Term	
BTCT303	Microbial Technology	4	48	30	70	100

#### COURSE CONTENT

##### Section A

<b>UNIT1</b>	<b>WEIGHTAGE: 25%</b>	<b>Lectures: 12</b>
General concepts of Microbial Technology, Principles of exploitation of microbial biodiversity. <b>Microbial production of Alcoholic beverages:</b> beer, wine, sake. <b>Microbial production of Food and Dairy products:</b> Single cell proteins and Mushroom cultivation; Cheese, bread and yoghurt.		

<b>UNIT2</b>	<b>WEIGHTAGE: 25%</b>	<b>Lectures: 12</b>
<b>Microbial production of: Enzymes:</b> Proteases, Amylases; <b>Vitamins:</b> Vitamin B <sub>12</sub> and Vitamin B <sub>2</sub> ; <b>Amino acids:</b> Glutamic acid, Lysine. <b>Antibiotics:</b> Penicillin, Streptomycin; <b>Organic acids:</b> Citric acid, acetic acid. <b>Microbial Polysaccharides:</b> Overview of all microbial polysaccharides and detailed production of Xanthan gum. <b>Alkaloids:</b> Production of Ergot Alkaloid and Microbial Transformations of Steroids.		

##### Section B

<b>UNIT3</b>	<b>WEIGHTAGE: 25%</b>	<b>Lectures: 12</b>
<b>Industrial applications of Algae:</b> Brief specifications of Algal classification on the basis of size, pigments and polysaccharides, Techniques of mass culture of Algae, Application of Macro and Micro Algae as a Food and feed supplement, as a biofertilizer, in cosmetic and drug industry, as a biofuel etc. <b>Production of Biofertilizers:</b> Symbiotic ( <i>Rhizobium</i> , <i>Bradyrhizobium</i> , <i>Acetobacter</i> , <i>Frankia</i> , BGA) and Non-symbiotic N <sub>2</sub> fixing biofertilizers ( <i>Azotobacter</i> ), Phosphate solubilizing biofertilizers (Bacteria, Fungi and VAM) and Potassium fixing biofertilizers		

<b>UNIT4</b>	<b>WEIGHTAGE: 25%</b>	<b>Lectures: 12</b>
<b>Biopesticides</b> ( <i>Bacillus</i> , <i>Metarhizium</i> and <i>Baculoviruses</i> ). <b>Biopolyesters</b> (polyhydroxyalkanoates and polylactate). <b>Bioconversions:</b> Biomining and bioleaching of ores, Biological fuel generation (Alcohols, Alkanes, Hydrogen and Methane), Microbial Enhanced Oil Recovery process.		

#### Reference Books:

S. N.	Title of book	Author
1	Comprehensive Biotechnology	Murray Moo-Young
2	Microbial Technology	H. J. Peppler & D. Perlman (Ed)
3	Microbial Biotechnology	Alexander N. Glazer & Hiroshi Nikaido (Ed.)
4	The Desk Encyclopedia of Microbiology	M. Schaechter (ed.)
5	Food Microbiology	Frazier William C and Westhoff Dennis C
6	Text Book of Industrial Microbiology	W Creuger & A Creuger
7	Industrial Microbiology	A. H. Patel
8	Industrial Microbiology: An Introduction	M. J. Waites, N. L. Morgan, J. S. Rockey, G. Higton
9	Biotechnology	HJ Rehm & G I Reed

# Kadi Sarva Vishwavidyalaya, Gandhinagar

## CBCS Syllabus of M.Sc. Biotechnology

Semester-3

### BTCT 304- PLANT BIOTECHNOLOGY AND ANIMAL CELL SCIENCE

#### Teaching and Evaluation Scheme:

Subject Code	Subject Title	Credits	Theory			Total Marks
			Hrs.	Max Marks		
				Mid Term	End Term	
<b>BTCT 304</b>	<b>Plant Biotechnology and Animal Cell Science</b>	<b>4</b>	<b>48</b>	<b>30</b>	<b>70</b>	<b>100</b>

#### Course Content

#### Section A

<b>Unit 1</b>	<b>No. of Lectures: 12</b>	<b>Weightage: 25%</b>
<b>Plant Tissue culture:</b>		
Introduction to cell and tissue culture; Tissue Culture Media; Sterilization in tissue culture, Initiation and maintenance of callus and suspension cultures; Single cell clones; Organogenesis; Somatic embryogenesis; Shoot tip culture; Virus-free plants; Anther, pollen and ovary culture for production of haploid plants and homozygous lines, Somaclonal variation.		
<b>Protoplast Isolation and Fusion, Cryopreservation</b>		

<b>Unit 2</b>	<b>No. of Lectures: 12</b>	<b>Weightage: 25%</b>
<b>Cell culture Laboratory design &amp; Equipments, Planning, construction and services; Layout; Sterile handling area; Aseptic concepts; Maintenance of sterility; Cell culture vessels.</b>		
<b>Different types of cell culture media:</b> constituents, Role of CO <sub>2</sub> ; Role of serum and supplements. Serum Free Media. Serum and protein free defined media and their applications.		
<b>Culturing &amp; Sub-Culturing of Animal Cells.</b> Primary culture; and maintenance; Primary and established cell line cultures. Measurement of viability, Cell Differentiation, Cell synchronization.		
<b>Scale-up:</b> Cell culture reactors; Perfusion cultures; Fluidized bed reactors, Scale-up in monolayers		

#### Section B

<b>Unit 3</b>	<b>No. of Lectures: 12</b>	<b>Weightage: 25%</b>
<b>Transformation Technology</b>		
Basis of tumor formation; Features of Ti and Ri plasmids; Mechanisms of DNA transfer; Role of virulence genes; Use of Ti and Ri as vectors; Binary vectors; Use of 35 S and other promoters; Genetic markers; Use of reporter genes; Methods of nuclear transformation; Viral vectors and their applications;		
<b>Vector-less or direct DNA transfer:</b> Particle bombardment, Electroporation, Microinjection, Markers		

<b>Unit 4</b>	<b>No. of Lectures: 12</b>	<b>Weightage: 25%</b>
<b>Application of Plant and Animal Biotechnology: Commercial Transgenic plants</b> Herbicide resistance, insect resistance, disease resistance, virus resistance, abiotic stresses.		
<b>Production of useful proteins and other products in transgenic animals, Stem cell technology:</b> Stem cell cultures, embryonic stem cells and their applications. Artificial insemination and embryo transfer, Invitro fertilization.		

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**References**

<b>S. N.</b>	<b>Name of Book</b>	<b>Authors</b>
1	Biotechnology in Crop Improvement	H.S.Chawla.
2	An Introduction to Plant Tissue Culture	M.K.Razdan.
3	Handbook of Plant Cell Culture (Vols. 1 to 4)	Evans <i>et. al.</i>
4	Plant Tissue and Cell Culture	H.E.Street
5	Applied and Fundamental Aspects of Plant Cell Tissue and Organ Culture	J.Reinert&Y.P.S.Bajaj (Eds)
6	Principles of Plant Biotechnology: An Introduction to Genetic Engineering in Plants	S.H.Mantellet. <i>al.</i>
7	Plant Propagation by Tissue Culture	E.F.George, M.A.Hall& G-J de Klerk (Eds.)
8	Cell Culture and Somatic Cell Genetics of Plants	A.K.Vasil
9	Genetic Engineering	SmitaRastogi
10	Culture of Animal Cells	R. I. Freshney



# Kadi Sarva Vishwavidyalaya, Gandhinagar

## CBCS Syllabus of M.Sc. Biotechnology

Semester-3

### BTCP 305 PRACTICALS

#### Teaching and Evaluation Scheme:

Subject Code	Subject Title	Credits	Practicals				Total Marks	
			Hrs/ week	Max Marks				
				Experiments & writing	Spots	Viva		Journal
<b>BTCP 305</b>	<b>Practicals</b>	<b>8</b>	<b>16</b>	<b>120</b>	<b>40</b>	<b>20</b>	<b>20</b>	<b>200</b>

#### List of experiments: Experiments correspond to the theory papers in the current semester

1. To determine the blood group of given sample.
2. To study Preparation of O antigen and H antigen from *Salmonella typhi*.
3. To detect the presence of antigen using WIDAL agglutination test.
4. To Perform Sandwich ELISA test
5. To Perform VDRL test for syphilis
6. To study Ag-Ab interaction by Immunoelectrophoresis.
7. To study Antigen-antibody interaction by using Oucaterlony Double Diffusion (ODD) technique.
8. Isolation of free living nitrogen fixing bacteria.
9. Isolation of symbiotic nitrogen fixing bacteria from root nodules of leguminous plant.
10. Isolation of Phosphate Solubilizing Microorganisms from soil.
11. Isolation of Potassium Solubilizing Microorganisms from soil.
12. Fermentative production of Cheese.
13. Fermentative production of Yogurt.
14. Estimation of alcohol by potassium dichromate method.
15. Fermentative production of alcohol by yeast.
16. Isolation of Exopolysaccharide producing organism from Citrus Canker
17. Mushroom spawn production technology
18. Sterility testing of paranteral products
19. Microbial limit test for oral dosage (capsules, tablet)
20. Enumeration of microbial load in class A and class B area by passive air sampling (settle plate method)
21. Analysis of microbial load in water. (purified water , WFI)
22. Tests for nonsterile pharmaceutical products.
23. Antibiotic potency testing.
24. Bioburden Estimation of medical devices
25. Sterilization techniques in tissue culture labs
26. Preparation of stock solutions
27. Laboratory design in animal tissue culture
28. Culture vessels used in animal tissue culture
29. Standardization of method of Surface Sterilization of leaves
30. Standardization of sterilants for surface sterilization of various explants materials
31. Isolation of single cells from plant leaves-Mechanical method.
32. Isolation of single cells from plant leaves-Enzymatic method.
33. Isolation of Protoplasts from plant leaves-Enzymatic method
34. Immobilization of isolated plant cells by entrapment
35. Single cell culture : Bergmann's plating technique
36. Single cell culture using micro chamber technique.

# Kadi Sarva Vishwavidyalaya, Gandhinagar

## CBCS Syllabus of M.Sc. Biotechnology

Semester-3

### BTET 306A- BIOSTATISTICS

#### Teaching and Evaluation Scheme:

Subject Code	Subject Title	Credits	Theory			Total Marks
			Hrs.	Max Marks		
				Mid Term	End Term	
<b>BTET 306A</b>	<b>Biostatistics</b>	<b>2</b>	<b>24</b>	<b>15</b>	<b>35</b>	<b>50</b>

#### COURSE CONTENT

<b>Unit 1</b>	<b>Weightage:50%</b>	<b>Lectures:12</b>
<p><b>Biostatistics:</b> Definition, branches and Scope of Biostatistics, Types of Variable and Measurement scale of Variable, Sample and statistic vs. Population and parameter.</p> <p><b>Sampling:</b> Rules for sample collection, Sampling error and Sampling techniques.</p> <p><b>Analysis of data: Measures of central tendency</b> – Mean (arithmetic, harmonic and geometric), Median and Mode.</p> <p><b>Measures of dispersion</b> (Standard deviation, Variance and coefficient of variance) and Standard Error and its significance.</p> <p><b>Gaussian's Normal distribution</b></p>		

<b>Unit 2</b>	<b>Weightage:50%</b>	<b>Lectures:12</b>
<p><b>Inferential statistics:</b> Basic idea of significance test, Statistical hypothesis, types of errors, level of significance.</p> <p><b>Parametric and Nonparametric tests:</b> Paired and Unpaired Student's t test and one way ANOVA as a parametric tests, Chi-square test as a Nonparametric test.</p> <p><b>Measures of Relationship:</b> Karl Pearson's Correlation coefficient and Simple linear regression.</p> <p><b>Data Analysis using Microsoft office Excel</b></p>		

#### REFERENCES

S. N.	Name of Book	Authors
1	Biostatistical Analysis	Jerrold H. Zar
2	Basic Biostatistics: Statistics for Public health Practice	B. Burt Gerstman
3	An Introduction To Biostatistics	P.S.S. Sundar Rao, Richard J.
4	Research Methodology: Methods and Techniques	C. R. Kothari
5	Comprehensive Textbook of Biostatistics & Research Methodology	S. Kartikeyan, R.M. Chaturvedi, R.M. Bhosale
6	Methods In Biostatistics For Medical Students And Research Workers	B. K. Mahajan
7	Elements of Biostatistics	S. Prasad

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## CBCS Syllabus of M.Sc. Biotechnology

Semester-3

### BTET: 306B – GENOMICS

#### Teaching and Evaluation Scheme:

Subject Code	Subject Title	Credits	Theory			Total Marks
			Hrs.	Max Marks		
				Mid Term	End Term	
<b>BTET: 306B</b>	<b>GENOMICS</b>	<b>2</b>	<b>24</b>	<b>15</b>	<b>35</b>	<b>50</b>

#### COURSE CONTENT

<b>Unit 1</b>	<b>Weightage: 50 %</b>	<b>No. of Lectures: 12</b>
<p><b>Genomics: Concepts and Applications</b> - Microbial genome and genome epidemiology. Organization of eukaryotic genomes. Repetitive and transposable genetic elements. Telomere regions. Structural genomics, Functional genomics and comparative genomics.</p> <p><b>Whole genome analysis</b> - Preparation of genome libraries (cosmid, BAC), shotgun sequencing, conventional and automated sequencing methods, Next generation sequencing methods. Genome mapping and DNA fingerprinting. Gene knockout, genome-wide mutagenesis</p>		

<b>Unit 2</b>	<b>Weightage: 50 %</b>	<b>No. of Lectures: 12</b>
<p><b>Transcriptomics and Microarray</b> - Introduction to transcriptomics and Global gene expression profiling. RNA and DNA Microarray preparation, working and analysis. DNA Chips, SNPs EST, SAGE.</p> <p><b>Proteomics</b> - concepts and applications of Expressional Proteomics, Functional Proteomics, Structural Proteomics.</p> <p><b>Protein separation techniques:</b> Affinity purification of proteins and TAP tag, 2D Gel electrophoresis, ITRAQ Isoelectric Focusing (IEF).</p>		

#### REFERENCE:

S. N.	Name of Book	Authors
1	Biochemistry	J. M. Berg, J. L. Tymoczko, L. Stryer
2	Principles and Techniques of Biochemistry & Mol. Biology	Keith Wilson & John Walker
3	The Cell: A Molecular Approach	G.M.Cooper&R.E.Hausman
4	Gene IX	Lewin
5	Molecular Biology of the Gene	Watson et al.
6	Protein Structure Prediction: Methods and Protocols	Webster, David
7	Bioinformatics: A Practical guide to the Analysis of genes and Proteins	A. D. Bzxevanis and B. F. F. Onellette
8	Bioinformatics Methods and protocols: Methods molecular biology Vol. 132	S. Misenes and S. A. Krawetz (Eds)
9	Biopharmaceuticals Biochemistry and Biotechnology	G. Walsh

# Kadi Sarva Vishwavidyalaya, Gandhinagar

## CBCS Syllabus of M.Sc. Biotechnology

Semester 4

### BTCT: 401- BIOINFORMATICS

#### Teaching and Evaluation Scheme:

Subject Code	Subject Title	Credits	Theory		Total Marks	
			Hrs.	Max Marks		
				Mid Term		End Term
<b>BTCT 401</b>	<b>Bioinformatics</b>	<b>4</b>	<b>48</b>	<b>30</b>	<b>70</b>	<b>100</b>

#### COURSE CONTENT

##### Section A

<b>Unit 1</b>	<b>Weightage:25%</b>	<b>Lectures:12</b>
<p><b>Biotechnology and Bioinformatics:</b> Origin, history, aims and scope of biotechnology and bioinformatics, branches of biotechnology and bioinformatics;</p> <p><b>Gene structure and information content:</b> Nucleotides and their orientation, Promoter sequences, Open reading frames, Introns and Exons, Structural features of RNA: Primary, Secondary, Tertiary Structures.</p> <p><b>Protein structure:</b> Primary, secondary and tertiary. Nature of chemical bonds.</p>		

<b>Unit 2</b>	<b>Weightage:25%</b>	<b>Lectures:12</b>
<p><b>Biological Data Acquisition:</b> Sequencing, PCR, Blotting, Microarrays, Restriction digestion, Cloning, NGS.</p> <p><b>Databases:</b> Introduction, Biological databases: Nucleic acid databases (NCBI, DDBJ, and EMBL). Protein databases (Primary, Composite, and Secondary), Specialized Genome databases: (SGD, TIGR, and ACeDB), Structure databases (CATH, SCOP, and PDB sum).</p>		

##### Section B

<b>Unit 3</b>	<b>Weightage:25%</b>	<b>Lectures:12</b>
<p><b>Sequence Similarity Searches:</b> Sequence homology as product of molecular evolution; Sequence similarity searches; Significance of sequence alignment.</p> <p><b>Methods of Sequence Alignment,</b> Dot plots, simple alignments, Alignment scores and gap penalties; Measurement of sequence similarity; Similarity and homology, Multiple sequence alignments – CLUSTAL, Significance of multiple sequence alignment.</p>		

<b>Unit 4</b>	<b>Weightage:25%</b>	<b>Lectures:12</b>
<p><b>Database searches:</b> BLAST, FASTA, PSI-BLAST algorithms. Phylogenetic trees, Distance based and character based methods of Phylogenetics, Application of phylogenetic analysis.</p> <p><b>Visualisation tools:</b> 3D structure viewers (Rasmol, SPDBv, Chime, Cn3D, PyMol).</p> <p><b>Applied Bioinformatics:</b> Human genome analysis, Gene therapy, Genetic variability and connections to clinical data, Recombinant pharmaceuticals, Gene Silencing- RNAi, siRNA, miRNA</p>		

#### REFERENCES:

S.N.	Name of Book	Authors
1	Genetic Engineering	SmitaRastogi
2	Biotechnology	U. Satyanarayana
3	Developing Bioinformatics Computer Skills	C. Gibas and P. Jamback.
4	Bioinformatics A machine learning approach	P. Baldi& S. Brunak
5	Bioinformatics: A Practical guide to the analysis of genes and Proteins	A. D. Bzxevanis and B. F. F. Onellette

Kadi Sarva Vishwavidyalaya, Gandhinagar  
CBCS Syllabus of M.Sc. Biotechnology  
Semester 4  
**BTCT: 402- ENVIRONMENTAL BIOTECHNOLOGY**

**Teaching and Evaluation Scheme:**

Subject Code	Subject Title	Credits	Theory			Total Marks
			Hrs.	Max Marks		
				Mid Term	End Term	
BTCT 402	Environmental Biotechnology	4	48	30	70	100

**COURSE CONTENTS**

<b>Unit 1</b>	<b>Weightage:25%</b>	<b>Lectures:12</b>
<b>Environmental issues:</b> Types of pollution and its measurement.		
<b>Air pollution: Types of air pollutants, Effects of air pollution and control by physical and biological methods</b>		
<b>Climate change:</b> Air pollution and its role in climate change. Introduction to Ecological foot print, Carbon credit Introduction to Kyoto Protocol, Introduction to Role of United Nations Framework Convention on Climate Change (UNFCCC).		
<b>Microbial indicators:</b> WHO criteria for microbial indicators, Examples of microbial indicators and enumeration of microbial indicators		

<b>Unit 2:</b>	<b>Weightage:25%</b>	<b>Lectures:12</b>
<b>Waste water treatment:</b> Introduction to waste water treatment .		
<b>Preliminary, Primary, Secondary : Aerobic and anaerobic waste water treatment systems, Tertiary treatment systems:</b> Nitrogen removal, Phosphorus removal, removal of microbes		

**Section B**

<b>Unit 3</b>	<b>Weightage:25%</b>	<b>Lectures:12</b>
<b>Biofilms:</b> Definition, Stage of biofilm development, Microbes involved in Biofilm, Problems related to biofilm formation its control method.		
<b>Microbiology of degradation of Xenobiotic in environment:</b> Degradation of simple aliphatic, aromatic, polycyclic aromatic hydrocarbons, halogenated hydrocarbons, Surfactants, azo dyes.		

<b>Unit 4</b>	<b>Weightage:25%</b>	<b>Lectures:12</b>
<b>Bioremediation of solid waste:</b> Principles of Bioremediation, Strategies of bioremediation: In situ and ex situ bioremediation technologies. Phytoremediation. Composting, Vermicomposting.		

**REFERENCES:**

Waste Water Treatment for Pollution Control:	Arceivala.
Environmental Microbiology:	R. M. Maier, I. L. Pepper & G. P. Gerba
Comprehensive Biotechnology, Vol. 4	M. Moo-Young (Ed)
Biotechnology:	H.J.Rehm and J.I.Reid (Eds)
Environmental Microbiology and Biotechnology	Singer Samuel
Biotechnology for Waste and Wastewater Treatment	Nicholas P. Cheremisinoff,
Environmental Biotechnology Theory and Application	Gareth M. Evans & Judith C. Furlong
Environmental Biotechnology	S.N.Jogdand
Handbook of Environmental Biotechnology	S.C.Bhatia

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Environmental Biotechnology	M.H.Fulekar
Environmental Microbiology	Pradipta K Mohaptra
Microbial Ecology (Fundamentals and applications)	Atlas and Bartha

# Kadi Sarva Vishwavidyalaya, Gandhinagar

## CBCS Syllabus of M.Sc. Biotechnology

Semester-4

### BTCP 403 PRACTICALS

#### Teaching and Evaluation Scheme:

Subject Code	Subject Title	Credits	Practical				Total Marks	
			Hrs/ week	Max Marks				
				Experiments & writing	Spots	Viva		Journal
BTCP 403	Practicals	4	8	60	20	10	10	100

**List of Experiments:** Experiments related to the Theory papers offered in the current semester.

1. Bacteriological examination of water particularly for pathogenic microbes
2. Isolation of Coliphages from raw sewage
3. Detection of Coliform in water by membrane filter method
4. Determination of Chemical Oxygen demand of water
5. Determination of Dissolved Oxygen of Water
6. Determination of Biochemical Oxygen Demand of Water
7. Measurement of Total Solids, Suspended Solids and Dissolved Solids in a given sample of Water and Waste Water
8. Measurement of Acidity in given Water Sample
9. Measurement of Alkalinity of the given Water Sample
10. Determination of the Hardness of Water
11. Measurement of Sulfate in Water Sample
12. Determination of Chlorides concentration (Mohr's method )
13. Determination of Orthophosphate
14. Short group projects involving, exploring the databases and database types, sequence searching, comparing presentation of a proteins in various databases, Blast, Multiple sequence alignment etc.

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## CBCS Syllabus of M.Sc. Biotechnology

Semster-4

### **BTDI-404- DISSERTATION /INDUSTRIAL TRAINING**

#### **Teaching and Evaluation Scheme:**

Subject Code	Subject Title	Credits	Theory			Total Marks
			Hrs.	Max Marks		
				Mid Term	End Term	
<b>BTDI-404</b>	<b>DISSERTATION/ INDUSTRIAL TRAINING</b>	<b>12</b>	<b>---</b>	<b>---</b>	<b>300</b>	<b>300</b>

- Project work and Dissertation/ Industrial Training must be based on applied aspects of Biotechnology, Microbiology, Pharmaceuticals, Agriculture, Dairy & Food Processing, Environmental Issues and Bioinformatics.
- Semester 4 students will be at Industry / Research Institution / Department for 3 days in a week during entire term for Project Work and Dissertation. The Students have to devote 3 days, 8 hours per day at the work place that may be an Institute, Industry, Department and Hospital Laboratory.
- The Students will have to undergo continuous interaction and one evaluation of progress by a team of Departmental experts. A student who has undergone such evaluations only will be entitled to present his complete project work to the University for Exam.
- The University End Term Practical Examination will be carrying 300 marks divided as underneath and shall be conducted by One external expert along with an Internal expert:
  - Thesis Write up : 100 marks
  - Thesis Content : 100 marks
  - Thesis Presentation : 50 marks
  - Viva Voce : 50 marks
- Area of Final Project can be any of the following :
  - Biopharmaceuticals,
  - Biofertilizers,
  - Biopesticides
  - Enzymes
  - Biofuels,
  - Diagnostic Procedures
  - Dairy & Food Processing,
  - Tissue Culture
  - Bioremediation,
  - Bioleaching,
  - Pollution Abatement,
  - Extremophiles
  - Biological Effluent Treatment
  - Environmental Issues and
  - Bioinformatics.



# Kadi Sarva Vishwavidyalaya, Gandhinagar

## CBCS Syllabus of M.Sc. Biotechnology

### Semester 4

#### BTET: 405A-BIOTECHNOLOGY BUSINESS MANAGEMENT

Teaching and Evaluation Scheme:

#### COURSE CONTENT

Subject Code	Subject Title	Credits	Theory		Total Marks	
			Hrs.	Max Marks		
				Mid Term		End Term
BTET 405A	Biotechnology Business Management	2	24	15	35	50

#### COURSE CONTENT

##### Section A

<b>Unit 1</b>	<b>No. of Lectures:12</b>	<b>Weightage: 25%</b>
<p><b>Biotechnology:</b> Multidisciplinary science, public perception, Biotechnology Companies, Business areas and priorities.</p> <p><b>Evaluating an idea:</b> Decision on starting a venture; Assessment of feasibility of a given venture/new venture; The Business proposal /Plan.</p> <p><b>Accounting and finance:</b> Sources of financial assistance; Funds for capital expenditure and for working (Estimation of income, expenditure, profit, tax etc.), Budget planning, cash flow management and auditing; concepts of balance sheet, Incubators.</p>		

<b>Unit 2:</b>	<b>No. of Lectures:- 12</b>	<b>Weightage: 25%</b>
<p><b>Marketing:</b> Market research, Developing distribution channels; Pricing /Competition; Promotion/ Advertising, virtual marketing.</p> <p><b>Human Resource Development (HRD):</b> Leadership skills; Team building, teamwork; Appraisal.</p> <p><b>Intellectual property rights:</b> Intellectual property rights: Meaning – Classification and forms, Importance of IPRs in the fields of science and technology, Patents – Concepts and principles of Patenting, Types of patents.</p> <p><b>Regulatory approval and compliances</b></p>		

#### REFERENCES:

Comprehensive Biotechnology	KG Ramawat&ShailyGoyal
Economic Analysis of Fermentation Processes	Reissman
Management of Pharmaceutical Industry	

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## CBCS Syllabus of M.Sc. Biotechnology

### BTET 405B PROTEOMICS

#### Teaching and Evaluation Scheme:

Subject Code	Subject Title	Credits	Theory			Total Marks
			Hrs.	Max Marks		
				Mid Term	End Term	
BTET 405B	Proteomics	2	24	15	35	50

#### COURSE CONTENT

##### Unit 1 Weightage: 50 % No. of Lectures: 12

**Protein-Protein interactions-** Yeast-two hybrid Assays, Phage display. Fluorescent tagging and FRET microscopy. Protein crystallization: technique and application.

**Mass spectrometry in proteomics** – Principle, techniques, data analysis and applications (MALDI-TOF, LC-MS, MS/MS). Peptide sequencing. Protein Microarray

##### Unit 2

##### Weightage: 50 % No. of Lectures: 12

**Applications of Genomics and Proteomics:** In basic research and medical genetics: Metagenomics, Pharmacogenomics: Overview, concept and application of Individualized Therapy; RNAi: Targeted Medicine and gene silencing. Peptidomics/ Drug discovery, Toxicoproteomics, Biomarkers in disease diagnosis, Identification and characterization of novel proteins.

**Genomics and proteome data analysis:** Public domain databases for NA and proteins (EMBL, GeneBank), Similarity, homology, sequences alignments and genome analysis program (BLAST, FASTA, GCC, ClustalW etc.). ORFs, genes annotation, conserved protein motifs related structure / function analysis (PROSITE, PFAM, Profile Scan, PDB).

#### REFERENCES:

S. N.	Name of Book	Authors
1	Biochemistry	J. M. Berg, J. L. Tymoczko, L. Stryer
2	Principles and Techniques of Biochemistry & Mol. Biology	Keith Wilson & John Walker
3	The Cell: A Molecular Approach	G.M.Cooper&R.E.Hausman
4	Gene IX	Lewin
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**Department of Biotechnology**  
**Question Paper Scheme for Core Theory End Term Examination**

**Time: 3 hrs**

**Date:**  
**SECTION-A**

**Maximum marks: 70**

**Q.1 Answer all questions. Each question carries 1 mark (10X1=10 Marks)**  
**(MCQ. Out of these 5 will be from Unit 1 and 5 will be from Unit 2)**

- 1)
- 2)
- 3)
- 4)
- 5)
- 6)
- 7)
- 8)
- 9)
- 10)

**Q. 2 Answer all questions. Each question carries 5 marks (2X5=10M)**

**I) 5M Question (Unit3)**

**or**

**II) 5 M Question (Unit3)**

**III) 5M Question (Unit4)**

**or**

**IV) 5 M Question (Unit4)**

**Q. 3 Answer any 5 questions. Each question carries 3 marks (5X3=15 Marks)**  
**(4 questions from Unit 1 and 4 from Unit 2)**

- a)
- b)
- c)
- d)
- e)
- f)
- g)
- h)

**P.T.O**

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**SECTION-B**

**Q.4 Answer all questions. Each question carries 1 mark (10X1=10 Marks)**  
**(MCQ. Out of these 5 will be from Unit 3 and 5 will be from Unit 4)**

- 1)
- 2)
- 3)
- 4)
- 5)
- 6)
- 7)
- 8)
- 9)
- 10)

**Q. 5 Answer all questions. Each question carries 5 marks (2X5=10M)**

**I) 5M Question (Unit3)**

**or**

**II) 5 M Question (Unit3)**

**III) 5M Question (Unit4)**

**or**

**IV) 5 M Question (Unit4)**

**Q.6 Answer any 5 questions. Each question carries 3 marks (5X3=15 Marks)**  
**(4 questions from Unit 3 and 4 questions from Unit 4)**

- a)
- b)
- c)
- d)
- e)
- f)
- g)
- h)

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**Department of Biotechnology**  
**Question Paper Scheme for Elective Theory End Term Examination**

**Time: 3 hrs**

**Date:**

**Maximum marks: 35**

**Q.1 Answer all questions. Each question carries 1 mark (10X1=10 Marks)**  
**(MCQ. Out of these 5 will be from Unit 1 and 5 will be from Unit 2)**

- 1)
- 2)
- 3)
- 4)
- 5)
- 6)
- 7)
- 8)
- 9)
- 10)

**Q. 2 Answer all questions. Each question carries 5 marks (2X5=10M)**

**I) 5M Question (Unit3)**

**or**

**II) 5 M Question (Unit3)**

**III) 5M Question (Unit4)**

**or**

**IV) 5 M Question (Unit4)**

**Q. 3 Answer any 5 questions. Each question carries 3 marks (5X3=15 Marks)**  
**(4 questions from Unit 1 and 4 from Unit 2)**

- a)
- b)
- c)
- d)
- e)
- f)
- g)

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