NEP-2020 BASED CURRICULA AND EXAMINATION SCHEME,
UNIVERSITY OF KOTA,KOTA

M.Sc. Biotechnology programme

CBCS pattern (with effect from 2025-2026)

DEPARTMENT OF BIOTECHNOLOGY

UNIVERSITY OF KOTA
MBS Marg, KOTA (Rajasthan)-324 005
INDIA

Course Code: MBT 12350P

Type of the Course:Professional

Title of the Course: M.Sc. Biotechnology

Level of the Course: PG level

Credit of the Course:100

Delivery subtype of the Course:Practical

Pre requisites and co requisites of the Course

- A candidate who has passed any one of the following examinationsfrom any University recognized by the UGC shall be permitted to take admission in M.Sc. First Semester to award M.Sc. degree in Biotechnology from this University after completion of a course of study of two academic years divided in the foursemester scheme of examination:
- B.Sc. (Pass / Hons)under biological science stream with subjects: Biotechnology, Microbiology, Biochemistry, Biology, Chemistry, Botany, Zoology, Genetics, Environmental Sciences, Bioinformatics, Pharmaceutical Science, etc. or
- Bachelor of Science and Education (B.Sc.-B.Ed.) with subject biology, chemistry, botany, zoology.
- B.Tech. Biotechnology

University of Kota, Kota

M.Sc. Biotechnology

Semester wise Consolidated Common Scheme of Examinations for the Academic Sessions 2025-2026

Year / Semester	Number, Code or ID and Nomenclature of Paper				Duration of Exam. (in Hrs.)	Distribution of Assessment Marks								Total	
	Number of Paper	Code / ID of Paper		Nomenclature of Paper		Teaching Hrs / Week& Credit points			Continuous or Internal Assessment (30%)		Semester or External Assessment (70%)				
						Teaching Th.	Pr.	Credit Points	Max. Marks	Min. Pass Marks	Max. Marks	Min. Pass Marks		Max. Marks	Min. Pass Marks
1st Year I Semester	Paper-1.1	MBT-5101	DCC	Cell Biology and Enzyme Technology	3	4	-	4	30	12	70	28		100	40
	Paper-1.2	MBT-5102	DCC	General Microbiology	3	4	-	4	30	12	70	28		100	40
	Paper-1.3	MBT-5103	DCC	Bio-Instrumentation	3	4	-	4	30	12	70	28		100	40
	Paper-1.4	MBT-5104	DCC	Fundaments of Biochemistry	3	4	-	4	30	12	70	28		100	40
	Paper-1.5	MBT-5105	DCC	Lab Course-I	6	-	8	4	--	--	100	50		100	50
	Paper-1.6	MBT-5106	DCC	Lab Course-II	6		8	4			100	50		100	50
	Total (I Semester)				**24**	**32**		**24**	**120**	**48**	**480**	**212**		**600**	**260**
1st Year II Semester	Paper-2.1	MBT-5201	DCC	Fundamentals of Molecular Biology	3	4	-	4	30	12	70	28		100	40
	Paper-2.2	MBT-5202	DCC	Basic Plant and Animal Tissue Culture	3	4	-	4	30	12	70	28		100	40

	Paper-2.3	MBT-5203	DCC	Immunology and Immunotechnology	3	4	-	4	30	12	70	28	100	40
	Paper-2.4	MBT-5204	DCC	Genetic Engineering and its Applications	3	4	-	4	30	12	70	28	100	40
	Paper-2.5	MBT-5205	DCC	Lab Course-III	6		8	4			100	50	100	50
	Paper-2.6	MBT-5206	DCC	Lab Course-IV	6		8	4			100	50	100	50
		Total (II Semester)			**24**	**32**		**24**	**120**	**48**	**480**	**212**	**600**	**260**
2nd Year III Semester	Paper-3.1	MBT-6301	SEC	Applied Plant and Animal Biotechnology	3	4	-	4	30	12	70	28	100	40
	Paper-3.2	MBT-6302	DSE	Fermentation Technology, Biosafety and IPR	3	4	-	4	30	12	70	28	100	40
	Paper-3.3	MBT-6303	DSE	ELECTIVEI 1.Environnental Biotechnology 2. Stem cells and Healthcare	3	4	-	4	30	12	70	28	100	40
	Paper-3.4	MBT-6304	DSE	ELECTIVE II 1.Medical Biotechnology 2.Genomics and Proteomics	3	4		4	30	12	70	28	100	40
	Paper-3.5	MBT-6305	DCC	Lab Course-V	6	-	8	4	--	--	100	50	100	50
	Paper-3.6	MBT-6306	DCC	Lab Course-VI	6		8	4			100	50	100	50
		Total (III Semester)			**24**	**32**		**24**	**120**	**48**	**480**	**212**	**600**	**260**
2nd Year IV Semester	Paper-4.1	MBT-6401	DSE	Industrial Bioprocess Technology	3	4	-	4	30	12	70	28	100	40
	Paper-4.2	MBT-6402	DSE	Biostatistics, Bioinformatics and Research Methodology	3	4	-	4	30	12	70	28	100	40
	Paper-4.3	MBT-6403	DCC	Agricuture biotechnology	6	-	8	4	-	-	200	100	100	100
	Paper-4.4	MBT-6404	SEM	Lab Course VII	3	-	-	4	-	-	100	50	100	50
	Paper-4.5	MBT-6405	DPR	Dissertation	3	-	-	8	--	--	100	50	200	50
		Total (IV Semester)			**18**	**16**		**24**	**60**	**24**	**540**	**256**	**600**	**280**

	GrandTotal (I + II + III + IV Semester)	**90**	**112**	**96**	**420**	**168**	**1980**	**892**	**2400**	**1060**

Salient features are as follows:

- Discipline Centric Core (DCC) Core Courses in Biotechnology as Major.
- Discipline Specific Electives (DSE) or Elective Courses in the Core Subject or Discipline.
- Open Electives (OE) are Elective Courses offered to students from non-core Subjects across disciplines.
- Skill Enhancement Courses (SEC) that are domain-specific or generic.
- Dissertation/Project/ course (DPR) or Elective course in the core subject Seminar/Viva course (SEM) or Elective course in the core subject

Objectives of the Course: Biotechnology is the broad area of biology involving living systems and organisms to develop or make products, or "any technological application that uses biological systems, living organisms, or derivatives thereof, to make or modify products or processes for specific use".

- Students will gain necessary knowledge and develop specialized skills in the different areas ofBiotechnology.
- Students will think critically and creatively about the use of biotechnology to address local and globalproblems.
- Students will be able to implement the scientific skills for development of industrial applications andentrepreneurship

Hyperlinks of suggested e resources onUniversity website and on web

https://link.springer.com/https://www.tandfonline.com/
https://onlinelibrary.wiley.com/

NPTEL and UGC epathsala, SWAYAM,MH Education,GeoGebra and MS Excel toolbox
https://ghr.nlm.nih.gov/resources#inheritance
https://opentextbc.ca/biology/chapter/10-1-cloning-and-geneticengineering/
http://www.hoajonline.com/molbiolgeneteng
https://www.yourgenome.org/facts/what-is-genetic-engineeringhttps://www.immunology.org/
https://onlinelearning.hms.harvard.edu/hmx/courses/hmximmunology
https://www.rcsb.org/ http://jgi.doe.gov/our-science/https://www.genengnews.com/http://biosafety.icgeb.org/in
https://iop.vast.ac.vn/theor/conferences/smp/1st/kaminuma/SWISSPROT/index.html http://www.ipindia.nic.in/http://www.wipo.int http://www.wto.org
http://www.nbaindia.org
http://www.envfor.nic.in/ divisions/csurv/geac/annex-5.pdf Springer®
Journal author tutorials now with interactive courses

Elsevier® Researcher Academy
https://www.hhs.gov/vaccines/about/resources/smart-vaccinetool/index.html
https://www.cdc.gov/vaccines/pubs/pinkbook/index.htmlhttps://www.embl.org/ https://www.cathdb.info/
Environmental biotechnology latest research and news
Biotechnology news, Science Daily, Nature News, Science News
Nature Biotechnology, Journal of Applied Biology & Biotechnology

Course learning outcome

Upon completion of the M.Sc. Biotechnology programme, the candidate should be able to**:**

- Demonstrate knowledge for in-depth analytical and critical thinking to identify, formulate and solve the issues related to Biotechnology Industry, Pharma industry, Medical or hospital related organizations, Regulatory Agencies & Academia.
- Demonstrate skills to use modern analytical tools/ software/ equipment to design & develop experiments and analyze and solve problems in various courses of biotechnology.
- Appreciate and execute their professional roles in society as biotechnology professionals,employers and employees in various industries, regulators, researchers, educators andmanagers
- Acquire basic and advance skills in in various fields of biotechnology for self- employment and entrepreneurship

Duration of the Course:

The course for the degree of Master of Science in Biotechnology shall consist of two academic years / sessions divided in to four equal semesters. The first academic year / session will comprise first and second semesters. The second academic year / session will comprise of the third and fourth semesters. Each semester shall comprisenormally 90 working days. The course shall run on the regular basis.

Minimum Marks required in Qualifying Examination:

Qualifying examination passed from any recognised University which is situated in Rajasthan State:

- General Category = 55%.
- SC / ST / OBC / SBC or MBC = Min. Pass Marks
- Qualifying examination passed from any recognised University which is situated at outside the Rajasthan State:
- All Categories = 60%.

Eligibility for Admission in M.Sc. Third Semester:

A candidate may be promoted in the next academic session (in odd semester *i.e.* III semester) if he/she has cleared collectively at least 50% of the papers of both semesters (*i.e.*semester I & II) of previous academic session with 50% of the aggregate marks. The candidate who does not fulfill the above condition will remain as an ex-student and will re-appear in the due papersexaminations along with next odd/even semester examinations.

A candidate who has passed B.Ed. examination as a regular course of study after completing first and second semester examinations from this University shall also be eligible to take admission in third semester examination as a regular candidate.

Open elective:

This course is open to students of other Department of the University. The student of the M.Sc. BiotechnologyProgramme can also take up an open elective being offered by any of the other Department of the University of Kota or from Government online portal like SWAYAM, MOOC etc.

Attendance:

Every teaching faculty, handling a course, shall be responsible for the maintenance of Attendance Register for candidates who have registered for the course. The teacher of the course must intimate the Head of the Department at least seven calendar days before the last instruction day in the semester about the attendance particulars of all students. Each student should earn 75% attendance in the courses of the particular semester failing which he or she will not be permitted to sit in the end semester examinations. However, it shall be open to the authorities to grant exemption to a candidate who has failed to obtain the prescribed 75% attendance for valid reasons and such exemptions should not under any circumstance be granted for attendance below 65%.

Teaching Methodologies:

The classroom teaching would be through conventional lectures or use of OHP or power point presentations (PPT). The lecture would be such that the student should participate actively in the discussion. Student seminars would be conducted and scientific discussions would be arranged to improve their communicative skill. In the laboratory, instruction would be given for the experiments followed by demonstration and finally the students have to do the experiments individually. For the students of slow learners, special attention would be given.

Assessment Pattern:

The assessment of the students shall be divided into two parts in which first part is continuous assessment or internal assessment or mid-term assessment (30% weightage of the maximum marks) and second part is semester assessment or external assessment or end-term assessment (70% weightage of the maximum marks). Assessment pattern and distribution of maximum marks is summarized as given below:

(i) Continuous or Internal or Mid Term Assessment:

(a) The continuous or internal or mid-term assessment (30% weightage of the maximum marks) for each theory paper shall be taken by the faculty members of the respective Departments during each semester. There will be three internal assessment tests (*i.e.*firstinternal assessment test or first mid-term test and second internal assessment test or second mid-term test and third internal assessment test) each of 10% weightageof maximum marks of each theory paper. Each internal assessment shall be of one hour duration for theory paper and shall be taken according to academic calendar which will be notified by the Department / University.

(b) For practical papers, there will be no continuous or internal or mid-term assessment. There will be only one external or semester or end-term assessment (100% weightage of maximum marks).

(c) A student who remains absent (defaulter) or fails or wants to improve the marks in the internal assessment may be permitted to appear in the desired paper(s) (only one time) in the same semester with the permission of the concern Head of the Department. A defaulter / improvement fee of Rupees 250/- per paper shall be taken from such candidates. Duly forwarded application of such candidates by the teacher concerned shall be submitted to Head of the Department who may permit the candidate to appear in the internal assessment after production of satisfactory evidence about the reason of his/her absence in the test(s) and deposition of the defaulter / improvement fee. A record of such candidates shall be kept in the Department.

(d) Regular attendance of the student shall be considered in the internal assessment. Some marks for regularity shall be given to the student(s) who is/are taken classes regularly from the 5% weightage of the maximum marks. The 5% weightage of the maximum marks of regularity shall be taken from the weightage given for second internal assessment (10% weightage of maximum marks). After excluding the 5% weightage of regularity, the second internal assessment shall be of 10% weightage of maximum marks.If the attendance / regularity factor is similar for all the students, then it may be merged with the weightage of second internal assessment test (class test, home assignment, quiz, seminar, *etc*.) and then second internal assessment test shall be of 15% weightage of maximum marks.

(e) 'Student should qualify both internal & external assessment separately to pass the paper i.e., if candidate passes in external & fails in internal, the candidate has to reappear in internal & external exam of that paper. But if candidate passes in the internal & fails in the external, the candidate has to reappear in external exam of the paper and in internal examination he has option either to forward the obtained internal marks of that paper in the previous attempt (on the basis of the application submitted by the candidate and approval of Head of Department for the same) or can reappear in the internal examination if he wants to improve his marks in that paper.'

(ii) Semester or External or End Term Assessment:

(a) The semester or external or end-term assessment (70% weightage of the maximum marks) shall be three hours duration to each theory paper and twelve hours duration (spread over two days with 6 hours per day) for each practical paper and shall be taken by the University at the end of each semester.

(b) The syllabus for each theory paper is divided into five independent units and question paper for each theory will be divided into three sections as mentioned below:

Section-A *will carry 20 marks with one compulsory question comprising ten short answer type questions taking two questions from each unit. Each question shall be of two marks.*

Section-B *will carry 50 marks with equally divided into five long answer type questions. Paper setter shall be advised to set two questions from each unit and students are instructed to attempt five questions by selecting one question from each unit.*

(c) The syllabus of practical paper is divided according to main streams of Biotechnology. Marks shall be awarded on the basis of major & minor experiments,spotting, viva-voce, practical record, regularity factor, lab skills, maintain cleanness of workplace, *etc*.

Question Paper Pattern:

(A)Continuous or Internal or Mid Term Assessment:

30% weightage of Maximum Marks (30 Marks out of 100 Maximum Marks).

(i)First Continuous or Internal or Mid Term Assessment:

Format

Department of .....
College / University ..... Address.....

First Internal Assessment Test 20… - 20….

Class	**:**	**Max. Marks**	**: 10 Marks**
Semester	**:**	**Duration of Exam.**	**:**
Subject	**:**	**Date of Examination**	**:**
Paper	**:**	**Name of Teacher**	**:**

Note: All questions are compulsory and marks are given at the end of the each question. Two or three sub-divisions may be given in the question.

Q. No. 1. …….. or

…….
4 Marks
Q. No. 2. …….. or
…….
3 Marks
Q. No. 3. ……..
or
…….
3 Marks

(ii)Second Continuous or Internal or Mid Term Assessment:

(a) Attendance:
Marks shall be given by the faculty member in each paper according to its weightage.
5% weightage of Maximum Marks
Note:
If the attendance / regularity factor is similar for all the students, then it may be merged with the weightage of second internal assessment test (class test, assignment, quiz, etc.).

(b) Seminar / Presentation/ Minor Projects
5% or 10% weightage of Maximum Marks

Format

Department of .....
College / University ..... Address.....
Second Internal Assessment Test 20… - 20….

Class : Max. Marks : 10 Marks Semester : Duration of Exam. : Subject : Date of Examination : Topic/Paper : Name of Teacher :

Seminar /Presentation
(Based on Curriculum)

Format

Department of .....
College / University ..... Address.....
Third Internal Assessment Test 20… - 20….

Class : Max. Marks : 10 Marks Semester : Duration of Exam. : Subject : Date of Examination : Topic/Paper : Name of Teacher :

(a) Assignment:
(May be divided in parts or questions or may not be. It will be depending on the nature of assignment). **10% weightage of Maximum Marks or**
(b) Quiz:
(May be divided in parts or questions or may not be. It will be depending on the nature of quiz).
10% weightage of Maximum Marks
Or
(c) Excursion or Industrial visit or Anyother tool may be adopted for internal Assessment
10% weightage of Maximum Marks

(B)Semester or External or End Term Assessment:

70% weightage of Max Marks (*i.e.*70 Marks out of 100 Max Marks).

Duration of Examination: 3 Hours **Max. Marks: 70**

Note*: The syllabus is divided into five independent units and question paper will be divided into three sections.*

- ***Section-A*** *will carry 20 marks with one compulsory question comprising ten short answer type questions taking two questions from each unit. Each question shall be of one mark.*
- ***Section-B*** *will carry 50 marks with equally divided into five long answer type questions. Paper setter shall be advised to set two questions from each unit and students are instructed to attempt five questions by selecting one question from each unit.*

SECTION-A

Q. 1.

Unit-I

(i) …… **2 Mark**
(ii) …… **2 Mark**

Unit-II

(iii) …… **2 Mark**
(iv) …… **2 Mark**

Unit-II

(v) …… **2 Mark**
(vi) …… **2 Mark**

Unit-IV

(vii) …… **2 Mark**
(viii) ..…… **2 Mark**

Unit-V

(ix) …… **2 Mark**
(x) …… **2 Mark**

SECTION-B

Unit-I

Q. 2. ……..…… **10 Marks**

or

……....……**10Marks**

Unit-II

Q. 3. ……...…… **10 Marks**

or

……..…..…… **10 Marks**

Unit-III

Q. 4. ……..……**10 Marks**

or

……..…..…… **10 Marks**

Unit-IV

Q. 5. . ……..…..…… **10 Marks**

or

……..…….. **10 Marks**

Unit-V

Q. 6. ……....…… **10Marks**

or

……..…..…**10 Marks**

Practical Examinations: For All Lab Courses

Continuous or Internal or Mid Term Assessment: *Not applicable in practical.*

External or Semester or End Term Assessment:

Duration of Exam : 6 Hours Maximum Marks : 100 Marks*

Distribution of Maximum Marks:

S. No.	Name of Exercise	Marks
1.	Exercise No. 1 : Major Experiment	20
2.	Exercise No. 2 : Major Experiment	20
3.	Exercise No. 3 : Minor Experiment	10
4.	Exercise No. 4 : Minor Experiment	10
5.	Exercise No. 5 : Spotting Experiment(5 spots)	15
6.	Laboratory Skills, Regularity, *etc.*	10
7.	Practical Record	5
8.	Viva-voce	10
Total Marks		**100**

Seminar:

The students shall compulsorily have to deliver an oral presentation on for continuous or internal or mid-term assessment in each semester. There will not be semester or external or end-term assessment for seminar.

Dissertation:

A dissertation shall be initiated at the end of the Semester III and continued during Semester IV.A dissertation may be undertaken in any research laboratories/industries/university department. The students shall compulsorily submit the certificate of completion and report to the Department during the practical examination.The marks will be awarded by the external examiner on the day of the practical examination on the basis of the experimental,presentation and viva-voce.

Minimum Pass Marks and Rules regarding Determination of Results:

Each semester shall be regarded as a unit for working out the result of the candidates. The result of each semester examination shall be worked out separately (even if the candidate has appeared at the paper(s) of the lower semester examination alongwith the papers of higher semester examination) in accordance with the following conditions:

(i) The candidate shall be declared as pass in a semester examination, if he/she secures at least 40% marks in each theory paper separately in external & internal examinations and 50% marks in each practical paper and at least 50% marks in project/ dissertation with 50% aggregate marks in that semester.

(ii) A candidate declared as fail/absent in one or more papers at any odd semester examination shall be permitted to take admission in the next higher semester (even semester) of the same academic session.

(iii) A candidate may be promoted in the next academic session (odd semester) if he/she cleared collectively at least 50% of the papers of both semester of previous academic session with 50% of the aggregate marks. The candidate who does not fulfil the above condition will remain as an ex-student and will appear S in the due papers with next odd/even semester exams.

(iv) If any student who is provisionally admitted in higher odd semester but not secure prescribed minimum marks in previous semesters will be treated as ex-student and his/her admission fee will be carry forward to the next odd semester of forthcoming academic session.

(v) A candidate may be promoted in the next semester (odd semester) if he/she has cleared collectively at least 50% of the papers of both semesters of previous academic session with 50% of the aggregate marks. The candidate who does not fulfill this condition will remain in the same semester as an ex-student and will re-appear in the due papers examination along with next odd/even semester examinations.

(vi) If any student who is provisionally admitted in higher odd semester but could not secure prescribed minimum marks in previous semesters will be treated as ex-

student and his/her admission fee will be carry forwarded to the next odd semester of forthcoming academic session.

(vii) A candidate declared as failed in that particular paper he/she can re-appear for that paper in the next year examination as a due paper. However, the internal marks shall be carried forward for the total marks of the due examination. A candidate will not be allowed to re-appear in the practical examination.

(viii) A candidate may be given only two additional chances for passing the semester thus maximum tenure for completing the two years' postgraduate course will be limited to four years, for three years postgraduate programme up to five years and so on.

(ix) If the number of papers prescribed at the first and second or third and fourth semester examination is an odd number, it shall be increased by one for the purpose of reckoning 50% of the papers.

(x) A candidate who passes in 50% or more papers of the first and second semester examination, and thereby becomes eligible for admission to the third semester examination, but chooses not to do so and desires to appear in the remaining papers of first and second semester examination only or to re-appear in all the prescribed papers and practical/dissertation/seminar of the M.Sc. first and second semester examination will be permitted to do so on the condition that in the latter case his previous performance will be treated as cancelled.

(xi) If a candidate, who has been promoted to the next semester and wishes to improve his / her performance in the theory paper(s) of previous semester,can be permitted to do so in case of the theory papers only, not in practical / project / dissertation / seminar, belonging to the immediately preceding semesteronly for one time in these papers in next odd/even semester examinations. In such a case, he/she shall have to appear in these papers alongwith the papers of his/her own semester.

(xii) A candidate shall be declared as passed after the result of the fourth semester examination, if he/she cleared all papers of the all the four semesters and secure minimum 40% of the aggregate marks of the maximum marks in theory papers and 50% of the aggregate marks of the maximum marks for practical / dissertation / presentation / seminar prescribed for four semesters Master's programme.

(xiii) In the case of an ex-student, the marks secured by him/her at his/her last examination as a regular candidate shall be taken into account except in cases where a candidate is reappearing at the examination as a regular student and in that event, he/she shall have to repeat the internal assessment test which will be finally accounted for working out his result.

(xiv) A candidate who has failed at the M.Sc. third and fourth semester examination but has passed in at least 50% of the papers prescribed for the examination shall be exempted from re-appearing in a subsequent year in the papers in which he/she has passed.

(xv) If a candidate clears any paper(s) prescribed at the first and second semester (previous) and/or third and fourth semester (final) examination after a continuous period of three years, then for the purpose of working out his/her division, only the minimum pass marks shall be taken into account in respect of such paper(s) as are cleared after the aforesaid period provided that in case where a candidate requires more than 40% marks in order to reach the requisite minimum aggregate, as many marks out of those secured by him/her will be taken in to account as would enable him/her to make up the deficiency in the requisite minimum aggregate.

(xvi) In case the candidate is not able to clear his/her due paper(s) in the stipulated period as mentioned above (continuous period of three years), he/she may be given last one mercy attempt to clear due paper(s) subjected to approval of the Vice Chancellor or Board of Management.

(xvii) The grace marks scheme shall be applicable as per University norms.

M.Sc. Biotechnology
First Semester Examination

Paper 1.1: MBT-5101 Cell Biology and Enzyme Technology

Contact Hours / Week : 4 Hours	Maximum Marks	: 100 Marks
Duration of Examination : 3 Hours	Continuous/Internal/Assessment	: 30 Marks
	Semester Assessment	: 70 Marks

Note*: The syllabus is divided into five independent units and question paper will be divided into two sections.*

- ***Section-A*** *will carry 20 marks with one compulsory question comprising ten short answer type questions taking two questions from each unit. Each question shall be of two marks.*
- ***Section-B*** *will carry 50 marks with equally divided into five long answer type questions (answer about in 400 words). Paper setter shall be advised to set two questions from each unit and students are instructed to attempt five questions by selecting one question from each unit.*

Note: *Contents of each unit may be completed into 15-18 lectures or contact hours which also include revisions, seminars, internal assessments, etc.*

UNIT-I **15-18L**

The cell theory, Modern concepts of cell, Endosymbiont theory, overview of prokaryotic and eukaryotic cell types.

Plasma Membrane: various models of biological membrane, Membrane structure and composition: lipid bilayer, membrane carbohydrates, membrane proteins, channel proteins, carrier proteins and pumps. Study of the GERL Complex: Golgi complex, Endoplasmic reticulum and Lysosomes. Peroxisomes and Ribosome.

UNIT-II **15-18L**

Structure of Nucleus: Internal organization of Nucleosome.

Chromosome: Structure , chemical composition and function , cellular cytoskeleton. Structure and function.

Transport across memberane as active transport and simple and facilitated diffusion).

Mitochondrial and chloroplast energy transformation: ultra structure of mitochondria and chloroplasts.

UNIT-III **15-18L**

Chromosome structure and packaging of DNA. Nucleosome organization , molecular organization of centromere and telomeres .Cell cycle, Cell Cycle Regulators- Cyclin and CDKs, Mechanism of cell division: Mitosis and Meiosis. Programmed Cell Death: intrinsic and extrinsic pathways. Cancer cells and factors involved in oncogenesis.

UNIT- IV **15-18L**

Introduction of enzymes, Classification,Nomenclature,General Properties.Mechanism of enzyme action and regulation.

Steady state kinetics: Methods of estimation of rate of enzyme catalyzed reaction with special reference to Michaelis-menton kinetics. Feedback inhibition. Isozymes, ribozymes, abzymes, zymogens, multi-enzymes complexes and multifunctionalenzymes.

UNIT- V **15-18L**

Enzyme and cell immobilization.

Mechanism of enzyme function and reactions in process techniques; enzymatic bioconversions e.g., starch and sugar conversion processand various other enzyme catalytic action in food processing.

Enzymes biosensor: Principle,components and applications.

Advancement in enzyme technology. Diagnostic importance of enzymes.

Reference Books:

1. The World of the Cell:Becker ,Kleinsmith and Hardin.
2. Cell and molecular biology: GeraldKarp.
3. Cell and molecular biology: P.K.Gupta.
4. Molecular cell biology: By Lodish.
5. The Cell: Cooper.
6. Molecular biology of the cell: Bruce Alberts.
7. Enzymology and Enzyme Technology: S M Bhatt.
8. Enzyme Technology- M F Chaplin and D CBucks
9. Industrial Enzymology- Godfrey and West
10. Enzyme –Copeland
11. Enzyme in Industry – W.Gerhartz
12. Principles of Biochemistry. Ed Lehninger, Nelson and Cox. CBS publishersanddistributors.
13. Biochemistry. Ed Donald Voet and Judith G. Voet. John Wiley &sons,Inc.

Paper-1.2 MBT-5102 General Microbiology

Contact Hours / Week : 4 Hours Maximum Marks : 100 Marks

Duration of Examination : 3 Hours Continuous/Internal/Assessment : 30 Marks
Semester Assessment : 70 Marks

Note*: The syllabus is divided into five independent units and question paper will be divided into two sections.*

- ***Section-A*** *will carry 20 marks with one compulsory question comprising ten short answer type questions taking two questions from each unit. Each question shall be of two marks.*

M.Sc. Biotechnology

First Semester Examination

Section-B *will carry 50 marks with equally divided into five long answer type. Paper setter shall be advised to set two questions from each unit and students are instructed to attempt five questions by selecting one question from each unit.*

Note: *Contents of each unit may be completed into 15-18 lectures or contact hours which also include revisions, seminars, internal assessments, etc.*

UNIT I **15-18L**

Introduction, History of Microbiology, Contribution of Antony Von Leeuwenhoek, Louis Pasture, Robert Koch, Louis pasteur, Alexander Flemming, Edward Jenner etc

Classification of microorganisms – Haeckel's three kingdom concept, Whittaker's five kingdom concept, Classification and salient features of bacteria according to the Bergey's manual of determinative bacteriology. Classification of microbes on the basis of phenotypic and genotypic characters. Prokaryotic and Eukaryotic diversity, Ribosomal Database Project.

UNIT II **15-18L**

Staining techniques: Stains and Dyes (Simple, Gram, Negative, Capsule, Endospore, Acid fast)
Sterilization and Disinfection (Physical and Chemical methods)
Isolation Techniques, Culture Media,Types of Media

UNIT III **15-18L**

General account of classification, ultrastructure, nutrition, reproduction, biology and economic importance of Archaebacteria, Eubacteria, Cyanobacteria, Actinomycetes and Fungi. General account of L- forms, Mycoplasma, Phytoplasma, Spiroplasma, Ureoplasma& Rickettsiae.

Study of Viruses: General structure and properties of viruses, reproduction, purification and assay, prions, Viroids and retro viruses

UNIT IV **15-18L**

Bacteriophage: Structure and life cycle

Bacterial morphology, Bacterial Growth: Growth curve and its kinetics and growth yield, growth synchronization. Environmental factors affecting growth. Culture Collection and preservation

Microbial metabolism: Phototrophy, chemolithotrophy, anaerobic respiration, fermentation, methanogens, biological nitrogen fixation.

UNIT V

15-18L

Microbial diseases: Food and water borne disease, Anthrax, Tuberculosis, Covid-19, AIDS, Influenza, cutaneous and systemic mycoses, Malaria.

Antimicrobial drugs: General Characteristics, Antibacterial (Classification and mode of action), antifungal and antiviral.

Text/Reference books:

1. Pelczar, M.J. Chan, ECS and Kreig, NR (2004) , Microbiology. Tata Mc Graw Hill.
2. Microbes: Concepts & Applications- P.S. Bisen, Mousumi Debnath, Godavarthi B.K.S. Prasad, John Wiley & Sons Publication 2012
3. Salle, AJ (1999) Fundamental principles of Bacteriology. Tata Mc Graw Hill publication.
4. Bergey`s manual of systematic bacteriology. George M. Garrity, David R. Boone, Richard W. Castenholz.
5. Brock Biology of Microorganisms, 14th Edition. Michael T. Madigan, John M. Martinko, Paul V. Dunlap and David P. Clark.
6. Prescott, L.M., J.P Harley and D.AKlein, 2007. Microbiology VII Ed.McGrowHill,
7. Benson, HJ (1999) Microbiological application (A laboratory manual in general Microbiology) William C Brown Publishers.
8. Stainer. General Microbiology, V Ed., Printice Hall of India Pvt, Ltd. New Delhi
9. Ronald M. Atlas 1997. Principles of Microbiology. II Ed. Mc Graw HillPub.
10. P D sharma (2019) Microbiology . Rastogi publication.
11. Srivastava, S and Srivastava P S. (2003) Understanding bacteria, Kiuwer Academic publisher Dordecht.

Paper-1.3 MBT-5103 Bio-Instrumentation

Contact Hours / Week	: 4 Hours	Maximum Marks	: 100 Marks
Duration of Examination	: 3 Hours	Continuous/Internal/Assessment	: 30 Marks
		Semester Assessment	: 70 Marks

Note*: The syllabus is divided into five independent units and question paper will be divided into two sections.*

- ***Section-A*** *will carry 20 marks with one compulsory question comprising ten short answer type questions taking two questions from each unit. Each question shall be of two marks.*
- ***Section-B*** *will carry 50 marks with equally divided into five long answer type.. Paper setter shall be advised to set two questions from each unit and students are instructed to attempt five questions by selecting one question from each unit.*

Note: *Contents of each unit may be completed into 15-18 lectures or contact hours which also include revisions, seminars, internal assessments, etc.*

UNIT-I **15-18L**

Microscopy: Microscopes types, use of techniques of preparing specimens, resolving power, optical microscope-Basic idea of light microscopy, Types- bright field, dark field, ultra-violet, fluorescence and phase-contrast microscopes, confocal microscopy Electron microscope: TEM, SEM.

Microtomy and sample preparation for microscopy.

M.Sc. Biotechnology

First Semester Examination

UNIT – II **15-18L**

Centrifugation techniques: - Differential, gradient, zonal or band and isopycnic density gradient centrifugation.

Chromatography: principle and procedure of absorption, column, thin layer (TLC), partition, and gas-liquid, ion-exchange chromatography.

UNIT – III **15-18L**

Electrophoresis: Principle, equipment and procedure of various types:Pulse field GE, Denaturing gradient GE, Temperature gradient GE, SDS-PAGE electrophoresis, Iso- electric focusing,

Nucleic acid hybridizations Technique: colony, plaque, dot blot, southern, northern and western blotting. *Insitu*hybridization, Microarray technology.

UNIT- IV **15-18L**

DNA sequencing techniques: Sanger-Coulson method, Maxam Gilbert method and next generation sequencing.

Polymerized Chain Reaction: PCR -steps, Types of PCR and its applications.

Spectroscopy: Laws of absorption, Principles, instrumentation and applications of colorimetry, UV-visible spectroscopy.

UNIT- V **15-18L**

Principles, instrumentation and applications: Infrared Spectroscopy,fluorescence Spectroscopy, NMR, ESR., Mass Spectroscopy (types of ion source, analyzers and detectors), GC-MS, X Ray Microanalysis.

Techniques with radioisotopes: GM counter, Scintillationcounter,Autoradiography, RIA.

Text/Reference

1. Introduction to Instrumentation in Life Science. P.S. Bisen & Anjana Sharma. 2013. CRCPress. Tylor & Francis group.
2. Wilson K. And Walker J. (2008). Principal and Techniques of Biochemistry and Molecular Biology. Cambridge University Press.
3. Molecular Diagnostics: Promises & Possibilities 2010. MousuniDabnath, G.B.K.S. Prasad P.S. Bisen.
4. Nelson D and Cox MM(2009). Principal of Biochemistry. W.H. Freeman and Company, New York.
5. Voet D and Voet JG. (2003). Biochemistry. Jhon Wiley and sons New York.
6. Zubay G (2003). Biochemistry. W.C. Brown, New York.
7. Life Science in tools and Techniques: P.S Bisen and Shruti Mathur, S Chand Publication
8. Berg J, Tymoczko J, StryerL(2001). Biochemistry W.H. Freeman, New York.
9. Nuclear Magnetic Resonance: Williams.
10. A Biologist Guide to Principal and techniques: Williams K. and Gounding K.H.
11. Biochemical Techniques theory and practice: White R.

12. Molecular biotechnology- Glick.
13. An Introduction to practical Biochemistry. Plummer D.T.
14. Bioinstrumentation by Merit,Vivaladi and Deen.
15. Bioinstrumentation , M.H. Fulaker, Bhawana Pandey, Dreamtech press.
16. Understanding Bioinstrumentation M, Praakash , Discovering Publishing Private Limited ,2009

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First Semester Examination

Paper-1.4 MBT-5104 Fundamentals of Biochemistry

Contact Hours / Week	: 4 Hours	Maximum Marks	: 100 Marks
Duration of Examination	: 3 Hours	Continuous/Internal/Assessment	: 30 Marks
		Semester Assessment	: 70 Marks

Note*: The syllabus is divided into five independent units and question paper will be divided into two sections.*

- ***Section-A*** *will carry 20 marks with one compulsory question comprising ten short answer type questions taking two questions from each unit. Each question shall be of two marks.*
- ***Section-B*** *will carry 50 marks with equally divided into five long answer type. Paper setter shall be advised to set two questions from each unit and students are instructed to attempt five questions by selecting one question from each unit.*

Note: *Contents of each unit may be completed into 15-18 lectures or contact hours which also include revisions, seminars, internal assessments, etc.*

UNIT- I **15-18L**

Covalent, Non-Covalent, hydrophilic and hydrophobic interaction and their influence on structure of biomolecules. Acid, bases, pH, pk, and ionization of water and Buffers.Henderson-Hasselbalch equation

High energy phosphate compounds: Introduction, Phosphate group transfer free energy of hydrolysis of ATP and sugar phosphate, Concepts of bioenergetics. First and second law of thermodynamics. Gibb's free energy.

UNIT-II **15-18L**

Carbohydrates: Classification, characteristics and functions. Reactions of carbohydrates, Isomerism of carbohydrates, Fischer projections, Haworth structures.

Carbohydrate Metabolism: Introduction, Glycogenolysis, Gluconeogenesis, Glycolysis.TCA cycle, Electron Transport chain, Oxidative phosphorylation.

UNIT-III15-18L

Lipids-Introduction, Sources, Nomenclature,Classification. Properties and Functions.

Lipid Metabolism- Biodegradation of fatty acids,beta – oxidations of fatty acids

Biosynthesis of fatty acids – phospholipids,sphigolipidsand Cholestrol.

UNIT- IV **15-18L**

Amino Acid Metabolism- Overview of amino acid metabolism, Biodegradation of amino acids – deamination, transamination, decarboxylation, glutamine and glutamic acid pathway, urea cycle, uric acid synthesis. Protein structure (primary, secondary, tertiary and quaternary). Ramachandran plot.

UNIT- V **15-18L**

Structure, composition and properties of Nucleic acid, Biosynthesis and degradation of Purines and Pyrimidines.Biodegradation of Purines and Pyrimidine, Water and Fatsoluble Vitamins; Distribution, interaction and functions

Text/Reference books:

1. Wilson K. and Walker J. (2008). Principles and Techniques of Biochemistryand Molecular Biology. Cambridge UniversityPress.
2. Nelson D and Cox MM. (2009). Principles of Biochemistry. W.H. Freemanand Company, NewYork.
3. Voet D and Voet JG. (2003). Biochemistry. John Wiley and Sons NewYork.
4. Zubay G (2000). Biochemistry. W. C. Brown, NewYork.
5. Berg J, Tymoczko J, Stryer L (2001). Biochemistry. W. H. Freeman, NewYork.
6. Robert K., Murray M.D., Granner D.K., Mayes P.A.and Rodwell V.I.Harper's Biochemistry. McGraw-Hill/Appleton andLange.
7. Biochemistry:-Pankaja Nayak.
8. Biochemistry:-Lehninger
9. Fundamental of Biochemistry:-A.C.Dev.
10. Biochemistry: - J.L. Jain.
11. Elements of Biochemistry :- H.R.Shrivastava.
12. Essentials of Biochemistry:- Pankaja Naik
13. Instrument method of Analysis :- Dean John A

First Semester Examination
Paper 1.5 MBT 5105 Lab Course-I

Practical Exercises

1. Mitosis in onion root tip cells.
2. Meiosis in anther.
3. Study of mitosis and meiosis from permanents slides.
4. Study of cell biology techniques.
5. Urease estimation by titrimetric method.
6. Urease estimation by colorimetric method.
7. Acid Phosphatase estimation.
8. Alkaline Phosphatase estimation.
9. Estimation of amylase.
10. Study of enzyme kinetics – calculation of *V*max, Km, Kcat values.
11. Applications of enzymes.
12. Immobilization of *Saccharomycescerevisiae*.
13. Microscopy: simple, compound, Dark Field, phase contrast.
14. Micrometry: Calibration of stage and Occularmicrometer and measurement of the given biologicalsample
15. Cleanliness, media preparation, sterilization, culture methods, dilution techniquesin microbiology.
16. Staining techniques in microbiology i) Flagella staining ii) Negativestaining iii) Spore staining iv) Capsule staining. (v) Lactophenol blue.
17. Isolation of pure culture- Serial Dilution, Pour, Spread,Streak.
18. To learn culture preservation techniques (Agar slants, stabs and glycerol stocks).
19. Identification of unknown bacteria by biochemicaltests-IMVIC, Catalase test, starch hydrolysis.
20. Bacterial growth curve-serial dilution, plating and turbiditymeasurement.
21. Antibiotics Sensitivitytest.
22. Standard qualitative analysis of water(microorganisms).

First Semester Examination
Paper 1.6 MBT 5106Lab Course-II

Practical Exercises

1. Ion exchange and gel filtration chromatography.
2. Separation of subcellular organelles by differential centrifugation.
3. Separation of blood cells by density gradient centrifugation.
4. Polyacrylamide gel electrophoresis of proteins.
5. To perform PCR for amplification of target DNA segment (or gene).
6. Electrophoretic separation of DNA in agarose gel.

7. SDS PAGE for protein separation.
8. Southern BlottingTechniques.
9. Restriction Digestion.
10. Demonstration of DNA fingerprinting.
11. Preparation of reagents, buffers and solutions.pH meter: Buffering capacity of a buffer, indicators. To determine the pKavalueand hence the dissociation constant of a given acid by using pHmeter.
12. Estimation of protein: Lowry, Biuret and Bradford methods, standard curveslinear regression and assessment of ranges and reliability.
13. Estimation of reducing sugar by DNS method.
14. Protein purification: Ammonium sulphate, acetone, TCA pptn. Dialysis concentration.
15. Thin layer chromatography: amino acids lipids, mixture ofdyes.
16. Chlorophyll-a concentration measurement with acetone methodusing spectrophotometer.
17. Spectrophotometry: To find out absorption spectrum of given chromophore and/or oxidised and reduced forms (NAD andNADH).
18. Colorimetry: To determine the association constant of given indicator calorimetrically and to prepare the buffer solutions in pH range of 2.2 to 8.0.
19. To estimate total hardness of water
20. To estimate Calcium hardness of water
21. To estimate the total solids (Ts), total dissolved solids (TDS) and suspended solids (SS) in the given water sample

Second Semester Examination

Paper-2.1: MBT-5201 Fundamentals of Molecular Biology

Contact Hours / Week	: 4 Hours	Maximum Marks	: 100 Marks
Duration of Examination	: 3 Hours	Continuous/Internal/Assessment	: 30 Marks
		Semester Assessment	: 70 Marks

Note*: The syllabus is divided into five independent units and question paper will be divided into two sections.*

- ***Section-A*** *will carry 20 marks with one compulsory question comprising ten short answer type questions taking two questions from each unit. Each question shall be of two marks.*
- ***Section-B*** *will carry 50 marks with equally divided into five long answer type. Paper setter shall be advised to set two questions from each unit and students are instructed to attempt five questions by selecting one question from each unit.*

Note: *Contents of each unit may be completed into 15-18 lectures or contact hours which also include revisions, seminars, internal assessments, etc.*

UNIT- I **15-18L**

Genetic Material: Structure, chemical composition and organization. Central Dogma Difference between euchromatin and heterochromatin. DNA super coiling, Different forms

of DNA. Repetitive DNA and satellite DNA. Experimental proof of DNA as genetic material. Mutation- Types and various mutagens.

UNIT- II **15-18L**

DNA replication in prokaryotes and eukaryotes-Initiation, elongation, termination, fidelity of replication, enzymology of replication. Regulation at replication level. Chromosome walking, extrachromosomal replicons, DNA repair- enzymes; Photoreactivation; Nucleotide excision repair; Mismatch correction; SOS repair; Non-homologous end joining; Recombination: Homologous.

UNIT- III **15-18L**

Transcription: transcription in prokaryotes and eukaryotes- Initiation, elongation and termination. Transcription factors and machinery, transcription activator and repressor. RNA processing-capping, splicing and polyadenylation, RNA editing Structure and function of different types of RNA, RNA transport. Ribozymes

UNIT- IV **15-18L**

Translation machinery; Ribosomes; Features of genetic code. Proteins Synthesis: Mechanism of translation in Prokaryotes and Eukaryotes–initiation, elongation, termination. Transposons – Transposable Elements, Classification of Transposons, Types.

UNIT- V **15-18L**

Gene Regulation: Prokaryotic Gene Regulatory Mechanism; Operon concept: Lac and Trp operons. Gene Regulation in Eukaryotes – Attenuation control, Regulation by DNA Methylation, Transcription Factors, Enhancer Element.

Text/Reference books:

1. Molecular Biology of the Gene:Watson-Baker-Bell-Gann- Levine-Losick,PearsonEducation
2. Molecular Biology: D. Freifelder, Narosa Publishing House, NewDelhi
3. Genome: T.A. Brown, John Wiley &Sons
4. Microbial Genetics: Freifelder, Narosa Publishing House, NewDelhi
5. Gene VII: Lewin Benjamin(Oxford)
6. Molecular Cell Biology: J.Darnell, H.Lodhis&D.Baltimore (W.H.Freeman&Co.)
7. DNA Repair and Mutagenesis: E.C.Friedberg, G.C.Walker and W. Seide (ASMPublisher)
8. Molecular Biotechnology: S.B.Primrose
9. Molecular Biotechnology:Glick
10. Lodish , H *et al* (2012) molecular cell biology (1st edition) Benjamin cummings publication, USA

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Second Semester Examination

Paper-2.2 MBT-5202 Basic Plant and Animal Tissue Culture

Contact Hours / Week	: 4 Hours	Maximum Marks	: 100 Marks
Duration of Examination	: 3 Hours	Continuous/Internal/Assessment	: 30 Marks
		Semester Assessment	: 70 Marks

Note*: The syllabus is divided into five independent units and question paper will be divided into two sections.*

- ***Section-A*** *will carry 20 marks with one compulsory question comprising ten short answer type questions taking two questions from each unit. Each question shall be of two marks.*
- ***Section-B*** *will carry 50 marks with equally divided into five long answer type. Paper setter shall be advised to set two questions from each unit and students are instructed to attempt five questions by selecting one question from each unit.*

Note: *Contents of each unit may be completed into 15-18 lectures or contact hours which also include revisions, seminars, internal assessments, etc.*

UNIT-I **15-18L**

Plant Transformation Technology: Features of Ti and Ri plasmid; mechanisms of T- DNA transfer, role of virulence genes; Vectors engineered from Ti plasmid, practical applications of *Agrobacterium* mediated gene transfer, Direct DNA transfer (particle bombardment, electroporation, microinjection) Transgene stability and gene silencing.

UNIT-II **15-18L**

Application of plant transformation for productivity and performance: herbicide resistance, insect resistance with special reference to Bt genes, virus resistance, Use of antisense technology to prevent post-harvest losses and prolonging shelf-life of fruits (Flavr Savr tomato)and flowers, Production of vaccines/ plantibodies in GM plants, Terminator gene technology, Applications of genome editing.

UNIT-III **15-18L**

Scaling up of cell cultures, measurement of viability and cytotoxicity, cell synchronization, bioreactors for animal cell cultures, scale up in monolayers, microencapsulation.

UNIT-IV **15-18L**

Stem cell: Embryo stem cells and their application., Apoptosis, measurement of cell death, animal cloning and micromanipulation, Mapping of genome and genome sequencing. Marker assisted selection. Gene banking.

UNIT-V **15-18L**

Application of Animal tissue culture- Cell culture-based vaccines, Ribozymes, Tissue engineering. Safety measures, hazards and ethics of animal cell culture. Biotechnological application in animal improvements (transgenic goat, sheep, mice, cattle,fishetc), *in vivo* and *in vitro* embryo production and preservation, DNA based diagnosis of genetic diseases, Human somatic cell gene therapy.

Reference books:

1. Plant cell, tissue and organ culture, applied and fundamental aspects by Y.P.S. Bajaj and A. Reinhard.
2. Plant Tissue Culture by MK Razdan & SS Bhojwani (1996) Elsevier
3. Plant Biotechnology by H.S.Chawla.
4. Plant Biotechnology and Transgenic Plants, Edited by KirsiMarjaOksman-Caldentey, Wolfgang Barz Marcel Dekker 2002
5. Plant Tissue Culture Concepts and Laboratory Exercises, Second Edition, Robert N Trigiano, Dennis J Gray, CRC Press November 1999.
6. Modern Concepts of Biotechnology H.D. Kumar Vikas Publishing House Pvt. Ltd., New Delhi.
7. Butler. M 2014, Animal Cell Biotechnology-Methods & Protocol (Portner, R ed.) Springer.
8. Practical animal breeding. Blackwell Science.
9. Houdebine L.M. Animal transgenesis and cloning. Wiley Publishers.
10. Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications" by R. Ian Freshney
11. Plant Tissue Culture, Animal Tissue Culture, Immunology-A Laboratory Manual by Neerja Srivastava and Satish kumarsharma, laxmj publication private lmt.
12. 12 Animal Cell Culture: Concept And Application" by S M Bhatt, Narosa publication house,(2011)

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Second Semester Examination
Paper -2.3: MBT-5203 Immunology and Immuno-technology

Contact Hours / Week	: 4 Hours	Maximum Marks	: 100 Marks
Duration of Examination	: 3 Hours	Continuous/Internal/Assessment	: 30 Marks
		Semester Assessment	: 70 Marks

Note*: The syllabus is divided into five independent units and question paper will be divided into two sections.*

- ***Section-A*** *will carry 20 marks with one compulsory question comprising ten short answer type questions taking two questions from each unit. Each question shall be of two marks.*

- ***Section-B*** *will carry 50 marks with equally divided into five long answer type. Paper setter shall be advised to set two questions from each unit and students are instructed to attempt five questions by selecting one question from each unit.*

Note: *Contents of each unit may be completed into 15-18 lectures or contact hours which also include revisions, seminars, internal assessments, etc.*

UNIT-I **15-18L**

Cells of immune system and organs of the immune system.
Types of the Immunity - Innate and adaptive, Humoral and cell mediated, Active and passive immunization.
Antigens: Structure and properties, Types, haptens, adjuvants, antigen specificity, antigenic determinants, super antigens.

UNIT-II **15-18L**

Immunoglobulins-basic structure, classes and subclasses of immunoglobulins.
Complement system: Structure, complement pathways and biological consequence of complement activation.
Hybridoma Technology: Monoclonal antibodies production. Antibody engineering: Chimeric and Humanized monoclonal antibodies
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UNIT-III
15.18₹

Secondary Immune Response; Generation of Humoral Immune Response (Plasma and Memory cells); Generation of Cell Mediated Immune Response (Self MHC restriction, T cell activation, Co- stimulatory signals).
Major Histocompatibility Complex (MHC), HLA typing
Hypersensitivity reactions- Type I- Anaphylaxis. Type II- Antibody dependent cell cytotoxicity. Type III- Immune complex mediated reactions. Type IV-Cell mediated hypersensitivity reactions.

UNIT-IV **15-18L**

Vaccines and its types **(**Live, Attenuated, Inactivated, Subunit, Toxoid**).**
Tumour Immunology: Tumor specific antigens. Immune response to tumors.
Cytokines : Properties and their role in immune regulation.

UNIT-V **15-18L**

Antigen- Antibody interaction - Agglutination, Precipitation, Immunofluorescence, ELISA, Radioimmunoassays, Western blotting, Cell cytotoxic assay
Autoimmunity: Autoimmune diseases (Addison's disease, Grave's disease, Hashimoto's thyroiditis, rheumatoid arthritis. Systemic Lupus erythematosus).

Text/Reference books:

1. Essentials of Immunology, Author- Roitt, I.M., ELBS. Blackwell Scientific Publishers, London.
2. Immunology II Edition, Author- Kuby, J. WH., Freemanand Company, NewYork.
3. Immunology. Author- Klaus D. Elgert,Wiley-Liss. NY.

4. Text Book on Principles of Bacteriology, Virology and Immunology, IX Edition (5 volumes). Authors- Topley and Wilson's, Edward Arnold,London.
5. The Experimental Foundations of Modern Immunology. Authors- Clark, V.R., John Willey andSons,Incl.
6. Fundamental Immunology. Author – W.E. Paul, Raven Press, NewYork.
7. Fundamentals of Immunology. Authors – R.M. Coleman, M.F. Lombord and R.E. Sicard 2nded. C. Brownpublishers.
8. Immunology. Authors – D.M. Weir and J. Steward 7thEd. (1993).
9. Immunology : Shailendra Sharma.
10. Immunology: C.V.Rao.
11. Immonology and Immunotechnology: ASHIM K. CHAKRAVARTY

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Second Semester Examination

Paper 2.4 MBT-5204 Genetic Engineering and its Application

Contact Hours / Week	: 4 Hours	Maximum Marks	: 100 Marks
Duration of Examination	: 3 Hours	Continuous/Internal/Assessment	: 30 Marks
		Semester Assessment	: 70 Marks

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- ***Section-A*** *will carry 20 marks with one compulsory question comprising ten short answer type questions taking two questions from each unit. Each question shall be of two marks.*
- ***Section-B*** *will carry 50 marks with equally divided into five long answer type. Paper setter shall be advised to set two questions from each unit and students are instructed to attempt five questions by selecting one question from each unit.*

Note: *Contents of each unit may be completed into 15-18 lectures or contact hours which also include revisions, seminars, internal assessments, etc.*

Unit -I **15-18L**

Genetic engineering tools and their applications: Restriction-modification system & different enzymes, Gene Cloning Vectors- Plasmids, bacteriophages, phagemids, cosmids. Artificial chromosome vectors (YAC, BAC), virus derived vectors-SV40, M13, retroviral vectors.

UNIT- II **15-18L**

Gene manipulation: cDNA Synthesis and its Cloning; mRNA enrichment, DNA primers, linkers and adaptors, Library (cDNA and Genomic) construction and screening. Alternative Strategies of Gene Cloning- Two and three hybrid systems, cloning of genes in expression vectors, Microarray Technology.

UNIT-III **15-18L**

Protein Engineering and Processing of Recombinant proteins - Directed Mutagenesis-Oligo- nucleotide with M13 DNA, PCR, PCR amplified oligo-nucleotide and Random mutagenesis. Protein Engineering: adding disulfide bonds, reducing number of free sulfhydryl residues, changing amino-acids, increasing and modifying enzymatic activity.

UNIT- IV **15-18L**

Processing of Recombinant proteins: Purification and refolding. Characterization of recombinant proteins, stabilization of proteins, DNA markers Molecular marker: RAPD, RFLP, AFLP, ISR, SNP. Omics Technology: Genomics, transcriptomics, proteomics, metabolomics.

UNIT- V **15-18L**

Application of genetic engineering – GMO, Transgenic animals, Transgenic Plants, Recombinant pharmaceuticals, Gene knockout technology

Gene Therapy- Vector Engineering, DNA fingerprinting, Human genome project, Antisense technology, Nanotechnology, Stem cell technology

Text/Reference books:

1. Molecular Biology of the Gene: Watson-Baker-Bell-Gann-Levine-Losick, 5thEdn., Pearsoneducation
2. Molecular Biology: D. Freifelder, Narosa Publishing House, NewDelhi
3. Genome: T.A. Brown, John Wiley &Sons
4. Microbial Genetics: D. Freifelder, Narosa Publishing House, NewDelhi
5. Gene VII: Lewin Benjamin(Oxford)
6. Molecular Cell Biology: J.Darnell, H.Lodhis&D.Baltimore (W.H.Freeman&Co.)
7. DNA Repair & Mutagenesis: E.C.Friedberg, G.C.Walker and W. Seide (ASMPublisher)

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Second Semester Examination
Paper 2.5MBT 5205 -Lab Course-III
Practical Exercises

1. Isolation of total DNA.
2. Isolation of plasmid and its quantification.
3. Preparation of competent cells

4. To induce mutation by UV radiations and to exhibit DNA repair by photo reactivation.
5. To isolate and produce UV induced auxotrophic mutants by replica plating method.
6. To perform Ames test for detecting carcinogen or mutagen.
7. Quantification of DNA by DPA method.
8. Quantification of RNA by Orsinol method
9. To check purity and quantity of DNA by Spectrophotometric method.
10. Preparation of competent cells.
11. Sterilization techniques: Washing of glassware, dry and steam sterilization.
12. Preparation of culture Media. Stock solutions for MS media.
13. Micro propagation techniques. Hardening and transfer of plants to soil 14.Surface sterilization and Organ culture. Ovary culture
15. Study of somatic embryogenesis.
16. Anther culture, production of Haploids.
17. Demonstration of protoplast fusion employing PEG
18. To study the development and maintenance of animal cell line.
19. Studying cell death and cytotoxicity by staining methods
20. Differentiation of the viable and nonviable cell by staining methods.
21. Introduction to culture environment, medium and culture vesselsfor animal cell culture.
22. Preparation of culture media and concept of sterilization in animal cell culture. 23. Demonstration of establishment of primary cell culture by trypsinization 24.Identification of cell types by maceration method.
25.Preparation of metaphase chromosome from cultured cells.

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Second Semester Examination
Paper 2.6MBT 5206-Lab Course-IV

Practical Exercises

1. Antibody titre by ELISA method.
2. Double diffusion, Immuno-electrophoresis and Radial Immuno-diffusion.
3. Immunoblotting, Dot Elisa assays
4. Blood smear identification of leucocytes by Giemsa stain.
5. Separation of leucocytes.
6. Blood group typing.
7. Blood film preparation and identification of cells.
8. MIC assay – Kirby Bauer method.
9. Isolation of serum from whole blood.
10. Bacterial culture and antibiotic selection media.
11. Isolation of plasmid DNA.

12. Isolation of phage DNA.
13. Restriction mapping of Plasmid DNA.
14. Cloning in Vectors.
15. PCR.
16. To study the production of transgenic crops for disease resistance.
17. To study the genetically modified crop plants production &theirusefulness.
18. Restriction endonuclease digestions and separation of fragments.
19. RFLP analysis
20. Biosynthesis of nanoparticles.
21. Use to nanobiotechnology in various fields.

M.Sc. Biotechnology

Third Semester Examination

Paper3.1 MBT-6301– Applied Plant and Animal Biotechnology

Contact Hours / Week	: 4 Hours	Maximum Marks	: 100 Marks
Duration of Examination	: 3 Hours	Continuous/Internal/Assessment	: 30 Marks
		Semester Assessment	: 70 Marks

Note*: The syllabus is divided into five independent units and question paper will be divided into two sections.*

- ***Section-A*** *will carry 20 marks with one compulsory question comprising ten short answer type questions taking two questions from each unit. Each question shall be of two marks.*
- ***Section-B*** *will carry 50 marks with equally divided into five long answer type. Paper setter shall be advised to set two questions from each unit and students are instructed to attempt five questions by selecting one question from each unit.*

Note: *Contents of each unit may be completed into 15-18 lectures or contact hours which also include revisions, seminars, internal assessments, etc.*

UNIT-I **15-18L**

Plant Transformation Technology: Features of Ti and Ri plasmid; mechanisms of T- DNA transfer, role of virulence genes; Vectors engineered from Ti plasmid, practical applications of *Agrobacterium* mediated gene transfer, Direct DNA transfer (particle bombardment, electroporation, microinjection) Transgene stability and gene silencing.

UNIT-II **15-18L**

Application of plant transformation for productivity and performance: herbicide resistance, insect resistance with special reference to Bt genes, virus resistance, Use of antisense technology to prevent post-harvest losses and prolonging shelf-life of fruits (Flavr Savr tomato) and flowers, Production of vaccines/ plantibodies in GM plants, Terminator gene technology, Applications of genome editing.

UNIT-III **15-18L**

Scaling up of cell cultures, measurement of viability and cytotoxicity, cell synchronization, bioreactors for animal cell cultures, scale up in monolayers, microencapsulation.

UNIT-IV **15-18L**

Stem cell: Embryo stem cells and their application., Apoptosis, measurement of cell death, animal cloning and micromanipulation, Mapping of genome and genome sequencing. Marker assisted selection. Gene banking.

UNIT-V **15-18L**

Application of Animal tissue culture- Cell culture-based vaccines, Ribozymes, Tissue engineering. Safety measures, hazards and ethics of animal cell culture. Biotechnological application in animal improvements (transgenic goat, sheep, mice, cattle,fishetc), *in vivo* and *in vitro* embryo production and preservation, DNA based diagnosis of genetic diseases, Human somatic cell gene therapy.

Reference books:

1. Plant cell, tissue and organ culture, applied and fundamental aspects by Y.P.S. Bajaj
   a. and A. Reinhard.
2. Plant Tissue Culture by MK Razdan & SS Bhojwani (1996) Elsevier
3. Plant Biotechnology by H.S.Chawla.
4. Plant Biotechnology and Transgenic Plants, Edited by KirsiMarja Oksman-Caldentey,
5. Wolfgang Barz Marcel Dekker 2002
6. Plant Tissue Culture Concepts and Laboratory Exercises, Second Edition, Robert N Trigiano, Dennis J Gray, CRC Press November 1999.
7. Modern Concepts of Biotechnology H.D. Kumar Vikas Publishing House Pvt. Ltd., New Delhi.
8. Butler. M 2014, Animal Cell Biotechnology-Methods & Protocol (Portner, R ed.) Springer.
9. Practical animal breeding. Blackwell Science.
10. Houdebine L.M. Animal transgenesis and cloning. Wiley Publishers.
11. Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications" by R. Ian Freshney
12. Plant Tissue Culture, Animal Tissue Culture, Immunology-A Laboratory Manual by Neerja Srivastava and Satish kumarsharma, laxmj publication private lmt.
13. Animal Cell Culture: Concept And Application" by S M Bhatt, Narosa publication house,(2011)

M.Sc. Biotechnology

Second Semester Examination

Paper-2.2 MBT-6302 -Fermentation Technology,Biosafety and IPR

Contact Hours / Week	: 4 Hours	Maximum Marks	: 100 Marks
Duration of Examination	: 3 Hours	Continuous/Internal/Assessment	: 30 Marks
		Semester Assessment	: 70 Marks

Note*: The syllabus is divided into five independent units and question paper will be divided into two sections.*

- ***Section-A*** *will carry 20 marks with one compulsory question comprising ten short answer type questions taking two questions from each unit. Each question shall be of two marks.*
- ***Section-B*** *will carry 50 marks with equally divided into five long answer type. Paper setter shall be advised to set two questions from each unit and students are instructed to attempt five questions by selecting one question from each unit.*

Note: *Contents of each unit may be completed into 15-18 lectures or contact hours which also include revisions, seminars, internal assessments, etc.*

UNIT-I **15-18L**

Isolation, screening, preservation and maintenance of industrial microorganisms. Novel microbes for future industry. Isolation and screening of the industrially important strain from diverse ecosystem. Method of strain improvement, mutagenesis, strain breeding by protoplast fusion, sexual and para sexual recombination. Microbial growth and death kinetics. Media for industrial fermentation: Input economizing, carbon, nitrogen, mineral sources, buffers, precursors, inhibitors, inducers and antifoam agents.

UNIT-II **15-18L**

Basic design and operation of a microbial fermentor. Types of Fermenters. Basic principles of scale –up. Analysis of mixed microbial populations, Industrial sterilization process for media, air and equipment

Concept of submerged, surface, solid state fermentation, Batch and continuous Fermentations.

UNIT-III **15-18L**

Downstream processing: Biomass separation by centrifugation, filtration, flocculation and other recent developments.

Cell disintegration: Physical, chemical and enzymatic methods, Extraction: Solvent, two phase, liquid extraction, whole broth, aqueous multiphase extraction. Purification by different methods. Concentration by precipitation, ultra-filtration, reverse osmosis. Drying and crystallization.

UNIT-IV **15-18L**

Introduction to biosafety: Biosafety issues in biotechnology – risk assessment and risk management – safety protocols: risk groups – biosafety levels – biosafety guidelines and regulations (National and International), types of biosafety containment. The cartagena protocol on biosafety, Benefits and risks of genetic engineering, ethical aspects of genetic testing, ethical aspects relating to use of genetic information, genetic engineering and biowarfare, GM crops and GMO's and biopiracy

UNIT-V **15-18L**

Introduction to intellectual property and intellectual property rights: Types, patents, copy rights, trade secrets and trademarks, design rights, geographical indications, Importance of IPR Patent claims, the legal decision-making process. Basic requirement of patentability,

Special issues in Biotechnology Patent: Disclosure Recruitment, Ethical issues, Plant Biotechnology-UPOV and Plant breeder's rights, case studies/experiences from developing and developed countries, IPR issues in the Indian context.

Reference Books

1. Sullia S. B & Shantharam S: (1998) General Microbiology, Oxford & IBH Publishing Co. Pvt. Ltd.
2. Glaser A.N &Nilaido.H (1995) Microbial Biotechnology,W.H Freeman & Co.
3. Prescott & Dunn (1987) Industrial Microbiology 4th Edition, CBSPublishers&Distributors.
4. Crueger W. &Crueger A. (2000) A text of Industrial Microbiology, 2nd Edition, Panima Publishing Corp.
5. Stanbury P.F, Ehitaker H, Hall S.J (1997) Principle's of Fermentation Technology, Aditya Books (P) Ltd.

6S.N.Jogdan (2006) Industrial Biotechnology, Himalaya Publishing House .

7. Intellectual Property Right in the Global Economy. Maskus, K.E. (2000), Peterson Institute, ISBN 0881322822, pp. 1-266.
8. Intellectual Property: Patent ,copyright , trade mark and allied rights, Cornish,

W.R. (2003). Universal Law Publishing, New Delhi. ISBN-10: 0421781203, pp. 1-895.

9. Intellectual Property Rights: Infringement and Remedies, Padmanabha A. (2012). Publisher: Lexis Butterworth Wadhwa Inc. ISBN: 9788180387937.pp. 1-638.
10. Miller , Raphael A. and Michal HD (2000) Intellectual property: patent trademarks and copyright. 3ed New York , west wadsworth

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Third Semester Examination

Paper3.3 MBT-6303 (1)– Environmental Biotechnology

Contact Hours / Week : 4 Hours Maximum Marks : 100 Marks

Duration of Examination : 3 Hours	Continuous/Internal/Assessment	: 30 Marks
	Semester Assessment	: 70 Marks

Note*: The syllabus is divided into five independent units and question paper will be divided into two sections.*

- ***Section-A*** *will carry 20 marks with one compulsory question comprising ten short answer type questions taking two questions from each unit. Each question shall be of two marks.*
- ***Section-B*** *will carry 50 marks with equally divided into five long answer type. Paper setter shall be advised to set two questions from each unit and students are instructed to attempt five questions by selecting one question from each unit.*

Note: *Contents of each unit may be completed into 15-18 lectures or contact hours which also include revisions, seminars, internal assessments, etc.*

revisions, seminars, internal assessments, etc.

UNIT-I **15-18L**

Environmental biotechnology: Current status of biotechnology in environmental protection. Pollution (Air, Soil, Water) - its causes and consequences. Waste water- its types and sources. Methods of waste water treatment. Eutrophication and algal blooms. Solid waste- sources, types and characterization. Biomedical waste and its disposal.

Biomonitoring: Objectives, Parameters for biomonitoring. Micro-organisms, lower plants, higher plants, chromosome and human system as indicator of pollution. Applications of bioindicators. Spiderwort strategy for detection of low level atomic radiation.

UNIT- II **15-18L**

Sustainable development - concept and strategies. Concept of clean technology. Green technologies and their applications. Microbial biofertilizers- types, sources and their commercial production. Mycorrizhae (VM) and their significance. Rhizobia and other symbiotic and nonsymbiotic nitrogen fixing microbes and their role in crop productivity. Azolla as biofertilizer and its commercial production. Significance and application of Phosphate Solubilizing Bacteria (PSB) and Plant Growth Promoting Rhizobacteria (PGPR).

UNIT-III **15-18L**

Bioremediation Introduction, Methods of Bioremediation (*In Situ* and *Ex Situ* Methods). Applications of Bioremediation. Nanotechnology in bioremediation , Phytoremediation- Concept and applications. Microbes and their genetic engineering for degradation of environmental pollutants. Xenobiotics in environment. Biodegradation of Hydrocarbons, Substituted hydrocarbons, Surfactant, Pesticides, Lignin, Tannin, Synthetic dyes.

UNIT-IV **15-18L**

Biosorption and Bioleaching of heavy metals: Cadmium, Lead, Mercury, Metal binding targets and organisms, Metal microbial interaction, Biomethylation of elements (Methylation of mercury and arsenic), Commercial biosorbants, bioleaching, metal precipitation, advantages and disadvantages of bioleaching.

Biomineralization: Modes, Biomineralization of metals-iron, zinc, copper, gold.

Bioaccumulation: Bioaccumulation process-uptake, storage, elimination, state of dynamic equilibrium. Factors affecting bioaccumulation.

UNIT-V **15-18L**

Biopesticides- definition, significance, types, sources, commercial production, use and mode of action. Entomopathogenic fungi and viral insecticides. Significance of *Bacillus thuringienesis* as

biocontrol agent. Biomagnification of pesticides and heavy metals. Consequences of biomagnification.

Microbes as biological weapons. Role of microbes in production of biofuels. Biogas production and factors affecting methane formation. Biosensors- principle and working. Applications of biosensors in environmental monitoring.

Reference Books:

1. Environmental Biotechnology: Concepts and Applications Hans-Joachim Jördening, Josef Winter John Wiley & Sons.
2. Advanced Environmental Biotechnology By S.K.Agarwal APH Publishing,
3. Environmental Biotechnology By S.N Jogdand Himalaya Publishing
4. Textbook of Environmental Biotechnology By MohapatraI. K. International Pvt Ltd
5. Environmental Biotechnology: Basic Concepts and Applications By Indu Shekhar Thakur6.Environmental Biotechnology: Theory and Application By Gareth G. Evans,Judy Furlong
7. Introduction to Environmental Microbiology; R. Mitchell.
8. Milton Wainwright. An Introduction to Environmental Biotechnology.
9. Kluwer Academic Publishers, Boston. Hardbound, ISBN 0-7923-8569-1. July 1999, 192.
10. Bruce Rittman, Perry L. McCarty. Environmental Biotechnology: Principles and Applications. McGraw-Hill 2nd edition (July 25, 2000) ISBN: 0072345535.
11. Martin Alexander. Biodegradation and Bioremediation. Academic Press; 2nd edition (April 15, 1999) ISBN: 0120498618.
12. Ecotechnology for pollution control & environmental management - By R.K. Trivedi & Arvind Kr.
13. Basic Environmental Technology - J.A. Nathanso
14. Environmental Biotechnology,Bimal C. Bhattcharya and RintuBanarjee,OUP India Publishers

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Third Semester Examination

Paper3.3 MBT-6303 (2)– Stem Cells & Healthcare

Contact Hours / Week	: 4 Hours	Maximum Marks	: 100 Marks
Duration of Examination	: 3 Hours	Continuous/Internal/Assessment	: 30 Marks
		Semester Assessment	: 70 Marks

Note*: The syllabus is divided into five independent units and question paper will be divided into two sections.*

- ***Section-A*** *will carry 20 marks with one compulsory question comprising ten short answer type questions taking two questions from each unit. Each question shall be of two marks.*
- ***Section-B*** *will carry 50 marks with equally divided into five long answer type. Paper setter shall be advised to set two questions from each unit and students are instructed to attempt five questions by selecting one question from each unit.*

Note: *Contents of each unit may be completed into 15-18 lectures or contact hours which also include revisions, seminars, internal assessments, etc.*

UNIT-I **15-18L**

Introduction and history of Stem Cells, Stem cells: the promising field of research, Unique Properties(Selfrenewal, Potency ,identification and proliferation). Asymmetric Cell Division, Types and sources of Stem Cells: Embryonic Stem cellsand adult Stem cells their characterstics types of adult Stem cells and their potential benefits. Adipose derived Stem cells(ASCs),their Types ,importance and clinical applications.. Stem cell tourism.

UNIT- II **15-18L**

Cloning and Reprogramming of somatic cells: iPSCs Cloning strategy, Reprogramming of Cells to Stem cells, Detail strategy and properties and application of ipsc

UNIT-III **15-18L**

Therapeutic applications of stem Cells: Gene therapy: Introduction, History and evolution of gene therapy.Gene delivery methods : viral and non-viral approach.Application of GM stem cells in gene therapy, cancer therapy,regenerative medicines,drug testing , disease modelling.Challenges and future directions.

UNIT-IV **15-18L**

Stem cell: definition , types , stem cells research :- regenerative medicine, disease modelling , drug discovery , ethical consideration, application of stem cell in Healthcare.
Tissue engineering : Opportunities and Challenges, Case studies**.** Stem cell banking vision, collection and storage procedure. Insurance against life threatening diseases, Existing Centres both in India and abroad.

UNIT-V **15-18L**

Stem cell research: Indian and Global scenario: Ethical and legal issues .Stem cell research Centers in India and abroad and their valuable contribution, National and International guidelines for conducting stem cell research.

Reference Books:

1. Robert Lanza et.al., Handbook of Stem Cells, Volume 1-Embryonic Stem Cells; 2006, Academic press
2. Robert Lanza et.al. Handbook of Stem Cells Volume 2-Adult & Fetal Stem Cells
3. M.J. Laughlin & H.M. Lazarus Allogeneic Stem cell Transplantation 2003 Humana Press, USA
4. Mehmet R. TOPCUL and Idil CETIN Stem Cells in Cell Therapy and Regenerative Medicine, OMICS International, ebook, 2018
5. Robert Paul. Essentials of Stem Cell Biology 2006 Elsevier Academic
6. Jeanne F. Loring Human Stem Cell Manual: A Laboratory Guide, Elsevier Science& Technology, 2007
7. Stewart Sell, Stem Cells Handbook 2003 Humana Press, USA

M.Sc. Biotechnology

Third Semester Examination

Paper3.4 MBT-6304 (1)– Medical Biotechnology

Contact Hours / Week	: 4 Hours	Maximum Marks	: 100 Marks
Duration of Examination	: 3 Hours	Continuous/Internal/Assessment	: 30 Marks
		Semester Assessment	: 70 Marks

Note*: The syllabus is divided into five independent units and question paper will be divided into two sections.*

- ***Section-A*** *will carry 20 marks with one compulsory question comprising ten short answer type questions taking two questions from each unit. Each question shall be of two marks.*
- ***Section-B*** *will carry 50 marks with equally divided into five long answer type. Paper setter shall be advised to set two questions from each unit and students are instructed to attempt five questions by selecting one question from each unit.*

Note: *Contents of each unit may be completed into 15-18 lectures or contact hours which also include revisions, seminars, internal assessments, etc.*

UNIT I **15-18L**

Molecular basis of disease: Chromosomal disorders- Numerical disorders and Structural. Single gene disorders; Polygenic diseases; Mitochondrial diseases. Infectious disorders- Hepatitis and HIV. Identification of disease genes. Molecular pathology of genetic diseases. Genomic imprinting. Drug delivery systems- criteria for drug delivery systems, drug delivery carriers, controlled release mechanisms, administration routes.

UNIT II **15-18L**

Techniques for disease diagnosis:Prenatal diagnosis; pre-implantation genetic diagnosis; invasive techniques- amniocentesis, fetoscopy, chorionic villi sampling (CVS); non-invasive techniques- ultrasonography, X-ray, TIFA, maternal serum screening and fetal cells in maternal blood.Diagnosis using protein and enzyme markers. Diagnosis using monoclonal antibodies- hormonal disorders & infectious diseases. DNA/RNA based diagnosis. Microarray technology- genomic and cDNA arrays, application to disease diagnosis. Genetic counselling.

UNIT III **15-18L**

Therapeutics and Management of diseases: Gene therapy- *Ex-vivo, In vivo, In situ* gene therapy; Strategies of Gene Therapy- Gene augmentation, Prodrug therapy/Suicide gene, TFO, Antisense therapy, SmaRT therapy, Ribozymes, Protein aptamers, Intrabodies. Vectors used in gene therapy: Biological vectors, Synthetic vectors.

UNIT IV **15-18L**

RNA interference and its applications in prevention of cancer and generation of antiviral drugs; Therapeutic genome editing. Enzyme therapy, Hormone replacement therapy,Cytokine therapy. Pharmacogenomics; Benefits of pharmacogenomics. Vaccines-Live, killed, Subunit, Attenuated, DNA, Peptide vaccines and Dendritic cell vaccines.

UNIT V **15-18L**

Regenerative medicine: Stem cells in therapy: Therapeutic proteins, interleukins, interferonsprinciple, production and application. Cell and tissue engineering- Characteristics of cells involved in tissue engineering; Types and characteristics of biomaterials. Bioartificial organs (Liver, Heart auricles, Blood vessels & Skin). Nanomedicine: Nanomaterials in medicine, nano robots, DNA based nano devices; Nanomedicine in cancer.

Suggested Readings:

1. Introduction to Human Molecular Genetics- J.J Pasternak, John Wiley Publishers
2. Human Molecular Genetics- Tom Strachen and A P Read, Bios Scientific Publishers
3. Human Genetics Molecular Evolution- Mc Conkey
4. Recombinant DNA Technology- AEH Emery
5. Principles and Practice of Medical Genetics, I, II, III Volumes by AEH Edts. Emery
6. Medical Biotechnology- Pratibha Nallari, V. Venugopal Rao- Oxford Press
7. Medical Biotechnology 1st Edition- Judit pongracz, Mary Keen
8. Medical Biotechnology by Bernard R. Glick, Terry L. Delovitch, Cheryl L. Pattern.
ASM press, 2014
9. Molecular Biotechnology-Principles and Applications of Recombinant DNA- 4th Edition by Bernard R. Glick, Jacj J. Pasternack, Cheryl L. Pattern

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Third Semester Examination

Paper3.4 MBT-6304 (2)– Genomics and Proteomics

Contact Hours / Week	: 4 Hours	Maximum Marks	: 100 Marks
Duration of Examination	: 3 Hours	Continuous/Internal/Assessment	: 30 Marks
		Semester Assessment	: 70 Marks

Note*: The syllabus is divided into five independent units and question paper will be divided into two sections.*

- ***Section-A*** *will carry 20 marks with one compulsory question comprising ten short answer type questions taking two questions from each unit. Each question shall be of two marks.*
- ***Section-B*** *will carry 50 marks with equally divided into five long answer type. Paper setter shall be advised to set two questions from each unit and students are instructed to attempt five questions by selecting one question from each unit.*

Note: *Contents of each unit may be completed into 15-18 lectures or contact hours which also include revisions, seminars, internal assessments, etc.*

UNIT I **15-18L**

Introduction to genomics, Structural organization of genome in Prokaryotes and Eukaryotes; Genome size, Organelle DNA- mitochondrial, chloroplast; DNA sequencing- principles and translation to large scale projects, Introduction to metagenomics

UNIT II **15-18L**

Functional Genomics of microbes, plants and animals; Genomes and databases; Comparative genomics, Identification and classification using molecular markers- 16S rRNA analysis, ESTs and SNPs.

UNIT III **15-18L**

Analysis of Proteomes : SDS -PAGE, 2- D gel electrophoresis of proteins; Isoelectricfocusing; Peptide mass fingerprinting; LC/MS-MS for identification of proteins and modified proteins; MALDI- TOF

UNIT IV **15-18L**

Introduction to Pharmacogenetics, High throughput screening in genome for drug discovery, Pharmacogenetics and drug development

UNIT V **15-18L**

Functional genomics and proteomics, Structural proteomics, Protein and peptide microarray- based technology,Applications of Genomics and Proteomics in Health, Agriculture and Biotechnology.

Suggested Readings:

1. Voet D, Voet JG & Pratt CW, Fundamentals of Biochemistry, 2nd Edition. Wiley 2006
2. Brown TA, Genomes, 3rd Edition. Garland Science 2006
3. Campbell AM & Heyer LJ, Discovering Genomics, Proteomics and Bioinformatics, 2nd Edition. Benjamin Cummings 2007
4. Primrose S & Twyman R, Principles of Gene Manipulation and Genomics, 7th Edition, Blackwell, 2006.
5. Glick BR & Pasternak JJ, Molecular Biotechnology, 3rd Edition, ASM Press, 1998.

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Third SemesterExamination

Paper 3.5 MBT 6305 Lab Course V Practical Exercises

1. Micronucleus test.
2. Immunofluorescence detection to check transfection efficiency (using fluorescence and confocal microscopes)
3. Callus induction & Production of secondary metabolites.
4. Preparation of synthetic seeds.
5. Induction of hairy root cultures using *Agrobacterium rhizogenes* for the production of secondary metabolites
6. Preparation of recombinant plant expression vector with gene of interest 7.Genetic transformation of plant tissue using *Agrobacterium tumefaciens.*
8. Confirmation of transgenic plants by PCR and southern blotting techniques
9. Instrumentation of fermentor: Design of various types of fermentors& bioreactors.
10. Operation of fermentor.
11. Batch fermentation in conical flask
12. Solid state fermentation
13. Screening of microbes for production of industrially important enzymes.
14. Optimization of conditions for optimal production: - Media composition, Incubation temperature, Aeration, Incubation time.
15. Determination of TDP of an organism.
16. Determination of TDT of an organism.
17. To demonstrate DSP.
18. Searching of India Patent databases
19. Drafting and filing of Indian Patent databases
20. Searching of International Patent application
21. Drafting and filing of International Patent application

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Paper 3.6 MBT 6306 Lab Course VI

Practical Exercises based on Environment Biotechnology

1. To estimate total hardness of water
2. To estimate Calcium hardness of water
3. To estimate the total solids (TS), total dissolved solids (TDS) and suspended solids (SS) in the given water sample
4. To estimate dissolved oxygen content of wastewater.
5. To estimate chemical oxygen demand of the given sample.
6. To estimate Biological Oxygen Demand (BOD).

7. To measure the concentration of chloride in it the given sample.
8. To measure the Sulfite content in the given sample by iodometric titration.
9. Practical based on soil bioremediations.
10. Detection of coliforms for Determination of the purity of potable water. 11.Preparation and formulation of Microbial Biopesticides
12. Visit to waste water treatment plant.

Practical Exercises based on Stem cells & Healthcare

1. Establishment of embryonic stem cells (ESCs).
2. Characterization of pluripotent stem cells (PSCs).
3. Somatic cell reprogramming using TFs.
4. Intestinal stem cells and dedifferentiation.
5. Homeostasis by stem cell proliferation and differentiation.
6. Lung stem cells and dedifferentiation.
7. Tissue-specific stem cells and differences among different tissue.
8. Tools to study stem cell Biology.
9. Bioethics and ethical issues related to stem cells.
10. Guidelines to follow regarding stem cell Biology.

Practical Exercises based on Medical Biotechnology

1. Genotyping of candidate genes for diseases by RFLP, Microsatellite & VNTR analysis
2. Screening for known mutations by ARMS-PCR/ASO.
3. Screening for unknown mutations by SSCP and sequencing.
4. Detection for dynamic mutations- Trinucleotide repeat polymorphism.
5. Identification of disease gene expression by Real-time PCR.
6. Sequencing of cDNA and cloning in expression vectors.
7. Detection of congenital abnormalities by triple test.
8. Preparation of Ag nano particles and testing their antimicrobial effect.
9. Encapsulation of lymphocytes/ RBCs.

Practical Exercises based on Genomics & Proteomics

1. Use of SNP databases at NCBI and other sites
2. Use of OMIM database
3. Detection of Open Reading Frames using ORF Finder
4. Proteomics 2D PAGE database
5. Softwares for Protein localization.
6. Native PAGE
7. SDS-PAGE

M.Sc. Biotechnology

Fourth Semester Examination

Paper 4.1 MBT-6401– Industrial Bioprocess Technology

Contact Hours / Week	: 4 Hours	Maximum Marks	: 100 Marks
Duration of Examination	: 3 Hours	Continuous/Internal/Assessment	: 30 Marks
		Semester Assessment	: 70 Marks

Note*: The syllabus is divided into five independent units and question paper will be divided into two sections.*

- ***Section-A*** *will carry 20 marks with one compulsory question comprising ten short answer type questions taking two questions from each unit. Each question shall be of two marks.*
- ***Section-B*** *will carry 50 marks with equally divided into five long answer type. Paper setter shall be advised to set two questions from each unit and students are instructed to attempt five questions by selecting one question from each unit.*

Note: *Contents of each unit may be completed into 15-18 lectures or contact hours which also include revisions, seminars, internal assessments, etc.*

UNIT I **15-18L**

Conventional fermentation v/s biotransformations; Introduction to bioprocess engineering and technology. Effluent treatment and disposal. Application of computers in bioprocess engineering: data logging, analysis and control., Material balance in biological systems, energy balance in biological system.

Microorganism in agriculture biosafety- Biofertilizer and their application biopesticide and disease management, role of (Rhizobacteria, Azobacteria) for plant growth production and disease management.

UNIT II **15-18L**

Industrial Production of Antibiotics – Penicillin, Streptomycin, Tetracyclines Organic acids – Citric acid, Lactic acid, Acetic acid and glutamic acid.; Enzymes – Amylases, Proteases, lipases; Amino acids – Lysine, Glutamic acid. Microbial Production of Ethanol, Vinegar, SCP, Vitamin B2 and B12.

UNIT III **15-18L**

Fermented foods and beverages; fermentation as a method of preparing and preserving foods; microbes and their use in pickling, producing colours and flavours, Traditional fermented foods (Bread, cocoa, coffee, tea, sauerkraut, cheese, butter, yoghurt, meat, fish, etc.), alcoholic beverages (Beer, wine and whisky). Edible fungus: Mushrooms.

UNIT IV **15-18L**

Applications of enzymes in food processing. Bioreactors in food fermentation; process wastes whey, molasses, starch substrates and other food wastes for bioconversion to useful products; bacteriocins from lactic acid bacteria – production and applications in food preservation. HACCP and hurdle technology. Hygiene and safety in fermentation industries.

Sterilization and pasteurization of food products, Elementary idea of canning and packaging and food preservation.

UNIT V **15-18L**

Protein engineering in food technology: methods, targets and applications in foods. Applications of Biochips and biosensors. Microbial production of vaccines, microbial production of Alkaloids, Bioplastic, Biopolymers and therapeutic proteins. Microbial transformations: Steroid biotransformation. Biofuels and biorefinery.

Reference Book:

1.Jackson AT., Bioprocess in Biotechnology, Prentice Hall, Engelwood cliffs, 1991
2. Shufler ML and Kargi F., Bioprocess Engineering: Basic Concepts, 2nd Edition, Prentice Hall,Engelwood Cliffs, 2002.
3. Stanburry RF and Whitaker A., Principles of Fermentation Technology, Pergamon press, Oxford,1977
4. Baily JE and Ollis DF., Biochemical Engineering fu8ndamentals, 2nd edition, McGraw- Hill Book Co.,New York, 1986.
5. Aiba S, Humphrey AE and Millis NF, Biochemical Engineering, 2nd Edition, University of Tokyo.Press, Tokyo 1973.
6. Young M.M., Comprehensive Biotechnology: The Principles, applications and regulations of Biotechnology in Industry, Agriculture and Medicine, Vol 1, 2, 3 and 4. Reed Elsevier India Private Ltd, India, 2004.
7. Mansi EMTEL, Bryle CFA, Fermentation Microbiology and Biotechnology, 2nd Edition, Taylor & Francis Ltd. UK, 2007.
8. Jean T. (2005) Industrial Biotechnology.
9. Boekert W and Vandamme EJ (eds) (2010) Industrial Biotechnology, willey Verlag.
10.Watson k vol.1 Industrial Biotechnology CBS publishers and Distributers
11.Turner E Bioprocess Engineering syerwood publishing house

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Fourth Semester Examination

Paper 4.2 MBT-6402– Biostatistics,Bioinformatics& Research Methodology

Contact Hours / Week	: 4 Hours	Maximum Marks	: 100 Marks
Duration of Examination	: 3 Hours	Continuous/Internal/Assessment	: 30 Marks
		Semester Assessment	: 70 Marks

Note*: The syllabus is divided into five independent units and question paper will be divided into two sections.*

- ***Section-A*** *will carry 20 marks with one compulsory question comprising ten short answer type questions taking two questions from each unit. Each question shall be of two marks.*
- ***Section-B*** *will carry 50 marks with equally divided into five long answer type. Paper setter shall be advised to set two questions from each unit and students are instructed to attempt five questions by selecting one question from each unit.*

Note: *Contents of each unit may be completed into 15-18 lectures or contact hours which also include revisions, seminars, internal assessments, etc.*

UNIT-I **15-18L**

Principles and practice of statistical methods in biology; samples and populations; Data collection and graphical representation Measures of central tendency- mean, median, mode; Measures of dispersion- range, mean deviation, standard deviation, standard error, coefficient of variation

UNIT-II **15-18L**

Probability: counting, conditional probability, discrete and continuous random variables; Error propagation; Populations and samples, expectation, parametric tests of statistical significance, nonparametric hypothesis tests, linear regression, correlation & causality, calculation of Karl-Pearson's coefficient of correlation; analysis of variance, factorial experiment design; Use of biostatistics software.

UNIT-III **15-18L**

Bioinformatics: An overview, introduction and scope of bioinformatics. Databases: Characteristics, categories and types (Genome database, Literature database, Disease database, Sequence database, Structure database). Information retrival system (Entrez, SRS), Data mining tools: Modelling tools (RasMol, PyMol and Hyperchem), Data submission tools (Bankit, Sequin, Webin, Sakura).

UNIT-IV **15-18L**

Tools for sequence alignment. Tools for Genome analysis. Phylogenetic analysis: Phylogenetic trees. Methods of phylogenetic evaluation. Prediction tools Proteomics: Proteome analysis, Tools for Protein sequence analysis and proteomics, structure analysis: Insilico drug designing

UNIT-V **15-18L**

Research Methodology: Introduction-Basic research, applied research, need based research. Identification of the problem, defining the problem. Research Project planning. Literature search-information sources, library resources-books, abstracts hand books, procedure manuals, encyclopedias, annual report, data banks, CDROMS, online literature search- internet access, websites, directories of information resources.

Progress of research- evaluation of results, statistical approach, comparison with existing methodologies, validation of findings, research communication, impact factor of journals, plagiarism. Art of scientific writing and editing. Thesis/Dissertation writing. Software packages for statistical analysis.

Reference Book:

1. Principles of Technical Writing by Robert Hays. Addison-Wesley, 1965 2.
2. Rastogi. S. C, Mendiratta. N and Rastogi. P. Bioinformatics Methods and Applications: Genomics, Proteomics and Drug Discovery. Prentice-Hall of India Pvt. Ltd.3rd edition.
3. Zhumur Ghosh &Bibekanand Mallick, Bioinformatics: Principles and Applications, Oxford University Press, Second Edition
4. Teresa K. Attwood and David J. Parry – Smith. 2005. Introduction to Bioinformatics. Pearson
5. education, Singapore.
6. A.R. Leach, Molecular Modeling- Principles and Applications, Second Edition, Pearson.
7. David W. Mount. 2003. Bioinformatics: Sequence & Genome Analysis.CBS Publishers and Distributors. New Delhi.
8. Westhead. D. R, Parish. J. H and Twyman. R. M, 2003. Bioinformatics. Viva Books Private Limited, New Delhi.

9. C.R., Kothari,Research methodology.

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Fourth Semester Examination

Paper 4.3 MBT-6403 -Agriculture Biotechnology

Contact Hours / Week	: 4 Hours	Maximum Marks	: 100 Marks
Duration of Examination	: 3 Hours	Continuous/Internal/Assessment	: 30 Marks
		Semester Assessment	: 70 Marks

Note*: The syllabus is divided into five independent units and question paper will be divided into two sections.*

- ***Section-A*** *will carry 20 marks with one compulsory question comprising ten short answer type questions taking two questions from each unit. Each question shall be of two marks.*
- ***Section-B*** *will carry 50 marks with equally divided into five long answer type. Paper setter shall be advised to set two questions from each unit and students are instructed to attempt five questions by selecting one question from each unit.*

Note: *Contents of each unit may be completed into 15-18 lectures or contact hours which also include revisions, seminars, internal assessments, etc.*

Unit I **15-18 L**

Concept, scope, and evolution of agricultural biotechnology, Role of genetics, molecular biology, and tissue culture,Gene transfer techniques: Agrobacterium-mediated, biolistics, electroporation, Genetically modified organisms (GMOs) in agriculture,Bioethics and public perception of biotech crops,Marker-assisted selection (MAS), quantitative trait loci (QTLs) and molecular markers

Unit II **15-18 L**

CRISPR/Cas9 and genome editing for crop enhancement, Promoters and vectors used in plant transformation, Biosafety regulations and ethical concerns in genetic engineering, Transgenic plants: traits for pest resistance, drought tolerance, enhanced nutrition

Unit III **15-18 L**

GM crops and food security: case studies and regulatory aspects. Biotechnology in abiotic and biotic stress management. Biotechnology for post-harvest technology and food processing

Climate-resilient agriculture through biotechnological interventions

Unit IV **15-18 L**

Genetic engineering of microbes for stress tolerance and plant growth promotion, Industrial and Emerging Trends in Agri-Biotech- Agricultural nanobiotechnology: nano-fertilizers, nano-pesticides, Synthetic biology in crop design, Metagenomics for soil microbial diversity analysis, Bioinformatics tools in agricultural genomics, Future perspectives: climate-resilient agriculture, vertical farming

Unit V **15-18 L**

Molecular breeding, Application of bioinformatics tools in crop genome analysis, Bio-entrepreneurship, seed technology: seed production, quality control and storage.

Suggested Readings:

"Agriculture Biotechnology" by SVS Chauhan and Seeema Chauhan
"Plant Biotechnology" by Slater, Scott & Fowler
"Agricultural Biotechnology" by Arie Altman
Research papers and government policy documents on GM crops and biosafety

M.Sc. Biotechnology
Fourth Semester Examination
Paper 4.4 MBT 6404- Lab Course VII

Practical Exercises

1. Immobilization of cells and enzymes.
2. Instrumentation of fermenter. Design of various types of fermenters & bioreactors
3. Production of Beer / wine.
4. Demonstration of Plackett Burman design for formulation of fermentation media.
5. Pigment production and isolation from a microbial source (yeast, fungi or bacteria)
6. Physico chemical characterization of an industrial effluents.
7. Detection of different food enzymes by simple tests (amylase, catalase, invertase, papain, pectinase, pepsin).
8. Microbial fermentations for the production and estimation (qualitative and quantitative) of:
   i. Enzymes: Amylase and Protease and cellulase.
   ii Amino acid: Glutamic acid.
   iii. Organic acid: lactic acid/ Acetic Acid
   iv. Alcohol: Ethanol (yeast / wheat flour)

9. A visit to any educational institute/industry to see an industrial fermenter, and other downstream processing operations.
10. Study of pickling process (sauerkraut /pickled cucumbers) with respect to physical,chemical/biochemical and biological changes occurring during the pickling process.
11. Production of Single Cell Protein.
12. Production of Yoghurt.
13. Mushroom cultivation.
14. Introduction to Food Technology: Sterilization and Pasteurization of Food Products
15. Technology of Fermented Food products.
16. To access scientific data from Literature data bases (PUBMED, LITDB, Medline)
17. To access nucleic acid databases for retrieval of gene sequence.
18. To access protein databases for retrieval of amino acid sequence of target protein.
19. To perform pair wise sequence alignment using Dot matrix.
20. To perform multiple sequence alignment using BLAST.
21. To prepare Phylogenetic tree using CLUSTAL-W
22. 3D protein structure prediction and structure refinement using Swiss-PDB viewer
23. Representation of statistical data by
    a.Histogram 2. O give curves 3. Pie diagrams
24. Collection of data using different sampling methods
25. Determination of Averages or Central tendencies (Mean, Mode, Median)
26. Determination of measures of dispersion (Mean deviation, Standard deviation and Coefficient of variation, Quartile deviation)
27. Application of Tests of significance (Chi-Square test, student t-test, Standard error)
28. Applications of computers in biology using MS-office (MS-Word, Excel, Power point)
29. Isolation of Plant DNA & quantification by spectrophotometric method.
30. RFLP and RAPD analysis
31. RNA extraction, Agarose gel electrophoresis of RNA, RT-PCR analysis of a plant gene.
32. Polymerase chain reaction to amplify a plant gene.
33. Rapid screening tests for abiotic stress tolerance (drought, salinity - PEG, Mannitol & NaCl)
34. Surface-sterilization of seeds, establishment of axenic plants, acclimatization of tissue culture plants and establishment in greenhouse.
35. Seed germination test and purity analysis

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Fourth Semester Examination
Paper 4.5 MBT-6405– Dissertation

A dissertation shall be initiated at the end of the Semester III and continued during Semester IV.A dissertation may be undertaken in any research laboratories/industries/university department. Project work will involve experimental work and the student will have to complete this in stipulated time i.e 3 months.The final evaluation of the project work will be through a Panel involving internal and external examiners. The students shall compulsorily submit the certificate of completion and report to the Department during the practical examination. This process includes: Conceptualization of the independent research, Collection, analysis, and interpretation of data, Thesis writing, Oral presentation of findings, Viva-Voce.
The marks will be awarded by the external examiner on the day of the practical examination on the basis of the experimental, presentation and viva-voce. The distribution of marks for project work will be:

Project work : 200 Marks
Experimental Work &Thesis : 100
Research work presentation :50
Viva-voce :50