SCHEME OF EXAMINATION
RULES & REGULATIONS
AND
SYLLABUS

(Applicable for Academic Session 2020-2021)

Master of Science (M.Sc.)
Biotechnology

Faculty of Science

UNIVERSITY OF KOTA

MBS Marg, KOTA (Rajasthan)-324 005
INDIA

CONTENTS

University of Kota, Kota

M.Sc. Biotechnology

Semester wise Consolidated Common Scheme of Examinations for the Academic Sessions 2020-2021

Year / Semester	Number, Code or ID and Nomenclature of Paper			Duration of Exam. (in Hrs.)	Distribution of Assessment Marks									
	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%)		Total	
					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	BT-511	Cell Biology and Enzyme Technology	3	4	-	4	30	12	70	28	100	40
	Paper-1.2	BT-512	General Microbiology	3	4	-	4	30	12	70	28	100	40
	Paper-1.3	BT-513	Bio-Instrumentation	3	4	-	4	30	12	70	28	100	40
	Paper-1.4	BT-514	Fundaments of Biochemistry	3	4	-	4	30	12	70	28	100	40
	Paper-1.5	BT-515	Lab Course-I	6	-	9	9	--	--	100	50	100	50
	Paper-1.6	BT-516	Lab Course-II	6		9				100	50	100	50
	Total (I Semester)			**24**	**34**			**120**	**48**	**480**	**212**	**600**	**260**
1st Year II Semester	Paper-2.1	BT-521	Fundamentals of Molecular Biology	3	4	-	4	30	12	70	28	100	40
	Paper-2.2	BT-522	Fermentation Technology, Biosafety and IPR	3	4	-	4	30	12	70	28	100	40
	Paper-2.3	BT-523	Immunology and Immunotechnology	3	4	-	4	30	12	70	28	100	40
	Paper-2.4	BT-524	Genetic Engineering and its Applications	3	4	-	4	30	12	70	28	100	40
	Paper-2.5	BT-525	Lab Course-III	6		9	9			100	50	100	50
	Paper-2.6	BT-526	Lab Course-IV	6		9				100	50	100	50
	Total (II Semester)			**24**	**34**			**120**	**48**	**480**	**212**	**600**	**260**
2nd Year III Semester	Paper-3.1	BT-631	Basic and Applied Animal Biotechnology	3	4	-	4	30	12	70	28	100	40
	Paper-3.2	BT-632	Basic and Applied Plant Biotechnology	3	4	-	4	30	12	70	28	100	40
	Paper-3.3	BT-633	Environmental Biotechnology	3	4	-	4	30	12	70	28	100	40
	Paper-3.4	BT-634	Medical Biotechnology	3	4		4	30	12	70	28	100	40
	Paper-3.5	BT-635	Lab Course-V	6	-	9	8	--	--	100	50	100	50
	Paper-3.6	BT-636	Lab Course-VI	6		9				100	50	100	50
	Total (III Semester)			**24**	**34**			**120**	**48**	**480**	**212**	**600**	**260**
2nd Year IV Semester	Paper-4.1	BT-641	Industrial BioProcess Technology	3	4	-	4	30	12	70	28	100	40
	Paper-4.2	BT-642	Biostatistics,Bioinformatics and Research Methodology	3	4	-	4	30	12	70	28	100	40
	Paper-4.3	BT-643	Dissertation	3		-	4	-	-	200	100	200	100
	Paper-4.4	BT-644	Lab Course-VII	6		9	4	-	-	100	50	100	50
	Paper-4.5	BT-645	Comprehensive Viva Voce	8	-		8	--	--	100	50	100	50
	Total (IV Semester)			**16**	**17**			**60**	**24**	**540**	**256**	**600**	**280**
Grand Total (I + II + III + IV Semester)				**88**	**119**			**420**	**168**	**1980**	**892**	**2400**	**1060**

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". M.Sc. Biotechnology programme is to promote education and research in biotechnology and provide academic and professional excellence for immediate productivity in industrial, governmental, or clinical settings for an ultimate benefit of society and environment.

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 comprise normally 90 working days. The course shall run on the regular basis.

Eligibility for Admission in M.Sc. First Semester:

- A candidate who has passed any one of the following examination from 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 four semester 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
- Foreign students who are residing in India and are studying in Indian universities are also eligible to seek admission in this course after due screening.
- An applicant for the M.Sc. Biotechnology examination, prosecuting a regular course of study leading to the Master of Science in Biotechnology, shall not be permitted for doing any service or for giving any other regular examination simultaneously to earn a degree.
- No person shall be admitted to M.Sc. Biotechnology if he/she has already passed M.Sc. Biotechnology or equivalent examination of any University or statutory body. However, this restriction shall not be applicable to diploma / certificate holders.
- The candidate who has passed any part of M.Sc. Biotechnology programme of any University or statutory body will not be admitted to M.Sc. Biotechnology programme of this University on migration 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 papers examinations 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.

Course Structure:

The Master of Science in Biotechnology programme will consist of core and advanced courses of theory as well as practical which are compulsory for the students. Each semester consist of four theory papers, one practical paper and one seminar / personality development / skill development activity. Dissertation(s), project work(s), training(s), field work(s), industrial visit(s), *etc.* (which is/are approved by the concerned Department) may be performed / executed by the students in the government / public / private organization(s), institution(s), industry(ies), firm(s), enterprise(s), *etc.* for advanced learning and more practical exposures.

Course Number, Course Code or ID and Nomenclature:

Number of the course has been given in the Arabic number as Paper-1.1, Paper-1.2, and Paper-1.3 and so on. In the Paper-1.2, 1 represents the semester number and 2 represent the paper number. To give a code to a particular course, following sequence has been adopted:

"Abbreviation of the programme in upper case + n^{th} number of year of study + n^{th} number of semester of the programme + course number in Arabic number"

According to the above sequence, code of paper-IV of the first semester of postgraduate Microbiology programme shall be as "BT-514". It is noted that the 5 represents here the fifth year of study because it is considered that the student has completed four years of study during his / her undergraduate programme *e.g.* B.Sc. pass course with three or B.Sc. Hons course with three / four years or B.Sc.-B.Ed. / B.Sc.-Tech. / B.Tech. *etc.* with four years. Therefore, the figure 5 represents the fifth year of study.

Nomenclature of the particular course has been given according to the nature or type of contents included in the Unit-I to Unit-V of course of study.

Maximum Marks and Credit Points:

Maximum marks of a theory and practical paper will be decided on the basis of their contact hours per week and subsequently their credit points. One teaching or tutorial hour per week will be equal to 01 credit point and will carry 25 maximum marks. Therefore, 4 teaching hours per week will be equal to 4 credit points and will carry 100 maximum marks for each theory paper / course. For calculating of credit points for practical papers, two contact hours per week for laboratory or practical work will be equal to one contact hour per week of theory paper and will carry 01 credit point. Therefore, 18 contact hours per week for practical work or laboratory work will be equal to 9 contact hours per week of theory paper and will carry 9 credit points. Therefore, 9 credit points per week for practical / laboratory work will carry 225 maximum marks.

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.* first internal 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% weightage of 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) Paper wise consolidated marks for each theory paper and dissertation / seminar (*i.e.* total marks obtained during various modes of internal assessment) obtained by the students (out of the 30% weightage of the maximum marks of the each paper) shall be forwarded (in two copies) by the Head of the Department to the Controller of Examinations of the University within a week from the date of last internal assessment test for incorporation in the tabulation register.

(f) The consolidated marks obtained by the students be also made known to them before being communicated by the concerned Head of the Department to the University for final incorporation in the tabulation register. If any discrepancies are discovered or pointed out by the students, the same shall be looked into by the concerned faculty member and corrections made wherever necessary. The decision of the Head of the Department before the communication of marks to the University shall be final. No corrections shall be made in the internal assessment marks after the declaration of the result by the University.

(g) Consolidated marks of internal assessment obtained out of the 30% weightage of maximum marks of each theory paper which will be communicated to the University shall be in whole number and not in fraction. Marks awarded for the various internal assessments in each paper shall be added up and then round off to the next whole number to avoid any fraction.

(h) All test copies and other material related to the internal assessment shall also be sent to the Controller of Examinations of the University to keep in record as per the University guidelines.

(i) The concerned Head of the Department shall be responsible for proper conduct of internal assessment tests and for communication of the consolidated marks to the University within the prescribed time.

(j) The Head of the Department shall keep a record of the marks and also notify the same to the candidates immediately so that if any candidate is not satisfied with the award in any test or seasonal work, he / she should represent the matter to the higher authority.

(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 10 marks with one compulsory question comprising ten short answer type questions (maximum 20 words answer) taking two questions from each unit. Each question shall be of one mark.*
- ***Section-B*** *will carry 30 marks with equally divided into five long answer type questions (answer about in 250 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.*
- ***Section-C*** *will carry 30 marks with equally divided into three long answer type questions (answer about in 500 words). Paper setter shall be advised to design total five questions by setting one question from each unit. Students are instructed to attempt any three questions.*

(c) The syllabus of practical paper is divided according to main streams of Microbiology. 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

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 Any other 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 10 marks with one compulsory question comprising ten short answer type questions (maximum 20 words answer) taking two questions from each unit. Each question shall be of one mark.*
- ***Section-B*** *will carry 30 marks with equally divided into five long answer type questions (answer about in 250 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.*
- ***Section-C*** *will carry 30 marks with equally divided into three long answer type questions (answer about in 500 words). Paper setter shall be advised to design total five questions by setting one question from each unit. Students are instructed to attempt any three questions.*

SECTION-A

Q. 1.

Unit-I

(i) …… **1 Mark**
(ii) …… **1 Mark**

Unit-II

(iii) …… **1 Mark**
(iv) …… **1 Mark**

Unit-III

(v) …… **1 Mark**
(vi) …… **1 Mark**

Unit-IV

(vii) …… **1 Mark**
(viii) …… **1 Mark**

Unit-V

(ix) …… **1 Mark**
(x) …… **1 Mark**

SECTION-B

Unit-I

Q. 2. ……..…… **6 Marks**

or

……...…… **6 Marks**

Unit-II

Q. 3. ……..…… **6 Marks**

or

……..…… **6 Marks**

Unit-III

Q. 4. ……..…… **6 Marks**

or

……..…… **6 Marks**

Unit-IV

Q. 5. . ……..…… **6 Marks**

or

……..….. **6 Marks**

Unit-V

Q. 6. ……..…… **6 Marks**

or

……..…… **6 Marks**

SECTION-C

Unit-I

Q. 7. ……..…… **10 Marks**

Unit-II

Q. 8. ……..…… **10 Marks**

Unit-III

Q. 9. ……..…… **10 Marks**

Unit-IV

Q. 10. ……..…… **10 Marks**

Unit-V

Q. 11. ……..….. **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 along with the papers of higher semester examination) in accordance with the following conditions:

(i) A candidate, for a semester examination, shall be offered all the papers prescribed for that semester examination and besides he/she also shall be offered paper(s) not cleared by him/her at any of the lower semester examination subject to the limitation that the number of un-cleared papers of the lower semester examinations shall not be exceed the total number of the papers prescribed for any one semester.

(ii) The candidate shall be declared to have passed the examination, if the candidate secures at least 40% marks in each theory paper separately in continuous or internal or mid-term examination & semester or external or end-term examination and also separately 50% marks in each practical / project / dissertation / seminar with 50% aggregate marks of the maximum marks prescribed for each semester examination. There is no minimum pass marks for the practical record / notebook. However, submission of a practical record / notebook is a mandatory during the practical examination. The candidate should compulsorily attend viva-voce / presentation examination to secure pass in practical / project / dissertation / seminar.

(iii) A candidate, who has been declared as failed/absent in one or more theory paper(s) at any odd semester examination shall be permitted to join the courses of study for the next higher semester *i.e.* permitted to join the course of second semester after first semester examination, permitted to join the course of fourth semester after third semester examination, permitted to join the course of sixth semester after fifth semester examination and so on and eligible to re-appear in that paper(s) as due paper(s) along with next higher semester (next year) examination provided that he/she must have cleared at least 50% of the papers (including practical / project / dissertation / seminar as one paper) collectively prescribed for the first and second semester examinations taken together for promotion to the third semester examination.

(iv) 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 the 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.

(v) 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.

(vi) 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.

(vii) 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.

(viii) 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.

(ix) 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.

(x) 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 semester only 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 along with the papers of his/her own semester.

(xi) 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.

(xii) 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 re-appearing 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.

(xiii) 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.

(xiv) 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.

(xv) 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.

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

Classification of Successful Candidates:

The classification of successful candidates after last semester examination shall be as:

Description of Marks Obtained	Division / Result
• 80% and above marks in a paper.	Distinction in that paper.
• A candidate who has secured aggregate 60% and above marks	First Division
• A candidate who has secured aggregate 50% and above but less than 60% marks	Second Division
• A candidate who has secured aggregate 40% and above but less than 50% marks	Pass

Candidates who pass all the examinations prescribed for the course in the first instance and within a period two academic years in four semesters from the year / semester of admission to the course only are eligible for University Ranking. A candidate is deemed to have secured first rank provided he/she

(i) Should have passed all the papers in first attempt itself.

(ii) Should have secured the highest marks in the whole examination of the programme / course, or should have secured the highest cumulative grade point average (CGPA).

……. x …….. x ……..…… x ……..……..

M.Sc. Biotechnology

First Semester Examination

Paper 1.1: BT-511 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 three sections.*

- **Section-A** will carry 10 marks with 01 compulsory question comprising 10 short answer type questions(maximum 20 words answer) taking two questions from each unit. Each question shall be of one mark.
- **Section-B** will carry 25 marks with equally divided into five long answer type questions (answer about in 250 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.
- **Section-C** will carry 35 marks with five long answer type questions comprising one compulsory question of 15 marks and four questions of 10 marks each. Students are instructed to attempt total three questions with one compulsory question (answer about in 500 words) and any two more questions (answer about in 400 words) out of remaining four questions. Paper setter shall be advised to design question paper covering from all five units..

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, pre-cellular evolution, 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 and Chromosome.

Transport across member as active facilitated and passive transport.

Mitochondrial and chloroplast energy transformation: ultra structure of mitochondria and chloroplasts, structure and role of ATP synthetase, oxidative and photophosphorylation. Proton gradient and chemiosmotic coupling.

UNIT-III **15-18L**

Cell cycle, Cell Cycle Regulators- Cyclin and CDKs, Mechanism of cell division: Mitosis and Meiosis. Programmed Cell Death: intrinsic and extrinsic pathways.

Overview of extracellular signaling, modes of signaling, ligands and receptor molecules. G-protein coupled receptors, Secondary messengers (cAMP), Tyrosine kinase linked receptors.

UNIT- IV **15-18L**

Introduction to enzyme and enzyme technology: Enzymes:- General properties, Classification and Nomenclature. 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 multifunctional enzymes.

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 processes and various other enzyme catalytic action in food processing.
Enzymes biosensor: Principle, components and applications.
Advancement in enzyme technology.

Reference Books:

1. The World of the Cell:Becker ,Kleinsmith and Hardin.
2. Cell and molecular biology: Gerald Karp.
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 C Bucks
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 publishers and distributors.
13. Biochemistry. Ed Donald Voet and Judith G. Voet. John Wiley & sons, Inc

M.Sc. Biotechnology

First Semester Examination

Paper-1.2 BT-512 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 three sections.*

- **Section-A** will carry 10 marks with 01 compulsory question comprising 10 short answer type questions(maximum 20 words answer) taking two questions from each unit. Each question shall be of one mark.
- **Section-B** will carry 25 marks with equally divided into five long answer type questions (answer about in 250 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.
- **Section-C** will carry 35 marks with five long answer type questions comprising one compulsory question of 15 marks and four questions of 10 marks each. Students are instructed to attempt total three questions with one compulsory question (answer about in 500 words) and any two more questions (answer about in 400 words) out of remaining four questions. Paper setter shall be advised to design question paper covering from all five units..

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 and Basic Principles of Microbiology. Contribution of Antony Von Leeuwenhoek, Louis Pasture, Robert Koch.

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. Molecular methods in assessing microbial diversity; 16S rDNA sequencing and 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): Heat, Temperature, Filtration Pasteurization, Dehydration, Radiation, Alcohol, Surface active agents, Aldehyde, Halogen, Gases.

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, taxonomy, reproduction, cultivation, purification and assay.

UNIT IV **15-18L**

.Bacteriophage: Structure and life cycle. Prions, Viroids and retro viruses.

Bacterial morphology, Bacterial Growth: Growth curve and its kinetics and growth yield, growth synchronization. Determination of biomass, Environmental factors affecting growth. Microbial metabolism: Phototrophy, chemolithotrophy, anaerobic respiration, fermentation, methanogens, biological nitrogen fixation.

UNIT V **15-18L**

Microbiol 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. Microbes: Concepts & Applications- P.S. Bisen, Mousumi Debnath, Godavarthi B.K.S. Prasad, John Wiley & Sons Publication 2012
2. Microbiology: An Introduction. Tortora GJ, Funke BR, and Case CL.
3. Bergey`s manual of systematic bacteriology. George M.Garrity,David R. Boone,Richard W.Castenholz.
4. Brock Biology of Microorganisms, 14thEdition. Michael T. Madigan, John M. Martinko, Paul V. Dunlap and David P. Clark.
5. Prescott, L.M., J.P Harley and D.AKlein, 2007. Microbiology VII Ed.Mc Grow Hill,
6. Davis R.Y. E.A. Adeberg and J.L. Ingram,1991 General Microbiology
7. Stainer .General Microbiology, V Ed., Printice Hall of India Pvt,Ltd. New Delhi
8. Ronald M. Atlas 1997. Principles of Microbiology. II Ed. Mc Graw Hill Pub.
9. Salle A.J., Fundamental Principles of Bacteriology.
10. Microbiology Vol.I & II. Power and Daginawala
11. Microbiology. P.D.Sharma

M.Sc. Biotechnology

First Semester Examination
Paper-1.3 BT-513 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 three sections.*

- **Section-A** will carry 10 marks with 01 compulsory question comprising 10 short answer type questions(maximum 20 words answer) taking two questions from each unit. Each question shall be of one mark.
- **Section-B** will carry 25 marks with equally divided into five long answer type questions (answer about in 250 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.
- **Section-C** will carry 35 marks with five long answer type questions comprising one compulsory question of 15 marks and four questions of 10 marks each. Students are instructed to attempt total three questions with one compulsory question (answer about in 500 words) and any two more questions (answer about in 400 words) out of remaining four questions. Paper setter shall be advised to design question paper covering from all five units..

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

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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.

UNIT – II **15-8L**

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 and 2D gel electrophoresis.
Nucleic acid hybridizations Technique: colony, plaque, dot blot, southern, northern and western blotting. *In situ* 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. Omics Technology: Genomics, transcriptomics, proteomics, metabolomics. Biochips.
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, MALDI-TOF. X Ray Microanalysis, Techniques with radioisotopes: GM counter, Scintillation counter, Autoradiography, RIA,

Text/Reference books:

1. Introduction to Instrumentation in Life Sciences. P.S. Bisen & Anjana Sharma . 2013. CRC Press. Taylor & Francis group
2. Wilson K. and Walker J. (2008). Principles and Techniques of Biochemistry and Molecular Biology. Cambridge University Press.
3. Molecular Diagnostics: Promises & Possibilities 2010. Mousuni Dabnath , G.B.K.S. Prasad P.S. Bisen.
4. Nelson D and Cox MM. (2009). Principles of Biochemistry. W.H. Freeman and Company, New York.
5. Voet D and Voet JG. (2003). Biochemistry. John Wiley and sons New York.
6. Zubay G (2000). 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, Stryer L (2001). Biochemistry. W. H. Freeman, New York.
9. Nuclear Magnetic Resonance: Williams
10. A Biologist Guide to Principle and Techniques: Willson 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.

M.Sc. Biotechnology
First Semester Examination
Paper-1.4 BT-514 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 three sections.*

- **Section-A** will carry 10 marks with 01 compulsory question comprising 10 short answer type questions(maximum 20 words answer) taking two questions from each unit. Each question shall be of one mark.
- **Section-B** will carry 25 marks with equally divided into five long answer type questions (answer about in 250 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.
- **Section-C** will carry 35 marks with five long answer type questions comprising one compulsory question of 15 marks and four questions of 10 marks each. Students are instructed to attempt total three questions with one compulsory question (answer about in 500 words) and any two more questions (answer about in 400 words) out of remaining four questions. Paper setter shall be advised to design question paper covering from all five units..

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 biomoleculars. Acid, bases, pH, pk, and ionization of water. Buffers.

High energy phosphate compounds: Introduction, Phosphate group transfer free energy of hydrolysis of ATP and sugar phosphate. Henderson Hasselbalch equation, 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. Structure and functions of homo and heteropolysaccharides, glycoconjugates,

Carbohydrate Metabolism: Introduction, Aerobic and anaerobic pathways:, Glycogenolysis, Gluconeogenesis, Glycolysis.TCA cycle, Electron Transport chain, Oxidative phosphorylation, Chemiosmotic theory of ATP Synthesis Reductive TCA cycle, Glyoxylate cycle, amphibolic & anaplerotic reactions. Pentose phosphate pathway (HMP Shunt), Glycogen metabolism.

UNIT-III **15-18L**

Lipids-Introduction, Sources, Nomenclature,Classification. Properties and Functions. Steroids: Structure of steroid nucleus, biological role of cholesterol. Lipid Metabolism- Biodegradation of fatty acids, beta – oxidations of fatty acids. Ketone bodies production during starving and diabetes.

Biosynthesis of fatty acids – Acetyl-CoA carboxylase reaction, Fatty acid synthase complex, biosynthesis of palmitate. Biosynthesis of triacylglycerols, Biosynthesis of cholesterol, Prostaglandins.

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 biosynthesis. Protein structure (primary, secondary, tertiary and quaternary). Ramachandran plot. Protein degradation and Targeting.

UNIT- V **15-18L**

Nucleic Acid: Biosynthesis and degradation of Purines and Pyrimidines. Coenzymes and cofactors: Role and mechanisms of action of NAD^+/$NADP^+$, FAD, lipoic acid, thiamine, Pyrophosphate, Biotin, Pyridoxal Phosphate, B_{12} co-enzymes and Metal ions with specific examples. Water and Fat soluble Vitamins; Structure, distribution, interaction and functions.

Text/Reference books:

1. Wilson K. and Walker J. (2008). Principles and Techniques of Biochemistry and Molecular Biology. Cambridge University Press.
2. Nelson D and Cox MM. (2009). Principles of Biochemistry. W.H. Freeman and Company, New York.
3. Voet D and Voet JG. (2003). Biochemistry. John Wiley and Sons New York.
4. Zubay G (2000). Biochemistry. W. C. Brown, New York.
5. Berg J, Tymoczko J, Stryer L (2001). Biochemistry. W. H. Freeman, New York.
6. Robert K., Murray M.D., Granner D.K., Mayes P.A.and Rodwell V.I. Harper's Biochemistry. McGraw-Hill/Appleton and Lange.
7. Biochemistry: U, SatyaNarayan.
8. Biochemistry: Lehninger
9. Fundamental of Biochemistry: A.C.Dev.
10. Biochemistry: J.L. Jain.
11. Elements of Biochemistry : H.R. Shrivastava.

M.Sc. Biotechnology

First Semester Examination
Paper 1.5 BT 515 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 *Saccharomyces cerevisiae*.
13. Microscopy: simple, compound, Dark Field, phase contrast.
14. Micrometry: Calibration of stage and Occular micrometer and measurement of the given biological sample
15. Cleanliness, media preparation, sterilization, culture methods, dilution techniques in microbiology.
16. Staining techniques in microbiology i) Flagella staining ii) Negative staining 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 biochemical tests.-IMVIC, Catalase test, starch hydrolysis.
20. Bacterial growth curve-serial dilution, plating and turbidity measurement.
21. Antibiotics Sensitivity test.
22. Standard qualitative analysis of water (microorganisms).

M.Sc. Biotechnology

First Semester Examination
Paper 1.6 BT 516 Lab 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 Blotting Techniques.
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 pKa value and hence the dissociation constant of a given acid by using pH meter.
12. Estimation of protein: Lowry, Biuret and Bradford methods, standard curves, linear 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 of dyes.
16. Chlorophyll-a concentration measurement with acetone method using spectrophotometer.
17. Spectrophotometry: To find out absorption spectrum of given chromophore and /or oxidised and reduced forms (NAD and NADH).
18. Colorimetry: To determine the association constant of given indicator colorimetrically 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

M.Sc. Biotechnology

Second Semester Examination

Paper-2.1: BT-521 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 three sections.*

- **Section-A** will carry 10 marks with 01 compulsory question comprising 10 short answer type questions(maximum 20 words answer) taking two questions from each unit. Each question shall be of one mark.
- **Section-B** will carry 25 marks with equally divided into five long answer type questions (answer about in 250 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.
- **Section-C** will carry 35 marks with five long answer type questions comprising one compulsory question of 15 marks and four questions of 10 marks each. Students are instructed to attempt total three questions with one compulsory question (answer about in 500 words) and any two more questions (answer about in 400 words) out of remaining four questions. Paper setter shall be advised to design question paper covering from all five units..

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 prokaryptes 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, Pearson Education
2. Molecular Biology: D. Freifelder, Narosa Publishing House, New Delhi
3. Genome: T.A. Brown, John Wiley & Sons
4. Microbial Genetics: Freifelder, Narosa Publishing House, New Delhi
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 (ASM Publisher)
8. Molecular Biotechnology: S.B. Primrose
9. Molecular Biotechnology: Glick

M.Sc. Biotechnology

Second Semester Examination

Paper-2.2 BT-522 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 three sections.*

- **Section-A** will carry 10 marks with 01 compulsory question comprising 10 short answer type questions(maximum 20 words answer) taking two questions from each unit. Each question shall be of one mark.
- **Section-B** will carry 25 marks with equally divided into five long answer type questions (answer about in 250 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.
- **Section-C** will carry 35 marks with five long answer type questions comprising one compulsory question of 15 marks and four questions of 10 marks each. Students are instructed to attempt total three questions with one compulsory question (answer about in 500 words) and any two more questions (answer about in 400 words) out of remaining four questions. Paper setter shall be advised to design question paper covering from all five units..

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**

Down stream 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 biowarfar. 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 trade marks, 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, CBS Publishers &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.
6 S.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.

M.Sc. Biotechnology

Second Semester Examination

Paper -2.3: BT-523 Immunology and Immunotechnology

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 three sections.*

- **Section-A** will carry 10 marks with 01 compulsory question comprising 10 short answer type questions (maximum 20 words answer) taking two questions from each unit. Each question shall be of one mark.
- **Section-B** will carry 25 marks with equally divided into five long answer type questions (answer about in 250 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.
- **Section-C** will carry 35 marks with five long answer type questions comprising one compulsory question of 15 marks and four questions of 10 marks each. Students are instructed to attempt total three questions with one compulsory question (answer about in 500 words) and any two more questions (answer about in 400 words) out of remaining four questions. Paper setter shall be advised to design question paper covering from all five units..

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 and organs of immune system, Immunity - Innate and adaptive, Humoral and cell-mediated, Clonal selection theory, Hematopoiesis, Cells of Immune System, Lymphoid organs. Immunoprophylaxis –Active and passive immunization, Vaccines: Types and toxoids. 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, Multigene organization of immunoglobulin genes, Generation of antibody diversity.Class switching Antigen processing and presentation.

Complement system: Structure, complement pathways and biological consequence of complement activation.

Hybridoma Technology: Monoclonal antibodies production. Antibody engineering: Chimeric and Humanized monoclonal antibodies.

UNIT-III **15-18L**

Primary and 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); Killing Mechanisms by CTL and NK cells, Introduction to tolerance.

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**

Major Histocompatibility Complex: Structure and functions of MHC. HLA and tissue transplantation. Graft versus host reaction and rejection. Tissue typing methods for organ and tissue transplantations in humans. Cytokines: Structure and function.
Tumor Immunology: Tumor specific antigens. Immune response to tumors. Immunodiagnosis of tumors. Cancer Immunology. Immune response to SARS-CoV-2.

UNIT-V **15-18L**

Antigen- Antibody interaction - Agglutination, Precipitation, Immunofluorescence, ELISA, Radioimmunoassays; Immuno blotting, Immunofluorescence, Flow cytometry, Protein microarrays, *In vivo* methods: skin test and their applications. Epitope mapping, Detection of immune complex. Cell cytotoxic assay.
Autoimmune diseases- Addison's disease, Grave's disease, Hashimoto's thyroiditis, goodpasture's disease, rheumatoid arthristis. Systemic Lupus erythematosus, Multiple Sclerosis. Immune deficiencies- Primary and secondary.

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, New York.
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 and Sons, Incl.
6. Fundamental Immunology. Author – W.E. Paul, Raven Press, New York.
7. Fundamentals of Immunology. Authors – R.M. Coleman, M.F. Lombord and R.E. Sicard 2nded. C. Brown publishers.
8. Immunology. Authors – D.M. Weir and J. Steward 7thEd. (1993).
9. Immunology : Shailendra Sharma.
10. Immunology: C.V.Rao.

M.Sc. Biotechnology

Second Semester Examination
Paper 2.4 BT-524 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

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

- **Section-A** will carry 10 marks with 01 compulsory question comprising 10 short answer type questions (maximum 20 words answer) taking two questions from each unit. Each question shall be of one mark.
- **Section-B** will carry 25 marks with equally divided into five long answer type questions (answer about in 250 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.
- **Section-C** will carry 35 marks with five long answer type questions comprising one compulsory question of 15 marks and four questions of 10 marks each. Students are instructed to attempt total three questions with one compulsory question (answer about in 500 words) and any two more questions (answer about in 400 words) out of remaining four questions. Paper setter shall be advised to design question paper covering from all five units.

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, HAC, PAC, MAC), 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 and regulation. Microarray Technology.

UNIT-III **15-18L**

Protein Engineering and Processing of Recombinant proteins - Directed Mutagenesis- Oligo- nucleotide with M13 DNA, 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. Protein markers. DNA markerss Molecular marker: RAPD, RFLP, AFLP, ISR, SNP. Omics Technology: Genomics, transcriptomics, proteomics, metabolomics. Biochips.

UNIT- V **15-18L**

Genome analysis: Introduction, DNA typing, human genome project.

Genetically modified organisms: Introduction, Transgenic animals, Transgenic Plants. Transgenic Technology. Antisense technology.
Nanotechnology: Introduction and Biological materials. DNA nanotechnology. Stem cell technology.

Text/Reference books:

1. Molecular Biology of the Gene: Watson-Baker-Bell-Gann-Levine-Losick, 5th Edn., Pearson education
2. Molecular Biology: D. Freifelder, Narosa Publishing House, New Delhi
3. Genome: T.A. Brown, John Wiley & Sons
4. Microbial Genetics: D. Freifelder, Narosa Publishing House, New Delhi
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 (ASM Publisher)

M.Sc. Biotechnology

Second Semester Examination
Paper 2.5 BT 525 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. Instrumentation of fermentor: Design of various types of fermentors & bioreactors.
12. Operation of fermentor.
13. Batch fermentation in conical flask
14. Solid state fermentation
15. Screening of microbes for production of industrially important enzymes.
16. Optimization of conditions for optimal production: - Media composition, Incubation temperature, Aeration, Incubation time.
17. Determination of TDP of an organism.
18. Determination of TDT of an organism.
19. To demonstrate DSP.
20. Searching of India Patent databases
21. Drafting and filing of Indian Patent databases
22. Searching of International Patent application
23. Drafting and filing of International Patent application

M.Sc. Biotechnology

Second Semester Examination
Paper 2.6 BT 526 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. Restiction 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 & their usefulness.
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 BT-631– Basic And Applied 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 three sections.*

- **Section-A** will carry 10 marks with 01 compulsory question comprising 10 short answer type questions (maximum 20 words answer) taking two questions from each unit. Each question shall be of one mark.
- **Section-B** will carry 25 marks with equally divided into five long answer type questions (answer about in 250 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.
- **Section-C** will carry 35 marks with five long answer type questions comprising one compulsory question of 15 marks and four questions of 10 marks each. Students are instructed to attempt total three questions with one compulsory question (answer about in 500 words) and any two more questions (answer about in 400 words) out of remaining four questions. Paper setter shall be advised to design question paper covering from all five units..

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**

Structure and organization of animal cell. Animal cell culture- Equipment and facilities for animal cell culture. Cell culture technique: cell culture media, sterilization techniques, cell lines, maintenance and cell adaptation. Media and its preparation, pH and pH maintenance in culture media, role of carbon dioxide, serum and- serum free media, artificial media. Concept of stem cell, totipotency, pluripotency and induced pluripotency.

UNIT-II **15-18L**

Types of animal cell culture- primary and secondary cell culture, development of cell lines or established cultures. Biological characterization of cell cultures, contact inhibition, cell transformation, cancer cells, indefinite cell lines, anchorage dependence, stem cell culture, embryonic stem cell culture and 3D cell culture.Measurement of cell viability, cytotoxicity. Screening of cytotoxic compounds and its importance.

UNIT-III **15-18L**

Basic techniques of mammalian cell culture, methods of sub culturing. Scaling up of cell cultures, bioreactors for animal cell cultures. Biotechnological application in animal improvements: Embryo biotechniques, *in vivo* and *in vitro* embryo production and preservation, sexing, micromanipulation and cloning.

UNIT-IV **15-18L**

Stem cell research- types of stem cells, application of stem cells. Somatic cell genetics, animal cloning and micromanipulation, Measurement of cell death; Apoptosis. Mapping of genome and genome sequencing. Marker assisted selection. Gene banking. Genetic manipulation of microbes to improve feed utilization and health.

UNIT-V **15-18L**

Methods of genetic transformations. Transgenic animals and its uses. Molecular diagnosis including PCR and DNA probes. Hybridoma and monoclonal antibodies. Cell culture based

vaccines. siRNA, Aptamers, antisense oligodeoxynucleotides (AS-ODN), Ribozymes, Peptide Nucleic Acids, Gene therapy- methods of gene therapy. Tissue engineering. Safety measures, hazards and ethics of animal cell culture.

Reference books:

1. Animal Cell Culture John R.W. Masters Oxford University Press
2. R.Ian Freshney, Culture of Animal Cells, 5th Edition, Wiley-Liss, 2005
3. Modern Concepts of Biotechnology H.D. Kumar Vikas Publishing House Pvt. Ltd., New Delhi.
4. Butler. M 2014, Animal Cell Biotechnology-Methods & Protocol (Portner, R ed.) Springer.
5. Practical animal breeding. Blackwell Science.
6. Houdebine L.M. Animal transgenesis and cloning. Wiley Publishers.
7. Akano IE. DNA technology. IAP Academic Press.
8. Micklos DA, Fryer GA & Crotty DA. DNA science. Cold Spring Harbour.
9. Setlow JK. Genetic Engineering - Principles and methods. Springer.
10. Hare WCD & Elizabeth L Singh. Cytogenetics in animal reproduction. CABI

M.Sc. Biotechnology

Third Semester Examination

Paper3.2 BT-632– Basic And Applied Plant 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 three sections.*

- **Section-A** will carry 10 marks with 01 compulsory question comprising 10 short answer type questions(maximum 20 words answer) taking two questions from each unit. Each question shall be of one mark.
- **Section-B** will carry 25 marks with equally divided into five long answer type questions (answer about in 250 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.
- **Section-C** will carry 35 marks with five long answer type questions comprising one compulsory question of 15 marks and four questions of 10 marks each. Students are instructed to attempt total three questions with one compulsory question (answer about in 500 words) and any two more questions (answer about in 400 words) out of remaining four questions. Paper setter shall be advised to design question paper covering from all five units..

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 Tissue Culture: General Introduction; Concept of Totipotency, Historical Background; Concept of asepsis and methods of sterilization. Laboratory planning and design. Basic tools and techniques of *in vitro* culture, Explant selection and surface sterilization, Composition and preparation of tissue culture media.

UNIT-II **15-18L**

Micropropagation: Pathways (Axillary bud proliferation, adventitious shoot bud differentiation, callus organogenesis and somatic embryogenesis), meristem tip culture and production of virus - free plants. Thermotherapy, chemotherapy, virus indexing, Applications and limitations. Anther, pollen and ovule culture for haploid production, in vitro fertilization and ovary culture; Somaclonal Variations-Isolation of somaclonal variants, molecular basis, Applications and Limitations.

UNIT-III **15-18L**

Germplasm conservation and cryopreservation: Importance, methods of conservation: In situ and ex situ conservation; In vitro conservation, cryopreservation technique – importance of cryopreservation, pretreatment, freezing methods, cryoprotectants, vitrification.Protoplast Culture: Isolation, purification and regeneration of protoplast; Testing of viability of isolated protoplast; Somatic hybridization and methods of protoplast fusion; Selection of hybrids, Practical applications of somatic hybridization (hybrids/cybrids).

UNIT-IV **15-18L**

Plant Transformation Technology: Features of Ti and Ri plasmid; The basis of tumour formation, mechanisms of DNA transfer, role of virulence genes; Vectors engineered from Ti plasmid; Use of 35S and other promoters;Methods of nuclear transformation, Direct DNA transfer: particle bombardment, electroporation, microinjection;Transgene stability and gene silencing.

UNIT-V **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 and flowers, Production of vaccines/ plantibodies in GM plants, Terminator gene technology, Transplastomics , cis-genics, Applications of genome editing.

Reference books:

1. Plant tissue culture and its biotechnological applications by W. Barz, E. Reinhard, M.H. Zenk
2. Purohit, SD 2013, Introduction to Plant Cell, Tissue and Organ Culture, PHI Learning Private Limited, Delhi.
3. Plant tissue culture by Akio Fujiwara
4. Frontiers of plant tissue culture by Trevor A. Thorpe
5. *In vitro* haploid production in higher plants by S. Mohan Jain, S.K. Sopory, R.E. Veilleux
6. Plant tissue culture: theory and practice by S.S. Bhojwani and A. Razdan
7. Plant cell, tissue and organ culture, applied and fundamental aspects by Y.P.S. Bajaj and A. Reinhard.
8. Plant Tissue Culture by MK Razdan & SS Bhojwani (1996) Elsevier
9. Plant Biotechnology by H.S.Chawla.
10. Plant Biotechnology and Transgenic Plants, Edited by KirsiMarjaOksman-Caldentey, Wolfgang Barz Marcel Dekker 2002
11. Plant Tissue Culture Concepts and Laboratory Exercises, Second Edition, Robert N Trigiano,Dennis J Gray, CRC Press November 1999

M.Sc. Biotechnology

Third Semester Examination

Paper3.3 BT-633– Environmental Biotechnology

Contact Hours / Week Marks	: 4 Hours	Maximum Marks	: 100
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 three sections.*

- **Section-A** will carry 10 marks with 01 compulsory question comprising 10 short answer type questions(maximum 20 words answer) taking two questions from each unit. Each question shall be of one mark.
- **Section-B** will carry 25 marks with equally divided into five long answer type questions (answer about in 250 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.
- **Section-C** will carry 35 marks with five long answer type questions comprising one compulsory question of 15 marks and four questions of 10 marks each. Students are instructed to attempt total three questions with one compulsory question (answer about in 500 words) and any two more questions (answer about in 400 words) out of remaining four questions. Paper setter shall be advised to design question paper covering from all five units..

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**

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. Methods of solid waste management. Biomedical waste and its disposal. Incineration, composting, vermi-composting and vermi-culture. 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.

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 in an ecosystem and crop productivity. Rhizobia and other symbiotic and non-symbiotic 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. 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 Mohapatra I. K. International Pvt Ltd
5. Environmental Biotechnology: Basic Concepts and Applications By Indu Shekhar Thakur
6. 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

M.Sc. Biotechnology

Third Semester Examination

Paper3.4 BT-634– 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 three sections.*

- **Section-A** will carry 10 marks with 01 compulsory question comprising 10 short answer type questions(maximum 20 words answer) taking two questions from each unit. Each question shall be of one mark.
- **Section-B** will carry 25 marks with equally divided into five long answer type questions (answer about in 250 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.
- **Section-C** will carry 35 marks with five long answer type questions comprising one compulsory question of 15 marks and four questions of 10 marks each. Students are instructed to attempt total three questions with one compulsory question (answer about in 500 words) and any two more questions (answer about in 400 words) out of remaining four questions. Paper setter shall be advised to design question paper covering from all five units..

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, 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, interferons-principle, 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

M.Sc. Biotechnology

Third Semester Examination
Paper 3.5 BT 635 Lab Course V

Practical Exercises

1. To study the development and maintenance of animal cell line.
2. Studying cell death and cytotoxicity by staining methods
3. Differentiation of the viable and nonviable cell by staining methods.
4. Introduction to culture environment, medium and culture vessels for animal cell culture.
5. Preparation of culture media and concept of sterilization in animal cell culture.
6. Demonstration of establishment of primary cell culture by trypsinization
7. Identification of cell types by maceration method.
8. Preparation of metaphase chromosome from cultured cells.
9. Micronucleus test.
10. Immunofluorescence detection to check transfection efficiency (using fluorescence and confocal microscopes)
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. Callus induction & Production of secondary metabolites.
19. Preparation of synthetic seeds.
20. Induction of hairy root cultures using *Agrobacterium rhizogenes* for the production of secondary metabolites
21. Preparation of recombinant plant expression vector with gene of interest
22. Genetic transformation of plant tissue using *Agrobacterium tumefaciens.*
23. Confirmation of transgenic plants by PCR and southern blotting techniques

M.Sc. Biotechnology

Third Semester Examination
Paper 3.6 BT 636 Lab Course VI

Practical Exercises

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.
13. Genotyping of candidate genes for diseases by RFLP, Microsatellite & VNTR analysis
14. Screening for known mutations by ARMS-PCR/ASO.
15. Screening for unknown mutations by SSCP and sequencing.
16. Detection for dynamic mutations- Trinucleotide repeat polymorphism.
17. Identification of disease gene expression by Real-time PCR.
18. Sequencing of cDNA and cloning in expression vectors.
19. Detection of congenital abnormalities by triple test.
20. Preparation of Ag nano particles and testing their anti microbial effect.
21. Encapsulation of lymphocytes/ RBCs.

M.Sc. Biotechnology

Fourth Semester Examination

Paper 4.1 BT-641– 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 three sections.*

- **Section-A** will carry 10 marks with 01 compulsory question comprising 10 short answer type questions(maximum 20 words answer) taking two questions from each unit. Each question shall be of one mark.
- **Section-B** will carry 25 marks with equally divided into five long answer type questions (answer about in 250 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.
- **Section-C** will carry 35 marks with five long answer type questions comprising one compulsory question of 15 marks and four questions of 10 marks each. Students are instructed to attempt total three questions with one compulsory question (answer about in 500 words) and any two more questions (answer about in 400 words) out of remaining four questions. Paper setter shall be advised to design question paper covering from all five units..

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. Fermentation economics; market analysis; equipment and plant costs; media; sterilization, heating and cooling; aeration and agitation; bath-process cycle times and continuous cultures; recovery costs; water usage and recycling; measurement and control of bioprocess parameters; scale up and scale down process. 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,.

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.

UNIT V **15-18L**

Protein engineering in food technology: methods, targets and applications in foods. Bioelectronics: Biochips and biosensors. Microbial production of Interferon, Insulin, flavours and fragrances. Microbial production of vaccines. Microbial production of polymers:Dextran and xanthan. 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.

M.Sc. Biotechnology

Fourth Semester Examination

Paper 4.2 BT-642– 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 three sections.*

- **Section-A** will carry 10 marks with 01 compulsory question comprising 10 short answer type questions (maximum 20 words answer) taking two questions from each unit. Each question shall be of one mark.
- **Section-B** will carry 25 marks with equally divided into five long answer type questions (answer about in 250 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.
- **Section-C** will carry 35 marks with five long answer type questions comprising one compulsory question of 15 marks and four questions of 10 marks each. Students are instructed to attempt total three questions with one compulsory question (answer about in 500 words) and any two more questions (answer about in 400 words) out of remaining four questions. Paper setter shall be advised to design question paper covering from all five units..

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 statistics: Aim and Scope of statistics, Sample size & Sampling. Tabulation and graphics representation. Measure of central tendency, Measure of dispersion, Range, Standard deviation, Lorenz curve.
Skewness and kurtosis: Definition, Types and measures of skewness. Kurtosis.
Correlation analysis: Definition,Types of Methods of correlation- scatter diagram, Karl Pearson's coefficient, Rank correlation.
Regression analysis: Regression Line, regression equations. Multiple regression.

UNIT-II **15-18L**

Probability theory: Types and Theorems. Theoretical distributions: Binomial, Poission and Normal distribution.
Hypothesis Testing: population and sample, sampling and non sampling error. Steps in tests of hypothesis. Sampling and non sampling error. Test of significance for attributes. Test for number of success and proportion of success. Test of significance for variables (Large samples)- tests of differences between means of two samples and between two standard deviations. Tests of significance for variables (Small samples)- Students t-distribution, F-Test. Chi-square, ANOVA

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, SPDV, HyperChem), Data submission tools (Bankit, Sequin, Webin, Sukura, Spin, AutoDep).

UNIT-IV **15-18L**

Algorithms: Classification of algorithms. Sequence Comparison algorithms. Submission metrics algorithms, Tools for sequence alignment. Gene Prediction: Methods, Gene mapping:

DNA sequencing, Sequence alignment optimal algorithms. 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. Molecular descriptors in QSAR studies, Small molecule force field parameters (charges), potentials, Active site identification, ligand docking, Drug stability, synthesizability and drug delivery. Steps and software of 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 education, Singapore.
5. A.R. Leach, Molecular Modeling- Principles and Applications, Second Edition, Pearson.
6. David W. Mount. 2003. Bioinformatics: Sequence & Genome Analysis.CBS Publishers and Distributors. New Delhi.
7. Westhead. D. R, Parish. J. H and Twyman. R. M, 2003. Bioinformatics. Viva Books Private Limited, New Delhi.
8. C.R., Kothari,Research methodology.

M.Sc. Biotechnology

Fourth Semester Examination
Paper 4.3 BT-643– Dissertion

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

M.Sc. Biotechnology

Fourth Semester Examination
Paper 4.4 BT 644 Lab Course VII

Practical Exercises

1. Immobilization of cells and enzymes.
2. Instrumentation of fermentor. Design of various types of fementers & 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 perform multiple sequence alignment using CLUSTAL-W and to find conserved sequences using JAL view.
22. To prepare Phylogenetic tree and Cladogram using CLUSTAL-W
23. 3D protein structure prediction and structure refinement using Swiss-PDB viewer
24. Representation of statistical data by
    a. Histogram 2. O give curves 3. Pie diagrams
25. Collection of data using different sampling methods

26. Determination of Averages or Central tendencies (Mean, Mode, Median)
27. Determination of measures of dispersion (Mean deviation, Standard deviation and Coefficient of variation, Quartile deviation)
28. Application of Tests of significance (Chi-Square test, student t-test, Standard error)
29. Applications of computers in biology using MS-office (MS-Word, Excel, Power point)

M.Sc. Biotechnology

Fourth Semester Examination

Paper 4.5 BT 645 Comprehensive Viva Voce

A viva-voce of all the papers of all the semesters will be conducted at the end of semester of the programme by a board of examiners.