SCHEME OF EXAMINATION
RULES & REGULATIONS
AND
SYLLABUS

(Applicable for Academic Session 2020-2021)

Master of Science (M.Sc.)
Microbiology

Faculty of Science

UNIVERSITY OF KOTA

MBS Marg, KOTA (Rajasthan)-324 005
INDIA

CONTENTS

University of Kota, Kota

M.Sc. Microbiology

Semester wise Consolidated Common Scheme of Examinations for the Academic Sessions 2019-2021

Year / Semester	Number, Code or ID and Nomenclature of Paper			Duration of Exam. (in Hrs.)	Teaching Hrs / Week		Distribution of Assessment Marks					
	Number of Paper	Code / ID of Paper	Nomenclature of Paper				Continuous or Internal Assessment (30%)		Semester or External Assessment (70%)		Total	
					Teaching		Max. Marks	Min. Pass Marks	Max. Marks	Min. Pass Marks	Max. Marks	Min. Pass Marks
					Th.	Pr.						
1st Year I Semester	Paper-1.1	MB-511	General Microbiology	3	4	-	30	12	70	28	100	40
	Paper-1.2	MB-512	Cell Biology and Enzymology	3	4	-	30	12	70	28	100	40
	Paper-1.3	MB-513	Microbial Genetics	3	4	-	30	12	70	28	100	40
	Paper-1.4	MB-514	Biochemistry and Microbial Physiology	3	4	-	30	12	70	28	100	40
	Paper-1.5	MB-515	Lab Course-I	6	-	9	--	--	100	50	100	50
	Paper 1.6	MB-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	MB-521	Microbial Diversity	3	4	-	30	12	70	28	100	40
	Paper-2.2	MB-522	Molecular Biology	3	4	-	30	12	70	28	100	40
	Paper-2.3	MB-523	Immunology and Immunotechnology	3	4	-	30	12	70	28	100	40
	Paper-2.4	MB-524	Tools and Techniques of Molecular Biology	3	4	-	30	12	70	28	100	40
	Paper-2.5	MB-525	Lab Course-III	6		9			100	50	100	50
	Paper 2.6	MB-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	MB-631	Soil and Agriculture Microbiology	3	4	-	30	12	70	28	100	40
	Paper-3.2	MB-632	Microbial Ecology	3	4	-	30	12	70	28	100	40
	Paper-3.3	MB-633	Environmental Microbiology and Microbiology of Waste	3	4	-	30	12	70	28	100	40
	Paper-3.4	MB-634	Biofuel and Bioenergy	3	4	-	30	12	70	28	100	40
	Paper-3.5	MB-635	Lab Course-V	6	-	9	--	--	100	50	100	50
	Paper-3.6	MB-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	MB-641	Industrial Microbiology/Medical Microbiology	3	4	-	30	12	70	28	100	40
	Paper-4.2	MB-642	Biostatistics, Bioinformatics and Research Methodology	3	4	-	30	12	70	28	100	40
	Paper-4.3	MB-643	Dissertation	3	-	-	--	--	200	100	200	100
	Paper-4.4	MB-644	Lab Course-VII	6	-	9	-	-	100	50	100	50
	Paper-4.5	MB-645	Comprehensive viva voce	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**

Rules & Regulations

Objectives of the Course:

Microbiology discipline deals the understanding of knowledge from basic to advanced level on the biochemistry, physiology, cell biology, ecology, evolution and clinical aspects of micro-organisms including the host response to these agents. Recent trends from the industry focus on production of totally new eukaryotic compounds like insulin, interferon and other recombinant products using micro-organisms at industrial scale. Many new recombinant vaccines are produced to replace crude vaccines and make them polyvalent to reduce the dosage. The Master of Science in Microbiology programme builds a strong platform on biological education and research. The programme is especially dedicated to the integration and consolidation of deep knowledge in the field of microbiology.

Duration of the Course:

The course for the degree of Master of Science in Microbiology 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 Microbiology 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: Microbiology, Applied Microbiology, Biotechnology, Biochemistry, Biology, Chemistry, Botany, Zoology, Genetics, Environmental Sciences, Bioinformatics, Pharmaceutical Science, food microbiology or etc.
  - Bachelor of Science and Education (B.Sc.-B.Ed.) with subject biology, chemistry, botany, zoology.
- 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. Microbiology examination, prosecuting a regular course of study leading to the Master of Science in Microbiology, 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. Microbiology if he/she has already passed M.Sc. Microbiology 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. Microbiology programme of any University or statutory body will not be admitted to M.Sc. Microbiology 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 Microbiology 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 "MB-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, 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:

Continuous or Internal or Mid Term Assessment: *Not applicable in practical.*
External or Semester or End Term Assessment: For all Lab Courses.
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 …….……..

Syllabus

M.Sc. Microbiology
First Semester Examination

Paper 1.1: MB-511-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**

Overview of history of Microbiology: Contribution of Antonie Von Leeuwenhoek, Needham, Redi, Spallanzini, Tyndal, Joseph Lister, Paul Ehrlich, Edward Jenner, Louis Pasteur, Robert Koch, Alexander Fleming, Scope of Microbiology.
Microbial World: Classification system and distinctive characters of major groups: Fungi, Algae, Protozoa,Viruses,Viroids and Prions.
Microbial Taxonomy: Taxonomy, Bergey's manual of systematic bacteriology. Classification of microbes on the basis of phenotypic and genotypic characters.Aptamers for detection of pathogens.

UNIT II **15-18L**

Principles, function and application of Microscopy: Light, Dark field, Phase Contrast, Fluorescence interference, Confocal and Electron (transmission and scanning) Microscopy. Hanging drop, Wet mounting Method.
Stains and Staining Techniques: Definition of Auxochrome, Chromophores, dyes, Classification of Stains, Mechanism of Gram's, Capsule, Endospore, Flagella, Acid fast staining.

UNIT III **15-18**L

Concept of asepsis: Definition of Sterilization, disinfection, Sanitization, Antisepsis, Sterilants and Fumigation.
Physical methods: Moist and Dry heat, Pasteurization, Tyndallization, Radiation, Filtration. Chemical Methods: Phenol and its Derivatives, Aldehyde, Heavy metal, Halogens.
Culture Media,Isolation Techniques ,Maintenance and Preservation of pure cultures.

UNIT IV **15-18**L

Bacterial Morphology: size, shape and arrangement, glycocalyx, capsule, flagella, fimbriae and pili. Composition and detailed structure of gram positive and gram negative cell walls, spheroplasts, protoplasts, and L-forms. Ribosomes, mesosomes, inclusion bodies, nucleoid, chromosome and plasmids. Endospore: structure, formation,

stages of sporulation. Methods of reproduction in bacteria and new cell formation. Microbial Growth curve and its kinetics and growth yield. Determination of cell mass and cell number. Environmental factors affecting growth.Antibiotics their classification and Mechanism.

UNIT V **15-18**L

Innovations in microbiology for human welfare: Impact of microbes on the genome project,microbial biosensors, Nanobmedicines, molecular diagnostics. Probiotics microbes. Application of Artificial intelligence and machine learning in microbiology.
Microbes as a biowarfare agent, Microbes in the space.

Text/Reference books:

1. Microbes : Concepts & Applications- P.S. Bisen, Mousumi Debnath, Godavarthi B.K.S. Prasad , John Wiley & Sons Publication 2012.
2. Brock Biology of Microorganisms, 14thEdition. Michael T. Madigan, John M. Martinko, Paul V. Dunlap and David P. Clark.
3. Bergey`s manual of systematic bacteriology. George M.Garrity,David R. Boone,Richard W.Castenholz.
4. Molecular Diagnostics: Promises & Possibilities 2010. Mousuni Dabnath , G.B.K.S. Prasad P.S. Bisen.
5. General Microbiology by S. B. Sullia, 2017, Oxford Publisher's.
6. Prescott, L.M., J.P Harley and D.AKlein, 2007. Microbiology VII Ed.Mc Grow Hill,
7. Davis R.Y. E.A. Adeberg and J.L. Ingram,1991 General Microbiology
8. Stainer .General Microbiology, V Ed., Printice Hall of India Pvt,Ltd. New Delhi
9. Ronald M. Atlas 1997. Principles of Microbiology. II Ed. Mc Graw Hill Pub.
10. Salle A.J., Fundamental Principles of Bacteriology.
11. Microbiology Vol.I & II. Power and Daginawala
12. Microbiology. P.D.Sharma.
13. Microbiology: An Introduction. Tortora GJ, Funke BR, and Case CL.

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M.Sc. Microbiology
First Semester Examination

Paper 1.2: MB-512-Cell Biology and Enzymology

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**

Cell as a unit of living organism and structure of prokaryotic cell, Structural and functional features of eukaryotic cell.Cell organelles; endoplasmic reticulum, golgi complex, lysosomes, vacuoles, peroxisomes, mitochondria, chloroplast, cytoskeleton. Structure of nucleus and chromosomes of eukaryotes. Cancer biology: characteristics of cancer cell, types of cancer, oncogene and tumor markers.

UNIT II **15-18L**

Biological membranes: Membrane structure and transport mechanisms- diffusion, active and co-transport, secondary active transport, membrane selectivity, electrolyte selectivity, non electrolyte selectivity, stimuli, receptors, second messengers and cellular response, membrane channels and pumps. Cell cycle: mitosis and meiosis and their regulation. Programmed cell death and apoptosis. Stem cells. Types: Embryonic stem cell, induced pluripotent stem cells

Cell signaling and signal transduction pathways-Signalling molecules and their receptors. Function of cell surface receptors MAPK/ERK pathway, cAMP dependent pathway, IP_3/DAG Pathway.

UNIT III **15-18L**

General properties,structure,classification and nomenclature of enzymes. Enzyme activators, co-enzymes, co-factors and prosthetic groups in enzyme catalysis, Enzyme and substrate specificity. Enzyme activation, zymogens, multi-enzymes complexes and multifunctional enzymes. Mechanism of Enzyme Action.

UNIT IV **15-18L**

Factors affecting enzyme activity.Steady state kinetics: Methods of estimation of rate of enzyme catalyzed reaction with special reference to Michaelis-menton kinetics.

Enzyme inhibition and its kinetics: Reversible and irreversible inhibition, competitive, non competitive and uncompetitive, mixed, partial, substrate and allosteric inhibition.

UNIT V **15-18**L

Isoenzymes and its physiological significance, Ribozymes and Abzymes.

Enzyme engineering: Chemical modification of enzymes: methods of modification of primary structure, catalytic and allosteric properties, use of group specific reagents. Enzyme Immobilization Enzymes in non conventional media, Enzymes sensors, Enzymes as analytical reagents.

Text/Reference books:

1. Biochemistry: Lubert Stryer
2. Biochemistry: Lehninger
3. Microbial Physiology: Moat, Foster and Spector
4. Molecular biology of the cell: Bruce Alberts et al.
5. Cell and molecular biology: Gerald Karp.
6. Cell and molecular biology: P.K.Gupta.
7. Molecular cell biology: By Lodish
8. The Cell: Cooper.
9. Enzyme: Copeland.
10. Enzyme Technology: M F Chaplin and D C Bucks.
11. Enzymology and Enzyme Technology: S M Bhatt.
12. Essentials of Biochemistry: Dr Pankaja Naik, Jaypee Brothers Medical Publishers

M.Sc. Microbiology
First Semester Examination

Paper1.3: MB-:513- Microbial Genetics

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 Molecular Genetics. Cell cycle. DNA structure and types. Superhelicity in DNA. Law of DNA constancy, Cot curve and C value paradox, DNA renaturation kinetics and Tm value determination and interpretation, Repetitive DNA, Satellite DNA, Selfish DNA, DNA Compaction.

UNIT-II **15-18**L

Recombination: Types of recombination, Models for Homologous recombination, Molecular mechanism of homologous recombination, Homologous recombination in eukaryotes, Molecular mechanism and biological role of site specific recombination. Transposable elements in prokaryotes.

UNIT-III **15-18**L

Plasmid: types and their significance. Conjugation and chromosomal mobilization. E. coli as model prokaryote**s**: Conjugation by *E. coli* F factor. (Structure of F factor and regulation of F-factor fertility), F- prime conjugation, , Hfr and chromosomal mobilization.

UNIT-IV **15-18**L

Transformation: Mechanism of natural competence and transformation in *Bacillus subtilis*, *Streptococcus pneumoneae and Haemophilus influenzae.* Transformation by artificial competence. Gene linkage and mapping by transformation. Transduction- specialized and generalized transduction and its applications.

UNIT-V **15-18**L

Regulation of gene expression: Operon concept, catabolite repression, positive and negative regulation: inducers and co-repressors. Negative regulation in *E. coli* lac operon. Positive regulation in *E. coli* ara operon; regulation by attenuation of his and trp operons.

Text/Reference books:

1. Genetics of Bacterial by Sheela Shrivastava, 2013 Springer Publisher.
2. Concepts of genetics: Klug and Cummings
3. Genetics: From Genes to Genomes: Leland Hartwell, Leroy E. Hood, Michael L. Goldberg
4. Genetics: Analysis and Principles (3rd Edition): Brooker
5. Gene cloning : T.A.Brown
6. Cell and molecular Biology : P.K. Gupta.

M.Sc. Microbiology
First Semester Examination
Paper 1.4 MB- 514- Biochemistry and Microbial Physiology

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**

Water, acid, base and buffers, pH and pH indicators, Solutions, Redox potential, Hydrogen bonding; Hydrophobic, Electrostatic and Vander Waal forces. Scope and importance of biochemistry . Bioenergetics and metabolism: Basic concepts. First and second law of thermodynamics. High energy phosphate compounds. Biological redox reactions, Biological reducing power and its role in biological system.

UNIT II **15-18**L

Carbohydrate and glycobiology: Structure, properties and functions of carbohydrates. Gluconeogenesis,Glycogenolysis, Glycolysis. Citric acid cycle, Electron transport system, Oxidative phosphorylation, inhibitors of oxidative phosphorylation. Chemiosmotic theory of ATP, Glyoxalate Cycle, Pentose phosphate pathway, E-D pathway, Amphibolic and Anapleurotic reaction, Photosynthesis: Oxygenic and an-oxygenic.

UNIT III **15-18**L

Amino acids: structure, classification, properties and functions. 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 IV **15-18**L

Lipids: classification, structure, 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 **.**

Biological Nitrogen Fixation: Nitrogen fixing organisms, difference in symbiotic and non symbiotic fixation. Oxygen Protection mechanisms. nif gene organization and regulation

UNIT V **15-18**L

Nucleic acids: structure and properties.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. Advances in Microbial Physiology, 2020 editor: Robert Poole Elsevier Publisher
2. Wilson K. and Walker J. (2008). Principles and Techniques of Biochemistry and Molecular Biology. Cambridge University Press.
3. Nelson D and Cox MM. (2009). Principles of Biochemistry. W.H. Freeman and Company, New York.
4. Voet D and Voet JG. (2003). Biochemistry. John Wiley and sons New York.
5. Zubay G (2000). Biochemistry. W. C. Brown, New York.
6. Berg J, Tymoczko J, Stryer L (2001). Biochemistry. W. H. Freeman, New York.
7. Moat AG and Foster J W (2003). Microbial Physiology. John Wiley and Sons, New York.
8. Robert K., Murray M.D., Granner D.K., Mayes P.A.and Rodwell V.I. Harper's Biochemistry. McGraw-Hill/Appleton and Lange.
9. Biochemistry U, SatyaNarayan.
10. Biochemistry: Lehninger
11. Fundamental of biochemistry by A.C.Dev.
12. J.L. Jain, Biochemistry.
13. Elements of biochemistry by H.R. Shrivastava.

M.Sc. Microbiology
First Semester Practical Examination
Paper 1.5 MB- 515 Lab Course-I

1. Good Microbiology laboratory practices: Laboratory safety (Dos and Don'ts), hazard from chemicals, handling of cultures and chemicals, disposal of chemicals and cultures.
2. Introduction to different Glass wares used in Microbiology Laboratory.
3. To learn handling of different instruments and Equipments used for culture and Sterilization**.**
4. Techniques of pure culture isolation-pour plate, spread plate, streaking.
5. Preparation of Basic Liquid and Solid media for cultivation of bacteria and fungi.
6. Isolation and Enumeration of microorganisms from Air (plate exposure method), Soil and Water (serial dilution method)
7. To perform different staining methods to study morphological and structural characteristics of bacteria and fungi a. Gram Staining b. Acid fast staining c. Fungal staining (Lacto-phenol cotton blue) d. Spore staining e. Flagella staining f. Capsule staining (Negative staining)
8. To check motility of bacteria by hanging drop and semi solid agar methods
9. To learn culture preservation techniques (Agar slants, stabs and glycerol stocks)
10. Calibration of an ocular micrometer for different objectives of microscope.
11. Measurement of microorganisms by the use of an ocular micrometer.
12. To study microorganisms under dark and phase contrast microscope.
13. To study activity of disinfectants.
14. Bacterial growth curve-serial dilution, plating and turbidity measurement.
15. Standard qualitative analysis of water (microorganisms).
16. Antibiotics sensitivity test.
17. Study the effect of colchicine on the mitotic division of the Onion root tip .
18. Identification and study of cancer cells by photomicrographs.
19. Study of different stages of mitosis and meiosis.
20. Urease estimation by titrimetric method.
21. Urease estimation by colorimetric method.
22. Acid Phosphatase estimation.
23. Alkaline Phosphatase estimation.
24. Estimation of amylase.
25. Study of enzyme kinetics – calculation of *V*max, Km, Kcat values

M.Sc. Microbiology
First Semester Practical Examination
Paper 1.6 MB- 516 Lab Course-II

1. Triple Sugar Iron Test.
2. IMVIC Test
3. Oxidase test
4. Casein hydrolysis.
5. Urease test
6. H_2S Production
7. Catalase Test.
8. Separation of amino acids by paper chromatography
9. Thin layer chromatography:Amino acids, lipids, mixture of dyes.
10. Qualitative estimation of lipid, carbohydrates & proteins.
11. Reducing sugar estimation by benedict's method.
12. Colorimetry: To determine the association constant of a. given indicator colorimetrically and to prepare the buffer solutions in pH range of 2.2 to 8.0
13. Spectrophotometry: To find out absorption spectrum of given chromophore and /or oxidised and reduced forms (NAD,NADH).
14. Chlorophyll-a concentration measurement with acetone method using spectrophotometer
15. Separation of sub cellular organelles by differential centrifugation.
16. Polyacrylamide gel electrophoresis of proteins.
17. Separation of DNA by gel electrophoresis.
18. To induce mutation by UV radiations and to exhibit DNA repair by photo reactivation.
19. To isolate and produce UV induced auxotrophic mutants by replica plating method.
20. Study of sex linked gene inheritance.
21. Estimating gene frequencies in human population,
22. Recombination in Bacteria.
23. To check purity and quantity of DNA by Spectrophometeric method.

M.Sc. Microbiology
Second Semester Examination
Paper 2.1: MB-521 Microbial Diversity

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**

Evolutionary (Phylogenetic) tree of microorganisms. Classification of microorganisms – Haeckel's three kingdom concept, Whittaker's five kingdom concept, Three domain concept of Carl Woese, Classification systems-artificial, natural and phylogenetic,Classification and salient features of bacteria according to the Bergey's manual of determinative bacteriology.

UNIT II **15-18**L

Fungi: Recent Trends in fungal systemetics (Alexopolus & Mims), Fungi (habitat, nutritional requirements, fungal cell ultrastructure, thallus organization and aggregation, fungal wall structure and synthesis, asexual reproduction, sexual reproduction, Life cycle) , heterokaryosis Parasexuality and Heterothallism. Economic Importance (Agriculture, Environment, Industry, Medicine, Food, Biodeterioration, Mycotoxins).

UNIT III **15-18**L

Algae: Definition, occurrence, Classification upto class level, Ultra-structure, Reproduction and Life cycle. Economic importance (Agriculture, Industry, Environment and Food)
Protozoa (Occurrence,classification ,Ultrastructure, Reproduction, Economic importance).
Virus (Definition, Structure, multiplication and replication,Capsids). Virus related agents–Viroids, Prions.
Bacteriophages: Structure, Life cycle –Lytic & Lysogenic

UNIT IV **15-18**L

Characteristics of important genera and physiology of: Chemoautotropihic and Methanogenic eubacteria, Gram negative aerobic eubacteria, Gilding bacteria (Myxobacteria), Enteric group and related eubacteria, Gram negative anaerobic eubacteria, Gram negative eubacteria- Rickettsia, Chlamydia and Spirochaetes. Gram positive eubacteria- Unicellular endospore forming eubacteria, Actinomycetes.

UNIT V **15-18**L

General Characters, Classification, Adaptations and Physiology of Archaebacteria: methanogens, Acidophiles, Halophiles, Thermoacidophiles.

Cyanobacteria: General characters , Ultra structure, Reproduction and Economic importance. Photosynthetic eubacteria : Anoxygenic and oxygenic photosynthesis, Sulfur or Non Sulfur Bacteria (purple and green), Mollicutes. Gram positive fermentative eubacteria. Bdellovibrio and its interperiplasmic growth cycle.

Text/Reference books:

1. Michael T. Madigan, John M. Martinko, Paul V. Dunlap and David P. Clark, Brock Biology of Microorganisms, 13th Edition,Pearson Education, Limited, 2011.
2. Microbial Diversity : Principles of microbial diversity.James W.Brown.Wiley Blackwell Publishers.2014.
3. Microbes : Concepts & Applications- P.S. Bisen, Mousuns Debnath, Godavarthi B.K.S. Prasad , Wiley Blackwell . John wiley & Sons Publication 2012.
4. Pelczar, M.J., ChanE.C.S. and Krieg, N.R., Microbiology –Application based approach, 5th edition, Mc Graw Hill, 2009.
5. Tortora,G. Microbiology: An Introduction-Benjamin Cummings, 10thEdition, 2009.
6. Willey J, Sherwood and Woolwerton C, Prescott, Harley and Klein's, Microbiology, 8thEdition, McGraw Hill International, 2010.
7. Singh, Pandey, Jain. A text Book of Botany, 2016

M.Sc. Microbiology
Second Semester Examination
Paper 2.2 MB-522- 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**

The nature of Genetic material: The structure of DNA and RNA. Organization of Microbial Genomes, Organization of Eukaryotic Genomes, Chromatin arrangement, nucleosome and solenoid structure of DNA. Genetic code. introduction of Central dogma.

UNIT II **15-18**L

DNA Replication: DNA replication in prokaryotes and eukaryotes- Initiation, elongation and termination. Enzymology of replication. Regulation of replication. code. Proofreading of DNA with reference to specific enzymes and co-factors. Mutations: Types of Mutations and mutagens. Molecular mechanisms of induced mutation, DNA damages and it repair pathways.

UNIT III **15-18**L

Transcription: Transcription machinery of prokaryotes and eukaryotes -initiation, elongation and termination, various transcription enzymes and cofactors. Transcription eukaryotes -initiation, elongation and termination Types of RNA polymerase. Regulation of transcription. Promoters, enhancers, silencers, activators

UNIT IV **15-18**L

Translation: Mechanisms of translation in prokaryotes and eukaryotes- initiation, elongation and termination. RNA processing: splicing, capping and polyadenylation, rRNA and tRNA, processing, RNA Editing, RNAi: miRNAs and siRNA, Post-transcriptional gene regulation. Ribozymes.

UNIT V **15-18**L

Genetic Engineering: Principle and basic tools and application. Gene cloning vectors: DNA sequencing methods, Gene libraries, Human genome project ,Genetic disorders. Genetically modified organisms, IPR,Transgenic Technology. Antisense technology.
Nanotechnology, DNA nanotechnology. Stem cell technology.

Text/Reference books:

1. Molecular Biology: D. Freifelder
2. Molecular biotechnology: Glick.
3. Gene VII: Lewin Benjamin (Oxford)
4. Molecular Cell Biology: J.Darnell, H.Lodhis & D.Baltimore (W.H.Freeman & Co.)
5. Genetics: From Genes to Genomes by Leland Hartwell, Leroy E. Hood, Michael L. Goldberg
6. Genetics: Analysis and Principles (3rd Edition) : Brooker
7. Gene cloning : T.A.Brown
8. Genetic Engineering : Nicoll
9. Molecular Biology and Genetic Engineering: P.K.Gupta

M.Sc. Microbiology
Second Semester Examination
Paper 2.3-MB-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**

Historical account and introduction to immune system. Innate and acquired immunity. Humoral and cell mediated immune responses. Cells and tissues of immune system – Structure, Functions and Properties of: Immune Cells – Stem cell, T cell, B cell, NK cell, Macrophage, Neutrophil, Eosinophil, Basophil, Mast cell, Dendritic cell; and Immune Organs – Bone Marrow, Thymus, Lymph Node, Spleen, GALT, MALT, CALT. Immunoprophylaxis – Active and passive immunization, Vaccines: whole organism vaccine, subunit vaccine, vaccine, DNA vaccine, recombinant vaccine, subunit vaccines and anti-idiotype vaccine.

UNIT-II **15-18**L

Antigens: Structure and properties, Types, haptens, adjuvants, antigen specificity, Epitopes (T & B cell epitopes); T-dependent and T-independent antigens; Immunoglobulins- structure, heterogeneity, types and properties. Molecular mechanism of antibody diversity and class switching. Antigen processing and presentation. Cytokines: profile and functions.

Complement system: components, activation pathways, regulation of activation pathways.

UNIT-III **15-18**L

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. Antibody: Mediated – type I. Anaphylaxis; Type II. Antibody dependent cell cytotoxicity; Type III immune complex mediated reactions; Type IV Cell mediated hypersensitivity reactions.

UNIT-IV **15-18**L

Major histocompatibility complex: organization of MHC genes, types and function of MHC molecules, antigen presentation. Transplantation immunology: immunologic basis of graft rejection, HLA typing methods.

Autoimmunity–mechanism and diseases. Tumorimmunology: cancer,oncogenes,tumor antigens,immune response to tumors, tumor evasion of the immune system, immunodiagnosis. . Imunodeficiencies:congenital and acquired .Immune response to SARS-Cov-2.

UNIT-V **15-18**L

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

Text/Reference books:

1. Essentials of Immunology, Author- Roitt, I.M., ELBS. Blackwell Scientific Publishers, London.
2. Immunology II Edition, Author- Kuby, J. WH., Freeman and Company, New York.
3. Immune Response Activation and Immunomodulation.Edit by R.K. Tyagi & P.S. Bisen, 2019. Intechopen .com
4. Immunology. Author- Klaus D. Elgert ,Wiley-Liss. NY.
5. Text Book on Principles of Bacteriology, Virology and Immunology, IX Edition (5 volumes). Topley and Wilson's, Edward Arnold, London.
6. The Experimental Foundations of Modern Immunology. Authors- Clark, V.R., John Willey and Sons, Incl.
7. Fundamental Immunology. Author – W.E. Paul, Raven Press, New York.
8. Fundamentals of Immunology. Authors – R.M. Coleman, M.F. Lombord and R.E. Sicard 2nded. C. Brown publishers.
9. Immunology. Authors – D.M. Weir and J. Steward 7thEd. (1993).
10. Immunology : Shailendra Sharma.
11. Immunology: C.V.Rao.

M.Sc. Microbiology
Second Semester Examination
Paper 2.4: MB-524- Tools and Techniques 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 **15-18**L

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.

UNIT – II **15-18**L

Centrifugation techniques: - Differential, gradient, zonal or band and isopycnic density gradient centrifugation. Chromatography:Basic principles and applications: absorption, exclusion, ion-exchange, partition and affinity chromatography; GLC, HPLC,fast protein liquid chromatography and gas-liquid ion-exchange chromatography.

UNIT – III **15-18**L

Electrophoresis: principle, types and applications. 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 **15-18**L

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 **15-18**L

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. Microbiology
Second Semester Practical Examination
Paper 2.5 MB- 525 Lab Course III

1. Isolation cultivation and morphological studies of Actinomycetes.
2. Isolation cultivation and morphological studies of fungi.
3. Study of *Rhizopus*, *Penicillium*, *Aspergillus, Saccharomyces* using temporary mounts.
4. Study of *Spirogyra* and *Chlamydomonas, Volvox* using temporary mounts
5. Study of the following protozoans using permanent mounts/photographs: *Amoeba*,*Entamoeba*, *Paramecium* and *Plasmodium*.
6. Isolation and enumeration of bacteriophages (PFU) from water/sewage sample.
7. To isolate genomic DNA from bacteria.
8. DNA: a) Isolation of DNA (nuclear and Mt)
    i. Agarose gel electrophoresis
    ii. Demonstration of DNA modifications
    iii. Restriction endonuclease digestions and separation of fragments by gel chromatography

9. Isolation of total cellular RNA from suitable organisms (yeast, plant, animal cells)
10. Isolation of total m RNA from suitable organisms.
11. To isolate total RNA and mRNA from bacteria.
12. Thermal melting of DNA
13. To perform SDS-PAGE for separation of proteins in given sample.
14. Blotting Techniques.
15. Fragment separation by restriction endonuclease enzyme.
16. Isolation of plasmid DNA - i) minipreparation ii) large scale isolation.
17. DNA *ligation*, transformation of *E.coli*.
18. Culture of *E.coli* cells & plasmid isolation
19. Preparation of competent cells.
20. Calcium chloride mediated transformation.

M.Sc. Microbiology
Second Semester Practical Examination
Paper 2.6 MB- 526 Lab Course IV

1. To prepare soluble antigen by different methods.
2. To demonstrate various routes of immunization in mice.
3. To prepare serum and plasma from blood.
4. To precipitate immunoglobulins by ammonium sulphate and to determine total protein contents.
5. To determine Blood group and Rh factor by slide agglutination test
6. Estimation of haemoglobin content.
7. To determine Total Leukocyte Count (TLC) for given blood sample
8. To determine Differential Leukocyte Count (DLC) for given blood sample using Leishmans stain.
9. To perform Widal agglutination test (slide and tube) for diagnosis of typhoid.
10. To perform Ouchterlony double diffusion test for detection of antigen and antibody reaction and to demonstrate relationship between antigens.
11. To perform Radial immuno-diffusion test for detection of antigen and antibody reaction and for quantification of antigens.
12. To perform immuno-electrophoresis for separation of antigens and for detection of antigen and antibody reaction
13. To perform Rocket immuno-electrophoresis for detection of antigen and antibody reaction
14. To perform ELISA for assay of antibodies in serum sample against given antigen.
15. To perform DOT ELISA.
16. Study of Laboratory Instruments
17. Ion exchange and gel filtration chromatography.
18. Separation of subcellular organelles by differential centrifugation .
19. Separation of blood cells by density gradient centrifugation.
20. Polyacrylamide gel electrophoresis of proteins.
21. To perform PCR for amplification of target DNA segment (or gene).
22. Electrophoretic separation of DNA in agarose gel.
23. SDS PAGE for protein separation.
24. Southern Blotting Techniques.
25. Restriction Digestion.
26. Demonstration of DNA fingerprinting,
27. Gel documentation of DNA, RNA and proteins

M.Sc. Microbiology

Third Semester Examination

Paper3.1 MB-631– Soil & Agriculture 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

Soil: Soil profile, Soil Plant Microorganisms:Soil fertility, Rhizosphere environment, organic compounds released by plant. Rhizosphere and phyllosphere microflora

Plant associated microbiome for enhanced plant growth and yield of agricultural crops.
Exploration of soil microbial diversity wealth through metagenomics approach for novel microbial genes and products for agricultural and industrial applications. Reclamation of waste agricultural land by microorganisms.

UNIT II 15-18L

Biogeochemical cycles: Carbon cycle, nitrogen cycle, phosphorous cycle and sulphur cycle. Mechanism of biological nitrogen fixation: Biological dinitrogen fixation, free living dinitrogen fixation, legume rhizobia symbiosis: nodule formation, bacteroids, leghaemoglobin, mycorrhizal association. Amino acid synthesis, proteolysis, urea cycle. Lichens.

UNIT III 15-18L

Role of enzymes and toxins in pathogenesis. Host parasite relationship and control measures, symptomatology of various diseases.
Fungal diseases of plants: Rusts of wheat; late blight of potato; red rot of sugarcane. Bacterial diseases of plants: Citrus canker, blight of rice. Viral diseases of plants: Leaf curl of Papaya, vein clearing of lady's finger.

UNIT IV **15-18L**

Biological control: Introduction, mechanism. Bacterial control of insect pests: *Bacillus thuringiensis* as bacterial insecticide. Viral control of insect pests: Nuclear polyhedrosis viruses (NPV) and cytoplasmic polyhedrosis viruses (CPV). Fungal control of insect pests: Entomopathogenic fungi.

UNIT V **15-18L**

Biofertilizers: Definition, types- Nitrogen fixing, Phosphate solubilizing and cellulolytic microbes,mass production of bacterial inoculants (*Rhizobium, Azotobacter, Azospirillum,cyanobacteria*) mode of applications, advantages and limitations.

Biopesticides: Definition, types – bacterial, viral, fungal and protozoan, mode of action, factors influencing, genes involved, target pests,production technology and use of transgenic plants. Microbial herbicides. Mycorrhiza: Types and their application in agriculture and forestry.

Recommended Books:

1. Microbiology for sustainable agriculture, soil health and environment protection by Deepak Kumar Verma (2019) Publisher: Taylor and Francis LTD.
2. Microbes : Concepts & Applications- P.S. Bisen, Mousumi Debnath, Godavarthi B.K.S. Prasad , John Wiley & Sons Publication 2012.
3. Soil Microbiology by Prof. N.S. Subba Rao, Fourth edition, Oxford and IBH Publishing CO. PVT., LTD., New Delhi
4. Alexander M. (1977) Introduction to soil microbiology. John Wiley & Sons, Inc., New York.
5. P.D.Sharma.2006. Plant pathology. Alpha Science International.19.
6. R.S Mehrotra. Plant Pathology
7. Modern Soil Microbiology, Dirk J, Elas V, Trevors JT, Wellington, EMH (1997) Marcel Dekker INC, New York.

M.Sc. Microbiology

Third Semester Examination

Paper 3.2 MB-**632– Microbial Ecology**

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**

Microbial ecology: Concept of habitat and niche. Concept of population and community.
Development of microbial communities. Microbial growth curve representing r and k reproductive strategies. Microbial community diversity analysis. Planktonic growth and Biofilm formation.

UNIT –II **15-18L**

Microbial interactions with animals: Symbiosis of algae and invertebrates, endosymbionts of insects. Symbiosis and cellulose digestion. Endosymbiogenesis.
Rumen "Microorganisms: their metabolism and ecological behavior. Bacterial and protozoan fermentation of carbohydrates. Dietary proteins and other nitrogenous substances. Rumen dysfunction and detoxification mechanisms

UNIT –III **15-18L**

Plant-microbe beneficial interactions. Role of biotic and abiotic factors in plant- microbe interactions. Impact of root-beneficial microbe interactions on aboveground plant phenotypic plasticity. Concept of plant probiotics.
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UNIT –IV **15-18L**

Microbe interactions: Neutralism, antagonism**,** competition, commensalisms, amensalism, mutualism, synergism, syntropism, parasitism and predation. Microbial interactions with plant roots- Rhizosphere, Mycorrhizae, Lichen.

UNIT-V **15-18L**

Microbiology of extremophiles (Stress microbiology): Stress sequestration in halophiles, osmophiles, thermophiles, xerophiles, barophiles. Heavy metal detoxificants.
Quantitative microbial ecology: Modern and conventional methods used to study microorganism, sampling procedure, microbial enumeration, biomass determination.

Reference Books:

1. Ronald M. Atlus,2011. Microbial Ecology: Fundamental and applications. Richard Bartha.
2. David L. Kirchman, 2009. Microbial ecology of Oceans.
3. Robert, S. Burlage Ronald Maltus, 1998. Techniques in Microbial Ecology. ASM Press.
4. Larry Barton, Diana E. Northup, 2011. Microbial Ecology. John Publisher, Academic Press.
5. Alexander ,M. 1997. Introduction to Soil Microbiology. John Wiley and sons Inc., New York.
6. Journals of Microbial ecology
7. FEMS journal of microbial ecology

M.Sc. Microbiology

Third Semester Examination

Paper3.3 MB-633– **Environmental Microbiology and**

Microbiology of Wastes

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 of environmental microbiology. Applications of microbes in solving environmental pollution problems. Aerobiology: Microbiology of air, Assessment of air quality, Air borne microbes. Water microbiology, Bacterial indicators of water safety. Microbiology of waste water. Biofilms and their importance. Techniques in environment microbiology: Methods for determination of numbers, biomass and activities of microbes. Biosensors for environment monitoring.

UNIT II **15-18L**

Biodeterioration: Role of microbes in degradation, Biodegradation of Xenobiotics hydrocarbons, pesticides and plastics. Biodeterioration of wood, pulp and paper;

Biomonitoring: Microorganisms as bioindicators and applications of bioindicators. Role of *Dianococcus radiodurans* in disposal of radioactive waste material and its future in environmental biotechnology.

UNIT III **15-18L**

Bioremediation techniques : *In situ* (Bioventing,air sparging,liquid delivery system,anerobic bioremediation and phytoremediation) and *ex-situ* (Land farming, composting,biopiling & slurry-phase).

Bioaccumulation of metals and detoxification, biosorption, scavenging.

UNIT IV **15-18L**

Bioaugmentation: Pollution, wastes, their types and characterization. Methods of treatment-Physical, chemical, biological-aerobic and anaerobic (Oxidation ponds, HRABP, ASP, Trickling Filter, Fluidized Bed Reactor, Biogas, Rotating contactor).

Solid waste treatment (Agricultural/urban): Saccharification, gasification, composting. vermicompost, mushroom compost, ensilage.

UNIT V **15-18L**

Utilization of solid wastes- food (SCP, mushroom, yeast), fuel, manure. Non biodegradable solid waste and its management: Landfill development, incineration and recycling.

Biological alternatives for xenobiotic and Chemical synthesis (biopesticides, biosurfactants, biocolours and Biofuel).

Genetically Engineered Microorganisms for bioremediation.

Nanotechnology: Concept, scope and their role in pollution abatement.

Recommended Books:

1. Environmental microbiology: principles and applications by Patrick K. Jemba.Science publisher,2004.
2. Environmental microbiology by P. D. Sharma, Alpha Sciences international, 2005.
3. Environmental microbiology, second edition, by Ralph, Ji Doug Gu, Wiley.
4. Atlas R M and Bartha, 1993. Microbial Ecology, Bejaminn Cummings Publishing Co.Redwood City CA
5. Environmental microbiology by Ian Papper and Charles Gerba, Elsevier Press.
6. Environmental microbiology by Rose Environmental microbiology Vol III-IV, 1999
7. Practical microbiology, third edition, by Dubey , D K. Maheswari, S. Chand publishers, 2012
8. Advances in applied Bioremediation, Springer.
9. Alexander M 1971. Microbial Ecology. John Wiley & Sons Inc., New York.
10. Eldowney Ec S., Hardman DJ. and Waite S 1993. Pollution: Ecology and biotretament. Longman Scientific Technical.
11. Baker KH and Herson DS 1994. Bioremediation. Mc Graw Hill Inc., New York.
12. Michel R. 1999. Introduction to environmental microbiology.
13. Atlas & Bartha. Microbial Ecology
14. Indu Shekhar. Environmental Biotechnology
15. Environmental engineering and management S. K. Dhameja, Publ: Kataria & Sons
16. Experimental ecology R.M. Atlas
17. Environment Microbiology for Engineers by Ivanov V, Taylor and Francis CBS Publishers

M.Sc. Microbiology

Third Semester Examination

Paper3.4 MB-634– **Biofuel and Bioenergy**

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**

Current energy consumption, overview of biofuel/bioenergy and biorefinery concepts. Fundamental concepts in understanding biofuel/bioenergy production. Biomass preprocessing: drying, size reduction, and densification. Microbes as a source of bioenergy.

Biomass for energy. Calorific value and its estimation. Co-generation of energy. Various biofuels/bioenergy from biomass. Biomass conversion to heat and power: thermal gasification of biomass, anaerobic digestion.

UNIT II **15-18L**

Biomass conversion to biofuel: thermochemical conversion, syngas fermentation. Environmental impacts of biofuel production. Alternatives as biofuels: Alkanes, Biobutanol, bioethanol, biomethanol, biodiesel, biogas, hydrogen, syngas/synfuels and other energy dense molecules and their comparisons.

Biochemical conversion to ethanol: biomass pretreatment,Starch to sucrose conversion and Sucrose to ethanol fermentation. Different enzymes, enzyme hydrolysis, and their applications in ethanol production. Distillation and Quantification of ethanol.

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UNIT III **15-18L**

Lignocelluosics hydrolysis, Fermentation of pentoses and other issues in bioethanol production from lignocelluloses. Biobutanol production, Estimation of biobutanol.

Microbes and biogas production: Biogas and methane estimation. Bio gas Bottling Plant Technology, Application of Bio gas slurry in agriculture.Design of Biogas for cold climates.

UNIT IV **15-18L**

Global biodiesel scenario. Oil crops. Microbes and Biodiesel:Production and feed stock. Techniques of lipid extraction and conversion to biodiesel (lipid transesterification), Biodiesel quality and its assessment.
Strategies of genetic engineering of organisms for biofuel production.

Wastewater remediation and biomass generation for biofuel purposes. Microbial Fuel Cells.

UNIT V **15-18L**

Food vs Fuel debate. Carbon sequestration and its necessity. Carbon credits. Biorefinery, Thermochemical Conversion Processes (Gasification: Biofuels from Synthesis Gas and Pyrolysis) Biochemical Conversion Processes, Photobiological conversion: Biohydrogen production. Commercialized microalgae (*Spirulina, Dunaliella, Hematococcus, Chlorella* and others) and their production. Economics of microalgae production. Cultivation of seaweeds.

Reference Books:

1. Balachandran P. (2010); Engineering Fluid Mechanics, Prentice Hall India
2. Dessler A. (2011); Introduction to Modern Climate Change, Cambridge University Press
3. Bioenergy (Biomass to Biofuel) 1st Edition 2014 Academic Press Editor: Anju Dahiya
4. Biorenewable Resources: Engineering New Products from Agriculture. Robert C. Brown. Wiley-Blackwell Publishing (2003).
5. Anaerobic Biotechnology for Bioenergy Production: Principles and Applications. Samir K. Khanal. Wiley-Blackwell Publishing (2008).
6. Kothari D. P. and Nagrath I. (2009); Basic Electrical Engineering, Third Edition, McGraw Hill, India
7. Zemansky M. and Dittman R. (2011); Heat and Thermodynamics, McGraw Hill, India
8. Wadhwa C. L. (2012); Generation, Distribution and Utilization of Electrical Energy, Third Edition, New Age International .

M.Sc. Microbiology

Third Semester Examination
Paper 3.5 BT 635 Lab Course V

Practical Exercises

1. Analysis of soil: Texture, pH, moisture content, water holding capacity, percolation and capillary action.
2. Isolation and study of microbes (bacteria and fungi) from Rhizosphere and Rhizoplane.
3. Isolation of *Rhizobium* from root modules of legumes (*Trigonella / Cicer / Soybean*)
4. Isolation of free nitrogen fixers (*Azotobactor*, *Azospirillum*) from soil.
5. Isolation of Phosphate solubilizing bacteria from soil.
6. To enumerate microorganisms from different natural habitats.
7. To study the bacterial ecology in fresh water environment
8. To study the microbial ecology of the rhizosphere and determination of rhizospheric effect.
9. To study the effect of various salt concentrations on bacterial fungal growth.
10. To study the effect of osmotic pressure on bacterial fungal growth.
11. To determine the microbial biomass from different natural habitats.
12. Nitrogen spot test
13. Determination of moisture holding capacity of soil.
14. Microbiome analysis of different agro-climatic soils

M.Sc. Microbiology

Third Semester Examination
Paper 3.6 BT 636 Lab Course VI

Practical Exercises

1. To study the micro-flora of air (indoor and outdoor).
2. Isolation of phosphate solubilizing micro- organism from soil and water.
3. Demonstration of biological treatment.
4. Determination of dissolved oxygen of water.
5. Determination of BOD of water (raw/ treated).
6. Determination of COD of water (raw/ treated).
7. Determination of alkalinity
8. Determination of chlorine in water.
9. Demonstration of VAM.
10. Production of Biofertilizers: *Rhizobium / Azotobacter sp.*
11. Production of Single cell protein
12. Mushroom cultivation.
13. Bioremediation of polluted soils by plants/ microbes.
14. Laboratory demonstration of vermi-composting
15. Field visit to recycling industries.
16. Qualitative and Quantitative estimation of solid waste from different sites.
17. Liquid bio-fuel production and characterization.
18. Biogas production by anaerobic digestion and analysis.
19. Production of energy from microbes (microbial fuel cell)
20. Production of Biodiesel from nonedible oil.
21. Biogas production and application.
22. Bioethanol production.
23. Cultivation of seaweeds.

M.Sc. Microbiology

Fourth Semester Examination

The students have to select one of the following specializations that shall be taught in fourth semesters:
Paper 4.1 MB-641– Industrial Microbiology or Paper 4.2 MB-642– Medical Microbiology.

Paper 4.1 MB-641– **Industrial Microbiology**

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

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- **Section-A** will carry 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**

Novel microbes for future industry.Industrial microorganisms: Isolation, screening and strain improvement. Preservation and maintenance of industrially important microbes. Media for industrial fermentation.
Industrial sterilization process for media, air and equipment.Fermentations technology: Principles of fermentation, Basic design and operation of a microbial fermentor. Types and their applications. Basic principles of scale –up.

UNIT-II **15-18L**

Downstream processing: Biomass separation by centrifugation, filtration, flocculation and other recent developments. Cell disintegration methods**.**
Extraction: Solvent, two phase, liquid extraction, supercritical fluid extraction, whole broth, aqueous multiphase extraction. Product Purification: precipitation, Crystallization, chromatographic methods, ultra-filtration, reverse osmosis. Drying devices.

UNIT-III **15-18L**

Industrial production of antibiotics: Streptomycin, Penicillin. Industrial production of: Vitamin B12, Riboflavin ,Citric acid, Lactic acid, Vinegar; Glutamic acid, L – lysine; Acetone, glycerol, alcohol. Steroid biotransformation. Production of alcoholic beverages. Microbial Enzymes**:**Tannases, Proteases, Amylases,
Production of biopharmaceuticals through GEMs: Insulin, Interferons, Tissue plasminogen activator, Streptokinase. Immobilization of enzymes and cells: Types & applications.

UNIT- IV **15-18L**

Microbiology of food: sources and types of microorganisms in food, food borne pathogens, microbiological examination of food, spoilage of food, food preservation. Starter cultures their biochemical activities, production and preservation of the following fermented foods: Soy sauce fermentation by Moulds, Fermented vegetables – Sauerkraut, Fermented Meat – Sausages. Production and application of Baker's Yeast. Role of microorganisms in beverages – tea and coffee fermentations. Genetically modified foods. Biosensors in food,

UNIT- V **15-18L**

Dairy microbiology: sources and types of microorganisms in milk, microbial examination of milk, pasteurization and phosphatase test, sterilization of milk, grades of milk, Microbiology of fermented milk products (acidophilus milk, yoghurt), butter &cheese. Applications of microbial enzymes in dairy industry (Protease, Lipases). Quality assurance: Microbiological quality standards of food. Government regulatory practices and policies. FDA, EPA, HACCP, ISI.

Reference Books:

1. Microbiology an Introduction by Gerard J Tortora, Berdell R Funke and Christine L Case. Pearson Publisher (11th Edition) 2016.
2. Basic and Industrial Microbiology by S. M. Reddy.
3. Microbes : Concepts & Applications- P.S. Bisen, Mousumi Debnath, Godavarthi B.K.S. Prasad , John Wiley & Sons Publication 2012.
4. Industrial Microbiology by David B. Wilson, Hermann Sahm, Klaus-Peter Stahmann, Mattheos Koffas. Wiley Publisher 2019.
5. Reed G (2004). Industrial Microbiology. CBS Publishers (AVI Publishing Co.)
6. Stanbury PF, Whitekar A. and Hall (2006). Principles of Fermentation Technology. Pergaman. McNeul and Harvey.
7. Creuger and Creuger (2004). Biotechnology- A textbook of Industrial Microbiology, Sinaeur Associates.
8. Casida LE (2001). Industrial Microbiology, Wiley Eastern.
9. Manual of Industrial Microbiology and Biotechnology, Demain & Davies, 2nd ed.
10. Microbial Biotechnology A. N. Glazer and H. Nikaido
11. Biotechnology An Introduction Susan R. Barnum
12. Topics in Enzyme & Fermentation Biotechnology by Wisemen
13. S.N. Jogdand. Medical Biotechnology
14. S.N. Jogdand. Biopharmaceuticals

M.Sc. Microbiology

Fourth Semester Examination

Paper 4.2 MB-642– **Medical 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**

Human microbiome & its significance. Probiotics: Gut microbiota, Gut brain interaction. Infection: types, sources, reservoirs and vehicles of infection, predisposing factors. Host-parasite relationship governing the infection and establishment of disease, factors affecting virulence. Mode of spread of infection.

Emerging epidemics, Re-emerging epidemics. Epidemics fundamentals: Types of epidemics, investingation, management and control. Biosafety:components,laboratory safety management.Management of biomedical waste. Biosafety levels.Introduction of center for Disease Control (CDC) and National center for disease control (NCDC).

UNIT-II **15-18L**

Study of diseases caused by pathogenic bacteria: Pathogenicity, laboratory diagnosis, epidemiology and control measures– *Streptococcus, Staphylococcus, Neisseria, Salmonella, E.coli, Klebsiella, Proteus, Pseudomonas, Shigella, Corynebacterium, Vibrio, Corynebacterium, Bacillus ,Clostridium, Vibrio, Mycobacterium, Spirochetes ,Chlamydiae, Rickettsia , Mycoplasma.*

UNIT-III **15-18L**

Morphology, pathogenesis, immune response, diagnosis and prevention of Pox viruses, Herpes, Picorna viruses (Enteroviruses and Polioviruses).Paramyxo viruses, Orthomyxoviruses, Hepatitis viruses, Rhabdo viruses (Rabies virus), Oncogenic viruses, HIV virus, Prion infection. Introduction to emerging diseases- Swine flu, chikungunya, Ebola, SARA-CoV-2. Important protozoal diseases: Route of entry, Life Cycles, Immunity, diagnosis & prophylaxis of *Plasmodium, Entamoeba, Leishmania, Giardia, Taenia.*

UNIT-IV **15-18L**

Fungal diseases: Aetiology, clinical symptoms, laboratory diagnosis and treatment of Human mycotic infections caused by Dermatophytes, Histoplasma,Cryptococcus, Candida, opportunistic mycoses. Mycotoxins.

Classification of antimicrobial agents, Mechanism of drug action: Antibacterial, Antifungal and Antivirals. Methods of testing drug sensitivity. Preclinical development: Safety profile of drugs, Toxicological evaluation of drug, Mutagenecity and Carcinogenicity.Clinical studies.

UNIT-V **15-18L**

Antimicrobial resistance: Drug resistance organisms, mechanisms and development of multidrug resistance. Recent advances in medical microbiology-antiretroviral therapy, Plasma therapy. Probiotics as therapeutic agents, Aptamers, nanotechnology in medicines, Interferons.
Brief account of vaccines (conventional, recombinant and live vaccines).

Reference Books:

1. Emerging epidemics: Management and control P.S. Bisen and E. Raghuvanshi 2013. Wilay & Sons publication New Jeisey
2. Molecular Diagnostics: Promises & Possibilities 2010. Mousuni Dabnath , G.B.K.S. Prasad P.S. Bisen.Principles of Therapeutics, Burn J. H., Blackwell Scientific Pub. O. Ltd. Oxford.
3. Medical Microbiology, McGraw Hill Publication 2019, by Stefan Riedel, Stephen A. Morse, Timothy A. Mietzner, Steve Miller
4. Role of Novel Drug Delivery Vehicles in Nanomedicine Edited by R.K. Tyagi , N. Garg, R. Shukla & P.S. Bisen 2020.
5. Ananthanarayan and Jayaram Paniker. Textbook of Microbiology, 4th ed. Orient Longman, 2000.
6. Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. (2013)Jawetz, Melnick and Adelberg's Medical Microbiology. 26th edition. McGraw Hill Publication
7. Tille P (2013) Bailey's and Scott's Diagnostic Microbiology, 13th edition, Mosby
8. Medical Microbiology-David Green wood
9. Text book of Microbiology,Ananthanarayan& Jayaram Panicker
10. Jawetz-Medical Microbiology-Geo F.Brooks,Janet S Butel.
11. Microbiology: An introduction, G.J. Tortora, B.R. Funke and C.L. Funke.
12. Virology; Renato Dulbecco and Harold S. Ginsberg, Fourth edition, J.B. Lippincott Company,USA
13. An Introduction to viruses, S. B. Biswas and Amita Biswas. Forth edition, Vikas Publishing House PVT LTD New Delhi.
14. Medical Bacteriology, Medical Mycology and AIDS; N.C.Dey, T.K. Dey and D. Sinha, New Central Book Ajency (P) Ltd.

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Fourth Semester Examination

Paper 4.2 MB-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. Software packages for statistical analysis.

Reference Book:

1. Principles of Technical Writing by Robert Hays. Addison-Wesley, 1965.
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.
9. Jin Xiong, 2006 Cambridge University Press, Essential of bioinformatics
10. Guide to Research Methodology and Biostatistics. Edited by KMK Masthan 2017 CBS Publisher.

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Fourth Semester Examination
Paper 4.3 MB-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 and 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

1. Experimental Work & Thesis : 100
2. Research work presentation :50
3. viva-voce :50

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Fourth Semester Examination
Paper 4.4 BM 644 Lab Course VII

Practical Exercises based on Paper 4.1 MB-641– Industrial Microbiology

1. Components and Operation of a Bioreactor
2. Batch fermentation in conical flask
3. Solid state fermentation
4. Screening of industrially important microbes: Antibiotics producers, enzymes producers and organic acid producers.
5. Optimization of conditions for optimal production of enzyme: - Media composition, Incubation temperature, Aeration, Incubation time.
6. Purification of antimicrobial metabolites from a microbe.
7. Production of amylase and cellulase by SmF and SSF.
8. Production of antibiotics by SmF technology
9. Immobilization of cells and enzymes.
10. Instrumentation of fermentor. Design of various types of fermentors & bioreactors
11. Production of ethanol & wine from grapes.
12. DSP for microbial enzymes/antibiotics/organic acids.
13. Determination of TDT of microbes.
14. Determination of TDP of microbes.
15. Production and estimation of lactic acid by *Lactobacillu*s Sp. or *Streptococcus* Sp.
16. Sauerkraut fermentation
17. Isolation of food poisoning bacteria from contaminated foods,
18. Production of Dairy products :yoghurt,cheese.
19. Extraction and detection of aflatoxin for infected foods.
20. Preservation of potato/onion by UV radiation
21. Production of fermented milk by *Lactobacillus acidophilus*.
22. Rapid analytical techniques in food quality control using microbial Biosensors.

Practical Exercises based on Paper 4.2 MB-642– Medical Microbiology

1. To prepare various basic, selective, enrichment and enriched media used for isolation of medically important bacteria from clinical samples.
2. To perform various biochemical tests (IMVC, oxidase, catalase, urea utilization test, sugar utilization and H2S production on TSI agar slant) used for identification.
3. To perform sugar fermentation tests used for identification of medically important bacteria.
4. Preparation of transport media for different clinical samples.
5. Demonstration normal microbial flora of skin, mouth and throat

6. Isolation and identification of *Staphylococcal* species using suitable media, staining techniques and biochemical tests.
7. Identification of bacterial species belonging to Enterobacteriacea family using suitable biochemical tests (*E.coli, Proteus, Pseudomonas, Klebsiella)*
8. Isolation and identification of enteric fever causing bacteria (*Salmonella typhi*) using suitable media and biochemical tests.
9. Isolation and identification of *Bacillus* species using suitable media, staining techniques and biochemical tests.
10. Microbiological analysis of urine specimens.
11. Microbiological analysis of sputum specimens
12. Isolation dermatophytes and their identification based on colony morphology and microscopic characteristics.
13. To determine antibiotic sensitivity for Gram negative and Gram positive bacteria by disc diffusion method
14. To determine Minimal Inhibitory Concentration (MIC) and Minimal Bactericidal concentration of an antibiotic for test bacteria.
15. Identification of human blood groups.
16. Estimation of blood haemoglobin.
17. Perform Total Leukocyte Count of the given blood sample.
18. Perform Differential Leukocyte Count of the given blood sample
19. Separate serum from the blood sample.

Practical Exercises based on Paper 4.2 MB-642– Biostatistics,Bioinformatics & Research Methodology

1. To access scientific data from Literature data bases (PUBMED, LITDB, Medline)
2. To access nucleic acid databases for retrieval of gene sequence.
3. To access protein databases for retrieval of amino acid sequence of target protein.
4. To perform pair wise sequence alignment using Dot matrix.
5. To perform multiple sequence alignment using BLAST.
6. To perform multiple sequence alignment using CLUSTAL-W and to find conserved sequences using JAL view.
7. To prepare Phylogenetic tree and Cladogram using CLUSTAL-W
8. 3D protein structure prediction and structure refinement using Swiss-PDB viewer
9. Representation of statistical data by
    a. Histogram 2. O give curves 3. Pie diagrams
10. Collection of data using different sampling methods
11. Determination of Averages or Central tendencies (Mean, Mode, Median)
12. Determination of measures of dispersion (Mean deviation, Standard deviation and Coefficient of variation, Quartile deviation)
13. Application of Tests of significance (Chi-Square test, student t-test, Standard error)
14. Applications of computers in biology using MS-office (MS-Word, Excel, Power point)

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Fourth Semester Examination

Paper 4.4 MB 644 Comprehensive Viva Voce

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