Starex University, Gurugram

Choice Based Credit System(CBCS)

M.Sc. (Microbiology)

(2018-20)

Ordinance, Scheme & Syllabus

M.Sc. (Microbiology)

(W.E.F. 2018-19)

Ordinance, Scheme of Examination and Syllabi

M.Sc (Microbiology)

Saved as provided in the First Ordinance of the University, this Ordinance shall contain the following;

1. Title and Commencement

This Ordinance shall be called the Ordinance of Starex University and shall be effective from the Academic Session 2018-19.

2. Duration of the Course

The duration of M.Sc. (Microbiology) course shall be of two academic years. Each year shall be divided in two semesters i.e. semester-1, semester-2. Accordingly, the two years shall consist of four semesters. However, a student is required to pass out the said course within a maximum period of 4 years from the date of admission to 1st semester where after he/she shall stand unfit for the course.

3. Eligibility

B.Sc.(Hons.)Botany, Zoology, Microbiology, Biotechnology/ B.Sc.(pass course) Medical with 45% marks or any other equivalent degree from any recognized University.

4. Admission Schedule, Submission of Examination Forms and Fee

The admission schedule along with the last date for submission of admission form and fee shall be fixed by the Vice-Chancellor from time to time and displayed by the University.

Date of examinations and fee shall be fixed by the Vice-Chancellor from time to time and notified by the Controller of Examinations.

5. Change of Branch/ Discipline

A student will be entitled to change/switch over Branch/Discipline within 15 days after the commencement of academic session where after no change will be allowed. Such a student must be eligible for admission to the Branch/Discipline intended to be admitted to.

6. Promotion to Higher Semester(s)

The student shall be promoted to 2nd and 4th semester automatically without any condition of passing minimum number of papers. For promotion from 2nd to 3rd semester, the student shall have to clear at least 50% paper of 1st and 2nd semester taken together.

7. Reappear Examinations

Re-appear examinations for odd semesters will be held along with the regular semester examinations of these semesters in December and those of even semesters along with the regular examinations of these semesters in May. However, the re-appear examination of 4th semester may be held in December along with the odd semester examinations.

8. Medium of Instruction and Examination

The medium of instructions and writing question papers shall be English only.

9. Type of Examinations

Wherever not otherwise provided in any course Ordinance there will be two types of examinations.

(a) **End term:** End term examination shall be held at the end of each semester and will cover the entire syllabus for that semester. 1st and 3rd semester examinations shall ordinarily be held in the month of December and 2nd and 4th semester examinations in the month of May.

(b) **Internal Test:** There may be one/two Internal Assessment test(s) in each semester. Each Internal Assessment test will cover the syllabus taught up to the date of test.

10. Scheme of Examinations

25% marks of the total marks of the concerned subject shall be earmarked for Internal Assessment.

a) Distribution of Marks

i)	Theory	75
ii)	Internal Assessment	25

b) Pass Percentage

Theory:

i) 40% marks in written paper.
ii) 40% marks in written paper and Internal Assessment taken together

Practical: (Wherever provided)

i) 40 % marks in Practical.
ii) 40 % marks in Practical and Internal Assessment taken together.

Viva-Voce: (Wherever provided)

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i) 40% marks in Viva-Voce separately.

Note:

i) In case, a student fails to secure 25% marks in Internal Assessment in Theory of a particular subject, he/she shall be detained from appearing in the Theory paper examination of that subject and so for practical exams (wherever provided).

ii) A list of detained students and the students detained due to shortage of attendance shall be forwarded to the Examination Branch by the School/Faculty before a week from the date of commencement of examination.

c) Components of Internal Assessment

The Internal Assessment marks shall comprise of the following;

i) Attendance	10 Marks
ii) Internal Test	10 Marks
iii) Assignment/Seminar/Presentation etc.	05 Marks

Note:-

i) In case, a student is detained from appearing in the examination of Theory or Practical having failed to secure 25% marks in Internal Assessment, he/she may improve the same for appearing in the relevant subsequent examination. In all other cases, the marks of Internal Assessment shall be carried forward for the subsequent examination.

ii) The concerned teacher shall preserve the records of the Internal Assessment and shall make the same available as and when required.

iii) The concerned School/Faculty shall display the marks of Internal Assessment on the Notice Board for information of the students.

11. Eligibility to appear in the Examination

The Student should fulfill the following criteria to be eligible for appearing in the end term examination;

i) He/she should bear a good moral character.

ii) He/she should be on the rolls of the University during the semester.

iii) He/she should have not less than 75% of the attendance during the respective semester. In case, a student fails to secure the prescribed percentage of lectures either in Theory or Practical, he/she shall be detained from appearing in the said part of examination (Theory or practical or both, as the case may be).

iv) He/she should not be a defaulter of payment of tuition fee or any other dues of the University and no disciplinary action should be pending against him/her.

Note: In case, a student fails to secure 75% attendance in Theory or Practical or both, he/she will be detained from appearing in Theory or Practical or both examinations, as the case may be.

12. Exemption from Attendance/Condonation of Shortage of Attendance

The shortage of attendance can be condoned/ relaxed as under;

S.No	Category for Exemption/Condonation of lectures/attendance	Ground for Exemption/Condonation	Competent Authority
*1	All periods of the day of Blood donation	Voluntarily blood donation to the blood bank	Dean of the School/Faculty
*2	All periods of the day of Examination	For appearing in the supplementary Examinations (Th./Pr./Vive-Voce)	-do-
*3	1 10 Days attendance during a Semester	For participation in University or Inter University/College Sports Tournaments / Youth Festivals, NCC/NSS camps/ University Educational Excursions	-do-

*Provided that:

1. He/she has obtained prior approval of the Dean of School/faculty.
2. Credit may be given only for the days on which lectures were delivered or tutorials or practical work done during the period of participation in the aforesaid events.

S S.No.	Category for Exemption/Condonation of lectures/attendance	Ground for Exemption/Condonation	Competent Authority
4	O Condonation /Relaxation up to 5% during a Semester	Genuine reason such as illness, transfer of parents, sudden death in blood relation, on production of proof.	1. The concerned Dean of his own or on the recommendation of HOD 2. Vice-Chancellor of his own or on the recommendation of Concerned Dean

13. Setting of Question Papers and Re-Checking, Evaluation/Re-evaluation of Answer book(s)

As per provisions in the First Ordinance and rules and regulations of the University.

14. Grace Marks

As per provisions in the First Ordinance of the University.

15. Improvement of Examination Result

A student may be permitted to improve his/her result subject to the followings:

i) The student will be permitted to appear in improvement examination as an ex-student with regular batches for the purpose of improvement of CGPA/Division.
ii) Only one chance for improvement for a Semester will be given. The chance must be availed within a period of 1 year from passing the final examination.
iii) In case the nature of result does not improve i.e. up to CGPA 5, 6, 7, 8 and 9, his/her improvement result shall be declared as **"PRS"** (Previous Result Stands).
iv) There will be no separate examination for improvement i.e. the student intending to improve his/her result shall appear along with the regular batches in accordance with the syllabus prescribed for the regular batches.

16. Issuance of DGS, Award of Degree

A student shall be issued Detailed Grade Statement for each examination and shall be awarded Degree on successful completion of the course. The division and performance shall be indicated in the Degree as depicted in **Grading Method** against **Clause No. 19.**

17. Inter University Migration

a) A student of this University may seek Migration as per provision in the First Ordinance of the University.
b) Any student intending to seek Migration to this University may do so subject to the following;
i) The Migration cannot be claimed as a matter of right and shall subject to the availability of seat.
ii) The Migration shall be allowed only in 2^{nd} year (3^{rd} semester).
iii) Thestudent must have pursued the previous Exam(s) under semester system.
iv) At least 50% papers, of the papers passed by him/her in the previous Institute/University must have matched with the papers prescribed by this University.
v) Rest of the unmatched Subjects/Papers will be required to be passed by him/her from this University as deficient Subjects/Papers.

18. Choice Based Credit System

Definitions of Key Words

1. **Academic Year:** Two consecutive (one odd + one even) Semesters constitute one academic year.
2. **Choice Based Credit System (CBCS):** The CBCS provides choice for students to select from the prescribed courses (core, elective or minor or soft skill courses).
3. **Course**: Usually referred to, as 'papers' is a component of a programme. All courses need not carry the same

weight. The courses should define learning objectives and learning outcomes. A course may be designed to comprise lectures/ tutorials/laboratory work/ field work/ outreach activities/ project work/ vocational training/viva/ seminars/ term papers/assignments/ presentations/ self-study etc. or a combination of some of these.

4. **Credit Based Semester System (CBSS):** Under the CBSS, the requirement for awarding a degree or diploma or certificate is prescribed in terms of number of credits to be completed by the students.

5. **Credit Point:** It is the product of grade point and number of credits for a course.

6. **Credit:** A unit by which the course work is measured. It determines the number of hours of instructions required per week. One credit is equivalent to one hour of teaching (lecture or tutorial) or two hours of practical work/field work per week.

7. **Cumulative Grade Point Average (CGPA):** It is a measure of overall cumulative performance of a student over all semesters. The CGPA is the ratio of total credit points secured by a student in various courses in all semesters and the sum of the total credits of all courses in all the semesters. It is expressed up to two decimal places.

8. **Grade Point:** It is a numerical weight allotted to each letter grade on a 10-point scale.

9. **Letter Grade:** It is an index of the performance of students in a said course. Grades are denoted by letters O, A+, A, B+, B, C, P and F.

10. **Programme:** An educational programme leading to award of a Degree, Diploma or Certificate.

11. **Semester Grade Point Average (SGPA):** It is a measure of performance of work done in a semester. It is ratio of total credit points secured by a student in various courses registered in a semester and the total course credits taken during that semester. It shall be expressed up to two decimal places.

12. **Semester:** Each semester will consist of 15-18 weeks of academic work equivalent to 90 actual teaching days. The odd semester may be scheduled from July

to December and even semester from January to May/June.

13. Transcript and Detailed Grade Certificate/Statement (DGS):

Based on the earned credit points, a detailed grade Certificate/Statement (DGS) shall be issued to all the registered students after every semester. The grade Certificate/Statement will display the course details (Course Code, its nomenclature, total credit points and letter grade) along with SGPA of that semester and CGPA in the final semester.

19. Grading Method

The grading method for evaluating students' performance involves award, of grade according to the range of total marks in the course. The grade will be awarded based on marks out of 100, as depicted below:

Formula for Computation of SGPA & CGPA

i. The SGPA is the ratio of sum of the product of the number of credits with the grade points scored by a student in all the courses taken by a student and the sum of the number of credits of all the courses undergone by a student, i.e

$$SGPA\ (Si) = \sum (Ci \times Gi) / \sum Ci$$

Where Ci is the number of credits of the ith course and Gi is the grade point scored by

Range of Percentage of Marks	Letter Grade	Grade Points	Range of Grade Points	Classification
90 and above	O (Outstanding)	10	9-10	Outstanding
80 & above but less than 90	A+ (Excellent)	9	8 < 9	Excellent
70 & above but less than 80	A (Very Good)	8	7 < 8	1st Div. with Distinction
60 & above but less than 70	B+ (Good)	7	6 < 7	1st Division
50 & above but less than 60	B (Above Average)	6	5 < 6	2nd Division
Above 40 but less than 50	C (Pass-Average)	5	Above 4 < 5	3rd Division
35 To 40	P (Pass)	4	3.5 To 4	Pass
Below minimum pass marks	F (Fail)	0	-	-

the student in the ith course.

ii. The CGPA is also calculated in the same manner taking into account all the courses undergone by a student over all the semesters of a programme, i.e.

$$CGPA = \sum (Si \times Si) / \sum Ci$$

Where Si is the SGPA of the ith semester and Ci is the total number of credits in that semester.

iii. The SGPA and CGPA shall be worked up to 2 decimal points and mentioned in the DGS and transcripts.

iv). Formula for calculation of aggregate pass percentage CGPA x 10

Example

Course	**Credit**	**Grade Letter**	**Grade Point Block**	**Range of Grade Points(Actual Grade Value as per marks obtd.**	**Earned Credit Points (Credit ×Actual Grade Value)**
Course 1	3	O	10	9.2	3×9.2=27.6
Course 2	3	A+	9	8.2	3×8.2=24.6
Course 3	4	A	8	7	4×7=28
Course 4	3	B+	7	6.7	3×6.7=20.1
Course 5	3	B	6	5.6	3×5.6=16.8
Course 6	4	C	5	4.7	4×4.7=18.8
	20				135.9

Thus, **SGPA** = 135.9/20 = 6.79
Similarly, suppose SGPA for 2nd, 3rd , and 4th semester are 7.85, 5.6 and 6.0 with credits 22, 24 and 22 respectively than for a two year programme, the CGPA will be computed as follows

CGPA= 20 × 6.79 + 22× 7.85 + 24 × 5.6 + 22 × 6.0/88 = 6.53
Formula for calculating percentage of marks
CGPA × 10 e.g. 6.53 × 10 = 65.3

20. Other Provisions

i) Nothing in this Ordinance shall debar the University from amending the Ordinance and the same shall be applicable to all the students whether old or new.

ii) Any other provision not contained in the Ordinance shall be governed by the rule and regulations framed by the University from time to time.
iii) All disputes shall Subject to Gurugram Court Jurisdiction.

PREAMBLE

The University Grants Commission (UGC) has initiated several measures to bring equity, efficiency and excellence in the Higher Education System of country. The important measures taken to enhance academic standards and quality in higher education include innovation and improvements in curriculum, teaching-learning process, examination and evaluation systems, besides governance and other matters. The UGC has formulated various regulations and guidelines from time to time to improve the higher education system and maintain minimum standards and quality across the Higher Educational Institutions (HEIs) in India. The academic reforms recommended by the UGC in the recent past have led to overall improvement in the higher education system. However, due to lot of diversity in the system of higher education, there are multiple approaches followed by universities towards examination, evaluation and grading system. While the HEIs must have the flexibility and freedom in designing the examination and evaluation methods that best fits the curriculum, syllabi and teaching–learning methods, there is a need to devise a sensible system for awarding the grades based on the performance of students.

Presently the performance of the students is reported using the conventional system of marks secured in the examinations or grades or both. The conversion from marks to letter grades and the letter grades used vary widely across the HEIs in the country. This creates difficulty for the academia and the employers to understand and infer the performance of the students graduating from different universities and colleges based on grades. The grading system is considered to be better than the conventional marks system and hence it has been followed in the top institutions in India and abroad. So it is desirable to introduce uniform grading system. This will facilitate student mobility across institutions within and across countries and also enable potential employers to assess the performance of students. To bring in the desired uniformity, in grading system and method for computing the cumulative grade point average (CGPA) based on the performance of students in the examinations, the UGC has formulated these guidelines.

CHOICE BASED CREDIT SYSTEM (CBCS)

The CBCS provides an opportunity for the students to choose courses from the prescribed courses comprising core, elective/minor or skill based courses. The courses can be evaluated following the grading system, which is considered to be better than the conventional marks system. Therefore, it is necessary to introduce uniform grading system in the entire higher education in India. This will benefit the students to move across institutions within India to begin with and across countries. The uniform grading system will also enable potential employers in assessing the performance of the candidates. In order to bring uniformity in evaluation system and computation of the Cumulative Grade Point Average (CGPA) based on student's performance in examinations, the UGC has formulated the guidelines to be followed.

Outline of Choice Based Credit System:

1. **Core Course**: A course, which should compulsorily be studied by a candidate as a core requirement is termed as a Core course.

2. **Elective Course**: Generally a course which can be chosen from a pool of courses and which may be very specific or specialized or advanced or supportive to the discipline/ subject of study or which provides an extended scope or which enables an exposure to some other discipline/subject/domain or nurtures the candidate's proficiency/skill is called an Elective Course.

Discipline Centric Elective (DCE) Course: Elective courses may be offered by the main discipline/subject of study is referred to as Discipline Specific Elective. The University/Institute may also offer discipline related Elective courses of interdisciplinary nature (to be offered by main discipline/subject of study).

Dissertation/Project: An elective course designed to acquire special/advanced knowledge, such as supplement study/support study to a project work, and a candidate studies such a course on his own with an advisory support by a teacher/faculty member is called dissertation/project.

Generic Elective (GE) Course: An elective course chosen generally from an unrelated discipline/subject, with an intention to seek exposure is called a Generic Elective. P.S.: A core course offered in a discipline/subject may be treated as an elective by other discipline/subject and vice versa and such electives may also be referred to as Generic Elective.

3. **Skill Enhancement Elective (SEE) Course:**-SEEC courses are value-based and/or skill-based and are aimed at providing hands-on-training, competencies, skills, etc.

Project work/Dissertation is considered as a special course involving application of knowledge in solving / analyzing /exploring a real life situation / difficult problem. A Project/Dissertation work would be of 24 and 16 credits for Major and Minor projects, respectively. A Project/Dissertation work may be given in lieu of a discipline centric elective paper.

Program Mission:
The mission **of** M.Sc. Microbiology program is to develop skills of Microbiology and Biotechnology techniques in the students which will be helpful in industrial and research exposure of students.

Program Specific Outcome:

- Students will be able to design, conduct experiments, analyze and interpret the data for investigating problems in Microbiology and allied fields. Higher studies (M.Phil, Ph.D) can be pursued in order to attain research positions.
- Various examinations such as CSIR-NET, ICAR-NET GATE, ICMR, and many other opens channels for promising career in research.
- Students can become Junior Production Officer and Technical Assistant in Microbiology, pharmaceutical Companies, bio-fertilizer industry, aquaculture industries, environmental units, crop production units, food processing industries, national bio-resource development firms, banking and KPO.
- Entrepreneurship ventures such as consultancy and training centers can be opened. Some of the major pharmaceutical and drug companies' hiring microbiological professionals include Dabur, Ranbaxy, Hindustan Lever and Dr Reddy's Labs, food processing industries, chemical industry and textile industry as well.
- Beside industrial sector there are ample opportunities in academics as well. Students will be able to understand the potentials, and impact of biotechnological and microbiological innovations on environment and their implementation for finding sustainable solution to issues pertaining to environment, health sector, agriculture, etc.
- Several career opportunities are available for students with microbiology background abroad especially in countries like Germany, Australia, Canada, USA and many more where biotechnology is a rapidly developing field.

Program Educational Objectives/Goals

PEO 1	To develop the technical skills of microbiology and biotechnology in students.
PEO 2	To develop the industrial and environmental skills in respect to microbiology and biotechnology to the students.
PEO 3	To develop microbial identification skills to the students.
PEO 4	To Understand the concept of cell and cellular functions.
PEO 5	To understand the biological techniques.
PEO 6	To understand the clinical applications of the microbes.
PEO 7	To understand the Immunology and cells of immune system.
PEO 8	To understand the microbe Plant interactions.
PEO 9	To Understand the microbes animal relationships.
PEO 10	To Understand the Recombinant DNA technology
PEO 11	To understand the chemicals of microbes and their effect
PEO 12	To understand the Industrial Applications of Microbes.

Program Learning Outcomes (PLOs):

PLO 1	The Post graduate M.Sc. Microbiology outcome will be to develop technical skills in the students which help in the manipulation of living organisms and biological systems to produce products.
PLO 2	After the completion of this course students will be contributing in the advancement of healthcare, medicine, agriculture, food, pharmaceuticals and environment control.
PLO 3	This program outcome will be to develop historical knowledge about biotechnology, microbiology and microscopy. After completion of this M.Sc. program students will able to characterize different types of microbes and also able to culture them. The program should be designed on the basis of applications; however this program is also having various applications for human welfare. So after completion of this course students will be skilled in agriculture, industrial, environment, and forensic as well as medical biotechnology. This program also has some specific courses related to developmental biology, so students can understand well about the developing process of living beings.
PLO 4	This program also has some specific courses related to developmental biology, so students can understand well about the developing process of the living beings. This program will also provide broad idea about cell and their structures, so that students can easily explain about cells as well as cellular organs.
PLO 5	After the completion of this course students will able to understand about the diagnostic procedures such as ELISA, PCR, Immunological Assay, chromatography and microscopy. This program is a professional course so it has industrial applications also. At the end of this program students will be skilled for bioprocess technology, biosynthesis of products such as alcohol, biodiesel, pharmaceutical products, agriculture products, enzyme engineering and protein engineering etc. on the basis of above skills students will able to self entrepreneur and able to know about business, copyrights as well as patents. The students will get the basic idea of bio-techniques to apply in their future carrier. The students will learn modern data analysis techniques which can be applied in industries for drug development.
PLO 6	The program encourages chemical thinking in students to understand the chemical process in the real life. The program helps to the students to understand the chemical mechanism of poisons substances that can toxicate a person and the information can further be used in clinical environment.
PLO 7	This postgraduate program of M.Sc. outcome will be to understand basics of immunology, role of antibodies with the development of various types of vaccines. Students would able to learn of viruses and their diagnosis.
PLO 8	After completion of this course students have the knowledge of lower plants their classification and economic importance. Students also gains knowledge of various plant diseases. This program also helps the students to understand the concept of root and shoot tissue system and secondary growth. This program also gives the knowledge of plant water relation, role of micro and macro nutrients and other biochemical pathways in plants.
PLO 9	This program will give an in-depth knowledge about the origin of non-chordates and chordates with their economic importance and will also be able to recognize different species in levels of classification. This course wills insight about the relationships between different physiological mechanisms and help in explaining the different mechanisms of human body.
PLO 10	This course will give idea about various tools and technology for DNA application and methods and also helpful to develop knowledge about prospective of environment and their issues. This course designed will helpful to develop various technologies for food preservation and industrial work out for food manufacturing.
PLO 11	The students will learn about the general characteristics of Lower Plants. As well as students will learn about the abiotic and biotic components of the environment. The study of protein purification techniques will help the students to establish structural and function relationship of any novel protein
PLO 12	The students will get aware about advanced agriculture techniques to enhance the crop productivity. After the completion of this program the students will able identify the microbes with the help of various biological techniques.

Course Objective:		
S. No.	**Courses**	**Objectives**
1.	Principles of Microbiology & Bacteriology	The objective of this course to develop the basic knowledge about the microbes and their culture characteristics. Students will also learn about the bacteria and their infectious diseases, antibiotics etc.
2	Microbial Physiology& Metabolism	The Objective of this course is to understand metabolic process of the micerobes.
3	Fundamentals of Biochemistry	The aim of this course is to provide knowledge of different types of biomolecules and their uses.
4	Introduction to Biotechnology	This course objective is to develop the basic knowledge of biotechnology to the students.
5	Food and Dairy Microbiology	The objective of this course is to provide the basic applications of microbes in food and dairy products production along with their preservation.
6	Microbial Genetics	This course targeted to develop knowledge in the students about microbes genetics.
7	Plant Pathology	This course objective is to understand the plant microbe interactions.
8	Techniques in Biotechnology	The objective of this course is to skill the students about tools and techniques in biotechnology.
9	Medical Microbiology and Immunology	This course objective is to provide the knowledge to the students about microbes involved in the diseases along with concept of immunology.
10	Industrial Microbiology	The objective of this course is to provide industrial applications of microbes.
11	Virology	This course objective is to provide information about viruses to the students.
12	Soil And Agricultural Microbiology	The objective of this course is to understand the role of microbes in soil and agriculture
13	Biostatistics and Computers (Compulsary)	This course objective is to skill the students in biostatics and computers.

Scheme:-

Semester	Paper Type	Paper Title	Max. Marks	Credits
1	CC	Principles of Microbiology & Bacteriology	75+25=100	4
	CC	Microbial Physiology& Metabolism	75+25=100	4
	CC	Fundamentals of Biochemistry	75+25=100	4
	GEC	Introduction to Biotechnology/ Elective Animal Biotech	75+25=100	4
	CC	Practical- I	75+25=100	4
		Total	**500**	**20**
		For Other Departments		
	GEC	Introduction to Microbiology	75+25=100	4
	GEC	Microbial Energetics and Biosynthesis/	75+25=100	4
2	CC	Food and Dairy Microbiology	75+25=100	4
	CC	Microbial Genetics	75+25=100	4
	DCEC*	Mycology and Phycology	75+25=100	4
	DCEC*	Plant Pathology	75+25=100	4
	GEC	Techniques in Biotechnology/ Plant Biotech	75+25=100	4
	CC	Practical- II	75+25=100	4
	CC	Seminar	50	2
		Total	**550**	**22**
		For Other Departments		
	GEC	Food Microbiology	75+25=100	4
3	CC	Medical Microbiology and Immunology	75+25=100	4
	CC	Industrial Microbiology	75+25=100	4
	CC	Virology	75+25=100	4
	DCEC*	Environmental Microbiology	75+25=100	4
	DCEC*	Soil And Agricultural Microbiology	75+25=100	4
	GEC	Bioinformatics and Biostatics	50	2
	NTCC	Research Article writing	50	2
	CC	Practical- III	75+25=100	4
		Total	**600**	**24**

4	SEEC	Dissertation	600	24
	OR			
	DCEC	Cell Biology	75+25=100	4
	DCEC	Molecular Biology	75+25=100	4
	SEEC	Dissertation/Project	400	16
		Total	**600**	**24**
	CC	Core Course		
	DCEC	Discipline Centric Elective Course		
	GEC	Generic Elective Course		
	SEEC	Skill Enhancement Elective Course		
	*****	Choose any one in given semester		
		GEC in 1st and 2nd Semesters are offered by Department of Biotechnology		

Semester	**Credits**			**Total Credits**	**Total marks**
	Core Courses	**Elective Courses**			
		DCEC	**GEC**		
I	16		4	20	500
II	14	4	4	22	550
III	16	4	4	24	600
IV	16(SEEC)	8		24	600
Total	62	16	12	90	2250

M.Sc. (Microbiology)
(SEMESTER-I)
CC- Principles of Microbiology & Bacteriology

Paper Code: Time Allowed: 3 Hours
Max. Marks:75 Credits: 4

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

Section-A

History of development of Microbiology in 20th century; The spontaneous generation controversy; Germ theory of disease; Microbes and fermentation; Physical and chemical methods of sterilization; Microscopy - light, confocal and electron. 12 hours

Section-Bs

Binomial Nomenclature; Haeckel's three kingdom classification; Basic principles and techniques used in bacterial classification; Use of DNA and r-RNA sequencing in classification of microorganisms; Woese's three kingdom classification system and its utility - archaea, eubacteria, eukarya; Organization of prokaryotic and eukaryotic cell in detail; Different groups of acellular microorganisms - viruses, viriods and prions. 15 hours

Section-C

General features of microorganisms - Bacteria, Algae, Fungi and Protozoa; Classification of bacteria; Bacterial growth and metabolism; Microbes in different environment; Microbes in extreme environment - special features of the thermophilic, methanogenic and halophilicarchaea; Photosynthetic bacteria, Cyanobacteria; Microbes in other extreme conditions - deep ocean and space. Growth and Nutrition - cultivation of aerobic, anaerobic and accessing non-culturable bacteria; Maintenance and preservation of bacterial cultures; Components of media and different types of culture media.

15 hours

Section-D

Eubacteria – Non-Proteobacteria and Proteobacteria – Morphology, metabolism, ecological significance and economic importance of following groups:

Gram Negative - Non proteobacteria*(Aquifex, Thermotoga, Deinococcus, Thermus,Chlorobium, Chloroflexus, Chlamydiae, Spirochaete*), Alpha proteobacteria (*Rickettsia, Coxiella, Caulobacter, Rhizobium, Hyphomicrobium, Agrobacterium),* Beta proteobacteria(*Neisseria, Burkholderia, Thiobacillus*), Gamma proteobacteria (*Enterobacteriaceae* family, Purple sulphur bacteria, *Pseudomonas, Vibrio, Beggiatoa, Methylococcus, Haemophilus*), Delta proteobacteria (*Bdellovibrio, Myxococcus*), Epsilon proteobacteria (*Helicobacter,Campylobacter*).

Gram Positive - Low G+C or Firmicutes (Mycoplasmas,*Clostridium, Heliobacterium,Lactobacillus, Lactococcus, Staphylococcus, Streptococcus, Leuconostoc, Bacillus*), HighG+C or Acinetobacteria (*Arthrobacter, Bifidobacterium, Corynebacterium, Frankia,Mycobacterium, Nocardia, Streptomyces, Thermomonospora, Propionibacterium, Cyanobacteria*). 19 hours

Suggested readings:

1. Atlas RM (1997). Principles of Microbiology, Wm C Brown Publishers, USA.
2. Brock TD (1961). Milestones in Microbiology, Infinity Books.
3. Madigan MT, Martinko JM, Parker J (2015). Brock Biology of Microorganisms, 14th edition, Pearson Education Ltd, Prentice-Hall, Englewood Cliffs, NJ, Inc USA.
4. Pelczar MJ, Chan ECS, Kreig NR (1993). Microbiology: Concepts and Application, 5th edition, Tata McGraw Hill, New Delhi.
5. Stanier RY, Ingraham JL, Wheelis ML, Painter PR (1976). General Microbiology, 4th edition, MacMillan, New Jersey, USA.
6. Whitman WB, Goodfellow M, Kämpfer P, Busse HJ, Trujillo ME, Ludwig W, Suzuki K (2012). Bergey's Manual of Systematic Bacteriology, 2nd edition, Springer-Verlag, New York.

M.Sc. (Microbiology)
(SEMESTER-I)
CC- Microbial Physiology and Metabolism

Paper Code: Time Allowed: 3 Hours
Max. Marks:75 Credits: 4

Note for Examiners and Students:
1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

Section-A

Nutritional categories of microorganisms based on carbon and energy sources; Metabolite transport - passive and facilitated, primary and secondary active transport, group translocation (phosphotransferase system), symport, antiport and uniport, electrogenic and electroneutral transport, transport of iron; Microbial Growth - Definition balanced and unbalanced growth, growth curve, the mathematics of growth, generation time, specific growth rate, batch and continuous culture, synchronous growth, diauxic growth curve; Effect of physical and chemical factors on growth. 18 hours

Section-B

Brief account of Microbial photosynthetic and accessory pigments - chlorophyll, bacteriochlorophyll, rhodopsin, carotenoids, phycobiliproteins; Autotrophy - oxygenic, anoxygenic photosynthesis; Autotrophic generation of ATP; Nitrogen Metaboilsm. Chemolithotrophy - Sulphur, iron, hydrogen, nitrogen oxidations, methanogenesis, luminescence. 12 hours

Section-C

Respiratory metabolism - Embden-Mayer Hoff pathway, EntnerDoudroff pathway, Pentose phosphate pathway, Krebs cycle, Branched TCA cycle, Reverse TCA cycle, Glyoxalate pathway, Oxidative and substrate level phosphorylation,, Gluconeogenesis, Pasteur effect; Fermentation of carbohydrates - homo and heterolactic fermentations; Halophiles and ATP synthesis. 17 hours

Section-D

Biosynthesis of peptidoglycan, polysaccharides, major amino acids, polyamines, lipids, nucleotides - purines and pyrimidines; Assimilation of nitrogen; Dormancy and germination; Microbial Differentiation, Sporulation and morphogenesis, Cell division cycle in *E. coli* and yeast. 13 hours

Suggested Readings:

1. Doelle HW (1969). Bacterial Metabolism, Academic Press, USA.
2. Gottschalk G (1979). Bacterial Metabolism, Springer Verlag, New York, USA.
3. Moat AG (1979). Microbial Physiology, John Wiley & Sons, New York, USA.
4. Moat AG, Foster J W, Spector M P (2009). Microbial Physiology, 4th edition, Wiley India Pvt Ltd, Country.
5. Sokatch JR (1969). Bacterial Physiology and Metabolism, Academic Press, USA.

M.Sc. (Microbiology)
(SEMESTER-I)
CC- Fundamentals of Biochemistry

Paper Code: Time Allowed: 3 Hours
Max. Marks: 75 Credits: 4

Note for Examiners and Students:
1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

Section-A

Chemical basis of life; Composition of living matter; Water – properties, pH, ionization and hydrophobicity; Emergent properties of biomolecules in water; Biomolecular hierarchy; Macromolecules; Molecular assemblies; Structure-function relationships Amino acids – structure and functional group properties; Peptides and covalent structure of proteins; Elucidation of primary and higher order structures; Evolution of protein structure; Structure-function relationships in model proteins like ribonuclease A, myoglobin, hemoglobin, chymotrypsin etc.; Tools to characterize expressed proteins. 17 hours

Section-B

Enzyme catalysis – general principles of catalysis; Quantitation of enzyme activity and efficiency; Enzyme characterization and Michaelis-Menten kinetics; Relevance of enzymes in metabolic regulation, activation, inhibition and covalent modification; Single substrate enzymes, Sugars - mono, di, and polysaccharides; Suitability in the context of their different functions- cellular structure, energy storage, signaling; Glycosylation of other biomolecules - glycoproteins and glycolipids; Lipids - structure and properties of important members of storage and membrane lipids; lipoproteins. 12 hours

Section-C

Biomembrane organization - sidedness and function; Membrane bound proteins - structure, properties and function; Transport phenomena Nucleosides, nucleotides, nucleic acids - structure, diversity and function; sequencing; Brief overview of central dogma. 12 hours

Section-D

Bioenergetics-basic principles; Equilibria and concept of free energy; Coupled processes; Glycolytic pathway; Kreb's cycle; Oxidative phosphorylation; Photosynthesis; Elucidation of metabolic pathways; Logic and integration of central metabolism; entry/ exit of various biomolecules from central pathways; Principles of metabolic regulation; Regulatory steps; Signals and second messengers 19 hours

Suggested readings:

1. V. Voet and J. G. Voet, Biochemistry, 3rd edition, John Wiley, New York, 2004.
2. A.L. Lehninger, Principles of Biochemistry, 4th edition, W.H Freeman and Company, 2004.
3. L. Stryer, Biochemistry, 5th edition, W.H. Freeman and Company, 2002.
4. A. C. Deb, Fundamentals of Biochemistry

M.Sc. (Microbiology)
(SEMESTER-I)
GEC- Introduction to Biotechnology

Paper Code: Time Allowed: 3 Hours
Max. Marks: 75 Credits: 4

Note for Examiners and Students:
1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

Section-A

Biotechnology: An overview-definition, Scope and importance of biotechnology, Concepts of recombinant DNA technology and Gene Cloning.
Nano Science & Technology: An Overview, Insights and intervention into the Nano world.
14 hours

Section-B

Microbial Biotechnology: A brief account of microbes in industry and agriculture, Metabolic engineering for over production of metabolites.
Plant Biotechnology: Introduction to plant tissue culture and its applications, Gene transfer methods in plants, Transgenic plants (A brief introduction), Chloroplast and mitochondria engineering. 15 hours

Section-C

Animal Biotechnology: In-vitro fertilization and embryo transfer in humans and livestock, Transfection techniques and transgenic animals, Animal Cloning.
Medical Biotechnology: (A brief account) Biotechnology in medicine, Vaccines, Molecular diagnostics, Forensic, Gene therapy, Nano Medicine & Drug Delivery Cell & Tissue Engineering, Stem Cell therapy. 17 hours

Section-D

Environmental Biotechnology: (A brief account) Role of biotechnology in pollution control, Sewage treatment, Energy management, Bioremediation, Restoration of degraded lands and Conservation of biodiversity. 14 hours

Suggested Readings:

1. Nelson DL and Cox MM (2013), Lehninger Principles of Biochemistr, 6th Edition Freeman and Company, New York
2. Pelczar, M.J. et. al (2001), Microbiology- Concepts and Applications, International Ed. McGraw Hill Publication, New York
3. Stanbury, P.F., Hall, S., Whitaker, A. (1998), Principles of Fermentation Technology, 2 ndedn. Butterworth-Heinemann Ltd
4. Plant Biotechnology – The genetic manipulation of plants (2003) by Slater A., Scott N. and Fowler M., Oxford University Press.
5. Animal Cell Culture Methods In: Methods in Cell Biology, Vol. 57, Ed. Jenni P Mather and David Barnes, Academic Press.
6. Genome-3 (2007) T.A Brown. Garland science, Taylor & Francis, NewYork.
7. Diagnostic and Therapeutic Antibodies (Methods in Molecular Medicine by Andrew J.T. George (Editor), Catherine E. Urch (Editor) Publisher: Humana Press; edition (2000).
8. Ajayan, P., Schadler, L.S. & Braun, P.V., 2003. Nanocomposite Science and Technology. Wiley-VCH Verlag.

M.Sc. (Microbiology)
(SEMESTER-I)
CC- Practical –I

Paper Code: Time Allowed: 6 Hours
Max. Marks: 100 Credits: 4

(Principles of Microbiology; Microbial Physiology and Metabolism; Introduction to Biotechnology; Fundamentals of Biochemistry)

Principles of Microbiology: Microscopic examination of bacteria, actinomycetes, algae, fungi andprotozoa; Differential staining methods; Study of shape and arrangement of bacterial cells; Preparation of microbiological media; Sterilization: Principles and operations; Preparation of specific media for isolation of bacteria, actinomycetes and fungi from natural sources; Sampling and quantification of microorganisms in air, soil and water.

Microbial Physiology and Metabolism: Determination of viable number of bacterialcells in a given sample; Determination of bacterial growth by turbidity measurements (Bacterial growth curve); To study the microscopic measurements; To study the types of growth (synchronous, diauxic, batch); To study the effect of incubation temperature on the growth of microorganisms; To study the lethal effect of temperature; To study the effect of different pH on the growth of microorganisms; To study the effect of salt concentration on the growth of microorganisms; Preparation of selective and differential media for the growth of microorganisms; Ferrmentation of different carbohydrates.

Introduction to Biotechnology: Microscopy;Gram's staining; Bacterial Transformation; Cell line development and maintenance of cell lines(in-vitro and in-vivo).

Fundamentals of Biochemistry: Preparation of standard and buffer solutions, Use of simple techniques in laboratory (spectrophotometery-verification of Beer's law, relation between O.D. and percentage transmission; Centrifugation) Estimation of sugars, Estimation of Proteins by Lowry's method.

M.Sc. (Microbiology)
(SEMESTER-I)
GEC- Introduction to Microbiology

Paper Code: Time Allowed: 3 Hours
Max. Marks:75 Credits: 4

Note for Examiners and Students:
1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

Section-A

History and Development of various fields of Microbiology in 20^{th} century; The spontaneous generation vs Biogenesis of microorganisms; Microbes - causative agents of disease; Microbes- fermentation and putrefaction; Preparation of microbiological media; Physical and chemical methods of sterilization. Microscopy - Light and Electron Microscopes. 14 hours

Section-B

Microbial classification - Haeckel's classification- lower and higher protista; Woese's three kingdom classification systems – Archaea, Eubacteria, Eukarya; Organization of archaea, bacteria and eukaryotic cell; Different types of acellular microorganisms-Viruses, viroids and prions. 15 hours

Section-C

General features and classification of Bacteria, Algae, Fungi and Protozoa; Bacterial growth and metabolism; Photosynthetic bacteria; Photoheterotrophs; Chemolithotrophs and Chemoheterotrophs; Microbes in Extreme Environment – Characteristic features of the thermophilic, methanogenic and halophilicarchaea; Microbes in other extreme conditions – Deep ocean, arctic and antarctic region and space. 14 hours

Section-D

Scope of Microbiology - Cycle of matter in nature; Microbial interactions – Symbiosis and parasitism; Biodegradation and Bioremediation; Biofilms; Microbes in composting; Biofertilizers and Biopesticides; Microbes and Industry - SCP, microbial enzymes and fermented foods. Human diseases and their causative agents; Vaccines and antibiotics; Phytopathogenic bacteria. 17 hours

Suggested readings:

1. Brock TD (1961). Milestones in Microbiology, Infinity Books.
2. Madigan MT, Martinko JM, Parker J (2015). Brock Biology of Microorganisms, 14th edition, Pearson Education Ltd, Prentice-Hall, Englewood Cliffs, NJ, Inc USA.
3. Pelczar MJ, Chan ECS, Kreig NR (1993). Microbiology: Concepts and Application, 5th edition, Tata McGraw Hill, New Delhi.
4. Stainier RY, Ingraham JL, Wheelis ML, Painter PR (1976). General Microbiology, 4th edition, MacMillan, New Jersey, USA.

M.Sc. (Microbiology)
(SEMESTER-I)
GEC- Microbial Energetics and Biosynthesis

Paper Code: Time Allowed: 3 Hours
Max. Marks:75 Credits: 4

Note for Examiners and Students:
1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

Section-A

Classification of microorganisms based on carbon and energy sources; Metabolite Transport - Different types and their mechanisms; Microbial Growth - Balanced and Unbalanced growth, salient features of growth curve, generation time, specific growth rate during batch and continuous culture systems; synchronous growth, diauxic growth curve; Effect of chemicals and other environmental factors on growth. 15 hours

Section-B

Photophosphorylation by bacteria - photosynthetic and accessory pigments; Carbohydrates – anabolism; Autotrophy, oxygenic, anoxygenic photosynthesis – autotrophic generation of ATP; fixation of CO2, Calvin cycle.Chemolithotrophy - Sulphur, iron, hydrogen, nitrogen oxidations, methanogenesis. 13 hours

Section-C

Embden-Mayer Hoff pathway, Entner-Doudroff pathway, Pentose phosphate pathway, Glyoxalate pathway, Krebs cycle, Oxidative and substrate level phosphorylation, Reverse TCA cycle, Gluconeogenesis, Pasteur effect; Fermentation of carbohydrates - Homo and heterolactic fermentations by microbes. 17 hours

Section-D

Biosynthesis of amino acids, polyamines, nucleotides - purines and pyrimidines; Regulation of microbial metabolism; Assimilation of nitrogen; Biosynthesis of Lipids; Biosynthesis of peptidoglycan and other cell wall polysaccharides; Dormancy and germination; Microbial differentiation; Sporulation and morphogenesis, Cell division cycle in microbes. 15 hours

Suggested Readings:

1. Doelle HW (1969). Bacterial Metabolism, Academic Press, USA.
2. Gottschalk G (1979). Bacterial Metabolism, Springer Verlag, New York, USA.
3. Moat AG (1979). Microbial Physiology, John Wiley & Sons, New York, USA.
4. Moat AG, Foster J W, Spector M P (2009). Microbial Physiology, 4th edition, Wiley India Pvt Ltd, Country.
5. Sokatch JR (1969). Bacterial Physiology and Metabolism, Academic Press, USA

M.Sc. (Microbiology)
(SEMESTER-II)
DCEC- Mycology and Phycology

Paper Code: Time Allowed: 3 Hours
Max. Marks:75 Credits: 4

Note for Examiners and Students:
1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

Section-A

Cellular Organization of algal and fungal cells in detail; Fungi - Occurrence and distribution, somatic structure, hyphal growth, nutrition, heterothallism; Recent classification of fungi; Reproduction in fungi - asexual, sexual and parasexual cycle. 14 hours

Section-B

Life cycle and economic importance of fungal genera representing the following phyla: Chytridiomycota; Blastocladiomycota; Neocallimastigomycota; Microsporidia; Glomeromycota; Ascomycota and Basidiomycota. 13 hours

Section-C

Algae - occurrence and distribution, thallus structure, characteristics, nutrition, classification and reproduction; Algae as pollution indicators and eutrophication agent; Role of algae in bioremediation; Aalgae in global warming and environmental sustainability; Cyanobacteria and selected microalgae in agriculture as biofertilizer; Importance of algae in production of algal pigments, biofuels, hydrogen production and important bioactive molecules. Lichens and Mycorrhiza - occurrence, structure, types and importance. 17 hours

Section-D

Fungal metabolites and their potential applications in food, agriculture, industry and environment; Fungi as symbionts; Biocontrol agents; Role of fungi in deterioration of biomolecules and biomaterials; Mycotoxins. 16 hours

Suggested Readings:

1. Alexopolus CJ, Mims CW, Blackwell M (2002). Introductory Mycology, 4th edition, Wiley India Pvt. Ltd, India.
2. Barsanti L, Gualtieri P (2005). Algae, Anatomy, Biochemistry & Biotechnology, CRC press, Taylor & Francis, Florida, USA.
3. Carlile MS, Watkinson SC, and G. Gooday (2001). The Fungi, 2nd edition, Academic Press, New York.
4. Graham LE, Graham JM, Wilcox LW (2009). Algae, 2nd edition, Benjamin Cummings, San Francisco.
5. http://nt.ars-grin.gov/fungaldatabases/
6. Landecker ME (1996). Fundamentals of the fungi, 4th edition, Benjamin Cummings, San Francisco.
7. Moore D, Robson GD, Anthony P, Trinci J (2011). 21st Century Guidebook to Fungi, Cambridge University Press, UK.
8. Sumbali G (2005). The Fungi, 2nd edition, Narosa Publishing India House, India.
9. The Index Fungorum- http://www.indexfungorum.org/.

M.Sc. (Microbiology)
(SEMESTER-II)
DCEC- Plant Pathology

Paper Code: Time Allowed: 3 Hours
Max. Marks:75 Credits: 4

Note for Examiners and Students:
1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

Section-A

Introduction and history of plant pathology; Definitions and concepts of plant diseases; Biotic and abiotic factors responsible for plant diseases; Interaction of microorganisms with plants and their effect on plant growth. 13 hours

Section-B

Growth, reproduction, survival and dispersal of important plant pathogens; Production of various enzymes, toxins and other metabolites by pathogens for causing disease; Role of environment and host nutrition on disease development; Diseases of some important cereals, vegetables and crops - Crown gall, downy mildew; Symptoms of important viral diseases and their control. 16 hours

Section-C

Host parasite interactions - recognition and infection, symptomatology, disease development-role of enzymes, toxins, growth regulators; defense strategies, oxidative burst; Phenolics, phytoalexins, PR proteins, elicitors and their effects on host plants. 14 hours

Section-D

Plant disease resistance – Pathogen Associated Molecular patterns, Pattern Recognition Receptors, PTI, Effectors, ETI, 'R' genes; Mechanism of genetic variation in pathogens; Disease control in plants - physical, chemical methods; Use of biocontrol agents - bacteria and fungi; Molecular markers for disease resistance in plants; Transgenic approach for plant protection - applications and constraints. 17 hours

Suggested Readings

1. Agrios GN (2005). Plant Pathology, 5th edition, Academic Press, New York.
2. Dickinson M (2003). Molecular Plant Pathology, BIOS Scientific Publishers, London.
3. Mukerji KG, Garg KL (1988). Biocontrol of Plant Diseases (Vol. I) CRC Press, Inc., Boca Raton, Florida, USA.
4. Sigee DC (1993). Bacterial Plant Pathology, Cell and Molecular aspects, Cambridge University Press, UK.
5. Upadhyay RK, Mukherjee KG (1997). Toxins in Plant Disease Development and Evolving Biotechnology. Oxford & IBH.

M.Sc. (Microbiology)
(SEMESTER-II)
CC- Food & Dairy Microbiology

Paper Code: Time Allowed: 3 Hours
Max. Marks:75 Credits: 4

Note for Examiners and Students:
1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

Section-A

Natural flora and source of contamination of foods; Intrinsic and extrinsic factors that affect growth and survival of microbes in foods; Microbial spoilage of vegetables, fruits, meat, eggs, milk, bread, butter, and canned foods. 13 hours

Section-B

Principles of food preservation; Physical methods of food preservation - temperature (low, high, canning, and drying), irradiation, hydrostatic pressure, high voltage pulse, microwave processing and aseptic packaging; Chemical methods of food preservation - salt, sugar, organic acids, SO2, nitrite and nitrates, ethylene oxide, antibiotics and bacteriocins; Food sanitation - HACCP, indices of food sanitary quality and sanitizers. 16 hours

Section-C

Fermented foods - Dairy starter cultures and fermented dairy products (yogurt, acidophilus milk, curd, kefir, kumiss, cheese, dosa, sauerkraut, soy sauce and tempeh); Probiotics and prebiotics - Health benefits, types of microorganisms used, probiotic foods available in the Indian market. 15 hours

Section-D

Food-borne diseases (causative agents, foods involved, symptoms and preventive measures) - Food intoxications caused by *Staphylococcus aureus*, *Clostridium botulinum* and mycotoxins; Food infections caused by *Bacillus cereus*, *Vibrio parahaemolyticus*, *Escherichia coli*, *Salmonella*,*Shigella*, *Yersinia enterocolitica*, *Listeria monocytogenes*and *Campylobacter jejuni*; Conventional and recent methods for detection of food-borne pathogens. 16 hours

Suggested Readings

1. Frazier WC, Westhoff DC (1992). Food Microbiology, 3rd edition, Tata McGraw-Hill Publishing Company Ltd, New Delhi, India.
2. Gould GW (1995). New Methods of Food Preservation, Blackie Academic and Professional, London, UK.
3. Jay JM, Loessner MJ, Golden DA (2005). Modern Food Microbiology, 7th edition, CBS Publishers and Distributors, Delhi, India.
4. Lund BM, Baird Parker AC, Gould GW (2000). The Microbiological Safety and Quality of Foods. Vol. 1-2, ASPEN Publication, Gaithersburg, MD.
5. Tortora GJ, Funke BR, Case CL (2008). Microbiology: An Introduction, 9th edition, Pearson Education, New York, USA.

M.Sc. (Microbiology)
(SEMESTER-II)
CC- Microbial Genetics

Paper Code: Time Allowed: 3 Hours
Max. Marks:75 Credits: 4

Note for Examiners and Students:
1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

Section-A

Mendel's work on transmission of traits; Genetic variation; Prokaryotic, eukaryotic and viral genome - Structure and Functions; Extrachromosomal DNA; Mitosis and meiosis; Linkage and crossing over; Molecular mechanism of crossing over; Structure, classification and replication of plasmids. 13 hours

Section-B

Molecular basis of mutations - Induced *versus* spontaneous mutations; Gene mapping by recombination and complementation; Fine gene structure analysis; Cloning genes by complementation and marker rescue; DNA repair mechanisms; Mutation and microbial evolution. 14 hours

Section-C

Gene transfer in bacteria - conjugation, transformation and transduction; Regulation of gene transfer by conjugation; Mapping the bacterial genomes using Hfr strains; Transfer systems in gram positive bacteria; Ti plasmid and applications; Transformation - molecular basis of natural transformation; Transduction- Generalized *versus* specialized transduction; Mapping bacterial genes by transduction; Tetrad analysis in fungi; Positive and negative gene regulation and attenuation in different operons; Riboswitches. 17 hours

Section-D

Genes involved in the lytic and lysogenic cycle of lambda phage; Replication and packaging of filamentous phages M13; Benzer's experiments to construct phage genetic linkage maps; Transposons and gene regulation; Yeast Ty -1 transposon; Methods of gene cloning and sequencing; Genome transplantation (Synthetic genome). 16 hours

Suggested Reading

1. Birge EA (1981). Bacterial and Bacteriophage Genetics, Springer Verlag, Germany.
2. Gardner JE, Simmons MJ, Snustad DP (1991). Principles of Genetics, John Wiley &
3. Klug WS, Cummings MR (2012). Concepts of Genetics 1^{0th} edition, Benjamin Cummings, San Francisco.
4. Lewin B (2008). Gene, Vol IX, John Wiley & Sons, New York, USA.
5. Maloy A, Friedfelder D (1994). Microbial Genetics, Narosa Publishing house, New Delhi, India.
6. Snyder L, Chapness W (2013). Molecular Genetics of Bacteria, 4^{th} edition, ASM Press, USA.
7. Watson JD, Hopkins NH, Roberts JW, Steitz JA, Weiner AM (1987). Molecular Biology of the Gene, 4^{th} edition, Benjamin Cummings, San Francisco

M.Sc. (Microbiology)
(SEMESTER-II)
CC- Practical- II

Paper Code: Time Allowed: 6 Hours
Max. Marks: 100 Credits: 4

(Mycology & Phycology; Plant Pathology; Food and Dairy Microbiology; Microbial Genetics, Techniques in Biotechnology)

Mycology and phycology: Isolation and identification of fungi from different environmentalsamples; Study yeast dimorphism; Isolation and identification of algae from different habitats; Growth of algae under lab conditions; Study of nutritional requirement of mycelial fungi and yeasts; Cultivation of fungi in submerged and solid state; Production of enzymes, organic acids and other metabolites by fungi; Collection and study of basidiomycetous fungi.

Plant pathology: Isolation, characterization and frequency of occurrence of fungi present incultivated plants; Isolation and characterization of bacteria and fungi present on different diseased/infected plant samples; To study occurrence of disease by inoculation with bacterial or fungal pathogens; Measuring plant disease intensity under controlled conditions; Isolation of bacteria from infected vegetables and fruits; Biochemical and physiological tests for detection of pathogens in fruits and vegetables; Study of soil borne pathogens.

Food and Dairy Microbiology: Isolation of lactic acid bacteria (LAB) from curd or milk sample; Detectionof number of bacteria in milk by SPC; Determination of quality of milk sample by methylene blue reductase test (MBRT); Microbiological examination of different food samples; Production of Sauerkraut by microorganisms; Determination of antibacterial activity of lactic acid bacteria using agar well diffusion method; Statutory, recommended and supplementary tests for microbiological analysis of various foods - Baby foods, canned foods, milk and dairy products, eggs, meat, vegetables, fruits, cereals, surfaces, containers and water.

Microbial genetics: Inactivation of microorganisms by different mutagens; Production, isolationand characterization of mutants; Isolation and characterization of plasmids; Transformation of *E.coli*using isolated plasmid DNA.

Techniques in Biotechnology: Separation of amino acids/ sugars/ lipids by Thin Layer Chromatography; Polyacrylamide gel electrophoresis of proteins; Radial immunodiffusion; Immunoelectrophoresis; Enzyme Linked Immunosorbent Assay (ELISA).

M.Sc. (Microbiology)

(SEMESTER-II)

GEC- Food Microbiology

Paper Code: Time Allowed: 3 Hours
Max. Marks:75 Credits: 4

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

Section-A

Food and Microorganisms - Historical developments, Microorganisms important in food - Molds, yeast and bacteria - general characteristics, classification and importance; Factors affecting growth of microorganisms - Nutrient content, inhibitory substances and cell structures. 13 hours

Section-B

Spoilage of different foods - Microorganisms associated with plants, soil, animals, water and air; Chemical composition of various foods and their spoilage- Vegetables, fruits, cereals, sugar and its products, milk and its products, meat and meat products, poultry, fish and sea foods. Principles of Food preservation - Types of preservation methods used – Physical, Chemical and Biological. 16 hours

Section-C

Food fermentation - Production methods of bread, cheese, fermented vegetables and dairy products; Production of vinegar, wine, bear and oriental fermented foods on industrial scale, Microbes as a single cell protein (quron and pruteen); Production of Mushroom and some indigenous Indian fermented foods. 15 hours

Section-D

Food borne infections and intoxications - Bacterial and non-bacterial infection - *Brucella*, *Bacillus*, *Clostridium*, *Escherichia*, *Salmonella*,*Shigella*, *Staphylococcus*, *Vibrio*,*Yersinia*,fungi, viruses, nematodes and emerging food-borne pathogens; Foodborne outbreaks; Laboratory testing procedures and preventive measures; Food sanitation in manufacture and retail trade. 16 hours

Suggested Readings:

1. Adams MR, Moss MO (2005). Food Microbiology, 2nd edition, Royal Society of Chemistry Publication, Cambridge.
2. Frazier WC, Westhoff DC (2007). Food Microbiology, Tata McGraw Hill Publishing Company Ltd, New Delhi.
3. George J Banwart (1989). Basic Food Microbiology, AVI publication, New Delhi.
4. Jay JM (2008). Modern Food Microbiology, 6th edition, Aspen Publishers, Inc, Gaithersburg, Maryland.
5. Peppler HJ, Perlman D (1979). Microbial Technology, 2nd edition, Academic Press, USA.
6. Ray B (2005). Fundamental Food Microbiology, 3rd edition, CRC Press, New York, USA.

M.Sc. (Microbiology)

(SEMESTER-III)

CC- Virology

Paper Code: Time Allowed: 3 Hours
Max. Marks:75 Credits: 4

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.

2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

Section-A

Discovery and general characteristics of viruses; Capsid symmetry; Enveloped and non- enveloped viruses; Isolation, purification and cultivation of viruses; Viral taxonomy - classification and nomenclature of different groups (animal viruses and plant viruses) of viruses; Basic understanding of viroids, virusoids, satellite viruses andprions. 13 hours

Section-B

Diversity and classification of bacteriophages; One step multiplication curve; Lytic and lysogenic phages (lambda phage); Concept of early and late proteins; Regulation of transcription in lambda phage; Phagetherapy. 13 hours

Section-C

Salient features of viral nucleic acid - Unusual bases (TMV, T4 phage), overlapping genes (ϕX174, Hepatitis B virus), alternate splicing (HIV), terminal redundancy (T4 phage), terminal cohesive ends (Lambda phage), partial double stranded genomes (Hepatitis B), long terminal repeats (Retrovirus), segmented genomes (Influenza virus), non-segmented genomes (Picornavirus), capping and tailing (TMV); Modes of transmission of plant and animal viruses; Viral multiplication and replication strategies: Interaction of viruses with cellular receptors and entry of viruses; Replication of viruses as per Baltimore classification - assembly, maturation and release of virions.

18 hours

Section-D

Disease caused by human, animal and plant viruses – Polio, influenza, rabies, common cold, AIDS, hepatitis, chikungunya, dengue, ebola, foot and mouth disease, blue tongue disease, mad cow disease, bud necrosis, tobacco mosaic disease and cauliflower mosaic disease; Introduction to oncogenic viruses; Types of oncogenic DNA and RNA viruses; Mechanism of disease causation by plant viruses; Antiviral compounds and their mode of action; Interferon and their mode of action; Use of viral vectors in cloning, expression, and gene therapy. 16 hours

Suggested Reading:

1. Dimmock NJ, Easton AL, Leppard KN (2007). Introduction to Modern Virology, 6th edition, Blackwell Publishing Ltd,UK.
2. Carter J, Saunders V (2007). Virology: Principles and Applications. John Wiley and Sons, NewYork.
3. Flint SJ, Enquist, LW, Krug, RM, Racaniello, VR, Skalka, AM (2004). Principles of Virology, Molecular biology, Pathogenesis and Control, 2nd edition, ASM press, WashingtonDC.
4. Wagner EK, Hewlett MJ (2004). Basic Virology, 2nd edition, Blackwell Publishing,UK.
5. Mathews REF (2004). Plant Virology, Hull R. Academic Press, NewYork.
6. Versteeg J (1985). A Color Atlas of Virology, Wolfe Medical Publication, NewYork.

M.Sc. (Microbiology)

(SEMESTER-III)
CC- Medical Microbiology & Immunology

Paper Code: Time Allowed: 3 Hours
Max. Marks:75 Credits: 4

Note for Examiners and Students:
1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

Section-A

Normal microflora of the human body and its importance: normal microflora of skin, throat and gastrointestinal tract; Collection, transport and culturing of clinical samples (sputum, urine, blood, stools) for microbiological analysis; Human microbiome. 13 hours

Section-B

Causative agents, symptoms, mode of transmission and control of diseases caused by Staphylococcus aureus, Streptococcus pyogenes, Haemophilusinfluenzae, Mycobacterium tuberculosis, Escherichia coli, Salmonella typhi, Vibrio cholerae, Helicobacter pylori, Bacillus anthracis, Clostridium tetani, Treponemapallidum and TORCH group of pathogens; Causative agents, symptoms, mode of transmission and control of diseases dermatomycoses, histoplasmosis, candidiasis, malaria and kala-azar; Mechanism of action of various antimicrobial agents - inhibitors of nucleic acid synthesis, cell wall synthesis, cell membrane function and protein synthesis. 15 hours

Section-C

Concept of innate and adaptive immunity; active and passive immunity; humoral and cell-mediated immunity; Structure, characteristics and functions of T cell, B cell, NK cell, Macrophage, Neutrophil, Eosinophil, Basophil, Mast cell and Dendritic cell; Immune Organs – Bone Marrow, Thymus, Lymph node, Spleen, GALT and MALT; Characteristics of an antigen (Foreignness, Molecular size and Heterogeneity); Haptens ; Epitopes (T and B cell epitopes); T- dependent and T-independent antigens; Adjuvants; Types and properties of antibodies; VDJ rearrangements; Monoclonal antibodies; Principles of Precipitation, Agglutination, Immunodiffusion, Immuno-electrophoresis, Immunofluorescence, ELISA, ELISPOT and Western blotting. 16 hours

Section-D

Organization of MHC locus (Mice and Human); Structure and functions of MHC I and II molecules; Antigen processing and presentation (cytosolic and endocytic pathways); Components of the complement system; Activation pathways (classical, alternative); Biological consequences of complement activation, 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, autoimmunity, hypersensitivity and immune deficiencies; Characteristics of tumours antigens and immune response to tumour antigens. 16 hours

Suggested Readings:

1. Ananthanarayan R, Paniker CKJ (2009). Textbook of Microbiology, 8th edition, University Press Publication, India.
2. Brooks GF, Carroll KC, Butel JS, Morse SA, Mietzner TA (2010). Jawetz, Melnick and Adelberg's Medical Microbiology, 25th edition, McGraw Hill Publication,
3. Abbas AK, Lichtman AH, Pillai S (2007). Cellular and Molecular Immunology, 6th edition, Saunders Publication, Philadelphia.
4. Goldsby RA, Kindt TJ, Osborne BA, Kuby J (2007). Immunology, 6th edition, W.H. Freeman and company, New York, USA.
5. Murphy K, Travers P, Walport M (2008). Janeway'sImmunobiology, Garland Science Publishers, 7th edition, New York, USA.
6. Willey JM, Sherwood LM, Woolverton CJ (2008). Prescott, Harley and Klein's Microbiology, 7th edition, McGraw Hill Higher Education, USA.

M.Sc. (Microbiology)

(SEMESTER-III)

DCEC- Environmental Microbiology

Paper Code: Time Allowed: 3 Hours
Max. Marks:75 Credits: 4

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

Section-A

Introduction and scope of environmental microbiology; An overview of microbial activities in microbial niches in biosphere; Microbiology of water, air and environment in relation to human, animal and plant health and their activities. 13 hours

Section-B

Microbiology of natural waters; Environmental pollution – beneficial and deleterious role of microorganisms; Microflora of various soil types, rhizosphere and phyllosphere; Remedial measures of specialized habitats by using microorganisms - water bodies, mangroves, coral reefs and mined area; Brief account of microbial interactions; Biofertilizers and vesicular mycorrhizae (VAM); Microorganism in extreme environments. 16 hours

Section-C

Microbial technology in waste treatment; Solid and liquid wastes characterization - physical, chemical and biological; Aerobic, anaerobic, primary, secondary and tertiary treatments - trickling filters, activated sludge, oxidation ponds etc; Utilization of solid wastes for production of food (SCP, mushroom, yeast), fuel (ethanol, methane) and fertilizer (composting); Waste management and resource recovery in metal, petroleum and bioenergy fields; Biofuels and biorefineries. 16 hours

Section-D

Value addition in fossil fuels and coal gas by use of microorganisms; Microbial interaction in rumen and gastrointestinal tract; Biodeterioration and bioremediation by microorganisms; Biotransformation of xenobiotic compounds. 15 hours

Suggested Readings:

1. Arnold E, Maier RM, Pepper IL, Gerba CP (2009). Environmental microbiology, 2nd edition, Academic Press, USA.
2. Atlas RM, Bartha R (1998). Microbial Ecology: Fundamentals and Applications, 4th editions, Benjamin Cummings, San Francisco.
3. Baker KH, Herson DS (1994). Bioremediation, McGraw Hill Inc., New York.
4. Campbell R (1983). Microbial ecology, Blackwell Scientific Publications, London, UK.
5. Maier RM, Pepper IL, Gerba CP (2000). Environmental microbiology, Academic Press. USA.

M.Sc. (Microbiology)

(SEMESTER-III)
DCEC- Soil And Agricultural Microbiology

Paper Code: Time Allowed: 3 Hours
Max. Marks:75 Credits: 4

Note for Examiners and Students:
1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

Section-A

History of Development of soil microbiology; Soil microbiota and their interactions; Unculturable soil microbiota; Soil microbial ecology; Microorganisms in soil fertility; Influence of soil and environmental factors on microflora; Microbial population in manure and composts; Soil amendments and microbial dynamics. 14 hours

Section-B

Microorganisms in biogeochemical cycles; Microbial transformations of carbon, nitrogen, phosphorus, sulphur, iron and manganese; Biodegradation of pesticides and other organic wastes; Production of biogas; Production of manure using organic waste; Methods to improve soil structure and soil health by microorganisms.

16 hours

Section-C

Interrelationships between plants and microorganisms – Rhizosphere (Quantitative and qualitative studies – R:S ratio), Rhizoplane, spermosphere, phyllosphere microorganisms; Nitrogen fixation by soil bacteria - symbiotic, non-symbiotic, associative symbiotic and endophytic organisms, process of nitrogen fixation; Molecular biology of Nitrogen fixation; PGPR (plant growth promoting rhizobacteria), siderophore producers and biocontrol agents

16 hours

Section-D

Biofertilizers – Mycorrhizal inoculants, Mass cultivation of microbial inoculants; Green manuring; Microbial products and plant health; ; Microbial Pesticides: development and their significance. 14 hours

Suggested readings:

1. Alexander M (1985). Introduction to Soil Microbiology, 3rd edition, Wiley Eastern, New Delhi.
2. Atlas RM, Bartha R (1998). Microbial Ecology: Fundamentals and Applications, 4th editions, Benjamin Cummings, San Francisco.
3. Paul EA (2007). Soil Microbiology, Ecology and Biochemistry, 3rd edition, Academic Press, New York, USA.
4. Sylvia D, Fuhrmann J, Hartel P, Zuberer D (2005). Principles and Applications of Soil Microbiology, 2nd edition, Pearson Education, USA.

M.Sc. (Microbiology)

(SEMESTER-III)
CC- Industrial Microbiology

Paper Code: Time Allowed: 3 Hours
Max. Marks:75 Credits: 4

Note for Examiners and Students:
1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

Section-A

Introduction and scope of industrial microbiology; Biology of industrially important microbes (metabolic pathways and control mechanisms); Isolation and selection of industrially important microorganisms; Genetic improvement of microbes by using classical and r-DNA techniques; Preservation and maintenance of microbial cultures. 14 hours

Section-B

Microbial substrates - Media formulation, optimization of media; Cell growth kinetics - Kinetics of substrate utilization, biomass production and product formation in batch, fed batch and continuous cultivations; Types of fermentation processes - solid state, static and submerged fermentations; Design of laboratory bioreactor; Types of bioreactor - Stirred tank reactor, bubble column reactor, Airlift reactor, Packed bed reactor and Fluidized bed reactors; Scale-up principles; Downstream processes; Fermentation economics. 16 hours

Section-C

Types of microbial products; Production of biomass: Baker's Yeast, mushrooms, single cell proteins, biopesticides and biofertilizers; Production of primary metabolites: Ethanol, organic acids, amino acids, vitamins; industrial enzymes and bioplastics. 14 hours

Section-D

Production of secondary metabolites: Antibiotics (penicillin, cephalosporins, streptomycin), pigments, Microbial transformation, Production of metabolites of non-microbial origin like Insulin, Interleukins and growth hormones using rDNA technology. Development of designer microbes for food, energy and health care products. 16 hours

Suggested readings:

1. Casida LE (1968). Industrial Microbiology, New Age Publishers, New Delhi.
2. Crueger W, Crueger A (1991). Biotechnology. A Textbook of Industrial Microbiology, 2nd edition, Sinauer Associates, USA.
3. Shuler ML, F Kargi (2004). Bioprocess Engineering - Basic Concepts, 2nd edition, Prentice Hall, New Jersey, USA.
4. Stanbury PF, A. Whitaker SJ (1999). Principles of Fermentation Technology, 2nd edition, Butterworth-Heinemann, UK.

M.Sc. (Microbiology)

(SEMESTER-III)

GEC-Bioinformatics and Biostatistics

Paper Code: Time Allowed: 3 Hours

Max. Marks:50 Credits: 2

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.

2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

Section- A

Computers: Components and functions; generations of computer; input and output devices; types of memory; file manager; internet and its applications. Operating system and its evolution; system and application software; internal and external commands of DOS, UNIX, WIN 98/2000/XP; Office applications including MS-Word, MS-Excel, MS-Powerpoint.

Section- B

Bioinformatics: Introduction and uses of bioinformatics tools – a. BLAST b. FASTA c. Multiple sequence alignment-CLUSTAL-W d. MEDLINE &PubMED

Retrieving and installing a programme (Tree Tool); Searching Science Citation Index & current content; Accessing full text Journal.

Section- C

Biostatistics: Graphical representation of data; Analysis of variation; Analysis of frequencies; Measures ofcentral tendency; coefficient of variation. Correlation and regression; Hypothesis testing; Experimental design and sampling theories.

Section- D

Probabilities theory; t- test, F- test and $\chi 2$- test; Probability distributions and their properties.Non-parametric test: Sign test; Run & Median test; Wilcoxon Signed Rank Mann-whiteney test; Kruskal Wallis test.

Suggested Readings:

1. Baxevanis AD, Ouellett BFF (2005). Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, 3rd Edition, John Wiley and Son Inc., New York, USA.
2. Casella G, Berger RL (2001). Statistical Inference (The Wadsworth and Brooks/Cole Statistics/ Probability Series), Brooks/Cole Pub Company, Belmont, CA.
3. Grant GR, Ewens WJ (2001). Statistical Methods in Bioinformatics: An Introduction. Springer Verlag, New York.
4. Gupta SC, Kapoor VK (2014). Fundamentals of Mathematical Statistics, S Chand and sons, India.
5. Gupta SP (2009). Statistical Methods, 28th edition, S Chand and Sons, India.
6. Jagota A. (2000). Data Analysis and Classification for Bioinformatics, Bioinformatics by the Bay Press.

M.Sc. (Microbiology)
(SEMESTER-III)
CC- Practical- III

Paper Code: Time Allowed: 6 Hours
Max. Marks: 100 Credits: 4

(Virology, Medical Microbiology & Immunology; Environmental Microbiology; Soil & Agricultural Microbiology and Industrial Microbiology)

Virology: Study of virus architecture using electron microphotographs of TMV, poliovirus and adenovirus; Study of virus architecture using models of TMV and any virus having icosahedral symmetry; Discussion as to how animal viruses are cultivated in various media like embryonated eggs and cell cultures; Study of the cytopathic effects of viruses using electron microphotographs; Bacteriophage assay using the plaque technique; Salient symptoms of viral diseases using colored slides – small pox, chicken pox, herpes, foot and mouth disease of cattle, genital warts, tobacco mosaic, tomato leaf curl; Good laboratory practices while handling the viruses in the laboratory.

Medical microbiology and Immunology: Study composition, preparation and use of common selective differential media commonly used in medical microbiology – MacConkeyagar, EMB agar, MH agar, Deoxycholate citrate agar (DCA); Staining techniques used in medical microbiology - Gram's staining and Ziehl-Neelsen staining for acid fast bacilli (AFB); Study resident microflora of the skin; Widal test; Antibiotic susceptibility testing using Kirby-Bauer method; Determine minimal inhibitory concentration (MIC) of an antibiotic using double dilution technique or E-test strips. **Immunology:** Determine total leucocyte count (TLC) of a given blood sample; Determine differential leucocyte count (DLC) of the blood sample, study cell morphology in blood; Identification of human blood groups - ABO and Rh factor; Immunodiffusion by Ouchterlonymethod; Immunoelectrophoresis; Dot-ELISA; Demonstration of Westernblotting.

Environmental microbiology: Screening for microorganisms from soils and industrial effluents; Analysis of natural waters, waste waters and organic waste in relation to water pollution; Quality control tests for water; Waste treatment and anaerobic digestion; Demonstration of waste water treatment processes such as activated sludge biofilters and fluidized bed process; Isolation and screening of thermotolerant microbes from environmental samples for hydrolytic enzymes; Metagenomic analysis of any environmental sample and study the microbial diversity; Bioremediation of effluents from alcohol and textile industry using microbial cultures; To study dye and industrial effluent treatment by the microbial cultures.

Soil & agricultural microbiology: Determination of soil microbial population; Isolation of different bacterial and fungal organisms important in recycling of C, N, P, S in soil; Soil microbial biomass; Decomposition studies in soil, Soil enzymes; Measurement of important soil microbial processes such as ammonification, nitrification, N_2 fixation, S oxidation, P solubilization and mineralization of other micro nutrients; Study of rhizospheremicroflora effect on plantgrowth.

Industrial microbiology: Isolation of industrially important microorganism from different sources using specific substrates; Design and formulation of media for microbial fermentations; Growth curve studies and determination of yield coefficient of *Saccharomyces cerevisiae*on various substrates; To study the design of fermenter and its working; To study the various methods of biomass production and its measurement; Production of ethanol using sugar by yeast isolate; Vinegar production using immobilized bacterial culture; Production of citric acid using sucrose by fungi using static, submerged and solid state conditions; Production of extracellularenzymes. International Organization for Standardization (ISO) and Indian Standards. Eg. ISO 17025, Quality Management, Method Validation, Interlaboratory Comparison (ILC) and Proficiency Test (PT), Calculation of measurement of Uncertainty

M.Sc. (Microbiology)

(SEMESTER-IV)
DCEC- Molecular Biology

Paper Code: Time Allowed: 3 Hours
Max. Marks:75 Credits: 4

Note for Examiners and Students:
1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

Section-A

History of molecular biology; Nucleic acids as hereditary material; Structure of nucleic acid; Secondary and tertiary structure of nucleic acids; Types of RNA - rRNA, tRNA and mRNA; structure of ribosomes; Nucleases; Restriction and modification; Salient features of Prokaryotic and eukaryotic genomes 15 hours

Section-B

DNA replication , DNA polymerase, The replication fork, The fidelity of DNA replication Origin and initiation of DNA replication. DNA replication in prokaryotes and eukaryotes. Telomeres and Telomerase 15 hours

Section-C

Transcription; RNA polymerases and Transcription, Transcription in prokaryotes,Repressor and negative control of transcription , Positive control of transcription. Transcription in eukaryotes : formation of transcription initiation complex, Transcription factors, Capping, elongation and termination. RNA splicing ,Polyadenylation, RNA editing. 15 hours

Section-D

Translation in prokaryotes and eukaryotes.: Ribosome, formation of initiation complex, initiation factors and their regulation, elongation and elongation factor, termination, Genetic Code, Translation proof reading, Translational inhibitors. Posttranslational modification 16 hours

Suggested readings:

1. Alberts B, Bray D, Lewis J, Raff M, Roberts K, Watson JD (1989). Molecular Biology of the Cell, 2nd edition, Garland Publishing, New York,USA.
2. Brown TA (2003). Genomes, 2nd edition, John Wiley and Sons Inc, New York,USA.
3. Lewin B (2009). Gene, Vol X, John Wiley & Sons, New York,USA.
4. Lodish H, Berk A, Zipursky S, Matsudaira P, Baltimore D, Darnell JE (1999). Molecular Cell Biology, 4th edition, W.H. Freeman and Company,USA.
5. Watson JD, Hopkins NH, Roberts JW, Steitz JA, Weiner AM (1987). Molecular Biology of the Gene, 4th edition, Benjamin Cummings, SanFrancisco.

M.Sc. (Microbiology)

(SEMESTER-IV)
DCEC- Cell Biology

Paper Code: Time Allowed: 3 Hours
Max. Marks:75 Credits: 4

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

Section-A

Structure of Cell

Plasma membrane: Structure and transport of small molecules.
Cell Wall: Eukaryotic cell wall, Extracellular matrix and cell matrix interactions, Cell-Cell Interactions - adhesion junctions, tight junctions, gap junctions, and plasmodesmata (only structural aspects). Mitochondria, chloroplasts and peroxisomes. Cytoskeleton: Structure and organization of actin filaments, association of actin filaments with plasma membrane, cell surface protrusions, intermediate filaments, microtubules.

15 hours

Section-B

Nucleus

Nuclear envelope, nuclear pore complex and nuclear lamina. Chromatin – Molecular organization. Nucleolus.

Protein Sorting and Transport

Endoplasmic Reticulum – Structure, targeting and insertion of proteins in the ER, protein folding,processing and quality control in ER, smooth ER and lipid synthesis, export of proteins and lipids. 17 hours

Section-C

Golgi Apparatus – Organization, protein glycosylation, protein sorting and export from Golgi Apparatus. Lysosomes.

Cell Signalling Signalling molecules and their receptors.Function of cell surface receptors. Pathways of intracellular signal transduction– Cyclic AMP pathway, cyclic GMP and MAP kinase pathway. 14 hours

Section-D

Cell Cycle, Cell Death and Cell Renewal Eukaryotic cell cycle and its regulation, Mitosis and Meiosis.Development of cancer, causes, types, Diagnosis and therapy.Programmed cell death.

Stem cells. Types-Embryonic stem cell, induced pluripotent stem cells. 14 hours

Suggested readings:

1. Hardin J, Bertoni G and Kleinsmith LJ. (2010). Becker's World of the Cell. 8th edition. Pearson.
2. Karp G. (2010) Cell and Molecular Biology: Concepts and Experiments. 6th edition. John Wiley & Sons. Inc.
3. De Robertis, EDP and De Robertis EMF. (2006). Cell and Molecular Biology. 8th edition. Lipincott Williams and Wilkins, Philadelphia.
4. Cooper, G.M. and Hausman, R.E. (2009). The Cell: A Molecular Approach. 5th Edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.