KARNATAK UNIVERSITY, DHARWAD

Accredited by NAAC with "A" Grade
University with Potential for Excellence

Regulations and Syllabus

for

P.G. Studies in

MICROBIOLOGY

(I to IV Semesters)

Under
Choice Based Credit System

From
2019-20 & onwards

Regulations Governing Post-Graduate Programmes in Faculty of Science & Technology under Choice Based Credit System

(Framed under Section 44(1) (c) of the K. S.U. Act, 2000)

1.0 Title

These Regulations shall be called "Regulations Governing the Post-Graduate Programmes in the Faculty of Science & Technology under the Choice Based Credit System" in Karnatak University, Dharwad

2.0. Commencement

These Regulations shall come into force with effect from the academic year 2008-09.

3.0. Definitions

a In these Regulations, unless otherwise provided:
"Academic Council" means Academic Council of the University constituted according to the *Karnataka State Universities Act, 2000.*

b "Board of Studies" means P.G. Board of Studies of the University, Adhoc/ Combined and Steering Committees of International Diploma Programmes in the discipline/subjects concerned.

c "Compulsory Course" means fundamental paper, which the student admitted to a particular Post-Graduate Programme, should successfully complete to receive the Post Graduate Degree in the concerned subject.

d Course Weightage" means number of credits assigned to a particular course.

e "Credit" means the unit by which the course work is measured. One Credit means one hour of teaching work or two hours of practical work per week. As regards the marks for the courses, 1 Credit is equal to 25 marks, 2 credits are equal to 50 marks, 3 credits are equal to 75 marks and 4 credits are equal to 100 marks.

f "Cumulative Grade Point Average (CGPA)" refers to the cumulative Grade Point Averages weighted across all the semesters and is carried forward from first semester to subsequent semesters.

g "Degree" means Post-Graduate Degree.

h "Grade" is an index to indicate the performance of a student in the selected course. These Grades are arrived at by converting marks scored in each course by the candidate in both Internal Assessment and Semester-end Examinations.

i "Grade Point Average (GPA)" refers to an indication of the performance of the student in a given semester. GPA is the weighted average of all Grades a student gets in a given semester.

j "Open Elective Course" means a paper offered by a Department to the students of other Departments.

k "Post Graduate Programme" means semesterised Master's Degree Programmes excluding P.G. Diploma.

l "Specialization course" means advanced paper offered by a Department that a student of that Department can opt as a special course.

m "Student" means the student admitted to programmes under (k).

n "University" means Karnatak University, Dharwad.

4.0. Minimum Eligibility for Admission

A candidate, who has successfully completed Bachelor's Degree programme in Science or any other Degree programme of this University or of any other University recognized as equivalent thereto by this University, shall be eligible for admission to the Post Graduate Programmes in science provided the candidate also satisfies the conditions like the minimum percentage of marks and other eligibility conditions as

prescribed by the University from time to time.
Admissions shall be as per Government of Karnataka reservation policy and the directions issued in this regard from time to time.

5.0. Duration of the Programme

The duration of the study for the Post-Graduate Degree programme shall extend over a period of two (three in case of MCA) consecutive academic years, each academic year comprising two semesters, and each semester comprising sixteen weeks with a minimum of ninety working days.
However, the students, who discontinue the programme after one or more semesters due to extraordinary circumstances, are allowed to continue and complete the programme with due approval from the Registrar. Candidates shall not register for any other regular course other than Diploma and Certificate courses being offered on the campus during the duration of P.G. Programme.

6.0. Medium of Instruction and Evaluation

The medium of instruction shall be English. However, the students may write the examinations in Kannada if so provided by the concerned Board of Studies.

7.0 Programme Structure

7.1 The students of Post-Graduate Programme shall study the courses as may be approved by the concerned Board of Studies, Faculty and the Academic Council of the University from time to time subject to minimum and maximum credits as outlined in these regulations.

7.2 There shall be three categories of courses namely, Compulsory Courses, Specialization Courses and Open Elective Courses

7.3 Each programme shall have a set of Compulsory Courses, as stipulated in the regulations governing the concerned programme that a student must complete to get the concerned degree.

7.4 In those programmes that offer specialization courses, the students shall choose the prescribed number of Specialization Courses offered within the Department.

7.5 Each Department shall offer Open Elective courses for students of other Departments. The students of a Department shall choose Open Elective courses from among those prescribed by the University and selected by the Department from time to time. P.G. Centers and affiliated colleges can offer those Open Elective Courses which are approved or prescribed by their Parent Department of the University. Such Open Elective courses shall be taught by qualified teachers approved by the University.

7.6 The credits for each of the Compulsory Courses may vary from 2 to 4; for Specialization Course, from 2 to 4; and for Open Elective Course, from 2 to 4. Wherever project work/ field work/practical are involved in the course, the credits may extend to 6 or as otherwise provided by concerned programme.

7.7 The minimum credits for P.G. Programme shall be 96. In the case of MCA, the minimum number of credits shall be 158 and in case of M.Sc. Computer Science the minimum credits are 116.

7.8 The students shall undertake project/field work during the programme as a compulsory course or in lieu of Specialization Course or Open Elective Course if so specified by the concerned Board of Studies.

7.9 The ratio between Compulsory, Specialization and Open Elective may differ from department to department.

7.10 The detailed programme structure for Faculty of Science & Technology shall be as prescribed and shown in Annexure-I, Annexure –Ia & Annexure-Ib.

7.11 The Open Elective Courses generally will have practical component, unless otherwise specified by the respective Board of Studies. The number of students admitted to the course shall commensurate with the availability of infrastructure.

8.0. Attendance

8.1 Each course shall be taken as a unit for the purpose of calculating the attendance.

8.2 Each student shall sign the attendance register maintained by the Department for each course for every hour/unit of teaching/practical. The course teachers shall submit the monthly attendance report to the Chairperson of the Department who shall notify the same on the notice board of the Department during the second week of the subsequent month.

8.3 Marks shall be awarded to the student for attendance as specified in the regulations concerning evaluation.

8.4 A student shall be considered to have satisfied the required attendance for each course if he/she has attended not less than 75 % of the total number of instructional hours during the semester.

8.5 There is no provision for condoning shortage of attendance.

8.6 The students who do not satisfy the prescribed requirement of attendance shall not be eligible for the ensuing examination. Such candidates may seek admission afresh to the given semester.

8.7 Such of the candidates who have participated in State/National level Sports, NSS, NCC, Cultural activities and other related activities as stipulated under the existing regulations shall be considered for giving attendance for actual number of days utilized in such activities (including travel days) subject to the production of certificates from the relevant authorities within two weeks after the event.

9.0 Examination

9.1 There shall be an examination at the end of each semester. The odd semester examinations shall be conducted by the respective Departments/ P.G. Centers/ Colleges. The even semester examinations shall be conducted by the University.

9.1.1 Unless otherwise provided, there shall be semester-end examination of 3 hours duration for 75/100 marks; 1.5 hours for 50 marks and 2/4 hours for 35/75 marks practical examination.

9.1.2 Every student shall register for each semester-end examination as per the University Notification by submitting duly completed application form through the proper channel and shall also pay the fees prescribed.

9.1.3 The Office of the Registrar (Evaluation) shall allot the Register Number to the candidate at the 1st semester-end examination. That will be the Register Number of the candidate for all subsequent appearances at semester-end examinations.

9.1.4 The Answer scripts shall be in the safe custody of the University for a maximum period of six months from the date of announcement of results. These shall be disposed off after six months.

9.1.5 The programme under CBCS is a fully carry-over system. A candidate reappearing for either the odd or even semester examinations shall be permitted to take examinations as and when they are conducted (even semester examination in even semester and odd semester examination in odd semester).

9.1.6 Candidates who have failed, remained absent or opted for improvement in any course/ courses shall appear for such course/ courses in the two immediate successive examinations that are conducted. However, in the case of the candidates appearing for improvement of their marks, the marks secured in the previous examination shall be

retained, if the same is higher.

9.1.7 Candidates who desire to challenge the marks awarded to them, in the even semester-end examinations, may do so by submitting an application along with the prescribed fee to the Registrar (Evaluation) within 15 days from the announcement of results.

9.2. Odd Semester Examination

9.2.1 There shall be a Board of Examiners to set, scrutinize and approve question papers.

9.2.2 The BOE shall scrutinize the question papers submitted in two sets by the paper setters and submit the same to the office of the Registrar (Evaluation).

9.2.3 The office of the Registrar Evaluation shall dispatch the question papers to the Departments/ P.G. Centers/ Colleges who shall conduct the Examinations according to the Schedule announced by the University.

9.2.4 The Chairperson of the Department/ Administrator of the P.G. Centre/ Principal of the College shall appoint one of their full time course teachers as Post Graduate Programme (PGP) Coordinator who shall conduct the examinations and arrange for evaluation of answer scripts.

9.2.5 Answer scripts shall be valued by the examiners appointed by the University. However, in those centers where an examiner for a particular course is not available, then the answer scripts of that course shall be dispatched to the office of the Registrar (Evaluation) who shall arrange for valuation of the same.

9.2.6 There shall be single valuation. The examiners (Internal or External) **shall** value the answer scripts and shall indicate the marks awarded to each question on the answer script.

9.2.7 The Marks List, a copy of the Examination Attendance Sheet and the sealed bundles of the answer scripts shall be dispatched by the PGP Coordinator to the Registrar (Evaluation)'s Office at the conclusion of the valuation at the respective centers.

9.2.8 The Office of the Registrar Evaluation shall process and announce the results.

9.3. Even Semester

9.3.1 There shall be a Board of Examiners to set, scrutinize and approve question papers.

9.3.2 As far as practicable, it will be ensured that 50% of the paper setters and examiners are from other Universities/ Research Institutes.

9.3.3 Each answer script of the semester-end examination (theory and project report) shall be assessed by two examiners (one internal and another external). The marks awarded to that answer script shall be the average of these two evaluations. If the difference in marks between two evaluations exceeds 20% of the maximum marks, such a script shall be assessed by a third examiner. The marks allotted by the third examiner shall be averaged with nearer award of the two evaluations.

Provided that in case the number of answer scripts to be referred to the third examiner in a course exceeds minimum of 5 or 20% of the total number of scripts, at the even semester-end examinations, such answer scripts shall be valued by the Board of Examiners on the date to be notified by the Chairperson of the Board of Examiners and the marks awarded by the Board shall be final.

9.3.4 Wherever dissertation/ project work is prescribed in the even semesters of a programme, the same shall be evaluated by both internal and external examiners. The evaluation shall be as prescribed by the concerned Board of Studies.

9.3.5 In case of programmes with practical examination details of maximum marks, credits or duration may vary from Department to Department as specified by the concerned Board of Studies.

9.4. Evaluation

9.4.1 Each Course shall have two evaluation components - Internal Assessment (IA) and the Semester End Exams.

9.4.2 The IA component in a course shall carry 25% / 30% / 50% and the Semester End Examination shall carry 75% / 70% / 50% respectively, as the case may be. Courses having 25% & 30% / 50% marks as internal assessment shall have 3 / 5 marks allotted to attendance. However, in case of project work, the distribution of marks for Internal Assessment and Examination shall be left to the discretion of the concerned BOS.

9.4.3 Marks for attendance shall be awarded to the students according to the following table.

For courses carrying 25 % of marks for IA, the attendance marks shall be

Attendance (in percentage)	Marks
Above 90	3
Above 80 and up to 90	2
Above 75 and up to 80	1

9.4.4 Internal Assessment (IA) shall be based on written tests, practical and seminars. However, the number of IA components per course per semester shall not be less than two.

9.4.5 The IA marks list shall be notified on the Department Notice Board as and when the individual IA components are completed and the consolidated list shall be submitted to the Office of the Registrar Evaluation before the commencement of semester-end examination, or as directed by the University.

9.4.6 The tests shall be written in a separately designated book supplied by the University which shall be open for inspection by the students after evaluation.

9.4.7 There is no provision for seeking improvement of Internal Assessment marks.

9.4.8 The IA records, pertaining to Semester Examination, shall be preserved by the department/Centers/Colleges for a period of one year from the date of semester examination. These records may be called by the University or a body constituted by the University as and when deemed necessary.

9.4.9 The dissertation/project work viva-voce shall be conducted by an internal and external examiner.

10.0. Maximum duration for completion of the Programme

10.1 A candidate admitted to a post graduate programme shall complete it within a period, which is double the duration of the programme from the date of admission.

10.2 Whenever the syllabus is revised, the candidate reappearing shall be allowed for the examinations only according to the new syllabus.

11.0 Declaration of Results

11.1 The minimum for a pass in each course shall be 40% of the total marks including both the IA and the semester-end examinations. Further, the candidate shall obtain at least 40% of the marks in the semester-end examination. There is no minimum for the IA marks.

11.2 Candidates shall secure a minimum of 50% in aggregate in all courses of a programme in each semester to successfully complete the programme.

11.3 Candidates shall earn the prescribed number of credits for the programme to qualify for the PG Degree.

11.4 For the purpose of announcing the results, the aggregate of the marks secured by a candidate in all the semester examinations shall be taken into account. However,

Ranks shall not be awarded in case the candidate has not successfully completed each of the semesters in first attempt or has not completed the programme in the stipulated time (vide Regulation 5) or had applied for improvement of results.

12.0 Marks, Credit Points, Grade Points, Grades and Grade Point Average

12.1 The grade points and the grade letters to candidates in each course shall be awarded as follows:

Percentage of marks	Grade Points	Grade Letter
75 and above, up to 100.00 %	7.50 to 10.00	A
60 and above but less than 75 %	6.00 and above but less than 07.5	B
50 and above but less than 60 %	5.00 and above but less than 6.0	C
40 and above but less than 50 %	4.00 and above but less than 05.00	D
less than 40.00 %	Less than 4.00	F

12.2 Credit Point (CP): The Credit Point for each course shall be calculated by multiplying the grade point obtained by the credit of the course.

12.3 The award of Grade Point Average (GPA) for any student is based on the performance in the whole semester. The student is awarded Grade Point Average for each semester based on the Total Credit Points obtained and the total number of credits opted for. The GPA is calculated by dividing the total credit points earned by the student in all the courses by the total number of credits of those courses of the semester.

12.4 The Cumulative Grade Point Average (CGPA) shall be calculated by dividing the total number of credit points in all the semesters by the total number of credits in all the semesters. The CGPA to date shall be calculated by dividing the total number of credit points in all the semesters to date by the total number of credits in all the semesters to date.

CGPA for the I Semester =
Sum of the CP of the I Semester ÷ Sum of the credits of the I Semester

CGPA for the II Semester =
Sum of the CP of the I Sem + Sum of the CP of II Sem. ÷ Sum of the credits of the I Semester + II Semester

CGPA for the III and IV Semesters shall be computed accordingly.

12.5 The Grade Card at each semester examination shall indicate the courses opted by the student, the credit for the course chosen by the student, the credit points obtained in each course, the grade letter and the grade point average. No class shall be awarded for each semester and the same would only be awarded at the end of all the semesters based on Cumulative Grade Point Average.

12.6 Class shall be awarded to the successful candidates based on the Cumulative Grade Point Average (CGPA) as specified below:

Cumulative Grade Point Average (CGPA)	Class to be awarded
7.5 to 10.0	First class with Distinction
6.0 and above but below 7.5	First Class
5.0 and above but below 6.0	Second Class

13. Miscellaneous:

a Notwithstanding anything contained in these regulations, the semester system at Post-Graduate level is hereby repealed.

b The provisions of any order, Rules or Regulations in force shall be inapplicable to the extent of its inconsistency with these Regulations.

c The University shall issue such orders, instructions, procedures and prescribe such format as it may deem fit to implement the provisions of this Regulations.

d The procedural details may be given by the University from time to time.

e Any unforeseen problems/ difficulties may be resolved by the Vice Chancellor, whose decision in the matter shall be final.

Annexure-I

The Programme structure of the Master of Science Degree shall be as follows:

Semester	No. of compulsory & Specialization courses (credits/course)	Total credits for compulsory & Specialization courses	No. of open elective course (credits/course)	Total credits of open elective course	Total credits for the semester
Sem. I	Th :04 (04) =16 Pra/Th:04 (02)=08	24	-	-	24
Sem. II	Th :03 (04) =12 Pra/Th*:03 (02)=06	18	Th :01 (04) =04 Pra/Th*:01(02)=02	06	24
Sem. III	Th :03 (04) =12 Pra/Th*:03 (02)=06	18	Th :01 (04) =04 Pra/Th*:01(02)=02	06	24
Sem. IV	Th :03 (04) =12 Pra/Th:03 (02)=06 Pj 01 (06) =06	24	-	-	24
Total	Th 13 (4) =52 Pra/Th 12(02)= 24 Pj:1 (06)=06	84	02 (04)=08 Pra/Th*:02(02)=04	12	96

Note: Except for I and IV semester, the concerned Department shall offer one each of open elective theory and practical course **or** two * open elective Theory courses for students of other science departments.

Abbreviations: Th = Theory; Pra = Practical; Pj = Project;

GRADE CARD

Programme: M.Sc., (Microbiology)

Name of the candidate: ……..… **Semester: IV**

Seat No.: Month & Year:

Course	Course Code	Credit	IA Marks		Theory/ Practical		Max	Marks Obtained	Semester Grade Point	Credit Points
			Max	Obt.	Max	Obt.				
Compulsory Courses										

Course-I	MB CT 4.1	04	25	15	75	45	100	60	6.00	24.00
Course-II	MB CT 4.2	04	25	15	75	59	100	74	7.40	29.60
Course-III	MB CT 4.3	04	25	15	75	28	100	43	4.30	17.20
Course-IV	MB CP 4.4	02	15	06	35	34	50	40	8.00	16.00
Course-V	MB CP 4.5	02	15	06	35	34	50	40	8.00	16.00
Course-VI	MB CP 4.6	02	15	06	35	34	50	40	8.00	16.00
Course-VII	MB CPJ 4.7	06	25	20	125	100	150	120	8.00	48.00
		24					600			185

MB refers to course abbreviations, 4.1 refers to IV semester course 1

GPA for IV Semester = CP (IV Sem) / Credits (IV Sem) = 185/24.00 = 7.71

GPA for I Semester = CP (I Sem) / Credits (I Sem)

CGPA for I Semester = GPA for I Semester

$$\text{CGPA for II Sem} = \frac{\text{CP (ISem)} + \text{CP (II Sem)}}{\text{Credits (I Sem)} + \text{Credits (II Sem)}}$$

$$\text{CGPA for III Sem} = \frac{\text{CP (I Sem)} + \text{CP (II Sem)} + \text{CP (III Sem)}}{\text{Credits (I Sem)} + \text{Credits (II Sem)} + \text{Credits (III Sem)}}$$

$$\text{CGPA for the Programme} = \frac{\text{CP (I Sem)} + \text{CP (II Sem)} + \text{CP (III Sem)} + \text{CP (IV Sem)}}{\text{Credits (I Sem)} + \text{Credits (II Sem)} + \text{Credits(IIISem)} + \text{Credits(IVSem)}}$$

(*CP: Credit Points)

KARNATAK UNIVERSITY, DHARWAD

P.G. DEPARTMENT OF STUDIES IN MICROBIOLOGY

M.Sc. DEGREE IN MICROBIOLOGY

CHOICE BASED CREDIT SYSTEM (CBCS) SYLLABUS

Preamble:

Microorganisms are the most versatile and adaptable forms of life on earth, and have existed here for some 3.5 billion years. Indeed, for the first 2 billion years of their existence, prokaryote alone ruled the biosphere, colonizing every accessible ecological niche, from glacial ice to the hydrothermal vents of the deep-sea bottoms. Over their long period of global dominance, prokaryotes also changed the earth, transforming its anaerobic atmosphere to one rich in oxygen and generating massive amounts of organic compounds. Eventually, they created an environment suited to the maintenance of more complex forms of life. Today, the biochemistry and physiology of bacteria and other microorganisms provide a living record of several billion years worth of genetic responses to an ever-changing world. Thus, it is likely that representative of most of the microbial species that existed before humans are still here to be explored

The scope of microbial processes has enlarged tremendously during last 20 years or so. The efforts are made to explicit the potentiality of microbial systems in the development of industry, medicine, agriculture and forestry. Microorganisms possess an array of unique characteristics that render them as most ideal organisms for use in these sectors. Microorganisms are thus vital to economy of any country. The microbiology includes virology, bacteriology, mycology, phycology and protozoology. The careers in microbiology are challenging rewarding and varied. The critical mass of Biotechnological/ Microbiological companies in areas of Pharmaceutical, Agriculture, Sericulture, Health care system, food processing and Bioinformatics etc., to help us to sustain the growth of Biotechnological/Microbiological industry there by providing the manpower to biotechnology/microbiology industry to fulfill this objective. With the advent of recombinant DNA technology, researches in microbiology enabled scientists to produce transgenic fungi and bacteria with new genetic traits. Conceptually the way, one studies living organisms has changed the fundamental way as these seems to be very little difference between microbes and higher organisms at the center stage of revolution called Biotechnology. This is perhaps the reason for all students of biology to grasp the fundamentals of microbiology.

Microbiology impinges on almost every aspect of human life. This syllabus forms a solid foundation and provides a broad insight into the discipline for the students who intend to pursue microbiology at Post-Graduate level. Candidates of M.Sc. Microbiology, in addition to finding job opportunities in pharmaceutical, food and beverage industries can find opportunities in biotechnology, R & D programmes, teaching assignments and self-employment.

M.Sc. DEGREE IN MICROBIOLOGY

The department offers two years M.Sc. course in Microbiology of four semesters with Choice Based Credit System (CBCS). Following are the Regulations governing the M.Sc. course in Microbiology offered by Karnatak University under Choice Based Credit System (KU-CBCS) from the academic year 2008-09.

Regulations Governing Post-Graduate Programme in the Faculty of Science and Technology Under Choice-Based Credit Scheme (CBCS)

(Framed under Section 14(1) (c) of K.S.U. Act, 2000)

1.0 Title

The regulations shall be called Karnatak University, Regulations Governing Postgraduate programmes under the "Choice Based Credit System" in Master of Science in Microbiology

2.0 Commencement

These Regulations shall come into forces from the academic year 2008-2009.

3.0 Definitions

a. In these Regulations, unless otherwise provided: "Academic Council" means Academic Council of the University constituted according to the *Karnatak State Universities Act, 2000.*
b. "Board of Studies" means P.G. Board of Studies of the University, Adhoc/Combined and Steering Committees of International Diploma Programme in the Discipline/subjects concerned.
c. "Compulsory Course" means fundamental paper, which the student admitted to a Particular Post-Graduate Programme, should successfully complete to receive the Post Graduate Degree in the concerned subject.
d. Course Weightage" means number of credits assigned to a particular course.
e. "Credit means the unit by which the course work is measured. One Credit means one hour of teaching work or two hours of practical work per week As regards the marks for the courses, 1 credit is equal to 25 marks, 2 credits are equal to 50 marks, 3 credits are equal to 75 marks and 4 credits are equal to 100 marks.
f. "Cumulative Grade point Average (CCPA)" refers to the cumulative Grade Point Averages weighted across all the semesters and is carried forward from first semester to subsequent semesters.
g. "Degree" means Post-Graduated Degree.
h. "Grade" is an index to indicate the performance of a student in the selected course. These Grades are arrived at by converting marks scored in each course by the candidate in both Internal Assessment and Semester-end Examinations
i. "Grade Point Average (GPA)" refers to an indication of the performance of the student in a given semester. GPA is the weighted average of all Grades a student gets in a given semester.
j. "Open Elective Course" means a paper offered by a Department to the students of other Departments.
k. "Post-Graduate Programme" means semesterised Master's Degree Programmes excluding P.G. Diploma.

l. "Specialization course means advanced paper offered by a Department that a student of that Department can opt as a special course
m. "Student" means the student admitted to programmes under (k).
n. "University" means Karnatak University, Dharwad

4.0 Minimum Eligibility for Admission

B.Sc. with any two biological science subjects of this University or of any other University recognized as equivalent there to by this University shall be eligible for admission provided they also satisfy the eligibility conditions like percentage of marks etc., as may be prescribed by the University and as per ordinance of the course.

The reservations, award of classes, attendance and evaluation are as per University regulations and statutes issued in this regard from time to time

Intake capacity: Total intake of students for M.Sc. degree in Microbiology is 40 for the First semester and may vary as prescribed by the University

5.0 Duration of the programme

The Durations of the study for the Post-Graduate programme shall extended over a period of two consecutive academic years, each academic year comprising two semesters, and each semester comprising sixteen weeks with a minimum of ninety working days.

However, the students, who discontinue the programme after one or more semesters due to extraordinary circumstances, are allowed to complete the programme with due approval from the Registrar. Candidate shall not register for any other regular course other than Diploma or Certificate courses being offered on the campus during the durations of P.G. Programme

I. Medium of Instruction:

The medium of instruction shall be English.

Programme Structure

As per the University regulations for CBCS (Refer Annexure-I)

Course Structure and Scheme of Examination for

M.Sc. MICROBIOLOGY

FIRST SEMESTER

Sl. No	Paper code No and Title Compulsory Courses and Open Elective Course	Credits	No of Hrs/ week Theory / Practical	Duration of exam in Hrs Theory/ Practical	Internal Assessment Marks Theory / Practical	Marks at the Exams	Total Marks
	A. Core Subjects						
1.	MB CT 1.1- General Microbiology	4	4	3	25	75	100
2.	MB CT 1.2- Microbial Diversity and Taxonomy	4	4	3	25	75	100
3.	MB CT 1.3- Microbial Techniques	4	4	3	25	75	100
4	MB CT 1.4- Microbial	4	4	3	25	75	100

	Physiology and Metabolism						
	B. Practical						
5.	MB CP 1.5 Based on MB CT 1.1	2	4	4	15	35	50
6.	MB CP 1.6 Based on MB CT 1.2	2	4	4	15	35	50
7.	MB CP 1.7 Based on MB CT 1.3	2	4	4	15	35	50
8.	MB EP 1.8 Based on MB ET 1.4	2	4	4	15	35	50
	Total	**24**	**32**	**28**	**160**	**440**	**600**

M.Sc. MICROBIOLOGY

SECOND SEMESTER

Sl. No	**Paper code No and Title Compulsory Courses and Open Elective Course**	**Credits**	**No of Hrs / week Theory / Practical**	**Duration of exam in Hrs Theory/ Practical**	**Internal Assessment Marks Theory / Practical**	**Marks at the Exams**	**Total Marks**
	A. Core Subjects						
1.	MB CT 2.1- Microbial Genetics and Molecular Biology	4	4	3	25	75	100
2.	MB CT 2.2- Computer Applications, Bioinformatics and Biostatistics	4	4	3	25	75	100
3.	MB CT 2.3- Genetic Engineering	4	4	3	25	75	100
	B. Elective						
4.	MB ET 2.4- Fundamentals and applications of Microbiology	4	4	3	25	75	100
	C. Practical						
5.	MB CP 2.5 Based on MB CT 2.1	2	4	4	15	35	50
6.	MB CP 2.6 Based on MB CT 2.2	2	4	4	15	35	50
7.	MB CP 2.7 Based on MB CT 2.3	2	4	4	15	35	50
8.	MB EP 2.8 Based on MB ET 2.4	2	4	4	15	35	50

	Total	**24**	**32**	**28**	**160**	**440**	**600**

M.Sc. MICROBIOLOGY
THIRD SEMESTER

Sl. No	Paper code No and Title Compulsory Courses and Open Elective Course	Credits	No of Hrs/ week Theory / Practical	Duration of exam in Hrs Theory/ Practical	Internal Assessment Marks Theory / Practical	Marks at the Exams	Total Marks
	A. Core Subjects						
1.	MB CT 3.1-Environmental Microbiology	4	4	3	25	75	100
2.	MB CT 3.2- Agricultural Microbiology and Plant pathology	4	4	3	25	75	100
3.	MB CT 3.3- Food and Dairy Microbiology	4	4	3	25	75	100
	B. Elective						
4.	MB ET 3.4- Food and Fermentation Technology	4	4	3	25	75	100
	C. Practical						
5.	MB CP 3.5 Based on MB CT 3.1	2	4	4	15	35	50
6.	MB CP 3.6 Based on MB CT 3.2	2	4	4	15	35	50
7.	MB CP 3.7 Based on MB CT 3.3	2	4	4	15	35	50
8.	MB EP 3.8 Based on MB ET 3.4	2	4	4	15	35	50
	Total	**24**	**32**	**28**	**160**	**440**	**600**

M.Sc. MICROBIOLOGY
FOURTH SEMESTER

Sl. No	Paper code No and Title Compulsory Courses and Open Elective Course	Credits	No of Hrs/ week Theory / Practical	Duration of exam in Hrs Theory/ Practical	Internal Assessment Marks Theory / Practical	Marks at the Exams	Total Marks
	A. Core Subjects						
1.	MB CT 4.1- Immunology and Immunotechnology	4	4	3	25	75	100
2.	MB CT 4.2- Medical Microbiology	4	4	3	25	75	100

3.	MB CT 4.3- Bioprocess and Fermentation Technology	4	4	3	25	75	100
	B. Practical						
4.	MB CP 4.4 Based on MB CT 4.1	2	4	4	15	35	50
5.	MB CP 4.5 Based on MB CT 4.2	2	4	4	15	35	50
6.	MB CP 4.6 Based on MB CT 4.3)	2	4	4	15	35	50
7.	MB CPJ 4.7 Project Work/ Dissertation	6	8		15	125	150
	Total	**24**	**32**	**21**		**455**	**600**

MB-CT: Microbiology Core Theory
MB-ET: Microbiology Elective Theory
MB-CP: Microbiology Core Practical
MB-EP: Microbiology Elective Practical
MB-CPJ: Microbiology Core Project

SELECTION OF ELECTIVES

In all the 'Science departments' number of seats available for the Electives depends on the facilities within the departments. **The selection shall be done on merit-cum choice basis, based on the aggregate marks at the degree level.** Candidate is required to give their Electives choice in preferential order at the time of admission

At, present, CBCS in Science Faculty is applicable on the Main campus, K.U. Dharwad only

Sl. No	Department	Semester	Electives	Intake
1	Botany	I	Biodiversity	44
		II	Medicinal Plants	
		III	Plant Biotechnology	
2	Biochemistry	I	Introduction to Biochemistry	15
		II	Biochemical Techniques	
		III	Clinical Biochemistry	
3	Biotechnology	II	Molecular Cell Biology	20
		III	Plant and Animal Tissue culture	
4	Chemistry	I	Applied Inorganic Chemistry	50
		II	Applied- Organic Chemistry	
		III	Applied- Physical Chemistry	
5	Computer Science	I	Computer Concepts and Office automation	60
		II	Programming in C-Language and Mat lab	
		III	Internet information and Web Designing	
6	Electronics	I	Basic Electronics	25
		II	Linear Integrated Circuits	
		III	Communication and digital circuits	

7	Geography	I	Geography of natural hazards and disaster management	30
		II	Regional Geography of India and Karnataka	
		III	Biogeography	
8	Applied Genetics	I	Human Genetics	20
		II	Molecular Biology Techniques	
		III	Genetic Disorders and Counseling	
9	Geology	I	Paleontology	20
		II	History of Earth	
		III	Remote sensing	
10	Mathematics	I	Computational methods I and II	70
		II	Fuzzy sets and fuzzy logic I and II	
		III	Discrete Mathematical Structures I and II	
11	Microbiology	II	Fundamentals and applications of Microbiology	20
		III	Molecular Microbiology	
12	Physics	I	Modern physics	60
		II	Instrumental Methods	
		III	Introductory Photonics	
13	Statistics	I	Statistical Methods	30
		II	Bio-Statistics	
		III	Applied Statistics	
14	Zoology	I	Environmental Biology	30
		II	Animal Behavior	
		III	Economic Zoology	
15	MCA	I	Computer Concepts and Office automation	60
		II	Programming in C-Language and Mat lab	
		III	Internet information and Web Designing	

Scheme of Examinations:

i. The examination will be conducted at the end of the each semester
ii. Each theory course will be have a question paper of 3 hours of duration and maximum marks of 75
iii. Each practical course will have examination of 4 hours duration and maximum marks of 35

QUESTION PAPER PATTERN:

A) THEORY

There shall be a total of three sections, Section-A and Section-B of 15 marks each and Section-C of 45 marks

1) Section-A shall have total 8 questions of 3 marks each and candidates should answer any five of them
2) Section-B shall have a total 5 questions of 5 marks of each and candidates should answer any three of them
3) Section-C shall have a total 5 questions of 15 marks of each and candidates should answer any three of them

The same scheme is applicable to both core and elective theory papers

B) PRACTICALS

The mark allotted for practicals is 50, out of which 15 is for internal and 35 is for Semester final.

The 35 marks is to be divided as follows	**Marks**
1. Principle and Procedure writing	5
2. Experiments	20
3. Viva	5
4. Records	5
Total	**35 marks**

The same scheme is applicable to both core and elective practical papers

C) PROJECT /DISSERTATION EVALUATION:

1. Internal assessment	:	25 marks
2. Evaluation of dissertation	:	75 marks
3. Viva-voce	:	50 marks
Total :		**150 marks**

Award of Gold medals:

The following gold medals will be awarded to the students for standing highest at the M.Sc. Microbiology Examination

1) Smt. Gangabai R Patil - Arishinagodi Gold Medal
2) Shri Vasudev Raghunath Kasbekar- Ankola Gold medal
3) Late Shri Murigeppa Chigateri – Gold Medal

Co-curricular Activities:

Seminars, tutorials and group discussions will be conducted periodically. Study tours may also be arranged. However, these activities do not carry any marks.

Microbiology Society:

The Department has an active “Microbiology Society” under the auspicious of which several invited lectures by distinguished scientists and professor are organized every year. All the faculty members, research students and M.Sc. students are the members of the Microbiology Society. Special lectures sponsored by University are also arranged in the department. The Microbiology society also organizes educational tours, sports and cultural activities for the staff and students of the department.

M.Sc Microbiology
PROGRAMME SPECIFIC OUTCOMES (PSOS)

After completion of this programme, the student will be able to:

1. Identify and classify the various microorganisms. Understand the logic of Microbiology, knowledge organization and its significance
2. Understand the information needs and requirements of different instruments. Learn various microbial techniques like Microscopy, Staining, Chromatography, Electrophoresis and Radio isotope techniques user communities and develop new services and facilities.
3. Learn the practical and managerial skills to handle the microorganisms. understand the physiology and metabolism of the organisms.
4. Gain the knowledge on computer applications using different softwares, Bioinformatics tools, and Biostatistical analysis and its applications in Molecular Biology and Genetic Engineering.
5. Effectively use Information concerning Application of Microbiology in the field of Environment, Agriculture, Plant Pathology, Food and Dairy Technology Microbial diversity as a source of innovations in biotechnology, Biotechnological approaches to improve microbial diversity and bio-productivity. will be dealt with in M. Sc. III Sem.
6. Contribute to microbiology as profession by identify diseases and their causative agents, Bioprocess Engineering and Fermentation Technology. Inculcating research aptitude, skills and other necessary soft skills.

MICROBIOLOGY FIRST SEMESTER

MBCT 1.1 - GENERAL MICROBIOLOGY

Course Outcomes

Paper Code and Name	**MBCT 1.1 - GENERAL MICROBIOLOGY**
COURSE OUTCOMES (COs)	
After completing this paper, the students will be able to:	
CO 1	Identify and classify the various microorganisms
CO 2	Use various microbial techniques like Microscopy, Staining, Chromatography, Electrophoresis and Radio isotope techniques
CO 3	understand the physiology and metabolism of the organisms.
CO 4	Learn about the different groups of Microorganisms

Particulars

Unit- 1 History and Scope of Microbiology:	
Introduction to Microbiology, Spontaneous generation theory, Contributions of Antony van Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Edward Jenner and Alexander Flemming. Beneficial and harmful microorganisms, Introduction to branches of Microbiology : a) Air, b) Water, c) Sewage, d) Soil, e) Dairy, f) Food, g) Medical, h) Industrial, i) Biotechnology j) Geo-microbiology	**09 Hrs**
Unit – 2 Prokaryotic and Eukaryotic cells:	
Introduction and evolution of Prokaryotic and Eukaryotic cells, Structural organization of Prokaryotic and Eukaryotic cells**,** Major groups of Microorganisms – Viruses, Bacteria, Algae, Fungi and Protozoa.	**08 Hrs**
Unit -3 Viruses:	
History and development of virology; Types and classification of viruses; Structural organization of viruses with examples: Capsids, Nucleic acids, Envelope; Structure of T4 bacteriophage, TMV, HIV. Brief introduction about Viroids, Virions and Prions.	**07 Hrs**
Unit 4 Bacteria:	
Morphology of Bacteria size, shape, arrangements, Structure and functions of Cell wall, Cell membrane, Capsule and slime layer, Flagella, Pilli, Nuclear material, Mesosome, Ribosome; General Characteristics of bacteria Spirochetes, *Rickettsia*, *Chlamydia*, *Mycoplasma, Cyanobacteria, Actinomycetes, Archeabacteria***;** Growth and reproduction of bacteria- effect of nutritional and environmental factors on bacterial growth	**09 Hrs**
Unit 5 Fungi::	
History and scope of Mycology; General Characteristics of Fungi ; Classification and Identification of fungi- Basidiomycetes, Ascomycetes, Deuteromycetes, Oomycetes, Hypochytriomycetes and Symbiotic fungi (Lichens); Growth and reproduction of fungi- effect of nutritional and environmental factors on fungal growth.	**07 Hrs**
Unit 6 Algae:	
History and development of Algae**;** General Characteristics of Algae: Classification, Growth and reproduction of Algae; Cultivation of algae, media, photo-bioreactors, Economic importance of Algae: *Spirullina, chlorella, Nostoc and Anabena.*	**05 Hrs**
Unit 7 Protozoa:	
History of Protozoa**;** Classification, Growth and reproduction of Protozoa. General Characteristics of Protozoa: *Paramoecium, Amoeba, Euglena, Trypanosoma and plasmodium*.	**05 Hrs**
PRACTICALS	
MB CP 1.5 Based on MB CT 1.1 - General Microbiology	
1. Safety Measures in Microbiology laboratory. 2. Preparation of media and stains for microbial work. 3. Study of Instruments – Autoclave, Hot air Oven, Incubator, Laminar airflow, Centrifuge, pH meter, Colorimeter, Spectrophotometer. 4. Isolation of different groups of microorganisms (Algae, Fungi, Bacteria and Protozoa) by various methods. 5. Calibration of Microscope and Micrometry. 6. Study of motility of cells by hanging drop technique. 7. Study and Staining of different groups of microorganisms- Algae, Fungi, Bacteria and Protozoa.	

8. Camera Lucida. 9. Effect Temperature and pH on growth curve of bacteria (*E.coli*). 10. Effect of antibiotics on bacterial growth – paper disc and cup plate method.	
REFERENCES	
1. Lodish, H.T. Baltimore, A. Berk, B. L, Zipursky, PMastudaira and J. Darnell, (2004) Molecular cell biology, scientific American Books, Inc. New York 2. Microbiology Pelczar, Chan and Krieg. (Indian edition) 3. Microbiology Vol II Power and Daginawala. 4. Outlines of Biochemistry Cohn and Stumpf. 5. Microbiology by Dubey & Maheswari 6. Microbiology by Purohit. 7. Tobin and Morel (1997). Asking about CELLS. Saunders college publishing. N.Y 8. Cooper, G. M (1997): THE CELL: A molecular approach ASM Press, USA. 9. De Robertis and De Robertis (1998) – Cell and Molecular Biology, 8th edn Saunders, New York. 10. Prescott. D.M (1998) Cells, Principles of molecular structure and functions. Jones Bartlett Publishers, Boston. 11. Garret R.H and Gresham, C.M. (1995) Molecular aspects of cell Biology, International Edition Saunders College Publishing, New York	

MB CT 1.2 – MICROBIAL DIVERSITY AND TAXONOMY
Course Outcome

Paper Code and Name	**MB CT 1.2 – MICROBIAL DIVERSITY AND TAXONOMY**
COURSE OUTCOMES (COs)	
After completing this paper, the students will be able to:	
CO 1	Identify and classify the various microorganisms
CO 2	understand the concepts and scope of microbial taxonomy and diversity
CO 3	understand the physiology and metabolism of the organisms.
CO 4	skills and have a Biotechnological approach towards Ecology, diversity and Bioproductivity

Particulars	**No of Hours Total (50 Hours)**
Unit 1 Microbial Taxonomy:	
Taxonomic ranks, nomenclature rules, identification, Classification systems, microbial diversity and evolution	**06 Hrs**
Unit 2 Classical taxonomy:	
Haeckle's three kingdom concepts, Whittaker's five-kingdom concept, three domain concept of Carl Woose criteria used for classification of microorganisms, Classification according to Bergey's manual of systematic bacteriology.	**10 Hrs**
Unit 3 Recent trends in microbial taxonomy:	
a. Chemo-taxonomy – Cell wall components, lipid composition, isoprenoid sequences, b. Cytochrome composition, amino acids, sequences of proteins, protein	**08 Hrs**

profile, DNA c. DNA homology, RNA homology, G+C ratio, RNA sequencing. d. Numerical taxonomy. e. Serological Methods. Molecular methods in taxonomy.	
Unit 4 Microbial Diversity:	
Concepts and scope, methods used in the study of microbial taxonomy and diversity	**04 Hrs**
Unit 5 Diversity of microorganisms	
Diversity of microorganisms at different levels of Assessment and measure of microbial diversity, Factors influencing microbial diversity	**04 Hrs**
Unit 6 Microbial interaction	
Microbial interaction- Basic principles and types, intra and inter-specific illustrations	**04 Hrs**
Unit 7 Ecology of microbial cells	
Ecology of microbial cells and population ecology, Distribution and significance of Viruses, Bacteria, Fungi, Algae and Protozoa	**10 Hrs**
Unit 8 Microbial diversity	
Microbial diversity as a source of innovations in biotechnology, Biotechnological approaches to improve microbial diversity and bio-productivity.	**04 Hrs**
PRACTICALS	
MBCP 1.6 Based on MBCT-1.2 Microbial Diversity and Taxonomy	
1. Isolation and Enumeration of Bacteria, Actinomycetes, Fungi and Yeasts from soil, Water and air Samples using selective media. 2. Isolation and Enumeration of Microorganisms in polluted environments. 3. Isolation and Enumeration of Microorganisms in Extreme environments. 4. Study of Biochemical tests-(IMVIC test, Urease test, Citrate utilization test, Gelatin Hydrolysis test, Starch hydrolysis test, Cellulose degradation test, Catalase test, Oxidase test, Coagulase test, H_2S Production test, Nitrate Reduction, Optochin Sensitivity test, Esculin Hydrolysis test) 5. Microbial taxonomy- DNA Homology test and Serological Methods 6. Observation of permanent slides a) Algae: *Cyanobacteria Spirulina, Anabaena Chlorella, Scenedesmus, Spirogyra, Diatoms and Gracilaria.* *b)* Fungi: *Pythium, Rhizopus, Saccharomyces, Penicillum, Aspergillus, Fusarium, Agaricus.* c) Virus infected Plant materials TMV/Bean mosaic. *d)* Protozoa: *Euglena, Paramaecium*, *Entamoeba histolytica*	
REFERENCE	
1. Magurran A.E, (1998) – Ecological diversity and its measure. PrincetonUniversity Press, Priceton, N.J. 2. Cowld, D (1999) – microbial Diversity, Academic Press. 3. Wilkinson, J.F, (1997) Basic Microbiology. Panima Book Distributors. New Delhi. 4. Sneath P.H.A, Mair. N.S, Elizabeth, M. Bergey's Manual of Systemic Bacteriology. 5. Flesentein J. (1983) – Numerical Taxonomy. Nato ASI Series, Springer-Verlag N.Y. 6. Biswas, S.B and Anitha Biswas (1997) – An Introduction to viruses. 4th Revised Edition, Vikas Publishing house Pvt. Ltd. New Delhi. 7. Breiman, L, Friedman, J.H, Olsen, R.A. and Stone, C.J (1984) – Classification and regression Trees. Wadsworth and Brooks/ Cole, Pacific Grav, CA. 8. Alexopoulos C .J and Mims (1979) Introductory Mycology, Wiley Eastern Limited. New Delhi. 9. Atlas R. M (1998) Microbiology, Fundamentals and Applications 2ndEdn. Mac Millan	

Publishing Company.
10. Brock T .D, Madigan M T, Prentice Hall Int. Inc. Biology of Microorganisms.
11. Ram R C (2007) Microbial Diversity-Modern Trends, Mittal publications. New Delhi.
12. Agarwal K C. (1996) Biodiversity, - Agro- Botanical Publishers, New Delhi.
13. Singh, H.B., Vijai, G.K and Jogaiah, S. 2018. New and Future Developments in Microbial Biotechnology. Elseiver Publications, UK.

MB CT 1.3- MICROBIAL TECHNIQUES

Course Outcomes

Paper Code and Name	**MB CT 1.3- MICROBIAL TECHNIQUES**
COURSE OUTCOMES (COs)	
After completing this paper, the students will be able to:	
CO 1	Identify different types of microscope and specimen preparation accordingly
CO 2	Acquainted with physical and chemical methods of sterilization
CO 3	Understand the methods of isolation and culture of microorganisms
CO 4	Aware of types of stains and various staining techniques
CO 5	Taught the principles types, and applications of chromatography, electrophoresis radioisotopic techniques

Particulars	**No of Hours Total (50 Hours)**
Unit 1 Microscopy & specimen preparation	
Microscopy –Basic principles and applications of light, phase, fluorescent, Bright field, Dark field and electron microscopes (TEM & SEM), Confocal microscopy, Scanning probe microscopy, Micrometry. **Sample preparations:** fixing of specimens, preparation of blocks, microtome, cytometer and flow-cytometer.	**08 Hrs**
Unit – 2 Basic principles and methods of sterilization:	
Physical methods: Dry and moist heat, Filtration, Radiation, Chemical methods: Phenols, Alcohols, Halogens, Heavy metals, Aldehydes, Quaternary ammonium compounds, disinfectants and gases	**03 Hrs**
Unit -3 Microbiological media:	
Definition, components, types and preparation, enrichment and preservation of media, pH and buffers	**02 Hrs**
Unit 4 Isolation of microbial cultures:	
Serial dilution, Inoculation techniques: Spread plate, Streak plate, Pour plate, Micromanipulator method, Colony morphology and characteristics of cultures. Maintenance and preservation of pure cultures, Culture collection centers- National and International	**05 Hrs**
Unit 5 Stains and Staining Techniques:	
Nature of stains, Principle, Mechanism, Types and Method of Staining: Simple, negative, differential and structural staining	**03 Hrs**

Unit 6 Measurement of Microbial growth:	
Direct method, direct microscopic plate, Standard plate count, Filtration, MPN, Indirect method, Turbidity, Metabolic activity & Dry weight	**03 Hrs**
Unit 7 Analysis of metagenomics:	
They will know skills and have a Metagenomics, Culture independent analysis of microbes, Phospholipids, Fatty acids analysis, Fluorescent in situ hybridization (FISH), Genomic *in situ* Hybridization (GISH).	**03 Hrs**
Unit 8 Chromatographic techniques:	
Chromatographic techniques: a. Principles, types and applications of Chromatography b. Gas Chromatography, GC-MS, LC – MS / MS, MALDI TOF mass spectrometer c. Ion Exchange Chromatography, gel permeation, Affinity and reverse phase chromatography d. HPLC, FPLC& UPLC	**08 Hrs**
Unit 9 Electrophoresis:	
Types of electrophoresis, Paper and Gel electrophoresis (Starch, Acrylamide and Agarose), Capillary, Disc and Slab, Vertical gel electrophoresis (SDS-PAGE, native PAGE, Isoelectrofocussing and 2-D gel, Immunoelectrophoresis, Pulse-field Gel electrophoresis (PFGE), Blotting of nucleic acids and proteins	**06 Hrs**
Unit 10 Spectroscopy:	
Spectroscopy: Principle and applications of spectrophotometer- UV/visible, fluorescence, circular dichroism, Raman spectra, NMR and ESR spectroscopy, Mass Spectrometry, X-ray diffraction and crystallography	**07 Hrs**
Unit 11 Radio isotopic Techniques:	
A. Nature of radioactivity and general principles of radio-isotopic techniques B. Methods of detection of radioactivity – gas ionization (GM counter), excitation (scintillation) and exposure of photographic emulsions (autoradiography). C. Methods of using radioisotopes – radioisotope tracer technique, isotope dilution assay and other methods	**02 Hrs**
PRACTICALS	
MB CP 1.7 based on MB CT 1.3 - Microbial Techniques	
1. Microscopy – Compound, Dark field, Phase contrast, Fluorescent, Electron, (SEM and TEM). 2. Sterilization technique – physical methods and chemical methods. 3. Preparation of culture media – broth, semisolid, and solid media. 4. Isolation of pure culture microorganism and cultivation 5. Isolation and enumeration of microorganisms by serial; dilution methods. 6. Staining techniques a. Simple and Negative Staining b. Differential staining – Gram staining. Acid fast staining, c. Structural Staining - flagellar staining, Endospore staining, capsule staining and cell wall staining d. Reserved food materials – starch granules, glycogen granules, and volutin granules. 7. Study of spectrophotometer and colorimetric techniques. a. Extraction of microbial pigments and profiling using UV-Vis spectrophotometer b. Colorimetric determination of any one amino acid. 8. Study of chromatographic techniques. a. Paper Chromatography of amino acids and sugars.	

b. Separation of pigments by adsorption chromatography.
c. Quantitative estimation of hydrocarbons/pesticides/organic solvents/methane by gas chromatography

9. Isolation and estimation of proteins and nucleic acids from cells.
10. Qualitative estimation of DNA by DPA method
11. Qualitative estimation of RNA by Orcinol method

Study of Electrophoretic techniques and Gel documentation methods

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1. James Miller, Chromatography: Concepts and Contrasts, (1988), John Wiley and Sons Inc., New York.
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12. Upadhyay&Nath. (2016). Biophysical chemistry: principles and techniques, 4th edition, Himalaya Publishing House Pvt. Ltd.
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14. James Miller, Chromatography: Concepts and Contrasts, (1988), John Wiley and Sons Inc., New York.
15. Singh, H.B., Vijai, G.K and Jogaiah, S. (2018). New and Future Developments in Microbial Biotechnology. Elsevier Publications, UK.

MB CT 1.4 –MICROBIAL PHYSIOLOGY AND METABOLISM

Course Outcome

Paper Code and Name	**MB CT 1.3- MICROBIAL TECHNIQUES**
COURSE OUTCOMES (COs)	
After completing this paper, the students will be able to:	
CO 1	Define the Structure, principles, types and uses of Enzymes.
CO 2	Understand the Concept of photosynthesis and associated pigments in microbes.
CO 3	Understand the nutrition in microorganisms, know the methods and mechanism of respiration in bacteria
CO 4	Understand carbohydrate, lipid, neucleotide, protein and amino acid metabolism

Particulars	**No of Hours**

	Total (50 Hours)
Unit 1 Enzymes:	
Definition, Structure, enzymes as biocatalysts properties and classification, specificity, active sites, coenzymes: Activators and inhibitors, activity unit, isozymes, enzyme kinetics (negative and positive comparatively); Michaelis–Menton equation for simple enzymes. Determination of kinetic parameters (K_M, V_{max}, K_I), multi-step reactions and rare limiting steps, enzyme inhibition, allosterism, Kinetic analysis of allosteric enzymes principles of allosteric regulation, Ribozyme and abzyme	**06 Hrs**
Unit – 2 Microbial Nutrition and Factors::	
Modes of nutritional uptake (Entry of nutrition in the cell, passive diffusion, facilitated diffusion and active transport, Utilization of nutrients, Microbial growth – Growth Curves, Phages of growth, factors influencing growth, chemostat, turbidostat, and measurement of growth, continuous and synchronous growth and growth kinetics. Classification of bacteria on the basis of growth supporting environmental factors such as oxygen, temperature, pH, osmotic pressure, salt and hydrostatic pressure.	**06 Hrs**
Unit -3 Microbial Photosynthesis:	
Concept of photosynthesis and associated pigments in microbes; photosynthetic apparatus in prokaryotes and eukaryotes, anoxygenic and oxygenic photosynthesis, light and dark reaction; photorespiration and its significance, Effect of light, temperature, pH and CO_2 concentration on photosynthesis, measurement of net photosynthetic yield.	
Unit 4 Bacterial Respiration:	
Bacterial aerobic respiration, components of electron transport chain, free energy changes and electron transport, oxidative phosphorylation and theories of ATP formation, inhibition of electron transport chain and Photophosphorylation, Electron transport chain in heterotrophic and chemo-lithotrophic bacteria. Bacterial anaerobic respiration: Nitrate, carbonate and sulfate as electron acceptors, electron transport chains in anaerobic bacteria, catalase, super oxide dismutase, mechanism of oxygen toxicity.	**08 Hrs**
Unit 5 Nitrogen metabolism:	
Nitrogen cycle, Ammonification, nitrification, denitrification and nitrogen fixation, Nitrogenase enzyme, physiology of nitrogen fixation in symbiotic and free living bacteria, Genetics of nitrogen fixation, acetylene reduction assay.	**03 Hrs**
Unit 6 Microbial stress responses:	
Osmotic stress and osmoregulation, aerobic and anaerobic transitions, Oxidative stress, pH stress and acid tolerance, thermal stress and heat shock response, nutrient stress and starvation stress. Fermentative pathways in specific group of microbes: alcoholic, lactic acid, formic, mixed, propionic, butyric, butanol, butanediol fermentation.	**04 Hrs**
Unit 7 Carbohydrate Metabolism:	
Characteristics and Classification of carbohydrates. Glycolysis, TCA cycle, Glyoxylate pathway, Pentose phosphate pathway, Special microbial roots for metabolism of monosaccharaides, Gluconeogenesis, Glycogenolysis and Glycogenesis, Substrate level Phosphorylation, Pasteur effect.	**05 Hrs**
Unit 8 Lipid metabolism:	

Characteristics and classification of lipids, β-oxidation, extra-mitochondrial fatty acid synthesis, microsomal chain elongation, metabolism of acyl glycerols and sphingolipids, biosynthesis of phospholipids, Ketosis, Ketoacidosis, Ketogenesis, Ketolysis, metabolism of cholesterol.	**04 Hrs**
Unit 9 Protein and Amino acid metabolism:	
Characteristics and classification of proteins and amino acids, Essential and non-essential amino acids, Transamination, Deamination decarboxylation, NH_3 transport, Urea formation, Significance and regulation of Urea synthesis, Metabolism of aromatic amino acids – tyrosine, tryptophan, phenyl alanine, metabolism of Sulphur containing amino acids, L-Methonine, L-cysteine, C-L cystine and their metabolic role. Metabolism of other amino acids like glycine, serine and Histidine	**04 Hrs**
Unit 10 Nucleotide metabolism:	
Characteristics and structure of Nucleic acids Biosynthesis of Purines & Pyrimidines, Regulation of nucleotide synthesis, catabolism of nucleotides.	**07 Hrs**
PRACTICALS	
MB CP 1.8 based on MB CT.1.4 - Microbial Physiology and Metabolism	
1. Determination of growth curve and generation time. 2. Determination of optimum pH, temperature for growth of bacteria and fungi. 3. Effect of different substrate (Primary, secondary &tertiary) on microbial growth 4. Estimation of microbial enzymes – amylase, protease, invertase, cellulase, lipase, catalase and phosphatase. 5. Determination of Km and Vmax. and Ki 6. Extraction and separation of aflatoxin by paper chromatography. 7. Effect of pH, temperature, enzyme concentration, substrate concentration and inhibitors on enzyme activity. 8. Lipid saponification value of fats, Iodine number of fatty acids 9. Qualitative analysis of lipids. 10. Qualitative and quantitative estimation of carbohydrates/proteins/amino acids 11. De-amination of Amino acids. 12. De-carboxylation of Amino acids.	
REFERENCES	
1. Arora D.K. and Seema Gupta (1996), Bacterial Physiology. Anmol Publications, New Delhi. 2. Palmer T. (2001), Biochemistry, Biotechnology and Clinical Chemistry. Harwood Publications, Chichester. 3. Boyer R. (2002), Concepts in Biochemistry 2nd Edition, Brooks/Cole, Australia. 4. Moat A.G., Foster J.W. Spector.(2004), Microbial Physiology 4ht Edition Panama Book Distributors. 5. Caldwell, D.R. (1995) - Microbial Physiology and Metabolism. Brown Publishers. 6. Nelson and Cox (2000), Lehninger's Principles of Biochemistry. Elsevier Publications. London. 7. Lodish H, T. Baltimore, A. Berck B.L. Zipursky, P. Mastsydaire and J.Darnell.(2004) - Molecular Cell Biology, Scientific American Books, Inc. Newyork. 8. J.Robin Harris, John Graham, David Rickwood – Cell Biology Protocols. Panima Book Distributors. New Delhi. 9. N.S. Sharma (2005), Molecular Cell Biology. 10. KalapanaTrivedi(2007), Molecular and Developmental Biology. 11. Bacterial signalling, Kramar and Jung Microbial Physiology, Moat, Foster and Spector. 12. The Physiology and Biochemistry of prokaryotes, David White Bacterial physiology: A molecular	

approach, W. E. Sharoud Topic related review articles.
13. Madigan, M.T., Martinka, M., Parker, J. and Brock, T.D. (2000). Twelth Edition, Biology Microorganisms, Prentice Hall, New Jerry.
14. Moat, A.G. and Foster, W.(2002). Microbial Physiology, Fourth Edition, John Wiley and Sons, New York.
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MICROBIOLOGY SECOND SEMESTER SYLLABUS

MBCT 2.1 – MICROBIAL GENETICS AND MOLECULAR BIOLOGY

Course Outcomes

Paper Code and Name	**MBCT 2.1 – MICROBIAL GENETICS AND MOLECULAR BIOLOGY**
COURSE OUTCOMES (COs)	
After completing this paper, the students will be able to:	
CO 1	Understand the structure and genome organization in microorganisms
CO 2	Understand the Structure and types of DNA and its replication.
CO 3	Know the process, mechanism and significance of transcription, Translation, mutation and recombination.
CO 4	Learn fungal, algal and viral genetics

Particulars	**No of Hours Total (50 Hours)**
Unit 1 Concepts in Microbial Genetics:	
History and developments of Microbial genetics, Microbes as Genetic Tools for Basic and Applied Genetic studies. Generalized reproductive cycles of microbes (Bacteria, Viruses, *Neurospora, Chlamydomonas, Saccharomyces, Acetabularia, Mycoplasma*)	**05 Hrs**
Unit – 2 Organization of genetic material:	

Genome organization in viruses, bacteria and eukaryotes. Interrupted genes, gene clusters, structure of nucleosome, chromatin and chromosome.	**06 Hrs**
Unit -3 Structural Polymorphism of DNA	
: DNA Structure A, B, and Z DNA, Super coiled DNA and DNA Binding Proteins, **DNA viruses:** Double stranded (Pox virus and SV40 virus) and single stranded DNA viruses. **Replication:** Rolling circle replication, semi-conservative replication, replication fork-leading and lagging strands, enzymes involved at different steps of replication. Folded fiber model of *E. coli* chromosome, split genes, overlapping genes, DNA amplification, the law of DNA constancy and C- value paradox. Structure, types and replication of RNA virus	**04 Hrs**
Unit 4 Transcription:	
DNA Binding Proteins, Classes of RNA Molecules and RNA Polymerases. Prokaryotic and Eukaryotic transcription, Post transcription modification – mRNA processing, 5'capping, 3'polyadenylation, Splicing mechanisms, rRNA and tRNA processing.	**04 Hrs**
Unit 5 Translation:	
Genetic code and wobble hypothesis, tRNA and the Aminoacyl-tRNA-synthetase, Clover leaf structure of tRNA prokaryotic and Eukaryotic translation machinery, Ribosomes, Mechanism of prokaryotic and eukaryotic transcription, Post translational modification of proteins, inhibitors of protein translation	**04 Hrs**
Unit 6 Gene as a Unit of Mutation:	
Mutation, mutagens and types of Mutations, Molecular basis of spontaneous and induced mutations and their role in evolution. Transposon and site directed mutagenesis, environmental mutagenesis and toxicity testing**,** Hot spots, AME's Test, Comet Assay.	**05 Hrs**
Unit 7 Molecular Genetic Recombination:	
In Bacteriophages and *E. coli*, Synapsis of homologous duplex, breakages and reunion, role of RecA in recombination. Transduction- generalized and specialized. Transformation and conjugation, legitimate and illegitimate recombination, gene conversion, overview of bacterial genetic map	**09 Hrs**
Fungal Algal and Viral Genetics:	
Fungal Genetics: *Neurospora*- Tetrad analysis and linkage detection - 2 point and 3 point crosses, chromatid and chiasma interference, Mitotic recombination in *Neurospora* and *Aspergillus*, Alternation of generation in *Neurospora crassa* and yeast. **Algal Genetics:** *Chlamydomonas* - unordered tetrad analysis, Nucleocytoplasmic interactions and gene expression in Acetabularia. Extranuclear (Cytoplasmic) inheritance. **Viral Genetics:** Lytic and Lysogenic cycles, Phage Phenotypes, Phenotypic Mixing, and Recombination in viruses: Mapping of rII loci	**09 Hrs**
PRACTICALS	
Mb CP 2.5 based on MB CT .2.1 - Microbial Genetics and Molecular Biology	

1. Isolation and estimation of DNA, RNA and plasmids.
2. Inheritance and pedigree analysis of simple Mendelian traits.
3. Induction and study of physical and chemical mutagens in bacteria/fungi
4. Study of mitosis direct method
5. Study of meossis
6. RFLP and RAPD analysis.
7. Isolation of drug resistant mutants
8. Study of mutagenic effect and Induction of mutation in yeast/ bacteria by chemical/radiation method
9. Plasmid Curing in bacteria
10. Transformation and selection of transformants
11. Conjugation and Gene Mapping in *E.coli*
12. Isolation of bacteriophages and Phage titration
13. Restriction digestion of DNA
14. Study of replica plating technique

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MBCT 2.2: COMPUTER APPLICATIONS, BIOINFORMATICS AND BIOSTATISTICS

Course Outside

Paper Code and Name	**MBCT 2.2: COMPUTER APPLICATIONS, BIOINFORMATICS AND BIOSTATISTICS**
COURSE OUTCOMES (COs)	
After completing this paper, the students will be able to:	
CO 1	Understand the parts, concepts and types of computers, Operating system, Computer Viruses and Computer network
CO 2	Have hands on training on various programmes and its applications in computers.
CO 3	Know the types of alignments, Phylogenetic analysis and Primer designing
CO 4	Analyze Commercial application of bioinformatics, Disease monitoring, profiles for therapeutic molecular targeting. Diagnostics, Comparative proteomics and its applications, IPR and Bioinformatics patents
CO 5	Apply Biostatistcs in basic problems, measures of – Central tendency Survival analysis and Statistical softwares

Particulars	**No of**

	Hours (50 Hrs)
Unit 1 Computer Science:	
Parts and types of computers-Basic components and essential details of digital computers and peripherals devises and their maintenance functions. Mainframes, mini and micro (PC, PC-XT, PC-AT) Computer Architecture, Internal and External devices, servers, computer software and super, hyper computers. **Operating system:** Windows, UNIX (Ubuntu), CRAN/ LINUX, Macintosh, application software's like word processor, formatting the document, tables, mail merge and spell check. Spreadsheets basics with MS Excel, labels, MS Power point, MS access. **Computer Viruses:** Overview and prevention **Computer network**: Advantages of Networks, Types of Network (LAN & WAN) WIFI. Internet protocol (TCP/IP) File transfer protocols (FTP) WWW, HTTP. Etc.), Cloud computing	**12 Hrs**
Unit – 2 Programming	
: Algorithm and flow chart, C and C^{++} and R-programming, structure of C programme, Header file, Global declaration, Main function, variable declaration, control statement, conditional looping and unconditional control statement hub functions.	**05 Hrs**
Unit -3 Introduction to Bioinformatics:	
Introduction to Biological Databases - Types of databases (Primary, secondary and complex databases), Bioinformatics platforms: NCBI, DDBJ EMBL, PUBMED**,** Nucleic Acid Sequence databases, Protein sequence database; Genomics, Transcriptomics, Proteomics and Metabolomics, PDB retrieval, Database visualization, Accessing bibliographic database, Integrated Information Retrieval, Extra 2 system. Bioinformatics software: Schrodinger**,** Perl and BioPerl, Rosetta/Remoneblod	**08 Hrs**
Unit 4 Sequence alignment and phylogenetics	
Pair wise sequence alignment: Eg. BLAST, FASTA, CONTIG sequence Multiple Sequence Alignment: Eg. Clustal W, Clustal X, Phylogenetic analysis with reference to nucleic acids – PHYLIP, MEGA, NTYSIS (3D and 2D) Primer designing: Primer 3, applied biosystems,	**06 Hrs**
Unit 5 Structural biology:	
Modeling: Protein secondary structure prediction – Chou Fasman rules– neural networks discriminant analysis, prediction of transmembrane segments in membrane proteins. Protein 3D structure prediction homology - identification of active sites/pockets, threading potential energy functions – energy minimization molecular dynamics simulated annealing. **Drug Design and discovery:** steps in drug discovery, ADME, Lead identification, QSAR.	**06 Hrs**
Unit 6 Commercial application of bioinformatics:	
Definition, genome technology, High throughput sequencing and assembly. Genomics in medicine, Disease monitoring, profiles for therapeutic molecular targeting. Diagnostics, drug discovery and genomics, Gene evolution, Comparative proteomics and its applications, IPR and Bioinformatics patents	**05 Hrs**
Unit 7 Biostatistics:	
Biostatistics: **1.** Organization, description and graphical representation of data. **2.** Summary measures of – Central tendency (mean, mode, median), dispersion (Standard Deviation, Standard error) correlation (2-D, 3-D, Pearson, R value,	**08 Hrs**

Heatmap) and regression Chi square tests, McNemar test, tests of significance (t test, P-value, F-test, ANOVA, HSD.

3. Survival analysis: Kaplan-Meier curve, log-rank test, proportional hazard, Cox regression.
4. Statistical softwares: MS Excel, MS access, Statistica, SPSS, Graph pad.

PRACTICALS

Mb CP 2.6 based on MBCT 2.2 Computer Applications, Bioinformatics and Biostatistics

1. Hardware and parts of a computer and laptop, types -Supercomputer, Mainframe Computer, Minicomputer, Microcomputer and mobile computers. Console I/O operations, Files and Streams.
2. Molecular graphics, analysis of phylogenetic tree and exploring PDB file.
3. **a)** Retrieval of sequences from NCBI, DDBJ, EBI, EMBL, NBRF-PIR, SWISSPROT and Protein database
   b) Retrieval of homologous sequences and exploring BLAST and FASTA
4. Study of Molecular Dynamics and Simulation of given protein (Hyperchem, Rosetta MOE, Speptide, RMSD, RMSF and Energies) and protein with drug interaction using Rosetta.
5. C, C^{++} and R-Language example programs based on topic wise.
6. **a)** Study of inheritance and polymorphism using different tools
   b) Generation of dot matrix and analyzing the homology
7. **a)** Exploring databases for motifs and domains.
   b) Exploring and analyzing multiple Gene and exon-intron from the given sequence, Sequence alignment by online and offline softwares.
8. *In silico* study of enzyme kinetics in metabolic pathway
9. Statistical concepts: Types of variables, probability distribution (binomial, Poisson, normal), population and sampling methods, characteristics of location and variability, standard error, histogram, point and interval estimation, confidence interval.
10. **a)** Statistical inference: testing statistical hypotheses and central tendency.
    b) Statistical tests for continuous variables: t-test and Wilcoxon test (one-sample, two-sample, paired), analysis of variance (ANOVA), F-test, pearson correlation analysis.
11. **a)** Statistical tests for categorical variables: contingency table, chi-square test, McNemar test
    b) Statistical methods in epidemiology: epidemiological measures of risk and corresponding confidence intervals, interpretation.
12. **a)** Statistical association: correlation, linear regression, multiple regression, logistic regression, test for trend
    b**)** Survival analysis: Kaplan-Meier curve, log-rank test, proportional hazard, Cox regression.
13. Planning surveys: power of statistical test, sample size determination for categorical and continuous endpoints, randomization in clinical trials.
14. Practical use of statistics: statistics in published papers, discussion on statistical methods with suitable example.

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15.	MountD. W. (2001). Bioinformatics. Sequence and Genome Analysis, Cold Spring Harbor Laboratory Press.
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MB CT 2.3 GENETIC ENGINEERING

Course Outcome

Paper Code and Name	**MB CT 2.3 GENETIC ENGINEERING**
COURSE OUTCOMES (COs)	
After completing this paper, the students will be able to:	
CO 1	Understand the Scope and importance of Genetic engineering and application
CO 2	Have hands on training on enzymes used as tools in genetic engineering
CO 3	Know the significance of cDNA, screening techniques and Genomic DNA Librar
CO 4	Understand Labelling, Transformation and Transfection, techniques,Antisense and Ribozyme technology
CO 5	**Apply Genetic engineering and rDNA technology tools and techniques required**

Particulars	**No of Hours Total (50 Hours)**
Unit 1 Introduction to Genetic Engineering	
: Scope and importance of Genetic engineering.	**02 Hrs**
Unit – 2 Cloning Vectors	

: Brief account of naturally occurring plasmids (Conjugative and Non conjugative plasmids, degradative plasmids, Resistance plasmids, Fertility plasmids, Col-Plasmids), artificial plasmids (pBR322, pUC vectors, Ti and Ri plasmids), Bacteriophages, Phagemids, Cosmids, Fosmids, Artificial chromosomes (BAC's, YAC's), Shuttle vectors, expression vectors, M13 derived vectors and Viral vectors (SV40 and Bovine Papilloma Virus).	**08 Hrs**
Unit -3 Tools of Genetic Engineering:	
Restriction endonucleases- nomenclature and types, recognition sequences and mechanism of action. DNA Modification enzymes (nucleases, kinases, Alkaline-phosphatase, Klenow polymerase, Lambda-Exonuclease and Exonuclease-III) and ligases- types and mechanism of action.	**05 Hrs**
Unit 4 Cloning and Construction of gene Libraries:	
cDNA library- isolation and purification of mRNA, Synthesis of cDNA, cloning of cDNA in to plasmids and phage vectors, **Genomic DNA Library**: Isolation and purification of Genomic and Plasmid DNA, preparation of DNA fragments for cloning, Construction of genomic DNA library with different vectors and screening techniques	**05 Hrs**
Unit 5 Selection, Screening and Analysis of Recombinants:	
Blotting Techniques- Southern Blotting, Northern Blotting, Western Blotting and DOT Blot. Nucleic acid hybridization (Colony Hybridization and Plaque Hybridization), Immunological methods and *In vitro* Translation. Chromosome walking, **Gel Electrophoresis**: Agarose gel Electrophoresis, PAGE and PFGE	**06 Hrs**
Unit 6 Labeling and Detection Techniques	
Labeling of DNA, RNA and Proteins (Radioactive and non-radioactive isotopes). DNA Sequencing (Chemical and Enzymatic method).	**04 Hrs**
Unit 7 Transformation Techniques:	
Transformation and Transfection techniques, Preparation of competent cells of bacteria, chemical methods- calcium phosphate precipitation method and liposome mediated method, Physical methods-Electroporation and Gene gun method. Biological methods-Agrobacterium mediated transformation, Co-cultivation methods, Chloroplast transformation, method of DNA transfer to yeast, mammalian and plant cells.	**06 Hrs**
Unit 8 Polymerase chain Reaction	
Methodology, types and applications.	**03 Hrs**
Unit 9 Chemical Synthesis of genes:	
Methods (Phosphodiester, and Phosphotriester methods principle and strategies), Oligonucleotide synthesis and application, synthesis of complete gene.	**04 Hrs**
Unit 10 Antisense and Ribozyme technology:	
Molecular mechanism of antisense molecules, inhibition of splicing poly-adenylation and translation, disruption of RNA structure and capping Biochemistry of Ribozyme, hammer head, hairpin and other Ribozymes, strategies for designing Ribozymes, application of antisense and Ribozymes technologies.	**03 Hrs**
Unit 11 Applications of Genetic engineering and rDNA technology	
: Transgenic plants (disease resistant, weedicide resistant, frost resistant, halotolerant and pest resistant) production of growth hormones, interferon, insulin, recombinant vaccines, gene therapy, anti-sense RNA technology RNA; requirement of recombinant molecules in health, pharmaceuticals, agriculture and industrial sectors, research labs.	**04 Hrs**
PRACTICALS	

MB CP 2.7 based on MB CT.2.3- Genetic Engineering

1. Isolation and electrophoretic separation of genomic DNA from Bacteria, Plant and Animal tissues.
2. Gel elution and purification of DNA fragment.
3. Isolation and electrophoretic separation of RNA from Bacteria, Plant and Animal tissues.
4. Quantification and purity check of Isolated DNA using UV spectrophotometer.
5. Isolation, purification and electrophoretic separation of plasmid DNA from Bacteria.
6. Restriction Digestion of Genomic DNA and Plasmid DNA with Restriction Endonucleases and separation of digested products in Agarose gel.
7. Effect of Agarose concentration on migration of DNA fragments.
8. DNA Ligation using T4 DNA Ligase and *E.coli* DNA ligase
9. Preparation of Competent cells using Calcium Chloride Method.
10. Transformation of Bacterial cells (blue white Selection).
11. Blotting techniques: Southern, Northern and Western Blotting

Amplification of DNA using Polymerase chain Reaction.

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21. From genes to clones by Winnaker.
22. Manipulations and expression of recombinant DNA by Robertson.
23. Gene targeting – A practical approach by Joyner.

Vedamurthy, A.B., and Mahesh, S. 2002. Biotechnology – IV including recombinant DNA technology, Environmental Biotechnology and Animal Cell Culture. New Age Publishers, New Delhi.

MBET 2.4 Fundamentals and applications of Microbiology

Course Outcome

Paper Code and Name	**MBET 2.4 Fundamentals and applications of Microbiology**
COURSE OUTCOMES (COs)	
After completing this paper, the students will be able to:	
CO 1	Know the history and contributions of various pioneers and scientists in the field of Microbiology.
CO 2	Understand the differences and comparison between the prokaryotes and the eukaryotic microorganisms
CO 3	Industrial production of Alcohol, Organic acids, Solvent, Antibiotics Single cell proteins (SCP) Vitamins (Riboflavin) Enzymes, Recombinant protein
CO 4	Understand pathogenesis, Clinical conditions, laboratory diagnosis, epidemiology, Prophylaxis and treatment of the diseases caused by microorganisms.
CO 5	Perform Specimen collections, handling, transport, identification of pathogens from specimens and hospital management

Particulars	**No of Hours (50 Hrs)**
Unit 1 Introduction to Microbiology:	
Contributions of Antony van Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Edward Jenner, Alexander Flemming. Beneficial and harmful microorganisms, Introduction to branches of Microbiology: a) Air, b) Water, c) Sewage, d) Soil, e) Dairy, f) Food, g) Medical, h) Industrial, i) Biotechnology j) Geomicrobiology.	**09 Hrs**
Unit – 2 Prokaryotic and Eukaryotic cells:	
Introduction and evolution of Prokaryotic and Eukaryotic cells, Structural organization of Prokaryotic and Eukaryotic cell**,** Major groups of Microorganisms – Viruses, Bacteria, Algae, Fungi and Protozoa.	**08 Hrs**
Unit -3 Industrial microbiology:	
Industrial production of Alcohol (Ethanol), Wine, Beer, Organic acids (Citric, acetic, Lactic and Gluconic acid) Solvent (Glycerol Acetone, Butanol), Antibiotics (Penicillin, streptomycin, tetracycline) Amino acids (lysine, glutamic acid) Single cell proteins (SCP) Vitamins (Riboflavin) Enzymes (Amylase, lactase, protease), Hydrocarbons – Biodegradable plastic – Polyhydroxyalkanoates (butyrate, propionate etc), recombinant protein	**11 Hrs**

(hepatitis – B vaccine)	
Unit 4 Microbial diseases:	
Pathogenesis, Clinical conditions, laboratory diagnosis, epidemiology, Prophylaxis and treatment of the following diseases. a) Virus – Measles, Mumps, Influenza, Yellow fever, HIV, Herpes, Rabies, Hepatitis, Polio myelitis, Dengue fever, Japanese Encephalitis, KFD, Rhinovirus, CJD and Kuru. b) Bacteria – Diphtheria, Typhoid, Gonorrhea, Syphilis, Plague, Leprosy, Tuberculosis, Gas gangrene, Tetanus, Septicemia, Cholera and Brucellosis. c) Fungi – *Candidiasis, Mycetoma, Chromomycosis, Sporotrichosis, Cryptococcosis, Blastomycosis, Coccidiomycosis and Histoplasmosis*. d) Protozoa– Amoebiasis, Giardiasis, Malaria, *Leishmaniasis and Trypanosomiasis*. e) Dental Infections – Dental Plaque, Dental carries and periodontal diseases. f) Nosocomial Infections – Bacterimia, Burn wounds, surgical site infections, Urinary tract and miscellaneous infections.	**14 Hrs**
Unit 5 Clinical Microbiology:	
Specimen collections, handling, transport, identification of pathogens from specimen, growth and biochemical characteristics, Rapid methods of identification, Immunological techniques, Bacteriophage typing, molecular measures (DNA probes, Restriction endonucleases, DNA Finger printing, RIA, ELISA, PCR) and susceptibility testing. A brief account on hospital management	**09 Hrs**
PRACTICALS	
MBCP 2.8 based on MBET-2.4-Fundametals and Applications of Microbiology	
1. Safety Measures in Microbiology laboratory 2. Study of Instruments – Autoclave, Hot air Oven, Incubator, Laminar airflow, Centrifuge, pH meter, Colorimeter, Spectrophotometer. 3. Isolation and Study of Different groups of Microorganisms- Algae, Fungi, Bacteria and Protozoa 4. Micrometry 5. Camera Lucida 6. Study of motility of cells by hanging drop technique 7. Effect of growth curve of bacteria (*E.coli*) 8. Effect of temperature on the growth of microorganisms 9. Effect of pH on the growth of microorganisms Effect of antibiotics on bacterial growth – paper disc and cup plate method	
REFERENCE	
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MICROBIOLOGY THIRD SEMESTER

MB CT 3.1 ENVIRONMENTAL MICROBIOLOGY

Course Outcome

Paper Code and Name	**MB CT 3.1 ENVIRONMENTAL MICROBIOLOGY**
COURSE OUTCOMES (COs)	
After completing this paper, the students will be able to:	
CO 1	Know the history, scope of environment and environmental pollution.
CO 2	Understand the Sources and characteristics of air pollutants, health hazards and control measures of air, soil, water pollution and waste management.
CO 3	Concepts and principles of bioremediation, biodeterioration biodegradation, biomining, and bioleaching.
CO 4	Provide Environmental Education regarding Agrochemicals, Botanicals of Global Warming, ozone depletion, Greenhouse gas effect, acid rains & their impact and Biotechnological approaches in the environment**.**

Particulars	**No of Hours (Hrs)**
Unit 1: Environment and environmental pollution	
Meaning, scope, concept of Environment and environmental pollution	**02 Hrs**
Unit – 2 Aerobiology:	
Air sampling techniques, Identification of Airborne bioparticles, Sources and characteristics of air pollutants, health hazards due to air pollution. Air borne diseases and control measures of air pollution	**06 Hrs**
Unit -3 Soil Microbiology	
Classification based on physical and chemical characteristics, Microorganisms in various soil types, soil pollution –sources and characteristics of soil pollutants, health hazards due to soil pollution, control measures of soil pollution-interaction among soil microbes-mutualism, commensalisms, amensialism, parasitism, predation, competition, antibiosis and their significance. Interrelationship between microbes, plant and soil-brief account on rhizosphere, phyllosphere and spermosphere Symbiotic and non-symbiotic association with higher plants, role of enzymes of microbial origin in the release of plant nutrients	**08 Hrs**
Unit 4 Aquatic Microbiology	
Water ecosystem (Fresh water and marine), Zonation of water ecosystem, water pollution-sources, characteristics of water pollution, health hazards due to	**08 Hrs**

water pollution, eutrophications. Biological indicators of water pollution-Chemical, Microbiological, enzymes and Biotechnological indicators, Water purifications, Brief account on water born diseases and control measures	
Unit 5 Waste management:	
Solid and Liquids wastes and their characterization. Treatment-Physical, chemical, biological solid waste treatment: Saccharification, Gasification, Composting and wastewater recycling-chlorination, ozonization, radiation, filtrations, reverse osmosis. Effluent treatment - (Dairy, Distillery, Tannery, Textile, Paper and sugar industries) Physical, chemical and biological sewage treatment-Trickling filters, oxidation pond, ditch and activated sludge treatment. Advanced wastewater treatment-rotating biological contactors (RBC), submerged aerobic filters, fluidized bed reactors, biological aerated flooded system, combination of anaerobic, denitrification and aerobic treatment of wastewater. Advanced activated sludge process and biogas Production, effluent treatment, DOC, COD, BOD and disposal of effluents.	**12 Hrs**
Unit 6 Bioremediation	
Concepts and principles *In-situ* and *Ex-situ* bioremediation, Phytoremediation. Biodegradation- Recalcitrant of pesticides in soil and their influence on soil micro flora, Xenobiotic (Halocarbons, C-1 compounds, aliphatic hydrocarbons, alicyclic hydrocarbons, aromatic hydrocarbons, Polycyclic hydrocarbons, Halogenated compounds). Biodegradation of natural polymers-Cellulose Lignin, Pectin, Chitin Detergents, soaps and plastics Biodeterioration-paper, Leather, Wood, Textiles, Mode of Deterioration and organisms involved	**10 Hrs**
Unit 7 Bioleaching and bio-mining	
Bioleaching and bio-mining, Productions of Oils and fuels from wood wastes, biofuels, Bio-diesel and byproducts of sugar industries	**02 Hrs**
Unit 8 Environmental Education	
Agrochemicals, Botanicals of Global Warming, ozone depletion, Greenhouse gas effect, acid rains & their impact and Biotechnological approaches in the environment	**02 Hrs**
PRACTICALS	
MB CP 3.5 based on MB CT 3.1 - Environmental Microbiology	
1. Detection of coli forms for determination of purity of potable water samples MPN method 2. Isolation of Bacteriophages from sewage water samples 3. Study of micro flora of industrial waste and effluents 4. Isolation of nucleic acids from environmental samples 5. Determination of DO, DOC, CO_2, BOD, COD and TDS of water samples (RO water, Tap water, Pond water and Sewage waste water) 6. Isolation of Xenobiotic degrading bacteria by selective enrichment technique 7. Study on Biogenic methane production 8. Estimation of phosphate, sulphates, nitrates and major cations (Na, K, Mg, and Ca) in water samples 9. Effect of industrial effluents/ heavy metals on seed germination and seedling growth 10. Effect of herbicides (Glyphosate and 2, 4, - D) on chlorophyll content 11. Sampling and quantification of airborne endotoxins by Limulus Amoebocyte Assay. 12. Field excursion to an industrial area to assess environmental impact 13. Isolation and determination of Iron and Manganese reducing bacteria 14. Selective enrichment of auxotrophic and antibiotic (Tet^R, Ref^R) mutants(Isolation of antibiotic resistant microbes from Hospital waste)	
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MB CT 3.2 AGRICULTURAL MICROBIOLOGY AND PLANT PATHOLOGY

Course outcome

Paper Code and Name	**MB CT 3.2 AGRICULTURAL MICROBIOLOGY AND PLANT PATHOLOGY**
COURSE OUTCOMES (COs)	
After completing this paper, the students will be able to:	
CO 1	Know the history, scope of agricultural microbiology and plant pathology
CO 2	Understand the Sources and characteristics of air pollutants, health hazards and control measures of air, soil, water pollution and waste management.
CO 3	Know the Concepts and principles of nitrogen fixation, Mineralization and immobilization of nitrogen,
CO 4	Gain knowledge onTypes and applications of Biopesticides, biofertiizers,
CO 5	Analyse plant diseases, etiology, post harvest disease and control measures
CO 6	Understand post harvest diseases, Integrated pest management and biological control agents for disease management

Particulars	
Unit 1 Agricultural Microbiology and Plant Pathology	
History, concepts and scope of agricultural microbiology and plant pathology	**02 Hrs**
Unit – 2Biological nitrogen fixation:	
Mineralization and immobilization of nitrogen, nitrification and denitrification. Symbiotic nitrogen fixation (*Rhizobium, Frankia*), Non symbiotic nitrogen fixation (*Azotobacter*), Associative symbiotic nitrogen fixation (*Azospirulum*), Mycorrhiza, Nitrogenase enzymes, Nifgenes.Role of	**08 Hrs**

nodulin genes in nodule development and symbiosis	
Unit -3 Biofertilizer	
Types, production and quality control. Cultivation and mass-production of biofertilisers- *Azotobacter, Rhizobium, Azospirillum*, *Cyanobacteria*, phosphate solubilizing microorganisms, *Azolla.*Carrier-based inoculants - production and applications	**06 Hrs**
Unit 4 Biopesticides:	
Types and applications (Entamopathogenic bacteria, fungi and virus, *Pseudomonas fluroscence, Bacillus thuringiensis, Bacillus sphericus, Trichodermaharzianum, Trichodermaviridae, Nuclear Polyhedrosis Virus, Fungi* (*Culicinomyces, langenidium and coelomomyces*)	**06 Hrs**
Unit 5 Plant pathology:	
Disease cycle, Mode of entry of pathogens into the plant system, Plant immune system- PTI and ETI. Defense Mechanisms of Plant- structural and chemical defenses, induced structural and biochemical defenses. Pathways involved in disease resistance- SA, JA and EA	**08 Hrs**
Unit 6 Host parasite interaction	
Production of phytoalexins, involvement of elicitors, role of R and Avr genes in disease development	**02 Hrs**
Unit 7 Plant Diseases:	
Plant Diseases: a. Diseases caused by Fungi (symptomology, etiology and control) i. Wilt disease ii. Downy mildew iii. Powdery mildew iv. Rusts v. Smuts b. Diseases caused by Bacteria (symptomology, etiology and control) i. Bacterial wilt ii. Bacterial blight of rice iii. Angular leaf spot of cotton iv. Citrus canker c. Mycoplasmal diseases i. Sandal spike ii. Grassy shoot of sugarcane d. Viral diseases (symptomology, etiology and control) i. Tobacco mosaic disease ii. Banana bunchy top iii. Cucumber mosaic iv. Cowpea mosaic e. Disease caused by Virioids i. Potato spindle tuber virioid Post-harvest diseases and control measures	**15 Hrs**
Unit 8 Integrated pest management	
Integrated pest management and biological control agents for disease management	**03 Hrs**
PRACTICALS	
MBCP 3.6 based on MBCT-3.2-Agricultural Microbiology and Plant Pathology	
1. Isolation and Charactrization of Rhizosphere, Spermosphere and phyllosphere	

microorganisms.
2. Mass production of bacteria or fungi in laboratory.
3. Isolation, enumeration and characterization of nitrogen fixing bacteria.
4. Measurement of nitrogen fixation – the tube culture, Leonard Jar and Pot culture methods.
5. Isolation, enumeration and characterization of phosphate solubilizing bacteria and fungi.
6. Assessment of Vesicular Arbuscular *mycorrhiza* association with plants and isolation spores.
7. Observation of wet mount of NPV.
8. Isolation of Cellulose, Hemicellulose, Starch, Lignin, Pectin degrading microorganisms.
9. Demonstration of Biogas production using different substrates like cattle dung, water hyacinth, sewage.
10. Mushroom cultivation and evaluation of protein content.
11. Organic matter decomposition - CO_2 evolution.
12. Evaluation of seed germination and vigor - Grow on test.
13. Artificial challenge inoculation techniques for bacterial and fungal pathogens.
14. Quantitative skills for biotic and abiotic disease stress evaluation and data analysis.
15. *In vitro* methods to determine antagonism effects of biological agents against fungal pathogens.
16. Laboratory scale production of bacterial and fungal biofertilizers.

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MB CT 3.3 FOOD AND DAIRY MICROBIOLOGY

Course Outcome

Paper Code and Name	**MB CT 3.3 FOOD AND DAIRY MICROBIOLOGY**
COURSE OUTCOMES (COs)	
After completing this paper, the students will be able to:	

CO 1	Know the Concepts and scope of food and dairy microbiology.
CO 2	Understand the Important microorganisms in food and their source.
CO 3	Know the various principles of food spoilage, contamination. and detection of food borne microbes. Food preservation techniques
CO 4	Gain knowledge on food borne diseases, Food Borne outbreaks, lab testing procedures and preventive measures
CO 5	Analyze the food borne diseases, Food Borne outbreaks, lab testing procedures and preventive measures
CO 6	Know the Sanitation in manufacture and retail trade; food control agencies and their regulations. Food safety laws, standards and Food packing strategies.

Particulars	**No of Hours (Hrs)**
Unit 1 Introduction:	
Definition, Concepts and scope of food and dairy microbiology	**02 Hrs**
Unit – 2 Food as a substrate for microorganisms:	
Important microorganisms in food (Molds, yeasts, Bacteria) and their source. (Air, soil, water, plants and animals)	**04 Hrs**
Unit -3 Contamination and spoilage:	
Principles of food spoilage. spoilage of cereals sugar products, fruits, vegetables, meat and meat products, fish and sea foods poultry, spoilage of canned foods, Detection of food borne microbes- sampling, detection by culturing methods, physical and chemical methods	**08 Hrs**
Unit 4 Food preservation:	
General principles, physical methods (low temperature, high temperature and drying), chemical methods (Food additives), irradiation, biological methods of food preservation. Processing for heat treatment- D, Z and F values and working out treatment parameters, Freeze drying methods	**08 Hrs**
Unit 5 Fermented foods:	
Microbial activity in food vegetables (olives and cucumbers), meat (sausages), bread, idli, cocoa and coffee. Dairy foods – cheese, Shrikand, Tempeh, Therapeutic and nutritional value of fermented foods, spoilage and defects of fermented dairy products, oriental fermented foods their quality, standard and control	**08 Hrs**
Unit 6 Milk and milk products:	
Composition, properties, food and nutritional value and microbiology of milk, contamination, preservation, spoilage, testing of milk and milk products. Safety systems in dairy industries, Fermented milk products – cheese, yoghurt, shrikand, Kefir, Kumis and acidophilus milk.	**08 Hrs**
Unit 7 Food borne infections and Bacterial Intoxication	
Brucella, Bacillus, Clostridium, Escherichia, Salmonella, Shigella, Staphylococcus, Vibrio, Yesinia and Listeria, **Nematodes, Protozoa, Algae, Viruses and Molds. Mycotoxins**–Aflatoxins, Ochratoxins, Trichothecenes, Zealenone, Ergot Alkaloids; Food Borne outbreaks, lab testing procedures and preventive measures	**08 Hrs**
Unit 8 Food sanitation:	
Sanitation in manufacture and retail trade; food control agencies and their regulations. Food safety laws and standards, Food packing International – HACCP, ISO 9000 series, GMP and GLP, FDA and EU	**04 Hrs**

India – PFAA, FPO, MPO, CSO, the AGMARK, standards, bureau of Indian Standards (BIS). Food testing laboratories in India - SRI, FRAC.	

PRACTICALS

MB CP 3.7 based on MB CT 3.3 - Food and Dairy Microbiology

1. Microbiological Examination of Utensils.
2. Enumeration of microorganisms from healthy and spoiled fruits and vegetables
3. Enumeration of microorganisms from cereals, spices and dry products
4. Enumeration study of spoilage of stored meat and fish
5. Study of microbiology of milk and milk products
6. Rapid platform test for milk - Resazurin test
7. Methylene blue reduction test
8. Production of yoghurt, acidophilus milk and tempeh
9. Production of chess from fermented food
10. Estimation of lactic acid in milk and curd
11. Estimation Fat in milk and milk products
12. Estimation of proteins from Spirulina
13. Estimation of ascorbic acid from tomato, chilly and lemon
14. Estimation of Aflatoxin from food samples
15. Mushroom cultivation (Oyster) and Spirulina, Agar-agar and single cell proteins
16. Mandatory visit to food research institutes/Industries

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MB ET - 3.4 FOOD AND FERMENTATION TECHNOLOGY

Course Outcome

Paper Code and Name	**MB ET - 3.4 FOOD AND FERMENTATION TECHNOLOGY**
COURSE OUTCOMES (COs)	
After completing this paper, the students will be able to:	
CO 1	Know the Concepts and scope of food and dairy microbiology.
CO 2	Understand the Important microorganisms in food and their source.
CO 3	Know the various principles of food spoilage, contamination. and detection of food borne microbes. Food preservation techniques
CO 4	Gain knowledge on food borne diseases, Food Borne outbreaks, lab testing procedures and preventive measures
CO 5	Understand the industrial production of agar, alcohols, vitamins recombinant protein

	etc

Particulars	No of Hours (Hrs) Total (50 Hours)
Unit 1 Introduction:	
Definition, Concepts and scope of food and dairy microbiology	**02 Hrs**
Unit – 2 Food as a substrate for microorganisms:	
Important microorganisms in food (Molds, Yeasts, Bacteria) and their source. (Air, soil, water, plants and animals)	**04 Hrs**
Unit -3 Contamination and spoilage:	
Principles of food spoilage. spoilage of cereals sugar products, fruits, vegetables, meat and meat products, fish and sea foods poultry, spoilage of canned foods, Detection of food borne microbes- sampling, detection by culturing methods, physical and chemical methods	**08 Hrs**
Unit 4 Food preservation:	
General principles, physical methods (low temperature, high temperature and drying), chemical methods (Food additives), irradiation, biological methods of food preservation. Processing for heat treatment- D, Z and F values and working out treatment parameters, Freeze drying methods	**08 Hrs**
Unit 5 Fermented foods:	
Microbial activity in food vegetables (olives and cucumbers), meat (sausages), bread, idli, cocoa and coffee. Dairy foods – cheese, shrikand, Temph, Therapeutic and nutritional value of fermented foods, spoilage and defects of fermented dairy products, oriental fermented foods their quality, standard and control	**08 Hrs**
Unit 6 Introduction to bioprocess engineering	
Isolation, screening, selection, preservation and maintenance of industrial microorganisms strain improvement, Inoculum development for bacterial and fungal processes, spore inoculum or vegetative mycelia inoculum for fungi	**03 Hrs**
Unit 7 Fermentation media:	
Natural, synthetic media typical media and media formulation strategies, Source of Carbon, Nitrogen, Vitamins and minerals, Role of buffers, precursors, inhibitors, inducers and antifoam agents. Solid state fermentation	**03 Hrs**
Unit 8 Sterilization process in fermentation industry	
– Media sterilization, method of batch sterilization and the design of continuous sterilization process, sterilization of fermentor, feeds air, and filter design	**03 Hrs**
Unit 9 Bioreactors	
Design of fermentors, basic function of a fermentors, body construction aeration and agitation. The achievement and maintenance of aseptic conditions sterilization of fermentors air supply, aeration and agitation, addition of inoculum and nutrients, sampling, foam control monitoring and control of various parameters, various types of values Types of bioreactors Specialized bioreactors – Tubular bioreactors, membrane bioreactors, Tower	**06 Hrs**

bioreactors, fluidized bed reactor, packed bed reactor and photo bioreactors	
Unit 10 Fermentation technology	
Types of fermentation process – Analysis of batch, fed batch and continuous bio-reactions, stability of microbial reactors, analysis of mixed microbial population, specialized bio-reactors (pulsed, fluidized, photo bioreactors etc). Measurement and control of bio-process parameters	**04 Hrs**
Unit 11 Industrial production	
Agar, Alginate, Alcohol (Ethanol), Organic acids (Citric, acetic, Lactic and Gluconic acid) Solvent (Glycerol Acetone, Butanol), Antibiotics (Penicillin, streptomycin, tetracycline) Amino acids (lysine, glutamic acid) Single cell proteins (SCP) Vitamins (Riboflavin) Enzymes (Amylase, lactase, protease), Hydrocarbons – Biodegradable plastic – Polyhydroxyalkanoates (butyrate, propionate etc), recombinant protein (hepatitis – B vaccine)	**08 Hrs**
PRACTICALS	
MBCP 3.8 based on MBCT 3.4. Food and Fermentation Technology	
1. Isolation and Enumeration of food pathogens from fruits, vegetables, cereals and dry products. 2. Extraction of starch from Potato. 3. Extraction of Casein from Milk. 4. Estimation of Ascorbic acid from Tomato, Chills and Lemon. 5. Estimation of Lactic acid from fermented milk products. 6. Estimation of Aflotoxins from food samples 7. Production Curd, Yoghurt, Paneer, Acidophilus milk, Tempeh. 8. Production of Microbial lipids 9. Production of Sauerkraut. 10. Production of Probiotics. 11. Isolation of lycopene from tomato 12. Mushroom Cultivation and spirulina	
REFERENCE	
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MICROBIOLOGY FOURTH SEMESTER SYLLABUS

Course Outcome

Paper Code and Name	**MB CT 4.1 IMMUNOLOGY AND IMMUNOTECHNOLOGY**
COURSE OUTCOMES (COs)	
After completing this paper, the students will be able to:	
CO 1	Know the fundamental concepts and cells involved in immunology.
CO 2	Understand the principles, types of antigens and immunoglobulins
CO 3	Know the various principles of different Serological methods for detection and quantization of viral diseasesborne microbes.
CO 4	Gain knowledge on Immunotechniques and applications
CO 5	Understand the different methods of immunization and also about the different types of vaccines.

PARTICULARS	**No of Hours (Hrs)**
Unit 1: Immunology- fundamental concepts and anatomy of the immune system:	
History and scope of immunology, cells involved in immune system – T-lymphocytes, B-lymphocytes, Monocytes, Macrophages, APC, Neutrophils, Mast cells, Types of immunity-Adaptive immunity, Innate immunity, Components of Innate and Acquired immunity; Phagocytosis, Complement and Inflammatory responses, Haematopoesis, Organs of the immune system- primary and secondary lymphoid organs, Lymphatic system, Lymphocyte circulation, Lymphocyte homing, Mucosal and Cutaneous associated Lymphoid tissue (MALT&CALT).	**08 Hrs**
Unit 2: Antigen:	
Concept of haptens, determinants, conditions of antigenicity, antigens and immunogenicity, super-antigen. Self and non-self-recognition, epitopes mapping, paratopes, nature of B-cell and T – cell epitopes, haptens, carbohydrate antigens, blood group antigens, synthetic peptides as antigens. **Immunoglobulins:** Structure and properties of immunoglobulin classes. Theories of antibody formation, Multiple myelomas and structural basis of antibody diversity.Freund's adjuvants and its significance	**05 Hrs**
Unit 3: Antigen-antibody Interaction and Immunotechniques:	
Agglutination, Precipitation, Affinity, avidity and cross reactivity, Immuno double- diffusion, single radial immunodiffusion, Haemagglutination and complement fixation, direct and indirect Immunofluorescence	**05 Hrs**
Unit 4: Immunodiagnostics:	
Anti-microbial immunity: a general scheme, Defense against bacteria, viruses, fungi and parasites. Immunodiagnostics in virology – Serological methods for detection and quantitation of viruses including Hepatitis, Influenza, HIV and others	**05 Hrs**

Unit 5: Immunotechniques and applications:	
Immuno-assays, SRID, ELISA, ELISA-PCR, RIA, Western Blotting, Immunoflurorescence and their application. Immuno-deficiencies and autoimmunity. Immunoelectrophoresis, Flow cytometry, Immunoblot, Complement fixation test (CFT), Montaux test. Applications of these methods in diagnosis of Microbial infections	**05 Hrs**
Unit 6: Expressions and Regulation of Immune Response:	
Regulation of immune response: Antigen processing and presentation, generation of humoral and cell mediated immune response, activation of B and T lymphocytes, cytokines and their role in Immune regulation, T cell regulation, MHC restriction, Immunological tolerance	**04 Hrs**
Unit 7: Hypersensitivity reactions:	
Allergy, Type I- Anaphylaxis, Type II- Antibody dependent cell cytotoxicity, Type III- Immune complex mediated reactions, Type IV- delayed type hypersensitivity, Symptoms and Immunological methods of diagnosis of hypersensitive reactions. Lymphokines and cytokines Assay methods, Immunological tolerance and modulation	**03 Hrs**
Unit 8: Transplantation immunology:	
Structure and functions of MHC and the HLA systems, types of grafts, grafts rejection, GVH reactions, mechanism of graft rejection, and prevention of graft rejection. Gene regulation and Ir-genes; HLA and tissue transplantation – Tissue typing methods for transplantations in humans; graft versus host reaction and rejection, Xeno-transplantation, (inter spices, intra Spices, Intra Genus) immunosuppressive therapy	**04 Hrs**
Unit 9: Tumor immunology:	
Tumor specific antigens, Immune response to tumors, Theory of surveillance, Immunodiagnosis of tumors – detection of tumor markers – Alpha foetal proteins, carcinoembryonic antigen, cancer therapeutics	**04 Hrs**
Unit 10: Immunization & Vaccine technology and recombinant vaccines:	
Common immunization practice, types of vaccines and its application, edible vaccines, conventional vaccines, viral vaccines, bacterial vaccines, peptide vaccines, genetically engineered vaccines, hybridoma technology, immunization of animals Isolation of stimulated spleen cells, myeloma cell lines used and fusion partners. Fusion method production, detection and applications of monoclonal and polyclonal antibodies, production and application of lymphokines	**05 Hrs**
Unit 11: Cytokines:	
Structure and receptors, signal transduction, modulation of immune response cytokine profile of diseases	
PRACTICALS	

MB CP 4.4 Based on MB CT 4.1 - Immunology and Immunotechnology

1. Study of cells / Organs of Immune system
2. WBC and RBC count
3. Determination of Blood groups and Rh factor.
4. Estimation of Hemoglobin.
5. Determination of Bleeding Time (BT) and Clotting Time (CT).
6. Separation of Serum / Plasma from whole blood,Electrophoretic separation of serum proteins/plasma
7. Blood film preparation and identification of cells.
8. Precipitation of Immunoglobulins from serum by Ammonium sulphate precipitation.
9. Partial purification of Ammonium sulphate precipitated Immunoglobulins by dialyzing against phosphate buffered saline.
10. Agglutination tests (Haemagglutination, Latex agglutination, Bacterial agglutination).
11. Immunoprecipitation tests – Radial Immunodiffusion test / Ochterlony double diffusion test.
12. Demonstration of antigen administration to animals Mice / Rat.(Intra muscular, Intra venial, Intra peritoneal)
13. Demonstration of ELISA
14. Demonstration of Western blot.
15. Isolation of Neutrophils
16. Determination of antibody titer of the serum.
17. Immunoelectrophoresis – Rocket Immunoelectrophoresis,

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MB CT- 4.2 MEDICAL MICROBIOLOGY

MB CT- 4.2 MEDICAL MICROBIOLOGY

Course Outcome

Paper Code and Name	**MB CT- 4.2 MEDICAL MICROBIOLOGY**
COURSE OUTCOMES (COs)	
After completing this paper, the students will be able to:	
CO 1	Know the classify medically important microorganisms, normal microbial flora and their significance..
CO 2	Understand the modes of disease transmission.
CO 3	Know the various principles of different Serological methods for detection and quantization diseases
CO 4	Gain knowledge on Immunotechniques and applications
CO 5	Understand the Clinical Microbiology: Students will learn methods of Specimen collections, handling, transport, identification of pathogens.
CO 6	Analyse the Pathogenesis, Clinical conditions, laboratory diagnosis, epidemiology, Prophylaxis and treatment of the microbial diseases. Nosocomial and Dental infections.

Particulars	**No of Hours (Hrs)**
Unit 1: History, development and scope of medical microbiology:	
Classification of medically important microorganisms, normal microbial flora of human body and their significance. Human microbiome project	**04 Hrs**
Unit – 2: Disease transmission:	
Infection by bacteria, fungi, viruses and protozoa – Signs, symptoms, sources and reservoir of infection nosocomial infections, Pathogenesis - adhesion, invasion, host cell damage, release of pathogens, modes of transmission and epidemiology	**10 Hrs**
Unit -3: Clinical Microbiology:	
Specimen collections, handling, transport, identification of pathogens from specimen, growth and biochemical characteristics, Rapid methods of identification, immunological techniques, Bacteriophage typing, molecular	**10 Hrs**

measures (DNA probes, Restriction endonucleases, DNA Finger printing, RIA, ELISA, PCR) and susceptibility testing. A brief account on hospital management	
Unit 4: Antimicrobial Therapy:	
General Characteristics of antimicrobial agents, determination of antimicrobial activity. Mechanisms of action of antimicrobial agents; Antibacterial drugs- Sulfonamide, Quinolones, Penicillin, Cephalosporin, Tetracycline, Erythromycins; Antifungal drugs-Clotrimazole, Econazole, Miconazole, Terbinafine, Fluconazole and antiviral drugs- Abacavir, Adefovir**;** Drug resistance – Types, mechanism and implication.; Brief account on available vaccines and schedules	**12 Hrs**
Unit 5: Disease diagnosis and epidemiology:	
Pathogenesis, Clinical conditions, laboratory diagnosis, epidemiology, Prophylaxis and treatment of the following diseases. a) **Protozoa**: Amoebiasis, Giardiasis, Malaria, Leishmaniasis and Trypanosomiasis. b) **Bacteria**: Diphtheria, Typhoid, Gonorrhea, Syphilis, Plague, Leprosy, Tuberculosis, Gas gangrene, Tetanus, Septicemia, Cholera and Brucellosis. c) **Fungi**: Candidiasis, Mycetoma, Chromomycosis, Sprorotrichosis, Cryptococcosis, Blastomycosis, Coccidiomycosis and Histoplasmosis. d) **Virus**: Measles, Mumps, Influenza, Yellow fever, HIV, Ebola, Zika, Herpes, Rabies, Hepatitis, Polio myelitis, Dengue fever, Japanese Encephalitis, KFD, Rhinovirus, CJD and Kuru. e) **Nosocomial Infections**: Bacteremia, Burn wounds, surgical site infections, Urinary tract and miscellaneous infections. **Dental Infections**: Dental Plaque, Dental carries and periodontal diseases	**08 Hrs**
PRACTICALS	
MBCP 4.5 based on MBCT 4.2 Medical Microbiology	
1. Preparation of culture media for the culture of different pathogenic microorganisms. 2. Anaerobic culture method for anaerobes of clinical importance. 3. Presumptive identification of pathogenic microorganisms using colony morphology on selective/differential/selective-differential/enrichment media. 4. Isolation and characterization of clinical significant species of *Staphylococcus, Streptococcus, Candida, Cryptococcus, Cornybacterium, Bacillus, Nocordia, Neisseria, Enterobacteriaceae, Vibrio, Pseudomonas, Aeromonas.* 5. Microscopic observation of important human pathogens. 6. Study of commensal microbial flora of human body (mouth/skin/hands/nose/ear). 7. Isolation, characterization and identification of bacterial pathogen from clinical specimen (Urine sample/Pus sample/Blood sample). 8. Study of *Mycobacterium tuberculosis* by AFB method using sputum (Bacterial infection). 9. Demonstration of the diagnosis of HIV by Dot-ELISA (Viral infection). 10. Detection of malarial parasite from human blood sample (Parasitic infection). 11. Identification of pathogenic fungi (Germ tube test/Slide culture technique). 12. Study of antibiotic sensitivity test by paper disc method. 13. Determination of MIC value for selected antibiotics by Kirby-Bauer method. 14. Analysis of antibiotic resistant mutants from clinical samples. 15. Lymphocyte viability test (Trypan blue exclusion test of cell viability).	

16. Study of cancer cells and visit to cancer research institute.
17. Mandatory visit to hospital and medical research centers.

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MB CT- 4.3 BIOPROCESS ENGINEERING AND TECHNOLOGY

Course Outcome

Paper Code and Name	**MB CT- 4.3 BIOPROCESS ENGINEERING AND TECHNOLOGY**
COURSE OUTCOMES (COs)	
After completing this paper, the students will be able to:	
CO 1	Know the concept of Bioprocess engineering, Isolation, screening, selection, preservation and maintenance of industrial important microorganisms..
CO 2	Understand the types of sterilization, bioreactors, and design of fermentors
CO 3	Know the various principles of downstream processing, crystallization, packaging and quality assurance.
CO 4	Gain knowledge on **Entrepreneurship**: Potential entrepreneurship activities in biotechnology,. Biotechnology industries in India and the potential job opportunities and Intellectual property rights (IPRs)

MB CT- 4.3 **BIOPROCESS ENGINEERING AND TECHNOLOGY**	**No of Hours (Hrs)**
Unit 1: Introduction:	
Bioprocess engineering, Isolation, screening, selection, preservation and maintenance of industrial important microorganisms Strain improvement, Inoculum development for bacterial and fungal processes, spore inoculum or vegetative mycelia inoculum for fungi.	**03 Hrs**
Unit – 2: Fermentation media:	
Natural, synthetic media typical media and media formulation strategies, source of Carbon, Nitrogen, Vitamins and minerals, Role of buffers, precursors, inhibitors, inducers and antifoam agents. Solid state fermentation	**04 Hrs**
Unit -3: Sterilization process in fermentation industry:	
Media sterilization, method of batch sterilization and the design of continuous sterilization process, sterilization of fermentor, feeds air, and filter design	**04 Hrs**
Unit 4: Bioreactors:	
Design of fermentors, basic function of a fermentors, body construction aeration and agitation. The achievement and maintenance of aseptic conditions sterilization of fermentorsair supply, aeration and agitation, addition of inoculum and nutrients, sampling, foam control monitoring and control of various parameters, various types of values, Types of bioreactors Specialized bioreactors – Tubular bioreactors, membrane bioreactors, Tower bioreactors, fluidized bed reactor, packed bed reactor and photo bioreactors	**06 Hrs**
Unit 5: Fermentation technology:	
Types of fermentation process – Analysis of batch, fed batch and continuous bio-reactions, stability of microbial reactors, analysis of mixed microbial population, specialized bio-reactors (pulsed, fluidized, photo bioreactors etc). Measurement and control of bio-process parameters	**05 Hrs**
Unit 6: Downstream processing:	

Introduction objectives and criteria for downstream processing, Removal of microbial cells and solid matter, Foam precipitation, filtration centrifugation, cell disruptions, liquid-liquid extraction, chromatography, membrane process, drying, crystallization, packaging and quality assurance	**06 Hrs**
Unit 7: Immobilization:	
Definition and concepts of immobilization, enzyme and whole cell immobilization, immobilization techniques – adsorption, cross-linking, ionic bonding, entrapment encapsulation, advantages and industrial applications of immobilized enzymes (α-galactosidase, glucoseisomerase, etc.) and cells	**04 Hrs**
Unit 8: Industrial production:	
Agar – Agar, Alginate, Alcohol (Ethanol), Organic acids (Citric, acetic, Lactic and Gluconic acid) Solvent (Glycerol Acetone, Butanol), Antibiotics (Penicillin, streptomycin, tetracycline) Amino acids (lysine, glutamic acid) Single cell proteins (SCP) Vitamins (Riboflavin) Enzymes (Amylase, lactase, protease), Hydrocarbons – Biodegradable plastic – Polyhydroxyalkanoates (butyrate, propionate etc), recombinant protein (hepatitis – B vaccine)	**12 Hrs**
Unit 9: Entrepreneurship:	
Potential entrepreneurship activities in biotechnology, An-inter disciplinary challenge, product development, marketing, research and training units, Industrial licensing, vesture capital, Biotech parks. Biotechnology industries in India and the potential job opportunities and Intellectual property rights (IPRs) Trade Mark, and development of branding, Trail market, Market survey, etc., Future challenges, and its solution)	**06 Hrs**
PRACTICALS	
MB CP 4.6 based on MB CT 4.3 - Bioprocess Engineering and Technology	
1. Study of Fermentor and Bioreactor 2. Isolation of industrially important microorganisms. 3. Study of antibiotic producing microorganisms in mass culture process and recovery of the product 4. Detection and quantification of Siderophores produced by *Pseudomonas sp.* 5. Study of alcohol fermentation – alcohol production from different substrates, Lab production of Wine, Estimation of percentage of Alcohol, Total acidity and volatile acidity in wine 6. Estimation of Alcohol by Potassium dichromate method 7. Production and analysis of SCP from *Spirulina and Yeast* 8. Product ion of Citric acid by *Aspergillus niger, Pencillium citrannum* and its estimation 9. Production of Pectinase from *Aspergillus niger* by using Wheat bran, Coffee pulp using small scale fermentor and its assay 10. Production of α- Amylase using *Aspergillus oryzae*, *Bacillus licheniformis* using Wheat bran in small scale solid state fermentation and its assay 11. Immobilization of yeast cells by calcium alginate gel entrapment and assay for enzymes Invertase and Catalase 12. Preparation of immobilized cells of *Bacillus licheniformis* for the use in the production of α- amylase 13. Extraction and estimation of vitamins- Thiamine/ Niacin/ Riboflavin/ Vitamin C 14. Mandatory visit to Research Institutes / Industries	

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MB CP- 4.7 Project Work/ Dissertation

Course Outcome

Paper Code and Name	**MB CP- 4.7 Project Work/ Dissertation**
COURSE OUTCOMES (COs)	
After completing this paper, the students will be able to:	
CO 1	Know the concept and skill of scientific writing papers
CO 2	Understand the research methodology
CO 3	Gain knowledge on skills, applications and entrepreneurship activities in Microbiology