VIJAYANAGARA SRIKRISHNADEVARAYA UNIVERSITY BALLARI-583105

SYLLABUS FOR P.G. DEPARTMENT OF STUDIES AND RESEARCH IN MICROBIOLOGY

(CBCS SEMESTER SCHEME)

EFFECTIVE FROM 2019-20 ONWARDS

DEPARTMENT OF MICROBIOLOGY

VIJAYANAGARA SRI KRISHNADEVARAYA UNIVERSITY

JNANA SAGARA CAMPUS, VINAYAKANAGAR, CANTONMENT

BALLARI-583 105

VIJAYANAGARA SRI KRISHNADEVARAYA UNIVERSITY, BALLARI-583 105

(EFFECTIVE FROM THE ACADEMIC YEAR 2019-2020)

Course outline and Syllabus for Master of Science in MICROBIOLOGY
Under CBCS and CAGP

The Board has framed and approved the Syllabus/Scheme of examination of Choice Based Credit Based System (CBCS) and recommended for implementation from 2019-20. The following are the core papers and scheme of examination proposed by the Board.

1. M.Sc, Degree in Microbiology - I and II Semester
2. M.Sc, Degree in Microbiology - III and IV Semester

The pattern of matrix for two year Master's Degree Program in Microbiology:

Sl. No	**COURSES**	**I SEM**			**II SEM**			**III SEM**			**IV SEM**			**TOTAL**		
		C	**P**	**M**	**C**	**P**	**M**	**C**	**P**	**M**	**C**	**P**	**M**	**C**	**P**	**M**
1.	HARD CORE (Theory)	12	3	300	12	3	300	12	3	300	14	3	350	48	12	1250
2.	HARD CORE (Practical)	6	3	150	6	3	150	6	3	150	4	2	100	22	11	550
3.	SOFT CORE	4	1	100	4	1	100	4	1	100	4	1	100	16	4	400
4.	OPEN ELECTIVE	-	-	-	4	1	100	4	1	100	-	-	-	08	2	200
	TOTAL	**22**	**7**	**550**	**26**	**8**	**650**	**26**	**8**	**650**	**22**	**6**	**550**	**96**	**29**	**2400**

Where, C-Credits, P-Papers, M-Marks

***The M.Sc. Microbiology students have to choose open elective papers from other disciplines**

P.G. DEPARTMENT OF STUDIES AND RESEARCH IN MICROBIOLOGY

M.Sc. DEGREE IN MICROBIOLOGY

[Choice Based Credit System (CBCS) Syllabus]

Regulations Governing Post-Graduate Programmes in the Department of Microbiology under CBCS

NAME OF THE DEGREE

Master of Science in Microbiology: M.Sc. Microbiology (MB)

OBJECTIVES AND SCOPE OF THE DEGREE

The microbiology includes Virology, Bacteriology, Mycology, Phycology, Protozoology and various applications of microorganisms. 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.

Candidates of M.Sc. Microbiology will be having wide scope and find job opportunities as a Microbiologist, QC, QA, Research associate, Scientist, Team leader in various pharmaceutical, food, waste water treatment plants, water purification units and beverage industries. They also can involve R & D programmes, teaching assignments and self-employment. The specialization in Medical microbiology and clinical research provides various insights in medical and diagnostic laboratories and pharmaceutical sectors.

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 Vijayanagara Sri Krishnadevaraya University, Ballari-583105.

2.0. COMMENCEMENT

These Regulations shall come into force with effect from the academic year 2019-20 onwards.

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 Hard core 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.

4.0. MINIMUM ELIGIBILITY FOR ADMISSION

A candidate, who has successfully completed Bachelor's Degree programme in any two biological sciences such as Microbiology, Biotechnology,Biochemistry, Botany, Zoology, and allied sciences 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 Microbiology 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 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, Hardcore (compulsory course), Soft core (any one) Course and Open Elective Courses (only in 3rd and 4 th semester, any one).

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. The minimum credits for P.G. Programme shall be 96.

7.7 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.

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.Centres/ 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, scrutinise and approve question papers.

9.2.2 The BOE shall scrutinise 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.Centres/ 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 centres 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 centres.

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, scrutinise 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/Centres/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.

QUESTION PAPER PATTERN

In each theory course, after completing 50% of the syllabus there shall be a written internal assessment test (CI) for 10 marks and a home assignment for 5 marks. Similarly, after completing the remaining 50% of the syllabus there shall be one more written internal assessment test (C2) for 10 marks and a seminar for 5 marks. The total marks secured by the student in the internal examination in a course will be sum of the marks obtained in two written tests (C1+C2) and one seminar and one home assignment.

In each practical course, there shall be 10 marks are earmarked for Viva- Voce and 05 marks for practical record book. In the final year the candidate has to go for a Tour/ Educational Field study and submit a report on the same. The candidate has to work for a project work on a specific topic in the Final year of the course. He/she shall submit a Dissertation on the project work for evaluation at the end of the final year.

THEORY AND PRACTICAL QUESTION PAPER FORMAT FOR CBCS SEMESTER EXAMINATION
I/II/III/IV Semester M.Sc. Examination, December/May/June 2019-20

MICROBIOLOGY (CBCS)

Paper Code (HCT/SCT/OET …….): Course Title

Time: 3 Hours **Max. Marks: 70**

SECTION-A

I. Write a short note any **Five** of the followings: (05x03=15)

1.
2.
3.
4.
5.
6.
7.

SECTION-B

II. Answer any **Five** of the followings: (05x05=25)

8.
9.
10.
11.
12.
13.
14.

SECTION-C

III. Answer any **Two** of the followings: (15x02=30)

15.
16.
17.
18.

SCHEME FOR PRACTICAL EXAMINATION

I. Major experiment for performance and report writing

----12 Marks

II. Minor experiment for performance or for Principle, procedure and interpretation writing

----08 Marks

III. Identify and comment on spotters (**a and b**)

----2.5x2=5 Marks

IV. Record

----05 Marks

V. Viva-voce **----05Marks**

VIJAYANAGARA SRI KRISHNADEVARAYA UNIVERSITY
BALLARI-583 105
COURSE STRUCTURE AND SYLLABUS FOR MASTER OF SCIENCE IN MICROBIOLOY (MB) CBCS AND CAGP PROGRAMME

SEMESTER-I

Semester	Code	Title of the paper	Semester exam	IA	Total	Credits
First		**Hard Core**				
	MB-HCT 1.1	Introduction to Microbiology	70	30	100	4
	MB-HCT 1.2	Microbial Taxonomy	70	30	100	4
	MB-HCT 1.3	Biochemistry	70	30	100	4
		Soft core (any one)				
	MB-SCT 1.1	Instrumentation and techniques	70	30	100	4
	MB-SCT 1.2	Computer applications and biostatistics	70	30	100	4
		Practicals				
	MB-HCP 1.1	Practicals based on HCT.1.1	35	15	50	2
	MB-HCP 1.2	Practicals based on HCT.1.2	35	15	50	2
	MB-HCP 1.3	Practicals based on HCT.1.3	35	15	50	2
		Total for First semester	**385**	**165**	**550**	**22**

4 Credits of Theory= per week 4 Hours of Teaching; 2 Credits of Practicals= 4 Hours per week

Note:

1. All hard core papers are **compulsory** for all the students.
2. The students have to select **one** of the two soft core papers.

SEMESTER-II

Semester	Code	Title of the paper	Semester exam	IA	Total	Credits
Second		**Hard Core**				
	MB-HCT 2.1	Microbial physiology and Enzymology	70	30	100	4
	MB-HCT 2.2	Microbial genetics	70	30	100	4
	MB-HCT 2.3	Molecular cell biology	70	30	100	4
		Soft core (any one)				
	MB-SCT 2.1	Green nanotechnology	70	30	100	4
	MB-SCT 2.2	Bioinformatics	70	30	100	4
		Open Elective (any one)				
	MB-OET 2.1	Microbial Diversity	70	30	100	4
	MB-OET 2.2	Microbial Technology	70	30	100	4
		Practicals				
	MB-HCP 2.1	Practicals based on HCT.2.1	35	15	50	2
	MB-HCP 2.2	Practicals based on HCT.2.2	35	15	50	2
	MB-HCP 2.3	Practicals based on HCT.2.3	35	15	50	2
		Total for Second semester	**385**	**165**	**550**	**26**

4 Credits of Theory= per week 4 Hours of Teaching; 2 Credits of Practicals= 4 Hours per week

Note:

1. All hard core papers are **compulsory** for all the students.
2. The students have to select **one** of the two soft core papers.
3. Open elective / cross border-papers are for the other than biotechnology students. Students have to opt one of the two open elective papers. However for the operationlization of such paper, a minimum of ten students are required to opt such a paper.

SEMESTER-III

Semester	Code	Title of the paper	Semester exam	IA	Total	Credits
Third		**Hard Core**				
	MB-HCT 3.1	Food and Dairy Microbiology	70	30	100	4
	MB-HCT 3.2	Microbial ecology and Environmental Microbiology	70	30	100	4
	MB-HCT 3.3	Agriculture Microbiology	70	30	100	4
		Soft core (any one)				
	MB-SCT 3.1	Recombinant DNA Technology	70	30	100	4
	MB-SCT 3.2	Bioethics, Biosafety and IPR	70	30	100	4
		Open Elective (any one)				
	MB-OET 3.1	Micro organism and Human welfare	70	30	100	4
	MB-OET 3.2	Biopharmaceuticals	70	30	100	4
		Practicals				
	MB-HCP 3.1	Practicals based on HCT.3.1	35	15	50	2
	MB-HCP 3.2	Practicals based on HCT.3.2	35	15	50	2
	MB-HCP 3.3	Practicals based on HCT.3.3	35	15	50	2
		Total for Third semester	**385**	**165**	**550**	**26**

4 Credits of Theory= per week 4 Hours of Teaching; 2 Credits of Practicals= 4 Hours per week

Note:

1. All hard core papers are **compulsory** for all the students.
2. The students have to select **one** of the two soft core papers.
3. Open elective / cross border-papers are for the other than biotechnology students. Students have to opt one of the two open elective papers. However for the operationlization of such paper, a minimum of ten students are required to opt such a paper

SEMESTER-IV

Semester	Code	Title of the paper	Semester exam	IA	Total	Credits
Fourth		**Hard Core**				
	MB-HCT 4.1	Bioprocess and Fermentation technology	70	30	100	4
	MB-HCT 4.2	Medical Microbiology	70	30	100	4
		Soft core (any one)				
	MB-SCT 4.1	Immunology and immunotechniques	70	30	100	4
	MB-SCT 4.2	Basics of Clinical research	70	30	100	4
		Practicals				
	MB-HCP 4.1	Practicals based on HCP.2.1	35	15	50	2
	MB-HCP 4.2	Practicals based on HCP.2.2	35	15	50	2
		Major Project				
	MB-HCP 4.3	Project dissertation (100 marks) + viva voce (25 marks) internal assessment (25 marks) =150 Marks	125	25	150	6
		Total for fourth semester	**400**	**150**	**550**	**22**
				Grand Total marks and Credits	**2400**	**96**

4 Credits of Theory= per week 4 Hours of Teaching; 2 Credits of Practicals= 4 Hours per week

Note:

1. All hard core papers are **compulsory** for all the students.
2. The students have to select **one** of the two soft core papers.

P.G. DEPARTMENT OF STUDIES AND RESEARCH IN MICROBIOLOGY

M.Sc. DEGREE IN MICROBIOLOGY

SEMESTER-I

MB-HCT 1.1 INTRODUCTION TO MICROBIOLOGY **(4 credits)**

52 Hrs

Preamble: *Introduction to Microbiology is a paper which aims to introduce microbiology wherein history of Microbiology will be studied. The basic equipments, cultivation and preservation of microorganisms will be studied and identification of microorganisms will be studied by staining techniques.*

Unit – I (**08 Hrs)**

History of Microbiology: Spontaneous generation vs. biogenesis. Contributions of Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming. golden era of microbiology, Contributions of Martinus W. Beijerinck, Sergei N. Winogradsky, Selman A.Waksman in soil microbiology. Contributions of Paul Ehrlich,Elie Metchnikoff, Edward Jenner in medical microbiology. History, origin, development and evolution of viruses.

Unit – II (**08 Hrs)**

Sterelization and disinfection: Principles, Types and techniques of sterilization and disinfection. Physical sterilization (dry heat and moist heat), chemical sterilization, filtration and radiation sterilization, pasteurization, Disinfection and fumigation.

Unit – III (**06 Hrs)**

Culture media: Components of culture media, Preparations and types of culture media. Basal media, complex media, differential media, selective media. Indicator, enriched and transport media.

Unit – IV (**08 Hrs)**

Staining techniques: Nature and types of Stains. Principles, mechanism, method and types of staining Simple, Differential, Gram staining, Acid fast staining, Vital staining, negative staining. Staining for capsule, cell wall, endospore, inclusion bodies and flagella.

Unit – V (**10 Hrs)**

Pure culture techniques: Isolation of different microorganisms from different environments. Sample collection, preservation and enrichment. Different methods of isolation-pour plate, spread plate and serial dilution techniques. Metagenomics.

Maintenance and Preservation of microbial cultures: Slant culture, stab culture, soil culture, mineral oil overlaying, glycerol preservation and lyophilization. Type culture collection centres-Indian and global-ATCC, MTCC and NCIM etc.

Unit – VI **(12 Hrs)**

Microscopy and Lab equipments: Microscope and its modifications – Light, phase contrast and interference, Fluorescence, Confocal, Electron (TEM and SEM), Electron tunneling and AFM.

Working principle and operation of instruments used in microbiology laboratory- Autoclave, Laminar air flow system, Incubator, Hot air oven, Orbital shaker, pH meter, Spectrophotometer, Centrifuges, refrigerators, deep freezers.

References:

1. Jefreey C Pommerville, 2011, Fundamentals of Microbiology, Bartlett Series.
2. Roger Y. Stanier, 1987, General Microbiology, MacMillan Publ.
3. Lammart JM, 2006; Techniques in Microbiology – a student handbook, amzon.com.
4. Madigan MT et al, 2008; Brock – Biology of Microorganisms, amzon.com.
5. Atlas RM, 1995; Principles of Microbiology, Mosby Yearbook Missouri
6. Pelczar, Chan & Kreig, 1982; Microbiology, McGraw Hill Book Co, New York
7. Phylogenetic Identification and In situ detection of Individual Microbial Cells without Cultivation, Microbiological Reviews 59, 143-169.

MB-HCP 1.1. Practicals: (2 Credits)

1. Good laboratory practices and Safety practices.
2. Contributions of Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming.
3. Description and operation of compound microscope, use of oil immersion objective.
4. Study of aseptic techniques in Microbiology.
5. Cleaning and packing of glassware's by cotton plugging.
6. Study of Instrumentations used in Microbiology experiments.
7. Components of Microbial culture media, preparation of liquid and solid media: nutrient broth, nutrient agar, potato dextrose broth/agar, starch casein agar and broth.
8. Sterilization of glassware's and media.
9. Sample collection, preservation and enrichment.
10. Pure culture techniques (pour plate, spread plate and serial dilution technique).
11. Preparation of stains, smears and simple staining technique.
12. Maintenance of microorganisms. (stock culture and subculture)
13. Storage of microorganisms by glycerol stocks preparation.

References:

1. Handbook of Microbiological Media by Atlas R.L.
2. Manual of Clinical Microbiology by Lennettee E.H.
3. Manual of Clinical Microbiology by Murray PR.
4. A Laboratory manual of Microbiology: Microbes in action.

MB-HCT 1.2.MICROBIAL TAXONOMY **(4 credits)**

52 Hrs

Preamble: *This paper in the course is designed to introduce the fundamental taxonomy and biodiversity, and essential aspects of bacteriology, virology, Mycology, algalogy and protozooloy.*

Unit – I **(14 Hrs)**

Taxonomy of microbes: Biodiversity of microorganisms, types of biodiversity. The concept of microbial species. Microbial systematics, classification systems, major characteristics used nucleic acid, serology, chemical composition and phylogenetic mode of classification. Numerical taxonomy, cluster analysis and construction of taxonomy groups based on dendrograms, similarity matrix. International codes, rules, recommendations, construction of names in bacterial nomenclature and its role in taxonomy. Salient features of Bergy's Manual of Systematic Bacteriology. Taxonomy of viruses: Salient features of viral classification-Baltimore classification of viruses, ICTV, classification of viruses and phages.

Unit – II **(6 Hrs)**

General characteristics, classification and economic importance of Archaebacteria, Actinobacteria, cyanobacteria bioluminescent bacteria. General characteristics, growth, multiplication and life cycle of Mycoplasma, Rickettsiae and Chlamydia.

Unit – III **(6 Hrs)**

Morphology and ultra structure of Bacteria: Size, shape and arrangement - structure, chemical composition of cell wall of archaebacteria, gram-negative bacteria, gram-positive bacteria and acid fast bacteria, Fine structure, composition and function of cell membrane, capsule, flagella, pili, gas vesicles, ribosomes, mesosomes, reserve food materials, magnetosomes, phycobilisomes and nucleoid. Reproduction in Bacteria, Bacterial endospore formation, germination and induction of endospores.

Unit – VI **(12 Hrs)**

General Structure of viruses and phages. Configuration and symmetry of viruses- helical and icosahedral, Physical and chemical components - capsomere, capsid, matrix and envelop; Viral genome, nucleoprotein organization, multiplication of viral genomes. Translocation and distribution of viruses in plants; different modes of transmission of plant viruses - Structure and life cycle of some important plant viruses. Dissemination of animal viruses - direct and indirect contacts, through vectors; Structure and life cycle of some of the important animal viruses. Oncogenic viruses, satellite virus, satellite RNA, Prions, and viriods. Bacteriophages, cyanophages, mycophages and phycophages, replication of phages, significance and applications. Cultivation and detection of viruses and phages.

Unit – V (**8 Hrs)**

General Characteristics and classification of fungi with distinguishing characteristics up to class level, distribution of fungi. Fine structure of hypha, mycelium and yeast, structure and composition of fungal walls, plasma membrane, septa, cytoskeleton**.** Modes of nutrition, fungal adaptations for nutrient capture.

Reproduction in fungi: Vegetative reproduction, asexual reproduction, Sexual reproduction - planogametic copulation, gametangial contact, gametangial copulation, spermatogamy, somatogamy, reduction of sex in fungi. Economic importance of fungi: Life cycle of economically important yeasts and molds.

Unit – VI (**6 Hrs)**

General characteristics and classification of algae with distinguishing characteristics up to class level, economic importance of algae**.** General characteristics and classification of protozoa with distinguishing characteristics up to class level, economic importance of protozoan**.**

References;

1. Cook T. (2002) Microbial Biodiversity: Saving Bacteria to save ourselves, Harvard Science Review, 26-28.
2. W D Frost and E. F. McCampbell, 2010; Text Book of General Bacteriology, Bibliobazaar, Publ.
3. Bergey's Manual of Systematic Bacteriology. 9th Edn. Lippincott Williams, Wilkin Bacteriology.
4. A.J. Salle, 1974; Fundamental Principles of Bacteriology, Tata McGraw Hill Edition.
5. Brock Biology of Microorganisms by Madigan, Martinko and Parker. 2005 al Inc.
6. RC Dubey and D K Maheswari, A text book of Microbiology, S.Chand and company ltd.
7. A Mani et al Microbiology. SARAS publication.2017.

HCP 1.2. Practicals: (2 Credits)

1. Distrubution of microbes from air, soil and water samples and Cultural characteristics of bacteria, fungi and actinomycetes.
2. Aseptic transfer of bacteria, fungi and actinomycetes.
3. Differential staining: Gram staining and acidfast staining.
4. Special staining of endospores, capsule, flagella, volutin granules and glycogen granules.
5. Microbial motility tests by Hanging Drop method.
6. Biochemical tests for identification of Bacteria: Catalase, oxidase, IMViC, motility, gelatin test, urease, levan formed from glucose, H_2S in TSIA and lead acetate paper, coagulase, acid and gas from glucose, arabinose, inosital, lactose, maltose, mannitol, rhamnose, salicin, trehalose, sucrose, xylose, fructose, chitin, starch, casein, Tween 80 hydrolysis, pectin, arginine dehydrolysis, lysine decarboxylase, ornithine, esculin hydrolysis.
7. Staining of Fungi by lacto phenol cotton blue
8. Study of spores of Fungi/actinomycetes by slide culture technique.
9. Isolation of fungi from soil: Dilution plate method or warcup method or stamping method.
10. Isolation of Epiphytic and endophytic fungi by washing method or implant method or impression method or maceration method.
11. Isolation of bacteriophages from sewage.
12. Isolation of plant viruses from sap.
13. Isolation and identification of microscopic algae and protozoa from soil and water

References:

1. Handbook of Microbiological Media by Atlas R.L.
2. Manual of Clinical Microbiology by Lennettee E.H.
3. Manual of Clinical Microbiology by Murray PR.
4. A Laboratory manual of Microbiology: Microbes in action.

MB-HCT 1.3. BIOCHEMISTRY **(4 credits)**

52 Hrs

Preamble: *This is an interdisciplinary course which involves basic essentials of fundamental biochemistry of Amino acids, proteins, carbohydrates and lipids and its metabolism.*

Unit – I **(8 Hrs)**

Aqueous solutions and acid base chemistry: Structure and properties of water molecule. units of expressing and inter-converting concentration of solutions: molarity, moles, normality, osmolarity, molality, mole fraction, Bronsted Concept of conjugate acid – conjugate base pairs, ionization of solutions, pH, titration curves.

Buffers: preparation, action and their use in Biology, Henderson-Hasselbalch equation, buffer capacity, polyproteic acids, amphoteric salts, ionic strengths.

Unit – II **(14 Hrs)**

Biomolecules:

Structure and function of protein and peptide bond, classification, Ramachandran plot, factors determining secondary, tertiary structures: amino acid sequence, thermodynamics of folding, role of disulfide bonds, dynamics of globular protein folding, chaperonins, motifs and domains, protein families, protein stability, prediction of secondary and tertiary structure, protein-protein interactions.

Structure and function of Amino acids: Classification and stereochemistry, biochemical information of amino acid sequence, derivative, ionization.

Structure and function of Carbohydrates; classification, stability of glycosidic bond, glycoconjugates, proteoglycans, glycoprtoeins, glycolipids, homopolysaccharide folding, functions of oligosaccharides.

Structure and function of Lipid classification, structure of lipids in membranes, glycerolipids, ether lipids, galactolipids, sulfolipids, lipids in archaebacteria, sphingolipids, terpenes, isoprenoids, Functions of lipids, signals, cofactors, pigments.

Structure and function of Nucleic acids.

Unit – III **(4 Hrs)**

Bioenergetics: Free energy, Enthalpy, Entrophy, Classification of High energy compounds, Redox potential, Laws of thermodynamics. Metabolism –Catabolism and anabolism, catabolic, anabolic and amphibolic pathways.

Unit – IV (**10 Hrs)**

Carbohydrate and lipid metabolism: Glycolysis, regulation. Glycogenesis, glycogenolysis, gluconeogenesis, regulations; TCA cycle, regulations. Amphibolic nature of TCA cycle. HMP shunt.

Fatty acid oxidation (β-oxidation), energetics of palmitic acid oxidation. Ketone bodies, ketogenesis, Ketonemia, ketonuria, ketosis, extra mitochondrial biosyntheses of long fatty acids (palmitate) and regulation. Synthesis of triacylglycerols, metabolism of phospholipids and glycolipids. Biosynthesis and degradation of cholesterol.

Unit – V (**8 Hrs)**

Metabolism of amino and nucleotide metabolism: Transamination, deamination, decarboxylation; Urea cycle - regulation.

Metabolism of ammonia; Synthesis and degradation of Glycine, phenylanine and Tyrosine, Synthesis and degradation of Sulfur containing amino acids.

Unit – VI (**8 Hrs)**

Nucleotide metabolism of IMP, AMP and GMP, Salvage pathway for purines, degradation of purine nucleotides. Biosynthesis and degradation of pyrimidine nucleotides.

References

1. Biochemical calculations, Segel I.R., John Wiley and Sons, 1995
2. Biochemistry 3rd edition, Mathew, Van Holde and Ahern , Pearson Education
3. Principles of Biochemistry, 4th edition, Zubay, G., Wm.C. Brown Publishers, 1998 Principles of Biochemistry.
4. Lehninger A.L., Cox and Nelson, CBS publishers and Distributors Pvt. Ltd. 1994
5. Microbial Biochemistry by GN Cohen 2011, Springer Biotechnology H.J. Rehm and G. Reed (ed.), Volume 6a.

MB-HCP 1.3. Practicals: **(2 Credits)**

1. Qualitative and Quantitative analysis of Carbohydrates.
2. Qualitative and Quantitative analysis of Proteins.
3. Qualitative and Quantitative analysis of Amino acids.
4. Qualitative and Quantitative analysis of Nucleic acids.
5. Estimation of sugars by DNS method.
6. Estimations of proteins by Biuret method.
7. Estimation of ascorbic acid.
8. Determination of Iodine value of oils.
9. Estimation of cholesterol.

References:

1. Hawk's physiological chemistry Ed. by Oser (Mc Graw Hill).
2. Biochemical methods By Sadasivam and Manikam (Wiley Eastern limited).
3. An introduction to practical biochemistry by D.T.Plummer (Mc Graw Hill).
4. Laboratory manual in Biochemistry by J.Jayaraman (Wilety Eastern limited).
5. Biochemistry - a laboratory courses by J.M.Beckar (Academic Press).

MB-SCT 1.1. INSTRUMENTATION AND TECHNIQUES IN BIOLOGY (4 credits)

52 Hrs

Preamble: This paper gives a wide exposure not only to microbiologists but also the other disciplines of life sciences. It gives a wide knowledge of different types of instruments and techniques involved in life sciences.

Unit – I (**10 Hrs)**

Electron microscopy and 3D image processing for Life sciences: Localization of macromolecules using electron microscopy. Principles of image formation, Fourier analysis, Contrast Transfer Function and point spread function. Advanced sample preparation, imaging, data collection techniques of bio-molecules by negative staining and cryo-electron microscopy. Theoretical, computational and practical aspects of various advanced 3D image processing techniques.

Unit – II (**10 Hrs)**

Spectroscopy Techniques : UV, Visible and Raman Spectroscopy; Theory and application of Circular Dichroism; Fluorescence; MS, NMR, PMR, ESR and Plasma Emission spectroscopy– Principles of IR spectroscopy, vibrational spectra of biopolymers, Fourier transform of Infra Red spectroscopy, Instrumentation.

Unit – III (**6 Hrs)**

Centrifugation: Basic principles; Types of centrifuges - Micro centrifuge, High speed & Ultracentrifuges; Preparative centrifugation; Differential & density gradient centrifugation; Applications; Analytical centrifugation, Ultra centrifugation.

Unit – IV (**8 Hrs)**

Radioactive & stable isotopes : Units and measurement of radioactivity, Geiger-Muller counter; Solid & Liquid scintillation counters; Autoradiography; Measurement of stable isotopes; Radiotracer techniques; Distribution studies; Isotope dilution technique; Metabolic studies; Clinical application; Radioimmunoassay.

Unit – V (**8 Hrs)**

Techniques in Molecular biology : Polymerase chain reaction, RT-PCR, Principles and techniques of nucleic acid hybridization and Cot curves, Theory and application of agarose gel electrophoresis; Capillary electrophoresis; 2D electrophoresis; Disc gel electrophoresis; Gradient electrophoresis; Pulsed field gel electrophoresis. Southern and Northern blotting techniques.

Unit – VI (**10 Hrs)**

Techniques in Protein purification: Chromatography Techniques - TLC and Paper chromatography; Gel permeation, Ion exchange, Hydrophobic, Reverse-phase and Affinity chromatography; HPLC and FPLC; Criteria of protein purity.
Theory and application of Poly acryl amide gel electrophoresis. SDS PAGE, NATIVE PAGE with tricine, tris acetate, and tris glycine gels, Blue native PAGE, Isoelectro focusing, Western blotting technique and MADI-TOFF.

References:

1. Berg, J. M., Tymoczko, J. L. and Stryer, L.(2006) Biochemistry. Freeman, New York.
2. Nölting, B. (2006) Methods in modern biophysics. Second Edition. Springer, Germany.
3. Wilson Keith and Walker John (2005) Principles and Techniques of Biochemistry and Molecular Biology, 6th Ed. Cambridge University Press, New York.
4. Horst Friebolin, Basic One-and Two-Dimensional NMR Spectroscopy (Fourth Edition), Wiley-VCH.Claridge, T.D., W, High Resolution NMR Techniques in Organic Chemistry, Volume27, Second Edition.
5. John J. Bozzola and Lonnie D. Russell (1992). Electron Microscopy (Jones & Bartlett Publishers).
6. Ray F. Egerton (2005). Physical Principles of Electron Microscopy: An Introduction to TEM, SEM, and AEM (Springer).

MB-SCT 1.2. COMPUTER APPLICATION AND BIO STATISTICS. (4 credits)

52 Hrs

***Preamble**: This paper gives a wide exposure not only to microbiologists but also the other disciplines of life sciences who choose this paper. It gives a wide knowledge of computer applications and quantitative analysis of biological data in life sciences.*

Unit – I (**10 Hrs)**

Introduction to Computers, Anatomy of Computers, Memory Concepts, Units of Memory, Types of memory; primary RAM, ROM, PROM, EPROM, EEPROM and secondary Floppy, hard disc, c band, DVD, video terminals, OMR, OCR, Printers and scanners.

Unit – II (**10 Hrs)**

Operating system: Introduction, definition and types; DOS; UNIX, Linex, MS-Office. Applications of MS-Office for creating, Editing and Formatting a Document, Data presentation, tabulation and graph creation statistical analysis, mathematical expression, Database, concepts and types, creating database, Internet and World Wide Web, Concepts, components and creation of web HTML, XML coding.ICT for Data collection, formation of development programmes, monitoring and evaluation of programmes.

Unit – III (**10 Hrs)**

Biostatistics: Descriptive Statistics, Testing of Hypothesis- I, Testing of Hypothesis – II, Introductory Biostatistics, Probability and Probability Distributions, Data and its nature; data representation; diagrams and graphs using MSExcel,

Unit – IV (**10 Hrs)**

Measures of Central tendency; Dispersion, Swekness and Kurtosis; Binomial and Normal Distributions. Test of significance, Designing of Experiments, Modeling in Biology. Numbers, variables (independent, dependent and continuous), Definition of Mathematical Function: linear, geometric and exponential functions; differentiation and integration of simple functions, graphs, plots.

Unit –V (**8 Hrs)**

Softwares used in analysis of data by ANOVA, Response surface methodology, and Randomized complete block design with examples of field experiments, production studies, regeneration experiments in tissue culture.

Unit – VI **(4 Hrs)**

Statistical Packages for environmental data: SPSs, MVSP, SAS mini tab, Graph Pad.

References:

1. Snedecor, W and G. Cochran, 1967. Statistical Methods. Oxford and IBH Publishing Co. Calcutta
2. Rosner, B. 1986. Fundamentals of Biostatistics. Duxbury Press, Boston.
3. Ford, E.D. 2000. Scientific methods for Ecological Research. Cambridge University Press, Cambridge.
4. Zar, J. H. 1974. Biostatistical Analysis. Prentice-Hall, Inc Englewood Cliffs, New Jersey.

SEMESTER II

MB-HCT 2.1.MICROBIAL PHYSIOLOGY AND ENZYMOLOGY (4 credits)

52 Hrs

Preamble: *The students of M.Sc are supposed to study and assimilate the nature of microorganisms through their growth parameters, nutritional requirements fermentation reactions and types of fermentation. The candidate is supposed to know different physiological processes governed by microorganisms having tremendrous metabolic diversities which influence the small creatures with different environmental conditions.*

Unit – I (**8 Hrs)**

Classification of microbes based on their physical adaptation. Classification of organisms based on nutritional sources such as Carbon source, energy source and electron source, macro and micronutrients. Microbial growth: Phases of growth, growth curve, physical and nutritional factors affecting the growth, Continuous and Synchronous growth, Measurement of growth by direct and indirect method.

Unit – II (**8 Hrs)**

Microbial Photosynthesis: Light Energy, Photolysis of Water, Photosynthetic Pigments, Cyclic and Non-Cyclic Photophosphorylation, Calvin's Cycle.

Fermentation Reaction: Homo and Heterofermentation pathways; Alcohol and Lactic acid fermentation pathways.

Biological Oxidation: Electron Transport System, Oxidative Phosphorylation, Inhibitors and mechanism of oxidative phosphorylation.

Unit – III (**10 Hrs)**

Signaling and stress. Introduction to two component signaling systems: i. Response by facultative anaerobes to anaerobiosis, nitrate and nitrite, nitrogen supply, inorganic phosphate supply. ii. Effect of oxygen and light on the expression of photosynthetic genes in purple photosynthetic bacteria, response to osmotic pressure and temperature, response to potassium ion and external osmolarity, response to carbon sources.

Bacterial response to environmental stress, Heat shock response. Repairing damaged DNA, the SOS response, oxidative stress, Synthesis of virulence factors and quorum sensors, chemo taxis, photo responses, aero taxis. Quorum sensing: Myxobacteria, Caulobacter, bioluminescence systems similar to LuxR/LuxI in nonluminescent bacteria, biofilms.

Unit – IV (**10 Hrs)**

Enzymes: classification of enzymes, Factors influencing enzyme activity –pH, temperature, substrate concentration and enzyme concentration.

Enzyme Kinetics: Michaelis – Menton equation, Line weaver- Burk plot, Haldane and Briggs equation. K_m and V_{max}, enzyme turnover, Mechanism of enzyme action- lock & key and induced fit model; Specificity-reaction and substrate specificity; acid base catalysis, covalent catalysis and metal ion catalysis.

Unit – V (**8 Hrs)**

Enzyme Activation and Regulation: enzyme activation, enzyme activators and allosteric enzymes (Threonine dehydratase and aspartate transcarbomylase); covalently modulated enzymes (Glycogen phosphorylase); multienzyme complex (PDH and fatty acid synthase) and membrane bound enzymes (ATPase).

Unit – VI (**8 Hrs)**

Enzyme Inhibition: Concept of enzyme inhibition; types of enzyme inhibitors-reversible, competitive, non-competitive, uncompetitive and irreversible; significance and applications of enzyme inhibitors.

Isoenzymes: Definition and significance and applications of isoenzymes. Lactate dehydrogenase, creatine phosphokinase, alcohol dehydrogenase, alkaline phosphatase and isocitrate dehydragenase. Principles of enzyme stabilization; methods of enzyme stabilization.

Reference Books:

1. Stryer L, 1995; Biochemistry, Freeman and Company, New York.
2. Voet & Voet, 1995; Biochemistry, John Wiley & Sons, New York.
3. Nelson & Cox, 2000; Lehninger's Principles of Biochemistry, Elsevier Publ.
4. Freifelder D, 1982; Physical Biochemistry, Freeman & Co. New York.
5. Harper, 1999; Biochemistry, McGraw Hill, New York.
6. Colowick S P and Kaplan N D, 1955; Methods in Enzymology. Vol. I. Academic Press.
7. Sualter C H, 1985; Practical Guide to Enzymology. John Wiley & Son.
8. Price & Steeves, Fundamentals of Enzymology

MB-HCP 2.1. Practicals: **(2 Credits)**

1. Culturing and cultural characteristics of microorganisms:
   i. Autotrophic - Benecks broth, Chu‟s medium
   ii. Heterotrophic -Nutrient agar, glucose peptone media.
2. Isolation of Thermophiles, acidophiles, basophiles and halophiles
3. Isolation of aerobic, facultative aerobic, anaerobic and microaerophilic microbes.
4. Micrometry and cell measurement- Use of ocular and stage micrometer, cell count (haemocytometer, Bacterial cell- *Bacillus subtilis*), fungal cell (Saccharomyces) and human blood cell).
5.
   A. Bacterial growth measurement by viable count of bacteria by serial dilution, turbidity measurements of growth by UV visible spectrophotometer. OR
   B. Bacterial growth measurement by Microscopic count by petroff Hauser method.
   C. Bacterial and Fungal growth measurement by Dry weight and wet weight mass determination. OR
   D. Growth measurement of fungi/actinomycetes- linear and biomass.
6. Effect of heat stress and osmotic stress of bacteria /fungi.
7. Study of phototaxis in *Dictyostelium*
8. Extraction of extracellular and intracellular enzymes.
9. Partial Purification of amylase/protease/lipase by ammonium salt precipitation and dialysis.
10. partial Purification of amylase/protease/lipase by column y/ion exchange chromatography
11. Determination of activity and specific activity of enzymes.
12. Effect of PH, Temperature, substrate concentration, enzyme concentration, inhibitor on enzyme activity of amylase/ protease/lipase.

References:

1. Wilson, K. and Walker, J. (1994). Practical Biochemistry. 4th Edition, Cambridge University Press, England.
2. Sawhney, S.K. and Singh, R. (2000). Introductory Practical Biochemistry, Narosa Publishing House, New Delhi.
3. Dubey, R.C. and Maheswari, D.K. (2002). Practical Microbiology. S. Chand & Co. Ltd., New Delhi.
4. Plummer, D.T. (1988). An Introduction to Practical Biochemistry. 3rd Edition, Tata Mc GrawHill, New Delhi.
5. Jaya Babu (2006). Practical Manual on Microbial Metabolisms and General Microbiology. Kalyani Publishers, New Delhi.
6. Gopal Reddy, M., Reddy, M.N., Saigopal, DVR and Mallaiah, K.V. (2007). Laboratory Experiments in Microbiology, .Himalaya Publishing House.

MB-HCT 2.2. MICROBIAL GENETICS (4 credits)

52 Hrs

Preamble: *Microbial Genetics is an important tool in dissecting the genetic structure of an organism. The basic principles presented in this paper is of major importance in constructing new organisms for practical applications leading to research in Genetic recombination and genetic engineering.*

Unit – I (**08 Hrs)**

Microbial Genetics: Definition and scope of Genetics. Premendelian genetic concepts – Preformationism, Epigenesis, Inheritance of acquired characters, traits, Germplasm theory. Hereditary and Environment, Genotype and Phenotype. Microbes as genetic tools for genetic studies.

Unit – II (**08 Hrs)**

Viral Genetics: General characteristics of viral genome, T4 virulent Phage- Structure- life cycle. Lambda temperate phage- Structure - Lytic and lysogenic cycle, Lysogenic repression. Genetic mapping of viruses, Recombination in viruses; Genetics of Bacteriophage.

Unit – III (**10 Hrs)**

Bacterial Genetics: Organization of genetic material in bacteria, Gene transfer mechanisms, Conjugation, Transformation and Transduction. Recombination in bacteria. Natural transformation systems- *Streptococcus pneumonia* and *Haemophilus influenzae*. Transfection and forced competence. Bacterial Conjugation- Properties of the F plasmid, F+ x F - mating, F' x F-conjugation. Transduction- Generalized and specialized transduction, Drug resistance in bacteria.

Unit – IV (**10 Hrs)**

Fungal Genetics: Features and consequences of heterothallism, homothallism, mating types, Vegetative incompatibility, Polyploidy and aneuploidy. Neurospora- Tetrad analysis and linkage detection - 2 point and 3 point crosses – Induction of Mutations - Mitotic recombination in Neurospora – Transposable elements - Gene conversion. Yeast plasmids, Mating type, genetics of yeast.

Unit – V (**8 Hrs)**

Gene Regulation and expression: Operon concept, Repression of the lac operon, Regulation of tryptophan biosynthesis operon by attenuation, catabolite repression instability of bacterial RNA, positive and negative regulation, inducers and co-repressors.

Negative regulation - *E. coli* lac operon; Regulation of the heat-shock regulon by an alternate sigma factor, two component regulatory systems.

Unit – VI (**8 Hrs)**

Mutations: Types of mutations, null, leaky, and conditional mutations, mutations as random or adaptive events; Mutants – isolation, selections, screening and enrichments, Uses of mutants. Mutagenic agents – physical, chemical and biological; molecular basis of mutations; Reversion and suppression - Reversion assays –Ames Test.

References:

1. Larry Snyder and Wendy Champness. Molecular Genetics of Bacteria. 3rd edition, ASM Press, Washington, D.C. 2007
2. Baumberg. S. Prokaryotic gene expression. Oxford University Press. 2002.
3. Daniel L. Hartl. Essential Genetics. A genomics perspective, 5th edition, 2009.
4. Jeremy W. Dale and Simon F. Park. Molecular Genetics of Bacteria. 2010.
5. Nancy Trun and Janine Trempy. Fundamental Bacterial Genetics. Wiley-Blackwell
8. Watson. J. D, Baker. T. A, Bell. S. P, Gann. A, Levine. M, Losick. R.
9. Molecular Biology of Gene. 5th Edn. The Benjamin / Cummings Pub. Co. Inc, 2003.
10. William Hays, 1980; The genetics of bacteria and their viruses, CBS Publ. New Delhi
11. Jenkins JB, 1995; Genetics, Houghton Mifflin Co., Boston.
12. Strickberger MW, 1990; Genetics MacMillan Publ. Co. Inc. New York.
13. Stent GS & Calendar R, 1978; Molecular Genetics, Freeman & Co., San Francisco.
14. Benjamin Lewin, 2005, Genes - VIII, John Wiley & Sons, New York
15. Watson JD et al, 2004; Molecular biology of the Gene, Pearson Education India
16. Hartwell LH et al, 2000; Genetics – from Genes to Genomes, McGraw Hill Publ.,

MB-HCP 2.2 Practical **(2 Credits)**

1. Preparation of competent cells and genetic transformation of DNA
2. conjugation in *E.coli*
3. Blue white screening
4. Induction of mutation in *Neurospora* or *Aspergillus* or yeast
5. Study of yeast plasmids
6. Isolation of plasmid DNA.
7. Colorimetric estimation of DNA by Diphenyl amine method.
8. Colorimetric estimation of RNA by Orcinol method

References:

1. Dubey, R.C. and Maheswari, D.K. (2002). Practical Microbiology. S. Chand & Co. Ltd., New Delhi.
2. Plummer, D.T. (1988). An Introduction to Practical Biochemistry. 3rd Edition, Tata Mc GrawHill, New Delhi.
3. Reddy, S.M. and Reddy, S.R. (1998). Microbiology – Practical Manual, 3rd Edition, Sri Padmavathi Publications, Hyderabad.
4. Jaya Babu (2006). Practical Manual on Microbial Metabolisms and General Microbiology. Kalyani Publishers, New Delhi.
5. Sashidhara Rao, B. and Deshpande, V. (2007). Experimental Biochemistry: A student Companion. I.K. International Pvt. Ltd.
6. Gopal Reddy, M., Reddy, M.N., Saigopal, DVR and Mallaiah, K.V. (2007). Laboratory Experiments in Microbiology,Himalaya Publishing House, Mumbai.

MB-HCT 2.3.MOLECULAR CELL BIOLOGY (4 credits)

Preamble: *Molecular cell biology course is useful study for post graduate students Inorder to study the structure and function of eukaryotic and prokaryotic cells at molecular level.*

52 Hrs

Unit-I (10 Hrs)

Cell: Structure and functions of cell wall, cell membrane, nucleus, lysosome, ER, ribosome, plastids, mitochondria, Golgi bodies. Cytoskeletons and cell movements-Microtubules, microfilaments and intermediate elements, motor proteins. Cell cycle- Regulation of CDK-cyclin activities, molecular basis of cellular check points. Cell to cell signaling and communication.

Unit-II (10 Hrs)

Genomic structure and organization in bacteria and eukaryotes. Euchromatin and heterochromatin, repetitive and non- repetitive DNA, C-value paradox. Nucleosome model, telomere, centromere and kinetochore, Interrupted genes, gene clusters.
Gene, genetic code, Elucidation and salient features of genetic code, wobble concept, Central dogma.
Replication of DNA, evidence of semi-conservative replication. Mechanism and enzymology of DNA replication. Regulation of DNA replication. Replication of RNA.

Unit – III (8 Hrs)

Transcription and Post transcriptional modifications: Biosynthesis of RNA in prokaryotes and eukaryotes, DNA dependent RNA polymerase, initiation, elongation and termination of transcription. Removal of intron transcripts, addition of 5’ cap and 3 poly A tail, processing of mRNA, rRNA and tRNA. Reverse transcription.

Unit – IV (8 Hrs)

Translation and post translation modifications: Involvement of ribosome in translation, ribosome structure, initiation, elongation and termination of polypeptide chain synthesis in prokaryotes and eukaryotes, extra ribosomal factors, ribosome cycle, post translation modifications of proteins.

Unit – V (6 Hrs)

Systems that safeguard DNA: DNA repair mechanisms – photo reactivation, mismatch repair, recombination repair, SOS repair, DNA restriction and modification.

Unit – VI **(10 Hrs)**

Transposable elements, Insertion sequences, transposons, and integrons. Replicative transposition, Nonreplicative transposition, Excision and transposase-mediated rearrangements, Regulation of transposition, Use of transposons. Chromosomal rearrangements, Transposons and evolution.

Gene silencing: Transcriptional – genomic imprinting, paramutation, transposon silencing, histone modifications, position effect; Post transcriptional – RNA interference, RNA silencing.

References:

1. De Robertis E. D. P. and De Robertis E. M. F. (1987), Cellular and Molecular Biology Lea and Febiger, Philadelphia.
2. Nelson D. L. and Cox M. M. (2005) Lehninger's Principles of Biochemistry, Fourth edition, W. H. Freeman & Co. New York.
3. Molecular Biology of Gene. 5th Edn. The Benjamin / Cummings Pub. Co. Inc, 2003.
4. Watson JD et al, 2004; Molecular biology of the Gene, Pearson Education India.

MB-HCP 2.3: Practical **(2 Credits)**

1. Study of mitosis and meiosis.
2. Isolation and Extraction of genomic DNA.
3. Problems related to DNA and RNA characteristics, Transcription and Translation.
4. Qualitative and quantitative estimation of nucleic acids by UV spectrophotometry.
5. Amplification of DNA
6. Digestion of plasmid DNA with restriction endonucleases.
7. Ligation of DNA fragments.
8. Separation of DNA fragments by Agarose gel electrophoresis.
9. Elution of DNA from agarose gels.
10. Cloning of green fluorescent protein.

References:

1. Molecular Cloning: A laboratory manual Vols. 1-3, Sambrook, J.
2. Sawhney, S.K. and Singh, R. (2000). Introductory Practical Biochemistry, Narosa Publishing House, New Delhi. 5. Dubey, R.C. and Maheswari, D.K. (2002). Practical Microbiology. S. Chand & Co. Ltd., New Delhi.
3. Plummer, D.T. (1988). An Introduction to Practical Biochemistry. 3rd Edition, Tata Mc GrawHill, New Delhi.
4. Reddy, S.M. and Reddy, S.R. (1998). Microbiology – Practical Manual, 3rd Edition, Sri Padmavathi Publications, Hyderabad.
5. Jaya Babu (2006). Practical Manual on Microbial Metabolisms and General Microbiology. Kalyani Publishers,New Delhi.
6. Sashidhara Rao, B. and Deshpande, V. (2007). Experimental Biochemistry: A student Companion. I.K. International Pvt. Ltd.
7. Gopal Reddy, M., Reddy, M.N., Saigopal, DVR and Mallaiah, K.V. (2007). Laboratory Experiments in Microbiology, Himalaya Publishing House, Mumbai.

MB-SCT 2.1.GREEN NANOTECHNOLOGY **(4 credits)**

52 Hrs

Preamble: *The course is mainly focused on the brief introduction, biological synthesis and applications of nanotechnology*

Unit – I (**10 Hrs)**

Introduction to Nanotechnology: Definition of nano, Scientific revolution-Atomic Structure and atomic size, emergence and challenges of nanoscience and nanotechnology, carbon age-new form of carbon (CNT to Graphene), influence of nano over micro/macro, size effects and crystals, large surface to volume ration, surface effects on the properties, nano particles, approaches for nano scale structure, Properties of the nanoparticles, types of nanoparticles.

Unit – II (**6 Hrs)**

Types of nanostructure and properties of nano materials: One dimensional, two dimensional and three dimensional nanostructured materials, Quantum Dots shell structures, metal oxides, semiconductors, composites, mechanical-physical-chemical properties.

Unit – III (**6 Hrs)**

Synthesis of nanoparticles; approaches to synthesis, mechanisms involved in biogenic nanoparticle synthesis. Green synthesis of nanoparticles bacterial biosynthesis, fungal and yeast synthesis, plant and plant extracts for biosynthesis, waste mediated synthesis of nanoparticles.

Unit – IV (**12 Hrs)**

Instruments used in nanoparticle detection: Characterization Techniques, Diffraction analyses: X-ray diffraction, powder diffraction, lattice parameters, structure analyses, strain analyses, phase identification, particle size analyses using - Scherer`s formula - X-ray photoelectron spectroscopy (XPS) - Auger electron spectroscopy (AES). Surface Imaging: Scanning Electron Microscope (SEM), Field Emission Scanning Electron Microscope (FESEM)-Atomic Force Microscopy (AFM), Scanning Tunneling Microscopy (STM), Transmission Electron Microscopy (TEM).

Spectroscopic techniques: Infra red spectroscopy (IR) Rotational & Vibrational UV-visible - Raman Spectroscopy- Photoluminescence (PL) – Cathodeluminescence (CL).

Unit – V (**6 Hrs)**

Biosensors and nanosensors: Introduction to sensors. Micro and nano-sensors, Fundamentals of sensors, Biosensors: Principles and types, Fabrication of biosensor devices, Detection in Biosensors. Micro fluids, Packaging and characterization of sensors, Gas, Organic and inorganic nanosensors, Bioelectronics, Nanoparticle biomaterial hybrid systems for sensing applications.

Unit – VI (**10 Hrs)**

Applications of nanoparticles: nanobiofertilizers and pesticides, nano-agriculture and microcapsule designs, DNA nanocapsule. Assessing nanotechnology for enhanced food security in India. Nanoparticles based smart delivery systems. Applications of nanotechnology in seed science and detoxification of herbicide residues. Applications of nanoparticles in environmental remediation and water treatment. Nanotechnology based water treatment strategies. Nanoporous polymers and their applications in water purification, nanotoxicology. Use of nanoparticles in medicine.

References:

1. Chemistry of nanomaterials: Synthesis, properties and applications by CNR Rao et.al.
2. Nanoparticles: From theory to applications – G. Schmidt, Wiley Weinheim 2004.
3. Instrument E L Principe, P Gnauck and P Hoffrogge, Microscopy and Microanalysis (2005), 11: 830- 831, Cambridge University Press.
4. Processing & properties of structural naonmaterials - Leon L. Shaw, Nanochemistry: A Chemical Approach to Nanomaterials, Royal Society of Chemistry, Cambridge, UK 2005.

MB-SCT 2.2.BIOINFORMATICS **(4 credits)**

52 Hrs

Preamble: *Bioinformatics is a dry lab where in the students learn the usage of softwares for biological data bases and predictions for understanding the developments in the fields of life science and to make further advancements in the field of biological research.*

Unit – I (**10 Hrs)**

Introduction to Bioinformatics: Overview, Internet and bioinformatics, Applications, Databases: Databases in Bioinformatics, various biological databases, Protein and Nucleotide sequence Data bases. Protein sequence, structure and Classification databases. Sequence analysis: Pairwise alignment, local and global alignment, Scoring matrices, multiple sequence alignment, tools for sequence alignment, programming algorithms.

Unit – II (**8 Hrs)**

Gene prediction: Gene structure in Prokaryotes and Eukaryotes, Gene prediction methods: Neural Networks, Pattern Discrimination methods, Signal sites Predictions, Evaluation of Gene Prediction methods.

Unit – III (**8 Hrs)**

Transcriptomics: Complete transcript cataloguing and gene discovery- sequencing based approach, Microarray based technologies and computation based technologies. RNA secondary structure prediction.

Unit – IV (**8 Hrs)**

Protein Computational Biology: Structural classification of proteins, Protein structure analysis, structure alignment and comparison, Secondary and tertiary structure prediction and evaluation, prediction of specialized structures, Active site prediction, Protein folding, Protein modeling and drug design.

Unit – V (**8 Hrs)**

Tools in Bioinformatics: Protparam, Translate, Bioedit, findmod, Coils, TMHMM, Rasmol, Deepview.

Unit – VI (**10 Hrs)**

Genomics: Comparative Genomics. Proteomics: Types of proteomics, tools for proteomics-separation and isolation of proteins, acquisition of protein structure information, databases and applications. Phylogenetic analysis: molecular basis of evolution, Phylogenetic trees & different methods for phylogenetic inference.

References:

1. Bioinformatics: A Beginners Guide, Clavarie and Notredame
2. Bioinformatics: David Mount
3. Bioinformatics: Rastogi
4. Introduction to Bioinformatics:Arthur M. Lesk
5. Bioinformatics: Principles and applications, Ghosh and Mallick
6. Bioinformatics: Genes, Proteins and Computer, C A Orengo
7. Protein Structure Prediction: Methods and Protocols, Webster, David (Southern Cross Molecular Ltd., Bath, UK.

MB-OET 2.1: MICROBIAL DIVERSITY **(4 credits)**

52 Hrs

Preamble: *This paper in the course is designed to introduce the biodiversity of microbes such as bacteria, virus, fungi and their importance ,conservation of microorganisms.*

Unit – I **(10 Hrs)**

Microbial World: Concepts and Scope: Types of diversity: Morphological, Structural, Metabolic, Biological, Ecological and Evolutionary diversity (Genetic diversity) of microbial world. B) Classifying and Naming Microorganisms: Classification systems, ICNB Rules, Major Characteristics used to Classify Microorganisms.

Unit –II **(10Hrs)**

Viral Diversity: Classification of viruses, Group I – T2 Bacteriophage, Group II – Banana bunchy top virus, Group III – Reovirus, Group IV- TMV, Group V – Rhabdovirus, Group VI – HIV, Group VII – Hepatitis virus. Sub-viral particles: Discovery, Structure, Classification, replication and diseases caused by Satellite, Satellites virus, Virusoids, Viroids and Prions.

Unit –III **(12Hrs)**

Bacterial Diversity: Archaebacteria, Photosynthetic Eubacteria, Chemoautotrophic and Methophilic Eubacteria, Gliding Eubacteria, Spirochetes, Rickettsiae and Chlamydiae, Actinomycetes, Mollicutes, Protists. Classification based on Bergey's manual (Determinative & Systematic).

Unit- IV **(10 Hrs)**

Fungal Diversity: Classification, Distribution, Importance, Structure, reproduction and general
characteristics of the fungal divisions: Zygomycota (*Rhizopus*), Ascomycota (*Neurospora*), Basidiomycota (*Agaricus*), Deuteromycota (*Penicillium*), Chytridiomycota (*Allomyces*), Myxomycota and Yeast.

Unit-V **(10 Hrs)**

Importance and Conservation of Microbial Diversity: Importance of microbial diversity in agriculture, forestry, environment, industrial & food biotechnology, animal & human health.
metagenomics. Importance of conservation. *In situ* conservation and *Ex situ* conservation. Roleof culture collection centers in conservation.

References:

1. Alexopoulos, C. J. and Mims, C. W. 1979. Introductory Mycology. III edition, Wiley Eastern,New Delhi.
2. Dimmock, N. J., Easton, A. J. and Leppard, K. N. 2001. Introduction to Modern Vorology. 5thedn. Blackwell publishing, USA.
3. Ghosh, A. 2003. Natural Resource Conservation and Environment Management. Aph PublishingCorp. Calcutta.
4. Landecker, E. M. 1972. Fundamentals of Fungi. Prentice-Hall, Angelwood Cliff, New Jersey.
5. Madigan M.T., Martinko M. J. and Parker, J. 2003. Brock Biology of microorganisms. Pearson education., New Jercy.
6. Pelczar, (Jr.) M. J., Chan, E. C. S. and Kreig, N. R.1993. Microbiology. McGraw Hill, New York.
7. Perry, J.J. and Staley, J.T. 1997. Microbiology. Dynamics and Diversity. 4th edn. Wesley
   Longman pub. New York.
8. Presscott, L. M., Harley, J. P. and Klein, D. A. 1999.Microbiology. 4th edn. WCB Mc Graw-Hill, New Delhi.Satyanarayana, T. and Johri, B. N. 2005.
9. Microbial Diversity – Current Perspectives andPotential Applications. I K Int. Pvt. Ltd. New Delhi.
10. Stainer, R. Y., Ingraha, J, L, Wheelis, M. L. and Painter, P. K. 1986. General Microbiology. McMillan Edun. Ltd. London.
11. Stanley J.T. and Reysenbach A.L.1977. Biodiversity of microbial life. John Wiley 7 Sons Inc.Publication. New York.

MB-OET 2.2. MICROBIAL TECHNOLOGY (4 credits)

52 Hrs

Preamble: The OET course in microbial technology provides knowledge in applications of microorganisms in various industries such as pharmaceutical, food and beverage industries.

Unit – I (**12 Hrs)**

General concept of Microbial technology and Fermentation economics. Microbial production of Antibiotics: penicillin, Streptomycin, Enzymes: proteases, amylases Organic acids: Citric acid, acetic acid

Unit – II (**10 Hrs)**

Microbial production of Amino acids: Glutamic acid, Lysine, Industrial Alcohol, Beer and Wine, Vitamins: Vit B_{12}, B_2 and Ergot alkaloids.

Unit – III (**10 Hrs)**

Biotransformation of steroids. Production of single cell protein from bacteria, fungi and algae: Nutritional value and safety. Edible Mushrooms: Cultivation of edible and medicinal mushrooms, Single cell oil, Bioplastics.

Unit – IV (**10 Hrs)**

Microbial Exopolysaccharides: Xanthan, Alginate, Microbial Flavours: Diacetyl, Methyl ketones, Terpenes, Vanillin.

Unit – V (**10 Hrs)**

Fermented food and dairy products: Starter cultures, science and technology of bread, cheese, and yogurt manufacture, kefir, kumiss, sauerkraut, Bulgarian buttermilk.

References:

1. Biotechnology: Rehm and Reid.
2. Comprehensive biotechnology: Murray Moo Young.
3. Microbial Technology: Pepler
4. Microbiology and technology of fermented foods: R. W. Hutkins. Blackwell publishing

III SEMESTER

MB-HCT 3.1.FOOD AND DAIRY MICROBIOLOGY **(4 credits)**

52 Hrs

Preamble: *This paper enables the students to study food as substrate to study food as substrate for microorganisms, food contamination, food spoilage and food preservation. This paper deals with food borne diseases and their content measures fermented foods, probiotics and prebiotics importance of neutraceuticals and their products. It encourages microbiology of milk contamination spoilage and preservation of milk and milk products Food sanitation and food safety, quality control and food standards.*

Unit – I **(4 Hrs)**

Introduction: Origin, Concept, Scope and historical developments. Food as substrate for microorganisms: Hydrogen ion concentration (pH), Moisture requirement, Water activity, Oxidation-Reduction potential, Nutrient content, Inhibitory substances and Biological structure.

Unit – II **(10 Hrs)**

Food contamination: Contamination of foods from green plants, animals, sewage, soil, water, air and handling. Food spoilage: General principles of food spoilage, Causes of food spoilage, Factors affecting kind and number of microorganism. Chemical changes caused by microorganisms. Spoilage of Meat and Meat products, Egg and Egg products, Fish and Marine products, Cereal and Cereal products, Fruits and Vegetables.

Unit – III **(6 Hrs)**

Food Preservation: General principles, Physical methods of food preservation (High temperature, Low temperature and Drying), Chemical methods of food preservation (Food additives) and Biological methods of food preservation.

Unit – IV **(14 Hrs)**

Food borne diseases and their control: Food Infection and Intoxication. Detection of food borne pathogens and their toxins by various methods. Fermented foods (Bread, Sauerkraut and temphe), Probiotics and Prebiotics. Concept and importance of Nutraceuticals and Nutraceutical products.

Unit – V **(14 Hrs)**

Milk: Definition, Composition, Nutritive value and Properties. Microbiology of milk. Testing of milk quality. Contamination, spoilage and preservation of milk and milk products. Fermented milk products: Production, Quality control and Significance of Cheese, Yogurt, Shrikhand and Acidophilus milk.

Unit – VI **(4 Hrs)**

Food sanitation and food safety: Concept, Importance and Safety laws, GMP and LP. Quality control and food standards: Bureau of Indian Standard (BIS). PFAA, FPO, MPO, CSO, Agmark Standards, International standards – HACCP, ISO 9000 Series. Food testing laboratories.

References:

1. Doyte MP, Loory RB & Thomas JM; Food Microbiology, ASM Pres, Washington DC.
2. Jay JM, Modern; Food Microbiology, Chapman & Hall, New York.
3. Joshi VK & Pandey Ashok; Biotechnology of Food Fermentation, Asia tech Publ. Delhi, India.
4. Frazier WC & Westhof DC; Food Microbiology, 3rd Ed., Tata McGraw Hill.
5. Doyle PM et al; Food Microbiology – Fundamentals & Frontiers, 2nd Ed., ASM Press.
6. Danwart GJ; Basic Food Microbiology, CBS Publ. Delhi.
7. Pitt J & Hocking. (1985); Fungi & Food spoilage, Academic Press.
8. Sandeep Sareeen; Food Preservation, Sarops & Soni, New Delhi.
9. Ananthakrishnan CP. Et al. (1994); Dairy Microbiology, Sreelakshmi Publ. Chennai. Rabinson RK. (1990); Dairy Microbiology, Elsevier Applied Science, London

MB.HCP.3.1. Practical **(2 credits)**

1. Enumeration of microorganisms from healthy and spoiled fruits and vegetables.
2. Enumeration of microorganisms from cereals and dry products.
3. Enumeration of microorganisms from jam, sauce and pickles.
4. Enumeration study of spoilage of egg, meat and fish.
5. Detection of food borne pathogens from street and restaurant food.
6. Study of microbiology of milk and milk products.
7. Production of yoghurt, acidophilus milk and tempeh.
8. Rapid platform test for milk
9. Fat estimation in milk and milk products
10. Methylene blue reduction test
11. Estimation of lactic acid in milk and curd .
12. Production of microbial lipids
13. Production of Sauerkraut
14. Estimation of proteins from Spirulina
15. Estimation of Aflatoxin from food samples.

References:

1. Aneja, K.R. (2001). Experiments in Microbiology, Plant pathology, Tissue culture and Mushroom Production Technology, 3rd Edition, New Age International (P) Ltd., New Delhi.
2. Dubey, R.C. and Maheswari, D.K. (2002). Practical Microbiology, S. Chand & Co., New Delhi.

MB-HCT 3.2. MICROBIAL ECOLOGY AND ENVIRONMENTAL MICROBIOLOGY

(4 credits)
52 Hrs

Preamble: *This paper encompasses the origin, concept and development of environmental microbiology and gives insides of microbial population and community, microbial diversity and their mechanism of adaptation to extreme environments. It also enlightens the role of microbes in pollution and their consequences on environment and health and in contrast their role in waste water treatment, solid waste management, indicators, degradation of xenobiotics, bioremediation and in leaching*

Unit – I **(6 Hrs)**

Introduction: Origin, Concept and Development of Environmental Microbiology. Microbial Community: Ecosystem, habitat and niche. Concept and dynamics of microbial population and community. Structure and functions of microbial communities. Ecological succession.

Unit – II **(6 Hrs)**

Microbial diversity: Diversity of microorganisms in different environments. Conventional and molecular methods of studying microbial diversity. Microbes in extreme environments. Extremophiles - Psychrophilic, thermophilic, acidophilic, alkalophilic, halophilic and barophilic. Mechanism of adaptation in extremophilic microorganism.

Unit – III **(14 Hrs)**

Water Pollution: Sources, Characteristics of water pollutants, health hazards due to water pollution. Standard water quality criteria, Water quality testing (MPN technique). Eutrophication - causes, consequences and prevention.

Waste water treatment: Primary-physical processes; Secondary-biological treatment by fixed biofilm systems (trickling filters, RBC, fluidized bed reactors), suspended systems (activated sludge process, oxidation lagoons, anaerobic digesters, septic tank); Tertiary- Filtration (sand beds & membrane filters) chlorination, ozonization, radiation and reverse osmosis.

Unit – IV **(6 Hrs)**

Air pollution and Radiation hazards: Sources and characteristics of air pollutants; Health hazards due to air pollution; Green house gases and green house effect. Ozone hole and acid rain. Radiation hazards and safety measures – sources, effect of radiations and safety measures.

Unit – V **(6**

Soil pollution: Sources and characteristics of soil pollutants. Effects of soil pollution on human health and crop productivity. Solid waste management: Handling and treatment of solid wastes. Sludge handling and disposal- sludge processing, screening, dewatering, thickening, conditioning; stabilization-aerobic and anaerobic digestion (biomethanogenesis).

Handling of biohazard and hospital wastes. Microbiological indicators: Concept and significance. Microbiological indicators of water and air pollution.

Unit – VI **(14 Hrs)**

Biodegradation of xenobiotics: Microbial degradation of pesticides, polycyclic aromatic hydrocarbons, natural and synthetic polymers (cellulose, pectin, lignin, detergents, plastics). Microbial remediation: Concept and scope of bioremediation. Methods and types of bioremediation of contaminated soil and water using microorganisms. Microbial leaching: Origin and concept. Mechanism and role of microorganisms in recovery of important minerals - Iron, Copper and Gold.

References :

1. Brock T.D. Principles of Microbial Ecology. Prentice Hall Publ. Co. Philadelphia.
2. Martin Alexander. Microbial Ecology. John Willey & Sons. New York.
3. Atlas & Bertha. 1998. Microbial Ecology. 3rd Ed.
4. Gabriel Britton, 1994, Wastewater Microbiology, John Willey & Sons, New York.
5. Ralph Mitchell, 1995, Environmental Microbiology, Wiley Liss, New York.
6. Criston J. Hurst, Manual of Environmental Microbiology, ASM Publ., New York.
7. Feltcher, M. & Grey TRG, 1987, Ecology of Microbial Communities, Cambridge Univ. Press.
8. Rose R.D. Air Pollution & Industry. Reinhold Co., New York.
9. Metcalf and Eddy. 1991. Waste Water Engineering. McGraw Hill Int. Publ.
10. APHA, 1994, Standard Methods, 17th Ed., American Public Health Associatio

MB.HCP.3.2. Practical (2 credits)

1. Study of microbial ecology by winogradsky column.
2. Isolation of microorganisms in unpolluted and polluted air by solid/liquid impingement method.
3. Isolation, enumeration of microorganisms in unpolluted and polluted soil and water.
4. Detection of coli forms for determination of purity of potable water samples.
5. Determination of dissolved O_2, CO_2, BOD, COD and Total dissolved solid of water sample.
6. Isolation and determination of Iron and Manganese reducing bacteria
7. Isolation of Xenobiotic degrading bacteria by selective enrichment technique
8. Test for degradation of aromatic hydrocarbons by bacteria
9. Survey of degradation plasmids in microbes growing in polluted environment
10. Effect of SO_2 on crop plants
11. Demonstration of heavy metals in water/soil by atomic absorption spectrophotometer.
12. Estimation of Phosphate, sulphates, Nitrates and major cations (Na, K, Mg, and Ca) in water samples
13. Isolation of Cellulose, Hemicellulose, Starch, Lignin, Pectin degrading microorganisms.

References:

1. Aneja, K.R. (2001). Experiments in Microbiology, Plant pathology, Tissue culture and Mushroom Production Technology, 3rd Edition, New Age International (P) Ltd., New Delhi.
2. Dubey, R.C. and Maheswari, D.K. (2002). Practical Microbiology, S. Chand & Co., New Delhi.
3. Burns, R.G. and Slater, J.H. (1982). Experimental Microbiology and Ecology. Blackwell Scientific Publications, USA.
4. Peppler, I.L. and Gerba, C.P. (2004). Environmental Microbiology – A Laboratory Manual. Academic Press. New York.
5. Gupte, S. (1995). Practical Microbiology. Jaypee Brothers Medical Publishers Pvt. Ltd.
6. Kannan, N. (2003). Hand Book of Laboratory Culture Medias, Reagents, Stains and Buffers. Panima Publishing Co., New Delhi.
7. Gopal Reddy, M., Reddy, M.N., Saigopal, DVR and Mallaiah, K.V. (2007). Laboratory Experiments in Microbiology, 2nd edition. Himalaya Publishing House, Mumbai.
8. Reddy, S.M. and Reddy, S.R. (1998). Microbiology – Practical Manual, 3rd Edition, Sri Padmavathi Publications, Hyderabad

MB-HCT 3.3: AGRICULTURALMICROBIOLOGY **(4 credits)**

52 Hrs

Preamble: *Agriculture is the basis of life without agriculture survival is difficult. Ours being an agriculturist country. This paper would enable the students to learn the origin concept and development of agricultural microbiology. Role of m.o's in soil & biochemical cycles.The students will be exposed to the concept of plant-microbe interactions, biological* N_2 *fixation, biofertilizers, biopesticides, green manure, compost, plant diseases, biological control biopesticides and genetically modified crops advantages and demerits.*

Unit – I **(6 Hrs)**

Introduction: Origin, Concept and Development of Agricultural Microbiology. Role of microorganisms in soil formation and soil fertility. Factors affecting soil microorganisms. Microbes and biogeochemical cycles - Nitrogen, Carbon, Sulfur and Phosphorous cycles.

Unit – II **(6 Hrs)**

Plant - Microbe Interactions: Types - Mutualism, Commensalism, parasitism, amensalism and synergism. Concepts of Rhizosphere, Phyllosphere and Spermosphere. Rhizosphere effect and R/S ratio. Factors influencing rhizosphere microorganisms. Plant growth promoting rhizobacteria.

Unit – III **(10 Hrs)**

Biological nitrogen fixation: Mechanism and genetics of biological nitrogen fixation. Nitrogen fixation by diazotrophs-*Rhizobium, Azatobacter, Azospirillum, Frankia and Blue Green Algae.* Phosphate solublizing microorganisms and *Mycorrhiza.* Mechanism of phosphate solubilization. significance and role of mycorrhizae.

Unit – IV **(8 Hrs)**

Biofertilizers: Concept and types of microbial biofertilizers - Bacterial (Rhizobium, Azotobacter and Azospirillum), Fungal and Algal. Screening and selection of potential strains for biofertilizer. Production and quality control of biofertilizers. Phosphate solubilising microbial biofertilizers. Methods of application and evaluation of biofertilizers.
Green manure, Organic matter, Compost and Composting .

Unit – V **(10 Hrs)**

Plant diseases: Etiology, pathogenesis, Symptoms and control measures of plant diseases. Bacterial diseases - Wilt and Citrus canker; Fungal diseases – Wilt, Downy mildew, Rust and Smuts); Viral diseases -Tobacco mosaic and Bunchy top of Banana; Mycoplasmal diseases - Grassy shoot of sugar cane and Coconut yellowing disease.

Unit – VI **(12 Hrs)**

Biological control: Various microorganisms as biocontrol agents. Isolation, screening, cultivation and mode of action of microbial biocontrol agents. Merits and demerits of biological control. Biopesticides: Types, mass production and applications of microbial biopesticides. Bacterial - *Bacillus thuringiensis* and *Pseudomonas fluroscence*; Fungal - *Trichoderma viridae* and Coelomomyces; Viral - NPV and CPV. Integrated pest and plant diseases management. Genetically modified crops: Role and significance of microbial genes. Construction, evaluation and field application of BT cotton and BT brinjal. Advantages and disadvantages of GM crop plants.

References:

1. Subba Rao. 2000. Soil Microbiology. 4th Ed. Oxford & IBH
2. Subba Rao. Biofertilizers in Agriculture. Oxford & IBH
3. Subba Rao. Recent Advances in Biological Nitrogen Fixation. Oxford & IBH.
4. Rangaswamy and Bagyraj. Agricultural Microbiology.
5. Swaminathan M.S. Biotechnology in Agriculture. McMillan.
6. Steinhaus. 1963. Insect Pathology. Vol I & II. Academic Press, New York.
7. Burges H D. 1970-1980. Microbial Control of Pests and Plant Diseases.
8. Plant pathology. By George Agrios; Academic Press, New York.
9. Microbial Ecology: Fundamentals and Applications by Rinald Atlas and Richard Bartha;
10. Benjamin/Cummings Science Publis., 2725 Sand Hill Road, Menlo Park, California
11. Plant pathology. By George Agrios; Academic Press, New York.

MB HCP.3.3. Practical (2 credits)

1. Isolation, enumeration of Rhizosphere and Phyllosphere microorganisms.
2. Study of root nodules of leguminous plants. Isolation enumeration and characterization of symbiotic and nonsymbiotic nitrogen fixing microorganisms.
3. Isolation enumeration and characterization of phosphate solubilising bacteria and fungi-plate method.
4. Staining & observation of VAM fungi.
5. Laboratory scale production of bacterial biofertilizers.
6. Assay of bio fertilizers (seed treatment, seedling, inoculation and measurement of root and shoot length).
7. Isolation of bioinoculants: *Bacillus thuringiensis*, *Bauveria bassiana*, *Trichoderma*, *Pseudomonas.* Observation of spores and crystals of *B.thuringenesis.*
8. Mass production of *B.thuringenesis* in laboratory.
9. Mass production of fungal entomopathogens in laboratory
10. Observation of wet mount of NPV.
11. Mushroom cultivation and evaluation of protein content
12. Plant diseases- Rust, Smuts, Powdery mildews, Tikka disease of ground nut, citrus canker, bhendi yellow vein mosaic, tomato leaf curl, little leaf of brinjal.
13. Isolation of funal and bacterial plant pathogens *sclerotium rolfsii*, *xantomonas*, *rolstonia*, *fusarium*, *Alternaria alternata*
14. Extraction and estimation of phenolics from diseased plants.

References:

1. Motsara, M.R. Bhattacharyya, P.and Srivastava, B. 1995 Biofertilizer- Technology, Marketing and Usage. Fertilizer Development & Consultant Organization , New Delhi.
2. Subba Rao, N.S., 1994. Biofertilizers in Agriculture and Agroforestry. Oxford & IBH, New Delhi.
3. Subba Rao, N.S. 1995. Soil Microorganisms and Plant growth. Oxford & IBH, New Delhi.
4. Aneja KR (2005). Experiments in Microbiology, Plant pathology and Biotechnology. 4th Edition, New Age International Publishers, Chennai.

MB-SCT 3.1: RECOMBINANT DNA TECHNOLOGY (4 credits)

52 Hrs

Preamble: *This paper provides the students with the relevant background information necessary to understand recombinant DNA technology with the necessary components and methods involved in it. Students will also gain knowledge on recent developments in the rDNA technology and its applications in human welfare.*

Unit – I (6 Hrs)

Basics of DNA cloning**,** Types of cloning. Cloning using linkers and adaptors. Cloning into various kinds of vectors – plasmids, (pSC 101, RI, pBR 322, pUC 18, Ti-plasmid), phages lambda and M13, phagemids, cosmids, P1 phage, PACs, BACs and YACs. Hosts for recombinant DNA technology, Restriction endonucleases – Type, I, II & III,Nucleotide kinase, reverse transcriptase, T4 DNA ligase, and klenow polymerase. Restriction mapping, RFLP and RAPD

Unit – II (6 Hrs)

Amlification of DNA, Concept of PCR and varitous thermophilic enzymes used in PCR. Gradient PCR versus Touchdown PCR. Designing primers. Cloning PCR products. Types of PCR , Overlap PCR, Rolling Circle Amplification Technology.

Unit – III (14 Hrs)

Construction of recombinant DNA, selection of DNA fragments for cloning, cDNA synthesis, chemical synthesis, gene synthesizers, ligation with RES, homopolymer tailing, blunt end ligation, linkers, monitoring restriction and ligation. Insertion of recombinant DNA – Host selection, transformation, transfection, electro-poration, lipofection, Screening of recombinants.

Construction of cDNA and genomic DNA libraries: Vectors used in the construction of cDNA versus genomic DNA libraries, Steps and enzymes involved in the construction of cDNA versus genomic DNA libraries. Screening libraries by colony hybridization and colony PCR. Screening expression libraries.

Enriching for clones in cDNA libraries by positive selection and subtractive hybridization. Identifying genes in complex genomes by direct selection of cDNA and exon trapping.

Unit – VI (6 Hrs)

Over expression of recombinant proteins**:** Over expression and tagging of recombinant proteins in *E.coli,* driven by lac, T7 and Tet-regulatable promoters, Expression in *B. subtilis*. Overexpression systems in yeast (*S.cerevisiae, P.pastoris),* Baculovirus overexpression system. Mammalian cell overexpression system.

Unit – V (6 Hrs)

Genome sequencing: DNA sequencing by Sanger's method – traditional and cycle sequencing. Physical mapping by restriction fragment fingerprinting of BAC clones and STS

mapping. Whole genome shotgun sequencing. Clone-by-clone shotgun sequencing of genome. Genome annotation at the nucleotide level, protein level and process level. Comparative genome sequencing of micro-organisms to identify and categorize SNPs.

Unit – VI **(6 Hrs)**

Transcriptional analysis of gene expression and transcriptomics: Gene expression analysis by Northern Blotting, RT-PCR, EST analysis and the use of reporter genes. Promoter analysis – deletion analysis and linker scanning analysis coupled to reporter assays, mapping transcriptional start sites by S1 nuclease mapping, primer extension studies or 5' RACE.
Transcriptome analysis by DD-PCR and EST analysis, DNA microarrays (cDNA arrays and oligo arrays), Serial Analysis of Gene Expresion (SAGE).

References:

1. Brown TA. Ed. Homes BD & Richwood D, 1998; Molecular Biology – LABFAX, Academic Press.
2. Gerard Karp, 1999; Cell and Molecular Biology, John Wiley & Sons Inc., New York.
3. Miller G et al, 1996; An introduction to Genetic analysis, Freeman & Co., New York.
4. Watson JD et al, 1992; Recombinant DNA, Scientific American Books.
5. Desmond ST & Nicoll, 1994; An introduction to Genetic Engineering, Cambridge Uni. Press.
6. Nicholl DST, 1994, An introduction to Genetic Engineering, Cambridge Univ. Press.
7. Trapp BE & Freifelder D, 2007; Molecular Biology – Genes to proteins, Jones & Bartlet Publ. Inc. Learning.
8. David P Clark, 2005; Molecular Biology, Academic Press
9. Harvey F Lodish, 2008; Molecular Cell Biology, W.H. Freeman
10. Cornell Mechardt, 2007; Molecular Biology & Genomics, Academic press

MB-SCT 3.2: BIOETHICS, BIO-SAFETY AND IPR (4 credits)

52 Hrs

Preamble: This paper provides the students with the relevant background information necessary to bioetics, biosafety and ipr related laws and regulations and filing up of patents.

Unit – I **(10 Hrs)**

Bioethics : Introduction to bioethics ,principles of bioethics, biotechnology and social responsibility, public acceptance issues in microbiology and biotechnology, issues of access, ownership, monopoly, traditional knowledge, biodiversity, benefit sharing, environmental sustainability, public vs private funding. Ethical conflicts in biotechnology- interference with nature, unequal distribution of risk and benefits of biotechnology, bioethics vs business ethics.

Unit – II **(10 Hrs)**

Biosafety: Definition of bio-safety, Biotechnology and bio-safety concerns at the level of individuals, institutions, society, region, country and world with special emphasis on Indian concerns. Biosafety in laboratory institution: laboratory associated infection and other hazards, assessment of biological hazards and level of biosafety.

Unit – III **(6 Hrs)**

Bio safety regulation: handling of recombinant DNA products and process in industry and in institutions (Indian context). Biosafety Levels of Specific Microorganisms; Recommended Biosafety Levels for Infectious Agents and Infected Animals.

Unit – IV **(6 Hrs)**

Biosafety guidelines - Government of India; Definition of GMOs & LMOs; Roles of Institutional Biosafety Committee, RCGM, GEAC etc. for GMO applications in food and agriculture; Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication; Overview of National Regulations and relevant International Agreements including Cartagena Protocol.

Unit–V **(8Hrs)**

Introduction to Intellectual Property: Types of IP: Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications, Protection of New GMOs; International framework for the protection of IP. Intellectual property protection. WTO: agency controlling trade among nations, WTO with reference to biotechnological affairs, TRIPs. WIPO, EPO. IP as a factor in R&D; IPs of relevance to Biotechnology and few Case Studies; Introduction to History of GATT, WTO, WIPO and TRIPS

Unit VI **(12 Hrs)**

Concept related to patents novelty, non-obviousness, utility, anticipation, prior art etc. Type of patents. Indian patent act and foreign patents. Patentability, Patent application, Revocation of patent, Procedure for filing a PCT application. Infringement and Litigation with case studies on patent, Commercialization and Licensing. Recent Amendments, Precautions before patenting-disclosure/non-disclosure; WIPO Treaties; Budapest Treaty; PCT and Implications; Role of a Country Patent Office.

References:

1. Fleming, D.A., Hunt, D.L.(2000).Biotechnology and Safety Assessment (3rd Ed) Academic press.
2. Thomas, J.A., Fuch, R.L.(1999).Biotechnology and safety assessment (3rd Ed).CRC press, Washington.
3. Law and Strategy of biotechnological patents by Sibley. Butterworth publication.(2007)
4. Intellectual property rights- Ganguli-Tat McGrawhill. (2001) ISBN-10: 0074638602,
5. Intellectual Property Right- Wattal- Oxford Publicatiopn House.(1997) ISBN:0195905024.
6. Biotechnology - A comprehensive treatise (Vol. 12). Legal economic and ethical dimensions. (2nd ed)
7. Encyclopedia of Bioethics 5 vol set, (2003) ISBN-10: 0028657748.
8. Thomas, J.A., Fuch, R.L. (2002). Biotechnology and safety Assessment (3rd Ed) Academic press.
9. B.D. Singh. Biotechnology expanding horizons.
10. H.K.Das. Text book of biotechnology 3rd edition
11.Sree Krishna, V., 2007. Bioethics and Biosafety in Biotechnology, 1st Ed. New Age International Publishers, New Delhi.
12. Trayror, P.C., Frederic.R. and Koch, M. 2002. Biosafety. Board of Trustees, Michigan State University, USA.

MB OET 3.1: MICROBES IN HUMAN WELFARE **(4 credits)**

52 Hrs

Preamble: *This paper gives a wide exposure not only to microbiologists but also the other disciplines of life sciences who choose this paper. It gives a wide knowledge of different types of microorganisms, their distribution, microscopic observation, their isolation and identification. The concept of preservation of microorganism, their biochemical properties and taxonomy can be learnt by the students, students will be exposed to the role of microorganisms in agriculture, food, industry and human health. The students will have a wide exposure of the relation of microorganisms with human health and welfare.*

Unit–I **(10Hrs)**

Introduction to microorganisms; Definition, Discovery of microorganisms, Types – viruses, mycoplasma, rickettsiae, bacteria, fungi, actinomycetes, algae and protozoa; General characteristics, structure and reproduction of microorganisms. Distribution of microorganisms: In air, water and soil; On and in the bodies of plants and animals. Appearance of microorganisms: Microscopic observations - different types of microscopes, different shapes and sizes of microorganisms, staining properties, staining of cells organelles and inclusion bodies.

Unit – II **(10 Hrs)**

Isolation and cultivation of microorganisms: Sterilization methods (physical and chemical); Media – preparation, ingredients and types; Pure culture techniques. Isolation and cultivation of microorganisms: Sterilization methods (physical and chemical); Media – preparation, ingredients and types; Pure culture techniques. Identification of microorganisms: Cultural and microscopic characters; Biochemical properties; Taxonomy of microorganisms. Preservation of microorganisms: Methods of maintenance and preservation of microbial cultures – slant cultures, glycerol cultures, refrigeration and lyophilization; Culture collection centers.

Unit – III **(10 Hrs)**

Microbes and Environment: Elemental and nutrient recycling, biogeochemical cycles; Esthetics loss of the environment - algal blooms, degradation of structures like buildings, pipelines etc.; Microbiological quality and standards of water. Microbes in Agriculture: Role of microorganisms in soil fertility and crop productivity; Biological nitrogen fixation; Phosphate solublization; Mycorrhiza; Plant growth promoting rhizobacteria; Composting. Causative agents and symptoms of major plant diseases.

Unit – IV **(6 Hrs)**

Microorganisms and Food: Fermented food and food products; Nutritative and medicinal value of fermented foods; Probiotics and nutraceuticals; Production of various fermented foods- curds, yogurt, cheese and beverage; Principals of food spoilage and contamination.

Unit–V **(8Hrs)**

Microorganisms and Industry: Microbial fermentations; Bioprocess engineering; Raw materials; Types of fermenters and fermentations; Production of antibiotics, enzymes, organic acids and pigments. Other activities of microorganisms: Microorganisms as models for life on earth; Universal lessons from microorganisms to human welfare; Microorganisms and social change.

Unit – VI **(8 Hrs)**

Microorganisms and human Health – Role of microorganisms in human health; Action of antibiotics to combat microbial diseases; Microbial vaccines as prophylactic measures; Microorganisms as probiotics to promote human health; Concepts and principals of immunity to microbial infections; Major human diseases caused by important microbial pathogens.

References:

1. Roger Y. Stanier, 1987, General Microbiology, MacMillan Publ.
2. Lammart JM, 2006; Techniques in Microbiology – a student handbook, amzon.com.
3. Madigan MT et al, 2008; Brock – Biology of Microorganisms, amzon.com.
4. Atlas RM, 1995; Principles of Microbiology, Mosby Yearbook Missouri
5. Pelczar, Chan & Kreig, 1982; Microbiology, McGraw Hill Book Co, New York
6. Frazier WC & Westhof DC; Food Microbiology, 3rd Ed., Tata McGraw Hill.
7. Doyle PM ; Food Microbiology – Fundamentals & Frontiers, 2nd Ed., ASM Press
8. Atlas & Bertha. 1998. Microbial Ecology. 3rd Ed.
9. Ralph Mitchell, 1995, Environmental Microbiology, Wiley Liss, New York.
10. Subba Rao. 2000. Soil Microbiology. 4th Ed. Oxford & IB

MB-OET 3.2: BIOPHARMACEUTICALS (4 credits)

52 Hrs

Unit – I (**10 Hrs)**

Drug discovery and development. Introduction to drug discovery and development, sources of drugs, approaches to new drug discovery, role of molecular recognition in drug design, enzymes and receptors as drug targets, prodrug design and applications, computer aided drug design, preclinical and clinical trials.

Unit – II (**12 Hrs)**

Biopharmaceuticals. Concepts of pharmaceuticals, biologics and biopharmaceuticals, sources of biopharmaceuticals, biopharmaceuticals in production and research, cytokines, heamopoetic growth factors, hormones, blood products, therapeutic enzymes (Asparaginase, Streptokinase, beta lactamases).

Unit – III (**10 Hrs)**

Antibiotics, microbial production of antibiotics, bacterial and viral vaccines, New vaccine production (DNA vaccines, synthetic, peptide vaccines, multivalent subunit vaccines, edible vaccines and their trials), Case studies.

Unit – IV (**10 Hrs)**

Spoilage of pharmaceutical products, regulatory practices and policies in pharmaceutical industries. Microbial production, contamination and spoilage of pharmaceuticals products (sterile injectables, ophthalmic preparations and implements) and their sterilization, FDA, govt. Regulatory practices and polices, concept of R & D, quality control and market planning. Significance of IP, BP and USP. Reimbursement of drugs, biological and legislative aspects, patenting of drugs and biological products.

Unit – V (**10 Hrs)**

Quality Assurance and Validation. Regulatory aspects of QC, QA, and QM. GMP, GLP and CMP in Pharma Industry. ISO, WHO, USFDA certification. Microbial Limit test of Pharma products. Sterility testing, pyrogen testing and LAL test of Sterile Pharma products. Sterilization- heat, D- value, Z-value and survival curve, radioactive, gaseous and filtration. Chemical and biological indicators. Designing layout for microbiology laboratory.

References.

1. Pharmaceutical Microbiology- Edited by W. B. Hugo & A.R. Russel Sixth Edition. Blackwell Scientific Publications.
2. Lippincott's illustrative Reviews: Pharmacology Edition: 02 Maryjnycck by Lippincott's review Publisher Pheladelphia 1997.
3. Principles of medicinal chemistry Vol. 1 by Kadam S.S., Mahadik K.R., Bothra K.G. Edition: 18, Nirali Publication.
4. Pharmacognosy by Gokhle S.D., KoKate C.K.. Edition: 18, Nirali Publication.
5. Biotechnology – Expanding Horizon by B.D. Singh., First Edition, Kalyani Publication, Delhi.
6. Analytical Microbiology- Edited by Fredrick Kavanagh volume I &II. Academic Press New York.
7. Pharmaceutical Biotechnology by S. P. Vyas & V.K. Dixit. CBS publishers & distributors, NewDelhi
8. Quniolinone antimicrobial agents- Edited by David C. Hooper, John S. Wolfson. ASM Washington DC.
9. Quality control in the Pharmaceutical industry - Edited by Murray S. Cooper Vol. 2, Academic Press New York.

SEMESTER-IV

MB-HCT 4.1. FERMENTATION TECHNOLOGY AND BIOPROCESS ENGINEERING (4 credits)

52 Hrs

Preamble: *Under this syllabus, the students will study the concept of fermentation, types of fermentation, industrially important microorganisms, strain development, inoculum development for industrial fermentation. Students will have an exposure to media for industrial fermentation, types of fermentors, sterilization of media and fermentors, kinetics of microbial growth. They should know the concept of bioprocess engineering , upstream, downstream processing, production and purification of microbial products, single cell protein and single cell oil, intellectual property rights and patents.*

Unit – I (**6 Hrs)**

Fermentation: Origin, concept and historical development of fermentation. Types of Fermentations- Surface, Submerged, Solid -State, Batch, Continuous, Dual and Fed batch fermentations.

Industrially important Microorganisms: Isolation, Screening of metabolites (Primary and Secondary metabolites) and Preservation. Strain development- Mutation, Recombination and Protoplast fusion technique. Inoculum development for industrial fermentation.

Unit – II (**6 Hrs)**

Media for industrial fermentations: Criteria, Media formulation, Media ingredients - Water, Carbon sources, Nitrogen sources, Minerals and Vitamin sources. Buffers, Precursors and Growth factors. Oxygen requirement, Chelaters and Antifoaming agents. Nutrients recycling.

Unit – III (**6 Hrs)**

Fermentor: Construction and Design of a typical fermentor. Parts and functions of a fermentor. Manual and automatic control systems. Types of fermentors- Tower, Jet, Loop, Airlift, Bubble, Column, Packed bed, Fluidized bed.Sterilization of media and fermentors - Design of sterilization process for batch and continuous fermentation. Sterilization of Fermentor and Media, Air and Exhaust air. Filter sterilization.

Unit – IV (**6 Hrs)**

Kinetics of microbial growth: Phases of cell growth in batch culture. Simple unstructured kinetic models for microbial growth-Monod model. Growth of filamentous organisms. Growth associated (primary) and non - growth associated (secondary) product formation Kinetics.

Unit – V (**14 Hrs)**

Bioprocess Engineering: Origin, Concept and Principles of Bioprocess Engineering. Basic components of bioprocess engineering. Upstream bioprocess: Major process variables. Optimization of process variables. Strategies for the enhanced production - Immobilization and Response surface methodology. Downstream bioprocess: Filtration-Micro, Cross-flow and Ultra. Centrifugation-High speed, Continuous and Ultra. Cell disruption. Precipitation, Coagulation and Flocculation. Solvent /Aqueous 2-phase extractions, Dialysis and Electro-dialysis. Reverse osmosis. SDS-PAGE, Ion Exchange chromatography and HPLC. Gel Filtration. Drying. Crystallization.

Unit – VI (**14 Hrs)**

Production and purification of microbial products: Enzymes-(Amylase, Proteases), Organic acids (Lactic acid, Citric acid and Vinegar), Amino acids (L-lysine and L-glutamic acid), Antibiotics (Penicillin and Streptomycin), Solvents-(Ethyl alcohol, Acetone- and butanol) Alcoholic beverages-(Beer, Wine, Brandy and Rum). Vitamins B12, Antitumours and Anticholesterol agent. An overview of bioenergy. Single cell protein and Single cell oil – Concept, production and uses. Intellectual property rights and patents

References:

1. Ali Cinar, SJ. Parulekar, et al., (2003) Batch Fermentation: Modeling, Monitoring, and Control. Marcel Dekker
2. Arnold D & J E. Davies, Atlas. RM 1999 Manual of Industrial Microbiology & Biotechnology 2nd Ed.Berry, D.R. (Ed) 1998 Physiology of Industrial fungi BSP, Oxford University.
3. Crueger & Crueger Biotechnology: A Text Book of Industrial microbiology 2nd edition
4. Casida, Industrial Microbiology
5. Demain, A.L Biology of Industrial Microorganisms
6. Diliello Methods in Food and Dairy Microbiology
7. Harold B. Reisman 1988 Economic Analysis of Fermentation Processes CRC Pr I Llc
8. Vogel A & L. Celeste Todaro 2005 Fermented and Biochemical Engineering Hand Book 2ndStandard Publishers Distribution New Delhi
9. Harvey,W., Blanch, S.Clark. 2007 Biochemical Engineering, Marcel Dekker
10. Waites, M.J., Morgan, N.L., Rockey, J.S. and Higton, G. 2002. Industrial Microbiology: AnIntroduction. Blackwell Science.
11. Puri, R.S. and Viswanathan, A. 2009. Practical Approach to Intellectual Property Rights. I.K.International Publishing House. New Delhi.

MB.HCP.4.1 Practical **(2 credits)**

1. Study of Fermentor and On-line measurement of a fermentation process.
2. Isolation of industrially important microorganisms for microbial processes.
3. Primary inoculum development in a seed fermentor.
4. Batch fermentation of Citric acid production, recovery and estimation of citric acid.
5. Production of any vitamin and its quantification by bioassay.
6. Antibiotic fermentation and estimation of penicillin.
7. Preparation of wine and estimation of alcohol by specific gravity method.
8. Alcoholic fermentation and determination of total acidity and non-reducing sugars
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 *A. oryzae, Bacillus licheniformis* using Wheat bran in small scale solid state fermentation and its assay
11. Preparation of banana juice using Pectinase.
12. Culturing of *Chlorella / Spirulina.*
13. Immobilization of yeast cells by calcium alginate gel entrapment and assay for enzymes Invertase.
14. Preparation of immobilized cells of *B. licheniformis* for the use in the production of alpha amylase.

References:

1. Demain, A.L. and Davies, J.E. 1999. Manual of Industrial Microbiology and Biotechnology IInd Edition. ASM Press, Washington.
2. Maheshwari, D.K., Dubey, R.C. and Saravanamtu, R. 2010. Industrial Exploitation of
3. Microorganisms. I.K. International Publishing House. New Delhi.
4. Nduka Okafor 2010. Modern Industrial Microbiology and Biotechnology ASM Publisher
5. Nupur Mathur Anuradha 2007. Industrial Microbiology A Laboratory Manual.
6. Peppler, H.J. and Perlman, D. 2005. Microbial Technology: Fermentation Technology Second Edition Volume 1. Elsevier India Private Limited.
7. Peppler, H.J. and Perlman, D. 2005. Microbial Technology: Fermentation Technology Second Edition Volume 2. Elsevier India Private Limited.
8. Richard H Baltz, Julian E Davies and Arnold L Demain 2010. Manual of Industrial Microbiology and Biotechnology 3e ASM Publisher.

MB-HCT 4.2. MEDICAL MICROBIOLOGY **(4 credits)**

52 Hrs

Preamble: *It covers mechanisms of infectious disease transmission, principles of aseptic practice, and the role of the human body's normal micro flora. The biology of bacterial, viral, fungal, and parasitic pathogens and the diseases they cause are covered. This provides the conceptual basis for understanding pathogenic microorganisms and the mechanisms by which they cause disease in the human body. It also provides knowledge on epidemiology, diagnosis, treatment, control of infectious diseases and their eradication through vaccination.*

Unit – I (**6 Hrs)**

Introduction: Historical developments - Major milestones and significant contributions. Human Anatomy and physiology: An overview of human anatomy and physiology. Important terms of human anatomy and physiology with special reference to microbial infections. Diseases caused by microorganisms: Concept and illustrations; Communicable diseases; normal flora of human body; opportunistic pathogens.

Unit – II (**6 Hrs)**

Microbial pathogenecity and pathogenesis: Attributes of pathogenecity and pathogenesis. Mechanism of disease process and prognosis. Host and microbial factors influencing susceptibility. Microbial infections: Concept and types of microbial infections; Modes of transmission of pathogens, Portal of entry and exit; Types of infections; Nosocomial infections.

Unit – III (**14 Hrs)**

Bacteriology: Systematic study of important pathogenic bacteria with reference to etiology, symptoms, diagnosis, treatment and epidemiology; Enterobacteriaceae (Salmonella, Shigella, *E.coli*, *Klebsiella*); *Mycobacterium tuberculosis*, *M .leprae,* Staphylococci, Streptococci, *Vibrio cholerae*, *Brucella pertusis*, *Clostridium welchi*, *C. tetami* and *Treponema palladium* Etiology, epidemiology, symptoms, diagnosis and treatment of diseases caused by Chlamydia, Mycoplasma and Rickketsia.

Unit – IV (**10 Hrs)**

Virology: Pathogenecity, symptoms, diagnosis, treatment and preventive measures of viral diseases caused by important viruses - Pox, Herpes, Adeno, Papovo Picarno, myxo, retro, arbo, hepatitis, Rabies, SARS, Chikungunya, Ebola and H_1N_1 viruses

Unit – V (**10 Hrs)**

Mycology and Parasitology: Mycoses, Candidiasis, Mycetoma, Chromomycosis, Sprorotrichosis, Cryptococcosis, Blastomycosis, Coccidiomycosis and Histoplasmosis. Morphology, life cycle and pathogenesis of the human parasites. Intestinal protozoa, Urogenital protozoa, *Leishmania donovani, P. falciparum* and *P. vivax, Toxoplasma gondii*,

Helminths Nematodes *Wuchereria*, Cestodes – *Taenia*, *Hymenolepis* and *Echinococcus*, neurocysticercosis and hydatid disease. Trematodes blood flukes. Entomology- relating to vector borne transmission of disease.

Unit – VI (**6 Hrs)**

Chemotherapy: Antimicrobial agents and antibiotics; Classification of antibiotics based on chemical structure, mode of action and range of effectiveness; Drug resistance - recent trends and its consequences; Antibiogram and Antibiotic policy; NCCLS (CLSI) guidelines and standards; WHO Guidelines.

References:

1. Topley and Wilson. Principles of bacteriology, Virology and Immunity. Edward
2. David Greenwood, Richard C and Slack B. Medical Microbiology. ELBS Churchill
3. Rajesh Bhatia R. Essentials of Medical Microbiology. Jayjee Brothers.
4. Kenneth jR. Medical Microbiology – Introduction to Infectious Disease. Prentice Hall
5. joanstokes, Ridewaywren and Sir ashleymiles. Clinica Microbiology. Edward Arnold.
6. Dougias J and Slekh. Medical Bacteriology. Churchill Livingstone.
7. Bailey and Scotts. Diagnositc Microbiology. C.V. Mosry Company
8. Hoghl and Moffet. Clinical Microbiology. JB Lippincott Company.

MB. HCP.4.2. Practical **(2 credits)**

1. Study of *Mycobacterium tuberculosis* by AFB method using sputum.
2. Detection of thyphoid by widal test
3. Detection of malarial parasite from human blood sample.
4. Study antibiotic sensitivity test by using paper disc as well as agar cup plate method.
5. Study of cancer cells and visit to cancer research institute.
6. Diagnosis of HIV by using Dot-ELISA.
7. Anaerobic culture method for anaerobes of clinical importance.
8. Presumptive identification of pathogens using colony morphology on selective/differential/ selective-differential/ Enrichment media. Isolation and characterization of clinical significant species of *Staphylococcus, Streptococcus, Cornybacterium, bacillus, nocordia, neisseria, enterobacteriaceae, Vibrio, pseudomonas, aeromonas.*
9. Drug susceptibility testing by various methods according to NCCLS.
10. Determinations of MIC for selected antibiotics (Kirby-Bauer method, T test, Checker board method).
11. Preparation of culture media: Simple tissue methods for growing different pathogenic microorganisms.
12. Conventional and rapid methods for isolation and identification of pathogenic bacteria, fungi.
13. Study of commensal flora of mouth and human body.
14. Bacteriological examination of Urine, Blood, Pus Samples from Hospitals.

References:

1. Mohamed A Daw. Medical microbiology laboratory manual second edition 2009. ISBN: 978-9959-53-052-3.
2. R Panjarathinam. Practical Medical Microbiology, Published by Jaypee Brothers Medical Publishers.

MB-SCT 4.1. IMMUNOLOGY AND IMMUNOTECHNOLOGY (4 credits)

52 Hrs

Preamble: *The major objective of the paper is to provide knowledge on basics of immune system and its components and their role in effective resistance mechanism. It also provides insights of response by immune system to antigen or foreign objects and consequences due to its failure and over response. It throws light on production of polyclonal and monoclonal antibodies and their applications in disease diagnosis and also on tumor and transplant immunology and vaccines production.*

Unit – I (**6 Hrs)**

Introduction: Origin, concept and historical development of immunology Immunity: Definition, Types of immunity-Innate and Acquired immunity. Cells and organs of immune system: Circulatory and lymphatic systems. Hematopoiesis. Cells of immune system.

Unit – II (**6 Hrs)**

Types, structure and functions of lymphoid organs: Biology of immune cells: B cells- Origin, development, maturation and surface molecules. T cells- Origin, development, maturation and surface molecules; Subsets of T cells. Structure and function of T Cell receptors. MHC molecules-Types, structure, genetics and functions. Complement system-Components and pathways of component activation**.**

Unit – III (**14 Hrs)**

Antigens and Antibodies: Antigens - Physical and chemical properties of antigens, Epitopes, Antigenicity and Immunogenicity; Types of antigens. Antibodies- Physical and chemical structures of antibodies, Types and biological functions of immunoglobulins.

Monoclonal and Polyclonal antibodies- Production and applications. Antigen-Antibody reactions: Mechanism and principles of antigen antibody reactions. Types and determination of antigen antibody reactions – Radio immune assay, Ouctherlony double diffusion technique, Complement fixation test, Enzyme linked immunosorbent assay and Immuno blotting.

Unit – VI (**10 Hrs)**

Immune response: Antigen processing and presentation; Activation of T and B cells; Differentiation and formation of functional T cells; Differentiation of B cells and formation of plasma and memory cells. Immune response-Primary and secondary. Effector mechanism of HMI and CMI. Cell mediated cytotoxicity, ADCC and Inflammation. Cytokines- Types, functions and applications.

Unit – V (**8 Hrs)**

Hypersensitivity: Mechanism and types of hypersensitivity. Autoimmunity and Immuno deficiency syndrome: Autoimmunity and autoimmune disorders. Immuno deficiency syndrome: AIDS due to deficient T and B cells, phagocytes, complement. Severe combined immunodeficiency syndrome.

Unit – VI (**8 Hrs)**

Tumor and Transplantation immunology: Tumor antigens and immunology to tumor cells. Transplantation immunology-Blood transfusion, Tissue transplantation and HLA typing. Immuno tolerance and Immuno modulators Vaccines- Types, production and immunization schedules.

References:

1. Bradley and Mecharty. Clinical Immunology. Oxford University Press, New York.
2. Abbas AK, Lichtman and Pobes. Cellular and Molecular Immunology. W.B. Saunders Co.,
3. Coleman. Fundamental Immunology. Brown Publishers. Bubuone Zowa.
4. Catty. Maintenance of Laboratory Animals and Production of antibodies.
5. Janis Kubey. Immunology. Freeman & Co., New York.
6. Janeway and Travers et al. Immunology. Churchill Publishers.
7. Stities, Tesss and Parslow. Medical Immunology. 9th Ed. Appleton & Lange, Connecticut.
8. Benjamin E, Coice R and Sunshine G. Immunology – A Short course. 4th Ed. Willey-Liss
9. Topley and Wilson. Principles of bacteriology, Virology and Immunity. Edward Arnold
10. Roitt I.M., 1994, Essential of Immunology, Raven Press, New York

MB-SCT 4.2. BASICS OF CLINICAL RESEARCH **(4 credits)**

52 Hrs

Preamble: *The major objective of the paper is to provide knowledge on scope, basics of clinical research and career opportunities for the students.*

Unit – I (**6 Hrs)**

Introduction to Clinical Research: Origin and History of Clinical Research ,Difference between Clinical Research and Clinical Practice ,Types of Clinical Research , Phases of clinical research. Historical guidelines in Clinical Research, Nuremberg code, Declaration of Helsinki Belmont report.

Unit – II (**8 Hrs)**

Introduction to Drug Discovery and drug Development: Basic pharmacology and Basic conceptual knowledge about receptors, drugs, preclinical studies, pharmacodynamics, pharmacokinetic (ADME), drug interactions, Introduction to pharmacoeconomics.

Unit – III (**12 Hrs)**

Clinical trials new drug discovery process: Clinical Trials in India –The National Perspective, purpose, main steps involved in new drug discovery process, timelines of each steps, advantages and purposes of each steps, thalidomide tragedy, Phase-I, II, III, IV trials.

Various phases of clinical trials -Post Marketing surveillance – methods, Principles of sampling, Inclusion and exclusion criteria -Methods of allocation and randomization -Informed consent process in brief -Monitoring treatment outcome -Termination of trial -Safety monitoring in clinical trials.

Unit – VI (**8 Hrs)**

Pre clinical toxicology: General principles, Systemic toxicology (Single dose and repeat dose toxicity studies), Carcinogenicity, Mutagenicity, Teratogenicity, Reproductive toxicity, Local toxicity, Genotoxicity, animal toxicity requirements.

Unit–V (**10 Hrs)**

Guidelines for Good Clinical Practice : The Principles of ICH GCP, Institutional Review Board / Independent Ethics Committee Investigator Sponsor, Clinical Trial Protocol and Protocol Amendment(S) Investigator's, Brochure Essential Documents for the conduct of a Clinical Trial Introduction of Clinical Trial Regulation, European Medicine Agency, Food and Drug Administration (US FDA), Drug and cosmetic act, Schedule Y, ICMR Guideline, clinical trial and data management, Career in Clinical Research.

References:

1. Basic and Clinical Pharmacology, Prentice hall, International, Katzung, B.G.
2. Clinical Pharmacology, Scientific book agency, Laurence, DR and Bennet PN.
3. Clinical pharmacokinetics, Pub. Springer Verlab, Dr. D.R Krishna, V. Klotz
4. Remington Pharmaceutical Sciences, Lippincott, Williams and Wilkins
5. Drug interaction, Kven Stockley. Hamsten
6. Drug interaction, Basic Bussiness Publ, Bombay, J.K. Mehra
7. Clinical pharmacology and drug therapy Grahame smith and Aronson,
8. Text Book of Therapeutics Drug and Disease Management Hardbound. Richard A Helms,
9. Clinical Pharmacy and therapeutics Herfindal E T and Hirschman JL, Williams and Wilkins.

BT-HCMP 4.3 MAJOR PROJECT (6 Credits)

Preamble: *Project work includes the major research problems associated with various fields relevant to microbiology which will help the students to understand, plan experimental designs and analyze the data of the experimental outcome. The outcome of the study will be having scientific relevance and commercial value.*

The candidate should submit an independent project report by the end of final year course on a topic relevant Microbiology, based on the laboratory experiments/case studies/field studies carried out in a Microbiology/related industry, it will be evaluated by external and internal examiners. It will be carried out 4th semester, but will be started in the 3rd semester. Three copies of the project report shall be submitted to the chairman, Department of Microbiology before one week of the theory examination of fourth semester.

The assignment of marks for Project is as follows:

Project dissertation	100 marks
Viva-voce	25 marks
Internal assessment	25 marks
Total	**150 marks**