KARNATAK UNIVERSITY, DHARWAD
ACADEMIC (S&T) SECTION

ಕರ್ನಾಟಕ ವಿಶ್ವವಿದ್ಯಾಲಯ, ಧಾರವಾಡ
ವಿದ್ಯಾಮಂಡಳ (ಎಸ್&ಟಿ) ವಿಭಾಗ

ಸ್ವಾತಂತ್ರ್ಯದ ಅಮೃತ ಮಹೋತ್ಸವ

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NAAC Accredited
'A' Grade 2014

website: kud.ac.in

No. KU/Aca(S&T)/JS/MGJ(Gen)/2024-25/436 Date: 11 NOV 2024

ಅಧಿಸೂಚನೆ

ವಿಷಯ: ರಾಷ್ಟ್ರೀಯ ಶಿಕ್ಷಣ ನೀತಿಯನುಸಾರ 2024-25ನೇ ಶೈಕ್ಷಣಿಕ ಸಾಲಿನಿಂದ ಎಲ್ಲ ಸ್ನಾತಕೋತ್ತರ ಪದವಿಗಳಿಗೆ / ಸ್ನಾತಕೋತ್ತರ ಡಿಪ್ಲೋಮಾಗಳಿಗೆ ಪಠ್ಯಕ್ರಮವನ್ನು ಪ್ರಕಟಣೆ ಕುರಿತು.

ಉಲ್ಲೇಖ: 1. ವಿದ್ಯಾವಿಷಯಕ ಪರಿಷತ್ ಸಭೆಯ ನಿರ್ಣಯ ಸಂಖ್ಯೆ: 2 ರಿಂದ 9, ದಿ: 08.11.2024.

2. ಮಾನ್ಯ ಕುಲಪತಿಗಳ ಅನುಮೋದನೆ ದಿನಾಂಕ: 11.11.2024.

ರಾಷ್ಟ್ರೀಯ ಶಿಕ್ಷಣ ನೀತಿಯನುಸಾರ 2024-25ನೇ ಶೈಕ್ಷಣಿಕ ಸಾಲಿನಿಂದ ಅನ್ವಯವಾಗುವಂತೆ, ಕರ್ನಾಟಕ ವಿಶ್ವವಿದ್ಯಾಲಯದ ಎಲ್ಲ ಸ್ನಾತಕೋತ್ತರ ಪದವಿಗಳಾದ M.A./ M.Sc / M.Com / MBA / M.Ed1 ರಿಂದ 4ನೇ ಸೆಮೆಸ್ಟರ್‌ಗಳಿಗೆ ಮತ್ತು 1 & 2ನೇ ಸೆಮೆಸ್ಟರ್‌ಗಳ ಸ್ನಾತಕೋತ್ತರ ಡಿಪ್ಲೋಮಾಗಳಿಗೆ ವಿದ್ಯಾವಿಷಯಕ ಪರಿಷತ್ ಸಭೆಯ ಅನುಮೋದನೆಯೊಂದಿಗೆ ಈ ಕೆಳಗಿನಂತೆ ಪಠ್ಯಕ್ರಮಗಳನ್ನು ಅಳವಡಿಸಿಕೊಳ್ಳಲಾಗಿದೆ. ಕಾರಣ, ಸಂಬಂಧಪಟ್ಟ ಎಲ್ಲ ಸ್ನಾತಕೋತ್ತರ ವಿಭಾಗಗಳ ಅಧ್ಯಕ್ಷರು / ಸಂಯೋಜಕರು / ಅಡಳಿತಾಧಿಕಾರಿಗಳು / ಮಹಾವಿದ್ಯಾಲಯಗಳ ಪ್ರಾಚಾರ್ಯರುಗಳು / ಶಿಕ್ಷಕರು ಸದರಿ ಪಠ್ಯಕ್ರಮಗಳನ್ನು ಅನುಸರಿಸುವುದು ಮತ್ತು ಸದರಿ ಪಠ್ಯಕ್ರಮವನ್ನು ಕ.ವಿ.ವಿ. ಅಂತರ್ಜಾಲ www.kud.ac.in ದಲ್ಲಿ ಭಿತ್ತರಿಸಲಾಗಿದನ್ನು ಸಂಬಂಧಪಟ್ಟ ವಿದ್ಯಾರ್ಥಿಗಳಿಗೆ ಸೂಚಿಸುವುದು.

Arts Faculty

Sl.No	Programmes	Sl.No	Programmes
1	Kannada	8	MVA in Applied Art
2	English	9	French
3	Folklore	10	Urdu
4	Linguistics	11	Persian
5	Hindi	12	Sanskrit
6	Marathi	13	MPA Music
7	MVA in Painting		

Faculty of Science & Technology

Sl.No	Programmes	Sl.No	Programmes
1	Geography	10	M.Sc (CS)
2	Chemistry	11	MCA
3	Statistics	12	Marine Biology
4	Applied Geology	13	Criminology & Forensic Science
5	Biochemistry	14	Mathematics
6	Biotechnology	15	Psychology
7	Microbiology	16	Applied Genetics
8	Zoology	17	Physics
9	Botany	18	Anthropology

Faculty of Social Science

Sl.No	Programmes	Sl.No	Programmes
1	Political Science	8	Journalism m & Mass Commn.
2	Public Administration	9	M.Lib. Information Science
3	History & Archaeology	10	Philosophy
4	A.I.History & Epigraphy	11	Yoga Studies
5	Economics	12	MTTM
6	Sociology	13	Women's Studies
7	MSW		

Management Faculty

Sl.No	Programmes	Sl.No	Programmes
1	MBA	2	MBA (Evening)

Faculty of Commerce

Sl.No	Programmes	Sl.No	Programmes
1	M.Com	2	M.Com (CS)

Faculty of Education

Sl.No	Programmes	Sl.No	Programmes
1	M.Ed	2	M.P.Ed

OEC subject for PG

Sl.No	Programmes	Sl.No	Programmes
1	Russian	5	Veman Peetha
2	Kanaka Studies	6	Ambedkar Studies
3	Jainology	7	Chatrapati Shahu Maharaj Studies
4	Babu Jagajivan Ram	8	Vivekanand Studies

PG Diploma

Sl.No	Programmes	Sl.No	Programmes
1	PG Diploma in Chatrapati Shahu Maharaj Studies	2	P.G. Diploma in Women's Studies
3	P.G. Diploma in Entrepreneurial Finance		

ಕುಲಸಚಿವರು.

ಅಡಕ: ಮೇಲಿನಂತೆ

ಗೆ,

1. ಕ.ವಿ.ವಿ. ಸ್ನಾತಕೋತ್ತರ ಅಧ್ಯಕ್ಷರುಗಳಿಗೆ / ಸಂಯೋಜಕರುಗಳಿಗೆ / ಆಡಳಿತಾಧಿಕಾರಿಗಳಿಗೆ / ಮಹಾವಿದ್ಯಾಲಯಗಳ ಪ್ರಾಚಾರ್ಯರುಗಳಿಗೆ
2. ಎಲ್ಲ ನಿಖಾಯದ ಡೀನರು, ಕ.ವಿ.ವಿ. ಧಾರವಾಡ.

ಪ್ರತಿ:

1. ಕುಲಪತಿಗಳ ಆಪ್ತ ಕಾರ್ಯದರ್ಶಿಗಳು, ಕ.ವಿ.ವಿ. ಧಾರವಾಡ.
2. ಕುಲಸಚಿವರ ಆಪ್ತ ಕಾರ್ಯದರ್ಶಿಗಳು, ಕ.ವಿ.ವಿ. ಧಾರವಾಡ.
3. ಕುಲಸಚಿವರು (ಮೌಲ್ಯಮಾಪನ) ಆಪ್ತ ಕಾರ್ಯದರ್ಶಿಗಳು, ಕ.ವಿ.ವಿ. ಧಾರವಾಡ.
4. ಅಧೀಕ್ಷಕರು, ಪ್ರಶ್ನೆ ಪತ್ರಿಕೆ / ಗೌಪ್ಯ / ಜಿ.ಎ.ಡಿ. / ವಿದ್ಯಾಂಡಳ (ಪಿ.ಜಿ.ಪಿಎಚ್.ಡಿ) ವಿಭಾಗ/ ಸಿಸ್ಟಮ್ ಅನಾಲೆಸಿಸ್ಟ್ / ಸಂಬಂಧಿಸಿದ ಪದವಿಗಳ ವಿಭಾಗಗಳು, ಪರೀಕ್ಷಾ ವಿಭಾಗ, ಕ.ವಿ.ವಿ. ಧಾರವಾಡ.
5. ನಿರ್ದೇಶಕರು, ಕಾಲೇಜು ಅಭಿವೃದ್ಧಿ / ವಿದ್ಯಾರ್ಥಿ ಕಲ್ಯಾಣ ವಿಭಾಗ, ಕ.ವಿ.ವಿ. ಧಾರವಾಡ.
6. ನಿರ್ದೇಶಕರು, ಐ.ಟಿ. ವಿಭಾಗ, ಕ.ವಿ.ವಿ. ಧಾರವಾಡ ಇವರಿಗೆ ಕ.ವಿ.ವಿ. ಅಂರ್ತಜಾಲದಲ್ಲಿ ಪ್ರಕಟಿಸುವುದು.

KARNATAK UNIVERSITY, DHARWAD

Faculty of Science and Technology

Two Years PG Programme

M.Sc. Microbiology

Programme structure and Syllabus

As per NEP-2020

With Effect from 2024-25

ABOUT THE DEPARTMENT

The Post Graduate Department of Microbiology and Biotechnology was established in the year 1999 and 2001 respectively in the beautiful campus of Karnatak University, Dharwad, Karnataka. Karnatak University is one of the premier universities catering the Microbiology and Biotechnology education to the northern Karnataka region. During the last five years the Department has made substantial progress in terms of research and generation of funds through sponsored research projects. Various funding agencies have sanctioned research projects which include three projects from DST, DBT, VGST, UGC etc. Microbiology and Biotechnology plays a pivotal role in human welfare. Realizing the scope and importance of biotechnology, Govt. of India has established Department of Biotechnology in the Ministry of Science and Technology in 1986 to promote the Research and Develop activities and commercialization of Biotechnological processes etc.

Microbiology overlaps the various other degree areas of biology like as molecular biology, genetics & immunology. Students can explore career scope in the field of Microbiology owing to its relevance in Pharmacy, Medicine, clinical research, agriculture, dairy industry, environment, fermentation & nanotechnology.

Biotechnology is one field that is closely associated with human life in many ways, from the making of bread to medicine, transgenic plants to animal. Biotechnology offers a diverse career scope for the students. One can chose the options like Microbiology, Genetic Engineering, Clinical Research, Biomedical Engineering, Immunology, Food technology etc.

In 2000, Government of Karnataka has announced the Millennium Biotech Policy. In this context, Karnatak University would provide trained manpower to biotechnology industry and the proposed M.Sc. Biotechnology and Microbiology courses intends to fulfill this objective.

Karnatak University with its life science faculty, specialized in different aspects of Biotechnology, is catering the needs in the development of the department. The staff along with the eminent biotechnologists from India is involved in designing the curriculum

The Department of Biotechnology and Microbiology is an independent department and it is an interdisciplinary course. All the formalities of establishing as separate department have been completed by getting the concurrence of appropriate university bodies and Vice Chancellor of University.

GENERAL INSTRUCTIONS

I. CREDIT, WORKLOAD AND SYLLABUS EQUIVALENCE:

1. One credit is equal to 1 hour theory teaching per week.
2. One credit is equal to 2 hour practical teaching per week.
3. One credit is equal to 15 hours theory syllabus per semester (1 Unit is equal to 15 Hours)
4. One credit is equal to 30 hours practical syllabus per semester (1 credit practical is equal to 2 hours/ week)

A. Workload for theory subjects:

1. There shall be 16 hrs/week workload for Assistant Professor
2. There shall be 14 hrs/week workload for Associate Professor/ Professor/Senior Professor.
3. There shall be 2hrs/week workload relaxation for Guiding Ph.D. students

B. Workload for practical subjects:

1. There shall be 20 hrs/week workload for Assistant Professor
2. There shall be 18 hrs/week workload for Associate Professor/ Professor/Senior Professor.
3. There shall be 2hrs/week workload relaxation for Guiding Ph.D. students

C. Workload for practical batches:

1. A batch of 10-12 students shall have 1 teacher

D. Workload for Project:

1. Students for projects / internship shall be preferably guided by permanent faculty for atleast10 students by sharing equally among the permanent faculty. If remained excess shall be allotted to other teacher's on roll on temporary basis.
2. If there are no permanent faculty, the students shall be distributed among the temporary teachers on roll.
3. There shall be maximum of 4 hrs/week workload for guiding the students for project work irrespective of number of students.

II. ALLOTMENT OF SPECIALIZATION:

While allotting specialization in 3rd and 4th semester, minimum of 10 students shall have to select the specialization

.

III. **ATTENDANCE:** 75% attendance is mandatory for every course (paper). No marks are reserved for attendance. If the candidates fail to fulfill 75% attendance in any one of the course (paper) in the given semester, such candidate is not eligible to appear for examination in all the papers and candidate has to get the readmission for such semester. However, up to 20% attendance may be condoned with the supportive documents for a student who represents University /State / National level sports, cultural and other events. Monthly attendance shall be displayed on notice board.

IV. CREDIT AND MARKS EQUIVALENCE:

1. Generally, 20% weightage for Formative assessment and 80% weightage for Summative assessment.
2. Up to 2 credits equal to 50 marks (10 marks Formative assessment and 40 marks summative assessment).
3. 3-4 credits equal to 100 marks (20 marks Formative assessment and 80 marks summative assessment).
4. 5-6 credits equal to 150 marks (30 marks Formative assessment and 120 marks summative assessment).
5. Example for 100 marks out of which 20 marks for Formative assessment i.e., Formative Assessment shall be in two internal assessments i.e.: 10 marks I.A. for 8th week and 10 marks for 14thweek of every semester.

V. Conduct of Examination:

1. Formative assessment examination shall be conducted for 1hr. There shall not be any provision for improvement. A special Formative assessment examination shall be conducted for a student who represents University /State / National level sports, cultural and other events if a schedule is overlapping.
2. 80 marks summative theory examination shall be conducted for 3 hrs and 40 marks for 1.5 hrs.
3. 80/ 40 marks Formative / Summative Practical examination shall be conducted for 4 hrs.
4. There shall be a single examiner for both even and odd semesters' Formative Practical examination.
5. There shall be a single examiner for odd semester Summative Practical examination and two examiners for even semester Summative Practical examination; one from internal and other shall be external examiner.

VI. Assessment:

1. **Theory papers:** There shall be a single valuation for odd semester theory papers preferably internal examiner and double valuation for even semesters; one from internal and other shall be external examiner.

2. **Project/Internship assessment**

A) **For150 marks Project/Internship assessment:**

i. **Formative Assessment**: Project/Internship assessment carrying 30 marks out of 150 marks Candidate has to submit two Progress Reports; each carries 15 Marks. i.e. 15 x 2= 30 marks.

ii. **Summative Assessment:** Project/Internship assessment carrying 120 marks out of 150 marks

a. Project Report : 50
b. Presentation : 30
c. Viva-voce : 40

VII. Passing criteria:

1. There shall be no minimum passing marks for Formative assessment.
2. Candidate has to score minimum 40% in summative examination and fulfill 40% of the maximum marks including Formative assessment marks. For example: for 80 marks summative examination, candidate has to score minimum of 32 marks (40%) and should score cumulatively 40 marks including formative assessment in every course.

VIII. DECLARATION OF RESULT:

1. Candidate has to score 40% as above in all the courses to pass the semester end examination to declare pass.
2. **Percentage and Grading:** Result shall be declared in terms of SGPA and at the end of four semesters as CGPA. The calculation of CGPA is as under
3. If P is the percentage of marks secured (IA + semester end score) by the candidate in a course which is rounded off to the nearest integer, the grade point (GP) earned by the candidate in that course will be given as below.

Percentage (%)	Grade(GP)	Percentage (%)	Grade(GP)
40	4.0	71-75	7.5
41-45	4.5	76-80	8.0

46-50	5.0	81-85	8.5
51-55	5.5	86-90	9.0
56-60	6.0	91-95	9.5
61-65	6.5	96-100	10.0
66-70	7.0		

Grade point of less than 4 shall be considered as fail in the course, hence, GP=0 and for the absent candidate also GP=0

4. A student's level of competence shall be categorized by grade point (GP), Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA) of the programme.

5. **Semester Grade Point Average (SGPA):** The SGPA is a ratio of sum of the number of Credit Grade Points scored from all the courses (subject) of given semester to the total credits of such semester in which the candidate studied. (Credit Grade Points of each course = Credits x GP).

6. **Cumulative Grade Point Average (CGPA):** It is calculated as below for 4 semester programme.
CGPA=$(Credit_1 \times SGPA_1) + (Credit_2 \times SGPA_2) + (Credit_3 \times SGPA_3) + (Credit_4 \times SGPA_4)$ / Total credits of programme (sum of credits of 4 semesters).

7. After studying and passing, all the credits prescribed for the programme the degree shall be awarded with CGPA score after rounding off to second decimal and class distinguishing as second class, first class, and distinction along with grade letter as under:

CGPA of the programme(Degree)	Class obtained	Grade Letter
9.5 to 10.00	Outstanding	A^{++}
7.00 to 9.49	Distinction	A^{+}
6.00 to 6.99	First Class	A
5.50 to 5.99	Second class	B^{+}
5.00 to 5.49		B
4.00 to 4.99	Pass	C
Less than 4.0	Fail/ Reappear	D

8. Each semester Grade Card shall have marks and SGPA and final Grade Card shall have semester wise marks obtained in all semesters, CGPA and % of cumulative marks obtained from all semesters.

9. There shall be Revaluation / Challenge valuations provisions as per the prevailing rules and regulations.

10. Marks obtained from the OEC shall not be considered for award of CASH PRIZE / RANK / GOLD MEDAL.

IX. MAXIMUM DURATION FOR COMPLETION OF THE PROGRAMME:

A candidate admitted to any P.G. Programme shall complete it within a period, which is double the duration of the programme from the date of admission.

X. ANY OTHER TERMS AND CONDITIONS:

Apart from the above, the prevailing rules and regulation are valid for any other matters which are not addressed in this regard.

Karnatak University, Dharwad

M.Sc..in **MICROBIOLOGY**

Effective from **2024-25**

Sem.	Type ofCourse	Theory/ Practical	Course Code	UUCMS Code	Course Title	Instruction hour/week	Total hours/ sem	Duration Of Exam	Marks			Credits
									Formative	Summative	Total	
I	DSC-1	Theory	**MB CT 1.1**	A1MCB001T	General Microbiology	04	60hrs	03hrs	20	80	100	04
	DSC-2	Practical	**MB CP 1.5**	A1MCB005P	General Microbiology	04	60 hrs	04hrs	10	40	50	02
	DSC-3	Theory	**MB CT 1.2**	A1MCB002T	Microbial Diversity & Taxonomy	04	60 hrs	03hrs	20	80	100	04
	DSC-4	Practical	**MB CP 1.6**	A1MCB006P	Microbial Diversity & Taxonomy	04	60 hrs	04hrs	10	40	50	02
	DSC-5	Theory	**MB CT 1.3**	A1MCB003T	Microbial Techniques	04	60 hrs	03hrs	20	80	100	04
	DSC-6	Practical	**MB CP 1.7**	A1MCB007P	Microbial Techniques	04	60 hrs	04hrs	10	40	50	02
	DSC-7	Theory	**MB CT 1.4**	A1MCB004T	Microbial Physiology & Metabolism	04	60 hrs	03hrs	20	80	100	04
	DSC-8	Practical	**MB CP 1.8**	A1MCB008P	Microbial Physiology & Metabolism	04	60 hrs	04hrs	10	40	50	02
								28	**120**	**480**	**600**	**24**
II	DSC-9	Theory	**MB CT 2.1**	A2MCB001T	Microbial Genetics & Molecular Biology	04	60hrs	03hrs	20	80	100	04
	DSC-10	Practical	**MB CP 2.5**	A2MCB004P	Microbial Genetics & Molecular Biology	04	60 hrs	04hrs	10	40	50	02
	DSC-11	Theory	**MB CT 2.2**	A2MCB002T	Computer Applications, Bioinformatics & Biostatistics	04	60hrs	03hrs	20	80	100	04
	DSC-12	Practical	**MB CP 2.6**	A2MCB005P	Computer applications, Bioinformatics & Biostatistics	04	60 hrs	04hrs	10	40	50	02
	DSC-13	Theory	**MB CT 2.3**	A2MCB003T	Genetic Engineering	04	60 hrs	03hrs	20	80	100	04
	DSC-14	Practical	**MB CP 2.7**	A2MCB006P	Genetic Engineering	04	60 hrs	04hrs	10	40	50	02
	OEC - 1	Theory	**MB ET 2.4**	A2MCB203T	Fundamentals & applications of Microbiology	04	60 hrs	03hrs	20	80	100	04
								24	**110**	**440**	**550**	**22**

Sem.	Type ofCourse	Theory/ Practical	Course Code	UUCMS Code	Course Title	Instruction hour/week	Total hours / sem	Duration Of Exam	Marks			Credits
									Formative	Summative	Total	
III	DSC-15	Theory	**MB CT 3.1**	A3MCB001T	Environmental Microbiology	04	60hrs	03 hrs	20	80	100	04
	DSC-16	Practical	**MB CP 3.5**	A3MCB004P	Environmental Microbiology	04	60 hrs	04 hrs	10	40	50	02
	DSC-17	Theory	**MB CT 3.2**	A3MCB002T	Agricultural Microbiology & Plant pathology	04	60 hrs	03 hrs	20	80	100	04
	DSC-18	Practical	**MB CP 3.6**	A3MCB005P	Agricultural Microbiology & Plant pathology	04	60 hrs	04 hrs	10	40	50	02
	DSC-19	Theory	**MB CT 3.3**	A3MCB003T	Food & Dairy Microbiology	04	60hrs	03 hrs	20	80	100	04
	DSC-20	Practical	**MB CP 3.7**	A3MCB006P	Food & Dairy Microbiology	04	60 hrs	04 hrs	10	40	50	02
	OEC - 2	Theory	**MB ET 3.4**	A3MCB203T	Food & Fermentation Technology	04	60 hrs	03 hrs	20	80	100	04
								24	**110**	**440**	**550**	**22**
IV	DSC-21	Theory	**MB CT 4.1**	A4MCB001T	Immunology &Immunotechnology	04	60hrs	03 hrs	20	80	100	04
	DSC-22	Practical	**MB CP 4.4**	A4MCB004P	Immunology &Immunotechnology	04	60 hrs	04 hrs	10	40	50	02
	DSC-23	Theory	**MB CT 4.2**	A4MCB002T	Medical Microbiology	04	60hrs	03 hrs	20	80	100	04
	DSC-24	Practical	**MB CP 4.5**	A4MCB005P	Medical Microbiology	04	60 hrs	04 hrs	10	40	50	02
	DSC-25	Theory	**MB CT 4.3**	A4MCB003T	Bioprocess and Fermentation Technology	04	60hrs	03 hrs	20	80	100	04
	DSC-26	Practical	**MB CP 4.6**	A4MCB006P	Bioprocess and Fermentation Technology	04	60 hrs	04 hrs	10	40	50	02
	Project - 1	Practical	**MBCPJ 4.7**	A4MCB007P	**Project Work/Dissertation**				25	125	150	06
								21	**115**	**485**	**600**	**24**

M.Sc. Microbiology

Programme Outcomes :

1: Develop thorough knowledge in understanding basic concepts of all the dimensions in Microbiology.
2: Students get an advanced outlook on the recent findings in all fields of Microbiology
3: Comprehensive understanding of microorganisms (bacteria, viruses, fungi, parasites).
4: Students acquire in depth knowledge of microbial physiology, genetics, and metabolism.
5: Students will understand the importance of immunology, microbiome, and infectious disease.
6: Understanding of microbial interactions with environment and hosts, and expertise in microbiological techniques (culturing, microscopy, molecular biology, PCR, sequencing).
7: Become efficient in managerial skills by learning Computer Science, Bioinformatics, Biostatistics and their applications in Microbiology. Employ analytical reasoning, problems solving, interpretation and documentation of experiments in Microbiology
8: Get acquainted with the tools, techniques and applications of Genetic engineering
9: Acquire thorough knowledge on Microbiology and its various applications.
10: Become an insightful individual with an in depth understanding of various research directions and methods.

M Sc. MICROBIOLOGY SEMESTER – 1

Discipline Specific Course (DSC)

Course Title: MBCT 1.1 - GENERAL MICROBIOLOGY

Course Code: A1MCB001T

Type of Course	Theory /Practical	Credits	Instruction hour per week	Total No. of Lectures/ Hours/Semester	Duration of Exam	Formative Assessment Marks	Summative assessment Marks	Total **Marks**
DSC	**Theory**	**04**	**04**	**60 hrs.**	**3 hrs.**	**20**	**80**	**100**

Course outcome:

After completion of course (Theory), students will be able to:

CO 1: At the end of the course the student will have broad and balanced knowledge of Microbiology. The History, general characters and classification of Microorganisms.

CO 2 : Understanding the different branches of microbiology.

CO 3 : Comprehend evolutionary importance of prokaryotic and eukaryotic cells.

CO 4 : Understanding the structural organization of the bacteria and eukaryotic microorganism.

Unit	Content	60 hrs/Sem
I	**History and Scope of Microbiology** **Basic microbiology:** Landmark achievements in 20th century: Reputation of a biogenesis: discovery of penicillin, Theory of Spontaneous generation. Major contribution of scientists– Antony Van Leeuwenhoek, Edward Jenner, Alexander Fleming, Joseph Lister, Robert Koch, Louis Pasteur. (8 Hours) **Introduction to branches of microbiology:** Air Microbiology**,** Water Microbiology**,** Sewage Microbiology**,** Soil Microbiology**,** Dairy Microbiology**,** Food Microbiology**,** Medical Microbiology**,** Industrial Microbiology**,** Biotechnology**,** Geo-microbiology, Microbial nanotechnology. (7 Hours)	**15**
II	**Prokaryotic and Eukaryotic cells** **Introduction and evolution of Prokaryotic and Eukaryotic cells:**	**15**

	Structural organization of Prokaryotic and Eukaryotic cells. (2 Hours) **Major groups of Microorganisms:** Bacteria, Fungi, Algae, Protozoa and Virus. (3 Hours) **Bacteria:** Morphology of Bacteria size, shape, arrangements, structure and functions of cell wall, cell membrane, capsule and slime layer, Flagella, Pilli, Nuclear material, Mesosome, Ribosome. (6 Hours) **General characteristics of bacteria** *Spirochetes, Rickettsia, Chlamydia, Mycoplasma, Cyanobacteria, Actinomycetes, Archeabacteria*. Beneficial and harmful microorganisms, Growth and reproduction of bacteria-effect of nutritional and environmental factors on bacterial growth. (4 Hours)	
III	**Fungi and Algae** **Fungi:** History and scope of Mycology, General Characteristics of Fungi, Classification and Identification of fungi -Basidiomycetes, Ascomycetes, Deuteromycetes, Oomycetes, Hypochytriomycetes and Symbiotic fungi (Lichens), Growth and reproduction of fungi-effect of nutritional and environmental factors on fungal growth. (8 Hours) **Algae:** History and development of Algae**,** General Characteristics of Algae, Classification, Growth and reproduction of Algae, Cultivation of algae, media, photo-bioreactors. Economic importance of *Spirulina, chlorella, Nostoc and, Anabaena*. (7 Hours)	**15**
1V	**Protozoa & Viruses** **Protozoa:** History of Protozoa**;** Classification, Growth and reproduction of Protozoa. General Characteristics of Protozoa: *Paramoecium, Amoeba, Euglena, Trypanosoma and plasmodium.* (7 Hours) **Viruses:** Types and classification of viruses, Structural organization of viruses with examples: Capsids and Nucleic acids, Envelope and Structure of T4 bacteriophage, TMV, HIV. Brief introduction about Viroids, Virions and Prions. (8 Hours)	**15**

Course Title: MB CP 1.5 Based on MB CT 1.1–General Microbiology

Course Code: A1MCB005P

Type of Course	Theory /Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours /Semester	Duration of Exam	Formative Assessment Marks	Summative assessment Marks	Total **Marks**
DSC	**Practical**	**04**	**04**	**60 hrs.**	**4 hrs.**	**10**	**40**	**50**

PRACTICALS

1. Safety Measures in the Microbiology laboratory.
2. Calibration of Microscope and Micrometry.
3. Study of instruments–Autoclave, Hot air Oven, Incubator, Laminar air flow, Centrifuge, pH meter, Colorimeter, Spectrophotometer.
4. Preparation of media and stains for microbial work.
5. Isolation of different groups of microorganisms (Algae, Fungi, Bacteria and Protozoa) by various methods.
6. Staining methods: Wet mount, Simple and Gram staining.
7. Study of motility of cells by hanging drop technique.
8. Staining of different groups of microorganisms-Algae, Fungi, Bacteria and Protozoa.
9. Methods of microbial culture preservations.
10. Effect of Temperature and pH on the growth curve of bacteria (*E.coli*).
11. Effect of antibiotics on bacterial growth–paper disc and cup plate method.

REFERENCES

1. Alexopoulos, C.J., Mims, C.W. and Blackwell, M. (1996). Introductory Mycology, Fourth Edition, WileyPiublishers, New York.
2. Atlas, R.A. and Bartha, R. (2000). Microbial Ecology – Fundamentals and Application, Fourth Edition, Benjamin Cummings, New York.
3. Black, J.G. (2005). Microbiology: Principles and Explorations, Sixth Edition, John Wiley, USA.

4. Dimmock, N.J., Easton, A.J. and Leppard, K.N. (2001). Introduction to Modern Virology, Seventh Edition, Blackwell Science Ltd, U.K.

5. Dube, R.C. and Maheswari, D.K. (2000) General Microbiology. S Chand, New Delhi.

6. Madigan, M.T., Martinkl, J.M. and Parker, J. (2000). Brock Biology of Microorganisms, Ninth Edition, MacMillan Press, England.

7. Moore – Landecker, E. (1996). Fundamentals of Fungi, Fourth Edition, Prentice-Hall, NJ, USA.

8. Pelczar, M.J., Chan, E.C.S. and Kreig, N.R. (1993). Microbiology. Fifth Edition, Tata Mc Graw Hill Publishing Co., Ltd., New Delhi.

9. Power, C.B. and Daginawala, H.F. (1986). General Microbiology Vol I & II (Second Edition), Himalaya Publishing House, Mumbai.

10. Prescott, M.J., Harley, J.P. and Klein, D.A. (2002). Microbiology. Fifth Edition, WCB McGraw Hill, New York.

11. Ram Reddy, S. and Reddy, S.M. (2007). Essentials of Virology. Second Edition, Scientific Publishers India, Jodhpur.

12. Singh, R.P. (2007). General Microbiology. 2021 Edition, Kalyani Publishers, New Delhi.

13. Stanier, R.Y., Adelberg, E.A. and Ingram, J.L. (1991). General Microbiology, Fifth Edition,Prentice Hall of India Pvt. Ltd., New Delhi.

14. Sullia, S.B. and Shantaram, S. (1998). General Microbiology, Second Edition, Oxford & IBH Publishing Pvt. Ltd., New Delhi.

15. Talaro, K. and Talaro, A. (1996). Foundations in Microbiology. Second Edition. UMC Brown Publications.

16. Tortora, G.J., Funke, B.R. and Case, C.L. (2004). Microbiology: An Introduction. Eleventh Edition, Pearson Education, Singapore.

17. Webster, J. (1980). Introduction to Fungi, Cambridge University Press, Cambridge, England.

M Sc. MICROBIOLOGY SEMESTER – 1

Discipline Specific Course (DSC)

Course Title: MBCT 1.2 – MICROBIAL DIVERSITY AND TAXONOMY

Course Code: A1MCB002T

Type of Course	Theory /Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours /Semester	Duration of Exam	Formative Assessment Marks	Summative assessment Marks	Total **Marks**
DSC	**Theory**	**04**	**04**	**60 hrs.**	**3 hrs.**	**20**	**80**	**100**

Course outcome:

After completion of course (Theory), students will be able to understand

CO 1: At the end of the course the student will have broad and balanced knowledge of Microbial diversity and interaction among microorganisms

CO 2: Understanding the diversity of microorganisms and their concept with view on microbial interaction.

CO 3: Comprehend microbial taxonomical with broad knowledge on taxonomic ranks, nomenclature rules and identification criteria.

CO 4 : Understanding the different microbial taxonomical methods for classification.

Unit	Content	60 hrs/Sem
I	**Microbial Diversity** **Concepts and scope**: Methods used in the study of microbial taxonomy and diversity. Diversity of microorganisms at different levels of assessment and measure of microbial diversity, factors influencing microbial diversity. (8 Hours) Microbial diversity as a source of innovations in biotechnology, biotechnological approaches to improve microbial diversity and bio-productivity. (7 Hours)	**15**
II	**Microbial Ecology and Interactions** Ecology of microbial cells and population ecology, distribution and significance of viruses, bacteria, fungi, algae and protozoa. Microbial ecosystem of soil, air and water. Study of Winogradsky column. (7 Hours) **Microbial interactions:** Basic principles and types, intra and inter-specific	**15**

	illustrations. Types of interactions-mutualism, commensalism, parasitism, competition, and predation. Mechanisms of interactions-secondary metabolites, siderophores, quorum sensing system, biofilm formation, and cellular transduction signalling. (8 Hours)	
III	**Microbial Taxonomy** **Taxonomic ranks**, nomenclature rules, identification, Classification systems, microbial diversity and evolution. (5 Hours) **Recent trends in microbial taxonomy and Chemo-taxonomy:** Cell wall components, lipid composition, isoprenoid sequences, Cytochrome composition, amino acids, sequences of proteins, protein profile, DNA, DNA homology, RNA homology, G+C ratio, RNA sequencing., Numerical taxonomy, Serological Methods, Molecular methods in taxonomy.(10 Hours)	**15**
1V	**Classical Taxonomy** **Microbial taxonomy:** Taxonomy and classification, identification and nomenclature of microbes (algae, protozoa, slime moulds, fungi, bacteria, archaea and viruses). Polyphasic classification approaches. (7 Hours) **Classical Taxonomy:** Haeckle's three kingdom concepts, Whittaker's five-kingdom concept, three domain concept of Carl Woose criteria used for classification of microorganisms, Classification according to Bergey's manual of systematic bacteriology. (8Hours)	**15**

Course Title: MB CP 1.6 Based on MB CT 1.2 – Microbial Diversity & Taxonomy

Course Code: A1MCB006P

Type of Course	Theory /Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours /Semester	Duration of Exam	Formative Assessment Marks	Summative assessment Marks	Total **Marks**
DSC	**Practical**	**02**	**04**	**60 hrs.**	**4 hrs.**	**10**	**40**	**50**

PRACTICALS

1. Isolation and enumeration of bacteria, actinomycetes, fungi and yeasts from soil, water and air samples using different selective media.
2. Isolation and enumeration of microorganisms from polluted environments.
3. Isolation and enumeration of microorganisms in extreme environments.
4. Study of biochemical tests-IMVIC test, urease test, citrate utilization test, gelatin hydrolysis test, starch hydrolysis test, cellulose degradation test, catalase test, oxidase test, coagulase test, H_2S production test, nitrate reduction, optochin sensitivity test, esculin hydrolysis test.
5. Microbial taxonomy- DNA homology test and serological methods
6. Observation of permanent slides of virus (infected specimens), bacteria, actinomycetes, fungi, yeasts and algae.

a) Bacteria: *Staphylococcus* spp. and *Streptococcus* spp., *Bacillus* spp. *Clostridium* spp., *Campylobacter* spp., and *Vibrio* spp.

b) Algae: *Cyanobacteria Spirulina, Anabaena Chlorella, Scenedesmus, Spirogyra, Diatoms* and*Gracilaria*.

c) Fungi/ Yeast: *Pythium, Rhizopus, Saccharomyces, Penicillium, Aspergillus, Fusarium, Agaricus.*

d) Virus infected Plant materials: TMV/ Bean mosaic.

e) Protozoa: *Euglena, Paramaecium, Entamoeba histolytica*

REFERENCES

1. Magurran A.E, (1998) – Ecological diversity and its measure. PrincetonUniversity Press, Priceton, N.J.
2. Cowld, D (1999) – microbial Diversity, Academic Press.
3. Wilkinson, J.F, (1997) Basic Microbiology. Panima Book Distributors. New Delhi.

4. Sneath P.H.A, Mair. N.S, Elizabeth, M. Bergey's Manual of Systemic Bacteriology.

5. Flesentein J. (1983) – Numerical Taxonomy. Nato ASI Series, Springer-Verlag N.Y.

6. Biswas, S.B and Anitha Biswas (1997) – An Introduction to viruses. 4th Revised Edition, Vikas Publishing house Pvt. Ltd. New Delhi.

7. Breiman, L, Friedman, J.H, Olsen, R.A. and Stone, C.J (1984) – Classification and regression Trees. Wadsworth and Brooks/ Cole, Pacific Grav, CA.

8. AlexopoulosC .J and Mims (1979) Introductory Mycology, Wiley Eastern Limited. New Delhi.

9. Atlas R. M (1998) Microbiology, Fundamentals and Applications 2ndEdn. Mac Millan Publishing Company.

10. Brock T .D, Madigan M T, Prentice Hall Int. Inc. Biology of Microorganisms.

11. Ram R C (2007) Microbial Diversity-Modern Trends, Mittal publications. New Delhi.

12. Agarwal K C. (1996) Biodiversity, - Agro- Botanical Publishers, New Delhi.

13. Singh, H.B., Vijai, G.K and Jogaiah, S. 2018. New and Future Developments in Microbial Biotechnology. Elseiver Publications, UK.

M Sc. MICROBIOLOGY SEMESTER – 1

Discipline Specific Course (DSC)

Course Title: MBCT 1.3 –MICROBIAL TECHNIQUES

Course Code: A1MCB003T

Type of Course	Theory /Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours/Semester	Duration of Exam	Formative Assessment Marks	Summative assessment Marks	Total Marks
DSC	**Theory**	**04**	**04**	**60 hrs.**	**3 hrs.**	**20**	**80**	**100**

Course outcome:

After completion of course (Theory), students will be able to understand

CO 1: At the end of the course the student will have broad and balanced knowledge of basic principle and application of different microscopes

CO 2 : Understanding the principle and working method of various types of sterilization.

CO 3 : Learning and practicing professional skills in handling the microorganism. Thorough knowledge and application of good laboratory and good manufacturing practices in microbial quality control.

CO 4 : Acquire the application and working methods of chromatography techniques.

Unit	Content	60 hrs/Sem
I	**Microscopy and specimen preparation** **Microscopy:** Basic principles and applications of light, phase, fluorescent, Bright field, Dark field and electron microscopes (TEM & SEM), Confocal microscopy, Scanning probe microscopy, Micrometry, AFM, Super resolved fluorescence microscopy, Cryo-electron microscopy. (10 Hours) **Sample preparations:** fixing of specimens, preparation of blocks, microtome, cytometer and flow-cytometer. (5 Hours)	**15**

II	**Basic principles and methods of sterilization** **Physical methods:** Dry and moist heat, Filtration, Radiation: -Ionizing (gamma rays, X-rays) and non-ionizing (UV light),Ultrasonic bath (physical method used for disinfection, especially for cleaning surfaces and tools in microbiology labs). (4 Hours) **Chemical methods:** Phenols, Alcohols, Halogens, Heavy metals, Aldehydes, Quaternary ammonium compounds, disinfectants and gases. (3 Hours) **Microbiological media:** Definition, components, types and preparation, enrichment and preservation of media, pH and Buffer & types (Biological buffers, Eg: - TBS-Tris buffered Saline, PBS-Phosphate-buffered saline). (4 Hours) **Stains and staining techniques:** Nature of stains, principle, mechanism, types and method of staining: simple, negative, differential and structural staining. (4 Hours)	**15**
III	**Microbial cultures, growth & Metagenomics** **Isolation of microbial cultures:** Serial dilution, inoculation techniques: spread plate, streak plate, Pour plate, micromanipulator method, colony morphology and characteristics of cultures. Maintenance and preservation of pure cultures, preservation techniques (e.g., cryopreservation, lyophilization), culture collection centers- National and international.(8 Hours) **Measurement of Microbial growth:** Direct method, direct microscopic plate, standard plate count, filtration, MPN, indirect method, turbidity, metabolic activity& dry weight. (4 Hours) **Analysis of metagenomics:** Metagenomics, culture independent analysis of microbes, phospholipids, fatty acids analysis, fluorescent insitu hybridization (FISH), genomic insituhybridization (GISH). (3 Hours)	**15**
1V	**Microbial Techniques** **Chromatographic techniques:** Principles, types and applications of gas chromatography, GC-MS, LC – MS / MS, MALDI TOF mass spectrometer for microbial identification, Ion exchange chromatography, gel permeation, affinity and reverse phase chromatography, HPLC, FPLC& UPLC. (4 Hours) **Electrophoretic Techniques:** Types of electrophoresis, paper and gel electrophoresis (Starch, Acrylamide and Agarose), Capillary, Disc and Slab, vertical gel electrophoresis (SDS-PAGE, native PAGE, Iso-electric focusing and 2-D gel, immunoelectrophoresis, pulse-field gel electrophoresis (PFGE), blotting of nucleic acids and proteins. (4Hours)**Spectroscopy Techniques:** Spectroscopy Principle and applications of spectrophotometer UV/visible, fluorescence, circular dichroism, Raman spectra, NMR and ESR spectroscopy, Mass Spectrometry, X-ray diffraction and crystallography. (2 Hours)	**15**

	Radio isotopic Techniques: Nature of radioactivity and general principles of radio-isotopic techniques, Methods of detection of radioactivity – gas ionization (GM counter), excitation (scintillation) and exposure of photographic emulsions (autoradiography). Methods of using radioisotopes – radioisotope tracer technique, isotope dilution assay and other methods, effects of radioactivity on matter, biological effects of radiation, applications of radio isotopes. (5 Hours)	

Course Title: MB CP 1.7 Based on MB CT 1.3 – Microbial Techniques

Course Code: A1MCB007P

Type of Course	Theory /Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours/Semester	Duration of Exam	Formative Assessment Marks	Summative assessment Marks	Total **Marks**
DSC	**Practical**	**02**	**04**	**60 hrs.**	**4 hrs.**	**10**	**40**	**50**

PRACTICALS

1. Microscopy–Compound, Dark field, Phase contrast, Fluorescent, Electron, (SEM and TEM).
2. Sterilization technique–physical methods and chemical methods.
3. Preparation of culture media – broth, semi solid, and solid media.
4. Isolation of pure culture microorganism and cultivation
5. Isolation and enumeration of microorganisms by serial dilution methods.
6. Staining techniques
   a. Simple and Negative Staining
   b. Differential staining–Gram staining. Acid fast staining,
   c. Structural Staining-flagellar staining, Endospore staining, capsule staining and cell wall staining
   d. Reserved food materials–starch granules, glycogen granules and volutin granules.
7. Study of spectrophotometer rand colorimetric techniques.
   a. Extraction of microbial pigments and profiling using UV-Vis spectrophotometer
   b. Colorimetric determination of anyone amino acid.
8. Study of chromatographic techniques.
   a. Paper Chromatography of amino acids and sugars.
   b. Separation of pigments by adsorption chromatography.
   c. Quantitative estimation of hydrocarbons/pesticides/organic solvents/methane by gas chromatography

9. Isolation and estimation of proteins and nucleic acids from cells.
10. Qualitative estimation of DNA by DPA method.
11. Qualitative estimation of RNA by Orcinol method.
12. Study of Electrophoretic techniques and Gel documentation methods.

REFERENCES

1. James Miller, Chromatography: Concepts and Contrasts, (1988), John Wiley and SonsInc., New York.
2. B.D.Singh. (2017).Biotechnology ,Kalyani Publishers.
3. Collins,C.H.,TatricaM.Lyne&Grange,J.M.(2004).Microbiologicalmethods,8th edition,Arnol d publishers.
4. Misener,S., and Krawetz,S.A.,(2000). Methodsin Molecular Biology–Bioinformatics.Methodsand Protocols, Humana Press.
5. MountD.W.(2001).Bioinformatics. Sequence and Genome Analysis, Cold Spring Harbor Laboratory Press.
6. Peleczar, M.J. Chan, Eosa and Kreig, N.R. (2001). Microbiology, 5th edition, McGrawHillInc.New York.
7. Persy,Staley,Lory–(2001)MicrobialLife,PanimaBookDistributors,NewDelhi.
8. Purohit,S.S.(2002).Microbiologyfundamentalsandapplications.Agrobios(India).
9. R.K.Sharma.(2009).BasicTechniquesinBiochemistryandMolecularBiology.I.K.Internationall Publishing House Ltd.New Delhi.
10. Singer,S.(2001).Experiments in Applied Microbiology .Academic Press.
11. Sullia, S.B. and Shantaram, S. (2006). General microbiology, 2nd edition, Oxford IBH, NewDelhi.
12. Upadhyay&Nath.(2016).Biophysicalchemistry:principlesandtechniques,4th edition,Himala yaPublishingHousePvt.Ltd.
13. Woolverton,J.C,Sherwood,L.(2017).Prescott'sMicrobiology,10th edition,McGrawHill.
14. James Miller, Chromatography: Concepts and Contrasts, (1988), John Wiley and SonsInc., New York.
15. Singh,H.B.,Vijai,G.KandJogaiah,S.(2018).New and Future Developments in Microbial Biotechnology. Elsevier Publications, UK.
16. Wilson And Walkers Principles And Techniques Of Biochemistry And Molecular Biology 8Ed (Sae) (Pb 2018).
17. Murugalatha, N., Growther, L., Hena, J. V., Shenpagam, N. H., Anitha, R., Devi, D. K., & Rajalakshmi, G. (2022). *Microbiological techniques*. MJP Publisher.

M Sc. MICROBIOLOGY SEMESTER – 1

Discipline Specific Course (DSC)

Course Title: MB CT 1.4 –MICROBIAL PHYSIOLOGY AND METABOLISM

Course Code: A1MCB004T

Type of Course	Theory /Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours/Semester	Duration of Exam	Formative Assessment Marks	Summative assessment Marks	Total Marks
DSC	**Theory**	**04**	**04**	**60 hrs.**	**3 hrs.**	**20**	**80**	**100**

Course outcome:

After completion of course (Theory), students will be able to understand

CO 1: At the end of the course the student will have broad and balanced knowledge of enzymes and mechanism of action including its kinetics.

CO 2 : Understanding the nutritional parameters for microbial growth and their metabolism.

CO 3 : Acquire the knowledge on the photosynthesis concept, bacterial respiration and stress response of microorganisms to various environmental factors. .

CO 4 : Understanding the microbial metabolism of carbohydrate, lipid, protein, amino acid and Nucleotide.

Unit	Content	60 hrs/Sem
I	**Enzymes** Definition, Structure, enzymes as biocatalysts properties and classification:specificity, active sites, coenzymes: Activators and inhibitors, activity unit, isozymes, enzyme kinetics (negative and positive comparatively); Michaelis–Menton equation for simple enzymes. (7 Hours) **Determination of kinetic parameters (K_M, V_{max}, Ki):** Multi-step reactions and rate limiting steps, enzyme inhibition, allosterism, Kinetic analysis of allosteric enzymes principles of allosteric regulation, Ribozyme and abzyme. (8 Hours)	**15**
II	**Microbial Nutrition, Factors and Microbial Photosynthesis** Modes of nutritional uptake: Entry of nutrition in the cell, passive diffusion, facilitated diffusion and active transport, Utilization of nutrients, Microbial	**15**

	growth–Growth Curves, Phases of growth, factors influencing growth, chemostat, turbidostat, and measurement of growth, continuous and synchronous growth and growth kinetics. Classification of bacteria on the basis of growth supporting environmental factors such as oxygen, temperature, pH, osmotic pressure, salt and hydrostatic pressure. (9 Hours) **Microbial Photosynthesis:** Concept of photosynthesis and associated pigments in microbes; photosynthetic apparatus in prokaryotes and eukaryotes, anoxygenic and oxygenic photosynthesis, light and dark reaction; photorespiration and its significance, Effect of light, temperature, pH and CO_2 concentration on photosynthesis, measurement of net photosynthetic yield. (6 Hours)	
III	**Metabolism** **Carbohydrate Metabolism:** Classification and characteristics of carbohydrates. Glycolysis, TCA cycle, glyoxylate pathway, pentose phosphate pathway, Special microbial roots for metabolism of monosaccharaides, gluconeogenesis, glycogenolysis and glycogenesis, substrate level phosphorylation, pasteur effect. (4 Hours) **Lipid metabolism:** Classification and characteristics of lipids, β-oxidation, extra-mitochondrial fatty acid synthesis, microsomal chain elongation, metabolism of acyl glycerols and sphingolipids, biosynthesis of phospholipids, Ketosis, Keto acidosis, Ketogenesis, Ketolysis, metabolism of cholesterol. (4 Hours) **Protein and Amino acid metabolism:** Classification and characteristics of proteins and aminoacids, essential and non essentialaminoacids, transamination, deamination, decarboxylation, NH_3 transport, urea formation, significance and regulation of urea synthesis, Metabolism of aromatic aminoacids – tyrosine, tryptophan, phenyl alanine, Metabolism of sulphur containing aminoacids – L – methionine, L – cysteine, L – cystine and their metabolic role. Metabolism of other aminoacids like glycine, serine and Histidine **Nucleotide metabolism:** Structure and characteristics of nucleic acids biosynthesis of purines & pyrimidines, regulation of nucleotide synthesis, catabolism of nucleotides. (2 Hours)	**15**
1V	**Bacterial Respiration and Microbial stress responses** **Bacterial Respiration:** Bacterial aerobic respiration, components of electron transport chain, free energy changes and electron transport, oxidative phosphorylation and theories of ATP formation, inhibition of electron transport chain and photophosphorylation, Electron transport chain in heterotrophic and chemo-lithotrophic bacteria. Bacterial anaerobic respiration: nitrate, carbonate and sulfate as electron acceptors, electron transport chains in anaerobic bacteria, catalase, super oxide dismutase, mechanism of oxygen toxicity. (8 Hours) **Microbial stress responses:** Osmotic stress and osmoregulation, aerobic and anaerobic transitions, Oxidative stress, pH stress and acid tolerance, thermal stress and heat shock response, nutrient stress and starvation stress. Fermentative pathways in specific group of microbes: alcoholic, lactic acid, formic, mixed, propionic, butyric, butanol, butanediol fermentation. (7 Hours)	**15**

Course Title: MB CP 1.8 Based on MB CT 1.4 - Microbial Physiology And Metabolism.

Course Code: A1MCB008P

Type of Course	Theory /Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours/Semester	Duration of Exam	Formative Assessment Marks	Summative assessment Marks	Total **Marks**
DSC	**Practical**	**02**	**04**	**60 hrs.**	**4 hrs.**	**10**	**40**	**50**

PRACTICALS

1. Determination of bacterial/ yeast growth curve and generation time.
2. Determination of optimum pH, temperature and O_2 for growth of bacteria and fungi.
3. Effect of different substrates (primary, secondary & tertiary) on phases of microbial growth.
4. Estimation of microbial enzymes (activity and specific activity) – amylase, protease, invertase, cellulase, lipase, catalase and phosphatase.
5. Determination of Km and Vmax and Ki.
6. Extraction and separation of microbial metabolites by paper chromatography (aflatoxins, enzymes, amino acids, bacteriocins, organic acids, pigments, bioactive compounds, and vitamins).
7. Effect of pH, temperature, enzyme concentration, substrate concentration and inhibitors on enzyme activity.
8. Lipid saponification value of fats and iodine number of fatty acids.
9. Qualitative analysis of lipids.
10. Qualitative and quantitative estimation of carbohydrates/proteins/amino acids.
11. De-amination of amino acids.
12. De-carboxylation of amino acids.

REFERENCES

1. Arora D.K. and Seema Gupta (1996), Bacterial Physiology. Anmol Publications, New Delhi.
2. Palmer T. (2001), Biochemistry, Biotechnology and Clinical Chemistry. Harwood Publications, Chichester.
3. Boyer R. (2002), Concepts in Biochemistry 2nd Edition, Brooks/Cole, Australia.
4. Moat A.G., Foster J.W. Spector.
5. (2004), Microbial Physiology 4th Edition Panama Book Distributors.
6. Caldwell, D.R. (1995) - Microbial Physiology and Metabolism. Brown Publishers.
7. Lodish H, T. Baltimore, A. Berck B.L. Zipursky, P. Mastsydaire and J.Darnell.(2004) - Molecular Cell Biology, Scientific American Books, Inc. Newyork.
8. J.Robin Harris, John Graham, David Rickwood – Cell Biology Protocols. Panima Book Distributors. New Delhi.
9. N.S. Sharma (2005), Molecular Cell Biology.
10. KalapanaTrivedi(2007), Molecular and Developmental Biology.
11. Bacterial signalling, Kramar and Jung Microbial Physiology, Moat, Foster and Spector.
12. The Physiology and Biochemistry of prokaryotes, David White Bacterial physiology: A molecular approach, W. E. Sharoud Topic related review articles.
13. Madigan, M.T., Martinka, M., Parker, J. and Brock, T.D. (2000). Twelth Edition, Biology Microorganisms, Prentice Hall, New Jerry.
14. Moat, A.G. and Foster, W.(2002). Microbial Physiology, Fourth Edition, John Wiley and Sons, New York.
15. Postgate,J. (1998), Nitrogen Fixation, third edition, Cambridge University Press.
16. Salisbury,F.W. and W.Ross, (1992), Plant Physiology, fourth edition, Wardsworth Publishing Company, California.
17. Deb, A.C. (2006). Fundamentals of Biochemistry, New Central Book Agency Pvt. Ltd., Kolkata.
18. Donald Voet and Judith G. Voet, (2011). Biochemistry. Third Edition, John Wiley and Sons, Inc. New York.
19. Stryer, L. (2010). Biochemistry, Seventh Edition, W.H. Freeman and Company, New York.
20. Nelson, D.L. and Cox, M.M. (2012). Lehingers's Principles of Biochemistry, Sixth Edition, Mac Millan worth Publishers, New Delhi.
21. Srivastava, M.L. (2008). Microbial Biochemistry, Narosa Publishing House, New Delhi.
22. Satyanarayana, U. and Chakrapani, U. (2013). Biochemistry, Fourth Edition Book and Allied Pvt. Ltd., Kolkata
23. Microbial Physiology 2nd Ed by Reddy (2022) S R, Scientific Publishers.
24. Topics in Microbial Physiology by P Tauro (2023).

25. Brock Biology of Microorganisms - Michael Madigan, Kelly Bender, Daniel Buckley, W. Sattley, David Stahl.

26. Microbial Physiology 4thEdn - Michael P. Sector, Albert G. Moat, John W. Foster, Michael P. Spector.

27. Nelson, D. L., & Cox, M. M. (2024). Lehninger Principles of Biochemistry (8th ed.). W.H. Freeman and Company.

28. Voet, D., Voet, J. G., & Pratt, C. W. (2024). Fundamentals of Biochemistry: Life at the Molecular Level (6th ed.). Wiley.

29. Berg, J. M., Tymoczko, J. L., &Gatto, G. J. (2024). Biochemistry (9th ed.). W.H. Freeman and Company.

M Sc. MICROBIOLOGY SEMESTER – 11

Discipline Specific Course (DSC)

Course Title: MB CT 2.1 – MICROBIAL GENETICS AND MOLECULAR BIOLOGY

Course Code: A2MCB001T

Type of Course	Theory /Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours/Semester	Duration of Exam	Formative Assessment Marks	Summative assessment Marks	Total Marks
DSC	**Theory**	**04**	**04**	**60 hrs.**	**3 hrs.**	**20**	**80**	**100**

Course outcome:

After completion of course (Theory), students will be able to understand

CO 1: At the end of the course the student will have knowledge on concepts in microbial genetics and structural polymorphism of DNA including its replication.

CO 2 : Understanding the Organization of genetic material and also obtain knowledge on transcription and translation.

CO 3 : Acquire the knowledge on the molecular genetics recombination and mutation.

CO 4 : Understanding the genetics of fungi, algae and viruses.

Unit	Content	60 hrs/Sem
I	**Concepts of Microbial Genetics** **Concepts in microbial genetics:** History and developments of microbial genetics, microbes as genetic Tools for basic and applied genetic studies. (3 Hours) **Microbial Genetics: - Fungal Genetics:** *Neurospora*- Tetrad analysis and linkage detection - 2 point and 3point crosses, chromatid and chiasma interference, Mitotic recombination in *Neurospora* and *Aspergillus*, alternation of generation in *Neurospora crassa*and yeast. (5 Hours) **Algal Genetics:** *Chlamydomonas*, tetrad analysis, Nucleocytoplasmic interactions and gene expression in *Acetabularia*. Extranuclear (Cytoplasmic) inheritance. (3 Hours) **Viral Genetics:** Lytic and Lysogenic cycles, phage phenotypes, phenotypic mixing, and Recombinationin viruses: Mapping of rIIloci. DNA viruses: Double stranded (Pox virus and SV40 virus) and single stranded DNA viruses. (4 Hours)	**15**

II	**Structural Polymorphism of DNA** DNA Structure A, B, and Z DNA, Super coiled DNA and DNA Binding Proteins. (2 Hours) **Replication:** Rolling circle replication, semi-conservative replication, replication fork- leading and lagging strands, enzymes involved at different steps of replication. Folded fiber model of *E.coli*chromosome, split genes, overlapping genes, DNA amplification, the law of DNA constancy and C-value paradox. Structure, types and replication of RNA virus. (8 Hours) **Transcription:** DNA Binding Proteins, Classes of RNA Molecules and RNA Polymerases. Prokaryotic and Eukaryotic transcription, Post transcriptional modification RNA processing, 5'capping, 3' polyadenylation, Splicing mechanisms, rRNA and tRNA processing. (6 Hours)	**15**
III	**Translation** **Organization of genetic material:** Genome organization in viruses, bacteria and eukaryotes. Interrupted genes, gene clusters, structure of nucleosome, chromatin and chromosome. (3 Hours) Genetic code and wobble hypothesis, tRNA and the Aminoacyl-tRNA-synthetase, Clover leaf structure of tRNA prokaryotic and Eukaryotic translation machinery, Ribosomes, Mechanism of prokaryotic and eukaryotic transcription, Post translational modification of proteins, inhibitors of protein translation.(12 Hours)	**15**
1V	**Genetic recombination and Mutation** **Molecular Genetic Recombination:** Bacteriophages and *E. coli*, Synapsis of homologous duplex, breakages and reunion, role of Rec A in recombination. Transduction- generalized and specialized. Transformation and conjugation, legitimate and illegitimate recombination, gene conversion, overview of bacterial genetic map. (10 Hours) **Gene as a Unit of Mutation:** Mutation, mutagens and types of Mutations, Molecular basis of spontaneous and induced mutations and their role in evolution. Transposon and site directed mutagenesis, environmental mutagenesis and toxicity testing**,** Hot spots, AME's Test, Comet Assay. (5 Hours)	**15**

Course Title: MB CP 2.5 Based on MB CT 2.1 – Microbial Genetics & Molecular Biology

Course Code: A2MCB004P

Type of Course	Theory /Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours/Semester	Duration of Exam	Formative Assessment Marks	Summative assessment Marks	Total Marks
DSC	**Practical**	**02**	**04**	**60 hrs.**	**4 hrs.**	**10**	**40**	**50**

PRACTICALS

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

REFERENCES

1. Brooker, R. J. (1999). Genetics – Analysis and Principles. Benjamin/Cummings, an imprient of addition Wesley longman, Inc.
2. Gardner, E. J. (1984). Principles of Genetics 7th edn. John Wiley & Sons. Inc. New York.
3. Hartl, D.L. (1994). Genetics. Jones and Bartler Publishers, London.
4. Moat, A.G., Foster, J.W. and Spector, M.P. (2002). Microbial Physiology, 4th edn. Wiley-Liss, Inc., New York.
5. Stanley R. Maloy, (1998)Microbial Genetics Second Edition, University of Illinois,

Unit	Content	60 hrs/Sem

6. Cronan, Jr., University of Illinois, Urbana, David Freifelder, (2004)Late of the University ... California, San Diego Fundamentals of Biochemistry, John Wiley and Sons.
7. Strickberger, M. W (1985). Genetics, 3rd Edn. Mac. Millan Pub. Co. Inc. NY.
8. Hartwell L.H. (2000). Genetics- From Genes to Genomes. McGraw Hill Publications New York
9. BenzaminLewin (2002). Gene- VIII, John Wiley and Sons New York.
10. John Ringo (2004). Fundamental Genetics. Cambridge University Press.

M Sc. MICROBIOLOGY SEMESTER – 11

Discipline Specific Course (DSC)

Course Title: MBCT 2.2-COMPUTER APPLICATIONS, BIOINFORMATICS, BIOSTATISTICS AND A.I:
Course Code: A2MCB002T

Type of Course	Theory /Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours/Semester	Duration of Exam	Formative Assessment Marks	Summative assessment Marks	Total Marks
DSC	**Theory**	**04**	**04**	**60 hrs.**	**3 hrs.**	**20**	**80**	**100**

Course outcome:

After completion of course (Theory), students will be able to understand

CO 1: At the end of the course the student will have broad and balanced knowledge computers and their operating system with view on networking.

CO 2 : Understanding the computational biology and different types of databases and their applications.

CO 3 : Acquire the knowledge on the sequence alignment, phylogeny and drug design.

CO 4 : Understanding the biostatistics for the representation of biological data.

I	**Concepts in Computer science** **Computer Science:** Parts and types of computers-Basic components and essential details of digital computers and peripherals devises and their maintenance functions. Mainframes, mini and micro (PC, PC-XT, PC-AT) Computer Architecture, Internal and External devices, servers, computer software and super, 4iyne/ computers. (6Hours) **Operating system:** Windows, UNIX (Ubuntu), CRAN/ LINUX, Macintosh, application software's like word processor, formatting the document, tables, mail merge and spell check. Spreadsheets basics with MS Excel, labels, MS Power point, MS access. Computer viruses: overview and prevention. (5 hours) **Computer network:** Advantages of Networks, Types of Networks (LAN & WAN) WIFI. Internet protocol (TCP/IP) File transfer protocols (FTP) WWW, HTTP. Etc.), Cloud Computing, Mobile Applications. (2 hours) **Programming:** Introduction to HTML and Python, C and C++ and R-programming, structure of C programs. (2 hours)	**15**
II	**Bioinformatics** **Bioinformatics** An Overview- Introduction to Computational Biology and Bioinformatics, scope and applications, Multiomics Technologies - Genomics, Proteomics, Transcriptomics, Metabolomics. Emergence of Bioinformatics as a separate discipline. (5 hours) **Biological databases** Types of databases, literature databases, sequence databases, structure database, functional databases and chemical databases. Nucleotide Sequence Database – GenBank, EMBL-EBI, DDBJ and INSDC. Protein sequence data – TrEMBL, Uniprot KB, PIR. Structure Databases (PDB, MMDB). Genome databases – Bacterial genome database – GOLD, MBGD. Viral genome databases – ICTVDB, VirGen,	**15**

	Human genome databases – MapViewer, Ensembl, UCSC, Vista-genome Browser, OMIM/OMIA.Organisms Specific Databases (Wormbase, Ecogene, SGD, TAIR, Flybaseetc). (10 hours)	
III	**Phylogeny and Structural Biology** **Sequence alignments** Pairwise sequence alignment and multiple sequence alignments – Basic concepts of sequence alignment, gap penalties. Sequence similarity search tools - BLAST and FASTA. Algorithm of CLUSTAL Omega. **Molecular Phylogenetics** – phylogenetics basics: molecular evolution and molecular phylogenetics, gene phylogeny versus species phylogeny, forms of tree representation; phylogenetic tree construction methods and programs: distance-based methods, character-based methods, phylogenetic tree evaluation, phylogenetic programs – PHYLIP, MEGA and PileUp. (8 hours) **Structural biology and Drug Design** Protein structure prediction, Homology Modelling, Concept of lead, lead identification and lead optimization, Computer Aided Drug Design (CADD) Structure based drug design (SBDD) and Ligand Based Drug Design (LBDD); Specific activity relationship (SAR), Quantitative Structure Activity Relationship (QSAR) methods and applications. Combinatorial chemistry and virtual screening. Drug designing softwares: Autodock, GOLD, Schrodinger, Discovery Studio. (7 hours)	**15**
1V	**Biostatistics** Biostatistics: Organization, description and graphical representation of data. Summary measures of–Central tendency (mean, mode, median), dispersion (Standard Deviation, Standard error) correlation (2-D,3-D, Pearson, Rvalue, Heatmap) and regression Chi square tests, McNemar test, tests of significance (t-test, P-value, F-test, ANOVA, HSD). (5 Hours) Survival analysis: Kaplan-Meier curve, log-rank test, proportional hazard, Coxregression. (4 Hours) Statistical softwares: MSExcel, MS access, Statistica, SPSS, Graphpad. (4 Hours) AI in Microbiology (2 Hours)	**15**

Course Title: MB CP 2.6 Based On MB CT 2.2 – Computer Applications, Bioinformatics, Biostatistics And AI:
Course Code: A2MCB005P

Type of Course	Theory /Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours/Semester	Duration of Exam	Formative Assessment Marks	Summative assessment Marks	Total Marks
DSC	**Practical**	**02**	**04**	**60 hrs.**	**4 hrs.**	**10**	**40**	**50**

PRACTICALS

1. Hardware and parts of a computer and laptop, types Super-computer, Mainframe Computer, Minicomputer, Microcomputer and mobile computers. Console I/O operations, Files and Streams.

2. Molecular graphics, analysis of phylogenetic tree and exploring PDB file.

3. a) Retrieval of sequences from NCBI, DDBJ, EBI, EMBL, NBRF-PIR, SWISSPROT and Protein database.
   b) Retrieval of homologous sequences and exploring BLAST and FASTA.
4. Study of Molecular Dynamics and Simulation of given protein (Hyperchem, Rosetta MOE, Speptide, RMSD, RMSF and Energies) and protein with drug interaction using Rosetta.

5. C, C^{++} and R-Language example programs based on topic wise.

6. a) Study of inheritance and polymorphism using different tools.

   b) Generation of dot matrix and analyzing the homology.
7. a) Exploring databases for motifs and domains.

b) Exploring and analyzing multiple Gene and exon-intron from the given sequence, Sequence alignment by online and offline softwares.

8. *In silico* study of enzyme kinetics in metabolic pathway.

9. Statistical concepts: Types of variables, probability distribution (binomial, Poisson, normal), population and sampling methods, characteristics of location and variability, standard error, histogram, point and interval estimation, confidence interval.

10. a) Statistical inference: testing statistical hypotheses and central tendency.

b) Statistical tests for continuous variables: t-test and Wilcoxon test (one-sample, two- sample, paired), analysis of variance (ANOVA), F-test, pearson correlation analysis.

11. a) Statistical tests for categorical variables: contingency table, chi-square test, McNemar test.

b) Statistical methods in epidemiology: epidemiological measures of risk and corresponding confidence intervals, interpretation.

12. a) Statistical association: correlation, linear regression, multiple regression, logistic regression, test for trend.

    b) Survival analysis: Kaplan-Meier curve, log-rank test, proportional hazard, Cox regression.

13. Planning surveys: power of statistical test, sample size determination for categorical and continuous endpoints, randomization in clinical trials.

14. Practical use of statistics: statistics in published papers, discussion on statistical methods with suitable example.

REFERENCES

1. Attwood, T.K., and Parry-Smith, D. J. (2007). Introduction to Bioinformatics, Pearson Education Asia.
2. B. D. Singh. (2017). Biotechnology, Kalyani Publishers.
3. Baxevanis, A.D., and Francis Ouellette, B.F. (2004). Bioinformatics – A Practical Guide to the Analysis of Genes and Proteins, 3rd edition, Wiley – Interscience.
4. Bergeron, B. (2002). Bioinformatics Computing. 1st edition, Prentice Hall Publishers.
5. Blum R and LeBlanc Dee-Ann. (2014). Linux for Dummies, 2nd edition, WILEY.
6. Campbell AM and Heyer LJ. (2007). Discovering Genomics, Proteomics and Bioinformatics, 2nd edition, Benjamin Cummings.
7. Dhananjaya (2002). Introduction to Bioinformatics, www.sd-bio.com series
8. Elmasr R and Navathe SB. (2017). Fundamentals of Database Systems, 7th edition, Pearson Education.
9. Higginns, D., and Taylor, W., (2000). Bioinformatics. Sequence, Structure and databanks – A Practical Approach, Oxford University Press.
10. Kothekar, V (2004) Introduction to Bioinformatics 1st edition Dhruv publication
11. Krane D.E.,Raymen, M. L. (2003) Fundamental Concepts of Bioinformatics, Benjamin Cummings.

12. Krawetz, S.A., David, D., Womble, S.A., Krawetz, D.D., Womble, D., (2003). Introduction to Bioinformatics: A theoretical and Practical approach. Humana Press, USA.

13. M. Barnes, Glaxo SmithKline, U.K, (2003). Bioinformatics for Geneticists.

14. Misener, S., and Krawetz, S.A., (2000). Methods in Molecular Biology – Bioinformatics. Methods and Protocols, Humana Press.

15. MountD. W. (2001). Bioinformatics. Sequence and Genome Analysis, Cold Spring Harbor Laboratory Press.

16. Rajaraman V. (2009). Fundamentals of Computers, Prentice-Hill India.

17. Rashidi, H., and Buehler, L.K. (2005). Bioinformatics Basics: Applications in Biological Science and Medicine. CRC Press/Taylor & Francis Group.

18. S C Rastogi, N Mendiratta, P. Rastogi. (2013). Bioinformatics: Methods and Applications Genomics Proteomics and Drug Discovery, 4th edition, Prentice Hall of India Private Ltd.

19. S.C.Rastogi, NamithaMendinatta. (2009). Bioinformatics Concepts, Skills and Applications, 2nd edition, CBC Publication.

20. Singer, S. (2001). Experiments in Applied Microbiology. Academic Press.

21. Sullia, S.B. and Shantaram, S. (2006). General microbiology, 2nd edition, Oxford IBH, New Delhi.

22. Upadhyay, Upadhyay & Nath. (2016). Biophysical chemistry: principles and techniques, 4thedition, Himalaya Publishing House Pvt. Ltd.

23. Woolverton, J.C.,Sherwood, L. (2017). Prescott's Microbiology, 10thedition,McGraw Hill.

24. Topology for computing by Afra J. Zomorodian.

25. An Introduction to Bioinformatics Algorithms by Neil C. Jones, and

    Pavel A. Pevzner

26. Bioinformatics – Sequence and Genome analysis by David W. Mount.

27. Bioinformatics by Vince Buffalo.

28. Biostatistics, Computer Application and Bioinformatics by N Arumugam, A. Gopi, V. Kumaresan A Meena, R Sundaralingam (2019).

29. Motulsky, H. (2024). Intuitive Biostatistics (4th ed.). Oxford University Press.

30. Pagano, M., & Gauvreau, K. (2024). Principles of Biostatistics (3rd ed.). CRC Press.

31. Sullivan, L. M. (2024). Essentials of Biostatistics in Public Health (4th ed.). Jones & Bartlett Learning.

32. Low, L. W. Y., & Tan, S. H. (2023). Practical Bioinformatics for Beginners: From Raw Sequence Analysis to Machine Learning Applications. Springer.

33. Jones, N. C., &Pevzner, P. A. (2023). An Introduction to Bioinformatics Algorithms (2nd ed.). MIT Press.

34. Choudhuri, S. (2024). Bioinformatics for Beginners: Genes, Genomes, Molecular Evolution, Databases and Analytical Tools. Academic Press.

M Sc. MICROBIOLOGY SEMESTER – 11

Discipline Specific Course (DSC)

Course Title: MB CT 2.3 - GENETIC ENGINEERING

Course Code: A2MCB003T

Type of Course	Theory /Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours/Semester	Duration of Exam	Formative Assessment Marks	Summative assessment Marks	Total Marks
DSC	**Theory**	**04**	**04**	**60 hrs.**	**3 hrs.**	**20**	**80**	**100**

Course outcome:

After completion of course (Theory), students will be able to understand

CO 1: At the end of the course the student will have broad and balanced knowledge the scope and importance of genetic engineering.

CO 2 : Understanding the concept of genomic DNA library and chemical synthesis gene.

CO 3 : Acquire the knowledge on the transformation, transfection and PCR techniques.

CO 4 : Understanding the broad application of genetic engineering.

Unit	Content	60 hrs/Sem
I	**Tools of Genetic Engineering** **Introduction to Genetic Engineering**: Scope and importance of Genetic engineering. Restriction endonucleases- nomenclature and types, recognition sequences and mechanism of action. DNA Modification enzymes (nucleases, kinases, Alkalinephosphatase, Klenow-Fragment polymerase, Lambda-Exonuclease and Exonuclease-III) and ligases- types and mechanism of action. (7 Hours) A brief account of naturally occurring plasmids (Conjugative and Non-conjugative plasmids, Degradative plasmids, Resistance plasmids, Fertility plasmids, Col-Plasmids), artificial plasmids (pBR322, pUC vectors, Ti and Ri plasmids), Bacteriophages, Phagemids, Cosmids, Fosmids, Artificial chromosomes (BAC's, YAC's), Shuttle vectors, expression vectors, M13 derived vectors and Viral vectors (SV40 and Bovine Papilloma Virus). (8 Hours)	**15**
II	**Gene Libraries and Selection of Recombinants** **cDNA library:** Isolation and purification of mRNA, Synthesis of cDNA, cloning of	**15**

	cDNA in to plasmids and phage vectors. (2 Hours) **Genomic DNA Library**: Isolation and purification of Genomic and Plasmid DNA, preparation of DNA fragments for cloning, Construction of genomic DNA library with different vectors and screening techniques. (5 Hours) **Chemical synthesis of Genes:** Methods (Phosphodiester, Phosphotriester and Phosphite ester methods principle and strategies). Oligonucleotide synthesis and application, synthesis of complete gene. (4 Hours) **Labeling and Detection Techniques**: Labeling of DNA, RNA and Proteins (Radioactive and non-radioactive isotopes). DNA Sequencing (Chemical and Enzymatic method). (4 Hours)	
III	**Techniques in Genetic Engineering** **Transformation and Transfection techniques**: Preparation of competent cells of bacteria, chemical methods- calcium phosphate precipitation method and liposome-mediated method. Physical methods-Electroporation and Gene gun method. Biological methods-*Agrobacterium* mediated transformation, Co-cultivation methods, Chloroplast transformation, method of DNA transfer to yeast, mammalian and plant cells**. PCR:** Methodology, types and applications. Gene Editing: CRISPR Cas-9, Blotting Techniques- Southern Blotting, Northern Blotting, Western Blotting and DOT Blot, Nucleic Acid hybridization (Colony Hybridization and Plaque Hybridization), Immunological methods and *In vitro* Translation. Chromosome walking. (13 Hours) **Gel Electrophoresis**: Agarose gel Electrophoresis, PAGE and PFGE (2 Hours)	**15**
1V	**Applications of Genetic Engineering** Transgenic plants (disease resistant, weedicide resistant, frost resistant, halo-tolerant and pest resistant) production of growth hormones, interferon, insulin, recombinant vaccines, gene therapy, RNA; requirement of recombinant molecules in health, pharmaceuticals, agriculture and industrial sectors, research labs. (9 Hours) **Antisense and Ribozyme technology:** Molecular mechanism of antisense molecules, inhibition of splicing poly-adenylation and translation, disruption of RNA structure and capping Biochemistry of Ribozyme, hammer head, hairpin and other Ribozymes, strategies for designing Ribozymes, application of antisense and Ribozymes technologies. (6 Hours)	**15**

Course Title: MB CP 2.7 Based on MB CT 2.3 - Genetic Engineering

Course Code: A2MCB006P

Type of Course	Theory /Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours/Semester	Duration of Exam	Formative Assessment Marks	Summative assessment Marks	Total Marks
DSC	**Practical**	**02**	**04**	**60 hrs.**	**4 hrs.**	**10**	**40**	**50**

PRACTICALS

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

REFERENCES

1. Becker. J.M, Caldwell.GA, Zacgho. E.A. (1996) Biotechnology, A laboratory Course. Second Edition.. Academic Press. INC, California.
2. Bernard R. Glick and Jack J. Pastemak. (1998) . Molecular Biotechnology: Principles and Applications of Recombinant DNA. 2 nd Edition, by, ASM Publications.
3. Channarayappa. (2006) Molecular Biotechnology, Principles and Practices. First Edition, University press (India) Pvt. Ltd, Hyderabad, India.
4. D.M. Glower and B.D. Hames(1995).DNA Cloning: A Practical Approach, Second edition, IRL Press, Oxford.
5. Das. H.K. (2007). Textbook of Biotechnology. Third Edition. Wiley India Pvt Ltd, New Delhi.

6. David A Micklos and Greg AFreyer. (2005). DNA Science, a first course. Second Edition. I.K. International Pvt Ltd, New Delhi.
7. Desmond S. T. Nicholl. (2000). Genetic Engineering, Fourth edition, Cambridge University Press
8. Gupta. P.K. Biotechnology and Genomics. 2008. Revised Edition, Rastogi Publications, New Delhi.
9. Helen Kreuz. (2001).Recombinant DNA and Biotechnology: Guide for Teachers. Second Edition by ASM Publications
10. Pamela Peters Biotechnology: A Guide to Genetic Engineering (1992). First edition William C Brown Publishers.
11. PCR Technology - Principles and Applications for DNA Amplification by Henry A. Erlich (Ed.) Stockton Press. (1989).
12. Primrose, S.B., & Twyman, R.M. (2006). Principles of gene manipulation and genomics (7th Ed.). John Wiley & Sons Publishers
13. Primrose. S.B. and Twyman R.M. Principles of gene manipulation and genomics. Seventh Edition. 2006. Blackwell Publishing, Australia.
14. S.M. Kingsman and A.J. Kingsman (1998) Genetic Engineering and Introduction to Gene Analysis and Exploitation in Eukaryotes, Blackwell Scientific Publications, Oxford
15. Sambrook and Russell. Molecular Cloning, A laboratory manual. Volume 1. ThirdEdition. (2001). Cold spring harbour laboratory press, New York.
16. Sambrook and Russell. Molecular Cloning, A laboratory manual. Volume 2. ThirdEdition. (2001). Cold spring harbour laboratory press, New York.
17. Sambrook and Russell. Molecular Cloning, A laboratory manual. Volume 3. ThirdEdition. (2001). Cold spring harbour laboratory press, New York.
18. Sandhya Mitra. (1996). Genetic Engineering. Principles and Practice. Second Edition, Macmillan India Ltd, New Delhi.
19. Vedamurthy, A.B., and Mahesh, S. (2002) Biotechnology – IV including recombinant DNA technology, Environmental Biotechnology and Animal Cell Culture. New Age Publishers, New Delhi.
20. Winnacker E.L. (1987) From Genes to clones, Introduction to gene technology. First Edition, VCH publishers, Germany.

M Sc. MICROBIOLOGY SEMESTER – 11

Discipline Specific Course (DSC)

Course Title: MB ET 2.4- FUNDAMENTALS AND APPLICATIONS OF MICROBIOLOGY

Course Code: A2MCB203T

Type of Course	Theory /Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours/Semester	Duration of Exam	Formative Assessment Marks	Summative assessment Marks	Total Marks
DSC	**Theory**	**04**	**04**	**60 hrs.**	**3 hrs.**	**20**	**80**	**100**

Course outcome:

After completion of course (Theory), students will be able to understand

CO 1: At the end of the course the student will have broad and balanced knowledge on the introduction and history of microbiology.

CO 2 : Understanding the scope and concept of industrial microbiology and also industrial production of microbial based commercial products

CO 3 : Acquire the knowledge on themicrobial disease pathogenesis, clinical conditions, epidemiology and diagnosis.

CO 4 : Understanding the clinical sample types and its handling, collection and processing.

Unit	Content	60 hrs/Sem
I	**Microbiology** **Introduction to Microbiology:** Contributions of Antony van Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Edward Jenner, Alexander Flemming. Beneficial and harmful microorganisms, Introduction to branches of Microbiology: a) Air b) Water c) Sewage d) Soil e) Dairy f) Food g) Medical h) Industrial i) Biotechnology j) Geomicrobiology. (4 Hours) **General characteristics of different groups of microorganisms**: Outline Classification of bacteria. Methods of classification of bacteria – Numerical taxonomy, Chemotaxonomy of bacteria, Nucleic acid-based and 16S rRNA-based classification, Fatty acid profile, Cell wall composition. Ecological groupings of bacteria. Identification of isolated microorganisms. (5 Hours) **Prokaryotic and Eukaryotic cells:** Introduction and evolution of Prokaryotic and Eukaryotic cells, Structural organization of Prokaryotic and Eukaryotic cell**,** Major groups of Microorganisms– Viruses, Bacteria, Algae,	**15**

	Fungi and Protozoa. (6 Hours)	
II	**Industrial Microbiology** **Introduction to industrial microbiology:** Definition, scope, history, microorganisms, properties and industrial products Screening for microbes of industrial importance. Primary screening, screening for amylase, organic acid, antibiotic, amino acid and vitamin producing microorganisms. Secondary screening. (4 Hours) **Industrial microbiology:** Industrial production of Alcohol (Ethanol), Wine, Beer, Organic acids (Citric, acetic, Lactic and Gluconic acid) Solvent (Glycerol Acetone, Butanol), Antibiotics (Penicillin, streptomycin, tetracycline) Amino acids (lysine, glutamic acid) Single cell proteins (SCP) Vitamins (Riboflavin) Enzymes (Amylase, lactase, protease), Hydrocarbons – Biodegradable plastic – Polyhydroxyalkanoates (butyrate, propionate etc), recombinant protein (hepatitis – B vaccine). (11 Hours)	**15**
III	**Microbial Diseases** **Microbial diseases:** Pathogenesis, Clinical conditions, laboratory diagnosis, epidemiology, Prophylaxis and treatment of the following diseases. a) Virus – Measles, Mumps, Influenza, Yellow fever, HIV, Herpes, Rabies, Hepatitis, Polio myelitis, Dengue fever, Japanese Encephalitis, KFD, Rhinovirus, CJD and Kuru. b) Bacteria – Diphtheria, Typhoid, Gonorrhea, Syphilis, Plague, Leprosy, Tuberculosis, Gas gangrene, Tetanus, Septicemia, Cholera and Brucellosis. (7 Hours) c) Fungi– *Candidiasis, Mycetoma, Chromomycosis, Sporotrichosis, Cryptococcosis, Blastomycosis, Coccidiomycosis and Histoplasmosis.* d) Protozoa– *Amoebiasis, Giardiasis, Malaria, Leishmaniasis and Trypanosomiasis.* e) Dental Infections – Dental Plaque, Dental carries and periodontal diseases. f) Nosocomial Infections – Bacterimia, Burn wounds, surgical site infections, Urinary tract and miscellaneous infections. (8 Hours)	**15**
1V	**Clinical Microbiology** **Clinical Microbiology:** Specimen collections, handling, transport, identification of pathogens from specimen, growth and biochemical characteristics, Rapid methods of identification, Immunological techniques, Bacteriophage typing, molecular measures (DNA probes, Restriction endonucleases, DNA Fingerprinting, RIA, ELISA, PCR) and susceptibility testing. A brief account on hospital management. (15 Hours)	**15**

REFERENCES

1. HayesW.(1970)Genetics of Bacteria and their viruses. The English Book Society of Black well Scientific publication, Oxford.
2. PrescottL.M.,J.P.HanleyandD.A.Klein.(1999)MicrobiologyWCBMcGraw-Hill,Con .NY.
3. AtlasR.M.(1998) Microbiology, Fundamentals and Application 2nd Edition MacMillan Publishing Company.
4. Hundersonetal.,(1999),Cellular Microbiology WileyPublications.
5. Bruijinetal.,(1998),Bacterial Genomes,ChapmanandHill.
6. SulliaS.B.andS.Shantaram.(1998),General Microbiology, Oxford IBH Publishing Con, New Delhi.
7. DaleJ.W.Molecular Genetics and Bacteria,(1994),JohnWileyandSons.
8. Lewin.B. (2002)GenesVIII,OxfordPress.
9. RogerL.P.JohnT.,KnowlerandD.A.Violp.Leadr.(1992).TheBiochemistryofNucleicAcids 11th Edition Chapman and Hall.
10. StanleyR.,Maloy,JohnE.,Cronan,Junior.DavidFrieifelour(1994).Microbial Genetics Jones and Barlett Publications. Bosten.
11. SamuelSinger.(2001) Experiments on Applied Microbiology, AcademicPress. New-York.
12. Alcamo's Fundamentals of Microbiology by Jeffrey C. Pommerville(2013)-12th Edn.
13. Microbiology Fundamentals And Applications by SS. Purohit.

M Sc. MICROBIOLOGY SEMESTER – 111

Discipline Specific Course (DSC)

Course Title: MB CT 3.1-ENVIRONMENTAL MICROBIOLOGY

Course Code: A3MCB001T

Type of Course	Theory /Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours/Semester	Duration of Exam	Formative Assessment Marks	Summative assessment Marks	Total Marks
DSC	**Theory**	**04**	**04**	**60 hrs.**	**3 hrs.**	**20**	**80**	**100**

Course outcome:

After completion of course (Theory), students will be able to understand

CO 1: At the end of the course the student will have wide knowledge on classification of soil microorganisms based on physical and chemical characteristics. Also acquire knowledge on interaction among soil microorganisms. Additionally, students will obtain understand the concept of environmental microbiology and water ecosystems with different types of zonation.

CO 2 : Understanding the scope and concept of solid and liquid waste treatment and their characterization.

CO 3 : Acquire the knowledge on the environmental education and impact of environmental disasters on globe.

CO 4 : Understanding the bioremediation strategies of pollutants.

Unit	Content	60 hrs/Sem
I	**Concept of Environmental Microbiology** **Aerobiology:** Meaning, scope and concept of Environment and environmental pollution:Air sampling techniques, Identification of Airborne bioparticles, Sources and characteristics of air pollutants, health hazards due to air pollution. Air borne diseases and control measures of air pollution. (6 Hours) **Aquatic Microbiology**: Water ecosystem (Fresh water and marine), Zonation of Water ecosystem, water pollution-sources, characteristics of water pollution, health hazards due to water pollution, eutrophications. Indicators of water pollution- biological, chemical, physical	**15**

	microbiological and biochemical. Water purifications: Brief account on water borne diseases and control measures. (9 Hours)	
II	**Unit 2: Concept of Soil Microbiology and Space Research** **Soil Microbiology:** Classification based on physical and chemical characteristics, soil stratification, microorganisms in various oil types, soil pollution–sources and characteristics of soil pollutants, health hazards due to soil pollution, control measures of soil pollution-interaction among soil microbes mutualism, commensalisms, amensialism, parasitism, predation, competition, antibiosis and their significance. Interrelationship between microbes, plant and soil-brief account on rhizosphere, phyllosphere and spermosphere Symbiotic and non-symbiotic association with higher plants, role of enzymes of microbial origin in the release of plant nutrients. Role of microorganisms in soil fertility- mineralisation and bioavailability. (11Hours) **Space Microbiology:** Possibilities and evidence of life in space, experiments to detect life in space, biomarkers in space. Examples of microbial life in space. (4 Hours)	**15**
III	**Waste Management and Environmental Education** **Waste Management Strategies**: Solid and Liquids wastes and their characterization. Treatment-Physical, chemical, biological solid waste treatment: Saccharification, Gasification, Composting and waste water recycling-chlorination, ozonization, radiation, filtrations, reverse osmosis. Effluent treatment – (Dairy, Distillery, Tannery, Textile, Paper and Sugar industries) Physical, chemical and biological sewage treatment-Trickling filters, oxidation pond, ditch and activated sludge treatment. Advanced wastewater treatment-rotating biological contactors (RBC), submerged aerobic filters, fluidized bed reactors, biological aerated flooded system, combination of anaerobic, denitrification and aerobic treatment of wastewater. Advanced activated sludge process and biogas Production, effluent treatment, DOC, COD, BOD and disposal of effluents. (12 Hours) **Environmental Education:** Agrochemicals, Botanicals of Global Warming, ozone depletion, greenhouse gas effect, acid rains & their impact and biotechnological approaches in the environment**.** (3 Hours)	**15**
1V	**Bioremediation** **Concept of Bioremediation:** Concepts and principles *Insitu*and *Exsitu*bioremediation, Phytoremediation. Biodegradation- Recalcitrant of pesticides/toxicants in soil and their influence on soil micro flora, xenobiotic (halocarbons, C-1 compounds, aliphatic hydrocarbons, alicyclic hydrocarbons, aromatic hydrocarbons, polycyclic hydrocarbons, halogenated compounds). (8 Hours) **Biodegradation**: Biodegradation of natural polymers-Cellulose Lignin, Pectin, Chitin Detergents, Soaps and Plastics. Biodeterioration-Paper, Leather, Wood, Textiles, Mode of deterioration and organisms involved. (4 Hours) **Bioleaching and bio-mining,** Productions of Oils and fuels from wood wastes, biofuels, Bio-diesel and byproducts of sugar industries.(3 Hours)	**15**

Course Title: MB CP 3.5 Based on MB CT 3.1 - Environmental Microbiology

Course Code: A3MCB004P

Type of Course	Theory /Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours/Semester	Duration of Exam	Formative Assessment Marks	Summative assessment Marks	Total Marks
DSC	**Practical**	**02**	**04**	**60 hrs.**	**4 hrs.**	**10**	**40**	**50**

PRACTICALS

1. Detection of coliforms for determination of purity of potable water samples by MPN method
2. Isolation of bacteriophages from sewage water samples
3. Study of micro flora of industrial waste and effluents
4. Isolation of nucleic acids from environmental samples
5. Determination of DO, DOC, CO_2, BOD, COD and TDS of water samples (RO water, Tap water, Pond water and Sewage waste water).
6. Isolation of Xenobiotic degrading bacteria by selective enrichment technique.
7. Study on Biogenic methane production.
8. Estimation of phosphate, sulphates, nitrates and major cations (Na, K, Mg and Ca) in water samples.
9. Effect of industrial effluents/heavy metals on seed germination and seedling growth
10. Effect of herbicides (Glyphosateand2,4, -D) on chlorophyll content
11. Sampling and quantification of air borne endotoxins by limulus amoebocyte assay.
12. Field excursion to an industrial area to assess environmental impact.
13. Isolation and determination of Iron and Manganese reducing bacteria
14. Selective enrichment of auxotrophic and antibiotic (Tet^R,Ref^R) mutants (Isolation of antibiotic resistant microbes from Hospital waste).

REFERENCES

1. Christon,J.,Harst (1997).Manual of Environmental Microbiology, ASM press, Washington DC,
2. Metcalf and Eaddy (2001) Inc.,waste water engineering treatment disposal and reuse. TATA McGraw Hill Delhi.
3. Raju,B.S.N. (1998)water supply and waste water engineering, Tata McGraw Hill publications, Co.
4. AtlasR.M.,Taylor and Francis (2005)Handbook of Media for Environmental Microbiology. CRC press

5. Patrick,K.Jjemba. (2004).Environmental microbiology. Principles and applications. Science Publishers.

6. McKinney,R.E (2004),Environmental pollution control, Microbiology. CRCpress

7. Paul.R.Hunter,MikeWaite,EletraRonchi (2002).Drinking water and infectious disease-Establishing the Links. ISTedition CRC Press.

8. VarnamA.H. and Evans, M (2000) Environmental Microbiology. Black Well Publishers.

9. PaulA.Rochelle, Environmental Molecular Microbiology: Protocol sand Applications Bios-scientific Publishers Ltd.

10. FrancisHChapelle (2000) Ground Water Microbiology and Geochemistry 2ndedition, John Wiley and Sons.

11. Robert.S.Burlage,RonaldAtlas,DavidStahl,GillGeesey,GarySayler.(1998).Techniques in Microbial Ecology. Oxford University Press. New york.

12. Barer.K.H.andHersonD.S. (1994)–Bioremediation. McGraw Hill Inc., New York.

13. Hiremath, M.B., Baligar, P.N. and Prashanth, M.S. (2012). Environmental Biotechnology. Prateeksha publishers, New Delhi.

M Sc. MICROBIOLOGY SEMESTER – 111

Discipline Specific Course (DSC)

Course Title: MBCT 3.2 AGRICULTURAL MICROBIOLOGY AND PLANT PATHOLOGY
Course Code: A3MCB002T

Type of Course	Theory /Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours/Semester	Duration of Exam	Formative Assessment Marks	Summative assessment Marks	Total Marks
DSC	**Theory**	**04**	**04**	**60 hrs.**	**3 hrs.**	**20**	**80**	**100**

Course outcome:

After completion of course (Theory), students will be able to understand

CO 1: At the end of the course the student will have wide knowledge on history, concept and scope of agricultural microbiology and plant pathology. Also acquire knowledge on biological nitrogen fixation.

CO 2 : Understanding the application and production of biofertilizers and formulation of biopesticides.

CO 3 : Acquire the knowledge on the microbial disease cycle of plant and their management.

CO 4 : Understanding the plant diseases and control measures. Also acquire knowledge on post harvest diseases.

Unit	Content	60 hrs/Sem
I	**Agricultural Microbiology** **Biological Nitrogen Fixation:** History, concepts and scope of agricultural microbiology and plant pathology. Mineralization and immobilization of nitrogen, nitrification and denitrification. Symbiotic nitrogen fixation (*Rhizobium, Frankia*), Non symbiotic nitrogen fixation (*Azotobacter*), Associative symbiotic nitrogen fixation (*Azospirulum*), Mycorrhiza, Nitrogenase enzymes, Nif genes. Role of nodulin genes in nodule development and symbiosis. (12 Hours) **Host Parasite Interaction:** Production of phytoalexins, involvement of elicitors, role of R and Avr genes in disease development. (3 Hours)	**15**
II	**Biofertilizers and Biopesticides** **Biofertilizer:** Types, production and quality control. Cultivation and mass-production of biofertilisers- *Azotobacter, Rhizobium, Azospirillum,*	**15**

	Cyanobacteria, phosphate solubilizing microorganisms, *Azolla*. Carrier-based inoculants production and applications. (8 Hours) **Biopesticides:** Types and applications (Entamo pathogenic bacteria, fungi and virus, *Pseudomonas fluorescens, Bacillus thuringiensis, Bacillus sphericus, Trichoderma harzianum, Trichodermaviridae, Nuclear Polyhedrosis Virus,* Fungi (*Culicinomyces ,langenidium and coelomomyces*). (7 Hours)	
III	**Plant pathology and IPM-Integrated Pest Management** **Plant pathology:** Disease cycle, Mode of entry of pathogens into the plant system, Plant immune system-PTI and ETI. Defense Mechanisms of Plant-structural and chemical defenses, induced structural and biochemical defenses. Pathways involved in disease resistance-Salicylic acid, Jasmonic acid and EA. (13 Hours) **IPM:** Integrated pest management and biological control agents for disease management. (2 Hours)	**15**
1V	**Plant Diseases and Control measures** **Plant Diseases:** a. Diseases caused by Fungi (symptomology, etiology and control), Wilt disease, Downy mildew, Powdery mildew and Rusts. b. Diseases caused by Bacteria (symptomology, etiology and control), Bacterial wilt, Bacterial blight of rice, Angular leaf spot of cotton, Citrus canker. c. Mycoplasmal diseases, Sandal spike, Grassy shoot of sugarcane (symptomology, etiology and control), d. Viral diseases Tobacco mosaic disease, Banana bunchy top, Cucumber mosaic, Cow pea mosaic e. Disease caused by Virioids, Potato spindle tuber virioid. (14 Hours) **Post Harvest Diseases:** Post-harvest diseases and control measures (1 Hour)	**15**

Course Title: **MB CP 3.6 Based on MB CT 3.2 - Agricultural Microbiology & Plant Pathology**

Course Code: **A3MCB005P**

Type of Course	Theory /Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours/Semester	Duration of Exam	Formative Assessment Marks	Summative assessment Marks	Total Marks
DSC	**Practical**	**02**	**04**	**60 hrs.**	**4 hrs.**	**10**	**40**	**50**

PRACTICALS

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

REFERENCES

1. Agrios,G.N. (2000).Plant pathology. Harcourt Asia Pvt. Ltd.
2. Bergersen, F.J. and Postgate, J.R. (1987). A Century of Nitrogen Fixation Research Present Status and Future Prospects. The Royal Soc., London.

3. Dixon, R.O.D. and Wheeler, C.T. (1986). Nitrogen Fixation in plants. Blackie USA, Chapmanand Hall, New York.

4. Richard E. Issacson. Marry. E. and Torrece (2005) Microbial Food Safety in Animal Agriculture: Current Topic. Black well Publishers.

5. Singh.R.S. Introduction to Principles of Plant Pathology.

6. Steinhaus. (1963). Insect Pathology. Vol I & II. Academic Press, New York.

7. SubbaRao. (2003) Bio-fertilizers in Agriculture. Oxford &IBH.

8. Swaminathan M.S. (1998) Biotechnology in Agriculture. McMillan.

9. Sylvia D.M., Jefrey. J.Ficherman, Peter G. Hartel, David A Zuberer .(1997). Principles and applications of Soil Microbiology.1st EditionPrenticeHall.

10. Vidhyasekaran, P. (2008). Fungal pathogenesis in plants and crops: molecular biology and host defence mechanisms, *Volume 58 of Books in soils, plants, and theenvironment*,2nd ed., illustrated, CRC Press.

11. Singh, H.B., Vijai, G.K and Jogaiah, S. (2018). New and Future Developments in Microbial Biotechnology. Elsevier Publications, UK.

M Sc. MICROBIOLOGY SEMESTER – 111

Discipline Specific Course (DSC)

Course Title: MBCT 3.3. FOOD AND DAIRY MICROBIOLOGY

Course Code: A3MCB003T

Type of Course	Theory /Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours/Semester	Duration of Exam	Formative Assessment Marks	Summative assessment Marks	Total Marks
DSC	**Theory**	**04**	**04**	**60 hrs.**	**3 hrs.**	**20**	**80**	**100**

Course outcome:

After completion of course (Theory), students will be able to understand

CO 1: At the end of the course the student will have wide knowledge on history, concept and scope of definition, concepts and scope of food and dairy microbiology. Also acquire knowledge on Milk and milk products.

CO 2: Understanding the application and techniques of Food preservation and different types fermented food

CO 3 : Acquire the knowledge on thecontamination and spoilage of food. Alsoontain the knowledge on GMP and GLP.

CO 4 : Understanding the different food borne infections and bacterial Intoxication.

Unit	Content	60 hrs/Sem
I	**Food and Dairy Microbiology** **Introduction:** Definition, Concepts and scope of food and dairy microbiology. **Food as a substrate for microorganisms:** Important microorganisms in food (Molds, Yeasts and Bacteria) and their utilization source. (Air, soil, water, humans plants and animals). (8 Hours) **Milk and Milk products:** Microbial quality of milk, contamination, preservation, spoilage, testing of milk and milk products. Safety systems in dairy industries, fermented milk products – cheese, yoghurt, shrikand, Kefir, Kumis and acidophilus milk, composition and properties of milk, nutritional value and microbiology of milk. (7 Hours)	**15**
II	**Food Preservation** **Food preservation:** general principles, physical methods (low temperature,	**15**

	high temperature and drying), chemical methods (food additives), irradiation, biological methods of food preservation. Processing for heat treatment- D, Z and F values and working out treatment parameters, Freeze drying methods. (7 Hours) **Fermented foods:** Microbial activity in food-vegetables (olives and cucumbers), meat (sausages), bread, idli, cocoa and coffee. Dairy foods– cheese, Shrikand, Tempeh, therapeutic and nutritional value of fermented foods, spoilage and defects of fermented dairy products, oriental fermented foods their quality, standards and control. (8 Hours)	
III	**Food spoilage** **Contamination and spoilage:** Principles of food spoilage. spoilage of cereals sugar products, fruits, vegetables, meat and meat products, fish and sea foods poultry, spoilage of canned foods, detection of food borne microbes- sampling, detection by culturing methods, physical and chemical methods. Food hygiene and quality control. (8 Hours) **Food sanitation:** Sanitation in manufacture and retail trade; food control agencies and their regulations. Food safety laws and standards, Food packing International – HACCP, ISO 9000 series, GMP and GLP, FDA and EU. India – PFAA, FPO, MPO, CSO, the AGMARK, standards, Bureau of Indian Standards (BIS). Food testing laboratories in India - SRI, FRAC. Food packaging. (7 Hours)	**15**
1V	**Food Infections** **Food borne infections and Bacterial Intoxication:** *Brucella, Bacillus, Clostridium, Escherichia, Salmonella, Shigella, Staphylococcus, Vibrio, Yesinia and Listeria*, Nematodes, Protozoa, Algae, Viruses and Molds. Mycotoxins–aflatoxins, Ochratoxins, Trichothecenes, Zealenone, Ergot Alkaloids; food borne outbreaks, lab testing procedures and preventive measures. (15 Hours)	**15**

Course Title: MB CP 3.7 Based on MB CT 3.3 - Food & Dairy Microbiology

Course Code: A3MCB006P

Type of Course	Theory /Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours/Semester	Duration of Exam	Formative Assessment Marks	Summative assessment Marks	Total Marks
DSC	**Practical**	**02**	**04**	**60 hrs.**	**4 hrs.**	**10**	**40**	**50**

PRACTICALS

1. Microbiological examination of utensils.
2. Enumeration of microorganisms from healthy and spoiled fruits and vegetables
3. Enumeration of microorganisms from cereals, spices and dry products
4. Enumeration study of spoilage of stored meat and fish
5. Study of microbiology of milk and milk products
6. Rapid platform test for milk - (MBRT, clot on boiling-COB, alcohol test, specific gravity test, two-minute resazurin test)
7. Production of yoghurt, acidophilus milk and tempeh
8. Production of cheese from fermented food
9. Estimation of lactic acid in milk and curd
10. Estimation fat in milk and milk products
11. Estimation of proteins from Spirulina
12. Estimation of ascorbic acid from tomato, chilly and lemon
13. Estimation of aflatoxin from food samples
14. Mushroom cultivation (Oyster) and Spirulina, agar-agar and single cell proteins
15. Mandatory visit to food research institutes/ industries.

REFERENCES

1. Dayte M.P., Lorry R.B. and Thomas J.M., Food Microbiology, ASM, Washington D.C.
2. Adams M.R. and Moss M.O. (2000) Food Microbiology. Royal Publishing Corporation.
3. Bibek Ray (2001). Fundamentals of Food Microbiology. Bibek Ray. 2nd Edition. CRC Press.
4. Bieleckis, Tramper J, Polak J. (2000), Food Biotechnology. Elsevier.
5. James.M.Jay(1996) Modern food Microbiology CBS Publishers and Distributors. Delhi.

6. John S. Norak, Gerald M. Sapers, Vijay Kumar Juneja, Daniel K Gay (2002), Microbial Safety of minimally processed foods 1st Edition CRC Press.
7. Ananth Krishnan C.P. et.al. (1994), dairy Microbiology, Sreelakshmi Publication., Chennai.
8. Robinson R.K. (1990), dairy microbiology, Elsevier Applied Science, London.
9. Casida (1994), Industrial Microbiology, Wiley Eastern Ltd. New Delhi.
10. Mary.E.Torrence, Richard E.Isaacson(2003), Microbial Food Safety in Animal Agriculture: Current Topics Low State University Press.
11. Diam Robert. (2002), Food Microbiology: An Introduction. Black Well Publishers.

M Sc. MICROBIOLOGY SEMESTER – 111

Discipline Specific Course (DSC)

Course Title: MB ET -3.4 FOOD AND FERMENTATION TECHNOLOGY

Course Code: A3MCB203T

Type of Course	Theory /Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours/Semester	Duration of Exam	Formative Assessment Marks	Summative assessment Marks	Total Marks
DSC	**Theory**	**04**	**04**	**60 hrs.**	**3 hrs.**	**20**	**80**	**100**

Course outcome:

After completion of course (Theory), students will be able to understand

CO 1: At the end of the course the student will have wide knowledge on history, concept and scope of food microbiology. Also acquire knowledge on Contamination and spoilage of food.

CO 2 : Understanding the application and techniques of food preservation and different types sterilization techniques.

CO 3 : Acquire the knowledge on thechoosing of most potent microorganisms by bioprocess engineering.

CO 4 : Understanding the different various fermentation technologies and microbial based production of commercial important products.

Unit	Content	60 hrs/Sem
I	**Food Microbiology** **Introduction:** Definition, concepts and scope of food and dairy microbiology. (2 Hours) **Food as a substrate for microorganisms**: Important microorganisms in food (Molds, Yeasts, Bacteria) and their source. (Air, soil, water, plants and animals) (4 Hours) **Contamination and spoilage:** Principles of food spoilage. spoilage of cereals sugar products, fruits, vegetables, meat and meat products, fish and sea foods poultry, spoilage of canned foods, Detection of food borne microbes- sampling, detection by culturing methods, physical and chemical methods. (9 Hours)	**15**

II	**Fermented foods and preservation** **Food preservation:** General principles, physical methods (low temperature, high temperature and drying), chemical methods (Food additives), irradiation, biological methods of food preservation. Processing for heat treatment- D, Z and F values and working out treatment parameters, freeze drying methods. (6 Hours) **Fermented foods**: Microbial activity in food vegetables (olives and cucumbers), meat (sausages), bread, idli, cocoa and coffee. Dairy foods – cheese, shrikand, temph, Therapeutic and nutritional value of fermented foods, spoilage and defects of fermented dairy products, oriental fermented foods their quality, standard and control.(6 Hours) **Sterilization process in fermentation industry** – Media sterilization, method of batch sterilization and the design of continuous sterilization process, sterilization of fermentor, feeds air, and filter design. (3 Hours)	**15**
III	**Bioprocess Engineering** **Introduction to bioprocess engineering:** Isolation, screening, selection, preservation and maintenance of industrial microorganisms strain improvement, Inoculum development for bacterial and fungal processes, spore inoculum or vegetative mycelia inoculum for fungi. 3 Hours) **Fermentation media:** Natural, synthetic media typical media and media formulation strategies, sources of carbon, nitrogen, Vitamins and minerals, Role of buffers, precursors, inhibitors, inducers and antifoam agents. Solid state fermentation. (4 Hours) **Bioreactors** – Design of fermentors, basic function of a fermentors, body construction aeration and agitation. The achievement and maintenance of aseptic conditions sterilization of fermentors air supply, aeration and agitation, addition of inoculum and nutrients, sampling, foam control monitoring and control of various parameters, various types of values Types of bioreactors Specialized bioreactors – Tubular bioreactors, membrane bioreactors, Tower bioreactors, fluidized bed reactor, packed bed reactor and photo bioreactors. (8 Hours)	**15**
1V	**Applications of fermentation Technology** **Fermentation technology** – Types of fermentation process – Analysis of batch, fed batch and continuous bio-reactions, stability of microbial reactors, analysis of mixed microbial population, specialized bio-reactors (pulsed, fluidized, photo bioreactors etc). Measurement and control of bio-process parameters. (4 Hours) Industrial production of Agar – Agar, Alginate, Alcohol (Ethanol), Organic acids (Citric, acetic, Lactic and Gluconic acid) Solvent (Glycerol Acetone, Butanol), Antibiotics (Penicillin, streptomycin, tetracycline) Amino acids (lysine, glutamic acid) Single cell proteins (SCP) Vitamins (Riboflavin) Enzymes (Amylase, lactase, protease), Hydrocarbons – Biodegradable plastic – Polyhydroxy alkanoates (butyrate, propionate etc), recombinant protein (hepatitis - B vaccine). (6 Hours) **Entrepreneurship:** Potential entrepreneurship activities in biotechnology, An-	**15**

	inter disciplinary challenge, product development, marketing, research and training units, Industrial licensing, venture capital, Biotech parks. Biotechnology industries in India and the potential job opportunities and Intellectual property rights (IPRs) Trade Mark, and development of branding, Trail market, Market survey, etc., Future challenges, and its solution. (5 Hours)	

REFERENCES

1. WCFrazier; (2001) Food Microbiology; Tata McGraw Hill, Delhi
2. Bisen (1995) Hand Book of Microbiology;
3. Dayte M.P., Lorry R.B. and Thomas J.M., (2008) Food Microbiology, ASM,WashingtonD.C.
4. Adams M.R. and Moss M.O. (2000) Food Microbiology. Royal Publishing Corporation.
5. Bibek Ray (2001). Fundamentals of Food Microbiology. Bibek Ray. 2nd Edition.CRCPress.
6. Bieleckis, TramperJ,PolakJ. (2000), Food Biotechnology. Elsevier.
7. James.M.Jay (1996) Modern food Microbiology CBS Publishers and Distributors. Delhi.
8. Bieleckis, Tramper J, Polak J. (2000), Food Biotechnology. Elsevier.
9. John S. Norak, Gerald M.Sapers, Vijay Kumar Juneja, Daniel K Gay (2002),Microbial Safety of minimally processed foods 1st Edition CRC Press.
10. Ananth Krishnan C.P. et.al. (1994), dairy Microbiology, Sreelakshmi Publication.,Chennai.
11. RobinsonR.K.(1990), dairy microbiology, Elsevier Applied Science, London.
12. Casida (1994), Industrial Microbiology, WileyEastern Ltd. New Delhi.
13. Mary.E.Torrence, Richard E.Isaacson (2003), Microbial Food Safety in AnimalAgriculture:CurrentTopicsLow State UniversityPress..
14. Diam Robert.(2002), Food Microbiology:An Introduction. Black Well Publishers

M Sc. MICROBIOLOGY SEMESTER – 1V

Discipline Specific Course (DSC)

Course Title: MBCT 4.1 IMMUNOLOGY AND IMMUNOTECHNOLOGY

Course Code: A4MCB001T

Type of Course	Theory /Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours/Semester	Duration of Exam	Formative Assessment Marks	Summative assessment Marks	Total Marks
DSC	**Theory**	**04**	**04**	**60 hrs.**	**3 hrs.**	**20**	**80**	**100**

Course outcome:

After completion of course (Theory), students will be able to understand

CO 1: At the end of the course the student will have wide knowledge on history, concept and scope of immunology. Also acquire knowledge on concept of immunity and its types.

CO 2 : Understanding the Antigen- Antibody and their interactions

CO 3 : Acquire the knowledge on : Immunodiagnostics, Immunotechniques and applications, Immunization & Vaccine Technology

CO 4 : Understanding the Expressions and Regulation of Immune Response, Transplantation and Tumor immunology.

Unit	Content	60 hrs/Sem
I	**Immunology** **Introduction to Immunology:** Fundamental concepts and anatomy of the immune system, History and scope of immunology. (3 Hours) **Cells involved in immune system** – Haematopoetic system, T-lymphocytes, B-lymphocytes, Monocytes, Macrophages, APC, Neutrophils, Mast cells. (3 Hours) **Organs of the immune system**- primary and secondary lymphoid organs, Lymphatic system, Lymphocyte circulation, Mucosal and Cutaneous associated Lymphoid tissue (MALT&CALT). (5 Hours) **Types of immunity**- Innate immunity, Adaptive immunity, Components of Innate and Acquired immunity. Phagocytosis, Complement and Inflammatory responses. (4 Hours)	**15**
II	**Antigen- Antibody & their interactions, Hypersensitivity reactions** **Antigen:** Identification and measurement of antigen, conditions of	**15**

	antigenicity, antigens and immunogenicity, super-antigen. Self and non-self-recognition, epitopes mapping, paratopes, nature of B-cell and T – cell epitopes, Concept of haptens carbohydrate antigens, blood group antigens, synthetic peptides as antigens. (3 Hours) **Immunoglobulin:**Structure and properties of immunoglobulin classes, Isotypes, Idiotypes and Allotypes, Genetics of antibody diversity, Polyclonal antibodies and Monoclonal antibodies. (3 Hours) **Antigen-antibody Interaction:** Agglutination, Precipitation, Affinity, avidity and cross reactivity, Haemagglutination and Complement fixation. (2 Hours) **Hypersensitivity reactions:** Allergies, Type I- Anaphylaxis, Type II- Antibody dependent cell cytotoxicity and Type III- Immune complex mediated reactions, Type IV- delayed type hypersensitivity,Symptoms and Immunological methods of diagnosis of hypersensitive reactions, Lymphokines, and cytokines–Assay methods, Immunological tolerance and modulation. (7 Hours)	
III	**Immunodiagnostics, Immunotechniques and applications, Immunization & Vaccine technology** **Anti-microbial immunity:** Defense against bacteria, viruses, fungi, protozoa and parasites. (4 Hours) **Immunodiagnostics in virology** – Serological methods for detection and quantitation of viruses including Hepatitis, Influenza, HIV and others. (2 Hours) **Immuno-assays:** Immuno double- diffusion, single radial immunodiffusion (SRID), ELISA, ELISA-PCR, RIA, Western Blotting, Immunoflurorescence and their application. Immune deficiencies and autoimmunity, Immunoelectrophoresis, Flow cytometry, Complement fixation test (CFT), Montaux test, Applications of these methods in diagnosis of Microbial infections. (4 Hours) **Vaccines:** Types of vaccines and its application, edible vaccines, conventional vaccines, viral vaccines, bacterial vaccines, peptide vaccines, genetically engineered vaccines, Hybridoma technology, immunization of animals Isolation of stimulated spleen cells, myeloma cell lines used and fusion partners, Fusion method production, detection and applications of monoclonal and polyclonal antibodies, production and application of Lymphokines. (5 Hours)	**15**
1V	**Expressions and Regulation of Immune Response, Transplantation and Tumor immunology** Regulation of immune response, Antigen processing and presentation, generation of humoral and cell mediated immune response, activation of B and T lymphocytes, cytokines and their role in Immune regulation, T cell regulation, MHC complex restriction, Immunological tolerance. (5 Hours) **Cytokines:** Structure and receptors, signal transduction, modulation of	**15**

	immune response cytokine profile of diseases. (2 Hours) **Transplantation Immunology:** Organ transplantation, Types of grafts, Structure and functions of MHC and the HLA systems, grafts rejection, mechanism of graft rejection and prevention of graft rejection, GVH reactions **HLA and tissue transplantation**: Tissue typing methods for transplantations in humans; Xeno-transplantation, (inter species, intra Species, Intra Genus) immunosuppressive therapy. (5 Hours) **Tumor Immunology:** Immune response to tumors, Tumor specific antigens, Theory of surveillance, Immunodiagnosis of tumors – Detection of tumor markers – Alpha-fetoprotein, Carcino-embryonic antigen, Cancer therapeutics. (3 Hours)	

Course Title: MB CP 4.4 Based on MB CT 4.1– Immunology And Immunotechnology

Course Code: A4MCB004P

Type of Course	Theory /Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours/Semester	Duration of Exam	Formative Assessment Marks	Summative assessment Marks	Total Marks
DSC	**Practical**	**02**	**04**	**60 hrs.**	**4 hrs.**	**10**	**40**	**50**

PRACTICALS

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

REFERENCES

1. Abbas AK, Lichtman AHH, Shiv Pillai. (2017). Cellular and Molecular Immunology, 9thEdition, Elseiver Saunders Publishers.
2. Ananthanarayan, R and Paniker. (2017). Text book of Microbiology, 10thEdition, Universities press Private Limited, Hyderabad, India.

3. Bisen, S.P. (2014). Laboratory Protocols in Applied Life Sciences, CRC Press Taylor and Francis Group

4. CV Rao (2006) An Introduction to Immunology 2nd Edition, Alpha Science Intl Ltd.

5. Christopher, J., Burrell, Colin. R., Howard, Frederick. A. Murphy. (2016). Fenner and White's Medical Virology, 5th Edition, Academic Press.

6. Coleman RM, Lombard MF and Sicard RE. (2012). Fundamental Immunology, 7th Edition, LWW publication.

7. Delves, P.J., Martin, S.J., Burton, D.R., Roitt, I.M. (2017). Roitt's Essential Immunology,13th Edition, Wiley-Blackwell Publishers

8. Frank Hay. (2002). Practical immunology, 4th Edition , Blackwell Science

9. IR Tizard, (2013), Immunology: An Introduction, 5th Edition, Saunders College Publishers, New York.

10. Plummer, D.T. (2017). Introduction to Practical Biochemistry, 3rd edition, Tata MacGraw Hill.

11. Pavri, KM (2010), Challenge of AIDS, National Book Trust, India.

12. Owen, J., Punt, J., Stranford, S., Jones, P. (2018) Kuby Immunology, 8th Edition, W.H. Freeman & Company, New York.

13. Pommerville, J. (2014). Alcamo's Fundamentals of Microbiology. 10th Edition. Viva books Pvt ltd. New Delhi.

14. Tortora, G. J., Funke, R.B., Case, L.C. (2016). Microbiology: An Introduction 12th EditionPearson Publication.

15. William E., Md. Paul (Editor). (2012). Fundamental Immunology, 7th Edition, Lippincott Williams & Wilkins Publishers.

M Sc. MICROBIOLOGY SEMESTER – 1V

Discipline Specific Course (DSC)

Course Title: MB CT 4.2 -MEDICAL MICROBIOLOGY

Course Code: A4MCB002T

Type of Course	Theory /Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours/Semester	Duration of Exam	Formative Assessment Marks	Summative assessment Marks	Total Marks
DSC	**Theory**	**04**	**04**	**60 hrs.**	**3 hrs.**	**20**	**80**	**100**

Course outcome:

After completion of course (Theory), students will be able to understand

CO 1: At the end of the course the student will have wide knowledge on history, Development and scope of Medical microbiology.

CO 2: Understanding the transmission of disease caused by bacteria, fungi, viruses, and protozoa.

CO 3 : Acquire the knowledge on clinical microbiology: Specimen collection, handling, transport, identification of pathogens from specimens

CO 4: Understanding the mechanism of antimicrobial agents and disease diagnosis of various microorganisms.

Unit	Content	60 hrs/Sem
I	**Medical Microbiology** **History, Development, and Scope of Medical Microbiology**: Classification of medically important microorganisms, normal microbial flora of the human body and their significance. Human microbiome project. (5 Hours) **Disease Transmission**: Infection by bacteria, fungi, viruses, and protozoa – Signs, symptoms, sources, and reservoirs of infection, nosocomial infections. Pathogenesis - adhesion, invasion, host cell damage, release of pathogens, modes of transmission, and epidemiology. (10 Hours)	**15**
II	**Clinical Microbiology** **Clinical Microbiology**: Specimen collection, handling, transport, identification of pathogens from specimens, growth and biochemical characteristics, rapid methods of identification, immunological techniques, bacteriophage typing, molecular measures (DNA probes, restriction endonucleases, DNA fingerprinting, RIA, ELISA, PCR), and susceptibility testing. A brief account of hospital management. (10 Hours) **Nosocomial Infections**: Bacteremia, burn wounds, surgical site infections, urinary	**15**

	tract infections, and miscellaneous infections. (5 Hours)	
III	**Antimicrobial Agents** **Antimicrobial Therapy**: General characteristics of antimicrobial agents, determination of antimicrobial activity. Mechanisms of action of Antimicrobial agents; Antibacterial drugs - Sulfonamide, Quinolones, Penicillin, Cephalosporin, Tetracycline, Erythromycin; Antifungal drugs -Azoles, Echinocandins, Polyenes, Pyrimidine Analogues (5FCs); and Antiviral drugs - Abacavir, Adefovir. Drug resistance – Types, mechanisms, and implications. Vaccines: A brief account of available vaccines and schedules. (15 Hours)	**15**
1V	**Microbial Diseases** **Disease Diagnosis and Epidemiology**: Pathogenesis, clinical conditions, laboratory diagnosis, epidemiology, prophylaxis, and treatment of the following diseases. (2 Hours) **Protozoa**: Leishmaniasis, and Trypanosomiasis. (2 Hours) **Bacteria**: Diphtheria, Gonorrhea, Syphilis, Plague, Leprosy, Tuberculosis, Gas gangrene, Tetanus. (2 Hours) **Fungi**: Candidiasis, Mycetoma, Chromomycosis, Sporotrichosis, Cryptococcosis, Blastomycosis, Coccidioidomycosis, and Histoplasmosis. (2 Hours) **Viruses**: Measles, Mumps, Influenza, HIV, Herpes, Rabies, Hepatitis, Dengue fever, KFD, Rhinovirus, CJD, and Kuru, Covid-19. (5 Hours) **Dental Infections**: Dental Plaque, Dental caries, and periodontal diseases.(2 Hours)	**15**

Course Title: MB CP 4.5 Based on MB CT 4.2– Medical Microbiology

Course Code: A4MCB005P

Type of Course	Theory /Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours/Semester	Duration of Exam	Formative Assessment Marks	Summative assessment Marks	Total Marks
DSC	**Practical**	**02**	**04**	**60 hrs.**	**4 hrs.**	**10**	**40**	**50**

PRACTICALS

1. Preparation of culture media, microscopic observation and Presumptive identification of pathogenic microorganisms using colony morphology on selective/differential/selective-differential/enrichment media.
2. Study of commensal microbial flora of human body (mouth/skin/hands/nose/ear).
3. Isolation and characterization of clinical significant species of *Staphylococcus, Streptococcus, Candida, Cryptococcus, Cornybacterium, Bacillus, Nocordia, Neisseria, Enterobacteriaceae, Vibrio, Pseudomonas aeruginosa.*
4. Isolation, characterization and identification of bacterial pathogen from clinical specimen (Urine sample/Pus sample/Blood sample).
5. Anaerobic culture method for anaerobes of clinical importance.
6. Study of *Mycobacterium tuberculosis*by AFB method using sputum (Bacterial infection).
7. Liver Function test.
   a. Serum Glutamic Pyurvic Transaminase test
   b. Serum Glutamic Oaloacetic Transaminase test.
   c. Estimation of serum glucose and protein.
   d. Estimation of Blood urea.
   e. Estimation of bilirubin from serum.
   f. Alkaline phosphatase test and Acid phosphatase test.
   g. Estimation of serum Albumin and serum globulin

8. Demonstration of the diagnosis of HIV by Dot-ELISA (Viral infection).
9. Identification of pathogenic fungi (Germ tube test/Slide culture technique).
10. Study of antibiotic sensitivity test
11. Determination of MIC value for selected antibiotics.
12. Lymphocyte viability test (Trypan blue exclusion test of cell viability).
13. Mandatory visit to hospital and medical research centers.

REFERENCES

1. Bailey, W. R., Scott, E. G., &Tille, P. M. (2017). Bailey & Scott's Diagnostic Microbiology (14th ed.). St. Louis: Mosby.
2. Baron, E. J., Peterson, L. R., &Finegold, S. M. (2020). Bailey & Scott's Diagnostic Microbiology (14th ed.). St. Louis: Mosby.
3. Bhatia, R., &Ichhpujani, R. L. (2018). Essentials of Medical Microbiology (2nd ed.). New Delhi: Jaypee Brothers.
4. Chakravarti, G., & Bhattacharya, K. (2010). A Handbook of Clinical Pathology Technique and Interpretation (2nd ed.). Calcutta: Acad. Publ.
5. Chatterjee, M. N., & Shinde, R. (2018). Textbook of Medical Biochemistry (9th ed.). New Delhi: Jaypee Brothers Medical Publishers.
6. Garcia, L. S., & Isenberg, H. D. (2018). Clinical Microbiology Procedures Handbook (4th ed.). Washington, DC: ASM Press.
7. Murray, P. R., Baron, E. J., Jorgensen, J. H., Landry, M. L., &Pfaller, M. A. (2015). Manual of Clinical Microbiology (11th ed.). Washington, DC: ASM Press.
8. Godkar, P. B., &Godkar, D. P. (2014). Textbook of Medical Laboratory Technology (3rd ed.). Mumbai: Bhalani Publishing House.
9. Green, M. R., & Sambrook, J. (2012). Molecular Cloning: A Laboratory Manual (4th ed.). Cold Spring Harbor Laboratory Press.
10. Greenwood, D., Slack, R. C. B., & Barer, M. R. (2012). Medical Microbiology: A Guide to Microbial Infections: Pathogenesis, Immunity, Laboratory Diagnosis and Control (18th ed.). Edinburgh: Churchill Livingstone.
11. Hazen, K. C. (2003). Davis, H. Larone, ed. Medically Important Fungi: A Guide to Identification (4th ed.). Mycopathologia, 156(4), 383-384.
12. Mackie, T. J., Collee, J. G., & McCartney, J. E. (2007). Mackie and McCartney Practical Medical Microbiology (14th ed.). New Delhi: Elsevier.
13. Moffet, H. L. (1980). Clinical Microbiology. Philadelphia: Lippincott.

14. Peter, J. B. (1994). Use and Interpretation of Tests in Clinical Immunology. Santa Monica, CA: Special Laboratories.

15. Pommerville, J. C. (2011). Alcamo's Laboratory Fundamentals of Microbiology (9th ed.). Sudbury, MA: Jones & Bartlett.

16. Prescott, L. M., Harley, J. P., Klein, D. A., Willey, J. M., Sherwood, L. M., & Woolverton, C. J. (2008). Microbiology (8th ed.). Estados Unidos: McGraw-Hill.

17. Ramakrishnan, S., Prasannan, K. G., &Rajan, R. (2001). Textbook of Medical Biochemistry (2nd ed.). Hyderabad: Orient Longman.

18. Slockbower, J. M. (1983). Collection and Handling of Laboratory Specimens: A Practical Guide. Philadelphia, PA: Lippincott.

19. Turnbaugh, P. J., Ley, R. E., Hamady, M., Fraser-Liggett, C., Knight, R., & Gordon, J. I. (2007). The human microbiome project: Exploring the microbial part of ourselves in a changing world. Nature, 449(7164), 804–810.

20. Wilson, K., & Walker, J. (2005). Practical Biochemistry: Principles and Techniques (5th ed.). U.K.: Press Syndicate of the University of Cambridge.

M Sc. MICROBIOLOGY SEMESTER – 1V
Discipline Specific Course (DSC)

Course Title: MBCT 4.3- BIOPROCESS AND FERMENTATION TECHNOLOGY

Course Code: A4MCB003T

Type of Course	Theory /Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours/Semester	Duration of Exam	Formative Assessment Marks	Summative assessment Marks	Total Marks
DSC	**Theory**	**04**	**04**	**60 hrs.**	**3 hrs.**	**20**	**80**	**100**

Course outcome:

After completion of course (Theory), students will be able to understand:

CO 1: At the end of the course the student will have wide knowledge on industrially important Microorganisms and role of sterilization in media formation.

CO 2: Understanding the fermentation technology.

CO 3: Understanding the application of bioprocess engineering.

CO 4: Acquire the knowledge on Entrepreneurship.

Unit	Content	60 hrs/Sem
I	**Bioprocess Technology** **Introduction:** Bioprocess engineering, isolation, screening, selection, preservation and maintenance of industrial important microorganisms, strain improvement, inoculum development for bacterial and fungal processes, spore inoculum or vegetative mycelia inoculum for fungi.(7 Hours) **Fermentation media:** Natural, synthetic media typical media and media formulation strategies, source of Carbon, Nitrogen, Vitamins and minerals, role of buffers, precursors, inhibitors, inducers, and antifoam agents. Solid state fermentation.(5 Hours) **Sterilization process in fermentation industry**: Media sterilization, method of batch sterilization and the design of continuous sterilization process, sterilization of fermentor, feeds air, and filter design.(3 Hours)	**15**
II	**Fermentation Technology** **Bioreactors:** Design of fermentors, basic function of a fermentors, body construction aeration and agitation. The achievement and maintenance of aseptic conditions sterilization of fermenters air supply, aeration and agitation, addition	**15**

	of inoculum and nutrients, sampling, foam control monitoring and control of various parameters, various types of values, Types of bioreactors, specialized Bioreactors-Tubular bioreactors, membrane bioreactors, Tower bioreactors, fluidized bed reactor, packed bed reactor and photo bioreactors. (8 Hours) **Types of fermentation:** Analysis of batch, fed batch and continuous bio-reactions, stability of microbial reactors, analysis of mixed microbial population, specialized bio-reactors (pulsed, fluidized, photo bioreactors etc). Measurement and control of bio-process parameters. (3 Hours) **Downstream processing:** Introduction objectives and criteria for downstream processing, Removal of microbial cells and solid matter, Foam precipitation, filtration centrifugation, cell disruptions, liquid-liquid extraction, chromatography, membrane process, drying, crystallization, packaging and quality assurance. (4 Hours)	
III	**Applications of Bioprocess engineering** **Immobilization:** Definition and concepts of immobilization, enzyme and whole cell immobilization, immobilization techniques–adsorption, cross-linking, ionic bonding, entrapment encapsulation, advantages, and industrial applications of immobilized enzymes (α-galactosidase, glucose isomerase etc.) and cells. (8 Hours) **Industrial production:** Agar – Agar, Alginate, Alcohol (Ethanol), Organic acids (Citric, acetic, Lactic and Gluconic acid) Solvent (Glycerol Acetone, Butanol), Antibiotics (Penicillin, streptomycin, tetracycline) Amino acids (lysine, glutamic acid) Single cell proteins (SCP) Vitamins (Riboflavin) Enzymes (Amylase, lactase and protease), Hydrocarbons– Biodegradable plastics- Polyhydroxy alkanoates (butyrate, propionate and etc), recombinant protein (hepatitis – B vaccine). (7 Hours)	**15**
1V	**Entrepreneurship** **Entrepreneurship:** Potential entrepreneurship activities in biotechnology, An-interdisciplinary challenge, product development, marketing, research and training units, Industrial licensing, vesture capital, Biotech parks. Biotechnology industries in India and the potential job opportunities and Intellectual property rights (IPRs) Trade Mark, and development of branding, Trail market, Market survey, etc. Future challenges, and its solution). (15 Hours)	**15**

Course Title: MB CP 4.6 Based on MB CT 4.3 - Bioprocess And Fermentation Technology
Course Code: A4MCB006P

Type of Course	Theory /Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours/Semester	Duration of Exam	Formative Assessment Marks	Summative assessment Marks	Total Marks
DSC	**Practical**	**02**	**04**	**60 hrs.**	**4 hrs.**	**10**	**40**	**50**

PRACTICALS

1. Study of Ferment or and Bioreactor.
2. Isolation of industrially important microorganisms.
3. Study of antibiotic producing microorganisms in mass culture process and recovery of the product.
4. Detection and quantification of Siderophores produced by *Pseudomonas sp*.
5. Study of alcohol fermentation – alcohol production from different substrates, Lab production of Wine, Estimation of percentage of Alcohol, Total acidity and volatile acidity in wine.
6. Estimation of Alcohol by Potassium dichromate method.
7. Production and analysis of SCP from *Spirulina and Yeast.*
8. Production of Citric acid by *Aspergillus niger*, *Pencilliumcitrannum*and its estimation.
9. Production of pectinase from *Aspergillus niger*by using Wheat bran, Coffee pulp using small scale fermentor and its assay.
10. Production of α- Amylase using *Aspergillus oryzae*, *Bacillus licheniformis* using Wheat bran in small-scale solid-state fermentation and its assay.
11. Immobilization of yeast cells by calcium alginate gel. Entrapment and assay for enzymes Invertase and Catalase.
12. Preparation of immobilized cells of *Bacillus licheniformis* for the use in the production of a-amylase.
13. Extraction and estimation of vitamins-Thiamine/Niacin/ Riboflavin/Vitamin C Mandatory visit to Research Institutes/Industries.

REFERENCES

1. Bailey and Ollis (2017). Biochemical Engineering Fundamentals, 2nd Edition, McGraw Hill.
2. Michael., Scheler and Fikretkargi (2001).Bioprocess engineering–basic concepts, 2nd Edn, Prentice Hall.
3. Frazier, W. C. and Westhoff, P. C. (1998). Food Microbiology, Tat McGraw Hill Publishers, New Delhi.
4. Kalaichelvan, P.T. (2011) Bioprocess Technology. MJP. Publishers, Chennai
5. Subhasch and Jain, S.C.–Fermentation Biotechnology. Panima Book Distributors, New Delhi.
6. Michael, J. Waites. Neil, L., Morgan., John S-Rockey (2001). Industrial Microbiology, Panima Book distributors, New Delhi.
7. Wulf crueger and Anneliesecrueger. (2005) Biotechnology-A Text Book of Industrial Microbiology-Second Edn, Panima Book distributors, New Delhi
8. Casida, Jr.L.E.(1997). Industrial Microbiology, New Age International Pvt. Ltd, New Delhi.
9. El-mansi, E.M.TandBruce,C.F.A.(2002).Fermentation Microbiology ,2ndEdn, Cambridge University Press.
10. Paulins, M. D. (2003). Bioprocess Engineering– Principles. John Wiley Publishers.
11. Prescott, S. C. and Dunn, C (1984). Industrial Microbiology. McGraw Hill, New York.
12. Arnolod L. Demain. (2001). Manual of Industrial Microbiology and Biotechnology, Panima Book distributors, New Delhi.

Project work

- Students will be identifying the research area for the project.
- Critically search the scientific literature for information.
- Develop teamwork to assign project duties ensuring efficiency and quality of the project outcome.
- Develop observational skills and make discoveries in the laboratory.
- Design templates using spreadsheets for evaluation of data.
- Prepare professional scientific reports of the project.
- Student will able to get opportunity to publish their work in National/International peer reviewed journals.