BLDE
(DEEMED TO BE UNIVERSITY)

Choice Based Credit System (CBCS)

Curriculum

B.Sc. Programme in
Microbiology

2020-21

Published by
BLDE
(DEEMED TO BE UNIVERSITY)
Declared as Deemed to be University u/s 3 of UGC Act, 1956

The Constituent College
SHRI B. M. PATIL MEDICAL COLLEGE, HOSPITAL & RESEARCH CENTRE, VIJAYAPURA
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BLDE(DU)/REG/B.Sc.Life-Sci/2020-21/ 1877 May 12, 2020

NOTIFICATION

Sub: Curriculum for B.Sc. Programme in Life Sciences with Semester Scheme
Ref: 1. Minutes of the meeting of the 5th Standing Committee Academic Council of the University held on 06- 05-2020.
2. Approval of Board of Management dtd.08-05-2020
3. Approval of Hon'ble Vice-Chancellor vide order no.1834, dtd.09-05-2020

In accordance with the Rule-09 (ii) of the Memorandum of Association (MoA) of the Deemed to be University, the Board of Management (BoM) has approved the Curriculum of **'B.Sc. Programme in Life Sciences'** in 1) Biotechnology, 2) Microbiology, 3) Biochemistry, 4) Food, Nutrition and Dietetics, following Choice Based Credit System (CBCS) with Semester Scheme.

The Curriculum shall be effective from the Academic Session 2020-21 onwards, in the Constituent College of the University viz. Shri B. M. Patil Medical College, Hospital and Research Centre, Vijayapura.

REGISTRAR
REGISTRAR
BLDE (Deemed to be University)
Vijayapura-586103. Karnataka

To,
The Dean, Faculty of Medicine & Principal,
Shri B. M. Patil Medical College,
Hospital and Research Centre,
Vijayapura

Copy to:
- The Secretary, UGC, New Delhi
- The Dean, Faculty of Medicine & Principal
- The Controller of Examinations
- The Dean, Student Affairs
- The Prof. & HoDs of Pre, Para and Clinical Departments
- The Coordinator, IQAC
- PS to the Hon'ble Chancellor
- PS to the Hon'ble Vice-Chancellor

Vision:

- To be a leader in providing quality medical education, healthcare & to become an Institution of eminence involved in multidisciplinary and translational research, the outcome of which can impact the health & the quality of life of people of this region.

Mission:

- To be committed to promoting sustainable development of higher education, including health science education consistent with statutory and regulatory requirements.
- To reflect the needs of changing technology
- Make use of academic autonomy to identify dynamic educational programs
- To adopt the global concepts of education in the health care sector

SEMESTER-I				
Course Code	**Course Name**	**Credit**	**Marks**	
			Internal Assessment	**End Sem Examination**
BMB 1.1	Introduction to Microbiology and Microbial Diversity (Theory)	4	10	40
BMB 1.1P	Introduction to Microbiology and Microbial Diversity (Practical)	2	15	10
BMB 1.3	Bacteriology (Theory)	4	10	40
BMB 1.3P	Bacteriology (Practical)	2	15	10
Total in semester I		**12**	**150**	
Besides this, a student has to complete **one SEC, one AECE and one DSE (6 credits/ 75 marks)** from the Departments other than Microbiology and **one Ability enhancement Compulsory Course (2 credit/25 marks)** • **Therefore, a student covers a total of 20 credits (12+6+2) in Semester I**				

SEMESTER-II				
Course Code	**Course Name**	**Credit**	**Marks**	
			Internal Assessment	**End Sem Examination**
BMB 2.1	Biochemistry (Theory)	4	10	40
BMB 2.1P	Biochemistry (Practical)	2	15	10
BMB 2.3	Environmental Microbiology (Theory)	4	10	40
BMB 2.3P	Environmental Microbiology (Practical)	2	15	10
Total in semester II		**12**	**150**	
Besides this, a student has to complete **one SEC, one AECE and one DSE (6 credits/ 75 marks)** from the Departments other than Microbiology and **one Ability enhancement Compulsory Course (2 credit/25 marks)** **Therefore, a student covers a total of 20 credits (12+6+2) in Semester I**				

SEMESTER-III				
Course Code	**Course Name**	**Credit**	**Marks**	
			Internal Assessment	**End Sem Examination**
BMB 3.1	Microbial Physiology and Metabolism (Theory)	4	10	40
BMB 3.1P	Microbial Physiology and Metabolism (Practical)	2	15	10
BMB 3.2	Cell Biology (Theory)	4	10	40
BMB 3.2P	Cell Biology (Practical)	2	15	10
BMB 3.3	Molecular Biology (Theory)	4	10	40
BMB 3.3P	Molecular Biology (Practical)	2	15	10
BMB 3.4	Food fermentation techniques	2	05	20
Total in semester III		**20**	**250**	

SEMESTER-IV				
Course Code	**Course Name**	**Credit**	**Marks**	
			Internal Assessment	**End Sem Examination**
BMB 4.1	Microbial Genetics (Theory)	4	10	40
BMB 4.1P	Microbial Genetics (Practical)	2	15	10
BMB 4.2	Virology (Theory)	4	10	40
BMB 4.2P	Virology (Practical)	2	15	10
BMB 4.3	Food and Dairy Microbiology (Theory)	4	10	40
BMB 4.3P	Food and Dairy Microbiology (Practical)	2	15	10
BMB 4.4	Microbiological Analysis of Air and Water	2	05	20
Total in semester IV		**20**	**250**	

SEMESTER-V				
Course Code	**Course Name**	**Credit**	**Marks**	
			Internal Assessment	**Examination**
BMB 5.1	Industrial Microbiology (Theory)	4	10	40
BMB 5.1P	Industrial Microbiology (Practical)	2	15	10
BMB 5.2	Immunology (Theory)	4	10	40
BMB 5.2P	Immunology (Practical)	2	15	10
BMB 5.3/ BMB 5.4/ BMB 5.5/	Advances in Microbiology / Biomathematics and Biostatistics / Inheritance Biology **(ANY TWO)**	2x4	10x2	40x2
BMB 5.3P/ BMB 5.4P/ BMB 5.5P/	Advances in Microbiology / Biomathematics and Biostatistics / Inheritance Biology (Practical) **(ANY TWO)**	2x2	15x2	10x2
Total in semester V		**24**	**300**	

SEMESTER-VI				
Course Code	**Course Name**	**Credit**	**Marks**	
			Internal Assessment	**Examination**
BMB 6.1	Medical Microbiology (Theory)	4	10	40
BMB 6.1P	Medical Microbiology (Practical)	2	15	10
BMB 6.2	Recombinant DNA Technology (Theory)	4	10	40
BMB 6.2P	Recombinant DNA Technology (Practical)	2	15	10
BMB 6.3/ BMB 6.4/ BMB 6.5	Microbes in sustainable Agriculture and Development/ Biosafety and Intellectual Property Rights/ Instrumentation and Biotechniques (Theory) **(ANY TWO)**	2x4	10x2	40x2
BMB 6.3P/ BMB 6.4P/ BMB 6.5P	Microbes in sustainable Agriculture and Development/ Biosafety and Intellectual Property Rights/ Instrumentation and Biotechniques (Practical) **(ANY TWO)**	2x2	15x2	10x2
Total in semester VI		**24**	**300**	

TOTAL CREDIT = 140 TOTAL MARKS = 1750

Rules and Regulations of Curriculum

B.Sc. Microbiology

Definitions of Key Words:

1. **Academic Year:** Two consecutive (one odd + one even) semesters constitute one academic year. Choice Based Credit System (CBCS).

2. The CBCS provides choice for students to select from the prescribed courses (core, elective or minor or soft skill courses).

3. **Course**: Usually referred to, as "papers" is a component of a programme. All courses need not carry the same weight. The courses should define learning objectives and learning outcomes. A course may be designed to comprise lectures/ tutorials/ laboratory work/ outreach activities/ project work/ viva/ seminars/ term papers/assignments/ presentations/ self-study etc. or a combination of some ofthese.

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

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

6. **Cumulative Grade Point Average (CGPA):** It is a measure of overall cumulative performance of a student over all semesters. The CGPA is the sum total of the credit points obtained by the student in various courses in all semesters and the sum of the total credits of all courses in all the semesters.

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

8. **Letter Grade:** It is an appreciated point of the student's performance in a selected course. Grades are denoted by letters O, A+, A, B, C and RA x. Programme: An educational programme leading to award of a Degree certificate.

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

10. **Semester:** Each semester will consist of minimum of 180 working days. The odd semester may be scheduled from June/ July to December and even semester from December/ January to June.

Duration of Study: The duration of the study for B.Sc. Medical Microbiology will be of Three years including 6 Months of Internship.

Program pattern:

- First Semester: July
- Second Semester: January
- Third Semester: July
- Fourth Semester: January
- Fifth Semester-July
- Sixth Semester-January

Eligibility Criteria:

- He/she has passed the Higher Secondary (10+2) with Science (PCB) or equivalent examination recognized by any Indian University or a duly constituted Board with pass marks in Physics, Chemistry, and Biology.
- Minimum percentage of marks: 45% aggregate.

Medium of Instruction:

English shall be the Medium of Instruction for all the Courses of study and for examinations.

CBCS – Definition and benefits: Choice Based Credit System is a flexible system of learning. The distinguishing features of CBCS are the following:

- It permits students to learn at their own pace.
- The electives are selected from a wide range of elective courses offered by the other University Departments.
- Undergo additional courses and acquire more than the required number of credits.
- Adopt an inter-disciplinary and intra-disciplinary approach in learning.
- Make best use of the available expertise of the faculty across the departments or disciplines
- Has an inbuilt evaluation system to assess the analytical and creativity skills of students in addition to the conventional domain knowledge assessment pattern.

Semester System and Choice Based Credit System:

The semester system initiates the teaching-learning process and screws longitudinal and latitudinal mobility of students in learning. The credit based semester system provides flexibility in designing curriculum and assigning credits based on the course content and hours of teaching. The choice based credit system provides a sun shone‟ type approach in which the students can take choice of courses, learn and adopt an interdisciplinary approach of learning.

Semesters:

An academic year consists of two semesters:

	UG
Odd Semester 1st semester	July – December
Odd Semester 3rd, 5thsemesters	June – October/ November
Even Semester 2nd, 4th, 6thsemesters	December –April

Credits:

Credit defines the coefficient of contents/syllabus prescribed for a course and determines the number of hours of instruction required per week. Thus, normally in each of the courses, credits will be assigned on the basis of the number of lectures/ tutorial laboratory work and other forms of learning required, to complete the course contents in a 15-20 week schedule:

a. ***1 credit*** **=** 1 hour of lecture per week
b. ***3 credits*** = 3 hours of instruction per week
- ✓ Credits will be assigned on the basis of the lectures (L) / tutorials (T) / Clinical Training (CR) / laboratory work (P) / Research Project (RP) and other forms of learning in a 15- 20 week schedule L - One credit for one hour lecture per week

c. **P/T -** One credit for every two hours of laboratory or practical
d. **CR -** One credit for every three hours of Clinical training/Clinical rotation/posting
e. **RP** - One credit for every two hours of Research Project per week – Max Credit 20- 25

	Lecture - L	**Tutorial - T**	**Practical - P**	**Clinical Training/ Rotation– CT/CR**	**Research Project–RP***
1 Credit	1 Hour	2 Hours	2 Hours	3 Hours	2 Hours
RP*	Maximum Credit 20 – 25 / Semester				

Types of Courses: Courses in a programme may be of three kinds:

- **Core Course**
- **Elective Course**
- **Ability Enhancement Compulsory Courses**

Core Course: A course, which should compulsorily be studied by a candidate as a basic requirement is termed as a Core course. There may be a Core Course in every semester. This is the course which is to be compulsorily studied by a student as a basic requirement to complete programme of respective study.

Elective Course: A course which can be chosen from a very specific or advanced the Course of study or which provides an extended scope or which enables an exposure to some other domain or expertise the candidates ability is called an Elective Course.

Discipline Specific Elective (DSE) Course: Elective courses offered by the main Course of study are referred to as Discipline Specific Elective. The University / Institute may also offer discipline related Elective courses of interdisciplinary nature. An elective may be "Discipline Specific Electives (DSE)" gazing on those courses which add intellectual efficiency to the students.

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

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

Ability Enhancement Compulsory Courses: The Abilit y Enhancement (AE) Courses may be of two kinds: Ability Enhancement Compulsory Courses (AECC) and Skill Enhancement Courses (SEC).

"AECC" courses are the courses based upon the content that leads to Knowledge enhancement (i) Environmental Science and (ii) English/MIL Communication. These are mandatory for all disciplines.

Assigning Credit Hours per Course: While there is flexibility for the departments in allocation of credits to various courses offered, the general formula would be:

- All core course should be restricted to a maximum of 4 credits.
- All electives should be restricted to a maximum of 3 credits.
- All ability enhancement course should be restricted to a maximum of 2 credits.
- Projects should be restricted to a maximum of 20-25 credits.

Rules and Regulation for Examination of Microbiology Program under CBCS Pattern

1. **Title of the Programme offered**: **Microbiology**

2. **Duration of the Programme:** Three years including 6 Months of Internship.

3. **Medium of instruction:** The medium of instruction and examination shall be in English

4. **Letter Grades and Grade Points:**

Adopted the UGC recommended system of awarding grades and CGPA under Choice Based Credit Semester System.

4.1 Would be following the absolute grading system, where the marks are compounded to grades based on pre-determined class intervals.

4.2 The UGC recommended 10-point grading system with the following letter grades will be followed:

Table 1: Grades and Grade Points:

Letter Grade	Grade Point
O (Outstanding)	10
A+ (Excellent)	9
A (Very Good)	8
B (Good)	7
C (Above Average)	6
F (Fail)/ RA (Reappear)	0
Ab (Absent)	0
Not Completed (NC)	0
RC (<50% in attendance or in Internal Assessment)	

4.3 A student obtaining Grade F/RA will be considered failed and will require reappearing in the examination.

4.4 Candidates with NC grading are those detained in a course (s); while RC indicate student not fulfilling the minimum criteria for academic progress or less than 50% attendance or less than 50% in internal assessments (IA). Registrations of such students for the respective courses shall be treated as cancelled. If the course is a core course, the candidate has to re-register and repeat the course when it is offered next time.

5. CBCS Grading System - Marks Equivalence Table

5.1 Table 2: Grades and Grade Points

Letter Grade	Grade Point	% of Marks
O (Outstanding)	10	86-100
A+ (Excellent)	9	70-85
A (Very Good)	8	60 -69
B (Good)	7	55 -59
C (Above Average) – **Passing criteria for Microbiology**	6	50- 54
F (Fail))/ RA (Reappear)	0	Less than 50
Ab (Absent)	0	-
NC- not completed	0	-
RC- Repeat the Course	0	0

5.2 Table 3: Cumulative Grades and Grade Points

Letter Grade	Grade Point	CGPA
O (Outstanding)	10	9.01 - 10.00
A+ (Excellent)	9	8.01 – 9.00
A (Very Good)	8	7.01 – 8.00
B (Good)	7	6.00 - 7.00
C (Above Average)	6	5.01 - 6.00

6. Assessment of a Course: Evaluation for a course shall be done on a continuous basis. Uniform procedure will be adopted under the CBCS to conduct internal assessments (IA), followed by one end-semester university examination (ES) for each course.

6.1 For all category of courses offered (Theory, Practical, Discipline Specific Elective [DE] ; Generic Elective [GE] and Ability Enhancement Courses [AE]; Skills Enhancement Courses [SE] Theory or P (Practical) & RP(Research Project), assessment will comprise of Internal Assessment (IA) in the form of continuous comprehensive evaluation and mid-semester exam, end–semester (ES) examination or college exam as applicable.

6.2 Courses in programs wherein Theory and Practical/Clinical are assessed jointly. The minimum passing head has to be 50% Grade each for theory and practical's separately. RA grade in any one of the components will amount to reappearing in both components. i.e. theory and practical.

6.3 Evaluation for a course with clinical rotation or clinical training or internship will be done on a continuous basis.

7. Eligibility to appear for the end-semester examinations for a course includes:

7.1 Candidates having ≥ 75% attendance and obtaining the minimum 40% in internal assessment in each course to qualify for appearing in the end-semester university examinations.

7.2 The students desirous of appearing for university examination shall submit the application form duly filled along with the prescribed examination fee.

7.3 Incomplete application forms or application forms submitted without prescribed fee or application form submitted after due date will be rejected and student shall not be allowed to appear for examination.

8. Passing Heads

8.1 Courses where theory and practical are involved, the minimum passing head shall be 50% in total including the internal assessment.

8.2 Elective Courses – the minimum prescribed marks for a pass in elective Course should be 50%. The marks obtained in elective Courses should be communicated to the university before the commencement of the universit y examination.

9 Detention: A student not meeting any of the above criteria maybe detained (NC) in that particular course for the semester. In the subsequent semester, such a candidate requires improvement in all, including attendance and/or IA minimum to become eligible for the next end-semester examination.

10 The maximum duration for completing the program will be 6 years (minimum duration of program x 2) i.e. (3x2) = 6 years, failing which his/her registration will be cancelled. Full fees of entire program of 3 years may be liable to be paid by the students.

11 Carry over benefit:

11.1 A student will be allowed to keep term for Semester II irrespective of number of heads of failure in Semester I.

11.2 A student will be allowed to keep term for Semester III if she/he passes each Semester I and II OR fails in not more than 2 courses each in semester I and II.

11.3 Student will be allowed to keep term for Semester IV irrespective of number of heads of failure in Semester III. However, student must mandatorily have passed each course of Semester I and II in order to appear for Semester IV exam.

11.4 Student will be allowed to keep term for Semester V, if she/he passes Semester I,II, III and IV OR has passed in all courses of Semester I and II and fails in not more than two courses each of Semester III and IV.

11.5 Student will be allowed to keep term for Semester VI, irrespective of number of heads of failure in Semester V. However, student must mandatorily have passed each course of Semester I, II, III and IV in order to appear for Semester VI exam.

12 Grace Marks for UG Courses:

12.1 A student shall be eligible for grace marks, provided he/she appeared in all the papers prescribed for the examination.

12.2 Maximum up to 5 grace marks may be allowed for passing, spread over between Courses.

12.3 No grace marks will be awarded in internal evaluation.

13 University End-Semester Examinations

13.1 There will be one final university examination at the end of every semester.

13.2 A student must have minimum 75% attendance (Irrespective of the type of absence) in theory and practical in each Course to be eligible for appearing the University examination.

13.3 The Principal / Director shall send to the university a certificate of completion of required attendance and other requirements of the applicant as prescribed by the university, two weeks before the date of commencement of the written examination.

13.4 A student shall be eligible to sit for the examination only, if she / he secure a minimum of 40% in internal assessment (individually in theory and practical as applicable). Internal examinations will be conducted at college/ department level.

13.5 Notwithstanding any circumstances, a deficiency of attendance at lectures or practical maximum to the extent of 10% - may be condoned by the Principal / Director.

13.6 If a student fails either in theory or in practical, he/ she have to re-appear for both.

13.7 There shall be no provision of re-evaluation of answer sheets. Student may apply to the university following due procedure for recounting of theory marks in the presence of the Course experts.

13.8 Internal assessment shall be submitted by the Head of the Department to the University through Dean at least two weeks before commencement of University theory examination.

14. Supplementary examination: The supplementary examination will be held in the next semester. Eligibility to appear for supplementary examination will be as per rule number 11.1-11.5.

15. Re-Verification

There shall be provision of re-totaling of the answer sheets; candidate shall be permitted to apply for recounting/re-totaling of theory papers within 8 days from the date of declaration of results.

16. Scheme of University Exam Theory UG Program: General structure / patterns for setting up question papers for Theory / Practical courses, for UG program are given in the following tables. Changes may be incorporated as per requirements of specific courses.

Guidelines to Prepare Internship Research Proposal & Project

1. **Selection of Research Problem:**
   Select your interest area of research, based on felt need, issues, social concern.
   a. State the problem in brief, concise, clear.
   b. State the purpose of selected study & topic.
   c. State the objectives of proposal/project.
   d. Prepare conceptual framework based on operational definition.
   e. Write scope of research proposal/project.

2. **Organizing Review of Literature**
   a. Study related and relevant literature which helps to decide conceptual framework and research design to be selected for the study
   b. Add specific books, bulletins, periodicals, reports, published dissertations, encyclopaedia and text books
   c. Organize literature as per operational definition
   d. Prepare summary table for review of literature

3. **Research Methodology: To determine logical structure & methodology for research project.**
   a. Decide and state approach of study i.e. experimental or non-experimental
   b. Define/find out variables to observe effects on decided items & procedure
   c. Prepare simple tool or questionnaire or observational checklist to collect data.
   d. Determined sample and sampling method
   e. Mode of selection ii) Criteria iii) Size of sample iv) Plan when, where and how data will be collected.
   f. Test validity of constructed tool
   g. Check reliability by implementing tool before pilot study(10% of sample size)
   h. Conduct pilot study by using constructed tool for 10% selected sample size

4. **Data collection: To implement prepared tool**
   a. Decide location
   b. Time
   c. Write additional information in separate exercise book to support inferences and interpretation

5. **Data analysis and processing presentation**
   a. Use appropriate method of statistical analysis i.e. frequency and percentage
   b. Use clear frequency tables, appropriate tables, graphs and figures.
   c. Interpretation of data:
   d. In relation to objectives
   e. Hypothesis
   f. Variable of study or project
   g. writing concise report

6. Writing Research Report

a. **Aims**:

i. To organize materials to write project report
ii. To make comprehensive full factual information
iii. To make appropriate language and style of writing
iv. To make authoritative documentation by checking footnotes, references & bibliography
v. To use computers & appropriate software

b. Points to remember

i. Develop thinking to write research report
ii. Divide narration of nursing research report
iii. Use present tense and active voice
iv. Minimize use of technical language
v. Use simple, straightforward, clear & concise language
vi. Use visual aids in form of table, graphs & figures
vii. Treat data confidentially
viii. Review & rewrite if necessary

Evaluation Criteria for Project Report

Sr. No	Criteria	Rating					Remark
		1	2	3	4	5	
I	**Statement of the problem**						
	1. Significance of the problem selected						
	2. Framing of title and objectives						
II	**Literature Review**						
	1. Inclusion of related studies on the topic and its relevance						
	2. Operational definition						
III	**Research Design**						
	1. Use of appropriate research design						
	2. Usefulness of the research design to draw the inferences among study variables/						
IV	**Sampling Design**						
	1. Identification & description of the target population						
	2. Specification of the inclusion & exclusion criteria						
	3. Adequate sample size, justifying the study design to draw conclusions						

V	**Data Collection Procedure**						
	1. Preparation of appropriate tool						
	2. Pilot study including validity & reliability of tool						
	3. Use of appropriate procedure/ method for data collection						
VI	**Analysis of Data & Interpretation**						
	1. Clear & logical organization of the finding						
	2. Clear presentation of tables(title, table & column heading)						
	3. Selection of appropriate statistical tests						
VII	**Ethical Aspects**						
	1. Use of appropriate consent process						
	2. Use of appropriate steps to maintain ethical aspects & principles						
VIII	**Interpretation of the finding**						
	& appropriate discussion of the results						
IX	**Conclusion**						
	Summary & recommendations						
X	**Presentation/ Report Writing**						
	Organization of the project work including language & style of						

Signature of the Evaluator

18. Eligibility for award of degree

18.1 A candidate shall have passed in all the Courses of all semester's I-VI, completed internship and submitted research project report to be eligible for award of Microbiology degree.

The performance of a candidate in a course will be indicated as a letter grade, whereas grade point will indicate the position of the candidate in that batch of candidates. A student is considered to have completed a course successfully and earned the prescribed credits if he/she secures a letter grade other than F/RA. A letter grade RA in any course implies he/she has to Re-appear for the examination to complete the course.

18.2 The RA grade once awarded in the grade card of the student is not deleted even when he/she completes the course successfully later. The grade acquired later by the student will be indicated in the grade sheet of the subsequent semester in which the candidate has appeared for clearance in supplementary exams

18.3 If a student secures RA grade in the Project Work/Dissertation, he/she shall improve it and resubmit it, if it involves only rewriting / incorporating the revisions suggested by the evaluators. If the assessment indicates lack of student performance or data collection then the student maybe permitted to re-register by paying the prescribed re-registration fee and complete the same in the subsequent semesters.

A candidate shall be declared to have passed the examination if he/she obtains the following minimum qualifying grade / marks:-

(a) For Core courses CT (Core Theory), CL (Core Lab), DE (Discipline centric Electives), clinical rotation and internship student shall obtain Grade B (50 % of marks) in the University End Semester Examination (ES) and in aggregate in each course which includes both Internal Assessment and End Semester Examination.
(b) For Generic Electives (GE), Ability Enhancement (AE) and Skill Enhancement (SE) courses student shall obtain Grade D (40 % of marks) in the College Examination.

19. Guidelines for Clinical Internship or Research internship:

19.1 Internship may be commenced only on completion of all course work. The internship may be observed only at the clinical postings and areas of extension activities of Department of Physiotherapy, BLDEDU. No external postings will be considered during internship. Students are expected to act in a responsible and professional manner at all times during their postings.

19.2 Eligibility for appearing for Internship: On completion of all course work, a candidate is permitted by the Director/Principal to join internship during the beginning of the semester i.e., Odd/ Even.

19.3 Responsibilities during internship: During the internship period candidates should show at least 90% attendance. They must engage in practice/ skill based learning of professional conduct. Their learning outcomes must be maintained and presented in the form of logbooks/ case studies/ research project report. The appropriate formats for the postings/ clinical rotations/ research assignments will be are prescribed as required.

19.4 Evaluation of internees and award of credits: All internees will be assessed based on their satisfactory attendance, performance in the postings/ research labs and the presentation of the logbook. The credits and hours of internship will be as defined in the Microbiology program

Computation of SGPA and CGPA

The UGC recommends the following procedure to compute the Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA):

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

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

where Ci is the number of credits of the ith course and Gi is the grade point scored by the student in the ith course.

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

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

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

iii. The SGPA and CGPA shall be rounded off to 2 decimal points and reported in the transcripts.

Illustration of Computation of SGPA and CGPA

Course	**Credit**	**Grade Letter**	**Grade Point**	**Credit Point (Credit x Grade)**
Course 1	3	A	8	3 X 8 = 24
Course 2	4	B+	7	4 X 7 = 28
Course 3	3	B	6	3 X 6 = 18
Course 4	3	O	10	3 X 10 = 30
Course 5	3	C	5	3 X 5 = 15
Course 6	4	B	6	4 X 6 = 24
	20			139
Illustration for SGPA Thus, SGPA = 139/20 = 6.95				

Semester 1	**Semester 2**	**Semester 3**	**Semester 4**
Credit : 20 SGPA : 6.9	Credit : 22 SGPA : 6.8	Credit : 25 SGPA : 6.6	Credit : 26 SGPA : 6.0
Semester 5	**Semester 6**		
Credit : 26 SGPA : 6.3	Credit : 25 SGPA : 8.0		
Illustration for CGPA			

Thus,

$$\text{CGPA} = \frac{20 \times 6.9 + 22 \times 6.8 + 25 \times 6.6 + 26 \times 6.0 + 26 \times 6.3 + 25 \times 8.0}{144} = 6.75/\text{B+}$$

ii. Transcript: Based on the above recommendations on Letter grades, grade points and SGPA and CGPA, the transcript for each semester and a consolidated transcript indicating the performance in all semesters may be issued.

Course Registration

17.1. After admission to a Program, a student identity number is generated .This PRN number may be used in the process of registration for a course.

17.2 The registration process is a registration for the courses in a semester. The registration card is generated after a student completes the choice of electives. Every student shall register for the stipulated number of Courses/Credits semester wise even if electives are not prescribed in their regulations for the said semester. Every student must register for Elective/Ability Enhancement Courses semester-wise for the courses he/she intends to undergo in that semester within two weeks of commencement of the semester.

The list of students registered for each elective will be communicated to the HoDs/ Course Chairpersons. Students will be requested to authenticate the chosen electives by appending their signature in acceptance with approval by the HoDs/ Course Chairpersons. A soft copy of the registered students will be submitted to the elective course offering departments for their official use.

Re - Entry after Break of Study:

The University regulations for readmission are applicable for a candidate seeking re-entry to a program.

a) Students admitted the program and absenting for more than 3 months must seek readmission into the appropriate semester as per university norms.
b) The student shall follow the syllabus in vogue (currently approved / is being followed) for the program.
c) All re-admissions of students are Course to the approval of the Vice-Chancellor.

Ranking

The first two ranks of the programme will be decided on the basis of grades of CGPA in the courses (core and DE courses only). In case of a tie, marks % [of core and DE courses only] will be taken into account.

Classification of Successful Candidates

Overall Performance in a Program and Ranking of a candidate is in accordance with the University regulations.

Consolidated Grade Card – Microbiology Program			
Letter Grade	% Marks Range	Grade point	CGPA RANGE
O	80 & Above	10	9.01 – 10
A+	75-80	9	8.01 - 9.00
A	60-74	8	7.01 - 8.00
B+	55-59	7	6.01- 7.00
B	50-54	6	5.01- 6.00
F/RA (Reappear)	Less than 50	0	4.51 – 5.00
Ab (Absent)		0	
Not Completed (NC)		0	
Repeat the course (RC = <50% in attendance or Internal Assessment)		0	

A successful candidate will be:

i. Who secures not less than O grade with a CGPA of 9.01 – 10.00 shall be declared to have secured 'OUTSTANDING' provided he/she passes the whole examination in the FIRST ATTEMPT;
ii. Who secures not less than A+ grade with a CGPA of 8.01 – 9.00 shall be declared to have secured 'EXCELLENT' provided he/she passes the whole examination in the FIRST ATTEMPT;
iii. Who secures not less than A grade with a CGPA of 7.01 –8.00 and completes the course within the stipulated course period shall be declared to have passed the examinations with 'Very Good'
iv. All other candidates (with grade B and above) shall be declared to have passed the examinations.

SEMESTER –I

BMB 1.1 INTRODUCTION TO MICROBIOLOGY AND MICROBIAL DIVERSITY

TOTAL HOURS: 60 **CREDITS: 4**

Unit 1 History of Development and scope of Microbiology No. of Hours: 8

Development of Microbiology as a discipline, spontaneous generation *vs.* biogenesis. Contributions of Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming Role of microorganisms in fermentation, Germ theory of disease, Development of various microbiological techniques and golden era of microbiology, Development of the field of soil microbiology: Contributions of Martinus W. Beijerinck, Sergei N. Winogradsky, Selman A.Waksman

Establishment of fields of medical microbiology and immunology through the work of Paul Ehrlich, Elie Metchnikoff, Edward Jenner

Unit 2 Microscopy: Basic principles & application No. of Hours: 10

Bright Field Microscope,Dark FieldMicroscope, Phase Contrast Microscope, Fluorescence Microscope, Confocal microscopy, Scanning and Transmission Electron Microscope

Unit 3 Diversity of Microbial World No. of Hours: 42

A. Systems of classification

Binomial Nomenclature, Whittaker's five kingdom and Carl Woese's three kingdom classification systems and their utility. Difference between prokaryotic and eukaryotic microorganisms.

Aim and principles of classification, systematics and taxonomy, concept of species, taxa, strain; conventional, molecular and recent approaches to polyphasic bacterial taxonomy, evolutionary chronometers, rRNA oligonucleotide sequencing, signature sequences, and protein sequences. Differences between eubacteria and archaebacteria

B. General characteristics of different groups: **Acellular** microorganisms (Viruses, Viroids, Prions) and **Cellular** microorganisms (Bacteria, Algae, Fungi and Protozoa) with emphasis on distribution and occurrence, morphology, mode of reproduction and economic importance.

• **Algae**

History of phycology with emphasis on contributions of Indian scientists; General characteristics of algae including occurrence, thallus organization, algae cell ultra structure, pigments, flagella, eyespot food reserves and vegetative, asexual and sexual reproduction. Different types of life cycles in algae with suitable examples: Haplobiontic, Haplontic, Diplontic, Diplobiontic and Diplohaplontic life cycles. Applications of algae in agriculture, industry, environment and food

• **Fungi**

Historical developments in the field of Mycology including significant contributions of eminent mycologists. General characteristics of fungi including habitat, distribution, nutritional requirements, fungal cell ultra- structure, thallus organization and aggregation, fungal wall structure and synthesis, asexual reproduction, sexual reproduction, heterokaryosis, heterothallism and parasexual mechanism.

Economic importance of fungi with examples in agriculture, environment, Industry, medicine, food, biodeterioration and mycotoxins.

• **Protozoa**

General characteristics with special reference to *Amoeba, Paramecium, Plasmodium, Leishmania and Giardia*

BMB 1.1P INTRODUCTION TO MICROBIOLOGY AND MICROBIAL DIVERSITY

TOTAL HOURS: 60 **CREDITS: 2**

1. Microbiology Good Laboratory Practices and safety measures.
2. To study the principle and applications of important instruments (Laminar Air Flow, autoclave, incubator, BOD incubator, hot air oven, light microscope, pH meter) used in the microbiology laboratory.
3. Preparation of Czapekdox Agar slant/plate for fungal cultivation.
4. Sterilization of medium using Autoclave and assessment for sterility
5. Inoculation of fungi (*Penicillium*, *Aspergillus)* in Czapekdox medium
6. Staining of fungi (*Rhizopus*, *Penicillium*, *Aspergillus*) using Lactophenol-Cotton blue

SUGGESTED READING

1. Tortora GJ, Funke BR and Case CL. (2008). Microbiology: An Introduction. 9th edition. Pearson Education
2. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms. 14th edition. Pearson International Edition
3. Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited
4. Wiley JM, Sherwood LM and Woolverton CJ. (2013) Prescott's Microbiology. 9th Edition. McGraw Hill International.
5. Atlas RM. (1997). Principles of Microbiology. 2nd edition. WM.T.Brown Publishers.
6. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company.
7. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General Microbiology. 5th edition. McMillan.

BMB 1.2 BACTERIOLOGY

TOTAL HOURS: 60 **CREDITS: 4**

Unit 1 Cell organization **No. of Hours: 18**

Cell size, shape and arrangement, glycocalyx, capsule, flagella, endoflagella, fimbriae and pili. Cell-wall: Composition and detailed structure of Gram-positive and Gram-negative cell walls, Archaebacterial cell wall, Gram and acid fast staining mechanisms, lipopolysaccharide (LPS), sphaeroplasts, protoplasts, and L-forms. Effect of antibiotics and enzymes on the cell wall. Cell Membrane: Structure, function and chemical composition of bacterial and archaeal cell membranes. Cytoplasm: Ribosomes, mesosomes, inclusion bodies, nucleoid, and plasmids(definition and types), Endospore: Structure, formation, stages of sporulation.

Unit 2 Bacteriological techniques **No. of Hours: 6**

Pure culture isolation: Streaking, serial dilution and plating methods; cultivation, maintenance and preservation/stocking of pure cultures; cultivation of anaerobic bacteria, non-culturable bacteria. Culture media: components of media, natural and synthetic media, chemically defined media, complex media, selective, differential, indicator, enriched and enrichment media

Unit 3 Staining methods **No. of Hours: 6**

Stain and dye, acidic and basic dyes, mordant, Simple staining, Gram staining, Negative staining, Acid fast staining, Basic mechanism of Gram staining, endospore and capsule staining, Basic mechanism of Lactophenol-cotton blue staining

Unit 4 Microbial Growth and Effect of Environment on Microbial Growth **No. of Hours: 18** Definitions of growth, Asexual methods of reproduction, logarithmic representation of bacterial populations, phases of growth, calculation of generation time and specific growth rate measurement of microbial growth, Batch culture, Continuous culture, generation time and specific growth rate, synchronous growth, diauxic growth curve Microbial growth in response to environment -Temperature, pH, solute and water activity, Oxygen, high pressure. Microbial growth in response to nutrition and energy – Autotroph/Phototroph, heterotrophy, Chemolithoautotroph, Chemolithoheterotroph, Chemoheterotroph, Chemolithotroph, photolithoautotroph, Photoorganoheterotroph.

Physical methods of microbial control: heat, low temperature, high pressure, filtration, desiccation, osmotic pressure, radiation.

Chemical methods of microbial control: Acid, alkali, alcohol, detergent, phenol & phenolics, heavy metals: types and mode of action, disinfectants and antiseptics; basic concept of antibiotics.

Unit 5 Important archaeal and eubacterial groups **No. of Hours: 12**

Archaebacteria: General characteristics, phylogenetic overview, genera belonging to Nanoarchaeota (Nanoarchaeum), Crenarchaeota (Sulfolobus, Thermoproteus) and Euryarchaeota [Methanogens (Methanobacterium, Methanocaldococcus), thermophiles (Thermococcus, Pyrococcus, Thermoplasma), and Halophiles (Halobacterium, Halococcus)]

Eubacteria:

Gram Negative:

Non proteobacteria: General characteristics with suitable examples
Alpha proteobacteria: General characteristics with suitable examples Beta proteobacteria: General characteristics with suitable examples Gamma proteobacteria: General characteristics with suitable examples Delta proteobacteria: General characteristics with suitable examples Epsilon proteobacteria: General characteristics with suitable examples Zeta proteobacteria: General characteristics with suitable examples

Gram Positive:

Low G+ C (Firmicutes): General characteristics with suitable examples
High G+C (Actinobacteria): General characteristics with suitable examples ***Cyanobacteria*:** Introductory idea with suitable example

BMB 1.2P BACTERIOLOGY

TOTAL HOURS: 60 **CREDITS: 2**

1. Preparation of different media: Nutrient Agar & broth, Luria broth
2. Simple staining
3. Negative staining
4. Gram staining
5. Endospore staining.
6. Isolation of pure cultures of bacteria by streaking method.
7. Study and plot the growth curve of *E. coli* by turbidometric method.
8. Calculations of generation time and specific growth rate of bacteria from the graph plotted with the given data
9. Estimation of CFU count by spread plate method/pour plate method.

SUGGESTED READINGS

1. Atlas RM. (1997). Principles of Microbiology. 2nd edition. WM.T.Brown Publishers.
2. Black JG. (2008). Microbiology: Principles and Explorations. 7th edition. Prentice Hall
3. Madigan MT, and Martinko JM. (2014). Brock Biology of Micro-organisms. 14th edition. Parker J. Prentice Hall International, Inc.
4. Pelczar Jr MJ, Chan ECS, and Krieg NR. (2004). Microbiology. 5th edition Tata McGraw Hill.
5. Srivastava S and Srivastava PS. (2003). Understanding Bacteria. Kluwer Academic Publishers,Dordrecht
6. Stanier RY, Ingraham JL, Wheelis ML and Painter PR. (2005). General Microbiology. 5th edition McMillan.
7. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9th edition Pearson Education.
8. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.
9. Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited

SEMESTER –II

BMB 2.1 BIOCHEMISTRY

TOTAL HOURS: 60 **CREDITS: 4**

Unit 1 Bioenergetics — No. of Hours: 8

First and second laws of Thermodynamics. Definitions of Gibb's Free Energy, enthalpy,and Entropyand mathematical relationship among them, Standard free energy change and equilibrium constant Coupled reactions and additive nature of standard free energy change, Standard Free Energy Change of coupled reactions, Energy rich compounds: Phosphoenolpyruvate, 1,3- Bisphosphoglycerate, Thioesters, ATP, . Numerical problems on calculations of Standard Free Energy Change and Equilibrium constant

Unit 2 Carbohydrates — No. of Hours: 12

Families of monosaccharides: aldoses and ketoses, trioses, tetroses, pentoses, and hexoses. Stereo isomerism of monosaccharides, epimers, Mutarotation and anomers of glucose. Furanose and pyranose forms of glucose and fructose, Haworth projection formulae for glucose; chair and boat forms of glucose, Sugar derivatives, glucosamine, galactosamine, muramic acid, N- acetyl neuraminic acid, Disaccharides; concept of reducing and non- reducing sugars, occurrence and Haworth projections of maltose, lactose, and sucrose, Polysaccharides, storage polysaccharides, starch and glycogen. Structural Polysaccharides, cellulose, peptidoglycan and chitin

Unit 3 Lipids — No. of Hours: 12

Definition and major classes of storage and structural lipids. Storage lipids. Fatty acids structure and functions. Essential fatty acids. Triacyl glycerols structure, functions and properties. Saponification Structural lipids. Phosphoglycerides: Building blocks, General structure, functions and properties. Structure of phosphatidylethanolamine and phosphatidylcholine, Sphingolipids.

Unit 4 Proteins — No. of Hours: 12

Functions of proteins, Primary structures of proteins: Amino acids, the building blocks of proteins. General formula of amino acid and concept of zwitterion. Concept of pH and buffers and related numerical problems, Titration curve of amino acid and its Significance, Classification, biochemical structure and notation of standard protein amino acids Ninhydrin reaction. Secondary structure of proteins: Peptide unit and its salient features. The alpha helix, the beta pleated sheet and their occurrence in proteins, Tertiary and quaternary structures of proteins. Forces holding the polypeptide together. Human haemoglobin structure, Quaternary structures proteins

Unit 5. Enzymes **No. of Hours: 16**

Structure of enzyme: Apoenzyme and cofactors, prosthetic group-TPP, coenzyme NAD,metal cofactors, Classification of enzymes, Mechanism of action of enzymes: active site, transition state complex and activation energy. Lock and key hypothesis, and Induced Fit hypothesis. Significance of hyperbolic, double reciprocal plots of enzyme activity, Km, and allosteric mechanism Definitions of terms – enzyme unit, specific activity and turnover number, Multienzyme complex :pyruvate dehydrogenase; isozyme: lactate dehydrogenase, Effect of pH and temperature on enzymeactivity. Enzyme inhibition: competitive- sulfa drugs; non-competitive-heavy metal salts

BMB 2.1P BIOCHEMISTRY

TOTAL HOURS: 60 **CREDITS: 2**

1. Preparation of buffers and numerical problems to explain the concepts
2. Qualitative/Quantitative tests for carbohydrates, reducing sugars, non-reducing sugars
3. Qualitative/Quantitative tests for proteins: Biuret & Lowry's method
4. Formol titration of glycine
5. Study of enzyme kinetics – calculation of *V*max , Km, Kcat values
6. Study effect of temperature, pH and Heavy metals on enzyme activity

SUGGESTED READING

1. Campbell, MK (2012) Biochemistry, 7th ed., Published by Cengage Learning
2. Campbell, PN and Smith AD (2011) Biochemistry Illustrated, 4th ed., Published by Churchill Livingstone
3. Tymoczko JL, Berg JM and Stryer L (2012) Biochemistry: A short course, 2nd ed., W.H.Freeman
4. Berg JM, Tymoczko JL and Stryer L (2011) Biochemistry, W.H.Freeman and Company
5. Nelson DL and Cox MM (2008) Lehninger Principles of Biochemistry, 5th Edition., W.H. Freeman and Company,
6. Willey MJ, Sherwood, LM & Woolverton C J (2013) Prescott, Harley and Klein's Microbiology by. 9th Ed., McGrawHill
7. Voet,D. and Voet J.G (2004) Biochemistry 3rd edition, John Wiley and Sons,

BMB 2.2 ENVIRONMENTAL MICROBIOLOGY

TOTAL HOURS: 60 **CREDITS: 4**

Unit 1 Microorganisms and their Habitats **No. of Hours: 14**

Structure and function of ecosystems-Terrestrial Environment: Soil profile and soil microflora Aquatic Environment: Microflora of fresh water and marine habitats Atmosphere: Aeromicroflora and dispersal of microbes Animal Environment: Microbes in/on human body (Microbiomics) & animal (ruminants) body. Extreme Habitats: Extremophiles: Microbes thriving at high & low temperatures, pH, high hydrostatic & osmotic pressures, salinity, & low nutrient levels. Microbial succession in decomposition of plant organic matter

Unit 2 Microbial Interactions **No.of Hours: 12**

Microbe interactions: Mutualism, synergism, commensalism, competition, amensalism, parasitism,predation Microbe-Plant interaction: Symbiotic and non symbiotic interactions Microbe-animal interaction: Microbes in ruminants, nematophagus fungi and symbiotic luminescent bacteria

Unit 3 Biogeochemical Cycling **No.of Hours: 12**

Carbon cycle: Microbial degradation of cellulose, hemicelluloses, lignin and chitin Nitrogen cycle: Nitrogen fixation, ammonification, nitrification, denitrification and nitrate reduction Phosphorus cycle: Phosphate immobilization and solubilisation. Sulphur cycle: Microbes involved in sulphur cycle.

Unit 4 Waste Management **No. of Hours: 12**

Solid Waste management: Sources and types of solid waste, Methods of solid waste disposal (composting and sanitary landfill) Liquid waste management: Composition and strength of sewage (BOD and COD), Primary, secondary (oxidation ponds, trickling filter, activated sludge process and septic tank) and tertiary sewage treatment

Unit 5 Microbial Bioremediation **No.of Hours: 5**

Principles and degradation of common pesticides, organic (hydrocarbons, oil spills) and inorganic (metals) matter, biosurfactants

Unit 6 Water Potability **No. of Hours: 5**

Treatment and safety of drinking (potable) water, methods to detect potability of water samples: (a) standard qualitative procedure: presumptive test/MPN test, confirmed and completed tests for faecal coliforms (b) Membrane filter technique and (c) Presence/absence tests

BMB 2.2P ENVIRONMENTAL MICROBIOLOGY

TOTAL HOURS: 60 **CREDITS: 2.**

1. Isolation of microbes (bacteria & fungi) from soil.
2. Isolation of microbes from rhizosphere and phyllosphere.
3. Assessment of microbiological quality of water.
4. Determination of BOD of waste water sample.
5. Study of amylase production by soil bacteria (qualitative).

SUGGESTED READINGS

1. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA
2. Madigan MT, Martinko JM and Parker J. (2014). Brock Biology of Microorganisms. 14th edition. Pearson/ Benjamin Cummings
3. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, Academic Press
4. Okafor, N (2011). Environmental Microbiology of Aquatic & Waste systems. 1st edition, Springer, New York
5. Singh A, Kuhad, RC & Ward OP (2009). Advances in Applied Bioremediation. Volume 17, Springer-Verlag, Berlin Hedeilberg
6. Barton LL & Northup DE (2011). Microbial Ecology. 1st edition, Wiley Blackwell, USA Campbell RE. (1983). Microbial Ecology. Blackwell Scientific Publication, Oxford, England.
7. Coyne MS. (2001). Soil Microbiology: An Exploratory Approach. Delmar Thomson Learning.
8. Lynch JM & Hobbie JE. (1988). Microorganisms in Action: Concepts & Application in Microbial Ecology. Blackwell Scientific Publication, U.K.
9. Martin A. (1977). An Introduction to Soil Microbiology. 2nd edition. John Wiley & Sons Inc. NewYork & London.
10. Stolp H. (1988). Microbial Ecology: Organisms Habitats Activities. Cambridge University Press,Cambridge, England.
11. Subba Rao NS. (1999). Soil Microbiology. 4th edition. Oxford & IBH Publishing Co. New Delhi.
12. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition.McGraw Hill Higher Education.

SEMESTER –III

BMB 3.1 MICROBIAL PHYSIOLOGY AND METABOLISM

TOTAL HOURS: 60 **CREDITS: 4**

Unit 1 Nutrient uptake and Transport **No.of Hours: 10**

Passive and facilitated diffusion Primary and secondary active transport, concept of uniport, symport and antiport Group translocation Iron uptake

Unit 2 Chemoheterotrophic Metabolism - Aerobic Respiration **No. of Hours: 16**

Concept of aerobic respiration, anaerobic respiration and fermentation Sugar degradation pathways i.e. EMP, ED, Pentose phosphate pathway TCA cycle Electron transport chain: components of respiratory chain, comparison of mitochondrial and bacterial ETC, electron transport phosphorylation, uncouplers and inhibitors

Unit 3 Chemoheterotrophic Metabolism- Anaerobic respiration and fermentation
No. of Hours:12

Anaerobic respiration with special reference to dissimilatory nitrate reduction (Denitrification; nitrate /nitrite and nitrate/ammonia respiration; fermentative nitrate reduction) Fermentation - Alcohol fermentation and Pasteur effect; Lactate fermentation (homofermentative and heterofermentative pathways), concept of mixed acid fermentation.

Unit 4 Chemolithotrophic and Phototrophic Metabolism **No. of Hours: 16**

Introduction to aerobic and anaerobic chemolithotrophy with an example each. Hydrogen oxidation (definition and reaction) and methanogenesis (definition and reaction) Introduction to phototrophic metabolism - groups of phototrophic microorganisms, anoxygenic *vs.* oxygenic photosynthesis with reference to photosynthesis in green bacteria, purple bacteria and cyanobacteria

Unit 5 Nitrogen Metabolism - an overview **No.of Hours: 6**

Introduction to biological nitrogen fixation Ammonia assimilation Assimilatory nitrate reduction, dissimilatory nitrate reduction, denitrification

BMB 3.1P MICROBIAL PHYSIOLOGY AND METABOLISM

TOTAL HOURS: 60 **CREDITS: 2**

1. Effect of temperature on growth of *E. coli*
2. Effect of pH on growth of *E. coli*
3. Effect of carbon and nitrogen sources on growth of *E.coli*
4. Effect of salt on growth of *E. coli*
5. Demonstration of alcoholic fermentation

SUGGESTED READINGS

1. Madigan MT, and Martinko JM (2014). Brock Biology of Microorganisms. 14th edition. Prentice Hall International Inc.
2. Moat AG and Foster JW. (2002). Microbial Physiology. 4th edition. John Wiley & Sons
3. Reddy SR and Reddy SM. (2005). Microbial Physiology. Scientific Publishers India
4. Gottschalk G. (1986). Bacterial Metabolism. 2nd edition. Springer Verlag
5. Stanier RY, Ingrahm JI, Wheelis ML and Painter PR. (1987). General Microbiology. 5th edition, McMillan Press.
6. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.

BMB 3.2 CELL BIOLOGY

TOTAL HOURS: 60 **CREDITS: 4**

Unit 1 Structure and organization of Eukaryotic Cell **No. of Hours: 14**

Cell Organization – Eukaryotic (Plant and animal cells) Cell Wall: Eukaryotic cell wall, Extra cellular matrix and cell matrix interactions, Cell- Cell Interactions - adhesion junctions, tight junctions, gap junctions, and plasmodesmata (only structural aspects) Mitochondria, chloroplasts an peroxisomes Cytoskeleton: Structure and organization of actin filaments, association of actin filaments with plasma membrane, cell surface protrusions, intermediate filaments, microtubules

Unit 2 Nucleus **No. of Hours: 6**

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

Unit 3 Basics of Protein Sorting and Transport **No. of Hours: 12**

Ribosomes, Endoplasmic Reticulum – Structure, targeting and insertion of proteins in the ER, smooth ER, export of proteins to Golgi Apparatus – Organization, protein glycosylation, protein sorting and export from Golgi Apparatus, Lysosomes

Unit 4 Introduction to Cell Signalling **No. of Hours: 13**

Signalling molecules and their receptors Function of cell surface receptors Pathways of intra-cellular receptors **–** Cyclic AMP pathway, cyclic GMP

Unit 5 Cell Cycle **No. of Hours: 15**

Eukaryotic cell cycle and its regulation, Mitosis and Meiosis Development of cancer, causes and types Programmed cell death.

BMB 3.2P CELL BIOLOGY

TOTAL HOURS: 60 **CREDITS: 2**

1. Study a representative plant (Allium cepa or any other suitable plant material) and Animal (squamous epithelial cells) cell By microscopy.
2. Cytochemical staining of DNA –Feulgen
3. Demonstration of the presence of mitochondria in striated muscle cells/ cheek epithelial Cell using vital stain Janus Green B
4. Study of different stages of Mitosis.
5. Study of different stages of Meiosis.

SUGGESTED READING

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

BMB 3.3 MOLECULAR BIOLOGY

TOTAL HOURS: 60 **CREDITS: 4**

Unit 1 Structures of DNA and RNA / Genetic Material **No. of Hours: 12**

DNA Structure: Miescher to Watson and Crick- historic perspective, DNA structure, Salient features of double helix, Types of DNA, Types of genetic material, denaturation and renaturation, cot curves. DNA topology - linking number, topoisomerases; Organization of DNA Prokaryotes,Viruses, Eukaryotes.RNA Structure, Organelle DNA -- mitochondria and chloroplast DNA.

Unit 2 Replication of DNA (Prokaryotes and Eukaryotes) **No. of Hours: 10**

Bidirectional and unidirectional replication, semi- conservative, semi discontinuous replication Mechanism of DNA replication: Enzymes and proteins involved in DNA replication –DNA polymerases, DNA ligase, primase, telomerase – for replication of linear ends, Various models of DNA replication including rolling circle, D- loop (mitochondrial), Θ (theta) mode of replication and other accessory protein.

Unit 3 Transcription **No. of Hours: 8**

Transcription in prokaryotes: Definition, difference from replication, promoter - concept and strength of promoter RNA Polymerase and the transcription unit Transcription in Eukaryotes: RNA polymerases, general Transcription factors (outline only)

Unit 4 Basic concept of Post-Transcriptional Processing **No. of Hours: 8**

Split genes, concept of introns and exons, RNA splicing, spliceosome machinery**,** concept of alternative splicing, Polyadenylation and capping, Processing of rRNA, RNA interference: si RNA, miRNA and its significance

Unit 5 Translation **No. of Hours: 10**

Prokaryotic Translational machinery, Charging of tRNA, aminoacyl tRNA synthetases, Mechanisms of initiation, elongation and termination of polypeptides. Fidelity of translation, Inhibitors of protein synthesis in prokaryotes. Difference between eukaryotic and prokaryotic translation

Unit 6 Regulation of gene Expression **No. of Hours:12**

Principles of transcriptional regulation, regulation at initiation with examples from *lac* and *trp* operons, Sporulation in *Bacillus,* Changes in Chromatin Structure - DNA methylation and Histone Acetylation mechanisms.

BMB 3.4P MOLECULAR BIOLOGY

TOTAL HOURS: 60 **CREDITS: 2**

1. Estimation of DNA using colorimeter (diphenylamine reagent) or UV spectrophotometer (A260 measurement)
2. Estimation of RNA using colorimeter (orcinol reagent) or UV spectrophotometer (A260 measurement)
3. Isolation of genomic DNA from *E. coli*
4. Determination of Purity of isolated DNA
5. Resolution and visualization of DNA by Agarose GelElectrophoresis.
6. Resolution and visualization of proteins by Polyacrylamide Gel Electrophoresis (SDS-PAGE): Demonstration only.

SUGGESTED READINGS

1. Watson JD, Baker TA, Bell SP, Gann A, Levine M and Losick R (2008) Molecular Biology of the Gene, 6th edition, Cold Spring Harbour Lab. Press, Pearson Publication
2. Becker WM, Kleinsmith LJ, Hardin J and Bertoni GP (2009) The World of the Cell, 7th edition, Pearson Benjamin Cummings Publishing, San Francisco
3. De Robertis EDP and De Robertis EMF (2006) Cell and Molecular Biology, 8th edition. Lippincott Williams and Wilkins, Philadelphia
4. Karp G (2010) Cell and Molecular Biology: Concepts and Experiments, 6th edition, John Wiley & Sons. Inc.
5. Sambrook J and Russell DW. (2001). Molecular Cloning: A Laboratory Manual. 4th Edition, Cold Spring Harbour Laboratorypress.
6. Krebs J, Goldstein E, Kilpatrick S (2013). Lewin's Essential Genes, 3rd Ed., Jones and Bartlett Learning
7. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-India

SEMESTER-IV

BMB 4.1 MICROBIAL GENETICS

TOTAL HOURS: 60 **CREDITS: 4**

Unit 1 Genome Organization, Mutation & DNA repair **No. of Hours: 22**

Genome organization: *E. coli*, Mutations and mutagenesis: Definition and types of Mutations; Physical and chemical mutagens; Molecular basis of mutations; Functional mutants (loss and gain of function mutants); Uses of mutations Reversion and suppression: True revertants; Intra- and inter-genic suppression; Ames test; Mutator genes, Repair: phoreactivation, NER, SOS, mismatch.

Unit 2 Plasmids **No. of Hours: 10**

Types of plasmids – F plasmid, R Plasmids, colicinogenic plasmids, Ti plasmids, linear plasmids, yeast- 2 μ plasmid, Plasmid replication and partitioning, Host range,

plasmid-incompatibility, plasmid amplification, Regulation of copy number, curing of plasmids

Unit 3 Mechanisms of Genetic Exchange **No. of Hours: 20**

Transformation - Discovery, mechanism of natural competence Conjugation - Discovery, mechanism, Hfr and F' strains, Interrupted mating technique and time of entry mapping Transduction - Generalized transduction, specialized transduction, LFT & HFT lysates, Mapping by recombination and co-transduction of markers

Unit 4 Transposable elements **No. of Hours: 8**

Prokaryotic transposable elements – Insertion Sequences, composite and non-composite transposons, Replicative and Non replicative transposition, Uses of transposons and transposition

BMB 4.1P MICROBIAL GENETICS

TOTAL HOURS: 60 **CREDITS: 2**

1. Preparation of Master and Replica Plates
2. Effect of ultraviolet (UV) light exposure on bacterial survival
3. Isolation of Plasmid DNA from *E.coli*
4. Study different conformations of plasmid DNA through Agaraose gel electrophoresis.
5. Bacterial Conjugation

SUGGESTED READING

1. Klug WS, Cummings MR, Spencer, C, Palladino, M (2011). Concepts of Genetics, 10th Ed., Benjamin Cummings
2. Krebs J, Goldstein E, Kilpatrick S (2013). Lewin's Essential Genes, 3rd Ed., Jones and Bartlett Learning
3. Pierce BA (2011) Genetics: A Conceptual Approach, 4th Ed., Macmillan Higher Education Learning
4. Watson JD, Baker TA, Bell SP et al. (2008) Molecular Biology of the Gene, 6th Ed., Benjamin Cummings
5. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley- India
6. Russell PJ. (2009). *i* Genetics- A Molecular Approach. 3rd Ed, Benjamin Cummings
7. Sambrook J and Russell DW. (2001). Molecular Cloning: A Laboratory Manual. 4th Edition, Cold Spring Harbour Laboratory press.
8. Maloy SR, Cronan JE and Friefelder D(2004) Microbial Genetics 2nd EDITION., Jones and Barlett Publishers

BMB 4.2 VIROLOGY

TOTAL HOURS: 60 **CREDITS: 4**

Unit 1 Nature and Properties of Viruses **No. of Hours: 12**

Introduction: Discovery of viruses, nature and definition of viruses, general properties, concept of viroids, virusoids, satellite viruses and Prions. Theories of viral origin Structure of Viruses: Capsid symmetry, enveloped and non-enveloped viruses Isolation, purification and cultivation of viruses

Viral taxonomy: Classification and nomenclature of different groups of viruses: Baltimore classification, ICTV classification

Unit 2 Bacteriophages & phage genetics **No. of Hours**: **10** Diversity, classification, one step multiplication curve, lytic and lysogenic phages (λ phage) concept of early and late proteins, regulation of transcription in λ phage

Unit 3 Viral Transmission, Salient features of viral nucleic acids and Replication **No. of Hours**: **22**

Modes of viral transmission: Persistent, non-persistent, vertical and horizontal
Salient features of viral Nucleic acid : Unusual bases (TMV,T4 phage), overlapping genes (ϕX174, Hepatitis B virus), alternate splicing (HIV), terminal redundancy (T4 phage), terminal cohesive ends (lambda phage), partial double stranded genomes (Hepatitis B), long terminal repeats (retrovirus), segmented (Influenza virus), and non-segmented genomes (picornavirus), capping and tailing (TMV), Viral multiplication and replication strategies, Viral Assembly, maturation and release (Adeno virus and influenza virus as example)

Unit 4 Viruses and Cancer **No. of Hours: 6**

Introduction to oncogenic viruses Types of oncogenic DNA and RNA viruses: Concepts of oncogenes and proto-oncogenes

Unit 5 Prevention & control of viral diseases **No. of Hours: 10**

Antiviral compounds and their mode of action Interferon and their mode of action General principles of viral vaccination, Mechanism of action of Amantadine, Acyclovir, Azidothymidine

BMB 4.2P VIROLOGY

TOTAL HOURS: 60 **CREDITS: 2**

1. Plaque assay of bacteriophages from standard teaching kit
2. Isolation and enumeration of bacteriophages (PFU) from water/sewage/cow dung sample using double agar layer technique (demonstrationonly)

SUGGESTED READING

1. Dimmock, NJ, Easton, AL, Leppard, KN (2007). Introduction to Modern Virology. 6th edition, Blackwell Publishing Ltd.
2. Carter J and Saunders V (2007). Virology: Principles and Applications. John Wiley and Sons.
3. Flint SJ, Enquist, LW, Krug, RM, Racaniello, VR, Skalka, AM (2004). Principles of Virology, Molecular biology, Pathogenesis and Control. 2nd edition, ASM press Washington DC.
4. Levy JA, Conrat HF, Owens RA. (2000). Virology. 3rd edition. Prentice Hall publication, New Jersey.
5. Wagner EK, Hewlett MJ. (2004). Basic Virology. 2nd edition. Blackwell Publishing.
6. Mathews. (2004). Plant Virology. Hull R. Academic Press, New York.
7. Nayudu MV. (2008). Plant Viruses. Tata McGraw Hill, India.
8. Bos L. (1999) Plant viruses-A text book of plant virology by. Backhuys Publishers.
9. Versteeg J. (1985). A Color Atlas of Virology. Wolfe Medical Publication.

BMB 4.3: FOOD & DAIRY MICROBIOLOGY

TOTAL HOURS: 60 **CREDITS: 4**

Unit 1 Foods as a substrate for microorganisms **No. of Hours: 8**
Intrinsic and extrinsic factors that affect growth and survival of microbes in foods, natural flora and source of contamination of foods in general.

Unit 2 Microbial spoilage of various foods **No. of Hours: 10**
Principles, Spoilage of vegetables, fruits, meat, eggs, milk and butter, bread, canned Foods

Unit 3 Principles and methods of food preservation **No. of Hours: 12**
Principles, physical methods of food preservation: temperature (low, high, canning, drying), irradiation, hydrostatic pressure, high voltage pulse, microwave processing and aseptic packaging, chemical methods of food preservation: salt, sugar, organic acids, SO2, nitrite and nitrates, ethylene oxide, antibiotics and bacteriocins

Unit 4 Fermented foods **No. of Hours: 12**
Dairy starter cultures, fermented dairy products: yogurt, acidophilus milk, kumiss, kefir, dahi and cheese, other fermented foods: dosa, sauerkraut, soy sauce and tampeh, Probiotics: Health benefits, types of microorganisms used, probiotic foods available in market.

Unit 5 Food borne diseases (causative agents, foods involved, symptoms and preventive measures) **No. of Hours: 12**
Food intoxications: *Staphylococcus aureus*, *Clostridium botulinum* and mycotoxins; Food infections: *Bacillus cereus*, *Vibrio parahaemolyticus*, *Escherichia coli*, Salmonellosis, Shigellosis, *Yersinia enterocolitica*, *Listeria monocytogenes* and *Campylobacter jejuni*

Unit 6 Food sanitation and control **No. of Hours: 6**
HACCP, Indices of food sanitary quality and sanitizers

BMB 4.3P FOOD & DAIRY MICROBIOLOGY

TOTAL HOURS: 60 **CREDITS: 2**

1. MBRT of milk samples and their standard plate count.
2. Alkaline phosphatase test to check the efficiency of pasteurization of milk.
3. Isolation of any food borne bacteria from food products.
4. Isolation of spoilage microorganisms from spoiled vegetables/fruits.
5. Isolation of spoilage microorganisms from bread.

SUGGESTED READINGS

1. Adams MR and Moss MO. (1995). Food Microbiology. 4th edition, New Age International (P) Limited Publishers, New Delhi, India.
2. Banwart JM. (1987). Basic Food Microbiology. 1st edition. CBS Publishers and Distributors, Delhi, India.
3. Davidson PM and Brannen AL. (1993). Antimicrobials in Foods. Marcel Dekker, New York.
4. Dillion VM and Board RG. (1996). Natural Antimicrobial Systems and Food Preservation. CAB International, Wallingford, Oxon.
5. Frazier WC and Westhoff DC. (1992). Food Microbiology. 3rd edition. Tata McGraw-Hill Publishing Company Ltd, New Delhi, India.
6. Gould GW. (1995). New Methods of Food Preservation. Blackie Academic and Professional, London.
7. Jay JM, Loessner MJ and Golden DA. (2005). Modern Food Microbiology. 7th edition, CBS Publishers and Distributors, Delhi, India.
8. Lund BM, Baird Parker AC, and Gould GW. (2000). The Microbiological Safety and Quality of Foods. Vol. 1-2, ASPEN Publication, Gaithersberg, MD.
9. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9th edition. Pearson Education.

SEMESTER –V

BMB 5.1 INDUSTRIAL MICROBIOLOGY

TOTAL HOURS: 60 **CREDITS: 4**

Unit 1 Introduction to industrial microbiology **No. of Hours: 2**
Brief history and developments in industrial microbiology

Unit 2 Isolation of industrially important microbial strains and fermentation media **No. of Hours: 12**

Sources of industrially important microbes and methods for their isolation, preservation and maintenance of industrial strains, strain improvement, Crude and synthetic media; molasses, corn- steep liquor, sulphite waste liquor, whey, yeast extract and protein hydrolysates

Unit 3 Types of fermentation processes, bio-reactors and measurement of fermentation parameters **No. of Hours: 14**
Types of fermentation processes - Solid-state and liquid-state (stationary and submerged) fermentations; batch, fed-batch (eg. baker's yeast) and continuous fermentations Components of a typical bio-reactor, Types of bioreactors-Laboratory, pilot- scale and production fermenters, constantly stirred tank and air-lift fermenters, Measurement and control of fermentation parameters - pH, temperature, dissolved oxygen, foaming and aeration

Unit 4 Down-stream processing **No. of Hours: 6**
Cell disruption, filtration, centrifugation, solvent extraction, precipitation, lyophilization and spray drying

Unit 5 Microbial production of industrial products (micro-organisms involved, media, fermentation conditions, downstream processing and uses) **No. of Hours: 20**
Citric acid, ethanol, penicillin, glutamic acid, Vitamin B12 Enzymes (amylase, protease, lipase) Wine, beer

Unit 6 Enzyme immobilization **No. of Hours: 6**
Methods of immobilization, advantages and applications of immobilization, large scale applications of immobilized enzymes (glucose isomerase and penicillin acylase)

BMB 5.1P INDUSTRIAL MICROBIOLOGY

TOTAL HOURS: 60 **CREDITS: 2**

1. Microbial fermentations for the production and estimation (qualitative and quantitative) of (a) Enzymes: Amylase

(b) Organic acid: Citric acid/Lactic acid

(c) Alcohol: Ethanol

2. A visit to any industry to see industrial fermentation and other downstream processing operations.

SUGGESTED READINGS

1. Patel A.H. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited
2. Okafor N. (2007). Modern Industrial Microbiology and Biotechnology. 1st edition. Bios Scientific Publishers Limited. USA
3. Waites M.J., Morgan N.L., Rockey J.S. and Higton G. (2001). Industrial Microbiology: An Introduction. 1st edition. Wiley – Blackwell
4. Glaze A.N. and Nikaido H. (1995). Microbial Biotechnology: Fundamentals of Applied Microbiology. 1st edition. W.H. Freeman and Company
5. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
6. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi.
7. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.

BMB 5.2 IMMUNOLOGY

TOTAL HOURS: 60 **CREDITS: 4**

Unit 1 Introduction **No. of Hours: 4**

Concept of Innate and Adaptive immunity; Contributions of following scientists to the development of field of immunology - Edward Jenner, Karl Landsteiner, Robert Koch, Paul Ehrlich, Elie Metchnikoff, Peter Medawar, MacFarlane Burnet, Neils K Jerne, Rodney Porter and Susumu Tonegawa

Unit 2 Immune Cells and Organs **No. of Hours: 7**

Structure, Functions and Properties of: Immune Cells – Stem cell, T cell, B cell, NK cell, Macrophage, Neutrophil, Eosinophil, Basophil, Mast cell, Dendritic cell; and Function of Immune Organs – Bone Marrow, Thymus, Lymph Node, Spleen

Unit 3 Antigens **No. of Hours: 4**

Characteristics of an antigen (Foreignness, Molecular size and Heterogeneity); Haptens; Epitopes (T& B cell epitopes); T-dependent and T-independent antigens; Adjuvants

Unit 4 Antibodies **No. of Hours: 6**

Structure, Types, Functions and Properties of antibodies; Antigenic determinants on antibodies (Isotypic, allotypic, idiotypic); Monoclonal and Chimeric antibodies

Unit 5 Major Histocompatibility Complex **No. of Hours: 5**

Structure and Functions of MHC I & II molecules; Antigen processing and presentation (Cytosolic and Endocytic pathways)

Unit 6 Complement System **No. of Hours: 4**

Components of the Complement system; Activation pathways (Classical, Alternative and Lectin pathways); Biological consequences of complement Activation

Unit 7 Generation of Immune Response **No. of Hours: 10**

Primary and Secondary Immune Response; Generation of Humoral Immune Response (Plasma and Memory cells); Generation of Cell Mediated Immune Response (Self MHC restriction, T cell activation, Co- stimulatory signals); Killing Mechanisms by CTL and NK cells, Introduction to tolerance

Unit 8 Immunological Disorders and Tumor Immunity **No. of Hours: 10**

Types of Autoimmunity and Hypersensitivity with examples; Immunodeficiencies - Animal models (Nude and SCID mice), tumor antigens

Unit 9 Immunological Techniques **No. of Hours: 10**

Principles of Precipitation, Agglutination, Immunodiffusion, Immunoelectrophoresis, ELISA, ELISPOT, Western blotting, Immunofluoresence, Flow cytometry

BMB 5.2P IMMUNOLOGY

TOTAL HOURS: 60 **CREDITS: 2**

1. Identification of human blood groups.
2. Single Radial Immuno Diffusion
3. Immunodiffusion by Ouchterlony method.
4. DOT ELISA (Demonstration)
5. Immunoelectrophoresis.

SUGGESTED READINGS

1. Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 6th edition Saunders Publication, Philadelphia.
2. Delves P, Martin S, Burton D, Roitt IM. (2006). Roitt's Essential Immunology.11th edition Wiley- Blackwell Scientific Publication, Oxford.
3. Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 6th edition W.H. Freeman and Company, New York.
4. Murphy K, Travers P, Walport M. (2008). Janeway's Immunobiology. 7th edition Garland Science Publishers, New York

BMB 5.3 ADVANCES IN MICROBIOLOGY

TOTAL HOURS: 60 **CREDITS: 4**

Unit 1 Evolution of Bacterial Genomes **No. of Hours: 15** Basic concept of bacterial genome evolution, Horizontal gene transfer (HGT), Evolution of bacterial virulence - Genomic islands, Pathogenicity islands (PAI) and their characteristics

Unit 2 Metagenomics **No. of Hours: 15**
Development of metagenomics, Understanding bacterial diversity using metagenomic approach. Basic knowledge of viral metagenome, metatranscriptomics, metaproteomics and metabolomics.

Unit 3 Molecular Basis of Host-Microbe Interactions **No. of Hours: 15** Virulence factors of pathogens: enzymes, toxins (host specific and non specific) growth regulators, virulence factors in viruses (replicase, coat protein, silencing suppressors) in disease development. Biofilms: types of microorganisms, molecular aspects and significance in environment, health care, virulence and antimicrobial resistance.

Unit 4 Systems and Synthetic Biology **No. of Hours: 15** Networking in biological systems: Quorum sensing in bacteria, Co-ordinated regulation of bacterial virulence factors. Introduction and implications of synthetic biology with respect to bacteria and viruses

BMB 5.3P ADVANCES IN MICROBIOLOGY

TOTAL HOURS: 60 **CREDITS: 2**

1. Extraction and purification genomic DNA from *E.coli* using phenol chloroform method.
2. Performing PCR amplification by using suitable DNA
3. Isolation of antibiotic resistant bacteria from soil and study of multiple antibiotic resistance, using at least three(3) antibiotics.

SUGGESTED READING

1. Fraser CM, Read TD and Nelson KE. Microbial Genomes, 2004, Humana Press
2. Miller RV and Day MJ. Microbial Evolution- Gene establishment, survival and exchange, 2004, ASM Press
3. Bull AT. Microbial Diversity and Bioprospecting, 2004, ASM Press
4. Sangdun C. Introduction to Systems Biology, 2007, Humana Press
5. Klipp E, Liebermeister W. Systems Biology – A Textbook, 2009, Wiley
6. Caetano-Anolles G. Evolutionary Genomics and Systems Biology, 2010, John Wiley and Sons
7. Madigan MT, Martink JM, Dunlap PV and Clark DP (2014) Brook's Biology of Microorganisms, 14th edition, Pearson-Bejamin Cummings
8. Wilson BA, Salyers AA Whitt DD and Winkler ME (2011)Bacterial Pathogenesis-A molecular Approach, 3rd edition, ASM Press,
9. Bouarab K, Brisson and Daayf F (2009) Molecular Plant-Microbe interaction CAB International
10. Voit EO (2012) A First Course in Systems Biology, Ist edition,Garland Science

BMB 5.4 BIOMATHEMATICS AND BIOSTATISTICS

TOTAL HOURS: 60 **CREDITS: 4**

Unit 1 Biomathematics **No of Hours: 30**

Reaction Kinetics: Zero order, first order, second order kinetics with examples; Michaelis- Menten equation; Coupled reactions, Application in fermentation technique: Mathematical expression in batch culture, continious culture, steady state condition, logarithm: Application in Henderson-Hesselbatch equation, problems related to buffer solution, Free energy: Mathematical expression and related problems, Differentiation and Integration: Radioactive decay, Half life, problems related to radioactivity, Decimal reduction time: mathematical expression and related problems

Unit 2 Biostatistics **No of Hours: 30**

Measures of central tendency, Measures of dispersion; skewness, kurtosis; Elementary Probability and basic laws; Discrete and Continuous Random variable, Mathematical Expectation; Curve Fitting; Correlation and Regression. Emphasis on examples from Biological Sciences; Poisson and Normal distribution.
Statistical methods: Principles of statistical analysis of biological data. Sampling parameters. Difference between sample and Population, Sampling Errors: Standard Error, Testing of Hypothesis, Level of Significance and Degree of
Freedom; t-test, Z- test and F test; Confidence Interval; Chi-square test

BMB 5.4P BIOMATHEMATICS AND BIOSTATISTICS (PRACTICAL)

TOTAL HOURS: 60 **CREDITS: 2**

1. Mean, Median, Mode from grouped and ungrouped Data set
2. Determination of Standard Deviation and standard error in laboratory experiment data
3. Graphical representation of Standard Deviation and standard error
4. Testing of Hypothesis- Normal Distribution, t-test and Chi-Square-test
5. Determination of Confidence Interval by MPN test of water sample

SUGGESTED READINGS

1. H. S. Bear: Understanding Calculus, John Wiley and Sons (Second Edition); 2003.
2. E. Batschelet : Introduction to Mathematics for Life Scientists,Springer Verlag, International Student Edition, Narosa Publishing House, New Delhi (1971,1975)
3. A. Edmondson and D. Druce : Advanced Biology Statistics, Oxford University Press; 1996.
4. W. Danial : Biostatistics : A foundation for Analysis in Health Sciences, John Wiley and Sons Inc; 2004.

BMB 5.5 INHERITANCE BIOLOGY

TOTAL HOURS: 60 **CREDITS: 4**

Unit 1 Introduction to Genetics **No. of Hours: 5**

Historical development, Model organisms in genetic analyses and experimentation: *Escherichia coli, Saccharomyces cerevisiae, Drosophila melanogaster, Arabidopsis thaliana*

Unit 2 Mendelian Principles **No. of Hours: 13**

Mendel's Laws: Dominance, segregation, independent assortment, deviation from Mendelian inheritance, Rediscovery of Mendel's principles, Chromosome theory of inheritance: Allele, multiple alleles, pseudoallele, complementation tests, Extensions of Mendelian genetics: Allelic interactions, concept of dominance, recessiveness, Incomplete dominance and co-dominance, Multiple alleles, Epistasis, penetrance and expressivity

Unit 3 Linkage and Crossing over **No. of Hours: 6**

Linkage and recombination of genes, Cytological basis of crossing over, Crossing over at four-strand stage, Molecular mechanism of crossing over.

Unit 4 Extra-Chromosomal Inheritance **No. of Hours: 9**

Extra nuclear inheritance in bacteria: Plasmid and episome, Organelle heredity – Chloroplast, Mitochondria,

Unit 5 Characteristics of Chromosomes **No. of Hours: 8**

Structural organization of chromosomes - centromeres, telomeres and repetitive DNA, Packaging DNA molecules into chromosomes, Concept of euchromatin and heterochromatin, Chromosome banding, Giant chromosomes: Polytene and lampbrush chromosomes,

Unit 6 Recombination **No. of Hours: 7**

Homologous and non-homologous recombination, including transposition, site-specific recombination.

Unit 7 Human genetics **No. of Hours: 12**

Pedigree analysis, lod score for linkage testing, karyotypes, Variations in chromosome structure: Deletion, duplication, inversion and translocation, Variation in chromosomal number and structural abnormalities - Klinefelter syndrome, Turner syndrome, Down syndrome.

BMB 5.5P INHERITANCE BIOLOGY

TOTAL HOURS: 60 **CREDITS: 2**

1. Chi-Square Analysis of Mendelian monohybrid/dihybrid cross
2. Study of polytene chromosomes using temporary mounts of salivary glands of *Chiromonas / Drosophila* larvae
3. Study of pedigree analysis: problems

SUGGESTED READING

1. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-India
2. Snustad DP, Simmons MJ (2011). Principles of Genetics. 6th Ed. John Wiley and Sons Inc.
3. Weaver RF, Hedrick PW (1997). Genetics. 3rd Ed. McGraw-Hill Education
4. Klug WS, Cummings MR, Spencer CA, Palladino M (2012). Concepts of Genetics. 10th Ed. Benjamin Cummings
5. Griffith AJF, Wessler SR, Lewontin RC, Carroll SB. (2007). Introduction to Genetic Analysis. 9th Ed. W.H.Freeman and Co., New York
6. Hartl DL, Jones EW (2009). Genetics: Analysis of Genes and Genomes. 7th Ed, Jones and Bartlett Publishers
7. Russell PJ. (2009). *i* Genetics - A Molecular Approach. 3rd Ed, Benjamin Cummings

SEMESTER –VI

BMB 6.1 MEDICAL MICROBIOLOGY

TOTAL HOURS: 60 **CREDITS: 4**

Unit 1 Normal microflora of the human body and host pathogen interaction

No. of Hours: 8

Normal microflora of the human body: Importance of normal microflora, normal microflora of skin, throat, gastrointestinal tract, urogenital tract

Host pathogen interaction: Definitions - Infection, Invasion, Pathogen, Pathogenicity, Virulence, Toxigenicity, Carriers and their types, Opportunistic infections, Nosocomial infections. Transmission of infection, Pathophysiologic effects of LPS

Unit 2 Sample collection, transport and diagnosis No. of Hours: 5

Collection, transport and culturing of clinical samples, principles of different diagnostic tests (ELISA, Immunofluorescence, Agglutination basedtests, Complement fixation, PCR, DNA probes).

Unit 3 Bacterial diseases No. of Hours: 15

List of diseases of various organ systems and their causative agents. The following diseases with Symptoms, mode of transmission, prophylaxis and control

Respiratory Diseases: *Haemophilus influenzae*, *Mycobacterium tuberculosis* Gastrointestinal Diseases: *Escherichia coli*, *Salmonella typhi*, *Vibrio cholerae*, *Helicobacter pylori* Others: *Staphylococcus aureus, Bacillus anthracis, Clostridium tetani*

Unit 4 Viral diseases No. of Hours: 14

List of diseases of various organ systems and their causative agents. The following diseases with Symptoms, mode of transmission, prophylaxis and control

Polio, Hepatitis, Rabies, Dengue, AIDS, Influenza with brief description of swine flu, Ebola, Chikungunya, Japanese Encephalitis

Unit 5 Protozoan diseases No. of Hours: 5

List of diseases of various organ systems and their causative agents. The following diseases with Symptoms, mode of transmission, prophylaxis and control Malaria, Kala-azar

Unit 6 Fungal diseases No. of Hours: 5

Brief description of each of the following types of mycoses and one representative disease to be studied with respect to transmission, symptoms and prevention Cutaneous mycoses: Tinea pedis (Athlete's foot) Systemic mycoses: Histoplasmosis Opportunistic mycoses: Candidiasis

Unit 7 Antimicrobial agents: General characteristics & mode of action

No. of Hours: 8

Antibacterial agents: Five modes of action with one example each: Inhibitor of nucleic acid synthesis; Inhibitor of cell wall synthesis; Inhibitor of cell membrane function; Inhibitor of protein synthesis; Inhibitor of metabolism Antifungal agents: Mechanism of action of Amphotericin B, Griseofulvin, Antibiotic resistance, MDR, XDR, MRSA, NDM-1

BMB 6.1P MEDICAL MICROBIOLOGY

TOTAL HOURS: 60 **CREDITS: 2**

1. Identify bacteria (any three of *E. coli, Staphylococcus, Bacillus*) using laboratory strains on the basis of cultural, morphological and biochemical characteristics: IMViC, TSI, nitrate reduction, urease production and catalase tests
2. Antibacterial sensitivity t est by agar cup assay
3. Antibacterial sensitivity t est by Kirby-Bauer method
4. Determination of minimal inhibitory concentration (MIC) of an antibiotic.

SUGGESTED READING

1. Ananthanarayan R. and Paniker C.K.J. (2009) Textbook of Microbiology. 8th edition, University Press Publication
2. Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. (2013) Jawetz, Melnick and Adelberg's Medical Microbiology. 26th edition. McGraw Hill Publication
3. Goering R., Dockrell H., Zuckerman M. and Wakelin D. (2007) Mims' Medical Microbiology. 4th edition. Elsevier
4. Willey JM, Sherwood LM, and Woolverton CJ. (2013) Prescott, Harley and Klein's Microbiology. 9th edition. McGraw Hill Higher Education
5. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms. 14th edition. Pearson International Edition

BMB 6.2 RECOMBINANT DNA TECHNOLOGY

TOTAL HOURS: 60 **CREDITS: 4**

Unit 1 Introduction to Genetic Engineering **No. of Hours: 2**

Milestones in genetic engineering and biotechnology

Unit 2 Molecular Cloning- Toolsand Strategies **No. of Hours: 20**

Restriction modification systems: Types I, II and III. Mode of action, nomenclature, applications of Type II restriction enzymes in genetic engineering DNA modifying enzymes and their applications: DNA polymerases. Terminal deoxynucleotidyl transferase, kinases and phosphatases, and DNA ligasesCloning Vectors: Definition and Properties Plasmid vectors: pBR and pUC series Bacteriophage lambda and M13 based vectors Cosmids, BACs, YACs Use of linkers and adaptors Expression vectors: *E.coli* lac and T7 promoter-based vectors, yeast YIp, YEp and YCp vectors, Baculovirus based vectors, mammalian SV40-based expression vectors

Unit 3 Methods in Molecular Cloning **No. of Hours: 16**

Transformation of DNA: Chemical method, Electroporation, Genedelivery: Microinjection, electroporation, biolistic method (gene gun), liposome and viral-mediated delivery, *Agrobacterium* - mediated delivery DNA, RNA and Protein analysis: Agarose gel electrophoresis, Southern - and Northern - blotting techniques, dot blot, DNA microarray analysis, SDS-PAGE and Western blotting.

Unit 4 DNA Amplification and DNA sequencing **No. of Hours: 10**

PCR: Basics of PCR, RT-PCR, Real-Time PCR Sanger's method of DNA Sequencing: traditional and automated sequencing Primer walking and shotgun sequencing

Unit 5 Construction and Screening of Genomic & cDNA libraries No. of Hours: 6

Genomic and cDNA libraries: Preparation and uses, Screening of libraries: Colony hybridization and colony PCR, Chromosome walking and chromosome jumping

Unit 6 Applications of Recombinant DNA Technology **No. of Hours: 6**

Products of recombinant DNA technology: Products of human therapeutic interest - insulin, hGH, Bt transgenic - cotton, brinjal, Gene therapy, recombinant vaccines and site directed mutagensis

BMB 6.2P RECOMBINANT DNA TECHNOLOGY

TOTAL HOURS: 60 **CREDITS: 2**

1. Preparation of competent cells for transformation
2. Bacterial Transformation and calculation of transformation efficiency.
3. Digestion of DNA using restriction enzymes and analysis by agarose gel electrophoresis
4. Ligation of DNA fragments
5. Cloning of DNA insert and Blue white screening of recombinants.

SUGGESTED READING

1. Brown TA. (2010). Gene Cloning and DNA Analysis. 6th edition. Blackwell Publishing, Oxford, U.K.
2. Clark DP and Pazdernik NJ. (2009). Biotechnology: Applying the Genetic Revolution. Elsevier Academic Press, USA
3. Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K.
4. Sambrook J and Russell D. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press
5. Wiley JM, Sherwood LM and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. McGraw Hill Higher Education
6. Brown TA. (2007). Genomes-3. Garland Science Publishers
7. Primrose SB and Twyman RM. (2008). Genomics: Applications in human biology. Blackwell Publishing, Oxford, U.K.

BMB 6.3 MICROBES IN SUSTAINABLE AGRICULTURE AND DEVELOPMENT

TOTAL HOURS: 60 **CREDITS: 4**

Unit 1 Soil Microbiology **No of Hours: 9**

Soil as Microbial Habitat, Soil profile and properties, Soil formation, Diversity and distribution of microorganisms in soil

Unit 2 Microbial Activity in Soil and Green House Gases **No of Hours: 6**

Carbon dioxide, methane, nitrous oxide, nitric oxide – production and control

Unit 3 Microbial Control of Soil Borne Plant Pathogens **No of Hours: 9**

Biocontrol mechanisms and ways, Microorganisms used as biocontrol agents against Microbial plant pathogens, Insects.

Unit 4 Biofertilization, Phytostimulation, Bioinsecticides **No of Hours: 16**

Plant growth promoting bateria, biofertilizers – symbiotic (*Bradyrhizobium, Rhizobium, Frankia*), Non Symbiotic (*Azospirillum, Azotobacter*, Mycorrhizae), Phosphate solubilizers.

Unit 5 Secondary Agriculture Biotechnology **No of Hours: 12**

Biomanure, biogas, biofuels – general concepts and advantages

Unit 6 Genetically Modified crops **No of Hours: 8**

Bt crops, golden rice, transgenic animals, advantages, social and environmental aspects.

BMB 6.3P MICROBES IN SUSTAINABLE AGRICULTURE AND DEVELOPMENT

TOTAL HOURS: 60 **CREDITS: 2**

1. Study of microflora of rhizospheric soils
2. Isolation and characterization of phosphate solubilizing bacteria from soil
3. Isolation and characterization of Nitrogen fixing bacteria from soil
4. Isolation of *Rhizobium* from root nodules
5. Soil dehydrogenase assay

SUGGESTED READINGS

1. Agrios GN. (2006). Plant Pathology. 5th edition. Academic press, San Diego,
2. Singh RS. (1998). Plant Diseases Management. 7th edition. Oxford & IBH, New Delhi.
3. Glick BR, Pasternak JJ, and Patten CL (2010) Molecular Biotechnology 4th edition, ASM Press,
4. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA
5. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, Academic Press
6. Barton LL & Northup DE (2011). Microbial Ecology. 1st edition, Wiley Blackwell, USA
7. Campbell RE. (1983). Microbial Ecology. Blackwell Scientific Publication, Oxford, England.
8. Coyne MS. (2001). Soil Microbiology: An Exploratory Approach. Delmar Thomson Learning.
9. Altman A (1998). Agriculture Biotechnology, Ist edition, Marcel decker Inc.
10. Mahendra K. Rai (2005). Hand Book of Microbial Biofertilizers, The Haworth Press, Inc. New York.
11. Reddy, S.M. et. al. (2002). Bioinoculants for Sustainable Agriculture and Forestry, Scientific Publishers.
12. Saleem F and Shakoori AR (2012) Development of Bioinsecticide, Lap Lambert Academic Publishing GmbH KG

BMB 6.4 BIOSAFETY AND INTELLECTUAL PROPERTY RIGHTS

TOTAL HOURS: 60 **CREDITS: 4**

Unit 1 **No of Hours: 16**

Concept of IPR, Designs, trademarks, trade secrets, domain names, geographical indications, copyright, Evolution of patent laws, hist ory of Indian patent system, Agreements and Treaties: GATT, TRIPS Agreements; Role of Madrid Agreement; Hague Agreement; WIPO Treaties; Budapest Treaty on international recognition of the deposit of microorganisms; UPOV & Brene conventions; Patent Co-operation Treaty (PCT); Indian Patent Act 1970 & recent amendments. Classification of patents in India,

Unit 2 **No of Hours: 12**

classification of patents by WIPO, categories of patent, special patents, patenting biological products, Patentable inventions in India and abroad, non patentable inventions in India and abroad, Rights of patent holder and co-owners, transfer of patent rights, limitations of patent rights, Patent and economy, patent management, patent growth, patenting of life forms, biodiversity and IPR, Study of famous case study between Diamond and Chakraborty.

Unit 3 **No of Hours: 12**

Overview of biosafety, risk assessment, cartagena protocol on biosafety, capacity building, GMOs Transgenic technology, future opportunities and challenges, Regulatory measures for biosafety, biosafety guidelines in India evolved by DBT.

Unit 4 **No of Hours: 12**

Prevention food adulteration act, food and safety standard bill and seed policy, rules for the manufacture and storage of hazardous, biosafety management, Some of the products development from RDT and their biosafety issues, biosafety and Gene therapy, ecological safety assessment of recombinant organisms.

Unit 5 **No of Hours: 8**

Bioethics and its scope, different approaches to ethics, biological weapons and their social and ethical implications, Importance of good laboratory practices, general good laboratory practices

BMB 6.4P BIOSAFETY AND INTELLECTUAL PROPERTY RIGHTS

TOTAL HOURS: 60 **CREDITS: 2**

Standardization of contamination free environment in laboratory practices. Biochemical and Microbiological analysis of Foods. Food adulteration and its Testing / Anlysis

Suggested Reading

1. Bare Act, 2007.Indian Patent Act 1970 Acts & Rules, Universal Law Publishing Co. Pvt. Ltd., New Delhi.
2. Goel D & Prashar S (2013). IPR, Biosafety and Bioethics. Pearson

BMB 6.5 INSTRUMENTATION AND BIOTECHNIQUES

TOTAL HOURS: 60 **CREDITS: 4**

Unit 1 Microscopy **No. of Hours: 10**

Brightfield and darkfield microscopy, Fluorescence Microscopy, Phase contrast Microscopy, Confocal Microscopy, Electron Microscopy (Scanning and Transmission Electron Microscopy).

Unit 2 Chromatography **No. of Hours: 14**

Principles and applications of paper chromatography (including Descending and 2-D), Thin layer chromatography. Column packing and fraction collection, Gel filtration chromatography, ion- exchange chromatography and affinity chromatography, GLC, HPLC.

Unit 3 Electrophoresis **No. of Hours: 14**

Principle and applications of native polyacrylamide gel electrophoresis, SDS-polyacrylamide gel electrophoresis, 2D gel electrophoresis, Isoelectric focusing, Zymogram preparation and Agarose gel electrophoresis.

Unit 4 Spectrophotometry **No. of Hours: 10**

Principle and use of study of absorption spectra of biomolecules, Analysis of biomolecules using UV and visible range, Colorimetry and turbidometry

Unit 5 Centrifugation **No. of Hours: 12**

Preparative and analytical centrifugation, fixed angle and swinging bucket rotors. RCF and sedimentation coefficient, differential centrifugation, density gradient centrifugation and ultracentrifugation

BMB 6.5P INSTRUMENTATION AND BIOTECHNIQUES

TOTAL HOURS: 60 **CREDITS: 2**

1. Separation of amino acid mixtures by thin layer chromatography.
2. Separation of protein mixtures by any form of chromatography.
3. Separation of protein mixtures by Polyacrylamide Gel Electrophoresis (PAGE).
4. Determination of λ_{max} for an unknown sample and calculation of extinction coefficient.
5. Separation of components of a given mixture using a laboratory scale centrifuge.

SUGGESTED READINGS

1. Wilson K and Walker J. (2010). Principles and Techniques of Biochemistry and Molecular Biology. 7th Ed., Cambridge University Press.
2. Nelson DL and Cox MM. (2008). Lehninger Principles of Biochemistry, 5th Ed., W.H. Freeman and Company.
3. Willey MJ, Sherwood LM & Woolverton C J. (2013). Prescott, Harley and Klein's Microbiology. 9thEd., McGraw Hill.
4. Karp G. (2010) Cell and Molecular Biology: Concepts and Experiments. 6th edition. John Wiley & Sons. Inc.
5. De Robertis EDP and De Robertis EMF. (2006). Cell and Molecular Biology. 8th edition. Lipincott Williams and Wilkins, Philadelphia.
6. Cooper G.M. and Hausman R.E. (2009). The Cell: A Molecular Approach. 5th Edition. ASM Press & Sunderland, Washington D.C., Sinauer Associates, MA.
7. Nigam A and Ayyagari A. 2007. Lab Manual in Biochemistry, Immunology and Biotechnology. Tata McGraw Hill.

Skill Enhancement Elective Courses

BMB 3.4 FOOD FERMENTATION TECHNIQUES

TOTAL HOURS: 30 **CREDITS: 2**

Unit 1 Fermented Foods **No of Hours: 4**

Definition, types, advantages and health benefits

Unit 2 Milk Based Fermented Foods **No.of Hours: 8**

Dahi, Yogurt, Buttermilk (Chach) and cheese: Preparation of inoculums, types of microorganisms and production process

Unit 3 Grain Based Fermented Foods **No of Hours: 6**

Soy sauce, Bread, Idli and Dosa: Microorganisms and production process

Unit 4 Vegetable Based Fermented Foods **No of Hours: 4**

Pickels, Saeurkraut: Microorganisms and production process

Unit 5 Fermented Meat and Fish **No of Hours: 4**

Types, microorganisms involved, fermentation process

Unit 6 Probiotic Foods **No of Hours: 4**

Definition, types, microorganisms and health benefits

Suggested Readings

1. Hui YH, Meunier-Goddik L, Josephsen J, Nip WK, Stanfield PS (2004) Handbook of food and fermentation technology, CRC Press
2. Holzapfel W (2014) Advances in Fermented Foods and Beverages, Woodhead Publishing.
3. Yadav JS, Grover, S and Batish VK (1993) A comprehensive dairy microbiology, Metropolitan
4. Jay JM, Loessner MJ, Golden DA (2005) Modern Food Microbiology, 7th edition. Springer

BMB 4.4 MICROBIOLOGICAL ANALYSIS OF AIR AND WATER

TOTAL HOURS: 30 **CREDITS: 2**

Unit 1 Aeromicrobiology **No of Hours: 4**

Bioaerosols, Air borne microorganisms (bacteria, Viruses, fungi) and their impact on human health and environment, significance in food and pharma industries and operation theatres, allergens

Unit 2 Air Sample Collection and Analysis **No of Hours: 7**
Bioaerosol sampling, air samplers, methods of analysis, CFU, culture media for bacteria and fungi, Identification characteristics

Unit 3 Control Measures **No of Hours: 4**
Fate of bioaerosols, inactivation mechanisms – UV light, HEPA filters, desiccation, Incineration

Unit 4 Water Microbiology **No of Hours: 4**
Water borne pathogens, water borne diseases

Unit 5 Microbiological Analysis of Water **No of Hours: 7**
Sample Collection, Treatment and safety of drinking (potable) water, methods to detect potability of water samples: (a) standard qualitative procedure: presumptive/MPN tests, confirmed and completed tests for faecal coliforms (b) Membrane filter technique and (c) Presence/absence tests

Unit 6 Control Measures **No of Hours: 4**
Precipitation, chemical disinfection, filtration, high temperature, UV light

Suggested Reading

1. da Silva N, Taniwaki MH, Junqueira VC, Silveira N, Nascimento MS, Gomes RAR (2012) Microbiological Examination Methods of Food and WaterA Laboratory Manual, CRC Press
2. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4 edition. Benjamin/Cummings Science Publishing, USA
3. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, Academic Press
4. Hurst CJ, Crawford RL, Garland JL, Lipson DA (2007) Manual of Environmental Microbiology, 3rd edition, ASM press edition, ASM press

Distribution of courses in different semesters for Undergraduate course in

MICROBIOLOGY GENERAL

Semester	Core	DSE (3.11)	GE	AECC	SEC	Total credit
I	BMB 2.11T/P			Environmental Science		20
II	BMB 2.12T T/P			English/MIL Communication		20
III	BMB 2.13T T/P				BMB 2.19	20
IV	BMB 2.14T T/P				BMB 2.20	20
V		BMB 2.15 T/P BMB 2.16 T/P **(Any one)**			BMB 2.21	20
VI		BMB 2.17 T/P BMB 2.18 T/P **(Any one)**			BMB 2.22	20
Total number of courses	12	6	0	2	4	120

Distribution of courses in different semesters for Undergraduate course in

MICROBIOLOGY GENERAL

Semester	Core	DSE (3.11)	GE	AECC	SEC	Total credit
I	BMB 2.11T/P			Environmental Science		20
II	BMB 2.12T T/P			English/MIL Communication		20
III	BMB 2.13T T/P				BMB 2.19	20
IV	BMB 2.14T T/P				BMB 2.20	20
V		BMB 2.15 T/P BMB 2.16 T/P **(Any one)**			BMB 2.21	20
VI		BMB 2.17 T/P BMB 2.18 T/P **(Any one)**			BMB 2.22	20
Total number of courses	12	6	0	2	4	120

X – FROM OTHER DISCIPLINE

BMB 1.11 (For General Students):

BACTERIOLOGY AND VIROLOGY (THEORY)

TOTAL HOURS: 60 **CREDITS: 4**

Unit 1 Cell organization — No. of Hours: 10

Cell size, shape and arrangements, capsule, flagella and pili, Composition and detailed structure of gram- positive and gram- negative cell wall. Structure, chemical composition and functions of bacterial cell membranes, Ribosomes, inclusions, nucleoid, plasmids, structure of endospore.

Unit 2 Bacterial growth and control — No.of Hours: 8

Culture media: Components of media, Synthetic or defined media, Complex media, enriched media, selective media, differential media, enrichment culture media, Pure culture isolation: Streaking, serial dilution and plating methods, cultivation, maintenance and stocking of pure cultures, phases of growth

Unit 3 Bacterial Systematics and Taxonomy — No. of Hours: 8

Taxonomy, nomenclature, systematics, types of classifications, Morphology, ecological significance and economic importance of Gram negative and Gram positive bacteria.

Unit 4 Introduction to Viruses — No. of Hours: 12

Properties of viruses; general nature and important features Subviral particles; viroids, prions and their importance Isolation and cultivation of viruses

Unit 5 Structure, and multiplication of viruses — No. of Hours: 12

Morphological characters: Capsid symmetry and different shapes of viruses with examples Viral multiplication in the Cell: Lytic and lysogenic cycle
Description of important viruses: salient features of the viruses infecting different hosts - Bacteriophages (T4 & Lambda); Plant (TMV & Cauliflower Mosaic Virus), Human (HIV & Hepatitis viruses)

Unit 6 Role of Viruses in Disease and its prevention — No. of Hours: 10

Viruses as pathogens: Role of viruses in causing diseases, Prevention and control of viruses: Viral vaccines, interferons and antiviral compounds

BMB 1.11P(For General Students):

BACTERIOLOGY AND VIROLOGY (PRACTICAL)

TOTAL HOURS: 60 **CREDITS: 2**

1. Preparation of different media: Nutrient agar, Nutrient broth
2. To perform Gram's staining of the bacterial smear
3. To perform spore staining
4. Isolation of pure cultures of bacteria by streaking method
5. Enumeration of colony forming units (CFU) count by spread plate method/pour plate

SUGGESTED READING

1. Atlas RM. (1997). Principles of Microbiology. 2nd edition. WM.T.Brown Publishers
2. Madigan MT, Martinko JM, Dunlap PV and Clark DP (2014). Brock Biology of Micro- organisms. 14th edition. Pearson Education, Inc.
3. Stanier RY, Ingraham JL, Wheelis ML and Painter PR. (2005). General Microbiology. 5th edition. McMillan
4. Carter J and Saunders V(2007). Virology; principles and Applications. John Wiley and Sons
5. Flint SJ, Enquist, LW, Krug, RM, Racaniello, VR Skalka, AM (2004) Principles of Virology, Molecular Biology, Pathogenesis and Contro*l.*2nd edition.ASM Press

BMB 1.12 (For General Students)**:**

INDUSTRIAL & FOOD MICROBIOLOGY (THEORY)

TOTAL HOURS: 60 **CREDITS: 4**

Unit 1 Introduction to Industrial microbiology **No. of Hours: 10**
Types of fermentation processes - solid state, liquid state, batch, fed-batch and continuous, Types of fermenters – laboratory, pilot-scale and production fermenters, Components of a typical continuously stirred tank bioreactor

Unit 2 Isolation of Industrial Strains and Fermentation Medium **No. of Hours: 8** Primary and secondary screening, Preservation and maintenance of industrial strains, Ingredients used in fermentation medium - molasses, corn steep liquor, whey & Yeast extract

Unit 3 Microbial fermentation processes **No. of Hours: 12** Downstream processing - filtration, centrifugation, cell disruption, solvent extraction. Microbial production of industrial products - citric acid, ethanol and penicillin, Industrial production and uses of the enzymes - amylases, proteases.

Unit 4 Food as a substrate for microbial growth **No. of Hours: 9** Intrinsic and extrinsic parameters that affect microbial growth in food, Microbial spoilage of food - milk, egg, bread and canned foods

Unit 5 Principles and methods of food preservation and food sanitation **No. of Hours: 9** Physical methods - high temperature, low temperature, irradiation, aseptic packaging Chemical methods - salt, sugar, benzoates, citric acid, ethylene oxide, nitrate and nitrite Food sanitation and control – HACCP

Unit 6 Dairy products, probiotics and Food-borne Diseases **No. of Hours: 12** Fermented dairy products - yogurt, acidophilus milk, dahi and cheese, Probiotics definition, examples and benefits, Food intoxication by *Clostridium botulinum* and *Staphylococcus aureus*, Food infection by *Salmonella* and *E.coli*

BMB 1.12P (For General Students)

INDUSTRIAL AND FOOD MICROBIOLOGY (PRACTICAL)

TOTAL HOURS: 60 **CREDITS: 2**

1. Isolation of amylase producing bacteria from soil
2. Determination of the microbiological quality of milk sample by MBRT
3. Isolation of fungi from spoilt bread/fruits/vegetables
4. Preparation of Yogurt/Dahi

SUGGESTED READING

1. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd Edition. Panima Publishing Company, New Delhi
2. Patel AH. (1996). Industrial Microbiology .1st Edition. MacMillan India Limited Publishing Company Ltd. New Delhi, India
3. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An introduction.9th Edition. Pearson Education

BMB 1.13 (For General Students)**:**

MICROBIAL GENETICS AND MOLECULAR BIOLOGY (THEORY)

TOTAL HOURS: 60 **CREDITS: 4**

Unit 1 Structures of DNA and RNA / Genetic Material No. of Hours: 6
DNA structure, Salient features of double helix, Types of DNA, denaturation and renaturation, topoisomerases; Organization of DNA in Prokaryotes.

Unit 2 Replication of DNA No. of Hours: 6
Bidirectional and unidirectional replication, semi- conservative, semi-discontinuous replication Mechanism of DNA replication: Enzymes and proteins involved in DNA replication –DNA polymerases, DNA ligase, primase.

Unit 3 Transcription No. of Hours: 6
Transcription: Definition, promoter - concept and strength of promoter. Transcriptional Machinery and Mechanism of transcription.

Unit 4 Translation No. of Hours: 6
Genetic code, Translational machinery, Charging of tRNA, aminoacyl tRNA synthetases, Mechanisms of initiation, elongation and termination of polypeptides.

Unit 5 Regulation of gene Expression No. of Hours: 3 Principles of transcriptional regulation, regulation at initiation with examples from *lac* operon.

Unit 6 Mutations No. of Hours: 8
Mutations and mutagenesis: Definition and types of Mutations; Physical and chemical mutagens.

Unit 7 Modes of Genetic Exchange in bactetia No. of Hours: 10 Transformation - Discovery, mechanism of natural competence Conjugation - Discovery, mechanism, Hfr and F' strains. Transduction - Generalized transduction, specialized transduction

Unit 8 Introduction to genetic engineering No. of Hours: 15 Restriction modification systems: Type II restriction enzymes in genetic engineering, DNA modifying enzymes: DNA polymerases, Terminal deoxynucleotidyl transferase, kinases and phosphatases, and DNA ligases.
Cloning Vectors: Definition and Properties Plasmid vectors: pBR and pUC series PCR: Basics of PCR.

BMB 1.13P (For General Students)**: MICROBIAL GENETICS & MOLECULAR BIOLOGY (PRACTICAL)**

TOTAL HOURS: 60 **CREDITS: 2**

1. Demonstration of transformation experiment in *E.coli*
2. Demonstration of Bacterial conjugation

BMB 1.14 (For General Students)**:**
MEDICAL MICROBIOLOGY AND IMMUNOLOGY (THEORY)

TOTAL HOURS: 60 **CREDITS: 4**

Unit 1 Normal microflora of the human body and host pathogen interaction No. of Hours: 10

Normal microflora of the human body: Importance of normal microflora, normal microflora of skin, throat, gastrointestinal tract, urogenital tract, Host pathogen interaction: Definitions - Infection, Invasion, Pathogen, Pathogenicity, Virulence, Toxigenicity, Carriers and their types, Opportunistic infections, Nosocomial infections. Transmission of infection

Unit 2 Bacterial diseases **No. of Hours: 4**
List of diseases of various organ systems and their causative agents. (Meningitis, tuberculosis, leprosy, cholera, diphtheria, whooping cough, tetanus)

Unit 3 Viral diseases **No. of Hours: 3**
List of diseases of various organ systems and their causative agents. (polio, influenza, pox, mumps, measles, rubella)

Unit 4 Protozoan diseases **No. of Hours: 2**
List of diseases of various organ systems and their causative agents.(Amoebic dysentery, malaria)

Unit 5 Fungal diseases **No. of Hours: 3**
Brief description of various types of mycoses.

Unit 6 Antimicrobial agents: General characteristics and mode of action
No. of Hours:10
Antibacterial agents: Five modes of action with one example each: Inhibitor of nucleic acid synthesis; Inhibitor of cell wall synthesis; Inhibitor of cell membrane function; Inhibitor of protein synthesis; Inhibitor of metabolism, Antifungal agents: Amphotericin B, Griseofulvin, Antiviral agents: Amantadine, Acyclovir, Azidothymidine

Unit 7 Immune Cells and Organs **No. of Hours: 8**
Structure, Functions and Properties of: Immune Cells – Stem cell, T cell, B cell, NK cell, Macrophage, Neutrophil, Eosinophil, Basophil, Mast cell, Dendritic cell; and Immune Organs – Bone Marrow, Thymus.

Unit 8 Antigens and Antibodies **No. of Hours: 8** Characteristics of an antigen (Foreignness, Molecular size and Heterogeneity); Haptens; Epitopes (T& B cell epitopes), Adjuvants, Structure, Types and Functions of antibodies.

Unit 9 Generation of Immune Response **No. of Hours: 6**
Primary and Secondary Immune Response; Generation of Humoral Immune Response (Plasma and Memory cells); Generation of Cell Mediated Immune Response

Unit 10 Immunological Techniques **No. of Hours: 6**
Principles of Precipitation, Agglutination, Immunodiffusion, Immunoelectrophoresis, ELISA

BMB 1.14P (For General Students)**:**
MEDICAL MICROBIOLOGY AND IMMUNOLOGY (PRACTICAL)

TOTAL HOURS: 60 **CREDITS: 2**

1. Identify bacteria on the basis of biochemical characteristics: IMViC, nitrate reduction, urease production and catalase tests
2. Perform antibacterial sensitivity by Kirby-Bauer method
3. Identification of human blood groups.
4. To perform immunodiffusion by Ouchterlony method.

SUGGESTED READING

1. Ananthanarayan R. and Paniker C.K.J. (2009) Textbook of Microbiology. 8th edition, University Press Publication
2. Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. (2013) Jawetz, Melnick and Adelberg's Medical Microbiology. 26th edition. McGraw Hill Publication
3. Goering R., Dockrell H., Zuckerman M. and Wakelin D. (2007) Mims' Medical Microbiology. 4th edition. Elsevier
4. Willey JM, Sherwood LM, and Woolverton CJ. (2013) Prescott, Harley and Klein's Microbiology, 9th edition. McGraw Hill Higher Education

DSE FOR B.Sc. GENERAL PROGRAMME:

BMB 2.15 INSTRUMENTATION AND BIOTECHNIQUES (THEORY)

TOTAL HOURS: 60 **CREDITS: 4**

Unit 1 Microscopy **No. of Hours: 10**

Brightfield and darkfield microscopy, Fluorescence Microscopy, Phase contrast Microscopy, Confocal Microscopy, Electron Microscopy (Scanning and Transmission Electron Microscopy).

Unit 2 Chromatography **No. of Hours: 14**

Principles and applications of paper chromatography (including Descending and 2-D), Thin layer chromatography. Column packing and fraction collection, Gel filtration chromatography, ion- exchange chromatography and affinity chromatography, GLC, HPLC.

Unit 3 Electrophoresis **No. of Hours: 14**

Principle and applications of native polyacrylamide gel electrophoresis, SDS-polyacrylamide gel electrophoresis, 2D gel electrophoresis, Isoelectric focusing, Zymogram preparation and Agarose gel electrophoresis.

Unit 4 Spectrophotometry **No. of Hours: 10**

Principle and use of study of absorption spectra of biomolecules, Analysis of biomolecules using UV and visible range, Colorimetry and turbidometry

Unit 5 Centrifugation **No. of Hours: 12**

Preparative and analytical centrifugation, fixed angle and swinging bucket rotors. RCF and sedimentation coefficient, differential centrifugation, density gradient centrifugation and ultracentrifugation

BMB 2.15 INSTRUMENTATION AND BIOTECHNIQUES (PRACTICAL)

TOTAL HOURS: 60 **CREDITS: 2**

1. Separation of amino acid mixtures by thin layer chromatography.
2. Separation of protein mixtures by any form of chromatography.
3. Separation of protein mixtures by Polyacrylamide Gel Electrophoresis (PAGE).
4. Determination of λ_{max} for an unknown sample and calculation of extinction coefficient.
5. Separation of components of a given mixture using a laboratory scale centrifuge.

SUGGESTED READINGS

1. Wilson K and Walker J. (2010). Principles and Techniques of Biochemistry and Molecular Biology. 7th Ed., Cambridge University Press.
2. Nelson DL and Cox MM. (2008). Lehninger Principles of Biochemistry, 5th Ed., W.H. Freeman and Company.
3. Willey MJ, Sherwood LM & Woolverton C J. (2013). Prescott, Harley and Klein's Microbiology. 9thEd., McGraw Hill.
4. Karp G. (2010) Cell and Molecular Biology: Concepts and Experiments. 6th edition. John Wiley & Sons. Inc.
5. De Robertis EDP and De Robertis EMF. (2006). Cell and Molecular Biology. 8th edition. Lipincott Williams and Wilkins, Philadelphia.
6. Cooper G.M. and Hausman R.E. (2009). The Cell: A Molecular Approach. 5th Edition. ASM Press & Sunderland, Washington D.C., Sinauer Associates, MA.
7. Nigam A and Ayyagari A. 2007. Lab Manual in Biochemistry, Immunology and Biotechnology. Tata McGraw Hill.

BMB 2.16 INHERITANCE BIOLOGY (THEORY)

TOTAL HOURS: 60 **CREDITS: 4**

Unit 1 Introduction to Genetics **No. of Hours: 5** Historical development, Model organisms in genetic analyses and experimentation: *Escherichia coli, Saccharomyces cerevisiae, Drosophila melanogaster, Arabidopsis thaliana*

Unit 2 Mendelian Principles **No. of Hours: 13** Mendel's Laws: Dominance, segregation, independent assortment, deviation from Mendelian inheritance, Rediscovery of Mendel's principles, Chromosome theory of inheritance: Allele, multiple alleles, pseudoallele, complementation tests, Extensions of Mendelian genetics: Allelic interactions, concept of dominance, recessiveness, Incomplete dominance and co-dominance.

Unit 3 Linkage and Crossing over **No. of Hours: 6**
Linkage and recombination of genes, Cytological basis of crossing over.

Unit 4 Extra-Chromosomal Inheritance **No. of Hours: 9** Extra nuclear inheritance in bacteria: Plasmid and episome, Organelle heredity – Chloroplast, Mitochondria,

Unit 5 Characteristics of Chromosomes **No. of Hours: 8**
Structural organization of chromosomes - centromeres, telomeres and repetitive DNA, Packaging DNA molecules into chromosomes, Concept of euchromatin and heterochromatin, Chromosome banding, Giant chromosomes: Polytene and lampbrush chromosomes,

Unit 6 Recombination **No. of Hours: 7**
Homologous and non-homologous recombination, including transposition, site-specific recombination.

Unit 7 Human genetics **No. of Hours: 12**
Karyotyping and genetic disorders: Variations in chromosome structure: Deletion, duplication, inversion and translocation, Variation in chromosomal number and structural abnormalities - Klinefelter syndrome, Turner syndrome, Down syndrome.

BMB 2.16P INHERITANCE BIOLOGY (PRACTICAL)

TOTAL HOURS: 60 **CREDITS: 2**

1. Chi-Square Analysis of Mendelian monohybrid/dihybrid cross
2. Study of polytene chromosomes using temporary mounts of salivary glands of *Chiromonas / Drosophila* larvae

SUGGESTED READING

1. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-India
2. Snustad DP, Simmons MJ (2011). Principles of Genetics. 6th Ed. John Wiley and Sons Inc.
3. Weaver RF, Hedrick PW (1997). Genetics. 3rd Ed. McGraw-Hill Education
4. Klug WS, Cummings MR, Spencer CA, Palladino M (2012). Concepts of Genetics. 10th Ed. Benjamin Cummings
5. Griffith AJF, Wessler SR, Lewontin RC, Carroll SB. (2007). Introduction to Genetic Analysis. 9th Ed. W.H.Freeman and Co., New York
6. Hartl DL, Jones EW (2009). Genetics: Analysis of Genes and Genomes. 7th Ed, Jones and Bartlett Publishers
7. Russell PJ. (2009). *i* Genetics - A Molecular Approach. 3rd Ed, Benjamin Cummings

BMB 2.17 MICROBES IN SUSTAINABLE AGRICULTURE AND DEVELOPMENT (THEORY)

TOTAL HOURS: 60 **CREDITS: 4**

Unit 1 Soil Microbiology **No of Hours: 9**
Soil as Microbial Habitat, Soil profile and properties, Soil formation, Diversity and distribution of microorganisms in soil

Unit 2 Microbial Activity in Soil and Green House Gases **No of Hours: 6**
Carbon dioxide, methane, nitrous oxide, nitric oxide – production and control

Unit 3 Microbial Control of Soil Borne Plant Pathogens **No of Hours: 9**
Biocontrol mechanisms and ways, Microorganisms used as biocontrol agents against Microbial plant pathogens, Insects.

Unit 4 Biofertilization, Phytostimulation, Bioinsecticides **No of Hours: 16**
Plant growth promoting bateria, biofertilizers – symbiotic (*Bradyrhizobium, Rhizobium, Frankia*), Non Symbiotic (*Azospirillum, Azotobacter*, Mycorrhizae), Phosphate solubilizers.

Unit 5 Secondary Agriculture Biotechnology **No of Hours: 12**
Biomanure, biogas, biofuels – general concepts and advantages

Unit 6 Genetically Modified crops **No of Hours: 8**
Bt crops, golden rice, transgenic animals, advantages, social and environmental aspects.

BMB 2.17P MICROBES IN SUSTAINABLE AGRICULTURE AND DEVELOPMENT (PRACTICAL)

TOTAL HOURS: 60 **CREDITS: 2**

1. Study of microflora of rhizospheric soil different types of soils
2. Isolation and characterization of phosphate solubilizing bacteria from soil
3. Isolation and characterization of Nitrogen fixing bacteria from soil
4. Isolation of *Rhizobium* from root nodules
5. Soil dehydrogenase assay
6.

SUGGESTED READINGS

1. Agrios GN. (2006). Plant Pathology. 5th edition. Academic press, San Diego,
2. Singh RS. (1998). Plant Diseases Management. 7th edition. Oxford & IBH, New Delhi.
3. Glick BR, Pasternak JJ, and Patten CL (2010) Molecular Biotechnology 4th edition, ASM Press,
4. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA
5. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, Academic Press
6. Barton LL & Northup DE (2011). Microbial Ecology. 1st edition, Wiley Blackwell, USA
7. Campbell RE. (1983). Microbial Ecology. Blackwell Scientific Publication, Oxford, England.
8. Coyne MS. (2001). Soil Microbiology: An Exploratory Approach. Delmar Thomson Learning.
9. Altman A (1998). Agriculture Biotechnology, Ist edition, Marcel decker Inc.
10. Mahendra K. Rai (2005). Hand Book of Microbial Biofertilizers, The Haworth Press, Inc. New York.
11. Reddy, S.M. et. al. (2002). Bioinoculants for Sustainable Agriculture and Forestry, Scientific Publishers.
12. Saleem F and Shakoori AR (2012) Development of Bioinsecticide, Lap Lambert Academic Publishing GmbH KG

BMB 2.18 BIOSAFETY AND INTELLECTUAL PROPERTY RIGHTS (THEORY)

TOTAL HOURS: 60 **CREDITS: 4**

Unit 1 **No of Hours: 16**

Concept of IPR, Designs, trademarks, trade secrets, domain names, geographical indications, copyright, Evolution of patent laws, hist ory of Indian patent system, Agreements and Treaties: GATT, TRIPS Agreements; Role of Madrid Agreement; Hague Agreement;
WIPO Treaties; Budapest Treaty on international recognition of the deposit of microorganisms;
UPOV & Brene conventions; Patent Co-operation Treaty (PCT); Indian Patent Act 1970 & recentamendments. Classification of patents in India,

Unit 2 **No of Hours: 12**

classification of patents by WIPO, categories of patent, special patents, patenting biological products, Patentable inventions in India and abroad, non patentable inventions in India and abroad, Rights of patent holder and co-owners, transfer of patent rights, limitations of patent rights.

Unit 3 **No of Hours: 12**

Overview of biosafety, risk assessment, cartagena protocol on biosafety, capacity building, GMOs Transgenic technology, future opportunities and challenges, Regulatory measures for biosafety, biosafety guidelines in India evolved by DBT.

Unit 4 **No of Hours: 12**

Prevention food adulteration act, food and safety standard bill and seed policy, rules for the manufacture and storage of hazardous, biosafety management, Some of the products development from RDT and their biosafety issues, biosafety and Gene therapy, ecological safety assessment of recombinant organisms

Unit 5 **No of Hours: 8**

Bioethics and its scope, different approaches to ethics, biological weapons and their social and ethical implications, Importance of good laboratory practices, general good laboratory practices

BMB 2.18P BIOSAFETY AND INTELLECTUAL PROPERTY RIGHTS (PRACTICAL)

TOTAL HOURS:60 CREDITS: 2

Standardization of contaminatio free environment in laboratory practices. Biochemical and Microbiological analysis of Foods. Food adulteration and its Testing / Anlysis

Suggested Reading

1. Bare Act, 2007.Indian Patent Act 1970 Acts & Rules, Universal Law Publishing Co. Pvt. Ltd., New Delhi.

2. Goel D & Prashar S (2013). IPR, Biosafety and Bioethics. Pearson

SEC COURSES FOR B.SC GENERAL PROGRAMME IN MICROBIOLOGY

BMB 2.19 FOOD FERMENTATION TECHNIQUES

TOTAL HOURS: 30
CREDITS: 2

Unit 1 Fermented Foods **No of Hours: 4**

Definition, types, advantages and health benefits

Unit 2 Milk Based Fermented Foods **No of Hours: 8**

Dahi, Yogurt, Buttermilk (Chach) and cheese: Preparation of inoculums, types of microorganisms and production process

Unit 3 Grain Based Fermented Foods **No of Hours: 6**

Soy sauce, Bread, Idli and Dosa: Microorganisms and production process

Unit 4 Vegetable Based Fermented Foods **No of Hours: 4**

Pickels, Saeurkraut: Microorganisms and production process

Unit 5 Fermented Meat and Fish **No of Hours: 4**

Types, microorganisms involved, fermentation process

Unit 6 Probiotic Foods **No of Hours: 4**

Definition, types, microorganisms and health benefits

Suggested Readings

1. Hui YH, Meunier-Goddik L, Josephsen J, Nip WK, Stanfield PS (2004) Handbook of food and fermentation technology, CRC Press

2. Holzapfel W (2014) Advances in Fermented Foods and Beverages, Woodhead Publishing.

3. Yadav JS, Grover, S and Batish VK (1993) A comprehensive dairy microbiology, Metropolitan

4. Jay JM, Loessner MJ, Golden DA (2005) Modern Food Microbiology, 7th edition. Springer

BMB 2.20 MICROBIOLOGICAL ANALYSIS OF AIR AND WATER TOTAL

HOURS: 30 **CREDITS: 2**

Unit 1 Aeromicrobiology **No of Hours: 4**

Bioaerosols, Air borne microorganisms (bacteria, Viruses, fungi) and their impact on human health and environment, significance in food and pharma industries and operation theatres, allergens

Unit 2 Air Sample Collection and Analysis **No of Hours: 7**

Bioaerosol sampling, air samplers, methods of analysis, CFU, culture media for bacteria and fungi, Identification characteristics

Unit 3 Control Measures **No of Hours: 4**

Fate of bioaerosols, inactivation mechanisms – UV light, HEPA filters, desiccation, Incineration

Unit 4 Water Microbiology **No of Hours: 4**

Water borne pathogens, water borne diseases

Unit 5 Microbiological Analysis of Water **No of Hours: 7**

Sample Collection, Treatment and safety of drinking (potable) water, methods to detect potability of water samples: (a) standard qualitative procedure: presumptive/MPN tests, confirmed and completed tests for faecal coliforms (b) Membrane filter technique and (c) Presence/absence tests

Unit 6 Control Measures **No of Hours: 4**

Precipitation, chemical disinfection, filtration, high temperature, UV light

Suggested Reading

1. da Silva N, Taniwaki MH, Junqueira VC, Silveira N, Nascimento MS, Gomes RAR (2012) Microbiological Examination Methods of Food and WaterA Laboratory Manual, CRC Press

2. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA

3. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, Academic Press

4. Hurst CJ, Crawford RL, Garland JL, Lipson DA (2007) Manual of Environmental Microbiology, 3rd edition, ASM press edition, ASM press