



**BHARATI VIDYAPEETH  
(DEEMED TO BE UNIVERSITY), PUNE**

**Faculty of Science  
M.Sc. - Microbiology  
New Syllabus**

“Social Transformation Through Dinamic Education”



**BHARATI VIDYAPEETH (DEEMED TO BE UNIVERSITY)**  
**YASHWANTRAO MOHITE COLLEGE OF ARTS, SCIENCE AND COMMERCE,**  
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Accredited with 'A+' Grade (2017) by NAAC  
'A' Grade University Status by MHRD, Govt. of India  
Accredited (2004) & Reaccredited (2011) with 'A' Grade by NAAC



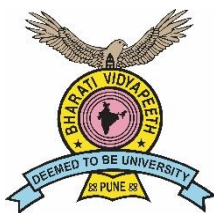
**MASTER OF SCIENCE (M.Sc. MICROBIOLOGY) PROGRAME**

**CBCS 2018 COURSE STRUCTURE**

**Under the Faculty of Science**

**TO BE IMPLEMENTED FROM ACADEMIC YEAR 2018-19**

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**BHARATI VIDYAPEETH**

**(DEEMED TO BE UNIVERSITY), PUNE, INDIA**

# **Learning Outcomes based Curriculum Framework**

## **(LOCF)**

### **For**

## **M.Sc. Microbiology**

## **(CBCS- 2018 COURSE)**

## **Faculty of Science**

**(To be implemented from June 2018)**

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<b>Table of Contents</b>		
<b>Sr. No.</b>	<b>Contents</b>	<b>Page No.</b>
1.	Preamble	5
2.	Introduction	6
3.	Learning Outcomes based approach to Curriculum Planning	6
4.	Post Graduate Attributes in subject	7
5.	Qualification Descriptors	7
6.	Objectives of the course	8
7.	Programme Learning Outcomes in course	9
8.	Course duration	9
9.	Eligibility to admissions	9
10.	Total intake	9
11.	Medium of instructions	9
12.	Course structure	10
13.	Rules for examination	15
14.	Assessment of internship (major project)	17
15.	Alternative to internship in case of national emergencies	19
16.	Standard of passing	22
17.	Format to calculate grade points	22
18.	Award of honours	24
19.	Format of the transcript	24
20.	Grade / class improvement	24
21.	Verification and reevaluation	24
22.	Course outcomes, learning outcomes and contents for PGMB 101: Biochemistry	25
23.	Course outcomes, learning outcomes and contents for PGMB 102: Immunology	28
24.	Course outcomes, learning outcomes and contents for PGMB 103: Genetics and Molecular biology	31

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25.	Course outcomes, learning outcomes and contents for PGMB 104: Microbial Ecology	34
26.	Course outcomes, learning outcomes and contents for PGMB 105: Environmental Microbiology	38
27.	Course outcomes, learning outcomes and contents for PGMB 111: Practical course 1	41
28.	Course outcomes, learning outcomes and contents for PGMB 112: Practical course 2	43
29.	Course outcomes, learning outcomes and contents for PGMB 201: Fermentor Design and Microbial Biotechnology	45
30.	Course outcomes, learning outcomes and contents for PGMB 202: Analytical techniques	47
31.	Course outcomes, learning outcomes and contents for PGMB 203: Quantitative Biology	49
32.	Course outcomes, learning outcomes and contents for PGMB 204: Microbial Metabolism	52
33.	Course outcomes, learning outcomes and contents for PGMB 205: Physiology and Metabolism	55
34.	Course outcomes, learning outcomes and contents for PG-AEC- 201: Scientific Writing	62
35.	Course outcomes, learning outcomes and contents for PGMB 211: Practical course 3	58
36.	Course outcomes, learning outcomes and contents for PGMB 212: Practical course 4	60
37.	Course outcomes, learning outcomes and contents for PGMB 304 and 305	Internship
38.	Course outcomes, learning outcomes and contents for PGMB 401: Virology	65
39.	Course outcomes, learning outcomes and contents for PGMB 402: Medical Microbiology	68
40.	Course outcomes, learning outcomes and contents for PGMB 403: Food and Dairy Microbiology	70

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41.	Course outcomes, learning outcomes and contents for PGMB 404: Advanced Biotechnology	73
42.	Course outcomes, learning outcomes and contents for PGMB 405: Advanced Analytical Techniques	76
43.	Course outcomes, learning outcomes and contents for PG-SEC 401: Exploring Microbial Diversity	79
44.	Course outcomes, learning outcomes and contents for PGMB 411: Practical course 5	81
45.	Course outcomes, learning outcomes and contents for PGMB 412: Practical course 6	83
46.	Teaching learning processes	85
47.	Assessment task	86
48.	Key words	87



**BHARATI VIDYAPEETH**  
**(DEEMED TO BE UNIVERSITY), PUNE, INDIA**  
**CHOICE BASED CREDIT SYSTEM (2018 course)**  
**M.Sc. Microbiology**  
**(Introduced from Academic Year 2018 – 2019)**

**1. Preamble-**

Completion of graduation course in Microbiology simply provides a platform for basic understanding of the subject. Inventions, innovations and technology have revolutionized and enriched the Microbiology subject. The demand of skilled manpower requires thorough knowledge of the subject. It also demands for incorporating latest knowledge and advanced technologies to fulfill the changing needs of society. The public private sector prefers the experienced manpower. Considering this, M.Sc. Microbiology CBCS-2018 course is designed to provide through and updated knowledge of the subject which makes easy entry of the students in public private sector. Uniqueness of the course is of having 6 months mandatory research projects. During the period students are getting an opportunity to work in nationally and internationally acclaimed research institutes and industries. This generates skilled human resources as per the demands of the society. The course has other research elements including scientific writing, writing research projects, preparing publications, preparing research posters for the conferences and the entire process also generates innovative minds to work in the capacity of scientists.

## **2. Introduction:**

In the increasingly globalized society, it is important that the younger generation especially the students are equipped with knowledge, skills, mindsets and behaviors which may enable them to perform their duties in a manner so that they become important contributors to the development of the society. This will also help them to fully utilize their educational training for learning a decent living so that the overall standard of their families and surroundings improve leading to development of welfare human societies. To achieve this goal, it is imperative that their educational training is improved such that it incorporates the use of newer technologies, use of newer assessment tools for mid-course corrections to make sure that they become competitive individuals to shoulder newer social responsibilities and are capable of undertaking novel innovations in their areas of expertise. In the face of the developing knowledge society, they are well aware about the resources of self-development using on-line resources of learning which is going to be a major component of learning in the future. The learning should also be a continuous process so that the students are able to re-skill themselves so as to make themselves relevant to the changing needs of the society. In the face of this need, the educational curricula, teaching learning processes, training, assessment methods all need to be improved or even re-invented.

## **3. Learning Outcomes based approach to Curriculum Planning:**

Learning Outcome based approach to curriculum planning (LOCF) is almost a paradigm shift in the whole gamut of higher education such that it is based on first and foremost identifying the outcomes of the learning required for a particular subject of study, and then planning all components of higher education so as to achieve these outcomes. The learning outcomes are the focal point of the reference to which all planning and evaluation of the end learning is compared and further modifications are made to fully optimize the education of the individuals in a particular subject. For the subject of Microbiology the outcomes are defined in terms of the understanding and knowledge of the students in microbiology and the practical skills the students are required to have to be competitive microbiologist so that they are able to play their role as microbiologist wherever required in the society such as the diseases caused by the microbes, their diagnosis and remedies;



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the role of microbiologists in the biotechnology industry and how they may be able to fit the bill in the industry. The students are also trained in such a way that they develop critical thinking and problem solving as related to the microbiology. The curriculum developed and the teaching and the evaluation tasks are such that the students are able to apply their knowledge and training of microbiology to solve the problems of microbiology as these exist or appear from time to time in the society. The curriculum envisions that the student, once post graduate as specialists in a discipline, have an important role to play in the newer developments and innovations in the future in the subject for advancement of the discipline.

#### **4. Postgraduate Attributes in Microbiology:**

- Broaden the outlook and attitude, develop the current skills and abilities, learn new one to excel in studies and career, grow into responsible global citizens.
- Contour the academic career of the students, make them employable, enhance research acumen and encourage the participation in co-curricular and extracurricular activities.
- Instill skills and abilities to develop a positive approach and be self-contained to shape one's life and also that of colleagues and peers.
- Demonstrate behavioral attributes for the enhancement of soft skills, socialistic approach and leadership qualities for successful career and nurture responsible human being.
- Provide highly skilled and knowledgeable human resources for agricultural sector, food industry, dairy industry, medical and paramedical field, pharmaceutical, space research and research institutes.

#### **5. Qualification Descriptors:**

The following may serve as the important qualification descriptors for a PG degree in Microbiology:

1. Knowledge of the diverse places where microbiology is involved.
2. Understanding of diverse Microbiological processes.
3. Advanced skills and safety issues related to handling of microbes, Good Microbiological practices etc.
4. Advanced skills in working with microbes such as pilot scale culturing, downstream processes, diagnostics etc.
5. Generation of new knowledge through research projects.

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6. Ability to participate in team work through microbiology projects.
7. Ability to present and articulate their knowledge of Microbiology.
8. Knowledge of recent developments in the area of Microbiology.
9. Analysis of data collected through study and projects / dissertations / reviews / research surveys.
10. Ability to innovate so as to generate new knowledge.
11. Awareness how some microbiology leads may be developed into enterprise.
12. Awareness of requirements for fruition of a microbiology-related enterprise.
13. Ability to acquire intellectual property rights.

## **6. Objectives of the course:**

The aim and objectives of the M.Sc. Microbiology course program essentially focus to develop skills of student for a successful career.

- A. The course structure emphasizes to put enough efforts in theory as well as laboratory work so as to gain thorough knowledge of the subject.
- B. The course includes project work that would develop and nourish the scientific approach and research attitude of the students.
- C. Genetic engineering, Biotechnology, Bioinformatics, Immunotherapy are the new horizons of the interdisciplinary subject Microbiology which might provide solutions to various problems of the society. The course work is essentially framed to acquaint the students with all the recent advances in this field.
- D. It is compulsory & essential for the students to read research papers, publications and deliver seminars that would better help them to know the recent advances in the subject and also develop the communication skills.
- E. The program is designed in such a way that it is essential for the students to read original publications, put enough efforts in laboratory work for practicals and project, be acquainted with all the recent advances in the field like Bioinformatics, drug designing and develop all the skills for a successful career.

## **7. Programme Outcomes:**

**At the end of this course the students will be able to:**

1. Deliver his/her duties in the medical and paramedical field which will aid the diagnosis of diseases and disorders.
2. Extend his/her duties in the field of biotechnology.
3. Perform duties as research fellows/scientist in biological sciences.
4. Learn desired skills through six months mandatory internship program.

## **8. Course duration:**

The M.Sc. degree course will be of two years duration.

The M.Sc. degree of two years duration has been designed and is to be implemented from the academic year 2018-2019.

## **9. Eligibility for Admission to M.Sc. (Microbiology) course:**

A candidate who has passed the

- Bachelor of Science from any recognized university with Microbiology as Principle subject (Major) or Microbiology (Honors).
- Bachelor of Science from any recognized university with Botany/Zoology/Biochemistry/Biotechnology/Environmental science as major subjects with Microbiology as subsidiary subject.
- Bachelor of Science from any recognized university with Microbiology as one of the subjects.
- The candidate who has secured aggregate of 50% marks (45 % marks in case of SC/ST) in the graduate course as well as in the Microbiology Subject shall be eligible for admission to the First Year M.Sc. degree course.

**10. Total Intake capacity: 30**

**11. Medium of Instruction: English**

## **12. Structure of M.Sc. (Microbiology) CBCS degree program:**

The overall structure of the course to be implemented from the academic year 2018-2019 onwards is as follows.

- A. The M.Sc. (Microbiology) course will be of 2 years duration. Each year will be of 2 semesters - Thus the entire course will be of 4 semesters.
- B. For semester I candidate has to appear for 3 core compulsory theory papers and one core elective theory paper. For semester I the candidate has to complete two practical courses as mentioned in the syllabus. For semester II, the candidate has to appear for 3 core compulsory papers, one core elective paper and one ability enhancement course paper. In semester II two practical courses will be conducted as mentioned in the syllabus. **At the end of both the semesters, practical examination will be conducted for practical courses 1, 2, 3 and 4.**
- C. Semester III will be totally for Internship (major project). For semester IV, the candidate has to appear 3 core compulsory papers, one core elective paper, one skill enhancement paper and two practical courses. **At the end semester IV, practical examination will be conducted for practical courses 5 and 6.**
- D. Entire M.Sc. course in Microbiology shall be covered in 14 theory papers including Ability enhancement course and Skill enhancement course, 6 practical courses, and an Internship (major project with Dissertation). Each theory paper will be covered in 4 lectures of one hour per week. Each practical course shall be covered in two practical turns of four clock hours per week. Thus, the students will work for each practical on two days of the week, daily for at minimum four hrs.
- E. Students will have to complete an Internship program (major project with dissertation) so as to learn research methodology and presentation of work. The Internship (major project/ dissertation) shall carry 200 marks. The students will work for their projects, complete the experimental work in third semester, and complete the writing part of the project in the allotted duration.

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**Structure of M.Sc. (Microbiology) degree programme**  
**Details with course number and title of the paper** The M. Sc.(Microbiology) is of 84 credits and of 2100 marks as maximum.  
**M.Sc. MICROBIOLOGY**  
**(CBCS-2018 COURSE) SEMESTER-I**

Subject Type	Code	Title of the paper	Hrs/ Week	Credits	Exam Hrs	Maximum Marks		
						Internal Assessment	University Examination	Total
Core Compulsory Theory	PGMB 101	Biochemistry	04	04	03	40	60	100
	PGMB102	Immunology	04	04	03	40	60	100
	PGMB103	Genetics and Molecular biology	04	04	03	40	60	100
Core Elective Theory	<b>Any one from the following:</b>							
	PGMB104	Microbial Ecology	04	04	03	40	60	100
	PGMB105	Environmental Microbiology	04	04	03	40	60	100
Core Compulsory Practical Course	PGMB111	Practical course 1	08	02	03	40	60	100
	PGMB112	Practical course 2	08	02	03	40	60	100

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**M.Sc. MICROBIOLOGY  
(CBCS-2018 COURSE)**

**SEMESTER-II**

Subject Type	Code	Title of the paper	Hrs/ Week	Credits	Exam Hrs	Maximum Marks		
						Internal Assess ment	Univer sity Exami nation	Total
Core Compulsory Theory	PGMB 201	Fermentor Design and Microbial Biotechnology	04	04	03	40	60	100
	PGMB202	Analytical techniques	04	04	03	40	60	100
	PGMB203	Quantitative Biology	04	04	03	40	60	100
Core Elective Theory	<b>Any one from the following:</b>							
	PGMB204	Microbial Metabolism	04	04	03	40	60	100
	PGMB205	Physiology and Metabolism	04	04	03	40	60	100
Ability Enhancement Course	PGAEC201	Scientific Writing	02	02	02	20	30	50
Core compulsory Practical Courses	PGMB211	Practical course 3	08	02	03	40	60	100
	PGMB212	Practical course 4	08	02	03	40	60	100

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**M.Sc. MICROBIOLOGY  
( CBCS-2018 COURSE)**

**SEMESTER-III**

Subject Type	Code	Title of the paper	Hrs/ Week	Credits	Maximum Marks		
					Internal Assessment	University Examination	Total
Core Compulsory	PGMB 304 and 305	Internship (Major Research Project).  OR in case of national emergencies like Covid pandemics, following alternative has been approved in BOS meeting dt. 02/07/2020.  1. Review Article : 50 marks 2. Field work (Data Collection)/ Online surveys/ Book Review: having subject relevance (Any one from enlisted) 100 marks 3. Evaluation: 50 Marks	08	20	80	120	200

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**M.Sc. MICROBIOLOGY  
(CBCS-2018 COURSE)  
SEMESTER-IV**

Subject Type	Code	Title of the paper	Hrs/ Week	Credits	Exam Hrs	Maximum Marks		
						Internal Assessment	University Examination	Total
Core Compulsory Theory	PGMB 401	Virology	04	04	03	40	60	100
	PGMB 402	Medical Microbiology	04	04	03	40	60	100
	PGMB 403	Food and Dairy Microbiology	04	04	03	40	60	100
Core Elective Theory	<b>Any one from the following:</b>							
	PGMB 404	Advanced Biotechnology	04	04	03	40	60	100
	PGMB 405	Advanced Analytical Techniques	04	04	03	40	60	100
Skill Enhancement Course	PGSEC 401	Exploring Microbial Diversity	02	02	02	20	30	50
Core compulsory Practical Courses	PGMB 411	Practical course 5	08	02	03	40	60	100
	PGMB 412	Practical course 6	08	02	03	40	60	100



### 13. Rules for the examination:

- A.** A candidate shall not be admitted to the semester examination unless he / she have satisfactorily kept terms for the courses at the respective department of this university.
- B.** An application (which must be in the prescribed form and accompanied by the prescribed fee) for admission to any of the examination of M.Sc. (Microbiology Degree course) shall be submitted by respective candidate to the Registrar through the Head of the Institution attended by him / her on or before the prescribed date along with a certificate from the Head of the Institution having attended the course and kept the terms in the various subjects and of having satisfied the other conditions laid down by the university and of being fit candidate for the examination.
- C. Assessment pattern:**

**a. Continuous Internal Assessment :**

**Theory:**

Internal assessment for PG students will be carried out as follow:

**Internal assessment for theory papers of 4 credits weightage:**

<b>Item</b>	<b>Maximum marks</b>
Mid semester (internal) examination	20
Tutorial (as given on paper or through 'Google Classroom'). <b>Note:</b> Respective subject teacher may preferably generate Google Classroom and should keep the record of conducted tutorials. Other MOOC platforms as provided by the University are also allowed to conduct tutorials.	10
Attendance	10
<b>Total marks</b>	<b>40</b>

**Internal assessment for theory papers of 2 credits weightage:**

<b>Item</b>	<b>Maximum marks</b>
Mid semester (internal) examination	20

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**Practical:** Internal marks for the practical course will be based on the continuous assessment of the daily work, orals, seminars/presentations; Tour/visit reports, class tests, literature review and attendance (**Any two**). Students will be assessed for 40 marks as an internal for each practical course.

**For example:**

<b>Item</b>	<b>Maximum marks</b>
Assessment of daily work (Attendance, Skill, Innovative approach, Timely completing task are the criteria for assessment of daily work.) Note: Practical demonstrator is expected to keep the record of above criteria.	20
Tour / visit report (Note: Practical demonstrator is expected to keep the duly signed visit reports/tour reports for departmental inspection.)	20
<b>Total marks</b>	<b>40</b>

**b. Semester Examination :**

**Theory:** An University examination will be held at the end of every semester. This Examination in each subject will be of 60 marks for three hours duration and for 30 marks for ability enhancement and skill enhancement courses. For ability enhancement and skill enhancement courses wherever 30 marks are applicable, the examination will be conducted for 2 hours only as a max per paper. The final result of the students in each subject will be based on Final GPA obtained by the students for the internal assessment and University Examination.

**Practical:** There shall be Annual practical examination of 60 marks/practical course at the end of 2<sup>nd</sup> and 4<sup>th</sup> Semester.

The practical examination for the courses PGMB 111, PGMB 112, PGMB 211, and PGMB 212 will be conducted at the end of second semester. Practical examination for courses PGMB 411 and PGMB412 will be conducted at the end of fourth semester.

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#### **14. Assessment for Internship (Major Project):**

PGMB 304 and PGMB 305 will be assessed as cumulative work. The project shall carry 200 marks. Internship course is of 20 credits. The assessment for the said courses should be carried out as follows;

**a. Assessment by Research Guide: The entire project will be assessed by research guide for 60 marks. Criteria used for the assessment are as follow:**

**(Confidential and to be sent through with signed sealed envelope by research guide)**

<b>Sr. No.</b>	<b>Criteria</b>	<b>Maximum Marks</b>	<b>Obtained Marks</b>
<b>1.</b>	Understanding the basic concept of dissertation	<b>05</b>	
<b>2.</b>	Fulfillment of Aims and objectives	<b>05</b>	
<b>3.</b>	Results, discussion and conclusion	<b>10</b>	
<b>4.</b>	Regularity and punctuality	<b>10</b>	
<b>5.</b>	Literature Review	<b>10</b>	
<b>6.</b>	Fulfillment of Plagiarism norms as per attached certificate	<b>05</b>	
<b>7.</b>	Publication of work	<b>05</b>	
<b>8.</b>	Potential Applications of the work /Social relevance	<b>10</b>	
<b>Total out of 60</b>			

**Note: respective research guide should submit weekly progress report to the head of the department through official mail. Signed print copies of the progress report are also accepted.**

#### **b. Internal (institutional) assessment of the project:**

Internal assessment of the project will be carried out in the Department where the candidate is registered for post graduate degree. This will be carried out as follow:

<b>Item</b>	<b>Marks</b>	<b>Note</b>
Presentation of the plan of work	20	Should be carried out as open defense. Any suggestions if are should be communicated to the guide.
Submission of completed work in the form of CD ROM of dissertation copy along with 2 certified bound copies	20	CD ROM should be submitted to the University where the University may take appropriate decision for forwarding it to Shodhganga.

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		Note: Any work having conflicts of interest with respect to intellectual properties should not be published without permission of respective guide.
<b>Total marks:</b>		<b>40</b>

### **University Evaluation:**

University evaluation will be carried out for 100 marks. This will be conducted as open defense presentation. For the purpose candidate is allowed to present the work through LCD Projector or any other alternative as available in the institute. In case of national emergencies, online presentation is allowed. For the purpose the candidate is allowed to use online meeting apps as allowed by the central government. For the purpose of the evaluation the University will appoint two examiners. One examiner will be external having adequate research experience and minimum qualification as Ph.D. For the purpose any senior academician / senior scientist working in institutes of national and international reputes / senior person working in industry / Entrepreneur with minimum qualification of Ph.D. in Microbiology may be appointed. Another examiner will be appointed from the institute where, the candidate has registered for his/her post graduate degree. Minimum qualification of the internal examiner should be Ph.D. in Microbiology.

### **Evaluation by external examiner: (University document)**

External examiner as appointed above will evaluate the dissertation of the candidate for 60 marks. Following criteria should be used for evaluation purpose by external examiner.

<b>Sr. No.</b>	<b>Criteria</b>	<b>Maximum Marks</b>	<b>Obtained Marks</b>
<b>1.</b>	Understanding the basic concept of dissertation	<b>05</b>	
<b>2.</b>	Fulfillment of Aims and objectives	<b>05</b>	
<b>3.</b>	Results, discussion and conclusion	<b>10</b>	
<b>4.</b>	Regularity and punctuality	<b>10</b>	
<b>5.</b>	Literature Review	<b>10</b>	
<b>6.</b>	Fulfillment of Plagiarism norms as per attached certificate	<b>05</b>	
<b>7.</b>	Publication of work	<b>05</b>	
<b>8.</b>	Potential Applications of the work /Social relevance	<b>10</b>	
<b>Total out of 60</b>			

[Type here]

### **Evaluation by internal examiner: (University document)**

External examiner as appointed above will evaluate the dissertation of the candidate for 40 marks. Following criteria should be used for evaluation purpose by external examiner.

<b>Sr. No.</b>	<b>Criteria</b>	<b>Maximum Marks</b>	<b>Obtained Marks</b>
<b>1.</b>	Understanding the basic concept of dissertation	<b>05</b>	
<b>2.</b>	Fulfillment of Aims and objectives	<b>05</b>	
<b>3.</b>	Results, discussion and conclusion	<b>05</b>	
<b>4.</b>	Regularity and punctuality	<b>05</b>	
<b>5.</b>	Literature Review	<b>05</b>	
<b>6.</b>	Fulfillment of Plagiarism norms as per attached certificate	<b>05</b>	
<b>7.</b>	Publication of work	<b>05</b>	
<b>8.</b>	Potential Applications of the work /Social relevance	<b>05</b>	
<b>Total out of 40</b>			

**Thus, internship (major project), PGMB 304 and PGMB 305 will be assessed for total of 200 marks.**

### **15. Alternative to internship (major project) in case of national emergencies like Covid pandemics:**

In case of national emergencies like Covid pandemics, following alternative has been approved in BOS meeting dt. 02/07/2020 with following references:

#### **References:**

1. Letter no. UNI/2020/Baithak/vishi 1/4131A dt. 8<sup>th</sup> May 2020, Pg. no. 6, clause no. 5
2. UGC Guidelines on Examinations and Academic Calendar for the Universities in View of COVID-19 Pandemic and Subsequent Lockdown dt. April 2020, pg. no. 6 and 7, clause no 10.

**1. Review article: 50 Marks**

**2. Field work/Online Surveys related to needs of society having subject relevance/Book review: 100 Marks,**

**3. Evaluation: 50 Marks,**

**Total= 200 marks**

[Type here]

**Note:** Here, in case of national emergencies or lockdown period students are allowed to work from home and the work done under above titles will be considered for evaluation and grading purposes.

### **Explanation:**

#### **1. Review Article: 50 marks**

The criteria for awarding the marks are as follow:

<b>Sr. No.</b>	<b>Criteria</b>	<b>Maximum Marks</b>
<b>1.</b>	Selection of the topic considering social relevance	<b>05</b>
<b>2.</b>	Well organized abstract/ introduction	<b>05</b>
<b>3.</b>	Survey of the topic selected as evidenced through references	<b>10</b>
<b>4.</b>	Discussion of current developments in a selected field/ topic	<b>10</b>
<b>5.</b>	Summarizing significant findings of the present study	<b>05</b>
<b>6.</b>	Literature Review and the use of software like Mendeley to keep flexibility for publication and referencing style.	<b>05</b>
<b>7.</b>	Fulfillment of Plagiarism norms as per attached certificate	<b>05</b>
<b>8.</b>	Publication of work	<b>05</b>
<b>Total marks = 50</b>		

#### **2. Field work (Data Collection)/ Online surveys: having subject relevance**

**(Any one from enlisted) 100 marks**

<b>Sr. No.</b>	<b>Criteria</b>	<b>Maximum Marks</b>
<b>1.</b>	Selection of the topic considering social relevance	<b>10</b>
<b>2.</b>	Method followed for data collection	<b>10</b>
<b>3.</b>	Statistical analysis of the data	<b>40</b>
<b>4.</b>	Well organized abstract/ introduction	<b>05</b>
<b>5.</b>	Reference work	<b>10</b>
<b>6.</b>	Discussion of current developments in a selected field/ topic	<b>10</b>
<b>7.</b>	Summarizing significant findings of the present study	<b>05</b>
<b>8.</b>	Fulfillment of Plagiarism norms as per attached certificate	<b>05</b>
<b>9.</b>	Publication of work	<b>05</b>
<b>Total marks = 100</b>		

**OR**

[Type here]

### 3. Book review: having subject relevance (Any one from enlisted) 100 marks

Sr. No.	Criteria	Maximum Marks
1.	Name of the author and book with relevant details of publisher and publication	05
2.	Relevant information about the author like who the author is and where he/she stands in the genre or the field of enquiry.	05
3.	Context of the book	10
4.	Brief discussion about the theme of book	30
5.	Strengths and weaknesses of the book	20
6.	Highlighting parts of the book by selecting particular chapter/ theme for the justification of review	10
7.	Concluding remarks about books overall perspective, argument and purpose	10
8.	Plagiarism check report	10
<b>Total marks = 100</b>		

### 4. Evaluation: 50 Marks

Internal evaluation for the alternative that is, submitting review article and field work /survey / book review will be carried out as follow:

Online presentations through central government approved apps	Maximum marks
Presentation based on review article (1)	10
Presentation based on field work/ survey / book reviews (2 presentations each of 20 marks)	40
Total marks	50

**IMP Note:** The candidate has to submit the project report before the deadlines notified by the department. The candidate who fails to submit the project report may re-submit the same in a subsequent semester examination for evaluation purpose. The project work activities must be duly supported by documentary evidences and those should be endorsed by the HOD or the guide. All forthcoming UGC notifications regarding promotion of academic integrity and prevention of plagiarism in higher education institutions will be binding to the students. Submitted thesis by the students will be evaluated by, 'Departmental Academic Integrity Panel (DAIP)' and will be certified to be eligible for further evaluation as mentioned above. Award of the Grade will be based on the following criteria.

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**c. Rules regarding ATKT to second year M.Sc. Microbiology course.**

A student will be allowed to keep terms at the second year of the M.Sc. course if her / his terms for the first year have been granted as per university rules.

**16. Standard of passing:**

For all courses, both University Examinations (UE) and Internal Assessments (IA) constitute separate heads of passing. In order to pass in such courses and to earn the assigned credits, the learner must obtain a minimum grade point of 5.0 (40% marks) at UE and also a minimum grade point of 5.0 (40 % marks) at IA.

If a student fails in IA, the learner passes in the course provided he/she obtains a minimum of 25 % in IA and GPA for the course is at least 6.0 (50% in aggregate). The GPA for a course will be calculated only if the learner passes at the UE.

A student who fails at UE in a course has to reappear only at UE as a backlog candidate and clear the head of passing. Similarly, a student who fails in a course at IA has to reappear only at IA as a backlog candidate and clear the head of passing.

The 10 point scale grades and grade points according to the following table:

Range of Marks (out of 100)	Grade	Grade point
$80 \leq \text{Marks} \leq 100$	O	10
$70 \leq \text{Marks} < 80$	A <sup>+</sup>	9
$60 \leq \text{Marks} < 70$	A	8
$55 \leq \text{Marks} < 60$	B <sup>+</sup>	7
$50 \leq \text{Marks} < 55$	B	6
$40 \leq \text{Marks} < 50$	C	5
Marks < 40	D	0

The performances at UE and IA will be combined to obtain the grade point average (GPA) for the course. The Weights for performances at UE and IA shall respectively be 60 % and 40 %. GPA is calculated by adding the UE marks out of 60 and IA marks will be out of 40. The total marks out of 100 are converted to grade point, which will be the GPA.

**17. Formula to calculate Grade points (GP):**

Suppose that, “Max” is the maximum marks assigned for an examination or evaluation based on which GP will be computed. In order to determine the GP, set  $x = \text{Max}/10$  (since we have adapted 10 point system). Then GP is calculated by the formula as shown as below.



[Type here]

Range of Marks at the evaluation	Formula for the grade point
$8x \leq \text{Marks} \leq 10x$	10
$5.5.x \leq \text{Marks} < 8x$	Truncate (Marks/x) + 2
$4x \leq \text{Marks} < 5.5x$	Truncate (Marks/x) + 1

Two kinds of performance indicators, namely the Semester Grade point average (SGPA) and the Cumulative Grade Point Average (CGPA) shall be computed at the end of each term. The SGPA measures the cumulative performance of a learner in all courses in a particular semester, while the CGPA measures the cumulative performance in all courses since his/her enrolment. The CGPA of learner when he/she completes the programme is the final result of the learner.

The SGPA is calculated by the formula  $SGPA = \frac{\sum C_k \times GP_k}{\sum C_k}$ , where  $C_k$  is the credit value assigned

to a course and  $GP_k$  is the GPA obtained by the learner in the course. In the above, the sum is taken over all the courses that the learner has undertaken for the study during the semester, including those in which he/she might have failed or those for which he/she remained absent.

**The SGPA shall be calculated up to two decimal place accuracy.**

The CGPA is calculated by the formula  $CGPA = \frac{\sum C_k \times GP_k}{\sum C_k}$ , where  $C_k$  is the credit value assigned

to a course and  $GP_k$  is the GPA obtained by the learner in the course. In the above, the sum is taken over all the courses that the learner has undertaken for the study from the time of his/her enrolment and also during the semester for which CGPA is calculated, including those in which he/she might have failed or those for which he/she remained absent. **The CGPA shall be calculated up to two decimal place accuracy.**

**The Formula to compute equivalent percentage marks for specified CGPA:**

% Marks (CGPA) =	$10 \times CGPA - 10$	If $5.00 \leq CGPA \leq 6.00$
	$5 \times CGPA + 20$	If $6.00 \leq CGPA \leq 8.00$
	$10 \times CGPA - 20$	If $8.00 \leq CGPA \leq 9.00$
	$20 \times CGPA - 110$	If $9.00 \leq CGPA \leq 9.50$
	$40 \times CGPA - 300$	If $9.50 \leq CGPA \leq 10.00$

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## **18. AWARDS OF HONOURS:**

A student who has completed the minimum credits specified for the program shall be declared to have passed in the program. The final result will be in terms of letter grade only and is based on the CGPA of all courses studied and passed. The criteria for the award of honors are given below.

Range of CGPA	Final Grade	Performance Descriptor	Equivalent Range Of Marks (%)
$9.50 \leq \text{CGPA} \leq 10.00$	O	Outstanding	$80 \leq \text{Marks} \leq 100$
$9.00 \leq \text{CGPA} \leq 9.49$	A <sup>+</sup>	Excellent	$70 \leq \text{Marks} < 80$
$8.00 \leq \text{CGPA} \leq 8.99$	A	Very Good	$60 \leq \text{Marks} < 70$
$7.00 \leq \text{CGPA} \leq 7.99$	B <sup>+</sup>	Good	$55 \leq \text{Marks} < 60$
$6.00 \leq \text{CGPA} \leq 6.99$	B	Average	$50 \leq \text{Marks} < 55$
$5.00 \leq \text{CGPA} \leq 5.99$	C	Satisfactory	$40 \leq \text{Marks} < 50$
CGPA below 5.00	F	Fail	Marks Below 40

## **19. Format of the transcript:**

Transcript will be provided to the candidate as per Bharati Vidyapeeth (Deemed to be University), Pune rules and respective amendments as implemented by the university.

## **20. Grade/ class improvement:**

The rules regarding the improvement of grade/class of M. Sc. Course will be as per notification of Bharati Vidyapeeth (Deemed to be University), Pune.

## **21. Verification and revaluation:**

There is provision for verification and revaluation of the result. A student can apply for the verification and revaluation of the result within the two weeks from the declaration of the results with the prescribed fee. The verification and revaluation shall be done as per the existing rules of the University.

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**BHARATI VIDYAPEETH  
(DEEMED TO BE UNIVERSITY), PUNE, INDIA**

**M.Sc. Microbiology  
(CBCS- 2018 COURSE)**

**Semester: I**

**PG MB 101: BIOCHEMISTRY**

**Total Credits: 4**

**Total Lectures: 60**

**Course Outcomes:**

**At the end of this course the students will be able to:**

1. Understand basic concepts in biochemistry.
2. Understand structural features and chemistry of macromolecules.
3. Know membrane transport mechanism in bacteria.

**Course contents:**

**UNIT I      INTRODUCTORY BIOCHEMISTRY      02**

1. The scope of Biochemistry
  - What is Biochemistry?
  - Goals of Biochemistry.
  - The roots of Biochemistry.
  - Biochemistry as a discipline and an interdisciplinary science.
  - Biochemistry as a chemical science.
  - Biochemistry as a biological science.
  - New tools in Biological revolution
  - The uses of Biochemistry.

**UNIT II      BASIC CONCEPTS IN BIOCHEMISTRY      04**

1. Common organic compounds found in living system

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- Common functional groups in biochemistry. OH, CHO, C = O, NH<sub>2</sub>, C – NH<sub>2</sub>, SH, ester, ethers, methyl, ethyl, phospho, guanidino, imidazole etc).
- Common ring structures in biochemistry.
- Isomerism.
- Isotopes.
- Energetics.
- Redox systems.
- High energy compounds.

**UNIT III WATER 02**

1. Structure and properties.
  - Water as a solvent.
  - Ionization.
  - Ionic equilibrium.

**UNIT IV STRUCTURAL FEATURES AND CHEMISTRY OF MACROMOLECULES 10**

1. Nucleic acids:
  - Tautomeric forms of bases and their implication in pairing of bases.
  - Structure of polynucleotides, DNA structure, DNA and RNA (t -RNA, r- RNA, m- RNA etc).
  - Structure of DNA double helix.
  - R and L handed forms.
  - A, B, C and Z forms of DNA.
  - Denaturation and Renaturation of DNA and T<sub>m</sub> value.
2. **Proteins 12**
  - Amino acids.
  - Peptides – Prepeptide linkage, partial double bond nature of peptide linkage.
  - Proteins – structural classification of Proteins, primary structure, secondary structure, tertiary structure, Quarternary structure.
  - Determination of primary structure of polypeptide (N terminal determination, C terminal determination, Partial hydrolysis, Overlapping sequence etc.) α helix of polypeptide.
  - Structure and functions of globular proteins.
  - Immunological techniques to investigate proteins.
  - Artificial synthesis of polypeptides.
3. **Membrane transport 10**
  - Overview of membrane transport.
  - ATP powered pumps and intracellular ionic environment.
  - Non gated Ion channels and the resting membrane potential.
  - Co-transport – symport, antiport.
  - Neurotransmitters.
  - ATP driven active transport system for Sodium and Potassium ions.
  - Proton gradient in *Halobacteria*.
  - Transport of antibiotics that increase the ionic permeability of membranes.

- 4. Carbohydrates** **08**
- L forms and D forms of sugar.
  - Reducing and non reducing sugars.
  - Aldoses / ketoses.
  - Alpha and Beta, ring forms of sugars.
  - Glycosidic linkages.
  - Sugar derivatives – sugar alcohol, amino sugars, dextro sugars, sugar acids
  - Polysaccharides (starch, glycogen, cellulose)
- 5. Lipids** **12**
- Fatty acids – Types and nomenclature.
  - Saturated and unsaturated fatty acids,
  - Structure and function of Triglycerides, Phospholipids, Sphingolipids.
  - Structure and function of steroids, terpenes, prostaglandins.

### References:

1. Doelle, H.W. (1975) Bacterial Metabolism 2<sup>nd</sup> Edition Academic Press, Inc. N.Y.
2. Jayraman – Laboratory manual in Biochemistry, New Age International publishers, New Delhi.
3. Lehninger A.L. (1984): Principles of Biochemistry, 1<sup>st</sup> Indian Edition, LBS publishers and distributors Pvt. Ltd. New Delhi.
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11. White A., P. Handler. E.L. Smith (1973) Principles of Biochemistry, 5<sup>th</sup> Edition.
12. Wilson K. and J. Walker, (1999) Cambridge University Press. Principles and techniques at Practical biochemistry

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**BHARATI VIDYAPEETH  
(DEEMED TO BE UNIVERSITY), PUNE, INDIA**

**M.Sc. Microbiology  
(CBCS- 2018 COURSE)**

**Semester : I**

**PG MB 102: IMMUNOLOGY**

**Total Credits: 04**

**Total Lectures: 60**

**Course Outcomes:**

**At the end of this course the students will be able to:**

1. Understand classes of immunoglobulin, organization and expression of immunoglobulin genes.
2. Know details of major histocompatibility complex and disease susceptibility.
3. Understand cytokines and their medical significance.
4. Understand hypersensitivity reactions.
5. Know immunodeficiencies and auto immunity.
6. Understand details of transplantation immunology and immunity to cancer.

**Course contents:**

**UNIT I IMMUNOGLOBULINS**

**10**

1. Fine Structure
2. Classes & biological activities
3. Organization & expression of immunoglobulin genes
  - Genetic model compatible with Ig structure
  - Multigene organization of Ig Genes.
  - Variable region gene rearrangements
  - Mechanism of Variable region DNA rearrangements
  - Generation of Antibody diversity

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- Expression of Ig Genes
- Regulation of Ig - Gene transcription.
- Antibody genes and antibody engineering

## **UNIT II MAJOR HISTOCOMPATIBILITY COMPLEX**

**07**

1. General Organization and Inheritance of the MHC
2. MHC molecules and Genes
3. Detailed Genomic Map of MHC genes
4. Cellular Distribution of MHC molecules
5. Regulation of MHC Expression.
6. MHC and Immune Responsiveness
7. MHC and Disease susceptibility

## **UNIT III IMMUNE EFFECTOR MECHANISMS**

**15**

1. Cytokines – properties, receptors, antagonists, Cytokine secretion, related diseases, Therapeutic uses.
2. Complement system - Functions, Components, activation, Regulation, Biological consequences, Deficiencies.
3. Leukocyte Migration & Inflammation- Lymphocyte re-circulation, Cell Adhesion molecules, Neutrophils Extravasation, Lymphocyte Extravasation, Mediators of Inflammation, The inflammatory process, Anti inflammatory agents.
4. Hypersensitive Reactions - Type I, Type II, Type III and Type IV hypersensitivity reactions.

## **UNIT IV IMMUNODEFICIENCIES, AUTOIMMUNITY & AIDS**

**10**

1. Primary Immunodeficiencies
  - X- linked Agammaglobunaemia
  - Common Variable Immuno Deficiency (CVID)
  - Di George Syndrome
  - Wiskott Aldrich Syndrome
2. Acquired or Secondary Immunodeficiencies.
  - Down's syndrome
  - AIDS
  - Hodgkins disease
3. Organ Specific autoimmune diseases
  - Graves Disease
  - Myasthenia gravis
  - Insulin Dependent Diabetes
4. Systemic Autoimmune diseases.
  - Goodpasteure's Syndrome,
  - Rheumatoid Arthritis,
  - Systemic Lupus Erythematosus
5. Animal models for Autoimmune Disease
6. Proposed Mechanism for Induction of Autoimmunity
7. Treatment of Autoimmune Diseases.

**UNIT V TRANSPLANTATION IMMUNOLOGY 08**

1. Immunologic Basics of Graft Rejection.
2. Clinical manifestation of Graft rejection
3. General Immunosuppressive Therapy
4. Specific Immunosuppressive Therapy
5. Clinical Transplantation

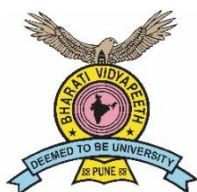
**UNIT VI CANCER & THE IMMUNE SYSTEM 10**

1. Cancer origin & Terminology
2. Malignant transformation of cells
3. Oncogenes & cancer induction.
4. Tumors of the Immune system
5. Tumor antigens.
6. Immune response to tumors.
7. Tumor Evasion of the Immune system
8. Cancer Immunotherapy.

**References:**

1. Cruse J and R. Lewis (2004) Atlas of Immunology 2<sup>nd</sup> Edn. CRC Press.
2. David Male, Jonathan Brostoff, David B Roth, Ivan Roitt.(2006).Immunology 7<sup>th</sup> edition.
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**M.Sc. Microbiology  
(CBCS- 2018 COURSE)**

**Semester –I**

**PG MB 103:– GENETICS AND MOLECULAR BIOLOGY**

**Total Credits: 04**

**Total Lectures: 60**

**Course Outcomes:**

**At the end of this course the students will be able to:**

1. Understand structure of chromosomes, expression and regulation of genes.
2. Understand techniques and applications of genetic engineering.

**Course contents:**

**UNIT I STRUCTURE OF EUKARYOTIC CHROMOSOME**

**15**

1. Genome complexity.
2. Chemical composition.
3. Packaging the giant DNA molecules into chromosome
4. Euchromatin and heterochromatin.
5. Repetitive DNA and sequence organization.
6. Replication of Eukaryotic chromosome.
7. Comparison with structure and replication of prokaryotic chromosome.
8. Effect of different antibiotics on chromosome structure and replication.
  - Antibiotics that affect replication and DNA structure.
  - Antibiotics that block precursor synthesis.
  - Antibiotics that block polymerization of Nucleotides.
  - Antibiotics that affect DNA structure.
  - Antibiotics that affect Gyrase.

**UNIT II GENE EXPRESSION**

**20**

1. Evolution of the one gene one polypeptide concept.
2. Genetic control of metabolism.
  - **Transcription.**
    - a. The transcription process. RNA synthesis, Classes of RNA and the Genes that code for them.

- b. Transcription of protein coding genes. Prokaryotes, Eukaryotes, mRNA molecules.
- c. Transcription of other genes, Ribosomal RNA and Ribosomes, Transfer RNA.
- **Protein structure.**
  - a. Chemical structure of proteins.
  - b. Molecular structure of proteins.
- **Nature of the Genetic code.**
  - a. Genetic code is a triplet code.
  - b. Deciphering the genetic code.
  - c. Nature and characteristic of the genetic code.
- **Translation of the genetic message.**
  - a. Aminoacyl t-RNA molecules.
  - b. Initiation of translation.
  - c. Elongation of the polypeptide chain.
  - d. Termination of Translation.
- **Protein sorting in the cell.**
  - a. Proteins distributed by the endoplasmic reticulum.
  - b. Proteins transported into mitochondria and chloroplast.
  - c. Proteins transported into the nucleus.

### UNIT III REGULATION OF GENE EXPRESSION

08

#### 1. Positive regulation.

- *E. coli* maltose operons.
- The *tol* operons.

#### 2. Feedback inhibition.

- Isoleucine – Valine operon.
- Histidine operon.
- Leucine operon.
- Phenylalanine operon.
- Threonine operon.

### UNIT IV GENETIC ENGINEERING

17

#### 1. Basic techniques.

- Agarose gel electrophoresis.
- Nucleic acid blotting.
- Transformation of *E. coli*.
- The polymerase chain reaction (PCR)

#### 2. Cutting and joining DNA molecules.

- Cutting DNA molecules.
- Joining DNA molecules.

#### 3. Vectors used for cloning

- Plasmids.
- Phages.
- Vectors for cloning large fragments of DNA.
- Specialist purpose vectors.

#### 4. Cloning strategies.

- Cloning genomic DNA.

- c -DNA cloning.
- Screening strategies.
- Difference cloning.

**5. Applications of recombinant DNA technology.**

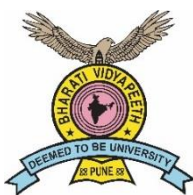
- Nucleic acid sequences as diagnostic tool.
- New drugs and new therapies for genetic diseases.
- Combating infectious diseases.
- Protein Engineering.
- Metabolic Engineering.
- Transgenic technology.
  - a. Transgenic plants.
  - b. Transgenic animals.

**References:**

1. Alberts. B.; Johnson. A, Lewis J. Raff, M. Roberts. K. and P. Walter (2002) Molecular Biology of the cell 4<sup>th</sup> Edition. Garland Science, Taylor & Francis Group.
2. Clayton. J and C. Dennis. (2003) 50 years of DNA. Nature Publishing group.
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12. Sambrook. J and D.W. Russel. (2001) Molecular cloning. A Laboratory Manual. 3<sup>rd</sup> Edn. Vol. 1,2,3. Cold Spring Harbor laboratory Press.
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**M.Sc. Microbiology  
(CBCS- 2018 COURSE)**

**Semester –I**

**PG MB-104: MICROBIAL ECOLOGY**

**Total Credits: 04**

**Total Lectures: 60**

**Course Outcomes:**

**At the end of this course the students will be able to:**

1. Understand microbial ecology, assimilation, bioleaching, production and recovery of fuels.
2. Know in details biodeterioration and biofilms.
3. Understand basics of plant pathology and details of biopesticides.

**Course contents:**

<b>UNIT I</b>	<b>INTRODUCTION TO BASIC CONCEPTS OF ECOLOGY</b>	<b>02</b>
<b>UNIT II</b>	<b>MICROBIAL ECOLOGY</b>	<b>15</b>
	1. Historical Developments	
	2. Microbial evolution and Biodiversity	
	3. Types of Biodiversity	
	4. Biodiversity concept -	
	• Alpha and Beta biodiversity.	
	• Steps to preserve biodiversity.	
	5. Genetic basis for evolution and Ribosomal RNA analysis for tracing microbial evolution	
	6. Biodiversity conservation and Species conservation	
	7. Microbial communities and ecosystem	
	• Development of microbial communities	
	• Succession within microbial communities	
	• Diversity and stability of microbial communities	
	• Risk of introducing genetically modified microorganisms	
	8. Quantitative ecology	
	• Sample collection	
	• Sample processing	
	• Detection of microbial populations	

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- Determination of microbial numbers
- Measurement of microbial metabolisms

**UNIT III      MICROBIAL LIFE IN EXTREME ENVIRONMENT      12**

1. Abiotic limitations to microbial growth
2. Effects of environmental determinants
  - Extreme pH.
  - Temperature.
  - Pressure.
  - Salt and solute.
  - Heavy metals.
  - Radiations.
  - Water activity
  - Movement
  - Magnetic poles
  - Redox potential
  - Organic and inorganic compounds.
  - Examples of extreme environments
    - a) Hot springs.
    - b) Acid springs and Lakes.
    - c) Sea and salt lakes.
    - d) Antarctica and ocean bottom.

**UNIT IV      MICROORGANISMS IN MINERAL AND ENERGY RECOVERY      10**

1. Microbial assimilation of metals
2. Bioleaching of metals-Gold, Uranium, Copper.
3. Metal and metallic transformation- Mercury, Arsenic, Lead.
4. Recovery of petroleum
5. Production of fuels – ethanol, methane, hydrogen

**UNIT V      BIODETERIORATION      03**

1. Concept of biodeterioration.
2. Biodeterioration of –
  - Wood.
  - Stone work.
  - Pharmaceutical products.
  - Metal Corrosion.
  - Rubber.
  - Plastic.
  - Concrete
  - Paper & Textile.
  - Paints.
  - Computer diskette and cassette films.
  - Lubricants and Adhesives, cosmetics.
3. Control of biodeterioration.

**UNIT VI BIOFILMS**

**02**

1. Population within biofilms
2. Fouling Biofilms
3. Control of Biofilms

**UNIT VII PLANT PATHOLOGY**

**08**

1. Pathogenesis, Entry through various routes.
2. Enzymes and toxins in plant diseases – different enzymes and toxins and their role in diseases.
3. How plants defend themselves against infections, different modes of defense.
4. Effect of environmental factors and nutrition on disease development.
5. Management of plant diseases.-
  - Microbial amensalism and parasitism to control microbial pathogens-antifungal amensalism and antibacterial amensalism
  - Bacterial biopesticides
  - Fungal biopesticides
  - Viral biopesticides

**UNIT VIII CASE STUDIES**

**08**

**References:**

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**BHARATI VIDYAPEETH  
(DEEMED TO BE UNIVERSITY), PUNE, INDIA  
M.Sc. – Microbiology  
(CBCS- 2018 COURSE)  
SEMESTER-I**

**PG MB 105: ENVIRONMENTAL MICROBIOLOGY**

**Total Credits: 04**

**Total Lectures: 60**

**Course Outcomes:**

**At the end of this course the students will be able to:**

1. Understand concept of aeromicrobiology, biosafety and waste water management.
2. Understand bioremediation and biodegradation processes.
3. Know environmental laws.

**Course contents:**

**UNIT I AEROMICROBIOLOGY 06**

1. Nature of Bioaerosols
2. Sampling of bioaerosols
3. Bioaerosol control
  - Extramural Aeromicrobiology
  - Intramural Aeromicrobiology
  - General Pathological effects of air pollution.
  - Biosafety in laboratory

**UNIT II WASTE WATER MICROBIOLOGY (DOMESTIC AND INDUSTRIAL) 15**

1. **Waste water types.**
  - Characteristics.
  - Nature of pollutants and their effects
  - Microbial pollution and its effects.
2. **Treatment.**
  - Principles of waste water treatment.
  - Disposal of waste water
  - Aerobic processes
    - a. Activated sludge process.
    - b. Fixed film systems.
    - c. High rate filters.
    - d. Trickling filters
    - e. Rotating biological contactors.



- f. Fluidized bed reactors.
- g. Oxidation ditch.
- h. Aerated lagoons.
- Anaerobic digestion
  - a. Anaerobic lagoons and covered anaerobic lagoons.
- Biosorption – N and P removal.
- Biofilms and kinetics
  - a. Root zone process.
  - b. Reverse osmosis.
  - c. Waste water disposal by dilution.
- Difficulties encountered in operation of different methods of waste treatment.
- Economics of waste treatment and feasibility.

**UNIT III BIOREMEDIATION 12**

1. Bioremediation of Metals
  - Metal toxicity effect on microbes
  - Mechanisms of microbial resistance to metals, metal -microbe interactions
  - Methods to detect metal – microbe interactions
  - Microbial remediation of metal contaminated soils
  - Microbial remediation of metal contaminated aquatic systems
2. Bioremediation of petroleum
3. Bioremediation of waste gases

**UNIT IV BIODEGRADATION OF XENOBIOTIC AND INORGANIC POLLUTANTS: 14**

1. Recalcitrant organic compounds and their presence in natural ecosystem
2. Concept and Consequence of biomagnifications.
3. Biomagnification of hydrocarbons and pesticides.
4. Process of Biodegradation
5. Relationship between Contaminant Structure, Toxicity and biodegradability
6. Environmental factors affecting biodegradability
7. Biodegradation of recalcitrant xenobiotic and toxic compounds
8. Recalcitrant Halocarbons
9. Recalcitrant Nitro aromatic compounds
10. Polychlorinated Biphenyl's
11. Radionuclide
12. Pesticides

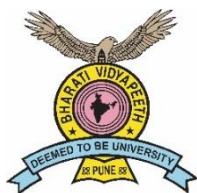
**UNIT V ENVIRONMENTAL LAWS 05**

1. Introduction
2. Environmental legislation in India
3. Legal aspects of waste treatment and disposal.
4. Notification relating to hazardous microorganisms and genetically modified organisms.
5. Rules for management of Bio medical wastes

**UNIT VI CASE STUDIES 08**

## References:

1. Arora. M.G. and M. Singh (1994) Industrial Chemistry Vol. I & II. Anmol Publications Pvt. Ltd.
2. Asthana D.K. and M. Asthana (2003) Environment Problems & Solutions. S. Chand and Co. Ltd. New Delhi..
3. Bathra Atlas (2007) Microbial Ecology Fundamentals and Application 4th edition, Pearson Education Publication.
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5. De. A.K. (1994) Environmental Chemistry, New Age International (P) Limited, Publishers.
6. Gray. N.F. (2000) Water Technology. An Introduction for Environmental Scientists and Engineers. Viva Books Pvt. Ltd. New Delhi.
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8. Kormondy H.J.(2007) Concepts of Ecology .fourth Edn .Pearson, Prentice Hall
9. Kumar A.(2005) Microbial pollution, APH Publishing house, New Delhi.
10. Katyal. T & M. Satake (1991) Environmental Pollution. Anmol Publishers Pvt. Ltd.
11. Khopkar S.M. (1993) Environmental Pollution Analysis Wiley Eastern Limited.
12. Maier R M , I L Pepler, C P Gerba (2000) Environmental Microbiology, Academic press.
13. Mukherjee N. and T. Ghosh (1995) Agricultural Microbiology. First Edition. Kalyani Publishers, New Delhi, Ludhiana, Hyderabad, Madras, Calcutta Cuttack.
14. Ranade D.R. and R.V. Gadre (1988) Microbiological aspects of anaerobic digestion. Laboratory Manual. Maharashtra association for cultivation of sciences
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17. Sharma B.K. and H. Kaur (1994). Water pollution Goel Publishing House Meerut..
18. Tripathi A.K. (1993) Understanding Environmental Disruption. Volume-I & II. Ashish Publishing House, New Delhi.
19. Trivedi R K (1998) Advances in Wastewater Treatment Technologies vol.1, Global Science, Aljgarh.
20. Verma, P.S and V.K. Agarwal (1996) Environmental Biology (Principles of Ecology) S. Chand & Co. New Delhi.



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**SEMESTER -I**

**PGMB 111: Practical course-1**

**Total Credits: 02**

**Total Lectures: 120**

**Course Outcomes:**

**At the end of this course the students will be able to:**

1. Handle different instruments
2. Develop skills needed to run blood transfusion and serological experiments.

**Course contents:**

<b>UNIT I</b>	<b>INSTRUMENTATION &amp; BIOCHEMISTRY</b>	<b>2P</b>
	1. Study of different instruments in the laboratory. <ul style="list-style-type: none"><li>• Laminar airflow, Microfuge, UV. Spectrophotometer, Incubator shaker, Cooling incubator, Deepfreeze, colorimeter, pH meter, lyophilizer (visit).</li><li>• Laboratory Safety.</li></ul>	
	2. Preparation of buffers and molar solutions.	<b>2P</b>
	3. Estimation of protein by Lowry's / Biuret method.	<b>2P</b>
	4. Separation & identification of amino acids, carbohydrates by TLC.	<b>2P</b>
	5. Estimation of reducing sugars by DNSA.	<b>3P</b>
	6. Estimation of lipids / fats	<b>1P</b>
	7. Beer Lambert's law.	
<b>UNIT II</b>	<b>IMMUNOLOGY</b>	
	1. <b>Blood transfusion related techniques.</b> <ul style="list-style-type: none"><li>• Blood grouping.</li><li>• Cross matching.</li><li>• Visit to blood bank.</li></ul>	<b>3P</b>
	2. <b>Study of Immunological reactions.</b> <ul style="list-style-type: none"><li>• Agglutination reactions.</li><li>• Haemagglutination Inhibition Test</li><li>• Immunodiffusion</li><li>• Demonstration / visit.</li></ul>	<b>5P</b>

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- a) RIA, ELISA,
- b) Study of vaccination schedule.

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### **References:**

1. 1Alberts. B.; Johnson. A, Lewis J. Raff, M. Roberts. K. and P. Walter (2002) Molecular Biology of the cell 4<sup>th</sup> Edition. Garland Science, Taylor & Francis Group.
2. Benjamin Cunnings publishing Co. Inc. 2<sup>nd</sup> Edition
3. Boyer. R. (2000) Modern Experimental Biochemistry. 3<sup>rd</sup> Edition. Pearson Education Asia.
4. Cruse J and R. Lewis (2004) Atlas of Immunology 2<sup>nd</sup> Edn. CRC Press
5. Elliott. W.H. and D.C. Elliot (2001) Biochemistry and molecular Biology. 2<sup>nd</sup> Edn. Oxford University Press.
6. Hand book of experimental immunology Vol. I by PM. Weinor (editor) 1978. Black Well scientific publications.
7. Jayraman – Laboratory manual in Biochemistry, New Age International. Publishers, New Delhi
8. Mathews C.K. and K.E. Van Holde (1996) Biochemistry. The Benjamin Cunnings publishing Co. Inc. 2<sup>nd</sup> Edition
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**M.Sc. Microbiology  
(CBCS- 2018 COURSE)**

**SEMESTER I**

**PGMB 112: Practical course-2**

**Total Credits: 02**

**Total Lectures: 120**

**Course Outcomes:**

**At the end of this course the students will be able to:**

1. Cultivate extremophiles.
2. Conduct experiment for detection of pollution strength.

**Course contents:**

- |  |             |
|--|-------------|
| 1. Cultivation of Extremophiles.(any two)  | <b>10 P</b> |
| • Acidophiles.   |             |
| • Alkalophiles.  |             |
| • Halophiles.  |             |
| • Psychrophiles.   |             |
| • Thermophiles.  |             |
| 2. Systematic study of the extremophile isolates using 'Bergey's Manual of Systematic Bacteriology'. | <b>6 P</b>  |
| 3. Study of Microbial diversity  | <b>2 P</b>  |
| 4. Sewage decomposition by aerobic and anaerobic microorganisms.                                     | <b>1 P</b>  |
| 5. Determination of BOD and COD of a given sample.   | <b>2 P</b>  |
| 6. Determination of TS, TSS and MLSS.  | <b>1 P</b>  |

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**22 P**

**References:**

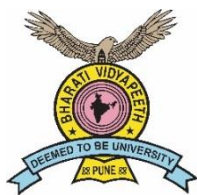
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2. Kormondy H.J(2007) Concepts of Ecology .fourth Edn .Pearson, Prentice
3. Maier R M , I L Pepler, C P Gerba (2000) Environmental Microbiology,
4. Krieg, M. R. and J. G. Holt (Editors) (1984) Bergey's Manual of Systematic Bacteriology. Vol I Williams and Wilkins, Baltimore, London, Tokyo
5. Sharma B.K. and H. Kaur (1994). Water pollution Goel Publishing House Meerut.
6. Sneath, P. H. A. Mair: N. S. Sharpe: M. E. and J. G. Holt (Eds) (1986). Bergey's Manual of Systematic Bacteriology Vol. II Williams and Wilkins, Baltimore, London, Tokyo.
7. Staley, J. T. Bryant: M. P. Penning: N and J. G. Holt (Eds) (1989) Bergey's Manual of Systematic Bacteriology Vol. III Williams and Wilkins, Baltimore, London, Tokyo,
8. Skinner,(1987)Bacterial Systematics Academic Press.
9. Cappucino & Sherman (2004) Microbiology a laboratory manual 6<sup>th</sup> Edn. Pearson Education, New Delhi.
10. Tripathi A.K. (1993) Understanding Environmental Disruption. Volume-I & II. Ashish Publishing House, New Delhi.
11. Trivedi R K (1998) Advances in Wastewater Treatment Technologie vol.1, Global Science, Aljgarh
12. Williams, S. T. Sharpe: M. E. and J. G. Holt (Eds) (1989) Bergey's Manual of Systematic Bacteriology. Vol. IV Williams and Wilkins, Baltimore, London, Tokyo.

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**M.Sc. Microbiology (CBCS 2018 COURSE)**

**Semester –II**

**PG MB 201:– FERMENTOR DESIGN AND MICROBIAL BIOTECHNOLOGY**

**Total Credits: 04**

**Total Lectures: 60**

**Course Outcomes:**

**At the end of this course the students will be able to:**

1. Understand designs of fermenter.
2. Know commercial production of biomolecules.

**Course contents:**

<b>UNIT I FERMENTOR DESIGN</b>	<b>15</b>
1.Design of a Fermentor	
2.Basic functions of a fermentor	
3.Aseptic operation and containment	
4.Body construction	
5.Parts of the fermentor and their functions: Impellers, Baffles, Sparger.	
6.Achievement and maintenance of aseptic conditions: - Sterilization of fermentor and its parts.	
7.Different methods of sterilization.	
8.Valves and steam traps: Role in maintaining aseptic conditions.	
9.Alterations in the fermentor design for ‘Animal cell culture’ and ‘Plant cell culture’	
<b>UNIT II OTHER DESIGNS OF A FERMENTOR</b>	<b>05</b>
1. The Waldhoff-type fermentor.	
2.Acitators and cavitators.	
3.The tower fermentors.	
4.Cylindro conical vessels.	
5.Airlift fermentors.	
6.The deep jet fermentor.	
7.The cyclone column	
8.The packed tower.	
9.Rotating-disc fermentor.	
<b>UNIT III AERATION AND AGITATION</b>	<b>10</b>

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1. The oxygen requirements of industrial fermentations
2. Oxygen supply.
3. Determination of  $K_{La}$  value.
4. Fluid Rheology
5. Factors affecting  $K_{La}$  value in fermentation vessels.
6. Scale-up and scale-down.

#### **UNIT IV      MICROBIAL BIOTECHNOLOGY.**

**30**

##### **1. Commercial production of**

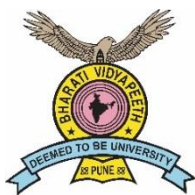
- Amino acids
- Polysaccharides.
- Antibiotics
- Solvents
- Enzymes
- Steroids
- Nucleotides
- SCP
- Organic acids
- Vitamins

#### **References:**

1. Casida. L.E. (2003) reprint Industrial Microbiology Publ: New Age International (p) Ltd. New Delhi.
2. Grace E.S. (1997) Biotechnology unzipped. Promises and Realities Joseph. Henry Press Washington D.C.
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11. Trehan. K. (1990). Biotechnology. New Age International New Delhi..
12. Borem A. Santos R. and D.E. Bowen (1998) Understanding Biotechnology.



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**M.Sc. Microbiology (CBCS -2018 COURSE)**

**Semester-II**

**PGMB 202: ANALYTICAL TECHNIQUES**

**Total Credits: 04**

**Total Lectures: 60**

**Course Outcomes:**

**At the end of this course the students will be able to:**

1. Understand different analytical techniques used in labs and industries.
2. Learn to handle radioactive isotopes for research and diagnostic purpose.

**Course contents:**

<b>UNIT I. RADIOACTIVE ISOTOPES &amp; THEIR USE</b>	<b>10</b>
1. Radioactive decay.	
2. Measuring radioactivity.	
3. Autoradiography.	
4. Biological applications.	
5. Working practices when using radioactive isotopes.	
6. Safety and procedural aspects.	
<b>UNIT II. CENTRIFUGATION.</b>	<b>10</b>
1. How to calculate centrifugal acceleration.	
2. Centrifugal separation methods.	
3. Types of centrifuge and their uses.	
4. Rotors.	
5. Centrifuge tubes.	
6. Safe practice.	
<b>UNIT III. CHROMATOGRAPHY.</b>	<b>14</b>
1. Types of chromatographic systems.	
2. Separation methods.	
3. Detectors.	
4. Recording & Interpreting chromatograms.	
<b>UNIT IV. ELECTROPHORESIS.</b>	<b>12</b>
1. Basic apparatus.	
2. Using a supporting medium.	

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3. Types of supporting media.
4. Post electrophoretic procedures.

#### **UNIT V. SPECTROPHOTOMETER.**

**14**

1. Principles.
2. UV spectrophotometer
3. Visible spectrophotometer
4. Fluorescence spectrophotometer.
5. Atomic spectroscopy.

#### **References:**

1. Boyer. R. (2000) Modern Experimental Biochemistry. 3<sup>rd</sup> Edition. Pearson Education Asia.
2. Lehninger. A.L. ( 1984 ) Principles of Biochemistry.
3. Mathews C.K. and K.E. Van Holde (1996) Biochemistry. The Benjamin Cunnings publishing Co. Inc. 2<sup>nd</sup> Edition.
4. Pattabiraman T.N. (1993) Principles of Biochemistry Gajanan Publisher.
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6. Satyanarayana (1999) Biochemistry. Books & Allied (p) Ltd.
7. Wilson and Walker (2000) 5<sup>th</sup> edition Practical Biochemistry principles and techniques, Cambridge Univ. Press

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M.Sc. Microbiology (CBCS-2018 COURSE)  
Semester II**

**PGMB 203: QUANTITATIVE BIOLOGY**

**Total Credits: 04**

**Total Lectures: 60**

**Course Outcomes:**

**At the end of this course the students will be able to:**

1. Learn different methods and aspects of biostatistics.
2. Understand statistical analysis of genetic data and different aspects of Mendelian genetics.
3. Understand population genetics and its use during pursual of research.

**Course contents:**

**UNIT I      BIostatistics      16**

**1. Introduction -**

- What is statistics- Definition, population & universe, sample & population? Statistical inference, Parameter & Statistics Designing simple experiments, Arithmetic mean and Standard deviation.

**2. Handling of Bulky data**

- Construction and interpretation of a Histogram, Normal distribution. Estimating the mean and standard deviation of a large sample, representing normal curve as a straight line, Uncertainties in estimating a mean.

**3. Proportion data :**

- Examples of proportion data (MPN, Sterility testing of medicines, animal toxicity, therapeutic trials of drug and vaccines, animal toxicity, infection and immunization studies eg LD50, ED50, PD50), Statistical treatment of proportion data, Chi-Square test, goodness of fit to normal distribution.

**4. Count data :**

- **Examples of count data:** Bacterial Cell count, radioactivity count, colony and plaque count etc.
- **Statistical treatment to count data:** Poisson distribution, standard error, confidence limits of count .

**5. Analysis of variance :**

- Introduction, procedure,

[Type here]

- F & T test.
- 6. Correlation regression & line fitting through graph points :**
  - Standard curve, correlation, linear, regression. (Fitting the best straight through the series of Points), Standard curves & interpolation of unknown Y value.
- 7. Statistical basis of biological assays:**
  - Standard line interpolation assay, parallel line assay (4 point, 6 point assay) slope ratio assay.

**UNIT II MENDELIAN GENETICS 16**

1. Monohybrid crosses and Mendel's principle of segregation.
2. Dihybrid crosses and Mendelian principle of independent assortment.
3. Statistical analysis of Genetic data. The chi-square test.
4. Multiple alleles – ABO blood groups.
5. Modification of Dominance relationships.
6. Gene interactions and modified Mendelian ratios.
7. Essential genes and lethal genes.
8. The environment and gene expression.

**UNIT III POPULATION GENETICS 16**

1. Difference in genotype frequencies amongst population. Hardy – Weinberg principle.
2. Random mating.
3. Polymorphic genes and DNA typing.
4. Inbreeding.
5. Genetic change in species leads to evolution.
6. Introduction of new alleles in population.
7. Natural selection.
8. Random changes in allele frequency.

**UNITIV PROBLEM SOLVING 12**

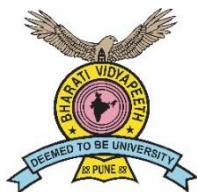
**References:**

1. Bailey N.T.J (1995) Statistical Methods in biology 3<sup>rd</sup> Edition. Cambridge lowprice Edition Cambridge university press.
2. Dixit J.V. (1996) Principles & Practice of Biostatistics 1<sup>st</sup> Edn. M/s. Banarasidas Bhanot (Publisher).
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4. Gardner E.J., Simmons, M.J and D.P. Snustad. (1991) Principles of Genetics. 8<sup>th</sup> Edition. John Willey & Sons. Inc.
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7. Khan And Khanum
8. Pranab Kr. Banerjee (2006) Problems on Genetics, Molecular Genetics and Evolutionary Genetics. New Central Book Agency (P) Ltd. Kolkata.

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10. Russel. P. (1998) Genetics Fifth edition. Addison. Wesley Longman Inc.
11. Snyder. L. and W. Champress. (1997) Molecular Genetics of Bacteria. ASM Press. Washington. D.C.
12. T. Bhaskararao (2002) Methods of Biostatistics. Paras Publishing.
13. Wardlaw A.C. (1985) Practical statistics for experimental Biologists John Wiley & Sons. Ltd.

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M. Sc. Microbiology (CBCS 2018 COURSE)**

**SEMESTER-II**

**PGMB 204: MICROBIAL METABOLISM**

**Total Credits: 04**

**Total Lectures: 60**

**Course Outcomes:**

**At the end of this course the students will be able to:**

1. Understand basic concepts of metabolism.
2. Understand bioenergetics, aerobic respiration and anaerobic respiration.
3. Know metabolism of carbohydrates, lipids and nucleic acids.

**Course contents:**

**UNIT I INTRODUCTION TO METABOLISM. 05**

1. Catabolism
2. Anabolism
3. Types of metabolic reactions
4. Methods employed to study metabolism.
5. Metabolic control mechanisms. Control of enzyme levels.
  - Control of enzyme activity.
  - Compartmentation.
  - Hormonal regulation.

**UNIT II BIOENERGETIC CONSIDERATIONS. 08**

1. Membrane Potential
  - Generation & maintenance.
  - Energetics of proton motive force.
2. Oxidation as a Metabolic enzyme source –
  - Biological oxidations.
  - Reductions.
  - Oxidation -
    - a. Reduction potentials and standard electrode potential.
    - b. Redox couple.
    - c. Nernst equation.

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- High energy compounds – ATP, GTP, CTP, PEP, NAD, NADP, FAD, FMN.
- Hormonal regulation.

**UNIT III      AEROBIC RESPIRATION      08**

1. Bacterial Electron transport chain
2. Mitochondrial ETC –
  - Structure of mitochondria
  - Mitochondrial ETC
  - Shuttle systems across mitochondrial membrane.
  - Citric acid cycle and oxidative phosphorylation.

**UNIT IV      ANAEROBIC RESPIRATION      05**

1. Concept.
2. Sulfur Compounds, Nitrate & CO<sub>2</sub> as electron acceptors.
3. ETC in SO<sub>4</sub> reducers and NO<sub>3</sub> reducers.

**UNIT V      CARBOHYDRATE METABOLISM: (Major pathways of carbohydrate metabolism)      15**

1. Concept of fermentation with respect to -
  - Homo & heterolactic, bacteria.
  - Saccharolytic *Clostridia* & proteolytic *Clostridia*.
  - Enzymes, intermediates, cofactors & regulation of glycolysis.
  - Gluconeogenesis.
  - HMP pathway.
  - ED pathway.
  - TCA cycle & glyoxylate bypass.
2. Metabolism of –
  - Starch.
  - Glycogen.

**UNIT VI      METABOLISM OF LIPIDS      10**

3. Fatty acid oxidation – stages and tissues.
4. Oxidation of odd carbon chain fatty acid.
5. Oxidation of unsaturated fatty acids –
  - Alpha ( $\alpha$ )
  - Beta ( $\beta$ )
  - Omega ( $\omega$ ).
4. Biosynthesis of fatty acids.
5. Synthesis of Triacylglycerols.
6. Metabolism of phospholipids.

**UNIT VII      NUCLEIC ACID METABOLISM      09**

1. Synthesis and Catabolism of purines and pyrimidines – *De novo* biosynthesis.

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2. Regulation of steps.
3. Purine degradation and clinical disorders of purine metabolism.
4. Pyrimidine metabolism.
5. Deoxyribonucleotide biosynthesis and metabolism.
6. Inhibitors of nucleotide biosynthesis.

**References:**

1. Agarwal G.R., Agarwal O. P. Agarwal K. Text book of Biochemistry, Goel publishing house Meerut, 8<sup>th</sup> Edition 1995.
2. Conn, E.E. P.K. Stumpf, G. Bruening and R.H. Dol. (1995). Outlines of Biochemistry. 5<sup>th</sup> Edition John Wiley and Sons.
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12. Stanier. R.Y. J.N. Ingraham, M.L. Wheelis & P.R. Painter (1995) – General Microbiology, 5<sup>th</sup> Ed. Mac Millan Press Ltd.
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14. Subbarao N.S. (1979), Recent advances in biological nitrogen fixation: Oxford & IBH Publishing Co. Private Ltd. New Delhi.

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**BHARATI VIDYAPEETH  
(DEEMED TO BE UNIVERSITY), PUNE, INDIA**

**M.Sc. Microbiology (CBCS- 2018 COURSE)**

**SEMESTER –II**

**PGMB-205: PHYSIOLOGY AND METABOLISM**

**Total Credits: 04**

**Total Lectures: 60**

**Course Outcomes:**

**At the end of this course the students will be able to:**

1. Understand structure and functions of proteins and vitamins
2. Know details of photosynthesis process.
3. Understand details of lipid metabolism and metabolism of nitrogenous compounds.

**Course contents:**

**UNIT I STRUCTURE AND FUNCTIONS OF PROTEIN**

**15**

**1. Protein Structure**

- Factors determining protein structure
- Tertiary structure of globular proteins and functional diversity
- Dynamics of globular protein structure
- Methods of protein detection Dicroism (CD) Nuclear Magnetic Resonance (NMR), X-ray crystallography.

**2. Protein Function and evolution**

- Actin– Myosin, structure of muscle, mechanism of mocontraction, role of calcium
- Microtubule system
- Oxygen Transport-Haemoglobin
- Changes in haemoglobin structure on oxygen binding
- Haemoglobin variants
- Evolution of Haemoglobin and Myoglobin

**3. The diversity of enzymatic function**

- Protein enzymes
- Non prorein enzyme
- The regulation of enzyme activity- substrate level, feed back control,
- Allosteric enzymes -

**UNIT II VITAMINS–OCCURRENCE, STRUCTURE AND BIOCHEMICAL FUNCTION 08**

1. Water soluble vitamins.
2. Fat soluble vitamins.

**UNIT III PHOTOSYNTHESIS 08**

1. Energy considerations of photosynthesis.
2. Light energy and photolysis of water.
3. Photo chemical centers.
4. Uphill flow of electrons.
5. Electron carriers in photosynthesis.
6. Cyclic photophosphorylation – Light reaction.
7. Non cyclic photophosphorylation.
8. Regulatory aspects of photosynthesis.
9. Dark reactions – The Calvin cycle
10. Photosynthesis –
  - C<sub>3</sub>, C<sub>4</sub>, & CAM plants.
  - Photorespiration.

**UNIT IV LIPIDS METABOLISM AND PHYSIOLOGICAL FUNCTION 16**

**1. Steroid metabolism**

- Structure of steroids
- Biosynthesis of cholesterol
- Bile acids
- Other isoprenoid compounds

**2. Eicosanoid metabolism**

- Structure
- Biosynthesis and catabolism
- Biological action

**3. Phospholipid metabolism**

- Structure
- Biosynthesis of phospholipids in bacteria
- Glycerophospholipid metabolism in eukaryotes.

**4. Hormones in regulation of metabolism.**

- Classification of hormones –
  - a. Based on the chemical nature.
  - b. Based on mechanism of action.
- Mechanism of hormone action –
  - a. Synthesis.
  - b. Signal transduction.
  - c. Steroid and thyroid hormones.
  - d. Endocrine glands & their secretion.

**UNIT V METABOLISM OF NITROGENOUS COMPOUND (AMINO ACIDS, NEUROTRANSMITTERS) 06**

1. Nitrogen metabolism – Glutamate dehydrogenase, Glutamate synthase & glutamine synthetase.
  - Biosynthesis and regulation of amino acids.
  - Catabolism of amino acids.
2. Amino acids related to citric acid cycle.
3. Amino acids and their metabolites as Neurotransmitters and biological regulators.

## UNIT VI      Tools in Biochemistry

07

### References :

1. Agarwal G.R., Agarwal O. P. Agarwal K. Text book of Biochemistry, Goel publishing house Meerut, 8<sup>th</sup> Edition 1995.
  2. Conn, E.E. P.K. Stumpf, G. Bruening and R.H. Dol. (1995). Outlines of Biochemistry. 5<sup>th</sup> Edition John Wiley and Sons.
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  4. Foster. R.L. (1980) The Nature of Enzymology Croon Helm Ltd. London.
  5. Kachel. P. W. & G. B. Ralstion (2003) Schaum's outlines. Biochemistry – II Edition. Tata McGraw Hill Edition.
  6. Lehninger. A. L; Nelson, M. M. Cox (1992) Principles of Biochemistry 2<sup>nd</sup> Edition, CBS Publishers and Distributors.
  7. Mathews C.K., K.E. van Holde, Kevin G. Ahern, Biochemistry Third Edition (2003), Published by Pearson Education (Singapore) Ltd. Delhi.
  8. Palmer. T. (1995) – Understanding enzymes. 4<sup>th</sup> Edition. Ellis Horwood Ltd. Publishers P. John Wiley & Sons. New York. Chichester, Brisbane Toronto.
  9. Satyanarayana U. Biochemistry (2001) Books and Allied Pvt. Ltd., Calcutta.
  10. Sheeler P, D. E. Bianchi (1987) Cell and Molecular Biology. Third, Edition, John Willey and sons.
  11. Simpson R. J. (2004) Purifying Proteins for proteomics – A laboratory manual – Cold Spring Harbor laboratory press.
  12. Stanier. R.Y. J.N. Ingraham, M.L. Wheelis & P.R. Painter (1995) – General Microbiology, 5<sup>th</sup> Ed. Mac Millan Press Ltd.
  13. Stryer L – (1995) Biochemistry, 4<sup>th</sup> Edition W.H. Freeman & Company New York.
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**BHARATI VIDYAPEETH  
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M.Sc. Microbiology (CBCS-2018 COURSE)**

**SEMESTER II**

**PGMB 211:- PRACTICAL COURSE-3**

**Total Credits: 02**

**Total Lectures: 120**

**Course Outcomes:**

**At the end of this course the students will be able to:**

1. Understand different methods for analysis of data.
2. Develop skills for enzyme purification and fermentation.

**Course contents:**

<b>1. Biostatistics:</b>	<b>12 P</b>
• Mean, mode, median.-3	
• Variance & correlation.-3	
• T – Test, F-Test. $r^2$ test.-3	
• Use of computers in Biostatistical analysis.-3	
2. Fermentor design	<b>1 P</b>
3. Production of citric acid by surface and submerged culture.	<b>2 P</b>
4. Production of ethanol by shake flask culture and in fermentor	<b>2 P</b>
<b>5. Enzymes – Enzyme purification.</b>	<b>1 P</b>
• Ammonium sulfate precipitation.	
• Organic solvent precipitation.	
• Gel filtration.	
6. Determination of $K_m$ and $V_{max}$ values of Invertase and amylase.	<b>2 P</b>
7. Spectrophotometric analysis of nucleic acid and protein	<b>2 P</b>
	<b>-----</b>
	<b>22 P</b>

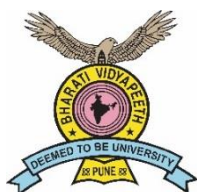
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### References:

1. Bailey N.T.J. (1995) Statistical Methods in Biology 3<sup>rd</sup> Edition. Cambridge lowprice Edition Cambridge university press.
2. Dixit J.V. (1996) Principles & Practice of Biostatistics 1<sup>st</sup> Edn. M/s. Banarasidas Bhanot (Publisher).
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4. Goldsby R.A. Kindt. T.S. and B.A. Osborne (2000) Kuby Immunology Fourth Edition W.H. Freeman & Co New York.
5. Khan And Khanum, (2008), Fundamentals of Biostatistics, 3rd Revised Edition, Ukaaz Publication, Hyderabad.
6. Reed R, Holmes; D; Weyers. J & A Jones (1998) Practical skills in Biomolecular sciences. Adison Wesley Longman Ltd.
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- 8 T. Bhaskararao (2002) Methods of Biostatistics.Paras Publishing.
- 9 Wardlaw A.C. (1985) Practical Statistics for experimental Biologists JohnWiley & Sonhs. Ltd

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**M.Sc. Microbiology (CBCS- 2018 COURSE)  
SEMESTER II**

**PGMB 212:- PRACTICAL COURSE-4**

**Total Credits: 02**

**Total Lectures: 120**

**Course Outcomes:**

**At the end of this course the students will be able to:**

1. Perform statistical analysis of genetic data.
2. Develop skills to conduct different genetic experiments.

**Course contents:**

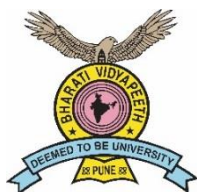
- |   |     |
|---|-----|
| 1. Calculation of Mendelian Ratios  | 2 P |
| 2. Statistical analysis of Genetic data.  | 2 P |
| 3. Problems on Hardy – Weinberg principle   | 2 P |
| 4. Determination of vitamin C/A/B2 in natural sources   | 2 P |
| 5. Measurement of activity NAD dependant enzymes  | 2 P |
| 6. Isolation of nucleic acid and characterization by gel Electrophoresis  | 2 P |
| 7. Recombination in bacteria – Preparation of competent cells and transformation of plasmid DNA in <i>E. coli</i> . | 2 P |
| 8. Conjugation in bacteria.   | 2 P |
| 9. Plasmid curing using different agents  | 2 P |
| 10. Protoplast fusion   | 1 P |
| 11. Determination of mutation rate – natural and induced  |     |
| 12. Gene Cloning – Demonstration  | 3 P |

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**22 P**

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1. Frank H. Stephenson (2003) Calculations for Molecular Biology and Biotechnology. A guide to Mathematics in the laboratory Academic Press an imprint of Elsevier.
2. Gardner E.J., Simmons, M.J and D.P. Snustad. (1991) Principles of Genetics. 8<sup>th</sup> Edition. John Willey & Sons. Inc.
3. Hartl. D.L. and E.W. Jones. (1999) Essential Genetics. Second Edition. Jones and Bartlett Publisher.
4. Irwin H. Segel (1976) Biochemical Calculations 2<sup>nd</sup> Edition John Wiley & Sons.
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6. Pierce.B.A, (2005) Genetics A Conceptual Approach.2<sup>nd</sup> Edition.W.H.Freeman and Company,New York
7. Pranab Kr. Banerjee (2006) Problems on Genetics, Molecular Genetics and Evolutionary Genetics. New Central Book Agency (P) Ltd. Kolkata.
8. Primrose. S.B. and R.M. Twyman and R.W. Old (2003). Principles of Gene Manipulation. 6<sup>th</sup> Edn. Blackwell Science.
9. Reed, R; Homes, D; Weyers, J. and A. Jones. Practical skills in Biomelecular Sciences. Addison Wesley Longman Limited
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11. Sambrook. J and D.W. Russel. (2001) Molecular cloning. A Laboratory Manual. 3<sup>rd</sup> Edn. Vol. 1,2,3. Cold Spring Harbor laboratory Press..
12. Snyder. L. and W. Champress. (1997) Molecular Genetics of Bacteria.
  - a. ASM Press. Washington. D.C.
13. Watson J.D. Baker T.A., Bell S.P. Gann A, Levine M. and R. Losick. 2004) Molecular Biology of the Gene.5<sup>th</sup> Edn.Low Price edition. Pearson

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**BHARATI VIDYAPEETH  
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**M.Sc. Microbiology (CBCS- 2018 ABILITY ENHANCEMENT COURSE)**

**SEMESTER II**

**PGAEC 201: SCIENTIFIC WRITING**

**Total Credits: 02**

**Total Lectures: 30**

**Course Outcomes:**

**At the end of this course the students will be able to:**

1. Understand concept of scientific writing.
2. Know presentation skills.

**Course contents:**

**UNIT I. SCIENTIFIC WRITING**

- 1. General aspects: 4**  
Organising time, Organizing information and ideas eg. writing - adopting a scientific style, Developing technique, Getting Started Revising your text with the help of words and phrases, sentences, paragraphs, using dictionaries, using a thesaurus, using guides for written English.
- 2. Review writing: 4**  
Organizing time, making a plan Construct possible content and examples, construct an outline, Start writing, Reviewing your write-up.
- 3. Reporting practical and project work: 6**  
Practical & project reports Thesis Structure of reports of experiment works - Title, Authors & their institution, Abstract Summary, List of Contents. Abbreviations, Introduction, Materials and Methods Results Discussion / conclusions, Acknowledgements, Literature cited (Bibliography) Production of a practical report choose the experiment, make up plants, write, Revise, prepare final version. Submit Producing a Scientific paper Assessing potential content, choosing a journal, writing, submitting. Responding to referees comments checking proofs & waiting for publication.
- 4. Writing literature surveys: 5**



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Selecting a topic Scanning the literature and organizing references, Deciding on Structure and content Introduction, Main body of the text, conclusion, References, Style of literature surveys.

- 5. Organizing a poster display:** **5**  
Preliminaries, Design, Layout, Title Text, Sub titles and headings, Colour Content. Introduction, Materials and Methods, Results and conclusion. The poster session.
- 6. Giving an oral presentation.** **4**  
• Preparation - Preliminary information, Audio - Visual aids, Audience. Content - Introductory remarks, the main message. Concluding remarks on presentation.
- 7. Writing research paper:** **2**  
• Title, Authors and address, Abstract, Key words, Introduction, Materials and Methods, Results & Discussion / conclusions, Acknowledgements, Literature cited (Bibliography)

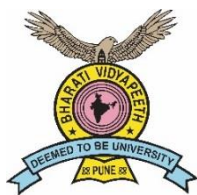
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8. Bergeron. B. (2003). Bioinformatics and Computing. Prentice Hall Inc. Eastern Economy Edition.
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11. Day Robert A. : How to write and publish a scientific paper.
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17. Irwin H. Segel (1976) Biochemical Calculations 2<sup>nd</sup> Edition John Wiley & Sons.
18. Khan And Khanum, (2008), Fundamentals of Biostatistics, 3rd Revised Edition, Ukaaz Publication, Hyderabad.
19. Khan Intiaz Alam : Elementary Bioinformatics, Pharma Book Syndicate.
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21. Prescott. S.C. and C.G. Dunn (2002) Industrial Microbiology. Publ. Agrobios. India Jodhpur
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26. T. Bhaskararao (2002) Methods of Biostatistics. Paras Publishing.
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29. Wayne Goddard and Stuart Melville: Research methodology – An Introduction.
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**BHARATI VIDYAPEETH  
(DEEMED TO BE UNIVERSITY), PUNE, INDIA  
M.Sc. Microbiology  
SEMESTER –IV  
PGMB 401 : VIROLOGY (CBCS- 2018 COURSE)**

**Total Credits: 4**

**Total Lectures: 60**

**Course Outcomes:**

**At the end of this course the students will be able to:**

1. Learn different techniques in cultivation of viruses.
2. Understand details about bacterial viruses, animal and plant viruses.
3. Know concept of viroids, satellites and prions.

**Course contents:**

**UNIT I. INTRODUCTORY VIROLOGY 10**

1. Morphological types of viral capsids: Icosahedral, Helical and Complex
2. Types of viral nucleic acids with representative examples
3. Viral replication cycles:
  - Lytic cycle,
  - Lysogeny

**UNIT II TECHNIQUES IN CULTIVATING VIRUSES 12**

1. 'Embryonated Egg Technique'
2. Tissue culture techniques with merits and demerits:
  - Primary cell cultures
  - Diploid cell cultures
  - Continuous cell cultures
3. The science and art of making viral vaccines:
  - Inactivated or "killed" virus vaccines
  - Attenuated Virus Vaccines
  - Subunit Virus Vaccines
  - Recombinant DNA approaches to Subunit vaccines
  - Virus Like Particles
  - DNA Vaccines
  - Attenuated Viral Vectors and Foreign Gene Expression

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4. Vaccine technology for Delivery and Improving Antigenicity
  - Adjuvants
  - Delivery and formulation
  - Immunotherapy

**UNIT III. BACTERIOPHAGES 10**

1. Morphology, genome organization and life cycle of :
  - T-even, T-odd, coliphages,  $\lambda$  phage Mu-1.
2. Phage Bacterium interaction / phage Biology
3. Genome mapping- T<sub>4</sub>R II locus, Benzer's Spot Test, Complementation test
4. Viruses that kill superbug (ESKAPE Therapy)

**UNIT IV. ANIMAL VIRUSES 08**

1. Reproduction of animal viruses:
  - i) Adsorption of virions
  - ii) Penetration and uncoating
  - iii) Replication and transcriptions in DNA viruses
  - iv) Replication and transcriptions in RNA viruses
  - v) Synthesis and assembly of virus capsids
  - vi) Virion Release
2. Cytocidal infections and cell damage.
3. Intrinsic Response to animal viral infections:
  - Programmed Cell Death (Apoptosis)

**UNIT V PLANT VIRUSES 08**

- 1) Effect of viruses on plants
- 2) Plant virus reproduction: Tobacco Mosaic Virus (TMV)
- 3) Transmission of Plant Infecting Viruses- with vectors and without vectors

**UNIT VI. UNUSUAL INFECTIOUS AGENTS 12**

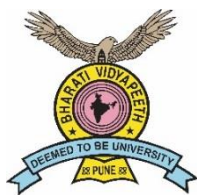
- 1) **Viroids**
  - i) Replication
  - ii) Sequence diversity
  - iii) Movement
  - iv) Pathogenesis
- 2) **Satellites**
  - i) Replication
  - ii) Pathogenesis
- 3) **Prions and transmissible spongiform encephalopathies**
  - i) Scrapie
  - ii) Creutzfeldt-Jakob disease (CJD)
  - iii) Prions and the *prnp* gene

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## References

1. Black J.G. (2002) Microbiology Principles and Explorations – ‘Viruses’ 255 – 283. 5<sup>th</sup> Edn. John Wiley & Sons Inc.
2. Darnell J.E. and Baltimore, Allan Campbell, General Virology
3. Dimmock N.J., A.J. Easton and K.N. Leppes, “Introduction to Modern Virology” Fifth edition, Blackwell Science (Topic B)
4. Flint S.J., L.W. Enquist, R.M. Krug, V.R. Racaniello, A.M. Skalka (2000) Principles of Virology, Molecular Biology Pathogenesis and Control ASM Press.
5. Lewin B. (2000) Genes VII. Oncogenes & Cancer 875-913. Oxford University Press.
6. Matthew K. Waldor, David I. Friedman and Sankar L. Adhya (2005) Phages : Their role in Bacterial Pathogenesis and Biotechnology, ASM Press, Washington DC
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**(DEEMED TO BE UNIVERSITY), PUNE, INDIA**  
**M.Sc. Microbiology (CBCS-2018 COURSE)**  
**SEMESTER –IV**  
**PGMB 402–MEDICAL MICROBIOLOGY**

**Total Credits: 4**

**Total Lectures: 60**

**Course Outcomes:**

**At the end of this course the students will be able to:**

1. Know in details the mechanism of entry of certain pathogens in host cells.
2. Understand different symptoms and medical terms commonly used during diagnosis and treatment of patients.
3. Understand details of bacterial, viral, fungal and protozoal diseases as mentioned in the syllabus.
4. Know the ways of controlling infections in hospitals.

**Course contents:**

<b>UNIT I.</b>	<b>MICROBIAL ADHESION AND INVASION</b>	<b>15</b>
	1. Role of sulfatide receptors in the pathogenesis of <i>Mycoplasma</i>	
	2. Significance of Ganglio and Lacto series glycolipids in pulmonary infections.	
	3. Molecular interactions between ‘Human Rhinoviruses and ‘ICSM-1’	
	4. Role of Heparin sulfate Glycosaminoglycans in the spread of Herpes simplex virus.	
	5. Interactions of Poliovirus with immunoglobulin like cell receptor.	
	6. Mycoloic Acid based invasion,( <i>Mycobacteria</i> )	
	7. Quorum Sensing	
<b>UNIT II.</b>	<b>INFECTIOUS DISEASE SYNDROMES</b>	<b>11</b>
	1. Bacteremia	
	2. Sepsis	
	3. Pathophysiology of septic shock	
	4. Vascular damage and peripheral vasodilation	
	5. Infective endocarditis	
	6. Pyrexia	
	7. Centrally distributed maculopapular eruptions	
	8. Peripheral eruptions	
	9. Vesicular eruptions	
	10. Purpuric eruptions	

**UNIT III. DETAILED STUDY OF FOLLOWING DISEASES 30**

1. Tuberculosis
2. Gonorrhoea
3. Syphilis
4. Bacillary Dysentery
5. Cholera
6. Herpes
7. Hepatitis A and B
8. Influenza
9. Dengue
10. Chikungunya
11. Systemic candidiasis
12. Invasive aspergillosis
13. Malaria
14. Amoebiasis
15. Nosocomial infections: *Staphylococcus* and *Pseudomonas*

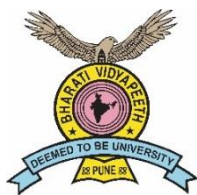
**UNIT IV. CONTROL OF INFECTIONS IN HOSPITALS 04**

1. Nursing Precautions
2. Isolation Policies
3. Hospital acquired infections
4. Prevention of surgical wound infections and burn infections.

**Literature Cited**

1. Ananthanarayan R., C.K.Jayram Paniker, “ Textbook of Microbiology” 8<sup>th</sup> Edition , Orient Longman Pvt.Ltd. (Topic C)
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4. Flint S.J., L.W.Enquist, R.M.Krug, V.R.Racaniello, A.M. Skalka (2000) Principals of Virology, Molecular Biology Pathologeneis and Control ASM Press.
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‘Principles of Virology’ 2000, American Society for Microbiology Press (Topic C)

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**BHARATI VIDYAPEETH  
(DEEMED TO BE UNIVERSITY), PUNE, INDIA**

**M.Sc. Microbiology (CBCS- 2018 COURSE)**

**SEMESTER –IV**

**PGMB 403: FOOD AND DAIRY MICROBIOLOGY**

**Total Credits: 4**

**Total Lectures: 60**

**Course Outcomes:**

**At the end of this course the students will be able to:**

1. Know the details of foodborne pathogens, fermented food products and role of microorganisms in dairy industry.
2. Understand concept and use of probiotics.

**Course contents:**

<b>UNIT I</b>	<b>FOOD MICROBIOLOGY</b>	<b>12</b>
	<b>1. Food borne pathogens.</b>	
	▪ Bacterial pathogens: <i>Salmonella</i> , <i>Shigella</i> , <i>E. coli.</i> , <i>Staph. aureus</i> , <i>Clostridium botulinum</i>	
	▪ Toxigenic molds: <i>Aspergillus</i> spp.	
	• Detection and identification of Aflatoxins,	
	• Viruses: Hepatitis, mechanism of pathogenesis, characteristics of disease, stability in foods, outbreaks.	
	▪ Parasites (different examples) , <i>Entamoeba histolytica</i>	
	<b>2. Fermented food products</b>	<b>08</b>
	• Fermented vegetables.	
	• Fermented meat, poultry and fish.	
	• Traditional Fermented foods.	
	• Wine.	
<b>UNIT II</b>	<b>DAIRY MICROBIOLOGY</b>	<b>06</b>
	<b>1. Milk and milk processing.</b>	
	• Milk composition and components.	
	• Milk processing. Different processes to manufacture products from milk.	



- Changes in milk components during processing.

**2. The Microbiology of Raw milk. 08**

- Initial microflora of raw milk.
- Milk and public health, safeguarding milk supply.
- Biosecurity, Udder disease and bacterial content of Raw milk.
- Environmental sources.
- Microflora of milking equipment and its effect on raw milk.
- Influence of storage and transport on the microflora of raw milk.

**3. Microbiology of market milks. 08**

- Market milk industry in India.
- Indian Standards
- Composition, Factors affecting composition, Food and Nutritive value.
- Current heat treatments.
- The microflora and Enzymatic Activity of heat-treated market milks – Influence on Quality and shelf life.
- Manufacture, Packaging and storage of pasturised milk.
- Pathogenic microorganisms associated with heat-treated market milks.
- Influence of added Ingredients.
- Potential Application of Alternative to heat for market milks.
- Flavor Defects in milk- causes and prevention.

**4. Fermented milk products 06**

- Special milks- Sterilised milk, Homogenised milk, Flavored milk, and frozen concentrated milk.
- Cream.
- Butter.
- Indian dairy products-Whole Milk, Dahi, Paneer

**UNIT III PROBIOTICS 12**

1. Probiotic microorganisms associated with therapeutic properties.
2. Criteria associated with probiotic microorganisms.
3. Safety of issues associated with use of Probiotic cultures for Humans.
4. Beneficial health effects of Probiotic cultures.
5. Effective daily intake of Probiotics.
6. Probiotic dairy products.
7. Factors affecting Probiotic survival in food Systems.

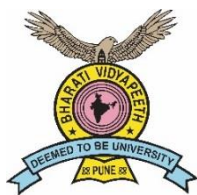
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**BHARATI VIDYAPEETH  
(DEEMED TO BE UNIVERSITY), PUNE, INDIA**

**M.Sc. Microbiology (CBCS- 2018 COURSE)**

**SEMESTER –IV**

**MB- 404: ADVANCED BIOTECHNOLOGY**

**Total Credits: 4**

**Total Lectures: 60**

**Course Outcomes:**

**At the end of this course the students will be able to:**

1. Understand different aspects of plant, animal and marine biotechnology.
2. Know different regulatory authorities and conduction of clinical trials.
3. Understand the concept and significance of patents.

**Course contents:**

**UNIT I PLANT BIOITECHNOLOGY TECHNIQUES AND APPLICATIONS 20**

1. Plant tissue culture laboratory design
2. Plant tissue culture and applications.
  - Micropropagation.
  - From callus to plant.
  - Somatic embryogenesis & synseeds
  - Somaclonal variation.
  - Valuable germplasm.
  - Chemicals from plants and techniques for study of - Hairy root, Elicitation, Biotransformation,
  - Bioreactor in PTC/ Fermentor in PTC.
3. Methods for gene transfer / Formation of transgenic plants
4. Applications of plant genetic engineering.
  - Crop improvement.
  - Herbicide resistance.
  - Insect resistance.
  - Virus resistance.
  - Plants as Bioreactors.
  - The first genetically engineered food plants.
  - Frost resistant plants
  - Fruit Vaccine.

<b>UNIT II</b>	<b>ANIMAL BIOTECHNOLOGY TECHNIQUES AND APPLICATIONS</b>	<b>20</b>
1.	Types of cell cultures – i. Primary , secondary ii. Continuous, established cell lines iii. Monolayer ,suspension cell cultures	
2.	Cell culture media: i. Nutrient requirements, ii. Media constituents, types of media, growth conditions, etc.	
3.	Culture techniques: i. Culturing, subculturing, establishment, ii. Maintenance and preservation of cell lines iii. Quantification- Cell counting, Plating efficiency, Growth curve. iv. Cytotoxicity v. Organotypic culture. vi. Molecular Techniques in cell culture <ul style="list-style-type: none"><li>• Gene transfer methods in animals:</li><li>• Microinjection.</li><li>• Microprojectile Gene Gun</li><li>• Embryonic stem cell Gene Transfer.</li><li>• Retrovirus and Gene transfer.</li><li>• Cell hybridization</li><li>• Monoclonal antibody production</li></ul>	
5.	Applications of ATC <ul style="list-style-type: none"><li>• Transgenic animals.</li><li>• Animal propagation.</li></ul>	
<b>UNIT III</b>	<b>MARINE BIOTECHNOLOGY</b>	<b>10</b>
1.	Aquaculture.	
2.	Algal products.	
3.	Algal cell culture.	
4.	Fuels from algae.	
5.	Medical applications.	
6.	Probing the marine environment.	
7.	Conservation.	
8.	Terrestrial agriculture.	
9.	Transgenic fish.	
<b>UNIT IV</b>	<b>CLINICAL DEVELOPMENT OF BIOLOGICAL PRODUCTS</b>	<b>05</b>
1.	Regulatory authorities for introduction of medicines in market- Role of food and drug administration, FDA guidelines for drugs/biologicals, Validation (GMP, GLP, GCP, etc.).	
2.	Clinical studies: Phase I, Phase II, Phase III, and Phase IV of clinical trials- Objectives, Conduct of trials, Outcome of trials.	
3.	Delivery systems- formulations, targeted drug delivery, sustained release drugs	

**UNIT V REGULATIONS, PATENT AND SOCIETY.**

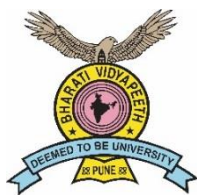
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1. The deliberate release of Genetically engineered organisms.EPA Guidelines
2. Risk assessment.
3. Patents and Biotechnology.
4. IPR & Ethical issues
5. Sustainable Biotechnology.
6. Biosafety Guidelines

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**BHARATI VIDYAPEETH  
(DEEMED TO BE UNIVERSITY), PUNE, INDIA  
M.Sc. Microbiology (CBCS- 2018 COURSE)**

**SEMESTER –IV**

**MB 405:– ADVANCED ANALYTICAL TECHNIQUES**

**Total Credits: 4**

**Total Lectures: 60**

**Course Outcomes:**

**At the end of this course the students will be able to:**

1. Understand advanced analytical techniques.
2. Know modern microscopic techniques.
3. Understand quality control techniques to be used in dairy industry.

**Course contents:**

<b>UNIT I.</b>	<b>ADVANCED SPECTROSCOPY &amp; SPECTROMETRY</b>	<b>06</b>
	1. Infrared Spectroscopy 2. Nuclear Magnetic Spectroscopy 3. Calculations	
<b>UNIT II.</b>	<b>ADVANCED ELECTROPHORETIC TECHNIQUES</b>	<b>06</b>
	1. Agarose Gel Electrophoresis 2. Matrix SDS-PAGE electrophoresis. 3. Disc Electrophoresis. 4. Capillary Electrophoresis 5. Calculations	
<b>UNIT III.</b>	<b>ADVANCED CHROMATOGRAPHY TECHNIQUES</b>	<b>06</b>
	1. Optimizing chromatographic separations 2. Gas Chromatography 3. High Performance Chromatography, HPTLC. 4. Interfacing GC or HPLC with mass spectrometry 5. Quantitative analysis.	
<b>UNIT IV</b>	<b>ELECTRON MICROSCOPY AND CELL SORTING TECHNIQUES</b>	<b>08</b>
	1. Principles, working & applications. Special techniques related to electron microscopy–fixation & staining, Negative staining	



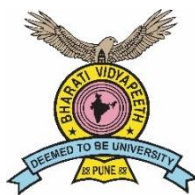
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\* Students are supposed to refer to “Current Contents” and periodicals for recent & additional information.



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**BHARATI VIDYAPEETH  
(DEEMED TO BE UNIVERSITY), PUNE, INDIA**

**M.Sc. Microbiology (CBCS-2018 COURSE)**

**SEMESTER : IV**

**PGSEC 401: Exploring Microbial Diversity**

**Total Credits: 2**

**Total Lectures:30**

**Course Outcomes:**

**At the end of this course the students will be able to:**

1. Understand different aspects of microbial diversity and taxonomy.
2. Know methods for identification of unculturable microorganisms.
3. Understand different methods of gene sequencing.

**Course contents:**

<b>UNIT I. Microbial diversity</b>	<b>4</b>
<ol style="list-style-type: none"><li>1. Definition of species in prokaryotes.</li><li>2. Types of 'species' Species Divergence</li><li>3. Measures and indices of diversity.</li></ol>	
<b>UNIT II Taxonomy</b>	<b>8</b>
<ol style="list-style-type: none"><li>1. Introduction to Bacterial Taxonomy</li><li>2. Bergey's Manuals and the classification of prokaryote<ul style="list-style-type: none"><li>• Determinative Bacteriology : Phenetic Approach</li><li>• Systematic Bacteriology : Phylogenetic Approach</li><li>• Polyphasic Approach</li></ul></li></ol>	
<b>UNIT III Gene sequencing</b>	<b>12</b>
<ol style="list-style-type: none"><li>1. Outline of gene sequencing procedures<ul style="list-style-type: none"><li>• Maxam Gilbert's method, Sangers method</li><li>• Automated Sequencer</li><li>• BLAST analysis</li><li>• RFLP</li><li>• RAPD</li><li>• Strategies for whole genome sequencing</li><li>• Whole Genome Shotgun Sequencing</li><li>• Applications of gene sequencing (identification of organisms)</li></ul></li></ol>	

**Unit IV : Unculturable microorganisms**

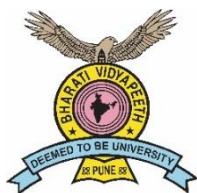
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- Culture independent molecular methods for identifying unculturable bacteria.

**References**

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2. Breed and Buchanan. Bergey's Manual of Determinative Bacteriology. 9th Edition, 1982.
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M.Sc. Microbiology (CBCS- 2018 COURSE)**

**SEMESTER –IV**

**PGMB 411:- Practical Course 5.**

**Total Credits: 2**

**Total Lectures: 120**

**Course Outcomes:**

**At the end of this course the students will be able to:**

1. Develop the skills for isolation and cultivation of viruses.
2. Develop the skills for performing clinical microbiology experiments.

**Course contents:**

**I. Virology:**

- Isolation of phages and Study of phage titre 4 P
- Study of plant viruses. 2 P
- Study of animal cell culture 2 P
- Egg inoculation technique for animal viruses. 3 P
- Preparation of animal viral vaccines ( Visit) 1 P

**II. Clinical Microbiology:**

- Isolation of pathogens from wound and burn infections. 4 P
- Study of antibiotic resistance pattern of these isolates. 2 P

**III Biochemistry:**

- Estimation of chlorides, sodium,/ potassium,/calcium /ions in blood 4 P

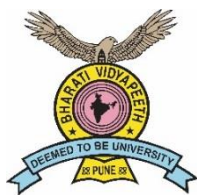
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2. Ananthanarayan R., C.K.Jayram Paniker, “ Textbook of Microbiology” 8<sup>th</sup> Edition , Orient Longman Pvt.Ltd. (Topic C)
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6. Jayraman – Laboratory manual in Biochemistry, New Age International Publishers, New Delhi
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M.Sc. Microbiology (CBCS- 2018 COURSE)**

**SEMESTER –IV**

**PGMB 412: – Practical Course-6**

**Total Credits: 2**

**Total Lectures: 120**

**Course Outcomes:**

**At the end of this course the students will be able to:**

1. Develop the skills for performing experiments in food and dairy industries.
2. Understand the concept of plant cell culture and mushroom cultivation.

**Course contents:**

1. Isolation and identification of food borne pathogens from food.- *Salmonella*,  
*Shigella*, *E.coli*., *Staph.aureus*. 4 P
2. Isolation of Aflatoxin producing organism and detection of Aflatoxin. 2 P
3. Microbial analysis of raw and pasteurized milk. 2 P
4. Production of gluconic acid by shake flask culture 3 P
5. Production of Antibiotics like polymyxin /Bacitracin etc. 2 P
6. Preparation of traditional fermented foods 1 P  
e.g. Curd, Idli, Dhokla etc .
7. Study of commercial probiotic products 5 P
8. Study of plant cell culture 1 P
9. Mushroom cultivation. 2 P

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22 P

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1. Varly H.C. (Fourth Edition) Practical Clinical Biochemistry, CBS Publishers & Distributors Pvt. Ltd, New Delhi, Bangalore, Pune, Cochin, Chennai (Indai), First Indian Edition 1988, reprint : 2002, 2003, 2004, 2005.
2. Ananthanarayan R., C.K.Jayram Paniker, “ Textbook of Microbiology” 8<sup>th</sup> Edition , Orient Longman Pvt.Ltd. (Topic C)
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## **45. Teaching learning processes:**

The teaching learning processes incorporate a variety of modes and a regular use of ICT. These are listed below:

1. **Classroom Teaching** for topics which are intensely information-based. This a very regular feature of all the courses in Microbiology
2. **Power Point slides** for topics which involve information related to intricate biological pathways such as metabolic pathways in bacteria and other microorganisms. Use of Power Point presentations are also made whenever the lectures are to be summarized in a crisp and pointwise manner to highlight salient / important conclusions from the topics.
3. **Classroom Discussions** are a regular feature while teaching. The students are drawn into impromptu discussions by the teacher during the process of teaching.
4. **Video Displaying**, both real-time and animations, are used for topics which require 3D dimensional viewing of the biological mechanisms to drive the point home. These have proved to be very helpful while teaching concepts of molecular biology like DNA replication, transcription and translation. These are also used to convey complexities of antigen-antibody interactions and generation of antibody diversity during the teaching of Immunology.
5. **Model Making** is also used especially for understanding and building a perception of the students for the structures of viruses which cannot be seen by a light microscope and can be seen only under expensive equipment like electron microscopes.
6. **Laboratory Practicals** are an integral part of every course included in UG programme in Microbiology. The is also a daily affair for UG students of Microbiology.
7. **Problem Solving** is encouraged during the laboratory work.
8. **Group Activity** as well as discussions with the laboratory supervisor/ among the students themselves/ Mentor is also encouraged during laboratory work.
9. **Project work** is included in the programme where students work individually or in groups to design experiments to solve/answer a problem suggested by the Mentor or identified by the students in consultation with the Mentor. The students are mentored regularly during the duration the project is in progress.
10. **Presentations by the Students** are regularly done. The students are mentored in presentation of data, interpretation of data and articulation with the students/teachers/Research Scholars during their presentation.
11. **Presentation by Experts** in different specialties of Microbiology are arranged to broaden the horizons of the students.

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**12. Interaction with Experts** is also encouraged during/after presentations to satisfy/ignite curiosities of the students related to developments in the different areas of Microbiology.

**13. Visit to Industries/Laboratories** related to Microbiology like fermentation, food, diagnostics etc. are organized to acquaint the students with real-life working environments of the professional microbiologists with a view to broaden their perspective of the subject of Microbiology

#### **46. Assessment Tasks:**

It is important that the students of UG Microbiology program achieve the desired results in terms of the learning outcomes to be professionally sound and competitive in a global society. Achieving the desired learning outcomes is also imperative in terms of job employment leading to a happy and prosperous individual further leading to a happy and prosperous family and thereby a happy and prosperous society or nation. The assessments tasks are pivotal to get an authentic feedback for the teaching learning process and for mid-course corrections and further improvements in future. The assessment tasks are carried out at various stages of the duration of the UG Microbiology programme like Mid-term assessments, End-term assessments, Semester examinations, Regular assessments, viva-voce etc. The assessment tasks are listed below:

**1. Multiple Choice Questions (MCQ)** are one of the predominant form of assessment tasks. This task may be used during all kinds of term and semester examinations.

**2. Short-Answer Questions/ Long –Answer Questions** during term and semester examinations are used to assess the ability of the student to convey his thoughts in a coherent way where prioritization of the information in terms of their significance is tested.

**3. Surprise Quizzes** are regularly used during continuous assessment while the teaching learning process is continuing which prepares the student to quickly recall information or quickly analyze a problem and come up with proper solutions.

**4. Visual/Pictorial Quizzes** are used to sharpen the comprehension of the students after looking at all the components of a system.

**5. Impromptu Opinions** on microbiological problems are sought from student during regular teaching learning which help them to think quickly in a given context. This help build their ability to come up with solutions to problems which the students might not have confronted previously.

**6. Problem Solving question** are generally given during the laboratory work.



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**7. Data Interpretation** is also another assessment task which is used to develop analytical skills of the students. This assessment is used during laboratory work as well as during conduction of project work.

**8. Analytical Skills** are assessed during work related to several experiments like enzyme kinetics, growth of bacteria and bacteriophages, mutation frequencies.

**9. Paper/ Project presentations** are used to assess the articulation skills of the student. These are carried out both during the duration of the teaching learning processes as well as during end-Semester examinations.

**10. Report Writing** is used to assess the keenness of the students for details related to microbiology while visiting laboratories / industries as students invariably are required to submit a report after such visits.

**11. Assignment Writing** are used to assess the writing abilities of the students.

**12. Viva-voce** during the laboratory working hours and during laboratory examination are used to assess the over-all knowledge and intelligence of the students.

#### **47. Key Words:**

Microbiology, Biochemistry, Immunology, Genetics, Microbial Ecology, Scientific writing, Internship, Virology, Medical Microbiology, Food and Dairy Microbiology, Advanced analytical techniques.



**BHARATI VIDYAPEETH  
(DEEMED TO BE UNIVERSITY), PUNE**

**Faculty of Science  
M.Sc. - Microbiology  
Old Syllabus**

“Social Transformation Through Dinamic Education”



**BHARATI VIDYAPEETH (DEEMED TO BE UNIVERSITY)**  
**YASHWANTRAO MOHITE COLLEGE OF ARTS, SCIENCE AND COMMERCE,**  
**PUNE 411038**

Accredited with 'A+' Grade (2017) by NAAC  
'A' Grade University Status by MHRD, Govt. of India  
Accredited (2004) & Reaccredited (2011) with 'A' Grade by NAAC



**MASTER OF SCIENCE (M.Sc. MICROBIOLOGY) PROGRAMME**

**CBCS 2012 COURSE STRUCTURE**

**Under the Faculty of Science**

**TO BE IMPLEMENTED FROM ACADEMIC YEAR 2012-13**

**BHARATI VIDYAPEETH  
DEEMED UNIVERSITY (PUNE) INDIA.**

**Syllabi for two year - Master of Science Degree Course (M.Sc. - Microbiology) Choice Based Credit and Grading System.**

**Aims and objective**

The aims and objectives of the M.Sc. course program essentially focus to develop all the skills of students for a successful career.

- The course structure emphasizes to put enough efforts in theory as well as laboratory work so as to gain thorough knowledge of the subject to produce the masters.
- It is compulsory & essential for the students to read research papers, publications and deliver seminars that would better help them to know the recent advances in the subject and also develop the communication skills.
- The course includes project work that would develop and nourish the scientific approach and research attitude of the students.
- Genetic engineering, Biotechnology, Bioinformatics, Drug design, Bioweapons are the new horizons of the interdisciplinary subject microbiology which might provide solutions to possibly all the problems of the society. The course work is essentially framed to acquaint the students with all the recent advances in this field.

The program is designed in such a way that it is essential for the students to read original publications, put enough efforts in laboratory work for practicals and project, be acquainted with all the recent advances in the field like Bioinformatics, drug designing and develop all the skills for a successful career.

The M.Sc. degree course will be of two years duration.

The M.Sc. degree of two years duration has been designed and is to be implemented from the academic year 2012-2013.

**Rules & Regulation for M.Sc. course :**

**Eligibility for Admission to M.Sc. (Microbiology) course :**

A candidate who has passed the

1. Bachelor of Science from any recognized university with Microbiology as Principle subject (Major) or Microbiology (Honors).
2. Bachelor of Science from any recognized university with Botany/Zoology/Biochemistry/Biotechnology/Environmental science as major subjects with Microbiology as subsidiary subject.
3. Bachelor of Science from any recognized university with Microbiology as one of the subjects.
4. The candidate who has secured aggregate of 50% marks (45 % marks in case of SC/ST) in the graduate course as well as in the Microbiology Subject shall be eligible for admission to the First Year M.Sc. degree course.

Total Intake capacity: 30  
Medium of Instruction ; English

### **Structure of M.Sc. (Microbiology) degree programme**

The overall structure of the course to be implemented from the academic year 2012-2013 onwards is as follows.

1. The M.Sc. (Microbiology) course will be of 2 years duration. Each year will be of 2 semesters - Thus the entire course will be of 4 semesters.
2. First two semesters and Fourth semester will comprise of four theory and two practical courses each
3. Third semester will be totally for Internship (major project).
4. This entire M.Sc. course in Microbiology shall be covered in 12 theory papers and 6 practical courses, and an Internship (major project). Each theory paper will be covered in 4 lectures of one hour per week. Each practical course shall be covered in two practical turns of four clock hours per week. Thus the students will work for each practical on two days of the week, daily for at minimum four hrs. There will be four lectures per day on four days of the week and on the remaining two days students will be given four hrs each for their library work in the college or other libraries in different institutes.
5. Students should undertake a Internship (major project ) so as to learn research methodology and presentation of work. The Internship (major project). shall carry 200 marks. The students will work for their projects in third semester – complete the experimental work during the third semester and will complete the writing part of the project during the winter break. At the beginning of fourth semester there will be a presentation of the project. Minimum number of students participating in a project will be two and maximum number of students would be four. The assessment of the project will be at beginning of the fourth semester

The M .Sc (Microbiology) is of 100 credits. The distribution of credits over the semesters is given below

L –Lecture. T –Tutorial. pw - per week. pt - per term.

\*\*\*\*Continuous Internal Assessment

Course Type	Credit	SEM-I		SEM-II		SEM-III		SEM-IV		Total Credits	EoTE Univ./ Institute.
		L(pw)	T(pt)	L(pw)	T(pt)	L(pw)	T(pt)	L(pw)	T(pt)		
Compulsory Theory	4	4 60Hrs	3	4 60Hrs	3	----	----	4 60Hrs	3	12C 180H	University
Compulsory Theory-	4	4 60Hrs	3	4 60Hrs	3	-----	----	4 60Hrs	3	12C 180H	University
Compulsory Theory-	4	4 60Hrs	3	4 60Hrs	3	-----	-----	4 60Hrs	3	12C 180H	University
Elective Theory	4	4 60Hrs	3	4 60Hrs	3	-----	-----	4 60Hrs	3	12C 180H	University /Internal
Lab course	5	8 120Hrs	***	8 120Hrs	***	----	----	8 120Hrs	***	15C 360H	University
Lab course	5	8 120Hrs	***	8 120Hrs	***	-----	-----	8 120Hrs	***	12C 360 Hrs	University
Internship (major project).		-		-		22 C 600hrs		-		22C 600 Hrs	University
Total Credits Per Semester		26		26		22		26		100	
Total Hours Per Semester		480		480		600		480		2040Hrs	

Extra Credits:Regular students can also audit for extra credits if the departmental committee agrees. A student must at the commencement of the semester communicate which extra credits s/he is going to audit. A student can enrol for extra credits over and above the total 100 credits prescribed for the course with following options:

- a. Attend and appear for the exam of the opted extra credits. However in such case grades of the extra credit will NOT be counted for arriving at GPA.
- b. Only attend the classes for the opted extra credit. The extra credit course can be selected from within the institute or any other Faculties of Bharati Vidyapeeth Deemed University offering courses for Faculty of Sciences., which will be declared at the commencement of session.  
  
Such audited credits will be mentioned separately in the Grade sheet.

**Structure of M.Sc. (Microbiology) degree programme**  
**Details with course number and title of the paper**

Year	Course	Paper Title	Core/General Compulsory /Optional	Credits	Total Hours	Weightage (Marks)
M.Sc. Part I Sem. I	PG MB 101	Biochemistry	Core Compulsory	4	60	100
	PG MB 102	Immunology	Core Compulsory	4	60	100
	PG MB 103	Analytical Techniques	Core Compulsory	4	60	100
	PGMB 104	Elective Theory	Core Optional	4	60	100
	PG MB 105	Elective Theory	Core Optional	4	60	100
	PG GEN 1	Soft Skills 1	Optional	2	30	Internal assement
	PG GEN 2	Basics of Information Technology	Optional	2	30	Internal assement
	PG MB 111	Practical Course – I	Core Compulsory	5	120	100
	PG MB 112	Practical Course – II	Core Compulsory	5	120	100
M.Sc. Part I Sem II	PG MB-201	Fermentor Design and Microbial Biotechnology	Core Compulsory	4	60	100
	PG MB 202	Genetics & Molecular Biology	Core Compulsory	4	60	100
	PG MB 203	Quantitative Biology	Core Compulsory	4	60	100
	PG MB 204	Microbial Metabolism	Core Optional	4	60	100
	PG MB-205	Physiology and Metabolism	Core Optional	4	60	100



	PG GEN 3	Cyber Security	Optional	2	30	Internal Assesement
	PG GEN 4	Scientific Writing	Optional	2	30	Internal Assesement
	PG MB 211	Practical Course IV	Core Compulsory	5	120	100
	PG MB 212	Practical Course IV	Core Compulsory	5	120	100
M.Sc. Part II Sem. III	Internship (major project).	PG MB 311 Practical Course V & PG MB 312 Practical Course VI	Core Compulsory	22	600	200
	PG GEN 3	Research Methodology	Optional	2	30	Internal assesement
	PG GEN 4	MIS	Optional	2	30	Internal assesement
M.Sc. Part II Sem.IV	PG MB401 –	Virology	Core Compulsory	4	60	100
	PG MB 402	Medical Microbiology	Core Compulsory	4	60	100
	PG MB 403	Applied Microbiology	Core Compulsory	4	60	100
	PG MB 404	Advanced Biotechnology	Core Optional	4	60	100
	PG MB 405	Advanced Analytical Techniques	Core Optional	4	60	100
	PG GEN 5	Soft Skills 2	Optional	2	30	Internal assesement
	PG GEN 6	Bioinformatics	Optional	2	30	Internal assesement
	PG MB 411	Practical Course VIII	Core Compulsory	5	120	100
	PG MB 412	Practical Course VIII	Core Compulsory	5	120	100

## Rules for the examination: -

1. A candidate shall not be admitted to the semester examination unless he / she have satisfactorily kept terms for the courses at the respective department of this university.
2. An application (which must be in the prescribed form and accompanied by the prescribed fee) for admission to any of the examination of M.Sc. (Microbiology Degree course shall be submitted by a candidate to the Registrar through the Head of the Institution attended by him / her on or before the prescribed date along with a certificate from the Head of the Institution having attended the course and kept the terms in the various subjects and of having satisfied the other conditions laid down by the university and of being fit candidate for the examination.

### 3. **Continuous Internal Assessment :**

Three Tutorials will be conducted through out the semester for each theory course and marks out of 40 per course will be submitted to the university as Internal marks.( IA. Internal marks for the practical course will be based on the continuous assessment of the daily work, orals, seminars/presentations; Tour/visit reports, class tests, literature review and attendance(Any two of the following). Students will be assessed for 40 marks for each practical course.

### 4. **Annual Examination :**

- i) **Theory:** An University examination will be held at the end of every semester. This Examination in each subject will be of 60 marks for two hours duration

The final result of the students in each subject will be based on Final GPA obtained by the students for the internal assessment and University Examination..

- ii) **Practical** ; There shall be Annual practical examination of 60 marks for at the end of 2<sup>nd</sup> and 4<sup>th</sup> Semester .

The practical examination for the courses MB 111, MB 112, MB 211, and MB 212 will be conducted at the end of second semester. Practical examination for courses MB 411 and MB412 will be conducted at the end of fourth semester. Practical courses MB 311 MB 312 are allotted for project work. The assessment for the said courses will be as follows.

- iii) **Project Work:** Students have to undertake a major project so as to learn research methodology and presentation of work. The project shall carry 200 marks which will be allotted as follows:

140 marks - actual project work - Assessment by the external examiner and project guide for 70 marks each.

20 marks presentation of the project - Assessment by the external examiner.

20 marks - Assessment by the guide - day to day project work.

20 marks will be allotted to the two seminars (10 marks per seminar) presented in third semester on the project work.

The assessment for the said courses will be conducted at the end of the third semester.

The student will be assessed on the basis of following criteria for 140 marks.

- (i) Choice of the topic selected for the project.
  - (ii) Aims and objectives of the project.
  - (iii) Updated literature survey.
  - (iv) Novel and other applications of the project (can a patent be filed on further work). Materials and methodology used.
  - (v) Out come and Achievements of the project.
  - (vi) Conclusion.
  - (vii) Presentation of the project. (methodology of presentation)
- Award of the Grade will be based on the following criteria.

**5. Rules regarding ATKT to second year M.Sc. Microbiology course.**

A student will be allowed to keep terms at the second year of the M.Sc. course if her / his terms for the first year have been granted.

**6. Standard of passing :**

- a. The candidate who has obtained at least D grade shall be declared to have passed in the said course.
- b. The candidate who has not secured C grade in a particular paper in the University Examination will have to secure at least C grade in the subsequent examination in the particular paper.:
  - A) The 10-point scale would be used to convert marks out of 100 to grades and grade points according to the following table:-

Marks as Percentage	Grade	Grade Point
[75.0, 100]	O	10.0
[70.0, 74.9]	A+	9.0
[65.0,67.9]	A	8.0
[60.0,64.9 ]	B+	7.0
[ 55.0,59.9]	B	6.0
[ 50.0,54.9]	C+	5.5
[ 45.0,49.9]	C	5.0
[40.0,44.9]	D	4.5
[00.0, 39.9]	F	0.0

**(B) For courses which have both University Examination (UE) and Internal Assessment (IA):**

In order to pass in a course, the student must obtain a minimum of 'D' grade at the UE and a GPI of 4.0 in aggregate of UE and IA . There is no separate passing in IA. The GPI is calculated only if the student passes at UE by combining percentage marks at UE and IA with weights 0.6 and 0.4 respectively. A student who fails has to clear the course by appearing at UE only as a back-log candidate.

**(C) For courses which have no University Examination:**

There are some courses, the General courses, for which there is no UE. The respective institutes conduct 'continuous assessment' and EoTE( End of term examination).For such courses the computation of GPI, passing criteria, and back-log clearing rules are as in (B) above.

- (D) At the end of each semester, a cumulative grade point average (CGPA) will be calculated as a weighted average of the GPI of all courses in which the student has passed till that semester.
- (E) A student who passes in all the courses will be declared to have passed the entire M.Sc (Microbiology) with the following honours.

**CGPI in [4.00, 4.99] -- Pass Class**

**CGPI in [5.00, 5.49] -- Second Class**

**CGPI in [5.50, 5.99] -- Higher Second Class**

**CGPI in [6.00, 6.99] -- First Class**

**CGPI in [7.00, 10.00] -- Distinction.**

#### **(F) PROMOTION RULES:**

A student will be allowed to keep all terms for the duration of the programme.

#### **(G)Continuous Assessment (CA)**

40% marks of the course towards CA will be based on tests (Minimum 2) .In addition, a teacher may consider one or more of the following evaluation systems:-

- i) Seminar /presentation by the student
- ii) Assignment by the student

Each theory paper is of 60 marks and internal paper is for 40 marks.

Each practical examination for lab course is of 60 marks and four hour duration for three consecutive days.. The project courses in Semester III will be evaluated for 200 marks for the allotted credits by a panel consisting of one internal and one external examiner .

### **7 STRUCTURE OF TRANSCRIPT**

At the end of each semester, student will be given a transcript showing the performance and result in each course. The transcript shows, for each course the title of the course, credit values, grade in UE, grade in IA, Grade point index, result as pass or fail. Also, the Semester grade point average and cumulative grade point average will be shown. Further, the equivalent percentage of marks corresponding to SGPA and CGPA will be shown. The formula to convert SGPA or CGPA to equivalent percentage is given by:

| 10 x CGPA if CGAI/SGPI is in [4.00, 6.00]

Equivalent percentage marks = | 05 x CGPA + 30 if CGPA/SGPI is in [6.00, 9.00]

| 25x CGPA – 150 if CGA/SGPI is in [9.00,10.00]

The above formula computes to the following table:-

Range in % of marks	Range in grade points	Letter grade	Grade Point
[75.0, 100]	[9.00, 10.00]	O	10.0
[70.0, 74.9]	[8.00,8.99 ]	A+	9.0
[65.0,67.9]	[7.00,7.99]	A	8.0
[60.0,64.9 ]	[6.00,6.99]	B+	7.0
[ 55.0,59.9]	[5.50,5.99]	B	6.0
[ 50.0,54.9]	[5.00,5.49]	C+	5.5
[ 45.0,49.9]	[4.50,4.99]	C	5.0
[40.0,44.9]	[4.00,4.49]	D	4.5
[00.0, 39.9]	[0.00,3.99]	F	0.0

BHARATI VIDYAPEETH DEEMED UNIVERSITY, PUNE

M.Sc. Microbiology Part-I

**COURSE INFORMATION**  
SEMESTER I

Course Number	Course Title	Credit Value	#Lec.	#Tut.	#Lab.	Weightage for EoTE/IA	EoTE
PG MB 101	Biochemistry	4	4	3	-	0.6/0.4	Univ.
PG MB 102	Immunology	4	4	3	-	0.6/0.4	Univ.
PG MB 103	Genetics & Molecular	4	4	3	-	0.6/0.4	Univ.

	Biology						
PG MB 104 Or PG MB 105	<b>ELECTIVE:-</b>	4	4	3	-	0.6/0.4	Univ.
PG MB 111	Practical Course - I	4	-	-	4	0.6/0.4	Univ.
PG MB 112	Practical Course - II	4			4	0.6/0.4	Univ.
		26	18		08		

**SEMISTER I :ELECTIVES:-**

PG MB 104: Microbial Ecology

PG MB 105: Environmental Microbiology

BHARATI VIDYAPEETH DEEMED UNIVERSITY, PUNE

M.Sc. Microbiology Part-I  
Semester : I

**PG MB 101: Biochemistry      Credits 4      60 Lectures**

**UNIT\_I Introductory Biochemistry      02**

The scope of Biochemistry

1. What is Biochemistry?
  - a. Goals of Biochemistry.
  - b. The roots of Biochemistry.
  - c. Biochemistry as a discipline and an interdisciplinary science.
2. Biochemistry as a chemical science.
  - a. Chemical elements of living matter.

- b. Biological molecules.
- 3. Biochemistry as a biological science.
  - a. Distinguishing characteristics of living matter.
  - b. The unit of biological organization: the cell.
- 4. New tools in Biological revolution.
- 5. The uses of Biochemistry.

**UNIT\_II. Basic concepts in Biochemistry.**

**02**

1. Common organic compounds found in living system.
2. Common functional groups in biochemistry.
3. Common ring structures in biochemistry.
4. Isomerism.
5. Isotopes.
6. Energetics.
7. Redox systems.
8. High energy compounds.

**UNIT\_III. Water.**

- 02**
1. Structure and properties.
  2. Water as a solvent.
  3. Ionization.
  4. Ionic equilibrium.

**UNIT IV Functional Groups found in biomolecules**

**02**

(OH, CHO, C = O, NH<sub>2</sub>, C – NH<sub>2</sub>, SH, ester, ethers, methyl, ethyl, phospho, guanidino, imidazole etc).

**UNIT\_V. Structural features and chemistry of macromolecules.**

1. **Nucleic acids:** **08**
  - (i) Tautomeric forms of bases and their implication in pairing of bases.
  - (ii) Structure of polynucleotides, DNA structure, DNA and RNA (t, RNA, r RNA, m RNA etc).
  - (iii) Structure of DNA double helix.
  - (iv) R and L handed forms.
  - (v) A, B, C and Z forms of DNA.
  - (vi) Denaturation and Renaturation of DNA and T<sub>m</sub> value.
2. **Proteins:** **12**
  - (i) Amino acids.
  - (ii) Peptides – Peptide linkage, partial double bond nature of peptide linkage.
  - (iii) Proteins – structural classification of Proteins, primary structure, secondary structure, tertiary structure, Quaternary structure.

- (iv) Determination of primary structure of polypeptide (N terminal determination, C terminal determination, Partial hydrolysis, Overlapping sequence etc.)  $\alpha$  helix of polypeptide.
- (v) Structure and functions of globular proteins.
- (vi) Immunological techniques to investigate proteins.
- (vii) Artificial synthesis of proteins.

**3**  
**12**

### **Membrane transport**

- (i) Overview of membrane transport.
- (ii) ATP powered pumps and intracellular ionic environment.
- (iii) Non gated Ion channels and the resting membrane potential.
- (iv) Co-transport – symport, Antiport.
- (v) Neurotransmitters.
- (vi) ATP driven active transport system for Sodium and Potassium ions.
- (vii) A model for the mechanism of Sodium and Potassium ions.
- (viii) Proton gradient in *Halobacteria*.
- (ix) Transport of antibiotics increase the ionic permeability of membranes – *valinomycin*.

### **4. Carbohydrates: 10**

- (i) L forms and D forms of sugar.
- (ii) Reducing and non reducing sugars.
- (iii) Aldoses / ketoses.
- (iv) Alpha and Beta, ring forms of sugars.
- (v) Glycosidic linkages.
- (vi) Sugar derivatives – sugar alcohol, amino sugars, dextro sugars, sugar acids etc.

### **5. Lipids: 10**

- (i) Fatty acids – Types and nomenclature.
- (ii) Saturated and unsaturated fatty acids.
- (iii) Triglycerides, Phospholipids, Sphingolipids.
- (iv) Structure and function of steroids, terpenes, prostaglandins.

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## BHARATI VIDYAPEETH DEEMED UNIVERSITY, PUNE

### M.Sc. Microbiology Part-I

#### Semester : I

#### PG MB 102: Immunology      Credits 04    60 Lectures

<b><u>UNIT I.</u></b>	<b>Immunoglobulins</b>	<b>12</b>
	1) Fine Structure	
	2) Classes & biological activities	
	3) Organization & expression of immunoglobulin genes	
	a. Genetic model compatible with Ig structure	
	b. Multigene organization of Ig Genes.	
	c. Variable region gene rearrangements	
	d. Mechanism of Variable region DNA rearrangements	
	e. Generation of Antibody diversity	
	f. Expression of Ig Genes	
	g. Regulation of Ig - Gene transcription.	
	h. Antibody genes and antibody engineering	
<b><u>UNIT II)</u></b>	<b>Major Histocompatibility complex</b>	<b>10</b>
	1. General Organization and Inheritance of the MHC	

2. MHC molecules and Genes
3. Detailed Genomic Map of MHC genes
4. Cellular Distribution of MHC molecules
5. Regulation of MHC Expression.
6. MHC and Immune Responsiveness
7. MHC and Disease susceptibility

**UNIT III) Immune Effector Mechanisms 14**

1. Cytokines – properties, receptors, antagonists, Cytokine secretion, related diseases, Therapeutic uses.
2. Complement system - Functions, Components, activation, Regulation, Biological consequences, Deficiencies.
3. Leukocyte Migration & Inflammation- Lymphocyte re-circulation, Cell Adhesion molecules, Neutrophils Extravasation, Lymphocyte Extravasation, Mediators of Inflammation, The inflammatory process, Anti inflammatory agents.
4. Hypersensitive Reactions - Type 1, Type II, Type III and Type IV hypersensitivity reactions.

**UNIT IV) Immunodeficiencies, Autoimmunity & AIDS 12**

1. Primary Immunodeficiencies
  - i) X- linked Agammaglobulinaemia
  - ii) Common Variable Immuno Deficiency (CVID)
  - iii) Di George Syndrome
  - iv) Wiskott Aldrich Syndrome
2. Acquired or Secondary Immunodeficiencies.
  - i) Down's syndrome
  - ii) AIDS
  - iii) Hodgkins disease
3. Organ Specific autoimmune diseases
  - i) Graves Disease
  - ii) Myasthenia gravis
  - iii) Insulin Dependent Diabetes
4. Systemic Autoimmune diseases.
  - i) Goodpasture's Syndrome
  - ii) Rheumatoid Arthritis
  - iii) Systemic Lupus Erythematosus
5. Animal models for Autoimmune Disease
6. Proposed Mechanism for Induction of Autoimmunity.
7. Treatment of Autoimmune Diseases.

**UNIT V) Transplantation Immunology 06**

1. Immunologic Basics of Graft Rejection.
2. Clinical manifestation of Graft rejection
3. General Immunosuppressive Therapy

4. Specific Immunosuppressive Therapy
5. Clinical Transplantation

**UNIT VI) Cancer & the Immune System**

**06**

1. Cancer origin & Terminology
2. Malignant transformation of cells
3. Oncogenes & cancer induction.
4. Tumors of the Immune system
5. Tumor antigens.
6. Immune response to tumors.
7. Tumor Evasion of the Immune system
8. Cancer Immunotherapy.

**Literature Cited**

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2. David Male, Jonathan Brostoff, David B Roth, Ivan Roitt.(2006).Immunology 7<sup>th</sup> edition.
3. Goldsby R.A. Kindt T.S. and B.A. Osborne Kuby (2000) Immunology Fourth Edition W.H. Freeman & Co New York.
4. Reed R; Holmes D; Weyers J and A Jones (1998) Practical skills in Biomolecular Sciences Adison Wesley Longman Ltd.
5. Tizard; I.R. (1995) Immunology an Introduction 4<sup>th</sup> Edn. Saunders College Publishing. Harcourt Brace College Publishers.

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BHARATI VIDYAPEETH DEEMED UNIVERSITY, PUNE

M.Sc. Microbiology Part-I

**Semester –I**

**PG MB 103– GENETICS AND MOLECULAR BIOLOGY Credits 04  
Lectures 60**

**UNIT\_(I) STRUCTURE OF EUKARYOTIC CHROMOSOME.**

**18**

- (1) Genome complexity.
- (2) Chemical composition.
- (3) Packaging the giant DNA molecules into chromosome
- (4) Euchromatin and heterochromatin.
- (5) Repetitive DNA and sequence organization.
- (6) Replication of Eukaryotic chromosome.
- (7) Comparison with structure and replication of prokaryotic chromosome.
- (8) Effect of different antibiotics on chromosome structure and replication.
  - i. Antibiotics that affect replication and DNA structure.
  - ii. Antibiotics that block precursor synthesis.
  - iii. Antibiotics that block polymerization of Nucleotides.
  - iv. Antibiotics that affect DNA structure.
  - v. Antibiotics that affect Gyrase.

**UNIT\_(II) GENE EXPRESSION.**

**14**

- (1) Evolution of the one gene one polypeptide concept.
- (2) Genetic control of metabolism.
  - i. Transcription.
    - a. The transcription process. RNA synthesis, Classes of RNA and the Genes that code for them.
    - b. Transcription of protein coding genes. Prokaryotes, Eukaryotes, mRNA molecules.
    - c. Transcription of other genes. Ribosomal RNA and Ribosomes. Transfer RNA.
  - ii. Protein structure.
    - a. Chemical structure of proteins.
    - b. Molecular structure of proteins.
  - i. Nature of the Genetic code.
    - a. Genetic code is a triplet code.
    - b. Deciphering the genetic code.
    - c. Nature and characteristic of the genetic code.
  - ii. Translation of the genetic message.

- a. Aminoacyl tRNA molecules.
- b. Initiation of translation.
- c. Elongation of the polypeptide chain.
- d. Termination of Translation.
- iii. Protein sorting in the cell.
  - a. Proteins distributed by the endoplasmic reticulum.
  - b. Proteins transported into mitochondria and chloroplast.
  - c. Proteins Transported into the nucleus.

**UNIT\_(III) REGULATION OF GENE EXPRESSION. 08**

- (1) Positive regulation.
  - i. *E. coli* maltose operons.
  - ii. The *tol* operons.
- (2) Feedback inhibition.
  - i. Isoleucine – Valine operon.
  - ii. Histidine operon.
  - iii. Leucine operon.
  - iv. Phenylalanine operon.
  - v. Threonine operon.

**UNIT\_(IV) GENETIC ENGINEERING . 20**

- (1) Basic techniques.
  - i. Agarose gel electrophoresis.
  - ii. Nucleic acid blotting.
  - iii. Transformation of *E. coli*.
  - iv. The polymerase chain reaction (PCR)
- (2) Cutting and joining DNA molecules.
  - i. Cutting DNA molecules.
  - ii. Joining DNA molecules.
- (3) Vectors used for cloning
  - i. Plasmids.
  - ii. Phages.
  - iii. Vectors for cloning large fragments of DNA.
  - iv. Specialist purpose vectors.
- (4) Cloning strategies.
  - i. Cloning genomic DNA.
  - ii. cDNA cloning.
  - iii. Screening strategies.
  - iv. Difference cloning.
- (5) Applications of recombinant DNA technology.
  - i. Nucleic acid sequences as diagnostic tool.
  - ii. New drugs and new therapies for genetic diseases.
  - iii. Combating infectious diseases.
  - iv. Protein Engineering.
  - v. Metabolic Engineering.
  - vi. Transgenic technology.
    - a. Transgenic plants.
    - b. Transgenic animals.

## Literature cited

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12. Sambrook. J and D.W. Russel. (2001) Molecular cloning. A Laboratory Manual. 3<sup>rd</sup> Edn. Vol. 1,2,3. Cold Spring Harbor laboratory Press.
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15. Watson J.D. Baker T.A., Bell S.P. Gann A, Levine M. and R. Losick. (2004) Molecular Biology of the Gene. 5<sup>th</sup> Edn. Low Price edition. Pearson Education.
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M.Sc. Microbiology Part-I

**Semester –I**

**PG MB-104 Microbial Ecology Credits 04 60 lectures**

<b>UNIT (I)</b>	<b>Intoduction to basic concepts of Ecology</b>	<b>02</b>
<b>UNIT (II)</b>	<b>Microbial Ecology</b>	<b>15</b>
	I. Historical Developments	
	II. Microbial evolution and Biodiversity	
	III. Types of Biodiversity	
	IV. Biodiversity concept -	
	i. Alpha and Beta biodiversity.	
	ii. Steps to preserve biodiversity.	
	V. Genetic basis for evolution and Ribosomal RNA analysis for tracing microbial evolution	
	VI. Biodiversity conservation and Species conservation	
	VII. Microbial communities and ecosystem	
	i. Development of microbial communities	
	ii. Succession within microbial communities	
	iii. Diversity and stability of microbial communities	
	iv. Risk of introducing genetically modified microorganisms	
	VII Quantitative ecology	
	i. Sample collection	
	ii. Sample processing	
	iii. Detection of microbial populations	
	iv. Determination of microbial numbers	
	v. Measurement of microbial metabolisms	
<b>UNIT (III)</b>	<b>Microbial life in extreme environment.</b>	<b>12</b>
	1) Abiotic limitations to microbial growth	
	2) Effects of environmental determinants	
	i. Extreme pH.	
	ii. Temperature.	
	iii. Pressure.	
	iv. Salt and solute.	
	v. Heavy metals.	
	vi. Radiations.	
	vii. Water activity	
	viii. Movement	
	ix. Magnetic poles	
	x. Redox potential	
	xi. Organic and inorganic compounds.	
	xii. Examples of extreme environments	
	a) Hot springs.	
	b) Acid springs and Lakes.	

- c) Sea and salt lakes.
- d) Antarctica and ocean bottom.

**UNIT (IV) Microorganisms in Mineral and energy recovery 10**

- I. Microbial assimilation of metals
- II. Bioleaching of metals-Gold, Uranium, Copper.
- III. Metal and metallic transformation- Mercury, Arsenic, Lead.
- IV. Recovery of petroleum
- V. Production of fuels – ethanol, methane, hydrogen

**UNIT (V) Biodeterioration - 03**

- 1) Concept of biodeterioration.
- 2) Biodeterioration of –
  - I. Wood.
  - II. Stone work.
  - III. Pharmaceutical products.
  - IV. Metal Corrosion.
  - V. Rubber.
  - VI. Plastic.
  - VII. concrete
  - VIII. Paper & Textile.
  - IX. Paints.
  - X. Computer diskette and cassette films.
  - XI. Lubricants and Adhesives cosmetics.
- 3) Control of biodeterioration.

**UNIT (VII) Biofilms 02**

- i. Population within biofilms
- ii. Fouling Biofilms
- iii. Control of Biofilms

**UNIT (VII) PLANT PATHOLOGY 08**

- 1. Pathogenesis, Entry through various routes.
- 2. Enzymes and toxins in plant diseases – different enzymes and toxins and their role in disease.
- 3. How plants defend themselves against infection, different modes of defense.
- 4. Effect of environmental factors and nutrition on disease development.
- 5. Management of plant diseases.-
  - I. Microbial amensalism and parasitism to control microbial pathogens-antifungal amensalism and antibacterial amensalism
  - II. Bacterial biopesticides



- III. Fungal biopesticides
- IV. Viral biopesticides

## UNIT (VI) Case Studies

08

### Literature Cited

1. Arora. M.G. and M. Singh (1994) Industrial Chemistry Vol. I & II. Anmol Publications Pvt. Ltd.
2. Asthana D.K. and M. Asthana (2003) Environment Problems & Solutions. S. Chand and Co. Ltd. New Delhi.
3. Barnum. S.R. (1998) Biotechnology: An introduction. Wadsworth Publishing company. An International Thomson Publishing company.
4. Bathra Atlas (2007) Microbial Ecology Fundamentals and Application 4th edition, Pearson Education Publication
5. De. A.K. (1994) Environmental Chemistry, New Age International (P) Limited, Publishers.
6. Gray. N.F. (2000) Water Technology. An Introduction for Environmental Scientists and Engineers. Viva Books Pvt. Ltd. New Delhi.
7. Jadhav H.V. (1992) Elements of Environmental Chemistry. Himalaya Publishing House.
8. Kormondy E J. (2007) Concepts in Ecology, 4<sup>th</sup> edition, Pearson Education Publication
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10. Mukherjee N. and T. Ghosh (1995) Agricultural Microbiology. First Edition. Kalyani Publishers, New Delhi, Ludhiana, Hyderabad, Madras, Calcutta Cuttack.
11. Rao. C.S. (1991) Environmental pollution control Engineering Wiley Eastern Limited New Delhi. Bangalore, Bombay, Calcutta, Guwahati, Hyderabad, Lucknow Madra & Pune.
12. Rittman B.E. and P.L. Mc Garty. (2001) Environmental Biotechnology. Principles & Applications. McGraw Hill International Editions. Biological Sciences Series.
13. Santra. S.C. (2001) Environmental Science, New Central Book Agency (P) Ltd.
14. Sharma B.K. and H. Kaur (1994). Water pollution Goel Publishing House Meerut.
15. Subbarao N.S., Soil Microbiology Fourth Edition of Soil Micro-organisms and plant growth. Published by Raju Primlani for oxford and JBH Publishing. Co. Pvt. New Delhi.
16. Tripathi A.K. (1993) Understanding Environmental Disruption. Volume-I & II. Ashish Publishing House, New Delhi.
17. Verma, P.S and V.K. Agarwal (1996) Environmental Biology (Principles of Ecology) S. Chand & Co. New Delhi.

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**BHARATI VIDYAPEETH DEEMED UNIVERSITY, PUNE**

**M.Sc.II – Microbiology**

**SEMESTER-I**

**PG MB 105 : Environmental Microbiology Credits 04 Lectures  
60**

<b>Unit (I)</b>	<b>Aeromicrobiology –</b>	<b>06</b>
	<ol style="list-style-type: none"><li>1. Nature of Bioaerosols</li><li>2. Sampling of bioaerosols</li><li>3. Bioaerosol control</li><li>4. Extramural Aeromicrobiology</li><li>5. Intramural Aeromicrobiology</li><li>6. General Pathological effects of air pollution.</li><li>7. Biosafety in laboratory</li></ol>	
<b>Unit (II)</b>	<b>Waste water Microbiology – (domestic and industrial)</b>	<b>15</b>
	<ol style="list-style-type: none"><li>1) Waste water types.<ol style="list-style-type: none"><li>i. Characteristics.</li><li>ii. Nature of pollutants and their effects</li><li>iii. Microbial pollution and its effects.</li></ol></li><li>2) Treatment.<ol style="list-style-type: none"><li>i. Principles of waste water treatment.</li><li>ii. Disposal of waste water</li><li>iii. Aerobic processes<ol style="list-style-type: none"><li>a. Activated sludge process.</li><li>b. Fixed film systems.</li><li>c. High rate filters.</li><li>d. Tricking filters</li><li>e. Rotating biological contactors.</li><li>f. Fluidized bed reactors.</li><li>g. Oxidation ditch.</li><li>h. Aerated lagoons.</li></ol></li><li>iv. Anaerobic digestion<ol style="list-style-type: none"><li>a. Anaerobic lagoons and covered anaerobic lagoons.</li></ol></li><li>v. Biosorption – N and P removal.</li><li>vi. Biofilms and kinetics<ol style="list-style-type: none"><li>a. Root zone process.</li><li>b. Reverse osmosis.</li><li>c. Waste water disposal by dilution.</li></ol></li><li>vii. Difficulties encountered in operation of different methods of waste treatment.</li><li>viii. Economics of waste treatment and feasibility.</li></ol></li></ol>	
<b>UNIT (III)</b>	<b>Bioremediation-</b>	<b>12</b>

1. Approaches to Bioremediation
2. Bioremediation of Metals
  - i. Metal toxicity effect on microbes
  - ii. Mechanisms of microbial resistance to metals, metal microbe interactions
  - iii. Methods to detect metal – microbe interaction
  - iv. Microbial remediation of metal contaminated soils
  - v. Microbial remediation of metal contaminated aquatic systems
3. Bioremediation of petroleum
4. Bioremediation of waste gases

**Unit (IV) Biodegradation of Xenobiotic and inorganic pollutants 14**

- i. Recalcitrant organic compounds and their presence in natural ecosystem
- ii. Concept and Consequence of biomagnifications.
- iii. Biomagnification of hydrocarbons and pesticides.
- iv. Process of Biodegradation
- v. Relationship between Contaminant Structure, Toxicity, and biodegradability
- vi. Environmental factors affecting biodegradability
- vii. Biodegradation of recalcitrant xenobiotic and toxic compounds
- viii. Recalcitrant Halocarbons
- ix. Recalcitrant Nitro aromatic compounds
- x. Polychlorinated Biphenyl's
- xi. Radionuclide
- xii. Pesticides

**Unit (IV) Environmental laws 05**

- i. Introduction
- ii. Environmental legislation in India
- iii. Legal aspects of waste treatment and disposal.
- iv. Notification relating to hazardous microorganisms and genetically modified organisms.
- v. Rules for management of Bio medical wastes

**Unit (V) Case Studies 08**

**Literature Cited**

1. Arora. M.G. and M. Singh (1994) Industrial Chemistry Vol. I & II. Anmol Publications Pvt. Ltd.

2. Asthana D.K. and M. Asthana (2003) Environment Problems & Solutions. S. Chand and Co. Ltd. New Delhi..
3. Bathra Atlas (2007) Microbial Ecology Fundamentals and Application 4th edition, Pearson Education Publication.
4. Agarwal A K , Q A Shammi, Purohit S S,(2007), Environmental Science – A New Approach, Agrabios Jodhapur.(India)
5. De. A.K. (1994) Environmental Chemistry, New Age International (P) Limited, Publishers.
6. Gray. N.F. (2000) Water Technology. An Introduction for Environmental Scientists and Engineers. Viva Books Pvt. Ltd. New Delhi.
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16. S. C. Santra(2001) Environmental Science, New Central Book Agency, Calcutta.
17. Sharma B.K. and H. Kaur (1994). Water pollution Goel Publishing House Meerut..
18. Tripathi A.K. (1993) Understanding Environmental Disruption. Volume- I & II. Ashish Publishing House, New Delhi.
19. Trivedi R K (1998) Advances in Wastewater Treatment Technologies vol.1, Global Science, Aligarh.
20. Verma, P.S and V.K. Agarwal (1996) Environmental Biology (Principles of Ecology) S. Chand & Co. New Delhi.

BHARATI VIDYAPEETH UNIVERSITY, PUNE

**M.Sc. Microbiology**

**M.Sc. Part-I**

**Sem.I : Practical course-I PG MB 111 Credits 05 120 hrs**

**UNIT (I) Instrumentation & Biochemistry.**

- (1) Study of different instruments in the laboratory.
- (a) Laminar airflow, Microfuge, UV. Spectrophotometer, Incubator shaker, cooling incubator, deepfreeze, colorimeter, pH meter, lyophilizer (visit). 5P
- (b) Laboratory Safety. 1 P
- (2) Preparation of buffers and molar solutions. 2 P
- (3) Estimation of protein by Lowry / Biurette method. 2 P
- (4) Separation & identification of amino acids, carbohydrates by TLC. 2 P
- (5) Estimation of reducing sugars by DNSA. 2 P
- (6) Estimation of lipids / fats 1 P
- (7) Beer Lambert's law. 1 P

**UNIT (II) Immunology –**

- (1) Blood transfusion. 3 P
- (a) Blood grouping.
- (b) Cross matching.
- (c) Visit to blood bank.
- (2) Study of Immunological reaction. 5 P
- (a) Agglutination reactions.
- (b) Haemagglutination inhibition test
- (c) Immunodiffusion
- (d) Demonstration / visit.
- (i) RIA, ELISA,
- (ii) Study of vaccination schedule.

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-  
24 P

**Any 15 practicals to be conducted for completion of the course.**

**Literature Cited**

1. 1Alberts. B.; Johnson. A, Lewis J. Raff, M. Roberts. K. and P. Walter (2002) Molecular Biology of the cell 4<sup>th</sup> Edition. Garland Science, Taylor & Francis Group.
2. Benjamin Cunnings publishing Co. Inc. 2<sup>nd</sup> Edition
3. Boyer. R. (2000) Modern Experimental Biochemistry. 3<sup>rd</sup> Edition. Pearson Education Asia.
4. Cruse J and R. Lewis (2004) Atlas of Immunology 2<sup>nd</sup> Edn. CRC Press
5. Elliott. W.H. and D.C. Elliot (2001) Biochemistry and molecular Biology. 2<sup>nd</sup> Edn. Oxford University Press.
6. Hand book of experimental immunology Vol. I by PM. Weinor (editor) 1978. Black Well scientific publications.
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8. Mathews C.K. and K.E. Van Holde (1996) Biochemistry. The Benjamin Cunnings publishing Co. Inc. 2<sup>nd</sup> Edition
9. Plummer D.T, (1992)An introduction to Practical Biochemistry Tata cGraw Hill Publisher,New Delhi
- 10..Reed, R; Homes, D; Weyers, J. and A. Jones. Practical skills in Biomelecular Sciences. Addison Wesley Longman Limited.

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BHARATI VIDYAPEETH UNIVERSITY, PUNE

**M.Sc. Microbiology**

**M.Sc. Part-I  
Sem.I**

**Sem.I : Practical course-II PG MB 112 Credits 05 120 hrs**

**UNIT (I) Study of Extremophiles.**

**a. Cultivation of Extremophiles.(any two) 10 P**

- I. Thermophiles.
- II. Acidophiles.
- III. Alkalophiles.
- IV. Halophiles.
- V. Psychrophiles.

**b. Systematic study of the extremophile isolates using Bergey's Manual of Systematic Bacteriology. 6 P**

**UNIT (II)**

- i. .Study of Microbial diversity 4p
- ii. Sewage decomposition by aerobic and anaerobic microorganisms. 3 P
- iii. Determination of BOD and COD of a given sample.
- iv. Determination of TS, TSS and MLSS.

23  
P

**Any 15 practicals are to be completed for completion of the course.**

**Literature Cited**



1. Bathra Atlas (2007) Microbial Ecology Fundamentals and Application 4th edition, Pearson Education Publication
2. Kormondy H.J.(2007) Concepts of Ecology .fourth Edn .Pearson, Prentice
3. Maier R M , I L Pepler, C P Gerba (2000) Environmental Microbiology,
- 4 Krieg, M. R. and J. G. Holt (Editors) (1984) Bergey's Manual of Systematic Bacteriology. Vol I Williams and Wilkins, Baltimore, London, Tokyo
- Sharma B.K. and H. Kaur (1994). Water pollution Goel Publishing House Meerut..
- 5 Sneath, P. H. A. Mair: N. S. Sharpe: M. E. and J. G. Holt (Eds) (1986). Bergey's Mannual of Systematic Bacteriology Vol. II Williams and Wilkins, Baltimore, London, Tokyo.
- 6 Staley, J. T. Bryant: M. P. Penning: N and J. G. Holt (Eds) (1989) Bergey's Mannual of Systematic Bacteriology Vol. III Williams and Wilkins, Baltimore, London, Tokyo,
- 7 Skinner,(1987)Bacterial Systematics Academic Press.
- 8 Cappucino & Sherman (2004) Microbiology a laboratory manual 6<sup>th</sup> Edn. Pearson Education, New Delhi.
- 9 Tripathi A.K. (1993) Understanding Environmental Disruption. Volume-I & II. Ashish Publishing House, New Delhi.
- 10 Trivedi R K (1998) Advances in Wastewater Treatment Technologies vol.1, Global Science, Aljgarh
- 11 Williams, S. T. Sharpe: M. E. and J. G. Holt (Eds) (1989) Bergey's Mannual of Systematic Bacteriology. Vol. IV Williams and Wilkins, Baltimore, London, Tokyo.

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**SEMESTER-WISE COURSE INFORMATION**  
**SEMESTER II**

Course Number	Course Title	Credit Value	#Lec.	#Tut.	#Lab.	Weightage for EoTE/IA	EoTE
PG MB-201	Fermentor Design and Microbial Biotechnology	4	4	3	-	0.6/0.4	Univ.
PG MB 202	Analytical Techniques	4	4	3	-	0.6/0.4	Univ.
PG MB 203	Quantitative Biology	4	4	3	-	0.6/0.4	Univ.
PG MB 204 or PG MB 205	<b>ELECTIVE:</b>	4	4	3	-	0.6/0.4	Univ.
PG MB 211	Practical Course III	5	-	-	5	0.6/0.4	Univ.
PG MB 212	Practical Course IV	5			5	0.6/0.4	Univ.
		26	16		10		

**SEMISTER II :ELECTIVES:-**

PG MB-204: Microbial Metabolism

PG MB-205 : Physiology and Metabolism

**Semester –II**

**PG MB 201– Fermentor Design and Microbial Biotechnology**  
**Credits 04 Lectures 60**

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<b>UNIT (I) FERMENTOR DESIGN</b>	<b>15</b>
I. Design of a Fermentor	
II. Basic functions of a fermentor	
III. Aseptic operation and containment	
IV. Body construction	
V. Parts of the fermentor and their functions: Impellor Baffles, Sparger.	
VI. Achievement and maintenance of aseptic conditions: - Sterilization of fermentor and its parts.	
VII. Different methods of sterilization.	
VIII. Valves and steam traps: Role in maintaining aseptic conditions.	
IX. Alterations in the fermentor design for animal cell culture	
X. Plant cell culture .	
<b>UNIT( II) Other designs of a Fermentor</b>	<b>05</b>
I. The Waldhoff-type fermentor.	
II. Acitators and cavitators.	
III. The tower fermentors.	
IV. Cylindro conical vessels.	
V. Airlift fermentors.	
VI. The deep jet fermentor.	
VII. The cyclone column	
VIII. The packed tower.	
IX. Rotating-disc fermentor.	
I.	
<b>UNIT III AERATION AND AGITATION</b>	<b>10</b>
i. The oxygen requirements of industrial fermentations	
ii. Oxygen supply.	
iii. Determination of $K_{La}$ value.	
iv. Fluid Rheology	
v. Factors affecting $K_{La}$ value in fermentation vessels.	
vi. Scale-up and scale-down.	
<b>UNIT (III) MICROBIAL BIOTECHNOLOGY.</b>	<b>30</b>

### **Commercial production of**

- |                  |                      |
|------------------|----------------------|
| i. Amino acids   | vi. Polysaccharides. |
| ii. Antibiotics  | vii. Solvents        |
| iii. Enzymes     | viii. Steroids       |
| iv. Nucleotides  | ix. SCP              |
| v. Organic acids | x. Vitamins          |

### **Literature cited**

1. Casida. L.E. (2003) reprint Industrial Microbiology Publ: New Age International (p) Ltd. New Delhi.
2. Grace E.S. (1997) Biotechnology unzipped. Promises and Realities Joseph. Henry Press Washington D.C.
3. Kumar. H.D. (1993) Molecular Biology and Biotechnology 2<sup>nd</sup> revised edition Vikas Publishing house Pvt. Ltd.
4. Mukhopadhyay. S.N. (2001) Process Biotechnology Fundamentals viva Books Pvt. Ltd.
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6. Peppler. H.J. and D. Perlman (1979) Microbial Technology Vol. I & II Academic Press Inc.
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**BHARATI VIDYAPEETH DEEMED UNIVERSITY, PUNE**

**M.Sc.II – Microbiology**

**Semester-II**

**PG MB 202 Analytical techniques**

**Credits 04 60**

**Lectures**

<b><u>UNIT 1.</u></b>	<b>Radioactive isotopes &amp; their use</b>	<b>12</b>
	(i) Radioactive decay.	
	(ii) Measuring radioactivity.	
	(iii) Autoradiography.	
	(iv) Biological applications.	
	(v) Working practices when using radioactive isotopes.	
	(vi) Safety and procedural aspects.	
<b><u>UNIT 2.</u></b>	<b>Centrifugation.</b>	<b>10</b>
	(i) How to calculate centrifugal acceleration.	
	(ii) Centrifugal separation methods.	
	(iii) Types of centrifuge and their uses.	
	(iv) Rotors.	
	(v) Centrifuge tubes.	
	(vi) Safe practice.	
<b><u>UNIT 3.</u></b>	<b>Chromatography.</b>	<b>12</b>
	(i) Types of chromatographic systems.	
	(ii) Separation methods.	
	(iii) Detectors.	
	(iv) Recording & Interpreting chromatograms.	
<b><u>UNIT 4.</u></b>	<b>Electrophoresis.</b>	<b>12</b>
	(i) Basic apparatus.	
	(ii) Using a supporting medium.	
	(iii) Types of supporting media.	
	(iv) Post electrophoretic procedures.	
<b><u>UNIT 5.</u></b>	<b>Spectrophotometer.</b>	<b>14</b>
	(i) Principles.	
	(ii) UV Spectrophotometer.	
	(iii) Visible spectrophotometer.	
	(iv) Fluorescence spectrophotometer.	
	(v) Atomic spectroscopy.	

### Literature Cited

1. Boyer. R. (2000) Modern Experimental Biochemistry. 3<sup>rd</sup> Edition. Pearson Education Asia.
2. Lehninger. A.L. ( 1984 ) Principles of Biochemistry.
3. Mathews C.K. and K.E. Van Holde (1996) Biochemistry. The Benjamin Cummings publishing Co. Inc. 2<sup>nd</sup> Edition.
4. Pattabiraman T.N. (1993) Principles of Biochemistry Gajanan Publisher.

5. Reed, R; Homes, D; Weyers, J. and A. Jones. Practical skills in Biomelecular Sciences. Addison Wesley Longman Limited.
6. Satyanarayana (1999) Biochemistry. Books & Allied (p) Ltd.
7. Wilson and Walker (2000) 5<sup>th</sup> edition Practical Biochemistry principles and techniques, Cambridge Univ. Press

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BHARATI VIDYAPEETH DEEMED UNIVERSITY, PUNE

**M.Sc. Microbiology Part-I**

**Semester II**

**PG MB 203: Quantitative Biology Credits 04 Lectures 60**

**UNIT I) Biostatistics**

**16**

1. Introduction – (4)  
What is statistics- Definition, population & universe, sample & population? Statistical inference, Parameter & Statistics  
Designing simple experiments, Arithmetic mean and Standard deviation.
2. Handling of Bulky data (5)  
Construction and interpretation of a Histogram, Normal distribution. Estimating the mean and standard deviation of a large sample, representing normal curve as a straight line  
Uncertainties in estimating a mean.
3. Proportion data : (5)  
Examples of proportion data (MPN, Sterility testing of medicines, animal toxicity, therapeutic trials of drug and vaccines, animal toxicity, infection and immunization studies eg LD50, ED50, PD50 Statistical treatment of proportion data, Chi-Square test, goodness of fit to normal distribution.
4. Count data : (2)  
Examples of count data Bacterial Cell count, radioactivity count, colony and plaque count etc. Statistical treatment to count data  
: Poison distribution, standard error, confidence limits of count .
1. Analysis of variance : (2)  
Introduction, procedure, F & T test.
2. Correlation regression & line fitting through graph points : (3)  
Standard curve, correlation, linear, regression. (Fitting the best straight through the series of Points) Standard curves & interpolation of unknown Y value.
7. Statistical basis of biological assays: (1)  
Standard line interpolation assay, parallel line assay (4 point, 6point assay) slope ratio assay.

## **UNIT\_ II) MENDELIAN GENETICS.**

**16**

- (1) Monohybrid crosses and Mendel's principle of segregation.
- (2) Dihybrid crosses and Mendelian principle of independent assortment.
- (3) Statistical analysis of Genetic data. The chi-square test.
- (4) Multiple alleles – ABO blood groups.
- (5) Modification of Dominance relationships.
- (6) Gene interactions and modified Mendelian ratios.
- (7) Essential genes and lethal genes.
- (8) The environment and gene expression.

## **UNIT\_ III) POPULATION GENETICS.**

**16**

- (1) Difference in genotype frequencies amongst population. Hardy – Weinberg principle.
- (2) Random mating.
- (3) Polymorphic genes and DNA typing.

- (4) Inbreeding.
- (5) Genetic change in species leads to evolution.
- (6) Introduction of new alleles in population.
- (7) Natural selection.
- (8) Random changes in allele frequency.

**UNIT\_IV) PROBLEM SOLVING**

**12**

**Literature Cited**

1. Bailey N.T.J (1995) Statistical Methods in biology 3<sup>rd</sup> Edition. Cambridge lowprice Edition Cambridge university press.
2. Dixit J.V. (1996) Principles & Practice of Biostatistics 1<sup>st</sup> Edn. M/s. Banarasidas Bhanot (Publisher).
3. Frank H. Stephenson (2003) Calculations for Molecular Biology and Biotechnology. A guide to Mathematics in the laboratory Academic Press an imprint of Elsevier.
4. Gardner E.J., Simmons, M.J and D.P. Snustad. (1991) Principles of Genetics. 8<sup>th</sup> Edition. John Willey & Sons. Inc.
5. Hartl. D.L. and E.W. Jones. (1999) Essential Genetics. Second Edition. Jones and Bartlett Publisher.
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7. Khan And Khanum
8. Pranab Kr. Banerjee (2006) Problems on Genetics, Molecular Genetics and Evolutionary Genetics. New Central Book Agency (P) Ltd. Kolkata.
9. Pierce.B.A, (2005) Genetics A Conceptual Approach.2<sup>nd</sup> Edition.W.H.Freeman and Company,New York
10. Russel. P. (1998) Genetics Fifth edition. Addison. Wesley Longman Inc.
11. Snyder. L. and W. Champress. (1997) Molecular Genetics of Bacteria. ASM Press. Washington. D.C.
12. T. Bhaskararao (2002) Methods of Biostatistics. Paras Publishing.
13. Wardlaw A.C. (1985) Practical statistics for experimental Biologists John Wiley & Sons. Ltd.

**BHARATI VIDYAPEETH DEEMED UNIVERSITY, PUNE**

**M.Sc-I Microbiology**

**SEMESTER-II**

**PG MB 204: MICROBIAL METABOLISM Credits 04 Lectures 60**

**UNIT I Introduction to Metabolism.**

**05**

- a. Catabolism
- b. Anabolism
- c. Types of metabolic reactions



- d. Methods employed to study metabolism.
- e. Metabolic control mechanisms.
  - Control of enzyme levels.
    - i. Control of enzyme activity.
    - ii. Compartmentation.
    - iii. Hormonal regulation.

**UNIT II Bioenergetic considerations. 08**

- (1) Membrane Potential
  - a. Generation & maintenance.
  - b. Energetics of proton motive force.
- (2) Oxidation as a Metabolic enzyme source –
  - a. Biological oxidations.
  - b. Reductions.
  - c. Oxidation -
    - (i) Reduction potentials and standard electrode potential.
    - (ii) Redox couple.
    - (iii) Nernst equation.
  - d. High energy compounds – ATP, GTP, CTP, PEP, NAD, NADP, FAD, FMN.
  - e. Hormonal regulation.

**UNIT III Aerobic respiration 08**

- (1) Bacterial Electron transport chain
- (2) Mitochondrial ETC –
  - a. Structure of mitochondria
  - b. Mitochondrial ETC
  - c. Shuttle systems across mitochondrial membrane.
  - d. Citric acid cycle and oxidative phosphorylation.

**UNIT IV Anaerobic respiration. 05**

- (1) Concept.
- (2) Sulfur Compounds, Nitrate & CO<sub>2</sub> as electron acceptors.
- (3) ETC in SO<sub>4</sub> reducers and NO<sub>3</sub> reducers.

**UNIT IV Carbohydrate Metabolism – 16  
(Major pathways of carbohydrate metabolism.)**

- (1) Concept of fermentation with respect to -
  - a. Homo & heterolactic, bacteria.
  - b. Saccharolytic clostridia & proteolytic clostridia.
  - c. Enzymes, intermediates, cofactors & regulation of glycolysis.
  - d. Gluconeogenesis.
  - e. HMP pathway.
  - f. ED pathway.

- g. TCA cycle & glyoxylate bypass.
- (2) Metabolism of –
  - a. Starch.
  - b. Glycogen.

**UNIT VI Metabolism of lipids – 09**

- (1) Fatty acid oxidation – stages and tissues.
- (2) Oxidation of odd carbon chain fatty acid.
- (3) Oxidation of unsaturated fatty acids –
  - a. Alpha ( $\alpha$ ) b. Beta ( $\beta$ ) c. Omega ( $\omega$ ).
- (4) Biosynthesis of fatty acids.
- (5) Synthesis of Triacylglycerols.
- (6) Metabolism of phospholipids.

**UNIT VII Nucleic acid metabolism - 09**

- 1) Synthesis and Catabolism of purines and pyrimidines – *De novo* biosynthesis.
- 2) Regulation of steps.
- 3) Purine degradation and clinical disorders of purine metabolism.
- 4) Pyrimidine metabolism.
- 5) Deoxyribonucleotide biosynthesis and metabolism.
- 6) Inhibitors of nucleotide biosynthesis.

### Literature Cited

1. Agarwal G.R., Agarwal O. P. Agarwal K. Text book of Biochemistry, Goel publishing house Meerut, 8<sup>th</sup> Edition 1995.
2. Conn, E.E. P.K. Stumpf, G. Bruening and R.H. Dol. (1995). Outlines of Biochemistry. 5<sup>th</sup> Edition John Wiley and Sons.
3. Doelle, H.M. (1975), "Bacterial metabolism". Academic Press Inc. Ltd. London.
4. Foster. R.L. (1980) The Nature of Enzymology Croon Helm Ltd. London.
5. Kachel. P. W. & G. B. Ralstion (2003) Schaum's outhlines. Biochemistry – II Edition. Tata McGraw Hill Edition.
6. Lehninger. A. L; Nelson, M. M. Cox (1992) Principles of Biochemistry 2<sup>nd</sup> Edition, CBS Publishers and Distributors.
7. Mathews C.K., K.E. van Holde, Kevin G. Ahern, Biochemistry Third Edition (2003), Published by Pearson Education (Singapure) Ltd. Delhi.
8. Palmer. T. (1995) – Understanding enzymes. 4<sup>th</sup> Edition. Ellis Horwood Ltd. Publishers P. John Wiley & Sons. New York. Chichester, Brisbane Toronto.
9. Satyanarayana U. Biochemistry (2001) Books and Allied Pvt. Ltd., Calcutta.
10. Sheeler P, D. E. Bianchi (1987) Cell and Molecular Biology. Third, Edition, John Willey and sons.
11. Simpson R. J. (2004) Purifying Proteins for proteomics – A laboratory manual – Cold Spring Harbor laboratory press.
12. Stanier. R.Y. J.N. Ingraham, M.L. Wheelis & P.R. Painter (1995) – General Microbiology, 5<sup>th</sup> Ed. Mac Millan Press Ltd.
13. Stryer L – (1995) Biochemistry, 4<sup>th</sup> Edition W.H. Freeman & Company New York.
14. Subbarao N.S. (1979), Recent advances in biological nitrogen fixation: Oxford & IBH Publishing Co. Private Ltd. New Delhi.

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M.Sc. Microbiology Part-I

**Semester –II**

**PG MB-205 Physiology and Metabolism Credits 04**  
**Lectures 60**

<b>UNIT I.</b>	<b>Structure and functions of Protein</b>	<b>15</b>
	<b>1 Protein Structure</b>	
	(i) Factors determining protein structure	
	(ii) Tertiary structure of globular proteins and functional diversity	
	(iii) Dynamics of globular protein structure	
	(iv) Methods of protein detection Dicroism (CD) Nuclear Magnetic Resonance (NMR), X-ray crystallography.	
	<b>2 Protein Funtion and evolution</b>	
	i. Actin – Myosin, structure of muscle, mechanism of mocontraction, role of calcium	
	ii. Microtubule system	
	iii. Oxygen Transport-Haemoglobin	
	iv. Changes in haemoglobin structure on oxygen binding	
	v. Haemoglobin varients	
	vi. Evolution of Haemoglobin and Myoglobin	
	<b>3 The diversity of enzymatic function</b>	
	i. Protein enzymes	
	ii. Non prorein enzyme	
	iii. The regulation of enzyme activity- substrate level, feed back control,	
	iv. Allosteric enzymes -	
<b>UNIT II</b>	<b>Vitamins –</b>	<b>08</b>
	<b>1) Occurrence, Structure and Biochemical function</b>	<b>06</b>
	i. Water soluble vitamins.	
	ii. Fat soluble vitamins.	
<b>UNIT II</b>	<b>Photosynthesis.</b>	<b>08</b>
	<b>1) Energy considerations of photosynthesis.</b>	

- 2) Light energy and photolysis of water.
- 3) Photo chemical centers.
- 4) Uphill flow of electrons.
- 5) Electron carriers in photosynthesis.
- 6) Cyclic photophosphorylation – Light reaction.
- 7) Non cyclic photophosphorylation.
- 8) Regulatory aspects of photosynthesis.
- 9) Dark reactions – The Calvin cycle
- 10) Photosynthesis –
  - i. C<sub>3</sub>, C<sub>4</sub>, & CAM plants.
  - ii. Photorespiration.

**UNIT III Lipids metabolism and physiological function**

**15**

**Steroid metabolism**

- i. Structure of steroids
- ii. Biosynthesis of cholesterol
- iii. Bile acids
- iv. Other isoprenoid compounds

**Eicosanoid metabolism**

- i. Structure
- ii. Biosynthesis and catabolism
- iii. Biological action

**Phospholipid metabolism**

- i. Structure
- ii. Biosynthesis of phospholipids in bacteria
- iii. Glycerophospholipid metabolism in eukaryotes.

**Hormones in regulation of metabolism.**

- 1) Classification of hormones –
  - i. Based on the chemical nature.
  - ii. Based on mechanism of action.
- 2) Mechanism of hormone action –
  - i. Synthesis.
  - ii. Signal transduction.
  - iii. Steroid and thyroid hormones.
  - iv. Endocrine glands & their secretion.

**UNIT IV Metabolism of nitrogenous compounds  
(Amino acids, Neurotransmitters)**

**08**

- (1) Nitrogen metabolism –
  - i. Glutamate dehydrogenase, Glutamate synthase & glutamine synthetase.
  - ii. Biosynthesis and regulation of amino acids.
  - iii. Catabolism of amino acids.
- (2) Amino acids related to citric acid cycle.
- (3) Amino acids and their metabolites as Neurotransmitters and biological regulators.

**UNIT IV Tools in Biochemistry**

**07**

### **Literature Cited**

1. Agarwal G.R., Agarwal O. P. Agarwal K. Text book of Biochemistry, Goel publishing house Meerut, 8<sup>th</sup> Edition 1995.
  2. Conn, E.E. P.K. Stumpf, G. Bruening and R.H. Dol. (1995). Outlines of Biochemistry. 5<sup>th</sup> Edition John Wiley and Sons.
  3. Doelle, H.M. (1975), "Bacterial metabolism". Academic Press Inc. Ltd. London.
  4. Foster. R.L. (1980) The Nature of Enzymology Croon Helm Ltd. London.
  5. Kachel. P. W. & G. B. Ralstion (2003) Schaum's outlines. Biochemistry – II Edition. Tata McGraw Hill Edition.
  6. Lehninger. A. L; Nelson, M. M. Cox (1992) Principles of Biochemistry 2<sup>nd</sup> Edition, CBS Publishers and Distributors.
  7. Mathews C.K., K.E. van Holde, Kevin G. Ahern, Biochemistry Third Edition (2003), Published by Pearson Education (Singapore) Ltd. Delhi.
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  9. Satyanarayana U. Biochemistry (2001) Books and Allied Pvt. Ltd., Calcutta.
  10. Sheeler P, D. E. Bianchi (1987) Cell and Molecular Biology. Third, Edition, John Willey and sons.
  11. Simpson R. J. (2004) Purifying Proteins for proteomics – A laboratory manual – Cold Spring Harbor laboratory press.
  12. Stanier. R.Y. J.N. Ingraham, M.L. Wheelis & P.R. Painter (1995) – General Microbiology, 5<sup>th</sup> Ed. Mac Millan Press Ltd.
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**BHARATI VIDYAPEETH UNIVERSITY, PUNE**

**M.Sc. Microbiology**

**M.Sc. Part-I sem II**

**PG MB211-(PRACTICAL COURSE)**

**5 Credits**

**120 hrs**

- |  |     |
|--|-----|
| 1. Biostatistics:  | 8 P |
| (1) Mean, mode, median.  |     |
| (2) Variance & correlation.  |     |
| (3) T – Test, F-Test. $r^2$ test.  |     |
| (4) Use of computers in Biostatistical analysis.                         |     |
| 2. Fermentor design  | 2P  |
| 3. Production of citric acid by surface and submerged culture.           | 2P  |
| 4. Production of ethanol by shake flask culture and in fermentor         | 2P  |
| 5. Enzymes – Enzyme purification.  | 2   |
| P  |     |
| a) Ammonium sulfate precipitation.                                       |     |
| b) Organic solvent precipitation.  |     |
| c) Gel filtration.   |     |
| 6. Determination of $K_m$ and $V_{max}$ values of Invertase and amylase. | 2 P |
| 7. Spectrophotometric analysis of nucleic acid and protein               | 2P  |

**Total 20 P**

**Any 15 practicals are to be completed for completion of the course.**

## Literature Cited

1. . Bailey N.T.J. (1995) Statistical Methods in Biology 3<sup>rd</sup> Edition. Cambridge lowprice Edition Cambridge university press.
2. Dixit J.V. (1996) Principles & Practice of Biostatistics 1<sup>st</sup> Edn. M/s. Banarasidas Bhanot (Publisher).
3. Frank H. Stephenson (2003) Calculations for Molecular Biology and Biotechnology. A guide to Mathematics in the laboratory Academic Press an imprint of Elsevier
4. Goldsby R.A. Kindt. T.S. and B.A. Osborne (2000) Kuby Immunology Fourth Edition W.H. Freeman & Co New York.
5. Khan And Khanum, (2008), Fundamentals of Biostatistics, 3rd Revised Edition, Ukaaz Publication, Hyderabad.
6. Reed R, Holmes; D; Weyers. J & A Jones (1998) Practical skills in Biomolecular sciences. Adison Wesley Longman Ltd.
7. Stanbury; P.F. and A. Whitaker (1984) Principles of fermentation Technology. Pergamon. New York
- 8 T. Bhaskararao (2002) Methods of Biostatistics. Paras Publishing.
- 9 Wardlaw A.C. (1985) Practical Statistics for experimental Biologists JohnWiley & Sonhs. Ltd

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BHARATI VIDYAPEETH UNIVERSITY, PUNE

**M.Sc. Microbiology**

**M.Sc. Part-I sem II**

**PG MB212-(PRACTICAL COURSE)**

**5 Credits**

**120 hrs**

	1 Calculation of Mendelian Ratios	02
	2 Statistical analysis of Genetic data.	02
01	3 Problems on Hardy – Weinberg principle	
	4 Determination of vitamin C/A/B2 in natural sources	02
	5 Measurement of activity NAD dependant enzymes	02
	6 Isolation of nucleic acid and characterization by gel Electrophoresis	02
04	7 Recombination in bacteria – Preparation of competent cells and transformation of plasmid DNA in <i>E. coli</i> .	
	8 Conjugation in bacteria.	
02	9 Plasmid curing using different agents	
	10 Protoplast fusion	02
02	11.Determination of mutation rate – natural and induced	
	12.Gene Cloning of (Demonstration )	02

**Total**

**23 P**

**Any 15 practicals are to be completed for completion of the course.**

## Literature Cited

- 1) Frank H. Stephenson (2003) Calculations for Molecular Biology and Biotechnology. A guide to Mathematics in the laboratory Academic Press an imprint of Elsevier.
- 2) Gardner E.J., Simmons, M.J and D.P. Snustad. (1991) Principles of Genetics. 8<sup>th</sup> Edition. John Willey & Sons. Inc.
- 3) Hartl. D.L. and E.W. Jones. (1999) Essential Genetics. Second Edition. Jones and Bartlett Publisher.
- 4) Irwin H. Segel (1976) Biochemical Calculations 2<sup>nd</sup> Edition John Viley & Sons.
- 5) Lewin B. (2004) Genes VIII – International Edition. Pearson. Prentice Hall. Pearson Education International
- 6) Pierce.B.A, (2005) Genetics A Conceptual Approach.2<sup>nd</sup> Edition.W.H.Freeman and Company,New York
- 7) Pranab Kr. Banerjee (2006) Problems on Genetics, Molecular Genetics and Evolutionary Genetics. New Central Book Agency (P) Ltd. Kolkata.
- 8) Primrose. S.B. and R.M. Twyman and R.W. Old (2003). Principles of Gene Manipulation. 6<sup>th</sup> Edn. Blackwell Science.
- 9) Reed, R; Homes, D; Weyers, J. and A. Jones. Practical skills in Biomelecular Sciences. Addison Wesley Longman Limited
- 10) Russel. P. (1998) Genetics Fifth edition. Addison. Wesley Longman Inc.
- 11) Sambrook. J and D.W. Russel. (2001) Molecular cloning. A Laboratory Manual. 3<sup>rd</sup> Edn. Vol. 1,2,3. Cold Spring Harbor laboratory Press..
- 11) Snyder. L. and W. Champress. (1997) Molecular Genetics of Bacteria. ASM Press. Washington. D.C.
- 12) Watson J.D. Baker T.A., Bell S.P. Gann A, Levine M. and R. Losick. ( 2004) Molecular Biology of the Gene. 5<sup>th</sup> Edn. Low Price edition. Pearson

BHARATI VIDYAPEETH UNIVERSITY, PUNE

**M.Sc. Microbiology**

**M.Sc. Part-I sem II**

**PG GEN 4 Scientific Writing,**

- |     |    |  |           |
|-----|----|--|-----------|
| II) | I. | Scientific writing   | <b>30</b> |
|     | A) | General aspects.<br>Organising time, Organizing information and ideas eg. writing - adopting a scientific style, Developing technique, Getting Started Revising your text with the help of words and phrases, sentences, paragraphs, using dictionaries, using a thesaurus, using guides for written English.  | (4)       |
|     | B) | Review writing:<br>Organizing time, making a plan Construct possible content and examples, construct an outline, Start writing, Reviewing your write-up.   | (5)       |
|     | C) | Reporting practical and project work:<br>Practical & project reports Thesis Structure of reports of experiment works - Title, Authors & their institution, Abstract Summary, List of Contents. Abbreviations, Introduction, Materials and Methods Results Discussion / conclusions, Acknowledgements, Literature cited (Bibliography) Production of a practical report choose the experiment, make up plants, write, Revise, prepare final version. Submit Producing a Scientific paper Assessing potential content, choosing a journal, writing, submitting. Responding to referees comments checking proofs & waiting for publication. | (4)       |
|     | D) | Writing literature surveys:<br>Selecting a topic Scanning the literature and organizing references, Deciding on Structure and content Introduction, Main body of the text, conclusion, References, Style of literature surveys.  | (4)       |
|     | E) | Organizing a poster display:<br>Preliminaries, Design, Layout, Title Text, Sub titles and headings, Colour Content. Introduction, Materials and Methods, Results and conclusion. The poster session.   | (5)       |
|     | F) | Giving an oral presentation.   | (4)       |

Preparation - Preliminary information, Audio - Visual aids, Audience. Content - Introductory remarks, the main message. Concluding remarks on presentation.

- G) Writing research paper: (2)  
Title, Authors and address, Abstract, Key words, Introduction, Materials and Methods, Results & Discussion / conclusions, Acknowledgements, Literature cited (Bibliography)

### **Literature Cited**

1. Day Robert A. : How to write and publish a scientific paper.
2. Gibaldi Joseph: MLA handbook for Writers of Research Papers.
3. Kothari R. C. : Research Methodology, Methods and Techniques, 2<sup>nd</sup> revised edition, New Age International.
4. Ranjit Kumar: Research Methodology.
5. Reed, R. Homes, D; Weyers, J. and A. Jones. Practical skills in Bimolecular Sciences. Addison Wesley Longman Limited.

## BOOKS RECOMMENDED

6. Bailey N.T.J (1995) *Statistical Methods in biology* 3<sup>rd</sup> Edition. Cambridge low price Edition Cambridge university press.
7. Baxevanis A. D. and B.F. F. Ouellette, *Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins*.
8. Bergeron. B. (2003). *Bioinformatics and Computing*. Prentice Hall Inc. Eastern Economy Edition.
9. Bergey's *Manual of Systematic bacteriology* (2<sup>nd</sup> Ed.), Volume, 1 Springer.
10. Campbell R.C. : *Statistics for Biologists*, Cambridge University Press.
11. Day Robert A. : *How to write and publish a scientific paper*.
12. Dixit J.V. (1996) *Principles & Practice of Biostatistics* 1<sup>st</sup> Edn. M/s. Banarasidas Bhanot (Publisher).
13. Dixit M. (1999) *Internet: an Introduction*, Tata McGraw-Hill Series.
14. Dwyer. R.A. (2003) *Genomic Perl. From Bioinformatics: Basics to working code*. Cambridge University Press.
15. Frank H. Stephenson (2003) *Calculations for Molecular Biology and Biotechnology. A guide to Mathematics in the laboratory* Academic Press an imprint of Elsevier.
16. Gibaldi Joseph: *MLA handbook for Writers of Research Papers*.
17. Irwin H. Segel (1976) *Biochemical Calculations* 2<sup>nd</sup> Edition John Wiley & Sons.
18. Khan And Khanum, (2008), *Fundamentals of Biostatistics*, 3<sup>rd</sup> Revised Edition, Ukaaz Publication, Hyderabad.
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21. Prescott. S.C. and C.G. Dunn (2002) *Industrial Microbiology*. Publ. Agrobios. India Jodhpur
22. Ranjit Kumar: *Research Methodology*.
23. Reed, R. Homes, D; Weyers, J. and A. Jones. *Practical skills in Bimolecular Sciences*. Addison Wesley Longman Limited.
24. Simpson R.J. (2004) *Purifying Proteins for Proteomics. A laboratory Manual*. Cold spring Harbor laboratory press.
25. Sneath, P.H.A. Mair : N. S. Sharpe : M.E. and J. G. Holt (Eds) (1986), *Bergey's Manual of Systematic bacteriology Vol. II* Williams and Wilkins, Baltimore, London, Tokyo.
26. T. Bhaskararao (2002) *Methods of Biostatistics*. Paras Publishing.
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- 28. Wayne Daniel: Biostatistics - A Foundation for Analysis of Health Sciences, John Wiley and Sons, Inc.**
- 29. Wayne Goddard and Stuart Melville: Research methodology – An Introduction.**
- 30. Westhead. D.R., Parish J.H and R.M. Twyman (2003) Instant notes in 'Bioinformatics' Viva Books Private Ltd.**

**SEMESTER-WISE COURSE INFORMATION**  
SEMESTER III

Course Number	Course Title	Credit Value	EoTM
	Project Work MB 911 Practical Course V & MB 912 Practical Course VI	20 600Hrs	Univ.
	G 3 Literature Review	2 30 hrs	Continuous Assessment
		22 630 hrs	

**SEMESTER-WISE COURSE INFORMATION**  
**SEMESTER IV**

Course Number	Course Title	Credit Value	#Lec.	#Tut.	#Lab.	Weightage for EoTE/IA	EoTM
MB 401	Virology	4	4	3	-	0.6/0.4	Univ.
MB 402	Medical Microbiology	4	4	3	-	0.6/0.4	Univ.
MB 403	Applied Microbiology	4	4	3	-	0.6/0.4	Univ.
MB 404	Advanced Biotechnology	4	4	3	-	0.6/0.4	Univ.
G 4	Bioinformatics	2	2	-	-	Continuous Assessment	Institute
MB 411	Practical Course VII	4	-	-	4	0.6/0.4	Univ.
MB 412 Course	Practical VIII	4			4	0.6/0.4	Univ.
		26	18		08		

**ELECTIVE:-**

**SEMESTER I:** MB 405: Advanced Analytical Techniques



**M.Sc. Microbiology Part-II**

**Semester : II**

**G 4 BIOINFORMATICS.**

**(30)**

1. Overview of Bioinformatics.  
(02)
  - i. The scope of bioinformatics.
  - ii. Bioinformatics and the Internet.
  - iii. Useful bioinformatics sites on www.
2. Basic principles of computing in bioinformatics. (04)
  - i. Running computer software.
  - ii. Computer operating systems.
  - iii. Software downloading and installation.
  - iv. Database management.
3. Databases.  
(04)
  - i. File formats.
  - ii. Annotated sequence databases.
  - iii. Genome and organism-specific databases.
  - iv. Miscellaneous databases.
4. Retrieval of biological data.  
(04)
  - i. Data retrieval with Entrez and DBGET/Link DB.
  - ii. Data retrieval with SRS.
5. Searching sequence databases by sequence similarity  
(02)  
criteria.
  - i. Sequence similarity searches.
  - ii. Amino acid substitution matrices.
  - iii. Database searches FASTA and BLAST.
  - iv. Sequence Filters.
  - v. Interactive database searches and PSI – BLAST.
6. Multiple sequence alignment: gene and protein families.  
(04)
  - i. Multiple sequence alignment and family relationships.
  - ii. Protein families and pattern databases.
  - iii. Protein domain families.

7. Phylogenetics.  
(05)
  - i. Phylogenetics, cladistics and ontology.
  - ii. Building phylogenetic trees.
  - iii. Evolution of macromolecular sequences.
8. Sequence annotation.  
(05)
  - iv. Principles of genome annotation.
  - v. Annotation tools and resources.

**Total : 60**

### **Literature Cited**

1. .
  1. Bergeron. B. (2003). Bioinformatics Computing. Prentice Hall Inc. Eastern Economy Edition.
  2. Dixit M. (1999) Internet: an Introduction, Tata McGraw-Hill Series.
  3. Dwyer. R.A. (2003) Genomic Perl. From Bioinformatics :Basics to working code. Cambridge University Press.
  4. Simpson R.J. (2004) Purifying Proteins for Proteomics. A laboratory Manual. Cold spring Harbor laboratory press.
  5. Westhead. D.R.,.Parish J.H and R.M. Twyman (2003) Instant notes in 'Bioinformatics' Viva Books Private Ltd.
  6. 9 Methods in microbiology
  7. Reed R, Holmes; D; Weyers. J & A. Jones (1998) Practical skills in Biomolecular sciences. Adison Wesley Longman Ltd. Pg. - 251 - 268, 303 - 323.

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**BHARATI VIDYAPEETH DEEMED UNIVERSITY, PUNE**  
**M.Sc. Microbiology Part-II Semester –III**  
**PGGEN 32 CLINICAL BIOCHEMISTRY**

**No. of Lectures**  
**30**

- I. Introduction to Clinical Biochemistry
- II. What is clinical biochemistry?
- III. Specimen Collection and Handling
- IV. Inborn errors of metabolism
- V. Transport and storage
- VI. Plasma proteins
- VII. Lipids and lipoproteins
- VIII. Acid base balance and blood gases
- IX. Defense
- X. Nutrition and drugs
- XI. Control of water and electrolyte metabolism
- XII. Control of calcium metabolism
- XIII. Control of carbohydrate metabolism
- XIV. Carbohydrates
- XV. Hormones
- XVI. Plasma Proteins
- XVII. Tumour Markers
- XVIII. Diagnostic Enzymes
- XIX. Liver Function Tests (LFT)
- XX. Factors Involved in Hemoglobin Synthesis
- XXI. Renal Function Tests

- XXII. Fluid Balance
- XXIII. Electrolytes
- XXIV. Electrolyte Balance
- XXV. Quality Control
- XXVI. Automation in the Clinical Laboratory
- XXVII. Input and Output
- XXVIII. Special Tests
- XXIX. Organization and Management of Clinical Biochemistry Laboratory
- XXX. Case Reports

## REFERENCES

11. Alberts. B.; Johnson. A, Lewis J. Raff, M. Roberts. K. and P. Walter (2002) Molecular Biology of the cell 4<sup>th</sup> Edition. Garland Science, Taylor & Francis Group.
12. Boyer. R. (2000) Modern Experimental Biochemistry. 3<sup>rd</sup> Edition. Pearson Education Asia.
13. Deb A.C. Comprehensible Viva & Practical ( First Pub 1996) Biochemistry (Third Edition : 2005), New Central Book Agency (P) Ltd
14. Elliott. W.H. and D.C. Elliot (2001) Biochemistry and molecular Biology. 2<sup>nd</sup> Edn. Oxford University Press.
15. Jayraman – Laboratory manual in Biochemistry, New Age International. Publishers, New Delhi
16. Luxton R (2010), Clinical Biochemisrty , 2<sup>nd</sup> Edition
17. Mathews C.K. and K.E. Van Holde (1996) Biochemistry. The Benjamin Cunnings publishing Co. Inc. 2<sup>nd</sup> Edition
18. Nayak S., (2007) Manipal Mannual of Clinical Biochemistry, Publisher Jaypees Brother Medical Publisher
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20. Reed, R; Homes, D; Weyers, J. and A. Jones. Practical skills in Biomelecular Sciences. Addison Wesley Longman Limited.
9. Sharma D.K., Biochemistry, Narosa Publishing House, New Delhi, Chennai, Mumbai, Kolkata Copy Right 2010
10. Varly H.C. (Fourth Edition) Practical Clinical Biochemistry, CBS Publishers & Distributers Pvt. Ltd, New Delhi, Bangalore, Pune, Cochin, Chennai (Indai), First Indian Edition 1988, reprint : 2002, 2003, 2004, 2005.

**BHARATI VIDYAPEETH DEEMED UNIVERSITY, PUNE**  
**M.Sc. Microbiology Part-II Semester –IV**  
**PGMB 401 : Virology**

**No. of Lectures**  
**60**

**I. Introductory.**

**04**

1. Size and shapes. Capsid symmetry, Nucleic acids, Envelopes.
2. Virioids , Prions and related diseases.
3. Virus growth cycle-lytic and lysogeny

**II. Techniques in cultivating viruses**

**12**

1. Egg inoculation
2. Growth of viruses in animal cell culture
3. Large scale production, types of cell culture reactors,
4. Immobilization and hollow fibre reactors
5. Harvesting viral components
6. Growth of viruses in plant cell culture
7. Use of animals
8. Infectivity assay for animal, plant and bacterial viruses- plaque method, pock counting, end point methods, LD50, ID50, EID50, TCID50, etc.

**III. Bacteriophages**

**10**

1. Morphology, genome organization and life cycle of T-even, T-odd, coliphages,  $\lambda$  phage Mu-1.
2. Phage Bacterium interaction / phage Biology
3. Lysogeny & Lysogenic conversion
4. Genome mapping- T<sub>4</sub>R II locus, Benzor's Spot Test, Complementation test
5. Phage therapy for control of bacterial poultry diseases.

**IV. Animal Viruses**

**04**

1. Study of animal viruses wrt to Rabies & Poliomyelitis
2. Patterns of Infection, Virus propagation in animal cell & its effect on host cell
3. Pathogenesis & Control

**V Plant Viruses**

**12**

1. Effect of viruses on plants

2. Methods of Assay, detection & diagnosis
3. Transmission of Plant Infecting Viruses- vectors and without vectors
4. Prevention of crop losses due to virus infection
5. Virus free plant, disease forecasting.

**VI. 08 Biotechnological Application of Phages**

1. Viral vaccines: live attenuated and killed vaccines,
2. Recombinant DNA vaccines, etc.
3. Role of viruses in recombinant DNA technology
4. Antiviral agents

**VII Other important aspects of viruses.**

**10**

1. Viruses and teratogenesis.
2. Viruses and cancer.
3. Human cancer viruses and oncogenes.
4. Mechanisms of viral transformation.

**Total:  
60**

**Literature Cited**

1. Black J.G. (2002) Microbiology Principles and Explorations – ‘Viruses’ 255 – 283. 5<sup>th</sup> Edn. John Wiley & Sons Inc.
2. Darnell J.E. and Baltimore, Allan Campbell, General Virology
3. Dimmock N.J., A.J. Easton and K.N. Leppesrd, “ Introduction to Modern Virology” Fifth edition, Blackwell Science (Topic B)
4. Flint S.J., L.W. Enquist, R.M. Krug, V.R. Racaniello, A.M. Skalka (2000) Principles of Virology, Molecular Biology Pathogenesis and Control ASM Press.
5. Lewin B. (2000) Genes VII. Oncogenes & Cancer 875-913. Oxford University Press.
6. Matthew K. Waldor, David I. Friedman and Sankar L. Adhya (2005) Phages : Their role in Bacterial Pathogenesis and Biotechnology, ASM Press, Washington DC
7. McKane. L. and K.J. Kandel. (1996) Microbiology Essentials and Applications. Viruses – pg. 305-332 McGraw-Hill Inc.
8. Packer. M. (1983) Veterinary Bacteriology and Virology. 7<sup>th</sup> Edition CBS Publisher.
9. Rangaswami G & D.J. Baygyaraj. (1993) Agriculture Microbiology, 2<sup>nd</sup> Edn. Viral diseases of plants – 313-323.
10. Talaro. K.P and A. Talaro. (2002) Foundation in Microbiology. 4<sup>th</sup> Edition. An introduction to viruses. 159 – 185. McGraw Hill.

\* Students are supposed to refer to “Current Contents” and periodicals for recent & additional information.

**BHARATI VIDYAPEETH DEEMED UNIVERSITY, PUNE**  
**M.Sc. Microbiology Part-I Semester –IV**  
**PGMB 402– Medical Microbiology**

	<b>No. of Lectures</b>
<b>I. Microbial Adhesion and Invasion</b>	<b>60</b>
	<b>15</b>
1. Role of sulfatide receptors in the pathogenesis of <i>Mycoplasma</i>	
2. Significance of Ganglio and Lacto series glycolipids in pulmonary infections.	
3. Molecular interactions between 'Human Rhinoviruses and 'ICSM-1'	
4. Role of Heparin sulfate Glycosaminoglycans in the spread of Herpes simplex virus.	
5. Interactions of Poliovirus with immunoglobulin like cell receptor.	
6. Mycollic Acid based.,(Mycobacteria)	
7. Quorum Sensing	
<b>II. Infectious Disease Syndromes</b>	<b>11</b>
1. Bacteraemia	
2. Sepsis	
3. Pathophysiology of septic shock	
4. Vascular damage and peripheral vasodilation	
5. Infective endocarditis	
6. Pyrexia	
7. Centrally distributed maculopapular eruptions	
8. Peripheral eruptions	
9. Vesicular eruptions	
10. Purpuric eruptions	
<b>III. Detailed study of following diseases</b>	<b>30</b>
1. Tuberculosis	
2. Gonorrhoea	
3. Syphilis	
4. Bacillary Dysentery	
5. Cholera	
6. Herpes	
7. Hepatitis	
8. Influenza	
9. Dengue	
10. Dermatophytosis	
11. Systemic candidiasis	
12. Invasive aspergillosis	
13. Malaria	
14. Amoebiasis	
15. Nosocomial infection: <i>Staphylococcus</i> and <i>Pseudomonas</i>	

**IV. Control of Infections in hospitals****04**

1. Nursing Precautions
2. Isolation Policies
3. Hospital acquired infections
  4. Prevention of surgical wound infections and burn infections.

**Total: 60****References :**

1. Ananthanarayan R., C.K.Jayram Paniker, " Textbook of Microbiology" 8<sup>th</sup> Edition , Orient Longman Pvt.Ltd. (Topic C)
2. Collee J.G., J.P.Duguid, A.G.Fraser, B.P.Marmion, "Practical Medical Microbiology" Thirteenth edition, Churchill Livingstone (Topic C)
3. Dimmock N.J. , A.J.Easton and K.N.Leppsr, " Introduction to Modern Virology" Fifth edition, Blackwell Science (Topic B)
4. Flint S.J., L.W.Enquist, R.M.Krug, V.R.Racaniello, A.M. Skalka (2000) Principals of Virology, Molecular Biology Pathologeneis and Control ASM Press.
5. King Maurice, " A Medical Laboratory for developing countries" First Edition, Oxford University Press (Topic D)
6. Magnus Hook, Lech Switalski, Microbial Adhesion and Invasial, First Edition, Springer – Verlag New Yark Inc. (Topic A)
7. Matthew K Waldor, David J Friedman and Sankar L. Adhya, "Phages" 2005, American Society for Microbiology Press (Topic A)
8. Saravanan P., Virology, MJP Publishers Chennai. (Topic C)
9. Sharma B., 'Medical Microbiology' A Clinical Perspective' First edition 2001, Paras Medicla Publishers Hydrabad (Topic D)  
'Principles of Virology' 2000, American Society for Microbiology Press (Topic C)

**BHARATI VIDYAPEETH DEEMED UNIVERSITY, PUNE****M.Sc. Microbiology Part-II Semester –IV****PGMB 403: FOOD and DAIRY****MICROBIOLOGY****No. of Lectures****60****(I) FOOD MICROBIOLOGY**



<b>(1)</b>	<b>Food borne pathogens.</b>	<b>12</b>
i.	Bacterial pathogens: <i>Salmonella</i> , <i>Shigella</i> , <i>E.coli.</i> , <i>Staph.aureus</i> . <i>Clostridium botulinum</i>	
ii.	Toxigenic molds: <i>Aspergillus</i> spp. Detection and identification of Aflatoxins,	
iii.	Viruses: Hepatitis , mechanism of pathogenesis, characteristics of disease, stability in foods, outbreaks.	
iv.	Parasites (different examples) , <i>Entamoeba histolytica</i>	
<b>(2)</b>	<b>Fermented food products</b>	<b>06</b>
i.	Fermented vegetables.	
ii.	Fermented meat, poultry and fish.	
iii.	Traditional Fermented foods.	
iv.	Wine.	
<b>(II)</b>	<b>DAIRY MICROBIOLOGY</b>	
<b>(1)</b>	<b>Milk and milk processing.</b>	<b>06</b>
i.	Milk composition and components.	
ii.	Milk processing. Different processes to manufacture products from milk.	
iii.	Changes in milk components during processing.	
	<b>(2) The Microbiology of Raw milk.</b>	<b>08</b>
i.	Initial microflora of raw milk.	
ii.	Milk and public health, safeguarding milk supply.	
iii.	Biosecurity, Udder disease and bacterial content of Raw milk.	
iv.	Environmental sources.	
v.	Microflora of milking equipment and its effect on raw milk.	
vi.	Influence of storage and transport on the microflora of raw milk.	
<b>(3)</b>	<b>Microbiology of market milks.</b>	<b>08</b>
i.	Market milk industry in India.	
ii.	Indian Standards	
iii.	Composition, Factors affecting composition, Food and Nutritive value.	
iv.	Current heat treatments.	
v.	The microflora and Enzymatic Activity of heat-treated market milks – Influence on Quality and shelf life.	
vi.	Manufacture, Packaging and storage of Pasturised milk.	
vii.	Pathogenic microorganisms associated with heat-treated market milks.	
viii.	Influence of added Ingredients.	

- ix. Potential Application of Alternative to heat for market milks.
- x. Flavor Defects in milk- causes and prevention.

**(4) Fermented milk products 08**

- i. Special milks- Sterilised milk, Homogenised milk, Flavored milk, and frozen concentrated milk.
- ii. Cream.
- iii. Butter.
- iv. Indian dairy products-Whole Milk, Dahi, Paneer

**(IV) PROBIOTICS 12**

- 1. Probiotic microorganisms associated with therapeutic properties.
- 2. Criteria associated with probiotic microorganisms.
- 3. Safety of issues associated with use of Probiotic cultures for Humans.
- 4. Beneficial health effects of Probiotic cultures.
- 5. Effective daily intake of Probiotics.
- 6. Probiotic dairy products.
- 7. Factors affecting Probiotic survival in food Systems.

**Total: 60**

**REFERENCES**

- 1) Banwart. G.J. (1987) Basic Food Microbiology CBS Publishers and distributors.
- 2) Barnum. S.R. (1998) Biotechnology: An introduction. Wadsworth Publishing company. An International Thomson Publishing company.
- 3) Davis. J.G. (2002) Milk Testing. Agrobios – India. Jodhpur.
- 4) De. S. (980) Outlines of Dairy Technology. Oxford University Press.
- 5) Doyle M.P. Beychat. L.R. and T.J” Montville (1997) Food Microbiology Fundamentals and Frontiers. ASM Press. Washington D.C.
- 6) Frazier. W.C. and D.C. Westhoff. (1988). Food Microbiology. 4<sup>th</sup> Edn. Tata McGraw Hill. Publ. Co. Ltd.
- 7) Jay. J.M. (1986) Modern Food Microbiology 3<sup>rd</sup> Ed. CBS Publishers and Distributors.
- 8) Kinson. T.A. and R.F. Sherwook. Biotech Handbooks & series (1995). Eds. Larry Barton. Plenum Press New York.
- 9) Rajvaidya N. and D.K.Markandey. (2004) Applied Microbiology. Vol. 1-5 APH Publishing Corp. New Delhi.
- 10)Robinson R.K. (2002) Dairy Microbiology Handbook: The Microbiology of milk and milk products. :Publ: Wiley Interscience. A John Wiley & Sons. Inc. Publication.
- 11)Versalovic James and Wilson Michael (2008) Therapeuti Microbiology Probiotics and Related Strategies, ASM Press, Washington, DC.

12)Winton and Winton. (2002) milk and milk Products Agrobios India, Jodhpur.

**BHARATI VIDYAPEETH DEEMED UNIVERSITY, PUNE**  
**M.Sc. Microbiology Part-II Semester –IV**  
**MB- 404 Advanced Biotechnology**

	<b>No. of Lectures</b>
<b>(I) PLANT BIOITECHNOLOGY TECHNIQUES AND APPLICATIONS</b>	<b>60</b>
1. Plant tissue culture laboratory design	<b>02</b>
2. Plant tissue culture and applications.	<b>12</b>

- i. Micropropagation.
- ii. From callus to plant.
- iii. Somatic embryogenesis & synseeds
- iv. Somaclonal variation.
- v. Valuable germplasm.
- vi. Chemicals from plants and techniques for study of - Hairy root, Elicitation, Biotransformation,
- vii. Bioreactor in PTC/ Fermentor in PTC.

3. Methods for gene transfer / Formation of transgenic plants **03**

4. Applications of plant genetic engineering. **06**

- i. Crop improvement.
- ii. Herbicide resistance.
- iii. Insect resistance.
- iv. Virus resistance.
- v. Plants as Bioreactors.
- vi. The first genetically engineered food plants.
- vii. Frost resistant plants
- viii. Fruit Vaccine.

**(II) ANIMAL BIOTECHNOLOGY TECHNIQUES AND APPLICATIONS 12**

**1. Types of cell cultures –**

- i. Primary , secondary,
- ii. Continuous, established cell lines,
- iii. Monolayer ,suspension cell cultures

**2. Cell culture media:**

- i. Nutrient requirements,
- ii. Media constituents, types of media, growth conditions, etc.

**3. Culture techniques:**

- i. Culturing,, subculturing, establishment,
- ii. Maintenance and preservation of cell lines
- iii. Quantification- Cell counting, Plating efficiency, Growth curve.
- iv. Cytotoxicity
- v. Organotypic culture.

**4. Molecular Techniques in cell culture**

**i. Gene transfer methods in animals:**

**ii. Microinjection.**

- iii. Microprojectile Gene Gun
- iv. Embryonic stem cell Gene Transfer.
- v. Retrovirus and Gene transfer.
- vi. Cell hybridization
- vii. Monoclonal antibody production

- 5. Applications 08**
- i. Transgenic animals.
  - ii. Animal propagation.

**(III) MARINE BIOTECHNOLOGY. 06**

1. Aquaculture.
2. Algal products.
3. Algal cell culture.
4. Fuels from algae.
5. Medical applications.
6. Probing the marine environment.
7. Conservation.
8. Terrestrial agriculture.
9. Transgenic fish.

**(IV) Clinical development of biological products :**

**06**

1. Regulatory authorities for introduction of medicines in market- Role of food and drug administration, FDA guidelines for drugs/biologicals, Validation (GMP, GLP, GCP, etc.)
2. Clinical studies: Phase I, Phase II, Phase III, and Phase IV of clinical trials- Objectives, Conduct of trials, Outcome of trials
3. Delivery systems- formulations, targeted drug delivery, sustained release drugs

**(V) REGULATIONS, PATENT AND SOCIETY. 05**

1. The deliberate release of Genetically engineered organisms.  
EPA Guidelines
2. Risk assessment.
3. Patents and Biotechnology.
4. IPR & Ethical issues
5. Sustainable Biotechnology.
6. Biosafety Guidelines

**Total : 60**

**Literature cited**

1. Barnum. S.R. (1998) Biotechnology: An introduction. Wadsworth Publishing company. An International Thomson Publishing company.
2. Borem A. Santos R. and D.E. Bowen (1998) Understanding Biotechnology.

3. Casida. L.E. (2003) reprint Industrial Microbiology Publ: New Age International (p) Ltd. New Delhi.
4. Chirikjian J.G. (1995) Biotechnology Theory and Techniques. Vol. I. Plant Biotechnology. Animal cell culture. Immunobiotechnology. Ed. Karen Graf. Edvotex. Ind. Jones and Bartlett. Publishers.
5. Freshney R.I. (2000) Culture of Animal cells. A Manual of Basic Technique. 4<sup>th</sup> Edn. Publ: Wiley – Liss:
6. Grace E.S. (1997) Biotechnology unzipped. Promises and Realities Joseph. Henry Press Washington D.C.
7. Kumar. H.D. (1993) Molecular Biology and Biotechnology 2<sup>nd</sup> revised edition Vikas Publishing house Pvt. Ltd.
8. Mukhopadhyay. S.N. (2001) Process Biotechnology Fundamentals viva Books Pvt. Ltd.
9. Patel. A.H. (2003 reprint) Industrial Microbiology Publ: Macmillan. India Ltd. New Delhi.
10. Purohit S.S. (2004) Plant tissue culture Published by Student Edition, Jodhpur.
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12. Ratledge. C. and B. Kristiansen. (2001) Basic Biotechnology 2<sup>nd</sup> Edn. Cambrige University Press
13. Schmauder. H.P.; M Schweizer. (1997) Methods in Biotechnology. Taylor and Francis publisher.
14. Trehan. K. (1990). Biotechnology. New Age International New Delhi.

**BHARATI VIDYAPEETH DEEMED UNIVERSITY, PUNE**  
**M.Sc. Microbiology Part-II Semester –IV**  
**MB 405– Advanced Analytical Techniques**

**No. of Lectures**

**60**

- I. Advanced Spectroscopy & Spectrometry** **(6)**
1. Infrared Spectroscopy
  2. Nuclear Magnetic Spectroscopy
  3. Calculations
- II. Advanced electrophoretic techniques.** **(6)**
1. Agarose Gel Electrophoresis
  2. Matrix SDS-PAGE electrophoresis.
  3. Disc Electrophoresis.
  4. Capillary Electrophoresis
  5. Calculations
- III. Advanced chromatography techniques** **(6)**
1. Optimizing chromatographic separations
  2. Gas Chromatography
  3. High Performance Chromatography, HPTLC.
  4. Interfacing GC or HPLC with mass spectrometry
  5. Quantitative analysis.
- (IV) Electron Microscopy** **( 8)**
1. Principles, working & applications. Special techniques related to electron microscopy–fixation & staining, Negative staining
  2. Freeze etching, shadow casting Scanning, , Immunoelectron. microscopic techniques, Cryo electron Microscopy.
  3. Cytophotometry and Flowcytometry.
- V. Modern Microscopic Techniques** **(4)**
1. Confocal Microscopy, Laser microscopy, Laser scanning microscopy, Atomic force Microscopy.
- VI Sequencing and mutagenesis.** **(8)**
1. Basic DNA sequencing.
  2. Whole genome sequencing.
  3. Analysing sequence data.
  4. Changing genes, site directed mutagenesis
  5. RFLP,RAPD,PCR.
- VII Advanced techniques in food Microbiology:** **(8)**
1. Detecting foodborne pathogens and their toxins

conventional versus Rapid Automated methods.

2. Immunologic techniques for detecting foodborne pathogens and toxins.
3. Genetic and Metagenomic methods for detection of pathogens.
4. Predictive modeling, Hazard Analysis and critical control system

### **VIII Quality control in Dairy Industry.**

**( 10)**

1. Control of Airborne microorganisms in Dairy Plants.
2. Microbial control of water supplies.
3. Assessment of Dairy equipment hygiene.
4. Sampling of products for microbiological evaluation.
5. Procedures for the direct assessment of the microbial content of milk and milk products.
6. Procedures for the Indirect Assessment of the microbial content of milk and milk products.
7. Methods for determining the shelf life of milk.
8. Sterility Tests.
9. Genetic and Metagenomic method for detecting pathogenic microorganisms and their toxins.
10. Microbiology standards for different dairy products.
11. Relevance of techniques and interpretation of results.

### **IX) IMMUNOCHEMICAL TECHNIQUES**

**(4)**

1. Diagnostic Immunohistochemistry
2. Recent techniques

**Total:  
60**

### **REFERENCES**

1. Reed, R; Homes, D; Weyers, J. and A. Jones. Practical skills in Biomelecular Sciences. Addison Wesley Longman Limited.
2. Boyer. R. (2000) Modern Experimental Biochemistry. 3<sup>rd</sup> Edition. Pearson Education Asia.
3. Mathews C.K. and K.E. Van Holde (1996) Biochemistry. The Benjamin Cunnings publishing Co. Inc. 2<sup>nd</sup> Edition.
4. Lehninger. A.L. , Devid L, Nelson M, M.Cockes ( 1992 ) Principles of Biochemistry “ Second Edition” Publisher – CBS Publieshrs
5. Satyanarayana (1999) Biochemistry. Books & Allied (p) Ltd.
6. Pattabiraman T.N. (1993) Principles of Biochemistry Gajanan Publisher.

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**BHARATI VIDYAPEETH DEEMED UNIVERSITY, PUNE**  
**M.Sc. Microbiology Part-II Semester –IV**  
**Practical Course-MB411**

- I. Virology
- |   |     |
|---|-----|
| (1) Isolation of phages.                          | 2 P |
| (2) Study of phage morphology. (Visit)            | 1 P |
| (3) Study of phage titre.                         | 2 P |
| (4) Study of plant viruses.                       | 1 P |
| (5) Study of animal viruses.                      | 1 P |
| (6) Egg inoculation technique for animal viruses. | 2 P |
| (7) Preparation of animal viral vaccines ( Visit) | 1 P |
- II. Clinical
- |  |    |
|--|----|
| 1. Isolation of pathogens from wound and burn infections.    | 3P |
| 2. Study of antibiotic resistance pattern of these isolates. | 2P |
- III Biochemistry
- |  |      |
|--|------|
| Estimation of chlorides, sodium, / potassium, / calcium /ions in blood | 06   |
| Total:   | 21 P |
- Any 15 experiments to be performed.
- References
1. Varly H.C. (Fourth Edition) Practical Clinical Biochemistry, CBS Publishers & Distributers Pvt. Ltd, New Delhi, Bangalore, Pune, Cochin, Chennai (Indai), First Indian Edition 1988, reprint : 2002, 2003, 2004, 2005.
  2. Ananthanarayan R., C.K.Jayram Paniker, “ Textbook of Microbiology” 8<sup>th</sup> Edition , Orient Longman Pvt.Ltd. (Topic C)
  3. Collee J.G., J.P.Duguid, A.G.Fraser, B.P.Marmion, “Practical Medical Microbiology” Thirteenth edition, Churchill Livingstone (Topic C)
  4. Deb A.C. Comprehensible Viva & Practical ( First Pub 1996) Biochemistry (Third Edition : 2005), New Central Book Agency (P) Ltd
  5. Dimmock N.J. , A.J.Easton and K.N.Leppsrd, “ Introduction to Modern Virology” Fifth edition, Blackwell Science (Topic B)
  6. Jayraman – Laboratory manual in Biochemistry, New Age International Publishers, New Delhi
  7. Luxton R (2010), Clinical Biochemisrty , 2<sup>nd</sup> Edition
  8. Mathews C.K. and K.E. Van Holde (1996) Biochemistry. The Benjamin Cunnings publishing Co. Inc. 2<sup>nd</sup> Edition
  9. Nayak S., (2007) Manipal Mannual of Clinical Biochemistry, Publisher Jaypees Brother Medical Publisher
  10. Plummer D.T, (1992)An introduction to Practical Biochemistry Tata cGraw Hill Publisher,New Delhi
  11. Reed, R; Homes, D; Weyers, J. and A. Jones. Practical skills in Biomelecular Sciences. Addison Wesley Longman Limited.

**BHARATI VIDYAPEETH DEEMED UNIVERSITY, PUNE**  
**M.Sc. Microbiology Part-II Semester –IV**  
**MB 412 – Practical Course**

I. Isolation and identification of food borne pathogens from infected food.- <i>Salmonella</i> /, <i>Shigella</i> /, <i>E.coli</i> /., <i>Staph.aureus</i> .	4 P
II. Isolation of Aflatoxin producing organism and detection of Aflatoxin.	2 P
III. Microbial analysis of raw and pasteurized milk.	2 P
IV. Production of gluconic acid by shake flask culture	2 P
V. Production of Antibiotics like polymyxin /Bacitracin etc.	3 P
VI. Preparation of traditional fermented foods e.g. curds, idli, dhokla etc .	4 P
VII. Study of commercial probiotic products	
VIII. Plant tissue culture e.g. callus formation / plant propogation.	2 P
IX. Mushroom cultivation.	2 P
X. Animal tissue culture- inoculation in Egg.	2 P
	-----
Total:	23 P

Any 15 experiments to be performed.

### References

1. Chirikjian J.G. (1995) Biotechnology Theory and Techniques. Vol. I. Plant Biotechnology. Animal cell culture. Immunobiotechnology. Ed. Karen Graf. Edvotex. Ind. Jones and Bartlett. Publishers.
2. Davis. J.G. (2002) Milk Testing. Agrobios – India. Jodhpur.
3. De. S. (1980) Outlines of Dairy Technology. Oxford University Press.
4. Doyle M.P. Beychat. L.R. and T.J” Montville (1997) Food Microbiology Fundamentals and Frontiers. ASM Press. Washington D.C.
5. Freshney R.I. (2000) Culture of Animal cells. A Manual of Basic Technique. 4<sup>th</sup> Edn. Publ: Wiley – Liss:
6. Purohit S.S. (2004) Plant tissue culture Published by Student Edition, Jodhpur.

7. Rajvaidya N. and D.K.Markandey. (2004) Applied Microbiology. Vol. 1-5 APH Publishing Corp. New Delhi.
8. Ranga M.M. (2002) Animal Biotechnology – 2<sup>nd</sup> Edn. Publ: Agrobios India, Jodhpur.
9. Robinson R.K. (2002) Dairy Microbiology Handbook: The Microbiology of milk and milk products. :Publ: Wiley Interscience. A John Wiley & Sons. Inc. Publication.
10. Versalovic James and Wilson Michael (2008) Therapeuti Microbiology Probiotics and Related Strategies, ASM Press, Washington, DC.
11. Winton and Winton. (2002) milk and milk Products Agrobios India, Jodhpur.

BHARATI VIDYAPEETH DEEMED UNIVERSITY, PUNE

M.Sc. Microbiology Part-I

**Semester –IV**

**MB 405– Advanced Analytical Techniques**

- (i) Advanced Spectroscopy & Spectrometry
- Infrared Spectroscopy
  - Nuclear Magnetic Spectroscopy
  - Calculations
- (ii) Advanced electrophoretic techniques.
- Electrophoresis of nucleic acids
  - Electrophoresis of proteins
  - Capillary Electrophoresis
  - Calculations
- (iii) Advanced chromatography techniques
- Optimizing chromatographic separations
  - Gas Chromatography
  - High Performance Chromatography
  - Interfacing GC or HPLC with mass spectrometry
  - Quantitative analysis.
- (IV) **Electron Microscopy (6)**  
Principles working & applications. Special techniques related to electron microscopy–
- fixation & staining Negative staining
  - freeze etching, shadow casting Scanning, , Immunoelectron. microscopic techniques, .
  - Cytophotometry and Flowcytometry.
- V. **Modern Microscopic Techniques (4)**  
Confocal Microscopy, Laser microscopy, Laser scanning microscopy, Cryo electron Microscopy, Atomic force Microscopy.
- VI **Sequencing and mutagenesis.**
- Basic DNA sequencing.

- Whole genome sequencing.
- Analysing sequence data.
- Changing genes, site directed mutagenesis

**(2) Advanced techniques in food Microbiology:  
08**

- i. Detecting foodborne pathogens and their toxins conventional versus Rapid Automated methods.
- ii. Genetic and Immunologic techniques for detecting foodborne pathogens and toxins.
- iii. Predictive modelling.
- iv. Hazard Analysis and critical control system.

**4) Quality control in Dairy Industry.**

- i. Control of Airborne microorganisms in Dairy Plants.
- ii. Microbial control of water supplies.
- iii. Assessment of Dairy equipment hygiene.
- iv. Sampling of products for microbiological evaluation.
- v. Procedures for the direct assessment of the microbial content of milk and milk products.
- vi. Procedures for the Indirect Assessment of the microbial content of milk and milk products.
- vii. Methods for determining the shelf life of milk.
- viii. Sterility Tests.
- ix. Methods for detecting pathogenic microorganisms and their toxins.
- x. Microbiology standards for different dairy products.
- xi. Relevance of techniques and interpretation of results.

**5) Chemotaxonomy – cell wall components, Liquid composition, (3)**

- i. isoprenoid quinones, amino acid sequence of proteins, protein profiles
- ii. cytochrome composition, ribosomal RNA in detail.
- iii. 5. Genetic methods in taxonomy, chromosomal transfers, (3)
- iv. extrachromosomal elements, DNA base composition

and hybridization

**VII) Diagnostic Immunohisto chemistry (2)**  
**Recent techniques.**

**I. Sem.II : Practical course-I MB 411**

**I. Virology**

(8)	Isolation of phages.	2 P
(9)	Study of phage morphology. (Visit)	1 P
(10)	Study of phage titre.	1 P
(11)	Study of plant viruses.	1 P
(12)	Study of animal viruses.	1 P
(13)	Egg inoculation technique for animal viruses.	2 P
(14)	Preparation of animal viral vaccines ( Visit)	1 P

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18 P

**Literature Cited**

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2. Lewin B. (2000) Genes VII. Oncogenes & Cancer 875-913. Oxford University Press.
3. Rangaswami G & D.J. Baygyaraj. (1993) Agriculture Microbiology, 2<sup>nd</sup> Edn. Viral diseases of plants – 313-323.

\* Students are supposed to refer to “Current Contents” and periodicals for recent & additional information.

Titles in practicals

Study of microbial diversity / plt / animal.

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