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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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;

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.

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.

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	**Any one from the following:**							
	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

M.Sc. MICROBIOLOGY
(CBCS-2018 COURSE)

SEMESTER-II

Subject Type	Code	Title of the paper	Hrs/ Week	Credits	Exam Hrs	Maximum Marks		
						Internal Assessment	University Examination	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	**Any one from the following:**							
	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

M.Sc. MICROBIOLOGY
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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

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	**Any one from the following:**							
	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:

Item	**Maximum marks**
Mid semester (internal) examination	20
Tutorial (as given on paper or through 'Google Classroom'). **Note:** 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
Total marks	**40**

Internal assessment for theory papers of 2 credits weightage:

Item	**Maximum marks**
Mid semester (internal) examination	20

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:

Item	**Maximum marks**
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
Total marks	**40**

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 2nd and 4th 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.

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)

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

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:

Item	Marks	Note
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.

		Note: Any work having conflicts of interest with respect to intellectual properties should not be published without permission of respective guide.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

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.

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

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.

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

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. 8th 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

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:

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

2. Field work (Data Collection)/ Online surveys: having subject relevance (Any one from enlisted) 100 marks

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

OR

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**
Total marks = 100		

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.

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
$80 \leq$ Marks ≤ 100	O	10
$70 \leq$ Marks < 80	A^+	9
$60 \leq$ Marks < 70	A	8
$55 \leq$ Marks < 60	B+	7
$50 \leq$ Marks < 55	B	6
$40 \leq$ 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= *Max*/10 (since we have adapted 10 point system).Then GP is calculated by the formula as shown as below.

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 $SGPA = \frac{\sum Ck \text{ X } GPk}{\sum Ck}$, 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 $CGPA = \frac{\sum Ck \text{ X } GPk}{\sum Ck}$, 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 x CGPA- 10	If $5.00 \leq \text{CGPA} \leq 6.00$
	5 x CGPA+ 20	If $6.00 \leq \text{CGPA} \leq 8.00$
	10 x CGPA - 20	If $8.00 \leq \text{CGPA} \leq 9.00$
	20 x CGPA -110	If $9.00 \leq \text{CGPA} \leq 9.50$
	40 x CGPA- 300	If $9.50 \leq \text{CGPA} \leq 10.00$

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 ≤ CGPA ≤ 10.00	O	Outstanding	80 ≤ Marks ≤ 100
9.00 ≤ CGPA ≤ 9.49	A^+	Excellent	70 ≤ Marks < 80
8.00 ≤ CGPA ≤ 8.99	A	Very Good	60 ≤ Marks < 70
7.00 ≤ CGPA ≤ 7.99	B^+	Good	55 ≤ Marks < 60
6.00 ≤ CGPA ≤ 6.99	B	Average	50 ≤ Marks < 55
5.00 ≤ CGPA ≤ 5.99	C	Satisfactory	40 ≤ 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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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

- Common functional groups in biochemistry. OH, CHO, C = 0, NH2, C – NH2, SH, ester, ethers, methyl, ethyl, phospho, guanidio, 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 Tm 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 2nd 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, 1st Indian Edition, LBS publishers and distributors Pvt. Ltd. New Delhi.
4. Lehninger A.L. (2000) Principles of Biochemistry II Edition by D.KL. Nelson and M.M. Cox Mcmillan Worth Pub. Inc. N.Y.
5. Mehler H.R. (1968) Basic biological chemistry, Harper and Row publisher, Inc. New York.
6. Murray R..K., Harper's Biochemistry, Appleton and Lange Stanford, 25th Edition.
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11. White A., P. Handler. E.L. Smith (1973) Principles of Biochemistry, 5th 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

- 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. Leukoyte 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 IMMUNODEFICIENIES, 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 2nd Edn. CRC Press.
2. David Male, Jonathan Brostoff, David B Roth, Ivan Roitt.(2006).Immunology 7th edition.
3. Goldsdby 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 4th Edn. Saunders College Publishing. Harcourt Brace College Publishers.

BHARATI VIDYAPEETH
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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 4th Edition. Garland Science, Taylor & Francis Group.
2. Clayton. J and C. Dennis. (2003) 50 years of DNA. Nature Publishing group.
3. Elliott. W.H. and D.C. Elliot (2001) Biochemistry and molecular Biology. 2nd Edn. Oxford University Press.
4. Gardner E.J., Simmons, M.J and D.P. Snustad. (1991) Principles of Genetics. 8th Edition. John Willey & Sons. Inc.
5. Hartl. D.L. and E.W. Jones. (1999) Essential Genetics. Second Edition. Jones and Bartlett Publisher.
6. Kleinsmith L.J. and V.M. Kish. (1995). Principles of Cell and molecular Biology 2nd Edn. Haper Collins. College Publishers.
7. Lewin B. (2004) Genes VIII – International Edition. Pearson. Prentice Hall. Pearson Education International.
8. Lewin. B. (2000) Genes VII. Oxford University Press.
9. Pierce.B.A, (2005) Genetics A Conceptual Approach.2nd Edition.W.H.Freeman and Company,New York
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13. Sheeler P. and Bianchi D.E. (1987) Cell and Molecular Biology 3rd Edn. John Wiley and Sons. Inc.
14. Snyder. L. and W. Champress. (1997) Molecular Genetics of Bacteria. ASM Press. Washington. D.C.
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16. Winter P.C., G.I. Hickey and H.L. Fletcher (2000) Instant notes in Genetics. Viva Books Pvt. Ltd.

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BHARATI VIDYAPEETH
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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:

UNIT I INTRODUCTION TO BASIC CONCEPTS OF ECOLOGY 02

UNIT II MICROBIAL ECOLOGY 15

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

- 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:

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 Application4th 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,4th edition, Pearson Education Publication
9. MooreJ.W. and E.A. Moore (1976) Environmental Chemistry Academic Press, New York.
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, Calculta, Guwahati, Hyderabad, Lukknow 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 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 Application4th 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.
7. Jadhav H.V. (1992) Elements of Environmental Chemistry. Himalaya 9
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
15. Rao. C.S. (1991) Environmental pollution control Engineering Wiley Eastern Limited New Delhi. Bangalore, Bombay, Calculta, Guwahati, Hyderabad, Lukknow Madra & Pune..
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, Aljgarh.
20. Verma, P.S and V.K. Agarwal (1996) Environmental Biology (Principles of Ecology) S. Chand & Co. New Delhi.

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

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:

UNIT I INSTRUMENTATION & BIOCHEMISTRY **2P**

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

UNIT II IMMUNOLOGY

1. **Blood transfusion related techniques.** **3P**
   - Blood grouping.
   - Cross matching.
   - Visit to blood bank.

2. **Study of Immunological reactions.** **5P**
   - Agglutination reactions.
   - Haemagglutionation Inhibition Test
   - Immunodiffusion
   - Demonstration / visit.

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

22P

References:

1. 1Alberts. B.; Johnson. A, Lewis J. Raff, M. Roberts. K. and P. Walter (2002) Molecular Biology of the cell 4th Edition. Garland Science, Taylor & Francis Group.
2. Benjamin Cunnings publishing Co. Inc. 2nd Edition
3. Boyer. R. (2000) Modern Experimental Biochemistry. 3rd Edition. Pearson Education Asia.
4. Cruse J and R. Lewis (2004) Atlas of Immunology 2nd Edn. CRC Press
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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. 2nd 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
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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) **10 P**

- Acidophiles.
- Alkalophiles.
- Halophiles.
- Psychrophiles.
- Thermophiles.

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

3. Study of Microbial diversity **2 P**

4. Sewage decomposition by aerobic and anaerobic microorganisms. **1 P**

5. Determination of BOD and COD of a given sample. **2 P**

6. Determination of TS, TSS and MLSS. **1 P**

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22 P

References:

1. Bathra Atlas (2007) Microbial Ecology Fundamentals and Application4th 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
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 Mannual 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 Mannual 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 mannual 6^{th} 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 Mannual of Systematic Bacteriology. Vol. IV Williams and Wilkins, Baltimore, London, Tokyo.

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

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:

UNIT I FERMENTOR DESIGN 15

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: Impellors, 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’

UNIT II OTHER DESIGNS OF A FERMENTOR 05

1. The Waldfhoff-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.

UNIT III AERATION AND AGITATION 10

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 Realties Joseph. Henry Press Washington D.C.
3. Kumar. H.D. (1993) Molecular Biology and Biotechnology 2nd revised edition Vikas Publishing house Pvt. Ltd.
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8. Ratledge. C. and B. Kristiansen. (2001) Basic Biotechnology 2nd Edn. Cambrige University Press .
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10. Stanbury; P.F. and A. Whitaker (1984) Principles of fermentation Technology. Pergamon. New York.
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:

UNIT I. RADIOACTIVE ISOTOPES & THEIR USE **10**

1. Radioactive decay.
2. Measuring radioactivity.
3. Autoradiography.
4. Biological applications.
5. Working practices when using radioactive isotopes.
6. Safety and procedural aspects.

UNIT II. CENTRIFUGATION. **10**

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.

UNIT III. CHROMATOGRAPHY. **14**

1. Types of chromatographic systems.
2. Separation methods.
3. Detectors.
4. Recording & Interpreting chromatograms.

UNIT IV. ELECTROPHORESIS. **12**

1. Basic apparatus.
2. Using a supporting medium.

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. 3rd 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. 2nd 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) 5th 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 offit 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:** Poison distribution, standard error, confidence limits of count .

5. Analysis of variance :

- Introduction, procedure,

- 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 3rd Edition. Cambridge lowprice Edition Cambridge university press.
2. Dixit J.V. (1996) Principles & Practice of Biostactistics 1st 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 Elservier.
4. Gardner E.J., Simmons, M.J and D.P. Snustad. (1991) Principles of Genetics. 8th Edition. John Willey & Sons. Inc.
5. Hartl. D.L. and E.W. Jones. (1999) Essential Genetics. Second Edition. Jones and Bartlett Publisher.
6. Irwin H. Segel (1976) Biochemical Calculations 2nd Edition John Viley & Sons.
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.2nd 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.

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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.

- 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_2 as electron acceptors.
3. ETC in SO_4 reducers and NO_3 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. Metobolism 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 (α)
   - Beta (β)
   - Omega (ω).

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.

References:

1. Agarwal G.R., Agarwal O. P. Agarwal K. Text book of Biochemistry, Goel publishing house Meerut, 8th Edition 1995.
2. Conn, E.E. P.K. Stumpf, G. Bruening and R.H. Dol. (1995). Outlines of Biochemistry. 5th 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. Lehininger. A. L; Nelson, M. M. Cox (1992) Principles of Biochemistry 2nd 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. 4th Edition. Ellis Horwood Ltd. Publishers P. John Wiley & Sons. New York. Chichester, Brisbane Toronto.
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12. Stanier. R.Y. J.N. Ingraham, M.L. Wheelis & P.R. Painter (1995) – General Microbiology, 5th Ed. Mac Millan Press Ltd.
13. Stryer L – (1995) Biochemistry, 4th 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 (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 functionaldiversity
- Dynamics of globular protein structure
- Methods of protein detection Dicroism (CD) Nuclear Magnetic Resonance (NMR), X-ray crystallography.

2. Protein Funtion 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 varients
- 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_3, C_4, & 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, 8th Edition 1995.
2. Conn, E.E. P.K. Stumpf, G. Bruening and R.H. Dol. (1995). Outlines of Biochemistry. 5th Edition John Wiley and Sons.
3. Doelle, H.M. (1975), "Bacterial metabolism". Academic Press Inc. Ltd. London.
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5. Kachel. P. W. & G. B. Ralstion (2003) Schaum's outhlines. Biochemistry – II Edition. Tata McGraw Hill Edition.
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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, 5th Ed. Mac Millan Press Ltd.
13. Stryer L – (1995) Biochemistry, 4th 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 (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:

1. Biostatistics: **12 P**

- 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 **1 P**

3. Production of citric acid by surface and submerged culture. **2 P**

4. Production of ethanol by shake flask culture and in fermentor **2 P**

5. **Enzymes – Enzyme purification.** **1 P**

- Ammonium sulfate precipitation.
- Organic solvent precipitation.
- Gel filtration.

6. Determination of Km and Vmax values of Invertase and amylase. **2 P**

7. Spectrophotometric analysis of nucleic acid and protein **2 P**

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22 P

References:

1. Bailey N.T.J. (1995) Statistical Methods in Biology 3rd Edition. Cambridge lowprice Edition Cambridge university press.
2. Dixit J.V. (1996) Principles & Practice of Biostactistics 1st 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 Elservie
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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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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 *E. coli*.	**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

References:

1. Frank H. Stephenson (2003) Calculations for Molecular Biology and Biotechnology. A guide to Mathematics in the laboratory Academic Press an imprint of Elservier.
2. Gardner E.J., Simmons, M.J and D.P. Snustad. (1991) Principles of Genetics. 8th 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 2nd 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.2nd 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. 6th 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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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.5th Edn.Low Price edition. Pearson

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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**

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 conslusion.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)

Literature Cited

1. Day Robert A. : How to write and publish a scientific paper.
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BHARATI VIDYAPEETH
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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

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, λ phage Mu-1.
2. Phage Bacterium interaction / phage Biology
3. Genome mapping- T_4R II locus, Benzor'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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* Students are supposed to refer to "Current Contents" and periodicals for recent & additional information.

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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:

UNIT I. MICROBIAL ADHESION AND INVASION 15

1. Role of sulfatide receptors in the pathogenesis of *Mycoplasma*
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,(*Mycobacteria*)
7. Quorum Sensing

UNIT II. INFECTIOUS DISEASE SYNDROMES 11

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

UNITIII. DETAILED STUDY OF FOLLOWING DISEASES 30

1. Tuberculosis
2. Gonorrhoea
3. Syphilis
4. Bacillary Dysentry
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

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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.Leppsrd, " 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.
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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 foodborn pathogens, fermented food products and role of microorganisms in dairy industry.
2. Understand concept and use of probiotics.

Course contents:

UNIT I FOOD MICROBIOLOGY 12

1. Food borne pathogens.

- Bacterial pathogens: *Salmonella, Shigella, E. coli., Staph. aureus. Clostridium botulinum*
- Toxigenic molds: *Aspergillus* spp.
  - Detection and identification of Aflatoxins,
  - Viruses: Hepatitis, mechanism of pathogenesis, characteristics of disease, stablityin foods, outbreaks.
- Parasites (different examples) , *Entamoeba histolytica*

2. **Fermented food products 08**

- Fermented vegetables.
- Fermented meat, poultry and fish.
- Traditional Fermented foods.
- Wine.

UNIT II DAIRY MICROBIOLOGY 06

1. Milk and milk processing.

- 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. 0**8**

- 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.

Literature Cited

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.
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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.

UNIT II ANIMAL BIOTECHNOLOGY TECHNIQUES AND APPLICATIONS 20

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
      - Gene transfer methods in animals:
      - Microinjection.
      - Microprojectile Gene Gun
      - Embryonic stem cell Gene Transfer.
      - Retrovirus and Gene transfer.
      - Cell hybridization
      - Monoclonal antibody production

5. Applications of ATC
   - Transgenic animals.
   - Animal propagation.

UNIT III MARINE BIOTECHNOLOGY 10

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.

UNIT IV CLINICAL DEVELOPMENT OF BIOLOGICAL PRODUCTS 05

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. 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

Literature cited

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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:

UNIT I. ADVANCED SPECTROSCOPY & SPECTROMETRY 06

1. Infrared Spectroscopy
2. Nuclear Magnetic Spectroscopy
3. Calculations

UNIT II. ADVANCED ELECTROPHORETIC TECHNIQUES 06

1. Agarose Gel Electrophoresis
2. Matrix SDS-PAGE electrophoresis.
3. Disc Electrophoresis.
4. Capillary Electrophoresis
5. Calculations

UNIT III. ADVANCED CHROMATOGRAPHY TECHNIQUES 06

1. Optimizing chromatographic separations
2. Gas Chromatography
3. High Performance Chromatography, HPTLC.
4. Interfacing GC or HPLC with mass spectrometry
5. Quantitative analysis.

UNIT IV ELECTRON MICROSCOPY AND CELL SORTING TECHNIQUES 08

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.

UNIT V MODERN MICROSCOPIC TECHNIQUES 04

1. Confocal Microscopy, Laser microscopy, Laser scanning microscopy, Atomic force Microscopy.

UNIT VI SEQUENCING AND MUTAGENESIS 08

1. Basic DNA sequencing.
2. Whole genome sequencing.
3. Analysing sequence data.
4. Changing genes, site directed mutagenesis
5. RFLP, RAPD, PCR.

UNIT VII ADVANCED TECHNIQUES IN FOOD MICROBIOLOGY 08

1. Detecting foodborne pathogens and their toxins conventional versus Rapid Automated methods.
2. Immonunologic 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

UNIT 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 microgranisms and their toxins.
10. Microbiology standards for different dairy products.
11. Relevance of techniques and interpretation of results.

UNIT IX IMMUNOCHEMICAL TECHNIQUES 04

1. Diagnostic Immunohistochemistry
2. Recent techniques

Literature Cited

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. 3rd Edition. Pearson Education Asia.
3. Mathews C.K. and K.E. Van Holde (1996) Biochemistry. The Benjamin Cunnings publishing Co. Inc. 2nd Edition.
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5. Satyanarayana (1999) Biochemistry. Books & Allied (p) Ltd.
6. Pattabiraman T.N. (1993) Principles of Biochemistry Gajanan Publisher.

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BHARATI VIDYAPEETH
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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:

UNIT I. Microbial diversity **4**

1. Definition of species in prokaryotes.
2. Types of 'species' Species Divergence
3. Measures and indices of diversity.

UNIT II Taxonomy **8**

1. Introduction to Bacterial Taxonomy
2. Bergey's Manuals and the classification of prokaryote

. • Determinative Bacteriology : Phenetic Approach
• Systematic Bacteriology : Phylogenetic Approach
• Polyphasic Approach

UNIT III Gene sequencing **12**

1. Outline of gene sequencing procedures
   - Maxam Gilbert's method, Sangers method
   - Automated Sequencer
   - BLAST analysis
   - RFLP
   - RAPD
   - Strategies for whole genome sequencing
   - Whole Genome Shotgun Sequencing
   - Applications of gene sequencing (identification of organisms)

Unit IV : **Unculturable microorganisms** **6**

- Culture independent molecular methods for identifying unculturable bacteria.

References

1. Fakruddin1* and Khanjada Shahnewaj Bin Mannan2eylon C Methods for Analyzing Diversity of Microbial Communities in Natural Environments Md Journal of Science (Bio. Sci.) 42(1): 19-33, 2013 DOI: 10.4038/cjsbs.v42i1.5896 *
2. Breed and Buchanan. Bergey's Manual of Determinative Bacteriology. 9th Edition, 1982.
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5. Sonia R. Vartoukian, Richard M. Palmer & William G. MINIREVIEW Strategies for culture of 'unculturable' bacteria Wade King's College London Dental Institute, Infection Research Group, London, FEMS Microbiol Lett 309 (2010) 1–7 UK DOI:10.1111/j.1574-6968.2010.02000.x
6. Sandy Primrose, Richard Twyman, Bob Old (2001), Principles of Gene Manipulation 6th Edition, Blackwell Science Ltd. 2. Sambrook,

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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**: 4 P

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

III Biochemistry: 4 P

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

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22 p

Literature Cited

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" 8th 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)

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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 , 2nd Edition
8. Mathews C.K. and K.E. Van Holde (1996) Biochemistry. The Benjamin Cunnings publishing Co. Inc. 2nd Edition

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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 e.g. Curd, Idli, Dhokla etc .	1 P
7.	Study of commercial probiotic products	5 P
8.	Study of plant cell culture	1 P
9.	Mushroom cultivation.	2 P
		22 P

Literature Cited

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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.

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.

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.