

As per the BoS held on 24.07.2024

**Veer Bahadur Singh Purvanchal University  
Jaunpur**



**Ordinance and Syllabus for  
M. Sc. in Microbiology  
[Two-year (Four semesters) postgraduate degree program]**

**Faculty of Science  
Under Choice Based Credit System (CBCS)  
As per the guidelines of NEP-2020  
w.e.f. 2024-25 (Session)**

**V.B.S. PURVANCHAL UNIVERSITY, JAUNPUR  
Department of Microbiology  
Faculty of Science**

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## Vision

The Department is dedicated in providing the quality education, through both lectures and practical sessions, necessary to meet the needs of this growing field. The main objective and focus of the department are to guide and impart innovative education at par with national and international standards.

## Mission:

- To be a world-class hub for interdisciplinary education and research programs in microbiology.
- To promote high-impact education and innovative research in a diverse and inclusive environment by exploring fundamental questions in microbiology.
- To provide outstanding education in microbiology to post-graduate and professional students.
- To expand interdisciplinary and multidisciplinary collaborations that are recognized nationally and internationally for their innovative impacts on microbiology.
- To contribute to the mission of the University by engagement in outreach to enhance community understanding of the importance of microbiology.
- To attract and retain a diverse, talented and dedicated group of faculty and staff to advance their careers through collaborative efforts in education, research, and service.

*Amulya*      *S*  
*Rajesh*  
*24/7/24*

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*J. Anitha*      *[Signature]*  
*R. Rajeswari*  
*24/7/24*

# Veer Bahadur Singh Purvanchal University, Jaunpur

## Ordinance governing 2 Years (4 Semesters) Postgraduate Degree Programme

### M. Sc. in Microbiology

### Faculty of Science

### Under Choice Based Credit System (CBCS)

w.e.f. 2025-26 (Academic Session)

The following ordinance has been framed governing the admission, course structure, examination and other allied matters relating to the 2 Years (4 Semesters) Postgraduate Degree Programme (M.Sc.) in Microbiology being offered by Veer Bahadur Singh Purvanchal University.

#### 1. ADMISSION AND EXIT

- 1.1. All matters related to admission to M.Sc.- Microbiology programme shall be dealt by the Admission Committee constituted by the University.
- 1.2. The M.Sc.- Microbiology programme is open to science graduates (with 3 years undergraduate degree) with minimum of 50% of marks, from a recognized University (45% in case of SC/ST). Those who are appearing in qualifying examination of B.Sc. in Biology/Life Sciences/Agriculture/ B.V.Sc. & A.H. /M.B.B.S./B.Pharm/, B.Tech. in Biotechnology/Bioinformatics/Food Technology and related subjects programme can also apply for admission and shall be eligible to appear in the Entrance Test for admission, but they will have to produce a proof of being a graduate at the time of admission. However, students of Veer Bahadur Singh Purvanchal University can be given provisional admission by the Admission Committee in case of delayed result.
- 1.3. Admission in M.Sc.- Microbiology programme will be based on the Entrance Test or merit as per the rules of the university.
- 1.4. The intake of students in this programme shall be fixed by Veer Bahadur Singh Purvanchal University. The admission to M.Sc.- Microbiology programme shall be made through a merit based on Written Test conducted by Veer Bahadur Singh **Purvanchal University Combined Admission Test (PUCAT)**. The reservation norms for admission in M.Sc.- Microbiology programme shall be as per the Uttar Pradesh State Government/ University policy notified from time to time.
- 1.5. On selection for admission to the M.Sc.- Microbiology programme, the candidate shall deposit the prescribed fees to get their admission confirmed within the stipulated time period by the Admission Committee of the Department. If the candidate fails to do so their admission shall be automatically liable to be cancelled and the seat falling vacant shall be offered to another candidate as per the merit/category. There is no provision of Fee concession/exemption under any circumstances except the case related to Social Welfare Department, Uttar Pradesh Government. Fee refund policy shall be applicable as per the university norms.
- 1.6. Admission to M.Sc.- Microbiology programme cannot be claimed by any candidate as a matter of right. The Admission Committee of M.Sc.- Microbiology programme of the University shall have power to refuse, reject or cancel any admission if it possesses sufficient reasons to do so.
- 1.7. All teachers of the department shall function as Student Mentor (Advisors). Every student will be assigned a mentor (advisor) before commencement of the academic session to support the students for their overall development in all possible way related to their

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academics/cocurricular/extracurricular/sports/personality development/soft skill/ cultural activities and offer all possible student support services.

## 2. COURSES OF STUDY AND EXAMINATION

2.1. M. Sc.- Microbiology Programme will be based on CBCS (Choice Based Credit System) mode and conducted in semester system.

2.2. M.Sc. 1<sup>st</sup> semester - 4 Theory papers of major/core courses (4 credit each) = 16 credits  
 1 Practical (4 credits) = 4 credits  
 1 Minor elective from other faculty (4 credits) = 4 credits  
**1<sup>st</sup> semester there will be 24 credits.**

M.Sc. 2<sup>nd</sup> semester - 3 Theory papers of major/core courses (4 credits each) = 12 credits  
 1 Theory paper of major elective courses (4 credits) = 4 credits  
 1 Practical (4 credits) = 4 credits  
 1 Major/core Industrial Training/Surveys/Research Project = 8 credits  
**2<sup>nd</sup> semester there will be 28 credits.**

**Thus, 1<sup>st</sup> year of M.Sc. will be of 52 credits.**

M.Sc. 3<sup>rd</sup> semester - 3 Theory papers of major/core courses (4 credit each) = 12 credit  
 1 Theory paper of major elective courses (4 credit) = 4 credit  
 1 Practical (4 credit) = 4 credit

**3<sup>rd</sup> semester there will be 20 credits.**

M.Sc. 4<sup>th</sup> semester - 4 Theory papers of major elective courses (4 credits each) = 16 credits  
 1 Practical (4 credits) = 4 credit  
 1 Major/core Industrial Training/Surveys/Research Project = 8 credits

**4<sup>th</sup> semester there will be 28 credits.**

**Thus, 2<sup>nd</sup> year of M.Sc. will be of 48 credits.**

**Hence, two years (4 semesters) M.Sc.-Microbiology programme is of 100 credits.**

2.3. All four theory Major/core courses are compulsory in the first semester.

2.4. In the second and third semester, the student can choose one major elective course according to their interest and the resources available in the university /colleges.

2.5. All the theory papers in the fourth semester are major elective courses from which the student can choose any four elective courses as per their interest.

2.6. In the first year of post-graduation, the student will have to take only 1 minor elective course from other faculty of 4 (four) credits.

2.7. To conduct the M.Sc.- Microbiology programme systematically and within a time bound frame, the department shall strictly adhere to academic calendar notified by the university in the beginning of academic session.

2.8. A candidate admitted to the M.Sc.- Microbiology programme shall pursue a regular mode of study in all the four semesters and attend a minimum of 75% of the total classes held to be eligible for appearing in the semester examinations.

2.9. If a student fails to attend requisite classes (minimum of 75%) in a semester due to medical ground, there may be given relaxation of 15% attendance (5% at the level of Head of Department and 10% at the level of Vice-Chancellor) on production of medical certificate.

2.10. Semester examinations of the M.Sc.- Microbiology programme shall be conducted by way of theory papers, practical and industrial training/surveys/research project. Each theory of major/core and elective paper will be of 100 marks out of which 75 marks shall be allocated for

End Semester Examination (ESE) and 25 marks for Continuous Internal Evaluation (CIE). The pattern of question papers for theory examinations will be as per the University norms.

2.11. Continuous Internal Evaluation (CIE) is an integral part of the courses and is compulsory for all students. The academic performance of a student is evaluated by assessing day to day performance, attendance, assignments, periodic tests, seminar presentation, subject's quiz, class discussion, etc. There shall be no mid-term examination of CIE will be held rather a teacher assess the student along with the class teaching.

**The 25 Marks of CIE shall be allocated as given below:**

10 marks for Test/Subject' quiz,

10 marks for presentation along with assignment

05 marks for Class interactions, discussion, performance, attendance.

2.12. The responsibility of evaluating the internal assessment is vested on the teacher(s) who teaches the course.

2.13. One practical (4 credits of 100 marks) examination shall be conducted which will be assessed jointly by the internal examiner of the department and the external examiner nominated by the university at the end of each semester of 75 marks and 25 marks of internal practical are assessed by concerned teacher of the course and will be averaged before online submission.

2.14. The end semester examinations shall be held as per academic calendar notified by the university.

2.15. Industrial Training/Surveys /Research Project: In the first and second year, the student will have to do a major research project including internship/technical report/comprehensive review/online or field surveys work/training in industry or institute.

2.16. Industrial Training/Surveys/Research Project can also be interdisciplinary or multi-disciplinary.

2.17. The research project will be done under the guidance of a teacher (supervisor) of the department. In case of topic of the research project is interdisciplinary/ multidisciplinary, the student may carry out their research work under a Co-supervisor from outside the department viz Industry/Company/Technical Institute/Research Institute.

2.18. Bachelor's Degree (with Research) and postgraduate students will be required to undertake a research project of four credits (4 hours per week) in each semester.

2.19. Students will submit the final report (project report/dissertation) of the research project carried out in both the semesters at the end of the year, which will be assessed out of 100 marks - 8 credits jointly by the respective supervisor and the external examiner nominated by the university or as per the directive of university at the end of the academic year. The student has to submit a project report/dissertation/technical report in hard bound form duly certified by the supervisor. The evaluation of the project/dissertation/technical report/comprehensive review of the student will be done through presentation and viva-voce examination.

2.20. If a student publishes any research papers from their research project work in the UGC-CARE listed Journals and published during the Programme, then they can be given additional marks up to 25 in the evaluation of the research project (out of 100). The maximum received will be 100.

2.21. The marks obtained in the research project will be marked as grades and they will also be included in the calculation of CGPA.

2.22. It will be necessary to take the exam for credit validation. Credit will be incomplete without the examination.

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- 2.23.If a student qualifies for the examination on the basis of attendance in the class, however, is not able to give the examination due to any reason, then they can appear for the qualifying examination as per university PG ordinance- 2023, however, they will not need to attend the classes again.
- 2.24.Matters pertaining to the syllabi and conduct of examination shall be dealt with by the Board of Studies (BoS) constituted by the Vice-Chancellor.
- 2.25.The BoS shall recommend the panel of paper setters/examiners to the Vice-Chancellor. After getting approval from the Vice-Chancellor, the appointment letters shall be issued to the concerned paper setters/examiners by the Registrar/Controller of Examination of University.
- 2.26. Question papers for theory examination in sealed envelope shall be handed over/sent by registered post to the Registrar/Controller of Examination by the Examiners. Controller of Examinations will ensure the printing of question papers and fair conduct of the examinations.
- 2.27.The Registrar/Controller of the Examinations, with the approval of the Vice-Chancellor shall associate one or two members of the BoS for the moderation of the papers. The moderated papers shall have to be printed by the Registrar/Controller of the Examinations well before commencement of the Examinations.
- 2.28.After printing the questions papers in sealed covers, shall be handed over to the Examination Superintendent who will ensure the smooth and fair conduct of the examinations.
- 2.29.For appearing in the M.Sc.- Microbiology semester examination each student shall have to deposit a prescribed examination fee along with a copy of online filled examination form for online verification. Separate fees will also be charged for back and improvement papers as per university norms.
- 2.30.After the examinations, Controller of Examinations/Technical Cell for campus courses shall ensure the evaluation of the answer books and declaration of results of semester examinations within a reasonable time so as to enable the department to adhere to the Academic Calendar.
- 2.31.Practical examinations of semester VII (M.Sc.-I sem), VIII (M.Sc.-II sem), IX (M.Sc.-III sem) and X(M.Sc.-IV sem) shall be conducted by one internal and one external examiner nominated by the university.
- 2.32.The students of M.Sc.- Microbiology Programme shall be examined in the subjects in accordance with course curriculum and per the University PG programs ordinance-2023.

### 3. RESULTS, PROMOTION AND IMPROVEMENT

- 3.1. If a student wants to leave after passing the first year of post-graduation by earning a minimum of 52 credits, then he will be awarded a bachelor's (with research) degree. After earning a minimum of 52+48 credits in the first and second year of post-graduation, the student will be awarded a master's degree in that main subject of that faculty.
- 3.2. The results of M. Sc.- Microbiology semester examination shall be declared pass as per the University PG programs ordinance-2023.
- 3.3. If a student fails in more than 4 papers in an academic year, he/she will not be promoted to the next year. Such student should be re-admitted as Ex. Student with coming batch and their seat will

be counted as supernumerary.

- 3.4. Students, who failed in 4 or lower number of papers in the academic year will be awarded back<sup>4</sup> and given two chances to reappear and pass in respective paper(s) in next year and the following year with regular semester examination. There will not be any supplementary/special examination for back/improvement papers. However, all such papers must be cleared within two years ending fourth semester.
- 3.5. In order to pass the 2-year M.Sc.- Microbiology programme the students must pass both the year separately. The final result shall be declared on the basis of the combined marks secured by a candidate in all the four semesters as per the University PG programs ordinance-2023.
- 3.6. Student securing highest number of marks during the course in the first attempt will be awarded the University Gold Medal for the same.
- 3.7. Conversion of Marks into Grades, Grade points and CGPA calculation shall be applicable as per University PG programs ordinance-2023.




As per the BoS held on 24.07.2024

**Master of Science in Microbiology (M. Sc.- Microbiology) Programme**  
Syllabus Development as per Guidelines of National Education Policy-2020 (NEP 2020)

Syllabus Developed by				
Name	BoS Convener/ Member/ Experts	Designation	Department	University
Prof. Rajesh Sharma	Convener BoS - Microbiology	Professor	Microbiology, Faculty of Science	Veer Bahadur Singh Purvanchal University, Jaunpur
Prof. Gopal Nath	External Expert	Professor	Institute of Medical Science	Banaras Hindu University, Varanasi
Prof. Shailendra Kumar	External Expert	Professor	Microbiology, Faculty of Science	RML Avadh University, Ayodhya

  
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**Fourth Year / M.Sc. – Microbiology 1<sup>st</sup> Year**

Programme	Semester	Course Code	Course Type	Paper Title	Theory/ Practical / Project	Credits	Maximum Marks			
							CIE	ESE	Total	
Bachelor's Degree (with Research)	VII (M.Sc.- I)	B080701T	Major/ Core	Bacteriology	Theory	4	25	75	100	
		B080702T	Major/ Core	Bacteriological Techniques	Theory	4	25	75	100	
		B080703T	Major/ Core	Cell Biology and Biochemistry	Theory	4	25	75	100	
		B080704T	Major/ Core	Molecular Biology & Microbial Genetics	Theory	4	25	75	100	
			Minor Elective	Other Faculty	Theory	4	25	75	100	
		B080705P	Major	Practical I	Practical	4	25	75	100	
						<b>24</b>			<b>600</b>	
	VIII (M.Sc.-II)	B080801T	Major/ Core	Virology	Theory	4	25	75	100	
		B080802T	Major/ Core	Immunology and Immunotechnolo gy	Theory	4	25	75	100	
		B080803T	Major/ Core	rDNA Technology	Theory	4	25	75	100	
		B080804T	Major Elective Course 1*	Instrumentation and Analytical Techniques	Theory	4	25	75	100	
		B080805T	Major Elective Course 2*	Extremophiles & their Application	Theory	4	25	75	100	
		B080806P	Major/ Core	Practical II	Practical	4	25	75	100	
		B080807R	Major/ Core	Industrial Training/ Survey/ Research Project I	Project	8	-	100	100	
						<b>28</b>			<b>600</b>	
									<b>120</b>	
							<b>52</b>			<b>120</b>

CIE- Continuous Internal Evaluation

ESE – End Semester Examination

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Fifth Year / M.Sc. – Microbiology 2<sup>nd</sup> Year

Programme	Semester	Course Code	Course Type	Paper Title	Theory/ Practical/ Project	Credits	Maximum Marks			
							CIE	ESE	Total Marks	
Master of Science in Microbiology	IX (M.Sc.-III)	B080901T	Major/ Core	Industrial Microbiology	Theory	4	25	75	100	
		B080902T	Major/ Core	Microbial Physiology & Metabolism	Theory	4	25	75	100	
		B080903T	Major/ Core	Environmental Microbiology	Theory	4	25	75	100	
		B080904T	Elective Course 1*	Biostatistics & Bioinformatics	Theory	4	25	75	100	
		B080905T	Elective Course 2*	Microbial Biodiversity	Theory	4	25	75	100	
		B080906P	Major/ Core	<i>Practical III</i>	Practical	4	25	75	100	
							<b>20</b>			<b>500</b>
	X (M.Sc.-IV)	B081001T	Major Elective Course 1 <sup>#</sup>	Food Microbiology	Theory	4	25	75	100	
		B081002T	Major Elective Course 2 <sup>#</sup>	Agricultural Microbiology	Theory	4	25	75	100	
		B081003T	Major Elective Course 3 <sup>#</sup>	Clinical Microbiology	Theory	4	25	75	100	
		B081004T	Major Elective Course 4 <sup>#</sup>	Entrepreneurship, IPR & Biosafety	Theory	4	25	75	100	
		B081005T	Major Elective Course 5 <sup>#</sup>	Microbial Pathogenicity	Theory	4	25	75	100	
		B081006T	Major Elective Course 6 <sup>#</sup>	Plant Pathogen Interaction	Theory	4	25	75	100	
		B081007T	Major Elective Course 7 <sup>#</sup>	Mycology & Phycology	Theory	4	25	75	100	
		B081008T	Major Elective Course 8 <sup>#</sup>	Bioprocess Technology	Theory	4	25	75	100	
		B081009P	Major/ Core	<i>Practical IV</i>	Practical	4	25	75	100	
		B081010R	Major/ Core	<i>Industrial Training/ Survey/ Research Project IV</i>	Project	8	-	100	100	
							<b>28</b>			<b>600</b>
							<b>48</b>			<b>1100</b>
							<b>100</b>			<b>2300</b>

**PROGRAMME SPECIFIC OUTCOMES (PSOs)**  
**Bachelor's Degree with Research /M. Sc.-Microbiology**

This course introduces the knowledge of bacteriology, virology, molecular biology and genetic engineering. After completion of this course, students will be able to –

- PSO1:** Demonstrate and apply the knowledge of microbiology in core and allied fields.
- PSO2:** Perform practical in different microbiology courses.
- PSO3:** Understand the applications of microbiology in local and national development.

**M. Sc. Microbiology**  
**Programme Objectives (POs)**

At the time of completion of the programme the student will have developed extensive knowledge in various areas of Microbiology. Through the stimulus of scholarly progression and intellectual development the programme aims to equip students with excellence in education and skills, thus enabling the student to pursue a career of his/her choice. By cultivating talents and promoting all round personality development through multi-dimensional education a spirit of self-confidence and self-reliance will be infused in the student. The student will be instilled with values of professional ethics and be made ready to contribute to society as responsible individuals.

**M. Sc. Microbiology**  
**Programme Specific Outcomes (PSOs)**

After completing the two years degree course in M. Sc. Microbiology, the students will be:

- PSO1:** Able to understand and explain the technical aspects associated with existing microbiological challenges.
- PSO2:** Able to explain about various applications of Microbiology such as Environmental Microbiology, Industrial Microbiology, Food Microbiology, and Clinical Microbiology.
- PSO3:** Able to design and execute experiments related to Basic Microbiology, Immunology, Molecular Biology, Recombinant DNA Technology, and Microbial Genetics.
- PSO4:** Able to execute a short research project incorporating techniques of Basic and Advanced Microbiology
- PSO5:** Equipped to take up a suitable position in academia or industry.

The block contains three handwritten signatures or initials in blue ink. The top signature is a stylized, cursive mark. The middle signature is a large, bold 'R' with a horizontal line through it. The bottom signature is a cursive name, possibly 'J. Nalla', with a horizontal line underneath.

<b>Programme/Class:</b> <b>Bachelor's Degree with Research /</b> <b>M. Sc. Microbiology (I)</b>		
<b>Subject: Microbiology</b>	<b>Year: First (1)</b>	<b>Semester: First (I)</b>
<b>Core Paper (Compulsory)</b>	<b>Course Code: B080701T</b>	<b>BACTERIOLOGY</b>
<b>Marks: 100</b>	<b>75 (UE) + 25 (CIE)</b>	<b>Credits: 04</b>
<b>Total Number of Lectures-Tutorials-Practical (in hours per week L-T-P: 4-0-0)</b>		
Course Objectives	The primary objective of the course is to build a strong foundation in the area of bacterial cell structure, division, survival and propagation	
Course Learning Outcomes	Upon successful completion of the course, the student:	
CO1	Will be able to describe the morphological features, cell arrangement and structural components of bacterial cell in detail; will be able to differentiate between Gram-positive and Gram-negative bacteria.	
CO2	Will have gained knowledge about cell wall structure and extracellular appendages in different bacteria and is acquainted with current methodologies available for production of protoplasts, sphaeroplasts and L-forms.	
CO3	Will have gathered detailed information regarding bacterial cell division and endospore formation. Can enlist the salient features of the genome organization of <i>E. coli</i> .	
CO4	Can enlist the characteristics of archaea that differentiate it from eubacteria, and will have learnt key features of some model archaeal organisms.	
CO5	Can understand the basic concept of bacterial systematics and prokaryotic species. Develop an understanding of phenetic and phylogenetic classification with polyphasic approach of taxonomy	
Contents		Duration: 60 hours
UNIT I	Bacterial cell structure and appendages: Overview of eubacterial cell organization: nucleoid, ribosomes, intracytoplasmic membranes and cell inclusions. Detailed account of biogenesis and function of various cell structure appendages: flagella- structure, assembly and mechanism of movement; pili and fimbriae- types, structure and their role. External cell surface structures: capsule, glycocalyx, slime layer and S-layer.	12 Hours
UNIT II	Bacterial cell wall and cell membrane: Overview of gram negative and gram positive bacterial cell wall, outer membrane lipopolysaccharide (LPS). Detailed account of cell wall synthesis and its inhibitors including different antibiotics.	12 Hours
UNIT III	Bacterial cell division and reproduction: Genome organization of <i>E. coli</i> , Binary fission and other forms of reproduction in bacteria, bacterial cell cycle, assembly, maintenance and disassembly of Z ring, endospore structure and stages involved in endospore development in <i>Bacillus subtilis</i> .	12 Hours
UNIT IV	Archaeobacteria and Extremophiles: Introduction to extremophiles like-hyperthermophiles, psychrophiles, halophiles, acidophiles, methnogenic extremophiles etc. Adaptation mechanisms of extremophiles, Importance of extremophilic microbial diversity in environment, pharmaceuticals & human health and industry, General characteristics of archaeal cell structure and comparison with eubacteria.	12 Hours
UNIT V	Bacterial Systematics: Identification and classification of bacteria based on classical and modern approach, Numerical Taxonomy; 16s rRNA	12 Hours

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	<p>Analysis, Polyphasic Taxonomy, FAME Analysis, Prokaryotic Species Concept, Phylogenetic trees. General features of Archaea, Actinomycetes, Cyanobacteria, Mollicutes, <i>Rickettsia</i> and <i>Chlamydia</i>.</p>	
<p>Suggested Readings</p>	<ol style="list-style-type: none"> <li>1. Prescott's Microbiology by J. Willey, L. Sherwood, C. J. Woolverton. 10th edition. McGraw Hill Education. 2017.</li> <li>2. Brock Biology of Microorganisms by M. Madigan, K. Bender, D. Buckley, W. Sattley, D. Stahl. 15th Edition. Pearson Education. 2018.</li> <li>3. Alcamo's Fundamentals of Microbiology by J. C. Pommerville. 10th Edition. Jones and Bartlett Learning. 2013.</li> <li>4. Archaea Molecular and Cellular Biology by Ricardo Cavicchioli. American Society of Microbiology. 2007.</li> <li>5. The Physiology and Biochemistry of Prokaryotes by D. White, J. Drummond, C. Fuqua. 4th Edition. Oxford University Press. 2011.</li> </ol>	


<b>Programme/Class:</b> <b>Bachelor's Degree with Research /</b> <b>M. Sc. Microbiology (I)</b>		
<b>Subject: Microbiology</b>	<b>Year: First (I)</b>	<b>Semester: First (I)</b>
<b>Core Paper (Compulsory)</b>	<b>Course Code: B080702T</b>	<b>BACTERIOLOGICAL TECHNIQUES</b>
<b>Marks:100</b>	<b>75 (UE) + 25 (CIE)</b>	<b>Credits: 04</b>
<b>Total Number of Lectures-Tutorials-Practical (in hours per week L-T-P: 4-0-0)</b>		
Course Objectives	The primary objective of the course is to build a basic foundation in the area of bacteriological techniques used for isolation and cultivation of bacteria.	
Course Learning Outcomes	Upon successful completion of the course, the student:	
CO1	Will understand the basic concepts of various microbiological techniques and their applications.	
CO2	Will be able to understand the basic principles of sterilization. It will also develop an understanding about selection of suitable method for sterilization and disinfection	
CO3	Will learn the features of bacterial growth and phases of bacterial growth with various factors affecting growth.	
CO4	Will understand learn various conventional and non-conventional techniques of isolation and cultivation of bacteria. He/she will also be able to understand the techniques for isolation of unculturables.	
CO5	Will learn various techniques for short term and long term storage of microorganisms.	
Contents		Duration: 60 hours
UNIT I	Microscopy: Basics of microscopy: image formation, magnification, resolution, Biological applications and instrumentation of various kinds of microscopy: Optical Microscopy, Fluorescence, Confocal and Electron Microscopy. Stains, dyes and staining techniques	12 Hours
UNIT II	Methods of Disinfection and Sterilization: Chemical Disinfection by Alcohols, Formaldehyde Phenolic Compounds, Quaternary Ammonium Compounds, Chlorine, Iodophors and Heavy Metals; Sterilization by Moist Heat, Dry Heat, Mathematical modeling of sterilization processes, Arrhenius equation, Del factor, effect of sterilization on media quality and yield coefficients, batch and continuous sterilization, Sterilization Gases (Ethylene Oxide, Formaldehyde, Hydrogen Peroxide, Chlorine Dioxide) and Filtration. filter and steam sterilization at industrial scale	12 Hours
UNIT III	Bacterial Growth: Definition of growth, mathematical expression of growth, growth curve, measurement of growth and growth yield, synchronous culture, Introduction of continuous culture; Factors affecting growth.	12 Hours
UNIT IV	Techniques for Isolation and Cultivation: Techniques for Isolation of Aerobic and Anaerobic Bacteria; Micromanipulation techniques and Laser micromanipulation systems (Optical tweezers and Laser microdissection); Cultivation of bacteria and fungi, Approaches for the cultivation of Unculturables, Types of media. Techniques for isolation and cultivation of Viruses and Fungi	12 Hours

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UNIT V	Preservation and Maintenance of Microorganisms: Short-Term Preservation Methods- Subculturing, Immersing in Oil, Ordinary Freezing, Deep Freezing, Drying; Long-Term Preservation Methods- Freeze-Drying (Lyophilization and Ultrafreezing; Preservation of Representative Genera And Specific Groups- Anaerobes, Cyanobacteria, Methanogens, Plasmid-Containing Bacteria and Spore formers. Culture Collections and their Functions.	12 Hours
Suggested Readings	<ol style="list-style-type: none"> <li>1. Prescott's Microbiology by J. Willey, L. Sherwood, C. J. Woolverton. 10<sup>th</sup> edition. McGraw Hill Education. 2017.</li> <li>2. Brock Biology of Microorganisms by M. Madigan, K. Bender, D. Buckley, W. Sattley, D. Stahl. 15<sup>th</sup> Edition. Pearson Education. 2018.</li> <li>3. Alcamo's Fundamentals of Microbiology by J. C. Pommerville. 10<sup>th</sup> Edition. Jones and Bartlett Learning. 2013.</li> <li>4. Archaea Molecular and Cellular Biology by Ricardo Cavicchioli. American Society of Microbiology. 2007.</li> <li>5. The Physiology and Biochemistry of Prokaryotes by D. White, J. Drummond, C. Fuqua. 4<sup>th</sup> Edition. Oxford University Press. 2011.</li> </ol>	

  
  
  
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<b>Programme/Class:</b> <b>Bachelor's Degree with Research /</b> <b>M. Sc. Microbiology (I)</b>		
<b>Subject: Microbiology</b> <b>Core Paper (Compulsory)</b>	<b>Year: First (I)</b> <b>Course Code: B080703T</b>	<b>Semester: First (I)</b> <b>BIOCHEMISTRY &amp; CELL</b> <b>BIOLOGY</b>
<b>Marks:100</b>	<b>75 (UE) + 25 (CIE)</b>	<b>Credits: 04</b>
<b>Total Number of Lectures-Tutorials-Practical (in hours per week L-T-P: 4-0-0)</b>		
Course Objectives	The primary objective of the course is to build a basic understanding about various biomolecules and Cell Biology. The course has been developed to understand the basic structure composition and functional aspects of the cell.	
Course Learning Outcomes	Upon successful completion of the course, the student:	
CO1	Will learn about structure and functions of proteins and lipids. Develop a t basic concept of protein folding and sequencing	
CO2	Will learn about structure, functions and classification of carbohydrates and Nucleic acids.	
CO3	Will learn how individual proteins bind to specific substrates and other molecules to mediate catalysis.	
CO4	Will understand the basic structure composition and functional aspects of the cell.	
CO5	Will understand the basic concepts of cell to cell communication, cell cycle, programmed cell death and mechanisms of development of cancer.	
Contents		
UNIT I	Structures of Proteins- Primary; secondary (Ramachandran plot); tertiary and quaternary structure; Protein folding and methods of protein sequencing. Lipids: Classification, structure, properties and function of fatty acids	Duration: 60 hours 12 Hours
UNIT II	Carbohydrates: Structure, Classification and general properties of Carbohydrates. Complex carbohydrates, mucopolysaccharides, amino sugars and glycoproteins. Nucleic Acids; Structure and function of nucleotides, RNA and 3D structure of tRNA, DNA topology; A, B and Z DNA. satellite DNA.	12 Hours
UNIT III	Classification, structure and function of Enzymes, coenzymes, cofactors and prosthetics groups. Enzyme kinetics: Mechanism of action- Competitive, Uncompetitive, Non-competitive and Mixed inhibition, Allosteric and Regulatory enzymes.	12 Hours
UNIT IV	Organization of Eukaryotic Cell: Structure and function of Nucleus, mitochondria, chloroplast, mechanism of Protein segregation, Cell interaction: Cell-cell adhesion, cytoskeleton.	12 Hours
UNIT V	Cell signalling and cell differentiation, Cell cycle and its control, Apoptosis, Characteristics of cancer cells, Mechanism of Carcinogenesis, Agents promoting carcinogenesis.	12 Hours
Suggested Readings:	1. Principles of Biochemistry (5th Edition) – Lehninger, Nelson and Cox. Pub Macmillan 2. Harper's Illustrated Biochemistry, (28th Edition) – R.K. Murray, D.K. Garner, P.A. Mayers and V.W. Rockwell, Pub: McGraw Hill International Edition. 3. Biochemistry (3rd Edition) – G. Zubay., Pub: Wm. C. Brown Pub. 4. Biochemistry (5th Edition) – Lubert Stryer. Pub: W.H. Freeman and Com., NY.	

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5. Biochemistry – (2nd edition) D. Voet and J.G. Voet Pub: John Willy and Son
6. Molecular biology of the cell, (4th Edition) – Bruce Albert, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts and Peter Walter, Pub: G.S. Garland science Taylor and Francis Group New York – NY 10001-
7. Molecular Cell Biology, (5th Edition) H. Lodish, A. Berk P. Matsudaira Chris A.Kaiser, M.Krieger. M. P. Scott, L. Zipursky, J. Darnell. Pub: W.H. Freeman and Com., NY.
8. Cell and Molecular Biology: Concepts and Experiments: Gerald Karp, VithEds

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<b>Programme/Class:</b> <b>Bachelor's Degree with Research /</b> <b>M. Sc. Microbiology (I)</b>		
<b>Subject: Microbiology</b>	<b>Year: First (I)</b>	<b>Semester: First (I)</b>
<b>Core Paper (Compulsory)</b>	<b>Course Code: B080704T</b>	<b>MOLECULAR BIOLOGY &amp; MICROBIAL GENETICS</b>
Marks:100	75 (UE) + 25 (CIE)	Credits: 04
<b>Total Number of Lectures-Tutorials-Practical (in hours per week L-T-P: 4-0-0)</b>		
Course Objectives	The primary objective of this course is to develop an understanding of structure of gene its multiplication, expression and regulation in prokaryotic and eukaryotic microbial systems	
Course Learning Outcomes	Upon successful completion of the course, the student:	
CO1	Will learn about mechanism of Conjugation and bacterial gene mapping	
CO2	Will learn about mechanism of transformation and transduction.	
CO3	Will learn how the DNA replicates in Prokaryotic and eukaryotic cell along with the mechanism of DNA repair. Will also learn about concepts of CRISPR-Cas systems	
CO4	Will understand the basic concepts of transformation and transduction along with the mechanisms of post transcriptional RNA processing.	
CO5	Will understand the mechanism of gene regulation and learn about transposable genetic elements	
Contents:		Duration: 60 hours
UNIT I	Mutation, Mechanism of Conjugation, discovery, formation of Hfr and F' and their role in recombination, concept of transferosomes, bacterial gene mapping.	12 Hours
UNIT II	Transformation: discovery, mechanism of transformation in Gram positive and Gram-negative bacteria., Transduction- discovery, generalized and specialized recombination, regulation of lytic and lysogenic cycle	12 Hours
UNIT III	Replication of genetic material in prokaryotes and eukaryotes, DNA repair and recombination, DNA mismatch repair, Double Strand Break repair, recombination as a molecular biology tool, CRISPR-Cas systems for editing, regulating and targeting genomes.	12 Hours
UNIT IV	Mechanism of transcription in prokaryotes and eukaryotes, transcription factors. RNA polymerases., Translation: In Prokaryotes and Eukaryotes. Post transcriptional RNA processing (mRNA, tRNA and rRNA).	12 Hours
UNIT V	Regulation of gene expression, Positive and negative control, operon concepts – <i>lac</i> - and <i>trp</i> -operon, attenuation. An overview of regulation of gene expression in prokaryotes and eukaryotes, <i>cis</i> acting sites and <i>transacting</i> molecules. Transposable genetic elements.	12 Hours
Suggested Readings	<ol style="list-style-type: none"> <li>1. Genetics: Analysis and Principles by Robert J. Brooker, IIIrdEds</li> <li>2. Principles of Genetics by Eldon J. Gardner, 12thEds</li> <li>3. Modern Genetic Analysis: Integrating Genes and Genomes by Anthony J.F. Griffiths 7th</li> <li>4. Gene by Benjamin Lewin, IXthEds,Oxford Univ. Press, U.K..</li> <li>5. Molecular Biology of gene by Watson, 12th Eds</li> <li>6. Genetics Strickberger 13thEds</li> </ol> Cell and Molecular Biology (8th Edition) – DeRobertis and DeRoberties, B.I. Pub.	

As per the BoS held on 24.07.2024

Publishers Pvt Ltd. N. Delhi

**Programme/Class:**  
**Bachelor's Degree with Research /**  
**M. Sc. Microbiology (I)**

<b>Subject: Microbiology</b>	<b>Year: First (1)</b>	<b>Semester: First (I)</b>
<b>Minor Elective (Optional)</b>	<b>Course Code: to be provided by other faculty</b>	<b>MINOR (OTHER FACULTY)</b>
Marks:100	<b>75 (UE) + 25 (CIE)</b>	Credits: 04
<b>Total Number of Lectures-Tutorials-Practical (in hours per week L-T-P: 4-0-0</b>		
Duration: 60 hours		

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<b>Programme/Class:</b> <b>Bachelor's Degree with Research /</b> <b>M. Sc. Microbiology (I)</b>		
<b>Subject: Microbiology</b>	<b>Year: First (1)</b>	<b>Semester: First (I)</b>
<b>Core Paper (Compulsory)</b>	<b>Course Code: B080705P</b>	<b>Practical I</b>
<b>Marks:100</b> <b>75 (UE) + 25 (CIE)</b>	<b>Credits: 04</b>	<b>Duration: 120 hours</b>
<b>Total Number of Lectures-Tutorials-Practical (in hours per week L-T-P: 0-0-8)</b>		
<b>Course Objectives</b>	The major objective of the course is to impart hands-on training in basic microbiological and biochemical techniques. Students will be trained in basic bacterial culturing and identification methods, as well as working in biosafety cabinet. Student will become familiar with sterilization techniques when handling bacterial cells. Student will be trained in basic assays and be taught to present the results both, qualitatively and quantitatively.	
<b>Course Learning Outcomes</b>	Upon successful completion of the course, the student:	
CO1:	Will be able to use different sterilization procedures and learn handling of micropipette.	
CO2:	Will be able to work in Biosafety Cabinet.	
CO3:	Will be versed with identification and classification of given bacterial isolate by performing variety of cultural and biochemical tests.	
CO4:	Can determine pI of amino acids by titration method	
CO5:	Can determine concentration of sugar and protein in a given sample after drawing a standard curve.	
<b>Contents:</b>		
<ol style="list-style-type: none"> <li>1. To train students in handling, upkeep and calibration of micropipette for measuring small volumes</li> <li>2. To give hands-on training in sterilization techniques and their application in microbiology lab</li> <li>3. To train student in working with a biosafety cabinet in a BSL2 lab</li> <li>4. To purify and identify the given bacterial sample by determining their:- Colony morphology, staining characteristics and biochemical characteristics</li> <li>5. To analyze the given 16srRNA sequences by using BLAST and construct a phylogenetic tree based on the comparison results.</li> <li>6. To draw the titration curve of amino acid and determine its pI.</li> <li>7. To prepare standard curve of BSA and determine the concentration of unknown protein sample using Bradford / Lowry method using regression equation.</li> <li>8. Quantitative estimation of carbohydrate (anthrone/phenol-H<sub>2</sub>SO<sub>4</sub>/Dinitrosalicylic acid method).</li> <li>9. Quantitative estimation of proteins by biuret.</li> <li>10. Saponification and acid value of fats</li> <li>11. Estimation of DNA by diphenylamine method</li> <li>12. Estimation of RNA by orcinol method</li> <li>13. To prepare standard curve of ammonia and determine its uptake by bacterial cells with respect to time and temperature</li> <li>14. To determine the specific growth rate of <i>E. coli</i> in different media.</li> <li>15. Staining techniques for bacterial cells: simple, differential, negative, specialized</li> <li>16. Measurement of growth and preparation of growth curve</li> <li>17. To study glucose uptake by <i>E. coli</i>.</li> <li>18. Effect of temperature, pH, salt concentration, antibiotics on growth.</li> <li>19. Calculation of generation time and specific growth rate.</li> <li>20. Microscopic measurements (micrometry)</li> </ol>		
<b>Suggested Readings:</b>	<ol style="list-style-type: none"> <li>1. Microbiology: A laboratory manual by JG Cappucino, C.T. Welsh. 11<sup>th</sup> edition. Pearson. 2017.</li> <li>2. Biochemistry Lab Manual by D.A. Thompson, 3<sup>rd</sup> edition. Create Space</li> </ol>	

Independent Publishing Platform. 2013.

3. Biochemical calculations: how to solve mathematical problems in general biochemistry by Irwin H. Segel, Wiley, 2<sup>nd</sup> Edition 2004
4. Practical Biochemistry (3rd Edition) – David Plummer. Pub: Tata McGraw Hill
5. Practical Biochemistry (5th Edition) – K. Wilson and J. Walker. Pub: Cambridge Univ. Press, (U.K.)



**Programme/Class:**  
**Bachelor's Degree with Research /**  
**M. Sc. Microbiology (I)**

<b>Subject: Microbiology</b>	<b>Year: First (1)</b>	<b>Semester: Second (II)</b>
<b>Core Paper (Compulsory)</b>	<b>Course Code: B080801T</b>	<b>VIROLOGY</b>
<b>Marks:100</b>	<b>75 (UE) + 25 (CIE)</b>	<b>Credits: 04</b>
<b>Total Number of Lectures-Tutorials-Practical (in hours per week L-T-P: 4-0-0)</b>		
Course Objectives:	The course will facilitate in understanding of molecular virology by examining common processes and principles in viruses to illustrate viral complexity, to understand viral reproduction. The course will teach the strategies by which viruses spread within a host, and are maintained within populations. It covers the molecular biology of viral reproduction and addresses the interplay between viruses and their host organisms	
Course Learning Outcomes:	Upon successful completion of the course, the student	
CO1	Is able to describe classification of viruses	
CO2	Is able to describe tools for studying virus structure, process of virus attachment and entry, virus assembly and release	
CO3	Is able to describe steps in replication of genome of RNA viruses, retroviruses, and DNA viruses	
CO4	Is able to describe steps in virus infection, transmission, patterns of infection, virus virulence, and host defense against virus infection	
CO5	Is able to describe methods of making virus vaccines and anti-viral drugs, drivers of virus evolution, and emerging viruses	
Contents:		Duration: 60 hours
UNIT I	Introduction to Virology: The big picture of all viruses using a common strategy, virus classification, the infectious cycle, studying virus infection. Koch's Postulates for viruses, virus genome types, double stranded DNA (dsDNA),gapped DNA genomes, single-stranded (ssDNA) genomes, double stranded RNA (dsRNA), single stranded RNA (ssRNA), (+) strand RNA, single stranded (+) sense RNA with DNA intermediate, single stranded RNA (-) sense, ambisense RNA genomes.	12 Hours
UNIT II	Virus Structure and Assembly: Metastability, the tools for viral structural biology. Helical symmetry, Icosahedral symmetry, Triangulation number, Quasi-equivalence. Virus attachment and entry, Initiation of infection, Cellular receptor for viruses. Getting into the nucleus, virus disassembly, metastable structures, concentrating components for assembly, getting things to the right place. How do viruses make sub-assemblies, sequential and concerted assembly. Packaging signals, packaging of segmented genome, acquisition of an envelope, budding strategies.	12 Hours
UNIT III	RNA directed RNA synthesis, Reverse Transcription and Integration, Translation, and genome replication of DNA viruses: Identification of RNA polymerase, how RNA synthesis occurs in viruses? Reverse transcriptase, retrovirus genome organization, steps of DNA synthesis in retroviruses. Regulation of translation in virus infected cells. Basic rules of genome replication in DNA viruses, viral origins	12 Hours

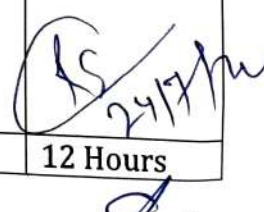
	of DNA replication. Generic steps in transcription, host polymerases, initiation, splicing, alternate splicing, promoter structure, steps in regulation of transcription, enhancers, virus coded transcriptional regulators, transcriptional cascade, export.	
UNIT IV	Virus Infections basics, interaction with host, acute and persistent infections: Fundamental questions of viral pathogenesis. Virion defenses to hostile environment, viral spread, viremia, determinants of tissue tropism. Virus shedding, transmission of infection, host defense, innate immune response, virus virulence, identifying virulence genes. Toxic viral proteins, cellular virulence genes, immunopathology, systemic inflammatory response syndrome. Immune complexes, virus induced auto-immunity, general pattern of infection. Inapparent acute infections, defense against the acute infection. Influenza, Polio, Measles, Rotavirus, persistent infections, chronic and latent Infections.	12 Hours
UNIT V	Anti-Viral drugs, virus evolution and emerging viruses: Anti-viral drugs, search for anti-viral drugs, the quasi-species concept, error threshold, genetic bottlenecks, Muller ratchet, genetic shift and drift. Theories on origin of virus, evolution of new viruses, emerging viruses.	12 Hours
Suggested Readings	<ol style="list-style-type: none"> <li>1. Principles of Virology: Molecular Biology, Pathogenesis and Control of Animal Viruses by S.J. Flint, L.W. Enquist, V.R. Racaniello, A.M. Skalka. 4<sup>th</sup> edition. ASM Press. 2015.</li> <li>2. Introduction to Modern Virology by N. Dimmock, A. Easton, K. Leppard. 7<sup>th</sup> edition. Blackwell Publishing. 2016.</li> <li>3. Basic Virology by Edward K. Wanger, M. Hewiett, D. Bloom, D. Camerini. 3<sup>rd</sup> edition. Blackwell Publishing. 2007.</li> </ol> Principles of Molecular Virology by A.J. Cann. 6 <sup>th</sup> edition. Elsevier Academic Press. 2015. e protein-only hypothesis.	

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<b>Programme/Class:</b> <b>Bachelor's Degree with Research /</b> <b>M. Sc. Microbiology (I)</b>		
<b>Subject: Microbiology</b>	<b>Year: First (I)</b>	<b>Semester: Second (II)</b>
<b>Core Paper (Compulsory)</b>	<b>Course Code: B080802T</b>	<b>IMMUNOLOGY &amp;</b> <b>IMMUNOTECHNOLOGY</b>
Marks:100	<b>75 (UE) + 25 (CIE)</b>	Credits: 04
<b>Total Number of Lectures-Tutorials-Practical (in hours per week L-T-P: 4-0-0)</b>		
Course Objectives	The objective of this course is to understand the various components of the host immune system, their structure and organization, and functions to serve as the defense system of the body. It would also make the students understand the operational mechanisms which underlie the host defense system, allergy and organ transplantation.	
Course Learning Outcomes	Upon successful completion of the course, the student:	
CO1	Will be able to understand the fundamental bases of immune system and immune response.	
CO2	Will be able to gather information about the structure and organization of various components of the immune system and Immunological techniques	
CO3	Will be able to understand the genetic organization of the genes meant for expression of immune cell receptors and the bases of the generation of their diversity	
CO4	Will be able to understand the operation and the mechanisms which underlie the immune response	
CO5	Will be able to apply the knowledge gained to understand the phenomena like host defense, hypersensitivity (allergy), organ transplantation and certain immunological diseases	
Contents		Duration: 60 hours
UNIT I	Basic concepts of Immunology – (a) Innate and acquired Immunity (b) concept of humoral and cell mediated Immunity. Organization and structure of lymphoid organs. Cell and the immune system: Memory, specificity, diversity, self- vs non-self-discrimination, B lymphocytes, T lymphocytes, Macrophages, Dendritic cells, NK cells, Eosinophils, Basophils, Neutrophils, Mast cells. Complement system: classical and alternative pathways.	12 Hours
UNIT II	Nature of antigen and antibody: Antigen Vs Immunogen, Superantigen, heptanes, types and structure of antibody – (i) constant and variable region Fab and Fc (ii) Isotype and idio type. Antigen antibody interactions: detection and estimation of antigen and antibody, primary and secondary reactions, antibody affinity and acidity, equilibrium dialysis, precipitation and agglutination reactions, complement fixation test, RIA, ELISA, immunoblotting, immunofluorescence, biotin-avidin assay.	12 Hours
UNIT III	Generation of diversity in immune response: clonal selection theory, concept of antigen specific receptor, BCR, TCR, the genes encoding antigen: specific receptors on T and B lymphocytes, genetic rearrangements, class switch, comparison of receptor on B and T lymphocytes, mechanism of immune response and generation of immunological diversity	12 Hours
UNIT IV	Hypersensitive reactions, Central role of MHC genes and products in	12 Hours


  
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	immune response. T cell recognition of antigen and MHC products, structure of MHC gene complex, polymorphism of MHC genes and products. Graft rejection and GVHD; HLA-matching; Use of CRISPR-Cas for generating transgenic animals for xenotransplantation, Activation of T and B cells by antigen: Antigen processing, antigen presentation on T cells, products and factors released by T cell activation: interleukins, interferons. Cell mediated cytotoxicity, mechanism of T cell and NK cell mediated lysis, ADCC, macrophage cytotoxicity.	
UNIT V	Monoclonal antibody: production, application. Immunodeficiency: T cell, B cell, combined B and T cell deficiencies, defect in phagocytes and complement components, secondary immunodeficiency, AIDS, Autoimmunity. Immunization: active and passive, Vaccines- types and importance, Tumor antigens, immune response to tumors and immunotherapy of tumors	12 Hours
Suggested Readings	<ol style="list-style-type: none"> <li>1. Kuby Immunology by J.A. Owen, J. Punt , S.A. Stranford. 7<sup>th</sup> edition. WH Freeman.2013.</li> <li>2. Cellular and Molecular Immunology by A.K. Abbas, A.H. Lichtman, S. Pillai. 9<sup>th</sup> edition.Saunders Elsevier. 2018.</li> <li>3. Janeway's Immunobiology by K. Murphy, W. Casey. 9<sup>th</sup> edition. Garland Science Publishing.2017.</li> <li>4. Review of Medical Microbiology and Immunology by W.Levinson. 15<sup>th</sup>edition.LangePublication. 2018.</li> <li>5. Fundamental Immunology by W.E. Paul. 7<sup>th</sup> edition. Lippincott Williams and Wilkins. 2013.</li> <li>6. Roitt's Essential Immunology by P.J. Delves, S.J. Martin, D.R. Burton, I.M. Roitt. 13<sup>th</sup>edition. Blackwell Publishing. 2017.</li> </ol>	





<b>Programme/Class:</b> <b>Bachelor's Degree with Research /</b> <b>M. Sc. Microbiology (I)</b>		
<b>Subject: Microbiology</b>	<b>Year: First (1)</b>	<b>Semester: Second (II)</b>
<b>Core Paper (Compulsory)</b>	<b>Course Code: B080803T</b>	<b>RECOMBINANT DNA TECHNOLOGY</b>
<b>Marks:100</b>	<b>75 (UE) + 25 (CIE)</b>	<b>Credits: 04</b>
<b>Total Number of Lectures-Tutorials-Practical (in hours per week L-T-P: 4-0-0)</b>		
Course Objectives	The objective of this course is to make the student familiar with the currently used techniques to manipulate/ analyze DNA, RNA and proteins. The student will be made familiar with the methods used to clone genes, make and screen libraries, and the various applications of the polymerase chain reaction. The student will be taught about the methods currently used to carry out genome- wide analyses and global analyses of transcription and protein expression. The student will be made familiar with how recombinant DNA technology has been exploited in the study of biology as well as in the production of pharmaceutical products.	
Course Learning Outcomes	Upon successful completion of the course, the student:	
CO1	Will be familiar with the use of various cloning vectors and molecular scissors.	
CO2	Will be able to describe artificial transformations and can understand the concept of genomic and cDNA libraries.	
CO3	Will be able to understand the Screening and characterization of cloned DNA.	
CO4	Will have learnt about various types of PCR and their applications.	
CO5	Will be aware of DNA sequencing, RNA Interference with a brief account of proteomics, genomics, transcriptomics and metabolomics.	
Contents		Duration: 60 hours
UNIT I	Host-Vector systems, cloning vectors (plasmids, phages, cosmids, bacterial artificial chromosomes and yeast artificial chromosomes), shuttle vectors, expression vectors, screening and selection methods for recombinants. HACS. Enzymes used for manipulating DNA (restriction endonucleases, methylases, polymerases, ligases, kinases and nucleases).	12 Hours
UNIT II	Preparation of competent cells and their transformation. Isolation of DNA (plasmid, cosmid, phage and genomic DNA) and RNA from prokaryotes and eukaryotes. Construction of genomic and cDNA library.	12 Hours
UNIT III	Restriction mapping and RFLP analysis. Southern, Eastern and Northern Hybridization probe preparation, heterologous and homologous Expression of cloned genes in cultured cells, synthetic oligonucleotides probes. <i>In situ</i> hybridization. Antibodies in screening of library.	12 Hours
UNIT IV	PCR and its application. Site directed mutagenesis. DNA: protein interaction: gel mobility shift assay, DNA foot-printing, protein-protein interaction. Principles and method of genetic engineering and gene targeting. Real time PCR.	12 Hours
UNIT V	DNA sequencing: Sanger's Method, Automated sequencing. Application of recombinant DNA technology in agriculture, health	12 Hours

	and industry. RNA Interference. Brief account of proteomics, genomics, transcriptomics and metabolomics.	
Suggested Readings	<ol style="list-style-type: none"><li>1. Molecular Biology by D.P. Clarke, N. Pazdernik. 2<sup>nd</sup> edition. Academic Press. 2012.</li><li>2. Molecular Cloning: A laboratory manual by J. Sambrook, D. Russell. 4<sup>th</sup> edition. ColdSpring Harbor laboratory Press. 2012.</li><li>3. DNA Technology: The Awesome Skill by I. Edward Alcamo. Harcourt Academic Press. 2001.</li><li>4. Molecular Biology of the Gene by J. Watson, T. Baker, S. Bell, A. Gann, M. Levine, R. Losick. 7<sup>th</sup> edition. Pearson. 2014.</li><li>5. Gene Cloning and DNA Analysis: An Introduction by T.A. Brown. 7<sup>th</sup> edition. Wiley-Blackwell Publishers. 2016.</li></ol>	

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<b>Programme/Class:</b> <b>Bachelor's Degree with Research /</b> <b>M. Sc. Microbiology (I)</b>		
<b>Subject: Microbiology</b>	<b>Year: First (1)</b>	<b>Semester: Second (II)</b>
<b>Major Elective (Optional)</b>	<b>Course Code: B080804T</b>	<b>INSTRUMENTATION &amp;</b> <b>ANALYTICAL</b> <b>TECHNIQUES</b>
Marks:100	<b>75 (UE) + 25 (CIE)</b>	Credits: 04
<b>Total Number of Lectures-Tutorials-Practical (in hours per week L-T-P: 4-0-0)</b>		
Course Objectives	To introduce the student to the variety of biophysical and biochemical techniques currently available to probe the structure and function of the biological macromolecules, make them aware of the physical principles behind each technique and the instrumentation involved, make them familiar with various methods of analyzing the output data, and to build a strong foundation in the area of bacterial cell structure, division, survival and propagation.	
Course Learning Outcomes	Upon successful completion of the course, the student will:	
CO1	Be able to carry out the analysis of the data from CD and Fluorescence experiments to monitor the stability of the protein under different environmental conditions	
CO2	Be able to evaluate the quality and highlights of the structure reported/deposited in journals/structural databases.	
CO3	Be able to design a multi-step purification protocol for a target protein	
CO4	Be able to understand and correctly interpret the migration of protein molecule on PAGE under native and SDS conditions	
CO5	Will be aware of the use of tracer techniques and safety precautions	
Contents:		Duration: 60 hours
UNIT I	Spectroscopy: Biological application and interpretations of Nuclear Magnetic Resonance (NMR) & Electron Spin Resonance (ESR)., Absorption spectroscopy, Infrared and Raman spectroscopy, Optical Rotatory Dispersion (ORD), Circular Dichroism (CD)., Basics of X-ray Crystallography.	12 Hours
UNIT II	Basics principles and applications of various chromatography methods: Partition and Absorption chromatography, gel filtration, ion- exchange and affinity chromatography. Biological applications of HPLC.	12 Hours
UNIT III	Basics of centrifugation-based methods: viscosity, diffusion, sedimentation equilibrium, dialysis, solvent fractionation, centrifugation, biological applications and interpretations of Density Gradient methods, Ultracentrifugation methods	12 Hours
UNIT IV	Basics of electrophoresis: electrophoretic mobility and affecting factors, biological applications, and interpretation of different types of electrophoresis: PAGE, gradient gel, Agarose Gel Electrophoresis, 2D Electrophoresis, iso-electricfocusing	12 Hours
UNIT V	Radioactive methods: Basics of radioactive isotopes and radioactive decay, sample preparation, counting, Safety precautions during handling, biological applications.	12 Hours
Suggested	1. Fundamentals of Molecular Spectroscopy by Colin Banwell. 4 <sup>th</sup> edition.	

Readings:

- McGrawHill.1994.
- Principles of Fluorescence Spectroscopy by J. Lakowicz, R. Joseph. 2<sup>nd</sup> edition. Springer.1999.
  - Molecular Fluorescence: principles and Applications by B. Valeur. 2<sup>nd</sup> edition. Wiley.2013.
  - NMR – Conformation of Biological Molecules by G. Govil, R.V. Hosur. 1<sup>st</sup> edition. Springer- Verlag, 2011.
  - Biomolecular crystallography: Principles, practice and application to structural biology by B. Rupp. 1<sup>st</sup> edition. Garland Science. 2009.
  - Optical methods in Biology by E.M. Slayter. 1<sup>st</sup> edition. John Wiley. 1970.
  - NMR of proteins and nucleic Acids by K. Wuthrich. 1<sup>st</sup> edition. Wiley Interscience Publications. 1988.
- Biophysical chemistry, Part 2: Techniques by C. R. Cantor, P. R. Schimmel. 1<sup>st</sup> edition, W.H Freeman and Co. 2008.

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Programme/Class: Bachelor's Degree with Research / M. Sc. Microbiology (I)		
Subject: Microbiology	Year: First (I)	Semester: Second (II)
Major Elective (Optional)	Course Code: B080805T	<b>EXTREMOPHILES AND THEIR APPLICATIONS</b>
Marks:100	75 (UE) + 25 (CIE)	Credits: 04
<b>Total Number of Lectures-Tutorials-Practical (in hours per week L-T-P: 4-0-0)</b>		
Course Objectives	The major objective of this paper is to develop an understanding about mechanisms by which microorganisms adopt to extreme environments and the critical role of extremophiles in the evolution related to the origin of life. The students will also learn about the application of extremophiles in the industrial processes that has opened a new era in the biotechnology. The study of extreme environment will develop an understanding for astrobiology that will help to understand what form life takes on another planetary bodies in our own solar system and beyond.	
Course Learning Outcomes	Upon successful completion of the course, the student:	
CO1	Will be introduced to extremophiles and will understand the critical role of extremophiles in the evolution related to the origin of life.	
CO2	Will develop an understanding about mechanisms by which thermophiles and psychrophiles adopt to extreme environments.	
CO3	Will develop an understanding about mechanisms by which Halophiles Acidophiles and Alkaliphiles: adopt to extreme environments.	
CO4	Will learn about the application of extremophiles in the industrial processes.	
CO5	Will help to understand what form life takes on another planetary bodies in our own solar system and beyond.	
Contents		Duration: 60 hours
UNIT I	Introduction to Extremophiles and Origin of Life; Isolation, classification and general properties of extremophiles like thermophiles, hyperthermophiles, psychrophiles, halophiles, acidophiles, alkaliophiles and polyxtremophiles, Natural habitats of extremophiles.	12 Hours
UNIT II	Thermophiles: Microbial Life at high temperature- the challenges & strategies of survival: Membrane Adaptations of (Hyper)Thermophiles to High Temperatures, Temperature-Dependent Molecular Adaptations, The Physiological Role, Biosynthesis, and Mode of Action of Compatible Solutes from (Hyper); Psychrophiles Mechanism of bacterial adaptation to low temperature, Membrane Adaptations, Cold-Adapted, The Cold-Shock Response, Perception and Transduction of Low Temperature in Bacteria	12 Hours
UNIT III	Halophiles: Biodiversity in Highly Saline, Response to Osmotic Stress in a Haloarchaeal Genome: a Role for General Stress Proteins and Global Regulatory Mechanisms; Acidophiles Aciduric Proteobacteria, Physiology and Ecology of Acidophilic Microorganisms; Alkaliphiles: Bioenergetic Adaptations that Support Alkaliphily.	12 Hours
UNIT IV	Piezophiles-Microbial Adaptation to High Pressure; Radiophiles: Radiation-resistant extremophiles and their potential in biotechnology and therapeutics; Exobiology: Astrobiology and the Search for Life in the Universe	12 Hours
UNIT V	Extremophiles as a source of novel enzymes for industrial application,	12 Hours

	Versatile applications of natural compounds from extremophiles, Polysaccharides from extremophilic microorganisms. Importance of extremophilic microbial diversity in environment, pharmaceuticals & human health,	
Suggested Readings	<ol style="list-style-type: none"><li>1. Extremophiles: From Biology to Biotechnology, Edited by- Ravi Durvasula and D. V. Subba Rao, CRC Press, Taylor &amp; Francis Group, ISBN 9781498774925</li><li>2. Physiology and biochemistry of extremophiles / Edited by C. Gerday and N. Glansdorff, ASM Press, American Society for Microbiology, ISBN-10: 1-55581-422-0</li></ol>	

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<b>Programme/Class:</b> <b>Bachelor's Degree with Research /</b> <b>M. Sc. Microbiology (I)</b>		
<b>Subject: Microbiology</b>	<b>Year: First (1)</b>	<b>Semester: Second (II)</b>
<b>Core Paper (Compulsory)</b>	<b>Course Code: B080806P</b>	<b>Practical II</b>
<b>Marks:100</b> <b>75 (UE) + 25 (CIE)</b>	<b>Credits: 04</b>	<b>Duration: 120 hours</b>
<b>Total Number of Lectures-Tutorials-Practical (in hours per week L-T-P: 0-0-8)</b>		
Course Objectives	The course will enable students to learn basic techniques used in separation and analysis of biomolecules. The students will also explore the immunological techniques along with some molecular biology techniques.	
Course Learning Outcomes	Upon successful completion of the course, the student:	
CO1:	Will be able to use chromatographic and centrifugation procedures.	
CO2:	Will be able to use electrophoretic techniques.	
CO3:	Will be aware of various immunological techniques	
CO4:	Will be able to make and transform desired plasmid DNA into bacterial cells along with the other techniques used in cloning and rDNA technology.	
CO5:	Will be able to isolate Bacteriophages	
<b>Contents:</b>		
<ol style="list-style-type: none"> <li>1. Paper chromatography – Separation of pigments, amino acids</li> <li>2. Separation of amino acids by Thin layer chromatography</li> <li>3. Column chromatography</li> <li>4. Agarose gel electrophoresis for separation of DNA</li> <li>5. SDS-PAGE for separation of Proteins</li> <li>6. Double immune diffusion</li> <li>7. Determination of Blood group</li> <li>8. Isolation of Macrophages</li> <li>9. Determination of hypersensitivity</li> <li>10. Immunoblotting</li> <li>11. Raising of Ab in mice/rabbit.</li> <li>12. ELISA</li> <li>13. Isolation and quantification of plasmid DNA, genomic DNA and RNA of <i>E. Coli</i></li> <li>14. Competent cells preparation of <i>E. coli</i></li> <li>15. Transformation and selection of transformant of <i>E. coli</i> cells using antibiotics and X gal selection</li> <li>16. Unit determination of restriction enzyme activity</li> <li>17. Restriction digestion of DNA and gene cloning</li> <li>18. Demonstration of PCR</li> <li>19. Isolation of Bacteriophages</li> </ol>		
Suggested Readings:	<ol style="list-style-type: none"> <li>1. Microbiology: A laboratory manual by JG Cappucino, C.T. Welsh. 11<sup>th</sup> edition. Pearson. 2017.</li> <li>2. Molecular Cloning: A laboratory manual by Joseph Sambrook, David Russell, 4<sup>th</sup> edition. Cold Spring Harbor laboratory Press. 2012.</li> </ol>	





As per the BoS held on 24.07.2024

<b>Programme/Class:</b> <b>Bachelor's Degree with Research /</b> <b>M. Sc. Microbiology (I)</b>		
<b>Subject: Microbiology</b>	<b>Year: First (1)</b>	<b>Semester: Second (II)</b>
<b>Core Paper (Compulsory)</b>	<b>Course Code: B080807R</b>	<b>Industrial Training</b> <b>/Surveys/Research Project I</b>
<b>Marks:100</b>	<b>Credits: 08</b>	
Course Details	This research project can be interdisciplinary / multi-disciplinary. This research project can also be in the form of industrial training / internship / survey work etc.	
	<b>* Students will submit the final report (project report/dissertation) of the research project carried out in both the semesters at the end of the year, which will be assessed jointly by the supervisor and the external examiner nominated by the university at the end of the year out of 100* marks</b>	

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Programme/Class: M. Sc. Microbiology (II)		
Subject: Microbiology Core Paper (Compulsory)	Year: Second (2) Course Code: B080901T	Semester: Third (III) <b>MICROBIAL PHYSIOLOGY AND METABOLISM</b>
Marks: 100	75 (UE) + 25 (CIE)	Credits: 04
<b>Total Number of Lectures-Tutorials-Practical (in hours per week L-T-P: 4-0-0)</b>		
Course Objectives	The major objective of this paper is to develop clear understanding of various aspects of microbial physiology along with diverse metabolic pathways existing in bacteria in relation to its survival and propagation, and to enable students to better understand courses taught later such as Microbial Pathogenicity and biotechnology-based courses.	
Course Learning Outcomes	Upon successful completion of the course, the student:	
CO1	Will be acquainted with methods of measuring microbial growth, calculating growth kinetic parameters with understanding of steady state and continuous growth.	
CO2	Will have gained an in-depth knowledge of phototrophic and chemotrophic bacteria.	
CO3	Will have learnt central metabolic pathways for carbon metabolism in bacteria enlisting differences with eukaryotic systems and their regulation in diverse physiological conditions. This allows students to apply the acquired knowledge in engineering metabolic pathways for developing industrially useful strains.	
CO4	Will have gathered understanding of inorganic and organic nitrogen assimilation and its regulation. Also knows role of glutathione in cellular redox regulation and biochemistry of glutamate overproducing strains.	
CO5	Will understand details of lipid and nucleotide metabolism in E. coli and its regulation along with biochemical basis of lipid accumulation in yeasts.	
Contents		Duration: 60 hours
UNIT I	Solute Transport: Introduction, primary and secondary transport, kinetics. Membrane transport proteins: porins and aquaporins, mechanosensitive channels, ABC transporter, group translocation PEP-PTS system. Catabolite repression, inducer exclusion and expulsion	12 Hours
UNIT II	Photosynthesis in green and purple bacteria, structural and functional properties of pigment, oxygenic and anoxygenic photosynthesis, photosystems, photodynamic death and photophosphorylation. cyanobacterial photosynthesis, photorespiration Chemolithotrophy, hydrogen-, iron- and sulfur, bacteria, methanogens and methylotrophs.	12 Hours
UNIT III	Central Metabolic Pathways and Regulation: Glycolysis and its regulation, Gluconeogenesis, Pentose-Phosphate Pathway, Entner-Doudoroff Pathway, Citric Acid Cycle, alternate TCA, Glyoxylate Pathway and its regulation. Examples of pathway engineering of carbon metabolic pathways to develop industrial useful strains: Co-metabolism of pentoses and hexoses, Succinic and citric acid production.	12 Hours
UNIT IV	Biochemistry of nitrogenase complex, nitrogenase types and function <i>nif</i> gene and genetic regulation of nitrogenase, symbiotic nitrogen fixation, regulation of nitrogenase by oxygen and combined N-sources, protection of nitrogenase against oxygen, nitrate reduction (assimilatory and	12 Hours

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	dissimilatory) and sulfate reduction, methanogenesis and acetogenesis. Hydrocarbon transformation	
UNIT V	Metabolism of lipids and nucleotides: Biosynthesis and degradation of lipids and its regulation in <i>E. coli</i> , lipid accumulation in yeast. Purine and pyrimidine biosynthesis, deoxyribonucleotide synthesis, regulation of purine and pyrimidine biosynthesis, inhibitors of nucleotide biosynthesis.	12 Hours
Suggested Readings	<ol style="list-style-type: none"> <li>1. Biochemistry by Geoffrey L. Zubay. 4<sup>th</sup> Edition. Brown Co, USA. 1999.</li> <li>2. Microbial Physiology by A.G. Moat, J. W. Foster, M. P. Spector. 3<sup>rd</sup> Edition. John Wiley &amp; Sons. 2002</li> <li>3. Lehninger Principles of Biochemistry by D. L. Nelson, M. M. Cox. 6<sup>th</sup> Edition. W. H. Freeman. 2012</li> <li>4. The Physiology and Biochemistry of Prokaryotes by D. White, J. Drummond, C. Fuqua. 4<sup>th</sup> Edition. Oxford University Press. 2011.</li> <li>5. Microbial Biochemistry by G. N. Cohen. 2<sup>nd</sup> Edition. Springer. 2014.</li> <li>6. Lippincott's Illustrated Reviews: Biochemistry edited by D. R. Ferrier. 6<sup>th</sup> Edition. Lippincott Williams &amp; Wilkins. 2013</li> <li>7. Biochemical Calculations: by Irwin H. Segel. 2<sup>nd</sup> Edition. Wiley. 2004.</li> <li>8. Understanding Enzymes by T. Palmer, E. Horwood. 3<sup>rd</sup> Edition. Wiley. 1991.</li> </ol>	



  
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Programme/Class: M. Sc. Microbiology (II)		
Subject: Microbiology	Year: Second (2)	Semester: Third (III)
Core Paper (Compulsory)	Course Code: B080902T	<b>INDUSTRIAL MICROBIOLOGY</b>
Marks:100	75 (UE) + 25 (CIE)	Credits: 04
<b>Total Number of Lectures-Tutorials-Practical (in hours per week L-T-P: 4-0-0)</b>		
Course Objectives	The course will enable students to apply the learning of microbiology concepts toward the exploitation of microbial population for industrial and human benefits. The strategies for development of microbial strains, process optimization, large scale production and product recovery will be covered for industrially relevant microbial products and therapeutic proteins. Acquires knowledge about the use of microbes as biosensors & biochips.	
Course Learning Outcomes	Upon successful completion of the course, the student:	
CO1	Will understand the biochemical and industrial concepts of fermentation along with the various types of fermentation systems used in the fermentation technology.	
CO2	Will attain knowledge about designing of industrial strains and various media optimization strategies. Develop an understanding about design and use of various types of fermenters.	
CO3	Will acquire knowledge about various food products by the application of microorganisms.	
CO4	Will acquire knowledge about various pharmaceutical products by the application of microorganisms.	
CO5	Will understand the production of commercial products by recombinant microorganisms	
Contents		Duration: 60 hours
UNIT I	UNIT I: Introduction to the fermentation; Introduction to bioreactor: Ideal bioreactor, Reactor with non-ideal mixing. Multiphase bioreactors, animal and plant cell reactor technology.	12 Hours
UNIT II	UNIT II: Screening for new metabolites - primary and secondary metabolites. Strain development through selection, mutation, recombination and other genetic and biochemical methods. Substrates for fermentations- types and availability.	12 Hours
UNIT III	Introduction to immobilization technology for enzymes and cells, Production of alcohol (ethanol), Organic acid (citric acid, lactic acid), amino acid (lysine, glutamic acid), nucleotides and related compounds.	12 Hours
UNIT IV	Production of enzymes (protease, amylase, lipase), Production of microbial food, single cell protein and mushroom. Production of antibiotics (streptomycin, tetracycline, penicillin, ampicillin), hormones, vitamins, steroids and alkaloids.	12 Hours
UNIT V	Synthesis of commercial products by recombinant microorganisms: restriction endonucleases, biopolymers, human insulin, growth hormones, interferon and vaccines. Microorganisms in biotransformation of antibiotics and steroids; Microorganisms as biosensors & biochips	12 Hours
Suggested Readings	<ol style="list-style-type: none"> <li>Principles of Fermentation Technology by P. Stanbury, A. Whitaker, S. Hall. 3<sup>rd</sup> edition. Butterworth-Heinemann. 2016.</li> <li>Bioprocess Engineering: Basic Concepts by M. L. Shuler, F. Kargi, 2<sup>nd</sup> edition. Pearson Education India. 2015.</li> <li>Modern Industrial Microbiology &amp; Biotechnology by N. Okafor. 1<sup>st</sup></li> </ol>	

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|  | <p>edition. CRC Press,USA. 2007.</p> <p>4. Fermentation Microbiology and Biotechnology edited by E.M.T. El-Mansi, C.F. Bryce, A.L. Demain, A.R. Allman. 3<sup>rd</sup> edition. CRC Press. 2012.</p> <p>Microbial Biotechnology: Fundamentals of Applied Microbiology by A.N. Glazer, H.Nikaido. 2<sup>nd</sup> edition. Cambridge University Press. 2007.</p> |
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Programme/Class: M. Sc. Microbiology (II)		Semester: Third (III)	
Subject: Microbiology	Year: Second (2)	ENVIRONMENTAL MICROBIOLOGY	
Core Paper (Compulsory)	Course Code: B080903T	Credits: 04	
Marks:100	75 (UE) + 25 (CIE)	Total Number of Lectures-Tutorials-Practical (in hours per week L-T-P: 4-0-0)	
Course Objectives	The major objective of this paper is to impart knowledge about structure, composition and functioning of microbial communities of diverse environment. The use of microbial population in agriculture, mineral recovery, management of various types of pollutants and conversion processes of various types of wastes into value added products will be discussed.		
Course Learning Outcomes	Upon successful completion of the course, the student:		
CO1	Will have an overview of the till date developments in the field of environmental microbiology with special emphasis on the role of microbes in mitigating environment pollution.		
CO2	Will have become acquainted with various cultural, biochemical and molecular techniques used in understanding microbial diversity.		
CO3	Will be able to describe the role of soil microbes in nutrient transformation, plant-microbe interactions and biotechnology. Also knows about potability of water and its quality control.		
CO4	Is able to describe the role of microbes in solid and liquid waste management, gaining knowledge of various methods employed in sewage treatment and solid waste treatment.		
CO5	Understands the role of microbes in bioremediation of environmental pollutants like petroleum hydrocarbons, pesticides, plastic and electronic waste; also understands utility of microbes in mineral and oil recovery.		
Contents		Duration: 60 hours	
UNIT I	Development in field of environmental microbiology: Development of microbial ecology and emergence of field of environmental microbiology, significant applications of microbes in solving environmental pollution problems	12 Hours	
UNIT II	Culture-dependent and culture-independent approaches for understanding microbial diversity in the environment: Understanding microbial diversity in the environment by culture-dependent and culture-independent approaches, Analysis by FAME, measuring metabolic capabilities using BIOLOG, G+C analysis, slot-blot hybridization of community DNA, and fluorescent <i>in situ</i> hybridization of intact cells, metagenomic analysis of solid and aquatic sediments	12 Hours	
UNIT III	Soil and water microbiology: Importance of soil microorganisms, nutrient transformation processes, plant-microbe symbiosis, microbial antagonism, biofilms and their biotechnological applications, drinking water microbiology and quality control.	12 Hours	
UNIT IV	Liquid and solid waste management: Treatment of sewage (primary, secondary and tertiary treatments), treatment of industrial effluents (distillery, textile, pulp and paper), methods to detect various pollutants (metals, sediments, toxin and organic matters). Solid waste types, composting, landfill development, incineration methods, composting and sustainable agriculture, biogas production, plastic degrading	12 Hours	

	microorganisms as a tool for bioremediation, challenges in waste management.	
UNIT V	Lignocellulolytic microorganisms, enzymes and their biotechnological applications in: biopulping, biobleaching, textiles biofuels, animal feed production. Bioremediation of environmental pollutants: Petroleum hydrocarbons and pesticides, use of biosensors for their detection. Microbial enhanced oil recovery, bioleaching of copper, gold and uranium, electronic waste management.	12 Hours
Suggested Readings	<ol style="list-style-type: none"> <li>1. Microbial Ecology by R.M. Atlas, R. Bartha. 3<sup>rd</sup> edition. Benjamin Cummings Publishing Co, USA. 1993.</li> <li>2. Environmental Microbiology by A.H. Varnam, M.G. Evans. Manson Publishing Ltd. 2000.</li> <li>3. Manual of Environmental Microbiology edited by C.J. Hurst, R.L. Crawford, J.L. Garland, D.A. Lipson, A. L. Mills, L.D. Stetzenbach. 3<sup>rd</sup> edition. Blackwell Publishing. 2007.</li> <li>4. Environmental Microbiology edited by R. Mitchell, J-D Gu. 2<sup>nd</sup> edition. Wiley-Blackwell. 2009.</li> <li>5. Environmental Microbiology by R. Maier, I. Pepper, C. Gerba. 2<sup>nd</sup> edition. Academic Press. 2009.</li> <li>6. Environmental Microbiology: Principles and Applications by P.K. Jemba, Science Publishing Inc. 2004.</li> <li>7. Lignocellulose Biotechnology: Future Prospects by R.C. Kuhad, A. Singh. I.K. International. 2007.</li> <li>8. Environmental Microbiology of Aquatic &amp; Waste systems by N. Okafor. 1<sup>st</sup> edition, Springer, New York. 2011.</li> </ol>	


  
  
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Programme/Class: M. Sc. Microbiology (II)		
Subject: Microbiology Major Elective (Optional)	Year: Second (2) Course Code: B080904T	Semester: Third (III) BIostatISTICS AND Bioinformatics Credits: 04
Marks:100	75 (UE) + 25 (CIE)	
<b>Total Number of Lectures-Tutorials-Practical (in hours per week L-T-P: 4-0-0)</b>		
Course Objectives	The course will introduce the student to the variety of computational methods currently available for predicting functional behavior of biological systems. The algorithms behind each method and the shortcomings in present methods will be discussed. Students should be able to analyze the output data to predict a biologically relevant function.	
<b>Section A: Biostatistics</b>		
Course Learning Outcomes	Upon successful completion of the course, the student:	
CO1	Will understand various methods of collection and representation of biological data.	
CO2	Will be able to understand the concepts of statistical population and samples and will become aware of Measures of Central tendencies and Dispersion.	
CO3	Will learn about sample size calculation and distribution. He/ She will also learn about principles of probability.	
CO4	Will be able to understand the concepts of correlation and regression.	
CO5	Will learn about basic idea of significance,	
Contents:		Duration: 30 hours
UNIT I	Scope of biostatistics, variables in biology. Collection, classification, tabulation and diagrammatic presentation of statistical data.	06 hours
UNIT II	Concepts of statistical population and samples. Measures of Central tendencies and Dispersion.	06 hours
UNIT III	Sample size calculation. Simple measure of Skewness and Kurtosis Probability: definition, simple theorems of probability and simple application of probability. Binomial and Poisson distributions.	06 hours
UNIT IV	Correlation, correlation coefficient, standard error of estimate and regression. Linear regressions, least square method of fitting.	06 hours
UNIT V	Testing level of significance, random variations. Statistical analysis test e.g. Chi square test, students 't' test.	06 hours
<b>Section B: Bioinformatics</b>		
Course Learning Outcomes	Upon successful completion of the course, the student:	
CO1	Will be able to gain elementary knowledge of computers	
CO2	Will be able to access and derive information from various primary and secondary databases	
CO3	Will be able to create and usefully interpret the results of a multiple sequence alignment.	
CO4	Can create and correctly interpret phylogenetic trees to gain insight into evolutionary path of the target molecule	
CO5	Will be able to use various protein databases and will learn about primer designing	
Contents		Duration: 30 hours
UNIT I	Elementary ideas of applications of common spreadsheet, word processing, graphics, DOS and Windows based software packages, MS	06 hours

	office.	
UNIT II	Biological Databases: Introduction. Types of databases in terms of biological information content. Protein and gene information resources. Different formats of molecular biology data.	06 hours
UNIT III	Molecular Phylogenetics: Sequence Alignment: Methods and algorithms of pairwise and multiple sequence alignment. Global and local alignment. Alignment scoring matrices. Database similarity searching.	06 hours
UNIT IV	Methods and tools for phylogenetic analysis. Creation evaluation and interpretation of evolutionary trees. Advantages and disadvantages of phenetic and cladistic approaches.	06 hours
UNIT V	Protein database: Retrieval of protein sequence from PDB, Primer designing.	06 hours
Suggested Readings	<ol style="list-style-type: none"> <li>1. Introduction to Computational Biology: An Evolutionary Approach by Haubold, Wiele. 1<sup>st</sup> edition. Springer International. 2006.</li> <li>2. Introduction to Bioinformatics by A. Lesk. 3<sup>rd</sup> edition. OUP India. 2009.</li> <li>3. Statistical methods in Bioinformatics: An introduction by W. Ewens, G.R. Grant. 2<sup>nd</sup> Edition. Springer-Verlag. 2006.</li> <li>4. Bioinformatics: Sequence and genome analysis by D. Mount. 2<sup>nd</sup> edition. Cold Spring Harbor Lab Press. 2004.</li> <li>5. Bioinformatics: A practical guide to the analysis of genes &amp; proteins. Edited by Baxevanis, Outlette. 2<sup>nd</sup> edition. John Wiley and Sons. 2001.</li> <li>6. An Introduction to Protein Informatics by K-H Zimmermann. 1<sup>st</sup> edition, Springer International. 2007.</li> <li>7. Fundamental Concepts of Bioinformatics by Krane. 1<sup>st</sup> edition. Pearson Education. 2003.</li> <li>8. Discovering Genomics, Proteomics and Bioinformatics by Campbell. 2<sup>nd</sup> edition. Campbell Pearson Education. 2007.</li> <li>9. Structural bioinformatics: an algorithmic approach by F. J. Burkowski. 1<sup>st</sup> edition, Chapman &amp; Hall/CRC. 2009.</li> <li>10. Structural Bioinformatics edited by J. Gu, P.E. Bourne. 2<sup>nd</sup> Edition. Wiley-Blackwell. 2009.</li> </ol>	





<b>Programme/Class:</b> <b>M. Sc. Microbiology (II)</b>		
<b>Subject: Microbiology</b>	<b>Year: Second (2)</b>	<b>Semester: Third (III)</b>
<b>Major Elective (Optional)</b>	<b>Course Code: B080905T</b>	<b>MICROBIAL DIVERSITY</b>
<b>Marks:100</b>	<b>75 (UE) + 25 (CIE)</b>	<b>Credits: 04</b>
<b>Total Number of Lectures-Tutorials-Practical (in hours per week L-T-P: 4-0-0)</b>		
Course Objectives	The objective of this course is to introduce the students with enormous range of biological diversity in the microbial world. The course will develop an understanding about the "big picture" of the microbial world and the power of the phylogeny.	
Course Learning Outcomes	Upon successful completion of the course, the student:	
CO1	Will establish a point of view to examine microbial diversity.	
CO2	Will learn how to construct and interpret evolutionary trees from DNA sequences.	
CO3	Will develop a basic understanding about the major branches of the "tree of life," and establish a base of knowledge about the microbial world.	
CO4	Will learn how new organisms are identified (usually without being cultivated) and will progress in steps to broad surveys of entire microbial communities.	
CO5	Will understand how specific kinds of organisms contribute to the ecosystem.	
Contents		Duration: 60 hours
UNIT I	Introduction to Microbial Diversity: Facets of microbial diversity, the fundamental similarity of all living things, Taxonomy and phylogeny, Phylogenetic Information, Obtaining the required sequence data, assembling sequences in a multiple-sequence alignment.	12 Hours
UNIT II	Constructing a Phylogenetic Tree. Tree Construction Complexities, Alternatives to Small-Subunit rRNA Analysis, SSU rRNA cannot be used to distinguish closely related organisms.	12 Hours
UNIT III	General properties of Primitive Thermophilic Bacteria: Green Phototrophic Bacteria: Proteobacteria (purple bacteria and relatives), Gram-Positive Bacteria, Firmicutes (low G+C gram-positive bacteria), Actinobacteria (high G+C gram-positive bacteria): Spirochetes and Bacteroids: Deinococci, Chlamydiae and Planctomycete: Archaea: Introduction to Eukaryotic Microorganisms	12 Hours
UNIT IV	Microbial Populations: Identification of Uncultivated Organisms, Sequence-Based Microbial Surveys, Fluorescent In Situ Hybridization Surveys, Molecular Fingerprinting of Microbial Populations, Linking Phenotype and Phylotype.	12 Hours
UNIT V	The Phylogenetic Perspective, Genomics, Comparative Genomics, and Metagenomics, Origins and Early Evolution, the timescale, Ancient microbial fossils, The last common ancestor, The RNA world hypothesis, The emergence of life.	12 Hours
Suggested Readings	1. Principles of microbial diversity / James W. Brown, Department of Biological Sciences, North Carolina State University, Raleigh, North Carolina. ISBN 978-1-55581-442-7 2. Microbial Diversity: Form and Function in Prokaryotes by Oladele Ogunseitan; 2005; Blackwell Science Ltd.; ISBN 0-632-04708-9	

  
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<b>Programme/Class:</b> <b>Bachelor's Degree with Research /</b> <b>M. Sc. Microbiology (I)</b>		
<b>Subject: Microbiology</b>	<b>Year: Second (2)</b>	<b>Semester: Third (III)</b>
<b>Core Paper (Compulsory)</b>	<b>Course Code: B080906P</b>	<b>Practical III</b>
<b>Marks:100</b> <b>75 (UE) + 25 (CIE)</b>	<b>04 credits</b>	<b>Duration: 120 hours</b>
<b>Total Number of Lectures-Tutorials-Practical (in hours per week L-T-P: 0-0-8)</b>		
Course Objectives	The course will enable students to apply the learning of microbiology concepts toward the exploitation of microbial population for industrial and human benefits.	
Course Learning Outcomes	Upon successful completion of the course, the student:	
CO1	Will be able to analyze the water quality and potability by using various techniques.	
CO2	Will be able to use various bioinformatics tools.	
CO3	Will be aware of various biochemical tests used in bacterial identification.	
CO4	Will be able to use special staining procedures.	
CO5	Will be able to use microorganisms for production of various useful and industrially important products.	
<b>Contents</b>		
<ol style="list-style-type: none"> <li>1. Analysis of water quality: DO, BOD, alkalinity, free CO<sub>2</sub>, free chloride, TS, TSS, TDS, nitrate, phosphate</li> <li>2. Determination of most probable number (MPN) for coliform bacteria</li> <li>3. Isolation of bacterial strains from different soil samples</li> <li>4. Analysis of sequence data and searching of research papers from various national and international journals</li> <li>5. Retrieval of gene and protein sequences from data bank</li> <li>6. Sequence comparisons and alignment (8P)</li> <li>7. Visualisation and other utilities (PDB viewer)</li> <li>8. Biochemical tests for characterization of microbes (based on metabolic properties:               <ol style="list-style-type: none"> <li>a. Carbohydrate fermentation</li> <li>b. H<sub>2</sub>S production</li> <li>c. Nitrate reduction</li> <li>d. Urease activity</li> <li>e. IMViC test</li> <li>f. Gelatine liquefaction</li> <li>g. Starch hydrolysis</li> <li>h. Glycine decarboxylation</li> <li>i. Catalase oxidase peroxidase test</li> </ol> </li> <li>9. Staining of polyphosphate bodies, polyhydroxybutyrate and endospore</li> <li>10. Isolation of protease, amylase and lipase producing bacterial strains and estimation of enzyme activity</li> <li>11. Mushroom production</li> <li>12. Cell and enzyme immobilization.</li> <li>13. Production of alcohol from molasses/cane sugar.</li> <li>14. Production of vinegar.</li> <li>15. Production of citric acid.</li> <li>16. Isolation of cellulose producing strain.</li> </ol>		
Suggested Readings:	<ol style="list-style-type: none"> <li>1. Microbiology: A laboratory manual by JG Cappucino, N Sherman. 10<sup>th</sup> edition. Pearson. 2014.</li> <li>2. Environmental Microbiology: A lab manual by I. Pepper, C. Gerba, J. Brendecke. 46<sup>th</sup> edition. Academic Press. 2011.</li> <li>3. Sequence - Evolution - Function: Computational Approaches in Comparative Genomics by E.V. Koonin , M.Y. Galperin. Kluwer Academic, USA. 2003.</li> <li>4. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins edited</li> </ol>	

by A. D. Baxevanis, B.F. Francis Ouellette . 3rd edition. Wiley and Sons. 2004

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Programme/Class: M. Sc. Microbiology (II)		
Subject: Microbiology	Year: Second (2)	Semester: Fourth (IV)
Major Elective (Optional)	Course Code: B081001T	FOOD MICROBIOLOGY
Marks:100	75 (UE) + 25 (CIE)	Credits: 04
Total Number of Lectures-Tutorials-Practical (in hours per week L-T-P: 4-0-0)		
Course Objectives	The course will enable students to understand the taxonomical classification, phenotypic and biochemical identification of food associated molds, yeasts, yeast-like fungi and bacteria. The course will teach the strategies to develop fermented and non-fermented milk products, plant-based products, fish products, meat products bioactive compounds and malt beverages, wines, distilled liquors and vinegar. The role of microbes in food spoilage, preservation and various foodborne diseases will be discussed.	
Course Learning Outcomes	Upon successful completion of the course, the student:	
CO1	Will know about microbial spoilage of various kinds of food.	
CO2	Will be aware of general principles of food preservation.	
CO3	Gathers information regarding fermented food products.	
CO4	Knows about indicator Microorganisms and microbial standards for food safety, quality assurance programs that revolutionize food safety.	
CO5	Gains knowledge about food borne microorganisms and food poisoning.	
Contents:		Duration: 60 hours
UNIT I	Food as a substrate for microorganisms, Microbial spoilage of Meat, Poultry, and Seafood; Milk and Dairy Products; Fruits and Vegetables; Nuts, Seeds, and Cereals	12 Hours
UNIT II	Food preservation: Various classical, physical, chemical, and biological methods of preservation. New developments in food preservation techniques. Analysis of practical implementation of such techniques.	12 Hours
UNIT III	Fermented Dairy Products, Microbial habitat of specific food materials, adaptations and changes in microbiome of vegetables, fruits, milk, fermented and non-fermented milk products, fresh meats, poultry and non-dairy fermented foods, Fermented Vegetables, Fermented Meat, Poultry, and Fish Products, Cocoa and Coffee, Beer, Wine, Vinegar, Probiotics and Prebiotics,	12 Hours
UNIT IV	Indicator Microorganisms as an indicator of good quality, Food adulteration (DART) and prevailing food standards in India ( <i>fssai</i> , Agmark and BIS), Hazard Analysis and Critical Control Point System	12 Hours
UNIT V	Food borne infections including bacterial, viral and fungal infections. Study of infections due to food borne parasites. In depth study of various types and causes of food intoxication.	12 Hours
Suggested Readings	<ol style="list-style-type: none"> <li>1. Food Microbiology by W.C. Frazier, D.C. Westhoff, K.N. Vanitha. 5<sup>th</sup> edition. McGrawHill Education. 2013.</li> <li>2. Modern Food Microbiology by J.M. Jay, M.J. Loessner, D.A. Golden. 7<sup>th</sup> edition. Springer. 2006.</li> <li>3. Fundamental Food Microbiology by B. Ray and A. Bhunia. 5<sup>th</sup> edition. CRC press. 2013.</li> <li>4. Food Microbiology by M. R. Adams, M. O. Moss, P. McClure. 4<sup>th</sup> edition. Royal Society of Chemistry. 2015.</li> <li>5. Food Microbiology: Fundamentals and Frontiers by M. P. Doyle, L. R. Beuchat. 3<sup>rd</sup> edition. ASM press. 2007.</li> <li>6. Food Microbiology: An Introduction by T. Montville, K. Matthews,</li> </ol>	

K.Kniel. 4<sup>th</sup> edition.ASM press. 2017.

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Programme/Class: M. Sc. Microbiology (II)		
Subject: Microbiology	Year: Second (2)	Semester: Fourth (IV)
Major Elective (Optional)	Course Code: B081002T	AGRICULTURAL MICROBIOLOGY
Marks:100	75 (UE) + 25 (CIE)	Credits: 04
Total Number of Lectures-Tutorials-Practical (in hours per week L-T-P: 4-0-0)		
Course Objectives	The course will facilitate in understanding of major groups of soil microorganisms along with the pathogens that interact with various plants and can affect the plant by causing changes in physiology, photosynthesis, respiration, transpiration and translocation. The course will cover the applications of Plant Growth Promoting Rhizobacteria and microbial biopesticides along with their detailed mode of action.	
Course Learning Outcomes	Upon successful completion of the course, the student:	
CO1	Will have acquired knowledge about the role of soil microorganism in various soil processes.	
CO2	Will learn about plant growth promotion attributes of PGPR and their mechanism of action. Will also learn about biostimulants.	
CO3	Understands about various types of plant microbe interactions.	
CO4	Will be introduced to mechanism of action of various bacterial biopesticides.	
CO5	Will be introduced to mechanism of action of various viral biopesticides.	
Contents:		Duration: 60 hours
UNIT I	Soil microorganisms, major groups, decomposition of organic matter, soil health, root exudates and rhizospheric effect, manipulation of rhizospheric microflora in plant productivity, microbial biomass, microbial transformation of phosphorus and sulphur, minor nutrients, role of biofertilizers in agriculture and forestry, bioremediation of problem soils.	12 Hours
UNIT II	Plant Growth Promoting Rhizobacteria and their mode of action, formation and composition of soil organic matter- Fulvic acid and humic acid	12 Hours
UNIT III	Plant microbe relationships: Association and pathogenicity, Mycorrhizal association: Their types and role in plant nutrition.	12 Hours
UNIT IV	Bacteria as biopesticides: production and method of application, Mechanism of action of common bacterial biopesticides ( <i>Bacillus thuringiensis</i> , <i>Pseudomonas</i> spp).	12 Hours
UNIT V	Viral biopesticides ( <i>nuclear polyhedrosis virus</i> , <i>cytoplasmic polyhedral virus</i> ) and fungal biopesticides ( <i>Metarrhizium anisopliae</i> , <i>Beauveria bassiana</i> , <i>Verticellium lecani</i> , <i>Hirsutella thomsonii</i> )	12 Hours
Suggested Readings	<ol style="list-style-type: none"> <li>1. Plant Pathology by Agrios GN. Fifth edition, Elsevier Academic press.</li> <li>2. Principles of plant pathology by R.S. Singh, Oxford and IBH Publishing Company Pvt. Ltd.</li> <li>3. Plant Diseases by R.S. Singh, CBS Publisher.</li> <li>4. Agriculture Microbiology by Rangaswami, G, and Bagyaraj, DJ, edition 2nd, Prentice Hall of India Pvt. Ltd., New Delhi.</li> <li>5. Advances in Agriculture Microbiology by Subba Rao, NS, Oxford &amp; IBH Pub.</li> </ol> Molecular plant pathology by M. Dickinson, Bios Scientific Publishers, New York.	



Programme/Class: M. Sc. Microbiology (II)		
Subject: Microbiology	Year: Second (2)	Semester: Fourth (IV)
Major Elective (Optional)	Course Code: B081003T	CLINICAL MICROBIOLOGY
Marks:100	75 (UE) + 25 (CIE)	Credits: 04
Total Number of Lectures-Tutorials-Practical (in hours per week L-T-P: 4-0-0)		
Course Objectives	The course will facilitate in understanding of major groups of Human pathogens along with their mechanism of action. The course will develop an understanding about mechanism of action of various antibiotics along with the mechanisms developed in microbes to counteract the action of various antimicrobial agents. The course will also aware the students with current scenario by an introduction to emerging infections.	
Course Learning Outcomes	Upon successful completion of the course, the student:	
CO1	Will have acquired knowledge about the normal microflora of human body along with the methods for collection and transportation of pathological specimens.	
CO2	Will have learnt about principles of pathogenicity.	
CO3	Understands about various bacterial and fungal diseases along with their symptoms and mechanism of action.	
CO4	Will have learn about various viral diseases along with their symptoms and mechanism of action.	
CO5	Will have been introduced to mechanism of action of various antibiotics along with the mechanism of development of antimicrobial resistance in microbes.	
Contents		Duration: 60 hours
UNIT I	History of medically important microorganisms; normal microflora of Human body. Collection, transportation and examination of pathologic specimens. Isolation and identification of pathogenic organisms.	12 Hours
UNIT II	Pathogenicity: Virulence factors, spreading and establishment of pathogens, bacterial toxins-their types, mycotoxins, involvement of extra-genetic elements. Epidemiology of infection diseases.	12 Hours
UNIT III	Brief account of bacterial diseases spread through air (diphtheria, tuberculosis and pertusis), food and water (typhoid, cholera and dysentery) soil (anthrax, tetanus, and gas gangrene) and contact (leprosy, conjunctivitis and venereal diseases). Bacterial zoonoses(brucellosis, bubonic plague and salmonellosis) and protozoal diseases (malaria, filarial and kalazar). Etiology, epidemiology, pathogenesis, symptomology, pathology, disease diagnosis and treatment of fungal diseases: Candidiasis, histoplasmosis, aspergillosis, cryptooccosis and dermatomycosis.	12 Hours
UNIT IV	General characteristics of common viral diseases like influenza (pneumotropic): herpes simplex, small pox, measles and rubella (dermotropic); dengue fever, hepatitis and AIDS (viscerotropic); rabies, poliomyelitis and slow virus disease (neurotropic). encephalitis and yellow fever viral zoonoses).	12 Hours
UNIT V	Principles of chemotherapy, role of antimicrobial agents and mechanisms of their action with special reference to antibiotics. Molecular basis of drug resistance in bacteria, and drug sensitivity test. Introduction to Nosocomial infections and emerging microbial infection diseases. Biosafety practices in biological sciences and disposal of biomedical waste, bio-terrorism.	12 Hours
Suggested Readings	1. Medical Microbiology by Murray, PR, Rosenthal, KS, Kobayashi, GS & Pfaller, MA (ed III) Mosby Inc.	5.

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	<ol style="list-style-type: none"><li>2. Essentials of Medical Microbiology By Volk WA, Gebhardt, BM, Hammarskjold, ML &amp; Kadner RJ (Ed V) Lipincott-Raven Publisher, Philadelphia</li><li>3. Jawetz, Melnick &amp; Adelberg's medical microbiology by Brooks, GF, Carroll, KC, Butel, JS, Morse, SA, Edition 24<sup>th</sup>, McGraw-Hill Medical,</li><li>4. Medical Microbiology by Cruikshank, Edition 12<sup>th</sup>, Churchill Livingstone Pub.</li></ol>	
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Programme/Class: M. Sc. Microbiology (II)		
Subject: Microbiology	Year: Second (2)	Semester: Fourth (IV)
Major Elective (Optional)	Course Code: B081004T	IPR AND BIOSAFETY
Marks:100	75 (UE) + 25 (CIE)	Credits: 04
<b>Total Number of Lectures-Tutorials-Practical (in hours per week L-T-P: 4-0-0)</b>		
Course Objectives	The course will develop an understanding about Intellectual Property Right and International framework for the protection of IP. The course will also aware the students about Biosafety when dealing with different categories of microbes.	
Course Learning Outcomes	Upon successful completion of the course, the student:	
CO1	Will have acquired basic knowledge about IPR and different types of Intellectual Property.	
CO2:	Will have learnt about international framework for the protection of IP	
CO3	Understands the basics of patents.	
CO4	Will be introduced to various levels of Biosafety.	
CO5	Will be introduced to GRAS organisms and biosafety levels of specific microorganisms.	
Contents:		Duration: 60 hours
UNIT I	Introduction to intellectual property; types of IP: patents, trademarks, copyright & related rights, industrial design, traditional knowledge, geographical indications, protection of new GMOs	12 Hours
UNIT II	International framework for the protection of IP; IP as a factor in R&D; IPs of relevance to Microbiology and few case studies;	12 Hours
UNIT III	Introduction to history of GATT, WTO, WIPO and TRIPS. Basics of patents.	12 Hours
UNIT IV	Introduction to Biosafety; historical background; introduction to biological safety cabinets; primary containment for biohazards; biosafety levels;	12 Hours
UNIT V	GRAS organisms, Biosafety levels of specific microorganisms; recommended biosafety levels for infectious agents and infected animals; definition of GMOs & LMOs	12 Hours
Suggested Readings:	An Introduction to Intellectual Property Rights (Third Edition, 2012) by J. P. Mishra. Intellectual Property Rights by Neeraj Pandey and Khushdeep Dharni Fundamentals of Intellectual Property Rights : For Students, Industrialist and Patent Lawyers by Ramakrishna B & Anil Kumar H.S.	


  
  
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Programme/Class: M. Sc. Microbiology (II)		
Subject: Microbiology	Year: Second (2)	Semester: Fourth (IV)
Major Elective (Optional)	Course Code: B081005T	MICROBIAL PATHOGENICITY
Marks:100	75 (UE) + 25 (CIE)	Credits: 04
<b>Total Number of Lectures-Tutorials-Practical (in hours per week L-T-P: 4-0-0)</b>		
Course Objectives	The objective of this course is to make the students understand various attributes which make the microbes pathogenic or disease-causing, the emergence of newer pathogens with relevance to India and the various tools for their local or global spread. The students would also learn the mechanisms of resistance of bacteria to antibiotics and role of newer vaccines in controlling infectious diseases. The course would also enable students to describe the molecular diagnostic methods and automated equipment which may be used for diagnosis of diseases caused by microorganisms.	
Course Learning Outcomes	Upon successful completion of the course, the student will be able:	
CO1	To understand classical and molecular determinants of disease-causing microbes	
CO2	To describe the characteristics of newer disease-causing bacteria and viruses	
CO3	To study and critique the various molecular tools available to work on the molecular epidemiology of disease-causing microorganisms	
CO4	To study and evaluate mechanisms underlying resistance of bacteria to antibiotics, spread of resistance and the use of newer vaccines to control infectious diseases	
CO5	To gather information as to how the infectious diseases may be diagnosed using newer diagnostic tools and what automated equipment are available for use in diagnostic microbiology laboratories.	
Contents:		Duration: 60 hours
UNIT I	Classical view of microbial pathogenicity: Define pathogenicity and virulence; Quantitative measures of pathogenicity: minimal lethal dose (MLD), LD <sub>50</sub> , ID <sub>50</sub> , TCID <sub>50</sub> . Virulence determinants: colonization, toxins, enzymes and invasiveness. Facultative/ obligate intracellular pathogens.	12 Hours
UNIT II	Molecular microbial pathogenicity: Molecular Koch's postulates, multiplicity of virulence determinants, coordinated regulation of virulence genes, and environmental regulation of virulence determinants by two component signal transduction systems, antigenic variation; clonal and panmictic nature of microbial pathogens, type three secretion system (TTSS, T3SS), Role of biofilms and quorum sensing in microbial pathogenicity	12 Hours
UNIT III	Molecular microbial epidemiology: Objectives of microbial epidemiology. Biochemical and Immunological tools - biotyping, serotyping, phage typing, multilocus enzyme electrophoresis (MLEE); Molecular typing: RAPD, rep (REP, ERIC, BOX)-PCR, IS based typing, PFGE, AFLP, MLST, VNTR and whole genome sequence, use of geographical information system (GIS) for microbial epidemiology.	12 Hours
UNIT IV	Antimicrobial resistance (AMR): Recent concepts – multidrug efflux pumps, extended spectrum $\beta$ -lactamases (ESBL), X-MDR <i>M. tuberculosis</i> , methicillin-resistant <i>S. aureus</i> (MRSA), role of integrons.	12 Hours
UNIT V	Rapid diagnostic principles: Nucleic acid probes in diagnostic microbiology, nucleic acid amplification methods, real-time PCR, lateral flow assays, diagnostic	12 Hours

	sequencing and mutation detection, automated instruments for detection/diagnosis of infectious agents (BACTAC and Vitek-2, GeneXpert).	
Suggested Readings	<ol style="list-style-type: none"> <li>1. Jawetz, Melnick, &amp; Adelberg's Medical Microbiology by Carroll KC, Hobdon JA, Miller S, Morse SA, Mietzner TA. 27<sup>th</sup> edition. Lange Publication, 2016.</li> <li>2. Beginner's guide to comparative genome analysis using next generation sequence data by Edward DJ and Holt KE in Microbial Informatics and Experimentation, 3:2, <a href="https://doi.org/10.1186/2042-5783-3-2">https://doi.org/10.1186/2042-5783-3-2</a>, 2013.</li> <li>3. Bacterial Pathogenesis: A molecular approach by Wilson BA, Salyers AA, Whitt DD, Winkler ME. 3<sup>rd</sup> edition. American Society for Microbiology Press, Washington, DC USA, 2011.</li> <li>4. Bacterial Pathogenesis: Molecular and Cellular Mechanisms by Locht C, Simonet M, Caister Academic Press, 2012.</li> <li>5. Molecular Microbiology: Diagnostic Principles and Practice by Persing DH, Tenover FC, Hayden R, Leven M, Miller MB, Nolte FS, Tang YW, Belkum AAV. 3<sup>rd</sup> edition. Washington, American Society for Microbiology Press, 2016</li> <li>6. Infectious Disease Epidemiology: Theory and Practice by Nelson KE, Williams CM. 4<sup>th</sup> edition. Jones and Bartlett, 2019.</li> </ol>	

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Programme/Class: M. Sc. Microbiology (II)		
Subject: Microbiology	Year: Second (2)	Semester: Fourth (IV)
Major Elective (Optional)	Course Code: B081006T	PLANT-PATHOGEN INTERACTIONS
Marks:100	75 (UE) + 25 (CIE)	Credits: 04
<b>Total Number of Lectures-Tutorials-Practical (in hours per week L-T-P: 4-0-0)</b>		
Course Objectives	The course will facilitate in understanding of how pathogens interact with various plants and effect plant physiology, photosynthesis, respiration, transpiration and translocation. The involvement of various enzymes and toxins and understanding the molecular interaction will help in designing biocontrol strategies and development of transgenic plants. The course covers the novel molecular diagnostic approaches and correct forecasting of plant diseases.	
Course Learning Outcomes	Upon successful completion of the course, the student:	
CO1	Will have gained insight into genetics of host-pathogen interactions, resistance genes, resistance mechanism in plants.	
CO2	Will have been introduced to plant disease control, physical, chemical and biological methods of disease control	
CO3	Understands about crown gall, symptoms of viral diseases and their control, diseases of some important cereals, vegetables and crops	
CO4	Will have attained knowledge about designing of molecular diagnosis of plant disease and development of transgenic plants with applications and constraints.	
CO5	Will be able to describe various important milestones in disease control and disease forecasting relevant in Indian farming.	
Contents:		Duration: 60 hours
UNIT I	Genetic basis of plant diseases: Genetics of host-pathogen interactions, resistance genes, resistance mechanisms in plants.	12 Hours
UNIT II	Disease control: Principles of plant disease control, physical and chemical methods of disease control, biocontrol, biocontrol agents - concepts and practices, fungal agents, <i>Trichoderma</i> as biocontrol agent, biocontrol agents – uses and practical constraints.	12 Hours
UNIT III	Some important plant diseases and their etiological studies: Crown gall, symptoms of viral diseases and their control, diseases of some important cereals, vegetables and crops.	12 Hours
UNIT IV	Molecular approach: Molecular diagnosis, transgenic approach for plant protection, futuristic vision of molecular diagnosis, applications and constraints.	12 Hours
UNIT V	Disease forecasting: History and important milestones in disease control, disease forecasting and its relevance in Indian farming.	12 Hours
Suggested Readings:	<ol style="list-style-type: none"> <li>1. Plant Pathology by G. N. Agrios. 5<sup>th</sup> edition. Academic Press. 2005</li> <li>2. Plant Pathology by R.S. Mehrotra, and A. Aggarwal, 3<sup>rd</sup> edition. Tata McGraw Hill. 2017</li> <li>3. Bacterial plant pathology: cell and molecular aspects by D. C. Sigeo. Cambridge University Press. 1993.</li> <li>4. Molecular plant pathology by M. Dickinson. BIOS Scientific Publishers, London. 2003.</li> <li>5. The essentials of Viruses, Vectors and Plant diseases by A.N. Basu &amp; B.K. Giri. Wiley Eastern Limited. 1993.</li> </ol>	

As per the BoS held on 24.07.2024

6. Biocontrol of Plant Diseases (Vol. I) by K.G. Mukerji and K.L.Garg. CRC Press Inc., USA. 1988.

7. Molecular Biology of Filamentous Fungi by U. Stahl and P. Tudzyski. VCH Verlagsgesellschaft mbH. 1992.

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Programme/Class: M. Sc. Microbiology (II)		
Subject: Microbiology Major Elective (Optional)	Year: Second (2) Course Code: B081007T	Semester: Fourth (IV) MYCOLOGY AND PHYCOLOGY
Marks:100	75 (UE) + 25 (CIE)	Credits: 04
Total Number of Lectures-Tutorials-Practical (in hours per week L-T-P: 4-0-0)		
Course Objectives	The course will develop a basic understanding about classification and characteristics of basic groups of algae and fungi along with their symbiotic associations and economic importance.	
Course Learning Outcomes	Upon successful completion of the course, the student:	
CO1	Will gain knowledge about occurrence and distribution of fungi along with the characteristics of different classes of fungi.	
CO2	Will have been introduced to different classes of fungi.	
CO3	Understands about economic importance of fungi	
CO4	Will attain knowledge about salient features of algae.	
CO5	Is able to know about economic importance of algae.	
Contents:		Duration: 60 hours
UNIT I	Introduction to fungi: Contributions of Mycologists in India, Introduction of fungi: Occurrence and distribution, somatic structure, hyphal growth, nutrition, heterothallism, sex hormones in fungi, physiological specialization in fungi, fungi and ecosystem; saprophytic parasitic, mutualistic and symbiotic relationship with plants and animals. Classification of fungi. Reproduction in fungi: asexual, sexual and parasexual.	12 Hours
UNIT II	Study of the different classes of fungi: Salient features of division and sub division of myxomycota, mastigomycota, zygomycota, ascomycotina, basidiomycotina and euetromycotina. Structure and reproduction of: <i>Dictyostelium</i> , <i>Allomyces</i> , <i>Pilobolus</i> , <i>Claviceps</i> and <i>Fusarium</i>	12 Hours
UNIT III	Economic importance of fungi: Economic importance of Mycorrhiza: ecto-, endo and ect-endo VAM, Fungi as insect symbionts, fungi as biocontrol agents, attack of fungi on other microorganisms, potential application in Agriculture, environment, industry, food. Role of fungi in bio deterioration of wood, paper, textile. Mycotoxins, quorum sensing in fungi.	12 Hours
UNIT IV	Salient Features of Algae: Contributions of Phycologists in India, Distribution, morphology and classification of algae. Isolation from soil and water, algal ecology, media and methods used for cultivating algae. Measurement of algal growth, strain selection and large scale cultivation. General features and life cycle pattern in different classes of algae	12 Hours
UNIT V	Microalgal biotechnology: Algae as source of food and feed, pigments, fine chemicals, fuel and bioactive compounds Uses of algae in heavy metal removal, algal blooms and toxins.	12 Hours
Suggested Readings	<ol style="list-style-type: none"> <li>Alexopoulos, C.J. and C.W. Mims 1979. Introduction to Mycology (3rd Ed.) Wiley Eastern Ltd., NewDel</li> <li>Charlile M. &amp; Watkinson S.C. The Fungi, Publisher: Academic Press.</li> <li>E.Moore –Landeeker: Fundamentals of the fungi, Publisher: Prentice Hall.</li> <li>L. Barsanti, Paolo Gualtieri: Algae: anatomy, biochemistry, and biotechnology</li> <li>AyhanDemirbas, M. FatihDemirbas: Algae Energy: Algae as a New Source of Biodiesel (2010)</li> <li>Linda E. Graham, James Graham, James M. Graham: Algae (2009) Burnett J.H., Publisher: Edward, Arnold Crane Russak: Fundamentals of Mycology.</li> </ol>	



Programme/Class: M. Sc. Microbiology (II)		
Subject: Microbiology Major Elective (Optional)	Year: Second (2)	Semester: Fourth (IV)
Marks:100	Course Code: B081008T	BIOPROCESS TECHNOLOGY
Total Number of Lectures-Tutorials-Practical (in hours per week L-T-P: 4-0-0)		Credits: 04
Course Objectives	The course will develop a basic understanding about biochemical engineering. The course will develop an idea about microbial growth kinetics, transport phenomenon and various control systems used to control various parameters during the course of fermentation process.	
Course Learning Outcomes	Upon successful completion of the course, the student:	
CO1	Will gain knowledge about upstream and downstream processing along with the growth behavior.	
CO2	Will have been introduced to volumetric mass transfer coefficient along with the methods of determination.	
CO3	Understands about rheological properties of fermentation broths and mass energy balance.	
CO4	Will attain knowledge about various types of bioreactors.	
CO5	Will be able to know about various control systems used to control various parameters.	
Contents:		Duration: 60 hours
UNIT I	Introduction to the bioprocess technology; Microbial growth kinetics: batch, continuous and fed batch culture.	12 Hours
UNIT II	Transport phenomenon in bioprocess: Introduction, oxygen requirement in industrial fermentation, oxygen supply and oxygen transfer rate, factors affecting oxygen transfer rate, determination of $K_{La}$ values.	12 Hours
UNIT III	Non-Newtonian fluids, heat transfer and heat transfer correlation, and mass and energy balance.	12 Hours
UNIT IV	Introduction to bioreactor: Ideal bioreactor, Reactor with non-ideal mixing, Sterilization reactors, Multiphase bioreactors, animal and plant cell reactor technology.	12 Hours
UNIT V	Instrumentation and control systems: A. Methods of measuring process variability a. Temperature b. Flow c. Pressure d. DO and free $CO_2$ e. pH and other chemical factors B. Control systems a. Manual b. Automatic c. Computers and interface	12 Hours
Suggested Readings	<ol style="list-style-type: none"> <li>Principles of Fermentation Technology by P. F. Stanbury, A. Whitaker and S. J. Hall; Second Edition; Butterworth Heinemann Publications; ISBN: 0-7506-4301-6.</li> <li>Putting Biotechnology to Work: Bioprocess Engineering; Committee on Bioprocess Engineering, National Research Council Washington, D.C. 1992; ISBN: 0-309-58487-6.</li> <li>The encyclopedia of bioprocess technology : fermentation, biocatalysis, and</li> </ol>	

bioseparation by Michael C. Flickinger, Stephen W. Drew; John Wiley & Sons, Inc.; ISBN 0-471-13822-3

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**Programme/Class:**  
**Bachelor's Degree with Research /**  
**M. Sc. Microbiology (I)**

**Subject: Microbiology****Year: Second (2)****Semester: Fourth (IV)****Core (Compulsory)****Course Code: B081009P****Practical III****Marks:100****04 credits****Duration: 120 hours****75 (UE) + 25 (CIE)****Total Number of Lectures-Tutorials-Practical (in hours per week L-T-P: 0-0-8)**

Course Objectives	The course will enable students to apply the learning of microbiology concepts toward the exploitation of microbial population for industrial and human benefits.
Course Learning Outcomes	Upon successful completion of the course, the student:
CO1	Will be able to measure various bioprocess parameters.
CO2	Will be able to microbiological quality of milk.
CO3	Will be aware of isolation procedure of various PGPR and their efficiency assessment
CO4	Will be able to determine Determination of antibiotic sensitivity and MIC by different procedures.

**Contents:**

1. Measurement of  $K_s$  value
2. Determination of specific growth rate and generation time
3. Estimation of  $K_{La}$  value by sulfite oxidation method
4. Milk quality test- methylene blue reduction test,
5. Ames test
6. Isolation of PGPR from soil.
  - a. Isolation of *Azotobacter*
  - b. Isolation of *Azospirillum*
  - c. Isolation of *Pseudomonas*
  - d. Isolation of *Rhizobium*
7. Determination of plant growth promotion activity of bacterial isolates
  - a. IAA Production
  - b. Ammonia Production
  - c. Siderophore production
  - d. Phosphate solubilization
  - e. Ammonia production
  - f. HCN Production
8. Determination of antibiotic sensitivity by
  - a. Well diffusion method.
  - b. Disk diffusion method.
  - c. Plug diffusion method..
9. Determination of MIC for selected antibiotics

**Suggested Readings:**

1. Microbiology: A laboratory manual by JG Cappucino, C.T. Welsh. 11<sup>th</sup> edition. Pearson. 2017.
2. Environmental Microbiology: A lab manual by I. Pepper, C. Gerba, J. Brendecke. 46<sup>th</sup> edition. Academic Press. 2011.

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**Programme/Class:**  
**Bachelor's Degree with Research /**  
**M. Sc. Microbiology (I)**

<b>Subject: Microbiology</b>	<b>Year: Second (2)</b>	<b>Semester: Third (III)</b>
<b>Core Paper (Compulsory)</b>	<b>Course Code: B081010R</b>	<b>Industrial Training /Surveys/Research Project II</b>
<b>Marks:100</b>	<b>Credits: 08</b>	
<b>Course Details</b>	This research project can be interdisciplinary / multi-disciplinary. This research project can also be in the form of industrial training / internship / survey work etc.	
	<b>* Students will submit the final report (project report/dissertation) of the research project carried out in both the semesters at the end of the year, which will be assessed jointly by the supervisor and the external examiner nominated by the university at the end of the year out of 100* marks</b>	

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