Chaudhary Bansi Lal University, Bhiwani

(A State University established under Haryana Act No. 25 of 2014)

Department of Microbiology

Examination Scheme and Syllabus

For

M.Sc. Microbiology

&

P.G. Diploma in Microbiology

In accordance with NEP-2020

w.e.f. 2025-2026

Chaudhary Bansi Lal University, Bhiwani
(A State University established under Haryana Act No. 25 of 2014)

Evaluation Scheme
of
M.Sc. Microbiology
Summary

Programme : **M.Sc. Microbiology**
Duration : **Two years (Four Semesters)**
Minimum Attendance Required : **75%**
Total Credits **100**
Total Marks : **2500**
Assessment/Evaluation of Theory examination:

Internal Marks	Major Test (End Semester Exam) Marks	Total Marks
150	350	500
60	140	300
30	70	100
20	50	70
15	35	50

Internal Evaluation:

Minor Test Marks	Attendance Marks	Assignment/ Quiz Marks	Total Marks
15	05	10	30
07	04	04	15

Duration of Examination:

Minor Test (Internal)	Major Test
1 hour for 15 Marks and 30 minutes for 7 marks	3 hours for 70 marks and 2 hours for 35 marks

Passing Criteria: *The pass percentage will be 40 percent (Grade 'P'), both for theory and practical and end term examinations. A student has to obtain minimum 40% marks (Grade 'P') in aggregate (Sum of internal assessment and end term examination marks) and in the end term examinations separately to qualify a course.*

The IKS is 5% in the syllabus of Microbiology including Assignments.

Internship Program:

The Students in summer break will do internship for 4-6 weeks' duration in Academic/Industry/Company/Research Institute to increase their skills for employability/to enhance research aptitude. The internship will be evaluated by the internship monitoring committee for guidelines of internship, see ordinance of PG programme.
Students exiting the programme after second semester shall be awarded **Post Graduate Diploma in Microbiology** after qualifying for all courses including internship.

For details go through the ordinance available on university-website

SEMESTER-III **CREDIT: 26** **MARKS: 650**

Sr. No.	Paper Code	Subjects	Type of Course	Contact hours per week			Credits			Examination Scheme				
										Theory		Practical		
				Theory	Practical	Total	Theory	Practical	Total	Internal	External	Internal	External	**Total**
1	25MB301	**Industrial Microbiology**	CC-9	04	-	04	04	-	04	30	70	-		100
2	25MB302	**Medical and Clinical Microbiology**	CC-10	04	-	04	04	-	04	30	70	-		100
3	25MB303	**Soil and Agriculture Microbiology**	DEC-3 **Choose any one**	04	-	04	04	-	04	30	70	-		100
4	25MB304	**Environmental Microbiology**		04	-	04	04	-	04	30	70	-		100
4	25MB305	**Advanced Biotechniques**	DEC-4	04	-	04	04	-	04	30	70	-		100
	25MB306	**Research Methodologies**	**Choose any one**	04	-	04	04	-	04	30	70	-		100
5	25MB307	**Lab course I**	PC-V (Practical based on CC-9 and CC-10)	-	08	08	-	04	04	-	-	30	70	100
6	25MB308	**Lab course II**	PC-VI (Practical based on DEC-3 and DEC-4)	-	08	08	-	04	04	-	-	30	70	100
7	25MB309	**Mushroom Cultivation Technology**	EEC	02		02	02		02	15	35			50
	TOTAL			**18**	**16**	**34**	**18**	**08**	**26**	**135**	**315**	**60**	**140**	**650**

SEMESTER-IV (For Option I) **CREDIT: 24** **MARKS: 600**

Sr. No.	Paper Code	Subjects	Type of Course	Contact hours per week			Credits			Examination Scheme				
										Theory		Practical		
				Theory	Practical	Total	Theory	Practical	Total	Internal	External	Internal	External	**Total**
1	25MB401	**Virology**	CC-12	04	-	04	04	-	04	30	70	-		100
2	25MB402	**Biostatistics and Bioinformatics**	DEC-5 **Choose any one**	04	-	04	04	-	04	30	70	-		100
	25MB403	**Plant Pathology**												
3	25MB404	**Food and Dairy Microbiology**	DEC-6 **Choose any one**	04	-	04	04	-	04	30	70	-		100
	25MB405	**Microbial nanotechnology**		04	-	04	04	-	04	30	70	-		100
4	25MB406	**Bioenterpreneurship, Biosafety and IPR**	DEC-7 **Choose any one**	04	-	04	04	-	04	30	70	-		100
	25MB407	**Multiomics skill for microbiologists**		04	-	04	04	-	04	30	70	-		100
5	25MB408	**Lab course I**	PC-VII (Practical based on CC-12 and DEC-5)	-	08	08	-	04	04	-	-	30	70	100
6	25MB409	**Lab course II**	PC-VIII (Practical based on DEC-6 and DEC-7)	-	08	08	-	04	04	-	-	30	70	100

	TOTAL		**16**	**16**	**32**	**16**	**08**	**24**	**120**	**280**	**60**	**140**	**600**

SEMESTER-IV (For Option II) **CREDIT: 24** **MARKS: 500**

Sr. No.	Paper Code	Subjects	Type of Course	Contact hours per week			Credits			Examination Scheme				
										Theory		Practical		
				Theory	Practical	Total	Theory	Practical	Total	Internal	External	Internal	External	**Total**
1	25MB402	**Biostatistics and Bioinformatics**	DEC-5 **Choose any one**	04	-	04	04	-	04	30	70	-		100
	25MB403	**Plant Pathology**		04	-	04	04	-	04	30	70	-		100
2	25MB404	**Food and Dairy Microbiology**	DEC-6 **Choose any one**	04	-	04	04	-	04	30	70	-		100
	25MB405	**Microbial nanotechnology**		04	-	04	04	-	04	30	70	-		100
3	25MB408	**Lab course I**	PC-VII (Practical based on DEC-5and DEC-6)	-	08	08	-	04	04	-	-	30	70	100
4	25MB410	**Dissertation /Research project /Project Work**	Dissertation	-	24	24	-	12	12	-	-	90	210	300
	TOTAL			**8**	**32**	**40**	**8**	**16**	**24**	**60**	**140**	**120**	**280**	**600**

T= Theory **P**=Practical **Int**=Internal assessment **CC**= Core Course **DEC**= Discipline Elective Course **EEC**= Employability Enhancement Course

ANNEXURE-'C'

* The students who opted Option 3 should submit a project report synopsis of at least 50 pages comprising of Literature survey, identification of Research Problem, Plan of work, methodology as well as practical work (if any) at the end of 3rd semester and the same will be evaluated by internal and external examiners.

** The students should continue the research work in 4th semester based on the project work synopsis submitted at the end of 3rd semester. The final thesis project report will be evaluated by the internal and external examiners.

Internship work-based vocational education and training apprenticeship etc.

A course requiring students to participate in professional employment-related activity or work experience or co-operative education activity with an entity external to the educational institution normally under the supervision of an employee of an organization or an individual professional. A key aspect of the internship is induction into actual, formal and organized work situations. Internship involves working with local industry (Government or Private organizations), business establishments, artists, craft persons, etc. to provide opportunities for students to actively engage in on-site experiential learning.

The students will undergo work-based learning internships. Apprenticeships in a firm, industry, or organization or Training in labs with faculty and researchers experts in their own or other institutions research organizations during the summer term. Students will be provided with opportunities for internships with local industry, business organizations, health and allied areas, local governments (such as panchayats, municipalities), Parliament or elected representatives, media organizations, artists, crafts persons, and a wide variety of organizations to provide opportunities to actively engage in on-site experiential practical learning and, as a by-product, further improve their employability. The curricular component of 'community engagement and service or the socio-economic development' seeks to expose students to the socio-economic issues in society so that the theoretical learning can be supplemented by actual life experiences to generate solutions to real-life problems. Students will be also given opportunities to gain a first-hand understanding of the policies, regulations, organizational structures, processes, and programs that guide the development process. The study areas mentioned above are not limited to these lines, departments colleges may also explore further.

This component will develop a skilful aptitude in the students and expose the students to society research. The student will identify a problem and possible solutions to it based on his knowledge that is obtained from books, journals, and internet.

Common rules related to the internship:

- The training should be of 12 credits with a structured internship, where one credit is equivalent to two hours of engagement and minimum of 150 hours is mandatory.
- A student for the PG Programme shall be required to undergo internship during the semester.
- A supervisor should be appointed by the department college and the Internship Monitoring Committee (IMC), composed of chairperson Principal, Nodal officer, Supervisor, Mentor at the place of internship, and an external member), duly assigned by the chairperson Principal, will evaluate the process of internship and the assignment.
- Each department college should provide the list of areas organizations etc. to the Nodal Officer in their college department to collaborate with these organizations in the form of MOUs etc. for the training of students.
- A student will inform and get approval from the Chairperson Principal Director of the Department College Institute before going for an internship. The internship will involve working with local industry (Government or Private organizations Institutions), business establishments, artists, craft persons, or a professional (individual organization).
- The training will be decided by the supervisor and student. A supervisor should have a minimum three years of research teaching experience. In case if the eligible supervisor is not available in the department college then supervisor could be assigned by the principal (with the recommendations from the head of the department, related discipline from the same or other institutions, with due consultation from supervisor and head of the department of the institute concerned).
- An outline of the proposal will be provided by the supervisor to Internship Monitoring Committee (IMT) before starting the training.
- At the end of the training student will submit the report in the same format as given by the University. The evaluation will be based on –attendance (10%), Seminar Presentation viva (40% weightage) and Report submission (50% weightage). A plagiarism up to 20% is acceptable in the report.
- The internal evaluation should be completed within a week after the training.
- Student will submit a copy of the report (a hard copy and a soft copy in PDF) to the Department College Institute within 15 days after the completion of internship. A student has to submit a certificate of attendance and work done report from the organization professional where at the internship was done. The evaluation of the internship shall be done by the IMT and other participants from the department college mainly on the basis of the report and Seminar Presentation viva-voce. The research outcomes of their project work may be published in peer-reviewed journals or may be presented in conferences, seminars or may be patented.
- The internship will be governed by the prevailing rules of the University from time to time.

Attendance:

Attendance (Minimum attendance required 75%)

Total Attendance (%)	Marks Awarded (Max marks 20)
>75-80	04
>80-85	16
>85-90	18
>90	20

DISSERTATION PROJECT WORK EVALUATION REPORT

Name of Course .....
Name of the Candidate .....
Subject .....
Title of the Dissertation Project Report .....
Academic Session .....
Registration Number .....

Dissertation Project Report will be evaluated under the following three evaluation heads

Quality, Content, Presentation

The grade for each of term on a scale of 5 – 10 where

"10" stands for "Excellent"	"6" stands for "Satisfactory"
"9" stands for "Very Good"	"5" stands for "Poor"
"8" stands for "Good"	"4" stands for "Inferior"

EVALUATION HEADS		SCORE
Quality		
1	Introduction to the work	
2	Review of literature	
3	Scope of the work	
4	Technical soundness (Research methodology, Experimental setup)	
5	Problem statement	
6	Originality of work	
7	Timeliness of work	
8	Contribution to the field	
9	Conclusions drawn	
10	Scope for further research in the field	
Content		
11	Adequacy of data and information	
12	Organization of the Dissertation Project Report	
13	Practical applications utility	
14	Adequacy of references Bibliography	
Presentation		
15	Clear explanation of the work	
16	Logical details of the methods, techniques and tools	
17	Justification of the work done	
18	Clarity and unambiguity of the language	
19	Clarity of Objectives	
20	Freedom from redundancy, Irrelevancy	
Total Score out of 200		
(in word ..... **)**		

EVALUATION CRITERIA

9. Kristensen, P., Taji, A., Reganold, J. Organic Agriculture. A Global Perspective. CSIRO Press. Victoria, Australia.
10. (http://www.oardc.ohio-state.edu/apsbcc/).
11. (https://nptel.ac.in/course).
12. (https://apeda.gov.in).

Date of PGBOS & R: August 14, 2025

M.Sc. Microbiology

Semester III

Name of the course: Industrial Microbiology	**Course Code: 25MB301**	**Credits: 4**
Maximum Marks: 100 **Theory: 30(Internal)+70(External)=100**	**Time of examination: 3 Hrs.**	

Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing seven short answer type questions from all sections. Further, examiner will set two questions from each section and the candidates will be required to attempt one question from each Section. All questions will carry equal marks.

Objectives: To familiarize students with various microbial processes and systems for the development of industrially important products such as enzymes, microbial metabolites, biofuels and recombinant therapeutics.

Course Outcomes: After completion of this course

- **CO1**. The student will gain insight on industrially important microbes, their isolation, preservation and selection of improved strains.
- **CO2.** The students will be able to differentiate between batch, fed-batch and continuous cultivation processes and their optimization strategies.
- **CO3.** The students will be able to differentiate between the design of a laboratory and industrial scale fermenters and associated instruments. The development of immobilized enzymes, biosurfactants shall be inculcated.
- **CO4.** The students will learn about various downstream processing techniques; process optimization involved in the development of enzymes, recombinant proteins and therapeutics.

Section-I

Introduction to industrial microbiology: sources of industrially important microbes, Isolation and selection of industrially important microorganism, metabolic pathways and control mechanisms of industrially important microbes. Genetic improvement of microbes, preservation and maintenance of microbial cultures, lyophillization and crystallization.

Section-II

Microbial strains, substrates, formulation and optimization of media. Kinetics of cell growth and substrate utilization. Biomass production and product formation in batch, fed batch and continuous cultivation. Application, advantages and disadvantage of type of reactors. Chemical, physical and biological methods of food preservation, production of milk and food products and food beverages.

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Section-III

Types of fermentation and fermenters: Static and submerged fermentations, Recent developments in fermentation technology. Types and design of bioreactor: Stirred tank reactor, bubble column reactor, airlift reactor, Packed bed reactor, fluidized bed reactor. Bioprocess control and fermentation economics. Enzyme and immobilized enzymes, biosurfactants and recombinant products.

Section-IV

Types of microbial products: Production of Biomass, Baker's yeast, Mushroom, Single cell proteins, biopesticides and bio fertilizers. Production of primary metabolites: Ethanol, organic acids, Amino acids, Vitamins, Industrial enzymes. Production of secondary metabolites: Antibiotics, pigments. Microbial transformation, Production of metabolites of non-microbial origin *e.g.* Insulin, Interleukin, Cytokines using rDNA technology.

Books Recommended:

1. Casida LE. Industrial Microbiology, New Age Publishers, New Delhi.
2. Crueger W, Crueger A. Biotechnology. A Textbook of Industrial Microbiology, Sinauer Associates, USA.
3. Shuler ML, F Kargi. Bioprocess Engineering Basic Concepts, Prentice Hall, New Jersey, USA.
4. Stanbury P. F., A. Whitaker, S.J. Hall. Principles of Fermentation Technology, Butterworth-Heinemann, UK.
5. Vogel H.C., C.L. Todaro, C.C. Todaro: Fermentation and Biochemical Engineering Handbook: Principles, Process Design, and Equipment by Publisher: Noyes Data Corporation/ Noyes Publications.
6. Prescott and Dunn's Industrial Microbiology.Publisher: Gerald Reed: Books.
7. Shukla P. and Pletschke, Brett I. (Eds.) Advances in Enzyme Biotechnology, Springer-Verlag Berlin Heidelberg. ISBN 978-81-322-1094-8 (ebook); ISBN 978-81-322-1093-1 (Softcover). [URL: http://link.springer.com/book/10.1007%2F978-81-322-1094-8]

Teaching learning process:

- **Lectures (online and offline mode):** Through white board, notes, power point presentation supported by smart class rooms and other online teaching platforms like Google meet and Google classroom. etc.
- **Doubt session :** once in a week
- **Assignments, seminars and different exercises**
- **Tests:** Learning level of the students will be tested through class tests, quizzes, surprise evaluation, assignments sessional exams and through interactive sessions.

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M.Sc. Microbiology

Semester III

Name of the course: Medical and Clinical Microbiology	**Course Code: 25MB302**	**Credits: 4**
Maximum Marks: 100 **Theory: 30(Internal)+70(External)=100**	**Time of examination: 3 Hrs.**	

Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing seven short answer type questions from all sections. Further, examiner will set two questions from each section and the candidates will be required to attempt one question from each Section. All questions will carry equal marks.

Objective: The objective of this course is to make the students understand various pathogenic or disease-causing microbes, the emergence of newer pathogens and its local or global spread. The course would also enable students to describe the molecular diagnostic methods and diseases caused by microorganisms.

Course outcomes: After reading this course

- **CO1.** The students will be able to understand about the disease transmissions, pathogenesis and diagnostics of diseases.
- **CO2.**The students will learn about microbial flora present in different part of human bodies and their sources
- **CO3.** The students will be able to explain the clinical features, treatments and prevention of various diseases
- **CO4.** The students will be able to learn handling the biomedical waste and its disposal

Section-I

Introduction to medical and clinical microbiology, normal microflora of Human body (Microbiota of skin, throat, gastrointestinal tract, urogenital tract).

Surveillance sampling Specimen Collection (Sterile swab, intubation, Catheter, sputum cups, Needle aspiration) and examination of pathological specimens (blood, urine and sputum), Transport medium with examples,

Methods of culture, techniques and organisms encountered in: Cerebrospinal Fluid, blood culture, sputum, pus, urine, stool, UTI, endocarditis, Bone and joint infections

Processing of clinical samples for pathogens.

Section-II

Normal microbial residents of the human body: characteristics of normal flora, distribution and occurrence of normal flora. Normal flora of the skin, respiratory tract, gastrointestinal tract and genitourinary tract

Concept of pathogenicity and virulence, microbial adherence, spreading, and establishment of pathogens, Biofilm mediated infection, Epidemiology of infection

Microbial Toxins (Bacterial Toxins, distinguishing feature of Endotoxins and exotoxins, Mycotoxins)

Section-III

Etiology, Pathogenesis, Symptomology, Treatment of Bacterial Diseases: Tuberculosis, Anthrax, Leprosy, and Tetanus

Fungal diseases: Candidiasis, Histoplasmosis, Coccidiomycosis, and Dermatophytosis.

Viral disease (Corona, Rabies, Influenza), protozoal disease (Malaria and African Sleeping sickness), zoonotic diseases (Lyme disease and Bubonic plaque)

Section-IV

Role of vectors in disease transmission (Dengue and Malaria)

Basic concept of one health

Nosocomial and emerging microbial infectious diseases, Establishment of risk groups and biosafety levels.

Biomedical waste handling and disposal: Biomedical Waste Management Rules, 2016 with subsequent amendments in 2018 and 2019

Book Recommended:

1. Medical Microbiology by C.G.A. Thomas. Bailliere Tindall/ WB Saunders, London.
2. Medical Microbiology by Mims, Playfiar, Roitt, Wakelin and Williams, Mosby- year Book Europe Ltd., U.K.
3. Microbiology: Concepts and Applications by Pelczar, Chan and Krieg. McGraw Hill, Inc., U.S.A.
4. Microbiology: A Human Perspective by Nester, E.W. Roberts C.E., Anderson, seventh edition McGraw Hill Education, Europe.
5. Sherris Medical Microbiology. K.J Ryan, Mc Graw Hill, Europe.
6. Essentials of Medical Microbiology by Apurba Sankar Sastry & Sandhya Bhat K.. Jaypee brothers medical publishers
7. Medical Microbiology(LANGE) Geo Brooks, Karen C. Carrol, Janet Butel and Stephen Morse, McGraw Hill Education, Europe.

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M.Sc. Microbiology

Semester III

Name of the course: Soil and Agricultural Microbiology	**Course Code: 25MB303**	**Credits: 4**
Maximum Marks: 100 **Theory: 30(Internal)+70(External)=100**	**Time of examination: 3 Hrs.**	

Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing seven short answer type questions from all sections. Further, examiner will set two questions from each section and the candidates will be required to attempt one question from each Section. All questions will carry equal marks.

Objectives: The Objective of this course is to teach students about the role of microorganisms in soil, including biogeochemical cycles, plant growth promotion, development of biofertilizers, and biocontrol agents for maintaining soil health.

Course Outcomes: After learning this course

- **CO1.** The students will be able to understand different microorganisms present in the soil ecosystem and their roles and different interactions for sustainable agriculture.
- **CO2.** The students will be able to understand the concept of plant nutrition through the roles of nitrogen-fixing bacteria, mycorrhiza, and other biofertilizers.
- **CO3.** The students will be able to understand the role of microorganisms in different biotransformation and biodegradation strategies of different organic matter, organic pollutants, and pesticides. They will gain a basic idea of biogas, composting, and vermicomposting.
- **CO4.** The students will be able to understand the mechanisms of major biopesticides based on Bacteria, viruses, and fungi.

Section-I

Soil microorganisms: major groups, effect on soil health, soil enzyme activities, and importance, Root exudates and rhizosphere effects. Nitrogen cycle: ammonification, nitrification, mineralization, immobilization, and denitrification. Biological nitrogen fixation–symbiotic and associative, biochemistry and genetics of nitrogen fixation.

Section-II

Microbiology of rhizosphere, phyllosphere, plant growth-promoting rhizobacteria, and their mode of action. Biofertilizers: Preparation and Role of Biofertilizers in Agriculture. Formation and composition of soil organic matter, fulvic acid, and humic acid, and Factors affecting the degradation of organic matter.

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Section-III

Microorganisms involved in phosphate solubilisation, potassium solubilisation, and sulfur solubilization. Microbial biomass, Carbon cycle, C: N ratio. Mycorrhiza and its role in plant growth promotion. Compost: types and methods, biogas plant, and a method for the preparation of biogas. Bioremediation of contaminated soil.

Section-IV

Biocontrol, concept, types, mode of action & applications of biopesticides and bioherbicides. Major biopesticides based on bacteria, viruses & fungi (*Bacillus thuringiensis* (Bt) toxin, Boverin, DeVine, Collego). Microbial degradation of polymers: cellulose, hemicelluloses, and biodegradation of pesticides.

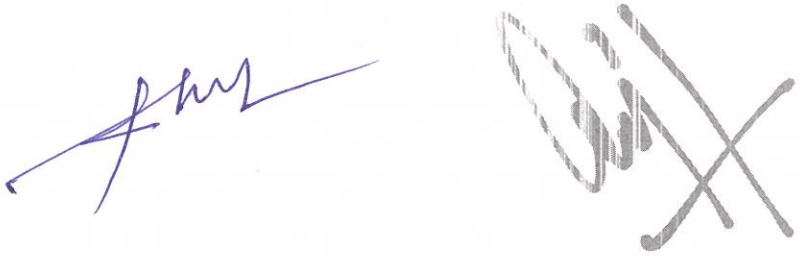
Bioconversion of solid waste, utilization as fertilizer, composting and vermicomposting

Books Recommended:

1. Martin Alexander. Soil Microbiology. John Wiley.
2. Paul EA. Soil Microbiology, Ecology and Biochemistry. Academic Press.
3. Sylvia et al. Principles and Applications of Soil Microbiology. Pearson Edu.
4. Van Elsas JD, Trevors JT & Wellington EMH. Modern Soil Microbiology. Marcel Dekker.
5. N S Subha Rao, Soil Microbiology, 4th edition. Enfield, Science Publishers.

Teaching learning process:

- **Lectures (online and offline mode):** Through white board, notes, power point presentation supported by smart class rooms and other online teaching platforms like Google meet and Google classroom. etc.
- **Doubt session:** once in a week
- **Assignments, seminars and different exercises**
- **Tests:** Learning level of the students will be tested through class tests, quizzes, surprise evaluations, assignments, sessional exams, and through interactive sessions.



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M.Sc. Microbiology

Semester III

Name of the course: Environmental Microbiology	**Course Code: 25MB304**	**Credits: 4**
Maximum Marks: 100 **Theory: 30(Internal)+70(External)=100**	**Time of examination: 3 Hrs.**	

Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing seven short answer type questions from all sections. Further, examiner will set two questions from each section and the candidates will be required to attempt one question from each Section. All questions will carry equal marks.

Objective: The course aims to educate students on the scientific principles of technologies to clean up contaminated environments and to generate valuable resources employing microorganisms.

Outcome: After reading this course

- **CO1**. The students will have an overview of recent developments in the field of environmental microbiology with special emphasis on the role of microbes in mitigating environmental pollution.
- **CO2.** The students will become acquainted with various cultural, biochemical, and molecular techniques used in understanding microbial diversity.
- **CO3**. The students will be 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 management.
- **CO4.** The students will be able to understand the role of microbes in the bioremediation of environmental pollutants like petroleum hydrocarbons, pesticides, plastic, and electronic waste. They will also understand the utility of microbes in mineral and oil recovery.

Section-I

Concept, development, and scope of the microbial community in the biosphere, biofilm, and its ecological implications. Microbes in terrestrial, aquatic, and aerial environments.

Section-II

Microbial Degradation of Organic Pollutants: Degradation and microbial remediation of xenobiotics, pesticides, hydrocarbons, and phytoremediation of pollutants. Understanding microbial diversity in the environment by culture-dependent approaches, limitations, and by culture-independent molecular approaches involving the metagenomics approach. Analysis of FAME profiles, G+C analysis, slot-blot hybridization of the community DNA, and fluorescent

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in situ hybridization.

Section-III

Microbiology of Wastewater Treatment, waste types-solid and liquid waste, characterization, physical, chemical, biological, aerobic, anaerobic, primary, secondary, and tertiary treatments. Anaerobic processes: Anaerobic digestion, anaerobic filters, and an up-flow anaerobic sludge blanket reactor. Microbes as bio-indicators.

Section-IV

Solid Waste Treatment, management of solid wastes, sanitary landfills. Bio-fuels, Bio-mining, bioremediation strategies for soils and water polluted with heavy metals and organic pollutants–treatment of industrial effluents from dairy, distillery, tannery, sugar, paper, and pharmaceutical industries.

Books Recommended:

1. Microbial Ecology By Atlas R.M., Bartha R., Benjamin Cummings Publishing Co, Redwood City, CA.
2. Environmental Microbiology by A.H. Varnam & M.G. Evans, Manson Publishing Ltd.
3. Manual of Environmental Microbiology by Christon J. Hurst, Ronald L. Crawford, Jay L. Garland, David A. Lipson, Aaron L. Mills, ASM Press.
4. Maier, R.M., Pepper, I.L. & Gerba, C.P. Environmental Microbiology. Academic Press.
5. Environmental Microbiology by R. Mitchel, Wiley-Blackwell.
6. Environmental Microbiology by Raina Maier, Ian Pepper, & Charles Gerba, Academic Press.
7. Environmental Microbiology: Principles and Applications by Patrick K. Jjemba, Science Publishing In.

Teaching learning process:

- **Lectures (online and offline mode):** Through white board, notes, power point presentation supported by smart class rooms and other online teaching platforms like Google meet and Google classroom. etc.
- **Doubt session:** once in a week
- **Assignments, seminars and different exercises**
- **Tests:** Learning level of the students will be tested through class tests, quizzes, surprise evaluation, assignments sessional exams and through interactive sessions.

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M.Sc. Microbiology

Semester III

Name of the course: Advanced Bio-techniques	**Course Code: 25MB305**	**Credits: 4**
Maximum Marks: 100 **Theory: 30(Internal)+70(External)=100**	**Time of examination: 3 Hrs.**	

Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing seven short answer type questions from all sections. Further, examiner will set two questions from each section and the candidates will be required to attempt one question from each Section. All questions will carry equal marks.

Objective: To introduce students to different molecular biology techniques applied in recombinant technology.

Course Outcomes: After learning this course

- **CO1:** The students will be familiar with the use of various cloning vectors, and methods of DNA, RNA, and protein analysis via various ICT tools.
- **CO2:** The students will be able to describe the various applications of PCR, and know how to make and screen genomic and cDNA libraries. They will be able to understand the creation of plant and animal transgenics, and animal cloning methods via various ICT tools.
- **CO3:** The students will be aware of the different bacterial and eukaryotic systems available for the overexpression of proteins.
- **CO4:** The students will have learnt about different methods to analyze protein-DNA and protein-protein interactions, and various genome editing tools via various ICT tools.

Section-I

Scope of genetic engineering; tools for genetic engineering: restriction and other modifying enzymes; vectors: basic biology of plasmids, bacteriophage vectors, cosmids, phasmids, YAC and BAC; special purpose vectors: M13 and expression vectors. Preparation and screening of genomic and cDNA library, mRNA enrichment.

PCR (Polymerase Chain Reaction): Types (qPCR, RT PCR, Multiplex PCR, Nested PCR) and applications

Section-II

Genetic manipulation of animals: Gene knockout and knock-in technologies; gene transfer methods to animal cells; Model organisms: transgenic mice and Drosophila. Genetic manipulation of plants: strategies for gene transfer to plants including Agrobacterium mediated transformation; selectable markers for plants; mapping the RNA by: primer extension, S1 nuclease, and RNase protection methods, t-DNA and transposon tagging.

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Section-III

Inducible expression systems; gene silencing by RNAi; strategies for heterologous gene expression in bacteria, yeast, insect, mammals and plant cells; Gene probes: generation, labeling and usage; reporter genes.

Section-IV

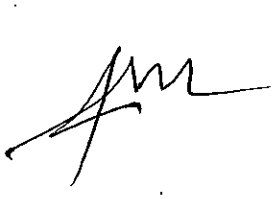
Processing of recombinant proteins: In vitro translation; purification, refolding, characterization and stabilization of recombinant proteins; site-directed mutagenesis and protein engineering. Analysis of protein-protein interactions by yeast two hybrid system. Genome editing using site-directed mutagenesis: Zinc finger nucleases (ZFN), Transcription activator-like effector nucleases (TALEN) and clustered regularly interspaced short palindromic repeats (CRISPR); gene therapy: types and methods.

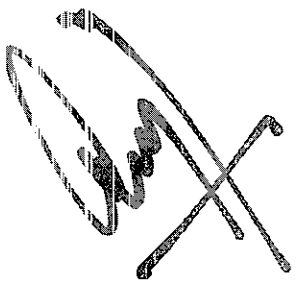
Books Recommended:

1. Principles of gene manipulation and genomics by Primose SB and Twyman RM, Blackwell publishing.
2. Gene cloning and DNA analysis–An introduction by Brown TA, Blackwell publisher
3. Biotechnology: expanding horizons by BD Singh, Kalyani Publishers
4. Molecular cloning: A laboratory manual by J Sambrook and Michael R Green.
5. Essential genes by Benzamin Lewin, Pearson education international.

Teaching learning process:

- **Lectures (online and offline mode):** Through white board, notes, power point presentation supported by smart class rooms and other online teaching platforms like Google meet and Google classroom. etc.
- **Doubt session:** once in a week
- **Assignments, seminars and different exercises**
- **Tests:** Learning level of the students will be tested through class tests, quizzes, surprise evaluation, assignments sessional exams and through interactive sessions.





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M.Sc. Microbiology

Semester III

Name of the course: Research Methodologies	**Course Code: 25MB306**	**Credits: 4**
Maximum Marks: 100 **Theory: 30(Internal)+70(External)=100**	**Time of examination: 3 Hrs.**	

Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing seven short answer type questions from all sections. Further, examiner will set two questions from each section and the candidates will be required to attempt one question from each Section. All questions will carry equal marks.

Objectives and outcomes of the course:

This course will develop scientific aptitude in the students. Here, the student will learn the ways to identify problems and, based on existing evidence, they will be able to develop a hypothesis, design a critical scientific methodology to find the solution and explanation to the problem.

Section-I

Identification and defining the research problem: Identification of research area, critical analyses of research problems; use of tools for searching literature through electronic databases; research design, sampling, and patent search. Meaning, objectives, types, and significance of research. Necessity and Techniques of defining the Research Problem.

Section-II

Experimental approaches and methodology: Formulation and objective of the research problem. Features and types of good research design; basic principles of experimental designs, different types of sample designs; characteristics of good sample design; techniques of selecting a random sample.

Section-III

Ethics in biological research: Guidelines for biosafety and bioethics; handling of genetically modified organisms; copyright, royalty, intellectual property rights; plagiarism, citation and acknowledgements; disposal of bio-waste, radioactive material, and hazardous chemicals.

Section-IV

Presentation and publication skills: Skills for scientific writing and research presentation: term paper, research project, research report, thesis, research article, and review; Use of electronic tools for bibliographic formatting and checking plagiarism; oral presentation skills.

Suggested Readings

1. Research Methodology: Methods and Techniques by Kothari, C.R., & Garg, G.

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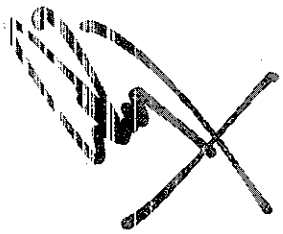
New Age International Publishers.

2. Introduction to Research Methods by Burns, R.B. Sage Publications.
3. Research Methods in the Biosciences by Saunders, N. Oxford University Press.
4. Scientific Research Methodology by Kumar, R. Sage Publications.
5. Biostatistics and Research Methodology by Gupta, S.P. Sultan Chand & Sons.



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M.Sc. Microbiology

Semester III

Name of the course: Lab course-I **Type of course: Practical**	**Course Code: 25MB307**	**Credits: 4**
Maximum Marks: 100 **Practical: 30(Internal)+70(External)=100**	**Time of examination: 08 Hrs.**	

1. Study of fermenter and its types
2. Isolation and screening of industrially important microorganisms from soils and industrial effluents
3. To evaluate the production of alcohol from molasses
4. To evaluate the production of alcohol from lignocellulose biomass
5. Production of Amylase/Peroxidase and its immobilization
6. Production of alcohol and its estimation by the potassium dichromate method
7. Production of Protease and its spectrophotometric estimation
8. Microbial biomass production (fungi/bacteria/yeast) in batch and fed-batch cultures
9. To compare the production of citric acid using sucrose and molasses as a carbon source
10. To study dye and industrial effluent treatment by the microbial cultures.
11. Total lymphocyte, TLC, DLC, and ESR estimation
12. Estimation of blood sugar and urea
13. Lipid profile studies
14. Estimation of Creatinine
15. Urine culture for UTI infections
16. Malaria, HIV, HCV detection
17. ELISA application for detection of HBV through serum

Note: This is the list of suggested practicals. The final list of practicals will be declared in the running semester

M.Sc. Microbiology

Semester III

Name of the course: Lab course-II **Type of course: Practical**	**Course Code: 25MB308**	**Credits: 4**
Maximum Marks: 100 **Practical: 30(Internal)+70(External)=100**	**Time of examination: 08 Hrs.**	

1. To demonstrate the liberation of ammonia from nitrogenous organic compounds (ammonification).
2. To demonstrate the reduction of nitrates to nitrogen gas (denitrification).
3. Isolation of rhizospheric and nonrhizospheric microflora.
4. Isolation of lignin, cellulose, and hemi-cellulose-degrading microorganisms from soil.
5. Isolation of *Rhizobium* from root nodules.
6. Isolation of antibiotic-producing bacteria from soil.
7. Detection of coliforms in water by multiple tubes fermentation test (Presumptive, confirmed; completed test).
8. Enumeration of water microflora by standard plate count (SPC)
9. To determine the quality of the water sample using membrane filter method
10. Isolation of thermophilic microbes from environmental samples
11. Determination of total hardness of water sample
12. Determination of alkalinity of water sample
13. To estimate the BOD and COD values of wastewater
14. Extraction of genomic DNA and its estimation using a spectrophotometer
15. Plasmid isolation by the alkaline lysis method and detection using electrophoresis
16. Restriction digestion of plasmid DNA and detection of digestion profile using electrophoresis

Note: This is the list of suggested practicals. The final list of practicals will be declared in the running semester

M.Sc. Microbiology

Semester III

Name of the course: Mushroom cultivation Technology	**Course Code: 25MB309**	**Credits: 2**
Maximum Marks: 50 **Theory: 15(Internal)+35 (External)=50**	**Time of examination: 2 Hrs.**	
Examiner will set five questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing seven short answer type questions (7x1) from all sections. Further, examiner will set two questions from each section and the candidates will be required to attempt one question from each Section (2x14).		
Section-I Overview of mushroom biology and life cycle, Mushroom Nutritional and Medicinal Properties, Types of mushrooms cultivated, overall status of mushroom production: regional and global. Basic requirements for mushroom cultivation, Techniques utilized during substrate preparation, pure culture isolation and mother spawn preparation.		
Section-II Factors associated with Spawn preparation, preparation of commercial spawn, Quality assessment parameters, Inoculation Strategies, spawn run and factors associated, Preparation of Casing material, Management of Fruiting/Mushroom Development, Harvesting and preservation methods. Mushroom Diseases and their management.		
Suggested Readings: 1. McCoy, P. (2016). "Radical Mycology: A Treatise on Seeing and Working with Fungi." Portland, OR: Chthaeus Press. 2. Stamets, P. (1993). "Growing Gourmet and Medicinal Mushrooms." Berkeley, CA: Ten Speed Press. 3. Przybylowicz, P., & Donoghue, J. (1990). "Shiitake Growers Handbook: The Art and Science of Mushroom Cultivation." Kendal, UK: ADAS Publications. Lynch, T. (2017). "Mushroom Cultivation: An Illustrated Guide to Growing Your Own Mushrooms at Home." New York, NY: Alpha Books.		

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Semester IV

Name of the course: Virology	**Course Code: 25MB401**	**Credits: 4**
Maximum Marks: 100 **Theory: 30(Internal)+70(External)=100**	**Time of examination: 3 Hrs.**	

Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing seven short answer type questions from all sections. Further, examiner will set two questions from each section and the candidates will be required to attempt one question from each Section. All questions will carry equal marks.

Objective: The syllabus is designed to do a comparative study of different viruses from general characteristics to diagnose their application in therapeutics.

Course Outcomes: After reading this course

- **CO1.** The students will be familiar with the history and structure of viruses.
- **CO2.** The students will learn principle of virus classification, system and mechanism of virus replication.
- **CO3.** The students will learn method of isolation, detection of viruses and their application for vaccine development.
- **CO4.** The students will be able to describe the various plant and animal diseases caused by viruses.

Section-I

Historical account and development of virology, general characteristics, morphological variations, envelope, capsid, nucleic acid, Discovery of the viruses as disease causing pathogens, development of methods of virus isolation & characterization. General description of viral vaccine available against human and animal viruses. Deadly viruses and their outbreak.

Section-II

Classification of plant, animal & human viruses. ssDNA viruses, dsDNA viruses, ssRNA viruses, dsRNA viruses, reverse transcribing viruses, satellite virus, viroid & prions. Assay of plant viruses, biophysical properties of viruses, thermal in-activation end point, dilution end point, longevity in-vitro and virus culture.

Section-III

Natural & mechanical transmission of viruses, isolation & purification of viruses, criteria of purity of viruses, serological & molecular based detection of viruses, Chloroplast agglutination, hem agglutination, use of electron microscopy in virology. General properties of bacteriophage, type of phages, one-step growth, Life cycle of M13 phage.

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Section-IV

Viral diseases of plants: papaya, banana, potato, symptoms, infections & control. Transmission of viruses by vectors & other means. Viral diseases of animals' human, Ranikhet disease of poultry farm, bird flu, SARS & Covid-19 diseases and their control. Viruses in genetic engineering.

Books Recommended:

1. Cann, Alan.J. Principles of Molecular Virology, Elsevier Science Publishing Company Inc.
2. Comparative Plant Virology. Roger Hull. Elsevier Sc Publishing Co Inc
3. Viruses & Mycoplame diseases in India, Raychandri, S.P. & Nariani, T.R. Malhotra Publishing House, New Delhi.
4. N. Dimmock, A. Earton and K. Leppard: Introduction to Modern Virology, Blackwell Publishing.
5. E.K. Wagner and M.J. Hewlett. Basic virology Blackwell publishing.
6. Fields Virology. Bernard N Field by Lippincott Williams & Wilkins.
7. Virology by S.Rajan & V Kumaresan , Saras Publication.

Teaching learning process:

- **Lectures (online and offline mode):** Through white board, notes, power point presentation supported by smart class rooms and other online teaching platforms like Google meet and Google classroom. etc.
- **Doubt session :** once in a week
- **Assignments, seminars and different exercises**

Tests: Learning level of the students will be tested through class tests, quizzes, surprise evaluation, assignments sessional exams and through interactive sessions.

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Semester IV

Name of the course: Biostatistics and Bioinformatics	**Course Code: 25MB402**	**Credits: 4**
Maximum Marks: 100 **Theory: 30(Internal)+70(External)=100**	**Time of examination: 3 Hrs.**	

Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing seven short answer type questions from all sections. Further, examiner will set two questions from each section and the candidates will be required to attempt one question from each Section. All questions will carry equal marks.

Objective: The course is designed to train students in basic statistical applications in biology and to provide basic bioinformatics knowledge

Course Outcomes: After reading this course

- **CO1.** Understand the concept and scope of statistics in biological data generation, collection and sampling.
- **CO2.** Apply the acquired skill in data interpretation, record keeping and scientific document generation
- **CO3.** To develop basic concepts of Bioinformatics and its significance in biological data analysis

Section-I

- Application of statistics in Biology, Types of Biological data, Collection, Frequency Distributions, Cumulative Frequency Distributions, Population and Samples, Outliers
- Measures of central tendency: Mean, Median, Mode, Quartile, and Percentile. Measures of Dispersion: Range, Variance, Standard deviation, Coefficient of Variation, Correlation and Regression
- Probability and its applications: Laws of Addition and Multiplication, Compound Probability, Bayes theorem. Probability distributions: Binomial, Poisson and Normal distributions and their applications.

Section-II

- Testing of hypothesis: Parameter and Statistic, Sampling distribution and Standard error, Null and Alternative hypotheses, Simple and composite hypotheses, Two types of errors, Level of significance and Power of the test, One tailed and two tailed tests.
- Tests of significance: t and Z tests for mean and proportion for one and two samples, Chi square test of goodness of fit and independence. F test, Analysis of variance for one way and two way classification.
- Elementary ideas of Designs of Experiments Important statistical softwares and their applications

Section-III

- Introduction to primary Databases: Nucleotide sequence databases-GenBank, EMBL, DDB; Protein Sequence Databases- UniProtKB, UniProt, TrEMBL, Swiss-Prot; Literature Databases- PubMed, PLos, BioMed Central

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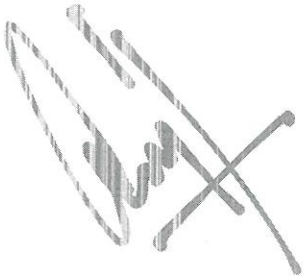
- Introduction to Secondary or Derived Databases- PDB, CSD, MMDB, SCOP, CATH, FSSP, CSA, KEGG ENZYME, BRENDA
- Sequence motifs Databases: Prosite, ProDom, Pfam, InterPro; Organism specific database (OMIM/OMIA, SGD, WormBase, PlasmoDB, FlyBase, TAIR)

Section-IV

- Nucleic acid and protein sequence information, composition and properties, Pair-wise sequence alignment, gaps, gap-penalties, scoring matrices, PAM 250, BLOSUM 62, global and local sequence alignment, similarity searching (FASTA and BLAST)
- Identification of genes in genomes, primer designing, Phylogenetic analysis with reference to nucleic acids and protein sequences using PHYLIP, DISTANCES, and GROWTREE, Identification of ORFs, Identification of motifs.
- Introduction to Genomics and Proteomics



M.Sc. Microbiology

Semester IV

Name of the course: Plant Pathology	**Course Code: 25MB403**	**Credits: 4**
Maximum Marks: 100 **Theory: 30(Internal)+70(External)=100**	**Time of examination: 3 Hrs.**	

Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing seven short answer type questions from all sections. Further, examiner will set two questions from each section and the candidates will be required to attempt one question from each Section. All questions will carry equal marks.

Course Objectives: To appraise the students about principles plant pathology and diseases of agricultural crops. And to upraise the students about disease resistance and various methods of controlling diseases.

Course outcomes: After studying this course students can

- **CO1**: Understanding of factors responsible for diseases in the crops
- **CO2**: Determining the mechanisms of pathogens for causing diseases in plants
- **CO3**:Perform the techniques for management of crop diseases

Section-I

Introduction and history of plant pathology; definitions and concepts of plant diseases; biotic and abiotic factors responsible for plant diseases; Interaction of microorganisms with plants and their effect on plant growth. Modern detection methods: PCR-Based methods,Next-Generation Sequencing (NGS) Methods.

Section-II

Host-pathogen interactions - recognition and infection, symptomatology, disease development-role of enzymes, mycotoxins, growth regulators; defense strategies,; hypersensitivity responses including oxidative burst, phenolics, phytoalexins. PR proteins, elicitors and their effects on host plants.

Section-III

Growth, reproduction, survival and dispersal of important plant pathogens; Role of environment and host nutrition on disease development; diseases of some important cereals (Rice, wheat),

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vegetables (Tomato, Potato), commercial crops (Cotton, Sugarcane) and fruit crops (Mango, Citrus, Grapes).

Section-IV

Plant disease resistance – pathogen associated molecular patterns, pattern recognition receptors, PTI, effectors, ETI, disease control in plants - physical, chemical methods; use of biocontrol agents - bacteria and fungi; Molecular approaches for plant protection - applications and constraints.

Suggested readings:

1. Introduction to Principles of Plant Pathology (2018) 5thed. Singh RS, Scientific International Pvt. Ltd. ISBN: 9739386479488.

2. Plant Pathology (2018) 1sted., Burchett, S and Burchett S CRC Press, ISBN: 9780815344834.

3. Principles of Plant Pathology (2014) Jagtap G, Dhutraj D and Dey U. Agrobios (India), ISBN-978-8177544916.

4. Plant Pathology, (2005) 5thed., Agrios GN, Academic Press (New York) ISBN: 9780120445653.

5. Molecular Plant Pathology (2003) 1st ed., Dickinson M, Sheffield Annual Plant Reviews, CRC Press. ISBN: 9781841271088.

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Semester IV

Name of the course: Food and Dairy Microbiology	Course Code: 25MB404	Credits: 4
Maximum Marks: 100 **Theory: 30(Internal)+70(External)=100**	**Time of examination: 3 Hrs.**	

Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing seven short answer type questions from all sections. Further, examiner will set two questions from each section and the candidates will be required to attempt one question from each Section. All questions will carry equal marks.

Objectives: To familiarize the students with various aspects of food microbiology including fermented food, dairy, detection of food borne diseases, their control measures and in addition it will impart knowledge regarding the biochemical aspects of various nutrients and their interactions in foods during processing, storage and deterioration.

Course Outcomes: After reading this course

- **CO1.** The students will understand the important microbes associated with different food products and various factors affecting growth.
- **CO2.** The students will learn different types of fermented products and microbes involved in their spoilage. Various physical, chemical, and biological methods of preservation shall be introduced.
- **CO3.** The students will learn about producing different fermented food products and various bioactive compounds in fermented food material.
- **CO4.** The students will be familiarized with different food born infections caused by bacterial, viral and fungal strains. Preventive measures during food processing shall be introduced.

Section-I

Food and Microorganisms, historical developments, microorganisms important in food-molds, Yeast and bacteria- general characteristics and importance. Intrinsic and extrinsic factors affecting microbial growth in foods: Intrinsic factors: Nutrient contents, pH, moisture content, water activity, antimicrobial barriers, antimicrobial substances. Extrinsic factors: relative humidity, temperature, gaseous atmosphere.

Section-II

Food fermentation; Fermented dairy products (Yogurt and Cheese), vegetable products (Pickle and Sauerkraut), meat products (Fresh and ground meat, sausages); Preservatives and preservation methods; physical methods, biologically based preservation system, chemical preservatives, natural antimicrobial compounds and effect of food preservatives on health.

Section-III

Contamination and spoilage of different foods; vegetables, fruits, milk, milk products, meat, meat products, poultry and fish, advanced techniques in detecting food borne pathogens and toxins,

Hurdle technology and Hazard analysis. Critical control point systems in controlling microbiological hazards in foods. Bacteriocins and their applications; Prebiotic and probiotic bacteria.

Section-IV

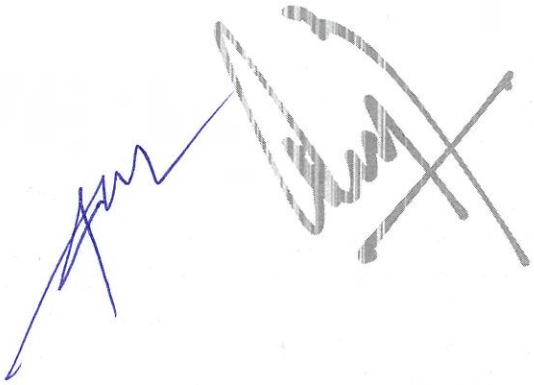
Food borne infections and intoxications; Bacterial and nonbacterial infection with examples of infective and toxic types, *Brucella, Bacillus, Clostridium, Escherichia, Salmonella, Shigella, Staphylococcus, Vibrio, Yersinia*, fungi, viruses, and emerging food-borne pathogens; Foodborne outbreaks, laboratory testing procedures and preventive measures, food sanitation in manufacture and retail trade.

Books recommended:

1. Bibek Ray. Fundamentals of Food Microbiology. CRC Press.
2. Frazier WC & Westhoff DC. Food Microbiology. Tata McGraw Hill.
3. George J Banwart. Basic Food Microbiology. AVI.
4. James M Jay. Modern Food Microbiology. CBS.
5. Peppler HJ & Perlman D. Microbial Technology. Academic Press.

Teaching learning process:

- **Lectures (online and offline mode):** Through white board, notes, power point presentation supported by smart class rooms and other online teaching platforms like Google meet and Google classroom. etc.
- **Doubt session :** once in a week
- **Assignments, seminars and different exercises**
- **Tests:** Learning level of the students will be tested through class tests, quizzes, surprise evaluation, assignments sessional exams and through interactive sessions.



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Semester IV

Name of the course: Microbial Nanotechnology	Course Code: 25MB405	Credits: 4
Maximum Marks: 100 **Theory: 30(Internal)+70(External)=100**	**Time of examination: 3 Hrs.**	

Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing seven short answer type questions from all sections. Further, examiner will set two questions from each section and the candidates will be required to attempt one question from each Section. All questions will carry equal marks.

Objective: The course is about the development of a basic understanding of microbial nanotechnology. The students will be covering the applications of microbial origin nanoparticles.

Course Outcomes: After completion of this course

CO1. The students will gain familiarity with the working principles, tools, and techniques in the field of nanomaterials.

CO2. The students will understand the strengths, limitations, and potential uses of nanomaterials.

CO3. The students can utilize nano materials for drug development and their application in nuclear medicine.

CO4. The students can apply nanotechnology for air and water treatment and become familiar with nanoscience education in India and abroad.

Section-I

Introduction to nanomaterials: Three-dimensional, two-dimensional, one-dimensional, and zero-dimensional nanomaterials. Carbon nanotubes, Graphene, Carbon dots, metal nanoparticles, quantum dots, Bio-nanomaterials, polymer nanoparticles, Synthesis methodologies for nanomaterial synthesis.

Section-II

Properties of nanomaterials: Structural, chemical, and physical properties of nanomaterial. Characterization of nanomaterials by various analytical methods, FTIR, DLS, Zeta potential, XPS, and AFM, Microscopy: SEM, TEM

Section-III

Nanotechnology in healthcare and environment: Role of nanotechnology in the area of infectious & noninfectious diseases, nanopharmaceuticals, diagnosis, sensors and biosensors. Multimodal nanoparticles, targeted drug delivery, theranostics. Nanotechnology for environment: contamination detection and remediation.

Section-IV

Cleaning the air with nanotechnology: Cleaner environment with Nanotech, Nanotechnology fo water treatment, Microbial nanoparticles used in cleaning air, Nanocarbon ball as deodorizer i

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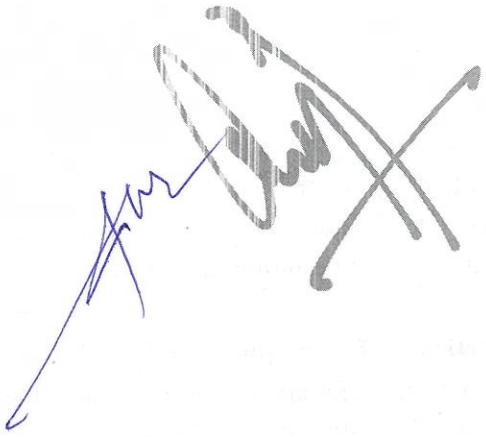
fermentation process, Possible harm from Nanomaterials, Nanoscience in India – Nanoscienc education abroad – ethics and society.

Books Recommended::

1. Introduction to Nanomaterials by Amit Kumar
2. Nanomaterials: Synthesis, Properties, and Applications by Alok Garg
3. Nanomaterials: A Guide to Fabrication and Applications by P.C. Mishra
4. Nanobiotechnology: Applications in Healthcare, Diagnostics, and Therapeutics by C.M. Hussain
5. Nanobiotechnology in Agriculture: Role of Nanomaterials in Crop Improvement by R.K. Sharma
6. Nanotechnology for Environmental Remediation by D. P. Singh
7. Nanobiotechnology: Concepts, Applications, and Perspectives by N.N. Mahapatra
8. Nanomaterials for Biosensors by R.S. Rawat
9. Nanobiotechnology: Principles and Applications by V.K. Gupta
10. Nanobiotechnology in Precision Agriculture by S.K. Shukla and M. Singh

Teaching learning process:

- **Lectures (online and offline mode):** Through white board, notes, power point presentation supported by smart class rooms and other online teaching platforms like Google meet and Google classroom. etc.
- **Doubt session:** once in a week
- **Assignments, seminars and different exercises**
- **Tests:** Learning level of the students will be tested through class tests, quizzes, surprise evaluation, assignments sessional exams and through interactive sessions.



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M.Sc. Microbiology

Semester IV

Name of the course: Bio-entrepreneurship, Biosafety and IPR	**Course Code: 25MB406**	**Credits: 4**
Maximum Marks: 100 **Theory: 30(Internal)+70(External)=100**	**Time of examination: 3 Hrs.**	

Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing seven short answer type questions from all sections. Further, examiner will set two questions from each section and the candidates will be required to attempt one question from each Section. All questions will carry equal marks.

Objective: The main objective of this course is to familiarize the students with the issues of intellectual property rights and disputes arising due to biotechnological patents. The course also emphasizes on biosafety of GMOs and other ethical issues

Course Outcomes: On successful completion of this course, students should be able to:

CO1. Gain entrepreneurial skills, understand the various operations involved in venture creation, identify scope for entrepreneurship in biosciences and utilize the schemes promoted through knowledge centres and various agencies.

CO2. Understand different types of intellectual property rights in general and protection of products derived from biotechnology research and issues related to application and obtaining patents;

CO3. Gain knowledge of biosafety and risk assessment of products derived from recombinant DNA research and environmental release of genetically modified organisms, national and international regulations;

CO4. Understand ethical aspects related to biological, biomedical, health care and biotechnology research.

Section-I

Innovation and Entrepreneurship in Bio-business: Introduction and scope in Bioentrepreneurship, Strategy and operations of bio-sector firms: Factors shaping opportunities for innovation and entrepreneurship in bio-sectors and the business implications of those opportunities, Entrepreneurship development programs of public and private agencies (MSME, DBT, BIRAC, Make in India etc.). Financing of Biofirms: Business plan preparation including statutory and legal requirements, Business feasibility study, Arrangement of risk capital: From Angeles, High net worth individuals, venture capital and other informal sources, Deal structuring, Negotiation.

Section-II

Intellectual Property Right: Introduction to intellectual property; types of IP: patents, trademarks, copyright rights, industrial design, geographical indications, protection of new GMOs; International framework for the protection of IP; IP as a factor in R&D. IPs of relevance to

microbiology and few case studies; Introduction to history of GATT, WTO, WIPO and TRIPS; Plant variety protection and farmers rights act, patent databases - countrywise patent searches (USPTO, EPO, India). Patenting: Basics of patents: types of patents; Indian Patent Act 1970; Procedure for filing a patent application; International harmonization of patent laws. Patenting of microbes, gene, process and products. Commercialization of patented innovations.

Section-III

Biosafety: Biosafety and Biosecurity - Introduction; Historical background; Biological safety cabinets; Primary containment for biohazards; Biosafety levels; GRAS organisms, Biosafety levels of specific microorganisms; Recommended biosafety levels for infectious agents and infected animals; GMOs & LMOs; Risk management issues - Containment; Problem formulation – protection goals, compilation of relevant information. Biosafety regulations and guidelines, Radioactive regulating body : Atomic Energy Regulatory Board

Section-IV

Bioethics: Introduction, ethical conflicts in biological sciences - interference with nature, bioethics in health care - genetic screening, gene therapy, transplantation. Bioethics in research – cloning and stem cell research, Human and animal experimentation, animal rights/welfare, Agricultural biotechnology - Genetically engineered food, environmental risk, labeling and public opinion.

Bioethics regulatory body:ICMR,IBC

Suggested Readings

1. Adams, D.J. & Sparrow, J.C., Enterprise for Life Scientists: Developing Innovation and Entrepreneurship in the Biosciences. Bloxham: Scion. 2008.

2. Karhad, P., How to Patent an Idea in India: From Idea to Granted Patent in Quickest Time, Saving Costs and Making Money with Your Patented Invention; A Step by step guideline on Intellectual Property in India. 2018.

3. Chopra, R.K., Indian Patent System. Himalaya Publishing House. 2010. 4. Patzelt, H. & Brenner, T., Handbook of Bioentrepreneurship:

4 (International Handbook Series on Entrepreneurship). Springer. 2010.

5. Shimasaki, C.D. Biotechnology Entrepreneurship: Starting, Managing, and Leading Biotech Companies. Amsterdam: Elsevier. Academic Press is an imprint of Elsevier. 2014.

6. Jordan, J.F., Innovation, Commercialization, and Start-Ups in Life Sciences. London: CRC Press. 2014.

7. Desai, V., The Dynamics of Entrepreneurial Development and Management. New Delhi: Himalaya Pub. House. 2009.

8. Ganguli, P., Intellectual Property Rights: Unleashing the Knowledge Economy. New Delhi. 2001.

9. Kuhse, H., Bioethics: an Anthology. Malden, MA: Blackwell. Office of the Controller General of Patents, Design & Trademarks; Department of Industrial Policy & Promotion; Ministry of Commerce & Industry; Government of India. http://www.ipindia.nic.in/. 2010

Date of PGBOS & R: August 14, 2025

M.Sc. Microbiology

Semester IV

Name of the course: Multiomics Skills for microbiologists	**Course Code: 25MB407**	**Credits: 4**
Maximum Marks: 100 **Theory: 30(Internal)+70(External)=100**	**Time of examination: 3 Hrs.**	

Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing seven short answer type questions from all sections. Further, examiner will set two questions from each section and the candidates will be required to attempt one question from each Section. All questions will carry equal marks.

Objective: The course is about the development of a basic understanding of microbial nanotechnology. The students will be covering the applications of microbial origin nanoparticles.

Course Outcomes: After completion of this course, Students will

CO1understanding of different Omics and experiment designs

CO2. Be familiar with different tools used for multiomics data analysis.

CO3. Be able To integrate data from different omics

CO4. Be able to conduct statistical analysis of multiomics data

Section-I

Overview of genomics, transcriptomics, proteomics, metabolomics, and other omics disciplines. Principles of data generation, data types, and experimental design. Data Integration and Bioinformatics Tools: Methods for integrating multiomics data sets. Introduction to bioinformatics tools and software for data analysis.

Section-II

Statistical Analysis of Multiomics Data: Basics of statistical methods used in multiomics data analysis. Differential expression analysis, clustering, and pathway analysis. Multiple sequence alignment of protein and DNA, Phylogenetic analysis. To design protein structure using Ras Mol, to design a vector Map using software. To analyse protein sequences to find hydrophobicity.

Section-III

Setting up bioinformatics software (e.g., R, Python) and learning basic commands for data manipulation. Using command-line tools for preprocessing raw omics data (e.g., quality control, data normalization). Integrating different omics datasets (e.g., genomic, transcriptomic) using bioinformatics pipelines. Applications of Multiomics in Microbiology Research: in precision medicine, drug discovery, and systems biology. Challenges and Future

Directions, Ethical considerations in multiomics research. Emerging technologies and trends in multiomics.

Section-IV

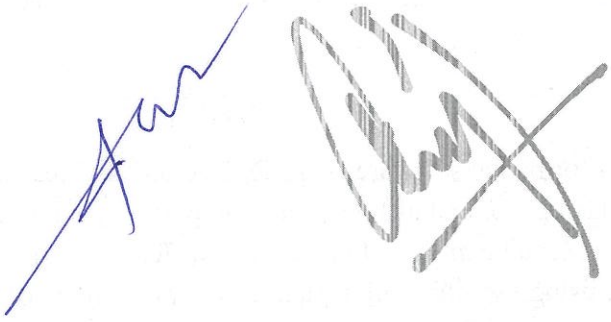
Visualizing integrated data using heatmaps, scatterplots, and other visualization tools. Statistical Analysis of Multiomics Data, differential expression analysis using RNA-seq data, identifying key genes and pathways. Clustering analysis of multiomics datasets to identify sample similarities and differences. Building network models using integrated omics data and network inference algorithms.

Books Recommended:

1. Methodologies of Multi-Omics Data Integration and Data Mining: Techniques and Applications. (2023). Germany: Springer Nature Singapore.
2. Functional Genomics (Methods in Molecular Biology) by Kaufmann, Michael, Klinger, Claudia, Savelsbergh, Andreas, Humana Press; ISBN: 978-1-4939-7230-2.
3. HOLMES, S. H., Huber, W. (2018). Modern Statistics for Modern Biology. United States: Cambridge University Press.
4. Proteomics: From Protein Sequence to Function. Stephen Pennington, Michael J Dunn, Viva Books Private Limited, ISBN: 9789386105998.
5. Discovering genomics, proteomics, and bioinformatics, by A Malcolm Campbell; Laurie J Heyer; Cold Spring Harbor Laboratory Press.; Benjamin/Cummings Publishing Company, ISBN: 0805382194 9780805382198.

Teaching learning process:

- **Lectures (online and offline mode):** Through white board, notes, power point presentation supported by smart class rooms and other online teaching platforms like Google meet and Google classroom. etc.
- **Doubt session:** once in a week
- **Assignments, seminars and different exercises**
- **Tests:** Learning level of the students will be tested through class tests, quizzes, surprise evaluation, assignments sessional exams and through interactive sessions.



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M.Sc. Microbiology

Semester IV

Name of the course: Lab course-I **Type of course: Practical**	**Course Code: 25MB408**	**Credits: 4**
Maximum Marks: 100 **Practical: 30(Internal)+70(External)=100**	**Time of examination: 08 Hrs.**	

Course contents:

1) Symptoms of virus infected plants.
2) To study Biophysical properties of plant virus.
3) Demonstration of virus isolation.
4) Phage isolation from sewerage water.
5) Indication of plant virus infection.
6) UV spectrophotometer of purified/semi purified virus preparation
7) Systematic tabular summarization of data (before analysis), measures of central tendency, measures of dispersion (using calculators)
8) Linear Regression Tests of significance (Mean, Standard Deviation, proportion, Correlation Coefficient)
9) Chi Square Test of Goodness of fit, test of independence of attributes, Analysis of Variance (One way and Two way)
10) Preparation of Graphs and statistical calculations using software
11) Identifying plant pathogens
12) Studying pathogen morphology and life cycles
13) Diagnosing plant diseases
14) Isolation and culture of pathogens
15) Molecular techniques for pathogen identification
16) Studying plant-pathogen interactions
17) Evaluating disease management strategies.
18) Local and global alignment-concepts, pair wise sequence alignment, multiple sequence alignment
19) Phylogenetic analysis HMM for sequence analysis, retrieving protein structure from PDB.
20) To predict homology of any protein sequence.
21) To Perform Homology Modeling using Swiss Modeler.
22) To study SNP databases
23) Culturing and identification of yeast involved in production of bread and beer.
24) To perform the methylene blue reduction test of raw and pasteurized milk.
25) Isolation of *Lactobacilli* and *Streptococci* from curd.
26) Sauerkraut production in the laboratory[4].
27) Statutory, recommended and supplementary tests for microbiological analysis of various foods:
    a) Canned foods
    b) Baby foods
    c) Milk and dairy products

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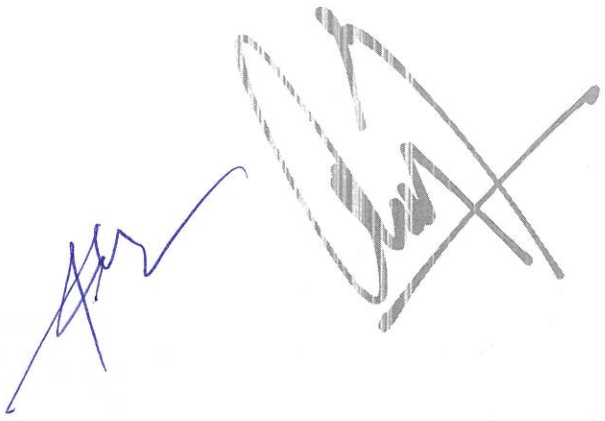
d) Eggs
e) Meat
f) Vegetables
g) Fruits

28) Production of wine in the lab Isolation

29) Identification of microorganisms from spoiled foods.
a) Bread
b) Fruits
c) Meat
d) Cake

Note: This is the list of suggested practicals. The final list of practicals will be declared in the running semester



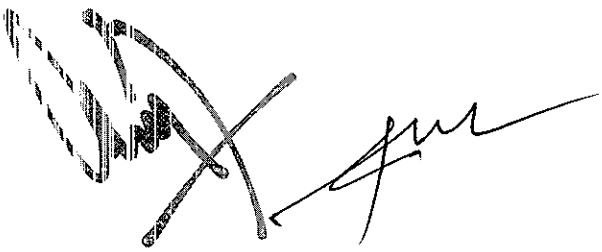
Semester IV

Name of the course: Lab course-II **Type of course: Practical**	**Course Code: 25MB409**	**Credits: 4**
Maximum Marks: 100 **Practical: 30(Internal)+70(External)=100**	**Time of examination: 08 Hrs.**	

Course contents:

1. Double diffusion and Immune-electrophoresis
2. Separation of mononuclear cells by Ficoll-Hypaque
3. Heamagglutination assay
4. ELISA
5. Immunoblotting
6. Immunodiagnostics (demonstration using commercial kits)
7. Culturing microbes for nanoparticles synthesis
8. Biosynthesis of nanoparticles.
9. Characterization of nanoparticles
10. Applications of microbial nanoparticles in bioremediation
11. Prepare a list of important sources of firewood and timber in your locality.
12. Patent searching on national/international data basis.
13. Preparation of charts based on biosafety and bioethics.
14. Case study and plagiarism check.
15. Study the working of biosafety cabinets
16. Use of SNP databases at NCBI and other sites
17. Use of OMIM database
18. Detection of Open Reading Frames using ORF Finder
19. Proteomics 2D PAGE database
20. Software for Protein localization.
21. Software for protein secondary sequencing prediction
22. Hydropathy plots

Note: This is the list of suggested practicals. The final list of practicals will be declared in the running semester



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M.Sc. Microbiology

Semester IV

Guidelines for the Preparation of Internship/Research Report

Objective:

The objective of these guidelines is to provide an idea to the students about the format of writing the internship/research report, dissertation, or any other related report that should be presented upon the completion of research work.

Features:

1. The dissertation is a formatted report of the student's own research work. Hence, the utmost care is to be taken to make the work presentable to outsiders absolutely error-free.
2. Total number of pages should be reasonable with relevant content.
3. The dissertation shall be preferably printed on A4 size paper with a 1.5-inch margin on the binding edge and a 1.0-inch margin on all other sides.
4. The dissertation shall be typed in "Times New Roman" font with a size 12-point or 'Arial' font with a 10.5-point size with 1.5 spacing between the lines. The equation must be typed in single spacing in italics. Scientific names of the organisms should also be italicized (e.g. *Homo sapiens*).
5. The dissertation shall be printed on one side of the paper (A4). Photographs, tables, and other depictions should be in the appropriate colour and size.
6. Dissertation shall be written in English, in your own words not just 'cut and paste'.
7. Mention (cite) references by name and year in parentheses in the text wherever applicable (e.g. Singh et al., 2020 for more than two authors. Singh and Kumar, 2020 for two authors. Singh, 2020 for the single author). Multiple references should be separated by ';' (e.g. Singh et al., 2020; Singh and Kumar, 2020).

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Some examples:

Negotiation research spans many disciplines (Thompson, 1990). This result was later contradicted (Becker and Seligman, 1996).

This effect has been widely studied (Abbott 1991; Barakat et al., 1995; Kelso and Smith, 1998; Medvec, 1993).

8. All the headings should have a font size of more than 12 points in bold.

The components of the report:

A. Cover page (also see the example Template-I at the end)

i. The format of the cover pages shall be as per template-I. The study/research title should be written clearly. Abbreviations should be avoided in the title, except the well-known abbreviations such as ATP, DNA, RNA, etc.

ii. The spine of the dissertation should be provided with the University logo, student's name, and year of completion.

B. Declaration

This page should be similar to Template II.

C. Certificate

This page should be similar to the Template-III printed on the University Letterhead.

D. Acknowledgment

E. List of symbols and abbreviations

F. List of figure captions

G. List of tables

H. Abstract

i. The abstract shall be preferably within one page of A4 size with the margin indicated earlier. The abstract shall be a concise summary of the research work.

ii. A list of Keywords based on your study should be given.

I. Review of literature

It should be an extensive background of the research area with relevant references. The numbering of page of the body of the text should start from the Review of Literature and in Arabic numerals centered at the bottom of the page. Pages with Appendices, tables, maps, photographs, etc, are to be numbered as well.

J. Materials and Methods

All the materials you used and methods you followed should be mentioned here with relevant references.

K. Results and discussion

1. Here you mention your observations and their relevance in the form of discussion. The results should be mentioned in chapters if you have worked for more than one chapter.

The chapter should have a number in Arabic numeral and shall be written as Chapter 1, Chapter 2, etc. This shall be followed by the title of the chapter.

2. Figures, tables, and graphs shall be positioned within the body of the text immediately after the citation and should not be positioned separately.

a. References

All the cited references should be enlisted here. Do not use footnotes or endnotes as a substitute for a reference list. Reference list entries should be alphabetized by the last names of the first author of each work.

Examples:

Journal article: Gamelin FX, Baquet G, Berthoin S, Thevenet D, Nourry C, Nottin S, Bosquet L. 2009. Effect of high-intensity intermittent training on heart rate variability in prepubescent children. Eur J Appl Physiol. 105:731-738. doi 10.1007/s00421-008-0955-8. Always use the standard abbreviation of a journal's name according to the ISSN List of Title Word Abbreviations

Article by DOI: Slifka MK, Whitton JL. 2000. Clinical implications of dysregulated cytokine production. J Mol Med. doi:10.1007/s001090000086.

Books: South J, Blass B. 2001. The future of modern genomics. 4th Ed., Blackwell Press, London

Book chapter: Brown B, Aaron M. 2001. The politics of nature. In: Smith J (ed) The rise of modern genomics, 3rd Ed., Wiley Press, New York, pp 230-257.

Online document: Cartwright J (2007) Big stars have weather too. IOP Publishing PhysicsWeb. http://physicsweb.org/articles/news/11/6/16/1. Accessed on 26 June 2020.

Dissertation or thesis: Trent JW. 1975. Experimental acute renal failure. Dissertation/thesis, University of California.

b. Appendices

If any

(Template-1: Cover Page)

TITLE…

A

Research/Internship report Submitted for the award of M. Sc./PG Diploma in Microbiology

By

Name of student (…Roll number…)

Under the Guidance of

Supervisor's Name

DEPARTMENT OF MICROBIOLOGY

CHAUDHARY BANSI LAL UNIVERSITY

June, 2025

Date of PGBOS & R: August 14, 2025

Chaudhary Bansi Lal University, Bhiwani

(A State University established under Haryana Act No. 25 of 2014)

DEPARTMENT OF MICROBIOLOGY

CHAUDHARY BANSI LAL UNIVERSITY

DECLARATION

It is certified that
(Template-2: Declaration by the student)

a. The work contained in this research dissertation is original and has been carried out by me under the guidance of my supervisor.
b. The work has not been submitted to other University/Institute for any degree or diploma.
c. I have followed the University guidelines and ethics throughout the study.
d. Wherever I have used materials (data, theoretical analysis, figures, and text) from other sources, I have given due credit to them by citing them in the text of the dissertation and giving their details in the references. Further, I have taken permission from the copyright owners of the sources, wherever necessary.

Date:

Signature

Place:

(Name of the Student with Roll number)

(Template-III: Certificate by the Department)

Date of PGBOS & R: August 14, 2025

CERTIFICATE

चौधरी बंसी लाल विश्वविद्यालय, भिवानी
Chaudhary Bansi Lal University, Bhiwani
(A State University Established Under Haryana Act. 25 of 2014)

This is to certify that the research/Internship report entitled ……..... submitted by ……... to Chaudhary Bansi Lal University, Bhiwani, for the partial fulfillment of award of **M.Sc./PG Diploma**..... in Microbiology , is a record of bonafide research work carried out by him/her under my supervision and has not been submitted to other University/Institute for any degree or diploma.

Signature

Name: ……

(Supervisor)

Signature

Name: ……

(Head of the Department)