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. 2025-26

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	200
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 hr.	3hrs.

To qualify for the course, a student is required to secure a minimum of 40% marks in aggregate.

including the internal evaluation and Major Test (End Semester Examination). A candidate who secures less than 40% of marks in a course shall be deemed to have failed in the course. The student should have obtained at least 40% marks in aggregate to qualify for the semester.

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. A maximum of 20 % of students are allowed to exit for diploma. Before the commencement of 2nd semester the students must disclose their exit to the Head of the department in advance. For other details visit university website.

Examination scheme (Question Paper Structure) **Note:**

For the course having 4 credits

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.

For the course having 2 credits
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 from all sections. Further, examiner will set two questions from each section and the candidates will be required to attempt three question from each Section. All questions will carry equal marks.

SEMESTER-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	25MB101	**General Microbiology**	CC-1	04	-	04	04	-	04	30	70	-		100
2	25MB102	**Fundamentals of Biochemistry**	CC-2	04	-	04	04	-	04	30	70	-		100
3	25MB103	**Microbial Genetics**	CC-3	04	-	04	04	-	04	30	70	-		100
4	25MB104	**Cell Biology**	DEC-1 Credits Choose any one	04	-	04	04	-	04	30	70	-		100
	25MB105	**Mycology and Phycology**		04	-	04	04	-	04	30	70	-		100
5	25MB106	**Lab course I**	CC-4 (Practical based on CC-1 and CC-2)	-	08	08	-	04	04	-	-	30	70	100
6	25MB107	**Lab course II**	PC-I (Practical based on CC-3 and DEC-I)	-	08	08	-	04	04	-	-	30	70	100
	TOTAL			**16**	**16**	**32**	**16**	**08**	**24**	**120**	**280**	**60**	**140**	**600**

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 them on a scale of 0 – 10 where:

"10" stands for "Excellent"	"4" stands for "Satisfactory"
"8" stands for "Very Good"	"2" stands for "Poor"
"6" stands for "Good"	"1" 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 set-up)	
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 applicability/ utility	
14.	Adequacy of reference/ Bibliography	
Presentation		
15.	Clear explanation of the work	
16.	Sufficient details of the methods/ techniques adopted	
17.	Satisfaction 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

Evaluation- 200 Marks

i) Presentation [illegible] [illegible] Marks
ii) Viva voce [illegible] Marks
iii) Internship Project report [illegible] Marks

The student will write the report in following: Title [illegible] Abstract, Introduction, Main body text (methodology, results, observations, and discussions), conclusion, future scopes, and plagiarism report. Use heading, and sub-headings, graphics wherever necessary [illegible]. List of books/references at the end that are cited in the main text.

Research thesis/dissertation report/practice

Every student will have to do research work based on the topic assigned by the supervisor and following the guidelines [illegible] internship. At the end of the semester student will submit a "Report" based on his/her research work. Evaluation will be on the basis of pre-assigned seminar and monthly progress reports (the format will be provided by the department) [illegible] respective research guide. External evaluation will be carried by external examiner on the basis of presentation, viva voce and research report.

Topics for the research report: [illegible] research topics to the students in following areas:

i. Lab oriented
ii. Computer and software oriented
iii. Survey oriented
iv. Field oriented
v. Combination of any of the above mentioned areas

Criteria for Evaluation:

a. Attendance (Minimum attendance required [illegible])

Total Attendance (%)	Marks Awarded (Max mark: 20)
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	18
[illegible]	[illegible]

b. Internal Evaluation ([illegible] Marks)
i. Pre-sub seminar [illegible] Marks
ii. Progress report [illegible] Marks

c. External evaluation ([illegible] Marks)
i. Final seminar [illegible] Marks
ii. Viva voce [illegible] Marks
iii. Research report [illegible] Marks

ANNEXURE "C"

* The students who opted Option I 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.

<u>Internship work-based vocational education and training apprenticeship etc.</u>

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 such as working with local industry (Government or Private organization), 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 socioeconomic 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 skillful 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

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO1- Students will develop strong fundamental concepts enabling critical thinking in various fields of Microbiology, understanding multiple aspects of microorganisms, including their biodiversity, physiology, metabolism, and biochemistry.

PSO2- Demonstrate the importance of immunity, pathogenesis, diagnostic, and therapeutic tools for the control of pathogens.

PSO3-Students will learn to evaluate the impact of microorganisms relevant to food, soil and agriculture, ensuring environmental conservation, food safety and societal health.

PSO4- Designing strategies in bio-processing and fermentation technology for industrial production of biomass, synthesis of value-added products, and sustainable bioenergy.

PSO5- Understanding the basics of bio-techniques so that they can explore the application of genetic engineering. Understanding the concepts of Genomics and Proteomics through analytical, molecular techniques for the betterment of society.

PSO6- Acquire basic Microbiology laboratory skills, techniques, and expertise in the use of analytical instruments applicable to research and clinical methods.

PSO7- Examine the significance of research using statistical tools and communicate the findings in research forums and publications. Ensure bio-safety and bioethics for social responsibility and research, environmental sensitization and understanding of IPR for the protection of research. Utilizing computing, communication, and development of research skills for the development of entrepreneurship.

M.Sc. Microbiology

Semester-I

Name of the course: General Microbiology	**Course Code: 25MB101**	**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 microbiology. The students will be covering the general features of various microbes and their interactions.

Course Outcomes: After completion of this course

- **CO1.** The students will know the history of microbiology & microbial classification systems.
- **CO2.** The students will know about microbial growth and culturing.
- **CO3.** The students will study the general features of different microbial habitats.
- **CO4.** The students will study various microbial interaction and their role in biological processes.

Section-I

History and development of microbiology in the 21st century: the spontaneous generation controversy, Introduction, branches, and applications of microbiology; characteristic features of bacteria, archaea, viruses, fungi, protozoa, and algae; concept of viroids and prions.

Microbial classification, taxonomy, and diversity: Woese's three kingdom classification systems and their utility–Archaea, Eubacteria, Eukarya, Bergey's manual of bacteriology; Classification of bacteria; Definition of Viruses, Viroid and Prions.

Section-II

Microbial growth and culturing: Isolation of microbes from natural and artificial sources; various techniques to establish a pure culture; different methods of sterilization; conventional and molecular approaches for identification of microorganisms; methods of growth measurement; types and formulation of aerobic & anaerobic culture; types of culture techniques (batch, semi-continuous, continuous, synchronous, enrichment, special); Procedure of microbial culture preservation and submission to repository

Section-III

General features of microorganisms: Bacteria, Algae, Fungi, Protozoa, and Mycoplasmas; Microbes in Extreme Environment – Special features of the thermophilic, methanogenic, and halophilic archaea; Photosynthetic bacteria, Cyanobacteria; microbes in other extreme conditions-Deep Ocean and space.

Section-IV

Microbial interactions: mutualism, symbiosis, commensalism, predation, parasitism, amensalism, competition

Microbial role in biological processes: bioluminescence, biodegradation, biofilms. Cleaning oil spills, microbes in composting, biopesticides, biocontrol agents, bioremediation, bioleaching, SCP, microbial enzymes, and fermented foods.

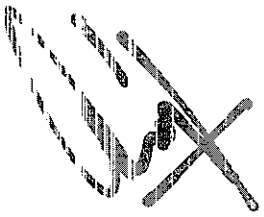
Definition of aero microbiology, airborne pathogens, and allergens.

Books Recommended:

1. Tortora, G.J., Funke, B.R., Case, C.L. Microbiology -An Introduction, Pearson
2. Madigan M.T., Martinko J.M. and Parker J. Brock Biology of Microorganisms, Pearson Education Ltd.
3. Kathleen, M. S., Dorothy, H. W.Prescott's microbiology, Tata McGraw Hill.
4. Brock T.D. Milestones in Microbiology, Infinity Books.
5. Pelczar MJ, Chan ECS, Kreig NR. Microbiology: Concepts and Application, Tata McGraw Hill.
6. Stainer RY, Ingraham JL, Wheelis ML & Painter PR. General Microbiology, MacMillan, New Jersey, USA.
7. Atlas R.M. Principles of Microbiology, Wm C. Brown Publishers, USA.
8. Vandenmark P.V. and Batzing B.L., The Microbes – An Introduction to their Nature and Importance. Benjamin-Cummings Pub Co.
9. Pratyoosh Shukla, Microbial Biotechnology: An Interdisciplinary Approach. Taylor and Francis Group. United States.

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.



M.Sc. Microbiology

Semester-I

Name of the course: Fundamentals of Biochemistry	Course Code: 25MB102	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 impart basic knowledge about macromolecules, classification of carbohydrates, lipids, proteins and catalytic role of enzymes.

Course Outcomes: After completion of this course

- **CO1.** The students will acquire the knowledge about the fundamental principles of chemistry that govern complex biological systems at the molecular level.
- **CO2.** Students will know the structure of various amino acids, proteins, enzymes, enzyme kinetics, and enzyme inhibition, and their role in biological systems.
- **CO3.** Students will have the foundation knowledge of fatty acid synthesis, and their role in metabolic pathways, along with their regulation.
- **CO4.** Students will know nucleic acids, their structures, and also the biosynthesis of purines and pyrimidines.

Section-I

General Principles of Biochemistry and Chemical Composition of Life, Buffer Solution: Properties, Types, and Preparation, Types of Chemical Bonds.

Classification, structure, and function of carbohydrates, Metabolism of Carbohydrates: Glycolysis, Gluconeogenesis, Citric acid cycle, Cori Cycle, Pentose phosphate pathway, and their regulation.

Section-II

Structure and Classifications of Amino Acids and Proteins, Ramachandran plot, Classification and Nomenclature of Enzymes, Coenzymes, Isozymes, Enzyme Kinetics (Michaelis-Menten equation, Km, Vmax, Turnover number, Enzyme inhibition, allosteric enzymes, Immobilized enzymes, coenzymes.

Section-III

Saturated and unsaturated fatty acids and their metabolism, Structure and function of major lipid subclasses-Acyl glycerol, Phospholipids, glycolipids, Sphingolipids, Waxes, Terpenes and

Sterols, Fatty acid biosynthesis, degradation and their regulations, Ketone bodies synthesis, biosynthesis of TAG, Phospholipids and Glycolipids, biosynthesis of cholesterol and its metabolism.

Section-IV

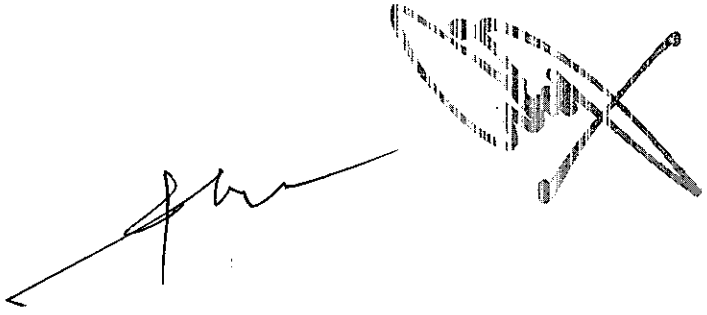
Structure and properties of nucleic acid bases, nucleosides, and nucleotides. Chemistry, structure, and properties of DNA and RNA. Biosynthesis and degradation of purines and pyrimidines. Confirmation of nucleic acids (A, B, Z-DNA), tRNA, microRNA. Structure and biochemical roles of vitamins.

Books Recommended:

1. Nelson, D.L. & Cox, M.M. Lehninger Principles of biochemistry. Freeman, W.H. & Company.
2. Voet, D. and J.G. Voet. Biochemistry, John Wiley & Sons
3. Wilson, K. and Walker, J. Principles and Techniques of biochemistry and molecular Biology. Cambridge University Press
4. Rodwell, V.W. Harper's Illustrated Biochemistry. McGraw-Hill Education-Medical.
5. Jeremy, M. B. Lubert, S.,Tymoczko, J.L., Gatto, G.J., Biochemistry. Macmillan international higher education New York W.H. Freeman and Company.
6. Mathews C.K., VanHolde K.E. and Ahern K.G., Biochemistry, Benjamin Cummings.

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.



M.Sc. Microbiology

Semester-I

Name of the course: Microbial Genetics	Course Code: 25MB103	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 paper will familiarize the students with the basic principles of genetics, the concept of linkage, mutation, chromosomal structure, genetic variations, and their effects on biological systems.

Course Outcomes: After completion of this course

- **CO1.** The students are expected to have a better understanding of the basic principles of Mendelian inheritance, the concept of genetic linkage, recombination, and crossing over.
- **CO2.** The students are expected to learn about the mutation, the importance of mutation analysis, and various DNA repair mechanisms.
- **CO3.** Students will learn all the methods of horizontal gene transfer in bacteria
- **CO4.** The student will become familiar with the lambda phage life cycle and the regulation of the different operons in bacteria

Section-I

Mendel's work on the transmission of traits, Genetic Variation, Molecular basis of Genetic Information, Mitosis and Meiosis, Linkage and crossing over, Molecular mechanism of crossing over, and Recombination and recombination frequency. Epigenetics and Inheritance.

Section-II

Mutations-Induced versus Spontaneous mutations, Suppressor mutations, Molecular basis of Mutations, mutant enrichment; Complementation tests; recombination tests and gene replacements; Cloning genes by complementation and marker rescue; DNA repair mechanisms, Mutation and Microbial evolution.

Section-III

Molecular mechanism of gene transfer by conjugation, Regulation of gene transfer by conjugation. Mapping bacterial genomes using Hfr strains. Transfer systems in Gram-positive

bacteria. T_i plasmid and application; Transformation and transduction: Natural transformation and competence. Generalized versus specialized transduction.

Section-IV

Lytic and lysogenic phages (M13, λ, T_2); Benzer's experiments to construct phage genetic linkage maps· Transposons and gene regulation; Yeast Ty-1 transposon; Positive and negative gene regulation and attenuation, using the *lac*, *gal*, *trp*, and *ara* operons.

Books Recommended:

1. Watson J.D., Hopkins NH, Roberts JW, Steitz JA, Weiner AM. Molecular Biology of the Gene, Benjamin Cummings, San Francisco.
2. Gardener, J.E., Simmons, M.J. Snustad, D.P. Principles of Genetics, John Wiley & Sons.
3. Snustad, P. D and M.J. Summons. Genetics, Wiley John & Sons.
4. Klug, W.S, Cummings, M.R., Concepts of Genetics. Pearson.
5. Snyder L, Chapness W. Molecular Genetics of Bacteria. ASM Press.
6. Hartl, D.L., Essential of Genetics: A Genomics perspective, Jones and Bartlett Publishers.
7. Miglani, G.S., Advanced Genetics, Alpha Science Intl Ltd.
8. Brown T.A, Gene Cloning and DNA Analysis. Blackwell Publishing.

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 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.

M.Sc. Microbiology

Semester-I

Name of the course: Cell Biology	Course Code: 25MB104	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 will provide a basic understanding of cellular structure and the regulation of cell division

Course Outcomes: After studying this course

- **CO1.** Students will understand the composition of the cellular membrane and its function.
- **CO2.** Students will be able to understand the functions of cellular organelles involved in diverse cellular processes and how a cell carries out and regulates cellular functions.
- **CO3.** Students will be able to explain the process of cell signaling and its role in cellular functions. They will also acquire knowledge of the cell cycle and its various checkpoints.
- **CO4.** The student will become familiar with protein trafficking and apoptosis.

Section-I

Introduction to Cell Biology: Ultrastructure of prokaryotic & eukaryotic cells, Structural organization & function of the cell wall. Membrane structure and function: Molecular composition of the cell membrane, Structural models of membrane, lipid bilayer and membrane proteins, mechanism of sorting and regulation of intracellular transport, electrical properties of membranes.

Section-II

Structural organization and function of intracellular organelles: Mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, chloroplasts, Nucleus; structure and organization, nuclear pores, nucleolus. Cell shape and motility: cytoskeleton, organization and role of microtubules and microfilaments, Motor movements; implications in flagella and other movements.

Section-III

Cellular communication: Regulation of homeostasis, general principles of cell communication, cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix, integrins, neurotransmission, and its regulation.

Cell cycle: Mitosis and meiosis; various stages in the cell cycle, regulation and control of the cell cycle, cyclin-dependent kinases.

Section-IV

Protein Localization: Synthesis of secretory and membrane proteins, Protein sorting and targeting of proteins into the nucleus, mitochondria, chloroplasts, vacuoles, and peroxisomes, receptor-mediated endocytosis.

Apoptosis (programmed cell death); its Mechanism and inducing factors, apoptosis triggered by internal and external pathways.

Books Recommended:

1. Essential Cell Biology by Bruce Albert, Garland Science (2nd Ed).
2. Cell and Molecular Biology by Phillip Sheeler and Donald E. Bianchi, John Wiley and Sons (3rd Ed).
3. The World of Cell by W.M Becker, L.J. Kleinsmith and J. Hardin. Pearson Education (5th Ed).
4. Molecular Cell Biology by Harvey Lodish, W H Freeman & Co (8th Ed)
5. Cell Biology by P S VermaandV K Agarwal, S Chand Publishing (1st Ed)
6. Brown and Berke: Text Book of Cytology, Blackstains Sons & Co.
7. Lewin, B. Genes VII, Oxford University Press, USA

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.

M.Sc. Microbiology

Semester I

Name of the course: Mycology and Phycology	Course Code: 25MB105	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 provide students with an overview of different aspects of phycology, mycology, and lichenology. **Course outcomes**: After studying this course • **CO1**. The students will have an understanding of the general features of various types of algal forms and their classification. • **CO2.** The students will be familiar with the importance of algae as a pollution indicator and its role as a biofertilizer. • **CO3.** The students will be acquainted with the general features of various Fungi, their classification, and their importance. • **CO4.** The students will be able to explain the general account and economic importance of lichens and their impact on human life.		
Section-I Phycology: Algae in diversified habitats (terrestrial, freshwater, marine), thallus organization, cell ultrastructure, reproduction (vegetative, asexual and sexual) Algal Classes: Overview and characteristics of Chlorophyta, Charophyta, Xanthophyta, Bacillariophyta, Phaeophyta and Rhodophyta.		
Section-II Algae as pollution indicators, eutrophication agent and role in bioremediation, global warming and environmental sustainability. Economic importance of algae: as food, feed, in medicine and industry, Algal blooms, algal biofertilizers, algal pigments, biofuels and important bioactive molecules from algae.		
Section-III Mycology: General characters, Organization of the thallus, nutrition and reproduction; General account of Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotina and		

Deuteromycotina, Heterothallism, Parasexuality, Sex hormones in fungi and economic importance of fungi.

Section-IV

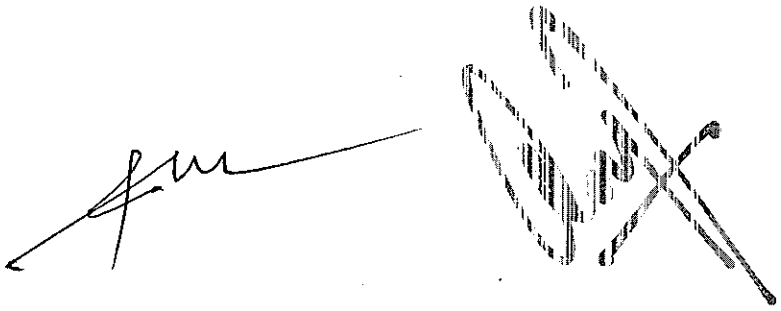
Lichens and Mycorrhiza: Occurrence, Structure, Types and Importance, VAM, Fungi as insect symbionts, biocontrol agents, attack of fungi on other microorganisms, potential application in agriculture, environment, industry and food. Role of fungi in biodeterioration of wood, paper, textile. Mycotoxins and quorum sensing in fungi.

Books Recommended:

1. Alexopoulos, C.J. and C.W. Mims 1988. Introduction to Mycology (3rd Ed.) Wiley Eastern Ltd., New Delhi
2. Charlile M. & Watkinson S.C. The Fungi, Publisher: Academic Press.
3. E.Moore –Landeekeer: Fundamentals of the fungi, Publisher: Prentice Hall.
4. L. Barsanti, Paolo Gualtieri: Algae: anatomy, biochemistry, and biotechnology
5. Ayhan Demirbas, M. Fatih Demirbas: Algae Energy: Algae as a New Source of Biodiesel (2010)
6. Linda E. Graham, James Graham, James M. Graham: Algae (2009)
7. Burnett J.H., Publisher: Edward, Arnold Crane Russak: Fundamentals of Mycology.

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.



M.Sc. Microbiology

Semester I

Name of the course: Lab course-I **Type of course: Practical**	**Course Code: 25MB106**	**Credits: 4**
Maximum Marks: 100 **Practical: 30(Internal)+70(External)=100**	**Time of examination: 08 Hrs.**	

Objective: The students will learn the basic hands-on training of various microbiology techniques.

Course Outcomes: After studying this course

- **CO1**. The students will be versed with different sterilization processes and staining techniques of given microbial isolates.
- **CO2**. The students will learn how to isolate and make pure culture of bacteria, fungi, algae from different sources.
- **CO3**. The students will learn about preparation of different cultivation media and different types of buffers.
- **CO4.** The students will learn the principle and operation of spectrophotometer, pH meter, centrifuge Hot air oven, Laminar air flow, micro pipetting, autoclave, weighing balance, BOD incubator, distillation apparatus.

Course contents:

1. Good microbiological laboratory practices: sterilization, gloves, lab coat etc.
2. Handling of general microbiological instrumentations (Hot air oven, Laminar air flow, micropipetting, autoclave, weighing balance, pH meter, BOD incubator, distillation apparatus, centrifuge.
3. Working of compound microscope and understanding the principles of different samples at different magnification.
4. Principles of sterilization techniques and their application in microbiology lab
5. Staining techniques: -
   (a) Simple staining (b) Gram staining (c) Negative staining (d) Endospore staining. (e) Capsule staining
6. Preparation of microbiological media: NAM, LB media, *etc.*
7. **Study of different isolation techniques:**
   (a) Pour plate. (b) Spread plate. (c) Streak plate.
8. Preparation of standard and buffer solutions: maintaining pH.
9. Carbohydrates estimation.
10. Protein estimation by Bradford method.

11. Lipid estimation by various methods
12. Determination of enzyme activity and study of enzyme kinetics.
13. Separation techniques - Centrifugation, Chromatography (Gel permeation, Ion exchange, TLC and HPLC).
14. Estimation of protein concentration in a given sample by Lowry's method

Suggested Reading:

1. Cappucino JG and Welsh CT. Microbiology: A laboratory manual. 11th edition. Pearson.
2. Thompson DA. Biochemistry Lab Manual. 3rd edition.
3. Segel IH. Biochemical calculations: how to solve mathematical problems in general biochemistry, Wiley, 2nd Edition.
4. Sambrook J & Russell D. Molecular Cloning: A laboratory manual. 4th edition. Cold Spring Harbor laboratory Press.
5. Collee JG, Fraser AG, Marmion BP & Simmons A (eds.). Mackie & McCartney Practical Medical Microbiology. Churchill Livingstone, Edinburgh.
6. Atlas RM, Parks LC & Brown AL. Laboratory Manual of Experimental Microbiology. MosbyYear Book, Inc., Missouri.

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

M.Sc. Microbiology

Semester I

Name of the course: Lab course-II **Type of course: Practical**	**Course Code: 25MB107**	**Credits: 4**
Maximum Marks: 100 **Practical: 30(Internal)+70(External)=100**	**Time of examination: 08 Hrs.**	

Objective: The student will acquire the practical knowledge of various techniques used in microbial genetics and cell biology.

Course Outcomes:

- **CO1.** The students will learn different techniques for the isolation and purification of plasmid.
- **CO2.** The students will learn about the preparation of competent cells and the bacterial transformation process using plasmid DNA.
- **CO4.** The students will be able to understand the karyotyping of various genetic disorders, mutation rate determination, tetrad analysis, and spore analysis via ICT tools.
- **CO4**: The students will be able to prepare the slides from the root tip and cell staining.

Course contents:

1. Preparation of Master and Replica Plates.
2. Study the effect of chemical (HNO_2) and physical (UV) mutagens on bacterial cells.
3. Isolation of Plasmid DNA from E. coli.
4. Study different conformations of plasmid DNA through Agarose gel electrophoresis.
5. Demonstration of Bacterial Conjugation.
6. Preparation of Competent Cells
7. Demonstration of bacterial transformation and transduction.
8. Demonstration of AMES test.
9. Demonstration of the ultrastructure of the cell
10. Cell staining and visualization under a microscope.
11. Mitotic division in root tip cells.
12. Effect of different factors on cell membrane permeability.
13. Effect of tonicity on animal and plant cells
14. Study of mitotic cell division
15. Study of meiotic cell division
16. Study of chromosomal disorders
17. Karyotyping
18. Production of enzymes, organic acids, and other metabolites by fungi,
19. Collection and study of basidiomycetous fungi
20. Study and culturing of yeasts, study yeast dimorphism
21. Isolation and identification of algae from different habitats, culturing of algae under lab conditions

22. Algae as a source of SCP study and pollution control

Suggested Reading:

1. Cappucino JG and Welsh CT. Microbiology: A laboratory manual. 11th edition. Pearson.
2. Thompson DA. Biochemistry Lab Manual. 3rd edition.
3. Segel IH. Biochemical calculations: how to solve mathematical problems in general biochemistry, Wiley, 2nd Edition.
4. Sambrook J & Russell D. Molecular Cloning: A laboratory manual. 4th edition. Cold Spring Harbor laboratory Press.
5. Collee JG, Fraser AG, Marmion BP & Simmons A (eds.). Mackie & McCartney Practical Medical Microbiology. Churchill Livingstone, Edinburgh.
6. Atlas RM, Parks LC & Brown AL. Laboratory Manual of Experimental Microbiology. MosbyYear Book, Inc., Missouri.

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