M. G. S. UNIVERISTY, BIKANER

SYLLABUS

M.Sc. Microbiology

(Semester System)

Session-2021-22

Maharaja Ganga Singh University

Bikaner

Curriculum Framework

M.Sc. Microbiology

Department of Microbiology

Faculty of Science

2021-2022

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Background

Considering the curricular reforms as instrumental for desired learning outcomes, all academic departments of Maharaja Ganga Singh University made a rigorous attempt to revise the curriculum of postgraduate programmes in alignment with National Education Policy-2020 and UGC Quality Mandate for Higher Education Institutions-2021. The process of revising the curriculum could be prompted with the adoption of "Comprehensive Roadmap for Implementation of NEP". The Roadmap identified the key features of the Policy and elucidated the Action Plan with well-defined responsibilities and indicative timeline for major academic reforms.

The process of revamping the curriculum started with the series of webinars and discussions conducted by the University to orient the teachers about the key features of the Policy, enabling them to revise the curriculum in sync with the Policy. Proper orientation of the faculty about the vision and provisions of NEP-2020 made it easier for them to appreciate and incorporate the vital aspects of the Policy in the revised curriculum focusing on creating holistic, thoughtful, creative and well-rounded individuals equipped with the key 21st century skills 'for the development of an enlightened, socially conscious, knowledgeable, and skilled nation'.

With NEP-2020 in background, the revised curricula articulate the spirit of the Policy by emphasizing upon- integrated approach to learning; innovative pedagogies and assessment strategies; multidisciplinary and cross-disciplinary education; creative and critical thinking; ethical and Constitutional values through value-based courses; 21st century capabilities across the range of disciplines through life skills, entrepreneurial and professional skills; community and constructive public engagement; social, moral and environmental awareness; Organic Living and Global Citizenship Education (GCED); holistic, inquiry-based, discovery-based, discussion-based, and analysis-based learning; exposure to Indian knowledge system, cultural traditions and classical literature through relevant courses offering 'Knowledge of India'; fine blend of modern pedagogies with indigenous and traditional ways of learning; flexibility in course choices; student-centric participatory learning; imaginative and flexible curricular structures to enable creative combination of disciplines for study; offering multiple entry and exit points, alignment of Vocational courses with the International Standard Classification of Occupations maintained by the International Labour Organization; breaking the silos of disciplines; integration of extra-curricular and curricular aspects; exploring internships with local industry, businesses, artists and crafts persons; closer collaborations between industry and higher education institutions for technical, vocational and science programmes; and formative assessment tools to be aligned with the learning outcomes, capabilities, and dispositions as specified for each course. The University has also developed consensus on adoption of Blended Learning with 10% component of online teaching and 90% face to face classes for each programme.

The revised curricula of various programmes could be devised with concerted efforts of the Faculty, Heads of the Departments and Deans of Schools of Study. The draft prepared by each department was discussed in series of discussion sessions conducted at Department, Faculty and the University level. The leadership of the University has been a driving force behind the entire exercise of developing the uniform template and structure for the revised curriculum. The Vice Chancellor of the University conducted series of meetings with Heads and Deans to deliberate upon the vital parameters of the revised curriculum to formulate a uniform template featuring Background, Programme Outcomes, Programme Specific Outcomes, Postgraduate Attributes, Structure of

Masters Course, Learning Outcome Index, Semester-wise Courses and Credit Distribution, Course-level Learning Outcomes, Teaching-Learning Process, Blended Learning, Assessment and Evaluation, Keywords, References and Appendices. The experts of various Boards of Studies and Faculties contributed to a large extent in giving the final shape to the revised curriculum of each programme.

To ensure the implementation of curricular reforms envisioned in NEP-2020, the University has decided to implement various provisions in a phased manner. Therefore, the curriculum may be reviewed annually so as to gradually include all relevant provisions of NEP-2020.

Programme Outcomes (PO)

On completing Masters in the Faculty of Arts, the students shall be able to realise the following outcomes:

PO	Description
PO1	Understand the basic concepts, fundamental principles, and the scientific theories related to various scientific phenomena and their relevance in day-to-day life.
PO2	Acquire the skills in planning and performing and handling scientific instruments during laboratory experiments
PO3	Realize how developments in one science subject help in the development of other science subjects and vice-versa.
PO4	Able to think creatively (divergently and convergent) to propose novel ideas in explaining facts and figures or providing new solutions to the problems.
PO5	Learn how an interdisciplinary approach helps in providing better solutions and new ideas for sustainable development.
PO6	Develop scientific outlook not only with respect to science subjects but also in all aspects of life.
PO7	Understand the knowledge of subjects in other faculties that can greatly and effectively influence the evolving new scientific theories and inventions.
PO8	Imbibe ethical, moral and social values in personal and social life
PO9	Develop various communication skills which we will help in expressing ideas and views clearly and effectively.
PO10	Analyse the given scientific data critically and systematically and the ability to draw the objective conclusions.

PO11	The skills of observations and drawing logical inferences from scientific experiments.
PO 12	Develop an overall personality by making them participate in various social and cultural activities voluntarily.
PO 13	Prepare for employment in chosen field
PO 14	Ability to think logically and creatively, and to solve scientific problems
PO 15	Equipped to take up a suitable position in academia or industry or Institutions and to pursue a career in research.

Programme Specific Outcomes (PSO)

On completing M.Sc. Microbiology Programme, the students shall be able to realise following outcomes:

PSO 1	Shall be able to design and execute experiments related to Basic Microbiology, Molecular Biology, Immunology, Recombinant DNA Technology, Biochemistry, Environment, Agriculture, Medical, Industrial, Food Microbiology.
PSO 2	Shall be able to perform minor research projects incorporating techniques of Basic and Advanced Microbiology. The learners will be equipped to take up a suitable position in academia or industry or Institutions and to pursue a career in research if so desired.
PSO 3	Shall be able to compete in national level competitive exams such as NET-JRF or GATE or International exams and can pursue career in higher studies
PSO 4	Shall practice safe microbiology, using appropriate protective, biosafety and emergency procedures.
PSO 5	Shall have in-depth theoretical and practical knowledge of huge diversity of microorganisms, their metabolism & physiology, concepts of molecular genetics and genetic engineering, biosynthetic pathways, enzymology, microbial pathogenicity, role of microbes in food, agriculture and environment, health and disease.

PSO 6	Shall be able to apply the scientific method and hypothesis testing in the design and execution of experiments including the understanding of theoretical background, hypothesis generation, collection and analysis of data, and interpretation and presentation of results.
PSO 7	Shall be able to communicate scientific results to the general public and experts by writing well-structured reports and contributions for scientific publications and posters, and by oral presentations

Post Graduate Attributes

The Post graduate attributes of our students shall be aligned with those of our University in terms of touching "the life of every student through inculcating virtues of empathy, ethics, efficiency, respect for diversity, prudence and creativity with compassion". We wish to achieve this through rigorous teachings and research efforts, which remains the basic tenet of our teaching-learning philosophy. The following are the Post graduate attributes of the subject:

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

Structure of Programme

Paper Code	Paper Name		Lecture	Tutorial	Practical	Total Credits	Maximum Marks		Minimum Passing Marks
							Internal Marks	External Marks	
Semester-I									
Theory Papers									
FS-MIC-CC-101	General Microbiology and Bacteriology	Core Compulsory	3	1	1	5	10	40	13 (25 %)
FS-MIC-CC-102	Microbial Physiology and Biochemistry	Core Compulsory	3	1	1	5	10	40	13 (25 %)
FS-MIC-CC-103	Molecular Biology	Core Compulsory	3	1	1	5	10	40	13 (25 %)
FS-MIC-CC-104	Microbial Genetics and Genetic Engineering	Core Compulsory	3	1	1	5	10	40	13 (25 %)
#FS-MIC-CF-100	Introduction to Microbiology	Core Foundation	2	2	1	5	50	--	18 (36%)
							40	160	
#Audit course. The candidate will have to qualify the paper by the time He / She qualifies for the Programme. He/She can avail maximum 4 chances along with the Semester Examinations.							Total Theory Marks	200	72 (36% aggregate)
Practical									
Combined Practical (5 Credit) (Based on theory papers)							25	75	36 (36% aggregate)
					Total Credits	**25**	**Grand Total**	**300**	
Semester-II									
Theory Papers									
FS-MIC-CC-201	Virology	Core Compulsory	3	1	1	5	10	40	13 (25 %)
FS-MIC-CC-202	Bioinstrumentation	Core Compulsory	3	1	1	5	10	40	13 (25 %)
FS-MIC-CC-203	Eukaryotic Microbiology	Core Compulsory	3	1	1	5	10	40	13 (25 %)
FS-MIC-CC-204	Industrial and food Microbiology	Core Compulsory	3	1	1	5	10	40	13 (25 %)

#FS-MIC-CF-200	National and Human Values	Core Foundation	2	2	1	5	50	--	
							40	160	
#Audit course. The candidate will have to qualify the paper by the time He / She qualifies for the Programme. He/She can avail maximum 3 chances along with the Semester Examinations.							Total Theory Marks	200	72 (36% aggregate)
Practical									
	Combined Practical (5 Credit) (Based on theory papers)						25	75	36 (36% aggregate)
				Total Credits		**25**	**Grand Total**	**300**	
Semester-III									
Theory Papers									
FS-MIC-CC-301	Immunology	Core Compulsory	3	1	1	5	10	40	13 (25 %)
FS-MIC-CC-302	Soil and Agricultural Microbiology	Core Compulsory	3	1	1	5	10	40	13 (25 %)
FS-MIC-CE-303(A) FS-MIC-CE-303(B)	Medical Microbiology **OR** Food and Dairy Microbiology	Core Elective	3	1	1	5	10	40	13 (25 %)
FS-MIC-OE-304(A) FS-MIC-OE-304(B)	Human Physiology **OR** Basics of Medical Lab Technology	Open Elective	3	1	1	5	10	40	13 (25 %)
							40	160	
							Total Theory Marks	200	72 (36% aggregate)
Practical									
Combined Practical (4 Credit) (Based on theory papers)							25	75	36 (36% aggregate)

					Total Credits	**20**	**Grand Total**	**300**	
Semester-IV									
FS-MIC-CC-401	Bioinformatics and Computer Applications	Core Compulsory	2	1	2	5	10	40	13 (25 %)
FS-MIC-CC-402	Microbial Ecology and Environmental Biotechnology	Core Compulsory	3	1	1	5	10	40	36 (25 %)
FS-MIC-CE-403(A) FS-MIC-CE-403(B)	Research Project OR Review	Core Elective	0	0	0	5[#]	10	40	
FS-MIC-OE-404(A) FS-MIC-OE-404(B)	Biostatistics OR Microorganisms and Health	Open Elective	3	1	1	5	10	40	13 (25 %)
					***10 min presentation/viva voce of each student**			40	160
							Total Theory Marks	200	72 (36% aggregate)
Practical									
Combined Practical (4 Credit) (Based on theory papers)							25	75	36 (36% aggregate)
					Total Credits	**20**	**Grand Total**	**300**	

[#] Teacher guide shall decide the hrs required for carrying out the decided Research Project/ Review/Case Study by the allotted student(s) in the forms of lecture, tutorial and lab work as per the requirement of the study topic.

Learning Outcome Index

I. Programme Outcomes (PO) and Programme Specific Outcomes (PSO)

PO	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	PSO-6	PSO-7
PO-1	X	X	X	X	X	X	X
PO-2	X	X	X	X	X	X	X
PO-3	X	X	X	X	X	X	X
PO-4	X	X	X	X	X	X	X
PO-5	X	X	X	X	X	X	X
PO-6	X	X	X	X	X	X	X
PO-7	X	X	X	X	X	X	X
PO-8	X	X	X	X	X	X	X
PO-9	X	X	X	X	X	X	X
PO-10	X	X	X	X	X	X	X
PO-11	X	X	X	X	X	X	X
PO-12	X	X	X	X	X	X	X
PO-13	X	X	X	X	X	X	X
PO-14	X	X	X	X	X	X	X
PO-15	X	X	X	X	X	X	X

II. Core Courses (CC):

PSO	CC-1	CC-2	CC-3	CC-4	CC-5	CC-6	CC-7	CC-8	CC-9	CC-10	CC
PSO-1	X		X	X	X	X		X	X	X	X
PSO-2		X	X		X	X	X	X		X	X
PSO-3	X		X	X		X	X	X	X		X
PSO-4	X	X	X	X	X	X	X		X	X	X
PSO-5	X	X	X	X	X		X	X	X		X
PSO-6	X	X	X		X	X	X		X	X	X
PSO-7	X	X	X		X	X	X	X	X		X

III. Elective Courses (EC):

PSO	FSMBCE-303A	FSMBCE-303B	FSMBEO-304A	FSMBEO-304B	FSMBCE-403A	FSMBCE-403B	FSMBEO-403A	FSMBEO-403B
PSO-1	X	X	X		X	X	X	
PSO-2	X		X	X		X	X	X
PSO-3		X	X	X	X	X		X
PSO-4	X	X	X	X	X		X	X
PSO-5	X	X		X	X	X		X
PSO-6	X		X	X		X	X	
PSO-7	X	X	X		X	X		X

M.Sc. MICROBIOLOGY (Semester System)

ELIGIBILITY

Looking at the interdisciplinary nature of Microbiology, the eligibility of candidates for admission to M.Sc. Microbiology shall be as given below:

Bachelor Degree with one of the subject of Life sciences i.e. Botany/Zoology/Microbiology/Biotechnology/Biochemistry/Genetics/Medicine/BDS/Agriculture /Pharmacy/Life Sciences with 50% marks.

M.Sc. Microbiology Programme Details:

Semester 1

Marking Scheme for External Exam

Theory Papers	Duration	Max. Marks
FS-MIC-CC-101	3 Hrs.	40
FS-MIC-CC-102	3 Hrs.	40
FS-MIC-CC-103	3 Hrs.	40
FS-MIC-CC-104	3Hrs.	40
Combined Practical	1 Day (6Hrs)	75
Academic/Industrial Tour	1-5 Days	00

FS-MIC-CC-101: General Microbiology and Bacteriology

Course Objectives:

The course objectives are to provide knowledge on: landmark discoveries and contribution of several Microbiologists in the field of Microbiology, different domains classification, familiarity with the bacterial taxonomy and their conventional and molecular characterization using modern methods, knowledge of their cultivation and growth requirement, life cycles of important groups of bacteria.

Course Level Learning Outcomes:

Upon successful completion of the course, students will have the knowledge and skills to:

CO1	Explain the key concepts in Microbiology and Bacteriology. Students will get the basics and understand the importance of Microbiology.
CO2	Students will be acquainted with the concept of prokaryotes, their taxonomy, and differentiation from eukaryotes. They will understand how Microbiology developed and what is the scope of the various branches of the subject.

CO3	Students will be acquainted with the microbial structure and function and study the comparative characteristics of prokaryotes and eukaryotes and also understand the structural similarities and differences among various physiological groups of eubacteria/archaea.
CO4	Students will be able to define and state the principles of various techniques used in microbiology. The course will enable them to understand staining techniques, CFU count and characterization of microbes etc. The students will know various culture media and their applications and also understand various physical and chemical means of sterilization.
CO5	At the end of the course, Bacteriology will provide the better understanding of bacteria and their characteristics in terms of identification, classification, growth and reproduction etc.
CO6	Through the course the students will learn the methods, requirements to grow different type of microorganisms, various physical and chemical growth requirements of bacteria and get equipped with various methods of bacterial growth measurement.
CO7	Students will be able to understand the concept of taxonomy and summarize them with the help of polyphasic taxonomy, numerical taxonomy etc and they will also be able to describe the importance of genetic analysis in taxonomy.
CO8	At the end of the course, the student will be able to describe genomic based methods to study microbial diversity in nature, the mechanisms behind it and general characteristics of important bacteria.

Course Description

UNIT-I

Scope of Microbiology, Culturable and unculturable bacteria. Microbial Taxonomy: Taxonomic ranks, Phenetic and Phylogenetic classification approaches, Numerical taxonomy and Polyphasic classification approaches, Major groups of bacteria according to Bergey's manual of systematic bacteriology. Ultra structure, chemistry and function of prokaryotic cells.

UNIT-II

Autotrophs, heterotrophs, lithotrophs, chemotrophs and phototrophs. Microbial Growth: Growth factors, Growth curve, kinetics, synchronous growth of bacteria. Control of Microorganisms: Sterilization; Dry, Wet, Chemical, Filtration, Radiation. Evaluation of effectiveness of physical and chemical antimicrobial agents. Media preparations, types of media. Differential, Selective and enrichment media. Aerobic and Anaerobic cultivation.

UNIT-III

General Characters of Important Bacteria- *Escherichia, Salmonella, Vibrio, Proteus, Bacillus, Lactobacillus, Streptococcus, Staphylococcus, Corynebacterium, Treponema, Mycobacterium, Pseudomonas, Klebsiella, Thiobacillus, Rhizobium, Azotobacter, Acetobacter, Streptomyces, Clostridium.*

Characters of Special groups of organisms as- Archaebacteria, Photosynthetic bacteria, Nitrogen fixing bacteria, Spirochaetes, Mycoplasma, Rickettsia, Bdellovibrio.

Scheme of Examination

Maximum Marks: 50 (40 External + 10 Internal) **Duration: 3 Hrs**

Minimum Passing Marks: 13

External

The question paper will consist of three Sections: A, B and C. Section A will consist of 10 questions (at least 3 questions from each unit of syllabus). Section B will consist of 9 questions (3 questions from each unit of syllabus). Section C will consist of 6 questions (2 questions from each unit of the syllabus).

Internal

Internal exam shall comprise Theory Exam (5 marks), Seminar Presentation (3 marks) and Class Performance (2 marks).

REQUIRED READINGS:

1. General Microbiology (5th edition) by Stanier Ingraham Wheelis, Macmillan; 2007.
2. Prescott/Harley/Klein's Microbiology by Willey J., Sherwood L. and Woolverton C. McGraw Hill;2007.

3. Microbiology A laboratory manual by Cappuccino, G. .James, Sherman Natalie, Pearson Education; 2011.
4. Microbiology by Pelczar J. Michael, Chan E.C.S, Krieg R. Noel, Tata McGraw-Hill Publishing Company Limited, 1998.
5. The Prokaryotes. A handbook on the biology of bacteria: ecophysiology, isolation, identification, applications. Volumes I-IV by Balows, A., Truper, H. G., Dworkin, M., Harder, W., Schleifer, K. H. Springer-Verlag, New York; 1992.
6. Principles of Microbiology by R.M. Atlas, Mosby publishers, St. Louis; 1995.
7. Brock Biology of Microorganisms (12th edition) by Madigan and John M. Martinko, Paul V. Dunlap, David P. Clark Benjamin Cummings; 2008.
8. Microbiology: An Introduction by Gerard J., Tortora, Berdell R. Funke, Christine L Case Benjamin-Cummings Publishing Company; 2008.

RECOMMEDED READINGS

9. Bacterial Systematics, by Logan, A., Niall A. Logan, Wiley-Blackwell; 1994.
10. Bergey's Manual of Determinative Bacteriology (8th edition) by Breed and Buchanan; 1974.
11. Bergey's Manual of Determinative Bacteriology (9th edition) by Breed and Buchanan; 1982.
12. Bergey's Manual of Systematic Bacteriology (2nd edition) by Breed and Buchanan. (Volumes. 1 – 5); 2001- 2003.

FS-MIC-CC-102: Microbial Physiology and Biochemistry

Course Objectives:

This course deals with characteristics, properties and biological significance of the biomolecules of life. In depth knowledge of the energetic and regulation of different metabolic processes in microorganisms.

Course Level Learning Outcomes:

Upon successful completion of the course, the learner will be able to :

CO1	Conceptual knowledge about growth and physiology of microorganisms with respect to various physical and chemical requirements of microbes and get equipped with various methods of their growth measurement.
CO2	The students will understand different microbial transport systems and their importance in microbial physiology.
CO3	Conceptual knowledge of properties, structure, function of enzymes, enzyme kinetics and their regulation ,enzyme engineering, Application of enzymes in large scale industrial processes
CO4	Understanding the laws of thermodynamics , concepts of entropy, enthalpy and free energy changes and their application to biological systems and various biochemical studies and reactions.
CO5	Conceptual knowledge of aerobic and anaerobic respiration and various intermediary mechanisms involved, oxidative phosphorylation
CO6	Overview of major biomolecules –carbohydrates, lipids, proteins, amino acids, nucleic acids, classification, structure, function of the above mentioned biomolecules
CO7	Discuss the biosynthesis and the degradation pathways involved.

1.

Course Description

UNIT-I

Microbial growth: definition of growth, growth curve; The mathematics of growth-generation time, specific growth rate, batch and continuous culture. Temperature -temperature ranges for microbial growth. pH- pH ranges for microbial growth. Microbial transport **:** diffusion – Passive and facilitated, Primary active and secondary active transport, Group translocation (phosphotransferase system), symport, antiport and uniport (Ritika Agarwal).
Structure of atom, molecules and chemical bonds. Biochemistry of enzymes: classification, nomenclature, specificity, isolation and purification. Enzyme kinetics and inhibition. Co-enzymes. Allosteric and other regulations of enzyme activity, Mechanism of action of enzymes.

UNIT-II

Cell metabolism: anabolic principles and synthesis of fatty acids, lipids (Poorvi Vyas), amino acids and proteins in microbes (Ravi Prakash). Studies of biosynthesis of hormones. Synthesis of vitamins and their role as coenzymes (Rekha Vaishnav). Basic aspects of bioenergetics, entropy and enthalpy. Electron carriers, artificial electron donors, inhibitors, uncouplers, energy bonds and phosphorylation (Prabha Sankhla). Brief account of photosynthetic and accessory pigments (Priya Mundhra). Autotrophic generation of ATP and Fixation of CO_2 in Microorganism, Calvin cycle (Priyanshi Panwar). Oxygenic and anoxygenic photosynthesis (Pryyanka).

UNIT-III

Microbial Oxidation of Inorganic Molecules: sulphur, iron, hydrogen and nitrogen (Monika Verma). Bioluminescence.
Catabolism of carbohydrates, proteins and lipids; Respiratory pathways: Embden Mayer Hoff Parnas pathway, EntnerDoudroff pathway, Glyoxalate pathway, Krebs cycle, oxidative and substrate level phosphorylation, Reverse TCA cycle, Gluconeogenesis, Pasture effect; Fermentation of carbohydrates: homo and heterolactic fermentations.

Scheme of Examination

Maximum Marks: 50 (40 External + 10 Internal) **Duration: 3 Hrs**
Minimum Passing Marks: 13

External
The question paper will consist of three Sections: A, B and C. Section A will consist of 10 questions (at least 3 questions from each unit of syllabus). Section B will consist of 9 questions (3 questions from each unit of syllabus). Section C will consist of 6 questions (2 questions from each unit of the syllabus).
Internal
Internal exam shall comprise Theory Exam (5 marks), Seminar Presentation (3 marks) and Class Performance (2 marks).
REQUIRED READINGS:
1. Biochemistry by Geoffrey L. Zubay. Fourth Edition, Addison-Wesley educational publishers Inc.,2008.
2. Lehninger: Principles of Biochemistry by David L. Nelson and Michael M. Cox.Fifth Edition, W.H.Freeman and Company; 2008.
3. Biochemistry, (2nd edition) by Voet Donald & Voet Judith G.,John Wiley & sons New York; 1995.
4. Physiology and Biochemistry of Prokaryotes(2nd edition) byWhiteDavid,Oxford University Press, NY;2000.
RECOMMENDED READINGS:
1. Microbial lipids edited by C. Ratledge and SG Wilkinson, second edition, Academic Press; 1988.
2. Microbial Physiology by Albert G. Moat and John W. Foster. (3rd edition), John Wiley and Sons;2002
3. The Physiology and Biochemistry of Prokaryotes by David White. (2nd edition), Oxford UniversityPress; 2000.
2. Biochemistry by Berg Jeremy, Tymoczko John, StryerLubert 6th Edition, W. H. Freeman, New York.(2001)

FS-MIC-CC-103: Molecular Biology

Course Objectives:

The purpose of this course is to introduce the student to the basic and advanced concepts in molecular biology. Learner will gain an understanding of molecular mechanisms of prokaryotic and eukaryotic DNA Structure, DNA Kinetics, DNA replication, DNA repair, transcription, translation, Transposition, Antitermination, Global regulatory responses and gene regulation. The student will study the techniques and experiments used to understand these mechanisms.

Course Level Learning Outcomes:

Upon successful completion of the course, the learner will be able to :

CO1	Describe structure of DNA and RNA, organization of genome

CO2	Compare the mechanisms of bacterial and eukaryotic DNA Replication
CO3	Explain concepts in DNA repair mechanisms, and recombination as a molecular biology tool.
CO4	Explain various levels of gene regulation in both prokaryotic and eukaryotic organisms
CO5	Describe Transcription and post-transcriptional Processes
CO6	Describe translation mechanism in prokaryotes and eukaryotes, regulation of translation, and post-translational processing
CO7	Describe mechanism of gene regulation, Antitermination.

Course Description

UNIT-I

Genetic Material : Chemical composition and organization, 3-D structure of DNA, linking number, topological properties, super coiling of DNA, packaging of DNA in pro & eukaryotes. DNA denaturation and renaturation, Coding and non-coding DNA, repetitive DNA sequences, DNA replication and repair mechanism: comparison between prokaryotes and eukaryotes, inhibitors of DNA replication, DNA damage, DNA recombination. Transposons and mechanism of transposition.

UNIT-II

Transcription in pro and eukaryotes, Reverse transcription, inhibitors of transcription, post transcriptional processing. Translation in pro- and eukaryotes, Genetic code. Inhibitors of translation, post translational modifications.

UNIT-III

Mechanism of gene regulation, catabolite repression, Lac and tryptophan operon, ara operon, cis-acting elements, transacting factors, positive and negative regulation, inducers and co-repressors. Negative regulation; regulation by attenuation. Antitermination - Proteins pN, pQ and nut sites,DNA binding sites, Global regulatory responses: heat shock response, stringent response and regulation by small molecules such as ppGpp(p) and cAMP.

Scheme of Examination

Maximum Marks: 50 (40 External + 10 Internal) **Duration: 3 Hrs**
Minimum Passing Marks: 13

External

The question paper will consist of three Sections: A, B and C. Section A will consist of 10 questions (at least 3 questions from each unit of syllabus). Section B will consist of 9 questions (3 questions from each unit of syllabus). Section C will consist of 6 questions (2 questions from each unit of the syllabus).

Internal

Internal exam shall comprise Theory Exam (5 marks), Seminar Presentation (3 marks) and Class Performance (2 marks).

REQUIRED READINGS:

1. Gene IX by Benjamin Lewin, Jones and Bartlett Publishers, Sudbury, Massachusetts, 2007.
2. Molecular Biology by R.F. Weaver , 4th edition, McGraw Hill. New York. USA, 2007.

3. Molecular Biology of the Gene by J.D. Watson, T.A. Baker, S.P. Bell, A. Gann, M. Levin, R. Losick, 6th edition, Benjamin Cummings, San Francisco, USA, 2007.
4. Molecular Biology of the Cell by B. Alberts, A. Johnson, J. Lewis, M. Raff, K. Roberts, P. Walter, 5th edition, Garland Science, New York and London, 2007.

RECOMMEDED READINGS:

1. Biochemistry (5th edition) by J.M. Berg, J.L. Tymoczko, L. Stryer, W.H. Freeman and Company, New York, USA, 2008.
2. 6. Current Protocols in Molecular Biology Edited by: Fred M. Ausubel; Roger Brent; Robert E. Kingston; David D. Moore; John A. Smith; Kevin Struhl, John Wiley and Sons, Inc. 2007

FS-MIC-CC-104: Microbial Genetics and Genetic Engineering

Course Objectives:

The course objectives are to provide an understanding of the genetic constituents of bacteria with special emphasis on various approaches and methods of genetic engineering and their applications.

Course Level Learning Outcomes:

Upon successful completion of the course, students will have the knowledge and skills to:

CO1	Explain the key concepts of extra chromosomal DNA, plasmid types, classic Luria Delbruck experiment, mutations, and mechanisms of genetic exchange.
CO2	The course teaches students with various approaches of genetic engineering and their applications in biological research as well as in biotechnology industries.
CO3	The course will help the students to appreciate the concepts of gene and relationship between genotype and phenotype. They will gain knowledge in gene concepts, gene expression, and gene regulation and also learn about mutation types.
CO4	Through completion the course the students will acquire the knowledge about different methods in molecular cloning, DNA amplification, DNA sequencing, construction and screening of genomic and cDNA libraries and its applications.
CO5	By the end of study in this course, the student will be able to understand nucleic acid hybridization techniques, restriction mapping and gel electrophoresis.
CO6	On successful completion of the subject the student will learn the gene transfer technologies, expression systems and methods of selection.
CO7	After the course students will be able to discuss the characteristics of various types of cloning vectors, restriction analysis, differentiate cloning vector and expression vector, and describe blue/white and red/white screening, antibiotic selection methods of cloning, and various DNA fingerprinting techniques.

CO8	Through the course students will be able to discuss various DNA modifying enzymes used in genetic engineering. Students will learn to perform PCR assays and explain the application of modern biotechnological tools in cutting-edge research. They will be able to review the various applications of genetic engineering.

Course Description

UNIT-I

Bacterial genome, Plasmids: Structure, classification, copy control, incompatibility, F-factor, col and R plasmids. Gene transfer in bacteria: Transformation, transduction, conjugation (F+, F- and Hfr cells)**,** Genetic map, Genetic mapping of *E. coli.* Mutation *versus* adaptation, Luria Delbruck experiment and significance, Mutagenesis: Spontaneous and induced mutations, deletions, insertion and point mutations, physico-chemical agents of mutation, mutant selection.

UNIT-II

Nucleic Acid Hybridization: Southern, Northern, Western Blotting, DNA fingerprinting, Foot printing, Gel retardation assay, Restriction endonucleases, Restriction mapping, Polymerase chain reaction, Gel electrophoresis (DNA, RNA and Protein).

DNA and RNA sequencing, (16S-23S rRNA), DNA Probes and their applications, RFLP, RAPD, AFLP, Use of microarrays to study gene expression.

UNIT-III

Genetic Engineering: Plasmids pBR322, PUC18, phagemids, cosmids, BAC, YAC, Expression vectors, Enzymes (Ligases, topoisomerases, Gyrase, Nuclease), Cloning vehicles, Gene transfer techniques: chemical, electroporation, microinjection, particle bombardment, *Agrobacterium* mediated gene transfer. Screening of recombinants, Reporter genes. Construction of cDNA and genomic library, Site directed mutagenesis. Applications of genetic engineering in agriculture, industry and medical, Biosafety regulations, Intellectual property rights, Patenting laws in India.

Scheme of Examination

Maximum Marks: 50 (40 External + 10 Internal) **Duration: 3 Hrs**

Minimum Passing Marks: 13

External

The question paper will consist of three Sections: A, B and C. Section A will consist of 10 questions (at least 3 questions from each unit of syllabus). Section B will consist of 9 questions (3 questions from each unit of syllabus). Section C will consist of 6 questions (2 questions from each unit of the syllabus).

Internal

Internal exam shall comprise Theory Exam (5 marks), Seminar Presentation (3 marks) and Class Performance (2 marks).

REQUIRED READINGS:

1. Principles of Gene Manipulation: An introduction to Genetic Engineering by R. W. Old, S. B. Primrose, University of California Press, 1980.
2. Molecular Genetics: An Introductory Narrative by Stent, G.S., Calendar, R. 2nd ed. San Francisco: W.H. Freeman, 1978.
3. Molecular Genetics of Bacteria by Larry Snyder and Wendy Champness, 3rd edition; ASM press; 2007.
4. Fundamental Bacterial Genetics by Nancy Trun and Janine Trempy, 1st edition; Blackwell Science Publishers; 2004.
5. Modern Microbial Genetics by U.N. Streips and R.E. Yasbin, 2nd edition; Wiley Publishers; 2002.

RECOMMENDED READINGS:

1. Microbial Genetics by Stanly R. Maloy, John E. Cronan, Jr. & David Freifelder, 2nd edition; Narosa Publishing House; 1987.
2. Molecular Biology by David P. Clarke, 1st edition; Elsevier Academic Press; 2005.
3. Molecular Cloning: A laboratory manual by Joseph Sambrook& David Russell, 3rd edition; CSHL press; 2001.
4. DNA Technology: The Awesome Skill by I. Edward Alcamo, 2nd edition; Hardcourt Academic Press; 2001.
5. Molecular Biology of the Gene by James Watson, Tania Baker, Stephen Bell, Alexander Gann, Michael Levine & Richard Losick , 6th Edition; CSHL Press; 2007.

FS-MIC-CF-100: Introduction to Microbiology

Course Objectives:

The students will be familiarized with the living world, biodiversity and classification. They will learn about various biomolecules found in microorganisms. They will learn the basics of Genetics and Genetic Engineering

Course Level Learning Outcomes:

Upon successful completion of the course, students will have the knowledge and skills to:

CO1	Get familiarized with different types of microorganisms
CO2	Get familiarized with classification systems used for microorganisms
CO3	Will be able to understand basics of Genetics and Genetic Engineering

Course Description

UNIT-1

Development of microbiology as a discipline, Spontaneous generation vs. biogenesis, Endosymbiotic theory, Contributions of Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming Role of microorganisms in fermentation, Germ theory of disease, Contributions of Martinus W. Beijerinck, Sergei N. Winogradsky, Selman A. Waksman Establishment of fields of medical microbiology and immunology through the work of Paul Ehrlich, Elie Metchnikoff, Edward Jenner.

UNIT- 2

Binomial Nomenclature, Whittaker's five kingdom and Carl Woese's three domian classification systems and their utility. Difference between prokaryotic and eukaryotic cellular structures. General characteristics of different groups: Acellular microorganisms (Viruses, Viroids, Prions) and Cellular microorganisms (Bacteria, Algae, Fungi and Protozoa) with emphasis on their distribution and occurrence, pathogenicity and economic importance.

UNIT-III

Biomolecules: Chemical constituents of living cells: biomolecules, structure and function of proteins, carbohydrates, lipids, nucleic acids; Enzymes- types, properties, enzyme action. Classical vs modern genetics, recombination in bacteria, cloning and applications of recombinant DNA technology. Molecular Basis of Inheritance: RNA and DNA as genetic material; Structure of DNA and RNA; DNA packaging; Basics of DNA replication, Central Dogma, transcription, genetic code, translation.

Scheme of Examination

Maximum Marks: 50 (40 External + 10 Internal) **Duration: 3 Hrs**

Minimum Passing Marks: 13

External

The question paper will consist of three Sections: A, B and C. Section A will consist of 10 questions (at least 3 questions from each unit of syllabus). Section B will consist of 9 questions (3 questions from each unit of syllabus). Section C will consist of 6 questions (2 questions from each unit of the syllabus).

Internal

Internal exam shall comprise Theory Exam (5 marks), Seminar Presentation (3 marks) and Class Performance (2 marks).

REQUIRED READINGS:

1. Prescot, M.J., Harley, J.P. and Klein, D.A. Microbiology. 5th Edition WCB Mc Graw Hill, New York, (2002).
2. Tortora, G.J., Funke, B.R. and Case, C.L. Microbiology: An Introduction. Pearson Education, Singapore, (2004).
3. Alcomo, I.E. Fundamentals of Microbiology. VI Edition, Jones and Bartlett Publishers. Sudbury. Massachusetts, (2001).
4. Black J.G.Microbiology-Principlesand Explorations.JohnWiley&SonsInc.NewYork, (2002).
5. Pelczar, MJ Chan ECS and Krieg NR, Microbiology McGraw-Hill.
6. Willey,Sherwood,Woolverton. Prescott,Harley, and Klein's Microbiology McGraw-Hill publication

RECOMMENDED READINGS:

1. Tortora,Funke,Case. Microbiology.Pearson Benjamin Cummings.
2. JACQUELYN G. BLACK. Microbiology Principles and explorations. JOHN WILEY & SONS, INC.

3. Madigan,Martinko, Bender,Buckley,Stahl.Brock Biology of Microorganisms. Pearson
4. Tom Besty,D.C Jim Koegh.Microbiology Demystified McGRAW-HILL

PRACTICALS

Isolation and identification of bacteria by phenotypic and biochemical tests.
Enrichment and isolation of members of Rhodospirillaceae: analysis of photopigments.
Induction of β-galactosidase gene in *E. coli.*
Staining techniques.
Growth curve analysis.
Media preparation, sterilization, inoculation and incubation methods.
Microbiological studies of air, water and soil.
Evaluation of antimicrobial chemical agents by log reduction method
Effect of following on the growth of microbes-
(a) Temperature, (b) Aeration, (c) pH, (d) Salts, (e) Nutrients.
Quantitative tests for Carbohydrates, fats, proteins, chlorophyll, Nucleic acids
Isolation of carbohydrates, proteins and fats.
Chromatographic separation methods for pigments and amino acids.
Study of Enzyme kinetics
Preparation of biologically important buffers
Protein purification using various column chromatography, SDS-PAGE and NATIVE PAGE analysis.
Identification and screening of autotrophic mutants of *E. coli* by replica plating
PCR amplification of DNA
Electrophoresis of DNA/RNA/Protein.
Isolation of DNA/RNA from plant, animal cell, bacteria.
Transformation and Conjugation in Bacteria
Restriction digestion, ligation of DNA and cloning in bacteria
Randomly Amplified Polymorphic DNA (RAPD) analysis in bacteria
16SrDNA gene amplification analysis for sequencing

Semester 2

Marking Scheme for External Exam

Theory Papers	**Duration**	**Max. Marks**
FS-MIC-CC-201	**3 Hrs.**	**40**
FS-MIC-CC -202	**3 Hrs.**	**40**
FS-MIC-CC-203	**3 Hrs.**	**40**
FS-MIC-CC -204	**3 Hrs.**	**40**
Combined Practical	**1 Day (6Hrs)**	**75**

FS-MIC-CC--201: Virology

Course Objectives:

The objectives of this course are to provide basic understanding of the nature of human and plant viruses (including phages), viral classification, cultivation of viruses and viral diseases.

Course Level Learning Outcomes:

Upon successful completion of the course, students will have the knowledge and skills to:

CO1	Learn and explain the nature, structure, general properties and importance of different animal and plant DNA and RNA viruses. They will also learn various physical and chemical methods to assay viruses.
CO2	The students will know about viral transmission, salient features of viral nucleic acids, replication and several diseases caused by viruses.
CO3	Students will be acquainted with the bacteriophage structural organization, lytic and lysogenic cycles and its molecular mechanisms as well as bacteriophage typing.

CO4	Through this course students will know the methods used in studying viruses, discern the replication strategies of representative viruses from the seven Baltimore classes.
CO5	The students will comprehend the intricate interaction between viruses and host cells and will understand the interactions between viruses and the host immune system.
CO6	Students will be acquainted with the terms oncogenes and tumor suppressor genes, and how tumor viruses interact with these products and their intersecting pathways and cause oncogenesis.
CO7	Students will be able to define and explain vaccine strategies and mechanisms of antiviral drugs.

Course Description

UNIT-I

Virology: Brief outline on discovery of viruses, Classification and nomenclature of viruses: distinctive properties and ultrastructure of viruses; DNA and RNA viruses, Replication of different groups of viruses; Cultivation of viruses in embryonated eggs, experimental animals and cell cultures.

UNIT-II

Assay of viruses: physical and chemical methods (Protein, nucleic acid, radioactivity, electron microscopy), Infectivity assay (plaque method, end point method). Bacteriophage structural organization; Lytic and lysogenic cycles (molecular mechanisms), bacteriophage typing and its application in bacterial genetics; brief details on M13, T, Lamda and P1 phage.

UNIT-III

Classifications and nomenclature of plant viruses; brief details of plant viruses like TMV, Cauliflower Mosaic Virus and Potato virus X; transmission of plant viruses.

Classification and nomenclature of animal and human viruses.Brief details of RNA viruses Picorna, OrthoMyxo, Paramyxo, Toga viruses, Rhabdo, Rota, HIV, Corona and Oncogenic Viruses; DNA viruses; Pox, Herpes, Adeno SV40; Hepatitis viruses, viral vaccines.

Scheme of Examination

Maximum Marks: 50 (40 External + 10 Internal) **Duration: 3 Hrs**
Minimum Passing Marks: 13

External

The question paper will consist of three Sections: A, B and C. Section A will consist of 10 questions (at least 3 questions from each unit of syllabus). Section B will consist of 9 questions (3 questions from each unit of syllabus). Section C will consist of 6 questions (2 questions from each unit of the syllabus).

Internal

Internal exam shall comprise Theory Exam (5 marks), Seminar Presentation (3 marks) and Class Performance (2 marks).

REQUIRED READINGS:

1. Principles of Virology: Molecular Biology, Pathogenesis and Control of Animal Viruses by S.J. Flint, L.W. Enquist, V.R. Racaniello, and A.M. Skalka 2nd edition, ASM Press, Washington, DC, 2004.
2. Introduction to Modern Virology EPZ by Nigel Dimmock, Andrew Easton and Keith Leppard, 5th edition, Blackwell Publishing, 2005.
3. Human virology by Collier, L H (Leslie Harold), Kellam, Paul; Oxford, J S (John Sidney). 4th ed., Oxford : Oxford University Press, 2011.

RECOMMENDED READINGS:

1. Basic Virology by Edward K. Wanger, Martinez Hewiett, David Bloom and David Camerini, 3rd edition, Blackwell Publishing, 2007.
2. Principles of Molecular Virology by Alan J. Cann, 3rd edition, Elsevier Academic Press, 2001.
3. Plant Virology by Roger Hull, 4th edition, Academic press, 2002.

FS-MIC-CC-202: Bioinstrumentation

Course Objectives:

To introduce the learner to the basic concept of qualitative and quantitative analysis of various biological samples. Students would be taught about the biophysical and biochemical techniques currently available to investigate the structure and function of the biological macromolecules. Learner would be made aware about the various separation techniques and its instrumentation, principles behind each technique, make them familiar with various methods of analysing the output data and to build a strong foundation in the area of microbiology.

Course Learning Outcomes:

Upon successful completion of the course, the student will able to:

CO1	carry out the analysis of cellular structure using different type of microscopies.
CO2	describe the techniques of vertical electrophoresis under native and SDS conditions.
CO3	describe the techniques of horizontal electrophoresis.
CO4	design a multi-step purification protocol to carry out spectroscopy.
CO5	understand and correctly interpret various chromatographic techniques.
CO6	understand the process of separation through centrifugation.
CO7	perform different immunological and serological testing's

Course Description

UNIT-I

Microscopy: Principles and use of light microscope, bright-field, dark-field, phase-contrast, fluorescent, electron microscopy (SEM, TEM), confocal microscopy and scanning probe microscopy. Specimen preparation for light microscopy and electron microscopy, staining of specific structures, fixatives and dyes, principle and uses of simple staining and differential staining. Principle and working of instruments used for sterilization.

UNIT-II

Electrophoresis: zonal techniques, supporting medium, vertical, submarine, gradient and two dimensional electrophoresis. Isoelectric focusing. Spectroscopy: Beer-Lambert relationship, components of a spectrophotometer, type of detectors; UV-Vis spectrophotometry, atomic absorption spectroscopy. Applications of spectroscopy.

UNIT-III

Chromatography: Adsorption Chromatography, liquid Chromatography, Gas- liquid Chromatography, Ion exchange Chromatography, Affinity Chromatography, GC-MS, HPLC.

pH meter, Centrifugation: Basic principle, working and application of analytical and preparative centrifuges, Differential, density gradient, zonal and isopycnic.

Scheme of Examination

Maximum Marks: 50 (40 External + 10 Internal) **Duration: 3 Hrs**

Minimum Passing Marks: 13

External

The question paper will consist of three Sections: A, B and C. Section A will consist of 10 questions (at least 3 questions from each unit of syllabus). Section B will consist of 9 questions (3 questions from each unit of syllabus). Section C will consist of 6 questions (2 questions from each unit of the syllabus).

Internal

Internal exam shall comprise Theory Exam (5 marks), Seminar Presentation (3 marks) and Class Performance (2 marks).

REQUIRED READING:

1. Principles and Techniques of Biochemistry and Molecular Biology. (6thEdition) by Wilson K. & Walker J. Cambridge University Press. 2008.

2. Biochemistry (6th edition) by Berg J. M., Tymoczko J. L. &Stryer, L. W.H. Freeman and Company, New York; 2007.

3. Foundations in Microbiology (6th edition) by Talaro K. P. &Talaro A. McGraw-Hill College, Dimensi;2006.

4. Analysis of Biological Molecules: An Introduction to Principles, Instrumentation and Techniques, by Potter G. W. H. & Potter G. W. Kluwer Academic Publishers; 1995.

5. Prescott/Harley/Klein's Microbiology by Willey J., Sherwood L. and Woolverton C. McGraw Hill; 2007.

RECOMMENDED READING:

1. "Dynamics of Water and Ions near DNA: Perspective from Time□Resolved Fluorescence Stokes Shift Experiments and Molecular Dynamics Simulation" Him Shweta, Nibedita Pal, Moirangthem Kiran Singh, Sachin Dev Verma and Sobhan Sen* Book Chapter in Reviews in Fluorescence 2017, Springer (DOI: https://doi.org/10.1007/978□3□030□01569□5).

2. "New Family of Fluorescent Probes for Characterizing Depth□Dependent Static and Dynamic Properties of Lipid/Water Interfaces" Moirangthem Kiran Singh, Him Shweta and Sobhan Sen* Book Chapter in Analysis of Membrane Lipids 2020, Springer (DOI: https://doi.org/10.1007/978□1□0716□0631□5_10

FS-MIC-CC-203: Eukaryotic Microbiology

Course Objectives:

This course deals with detailed general characteristics, life cycle and important agricultural and biotechnological applications of important Fungi, Yeats, Algae and Protozoa.

Course Level Learning Outcomes:

Upon successful completion of the course, the learner will be able to :

CO1	The students will gain knowledge about general characteristics and life cycle of important fungi such as *Dictyostelium, Rhizopus, Saccharomyces, Candida, Trichoderma, Penicillium, Gliocladium* etc.
CO2	The students will gain knowledge about Fungal endophytes of tropical plants and their applications.
CO3	The students will gain knowledge about Agriculturally important toxigenic fungi, their biodiversity, and application of toxigenic fungi in sustainable agriculture.
CO4	The students will gain knowledge about Mycorrhizal fungi: their diversity and importance in agriculture and plant growth in general, and recent advances in the field of mycorrhiza.
CO5	The students will know various biotechnological applications of yeasts.
CO6	The students will understand General Characteristics and Life Cycle of important Algae such as *Volvox, Chlamydomonas, Sargassum, Fucus, Gracileria* and *Gelidium.*
CO7	The students will know various biotechnological applications of algae.
CO8	The students will know the general characteristics and life cycle of various important Protozoa such as *Entamoeba, Trypanosoma, Plasmodium,* and *Coccidia.*

Course Description

UNIT-I

General Characteristics and Life Cycle of important Fungi- *Dictyostelium, Rhizopus, Saccharomyces, Candida, Trichoderma, Penicillium, Gliocladium, Fusarium, Helminthosporium, Alternaria, Albugo.* Fungal endophytes of tropical plants and their applications: Endophytic fungi, colonization and adaptation of endophytes. Agriculturally important toxigenic fungi: Biodiversity, toxigenic fungi in sustainable agriculture with special emphasis on biopesticides.

UNIT-II

Mycorrhizal fungi: Diversity of endo- and ectomycorrhizal fungi. Biology of arbuscular mycorrhizal fungi: signaling, penetration and colonization inside roots, culturing and benefits, recent advances in the field of mycorrhiza. Biotechnological applications of yeasts: Yeasts as producers of bioactive molecules such as pigments, lipids, organic acids and EPS, yeasts as probiotics, yeasts in bioremediation, yeasts in alcoholic fermentations.

UNIT-III

General Characteristics and Life Cycle of important Algae- *Volvox* and *Chlamydomonas, Sargassum* and *Fucus, Gracileria* and *Gelidium*. Algal diversity from morphology to molecules: Importance of algae in production of algal pigments, biofuels, hydrogen production, important bioactive molecules, role of algae in sustainable environment. Important Protozoa- *Entamoeba, Trypanosoma, Plasmodium, Coccidia.*

Scheme of Examination

Maximum Marks: 50 (40 External + 10 Internal) **Duration: 3 Hrs**

Minimum Passing Marks: 13

External

The question paper will consist of three Sections: A, B and C. Section A will consist of 10 questions (at least 3 questions from each unit of syllabus). Section B will consist of 9 questions (3 questions from each unit of syllabus). Section C will consist of 6 questions (2 questions from each unit of the syllabus).

Internal

Internal exam shall comprise Theory Exam (5 marks), Seminar Presentation (3 marks) and Class Performance (2 marks).

REQUIRED READINGS:

1. Fundamentals of the fungi by Elizabeth Moore, Fourth edition, Benjamin Cummings; Landecker;1996.
2. Mycotechnology: Present status and future prospects. Edited by MahendraRai.I.K., International Publishing House Pvt. Ltd.; 2007.
3. The Yeast Handbook: Biodiversity and Ecophysiology of yeasts by Carlos A. Rosa and Gabor Peter. Springer-Verlag Berlin Heidelberg; 2006.
4. Algae: Anatomy, Biochemistry and Biotechnology by Laura Barsanti and Paolo Gualtieri. Taylor and Francis Group, LLC; 2006.
5. Prescott. Microbiology 14. Joklik W.K., Zinssers. Microbiology. Mc Graw Hill.

RECOMMENDED READINGS:

1. Burnett J.H. Fundamentals of Mycology. Edwar Arnold, Crane Russak.
2. Charlie M. and Watkinson S.C. The Fungi. Academic Press.
3. Moore E. Landeekeer. The Fundamentals of Fungi. Prentice Hall.
4. Venkataraman G.S., Goyal S.K., Kaushik, B.D. and Rouchoudhary, P. Algae-Form and Function.
5. Alexopolous C.J. and Mims C.W. 1979. Introduction to Mycology (3/e). Wiley Eastern, New Delhi.
6. Kotpal R.L. Protozoa.
7. Mehrotra RS and Aneja KR 1990. An introduction to Mycology. New Age Int Pub.
8. E. Moore & Lendecker Fundamentals of the fungi
9. I.K. Ross Biology of the fungi
10. Alan T. Bull. Microbial Diversity and Bioprospecting. ASM press. Washington, D.C.
11. Stanier RY, Ingraham J.L., Wheelis M.L., Painter P.R. 1999. General Microbiology. MacMillan Education Ltd., London.
12. Schlegel. General Microbiology. Cambridge University Press, Cambridge.

FS-MIC-CC-204: Industrial and Food Microbiology

Course Objective:

This course elaborates on various processes and instruments used in Industrial and food Microbiology. It deals with different type of industrially important microorganisms their growth and preservation methods and their application in different processes related to industrial and food microbiology.

Course Level Learning Outcomes:

Upon successful completion of the course, the learner will be able to :

CO1	Comprehend the theoretical and practical understanding of industrial microbiology
CO2	Know how to screen and isolate microorganisms of industrial importance from the environment
CO3	Know about design of bioreactors and factors affecting their growth and production.
CO4	Understand the rationale in medium formulation & design for microbial fermentation, sterilization of instrument medium and air.
CO5	Appreciate the different types of fermentation processes
CO6	Identify techniques applicable for Improvement of microorganisms based on known biochemical pathways and regulatory mechanisms

CO7	Comprehend the techniques and the underlying principles used in downstream processing.
CO8	Understand the role of microorganisms in food spoilage and preservation.

Course Description

UNIT-I

Introduction to fermentation processes, history of fermentation process.

Bioreactors: Design and components- vessel materials, baffles, impellers, inoculation and sampling devices, biosensors etc., biohazard and containment. Types of bioreactors: airlift, fluidized bed, micro carrier, photo bioreactor, stirred bioreactor. Immobilization of cells and its industrial application (Pharmaceutical, food and chemical industries).

UNIT-II

Isolation, selection, screening, preservation and maintenance of industrially important microorganisms.

Formulation of fermentation media: energy source, water, nitrogen source, minerals, chelators, growth factors, buffers, precursors, inhibitors and antifoam agents, Optimization of media. Media and air sterilization. Types of fermentation processes with Growth kinetics: Batch, continuous and fed batch. Downstream processing: foam separation, cell disruption, industrial scale centrifugation, liquid-liquid extraction, solvent recovery, chromatography, two phase aqueous extraction, drying and crystallization.

UNIT-III

Production process for Yeast (Bakers, food and fodder), Single cell protein (SCP), Single cell and Single cell oil (SCO), lactic acid, Beer, Wine, Whisky, Sauerkraut, Bread, amylases and proteases, penicillin, streptomycin, Riboflavin, Production of non-microbial product through GEMs: insulin, cell growth factors, tissue plasminogen activator. Bioplastic (PHB, PHA), Steroid transformation. Production of bioinsecticides. Vaccine types: live, attenuated and recombinant and their production.

Parameters Affecting Microbial Growth in Foods: Intrinsic, Extrinsic. Food Preservation & Principles of Quality Control: Chemicals, antibiotics, Radiation, Low and high temperature, High-Pressure Processing. Aseptic Packaging, Microbiological quality standards of food, FDA, HACCP, ISI.

Microbial Food Spoilage and Food borne diseases: Staphylococcal, *E. coli*, Salmonellosis, shigellosis. Mycotoxins, Aflatoxins, and viruses.

Scheme of Examination

Maximum Marks: 50 (40 External + 10 Internal) **Duration: 3 Hrs**

Minimum Passing Marks: 13

External

The question paper will consist of three Sections: A, B and C. Section A will consist of 10 questions (at least 3 questions from each unit of syllabus). Section B will consist of 9 questions (3 questions from each unit of syllabus). Section C will consist of 6 questions (2 questions from each unit of the syllabus).

Internal

Internal exam shall comprise Theory Exam (5 marks), Seminar Presentation (3 marks) and Class Performance (2 marks).

REQUIRED READINGS:

1. Biotechnology: A Text Book of Industrial Microbiology by W. Crueger & A. Crueger, Panima Publishing Corporation, New Delhi/Bangalore, 2000.

2. Principles of Fermentation Technology by P.F. Stanbury, W. Whitaker &S.J. Hall, Aditya Books (P) Ltd., New Delhi, 1997.

3. Modern Industrial Microbiology & Biotechnology by N. Okafer, Scientific Publishers, Enfield, USA.,2007.

4. Fermentation Microbiology and Biotechnology by El Mansi & Bryce, Taylor & Francis, London, Philadelphia, 1999.

5. Fermentation Biotechnology by O.P. Ward, Open University Press, Milton Keynes, U.K., 1989

6. Industrial Microbiology: An Introduction by Waites, Morgan, Rockey& Highton, Blackwell Science, 2001.

7. Biochemical Engineering and Biotechnology by B. Atkinson & F. Mavituna , The Nature Press, 1982

8. Microbial Biotechnology: Fundamentals of Applied Microbiology by Glazer & Nikaido , W.H. Freeman and Co., New York, 1995.

9. Modern Food Microbiology, 4th edition by J.M. Jay, Springer, 2006.

10. Fundamental Food Microbiology, 3rd edition by B. Ray., CRC press, 2006.

11. Food Microbiology: Fundamentals and Frontiers, 2nd edition by Michael P. Doyle, Larry R. Beuchat, Thomas J. Montville, ASM press, 2001.

12. Food Microbiology by M.R. Adams & M.O. Moss., Royal Society of Chemistry, 2000.
13. Food Microbiology by M.R. Adams, Royal Society of Chemistry, 2008.

RECOMMENDED READINGS:

1. Modern Industrial Microbiology & Biotechnology by N. Okafer, Scientific Publishers, Enfield, USA., 2007.
2. Fermentation Microbiology and Biotechnology by El Mansi & Bryce, Taylor & Francis, London, Philadelphia, 1999.
3. Fermentation Biotechnology by O.P. Ward, Open University Press, Milton Keynes, U.K., 1989
4. Industrial Microbiology: An Introduction by Waites, Morgan, Rockey & Highton, Blackwell Science, 2001.
5. Biology of Industrial Microorganisms A.L. Duncun
6. Microbial Biotechnology A. N. Glazer and H. Nikaido
7. Molecular Industrial Mycology Leong & Berka
8. Manual of Industrial Microbiology and Biotechnology, Demain & Davies, 2nd ed.
9. Microbial Biotechnology A. N. Glazer and H. Nikaido
10. Biotechnology An Introduction Susan R. Barnum 22. Topics in Enzyme & Fermentation Biotechnology Volumes by Wisemen

PRACTICALS

Mounting and staining of fungal specimens, microscopic examination of bacteria, fungi, protozoa and nematodes
Chick embryo inoculation for viruses.
Estimation of infectivity titre of a virus sample using Plaque assay.
Production of purified virus stock and its quantification.
Study of virus infected plant material.
Isolation of Probiotic bacteria from milk and curd
Study of dimorphism in yeast
Testing of milk by MBRT.
Isolation and cultivation of fungi and protozoa.
Microbial examination of food and milk
Sample collection and biomass determination for small scale fermentation
To determine the specific growth rate and generation time of a bacterium during submerged fermentations.
To determine R: S ratio of bacteria by CFU counts.
To determine phenol coefficient
To determine Thermal death time and thermal death point.
To check the calibration of spectrophotometer
To check and verify Lambert- Beer Law
To find out the λ-max (absorption spectra) of $K_2Cr_2O_7$, $CuSO_4$, proteins and nucleic acids.
To grow yeast and fungus in artificial medium and to calculate the yield and productivity of biomass produced.
To make wine from different juices by fermentation.
To demonstrate production of sauerkraut and cheese.
To investigate heavy metals/pesticides etc. in the given food and water sample.

FS-MIC-CF-200: National and Human Values

Objectives:

1. To inculcate national and human values in the Students.
2. To enable the students imbibe the Indian cultural ethos.
3. To inculcate the spirit of Patriotism so that the Students develop a sense of strong bond with the nation.
4. To enable the Students grow into a citizen possessing civic sense.

Course Outcomes:

(i) On the completion of the course the students shall be able to
(ii) Attain the civic skills enabling him/her to become a well-behaved citizen of the country.
(iii) Imbibe and spread the feelings of devotion and dedication.

Course Description:

Unit-I

1. NCC – Introduction, Aims, NCC Flag, NCC Song, NCC Administration, Raising of NCC in Schools/Colleges, NCC: Rank, Honours and Awards, NCC Training, NCC Camps, NCC Examinations, Incentive and Scholarship for Cadets.
2. Importance of Discipline in life, Aims and Merits of Discipline, Problems related to Indiscipline and Solutions.
3. Drill – Definition, Principles of Drill, Bad habits in drill, Words of Command, Drill Movements, Arms Drill, Squad Drill, Guard of Honour, Ceremonial Drill, Guard Mounting.
4. Contribution of NCC in Nation Building.

Unit-II

1. Armed Forces – Control Command, Organization of Armed Forces, Weapons of Army, Navy and Air Force, Training institutes, Honours and Awards, Recipients of Param Veer Chakra, Badges of Ranks.
2. Commission in Armed Forces – Recruitment in Armed Forces, Commission in Technical, Non-Technical and Territorial Forces.
3. Weapon Training – 0.22 Rifle, 7.62 Rifle, 7.62 SLR (Self Loading Rifle), 5.56 MM I.N.S.A.S. Rifle, L.M.G. (Light Machine Gun), Stan Machine Carbine, 2" Mortar, Grenade, Pistol, Various types of Firing, Range Procedure and Range Drill.
4. Military History and Geography, Field Craft, Field Engineering, Battle Craft.

Unit-III

1. Obstacle Training. Adventure Training, Self Defence, Physical Posture Training.
2. Social Service, Disaster Management, Health and Hygiene, First Aid.
3. Leadership, Personality Development, Decision Making, Motivation, Duty and Discipline, Morale.

Unit-IV

1. Value system – The role of culture and civilization-Holistic living
2. Balancing the outer and inner – Body, Mind and Intellectual level- Duties and responsibilities
3. Salient values for life- Truth, commitment, honesty and integrity, forgiveness and love, empathy and ability to sacrifice, care, unity , and inclusiveness
4. Self-esteem and self confidence
5. punctuality – Time, task and resource management ,Team work
6. Positive and creative thinking.

Unit-V

1. Universal Declaration of Human Rights
2. Human Rights violations
3. National Integration – Peace and non-violence (in context of Gandhi, Vivekanad)
4. Social Values and Welfare of the citizen
5. The role of media in value building
6. Fundamental Duties
7. Environment and Ecological balance – interdependence of all beings – living and non-living.

Assessment and Evaluation:

The Students shall be assessed and evaluated as per the schedule given below –

1. Project Report / Case Study (in 5000-7000 words) – 75%
2. Viva-voce - 25%

The topics for the Project Report / Case Study shall be allotted by the Nodal Department (decided jointly with NSS wing under the supervision or IQAC) in consultation with the Department concerned. The Candidate shall submit the Report by the date fixed for the said purpose. It shall then be followed by a Viva-voce Examination. The whole evaluation shall be done by the Departmental Internal Faculty in consultation with the Nodal Department. It is a non-creditable Paper. The Student will have to score simply a qualifying score/grade as specified in the CBCS rules.

The candidate will have to qualify the paper by the time He / She qualifies for the Programme. He/She can avail maximum 3 chances along with the Semester Examinations.

Books Recommended:

1. Hand Book of NCC : Major R C Mishra & Sanjay Kumar Mishra
2. National Security: K. Subramanyam
3. ASEAN Security: Air Comdr. Jasjit Singh
4. Indian Political System, Dr . Pukhraj Jain & Dr. Kuldeep Fadiya
5. हैण्ड बुक ऑफ एनसीसी , मेजर आर. सी. मिश्र एवं संजय कुमार मिश्र
6. अन्तर्राष्ट्रीय राजनीतिः वी. एल. फाड़िया
7. भारतीय राजव्यवस्था , डॉ. पुखराज जैन , डॉ. कुलदीप फड़िया
8. राष्ट्रीय प्रतिरक्षाः डॉ. हरवीर शर्मा , जयप्रकाश नाथ कंपनी , मेरठ
9. राष्ट्रीय सुरक्षाः डॉ. लल्लन सिंह , प्रकाश बुक डिपो , बरेली
10. राष्ट्रीय सुरक्षाः डॉ. नरेन्द्र सिंह , प्रकाश बुक डिपो , बरेली
11. राष्ट्रीय सुरक्षाः डॉ. पाण्डेय व पाण्डेय , प्रकाश बुक डिपो , बरेली

12. राष्ट्रीय रक्षा व सुरक्षाः डॉ. एस. के. मिश्र , मार्डन पब्लिशर्स , जालंधर
13. NCERT, Education in Values, New Delhi, 1992.
14. M.G.Chitakra: Education and Human Values, A.P.H. Publishing Corporation, New Delhi,2003.
15. Chakravarthy, S.K.: Values and ethics for Organizations: Theory and Practice, Oxford University Press, New Delhi, 1999.
16. Satchidananda, M.K.: Ethics, Education, Indian Unity and Culture, Ajantha Publications,Delhi, 1991.
17. Das, M.S. & Gupta, V.K.: Social Values among Young adults: A changing Scenario, M.D.Publications, New Delhi, 1995.
18. Bandiste, D.D.: Humanist Values: A Source Book, B.R. Publishing Corporation, Delhi,1999.
19. Ruhela, S.P. : Human Values and education, Sterling Publications, New Delhi, 1986.
20. Kaul, G.N.: Values and Education in Independent Indian, Associated Publishers, Mumbai,1975.
21. Swami Budhananda (1983) How to Build Character A Primer : Ramakrishna Mission, NewDelhi.
22. A Cultural Heritage of India (4 Vols.), Bharatiya Vidya Bhavan, Bombay. (SelectedChapters only) For Life, For the future : Reserves and Remains –UNESCO Publication.
23. Values, A Vedanta Kesari Presentation, Sri Ramakrishna Math, Chennai, 1996.
24. Swami Vivekananda, Youth and Modern India, Ramakrishna Mission, Chennai.
25. Swami Vivekananda, Call to the Youth for Nation Building, Advaita Ashrama, Calcutta.
26. Awakening Indians to India, Chinmayananda Mission, 2003.

MASTER OF SCIENCE IN MICROBIOLOGY
Semester 3
Marking Scheme for External Exam

Theory Papers	Duration	Max. Marks
FS-MIC-CC-301	**3 Hrs.**	**40**
FS-MIC-CC-302	**3 Hrs.**	**40**
FS-MIC-CE-303(A)		
OR	**3 Hrs.**	**40**
FS-MIC-CE-303(B)		
FS-MIC-OE-304(A)		
OR	**3Hrs.**	**40**
FS-MIC-OE-304(B)		
Combined Practical	**1 Day (6Hrs)**	**75**
Academic/Industrial Tour	**1-5 Days**	**00**

FS-MIC-CC-301: Immunology
Course Objectives:

The objective of this course is to provide a detailed overview of immune system to the learners. The learner will understand structure, organization and functions of various components of the immune system like antigen, antibody, organs, MHC, cytokines and others in the defence system of the body. It would also make them understand the concepts of innate and adaptive immunity, immune diversity and specificity, autoimmunity, hypersensitivity, transplantation and others.

Course Level Learning Outcomes:

Upon successful completion of the course, the learner will be able to :

CO1	describe the fundamental bases of immune system and immune response
CO2	explain about the importance of innate immunity and acquired immunity
CO3	describe the structure and organization of various components of the immune system
CO4	describe the genetic basis for the expression of immune cell receptors and generation of immunological diversity, complement system
CO5	understand the operation and the mechanisms which underlie the immune response
CO6	explain knowledge of various diseased conditions generated due to interplay of immune system components.
CO7	perform different immunological and serological testing's

Course Description
UNIT-I

Historical background: Humoral and Cellular components of the immune system. Innate Immunity: Skin & mucosal surface, Physiological Barriers, Phagocytic barriers, Inflammation, Adaptic immunity. Cells and Organs of Immune System. Antigens: Structure, properties, types, epitopes, haptens. Immunogens, Adjuvants.

UNIT-II

Antibodies: Structure, function and diversity, antibody mediated functions, classes and biological activities. Monoclonal antibodies. Antigen-Antibody Interaction. Major Histocompatibility Complex- structure, functionsand genes. Cytokinesis (Properties, receptors, antagonism & secretion). The complement system (functions, components, activation, regulation and deficiencies). Cell mediated effecter responses: Cytotoxic T-cells, natural killer cells, antibody-dependent cell-mediated cytotoxicity.

UNIT-III

Hypersensitive reactions (Type I,II,III and delayed type (DTH). Immune response to infectious diseases: viral, bacterial and protozon. Vaccines.Immuno-deficiencies.

Transplantation; Graft rejection, mechanism and prevention, HLA and disease**.**

Autoimmunity; Organ specific and systemic,Autoantibodies, experimental models

Scheme of Examination

Maximum Marks: 50 (40 External + 10 Internal) **Duration: 3 Hrs**

Minimum Passing Marks: 13

External

The question paper will consist of three Sections: A, B and C. Section A will consist of 10 questions (at least 3 questions from each unit of syllabus). Section B will consist of 9 questions (3 questions from each unit of syllabus). Section C will consist of 6 questions (2 questions from each unit of the syllabus).

Internal

Internal exam shall comprise Theory Exam (5 marks), Seminar Presentation (3 marks) and Class Performance (2 marks).

REQUIRED READINGS:

1. Kuby Immunology by Kindt TJ, Goldsby RA, Osborne BA, Kuby J: 6th edition. New York. WHFreeman; 2006.
2. Cellular and Molecular Immunology by Abbas AK, Lichtman AH, Pillai S: Saunders Elsevier;
2007.
3. Immunobiology: The immune system in health and disease by JanewayCA,TraversP,Walport M,Shlomchik MJ: 6th edition. New York. Garland Science Publishing; 2005.
4. Medical Microbiology and Immunology by Levinson W, Jawetz E: Lange publication; 2001.
5. Fundamental Immunology by Paul WE: 4th edition. New York. Raven Press; 2000.
6. Roitt's Essential Immunology by Delves PJ, Martin SJ, Burton DR, Roitt IM; 11th
edition. Blackwell Publishing/Oxford Univ. Press; 2006.

RECOMMENDED READINGS:

1. Clark W.R. 1991. The experimental foundations of modern immunology. John Wiley
2. Mackie & McCartney. Medical Microbiology. 14/e.
3. Bailey & Scott's Diagnostic Microbiology.
4. Franklin TJ, Snow GA. 1981.Biochemistry of antimicrobial action. Chapman & Hall, New York.
5. Roitt IM. 1995. Essential Immunology. Blackwell Sci. Oxford.
6. Roth J.A. 1985. Virulence mechanisms of bacterial pathogens. American Society for Microbiology. Washington D.C.
7. Smith CGC. 1976. Epidemiology and infections. Medowfief Press Ltd. Shildon, England.
8. Stiem F. 1980. Immunological disorders in infants and children. W.B. Saunders & Co. Philadelphia. Page 19 of 27
9. Todd IR. 1990. Lecture notes in immunology. Blackwell Sci. Pub. Oxford.
10. Roitt IM, Brostoff and Male 1995. Immunology 4/e Gower Medical Pub Co..
11. Kuby J 1994. Immunology. 2/e. W.H. Freeman and Co., New York.

FS-MIC-CC-302: Soil and Agricultural Microbiology

Course Objective

This course elaborates on soil, its types, formation and its characteristics. It describes and discusses the role of microorganisms in nutrient re-cycling, microorganisms associated with different parts of the plants and their role in plant health and diseases.

Course Level Learning Outcomes:

Upon successful completion of the course, the learner will be able to :

CO1	Appreciate the diversity of microorganism and microbial communities inhabiting soil.

CO2	Learn the occurrence, abundance and distribution of microorganism on various surfaces of plants also learn different methods for their detection and characterization.
CO3	Competently explain various aspects of agriculture microbiology and to become familiar with current research in soil and agricultural microbiology.
CO4	Understand various biogeochemical cycles – Carbon, Nitrogen, Phosphorus cycles etc. and microbes involved.
CO5	Understand various plant microbes interactions especially rhizosphere, phyllosphere and mycorrhizae and their applications especially the biofertilizers and their production techniques
CO6	Understand the role of microorganisms in promoting plant growth and their protection from pathogens.
CO7	Understand the role of microorganisms in causing different plant diseases and their cure.
CO8	Learning the application of microorganism as biopesticides and their mass production techniques.

Course Description

UNIT-I

Soils: Origin and evolution, soil profiles. Major physiochemical and biological characteristics. Soil microflora: distribution and contribution to ecosystem.

Biogeochemical cycles: Carbon cycle, Nitrogen Cycle, Phosphorus cycle, Sulphur cycle, Iron and Manganese cycle. Bioleaching and biomining. Agricultural and urban waste compost, vermicompost, mushroom compost, silage, methane production, biogas plants. Microbiology of Rhizospheres, phyllosphere and spermosphere,

.UNIT-II

Plant Diseases: Physiology of parasitism, mechanism of disease resistance, host parasite relationship. Symptomatology and control measure of various diseases.

Viral diseases: TMV, Yellow vein mosaic of Bhindi, and Papaya leaf curl.

Bacterial diseases: Citrus canker, Crown gall

Fungal diseases: Green ear of bajra, Wheat rusts and Loose and Covered smuts.

Mycoplasmal diseases: Witches broom of potato, Stripe disease of sugarcane

UNIT-III

Biofertilizers: Production technology, standards, storage and application methods for *Rhizobium, Azotobacter, Azospirillium*, Cyanobacteria, *Azolla.* Biological nitrogen fixation - nitrogenase enzyme - nif genes; symbiotic nitrogen fixation - (*Rhizobium, Frankia*)- non-symbiotic microbes- *Azotobacter- Azospirillium* PSM, Cellulolytes, VAM and PGPR. Microbial pesticides: biology and chemistry of the biocidal component, mode of action, effect on target organisms, production technology. Microbial insecticides; advantages of microbial insecticides, limitations- Mass production techniques; fermentation, formulation of insecticides, carrier materials quality control etc.

Scheme of Examination

Maximum Marks: 50 (40 External + 10 Internal) **Duration: 3 Hrs**

Minimum Passing Marks: 13

External

The question paper will consist of three Sections: A, B and C. Section A will consist of 10 questions (at least 3 questions from each unit of syllabus). Section B will consist of 9 questions (3 questions from each unit of syllabus). Section C will consist of 6 questions (2 questions from each unit of the syllabus).

Internal

Internal exam shall comprise Theory Exam (5 marks), Seminar Presentation (3 marks) and Class Performance (2 marks).

REQUIRED READINGS:

1. Plant Pathology by Agrios G. N. Academic Press, San Diego;1997.
2. The Nature and practice of Biological Control of Plant Pathogens by Cook R. J. & Baker K. F.; 1983.
3. Amereca Phytopathological Society Press, St. Paul, MN.
4. Environmental Biotechnology by Forster C. F. & John D.A. Ellis Horwood Ltd. Publication;2000.
5. A Manual of Environmental Microbiology by Christon J. H. ASM Publications;2001.
6. Soil Microbiology by Rao, N.S.S. Oxford & IBH Publishing Co., New Delhi;1999.

RECOMMENDED READINGS:

1. Erneasst WC 1982. The environment of the deep sea. Vol.II J.G. Morin Rubey.
2. Norris JR and Pettipher GL 1987. Essays in agricultural and food microbiology. John Wiley & Sons, Singapore.
3. Burges A and Raw F 1967. Soil Biology. Academic Press, London.
4. Vanghan D and Malcolm RE. 1985. Soil Organic Matter and Biological Activity. Martinus Nighoff W. Junk Pub.
5. Buckman H. and Brady N.C. The nature and properties of soil. Eurasis Pub. House (P.) Ltd. New Delhi.

FS-MIC-CE-303(A): Medical Microbiology

Course objectives:

The course objectives are to impart knowledge on infectious disease epidemiology and outbreaks. It deals with the knowledge of pathogenic microorganisms (viruses, bacteria, fungi), their characterization, pathogenesis, control and treatment.

Course Level Learning Outcomes:

Upon successful completion of the course, students will have the knowledge and skills to:

CO1	Understand and explain the various stages of infectious diseases, describe various modes by which infections spread in community, describe various methods that can be adopted to control spread of infection in community, understand and explain various hospital borne, air borne and water-borne diseases
CO2	By the end of this course, the students will be able to safeguard themselves and society and can work in diagnostics laboratories and hospitals. They will be able to classify and characterize diseases causing organisms like bacterial, fungal, viral etc.
CO3	Through this course students will learn the role of pathogenic bacteria in human disease with respect to infections of the respiratory tract, gastrointestinal tract, urinary tract, skin and soft tissue.
CO4	They will acquire a clear understanding about host pathogen interaction, normal microflora in the human body and different sample collection and analysis.
CO5	Students will be able to understand the pathogenesis, epidemiology of diseases and their causative agents. They also learn about the diagnosis of various microbial diseases.
CO6	Through this course the students will also learn about the antimicrobial agents, their characteristics, mode of action etc.
CO7	The student at the end of the course will be able to gain knowledge about vaccination, screening of various diseases.

Course Description

UNIT-I

Early discovery of pathogenic microorganisms. Pathogenicity and virulence; Quantitative measures of virulence: minimal lethal dose (MLD), LD 50 , ID 50, TCID 50. Normal microbial flora of the human body; role of the resident flora. Nosocomial infection, common types of hospital infections and their diagnosis and control, Molecular diagnosis of diseases: basic principles and techniques involving nucleic acid in relation to laboratory evaluation of disease.

UNIT-II

Important diseases of human beings (short description of causal agent, pathogenesis, diagnosis and treatment)

Bacterial diseases: Typhoid, Syphilis, Cholera, Gonorrhoeae, Tuberculosis, Diphtheria, Tetanus, Plague, Botulism, Meningitis, Pneumonia, Enteritis.

Viral diseases: Influenza, Herpes, AIDS, Rabies, SARS, Human Pox, Yellow fever, Mumps and Measles.

Fungal diseases: Ringworm, Toxoplasmosis.

Important bacterial (Anthrax, Black quarter, Tuberculosis, Brucellosis) **and viral (**Foot and mouth disease, Rinderpest, Cowpox, Rabies) **diseases of domestic animals**, their causal agents, epidemiology, pathogenesis, diagnosis, vaccine and treatment).

UNIT-III

Antimicrobial therapy; Antibiotics and their classification, mode of action, Antimicrobial resistance: Multidrug efflux pumps, X- MDR *M. tuberculosis*, Methicillin-resistant *S. aureus* (MRSA), various methods of drug susceptibility testing. Brief account on available vaccines and schedules. Coordinated regulation of virulence genes, two component signal transduction systems, secretion systems, biofilms and quorum sensing.

Scheme of Examination

Maximum Marks: 50 (40 External + 10 Internal) **Duration: 3 Hrs**

Minimum Passing Marks: 13

External

The question paper will consist of three Sections: A, B and C. Section A will consist of 10 questions (at least 3 questions from each unit of syllabus). Section B will consist of 9 questions (3 questions from each unit of syllabus). Section C will consist of 6 questions (2 questions from each unit of the syllabus).

Internal

Internal exam shall comprise Theory Exam (5 marks), Seminar Presentation (3 marks) and Class Performance (2 marks).

REQUIRED READINGS:

1. Jawetz, Melnick, & Adelberg's Medical Microbiology by Brooks GF, Butel JS, Morse SA, Melnick JL,Jawetz E, Adelberg EA . 23rd edition. Lange Publication. 2004.

2. Cellular Microbiology by Cossart P, Boquet P, Normark S, Rappuoli R eds. 2nd edition. American Societyfor Microbiology Press. 2005.

3. Bacterial Pathogenesis: A molecular approach by Salyers AA and Whitt DD eds. American Society forMicrobiology Press, Washington, DC USA. 2002.

4. Pathogenomics: Genome analysis of pathogenic microbes by Hacker J and Dorbindt U. ed. Wiley-VCH.2006.

5. Molecular Microbiology: Diagnostic Principles and Practice by Persing DH, Tenover FC, Versalovic J,Tang Y, Unger ER, Relman DA, White TJ eds. American Society for Microbiology Press, 2004.

6. Infectious Disease Epidemiology: Theory and Practice by Nelson KE, Williams CM,
Graham NMH eds. An Aspen Publication. 2001.

RECOMMENDED READINGS:

1. Morag C. and Timbury M.C. 1994. Medical virology. X/e. Churchill Livingstone, London.
2. Topley and Wilson 1995. Text book on Principles of Bacteriology, Virology and Immunology. Edward Arnold, London
3. Mackie and McCartney. 1996. Medical Microbiology. Vol.1. Microbial Infection, Vol. 2. Practical Medical Microbiology. Churchill Livingstone.
4. Shanson DC. Wright PSG1982. Microbiology in Clinical Practice.

FS-MIC-CC-303(B): Food and Dairy Microbiology

Course Objectives:

The students will be familiarized with the apparatus and equipment used in a microbiology laboratory, how to maintain aseptic conditions in microbiological experiments. They will learn to prepare culture media, isolate and culture bacteria and fungi and to extract nematodes. They will learn to study the general morphological features of different microorganisms.

Course Level Learning Outcomes:

Upon successful completion of the course, students will have the knowledge and skills to:

CO1	Are able to describe the role of microorganisms in the production of food, its spoilage, including their role in homemade fermented foods.
CO2	Are able to understand different intrinsic and extrinsic factors responsible for food spoilage.
CO3	Are able to identify the role of microorganisms in the causation of the diseases and how to protect against food-borne pathogens.
CO4	Developed experimental skills for testing the milk and different foods for the presence of microorganisms

Course Description

UNIT-I

Dairy starter cultures, fermented dairy products: yogurt, acidophilus milk, kumiss, kefir, dahi and cheese, other fermented foods: dosa, sauerkraut, soy sauce and tampeh, Probiotics: Health benefits, types of microorganisms used, probiotic foods available in market. Utilization and disposal of dairy by-product – whey.

UNIT-II

Intrinsic and extrinsic factors that affect growth and survival of microbes in foods, natural flora and source of contamination of foods in general. Principles, Spoilage of vegetables, fruits, meat, eggs, milk and butter, bread, canned Foods. Principles of food preservation: temperature, canning, drying, irradiation, microwave processing and aseptic packaging, chemical methods of food preservation: salt, sugar, organic acids, SO_2, citrates, benzoates, nitrite and nitrates etc.

UNIT-III

Food borne diseases (causative agents, foods involved, symptoms and preventive measures)- Food intoxications: Staphylococcus aureus, Clostridium botulinum and mycotoxins; Food infections: Bacillus cereus, Vibrio parahaemolyticus, Escherichia coli, Salmonellosis, Shigellosis, Yersinia enterocolitica, Listeria monocytogenes and Campylobacter jejuni. Cultural and rapid detection methods of food borne pathogens in foods. Food sanitation and control; HACCP, Indices of food sanitary quality and sanitizers.

Scheme of Examination

Maximum Marks: 50 (40 External + 10 Internal) **Duration: 3 Hrs**

Minimum Passing Marks: 13

External

The question paper will consist of three Sections: A, B and C. Section A will consist of 10 questions (at least 3 questions from each unit of syllabus). Section B will consist of 9 questions (3 questions from each unit of syllabus). Section C will consist of 6 questions (2 questions from each unit of the syllabus).

Internal

Internal exam shall comprise Theory Exam (5 marks), Seminar Presentation (3 marks) and Class Performance (2 marks).

REQUIRED READINGS:

1. Banwart, GJ. Basic Food Microbiology. CBS Publishers and Distributors, Delhi. (1989).
2. Hobbs BC and Roberts D. Food poisoning and Food Hygiene. Edward Arnold (A division of Hodder and Stoughton) London.
3. Joshi. Biotechnology: Food Fermentation Microbiology, Biochemistry and Technology. Volume 2.
4. John Garbult. Essentials of Food Microbiology. Arnold International.
5. John C. Ayres. J. Orwin Mundt. William E. Sandinee. Microbiology of Foods. W.H. Freeman and Co.

RECOMMENDED READINGS:

1. Stanbury, PF., Principles of Fermentation Technology. Whittaker, A and Hall, S.J 2nd Edition. Pergamon Press (1995).
2. Photis Papademas.Dairy Microbiology: A Practical Approach. CRC Press
3. Rao M.K..Food and Dairy Microbiology. Manglam Publishers
4. William Frazier. Food Microbiology. McGraw Hill Education
5. Jay, James M., Loessner, Martin J., Golden, David A. Modern Food Microbiology.Springer

FS-MIC-OE-304(A): Human Physiology

The main objective of this course is to enable a learner to get acquainted with the basic organization of the human body and human physiology. The learner will be able to understand the relationship among various organs and organ systems.

Course Learning Outcomes:

Upon successful completion of the course, the student will able to:

CO1	Understand the anatomy, physiology and functions of various cells and tissues, organization of cellular system of the human body.
CO2	Understand the composition of blood, functioning of the circulatory, cardiovascular and lymphatic system.
CO3	Explain the anatomy and physiology of gastrointestinal system.
CO4	Explain the structure and functioning of kidney, formation of urine
CO5	Explain the concept of communication in the body through nervous and endocrine system
CO6	Describe about the organs involved in the respiratory system and the mechanism of breathing.
CO7	Describe about the organs involved in the reproduction system and phages of reproduction.

Course Description

UNIT-I

BASIC CELL PHYSIOLOGY**:** Organization of the human body (cell, tissue, organ and organ system)Cell-Introduction, Cell Organelles, Cell membrane, Movement of the substances and water through the cell membrane, Bioelectric potentials

BLOOD, LYMPH AND CIRCULATORY SYSTEM-Functions of Blood, hematopoiesis, erythropoiesis,granulocytes and agranulocytes,Macrophage system, Blood groups.Lymph and its role.

CIRCULATORY SYSTEM**:** Functional anatomy of the heart, Properties of cardiac muscles, Conducting system of the heart, Pressure changes during cardiac cycles, Capillary circulation, Arterial and venous blood pressure.

UNIT-II

GASTRO INTESTINAL SYSTEM(**Digestive system):** General structure of alimentary canal, Organs- Mouth, Pharynx, Oesophagus, Stomach, Small intestine, Large Intestine, Rectum. Glands and their secretion - Salivary, Liver, and Pancreas. Digestion of food.

RENAL PHYSIOLOGY- Structure of kidney- Nephrone, Bowman's capsule, renal tubule, Bladder, Ureters, urthera, Process of urine formation- glomerular filtrate, Reabsorption, mechanism of secretion, Concentrating and diluting mechanism of urine, Dialysis

RESPIRATORY SYSTEM- Upper and lower respiratory system, Organs involved, Mechanism of breathing, Regulation of respiration, Transport of gases, Hypoxia, Artificial ventilation.

UNIT III

REPRODUCTION SYSTEM**:** Organs (testis and ovary). Male primary and secondary reproductive organs **-** Testis, Scrotum, vas deferens, seminal vesicles, prostate gland, Urethera, penis. Female primary and secondary reproductive organs- Ovary, Fallopian tube, Uterus, Vagina. Phages of reproduction.

NERVOUS SYSTEM**:** Neurons, Central (brain and spinal cord) peripheral (somatic and Autonomic) system. Physiology of nervous system.

ENDOCRINE GLANDS(Hypothalamus, Pituitary, Pineal, Thyroid, Parathyroid, Adrenal, Pancreas, Thymus, Testes, Ovaries), their hormones and functions

Scheme of Examination

Maximum Marks: 50 (40 External + 10 Internal) **Duration: 3 Hrs**

Minimum Passing Marks: 13

External

The question paper will consist of three Sections: A, B and C. Section A will consist of 10 questions (at least 3 questions from each unit of syllabus). Section B will consist of 9 questions (3 questions from each unit of syllabus). Section C will consist of 6 questions (2 questions from each unit of the syllabus).

Internal

Internal exam shall comprise Theory Exam (5 marks), Seminar Presentation (3 marks) and Class Performance (2 marks).

REQUIRED READINGS:

1. Guyton AC and Hall JE,Text book of medical physiology.
2. *Human Physiology: An Integrated Approach***,** 6th Edition by Dee Unglaub Silverthorn
3. JOHNSON, Leonard R, Essential Medical Physiology

4. Nordin M and Frankel VH, Basic biomechanics of the musculoskeleton system, Lippincot, Williams and Wilkins.
5. Human Biology and Health. Upper Saddle River, NJ: Pearson Prentice Hall. 1993. ISBN 0-13-981176-
6. Gray's anatomy: the anatomical basis of clinical practice. Editor-in-chief, Susan Standring (40th ed.). London: Churchill Livingstone. 2008. ISBN 978-0-8089-2371-8.

RECOMMENDED READINGS:

1. Atlas of Human Anatomy, Professional Edition, 7th Edition.
2. Ross & Wilson Anatomy and Physiology in Health and Illness, 13th Edition.
3. Clinical Anatomy: Applied Anatomy for Students and Junior Doctors, 14th Edition.
4. Gray's Anatomy for Students, 4th Edition.
5. Anatomy: A Photographic Atlas, 8th North American Edition.
6. Marieb Human Anatomy & Physiology Standalone Book, 10th Edition.
7. Human Anatomy & Physiology, 11th Edition.

FS-MIC-CE-304(B): Basics of Medical Laboratory Techniques (BMLT)

Course Objectives:

The course objectives are to provide knowledge and skills to understand the chemical properties of the biomolecules, their functions and biomedical importance, basic understanding of diseases and their pathogenesis, laboratory diagnostics, safety measures and various types of laboratory tests.

Course Learning Outcomes:

Upon successful completion of the course, students will have the knowledge and skills to:

CO1	**Work efficiently in medical laboratories in India and abroad under different specialties and practice analytical testing processes.**
CO2	**Follow prescribed procedures, and with adequate orientation, perform routine testing in chemistry, microbiology, immunohematology, hemostasis, and molecular diagnostics.**
CO3	**Conduct analysis of body fluids/samples to diagnose different diseases.**
CO4	**Conduct molecular analysis of chromosomal aberrations in leukemias and lymphomas, molecular diagnosis of genetic diseases and practice established safety measures.**
CO5	**Demonstrate working of various instruments, process and formats of reporting in medical laboratory technology laboratory.**
CO6	**Manage and maintain laboratory operations and human resources to ensure cost-effective, high-quality laboratory services**
CO7	**Understand the application of molecular methods in clinical microbiology, and antimicrobial resistance.**
CO8	**Practice quality assurance and performance improvement techniques for optimum laboratory analysis. Utilize information management systems to provide timely and accurate reporting of laboratory data.**

Course Description

UNIT-I

Analysis of amino acids, screening tests, quantitative tests, test for specific amino acids, determination of proteins in serum, plasma and CSF, determination of glucose in body fluids, glucose tolerance test, analysis of ketone bodies, method of estimation of lactate, pyruvate and glycated hemoglobin in blood, analytical methods for estimation of triglycerides, high density lipoproteins, low density lipoproteins, apolipoproteins.

UNIT-II

Laboratory application of nucleic acid technologies to elucidate, diagnose, monitor disease state and to evaluate non-disease status, basic principles and techniques involving nucleic acid in relation to laboratory evaluation of disease, Clinical testing process, quality assurance, clinical validation and accreditation.

UNIT-III

Molecular analysis of chromosomal aberrations in leukemias and lymphomas, molecular diagnosis of genetic diseases, application of molecular methods in clinical microbiology, antimicrobial therapy; antimicrobial resistance, historical aspects advantage of DNA over traditional serology, DNA degradation and environmental damage, quality assurance, standard, databank, legal challenge.

Scheme of Examination

Maximum Marks: 50 (40 External + 10 Internal) **Duration: 3 Hrs**

Minimum Passing Marks: 13

External

The question paper will consist of three Sections: A, B and C. Section A will consist of 10 questions (at least 3 questions from each unit of syllabus). Section B will consist of 9 questions (3 questions from each unit of syllabus). Section C will consist of 6 questions (2 questions from each unit of the syllabus).

Internal

Internal exam shall comprise Theory Exam (5 marks), Seminar Presentation (3 marks) and Class Performance (2 marks).

REQUIRED READINGS:

1. Methods in Molecular Biology: Amino Acid Analysis Protocols By Catherine Cooper, Nicolle Packer and Keith Williams. Publisher: Humana Press
2. Medical Biochemistry [Paperback] By John Van Pilsum. Publsher: University of Minnesota Press.
3. Clinical Biochemistry: Metabolic and Clinical Aspects [Paperback] By William J. Marshall and Stephen K. Bangert. Publisher: Churchill Livingastone.
4. Clinical Chemistry: Techniques, Principles, Correlations (Bishop, Clinical Chemistry) [Hardcover] By Michael L Bishop, Edward P Fody and Larry E Schoeff. Publisher: Lippincott Williams and Wilkins
5. Nucleic Acid Amplification Technologies: Application to Disease Diagnosis [Hardcover] By H Olsvik (Editor), S Morse (Editor), O Lee (Editor). Publisher: Eaton Publishing, USA.
6. Chromosomal Alterations: Methods, Results and Importance in Human Health [Hardcover] By Gunter Obe and Vijayalaxmi. Publisher: Springer
7. Handbook of Hematologic Pathology (Diagnostic Pathology) [Hardcover] By Harold R. Schumacher, Sanford A. Stass and William A. Rock. Publisher: Marcel Dekker Inc.
8. Molecular Diagnosis of Genetic Diseases (Methods in Molecular Medicine) (Methods in Molecular Biology) (v. 1) [Hardcover] By Rob Elles. Publisher: Humana Press.
9. Color Atlas and Textbook of Diagnostic Microbiology [Hardcover] By Elmer W Koneman, Stephen D Allen, William M Janda, Paul C Schreckenberger and Washington C Winn. Publisher: Lippincott
10. Molecular Diagnostics: Promises and Possibilities [Hardcover] By Mousumi Debnath, Godavarthi B.K.S. Prasad and Prakash S. Bisen. Publisher: Springer

RECOMMENDED READINGS:

1. Henry, John Bernard, Todd Sanford and Davidson, 2002. Clinical diagnosis and management by laboratory methods. W.B. Saunders& Co.
2. Fischbach Francis A, 2003. Manual of laboratory and diagnostic tests. Philadelphia,J.B. Lippancott &Co, N.Y.
3. Gradwohls, 2000. Clinical laboratory methods and diagnosis ed.Alex.C. Sonnenwirth & Leonard Jarret.M.D.B.I.Publications, New Delhi.
4. Sood, R, 2005, Medical Laboratory methods and interpretation, Jaypee brothers medical publications, New Delhi.

PRACTICALS

Study of coliform bacteria in water samples from different sewage sources
Study of decolouration of distillery or textile industrial waste.
Study of microbial degradation of hydrocarbons(s) or pesticide(s).
Study of fungal degradation of wood.
Study of Bacterial interactions (antagonism etc)
Isolation and cultivation of *Azotobacter, Rhizobium, Azospirillum, Cyanobacteria, Actinomycetes, Mycorrhiza.*
Biofertilizer production using *Rhizobium*
Biofertilizer production using Mycorrhiza

Soil analysis for various parameters like moisture content, water holding capacity, Micro and macronutrients like carbon, nitrogen, carbonates etc

Determination of following enzyme activities in the soil sample: amylase, cellulose, xylanase, protease and phosphatase.

Laboratory methods for studying soilborne diseases

a. Isolation of soilborne pathogen

c. Chemical control of soilborne pathogens using acylanilide and alkyl phosphonates.

Bacterial diseases of food plants

a. Isolation of pathogenic bacteria from rotten vegetables and fruits

b. Biochemical and physiological tests for detection of pathogens in vegetables and fruits

To study normal micro-flora of Skin, Respiratory tract, Gastro-intestinal tract, uro-genital tract.

To study cultural characteristics of pathogenic bacteria on various selective and differential media.

To study pathogenicity of *Staphylococcus aureus* by coagulase test.

To study antimicrobial susceptibility using an octadisc.

To determine the minimal inhibitory concentration (MIC) of an antibiotic on bacteria and fungi

Determination of Blood group and Rh factor.Blood cell counts. Serological tests: Radio immuno-diffusion, Immuno-electrophoresis, DOT ELISA, Sandwich ELISA,

Ochterlony double diffusion, agglutination test, Fluorescent Antibody test.

Monitoring blood pressure, pulse rate, clotting time, bleeding time.

Haemoglobin estimation, erythrocyte sedimentation rate, packed cell volume. Prothrombin time, differential count.

Total red blood cell count, total white blood cell count, platelet count, eosinophilic count, reticulocyte count.

Monitoring blood sugar, urea, uric acid, creatinine.

Monitoring cholesterol, triglyceride, high density liporoteins, low density lipoproteins, very low density lipoproteins.

Estimation of sodium, potassium, calcium, chloride, bicarbonate, phosphorus and magnesium in biological fluids.

Collection of urine and blood, types of preservative, physical examination; volume, colour, odour, appearance, specific gravity and pH.

Reducing sugar-benedict test, protein: heat and acetic acid test, and sulfosalicylic acid method, ketone bodies-roth era's test, bile pigment (fouchet method), bile salt (hay's test), urobilinogen-ehrlich aldehyde test and bence jones protein test, renal clearance test-urea, creatine, test for mucin.

Antigen antibody assay, ELISA tests, immuno- electrophoresis.

Semester 4

Theory Papers	**Duration**	**Max. Marks**
FS-MIC-CC-401	**3 Hrs.**	**40**
FS-MIC-CC-402	**3 Hrs.**	**40**
FS-MIC-CE-403	**10 min Viva-voce for the project work**	**40**
FS-MIC-OE -404(A)		
OR	**3 Hrs.**	**40**
FS-MIC-OE -404(A)		
Combined Practical	**1 Day (6Hrs)**	**75**

***Each student shall give a presentation on his/her Research project/Review work of 10 min**

Students are advised to complete Research project preferably from some outside research institute/industry or otherwise in the University in the first 45 days starting from the beginning of the session.

FS-MIC-CC-401: Bioinformatics and Computer Applications

Course Objectives:

The objectives of this course are to provide theory and practical experience of the use of common computational tools and databases which facilitate investigation of biological molecules (DNA, RNA and protein) and evolution-related concepts.

Course Level Learning Outcomes:

Upon successful completion of the course, students will have the knowledge and skills to:

CO1	At the end of the course, the student will be able to apply basic principles of biology and computer science to address complex biological sequence problems. This allied course introduces the students various concepts to assess and analyze biological data.

CO2	It deals with understanding the molecular aspects of biology. It majorly emphasizes the concepts of central dogma of molecular biology spanning from DNA replication till protein synthesis and reverse transcription.
CO3	The course talks about primary, secondary and tertiary databases used in bioinformatics and will train the students in the use of databases for finding and retrieval of biological sequences.
CO4	Students should be able to develop an understanding of the theory of various computational tools used in bioinformatics and will gain working knowledge of these computational tools and methods.
CO5	This course will help students to learn the basics of mapping, genome sequencing, and genome sequence assembly, genome annotation and whole genome alignment.
CO6	The course is a skill based paper that introduces the students to the basics of computer operations. The student is imparted with knowledge on both hardware and software and operating systems. The student has a better understanding on the use of computers for various microbiological/biological applications.

Course Description

UNIT-I

Bioinformatics: Introduction, objectives. Bioinformatics and data analysis. Database concept, types of databases. Microbiological and Virology databases. Knowledge of basic algorithms in computational biology, Python for Bioinformatics: Basic concepts and application in biological sequence analysis.

UNIT-II

Metabolic pathway engineering. Finding and retrieving sequences from databases. Sequence alignment: pairwise and multiple sequence, evolutionary basis, sequence homology versus sequence similarity, sequence similarity versus sequence identity. Protein structural visualization, protein structure comparison, protein expression analysis, protein sorting, Gene phylogeny versus species phylogeny, forms of tree representation, why finding a true tree is difficult. phylogenetic tree construction methods and programs.

UNIT-III

Computers and their organization, hardware, software, operating system, R environment for computational biology and bioinformatics, introduction to graphics package, application packages for microbiologists, genome mapping, genome sequencing, genome sequence assembly, genome annotation.

Scheme of Examination

Maximum Marks: 50 (40 External + 10 Internal) **Duration: 3 Hrs**
Minimum Passing Marks: 13

External

The question paper will consist of three Sections: A, B and C. Section A will consist of 10 questions (at least 3 questions from each unit of syllabus). Section B will consist of 9 questions (3 questions from each unit of syllabus). Section C will consist of 6 questions (2 questions from each unit of the syllabus).

Internal

Internal exam shall comprise Theory Exam (5 marks), Seminar Presentation (3 marks) and Class Performance (2 marks).

REQUIRED READINGS:

1. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins by Baxevanis A.D. and Ouellette, Third Edition. John Wiley and Son Inc., 2005.
2. Bioinformatics Sequence and Genome Analysis by Mount D.W., CSHL Press, 2004.
3. Introduction to Bioinformatics by Tramontano A., Chapman & Hall/CRC, 2007.
4. Understanding Bioinformatics by Zvelebil, M. and Baum, Chapman & Hall/CRC, 2008.

5. Bioinformatics: Methods Express By: Paul H Dear, Scion Publishing Ltd, 2007
6. Bioinformatics: Sequence and Genome Analysis by David W. Mount, Cold Spring Harbor Laboratory, 2004.

RECOMMENDED READINGS:

1. W.J. Ewens, Gregory Grant,(2005). Statistical Methods in Bioinformatics: An Introduction (Statistics for Biology & Health), Springer
2. Bryan Bergeron,(2003).Bioinformatics Computing First Indian Edition, Prentice Hall
3. Cynthia Gibas & Per Jambeck (2001). Developing Bioinformatics Computer Skills: Shroff Publishers & Distributors Pvt. Ltd (O'Reilly), Mumbai
4. HH Rashidi & LK Buehler (2002). Bioinformatics Basics: Applications in Biological Science and Medicine, CRC Press, London
5. Des Higgins & Willie Taylor (2002). Bioinformatics: Sequence, structure and databanks, Oxford University Pres

FS-MIC-CC-402: Microbial Ecology and Environmental Biotechnology

Course Objectives:

The main objective of this course is to impart the basic and advance knowledge about the microbial communities inhabiting in diverse environments, their role in environment and ecosystem wellness and interaction with various type of pollutants. The learner will be acquainted with the concepts of aquatic microbiology, aero microbiology, use of microbial population in microbial waste recycling and bioremediation, rumen microbiology and other related topics.

Course Level Learning Outcomes:

Upon successful completion of the course, the learner will be able to :

CO1	explain various concepts of aero and aquatic microbiology.
CO2	describe advances in the field of environmental microbiology and the role of microbes in mitigating environment pollution.
CO3	prepare and perform sampling and microbial analyses to determine the microbial community composition in various environments.
CO4	describe Inter specie interactions among the microbes.
CO5	understand the role of microbes in bio-deterioration and biodegradation of various natural and manmade things and apply this concept in the field.
CO6	describe the role of microbes in solid and liquid waste management, gaining knowledge of various methods employed in sewage treatment and solid waste treatment.
CO7	Understand the concept of rumen microbiology, microorganism based Oxidative transformations.

Course Description

UNIT-I

Aero Microbiology : Droplet nuclei, aerosol, assessment of air quality, solid - liquid impingement methods, assessment of air quality, brief account of air- borne microbes – bacteria, fungi, and viruses, their diseases and preventive measures.

Aquatic microbiology: Water ecosystems - types, fresh water (ponds, lake, streams) - marine habitats (estuaries, mangroves, deep sea, hydrothermal vents, saltpans, coral-reefs). Potability of water- microbial assessment of water quality- water purification. Eutrophication. Brief account of major water borne diseases.

Extreme environments and extremophilic microbes: Habitats, diversity, adaptations and potential applications of oligotrophs, thermophiles, psychrophiles, metallophiles,acidophiles, alkaliphiles and halophiles.

UNIT-II

Inter species interactions-microbial behavior in ecosystems: Microbial Antagonism, competition, commensalisms, synergism, parasitism and predation. Gause and Hardin's principles of competition.

Rumen microbiology, digestion, fermentation and detoxification by microbes, factors influencing rumen microbes.

Plant-microbe symbiosis, microbial antagonism, biofilms and their biotechnological applications. Bio-fertilizers and Biopesticides, carriers for inoculants: types and characteristics, strain selection of bacteria. Plant growth promoting rhizobacteria, (PGPR), biocontrol agents

Understanding microbial diversity in the environment by culture-dependent and culture-independent approaches

Oxidative transformation of metals: sulfur oxidation, iron oxidation, ammonia oxidation and hydrogen oxidation.

UNIT-III

Waste water treatment : Wastes - types- solid and liquid wastes characterization. Sewage treatments methods - physical, chemical, biological (aerobic- anaerobic) ; primary, secondary and tertiary treatments (trickling; activated sludge, oxidation pond, oxidation ditch). Treatment of industrial effluents (distillery, textile, pulp and paper), methods to detect various pollutants (metals, sediments, toxin and organic matters).

Subterranean microbes and bioremediation. Biodeterioration and biodegradation of paints, plastics, rubber, paper, leather, wood, wool, degradation of xenobiotics, pesticides and polymers.
Microbial leaching and oxidation of minerals (copper bioleaching, cobalt bioleaching, Uranium bioleaching, biooxidation of gold ores, Nickel leaching, acid mine drainage). Microbial enhanced oil recovery.

Scheme of Examination

Maximum Marks: 50 (40 External + 10 Internal) **Duration: 3 Hrs**
Minimum Passing Marks: 13

External

The question paper will consist of three Sections: A, B and C. Section A will consist of 10 questions (at least 3 questions from each unit of syllabus). Section B will consist of 9 questions (3 questions from each unit of syllabus). Section C will consist of 6 questions (2 questions from each unit of the syllabus).

Internal

Internal exam shall comprise Theory Exam (5 marks), Seminar Presentation (3 marks) and Class Performance (2 marks).

REQUIRED READINGS:

1. Microbial Ecology By Atlas R.M., Bartha R., Benjamin Cummings Publishing Co, Redwood City, CA.,1993.
2. Environmental Microbiology by A.H. Varnam & M.G. Evans, Manson Publishing Ltd., 2000.
3. Manual of Environmental Microbiology by Christon J. Hurst, Ronald L. Crawford, Jay L. Garland, DavidA. Lipson, Aaron L. Mills, ASM Press, 2007.
4. Environmental Microbiology by W.D. Grant & P.E. Long, Kluwer Academic Publishers, 1981.
5. Assessing Ecological Risks of Biotechnology Lev R. Ginzburg
6. Environmental biotechnology G. M. Evans and J. C. Furlong
7. Environmental biotechnology A. Scragg, Oxford
8. Environmental Microbiology – A Laboratory Manual Pepper et. Al
9. Genetic control of environmental pollutants Gilbert & Alexander

RECOMMENDED READINGS:

1. Experimental ecology R.M. Atlas
2. Handbook of water and waste water treatment Technology Paul
3. Waste Water Treatment Arceivala
4. Environmental Microbiology by A.H. Varnam & M.G. Evans, Manson Publishing Ltd., 2000.
5. Manual of Environmental Microbiology by Christon J. Hurst, Ronald L. Crawford, Jay L. Garland, David A. Lipson, Aaron L. Mills, ASM Press, 2007.
6. Environmental Microbiology by W.D. Grant & P.E. Long, Kluwer Academic Pu
7. Ewesis ET. Al. 1998. Bioremediation Principles. Mac Graw Hill.
8. Dart. R.K. and Shettron R.J. 1980. Microbiological aspects of pollution control. 2 ed.

FS-MIC-CE-403(A): Research Project

Course Objectives:

To develop the skills of preparing and conducting independent research and/or reviewing the research work done on the selected topic.

Course level learning outcomes:

This will develop the students' ability to apply the tools and techniques of microbiology in conducting independent research/review.

Scheme of examination

The student shall prepare a report of his/her work carried out as mentioned below and shall present it to the external examiner. The examiner will evaluate the work carried out and shall award the marks accordingly.

Maximum Marks: 40 **Duration: 10 min per student**
Minimum Passing Marks: 15

The student will select a topic of research in consultation with his/her supervisor/guide to do a research work, write a review or carry out a case study on any topic related to microbiology or allied subjects.

FS-MIC-CE-403(B): Review

Course Objectives:

To develop the skills of preparing and conducting independent research and/or reviewing the research work done on the selected topic.

Course level learning outcomes:

This will develop the students' ability to apply the tools and techniques of microbiology in conducting independent research/review.

Scheme of examination

The student shall prepare a report of his/her work carried out as mentioned below and shall present it to the external examiner. The examiner will evaluate the work carried out and shall award the marks accordingly.

Maximum Marks: 40 **Duration: 10 min per student**

Minimum Passing Marks: 15

The student will select a topic of research in consultation with his/her supervisor/guide to do a research work, write a review or carry out a case study on any topic related to microbiology or allied subjects.

FS-MIC-OE-404(A): Biostatistics

Course Objective

This paper develops concepts about types of data observed in biological experiments, its handling and processing. It develops concepts of hypothesis and formulation of experiments. It gives understanding of various statistical operations needed to carryout and process the biological data.

Course Level Learning Outcomes:

Upon successful completion of the course, the learner will be able to :

CO1	Able to collect, handle, process and present the biological data.
CO2	Apply the principles of statistics on biological experiments.
CO3	Learn about how to collect data using different sampling methods
CO4	Learn to present data in various forms like tabular, graphical, pictorial, etc.
CO5	Learn the use of Simple Probability methods, Regression and Correlation, and simple linear regression in biological research.
CO6	Learn the use of use of partial correlation and partial covariance in biological research.
CO7	Understand about Count data: examples of count data (bacterial cell count, radioactivity, colony and plaque counts), statistical treatment to count data
CO8	Statistical basis of biological assays: Response-Dose relationship, direct and indirect assay, statistical analysis of LD50.

Course Description

UNIT-I

Definition of statistics, symbols, notations and terminology of statistics: Sampling and estimation of population parameters, Random sampling, Sampling size in random sampling, stratified two stage cluster and sequential sampling, Bias in sampling Presentation of research results, Graphic presentation.

UNIT-II

Interval Data: Construction of a histogram, interpretations of histogram, the normal distribution, the mean, mode, median and standard deviation, representing the normal curve, Chi square test, goodness of fit. Count data: examples of count data (bacterial cell count, radioactivity, colony and plaque counts), statistical treatment to count data. Poisson distribution, Standard error, confidence limits of counts.

UNIT-III

Simple Probability: Regression and Correlation, simple linear regression, Coefficient of determination. Brief introduction to the need and application on curvilinear and multiple regression. Use of partial correlation and partial covariance. Detecting association between a pair of species. Cole's measure of association and point correlation coefficient.

Statistical basis of biological assays: Response-Dose relationship, direct and indirect assay, statistical analysis of LD50.

Scheme of Examination

Maximum Marks: 50 (40 External + 10 Internal) **Duration: 3 Hrs**

Minimum Passing Marks: 13

External

The question paper will consist of three Sections: A, B and C. Section A will consist of 10 questions (at least 3 questions from each unit of syllabus). Section B will consist of 9 questions (3 questions from each unit of syllabus). Section C will consist of 6 questions (2 questions from each unit of the syllabus).

Internal

Internal exam shall comprise Theory Exam (5 marks), Seminar Presentation (3 marks) and Class Performance (2 marks).

REQUIRED READINGS:

1. Sampling Techniques by Cochran W. G., Wiley estern Ltd, New Delhi.
2. Fundamentals of Biostatistics, by Irfan Ali Khan and Atiya Khanum, (2nd edition). Ukaaz Publications, Hyderabad.
3. Introduction to probability theory and its applications, by Felller W., Asia Publishing House, Mumbai.
4. An introduction to Biostatistics by Glover T. and Mitchell K., McGraw-Hill , N.Y; 2002.
5. Fundamentals of statistics. Goon, Gupta and Dasgupta- World Press, Kolkota.
6. Design and analysis of experiments by Montgomery D. C., John Wiley and Sons.
7. Biostatistics, a foundation for analysis in the health Sciences, (7^{th} edition), Wayne Daniel; 2007.

RECOMMENDED READINGS:

1. Scrimshaw NS and Gleason GR 1992. Rapid assessment procedures. Quantitative methodologies for planning and evaluation of health related programs. International Nutrition Foundation for Developing Countries, Boston.
2. Van Maanen 1983. Quantitative methodology. Sage publications.
3. Cook TD and Reichardt CS 1979. Qualitative and quantitative methods in evaluation research. Sage Pub., London.
4. Creswell J 1994. Research design: Qualitative and quantitative approaches. Thousand Oaks. CA, Sage Pub.
5. Denzin NK and Lincoln YS 1994. Handbook of qualitative research. Sage pub.
6. Mienert CL 1986. Clinical trials: Design, conduct and analysis. Oxford Univ Press, New York.
7. Arora PN & Malhon PK (1996). Biostatistics Imalaya Publishing House, Mumbai.
8. Sokal & Rohif (1973). Introduction to Biostatistics, Toppan Co. Japan.
9. Stanton A & Clantz, Primer of Biostatistics (2005). The McGraw Hill Inc., New YorK

FS-MIC-OE-404(B): Microorganisms and Health

Course objectives:

This course gives basic knowledge about the microorganisms and their role in the life of human beings. It provides information about the locations of microorganism in the environment. It also gives information about how microbes are exploited for human well being.

Course Level Learning Outcomes:

Upon successful completion of the course, the learner will be able to :

CO1	Able to understand the basics of microorganisms.
CO2	Able to know about the habitats of microorganisms.
CO3	Learn about life, various places where living organisms are found and limits of Life on earth.
CO4	Learn to understand the role of Human microbiome in good health and preventinn of infectious diseases.
CO5	Know about the biological (Germs) terror, its origin, consequences and possible control through vigilance and Laws.
CO6	Learn about how to prevent infectious diseases through vaccination.
CO7	Learn about Antibiotic resistance and its control

Course Description

Unit I

What is life? Where can life exist? Limits of Life on earth . Invisible life. Microorganisms, what are they? Types of Microorganism, Where do they live? What do they do? Microorganisms and man, the friends and foes.

Unit II

Human microbiome, Preventing infectious diseases, New crop of diseases, Legionnaires disease, AIDS, Swine Flu, SARS, MERS, Ebola, Zica, West Nile Virus.

Unit III

Germs and terror, Prevention of infections, Vaccines and vaccine schedules, Return of the old foes: Antibiotic resistance

Scheme of Examination

Maximum Marks: 50 (40 External + 10 Internal) **Duration: 3 Hrs**

Minimum Passing Marks: 13

External

The question paper will consist of three Sections: A, B and C. Section A will consist of 10 questions (at least 3 questions from each unit of syllabus). Section B will consist of 9 questions (3 questions from each unit of syllabus). Section C will consist of 6 questions (2 questions from each unit of the syllabus).

Internal

Internal exam shall comprise Theory Exam (5 marks), Seminar Presentation (3 marks) and Class Performance (2 marks).

REQUIRED READINGS:

1. Stanier RY, Ingraham J.L., Wheelis M.L., Painter P.R. 1999. General Microbiology. MacMillan Education Ltd., London.
2. Schlegel. General Microbiology. Cambridge University Press, Cambridge.
3. Topley and Wilson 1995. Text book on Principles of Bacteriology, Virology and Immunology. Edward Arnold, London.
4. Ananthnarayanan R and Jayaram C.K. 1997.Textbook of Microbiology. Orient Longman.
5. Mackie and McCartney. 1996. Medical Microbiology. Vol.1. Microbial Infection, Vol. 2. Practical Medical Microbiology. Churchill Livingstone.
6. Shanson DC. Wright PSG1982. Microbiology in Clinical Practice. 6. Baron EJ, Peterson LR and Finegold SM. 1990. Bailey and Scott's Diagnostic Microbiology. Mosby

RECOMMENDED READINGS

1. Adams MR and Moss MO 1995. Food Microbiology. Royal Society of Chemistry Pub., Cambridge.
2. Robinson RK. 1990. Dairy Microbiology. Elsevier Applied Sciences, London.
4. Banwart GJ 1989. Basic Food Microbiology. CBS Pub and distributors, Delhi.
5. Hobbs BC and Roberts D 1993. Food Poisoning and Food Hygiene. Edward Arnold (A division of Hodder and Stoughton) London.

Teaching Learning Process

- Lectures
- Discussions
- Simulations
- Role Playing
- Participative Learning
- Interactive Sessions
- Seminars
- Research-based Learning/Dissertation or Project Work
- Technology-embedded Learning

Blended Learning

Blended Learning is a pedagogical approach that combines face-to-face classroom methods with computer-mediated activities in the process of teaching and learning. It has been decided that blended learning be taken recourse to only if such need arises (unfortunately). To face such a situation, the teacher be kept in a ready to use mode. Hence, only 10% teaching be done through blended learning after deliberations of the departmental level.

Assessment and Evaluation

- Continuous Comprehensive Evaluation at regular after achievement of each Course-level learning outcome
- Formative Assessment on the basis of activities of a learner throughout the programme instead of one-time assessment
- Oral Examinations to test presentation and communication skills
- Open Book Examination for better understanding and application of the knowledge acquired
- Group Examinations on Problem solving exercises
- Seminar Presentations
- Review of Literature
- Collaborative Assignments

Evaluation

Internal Assessment –	Midterm Examination	10%
	Term Paper	5%
	Students Participation	5%
External Assessment –		80%

PASS CRITERIA

Each theory paper shall be of 50 marks (40 Paper +10 Internal). For passing in each theory examination, a candidate is required to obtain 25% marks in individual paper and 36% marks in aggregate of all theory papers and 36% marks separately in the practical examination.

CLASSIFICATION OF SUCCESSFUL STUDENTS

Division	Total Marks
First Division	60% and above
Second Division	Above 48 % and below 60 %
Pass	Above 36 % and below 48 %
Fail	Below 36 %
BACKLOG	As per University Norms

Examination Paper Pattern

There shall be three Sections:

Section One shall comprise 10 Questions of 1 mark each (All Compulsory) selecting at least 3 questions from each Unit. Each question shall carry equal marks.

Section Two shall comprise 9 Questions selecting at least 3 questions from each unit. The student shall at least attempt 5 questions of 3 marks each.

Section Three shall comprise 6 questions. The student shall attempt 3 question of 5 marks each, selecting at least 1 question from each unit.

Questions of section I, II and III are to be answered in 50, 250 and 500 words respectively. The duration of each course examination shall be 3 hours. On the basis of the marks obtained the student shall be awarded SGPA and CGPA on the basis of the formula specified in the CBCS rules.