Maharaja Ganga Singh University

Curriculum Framework

M.Sc. Biotechnology (LOCF)

SYLLABUS
SCHEME OF EXAMINATION AND COURSES OF STUDY

Faculty of Science 2024-2026

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Background

Considering the curricular reforms as instrumental for desired learning outcomes, 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 by the adoption of the "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 an indicative timeline for major academic reforms.

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 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 Science, the students shall be able to realize the following outcomes **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. Biotechnology Programme, the students shall be able to understand the following:

PSO 1	Shall be able to demonstrate comprehensive knowledge and interdisciplinary skills in the fields of biochemistry, cell and molecular biology, bioprocess engineering, Immunology, Environment, Agriculture, plant biotechnology, genetic engineering, microbiology and bioinformatics.
PSO 2	Shall be able to perform minor research projects incorporating techniques of Basic and Advanced Biotechnology. 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 be able to practice safe Biotechnological practical techniques, using appropriate protective, biosafety and emergency procedures. Shall have moral and ethical awareness/reasoning related to recombinant DNA technology, genetic engineering, animals handling, intellectual property rights, biosafety and handling of sensitive experiments; awareness about the difference between data beautification and data manipulation/scientific misconduct.
PSO 5	Shall have in-depth theoretical and practical knowledge of huge diversity of organisms, 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 interpret and analyse data, collection and analysis of data, hypothesis generation, interpretation and presentation of results to solve various problems in different areas of biotechnology.
PSO 7	Shall be able to demonstrate communication skills, scientific writing and data recording abilities with well-structured reports, contribution for scientific publications in all the fields of biotechnology. Research-related skills: Demonstrate the ability to sense the scientific and technological trends in different academic and industry settings.

Post Graduate Attributes

The Postgraduate attributes of our students shall be aligned with those of the 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". On completion of the course, the students are expected to be proficient in the fundamental, applied and modern areas of Biotechnology. They are expected to have acquired the skills of theoretical and practical aspects of different branches of biotechnology; to be able to develop rationale thinking skills, logical interpretation and analytical skills. Effective communication of scientific developments to the society at large is very critical attribute expected from the students of this course. The attributes expected from the post-graduates of M.Sc. Biotechnology programme are:

PA1- Fundamental and advanced knowledge of different branches of biotechnology

PA2- Orientation and specialization in a specific branch of biotechnology and related fields

PA3- Proficiency in traditional as well as modern tools and techniques in the fields of Biotechnology
PA4- Awareness and sensitization about various societal problems related to Biotechnology
PA5- Effective skills of scientific communication, and knowledge about the recent developments within the society
PA6-Acquiring skills and ability to undertake research projects, writing, editing, and publication of research findings in reputed journals and magazines.
PA7-Proficiency in ICT technologies for personal, academic, and professional purposes

PA8-Demonstrate behavioral attributes for the enhancement of soft skills, instill skills and abilities to develop a positive approach socialistic approach and leadership qualities for a successful career and nurturing responsible human being.
PA9-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.

Paper Code	Paper Name		Lecture	Tutorial	Practical	Total Credits	Maximum Marks		Minimum Passing Marks
							Internal Marks	External Marks	
Semester-I									
Theory Papers									
FS-BT- CC-101	Biochemistry and Metabolism	Core Compulsory	3	1	1	5	10	40	13 (25 %)
FS-BT- CC-102	Concepts of Microbiology	Core Compulsory	3	1	1	5	10	40	13 (25 %)
FS-BT- CC-103	Molecular Biology	Core Compulsory	3	1	1	5	10	40	13 (25 %)
FS-BT- CC-104	Genetic Engineering	Core Compulsory	3	1	1	5	10	40	13 (25 %)
#FS-BT- CF-100	Basis of Biotechnology	Core Foundation	2	2	1	5	50	--	18 (36%)
							40	160	
dit course. The candidate will have to qualify for 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-BT- CC-201	Cell Biology	Core Compulsory	3	1	1	5	10	40	13 (25 %)
FS-BT- CC-202	Enzyme Technology	Core Compulsory	3	1	1	5	10	40	13 (25 %)
FS-BT- CC-203	Biophysics and Biotechniques	Core Compulsory	3	1	1	5	10	40	13 (25 %)

FS-BT-CC-204	Environmental Biotechnology	Core Compulsory	3	1	1	5	10	40	13 (25 %)
#FS-BT-CF-200	National and Human values	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 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-BT-CC-301	Concepts of Immunology	Core Compulsory	3	1	1	5	10	40	13 (25 %)
FS-BT-CC-02	Plant Tissue Culture	Core Compulsory	3	1	1	5	10	40	13 (25 %)
FS-BT-CE-303(A) or FS-BT-CE-303(B)	Industrial Biotechnology Or Agriculture Biotechnology	Core Elective	3	1	1	5	10	40	13 (25 %)
FS-BT-OE-304(A) or FS-BT-OE-304(B)	Food and Dairy Biotechnology Or Biosafety and IPR	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-BT-CC-401	Animal Tissue Culture	Core Compulsory	2	1	2	5	10	40	13 (25 %)
FS-BT-CC-402	Bioinformatics and Computer Science	Core Compulsory	3	1	1	5	10	40	13 (25 %)
FS-BT-CE-403(A) or FS-BT-CE-403(B)	Research Project OR Research Review	Core Elective	0	0	0	5[#]	10	40	13 (25 %)
FS-BT-OE-404(A) or FS-BT-OE-404(B)	Biostatistics OR Evolutionary Genetics	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/ Research 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-11	CC-12
PSO-1	X		X	X	X	X		X	X	X	X	X
PSO-2		X	X		X	X	X	X		X	X	X
PSO-3	X		X	X		X	X	X	X		X	X
PSO-4	X	X	X	X	X	X	X		X	X	X	X
PSO-5	X	X	X	X	X		X	X	X		X	X
PSO-6	X	X	X		X	X	X		X	X	X	X
PSO-7	X	X	X		X	X	X	X	X		X	X

III. Elective Courses (EC):

PSO	FSBTCE-303A	FSBTCE-303B	FSBTEO - 304A	FSBTEO - 304B	FSBTCE-403A	FSBTCE-403B	FSBTEO - 403A	FSBTEO - 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. Biotechnology (Semester System)

ELIGIBILITY

Looking at the interdisciplinary nature of Biotechnology, the eligibility of candidates for admission to M.Sc. Biotechnology shall be as given below:
B.Sc. from recognized University with one of the subjects of Life Sciences or bachelor degree in Microbiology/ Biotechnology/ Biochemistry/ Genetics/ Medicine/ Agriculture/ Horticulture/ Forestry /Wild life/ Pharmacy/Veterinary with 55% marks

M.SC. BIOTECHNOLOGY PROGRAMME DETAILS

MASTER OF SCIENCE IN BIOTECHNOLOGY

Semester I

Marking Scheme for External Exam

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

FS-BT-CC-101

Biochemistry and Metabolism

Course Objectives:

This course deals with the 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:

CO1	Have 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	U nderstand different microbial transport systems and their importance in microbial physiology.
CO3	Have conceptual knowledge of properties, structure, function of enzymes, enzyme kinetics and their regulation, enzyme engineering, Application of enzymes in large scale industrial processes
CO4	Understand 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	Have conceptual knowledge of aerobic and anaerobic respiration and various intermediary mechanisms involved, oxidative phosphorylation
CO6	Get an overview of major biomolecules –carbohydrates, lipids, proteins, amino acids, nucleic acids, and also knowledge about their classification, structure and functions.
CO7	Be able to describe the biosynthesis and the degradation pathways involved in various metabolic and physiological processes.

Course Description

Unit I

Structure, classification, properties and function of carbohydrates: Mono, di, oligo and polysaccharides, glycoproteins and peptidoglycans. Metabolism of carbohydrates: Glycolysis, fermentation, TCA, Electron transport and Oxidative Phosphorylation Gluconeogenesis, HMP and glyoxlate pathways. Synthesis and breakdown of and glycogen.

Unit II

Structure, classification, properties and function of lipids. Metabolism of lipids: Biosynthesis of fatty acids and triacylglycerols, Fatty acids oxidation alpha, beta and omega-oxidation. Primary structure of proteins: Confirmation of proteins and polypeptides- secondary, tertiary and quaternary structure; Ramachandran Plot, domains, motif and folds. Vitamins: Classification, properties, structure and functions.

Unit III

Structure, classification, properties and function of amino acids. Amino acid metabolism-amino acid deamination, urea cycle, common pathways of amino acid synthesis- Aspartate family, pyruvate family, aromatic amino acids family and histidine family.
Structure, Types, properties and function of nucleic acids, double helical structures. Forces stabilizing nucleic acid structure. Metabolism of nucleotides: Synthesis of purine & pyrimidine nucleotides, catabolism of purines and pyrimidines.

Suggested Readings:

1. Principles of Biochemistry, A.L. Lehninger, D.L. Nelson, M.M. Cox. , Worth Publishing.
2. Harper’s Biochemistry K. Robert, M.D. Murray, D.K. Granner, P.A. Mayes and V.I.

Rodwell, McGraw Hill
3. Biochemistry, Lubert Stryer, W H Freeman and Co., San Fransisco.
4. Biochemistry, Donald Voet, Judtin E. Voet; Panima Publication
5. Biochemistry by Geoffrey L. Zubay. Fourth Edition, Addison-Wesley educational publishers Inc.,2008
6. Biochemistry, (2nd edition) by Voet Donald & Voet Judith G.,John Wiley & sons New York; 1995.
7. Physiology and Biochemistry of Prokaryotes (2nd edition) by White David,Oxford University Press, NY;2000.
8. Biochemistry by Berg Jeremy, Tymoczko John, StryerLubert 6th Edition, W. H. Freeman, New York.(2001)

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

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

FS-BT-CC-102

Concepts of Microbiology Course Objectives:

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

Course Level Learning Outcomes:

Upon successful completion of the course, students will have substantial knowledge which would enable them to:

CO1	Explain the key concepts, basics and importance of Microbiology and Bacteriology.
CO2	Discuss and explain 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	Get acquainted with the microbial structure and function and study the comparative characteristics of prokaryotes, archaea and eukaryotes.

CO4	Discuss, define and state the principles of various techniques used in microbiology like staining techniques, CFU count and characterization of microbes etc. They will know the applications of culture media and various means of sterilization.
CO5	Understand the subject 'Bacteriology' which will provide better understanding of bacteria and their characteristics in terms of identification, classification, growth and reproduction etc.
CO6	Learn the methods and requirements to grow different type of microorganisms, various physical and chemical growth requirements, and with various methods of bacterial growth measurement.
CO7	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	ibe genomic-based methods to study microbial diversity in nature, the mechanisms behind it eneral characteristics of important bacteria, by the end of the Course.

Course Description

Unit I

Introduction to microbiology: Scope and History, distinctive characters and uses in agriculture, industry and environment of major groups: Fungi, Algae, Protozoa, Bacteria, Virus.
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.*
Virus: Chemical and physical properties, virus isolation, purification, cultivation, serology, plaque assay and viral replication Elementary account of most common diseases caused by microorganism in human, animals and plants: Tuberculosis, Chickenpox, SAARS, AIDS, Ranikhet, Brucellosis, Mastitis, TMV, Citrus canker, Green ear.

Suggested 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.
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.

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).

FS-BT-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, Anti-termination, 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, the 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, Anti-termination.

Course Description

Unit I

Genetic material: Structure, chemical composition and organization -structure of chromatin, coding and non-coding sequences, topological properties, super coiling of DNA, packaging of DNA in pro & eukaryotes. DNA denaturation and renaturation, linking number, repetitive DNA satellite DNA. DNA replication (enzymes, accessory proteins involved and mechanism), inhibitors of DNA replication. Recombination: Holliday junction, general and site specific recombination. Role of Rec A protein and other recombinase, DNA damage and repair.

Unit II

Gene Expression: Prokaryotic & eukaryotic transcription (RNA polymerase, transcription factors, regulatory elements, mechanism). Post transcriptional modification: RNA processing (capping, polyadenylation, splicing, editing). Prokaryotic and eukaryotic translation, mechanism of initiation, elongation, termination and regulation. Co and post-translational modifications of proteins.

Unit III

Regulation of gene expression: Operon concept, positive and negative control- lac operon, trp operon, catabolic repression, anti-termination, attenuation. Oncogenes: Viral and cellular oncogenes and tumor suppressor genes in man. DNA- transposable elements- types of transposable elements, its importance in variation and evolution.

Suggested 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, 6thedition, 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, 5thedition, Garland Science, New York and London, 2007.
5. Biochemistry (5th edition) by J.M. Berg, J.L. Tymoczko, L. Stryer, W.H. Freeman and Company, New York, USA, 2008.
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.
7.

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).

FS-BT-CC-104

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 extrachromosomal DNA, plasmid types, classic Luria Delbruck experiment, mutations, and mechanisms of genetic exchange.
CO2	Comprehend various approaches of genetic engineering and their applications in biological research as well as in biotechnology industries.

CO3	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	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	Understand nucleic acid hybridization techniques, restriction mapping and gel electrophoresis.
CO6	Describe and discuss the gene transfer technologies, expression systems and methods of selection.
CO7	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	Discuss and describe 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, Cloning vectors: Plasmids: Structure, classification, copy control, incompatibility, F-factor, col and R plasmids. Phages and construction of Phage vector, Cosmides, Expression vector (YAC and BAC). 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

Gene and protein targeting, antisense RNA technology & its application. 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. Construction of cDNA and genomic library.

Unit III

Enzymes (Ligases, topoisomerases, Gyrase, Nuclease), Gene transfer techniques: chemical, electroporation, microinjection, particle bombardment, *Agrobacterium* mediated gene transfer. Screening of recombinants, Reporter genes. Site directed mutagenesis. Applications of genetic engineering in agriculture, industry and medical, Biosafety regulations, Intellectual property rights, Patenting laws in India.

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

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).

FS-BT-CF-100

Introduction to Biotechnology Course Objectives:

The students will be familiarized with the living world, biodiversity and classification. They will learn about various tools of biotechnology and applications for the well fare of the society and environment.

Course Level Learning Outcomes:

Upon successful completion of the course, students will get familiarized to:

CO1	Vivid field of Biotechnology

CO2	Scope and importance of Biotechnology in today's world
CO3	'Biotechnology' and would be able to look into various opportunities in the field of biotechnology

Course Description

Unit 1

An overview-: Definition, scope and importance of old and new biotechnology, Historical development and major breakthrough research in Biotechnology; societal implications and ethical issues in biotechnology. Concepts of recombinant DNA technology and Gene Cloning.

Unit 2

An overview of different fields of biotechnology and their applications- plant biotechnology, animal biotechnology, microbial biotechnology, medical biotechnology, environmental biotechnology, food biotechnology, pharmaceutical biotechnology, industrial biotechnology and bioinformatics

Unit 3

Career options for biotechnology students in India and abroad; formulation and implementation of strategy for a desired career path; list of leading biotechnology research institutes/universities/industries in India and abroad. Indian biotechnology industry: status, opportunities and challenges. bio-entrepreneurship and start-ups; funding agencies for research and development.

Suggested Readings:

1. Elements of Biotechnology (4th reprint), P. K. Gupta, Rastogi Publications, 2019-20.
2. Biotechnology-Expanding Horizons, B. D. Singh, Kalyani Publishers, 2015.
3. Biotechnology: Prospects and Applications (2013). Salar, R.K., Gahlawat, S.K., Siwach, P. and Duhan, J. S., Springer, Germany. ISBN 978-81-322-1682-7.
4. Textbook of Biotechnology, H.K. Das, John Wiley & Sons 2004.
5. Introduction to Biotechnology (4th edition), W. J. Thieman & M. A. Palladino, Pearson Publications, 2018.
6. History of Modern Biotechnology, A. Fiechter (Ed.), Springer Publishing House, 2000

Scheme of Examination

It's an 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. The concerned department shall design an appropriate examination mechanism for the assessment purpose.

LIST OF PRACTICALS

1. Isolation and identification of bacteria by phenotypic and biochemical tests.
2. Enrichment and isolation of members of Rhodospirillaceae: analysis of photopigments.
3. Induction of *β*-galactosidase gene in *E. coli.*
4. Staining techniques.
5. Growth curve analysis.
6. Media preparation, sterilization, inoculation and incubation methods.
7. Microbiological studies of air, water and soil.
8. Evaluation of antimicrobial chemical agents by log reduction method
9. Effect of following on the growth of microbes-

   (a) Temperature, (b) Aeration, (c) pH, (d) Salts, (e) Nutrients.
10. Quantitative tests for Carbohydrates, fats, proteins, chlorophyll, Nucleic acids
11. Isolation of carbohydrates, proteins and fats.
12. Chromatographic separation methods for pigments and amino acids.
13. Study of Enzyme kinetics
14. Preparation of biologically important buffers
15. Protein purification using various column chromatography, SDS-PAGE and NATIVE PAGE analysis.
16. Identification and screening of autotrophic mutants of *E. coli* by replica plating
17. PCR amplification of DNA
18. Electrophoresis of DNA/RNA/Protein.
19. Isolation of DNA/RNA from plant, animal cell, bacteria.
20. Transformation and Conjugation in Bacteria
21. Restriction digestion, ligation of DNA and cloning in bacteria
22. Randomly Amplified Polymorphic DNA (RAPD) analysis in bacteria
23. 16SrDNA gene amplification analysis for sequencing

MASTER OF SCIENCE IN BIOTECHNOLOGY

Semester II

Marking Scheme for External Exam

Theory Papers	Duration	Max. Marks
FS-BT-CC-201	**3 Hrs.**	**40**
FS-BT-CC -202	**3 Hrs.**	**40**
FS-BT-CC-203	**3 Hrs.**	**40**

FS-BT-CC -204	**3 Hrs.**	**40**
Combined Practical	**1 Day (6Hrs)**	**75**

FS-BT-CC-201

Cell Biology

Course Objectives:

This course will provide an understanding of the structure of cell and function of various subcellular organelles. Students will learn about cell theory, basic cell structure, cell fractionation and cell visualization techniques. Besides, students will have an understanding of the composition of cytoskeleton and extracellular matrix. Students will acquire knowledge of cell cycle, cell division and cell death mechanisms.

Course Level Learning Outcomes:

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

CO1	Understand the structure of cell and various cellular events.
CO2	Understand the function of various subcellular organelles.
CO3	Learn about cell theory and techniques for fractionation of sub- cellular organelles.
CO4	Be acquainted to various microscopic techniques to visualize subcellular organelles.
CO5s	Have an understanding of the composition of cytoskeleton and extracellular matrix.
CO6	Learn about cell cycle, cell division and cell death mechanisms.
CO7	Provide an understanding of key cellular processes of central dogma

Course Description

Unit I

Ultrastructure and Function: Cell wall, Cell membrane, Transportation across biomembranes- Passive transport, facilitated transport, active transport (Na+, K+ & ATPase pump).

Nucleus, Mitochondria, Golgi bodies, Lysosomes, Endoplasmic reticulum, Peroxisomes, Plastids, Vacuoles, Chloroplast, Structure and function of cycloskeleton and its role in motility.

Unit II

Cell division and cell cycle: Mitosis and Meiosis, steps in cell cycle, Cytological, genetical and evolutionary significance of Mitosis and Meiosis, chiasma formation, Synaptonemal complex. Molecular events and regulation of cell cycle in eukaryotes. Check points, Cyclins and protein kinases, MPF (maturation promoting factor).

Unit III

Cellular communication and Signal transduction: Regulation of Hematopoiesis, general principles of cell communication, cell adhesion and role of different adhesion molecules, gap junctions, extracellular matrix, integrins. Cell signaling hormones , neurotransmitter proteins, cell surface receptors , Signal transduction pathways, second messengers and their role in signal transduction, regulation of signaling pathways, light signaling in plants, bacterial chemotaxis and quorum sensing.

Suggested Readings:

1. Molecular Cell Biology, Darnell J, Lodish H and Baltimore D, Scientific American Books, USA
2. Molecular Biology of the Cell, Alberts B., Bray D, Lewis J., Ralf M., Roberts K. and Watson J.D., Garland Publishing Inc.
3. Cell and Molecular Biology, E D de Roberties & E M F de Roberties (Jr) Lippincott Williams & Wilkins, Philadalphia
4. The Cell: A Molecular Approach (2018) 8th ed., Cooper, GM, Sinauer Associates is an imprint of Oxford University Press, ISBN: 1605357073.
5. Molecular Cell Biology (2016) 8th ed., Lodish H, Berk A, Zipursky SL, Matsudaira P, Baltimore D and Darnell J, W.H. Freeman &Company (New York), ISBN: 978-1-4641-0981- 2 / ISBN:10: 1464183392.
6. Molecular Biology of the Cell (2008) 6th ed., Alberts B, Johnson A. Lewis J and Enlarge M, Garland Science (Princeton), ISBN: 0-8153-1619-4 / ISBN:0-8153-1620-8.
7. Genes XII, (2017) 12th Revised edition ed., Lewin B, Krebs J, Kilpatrick ST, Goldstein ES, Jones and Bartlett Publishers, Inc. Sudbury, Massachusetts, USA. ISBN No. 9781284104493.
8. Molecular Biology of the Gene (2013) 7th ed., Watson JD, Baker TA, Bell SP, Gann A, M, Levin RL and Cumming B, San Francisco, ISBN: 0321905377.

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).

FS-BT-CC-202 ENZYME TECHNOLOGY

Course Objectives:

This course enables the students to understand the State the enzyme kinetics, various factors regulating catalysis, different models for analyzing the enzyme kinetics, Immobilization and large- scale production of enzymes. They will also learn extended comprehensive knowledge of scale-up of laboratory process, Instrumentation and process control- offline and online. They will g ain knowledge about the design of production of bioproducts under aerobic and anaerobic states, process economics and preparation of flow sheet of the production process

Course Level Learning Outcomes:

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

CO1	Explain the kinetics of enzyme catalyzed reaction in free and immobilized states.
CO2	Describe and use the equations of enzyme kinetics
CO3	Organize the production of microbial enzymes and operate variables affecting the production process.
CO4	Apply enzyme technology in food, medical, and household industries.
CO5	Provide an awareness of the current and possible future applications of enzyme technologies
CO6	Describe the catalytic mechanisms employed by the most well-characterized enzymes
CO7	Work on techniques employed in enzymes purification and characterization

Course Description

Unit I

Enzymes: Properties, classification and nomenclature. Mechanism of enzyme action, Mechanisms of catalysis. transition state, Effect of substrate, temperature, pH and inhibitors on enzyme activity. Enzyme Kinetics Single substrate- steady state kinetics, Inhibitors and activators, Multi-substrate systems, Feedback inhibition.

Unit II

Enzyme kinetics: Michaelis-Menten equation and its limitations, significance of Vmax and Kcat, linear plot Lineweaver-Burke plot, Eadie-hofstee plot method to study enzyme

kinetics, effect of substrate, pH and temperature on kinetics, co-factors and co-enzyme. allosteric enzyme and their kinetics. Isozymes, Zymogens, Multienzyme complexes Ribozymes and their applications. Enzyme activation, inhibition-competitive and non-competitive.

Unit III

Enzyme Isolation, purification and large scale production, enzyme immobilization: methods and advantages, Industrial production of enzymes: amylase, glucose oxidase, lipase, protease, production and their uses. Challenges and future trends Catalytic antibodies and Non-protein biomolecules as catalysts. Enzymes contributing in research diagnostics and sustainable industrial development (starch processing,, leather, pulp and paper manufacturing).

Suggested Readings:

1. Enzyme Technology, M.F. Chaplin and C. Bucke, Cambridge University Press.
2. Enzymes Biochemistry 2008, Biotechnology, Clinical Chemistry, Trevor Palmer,
3. Enzyme Kinetics: Behaviour and Analysis of Rapid Equilibrium and Steady State Enzyme Systems, I. H. Segel, Wiley-Interscience.
4. Industrial Enzymes & their applications, H. Uhlig, John Wiley and Sons Inc.
5. Fundamentals of Enzymology 3rd edition (2009), Nicholas C Price and Lewis Stevens, Oxford Univ Press.

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

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

FS-BT-CC-203

Biophysics and Techniques

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 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 analyzing the output data and 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

Biophysics of nerves, muscles and membranes, physics of cellular process. Attractive and repulsive forces generated within the molecules and their overall effect on molecular interactions. Concept of Energy- matter and energy, thermodynamics- entropy, enthalpy Application of thermodynamics in biological systems.

Unit II

Introduction to Fractional precipitation: Gel filtration, Gel Electrophoresis, tracer techniques, autoradiography, Microcalorimetry. Methods to elucidate structure of biochemical compounds found in living organisms: ultrafiltration, centrifugation, density gradient centrifugation, chromatography (PC, TLC, CC, GLC, HPLC). Small and macromolecule quantification: Colorimetry, Photometry, Nephelomtery, Flamephotometry, Visible, UV and Atomic absorption spectroscopy.

Unit III

Physical techniques in proteins, nucleic acids and polysaccharides structure analysis (IR, NMR, LASER, Raman spectroscopy, Mass spectroscopy, Fluorescence spectroscopy, Mossebäuer spectroscopy, and Atomic force microscope). Electrophysiological methods: Single neuron recording, patch-clamp recording, ECG, Brain activity recording, lesion and stimulation of brain, pharmacological testing, PET, MRI, fMRI, CAT. Bioelectronics: Biosensors, Biochips.

Suggested Readings:

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.
6. "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).
7. "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

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).

FS-BT-CC-204 ENVIRONMENTAL BIOTECHNIQUES

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

Global environmental problems, their impact and biotechnological approaches for management: Ozone depletion, UV-B, green house effect and acid rain. Water pollution sources and its biological control, Biological treatment processes: Water supply treatment, waste water collection, preparing potable water, removal of microbial contaminants. Aerobic treatment processes - Activated sludge, oxidation ditches, ponds, trickling filter, towers, rotating disc, rotating drums. Anaerobic treatment processes - Anaerobic digestion & anaerobic filters. Treatment schemes for waste waters of - Dairy, distillery, sugar industries & antibiotic industries.

Unit II

Scope, application & concept of cleaner technology. Solid wastes: Sources safety and management (ensilage, composting, vermiculture and biogas production). General hazardous waste, radioactive and other hazardous waste, bioscrubbing heavy metals and organic pollutant (Bioaccumulation, Biosorption).
principles of biomonitoring and application of biosensors for detection of environmental pollutants. Biomining: Use of microbes in biohydrometallergy and biomineralization, degradation of pesticides and other xenobiotics, genetic regulation of xenobiotic biodegradation, phytoremediation of disturbed ecosystems.

Unit III

Application of microbes as biofertilizers and bioinsecticides, productivity improvement and crop protection, Bioremediation, advantages and disadvantages; In situ and ex-situ

bioremediation; slurry bioremediation; Bioremediation of contaminated ground water and phytoremediation of soil metals Use and development of GEM for bioremediation, development of gene probes for environmental remediation & releasing and tracing GEMS. Emerging technologies : Microelectromechanical system (MEMs), genosensor technology, integrated treatment system with special reference to biodegradation of polychlorinated biophenyls (PCBs), PCB treatment process and design.

Suggested Readings:

1. Environmental Biotechnology, Alan Scragg, Oxford University Press
2. Introduction to Environmental Biotechnology, A. K. Chatterji, Practice Hall Of India.
3. Environmental Science (5th Edition) by WP Cunningham & BW Saigo., Mc Graw Hill.
4. Introduction to Biodeterioration , D Allsopp and K J Seal, ELBS/Edward Arnold. Cambridge Univ Press.
5. Biotechnology for Wastewater Treatment. P Nicholas Cheremisinoff. Prentice Hall Of India.
6. Biotechnological Methods of Pollution Control. SA Abbasi and E Ramaswami. Universities Press
7. Environmental Biotechnology, Concepts and Applications. Hans-Joachin Jordening and Josef Winter.
8. An Introduction to Environmental Biotechnology by Milton Wain Wright. Kluwar Acad Publ. Group, Springer

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).

FS-BT-CF-200

NATIONAL AND HUMAN VALUES

Course Objectives

1. To inculcate national and human values in the students.
2. To enable the students to 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 to grow into a citizen possessing civic sense.

Course Outcomes

On the completion of the course the students shall be able to:

(i) Attain the civic skills enabling him/her to become a well-behaved citizen of the country.

(ii) 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.

Suggested Readings:

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. NCERT, Education in Values, New Delhi, 1992.

6. M.G. Chitakra: Education and Human Values, A.P.H. Publishing Corporation, New Delhi,2003.

7. Chakravarthy, S.K.: Values and ethics for Organizations: Theory and Practice, Oxford University Press, New Delhi, 1999.

8. Satchidananda,M.K.: Ethics, Education, Indian Unity and Culture, Ajantha Publications, Delhi, 1991.

9. Das, M.S. & Gupta, V.K.: Social Values among Young adults: A changing Scenario, M.D.Publications, New Delhi, 1995.

10. Bandiste, D.D.: Humanist Values: A Source Book, B.R. Publishing Corporation, Delhi,1999.

11. Ruhela, S.P. : Human Values and education, Sterling Publications, New Delhi, 1986.

12. Kaul, G.N.: Values and Education in Independent Indian, Associated Publishers, Mumbai,1975.

13. Swami Budhananda (1983) How to Build Character A Primer: Ramakrishna Mission, NewDelhi.

14. A Cultural Heritage of India (4 Vols.), Bharatiya Vidya Bhavan, Bombay. (SelectedChapters only) For Life, For the future: Reserves and Remains –UNESCO Publication.

15. Values, A Vedanta Kesari Presentation, Sri Ramakrishna Math, Chennai, 1996.

16. Swami Vivekananda, Youth and Modern India, Ramakrishna Mission, Chennai.

17. Swami Vivekananda, Call to the Youth for Nation Building, Advaita Ashrama, Calcutta.

18. Awakening Indians to India, Chinmayananda Mission, 2003.

List of Practicals

1. Mounting and staining of fungal specimens, microscopic examination of bacteria, fungi, protozoa and nematodes
2. Study of dimorphism in yeast
3. Testing of milk by MBRT.
4. Isolation and cultivation of fungi and protozoa.
5. Sample collection and biomass determination for small scale fermentation

6. To determine the specific growth rate and generation time of a bacterium during submerged fermentations.
7. Study of mitosis and Meiosis from/plant material
8. Identification of cell organelles: Mitochondria, Chloroplast, Nucleus.
9. Study of mitotic index from suitable plant material.
10. Study of cyclosis in cells of suitable plant material.
11. To determine the osmotic fragility of RBC.
12. Principle and practice of microscopy: bright field, phase contrast and fluorescence
13. Microscopic examination of malarial parasite and tuberculosis in permanent slides
14. Microscopic examination of sperms
15. To determine R: S ratio of bacteria by CFU counts.
16. To determine phenol coefficient
17. To determine Thermal death time and thermal death point.
18. To check the calibration of spectrophotometer
19. To check and verify Lambert- Beer Law
20. To find out the λ-max (absorption spectra) of $K_2Cr_2O_7$, $CuSO_4$, proteins and nucleic acids.
21. Gel filtration chromatography for separation of macromolecules.
22. Native PAGE of given protein sample
23. Agarose gel electrophoresis of given DNA sample
24. Thin layer chromatography of given samplet
25. Detection of coliforms for determination of the purity of potable water.
26. Determination of dissolved oxygen concentration of water sample.
27. Chloride content of water samples using arginometric method.
28. Determination of MPN in wastewater.
29. Determination of chemical oxygen demand (COD) of sewage sample.
30. Study on biogenic methane production in different habitats.
31. Test of heavy metals (Zn, Cu, Pb) tolerance in some identified bacteria.
32. Isolation of bacteria from various polluted sites (waste water, distillery waste) and their identification
33. Determination of biological oxygen demand (BOD) of a sewage sample.
34. To study the impact of heavy metals on growth & survival of microbes.
35. To study the impact of salt and osmotic stress on the growth survival of microbes.
36. Isolation of enzyme from plants/ bacteria.
37. Estimation of enzyme activity and ammonium sulphate fractionation/ centrifugation based size fractionation.
38. Determination of pH optima for an enzyme.

39. Effect of temperature on enzymatic activity.
40. Enzyme immobilization.
41. Quantitative estimation of catalase activity from leaf sample

MASTER OF SCIENCE IN BIOTECHNOLOGY

Semester III

Marking Scheme for External Exam

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

FS-BT-CC-301

Concepts of 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

Immunity: Innate Immunity, Adaptic immunity. Cell mediated and Humoral immunity , Components of immunity (Physical, cellular, genetic, inflammation) Apoptosis. Cells of immune system: B lymphocyte, T lymphocytes, macrophages, Nk cells, killer cells, PMN cells, Antigen Presenting cell. Organs (primary and secondary) of Immune System. Immune response (primary and secondary), Cytokines. Development of T- cell and B-cells & Clonal selection.

UNIT-II

Antigens: Structure, properties and factors affecting antigenicity, haptens, Ajuvants, superantigens. Antibodies: Structure, function and diversity, antibody mediated functions, classes and biological activities. Monoclonal antibodies. Antigen-Antibody Interaction (Precipitation, Agglutination, neutralization, opsonisation, Immunofluorescence, Complement fixation test, Radio Immuno Assay, ELISA). The complement system.

UNIT-III

Major Histocompatibility Complex- structure, functions, MHC- restriction, Immunological tolerance. Hypersensitive reactions (Type I,II,III and delayed type (DTH). Immuno-deficiency Diseases. Vaccines: Live, killed, attenuated vaccines, recombinant DNA and protein based vaccines. Autoimmunity: Types and Treatment of autoimmune diseases.

Suggested Readings:

1. Kuby Immunology by Kindt TJ, Goldsby RA, Osborne BA, Kuby J: 6th edition. New York. WH Freeman; 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 Janeway CA,Travers P, 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.
7. Clark W.R. 1991. The experimental foundations of modern immunology. John Wiley
8. Franklin TJ, Snow GA. 1981.Biochemistry of antimicrobial action. Chapman & Hall, New York.
9. Roitt IM. 1995. Essential Immunology. Blackwell Sci. Oxford.

10. Roth J.A. 1985. Virulence mechanisms of bacterial pathogens. American Society for Microbiology. Washington D.C.
11. Smith CGC. 1976. Epidemiology and infections. Medowfief Press Ltd. Shildon, England.
12. Stiem F. 1980. Immunological disorders in infants and children. W.B. Saunders & Co. Philadelphia. Page 19 of 27
13. Todd IR. 1990. Lecture notes in immunology. Blackwell Sci. Pub. Oxford.
14. Roitt IM, Brostoff and Male 1995. Immunology 4/e Gower Medical Pub Co..

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).

FS-BT-CC-302

Plant Tissue Culture Course Objectives:

The main objective of this course is to make a student acquainted mainly with science, methodology and applications of plant tissue culture methods. The learner will understand Cell and organ culture and learn the Practical approaches of single-cell culture. They would learn Somatic embryogenesis, protoplast isolation, regeneration of protoplasts and protoplasts fusion etc.

Course Level Learning Outcomes:

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

CO1	Understand the history, Scope and Concepts in plant tissue culture
CO2	Comprehend the Techniques in Commercial plant tissue culture
CO3	Understand the process of somatic embryogenesis
CO4	Know about the significance of secondary metabolites in tissue culture
CO5	Know about the application of tissue culture in forestry, horticulture, agriculture and pharmaceutical industries.
CO6	Understand the formation of Synthetic seeds, generation of cybrid and hybrids
CO7	Know about the Somaclonal variation. In vitro mutation. Isolation of plant protoplasts and viability testing. Cryopreservation technique.

Course Description

Unit I

Introduction and History of Plant Tissue Culture: Tissue culture media, composition and preparation- Balance salt solution, simple growth medium, chemical, physical & metabolic function of different constituent of culture media. Callus culture & Suspension culture-Initiation and maintenance. Single cell clones, somaclonal variation, somatic embryogenesis. In vitro pollination: Embryo culture & embryo rescue. endosperm culture, Anther/Pollen culture: Production of haploid plants and homozygous lines.

Unit II

Clonal propagation (Micropropagation): Establishment of whole plant in soil, methods of micropropagation. Applications: Forestry, floriculture, agriculture, conservation of biodiversity and threatened plant species., Gene transfer and transgenic plants. Ethical issues related to transgenic plants. Cryopreservation: Germplasm conservation, protoplast-Isolation, culture, fusion cybrids, selection of hybrid cells, Application of plant protoplast culture in somatic hybridization and cybridization.

Unit III

Natural products (Secondary products): Introduction. Alkaloids production in plant tissue cultures, optimization for growth and production, time course of production, selection of cells for higher yields, extraction of alkaloids / steroids. Commercially used plant alkaloids and steroidsProduction of useful metabolites: Biotransformation, immobilization of cells, elicitors, hairy root culture. Application of plant tissue culture in plant pathology: Development of virus free plants, Application of biotechnology in breeding and crop improvement.

Suggested Readings:

1. Plant Cell and Tissue Culture, Narayanaswami, Tata Mc Graw Hill
2. Plant Biotechnology, K. G. Ramawat, S. Chand and Company Ltd. Biotechnology Expanding Horizons, B. D. Singh, Kalyani Publishers
3. Plant Biotechnology – The genetic manipulation of plants (2017) 3rd ed., Slater A, Scott N and Fowler M, Oxford University Press, ISBN: 1138407674.
4. Methods in Plant Molecular Biology and Biotechnology by B.R.Glick, 2014
5. Plant Biotechnology-The genetic manipulation of plants, Second Edition by Adrian Slater, Nigel Scott, and Mark Fowler, 2008
6. International Society for Acquisition of Agribiotech Applications- www.isaaa.org, an open resource for Agricultural Biotechnology related applications, world status of Agricultural Biotechnology
7. Review articles on individual topics form the major basis for this course as no single book covers all the topics listed above

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).

FS-BT-CE-303(A)

Industrial Biotechnology Course Objectives:

The main objectives of this course are to make students able to appreciate the relevance of microorganisms from an industrial context. This course will make him carry out stoichiometric calculations and specify models of their growth and Give an account of the design and operations of various bioreactors and downstream processes. Learner will learn to Calculate yield and production rates in a biological production process and interpret data. Moreover, they will learn to critically analyse any bioprocess from market point of view.

Course Level Learning Outcomes:

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

CO1	Understand the relevance, basic concepts and theories of utilizing bioprocesses for industrial applications
CO2	Understand the ways in which bioprocess technology can be value-added
CO3	Understand bioprocesses for industrial applications and ways in which industrial productivity can be enhanced
CO4	Put hands-on experience in techniques used in bioprocess technology and their applications
CO5	Know about the experimental design of fermentation.
CO6	Know about Basic reaction theory, calculation of reaction rates, cell growth kinetics, production kinetics, kinetics of cell death, Concept of maintenance and calculation of maintenance coefficient.
CO7	Know about the Heat and mass transfer issues in bioreactors, Scale up method by currently used rule, and various approaches to scale up including regime analysis and scale down.

Course Description

Unit I

Isolation, preservation and maintenance of industrial microorganisms, microbial growth kinetics, media for industrial fermentation, media sterilization. Fermentation, Types of fermentation, Bioreactors : Design, operation and control, Types (batch, fed-batch, continuous bioreactor pulse, fluidized and photobioreactors). Downstream processing (Recovery of microbial cells, cell disruption. Chromatography, membrane processes, drying and crystallization), whole cell immobilization and industrial applications.

Unit II

Industrial production of alcohol (ethanol), Alcoholic beverages: Beer, wine and whisky. acids

(citric acid and gluconic acid), solvents (glycerol, acetone, butanol), antibiotics (Pencillin, Streptomycin, Tetracycline), amino acids (Lysine, Glutamic acid), steroids, hormones and vaccines. Introduction to food technology: food preservation (drying, freezing, sterilization, pasteurization and irradiation of food products. Elementary idea of canning and packing, Production of mushroom, yoghurt, cheese, single cell protein and single cell oil.

Unit III

Scaling up production and automation in plant propagation, Mass scale plant production , Hardening and acclimatization, green house management and operations, quality control, packaging and shipment, cost benefit analysis. Current status and commercial opportunities for genetically engineered plants for: Insect tolerance, virus tolerance, herbicide tolerance, pesticide tolerance, stress tolerance, Improvement of crop yield and quality, Development of male sterile plants. Principles of green chemical biotechnology: green extraction, green reactors and green technology for the production of Biomolecules, edible vaccines. Synthetic seeds: Progress and potential.

Suggested Readings:

1. Biotechnology: A Text Book of Industrial Microbiology by W. Crueger & A. Crueger, Panima Publishing Corporation, New Delhi/Bangalore, 2000.
2. Principles of Ferm entation 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 Industrial Microbiology & Biotechnology by N. Okafer, Scientific Publishers, Enfield, USA., 2007.
10. Fermentation Microbiology and Biotechnology by El Mansi & Bryce, Taylor & Francis, London, Philadelphia, 1999.
11. Fermentation Biotechnology by O.P. Ward, Open University Press, Milton Keynes, U.K., 1989
12. Industrial Microbiology: An Introduction by Waites, Morgan, Rockey & Highton, Blackwell Science, 2001.
13. Manual of Industrial Microbiology and Biotechnology, Demain & Davies, 2nd ed.
14. Microbial Biotechnology A. N. Glazer and H. Nikaido
15. Biotechnology An Introduction Susan R. Barnum 22. Topics in Enzyme & Fermentation Biotechnology Volumes by Wisemen

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).

FS-BT-CE-303(B) AGRICULTURE BIOTECHNOLOGY

Course Objectives:

This course aims to make the students learn the approaches to manipulate and improve plant yield and throws light on transgenic plants. They are introduced to the concept of utilizing plants to produce vaccines and production of biofertilizers. The students will be able to understand the relationship between science and society and will be able to give justification for the biotechnological manipulation of plants for human use.

Course Level Learning Outcomes:

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

CO1	Understand the concept knowledge in soil microflora, plant pathology and post-harvest pathology.
CO2	Learn about microbial associations with soil and plants, plant diseases and their management.
CO3	Understand the role of biopesticides and biofertilizers in enhancing the fertility of soil
CO4	Understand about the large-scale production of biofertilizers and biopesticides and their mechanism of action and application.
CO5	Competently explain various aspects of agriculture microbiology and to become familiar with current research in soil and agricultural microbiology.
CO6	Understand various plant microbes' interactions especially rhizosphere, phyllo sphere and mycorrhizae and their applications especially the biofertilizers and their production techniques

Course Description

Unit 1

History and development of agricultural microbiology. Algal, fungal, bacterial, viral, mycoplasma, Nematode diseases and symptoms. Mode of entry of pathogens and factors affecting disease incidence - Plant disease resistance and various control measures. Phenolic compounds. Interaction of plant pathogens with host. Definition and History of Biopesticides

-Viral (NPV, CPV & GV), bacterial *(Bacillus thuringiensis*, *B. popillae* & Pseudomonas sp.), Fungal (Entomophthora musca, Beaveria sp., Metarrhizium sp. & Verticillium sp.), Protozoan (Mattesia sp., Nosema sp., Octospora muscaedomesticae & Lambornella sp.). Genetic engineering for increasing crop productivity, biotic stress tolerance, and quality improvement

Unit 2

Azotobacter sp and Azospirillum sp and their functions - Cyanobacteria (BGA) and their associations in Nitrogen fixation. Phosphate solubilizing microbes. Mycorrhizae and plant growth romoting rhizobacteria (PGPR). Role of biofertilizers. Quality control (BIS specification), marketing, Evaluation of field performance and economics of production. Role of biofertilizer in integrated nutrient management. Regulation and standards, Marketing and Monitoring field performance.

Unit 3

Ammonia assimilation in Nitrogen-Fixing legume nodules-Hydrogen Metabolism, action of Hydrogenase - factors controlling the Legume - Rhizobium symbiosis. Composition of Lithosphere, Soil Microbes, Factors influencing soil microbial population. The soil environment-Distribution and abundance, generic groups and nutrition of bacteria, actinomycetes, fungi, algae, protozoa and viruses. Phosphrous, sulfur, iron and other elements - Chemistry, cycles, mineralization and immobilization and oxidation/reduction.

Suggested Readings:

1. Gupta, S.K.2014 Approaches and trends in plant disease management. Scientific publishers, Jodhpur, India.
2. Jamaluddin et al 2013 Microbes and sustainable plant productivity. Scintific Publishers Jodhpur, India. G
3. Subba Rao, N. S. 1997. Biofertilizers in Agriculture and Forestry, III Ed., Oxford & IBH Publishing Co.Pvt.Ltd.,New Delhi.
4. Subba Rao, N. S. 1995. Soil microorganisms and plant growth. Oxford & IBH Publishing Co.Pvt.Ltd. New Delhi.
5. Martin Alexander 1983. Introduction to Soil Microbiology, Wiley eastern Ltd., New Delhi.
6. Newton, W.E and Orme, Johnson, W.H.1980. Nitrogen fixation vol II: Symbiotic Associations and Cyanaobacteria. University park Press Baltimore, USA.
7. Wheeler, B. E. 1976. An Introduction to Plant Disease. ELBS and John Wiley and Sons, Ltd.
8. Gaur, A.C., 1999. Microbial technology for Composting of Agricultural Residues by Improved Methods, 1st print, ICAR, New Delhi.
9. Glick, B.R. AND Pasternak, J.J 1994. Molecular Biotechnology, ASM Press, Washington DC.

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).

FS-BT-OE-304(A)

Food and Dairy Biotechnology Course Objectives:

Students in this course will learn about microbes in food, spoilage of food and preservation techniques of food. Through this course, they also learn about the microbiology of milk, fermented dairy products, industrially important microorganisms and the process of industrial production of various milk-based products.
At the end of the course, the student will be able to use the preservation techniques for food and use this experience to be employed as quality control experts.

Course Level Learning Outcomes:

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

CO1	Gain information about concepts of food safety and quality management, and importance of food engineering and packaging in food industry
CO2	Know the important genera of microorganisms associated with food and their characteristics. They would understand the role of microbes in fermentation and spoilage.
CO3	Gain knowledge about the beneficial role of microorganisms and different types of fermented foods.
CO4	Identify the role of microorganisms in food-borne diseases and control measures
CO5	Know about different products of milk.
CO6	Optimize and refine the processing of cheese and frozen milk product
CO7	Know about heat processing and preservation of food that is helpful in designing ,and optimizing heat processing conditions for different types of foods in different conditions without harming the nutritional quality of food products.

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.

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

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).

FS-BT-OE-304(B) BIOSAFETY AND IPR

Course Objectives:

This course aims to serve as a primer for intellectual property rights, patenting, ethical issues, and Biosafety in the context of biotechnology. The specific objective of the course is to teach students about intellectual property rights (IPRs) and their different kinds. The course aims to make students understand the process of patent filing, to make them aware of the patenting of materials of biological origin and to impart knowledge of ethical practices appropriate to biotechnology research.

Course Level Learning Outcomes:

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

CO1	Understand and differentiate between diverse types of IPRs
CO2	Understand the different types of patents, and learn about the importance of patent filing
CO3	Understand the various impact of ethical issues of related to biotechnology and their implications in biological research and product development.
CO4	Learn about policies, guidelines, and laws governing ethical practices in biotechnology research
CO5	Understand the importance of the protection of products derived from biotechnology research and issues related to application and obtaining patents.
CO6	Gain knowledge of biosafety and risk assessment of products derived from recombinant DNA research and environmental release of genetically modified organisms, national and international regulations
CO7	Practice a draft patent application preparation.

Course Description

Unit 1

Biosafety: introduction; historical background; biological safety cabinets; primary containment for biohazards; GRAS organisms, biosafety levels of specific microorganisms; definition of GMOs & LMOs; principles of safety assessment of transgenic plants-sequential steps in risk assessment; concepts of familiarity and substantial equivalence; risk-environmental risk assessment and food and feed safety assessment; problem formulation-protection goals, compilation of relevant information, risk characterization and development of analysis plan; risk assessment of transgenic crops plants or products

Unit 2

Bioethics: Introduction, ethical conflicts in biological sciences-interference with nature, bioethics in health care - patient confidentiality, informed consent, euthanasia, artificial reproductive technologies, prenatal diagnosis, genetic screening, gene 12 therapy, transplantation. Bioethics in research - cloning and stem cell research, Human and animal experimentation, animal rights/welfare, Agricultural biotechnology- genetically engineered

food, environmental risk, labeling and public opinion. Sharing benefits and protecting future generations - Protection of environment and biodiversity - biopiracy.

Unit 3

Patenting: Basics of patents: types of patents; Indian Patent Act 1970; recent amendments; WIPO Treaties; Budapest Treaty; Patent Cooperation Treaty (PCT) and implications; procedure for filing a PCT application; role of a Country Patent Office; filing of a patent application; precautions before patenting-disclosure/non-disclosure - patent application forms and guidelines. International patenting-requirement, procedures and costs; financial assistance for patenting, introduction to existing schemes; publication of patents-gazette of India, status in Europe and US; patent infringement, patenting by research students and scientists university/organizational rules in India and abroad.

Suggested Readings:

1. Office of the Controller General of Patents, Design & Trademarks; Department of Industrial Policy & Promotion; Ministry of Commerce & Industry; Government of India. http://www.ipindia.nic.in/
2. World Trade Organisation. http://www.wto.org
3. World Intellectual Property Organisation. http://www.wipo.int
4. International Union for the Protection of New Varieties of Plants. http://www.upov.int
5. National Portal of India. http://www.archive.india.gov.in
6. IPR, Biosafety and Bioethics (2013) Parashar S, Goel D, Pearson Publishing India.
7. An Introduction to Ethical, Safety and Intellectual Property Rights Issues in Biotechnology (2017) Nambisan P, Academic Press.
8. http://dbtindia.gov.in/guidelines-biosafety

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).

LIST OF PRACTICALS

1. Preparation of media for plant culture.
2. Surface sterilization.

3. Embryo culture.
4. Callus propagation.
5. Protoplast isolation.
6. Initiation & and maintenance of callus.
7. Cyto differentiation of tracheary elements in cultured explants.
8. Identification of secondary metabolites by TLC
9. Isolation, Purification & culture of protoplast
10. Somatic embryoids from vegetative cells of mature plants/ hypocotyl & Cotyledons of embryo.
11. Micro-propagation with shoot apex cultures.
12. Preparation of Murashige and Skoog (MS) stock solutions
13. Preparation of M.S. medium
14. Measurement of growth/ differentiation in plant tissue culture by fresh weight & dry weight.
15. Determination of mitotic index (MI) in callus/ suspension cultures.
16. Preparation of different solutions of Plant Growth Regulators
17. Blood film preparation and identification of cells.
18. Lymphoid organs and their microscopic organization.
19. Double diffusion assay.
20. Immuno-electrophoresis
21. Radial Immuno diffusion.
22. Dot ELISA.
23. Blood smear identification of leucocytes by Giemsa stain.
24. Separation of leucocytes by dextran method.
25. Separation of mononuclear cells by Ficoll-Hypaque.
26. Isolation and enumeration of microbes from soil
27. Demonstration of different steps in nitrogen cycle
28. Isolation of symbiotic and non symbiotic nitrogen fixing bacteria
29. Isolation and characterization of PGPR
30. Isolation and identification of field and storage fungi from cereal grains and oil seeds
31. Isolation of plant pathogenic bacteria and fungi from diseased plants
32. Study on important bio-control agents

MASTER OF SCIENCE IN BIOTECHNOLOGY

Semester IV

Marking Scheme for External Exam

Theory Papers			Duration	Max. Marks
FS-BT-CC-401			3 Hrs.	40
FS-BT-CC-402			3 Hrs.	40
FS-BT-CE-403 (A)				
OR			3 Hrs.	40
FS-BT-CE-403 (B)				
FS-BT-OE-404 (A)				
OR				
FS-BT-OE-404(B)	3 Hrs.	40		
Combined Practical				75
Academic/Industrial Tour		1-5 Days		00

FS-BT-CC-401

ANIMAL TISSUE CULTURE

Course Objectives:

This course is designed to develop an understanding of current techniques used in biotechnology and their applications to animal sciences and the biomedical field. Students could understand transgenics and its application for human welfare. This would help students to understand basic cell culture and preservation techniques and applications of Animal cell culture.

Course Level Learning Outcomes:

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

CO1	Acquaint with fundamentals of animal cell culture.
CO2	Utilize skills of cell culture for the development of biomolecules of clinical importance
CO3	Describe the relevance of cell cycle regulations in reference to cellular metabolism
CO4	Understand the mechanism of cellular cytotoxicity.
CO5	Describe stem cells: types -embryonic and adult, isolation, identification, expansion, differentiation and uses.
CO6	Understand manipulation of reproduction in animals: artificial insemination, embryo transfer, in vitro fertilization.
CO7	Understand the difference between stem cell types and methods for producing transgenic animals

Course Description

Unit I

Introduction to animal cell and tissue culture, its advantages and limitations, Animal cell culture- Equipments and facilities for animal cell culture. solution and simple growth medium, pH maintenance in culture media and role of carbon dioxide, serum and- serum free media in cell culture, Biology and characterization of the cultured cells, measurement of growth, measurement of cell viability and cytotoxicity.

Unit II

Basic techniques in animal cell culture: Disaggregation of tissue and setting up of primary culture, secondary cell culture, established cell line cultures, maintenance of cell culture, cell cloning and cell synchronization Scaling up of cell cultures, bioreactors for animal cell cultures. Organ and Histotypic culture, Microcarrier culture Hybridoma Technology and monoclonal bodies.

Unit III

Stem cell cultures: Embryonic and adult stem cells, their isolation, culture and applications, animal cloning, micromanipulation, apoptosis. Application of animal cell culture- industrial application, and clinical application-production. Animal cloning and transgenic animals, Methods of genetic transformations and its uses gene knockouts, ethical and biosafety considerations.

Suggested Readings:

1. Principles and Techniques of Biochemistry and Molecular Biology (2018) 8th ed. Keith Wilson & John Walker, Cambridge University Press, ISBN No: 131661476X.
2. Advances in Animal Biotechnology and its Applications. (2018). Gahlawat, S.K., Duhan, J. S., Salar, R.K., Siwach, P. and Kumar, S. and Kaur, P. Springer, Germany. pp. 1-401. ISBN978- 981- 10-4701-5
3. Principles of gene manipulation (2016), 8th ed. Primrose Twyman and Old. Blackwell Science, ISBN: 1405135441.
4. Animal Biotechnology (2013) Verma A and Singh A, Elsevier, ISBN: 9780124160026.
5. Molecular Biotechnology (2009), 4th ed. Glick and Pasternak, ASM Press, ISBN10: 1555814980.
6. Recombinant DNA (2006) 3rd ed., Watson JD, Richard M. Meyers, Amy AC, Jan AW, Cold Spring Harbor Laboratory Press, ISBN: 0716728664

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).

FS-BT-CC-402

Bioinformatics and Computer Science 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. The students would deeply learn the bioinformatics tools those are used in various field of Biotechnology.

Course Level Learning Outcomes:

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

CO1	Understand and remember about biological databases and its application in various sectors.
CO2	Remember, understand and create sequence alignment by applying appropriate algorithms.
CO3	Create phylogenetic trees by applying and evaluating suitable methods
CO4	Analyze, apply, and create protein structure and perform drug designing.
CO5	Apply concepts of bioinformatics in modern day biological tools
CO6	Learn the basics of mapping, genome sequencing, and genome sequence assembly, genome annotation and whole genome alignment.
CO7	Have a better understanding on the use of computers for various microbiological/biological applications as the course is a skill-based paper that introduces the students to the basics of computer operations. Also, the student would be imparted with knowledge on both hardware and software and operating systems.

Course Description

Unit I

Computer and their organization: Hardware, software, liveware and firmware. Introduction to M.S. office (word, powerpoint and excel), Introduction to data structure and database concepts, introduction to internet and its application. Computer aided learning (CAL) in Biotechnology, fermentation technology, imaging, simulation and mathematical modeling. Computer oriented statistical techniques: Frequency table of single discrete variable, bubble sort.

Unit II

Bioinformatics: Introduction, objectives, bioinformatics and data analysis. Data base concept, Biological, microbiological and virology databases, cell gene banks related sites, biodiversity information databases. Genome analysis. DNA / Genome sequencing. Finding and retrieving sequences. Sequence data base. Protein and nucleic acid sequence

database. Structural database. Identifying protein sequence from DNA sequence.

Unit III

Phylogenetic analysis: prediction method using protein and nucleic acid sequences. Computer tools for sequence analysis. Finding and retrieving sequences. Introduction to sequence alignment . Alignment of pairs of sequences. Multiple sequence alignments. Homology algorithms (BLAST, FASTA) for proteins and nucleic acids. Optimal alignment methods. Substitution scores and gap penalties. Annotations of genes. DNA and Protein micro array. Analysis of single nucleotide polymorphism using DNA chips. Proteome analysis: Two-dimensional separation of total cellular proteins, isolation and sequence analysis of individual protein spots by mass spectroscopy.

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

Scheme of Examination

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).

FS-BT-CE-403(A) DISSERTATION- 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: 13

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-BT-CE-403(B DISSERTATION: RESEARCH 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: 13

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-BT-OE-404(A)

Biostatistics Course Objectives:

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	Collect, handle, process and present the biological data.
CO2	Apply the principles of statistics on biological experiments.
CO3	Learn how to collect data using different sampling methods
CO4	Learn to present data in various forms like tabular, graphical, pictorial, etc.
CO5	Understand 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	Learn about Count data: examples of count data (bacterial cell count, radioactivity, colony and plaque counts), statistical treatment to count data
CO8	Understand Statistical basis of biological assays: Response-Dose relationship, direct and indirect assay, statistical analysis of LD50.

Course Description

Unit I

Biostatistics: population and sample. Statistical inference, Types of data, screening and representation of data. Frequency distribution, tabulation, bar diagram, histograms, pie diagram, cumulative frequency curves. Measures of central tendency-Mean, mode, median, measures of dispersion: range, variance, standard deviation, coefficient of variation. Simple linear regression and correlation. Brief idea of statistical software and their applications.

Unit II

Probability and distributions: definition and properties of binomial, poison and normal distributions. Random sampling, selection of simple random samples from a finite population, definition of sampling distribution, sampling variance and standard error. Stratified sampling and its advantages. Analysis of Variance (ANOVA), Idea of two types of errors and level of significance, test of significance, chi^2 test of independence and homogeneity test based on Z and T statistics.

Unit III

Standard curves, correlation, testing significance of correlation coefficient. Statistical basis of biological assays. Response - dose metameter - Dilution assays. Direct and indirect assays. Quantal responses. Probit, logit, LD 50, ED 50, PD 50 standard line interpolation assay. Parallel line assay (4point, 6point assays), stope ratio assay. Statistical modeling. Ordination techniques and their uses. Resource utilization models.

Suggested 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 Fellller 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.
8. 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.
9. Van Maanen 1983. Quantitative methodology. Sage publications.
10. Cook TD and Reichardt CS 1979. Qualitative and quantitative methods in evaluation research. Sage Pub., London.
11. Creswell J 1994. Research design: Qualitative and quantitative approaches. Thousand Oaks. CA, Sage Pub.
12. Denzin NK and Lincoln YS 1994. Handbook of qualitative research. Sage pub.
13. Mienert CL 1986. Clinical trials: Design, conduct and analysis. Oxford Univ Press, New York.
14. Arora PN & Malhon PK (1996). Biostatistics Imalaya Publishing House, Mumbai.
15. Sokal & Rohif (1973). Introduction to Biostatistics, Toppan Co. Japan.
16. Stanton A & Clantz, Primer of Biostatistics (2005). The McGraw Hill Inc., New YorK

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).

FS-BT-OE-404(B)

Evolutionary Genetics

Course Objectives:

This paper develops concepts about the basic understanding on human genetics and hereditary. It develops concepts of Molecular population genetics. The course provides training in molecular methods for studying genetic variation and relationships as well as the detection of mutations. It gives understanding of various process in genetics like Molecular phylogenetics and GeoGenomics and Human migrations.

Course Level Learning Outcomes:

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

CO1	Understand the theories and concept of evolution and speciation.
CO2	Demonstrate understanding of human migration, Geo-genomics and social Darwinism
CO3	Gain insight into molecular aspects of population genetics and evolution.
CO4	Gain information about the molecular and bioinformatic tools used to study molecular evolution.
CO5	Understand quantitative genetics and population genetics
CO6	Obtain an in-depth knowledge of their application in evolutionary biology and complex trait analysis
CO7	Gain a basic understanding on human genetics and hereditary.

Unit I

Concept and theories of evolution (Classical to Modern); Concept of species and modes of speciation: sympatry, allopatry, stasipatry & parapatry; Mechanism of speciation; Isolating mechanisms; Nonrandom and random breeding: Inbreeding and assortative mating; Path diagram construction and inbreeding coefficient, allelic identities by descent; Heterosis &

heterozygous superiority

Unit II

Molecular population genetics: Molecular evolution (neutral theory, punctuated equilibrium); Molecular clock; Molecular evolution and Phylogenetic tree: Development of Phylogenetic tree; Amino acid sequence and phylogeny; DNA-based phylogenetic trees; DNA-DNA hybridization; Restriction enzyme sites; Nucleotide sequence comparison and homologies; Human phylogeny: Hominid evolution: anatomical, Geographical, Cultural; Molecular phylogenetics of Homo sapiens.

Unit III

Admixture: Meeting of human populations & its genetic imprint; Detection of admixture (based on allele frequencies & DNA data); Y Chromosome & mitochondrial DNA markers in genealogical studies; Peopling of continents (Europe, Africa, Asia): Geo-Genomics and Human migrations; Culture and human evolution: Learning, society and culture; Relative rates of cultural and biological evolution; Social Darwinism; Sociobiology & economics of genetics (econogenomics)

Suggested Readings:

1. Principles of Genetics (2006) 8th ed. Gardner EJ, Simmons, MJ and Snustad DP, John Wiley & Sons Inc.
2. Essentials of Genetics (2015) 9th ed. William S, Michael K, Cummings R, Spencer, CA and Palladino MA, Prentice Hall Internationals, ISBN-10: 0134047796
3. Genetics (2017) 9th ed. Daniel L. Hartal&B. Cochrane.
4. Introduction to Quantitative Genetics (1995) Falconer DS, and Mackay TFC, ISBN: 0582243025.
5. An Introduction to Population Genetics Theory and applications (2013) Nielsen R and Slatkin M, Oxford University Press.
6. Evolution 4th ed. (2017) D. Futuma and M. Kirkpatrick.
7. An Introduction to Genetic Analysis (2015) Griffith AJFJ, Wessler SR, Carroll SV and Doebley J.

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).

LIST OF PRACTICALS

1. To study the laboratory organization and aseptic manipulations in plant and animal cell culture
2. To study the isolation and culturing of animal cells from primary tissue explant.
3. To study the sub-culturing of monolayer confluent cells.
4. To study the staining of monolayer confluent cells using geimsa and crystal violet.
5. To discriminate between viable and non-viable animal cells using trypan blue.
6. To study screening of different genotypes in crops using PCR based SSR markers.
7. To study the preparation of various stock solutions of Murashige and Skoog medium.
8. To study database search (GenBank, PDB) using BLAST and Sequence submission protocols.
9. To study the sequence alignments (Pair wise and Multiple), Sequence and structure prediction
10. To study the construction of phylogenetic tree and prediction
11. To study designing of SSR and SNP markers using in silico tools.
12. To study protein structure modelling and docking
13. To study the next generation sequencing data analysis: using freely available software & pipelines. To study the denaturation kinetics study of biomolecules using UV-VIS spectrophotometry
14. To study the calculation of mean, median and mode of the given biological data
15. To determine the significance (p-value) of given biological data set

Teaching Learning Process

- Lectures
- Discussions
- Simulations
- Role Playing
- Participative Learning
- Interactive Sessions
- Seminars
- Research-based Learning/Dissertation: Project Work/Project Review
- 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.

Continuous assessment of all papers will be broadly carried out in two forms of evaluation:

1) Continuous Internal Evaluation (CIE): The theoretical courses will be assessed based on any or all of the following-written tests, assignments, presentations and regularity in the class. Assessment of the practical courses will be based on any or all of the following-regularity, practical records, experiments performance, viva etc. The dissertation will be assessed based on the regular interaction with the supervisor, regular presentation of work, completion of assigned tasks, thesis submission, viva etc. The internal evaluation will be carried out throughout the term and will comprise 30% of the final grade. Participation of students in quiz, seminar, workshop, games, yoga and other extra-curricular activities will be promoted and facilitated by the department.

2) Term End Assessment/Evaluation (TEE): The theoretical courses will be assessed based on written exam, which may be subjective, objective for both. This will cover the entire syllabus. Assessment of the practical courses will be based on performing and/or description of experiments, maintaining of the practical records, viva etc. The dissertation will be assessed based on the thesis reported, viva etc. The end of semester examination comprises 70% of the final grade. Both internal and Term end evaluations will be in blended mode.

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.