(Master of Science) (Microbiology)
(M. Sc.) (Microbiology) Semester (IV)

Course Code	PS04CMIC51	Title of the Course	R-DNA Technology
Total Credits of the Course	04	Hours per Week	04

Course Objectives:	1 To understand the basic tools and techniques used for manipulation of DNA 2. To become familiar with the strategies for production of transgenic organisms 2. To learn applications of genetic engineering in agriculture, industry and medicine

Course Content		
Unit	Description	Weightage* (%)
1.	Concept and importance of Genetic Engineering; General strategies and Steps involved in gene cloning: Extraction and purification of DNA and RNA from bacteria, virus, plant and animal cells; physical and enzymatic methods for cutting DNA; Salient features of different enzymes used in R-DNA technology, Introduction of DNA into host cells; screening and selection methods for recombinant clones.	25%
2.	Basic properties and cloning strategies for vectors derived from Plasmids, bacteriophages and their chimeric vectors, YAC, BAC, HAC/MAC and viral vectors for Plant and animal cells. Salient features of expression vectors for heterologous expression in *E. coli*, Yeast, insect and mammalian system. Shuttle vectors and gene trapping vectors. Vector design and modification strategies; chemical synthesis of oligonucleotides.	25%
3.	DNA sequencing and sequence assembly: Maxam-Gilbert's and Sanger's methods, Shot gun sequencing, Next generation sequencing strategies for large genomes. DNA mapping and DNA fingerprinting: Physical and molecular mapping, Hybridization and PCR based methods of fingerprinting. Site directed mutagenesis: Methods and applications. Polymerase Chain Reaction: Principle and basic types of PCR; Reverse Transcription and Real Time PCRs. Construction genomic and cDNA libraries;	25%
4.	Applications of Genetic engineering in improvement of plants, animals and microbes; Gene editing and its applications; Metagenomics and	25%

	Metabolic engineering; Gene therapy; Restriction and regulations for the release of GMOs; Biosafety and levels of Physical and Biological containment; The Indian Guidelines for release and use of GM organisms.	

Teaching-Learning Methodology	Topics will be taught and discussed in interactive sessions using conventional black board and chalk as well as ICT tools such as power point presentations and videos. Practical sessions will be conducted in a suitably equipped laboratory either individually or in groups depending on the nature of exercise as well as availability of infrastructure. Course materials will be provided from primary and secondary sources of information.

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	15%
2.	Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3)	15%
3.	University Examination	70%

Course Outcomes: Having completed this course, the learner will be able to	
1.	explain different steps involved in gene cloning, different enzymes available and how to choose an enzyme for a particular application in genetic engineering.
2.	describe salient features of different vectors available, their design and strategies to be applied for cloning and selection of recombinants.
3.	explain details of preparation of genomic and cDNA libraries as well as discuss various strategies for screening of recombinant clones.
4	explain the PCR and its variants in detail along with their applications. Students will be able to design PCR primers and reaction parameters.
5	describe different types of molecular markers and their applications in detail.
6	explain various DNA sequencing techniques and their applications in detail.

7.	describe genetic engineering guidelines and regulatory procedures to be followed while conducting genetic engineering experiments

Suggested References:	
Sr. No.	References
1.	Principles of Gene Manipulation and Genomics" by Sandy B Primrose and Richard Twyman
2.	Genetic Engineering by Smita Rastogi and Neelam Pathak
3.	Gene cloning : An introduction. T. A. Brown

On-line resources to be used if available as reference material
On-line Resources

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Master of Science (Microbiology)
M. Sc Microbiology Semester IV

Course Code	PS04CMIC52	Title of the Course	**Environmental Biotechnology**
Total Credits of the Course	04	Hours per Week	04

Course Objectives:	1. To understand and address environment issues using knowledge of microbiology 2. To understand fundamentals of waste water treatment processes and biochemistry for removal of pollutants from water and technologies developed for that.. 3. To understand basic concepts of biodegradation and bioremediation strategies for conservation of environment. 4. To understand some of the major pollution problems caused by organic and inorganic pollutants and bioremediation technologies. 5. To learn about eco-friendly biotechnological processes for recovery of various resources. 6. To learn about need and applications of various biofertilizers and biocontrol agents.

Course Content		
Unit	Description	Weightage* (%)
1.	Waste water treatment- Waste water characterization and its significance: COD, BOD, TOC, TOD, Inorganic constituents, solids, biological components. Principles and aims of biological wastewater treatment processes: Primary, secondary and tertiary treatment of waste water. Biochemistry and microbiology of inorganic phosphorus and nitrogen removal from waste water. Suspended growth processes: Activated sludge process: Biology of activated sludge, flocculation, sludge settling, oxidation ditches, waste stabilization ponds. Fixed film processes: Biofilm formation and slaughing, Trickling filters, rotating biological contactors, fluidized bed and submerged aerated filters.	25
2.	Anaerobic digestion: microbiological and biochemical fundamentals, factors influencing anaerobic digestion. Anaerobic waste water treatment systems: Upflow anaerobic sludge blanket , rotating biological contactors, anaerobic filters. Merits and demerits of anaerobic treatment of waste. Composting: Objectives, fundamentals, microbiology, factors influencing composting and composting systems. Compost quality and uses. Vermicomposting.	25

	Toxicity testing in waste water treatment plants using microorganisms: Monitoring environmental processes with biosensors: BOD biosensor, Pesticide biosensor	
3.	Biodegradation of organic pollutants: Xenobiotic and recalcitrant organic compounds, mechanisms of biodegradation, factors affecting biodegradation, Acclimation phase in biodegradation. Biodegradation of simple aliphatic, aromatic, polycyclic aromatic hydrocarbons, halogenated hydrocarbons, azo dyes and lignin. Bioremediation approaches: Intrinsic bioremediation, Biostimulation, Bioaugmentation: Use of genetically modified organisms.. In situ and ex situ bioremediation technologies with examples. Bioremediation of heavy metal pollution, Phytoremediation. Biological treatment of waste gas (polluted air): biofilters, bioscrubbers, membrane bioreactors, biotrickling filters.	25
4.	Bioleaching of metals: Characteristics of commercially important microbes, mechanisms of bioleaching, factors affecting bioleaching and current biomining processes. Biobeneficiation of gold ores. Biodesulfurization of coal: Removal of organic and inorganic sulfur from coal. Microbially enhanced oil recovery. Microbial Insecticides: Bacterial, fungal and viral insecticides in pest management. Biofertilizers: applications of nitrogen fixing and phosphate solubilising/ mobilizing biofertilizers.	25
...		

Teaching-Learning Methodology	Topics will be taught and discussed in interactive sessions using conventional black board and chalk as well as ICT tools such as power point presentations and videos. Practical sessions will be conducted in a suitably equipped laboratory either individually or in groups depending on the nature of exercise as well as availability of infrastructure. Course materials will be provided from primary and secondary sources of information.

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	15%
2.	Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3)	15%

3.	University Examination	70%

Course Outcomes: Having completed this course, the learner will be able to	
1.	Get trained with analysis of waste waters to judge pollution potential and biological waste water treatment.
2.	Develop ability to understand various bioremediation strategies to overcome pollution problems caused by various pollutants in air, water and soil.
3.	Understand and apply solid waste management technologies and significance of generating valuable products from waste.
4.	Gain technical knowledge about environment friendly biotechnological processes for recovery of valuable resources .
5.	Understand the need and production of biofertilizers and biopesticides for enhanced crop production in agriculture.

Suggested References:

- Comprehensive Biotechnology Vol-4, Murray Moo Young.
- Biotechnology-Rehm and Reid.
- Waste water microbiology by G. Bitton
- Biodegradation and bioremediation by M.Alexander
- Waste water treatment for pollution control, 2nd edition. Arceivala
- Environmental Biotechnology by H. Jordening and Josef Winter
- Handbook of water and waste water Microbiology by Horan
- Topic related review articles

On-line resources to be used if available as reference material
On-line Resources

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Course Code	PS04CMIC53	Title of the Course	LAB-I
Total Credits of the Course	04	Hours per Week	04

Course Objectives:	1. To learn to handle enzymes used in R-DNA technology and perform various experiments in genetic engineering 2. To learn to do water analysis. 3. To learn analysis of environmental samples.

PS04CMIC53 (Lab 1)

List of Practical Exercises:

1. Restriction Digestion
2. Restriction Mapping
3. Ligation
4. Cloning of a gene in plasmid vector
5. Amplification of a desired fragment by PCR
6. RFLP
7. RAPD
8. Expression of a Recombinant Protein
9. Waste water characterization.
    a. BOD
    b. COD
    c. Nitrate estimation
    d. Sulfate estimation
10. Study of phosphate solubilizing activity
11. Isolation of 2,4 dichlorophenoxyacetic acid degrading bacteria
12. Isolation of naphthalene degrading bacteria
13. Dehydrogenase activity of soil
14. Bioremoval of chromium from polluted water
15. Decolourization of Azo dyes by microorganisms.

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Practical Examination (As per CBCS R.6.8.3)	15%
2.	Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3)	15%
3.	University Examination	70%

Course Outcomes: Having completed this course, the learner will be able to	
1.	perform experiments and contribute in the field of environmental biology.
2	perform experiments related to recombinant DNA technology.

References:

1	Thimmaiah S. K. (2012). Standad Methods of Biochemical Analysis. Kalyani Publishes, New Delhi, India.
2	Short Protocols in Molecular Biology, Frederick M. Ausubel, Roger Brent , Robert E. Kingston , David D. Moore , J. G. Seidman, John A. Smith , Kevin Struhl (Editor)
3	Molecular Cloning: A Laboratory Manual by Joseph. Sambrook, David W. Russell. ISBN 978-1-936113-41-5

Master of Science (Microbiology))
M.Sc. (Microbiology) Semester IV

Course Code	PS04EMIC51	Title of the Course	IPR and Biosafety
Total Credits of the Course	4	Hours per Week	4

Course Objectives:	1. To introduce basic concepts of ethics and safety that are essential for different disciplines of science and procedures involved and protection of intellectual property and related rights. 2. To understand balanced integration of scientific and social knowledge in sustainable development.

Course Content		
Unit	Description	Weightage* (%)
1.	**Biotechnology and society:** Biotechnology and social responsibility, public acceptance issues in biotechnology, issues of access, ownership, monopoly, traditional knowledge, biodiversity, benefit sharing, environmental sustainability, public vs private funding. **Bioethics:** Social and ethical issues in biotechnology. Principles of bioethics. Ethical conflicts in biotechnology- interference with nature, unequal distribution of risk and benefits of biotechnology, bioethics vs business ethics. Introduction and need of bioethics, its relation with other branches, types of risk associated with genetically modified microorganisms, Ethical Issues involving GMOs; ethics related to human cloning, human genome project, prenatal diagnosis, agriculture and animal rights, data privacy of citizens health**;** ethical issues in India and abroad through case studies; Socio-economic impact of biotechnology.	25%
2.	**Bio- safety:** Definition of bio-safety; History, evolution and concept of biosafety; need and application of biosafety in laboratories and industries; biosafety guidelines and regulations, international and national norms of biosafety; Implementation of biosafety guidelines; Classification and Description of Biosafety levels; Design of clean rooms and biosafety cabinets; Risk assessment and containment levels; biohazard, bio-medical and hazardous wastes, handling and disposal; transportation of biological materials; bio-terrorism; biosafety protocol (Cartagena biosafety protocol) regulations to protect nature, growers and consumers interest and nation interest; Good laboratory practice (GLP) and Good manufacturing practice (GMP), Use of GMO's and their release, GM products, issues in use of GMO's, risk for animal/human/agriculture and environment owing to GMOs., Biotechnology and bio-safety concerns at the level of individuals,	25%

	institutions, society, region, country and world. Bio safety regulation: handling of recombinant DNA products and process in industry and in institutions.	
3.	**IPR I:** The Concept/History of Intellectual Property; Intellectual Property System in India; Kinds of Intellectual Property Rights; Advantages and Disadvantages of IPR. International Instruments concerning Intellectual Property Rights: the Berne Convention, Universal Copyright Convention, The Paris Convention, Patent Co-operation Treaty, Trade Related Intellectual Property Rights (TRIPS), The World Intellectual Property Organization (WIPO) and the United Nations Educational, Scientific and Cultural Organization (UNESCO) World Intellectual Property Organisation (WIPO); World Trade Organization (WTO) European Patent Office (EPO). Patents Act, 1970 ; Trade Mark Act, 1999; The Designs Act, 2000; The Geographical Indications of Goods (Registration and Protection) Act, 1999; Copyright Act, 1957 ; The Protection of Plant Varieties and Farmers' Rights Act, 2001; The Semi Conductor Integrated Circuits Layout Design Act, 2000; Trade Secrets; Utility Models; IPR & Biodiversity; The Convention on Biological Diversity (CBD) 1992; Application forms of IPR and Intellectual property protection. Concept of property with respect to intellectual creativity, Tangible and Intangible property.	25%
4.	**IPR II:** Classification of patents in India, Classification of patents by WIPO, Categories of Patent, Special Patents, Patenting Biological products, Patent document, Granting of patent, Rights of a patent, Patent Searching, Patent Drafting, filing of a patent, different layers of the International patent system, Utility models, Concept related to patents novelty, non-obviousness, utility, anticipation, prior art etc. Type of patents. Indian patent act and foreign patents. Patentability, Patent application, Revocation of patent, Infringement and Litigation with case studies on patent, Commercialization and Licensing. Patent Cooperation Treaty (PCT); Copyright Overview of Copyright, Importance of Copyrights, Process for copyright, case studies. Overview of Trademarks & Trade Secret, Importance of Trademarks & Trade secret, Rights of Trademark & Trade Secret, Types of Trademarks, Registration process for Trademark & Trade Secret, Duration of Trademark and trade secret, Case Studies Geographical Indications Overview of Geographical Indications, Importance of Geographical Indication Protection, Case studies	25%

	Infringement: Direct, Contributory, and Induced Infringement; How Infringement is Determined; Who Is an Infringer; Official Machinery, Controller, Powers and Functions Defences to Infringement; Case studies	

Teaching-Learning Methodology	Online / Offline / Presentation / Videos

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	15%
2.	Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3)	15%
3.	University Examination	70%

Course Outcomes: Having completed this course, the learner will be able to	
1.	Interpret basics of biosafety and bioethics and its impact on all the biological sciences and the quality of human life.
2.	Recognize importance of biosafety practices and guidelines in research.
3.	Comprehend benefits of GM technology and related issues.
4.	Recognize importance of protection of new knowledge and innovations and its role in business.

Suggested References:	
Sr. No.	References
1.	Fleming, D.A., Hunt, D.L., (2000). Biotechnology and Safety Assessment (3rd Ed) Academic press.ISBN-1555811804,9781555811808.
2.	Thomas, J.A., Fuch, R.L. (1999). Biotechnology and safety assessment (3rd Ed). CRC press, Washington. ISBN: 1560327219, 9781560327219

3.	Law and Strategy of biotechnological patents by Sibley. Butterworth publication.(2007) ISBN: 075069440, 9780750694445.
4.	Intellectual property rights- Ganguli-Tat McGrawhill. (2001) ISBN-10: 0074638602,
5.	Intellectual Property Right- Wattal- Oxford Publicatiopn House.(1997) ISBN:0195905024.
6.	Biotechnology - A comprehensive treatise (Vol. 12). Legal economic and ethical dimensions VCH. (2nd ed) ISBN-10 3527304320.
7.	Encyclopedia of Bioethics 5 vol set, (2003) ISBN-10: 0028657748.
8.	Thomas, J.A., Fuch, R.L. (2002). Biotechnology and safety Assessment (3rd Ed) Academic press.
9.	B.D. Singh. Biotechnology expanding horizons.
10.	H.K.Das. Text book of biotechnology 3rd edition.
11.	*Sateesh, M.K., Bioethics and Biosafety, IK International Publishers (2008)*
12.	*Singh I. and Kaur, B., Patent law and Entrepreneurship, Kalyani Publishers (2006).*
13.	*Srinivasan, K. and Awasthi, H.K., Law of Patents, Jain Book Agency (1997)*
14.	Deepa Goel, ShominiParashar, (2013), IPR, Biosafety and Bioethics, Pearson.

On-line resources to be used if available as reference material
On-line Resources

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Master of Science (Microbiology)
M. Sc. Microbiology Semester (IV)

Course Code	PS04EMIC52	Title of the Course	RESEARCH ETHICS AND SCIENTIFIC WRITING
Total Credits of the Course	04	Hours per Week	04

Course Objectives:	1. To inculcate professional ethics in students of Science, especially in Biology 2.To familiarize types of plagiarism and tools for their detection 3. To teach various modes of data collection and its processing 4. To impart professional, scientific writing skills …

Course Content		
Unit	Description	Weightage* (%)
1.	Definition and significance of ethics; Professional ethics in Scientific research and development: Common ethical breaches; data fabrication; data falsification. Plagiarism: redundant publication; duplicate publication.	25%
2.	Types of plagiarism; tools and techniques for detection of plagiarism. Conflict of interest; salami slicing and authorship issues. Good Laboratory Practices (GLP): Instrument validation, reagents and materials certification, documentation and its record, Quality assurance and certification of laboratory facilities.	25%
3.	Data collection methods: Primary data and secondary data. Internet, online data collection, journals and books. References: Basic types of referencing; Quoting, paraphrasing and citing. APA, MLA and the Chicago/ Turabian styles of listing references.	25%
4.	Scientific writing: Basic differences between popular and scientific writing; fundamental rules of scientific writing; structure and content of research papers, thesis and dissertations. Do's and don't for scientific writing. Tools and techniques for correction and editing of manuscripts. Selection and publication in journals.	25%

Teaching-Learning	Topics will be taught and discussed in interactive sessions using conventional black board and chalk as well as ICT tools such as power

Methodology	point presentations and videos. Practical sessions will be conducted in a suitably equipped laboratory either individually or in groups depending on the nature of exercise as well as availability of infrastructure. Course materials will be provided from primary and secondary sources of information.

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	15%
2.	Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3)	15%
3.	University Examination	70%

Course Outcomes: Having completed this course, the learner will be able to	
1.	Understand the significance of professional ethics in Scientific research
2.	Appreciate the types and pitfalls of plagiarism
3.	Learn how to collect data from primary and secondary sources
4.	Understand the differences between, common, popular and scientific writing and learn the basics of scientific writing

Suggested References:	
Sr. No.	References
1.	Professional ethics and human values: M. Govindarajan, S. Natarajan and V.S. Senthilkumar
2.	The craft of Scientific writing: Michael Alley
3.	Science and Technology ethics: Raymond Spier
4.	Scientific writing and research quality: Prasanna Kumar and Pawan Kumar Bharti

On-line resources to be used if available as reference material
On-line Resources

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Course Code	PS04EMIC53	Title of the Course	LAB-II
Total Credits of the Course	04	Hours per Week	04

Course Objectives:	1. To develop practical skills corresponding to the elective papers chosen.

PS04EMIC53: Practicals corresponding to the elective papers offered.

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Practical Examination (As per CBCS R.6.8.3)	15%
2.	Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3)	15%
3.	University Examination	70%

Course Outcomes: Having completed this course, the learner will be able to	
1.	perform experiments corresponding to the two elective theory papers offered.

References:

1	Will be provided by respective Lab Instructor
2	
3	

(Master of Science) (Microbiology)
(M. Sc.) (Microbiology) Semester (IV)

Course Code	PS04EMIC54	Title of the Course	BIOMATERIALS AND TISSUE ENGINEERING
Total Credits of the Course	04	Hours per Week	04

Course Objectives:	1. To impart knowledge on the types and properties Biomaterials used in medicine. 2.Understand the composition of implants and their pros and cons. 3. Learn tissue engineering and its applications 4. Gain an understanding of stem cells and their emerging role in treatment of genetic and somatic disorders.

Course Content		
Unit	Description	Weightage* (%)
1.	Biomaterials: Introduction-definition of biomaterials, applications of biomaterials, classification of biomaterials, Comparison of properties of some common biomaterials. Effects of physiological fluid on the properties of biomaterials. Biological responses (extra and intra-vascular system). Surface properties, physical properties and mechanical properties of materials.Types of implant materials: Metallic, polymeric, ceramic and composite materials.	25%
2.	Properties of commonly used implant materials: Stainless steel and alloy importance of stress- corrosion cracking; role of passive films in tissue adhesion.Polymeric implant materials: general classification; Polyolefins polyamides, acrylic polymers, fluorocarbon polymers, silicon rubbers, acetals. Biodegradable polymers and synthetic polymers and their applications.Ceramic implant materials: Bioceramics; Common types of bioceramics. Bio -reabsorbable and bioactive ceramicsHost tissue reactions: importance of interfacial tissue reaction (e.g. ceramic/bone tissue reaction).Composite implant materials: different reinforcement materials, Composite theory of fiber reinforcement.	25%
3.	Tissue engineering: Introduction, stem cells, morphogenesis, generatic of tissue in the embryo, Tissue homeostasis, Cellular signalin Extracellular matrix as a biologic scaffold for tissue engineerin Scaffold fabrication, bioactive scaffold, Natural polymers in tissu engineering applications, Degradable polymers for tissue engineering.	25%
4.	Basic Biology Of Stem Cells: Stem Cells : Introduction, hematopoiet differentiation pathway; Potency and plasticity of stem cells, source	25%

	embryonic stem cells, hematopoietic and mesenchymal stem cells, Ste Cell markers, FACS analysis and differentiation. Stem cell system Liver, neuronal stem cells, Types and sources of stem cell wi characteristics: embryonic, adult, haematopoetic, fetal, cord bloo placenta, bone marrow, primordial germ cells, cancer stem cells induce pleuripotent stem cells.	
...		

Teaching-Learning Methodology	Topics will be taught and discussed in interactive sessions using conventional black board and chalk as well as ICT tools such as power point presentations and videos. Practical sessions will be conducted in a suitably equipped laboratory either individually or in groups depending on the nature of exercise as well as availability of infrastructure. Course materials will be provided from primary and secondary sources of information.

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	15%
2.	Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3)	15%
3.	University Examination	70%

Course Outcomes: Having completed this course, the learner will be able to	
1.	Understand about various types of biomaterials for a wide range of biomedical applications.
2.	Basic functions and performance of implant materials as well as corrosion and degradation mechanisms of biomaterials.
3.	Choice of biomaterials based on function, biological environments, toxicity. bioadhesion and implant surface interaction with tissues. Scaffolds for tissue-engineering, growth factor, stem cell signaling.
…	

Suggested References:	
Sr. No.	References
1.	Tissue Engineering: Bernhard O Palsson, Sangeeta N. Bhatia.
2.	Fundamentals of Tissue Engineering and Regenerative Medicine: Meyer, U,: Meyer, Th.; Handschel, J.; Wiesmann,H.P .
3	Biomaterials: Science and Engineering: J B Park
4	Biomaterials: Sujata V. Bhat

On-line resources to be used if available as reference material
On-line Resources

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(Master of Science) (Microbiology)
(M.Sc.) (Microbiology) Semester (IV)

Course Code	PS04EMIC55	Title of the Course	Biodiversity and Conservation
Total Credits of the Course	04	Hours per Week	04

Course Objectives:	1. To impart knowledge of fundamental concepts of biodiversity, the range of its extant and the need for conservation. 2. To provide information of the main threats to biological diversity and the ability to evaluate the effects of human influences on biodiversity. 3. To demonstrate the differences between the different categories of red listed species. 4. To understand different modes of biodiversity conservation, their merits and limitations. 5. To integrate the information generated from scientific investigations and use findings to address conservation and biodiversity issues.

Course Content		
Unit	Description	Weightage* (%)
1.	Biodiversity: Concepts, levels and types, changes in tune and space, evolution, species concept; significance of biodiversity for life security. Biogeography. Terristrial, Marine, Aquatic and Agricultural biodiversity: Changing patterns and practices. Influence of modern lifestyle on biodiversity. Pros and cons of genetically modified species	25
2.	Global conservation measures, institutions and conventions; IUCN concept of threatened and endangered species. The Red Data Books of Indian plants and animals. Causes and consequences of loss of biodiversity. Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES): aims, major ratifications and amendments. Exotic and invasive species: A few case studies of intentional and non-intentional introduction of exotic species and their influence on local biodiversity.	25
3.	Principles and strategies of biological diversity conservation: *in-situ* conservation and *ex-situ* conservation. Biosphere reserves, major protected areas (sanctuaries, national parks, biosphere reserves) of India and Gujarat. Wetlands, mangroves and coral reefs for conservation of wild biodiversity. Concept of Sacred groves and their role in biodiversity conservation.	25

	Role of botanical gardens, field gene banks, seed banks, in vitro repositories, cryobanks in conservation of plants and animal sperms. Role of Zoos, breeding centers in conservation of animals.	
4.	Biodiversity hot spots in India and world; Indian Biodiversity Act 2002; Major objectives of biodiversity authority board; Biodiversity and economics with special reference to India; People's Biodiversity register: Objectives, importance and modality of preparation. General account of the activities of Botanical Survey of India (BSI) and Zoological Survey of India (ZSI), National Bureau of Plant Genetic Resources (NBPGR), Indian Council of Agricultural Research (ICAR), Council of Scientific & Industrial Research (CSIR), Department of Biotechnology (DBT) and Department of Environment and Forest, Wild life Protection Society of India, Wildlife Instititute of India (WII), Animal Welfare Board of India and Bombay Natural History Society (BNHS) in the context of Indian biodiversity conservation.	25

Teaching-Learning Methodology	Topics will be taught and discussed in interactive sessions using conventional black board and chalk as well as ICT tools such as power point presentations and videos. Practical sessions will be conducted in a suitably equipped laboratory either individually or in groups depending on the nature of exercise as well as availability of infrastructure. Course materials will be provided from primary and secondary sources of information.

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	15%
2.	Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3)	15%
3.	University Examination	70%

Course Outcomes: Having completed this course, the learner will be able to	
1.	Understand the concept of biodiversity, its role for our survival, different direct and indirect threats on biodiversity.

2.	Appreciate the global and national initiatives and local traditions for biodiversity conservation.
3.	Become familiar with different modes of conservation, institutes involved in biodiversity conservation.
4.	Learn various guidelines and regulations for utilizing the biodiversity judiciously.

Suggested References:	
Sr. No.	References
1.	Wilson, E., O., (1988). Biodiversity. The National Academies Press. Harvard. Washington, DC.
2.	Hunter, M., L., Gibbs, J. P., (2007). Fundamentals of Conservation Biology. 3rd Edn. Blackwell Publishing, Malden.
3.	Myers, N., Mittermeier, R., A., Mittermeier, C. G., Fonseca, G., A., da, Kent, J., (2000). Biodiversity Hotspots for Conservation Priorities. Nature, 403, 853-858.
4.	Rodgers, N. A., Panwar, H. S. Planning a Wildlife Protected Area Network in India. Vol. 1. The Report Wildlife Institute of India, Dehradun.

On-line resources to be used if available as reference material
On-line Resources
Biodiversity: **Author:** John Spicer
Brian W. van Wilgen: Biological Invasions in South Africa
Recent review articles and research papers

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Master of Science (Microbiology)
M. Sc (Microbiology) Semester IV

Course Code	PS04EMIC56	Title of the Course	Food and Dairy Microbiology
Total Credits of the Course	04	Hours per Week	04

Course Objectives:	1. To understand about types of food spoilage and factors influencing food spoilage as well as microorganisms associated with spoilage of food. 2. To learn about food borne pathogens and types of infections or poisoning caused upon consumption of pathogen contaminated food products.. 3. To gain insights into methods of food preservation and production of fermented foods. 4. To gain information about detection of pathogens in food as well as analysis of food quality. 5. To learn about regulations governing and certifications for food quality and recommended sanitation practices for food processing plants.

Course Content		
Unit	Description	Weightage* (%)
1.	Scope of food microbiology Food as a substrate a) Microorganisms important in food microbiology – Bacteria, yeasts and moulds. b) Factors influencing microbial growth in food. Food Spoilage a) General principles underlying food spoilage and contamination. b) Spoilage of canned food, sugar products, vegetables, fruits, meat and meat products, milk and milk products fish, seafood and poultry	25
2.	Food poisoning a) Indicator food borne pathogens b) Bacterial food borne infections and intoxications-*Brucella, Campylobacter, Clostridium, Escherichia* (ETEC/EHEC/EPEC/EAEC), *Salmonella, Shigella, Listeria, Vibrio, and Yersinia.* c) Non- bacterial food borne infections and intoxications- Nematodes, protozoa, algae, fungi, and viruses. d) Culture and non-culture based detection of food pathogens and viruses e) General methods for diagnosis of infections, intoxications and preventive measures.	25
3.	Food preservation Principles of food preservation – Physical and chemical preservation	25

	methods, Bio preservatives Food fermentations Starter cultures for fermented foods: Biochemical activities in fermentation of foods. Oriental fermented foods: Shoyu, Temph, Kimchi etc Fermented milk products: Yogurt, Kefir, Koumiss etc. Fermented vegetables – Sauerkraut Application of microbial enzymes in food industry	
4.	Genetically modified foods. Biosensors in food Food research organizations/institutes in India Recent foodborne outbreaks Food sanitation – Microbiology of food plant sanitation, water and milk testing Food laws and quality control – HACCP, Codex alimentarius, PFA, FPO, MFPO, BIS, FSSAI AGMARK.	25
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Teaching-Learning Methodology	Topics will be taught and discussed in interactive sessions using conventional black board and chalk as well as ICT tools such as power point presentations and videos. Practical sessions will be conducted in a suitably equipped laboratory either individually or in groups depending on the nature of exercise as well as availability of infrastructure. Course materials will be provided from primary and secondary sources of information.

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	15%
2.	Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3)	15%
3.	University Examination	70%

Course Outcomes: Having completed this course, the learner will be able to

1.	describe the types of food spoilage and factors influencing food spoilage.
2	associate a type of food spoilage with the causative microorganisms
3.	describe different types of food poisoning or infection and design a study to determine the cause of food poisoning or food borne infection.
4.	recommend a method of preservation for a particular type of food and expected extension in the shelf life of foods preserved thereby.
5.	understand science and technology in production of a fermented food of high quality.
6	decide a method of sanitation for a food processing plant
7	describe the applicable laws for food processing and/packaging as well as associated quality certifications.

Suggested References:

- Food Microbiology, Frazier and Westhoff
- Food microbiology, Adam and Moss
- Dairy Microbiology by Robinson. Volume II and I.
- Fundamental Food Microbiology, Bibek Ray and ArunBhuniya

On-line resources to be used if available as reference material
On-line Resources

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Master of Science (Microbiology)
M.Sc. (Microbiology) Semester (IV)

Course Code	PS04EMIC57	Title of the Course	Mycology and Plant Pathology
Total Credits of the Course	04	Hours per Week	04

Course Objectives:	To understand the fungal classification. 2. To study the structure and reproduction fungi. 3. To understand modern techniques in mushroom cultivation 4. To understand structure and reproduction of lichens. 5. To understand various diseases caused by bacteria fungi and virus.

Course Content		
Unit	Description	Weightage* (%)
1.	Introduction to Fungi: History and classification of Fungi (Alexopoulas, 1962, Ainsworth 1973, Kirk et.al. 2008). Fungi: General characteristics. Economic importance of fungi. Life cycle, morphology, structure and reproduction in Kingdom: Fungi, Kingdom: Chromista and kingdom:Protozoa.	25%
2.	Lichens: Morphology, reproduction and economic importance. Techniques of mushroom cultivation: Schedule and systems of cultivation; composting; peak heating; spawn preparation and mushroom stains spawning and mycelia growth; supplementation; cultivation technique from casing to ruffling and recovery growth to harvesting; pests and diseases and its protection.	25%
3.	The disease triangle: Role of environment, host and pathogen in disease formation. Symptoms, life cycle and control of fungal diseases: Rusts, smuts, blast, red-rot, powdery mildew and tikka diseases. Symptoms, life cycle and control of bacterial and viral diseases: Leaf blight, canker, leaf spot, Mosaic, panama and leaf curl diseases.	25%
4.	Control measures for plant diseases. Chemical control, biological control and integrated disease and pest management. Host- pathogen interactions, plant defense mechanisms. HR and SAR in plant defense. Molecular mechanisms and signaling pathways in plant defenses.	25%
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Teaching-Learning Methodology	Topics will be taught and discussed in interactive sessions using conventional black board and chalk as well as ICT tools such as power point presentations and videos. Practical sessions will be conducted in a suitably equipped laboratory either individually or in groups depending on the nature of exercise as well as availability of infrastructure. Course materials will be provided from primary and secondary sources of information.

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	15%
2.	Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3)	15%
3.	University Examination	70%

Course Outcomes: Having completed this course, the learner will be able to	
1.	Students will have clear understanding of fundamentals of various classifications. Students will have clear understanding of various diseases and their control.
2.	Students will have clear understanding reproduction of various classes of fungi.
3.	Students will have understanding techniques involved in cultivation of various mushrooms and their economic importance
4	Students will have clear understanding of biology and economic importance of lichens.
5	Students will have clear understanding of various diseases and their control.

Suggested References:	
Sr. No.	References
1.	Dube, H. C. (2013). *An introduction to fungi*. Scientific Publishers.
2.	Alexopoulos, C. J., Mims, C. W., & Blackwell, M. (1996). *Introductory mycology* (No. Ed. 4). John Wiley and Sons.
3	Singh, R. S. (1980). Principles of Plant pathology.
4.	Singh, R. S. (2018). *Plant diseases*. Oxford and IBH Publishing

On-line resources to be used if available as reference material
On-line Resources

Master of Science (Microbiology)
M.Sc. (Microbiology) Semester (IV)

Course Code	PS04EMIC59	Title of the Course	Systems Biology
Total Credits of the Course	04	Hours per Week	04

Course Objectives:	1. To introduce the concept of systems and synthetic Biology to the students 2. To provide insight into quantitative modelling of biological systems at the molecular and cellular level, as well as how they are used, analysed and developed

Course Content		
Unit	Description	Weightage* (%)
1.	Concepts and working principles of System Biology - Practical applications of System Biology in Life Sciences - Introduction to System Biology platforms, Proprietary system Biology platform. Microarray data analysis - Microarray analysis platforms - Introduction to Concepts and principles of Microarray technology	25%
2.	Models and Modeling: purpose, adequateness, advantage of computational modeling, basic notion for computational models, model scope, statements, system state, variables parameters constants, behavior, classification, steady states.	25%
3.	Analysis of complex biological systems: Sequencing (DNA & amino acid), Protein structure analysis. Metabolic networks and flux balance analysis: Mathematical modeling of metabolic networks; formulation and optimization of Flux Balance Analysis; computational tools for FBA.	25%
4.	Introduction to synthetic biology. Modeling synthetic Biology; Applications of synthetic Biology. Human and Pathogens--Cancer genomics (Tumor complexity)--Gene regulatory network Codon optimization Algorithmic Drug designs. Current and emerging areas in the field of computational and systems biology.	25%
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Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	15%
2.	Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3)	15%
3.	University Examination	70%

Course Outcomes: Having completed this course, the learner will be able to	
1.	Model macromolecular complexes on different time and length scales model macromolecular structures with the help of experimental information
2.	Explain cellular processes by describing the interactions between macromolecules in a kinetic network
3.	Appreciate the significance of synthetic Biology and its potential in future
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Suggested References:	
Sr. No.	References
1.	System Biology: Computational Systems Biology (Hardcover) by Andres Kriete (Editor), Roland Eils (Editor)
2.	Microarray Data Analysis: Gene Expression Data Analysis. A Beginner's Guide By: Helen Causton (Imperial College), J Quackenbush and AlvisBrazma (The European Bioinformatics Institute)

3	Klipp E (2009) Systems biology: a textbook. Wiley-VCH, 1/e.

On-line resources to be used if available as reference material
On-line Resources

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