St. Xavier's College (Autonomous)
Mumbai

M.Sc. Syllabus
For 4th Semester Courses in Microbiology
(June 2019 onwards)

Contents:

Title: MICROBIAL ECOLOGY AND ENVIRONMENTAL MICROBIOLOGY

Course SMIC1001

LEARNING OBJECTIVES

1. Understand the role of microorganisms in different ecosystems
2. Understand the interactions of microbes with each other and higher organisms
3. Understand the principles of techniques used in microbial ecology
4. Learn the application of microorganisms in bioremediation and waste disposal

Number of lectures: 60

UNIT 1 MICROBIAL ECOLOGY: MICROBIAL ENVIRONMENTS AND BASIC CONCEPTS IN MICROBIAL ECOLOGY 15 LECTURES

LEARNING OBJECTIVES

1. Understand the role of microorganisms in biogeochemical cycling
2. Understand microbial biodiversity in different habitats
3. Know the adaptations of microorganisms to extreme environmental conditions
4. Understand the role of microbiomes

1. Introduction to ecological concepts 1L

2. Biogeochemical cycles/nutrient cycling in environments 2L

3. Microorganisms in Aquatic environments 3L

4. Microorganisms in Terrestrial environments 3L

5. Microorganisms in Extreme environments 3L

6. Microbiomes 3L

UNIT 2 MICROBIAL ECOLOGY: INTERACTIONS AND BIOFILMS

15 LECTURES

LEARNING OBJECTIVES

1. Understand the concepts in interaction of microbes with each other and also with higher organisms
2. Know biofilm formation in various environments

1. Microbial interactions 10L

- Symbiosis between microorganisms
- Plant microbial interactions
- Insects as microbial habitats
- Mammals as microbial habitats
- Aquatic invertebrates as microbial habitats

2. Microbial biofilms 5L

UNIT 3 TECHNIQUES IN MICROBIAL ECOLOGY 15 LECTURES

LEARNING OBJECTIVES

Understand the use of various techniques involved in microbial ecology

1. Environmental sample collection and processing **2L**

2. Culture based methods **1L**

3. Physiological methods **3L**

- Measuring microbial activity in pure culture
- Carbon respiration
- Stable isotope probing
- Use of radioisotopes as tracers
- Adenylate energy charge
- Enzyme assays

4. Nucleic acid-based methods of analysis **6L**

- Obtaining nucleic acids from environment
- Use of gene probes
- FISH, ISRT FISH, CARD FISH
- Microarrays
- PCR – RTPCR, qPCR, ICC PCR, PCR-fingerprinting
- RFLP
- ARISA, ARDRA
- Denaturing /Temperature gradient gel electrophoresis

5. Microbial community analysis of environmental samples with next-generation sequencing **3L**

- Introduction to microbial community analysis of environmental samples with NGS/TGS
- Microbial community analysis using High-Throughput Amplicon Sequencing
- Functional Metagenomics: Procedures and Progress
- Metagenomics: Assigning functional status to community gene content
- Generation and analysis of microbial metatranscriptomes

UNIT 4 BIOREMEDIATION AND WASTE DISPOSAL **15 LECTURES**

LEARNING OBJECTIVES

1. Understand the bioremediation process and its feasibility.
2. Learn the various methods of bioremediation.
3. Learn the various methods of sewage treatment
4. Understand solid and hazardous waste management

1. Introduction to bioremediation **2L**

- Factors affecting bioremediation – nutrient sources, environmental conditions, bioavailability, adsorption/desorption kinetics
- Needs and limitations
- Strategies for bioremediation

2. Types of bioremediation with examples **4L**

- Intrinsic and enhanced: Indigenous and bioaugmentation,
- In-situ bioremediation: Bioventing, Biosparging, Bioslurping
- Ex-situ bioremediation: Land farming, Composting, Biopile process, Bioreactors
- Novel technologies
- Molecular methods for bioremediation

3. Sewage and sludge treatment and disposal **4L**

- Aerobic processes
- Anaerobic processes
- Plant loading criteria – MLSS, TSS, HRT, MCRT, F:M
- Disposal methods

4. Solid waste management **3L**

5. Hazardous waste management **2L**

CIA: Visit/project on waste management, Test

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Unit 1:

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2. Advances in Environmental Microbiology Volume 1 Editor Christon J. Hurst, Cincinnati, OH, USA Universidad del Valle, Cali, Colombia, Springer 2016
3. Brock Biology of microorganisms, Madigan, Martinko, Dunlap, Clara, 14th and 15th Ed., 2015, 2017, Pearson Intl Ed., USA.
4. Environmental Microbiology: Fundamentals and Applications: Microbial Ecology, Ed. by Jean-Claude Bertrand (Editor), Pierre Caumette (Editor), Philippe Lebaron (Editor), Robert Matheron (Editor), Philippe Normand (Editor), Télesphore Sime-Ngando (Editor), 2015, Springer USA
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6. Microbial Ecology - Fundamentals and Applications, Atlas R. M. and Bartha R., 1998, Addison Wesley Longman, Inc., USA
7. Prescott's Microbiology, Willey J. M., Sherwood, L. M., Woolverton, C. J., 2014, 10th Ed., McGraw Hill Education, USA.

Unit 2:

1. Environmental Microbiology: Fundamentals and Applications: Microbial Ecology, Ed. by Jean-Claude Bertrand (Editor), Pierre Caumette (Editor), Philippe Lebaron (Editor), Robert Matheron (Editor), Philippe Normand (Editor), Télesphore Sime-Ngando (Editor), 2015, Springer USA.
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3. Biofilm formation as microbial development, O'Toole, G., Kaplan, H. B. and Kolter, R., 2000, Annu. Rev. Microbiol. 2000. 54:49–79.
4. Biofilms: An emergent form of bacterial life, Flemming, H.C.; Wingender, J.; Szewzyk, U.; Steinberg, P.; Rice, S.A.; Kjelleberg, S., Nat. Rev. Microbiol. 2016, 14, 563–575.
5. Brock Biology of microorganisms, Madigan, Martinko, Dunlap, Clara, 14th and 15th ed, 2015, 2017, Pearson Intl Ed, USA.

6. Prescott's Microbiology, Willey J. M., Sherwood, L. M., Woolverton, C. J., 2014, 10th Ed., McGraw Hill Education, USA.

Unit 3:

1. A review of methods and databases for metagenomic classification and assembly Florian P. B., Jennifer L., Salzberg S. L., Briefings in Bioinformatics, Volume 20, Issue 4, July 2019, Pages 1125–1136, https://doi.org/10.1093/bib/bbx120 Published: 23 September 2017.
2. Brock Biology of microorganisms, Madigan, Martinko, Dunlap, Clara, 14th and 15th ed, 2015, 2017, Pearson Intl Ed, USA.
3. Environmental Microbiology, Maier R. M., Pepper. L. and Gerba C. P., 2010, Academic Press, USA.
4. Manual of Environmental Microbiology, 2016, Marylynn Yates, ASM press.
5. Microbes and Microbial Technology, Rastogi & Sani, 2011, pp 29-57, Molecular Techniques to Assess Microbial Community Structure, Function, and Dynamics in the Environment in Microbes and Microbial Technology: Agricultural and Environmental Applications, Edited by Ahmad I., Ahmad F., Pichtel J., 2011, Springer Verlag New York, USA.
6. The Metagenomics of soil, Rolf Daniel,470/June2005/vol3, www.nature.com/reviews

Unit 4:

1. A Textbook of Biotechnology, Dubey R. C., Illustrated Revised Ed., 2010, S and Singleton I.; J Chemical Technology and Biotechnology, 80: 723-736, 2005.
2. Approaches in Bioremediation: The New Era of Environmental Microbiology and Nanobiotechnology, Edited by Ram Prasad, Aranda E., 2018, Springer, USA
3. Bioremediation of BTEX hydrocarbons, Prenafeta-Boldu, F.X. et. al Biodegration, 15:59-65. 2004.
4. Bioremediation of PAH: Current knowledge and future directions, Bamforth S.M.
5. Bioremediation: Principles and Applications, Crawford R. L. and Crawford D. L., 1st Ed. (September 8, 2005), Cambridge University Press Chand and company, India.
6. Environmental Biotechnology, Allan Scragg, 2nd Ed., 2005, Springer, USA
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11. In situ and ex situ biodegradation technologies for remediation of contaminated sites, Rawe, J., V. Hodge, C. M. Acheson, C. Lutes, and D. Liles. (Engineering issue). EPA/625/r-06/015, 2006.
12. Wastewater engineering: Treatment and reuse, Metcalf and Eddy, 4th Ed. 2004 Tata McGraw Hill Publishing Co. Ltd, India

Title: FOOD MICROBIOLOGY **Course: SMIC1002**

LEARNING OBJECTIVES

1. Understand significance of microbes in food and their control
2. Understand concepts of food Safety, quality management and regulation in the food industry

Number of lectures: 60

UNIT 1. MICROBES, THEIR GROWTH RESPONSE IN FOOD AND FOOD SPOILAGE **15LECTURES**

LEARNING OBJECTIVES

1. Understand the incidence of microbes in food and their role in food spoilage.
2. Understand biofilm formation and microbial stress in foods.
3. Predicting the growth of micro-organisms in foods

1. Microbes in foods **2L**

- Important microorganism groups in food and their sources
- Normal microbiological quality of food and its significance

2. Factors influencing microbial growth in food **5L**

- Intrinsic and extrinsic factors
- Biofilm formation in foods and assessment
- Microbial stress responses in the food environment
- Importance of spores in foods

3. Microbial food spoilage **5L**

- Important factors in microbial food spoilage
- Spoilage of specific foods
- New spoilage bacteria in refrigerated food
- Food spoilage by enzymes
- Indicators of microbial food spoilage

4. Predictive modeling of microbial growth in food **3L**

- Traditional methods and shelf life studies
- Mathematical models: developing a model, types of models
- Softwares: ComBase Browser and Predictor

UNIT 2: CONTROL OF MICROBES IN FOOD **15 LECTURES**

LEARNING OBJECTIVES

1. 1.Know the principles of traditional and novel techniques used in food preservation to control the access and growth of microorganisms in food
2. Learn principles of food packaging

1. Control of access of microbes in foods **1L**

- Cleaning, sanitation and disinfection in food handling operations
- Removal of biofilm

2. Control by physical agents **5L**

- Physical removal
- Thermal Processing: mathematical expressions, low heat and high heat processing
- Irradiation
- Reducing water activity and drying
- Low temperature

3. Control by chemical agents **1L**

- Low pH and organic acids
- Antimicrobial preservatives and bacteriophages
- Modified atmosphere

4. Control by a combination of methods (Hurdle Concept) **1L**

5. Control by novel processing technology **3L**

- Microwave and infrared heating
- Ohmic and inductive heating
- Pulsed electric fields processing
- High pressure processing
- Pulsed light technology
- Pulsed X-rays
- Plasma technology

6. Food packaging **4L**

- Functions of packaging
- Packaging materials and uses
- Aseptic packaging
- Innovations in packaging and future trends

UNIT 3: BENEFICIAL USES OF MICROBES AND OTHER FORMULATIONS IN FOOD 15 LECTURES

LEARNING OBJECTIVES:

1. Understand general production methods of ethnic Indian fermented foods from milk, meat, vegetables and cereals**.**
2. Know the other applications of microbes and microbial products in the food industry
3. Understand functional foods especially nutraceuticals.
4. Understand the production of packaged drinking water and its final quality

1. Microbiology of ethnic fermented foods of India **4L**

- Fermented cereal and cereal-legume mixture foods: e.g. Ambali, Bhatooru, Jalebi, Nan, Selroti, Seera, Adai Dosa.
- Fermented soyabean foods, non-soybean legume foods**: e. g.** Bekang, Kinema, Dhokla and Khaman, Masyaura and Wari
- Indian fermented dairy products**:** e.g. Dahi and Lassi, Chhurpi and Chhu, Shrikhand,and Misti dahi,

- Indian fermented fish and meat products**: e.g.** Fish - Gnuchi, Hentak, Karati, Bordia and Lashim, Sidra; Meat - Suka ko Masu, Chartayshya, Jamma or Geema/Juma, Kargyong

2. Food additives of microbial origin **5L**

- Enzymes
- Biopreservatives
- Sweetners, flavours and colors
- Probiotics and prebiotics

3. Nutraceuticals **4L**

- Introduction to nutraceuticals - definitions, basis of claims for a compound as a nutraceutical, regulatory issues for nutraceuticals.
- Production of nutraceuticals like lycopene, isoflavonoids, prebiotics and probiotics, glucosamine, phytosterols
- Applications of fibers from food sources
- Microbial fructooligosaccharides

4. Packaged water **2L**

- Types of bottled water
- BIS /regulations regarding the production of packaged waters with respect to final quality of product
- Potential chemical and microbiological hazards in the bottles depending on the type of water, the type of bottle and the bottling procedure
- Chemical and microbial indicators and limits in potable water
- The application of HACCP in the bottling plan

UNIT 4: METHODS FOR FOOD SAFETY **15 LECTURES**

LEARNING OBJECTIVES

1. Understand important facts of microbial food borne diseases.
2. Understand conventional, modern and rapid methods of detection of microbes and their products in food.
3. Be able to apply concepts of QA, QC, GMP, ISO 22000 and HACCP in food industry
4. Understand laboratory accreditation criteria**.**

1. Microbial foodborne diseases **2L**

- Important facts in food borne diseases
- Food Borne infections
- Food Borne intoxicants
- Foodborne toxico-Infections
- Opportunistic pathogens
- New and emerging food pathogens
- Indicators of bacterial pathogens

2. Methods for detection of microbes and their products **5L**

- Conventional microbiological methods
    i. Sampling schemes for microbial analysis

ii. Microbial enumeration in food
iii. Qualitative methods for detection of microbes and their toxins in food

- Chemical methods
  i. DNase test
  ii. LAL test
  iii. Tests with fluorogenic and chromogenic substrates
- Immunological methods
  i. FAT
  ii. ELISA
  iii. RIA
  iv. Hemagglutination
- Molecular Methods
  i. PCR
  ii. Lux gene luminescence
  iii. Fingerprinting methods
- Physical Methods
- Biosensors in food analysis
- Laboratory accreditation

3. Controlling the microbiological quality of food and food safety 8L

- Quality Control using microbiological criteria
- Food laws and regulation, FSSAI, Codex Alimentarius and other quality standards
- Quality Management, HACCP, FSMS /ISO 22000
- Risk Analysis for safe food supply
- Food safety in food service establishments and on the street

CIA: Presentation, Test

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Unit 1:

1. Food Microbiology, Adams M. R. and Moss M. O., 3rd Ed., 2008, RSC Publishing, Cambridge, UK.
2. Fundamental Food Microbiology, Bibek R. and Bhunia A., 5th Ed., 2014, CRC Press, USA.
3. Modeling in food Microbiology: From predictive microbiology to exposure assessment, Edited by Membre J. M., Valdramidis V., 2016, Elsevier Ltd and ISTE press, UK.
4. Modern Food Microbiology, Jay J., Loessner M. and Golden D., 7th Ed., 2005, Springer, USA.
5. Predictive Modeling of Microbial Behavior in Food, Stavropoulou & Bezirtzoglou, E. (2019). Foods. 8. 654. 10.3390/foods8120654.

Unit 2:

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2. Food Packaging: Principles and practice, Robertsn G.L., 2013, CRC Press, USA
3. Food processing and preservation, Subbulakshmi G., Udipi S. A., 2006, New Age International, New Delhi.
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Unit 3:

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2. Ethnic Fermented Foods and Alcoholic Beverages of Asia, Edited by Tamang J.P., 2016, Springer, India.0
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6. Manual for packaged drinking water, Bureau of Indian Standards, third issue, Doc No.: SM/IS14543 & IS13428/03 2013.
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8. Modern Food Microbiology, Jay J., Loessner M. and Golden D., 7th Ed., 2005, Springer, USA.
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Unit 4:

1. Food Microbiology and Food Safety Practical Approaches, Edited by King H., 2013, Springer, NY.
2. Food Microbiology, Adams M. R. and Moss M. O., 3rd Ed., 2008, RSC Publishing, Cambridge, UK.
3. Food safety and quality control, Mathur P., 2018, Orient Blackswan Private Ltd., Hyderabad.
4. Food safety and standards act, 2006 (Act No. 34 of 2006), 2019, Kamal Publishers, New Delhi.
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6. Fundamental Food Microbiology, Bibek R. and Bhunia A., 5th Ed., 2014, CRC Press, USA.

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11. www.codexindia.nic.in
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Title: CELLS IN THEIR SOCIAL CONTEXT **Course: SMIC1003**

LEARNING OBJECTIVES

1. Understand various aspects of cell communication
2. Understand cell division and cell death
3. Understand developmental biology and stem cells

Number of lectures: 60

UNIT 1: CELL COMMUNICATION 15 LECTURES

LEARNING OBJECTIVES

Understand principles of Cell communication

1. General Principles of cell communication 2L

- Extracellular signal molecules
- Intracellular signaling proteins
- Classes of cell-surface receptor proteins

2. Signaling through G-protein-coupled cell surface receptors 5L

- G-protein relay signals
- c-AMP and protein kinases
- Inositol phospholipid signaling pathway
- Intracellular mediators and their effects

3. Signaling through enzyme coupled cell surface receptors 6L

- Receptor Tyrosine Kinases
- Ras
- MAP kinase
- PI-3 kinase
- TGF
- Bacterial chemotaxis

4. Signaling in plants 2L

- Receptor Serine / Threonine kinases
- Role of ethylene
- Phytochromes

UNIT 2: CELL CYCLE AND CELL DEATH 15 LECTURES

LEARNING OBJECTIVES

1. Understand the concepts of cell division and apoptosis

1. Mechanism of cell division 9L

- Cell cycle and cell cycle control system
- S-phase
- Mitosis
- Cytokinesis

- Control of cell division and cell growth
- Comparison with prokaryotes

2. Apoptosis **6L**

- Programmed cell death
- Extrinsic pathway of apoptosis
- Intrinsic pathway of apoptosis

UNIT 3: STEM CELLS, GERM CELLS AND FERTILIZATION 15 LECTURES

LEARNING OBJECTIVES

1. Understand the types of stem cells and ethics involved in their use
2. Understand the gamete formation and fertilization in animals

1. Stem cells **7L**

- Types of stem cells
    i. Embryonic stem cells
    ii. Adult stem cells
    iii. Induced pluripotent stem cells
- Applications of stem cells in
    i. Regenerative medicine
    ii. Cancer therapy
- Ethical considerations of stem cell therapy

2. Germ cells and fertilization **8L**

- Overview of sexual reproduction
- Meiosis
- Eggs
- Sperm
- Fertilization

UNIT 4: DEVELOPMENTAL BIOLOGY 15 LECTURES

LEARNING OBJECTIVES

1. Understand the types of stem cells and ethics involved in their use
2. Understand the development of multicellular organisms

1. Development of animals **10L**

- Universal mechanisms of animal cell development
- Mechanisms of pattern formation
    i. Axes development
    ii. Role of egg polarity, gap, pair rule and *Hox* genes
- Developmental timing
    i. MicroRNA,
    ii. Environmental cues
    iii. Role of hormones
- Morphogenesis
- Growth regulation during development
- *Caenorhabditis elegans* and *Drosophila* as model organisms

2. The genetics of flower development in *Arabidopsis* **2L**

3. Development in *Dictyostelium* **1L**

4. Programmed cell death in development **1L**

5. Evo-Devo: The study of evolution and development **1L**

CIA: Group Presentation, Test

References:-

Unit 1

1. Molecular Biology of the Cell, Albert B., Johnson A., Lewis J., Raff M., Roberts K. &Walter P., 5th ed, 2008, Garland Science, Taylor & Francis Group, NY, USA.
2. Molecular Cell Biology, Lodish H., Berk A., Kaiser C. A., Krieger M. Bretscher A., Ploegh H., Amon A. and Scott M., 7th Ed., 2013, W.H Freeman & and Company, New York, USA.
3. Cell biology, Gerald Karp, 6th Ed., 2010, John Wiley & sons, USA.

Unit 2

1. Molecular Biology of the Cell, Albert B., Johnson A., Lewis J., Raff M., Roberts K. &Walter P., 5th ed, 2008, Garland Science, Taylor & Francis Group, NY, USA.
2. Molecular Biology of the Gene, Watson J. D., Baker T. A., Bell S. P., Gann A., Levine M., Losick R., 5th Ed., 2007, Pearson Education, UK.
3. Molecular Cell Biology, Lodish H., Berk A., Kaiser C. A., Krieger M. Bretscher A., Ploegh H., Amon A. and Scott M., 7th Ed., 2013, W.H Freeman & and Company, New York, USA.
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2. Molecular Biology of the Cell, Albert B., Johnson A., Lewis J., Raff M., Roberts K. &Walter P., 5th ed, 2008, Garland Science, Taylor & Francis Group, NY, USA.

Unit 4

1. http://dictybase.org/ - Online resource for Dictystelium development.
2. https://dev.biologists.org/ - Online resource for Developmental biology.
3. https://flybase.org/ - Online resource for Developmental biology in Drosophila.
4. Insights into morphogenesis from a simple developmental system. Chisholm, R.L. & Firtel, R.A. Nat. Rev. Mol. Cell Biol. 5, 531–541 (2004).
5. Molecular Biology of the Cell, Albert B., Johnson A., Lewis J., Raff M., Roberts K. &Walter P., 6th ed, 2014, Garland Science, Taylor & Francis Group, NY, USA.
6. Principles of Genetics, D. PeterSnustad & Michael J. Simmons, 6th Ed., 2012, John Wiley & Sons Inc., USA.

Title: ADVANCES IN BIOTECHNOLOGY **Course: SMIC1004**

LEARNING OBJECTIVES
Know the applications and advances in the field of animal, plant, molecular and nano biotechnology.

Number of lectures: 60

UNIT 1: ANIMAL BIOTECHNOLOGY **15 LECTURES**

LEARNING OBJECTIVES
1. Know the concept and techniques in animal tissue culture.
2. Understand generation and applications of transgenic animals.

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1. Animal Tissue Culture **2L**
- Primary culture, Organ culture, Embryo Culture, Established Cell lines

2. Scale up, cryopreservation **2L**

3. Risks and Safety associated with animal tissue culture **2L**

4. Stem cell culture and applications **2L**

5. Methods of generation of transgenic animals and their application **7L**
- Retroviral method
- DNA microinjection method
- Engineered embryonic stem cell method
- Transgenic cattle, transgenic birds, transgenic fish

UNIT 2: PLANT AND AGRICULTURAL BIOTECHNOLOGY **15 LECTURES**

LEARNING OBJECTIVES
1. Understand advanced technologies involved in plant biotechnology.
2. Understand applications of transgenic plants.

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1. Plant Transformation Technology **7L**
- *Agrobacterium* mediated gene transfer, *Agrobacterium* based vectors, viral vectors
- Direct gene transfer methods, chemical methods, electroporation, microinjection, particle bombardment, molecular breeding, plant selectable markers, reporter genes, positive selection, selectable marker elimination
- Transgene silencing, strategies to avoid transgene silencing

2. Plant Genetic Engineering for Productivity and Performance **8L**
- Biotic Stress Tolerance- Herbicide resistance, Glyphosate, Insect Resistance, *Bt* toxin, Disease Resistance, Virus resistance
- Abiotic Stress Tolerance-- drought, flood, salt and temperature.
- Manipulation of photosynthesis, nitrogen fixation, nutrient uptake efficiency

- Quality Improvement-protein, lipids, carbohydrates, vitamins and minerals.
- Biosafety concerns of transgenic plants
- Plants as bioreactor

UNIT 3: PLANT TISSUE CULTURE & NANOBIOTECHNOLOGY

15 LECTURES

LEARNING OBJECTIVES

1. Know the concept and techniques in plant tissue culture.
2. Understand synthesis and properties of nanostructures and their applications.

1. Plant Tissue Culture for crop improvement **5L**

- Initiation and maintenance of callus and suspension culture, direct and indirect organogenesis, Micropropagation, artificial seeds, anther culture and dihaploids, Protoplast isolation culture and fusion, production of haploids, somaclonal variations, Germplasm conservation, Somatic hybrids

2. Production of secondary metabolites from plant cell cultures **2L**

- Technology of plant cell culture for production of chemicals
- Bioreactor systems and models for mass cultivation of plant cells

3. Nanoscale systems and Synthesis of nanostructures **3L**

- Nanoparticles, nanowires, thin films and multilayers
- Physical, chemical and biological methods

4. Nano-biosensors **1L**

- Cantilevers: types and applications
- Electrochemical nanosensors

5. Manipulation of biomolecules using nanotechnology **2L**

- Optical tweezers
- Dielectrophoresis
- Micro and Nanofluidics
- Chip technologies

6. Medical nanotechnology **2L**

- Drug and gene delivery systems
- Nanoimaging
- Nanomedicine and cancer diagnostics and treatment.

UNIT 4: ADVANCES IN MOLECULAR BIOTECHNOLOGY 15 LECTURES

LEARNING OBJECTIVES:

Learn the different methodologies involved in molecular biotechnology

1. Chemical synthesis, sequencing of DNA and synthetic biology **3L**

- Phosphoramidite method for nucleotide synthesis, uses of synthesized oligonucleotides, Dideoxynucleotide method for sequencing of DNA, Automated DNA sequencing, Next generation sequencing

- **Synthetic Biology:** Introduction, types, mechanisms, applications in industry

2. Manipulation of Gene Expression in Prokaryotes **3L**

- Gene expression from strong and regulatable promoters, fusion proteins, unidirectional tandem gene arrays, increasing protein stability, protein folding, DNA integration into host chromosome

3. Heterologous protein production in eukaryotic cells **3L**

- Expression systems like *Saccharomyces cerevisiae*, *Pichia pastoris*, Baculovirus-Insect cell, mammalian cell

4. Protein Engineering **6L**

- Adding disulfide bonds, changing asparagine to other amino acids, Reducing the number of free sulfhydryl residues, increasing enzymatic activity, modifying metal cofactor requirement, decreasing protease sensitivity, modifying protein specificity, increasing enzyme stability and specificity
- Cre-lox system and CRISPR-Cas9 for gene modification
- Synthesis of commercial products by recombinant microorganisms

CIA: Test, Assignment
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1. Animal Cell Culture, Gangal S., 2010, Universities press, India.
2. Basic Cell Culture, Davis J. M., 2nd Ed., 2007, Oxford press, UK.
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Unit 2:

1. H. K. Das, Textbook of Biotechnology, 2004, Wiley India, India.
2. Introduction to Plant Biotechnology, H.S. Chawla, 3rd Ed., 2002, Oxford and IBH publishers, UK.
3. Molecular Biotechnology, Principles and Applications of recombinant DNA, Glick and Paternak, 4th Ed., 2010, ASM Press, USA.
4. Plant Biotechnology: The genetic manipulation of plants, 2005, A. Slater, N. Scott & M. Fowler, Oxford Univ Press, Oxford, UK.

Unit 3:

1. An introduction to Plant Tissue Culture, Kalyan Kumar De, 1992, New Central Book Agency, India.
2. Biotechnology, B. D. Singh, 2010, Kalyani Publishers, India.
3. Fundamentals of Nanotechnology, Hornyak D., Moore J., Tibbals H., Dutta J., 2008, CRC press, USA.
4. Handbook of Nanostructured biomaterials and their applications in nanobiotechnology, Nalwa H. S., 2005, American Scientific Publishers, USA.
5. Introduction to plant tissue culture, Razdan M. K., 2003, Science Publishers, USA.

6. Nanobiotechnology, Niemeyer C. M. and Mirkin C. A., 2005, Wiley-Interscience, USA.
7. Nanotechnology: principles and practices Kulkarni, S. K. (2014). Springer, USA.

Unit 4:

1. An Introduction to Molecular Biotechnology: Molecular Fundamentals, Methods and Applications in Modern Biotechnology, edited by Wink M., 2006, Wiley VCH, USA.
2. Molecular Biotechnology, Principles and Applications of recombinant DNA, Glick and Paternak, 4th Ed., 2010, ASM Press, USA.
3. Molecular biotechnology: Principles and practices, Channarayappa, 2006, Universities Press, India.
4. Synthetic Biology, Benner S., Sismour A. M., 2005, Nature Reviews Genetics, v6, p533 -543.

M.Sc. II **Course: SMIC10PR**
Practicals semester 4

INTERNAL PROJECT **SMIC 1001PR and SMIC 1002PR**
Group based Research Projects to study industrially/environmentally important microbes/ microbial processes using microbial diverse rich samples.

FOOD, PHARMACEUTICAL AND COSMETIC MICROBIOLOGY
SMIC 1003PR

Food Microbiology
1. Microbiological study of fermented food: Idli batter
2. Quality Assessment and Analysis of packaged foods: Salad, Juice, Milk, Yogurt (ISI standards)
3. Microbiological analysis of fish samples with respect to sample processing for recovery and detection of EPEC, S*almonella, Vibrio* as per BIS/ISO/APHA standards and computation of measure of uncertainty.

Pharmaceutical and Cosmetic Microbiology
1. Sterility testing of pharmaceutical product (eg: water for injection) and reporting
2. Microbial load of cosmetic product
3. Efficacy testing of preservatives from cosmetics shelf life study (used and unused products)

ENVIRONMENTAL MICROBIOLOGY, ANIMAL TISSUE CULTURE AND NANOTECHNOLOGY **SMIC 1004PR**

Environmental Microbiology
1. Soil analysis- nitrogen, phosphorus, chloride, organic matter, & calcium carbonate content.
2. Biofilm visualization by staining of a slide immersed in soil (to emphasize compositional and structural variations in biofilms from different environment).
3. Determination of MIC of antimicrobials with sessile and planktonic bacteria (to show higher resistance of biofilms to antimicrobials as compared to planktonic cells) quantified using crystal violet assay
4. Analysis of sludge: sewage and industrial for the following parameters: sludge volume index (SVI), Mixed liquor suspended solids (MLSS), Mixed liquor volatile suspended solids (MLVSS), F/M ratio.

Advances in Biotechnology
1. Terminology, Laboratory design of Animal tissue culture laboratory
2. Preparation of complete medium, Sterilization and sterility checking.
3. Chick embryo fibroblast culture, viable staining with haemocytometer
4. Basic techniques in Animal tissue culture: Revival, Subculturing, Cytotoxicity and Freezing
5. Preparation of Nanosilver By Wet reduction Method (Chemical), using plant extracts(plants) & microorganisms
6. Characterisation of Nanosilver by UV spectrometry methods
7. Antimicrobial effect of Ionic silver and Nanosilver prepared by above methods.
8. Study of Nanosilver coated Gauze/textiles for antimicrobial effect on different bacteria

CIA:
SMIC 1001PR: Project Conduct
SMIC 1002PR: Rough draft of internal Project Report
SMIC 1003PR: Lab experiment
SMIC 1004PR: Lab experiment