MNS UNIVERSITY OF AGRICULTURE, MULTAN
REGISTRAR OFFICE: ACADEMICS SECTION
Tel: 061-9201560, E-mail: aisha@mnsuam.edu.pk

No: MNS-UAM/RO(A)-38/960
Date: 15.12.202

NOTIFICATION

The Syndicate in its 35th meeting held on 19.11.2022 has approved the recommendations made by the Academic Council in its 9th meeting held on 02.11.2022, regarding revisions in scheme of studies of Master of Science (Honours) and Doctor of Philosophy (PhD) Biotechnology from session 2023 and onwards (as per attached Appendix).

Aisha Bibi
Deputy Registrar (Acad.)
For Registrar

Distribution: -

- Director Quality Enhancement Cell
- Dean Faculty of Agriculture and Environmental Sciences
- Director Graduate Studies
- Director, Institute of Plant Breeding and Biotechnology
- Controller of Examinations
- Treasurer
- Deputy Registrar (HR)
- Secretary to the Vice Chancellor
- Office File

Appendix

REVISION IN SCHEME OF STUDIES

MASTER OF SCIENCE (HONOURS)

AND

DOCTOR OF PHILOSOPHY (PhD)

BIOTECHNOLOGY

Approved vide	Meeting	Date
Academic Council	9th	02.11.2022
Syndicate	35th	19.11.2022

FACULTY OF AGRICULTURE AND ENVIRONMENTAL SCIENCES

MNS UNIVERSITY OF AGRICULTURE, MULTAN

Course Contents

Approved

Biotech-701
Biotechnology: Principles of and Applications 3(2-1)

Learning Objectives
This course will enable the students to:
• Understand the current trends and concepts in biotechnological research.
• Explain the application of modern biotechnological techniques in various fields.
• Comprehend nanomaterials, nanoparticle synthesis techniques, characterization techniques and their applications in various fields

Learning Outcomes
After completing the course, the students will be able to:

Course Learning Outcomes (CLOs)

Sr.	CLOs	Domains	PLOs
1	Understand how molecular techniques are contributing to field biotechnology.	Cognitive	1
2	Analyze different methods of molecular and biotechnological techniques and their applications for plants improvement	Psychomoter	3
3	Apply the basic concepts of biosecurity and bioethics on real life issue	Psychomotor	2

SDGs addressed in the course:
Goal 2: Zero Hunger

Teaching Mode: Blended Learning Mode

Theory
Concept of Biotechnology; Biotechnology in plant improvement; Tools of molecular biotechnology: DNA recombinant technology, manipulation and introduction into living cells; Organisms used in biotechnology; Gene cloning; Gene and genome sequencing: Platforms and generations of sequencing; Principles and methods of polymerase chain reaction (PCR);Electrophoresis and blotting in gene cloning and sequencing; Gene expression: regulation and function, promoter, transcript and protein analyses; Forward and reverse genetics; Structural, functional and comparative genomics; Genome annotation; Transcriptome analysis; High throughput genome analysis; Gene editing and its application to

biotechnology; Molecular analysis of cloned gene; Tissue culture and soma clonal variation; Hybridization; Methods of protoplast transformation: direct DNA uptake, PEG-induced uptake, electroporation and microinjection. Prospects of protoplast transformation; Principles of tissue engineering; Stem cells; Bioactive molecules; Biotechnology in agriculture; Production of therapeutic recombinant proteins in transgenic plants and animals; Directed mutagenesis and protein engineering. Nanobiotechnology and its application in Agriculture.

Practical

DNA extraction and purification, PCR and electrophoresis analysis; Promotor detection and analysis; Plasmid isolation and digestion; Restriction digestions and cloning; Preparation of competent cells; Transient expression analysis; Green fluorescent protein (GFP) and Beta glucuronides (GUS); Transformation techniques; Southern, northern and western blotting. Synthesis of Nano particles by different methods.

Text Books

1. Brown, T.A. 2016. Gene Cloning and DNA Analysis: An Introduction. 7th Ed. Wiley and Blackwell, Chichester, UK.

Suggested Readings

1. Khanna, D.R. 2010. Textbook of Blue Biotechnology. 1st Ed. Discovery Publishing House Pvt. Ltd, New Delhi, India.
2. Siegel, J. 2009. Forensic Science: A Beginner's Guide. 1st Ed. One World Publications, London, UK.
3. Slater, A., N.W. Scott and M.R. Fowler. 2008. Plant Biotechnology: The Genetic Manipulation of Plants. 2nd Ed. Oxford University Press, Oxford, UK.
4. Smith, R.H. 2012. Plant tissue culture: techniques and experiments. Academic Press. Massachusetts, MA, USA.
5. Wink, M. 2011. An Introduction to Molecular Biotechnology: Fundamentals, Methods and Applications. 2nd Ed. John Wiley & Sons, Inc. New Jersey, NJ, USA.

Biotech-702 Bioethics, Biosafety and Biosecurity 3(2-1)

Learning Objectives

This course will enable the students to:

- Understand bioethical rules and regulations.
- Explain risk assessments regarding genetically modified organisms and biosafety laws.
- Comprehend biohazards and bioweapons.

Learning Outcome

After completing the course, the students will be able to:

Sr.	CLOs	Domains	PLOs
1	Analyze the potential bio risks associated with biotechnology and molecular genetics research	Cognitive	9

2	Comprehend basic ethical principles which guide bioscience research	Cognitive	9
3	Apply the basic concepts of biosecurity and Bioethics on real life issue	Psychomotor	2

SDGs addressed in the course:
Goal 2: Zero Hunger

Teaching Mode: Blended Learning Mode

Theory

Introduction to bioethics; Bioethics in 21st century; Ethical issues related to genetically modified food; General principles and biosafety guidelines; Guidelines for laboratory/facility commissioning; Guidelines for laboratory/facility certification; Good microbiological techniques; Microbiological risk assessment; Basic laboratories – Biosafety Levels 1,2,3 and 4, Laboratory techniques; Contingency plans and emergency procedures; Disinfection and sterilization, transport of infectious substances; Transgenic plants, delivery of genes to plants and animals, marker free technology; Risks Related to GMOs (Gene flow; horizontal and vertical gene transfer); Risk assessments for genetically modified organisms; Safety organization and training; WHO Biosafety Collaborating Centres; Biohazards; Ethical issues in the Genetic Engineering/biotechnology industry, issues including rights of individuals in clinical trials, human care of laboratory plants and animals, proliferation of genetically engineered food, plant genome manipulation, animal genome manipulation, organism cloning, bioweapons; International rules and regulations for GMOs; Ethical issues regarding GMOs and Euthanasia; Issues related to reproductive and cloning technologies; Issues to transplants and Eugenics; Patent laws; Commercialization and benefits sharing; Role of national bioethics and biosafety committees; Biosafety regulations; The issues include rights of individuals in GMO's trials, care of transgenic plants, and delivery of genes to plants and animals.

Practical

Microbiological risk assessment, Laboratories Biosafety Level 1, 2, 3 and 4 (Code of practice; Laboratory design and facilities; Laboratory equipment; Health and medical surveillance; Waste handling; Chemical, fire, electrical, radiation and equipment safety), Using biological safety cabinets in the laboratory; Usage and safe handling of specimens and equipment in the Laboratory; Emergency procedures for microbiological laboratories.

Text Books

1. World Health Organization. 2020. Laboratory Biosafety Manual, 4th Ed. Geneva, Switzerland.

Suggested Readings

2. Furr, A.K. 2000. Handbook of Laboratory Safety. 5th Ed. CRC press, Boca Raton, FL, USA.
3. Krishna, S.V. 2011. Bioethics & Biosafety in Biotechnology. 2nd Ed. New Age International New Delhi, India.

4. Lewis, R.J. 1999. Sax dangerous properties of Industrial materials. 10th Ed. John Wiley and Sons, New Jersey, NJ, USA.
5. World Health Organization. 2006. Biorisk management; Laboratory biosecurity Guidance. Geneva, Switzerland.

Biotech-703 Molecular Cell Biology 3(2-1)

Learning Objectives

This course will enable the students to:

1. Understand molecular basis of cell structure and function.
2. Understand cell communication and behavior.
3. Comprehend advances in microscopy.

Learning Outcome

After completing the course, the students will be able to:

Sr.	CLOs	Domains	PLOs
1	Demonstrate the genetic information flow in the eukaryotic cell.	Cognitive	13
2	Understand how cells can communicate and the central intracellular signal transduction pathways.	Cognitive	10
3	Perform cell culture and microscopy.	Psychomotor	4

SDGs addressed in the course:

Goal 2: Zero Hunger

Teaching Mode: Blended Learning Mode

Theory

Cell cycle, structure and functions; Diversity of genomes and tree of life; Bio-membranes and internal organization of the cell: nucleus, membrane structure, membrane transport of small molecules and the ionic basis of membrane excitability, intracellular compartments and protein sorting, vesicular traffic in the secretory and endocytic pathways; Electron transport chains and their proton pumps; Molecular basis of photosynthesis and energy conversion. Protein trafficking; communication between cells and subcellular compartments and their role in organism adaptation; Plant cell signaling: cell surface signaling molecules and intracellular signal transduction; Signaling pathways of gene control; The Cytoskeleton: cell locomotion, molecular motors and cell behavior; Autophagy and selective autophagy; Molecular basis of cell cycle, apoptosis and cancer.

Practical

Cultivation of bacteria; Transformation; Isolation of plasmid DNA; PCR; Analysis of sequencing results and database searches; Microscopy in life sciences; Recent advances to

investigate protein dynamism and interactions like BiFC, FRET, FRAP microscopy; Analysis of gene expressions by means of Green Fluorescent Protein (GFP).

Text Book

1. Lodish, H. F. 2021. Molecular Cell Biology. 9th Ed. W.H. Freeman & Company, Madison Avenue, New York, NY, USA.

Suggested Readings

1. Alberts, B. 2014. Molecular Biology of Cell. 6th Ed, Garlan Science, Taylor and Francis group LLC, New York, NY, USA.
2. Bradshaw, R and E. Dennis. 2009. Handbook of Cell Signaling. 2nd Ed. Academic Press, Massachusetts, MA, USA.
3. Karp, G. 2009. Cell and molecular biology: concepts and experiments. John Wiley & Sons, Inc. New Jersey, NJ, USA.
4. Lim, W., M. Bruce and P. Tony. 2014. Cell Signaling: Principles and Mechanisms. 1nd Ed. Garland Science, LLC, New York, NY, USA.

Biotech- 704 Gene Expression and Regulation 3(2-1)

Learning Objectives

This course will enable the students to:

1. Understand the role of promoters and transcription factors in gene expression.
2. Comprehend modulation of gene expression in prokaryotic and eukaryotic system.
3. Learn how to modify regulation of gene expression.

Learning Outcomes

Sr. #	CLOs	Domain	PLOs
1	Understand role of promoters and transcription factors in gene expression	Cognitive	4
2	Explain regulation of gene expression	Cognitive	2
3	Apply modulation of gene expression in prokaryotic and eukaryotic system	Psychomotor	11

SDGs addressed in the course:

Goal 2: Zero Hunger

Teaching Mode: Blended Learning Mode

Theory

Principles of gene expression; Housekeeping genes; Segmentation genes; Positive and negative regulations of gene expression; Chromatin structure and control of gene expression;

Regulation of gene expression in prokaryotes and eukaryotes; Post-transcriptional modifications: Intron splicing, capping, Poly-adenylation; RNA mediated regulation of gene expression: transcriptional gene silencing through RNA-directed DNA methylation, role of lncRNAs in transcription; Post-translational modifications and their role in protein functions; Hormonal control of gene expression; Promoters and types of promoters (constitutive, inducible, tissue specific, hybrid and synthetic promoters); Cis acting elements of promoters (Transcription activators, Dehydration responsive elements, Light responsive elements, Heat responsive elements); Transcription factors (MYB factors, WRKY factors); DNA binding domains of transcription factors (zinc finger domains, helix turn helix, helix loop helix, etc); Interaction of transcription factors with promoter Cis acting element; Transcription activators; Post transcriptional suppression; Translation repressions.

Practical

Construction of genomic and cDNA libraries; Use of qPCR in genomic study; Primer designing for qPCR; Presentation of expression data in graphical form; Expression analysis: NGS, qPCR and ELISA; Protein purification by chromatography; SDS-PAGE; Peptide mass determination by mass spectrophotometry.

Textbook

1. Albert, B., A. Johnson, J. Lewis, M. Laff, K. Roberts, and P. Walter. 2008. Molecular Biology of the Cell. 5th Eds." Garland Science. New York, NY, USA.

Suggested Reading

1. Brown, T.A. 2016. Gene Cloning and DNA Analysis: An Introduction. 7th Ed. Wiley and Blackwell, Chicester, UK.
2. Heldt, H.W and Piechulla, B. 2010. Plant Biochemistry. 4th Ed. Academic Press, Massachusetts, USA.
3. Meisenberg, G and Simmons W. H. 2016. Principles of Medical Biochemistry. 4th Ed. Elsevier, Amsterdam, Netherlands.
4. Nelson, D.L and Michael, M.C. 2012. Lehninger Principles of Biochemistry. 6th Ed. W.H. Freeman & Company, Madison Avenue, New York, NY, USA.
5. Punia M.S. 1999. Plant Biotechnology and Molecular Biology: A Laboratory Manual. Scientific Publishers, Jodhpur, India.

Biotech-705 Bioremediation and Biodegradation 3 (2-1)

Learning Objectives

This course will enable the students to:

- Understand role of microorganisms in their environment.
- Explain biological degradation of toxic and environmental hazardous matters.
- Apply strategies and approaches of bioremediation and biodegradation.

Learning Outcome

After completing the course, the students will be able to:

Sr. #	CLOs	Domain	PLOs
1	Understand principles and protocols of bioremediation and degradation	Cognitive	1
2	Explain toxic material and hazardous matter	Cognitive	5
	Apply methods of bioremediation and biodegradation	Psychomotor	

SDGs addressed in the course:
Goal 2: Zero Hunger
Teaching Mode: Blended Learning Mode

Theory
Introduction to bioremediation and biodegradation; History and evolution of bioremediation and biodegradation; Current remediation practices; Microbial bioremediation: A potential tool for restoration of contaminated areas; Characteristics of microorganisms suitable for remediation; Factors of bioremediation; Strategies and approaches of microbial bioremediation; In situ and ex situ bioremediation; Bioreactors; Genetic manipulation and improvement of microbial strains for enhanced bioremediation; Removal of heavy metals; Role of microbes in improving salinity levels; Applications of microbes to treat wastewater; Degradation of polyaromatic hydrocarbons and other recalcitrants; Petroleum and diesel biodegradation; Degradation of plastic; Nanotoxicity: Aspects and concerns in biological systems, nanomaterials into living organisms and nanotoxicity; In vivo degradation, biodegradable nanomaterials and microbes; Application of molecular techniques for the assessment of microbial communities in contaminated sites; Microbial community profiling, library construction, sequencing, genetic fingerprinting and functional analysis; Metagenomics, metatranscriptomics, metaproteomics; Applying the bioreporter as a pollution monitoring and bioremediation tool; Biosurfactant-based bioremediation of toxic metals; genetic basis of biosurfactant production, biofilm-mediated bioremediation of polycyclic aromatic hydrocarbons; Microalgae in bioremediation: sequestration of greenhouse gases, clear-out of fugitive nutrient minerals, and subtraction of toxic elements from waters, bioreactor and enzymatic reactions in bioremediation, biohydrometallaurgy and biomining; Phytoremediation.

Practical
Microbial culture techniques; Selective media for identification of bacteria for bioremediation; Preparation of compost for biodegradation; Identification of microbes for waste-water treatment; Identification of microbes for soil bioremediation; Microcosm preparation and initial count; Biosurfactant synthesis study; Inoculation of degrading microorganisms; Count and degrader selection; Observation of degrader colonies; Evaluation of microbial communities in contaminated soil

Text Book

1. Shah, M. P. 2020. Microbial bioremediation & biodegradation. 1st Ed. Springer, Singapore.

Suggested Readings

1. Ergas, S.J., D.P.Y. Chang, E.D. Schroeder and J.B. Eweis. 1998. Bioremediation Principles. William C Brown Pub, Bel Air, California, CA, USA.
2. Kirchman, D.L. 2012. Processes in Microbial Ecology. 1st Ed. Oxford University Press, Oxford, UK.
3. Ollivier, B. and Magot, M. 2005. Petroleum Microbiology. 2nd Ed. ASM Press, Washington, D.C., USA.
4. Singh, A. and Ward, O.P. 2004. Biodegradation and Bioremediation. 1st Ed. Springer, Berlin, Germany.
5. Surajit, D. 2014. Microbial Biodegradation and Bioremediation. 1st Ed. Elsevier, Amsterdam, Netherlands.

Biotech-706 Plant Forensic Science 3(2-1)

Learning Objectives:

This course will enable the students to:

1. Understand genotyping, fingerprinting, polymorphism and forensics.
2. Understand gene transformation methods and their random insertion in host genome
3. Learn internationally quarantine audit through forensic approaches and laws and development of gene bank.

Learning Outcome

After completing the course, the students will be able to:

Sr.	CLOs	Domains	PLOs
1	Understand principles and practices of forensic science	Cognitive	1
2	Recognize the social, professional and ethical responsibilities	Cognitive	9
3	Learn internationally quarantine audit through forensic approaches and laws and development of gene bank	Cognitive	9, 11

SDGs addressed in the course:

Goal 2: Zero Hunger

Teaching Mode: Blended Learning Mode

Theory

Introduction to plant forensic or forensic botany; History, evolution and application of plant forensic; Standards and guidelines for forensic botany identification, training and personnel, evidence handling, equipment and methods, reference materials and collections; DNA sequencing; Genotyping: STR and SNP; Case documentation and reporting; Plant genetics for

forensic applications; Importance and origin of polymorphism Plant product forensics; Microsatellites in plant forensics; Resolution of microsatellite genotypes, discovery of microsatellite loci and primer development; Microsatellite genotyping and data collection: sample collection, storage, DNA extraction, PCR and gel electrophoresis; Genome scanning through genetic markers (EST, RFLP, AFLP, STS, CAPS, RAPD, DAF, AP-PCR, SSR, VNTR, ISSR, SNP, SCAR); Gene data bank; Homology-based genome analysis; DNA fingerprinting and barcoding; Direct and indirect ELISA, sandwich ELISA; Northern, Southern and Western blotting; International forensic laws and its implementation.

Practical

Sample and information collection for forensic study; Sample preparation and storage; DNA fingerprinting and barcoding of major crops; DNA extraction, PCR and gel electrophoresis; Southern, Northern and Western blots; ELISA; Forensic microscopy

Text Book

1. Jane H. Bock and David O. Norris. 2016. Forensic Plant Science. 1st Ed. Elsevier, Amsterdam, Netherlands.

Suggested Readings

1. Brown, T.A. 2000. Essential Molecular Biology: A Practical Approach. Oxford University Press, New York, NY, USA.
2. Gordh, G and S. McKirdy. (ed.). 2014. The Handbook of Plant Biosecurity. 1st Ed. Springer, Amsterdam, Netherlands.
3. Henry R. J. 2012. Molecular Markers in Plants. 1st Ed. John Wiley & Sons, New Jersey, NJ, USA.
4. Nelson, D.L and Michael, M.C. 2012. Lehninger Principles of Biochemistry. 6th Ed. W.H. Freeman & Company, Madison Avenue, New York, NY, USA.

Punia M.S. 1999. Plant Biotechnology and Molecular Biology: A Laboratory Manual. Scientific Publishers, Jodhpur, India.

Biotech- 707 Tissue Culture and Somatic Cell Genetics 3(2-1)

Learning Objectives

This course will enable the students to:

- Understand the importance of cell, tissue and organ culture.
- Know application of cell and tissue culture in life sciences.
- Learn cell and tissue culture techniques.

Learning Outcome

After completing the course, the students will be able to:

Sr.	CLOs	Domains	PLOs
1	Understand Plant Tissue culture technique	Cognitive	1
2	Analyze different plant tissue culture methods	Psychomotor	3
3	Apply different tissue culture methods in various crops to enhance their quality and quantity	Psychomotor	2

SDGs addressed in the course:

Goal 2: Zero Hunger

Teaching Mode: Blended Learning Mode

Theory

Totipotency: Genetics of cultured plant cells; Introduction to culture techniques: Organogenesis, embryogenesis, Callus culture, embryo rescue; Meristem culture for virus elimination; In vitro fertilization; Techniques for somatic cell culture: Haploid cell culture, double haploids and triploids production; Protoplast isolation and culture: experimental systems and monitoring of protoplast growth in culture; Somaclonal variation: Fate of somaclonal variations; Exploitation of protoplast-to-plant technologies: somatic hybridization via protoplast fusion; Selection and confirmation of somatic hybrids: Inheritance pattern of cellular genomes in the hybrids, Symmetric vs asymmetric somatic hybrids; Somatic hybridization to generate novel plants: Citrus, Brassica, Potato/ Solanaceae, Cereals; PGRs their role in In vitro techniques; Somaclonal variation; Application in different Crops.

Practical

Media preparation; Stock solutions; Maintenance of asepsis; In vitro propagation; Different types of explants culture (shoot-tip, nodal segments, leaf disks, embryo, callus, cell suspension); Cell line culture; Protoplast fusion and culture; Callus production and optimization; Plantlet regeneration; Transfer of plantlets from tissue culture to greenhouse and field; *In vitro* grafting; Production and testing of virus free plants.

Text Book

1. Razdan, M.K. 2003. Introduction to Plant Tissue Culture. 2nd Ed. Science Pub Inc, New York, NY, USA.

Suggested Readings

1. Basra, A.S. 2000. Plant Growth Regulators in Agriulture and Horticulture. CRC Press, Boca Raton, Florida, FL, USA.
2. Brown, T.A. 2016. Gene Cloning and DNA Analysis: An Introduction. 7thEd. Wiley and Blackwell, Chicester, UK.

3. Kumar, B. 2014. Culture of Plant Cells, Tissues and Organs. Random Publications, New Delhi, India.
4. Nicholl D.S.T. 2008. An Introduction to Genetic Engineering. 2nd Ed. Cambridge University Press, New York, NY, USA.

Scoggins, H. and M. Bridgen. 2014. Plants from Test Tubes: An Introduction to Micro propagation. 4th Ed. Timer Press Inc, Portland, USA.

Biotech-708 Advances in Viral Genomics 3(2-1)

Learning Objectives

This course will enable the students to:

- Understand the mode of action of viral replication, recombination and host resistance.
- **Comprehend virus and host relationships.**
- **Understand the development of resistance strategies against viruses using advanced biotechnology**

Program Learning Outcomes

Sr.	CLOs	Domains	PLOs
1	Understand viral replication and emergence of new viral strains	Cognitive	1
2	Apply advanced techniques to control viruses for providing solutions to public health, crop issues and livestock sector	Psychomotor	3
3	Use appropriate techniques to develop virus resistance and appropriate use of equipment and tools in laboratory	Psychomotor	4

SDGs addressed in the course:

Goal 2: Zero Hunger

Teaching Mode: Blended Learning Mode

Theory

Importance of viruses and role of viruses in the development of science; Evolution of viruses: place of viruses in tree of life, molecular mechanisms of genetic variation in viruses; Classification of viruses; Viroid; Viral pathogenesis: Structure and organization of viral genomes, factors responsible for maintenance of virus infection, virus host interaction; Replication and life styles of plant, animal and mycoviruses; Yeast as a model host to study plant virus replication; Viral strategies to capture host machinery, host immunity against viruses; Modes of viral replication in single and double stranded DNA or RNA viruses; Replication of plus strand and minus strand RNA viruses; Structure of RNA viruses and mechanism of replication via RNA synthesis from RNA; Gene expression strategies. Epidemiology. Transmission of viruses. Plant viruses: Virus induced gene silencing, reverse genetics and the modern era of plant virology, plant viral gene function; Insect viruses: Current impact and use of insect viruses, insect cell expression systems; Baculoviruses as bio control

agents; Viruses, a tool in biotechnology: for the study of viral pathogens, viral vectors and their applications; Diagnostic Virology: recent viral attack on living organisms e.g. dengue virus, ebola virus, Covid-19 etc.

Practical

Field surveys to explore the biodiversity of the viruses and collection of samples; DNA and RNA isolation; Primer designing, PCR, RCA and ELISA based detection of the viruses; Cloning of full-length infective viruses; Designing and construction of recombinant virus and its vectors; Viral genome characterization; Development of viral hairpin constructs; Importance and use of various microscopic techniques in virus replication research; Viral metagenomics; Effective approaches to develop viral vectors.

Text Book

1. Tresh, J.M. 2006. Advances in Virus Research: Plant Virus Epidemiology. 1st Ed. Academic Press, Massachusetts, MA, USA.

Suggested Readings

1. David, M.K. and P.M. Howlay. 2013. Field's Virology. 6th Ed. Lippincott Williams & Wilkins, Pennsylvania, USA.
2. Flint, S. J., V. R. Racaniello, G. F. Rall, T. Hatziioannou and A. M. Skalka. 2020. Principles of virology, Volume 2: pathogenesis and control. John Wiley & Sons, Inc. New Jersey, NJ, USA.
3. John B.C and A.S. Venetia. 2013. Virology: Principles and Applications. 2nd Ed. John Wiley and Sons, New Jersey, NJ, USA.
4. Leitner, T. 2012. The Molecular Epidemiology of Human Viruses. 1st Ed. Springer, Amsterdam, Netherlands.
5. Lostroh, P. 2019. Molecular and cellular Biology of Viruses. 1st Ed. CRC Press, Taylor and Francis, London, UK.

Biotech-709 Bioinformatics 3(2-1)

Learning Objectives

This course will enable the students to:

- Understand the latest bioinformatics tools of DNA and protein sequence analysis.
- Understand the contribution of bioinformatics to gene discovery in biotic and abiotic stress responses
- Use bioinformatical tools for application in agriculture.

Learning Outcomes

After completing the course, the students will be able to:

Sr .#	CLOs	Domain	PLOs
1	Understand about the types of information stored in	Cognitive	4

	different databases		
2	Find sequences for the gene of interest	Psychomotor	2
3	Use bioinformatical tools for application in agriculture.	Psychomotor	11

SDGs addressed in the course:

Goal 2: Zero Hunger

Teaching Mode: Blended Learning Mode

Theory

Bioinformatics and its interdisciplinary nature, Structural Bioinformatics; Database Warehousing in Bioinformatics; Data Mining for Bioinformatics: Browsing global DNA and ESI protein databases, NCBI, swissprot etc; Genome browsing: Biological sequence assembly and alignment; Pattern matching for motifs, visualization and fractal analysis of biological sequences; Modern tools of bioinformatics for DNA and protein sequence analysis: contig assembly, multiple sequence alignment, dot plots, protein structure prediction tools, translation tools, primer designing software, promoter prediction tools; Phylogenetic analysis: Sequence submission to data bases, Graphical representation of data, cluster analysis; Population structure analysis; Use of artificial intelligence in bioinformatics; Application of bioinformatics in agriculture.

Practical

Browsing data bases: EMBL, NCBI, Swissprot, BLAST for searching genes of interest from genebanks; Promoter, DNA and protein sequence analysis; Construction and analyses of multiple sequence alignment, phylogenetic tree and Sequence logo; Retrieving nucleotide data from chromatogram files; Analysis of high throughput sequences and expression; Transgene analysis

Text Book

1. KaviKishor, P.B, B. Rajib and S. Prashanth. 2014. Agricultural Bioinformatics. Springer, New Delhi, India.

Suggested Readings

1. Gustafson, J.P., R. Shoemaker and J.W. Snape. 2005. Genome Exploitation: Data Mining the Genome. 1st Ed. Springer, Amsterdam, Netherlands.
2. Lodge, J, L. Peter and M, Steve. 2007. Gene cloning; principles and applications. University of Birmingham. Taylor and Francis, London, UK.
3. Loging, W.T. 2016. Bioinformatics and Computational Biology in Drug Discovery and Development. 1stEd. Cambridge University Press, New York, NY, USA.
4. Orengo, C.A., D.T. Jones and J.J. Thornton. 2004. Bioinformatics: Gene, Protein, and Computers. 1stEd. Cromwell press, Trowbridge, U.K.

Simpson, R.J. 2004. Purifying Proteins for Proteomics: A laboratory manual. Cold Spring Harbor Laboratory Press, New York, NY, USA.

Biotech- 712 Recent Trends in Biotechnology and Nanobiotechnology 3(2-1)

Learning Objectives

This course will enable the students to:

- Understand the current trends and concepts in biotechnological research.
- Explain the application of modern biotechnological techniques.
- Create more comprehension towards nanomaterials, synthesis & characterization techniques, and their applications.

Learning Outcome

After completing the course, the students will be able to:

Sr.	CLOs	Domains	PLOs
1	Explain the importance and uses of recent development in Bio-nanotechnology	Cognitive	1, 2
2	Apply Bio-nanotechnology in sustainabke Agriculture	Psychomotor	10
3	Demonstrate the techniques used in Nanobiotechnology	Psychomotor	11

SDGs addressed in the course:

Goal 1: No Poverty

Teaching Mode: Blended Learning Mode

Theory

Molecular biotechnology and genetic engineering: methodology and applications. Magnetic particles in biotechnology: from drug targeting to tissue engineering. Synthetic gene and genome; Built-in synthetic gene circuits in *Escherichia coli;* System biology, genome editing and nuclease-based gene therapy (TALENs, CRISPR/CAS9); Microbial biotechnology: effective tool in biopharmaceutical production; Heterologous proteins; Cell-free protein expression systems: application in the research on antibiotics; Targeting ribosome. Experimental lichenology.

Nanotechnology: Concept of nanotechnology, nanobiotechnology and bionanotechnology; Types and dimension of nanomaterials; Nanoparticles: shape and size effects, quantum size effect, quantum dots, energy wavelength correlation, conduction band and resonance effect; Properties and synthesis of nanoparticles; Characterization techniques of nanoparticles: UV-visible spectrophotometer, Zeta potential/sizer (DLS), Scanning Electron Microscope (SEM), Transmission Electron Microscope (TEM), X-Rays Diffraction (XRD), X-rays photoelectron spectroscopy (XPS), and Atomic force microscopy (AFM); Applications of nanotechnology in agriculture; Nano-carriers for vaccine delivery into the living organism; Risk assessments

of nanotechnology; Future prospects of Nanobiotechnology; Nanoparticles in Sustainable Agricultural; Carbon Nanotubes and Modern Nanoagriculture.

Text Book

1. Atul Bhargava, Shilpi Srivastava. 2018. Biotechnology: Recent Trends and Emerging Dimensions. 1st Edition, CRC Press, Taylor and Francis Group. Boca Raton, Florida, FL, USA.

Suggested Readings

1. Bernard R. G., J.J. Pasternak and C.L. Patten. 2010. Molecular Biotechnology: Principles and Applications of Recombinant DNA. 4th Ed. ASM Press, Washington, D.C., USA.
2. Chand, A.M and M.N. Christof. 2007. Nanobiotechnology II: More Concepts and Applications. 1st Ed. John Wiley & Sons. New Jersey, NJ, USA.
3. Kumar, N. and S. Kumbhat. 2016. Essentials in Nanoscience and Nanotechnology. John Wiley & Sons. New Jersey, NJ, USA.
4. Marian P. 2011. Advances in Applied Biotechnology. 1st Ed. Intechopen, London, UK.

Shoseyov and I. Levy. 2008. Nanobiotechnology: Bio-inspired Devices and Materials of the Future. 1st Ed. Humana Press, New Jersey, NJ, USA.

Biotech-713 Advanced Genomics, Proteomics and Metabolomics 3(2-1)

Learning Objectives

This course will enable the students to:

- Understand genome prediction and annotation strategies.
- Explain structure and function of proteins in system biology.
- Learn modern metabolomics techniques.

Learning Outcomes

After completing the course, the students will be able to:

Sr. #	CLOs	Domain	PLOs
1	Understand genome prediction and annotation	Cognitive	4
2	Explain structure and function of proteins in system biology.	Cognitive	2
3	Comprehend metabolomics and other omics	Cognitive	11

SDGs addressed in the course:

Goal 2: Zero Hunger

Teaching Mode: Blended Learning Mode

Theory

Genomics: Eukaryotic genomes, genome size, population and comparative genomics; Nucleotide and structural variability; Advanced genomics tools; Next generation sequencing (NGS), sequence assembly, transcriptome profiling techniques, qPCR, gene chip, experimental design and implementation of gene chip; Exon prediction programs, integrated gene finding software packages; Proteomics: Update of Proteomics methods; Proteogenomics annotation; Biological function: function by context, moonlighting, etc. First draft of the human proteome and proteome atlas; Biomedical and biotechnological applications of proteomics: Biomarkers in biomedicine; MS imaging; Identification of drug targets and virulence factors in reverse vaccinology by differential proteomics, surfomics and immunomics; Pathogen identification (BioTyper); Expression, structural and functional proteomics; 2 D gel, densitometry using software, affinity purification, tandem affinity purification (TAP) tagging; Fluorescence resonance energy transfer (FRET) and co-immune precipitation; Protein-protein interactions, protein-DNA interaction; Yeast one hybrid and two hybrid systems; Metabolomics: tools for the metabolomic studies, magnetic resonance spectroscopy (NMR) and mass spectrometry (MS); The quest for biomarkers; Advanced lipoprotein profiling; Integrating proteomics and metabolomics to understand models of diseases; Challenges and solutions for high-throughput phenotyping approaches; Genomics and proteomics of COVID-19.

Practical

Finding of genome/protein sequences through different data basis; Sequence Alignment tools; Comparison at genome/proteomic level; Predictions of intron and exon; Reading of ORF sequencing; Identification tools for exon; Promoter analysis; Terminator types and analysis; Use of Gene Finder; Phytozome, NCBI; In silico Expressional profiling tools.

Text Book

1. Pevsner, J. 2015. Bioinformatics and Functional Genomics. 3rd Ed. John Willey and Sons, New Jersey. NJ, USA.

Suggested Readings

1. Arivaradarajan, P. and G. Misra. 2018. Omics Approaches, Technologies and Applications. Springer, Singapore.
2. Field, D and N. Davies. 2015. Biocode: The New Age of Genomics. 1st Ed. Oxford University Press, New York, NY, USA.
3. Guenter, K. 2015. The Dictionary of Genomics, Transcriptomics and Proteomics. 5th Ed. Wiley Blackwell, New Jersey, NJ, USA.
4. Reinders, J. 2016. Proteomics in Systems Biology: Methods and Protocols. 1st Ed. Humana Press, New York, NY, USA.

Sechi, S. 2016. Quantitative Proteomics by Mass Spectrometry. 2nd Ed. Humana Press. New York, NY, USA.

BIOTECH 719 Special Problem 1 (0-1) Student will be assigned a special topic for searching literature relevant to a particular problem or conducting an experiment or any other appropriate activity. Student has to compile a comprehensive report on the title assigned.
BIOTECH 720 Seminar 1(1-0) Student will be given a topic on a particular problem in the field of plant breeding and genetics. Student has to deliver a presentation in an open house gathering on the title assigned. PhD student has to defend his/her synopsis in an open house gathering as Seminar II.