MNS UNIVERSITY OF AGRICULTURE MULTAN

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APPROVED SCHEME OF STUDIES

B.Sc. (HONS.) AGRICULTURE

MAJOR - BIOTECHNOLOGY

INSTITUTE OF PLANT BREEDING AND BIOTECHNOLOGY

Approved vide	Meeting	Date
Academic Council	7th	09.08.2021
Syndicate	31st	10.10.2021

REVISION OF THE SCHEME OF STUDIES

B.SC. (HONS.) AGRI. MAJOR BIOTECHNOLOGY FOR SESSION 2021 AND ONWARDS

SEMESTER-Ill

Proposed			
Course #	**Title**	**Credit Hours**	**Course Type**
Biotech-401	**Introduction to Biotechnology and Molecular Genetics**	3(2-1)	FC

SEMESTER-IV			
Course #	**Title**	**Credit Hours**	**Course Type**
Biotech-402	Introduction to Biotechnology and Bioinformatics	3(2-1)	FC

SEMESTER-V (***Students will opt for 5 credit hours from elective courses***)			
Course #	**Title**	**Credit Hours**	**Course Type**
Biotech-501	Principles of Biotechnology	3 (2-1)	Major
Biotech-503	Introduction to Biosafety	**3 (2-1)**	Major
Biotech-505	Molecular Cell Biology	3 (2-1)	Major
Biotech-507	Modern Concepts in Biotechnology	3 (2-1)	Major
Biotech-509	Introduction to Bioinformatics and Functional Genomics	3 (2-1)	Major
	Sub-Total Credit Hours	**15**	
AGRON-505	Field Crop Physiology	3 (2-1)	Elective
SST-509	Seed Production of Transgenic Crops	3 (2-1)	Elective
PBG-505	Cytogenetics	3 (2-1)	Elective
Biotech-511	Molecular Virology	2(1-1)	Elective
Biotech-513	Biophysics and Computational Biology	**2(1-1)**	Elective
	Total Credit Hours	**20**	

SEMESTER-VI (*Students will opt for 5 credit hours from elective courses*)

Course #	Title	Credit Hours	Course Type
Biotech-502	Genomics and Proteomics	**3(2-1)**	Major
Biotech-504	Epigenetics	3(2-1)	Major
Biotech-506	Plant Transformation	4(3-1)	Major
Biotech-508	Principles of Plant Molecular Physiology	**3 (2-1)**	Major
Biotech-510	Nanobiotechnology	**2 (1-1)**	Major
	Sub-Total Credit Hours	**15**	
Biochem-502	Fundamental Biochemistry	3 (2-1)	Elective
PBG-504	Modern Concepts in Plant Breeding	3 (2-1)	Elective
ENT-516	Introduction to Insect Molecular Genetics	2 (1-1)	Elective
PP-518	Biotechnology and its applications in Plant Pathology	2 (1-1)	Elective
	Total Credit Hours	**20**	

SEMESTER-VII (*Students will opt for 2 credit hours from elective courses*)

Course #	Title	Credit Hours	Course Type
Biotech-601	Agricultural Biotechnology	**4 (3-1)**	Major
Biotech-603	Genome Editing and its Applications	3 (2-1)	Major
Biotech-605	Fundamentals of Seed Molecular Biology	**3 (2-1)**	Major
FST-621	Food Biotechnology	3 (2-1)	Major
Biotech-611	Preparation of Research Project and Scientific Writing	2 (1-1)	Major
Biotech-613	Biotechnology Entrepreneurship	**3 (2-1)**	Major
	Sub-Total Credit Hours	**18**	
PBG-613	Bio-Safety Measures in GM Crops	2 (1-1)	Elective
Biotech-615	Industrial Biotechnology	2(1-1)	Elective
Biotech-617	Animal Biotechnology	2 (1-1)	Elective
	Total Credit Hours	**20**	

SEMESTER-VIII

Course #	Title	Credit Hours	Course Type
Biotech -612	Internship and External Evaluation	6(0-6)	Major

Revised

Biotech-401 Introduction to Biotechnology and Molecular Genetics 3(2-1) FC

Learning Objectives

This course will enable the students to:

- **Describe the concept and principles of biotechnology.**
- **Understand modern concept of genetics and molecular biology**
- **Learn the application of genetics and biotechnology in agriculture**

Program Learning Outcomes:

Sr.	CLOs	Domain	PLOs
1	Describe the basics of genetics and biotechnology	Cognitive	1
2	Memorize advanced techniques of genetics and biotechnology	Cognitive	3
3	Illustrate the applications of genetics and biotechnology in agriculture	Cognitive	4

SDGs addressed in the course

(2) Zero Hunger
(4) Quality Education
(9) Industry, Innovation and Infrastructure

Teaching Mode:

Blended Learning

Theory

Introduction to biotechnology; Central dogma of molecular biology; Introduction to genetics; Concept of heredity and variation; Mendelian Genetics: Monohybrid, dihybrid phenotypic and genotypic ratios; Chromosome theory of heredity; Allelic and non-allelic interactions (epistasis): Illustration of epistasis with suitable examples; Pleiotropy and multiple allelism; Multiple factor hypothesis; Linkage and crossing over; Sex determination, sex linked, sex limited and sex influenced traits; Chromosomal aberrations; Recombinant DNA technology and genetic engineering; Tissue culture and plant transformation; Applications of biotechnology in agriculture; Interdisciplinary nature of biotechnology; Biosafety regulatory standard and risk assessment.

Practical

Vector designing and Gene cloning, Tissue culture and plant transformation, Genetic problems on mono-hybrid, dihybrid, epistasis, multiple alleles, Quantitative inheritance, linkage and crossing over.

Text Book:

1. **Brown, T. A. 2012. Introduction to genetics: a molecular approach. Garland Science, New York, NY, USA.**

Suggested Readings

1. Brown, T.A. 2016. Gene Cloning and DNA Analysis: An Introduction. 7th Ed. Wiley and Blackwell, Chicester, UK.
2. Khan I.A., F.M. Azhar, Z. Ali and A.A. Khan. 2008. Solving Numerical Genetic Problems. Department of Plant Breeding and Genetics., University of Agriculture, Faisalabad, Pakistan.
3. Strickberger, M.W. 1990. Genetics. 3rd Ed. McMillan Publishing Co., New York, NY, USA.

4. **Snustad, D. P. and M. J. Simmons. 2015. Principles of genetics. John Wiley & Sons. New Jersey, NJ. USA.**

Biotech-402 Introduction to Biotechnology and Bioinformatics 3 (2-1) Elective

Learning Objectives

This course will enable the students to:

- **Describe basic concept of biotechnology and bioinformatics**
- **Understand modern concept of genetic engineering and its applications**
- **Learn the application of basic bioinformatics tools**

Program Learning Outcomes:

Sr.	CLOs	Domain	PLOs
1	Describe the basics of biotechnology and bioinformatics	Cognitive	1
2	Get acquaintance with advanced techniques of genetic engineering and its applications	Cognitive	2,3
3	Apply basic bioinformatics tools	Psychomotor	4

SDGs addressed in the course

(2) Zero Hunger
(4) Quality Education
(9) Industry, Innovation and Infrastructure

Teaching Mode:

Blended Learning

Theory

Introduction to biotechnology and bioinformatics, Tools of biotechnology; Genetic engineering/Recombinant DNA technology; genetic transformation and plant tissue culture. Tools of bioinformatics; genome browsing, data downloading and phylogenetic analysis, various input query formats, Computer based analysis of genome organization in prokaryotes and eukaryotes. Achievements and prospects of biotechnology and bioinformatics in agriculture. Biosafety and risk assessment: Biosafety regulation system in Pakistan; composition and functions of various biosafety committees (IBC, TAC, NBC, etc.).

Practical

Lab safety rules and risk assessment. Preparation of stock solutions. DNA extraction, quantification, amplification, electrophoresis and scoring. RNA extraction, quantification and synthesis of cDNA. Media Preparations. Bioinformatics software applications; primer synthesis, BLAST and alignment.

Text Book:

1. Walker JM and Rapley, 2008. Molecular Biomethods Handbook (Methods in Molecular Biology). 2nd Edition; Humana Press. Totowa, NJ, USA.

Suggested Readings

1. Brown, T. A. 2010. Gene Cloning and DNA Analysis: An Introduction. (6th ed.). Wiley Blackwell, UK
2. Krawetz, S.A. and D.D. Womble. 2003. Introduction to Bioinformatics: A Theoretical and Practical Approach (1st ed.). Humana Press, New Jersey, USA.
3. Nicholl, D.S.T. 2010. An Introduction to Genetic Engineering (3rd ed.). Cambridge University Press. New Delhi, India.

4. Rashidi, H. and L.K. Buehler. 2005. Bioinformatics: Applications in Biological Science and Medicine (2nd ed.). CRC Press/Taylor & Francis Group.
5. Razdan, M. K. (Ed). 2003. Introduction to Plant Tissue Culture. (2nd ed.). Intercept, New York, USA.

Biotech- 501 Principles of Biotechnology 3 (2-1)

Learning Objectives:

This course will enable the students to:

- **Describe basic principles and concepts of Biotechnology.**
- **Learn advanced techniques in Biotechnology specially gene cloning and transformation**
- **Apply recent molecular techniques following biosafety rules.**

Program Learning Outcome:

Sr.	CLOs	Domain	PLOs
1	Describe basic principles and concepts of Biotechnology	Cognitive	1
2	Discuss advance techniques in Biotechnology specially gene cloning and transformation	Cognitive	1
3	Apply recent molecular techniques following biosafety rules.	Psychomotor	2,4

SDGs addressed in the course

(1) No Poverty,
(2) Zero Hunger
(4) Quality Education

Teaching Mode:

Blended Learning

Theory:

Nucleic acid isolation, quantification, amplification (Polymerase Chain Reaction), Electrophoresis, Restriction and digestion, Plasmid Isolation, Cloning (TA and gateway cloning), Sequencing, Transfection, Transduction and Transformation, Western blotting, Southern blotting, Northern blotting, ELISA, Immunochemistry, Tissue culturing, Slide Preparation and Cell Stains, Agar plate preparation and streaking for the purpose of individual colony isolation, Quantification: Colony Forming Units (CFU), Dilution Plating, Identification and characteristics of colonies, Bioinformatics and techniques, Rule for Primer designing, Ethical issues in biocenology.

Practical:

DNA/RNA extraction, Primer designing, PCR analysis, Electrophoresis, Cloning, Plasmid Isolation, ELISA, Agar plate preparation, Streaking, Transfection, Transformation.

Text Book:

1. **Brown, T. A., 2016. Gene Cloning and DNA Analysis: An Introduction; 7th Edition, John Wiley and Sons Ltd., Chicester, UK.**

Suggested Readings:

1. Brown, T.A. 2010. Gene cloning and DNA analysis: An Introduction; 6th Edition, A John Wiley and Sons, Ltd., UK.
2. **Brown, T. A., 2012. Introduction to genetics: A molecular approach; 1st Edition, Garland Science, New York, NY, USA.**

3. **Christou, P. and Klee, H., 2007. Handbook of Plant Biotechnology: Wiley International, London, UK.**
4. Klug, W.S. and Cummings, M.R. 2003. Concepts of Genetics: 7th Edition, Pearson Education, Singapore.
5. **Krishna, S.V., 2011. Bioethics & Biosafety in Biotechnology; 2nd Edition, New Age International, New Delhi, India.**
6. Lewin, B., 2008. Genes IX, Jones and Bartlett publishers, Burlington, Massachusetts, USA.
7. **Wong, D. W.S., 2018. The ABCs of gene cloning: 3rd Edition, Springer, Albany, CA, USA.**

Biotech-502 Genomics and Proteomics 3(2-1)

Learning Objectives:

This course will enable the students to:

1. **Describe the Principles of advanced genomics and proteomics approaches.**
2. **Explain the applications of modern genomics and proteomics tools in crop improvement.**
3. **Illustrate the integrated *In silico* techniques with modern genomics and proteomics tools for the better Describing for functional genomics and proteomics of the crops.**

Program Learning Outcomes:

Sr	CLOs	Domains	PLOs
1	Describe the basic concept of different genomics and proteomics approaches	Cognitive	1
2	Explain how to utilize the recent genomics and proteomics tools to exploit genetic resources of different agricultural crops	Psychomotor/Affective	3,5
3	Apply the *In silico* genomics and proteomics integrated tools design different in vitro projects	Psychomotor	3,11

SDGs Addressed in the Course

(4) Quality Education

Teaching Mode:

Blended Learning.

Theory:

Evolutionary prospect of genome; Different School of thoughts, Genetic mapping; Organization and structure of genomes; Genetic mapping: (RFLP, microsatellite, SNP), High resolution physical mapping (STS, EST), Comparative genomics and genome evolution; Whole genome shotgun sequencing: DNA sequencing strategies, Manual and automated sequencing, different platforms used for next generation sequencing (NGS) sequence assembly, Exon prediction programs; Integrated gene finding software packages; Digital gene expression profile (DGEP); Non allelic interaction (epistasis); Expression; structural and functional proteomics; Top down and bottom up strategies; 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; Two hybrid system (yeast); Mass spectrometry (APMS, MALDI TOF, FPLC, MALDI imaging)

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. **Subramanian, C. 2015. A text book of Bioinformatics. Dominant Publishers and Distributors New Dehli, India.**

Suggested Readings

1. **David W.M. 2004. Bioinformatics sequence and genome analysis 2nd edition. Cold spring Harbor Laboratory Press. New York, NY, USA.**
2. **Myllykangas S. and Buenrostro J. 2012. Bioinformatics for High Throughput Sequencing. Stanford Genome Technology Center, Stanford University School of Medicine, Springer Science Business Media, LLC. New York, NY, USA.**
3. **Myllykangas S. and Buenrostro J. 2012. Bioinformatics for High Throughput Sequencing. Stanford Genome Technology Center, Stanford University School of Medicine, Springer Science Business Media, LLC. New York, NY, USA.**
4. **Subramanian, C. 2015. A text book of Bioinformatics. Dominant Publishers and Distributors New Dehli. India**

Biotech-503 Introduction to Biosafety 3(2-1)

Learning Objectives:

This course will enable the students to:

- **Describe the Principles and primary controls of biosafety**
- **Explain the risk mitigation schemes at every biosafety levels**
- **Recognize the biosafety issues and existing Biosafety system in Pakistan.**

Program Learning Outcomes.

Sr	CLOs	Domains	PLOs
1	Describe the basics of biosafety and biosecurity approaches	Cognitive	1
2	Know how to implement different biosafety model to maintain all biosafety levels	Psychomotor / effective	3,5
3	Apply the integrated biosafety, approaches and law to mitigate the risk in genetically modified crops.	Psychomotor	2,3,11

SDGs Addressed in the Course

(4) Quality education

Teaching Mode:

Blended Learning.

Theory:

Introduction to Biosafety - definition, concept, uses and abuses of genetic information and biohazards; good laboratory practices; risks related to genetically modified organisms (GMO); National Biosafety Policy, its scopes and objectives, Need for a separate biosafety laws in Pakistan, Prohibition and license requirements, Biosafety guidelines, Pakistan biosafety rules, 2005; Duties of Biosafety Officer, Establishment and functions of Institutional Biosafety Committee, Establishment and functions of National Biosafety Committee, Technical Advisory Committee, its establishment and functions, Decision making and communication of decision,

Grant of license, Application for re-examination. Introduction to IPO Pakistan, Why Intellectual Property, Patent Ordinance 2000, Introduction to bioethics, Biotechnology and ethics, Social concerns, Public acceptance of biotechnology. Definitions and concepts in risk assessment, Objectives of risk assessment, Risk assessment and management, Stages of risk assessment: Risk benefits analysis, Non-target and biodiversity risk assessment, Gene flow and its consequences, GMOs as potential environmental hazards and management of field releases, Risk communication, Perception of risks and benefits related to the application of modern biotechnology, Risk assessment during laboratory research.

Risk Groups classifications, Bioethical and biosecurity concerns regarding the Shipment of biological substances, Biggest threat to biosafety, Contingency plans in lab, Beak method is the key to safer behavior, Risk communication tools

Practical:

Hand washing and beak method, Risk groups, Biosafety levels, engineering control, PPE control, SOP Development and Administrative control, Safe work practices, Modeling for lab. autoclaving and sterilization, handling radioactive material. Emergency evacuation plans.

Suggested Readings:

Text Book

1. Furr, A.K. 2000. Handbook of Laboratory Safety. 5th Ed. CRC press, Boca Raton, FL, USA.

Suggested Reading

1. Krishna, S.V. 2011. Bioethics & Biosafety in Biotechnology. 2nd Ed. New Age International New Delhi, India.
2. Bio Prism 2018: A laboratory Safety Training Initiative Program Manual. New York, NY, USA
3. Pakistan Biosafety Rules. 2005. Notified under S.R.O (1)336/(I)/2005-Published in the Gazette of Pakistan.
4. World Health Organization. 2004. Laboratory Biosafety Manual, 3rd Ed. Geneva, Switzerland.

Biotech-504 Epigenetics 3(2-1)

Learning Objectives

This course will enable the students to:

- **Describe the basic mechanisms of epigenetic regulation, and their impact on heritable changes in view of gene expression**
- **Understand how the epigenetic genetic factors and mechanisms could affect phenotypes and can be used for crop genetics improvement**
- **Identify an epigenetic dataset provided to detect epigenetic marks like DNA methylation and histone modification points**

Program Learning Outcome

Sr	CLOs	Domains	PLOs
1	Describe the insight into the genetic regulation, learn heritable changes in gene expression and cellular phenotypes	Cognitive	1, 2

2	Demonstrate skills on how the epigenetic data can be retrieved from the available plant genomic resources.	Psychomotor	4
3	Analyze an epigenetic dataset provided to identify epigenetic marks like DNA methylation and Histone modification points	Psychomotor	11

SDGs addressed in the course:
(4) Quality Education
(15) Life on Land
Teaching Mode:
Blended Learning

Theory:
Overview of Epigenetics, Genome organization of eukaryotes, Heterochromatin and Euchromatin, Levels of chromatin organization, Histone modifications, Histone code hypothesis, Genetic modulation by CpG Island, DNA methylation and its implication on gene expression, Types of methylases, DNA/RNA and Protein methylation, and its implication on gene expression, Types of acetylases and acetylation of histones, Book marking, Cellular memory and Imprinting, Maternal effects, Paramutation, X- chromosome inactivation, Position effect variegation, Gene silencing, Transvection and Reprogramming; Epigenetic regulation of gene expression, cellular differentiation and signal transduction. **Application of Epigenetic modification for Genetics Improvement**

Practical:
Visualization of heterochromatin by different methylation techniques, Detection of CpG motifs by restriction enzymes, Detection of CpG motif by PCR, Bi-sulphite PCR, Detection of methylated sites on DNA. **Analysis of methylated DNA datasets for detection of Epigenetic marks**

Text Book

1. **Tollefsbol, T.O. 2010. Handbook of Epigenetics. Academic Press. Massachusetts, USA**

Suggested Readings

2. Su, L. J. and Chiang, T. C. 2015. Environmental epigenetics. Humnna Press. London, UK.
3. Carey, N. 2012. The Epigenetic Revolution. Columbia University Press. New York, NY, USA.
4. Richard, C. F. 2012. Epigenetics. W. W. Norton & Company. New York, NY, USA.
5. Benedikt, H. and Brian, K. H. 2011. Epigenetics: Linking Genotype and Phenotype Development and Evolution. University of California Press. CL, USA.
6. Tollefsbol, T.O. 2010. Handbook of Epigenetics. Academic Press. Massachusetts, USA

Biotech-505 Molecular Cell Biology 3(2-1)

Learning Objectives
The course will enable the students to:

- **Describe cell structure and functions**

- **Get deep insight into molecular mechanisms involved in cellular functioning**
- **Learn applications of cell biology in applied biotechnology**

Program Learning outcomes

Sr	CLOs	Domains	PLOs
1	Describe the structure of cellular macro-molecules and their structure, biosynthesis and metabolism.	Cognitive	1, 2, 3
2	Identify cell organelles, intracellular compartments and origin of organelles	Affective	5, 10
3	Explain transportation and translocation across membranes	Cognitive	1, 2

SDGs addressed in the course:
(4) Quality Education and (15) Life on Land

Teaching Mode:
Blended Learning.

Theory:
Cellular Macro-molecules: Structure, biosynthesis and metabolism, Plant Cell Wall, Function, Molecular composition and ultra-structure, Cell Organelles, Intracellular compartments and origin of organelles, Cellular Membranes, Structure, function, transport and translocation across membranes, Vesicular traffic in the secretary and endocytic pathway, The Cell Nucleus, Molecular nature of the nucleoplasm, Genome organization and transport across nuclear envelope, Mitochondria and chloroplasts in energy conversion, Cytoskeleton, Motors and movements, Concepts in intracellular Communication, Cell cycle and cell divisions. Cell Junctions, Cell Adhesion, and the extracellular matrix, Molecular and physiological basis of cellular development and differentiation. **Apoptosis (program cell death)**

Practical:
Cell Fractionation, Microscopy, Micrometry in cell biology (phase-contrast, polarization, interference and fluorescence microscopes, Electron microscopy), **Techniques for the examination of mitotic and meiotic chromosomes, Mount smear and squash preparations**; the analysis of cell mobility, Cell viability tests, Cell wall removal and protoplast formation, Deposition and regeneration of cell wall.

Text books.

1. **Lodish, H., A. Berk, C. A. Kaiser, M. Krieger, M. P. Scott, A. Bretscher, H. Ploegh, and P. Matsudaira. Molecular cell biology. Macmillan. 9th ed. Macmillan. USA**
2. Pierik, R.L.M. 1997. In vitro culture of Higher Plants. Kluwer Academic Publishers, Dordrecht, The Netherlands.
3. Karp, G. 1996. Cell and molecular Biology, Concepts and experiments. John Willey & sons. New York, NY, USA.
4. Ausubel, F.M., et al.1995. Current Protocols in Molecular Biology, John Wiley and Sons, New York, NY, USA.
5. Stafford, A. and G. Warren. 1991. Plant Cell and Tissue Culture. Open University Press, Buckingham, UK.

Biotech 506 Plant Transformation 4(3-1)

Learning Objectives

This course will enable the students to:

- **Recall, or recognition of terms, ideas, procedure, theories related to tissue culture and their application in advanced biotechnological methods**
- **Describe the prerequisites of the genetic transformation system, selection system and vector design**
- **Analyze different genetic transformation methods and their applications**

Program Learning Outcomes

Sr	CLOs	Domains	PLOs
1	Describe how biotechnology is used to improve agriculture, develop novel b	Cognitive	1
2	Analyze different genetic transformation methods and their applications for plants improvement	Affective	2
3	Evaluate different schools of thought regarding GMOs and will assess their impacts on society.	Affective	13

SDGs addressed in the course:
(2) Zero Hunger (4) Quality Education

Teaching Mode:
Blended Learning

Theory
Prerequisites of plant transformation, Integration of plant tissue culture in transgenic technologies, Selectable and screen able markers, Plant transformation methods; Vector-based DNA delivery methods, *Agrobacterium*-mediated transformation of plants, Types of vectors, Development of plant transformation vectors, Non vector-based gene transfer methods, Gene gun method of transformation, Polyethylene glycol (PEG)-mediated transformation, Electroporation, Chloroplast transformation, *In planta* transformation, molecular analyses of transgene expression, Gene silencing, Clean gene technology, Commercial exploitation of transgenic plants

Practical:
Preparation of leaf samples for transformation, Preparation of protoplasts for transformation, *Agrobacterium*-mediated transformation of different explants, PEG-mediated transformation protocol, Transient gene expression assays, Genetic analyses of transgenic plants (PCR, RT-PCR etc), Southern blotting, floral dip transformation, Selection of transgenic plants, Gus staining in plants

Textbook

1. Brown, T. A., 2016. Gene Cloning and DNA Analysis: An Introduction; 7th Edition, John Wiley and Sons Ltd., Chicester, UK.

Suggested Readings

2. Gerald K. G., Janet I. J, Wallace M. W., 2016. Karp's Cell and Molecular Biology, 8th Edition. John Willey and Sons, Inc. New York, NY, USA.
3. Nicholl, D. S. T. 2002. An Introduction to Genetic Engineering. Cambridge University Press, Cambridge, UK.
4. Lanza, R.P., Langer R. and Vacanti, J. 2000. Principles of Tissue Engineering. 2nd Edition. Academic Press, California, CL, USA.

Biotech-507 Modern Concepts in Biotechnology 3 (2-1)

Learning Objectives

This course will enable the students to:

- **Memorize terms, ideas, procedure and historical perspectives related to tissue culture and their application in advanced biotechnological methods**
- **Describe the prerequisites of plant tissue culture system and different methods involved**
- **Analyze different genetic methods and their applications of biotechnology**

Program Learning Outcomes

Sr	CLOs	Domains	PLOs
1	Describe how tissue culture is used to improve agriculture, and its integration in modern biotechnology.	Cognitive	1
2	Analyze different tissue culture methods and their applications for plants improvement	Affective	2
3	Evaluate different biotechnological tools that have direct impacts on society	Affective	13

SDGs addressed in the course:

(2) Zero Hunger (4) Quality Education 3

Teaching Mode:

Blended learning

Theory:

Brief history of plant tissue culture/genetic engineering, Plant Tissue Culture and Micro propagation, Callus and cell culture, Micro propagation, Role of plant hormones in Organogenesis, Molecular mechanism of Organogenesis, Somatic embryogenesis, Transfer and sub-culturing of explants into multiplication and rooting media, Deflasking of tissue cultured plantlets, Epigenetic variation Genetic variation, Applications of somaclonal variation, Identification of somaclonal variations, Gene isolation from different plant organs, Vector design and construction, Promoters/Enhancers, Selectable genetic markers. Small RNAs Virus Induced Gene Silencing, Applications of plant biotechnology in pharmaceutical industry, Plant synthetic biology, Developments and issues in plant biotechnology, Impact on cropping systems; **Genome editing tools and mapping tools, Nanoparticles and Carbon dots**

Practical

Organization of a tissue culture laboratory, Sterile techniques and tissue culture media preparation, Bacterial/fungal growth, *Agrobacterium* culture growth, Selection of transgenic plants, Gus staining in plants, *Arabidopsis thaliana* floral dip transformation, Selection of transgenic plants, Gus staining in plants; **Preparation of explants for Callus induction, Observations of different types of callus.**

Text Books:

1. **Brown, T.A. 2010. Gene cloning and DNA analysis: An Introduction, Sixth Edition, A John Wiley and Sons, Ltd., Chichester, West Sussex, UK**

Suggested Readings:

1. **Fehér A (2019) Callus, Dedifferentiation, Totipotency, Somatic Embryogenesis: What These Terms Mean in the Era of Molecular Plant Biology? Front. Plant Sci. 10:536.**
2. **Ignacimutu, S. 1997. Plant Biotechnology. Oxford IBH Publisher, New Delhi, India.**
3. **Kumar, P.A., Plant Biotechnology: Future Perspectives. Cambridge University Press, Cambridge, UK.**
4. **Lanza, R.P., Langer R.and Vacanti, J. 2000. Principles of Tissue Engineering. 2nd Edition. Academic Press, California, CL, USA**

Biotech-508 Principles of Plant Molecular Physiology 3(2-1)

Learning Objective

The course will enable the students to;

1. **Describe basic concepts and principles of molecular physiology in plants**
2. **Understand basic knowledge towards cell fate and its response against external and internal stimuli**
3. **Apply concepts of gene expression and regulation in response to biotic and abiotic factors**

Program Learning Outcomes

Sr	CLOs	Domains	PLOs
1	Describe basic concepts and principles of molecular physiology in plants	Cognitive	1
2	Explain basic knowledge towards cell fate and its response against external and internal stimuli	Cognitive	1
3	Apply concepts of gene expression and regulation in response to biotic and abiotic factors	Psychometry	3

SDGs addressed in the course:

(4)Quality Education.

Teaching Mode:

Blended Learning

Theory

Cell division regulation, Biochemical regulation of Proteins, Lipids and Carbohydrates metabolism, Photosynthesis; Molecular basis of photosynthetic and transpiration pathways, Molecular physiology of mineral nutrient acquisition, Transport and utilization, Plants store and sense nutrients, Plant hormones, Signal perception and transduction and Responses to abiotic stresses, Reproductive development and **ABC gene model,** Physiological changes induced by plant microbe interactions; **Composition and synthesis of nucleic acids; Source sink relationship**

Practical

Identification of photosynthetic and transpiration rate in plants under normal and stress condition. Differentiation between healthy and stressed cell using expression profiling

Text Book

1. **Buchanan, B. B., Gruissem, W. and Jones, R. L. 2015. Biochemistry and Molecular Biology of Plants; 2nd Edition, John Wiley and Sons. New York, NY, USA.**

Suggested Readings

1. **Singh, P. P., Kujur, A., Yadav, A., Kumar, A., Singh, S. K., & Prakash, B. 2019. Mechanisms of Plant-Microbe Interactions and its Significance for Sustainable Agriculture. In PGPR Amelioration in Sustainable Agriculture (pp. 17-39). Woodhead Publishing. 10.1016/B978-0-12-815879-1.00002-1**
2. **Nelson, D. L., Lehninger, A. L., and Cox, M. M. 2008. Principles of Biochemistry. Macmillan. W.H. Freeman and Company, New York, NY, USA.**
3. Taiz, L., Zeiger, E., Møller, I. M. and Murphy, A. 2014. Plant Physiology and Development, 6th Edition, Sinauer Associates, Inc., Sunderland, USA.
4. Bidlack, J. E., and Jansky, S. H. 2014. Introductory Plant Biology, 13th Edition. The McGraw-Hill Companies, New York, NY, USA.

Biotech-509 Introduction to Bioinformatics and Functional Genomics 3(2-1)

Learning Objectives

This course will enable the students to:

- **Describe basic tools of bioinformatics and functional Genomics**
- **Recall the latest bioinformatics tools for DNA and protein sequence analysis.**
- **Use latest bioinformatics tools for analysis of sequences and genomics data.**

Program Learning Outcomes

Sr	CLOs	Domains	PLOs
1	Recall the latest bioinformatics tools for DNA and protein sequence analysis.	Cognitive	1, 2
2	Demonstrate skills on how the bioinformatics tolls can be employed to predict structural and functional aspects of biological sequences.	Psychomotor	4
3	Analyze a gene family for evolution, genetic diversity, structural variations and functional aspects through bioinformatics tools	Psychomotor	11

SDGs addressed in the course:

(4) Quality Education (15) Life on Land

Teaching Mode:

Blended learning

Theory

Introduction to various databases, Browsing global DNA and ESI protein databases, NCBI, Swissport, Genome browsing, Bioinformatics and its sub-disciplines, Levels of bioinformatics, aims and potentials, Tools of bioinformatics; BLAST, COPIA, PROSPECT, CLUSTALW, PATTERN, HUNTER and EMBOSS, DNA Sequence contig assembly, Sequence submission to data base, Functional genomics and its applications, Gene mapping, Real Time PCR, **Genome Browser, Genome Search Tools, Gene Homology Search Tools, Retrieve Expression datasets**

Practical, How to use data bases i.e., EMBL and NCBI, Searching genes of interest from gen bank, primer designing using software available on internet, protein and DNA sequence analysis, development of phylogenetic tree, Retrieving nucleotide data from chromatogram files, searching protein sequences by using nucleotide query sequences, **BLAST with all modules, Data retrieval from NCBI and Plant Genomic databases**

Textbook

1. **Lesk A. 2019. Introduction to bioinformatics. Oxford University Press. Oxford, UK.**

Suggested Readings

2. **Chen C, Huang H, Wu CH. Protein bioinformatics databases and resources. In Protein Bioinformatics 2017 (pp. 3-39). Humana Press, New York, NY, USA**
3. Orengo, C.A., Jones, D.T. and Thornton, J.J. 2004. Bioinformatics: Gene, Protein, and computers, Cromwell press, Trowbridge, U.K.
4. Krawetz, S.A. and Womble, D.D. 2003. Introduction to Bioinformatics: A theoretical and practical approach. Mumass Press, Totowa, New Jersey, NJ, USA.
5. Bourne, P.E. and Weissig, H. 2003. Structural Bioinformatics. Wiley Liss/ISBN 0471202002.

Biotech-510 Nanobiotechnology 2 (1-1)

Learning Objectives

This course will enable the students to:

- **Describe concepts and principles of nanobiotechnology**
- **Learn about the synthesis of nanoparticles from different physical, chemical and biological systems.**
- **Know about the applications of nanotechnology in living systems**

Program Learning Outcomes

Sr	CLOs	Domains	PLOs
1	Describe basic concepts and principles of nanobiotechnology	Cognitive	1
2	Explain synthesis of nanoparticles	Cognitive	1
3	Illustrate applications of nanoparticles in living systems	Cognitive	3

SDGs addressed in the course:

(4) Quality Education

(9) Industry, innovation and infrastructure

Teaching Mode:

Blended Learning

Theory

Brief introduction to nanotechnology; Interface between nanotechnology and bio-nanotechnology; Nanostructures; Methods to prepare nano-size-metal particles: iron, gold and silver; Bacterial synthesis of nanoparticles; Green chemistry; Use of particles to deliver genetic material into plants and animals; Use of nanotechnology in agriculture-related disciplines: Food industry, textile industry and chemical industry; Waste Management; Use of nanotechnology in risk assessment; Nanotechnology and Environment; Risk in Nanotechnology; Future of Nanotechnology.

Practical

Selection of material for the synthesis of nanoparticles; Top-down and bottom-up synthesis approaches, hydrothermal, solvothermal, chemical reduction, ionic gelation, reflux and acidic pyrolysis methods; Purification methods of nanoparticles, centrifugation and dialysis tubing; Characterization of prepared nanoparticles through different high techniques UV-visible spectroscopy, Fourier transform spectroscopy; Drug load and release profiling.

Text Book

1. Kumar, N. and Kumbhat, S. 2016. Essentials in nanoscience and nanotechnology. Wiley. New Jersey, NJ, USA.

Suggested Readings

1. Slingerland, J. 2016. Nanotechnology. Essential Library, An Imprint of ABDO Publishing, Edina, Minnesota, MN, USA.
2. Shoseyov and Levy, I. 2007. Nanobiotechnology: Bio-inspired Devices and Materials of the Future. Ist Humana Press, New Jersey, NJ, USA.
3. Joseph, T. and M. Morrison. 2006. Nanotechnology in Agriculture and Food. 2nd Edition. Oxford Press, London, UK.
4. Rosenthal, S.J. and Wrigh, D.W. 2006. Nanobiotechnology protocols. 2nd Ed. Humana Press, New Jersy, NJ, USA.
5. Sadana, A. 2006. Binding and Dissociation Kinetics for different Biosensors Applications. Ist Ed. Elsevier Science, New York, NY, USA.
   Dutta, P. and Gupta, S. 2004. Describeing of Nanoscience and Technology. Ist Ed. Global vision publishing house, New Delhi, India.

Biotech-511 Molecular Virology 2(1-1)

Learning Objectives

This course will enable the students to:

- Discover the diversity and complexity of viral genomes by differentiating different classes and subclasses of viruses through structural and expression profile differentials.
- Describe the molecular mechanism behind viral replication, transmission, infection and mutation.
- Identify viral symptoms and associated virus infectivity assays using cell lines and transient gene expression through plant based vectors.

Program Learning Outcome

Sr	CLOs	Domains	PLOs
1	Explain the molecular mechanism behind viral replication, transmission, infection and mutation.	Cognitive	4, 5
2	Utilize the diversity and complexity of viral genomes in identifying different classes of plant and animal viruses.	Cognitive	5, 10
3	Apply various diagnostic tools for virus infectivity assays and develop preventive measures from viral infections in plants and animals.	Psychomotor	5, 10, 14

SDGs addressed in the course:

(4) Quality Education (15) Life on Land

Teaching Mode:

Blended Learning

Theory:

The structure and complexity of virus genomes; Virus mutants; Genetic and non-genetic interactions between viruses; Single and double stranded DNA/RNA viruses; Segmented and multipartite virus genomes; Replication in viruses, Molecular mechanisms of viral infections; Virus induced gene silencing, Satellites and viroids; Prions; recombinant viruses; **Preventive strategies against viral infections**

Practical

Symptoms of plant and animal viruses; Transmission of viruses through sap; Grafting; dodder and insects; Determination of physical properties of the viruses; Identification of viruses by serological and molecular methods; Storage of viruses; Determination of host range; Transient expression of genes using plant virus-based vectors; ELISA.

Text book

1. **Brown, T.A. Gene cloning and DNA analysis: an introduction. 6th ed. Wiley-Blackwell. Oxford, UK.**

Suggested Readings

1. Cann, A. 2015. Principles of molecular virology. USA: Elsevier Academic Press. NY, USA
2. Flint, S. J., Racaniello, V. R., Rall, G. F., Skalka, A. M., & Enquist, L. W. 2015. Principles of virology. ASM Press. Washington, DC, USA.
3. Klasse, P. J. 2015. The molecular basis of viral infection: Elsevier, Amsterdam, UK.
4. Kessler, H. H. 2014. Molecular diagnostics of infectious diseases. 3rd revised edition. Berlin, Germany
5. Uyeda, I. and Masuta, C. 2014. Plant virology protocols: New approaches to detect viruses and host responses. Humana Press. NY, USA.

Biotech-513 Biophysics and Computational Biology 2(1-1)

Learning Objectives:

This course will enable the students to:

- **Describe the basics of biophysics and computational biology**
- **Learn 3D structures and properties of macromolecules**
- **Apply methods in structural biology**

Program Learning Outcomes

Sr	CLOs	Domains	PLOs
1	Describe the basics of biophysics and computational biology	Cognitive	1
2	Learn 3D structures and properties of macromolecules	Cognitive	3,5
3	Apply methods in structural biology	Psychomotor	3,8,11

SDGs Addressed in the Course

(2) Zero hunger

Teaching Mode:

Blended Learning

Theory

Architecture and Physical Properties of Proteins, Introduction to biological phenomena of Protein, Variety and similarity in protein architecture, 3D structure prediction, Symmetry in supramolecules, Membrane protein structure, Protein folding and the physical principles, Protein dynamic features: Complex and dynamic system, Observation of dynamic properties by molecular simulation, Dynamics from protein crystallography, Behaviour of genes-dynamic DNAs, Methods in Structural Biology.

Practical

X-ray diffraction; light and neutron scattering; Nuclear magnetic Resonance; Fluorescence; DNA Microarrays; DNA and protein sequence alignment DNA motif prediction; Protein motif perdition; Prediction of 3D structure of protein; DNA-Protein interaction; Molecular docking

Text Book

1. Wong, K. C. 2016. Computational Biology and Bioinformatics: Gene Regulation. CRC Press, Taylor and Francis Group. Boca Raton, FL, USA.

Suggested Readings:

1. Church, G. 2016. Biophysics Genomics and Computational Biology. Springer, Netherlands
2. Tu, J., Inthavong, K. and Wong, K. K. L. 2015. Computational thermodynamics - Theory, Modelling and Applications. Dordrecht: Springer, Netherlands
3. Meksem, K. and Kahl, G. 2005. The Handbook of Plant Genome Mapping: Genetic and Physical Mapping, John Willey and Sons, N.Y.
4. Sensen, C. W. 2005. Handbook of Genome Research: Genomics, Proteomics, Metabolomics, Bioinformatics, Ethical and Legal Issues, John Willey and Sons, N.Y.

Liebler, D. C. 2001. Introduction to Proteomics, Tools for the New Biology, Humana Press, NJ, USA.

Biotech-601 Agricultural Biotechnology 4(3-1)

Learning Objectives:

This course will enable the students to:

- **Describe the Principles and methods of advanced molecular approaches in agriculture**
- **Understand the integrated molecular techniques with crop sciences to provide a step-change in crop productivity**
- **Recognize the of existing biotechnological based agricultural businesses in the world with their biosafety measures.**

Program Learning Outcomes

Sr	CLOs	Domains	PLOs
1	Describe the Basic concepts biotechnological and molecular biology approaches.	Cognitive	1
2	Utilize recent molecular techniques to exploit genetic resources of different agricultural crops and ethics of lab experimentation.	Psychomotor/Affective	3,5

3	Apply the biotechnological approaches to mitigate the emerging challenges of climate changes and food security.	Psychomotor	3,8,9,11

SDGs Addressed in the Course
(2) Zero hunger
Teaching Mode:
Blended Learning

Theory:
Application of Biotechnology in Agriculture: Conventional Plant Breeding, Tissue Culture and Micropropagation, Marker Assisted Selection, Transgenic crops, Plant disease diagnostics and microbial fermentation. Increase tolerance resistance against insect pest and weeds, Value addition through transgene, Vaccine production, Impact of Biotechnology on Agribusiness, Biotechnology in less developed countries, International impact of GM crops, Increased nutritional qualities, quantity, taste and texture of food crops, Reduced dependence on fertilizers, pesticides and other agro-chemicals, Production of Biofertilizers, Criticism on Agricultural Biotechnology, Future prospects of Agricultural Biotechnology. **Criticism on the different school of thoughts of biotechnology; RDT in Agricultural Biotechnology; Clean gene technology; Super weed and biotechnological errors; Bioprocessing (downstream and upstream); Trending of biotechnological businesses in developing countries; Biosafety awareness: a demanding domain in all living sciences.**

Practical:
Designing of DNA based markers through bioinformatics tools; PCR and Diversity analysis tools; QTL finding softwares; RDT; Designing of vector/ Expressional cassette.
Transformation; Expression Cassette; transient expression and stable expression

Text Book

1- Phillips, P. W. B., Castle, D. and Smyth, S. J. 2016. Biotechnology, agriculture and development. A Cheltenham: Edward Elgar Publishing. New York, NY, USA.

Suggested Readings:

1. **Bhatia, S. K., Sharma, R. D and Tanmoy, B. 2015. Modern Applications of Plant Biotechnology in Pharmaceutical Sciences. Elsevier Inc. Netherlands. ISBN: 978-0-12-802221-4**
2. **Tutelyan, V. 2013. Genetically Modified Food Sources: Safety Assessment and Control. Elsevier Inc. Netherlands. ISBN: 978-0-12-405878-1.**
3. **Bio Prism: 2018. A laboratory Safety Training Initiative Program Manual. Florida, FL, USA.**
4. Christou, P. and Klee, H. 2007. Handbook of Plant Biotechnology. Wiley Inter Science, London, UK.
5. Fiechter, A. and sautter, C. 2007 Green Gene Technology. Springer, London, UK

Biotech-603 Genome Editing and Its Applications 3 (2-1)

Learning Objectives

The course will enable the students to:

- **Describe the science of gene editing in living organisms especially in plants**
- **Know about the problems and improvements in CRISPR/Cas9 technology in plant.**
- **Learn the application of the genome editing tools for genetic modifications**

Program Learning Outcomes

Sr	CLOs	Domains	PLOs
1	Describe the science of gene editing in living organisms especially in plants	Cognitive	1
2	Illustrate the application of the genome editing tools for genetic modifications	Cognitive	5
3	Apply ZFNs, TALENs and CRISPR/Cas for genetic engineering in plants	Psychomotor	2, 3, 11

SDGs addressed in the course:

(2) Zero hunger (4) Quality Education
(11) Sustainability (15) Life on Land

Teaching Mode:

Blended learning

Theory:

Brief history of genome editing its benefits, Introduction to Basic Principles of Genome Editing Technologies, Mechanisms of Double-Stranded DNA Break Repair, zinc finger nucleases, TALE nucleases, and CRISPR class nucleases, Structural Aspects of Target Recognition by CRISPR/Cas9/sgRNA Complexes, Biologic Diversity of Targeted Nucleases, Comparative Assessment of CRISPR and RNAi Technologies, Ethical and Biological Safety Aspects of CRISPR/Cas9 Technology, Bioinformatics Resources and Reagent Sources CRISPR technology, Principle of designing target specific CRISPR tools, Basic rules for efficient gene Knock-outs and knock-ins, Generation of guided RNA (gRNA) using *in vitro* transcription, Transfection optimization for efficient gene editing, Assays for detecting Gene modification and clone validation, **Resources/kits for designing and cloning of genome editing tools; Regulation of genome edited organisms; Use of genome editing tools for precision plant breeding.**

Practical

Software used for designing of genome editing tools; Designing of genome editing tools: cloning platforms and vectors for genome editing tools, cloning of genome editing tools, construction of genome editing tools; TALENs and CRISPR/Cas, Delivery methods of genome editing tools into plant cells; Detection of mutation and modification in the DNA: testing the efficacy of genome edited crop developed by CRISPR technology.

Textbook

1. **Ahmad, A., S. H. Khan and Z. Khan. (Eds.). 2021. CRISPR Crops: The Future of Food Security. Springer Nature, Singapore.**

Suggested Readings

2. **Yamamoto, T. 2015. Targeted Genome Editing Using Site-Specific Nucleases. Springer Japan. DOI: 10.1007/978-4-431-55227-7.**
3. **Sambrook, J. and Russel R.W. 2006. Molecular cloning: A Lab Manual, Cold Spring Harbor Laboratory Press, New York, NY, USA.**
4. **Weeks, D. and Yang, B. 2017. Gene Editing in Plants. Academic Press. New York, NY, USA.**
5. **Luo, Y. 2019. CRISPR Gene Editing. Springer New York, NY, USA.**

Biotech-605 Fundamentals of Seed Molecular Biology 3(2-1)

Learning Objectives:

The course will enable the student to:

- **Describe the life cycle of angiosperms their seed development and seed dormancy at molecular level**
- **Explain molecular biology and genetic engineering to synthesize synthetic and transgenic seeds**
- **Use the molecular biology and genetic engineering techniques for increasing the nutritive value and protein accumulation in the seeds**

Learning Outcomes:

Sr	CLOs	Domains	PLOs
1	Describe basic knowledge of different seed molecular and genetic engineering approaches	Cognitive	1
2	Explain molecular biology and genetic engineering to synthesize synthetic and transgenic seeds	Cognitive	1, 11
3	Apply the molecular approaches to design different in vitro and in vivo projects relevant to the seed deformities.	Psychomotor	11

SDGs Addressed in the Course

(2) Zero hunger (4) Quality education

Teaching Mode:

Blended Learning

Theory:

Evolution of seed habit in angiosperms, Molecular control of ovule development, Life cycle of angiosperms and seed development, Seed anatomy, Molecular foundation of seed dormancy, Synthetic seed development, Transgenic seed development and characterization, Increasing nutritive value of seed by genetic engineering, Bio-techniques to improve seed protein accumulation, Molecular basis of signaling of enzymes during seed development and seed

Practical:

Role of hormones in the seed development; cytokinin and gibberellic acid, biological approaches for enhancing seed germination; use of cellulolytic bacteria. Molecular approaches for seed genetic purity and identity; molecular markers, gel electrophoresis.

Text Book

1. **Bssavaraju, G.V., P. Ravishankar and S. Gowdiperu. 2014. A textbook of Seed Science and Technology. Kalyani Publishers, New Dehli, India.**

Suggested Readings

2. **Chakrabarti, K.S. 2010. Seed Production and Quality Control. Kalyani Publishers, New Dehli, India.**
3. **Vishunavat, K. 2011. Seed Health Testing Principles and Protocols. Kalyani Publishers, New Dehli, India.**
4. **Singh, P. 2013 Principles of Plant Biotechnology. Kalyani Publishers, New Dehli, India.**

Biotech-611 Preparation of Research Project and Scientific Writing 2(1-1)

Learning Objectives This course will enable the students to:

Course Contents Theory

The concept of science and scientific method, Reading skills. The concept, purpose and kinds of research. Types of Scientific Reports, Collection and organizing source materials: reviewing the literature and preparing bibliography. The techniques of composition: rules of scientific writing, word usage in scientific writing, style for composing scientific writing. Writing thesis, scientific papers, and project reports; table of contents, list of tables, the use of scientific quotations, illustrations, appendices, statistics and tables, standard abbreviations. Preparing preliminary draft, editing, and evaluating the final draft. Writing Research proposals, Preparation of PC forms. Plagiarism, its types and testing methods. Policy of HEC on Plagiarism.

Practical

Exercise of scientific writing and research proposal, Exercise of collecting material from different sources on assigned topics, oral presentations. Using Track Change in MS word for editing drafts. Use of reference manager, endnote and Turnitin software

Suggested Readings

1. Anderson, J., B. H. Durston and M. Poole. 1992. Thesis and Assignment Writing. Wiley Eastern Ltd. New Delhi, India
2. Andrew, C.O. 1993. Applied Agricultural Research: Foundations and Methodology. West view Press
3. Everything You Wanted to Know About Making Tables and Figures. http://abacus.bates.edu/~ganderso/biology/resources/writing/HTWtablefigs.html
4. Gatner, E. S. M. and F. Cordasco. 1959. Research and Report Writing. Barnes and Noble, Inc., New York, USA
5. George D. Gopen and Judith A. Swan. 1990. The Science of Scientific Writing. American Scientist, 78: 550-558.

6. Ghafoor, A. 2007. Manual for Synopsis and Thesis Preparation. University of Agriculture, Faisalabad.
7. Ghafoor, A., G. Murtaza, and S.I. Hussain. 2006. Fundamentals of Scientific Communications and Presentations. Allied Book Centre, Lahore.
8. Guidelines for Writing Scientific Papers. http://www.bms.bc.ca/library/Guidelines
9. Handbook of postgraduate Research students. UHI Millennium Institute, Perth College, Scotland, UK. WWW.PERTH.AC.UK
10. Hopkins, W. G. 1999. Guidelines on style for scientific writing. Sport Science 3(1), sportsci.org/jour/9901/wghstyle.html.
11. McGranaghan, M. Guidelines on writing a research. http://www2.hawaii.edu/~matt/proposal.html, http://www.imechanica.org/node/588
12. Plagiarism policy. 2007. HEC booklet.
13. Tischler, M. E. Scientific Writing Booklet. Dept. of Biochemistry and Biophysics, University of Arizona. www.biochem.arizona.edu/marc/Sci-Writing.pdf
14. William R. L. 2001. Fine-Tuning Your Writing. Wise Owl Publishing Co., Madison, USA

Biotech-613 Biotechnology Entrepreneurship 3(2-1)

Learning Objectives:

The course will enable the student to;

- **Describe biotechnology industries working on agriculture, health, environmental issues relevant to their entrepreneurship**
- **Explain ethical, legal and regulatory concern related to products, national and international funding opportunities for biotechnology enterprises**
- **Apply diversified leadership, management and marketing strategies to manage the biotechnology enterprises**

Program Learning Outcomes

Sr	CLOs	Domains	PLOs
1	Describe basic knowledge of biotechnology entrepreneurship, different industries, regulatory, ethical and strategic planning aspects	Cognitive	1
2	Discuss ethical, legal and regulatory concern related to products, national and international funding opportunities for biotechnology enterprises	Cognitive	1, 11
3	Apply design different models for better biotech entrepreneurship, by keeping in mind the leadership and marketing strategies.	Psychomotor	11

SDGs Addressed in the Course

(8) Decent work and economic growth

Teaching Mode:

Blended Learning

Theory:
Biotechnology industry and entrepreneurship. Nature of the biotechnology industry in the areas of science, regulation and enterprise. Ethical, Legal and Regulatory Aspects of the Biotechnology Enterprise. Strategic Planning for the Biotechnology Enterprise. Grants and Federal Funding for Biotechnology Enterprises. Leadership strategies, marketing strategies. SWOT analysis.

Practical:

Steps involved in the preparation of biotech products; Planning and regulation of a biotech entrepreneurship: Visit to different biotech industries, check their setups, how they work, raw material to product and scale up the final product

Suggested Readings:

Text Books

1. **Kohlis, R.L., and N.J. Uhl. 2015. Marketing of Agricultural Products. 9th Ed. Saurabh Printers Pvt. New Dehli, India**

Suggested Readings

2. **Kotler, P., G. Armstrong and P. Agnihotri. 2018. Principles of Marketing. 17th Ed. Rahul Printo Pack. New Dehli, India**
3. **Prosser, T. 2010. The Regulatory Enterprise: Government, Regulation, and Legitimacy. OUP Oxford, UK.**
4. Burns, P., and Hurst, J.D., 2011. Small Business and Entrepreneurship, 3rd Eds. London, UK.
5. Max, K., Tamvada, P., Audretsch, J., Sustaining, D.B., 2009. Entrepreneurship and Economic Growth. Springer. Netherlands.

Biotech-615 Industrial Biotechnology 2(1-1)

Learning Objectives:

- **Describe the fundamental biological and engineering principles for production of proteins, metabolites and cells.**
- **Understand the principles for engineering design of key unit operations and other functional operations.**
- **Carry out engineering computations and simulations of bioprocesses based on physical, chemical and biological fundamentals.**

Program Learning Outcomes

Sr	CLOs	Domains	PLOs
1	Describe the fundamental biological and engineering principles	Cognitive	1
2	Understand the principles for engineering design of key unit operations	Cognitive	1, 11
3	Apply engineering computations and simulations of bioprocesses	Psychomotor	11

SDGs Addressed in the Course
(8) Decent work and economic growth
Teaching Mode:
Blended Learning

Theory: Industrial biotechnology – introduction and scope; microorganisms commonly used in industry; media and nutritional requirements of industrial organisms; screening for productive strains and strain improvement; culture collections; fermentation and fermenters; extraction of fermented products; production of beer, wines, spirits and vinegar; use of single cell proteins as food products; biocatalysts; microbial insecticides; production of metabolites: organic acids and amino acids; vaccines and antibiotic production.

Practical: Isolation of lactobacillus from dairy products, fruit juices, etc.; fermentation of different sugars by bacteria (or other microorganisms); identification of proteases/ amylases producing bacteria; extraction of hydrolytic crude enzymes from microbes; effect of environmental factors (e.g., pH, temperature, salt, etc.) on activity of crude enzymes.

Text Book

1. **Soetaert, W. and Vandamme, E.J. eds., 2010. Industrial biotechnology: sustainable growth and economic success. John Wiley & Sons. New Jersey, NJ. USA.**

Suggested Readings

1. **Flickinger, M.C., 2010. Encyclopedia of Industrial Biotechnology: Bioprocess, Bioseparation, and Cell Technology, 7 Volume Set. John Wiley & Sons. New Jersey, NJ. USA.**
2. **Vandamme, E.J. and Revuelta, J.L., 2016. Industrial biotechnology of vitamins, biopigments, and antioxidants. John Wiley & Sons. New Jersey, NJ. USA.**
3. **Rastegari, A.A., Yadav, A.N. and Gupta, A. eds., 2019. Prospects of renewable bioprocessing in future energy systems (Vol. 10). Springer. Netherlands.**
4. **Liese, A., Seelbach, K. and Wandrey, C. eds., 2006. Industrial biotransformations. John Wiley & Sons. New Jersey, NJ. USA.**
5. **Thakur, I.S., 2013. Industrial biotechnology: problems and remedies. IK International Pvt Ltd.**

Biotech-617 Animal Biotechnology 2(1-1)

Learning Objectives:

- **Describe the structure of animal genes and genomes.**
- **Understand basic principles and techniques in genetic manipulation and genetic engineering.**
- **Learn techniques and problems both technical and ethical in animal cloning.**

Program Learning Outcomes

Sr	CLOs	Domains	PLOs
1	Describe basic knowledge of different animal genes and genomes	Cognitive	1
2	Understand genetic manipulation and genetic engineering.	Cognitive	1, 11
3	Apply techniques and problems both technical and ethical in animal cloning.	Psychomotor	11

SDGs Addressed in the Course

(8) Decent work and economic growth

Teaching Mode:

Blended Learning

Theory: Introduction and history of transgenic animals; role of synthetic peptides/proteins in animal health; Production and uses of monoclonal antibodies from animals; cytokines and their

potential therapeutic value as applicable to the diagnosis of microbial infections; micromanipulations of farm animal embryos; use of biotechnological techniques in animal breeding strategies; gene transfer through embryo microinjection; ethical and social issues in animal biotechnology, Applications of transgenic animals (animal models of diseases, pharming, farm animals improvement),.

Practical: Aquaculture methods and various DNA recombinant techniques for animal biotechnology

Text Book

1. **Gahlawat, S.K., Duhan, J.S., Salar, R.K., Siwach, P., Kumar, S. and Kaur, P. eds., 2018. Advances in animal biotechnology and its applications. Springer. Netherlands.**

Suggested Readings

2. **Holland, A.J. and Johnson, A. eds., 2012. Animal biotechnology and ethics. Springer Science & Business Media. Netherlands.**
3. **Singh, B., Mal, G., Gautam, S.K. and Mukesh, M., 2019. Advances in Animal Biotechnology. Springer International Publishing. Netherlands.**
4. **Niemann, H. and Wrenzycki, C. eds., 2018. Animal Biotechnology. Springer. Netherlands.**
5. **Verma, A.S. and Singh, A. eds., 2013. Animal biotechnology: models in discovery and translation. Academic Press. New York, NY, USA.**