Shri Vaishnav Vidyapeeth Vishwavidyalaya, Indore

M.Sc. (Biotechnology)

Semester III

SUBJECT CODE	Category	SUBJECT NAME	TEACHING &EVALUATION SCHEME								
			THEORY			PRACTICAL		Th	T	P	CREDITS
			END SEM University Exam	Two Term Exam	Teachers Assessment*	END SEM University Exam	Teachers Assessment*				
MSBT301	**DC**	**Genomics and Proteomics**	60	20	20	0	0	3	0	0	3

Legends: **L**-Lecture; **T**-Tutorial/Teacher Guided Student Activity; **P-**Practical; **C** - Credit;
***Teacher Assessment** shall be based following components: Quiz / Assignment / Project / Participation in Class, given that no component shall exceed more than 10 marks.

Course Objectives:

1. Basic knowledge concerning genomics and proteomics.
2. Utilizing genomics and proteomics in various molecular and biotechnological applications.

Course Outcomes:

1. Understanding of fundamentals of genomics and proteomics; transcriptomics and metabolomics.
2. Applications of genomics and proteomics

UNIT-I: Overview of OMICS

Concept of Genomics, Proteomics, Transcrptomics, Metabolomics, Lipidomics, Degradomics, systems biology: Goals, methods, applications. Genome overview with model organisms: example- *Escherichia coli*, *Saccharomyces cerevisiae*, *Drosophila melanogaster,Caenorhabditis elegans*, *Arabidopsis thaliana*.

UNIT–II: Genomics

Whole Genome sequencing – Methods, Assembly and Analysis; NGS Platforms- First generation (Sanger), Second generation (Illumina, Ion Torrent), Third generation (PacBio, Oxford Nanopore) Technologies; Comparative genomics; Structural and Functional genomics– Goals, methods, applications; Metagenomics: Introduction, metagenome, shotgun metagenomics (pyrosequencing) and applications in Gene survey, Environmental genomes, Microbial diversity; Epigenomics- Introduction, epigenome, shotgun bisulphite sequencing, and applications in diseases, DNA methylation and histone modifications. Human Genome Project.

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MSBT301 Genomics and Proteomics

UNIT–III: Transcriptomics

Introduction to transcriptomics; Transcription factor binding sites, mapping transcriptional start site and expression profiling- Northern Blotting, RT-PCR, EST analysis; RNA-seq, Differential expression analysis (DEG), Serial Analysis of Gene Expression (SAGE), Super SAGE; Small and long non coding RNA identification and analysis.

UNIT–IV: Proteomics

Importance of proteomics- Aims, strategies and challenges in proteomics; Strategies in analysis of proteome: 2-D PAGE, Mass spectrometry, Protein sequencing method (Edman degradation, MALDI TOF/TOF). Introduction, Concept, application, advantages and limitations of Expressional Proteomics, Functional Proteomics, Structural Proteomics; Biomarkers in disease diagnosis.

UNIT–V: Techniques in OMICS

DNA, RNA and protein Microarray: Preparation, working and analysis; Analysis of protein-DNA interactions: Electrophoretic Mobility Shift Assay (EMSA), DNA footprinting, southwestern blotting, yeast one-hybrid assay, Chromatin immunoprecipitation (ChIP), ChIP-chip; Protein-protein interactions: Yeast two- and three-hybrids assay, Co-immunoprecipitations (Co-IP), GST pull down, Phage display, Bimolecular Fluorescence Complementation (BiFC), Fluorescence Resonance Energy Transfer (FRET), Surface Plasmon Resonance (SPR).

BOOKS:

1. Campbell, A. M., & Heyer, L. J. (2006). Discovering Genomics, Proteomics, and Bioinformatics. (2nd Ed.). San Francisco: Benjamin Cummings.
2. Ekroos, K. (2012). Lipidomics- Technologies and Applications. (1st Ed.). Wiley-VCH. Web/Journal Resources.
3. Gomase, V., & Tagore S. (2009). Transcriptomics: Expression Pattern Analysis. VDM Publishing, Science.
4. Liebler, D. C. (2002). Introduction to Proteomics: Tools for the New Biology. Totowa, NJ: Humana Press.
5. Siuzdak, G. (2006). Mass Spectrometry for Biotechnology. (2nd Ed.). Academic Press.
6. Veenstra, T., & Wiley, J. Y. (2019). Proteomics for Biological Discovery. (2nd Ed.). John Wiley & Sons, Inc.
7. Weckwerth, W. (2007). Metabolomics- Methods and Protocols. (1st Ed.). Humana Press.

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			THEORY			PRACTICAL		Th	T	P	CREDITS
			END SEM University Exam	Two Term Exam	Teachers Assessment*	END SEM University Exam	Teachers Assessment*				
MSBT302	**DC**	**Plant and Animal Biotechnology**	60	20	20	0	0	3	0	0	3

Legends: **L**-Lecture; **T**-Tutorial/Teacher Guided Student Activity; **P-**Practical; **C** - Credit;
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Course Objectives:

1. Knowledge of basic concepts of plant and animal biotechnology.
2. Development and applications of transgenics in plant and animal biotechnology

Course Outcomes:

1. Understanding the basics of plant and animal biotechnology
2. Understanding the applications of biotechnology in agriculture and medical sciences

UNIT–I: Plant Genetic Manipulation

Genetic engineering: *Agrobacterium*-plant interaction; Virulence; Ti and Ri plasmids; Opines and their significance; T-DNA transfer; Disarmed Ti plasmid; Genetic transformation - *Agrobacterium*-mediated gene delivery; Co-integrate and binary vectors and their utility; Direct gene transfer - PEG-mediated, electroporation, particle bombardment and alternative methods; Screenable and selectable markers; Reporter genes and promoters used in plant vectors and their role in genetic transformation. Characterization of transgenics; Transgene stability and gene silencing; Chloroplast transformation; Marker-free methodologies; Advanced methodologies - cisgenesis, intragenesis and genome editing.

UNIT–II: Molecular Mapping and Marker Assisted Selection

Molecular markers- hybridization and PCR based markers: RFLP, RAPD, STS, SSR, AFLP, SNP markers; DNA fingerprinting- principles and applications; Introduction to mapping of genes/QTLs; Marker-assisted selection (MAS)- strategies for introducing genes of biotic and abiotic stress resistance in plants; QTL mapping techniques; Important properties of ideal markers for MAS; Selection for major genes linked to markers; Molecular diagnostics of pathogens in plants; Marker-assisted backcrossing: MABC procedure and theoretical and practical considerations; Marker-assisted gene pyramiding.

UNIT–III: Plant Genetic Manipulation for Productivity and Performance

Molecular pharming- concept of plants as biofactories, production of industrial enzymes and pharmaceutically important compounds, improvement in protein, lipids, carbohydrates, vaccines, antibodies, therapeutic proteins; Production of bioactive secondary metabolites; Increase in productivity by manipulation of photosynthesis and nitrogen fixation; Transgenic

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plants for biotic and abiotic stress, post-harvest losses, long shelf life of fruits and flowers, male sterile lines, barnase barstar system; Approaches to marker-free transgenics; Debate over GM crops.

UNIT–IV: Animal Biotechnology

Animal Cell Culture: Introduction, cell culture laboratory-design, layout and maintenance; Equipment and Instrumentation; Methods of sterilization, types of culture media, composition, preparation and metabolic functions; Role of CO_2, serum, supplements, growth factors (EGF, PDGF,NGF, Gap-43); Serum and protein free defined media; Culture and maintenance of primary and established cell lines; Biology of cultured cells, culture environment, cell adhesion, cell proliferation and differentiation; Characterization of cultured cells, viability, cytotoxicity, and growth parameters; Stem cells- embryonic and adult stem cells, properties, identification, stem cells culture, techniques and their applications in modern clinical sciences.

UNIT–V: Transgenic Animals and Animal Cloning

Methods involved in the production of transgenic animals; Importance and applications of transgenic animals; Gene knockout and mice models for tackling human diseases; Animal cloning: methods of cloning and their importance with reference to domestic animals; IVF technology for livestock and humans; Applications of Animal Biotechnology: Improvement of biomass, disease resistant, recombinant vaccines for poultry, livestock-farming products.

BOOKS:

1. Altman, A., & Hasegawa, P. M. (2012). Plant Biotechnology and Agriculture. Prospects for the 21st century. (1st Ed.). Academic press.
2. Buchanan, B. B., Gruissem, W., & Jones, R. L. (2015). Biochemistry & Molecular Biology of Plants. (2nd Ed.). Chichester, West Sussex: John Wiley & Sons.
3. Chawla, H. S. (2020). Introduction To Plant Biotechnology. (3rd Ed.). International Book Distributing Company.
4. Davis, J. M. (2011). Animal Cell Culture: Essential Methods. (1st Ed.). Wiley-Blackwell and Sons publisher.
5. Freshney, R. I. (2016). Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications (7th Ed.). Wiley & Sons.
6. Slater, A., Scott, N. W., & Fowler, M. R. (2008). Plant Biotechnology: an Introduction to Genetic Engineering. (2nd Ed.). Oxford: Oxford University Press.
7. Umesha, S. (2013). Plant Biotechnology. (1st Ed.). CRC Press.

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			THEORY			PRACTICAL		Th	T	P	CREDITS
			END SEM University Exam	Two Term Exam	Teachers Assessment*	END SEM University Exam	Teachers Assessment*				
MSBT303	**DC**	**Environmental Biotechnology**	60	20	20	0	0	3	0	0	3

Legends: **L**-Lecture; **T**-Tutorial/Teacher Guided Student Activity; **P**-Practical; **C** - Credit;
***Teacher Assessment** shall be based following components: Quiz / Assignment / Project / Participation in Class, given that no component shall exceed more than 10 marks.

Course Objectives:

1. Knowledge about the role of microorganisms in recycling soil nutrients and monitoring quality of environmental parameters.
2. Evaluation of the role of microorganisms in the biodegradation and bioremediation of recalcitrant compounds
3. Derivation of valuable products from waste with the help of microorganisms.

Course Outcomes:

1. Understanding the participation of microorganisms in ecosystems
2. Evaluation of the potential for biodegradation of organic pollutants.
3. Methods to derive valuable products from waste by using microorganisms.

UNIT–I: Microbial Environment and its monitoring

Microbial interactions, Role of microbes in biogeochemical cycles - Carbon cycle; Sulphur cycle; Nitrogen cycle and Phosphorus cycle

Environmental monitoring: environmental problems, microbial assessment of air, water quality and soil quality**,** assessment of environment using bioindicators, biomarkers, biosensors and toxicity testing, rDNA technology, Conservation strategies, Environmental laws and policies in India

UNIT–II: Sewage and waste treatments

Classification and characterization of waste, Conventional treatment process; Primary-Sedimentation or settling Principles; Biological wastewater treatment, Advanced tertiary processes; Biological nitrogen removal, Biological phosphorus removal. Landfills, composting, vermicomposting, recycling and processing of organic residues.

UNIT–III: Biodegradation and Bio-deterioration

Principles and Kinetics of biodegradation, Microbial basis of aerobic and anaerobic Biodegradation; Microbial degradation of pesticides, xenobiotics, polyaromatic hydrocarbons, dyes; biosurfactants and microbial treatment of oil pollution.

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Principles and mechanisms of biodeterioration, Methodology to assess biodeterioration, Prevention and control of biodeterioration, Biodeterioration of selected materials.

UNIT–IV: Bioremediation

Bioremediation principles, Strategies and techniques of bioremediation: in situ and ex situ, Bioaugmentation and biostimulation; Biofiltration; Biotrickling Filtration; Bioscrubbers; Use of microbes for Heavy metal detoxification, Phytoremediation, GMOs and their impact on bioremediation.

UNIT–V: Biotechnology and value addition

Production of value added products from waste – single Cell Protein (SCP), ethanol, methane and hydrogen, amino acids, vitamins and Enzyme, Microbial leaching and mining, microbial polymer production and bio-plastic technology, biofertilizers and microbial inoculants, biofuels and microbial fuel cells.

BOOKS:

1. Anderw D E and American Public Health Association, (2017) Standard Methods for the Examination of Water and Waste Water (23rdEds). Washington, D.C. APHA-AWWA-WEF, 2005.
2. Arceivala S. J. and Asolekar S (2007).Wastewater Treatment for Pollution Control and Reuse (3rd Ed), McGraw Hill Education.
3. Bruce Rittmann and Perry McCarty (2020) Environmental Biotechnology: Principles and Applications, 2nd Edition, McGraw Hill Education.
4. Christon J. Hurst, Ronald L. Crawford, Jay L. Garland, David A. Lipson, Aaron L. Mills, Linda D. Stetzenbach Crawfold (2007) Manual of Environmental Microbiology (3rd Ed) ASM press.
5. Gareth G. E, Judy F. (2010) Environmental Biotechnology: Theory and Application, (2nd Ed.), Wiley-Blackwell Publishing.
6. Maier R. M. and Pepper I. L. (2005)Environmental Microbiology: A Laboratory Manual, Academic Press.
7. Scragg A (2005) Environmental Biotechnology (2nd Ed). Oxford University Press.

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			END SEM University Exam	Two Term Exam	Teachers Assessment*	END SEM University Exam	Teachers Assessment*				
MSBT304	**DC**	**Bioethics, Biosafety, IPR & Bioentrepreneurship**	60	20	20	0	0	3	1	0	4

Legends: **L**-Lecture; **T**-Tutorial/Teacher Guided Student Activity; **P**-Practical; **C** - Credit;
***Teacher Assessment** shall be based following components: Quiz / Assignment / Project / Participation in Class, given that no component shall exceed more than 10 marks.

Course Objective:

1. Understanding ethical issues concerning transgenic science and genetic modification of crops and animals
2. Basic knowledge on intellectual property rights and their implications in biological research and product development
3. Understanding the concepts of entrepreneurship and establishment of business using biotechnology

Course Outcome:

1. Understanding the ethical issues of biotechnology
2. Knowledge of intellectual property rights and patenting
3. Identifying scope for entrepreneurship in biosciences

UNIT–I

Bioethics: Bioethics in Biodiversity, ethics of resource management, impact of patenting on biodiversity rich developing countries. Ethical issues associated with consumptions of genetically modified foods. Ethical implication of human genome project and animal biotechnology. Use of cell cultures as alternatives for animal models for research. Testing of drugs on human volunteers, use of animals for research and testing; animal and human cloning- ethical and social issues, international ethical and legal issues connected with human genome diversity research. Genetic studies of ethnic races.

UNIT–II

Biosafety: The Cartagena protocol on biosafety. Biosafety management: Key to the environmentally responsible use of biotechnology. Biosafety regulations and national and international guidelines with regard to rDNA technology, transgenic science, GM crops,. Experimental protocol approvals, levels of containment. Guidelines for research in transgenic plants. Good manufacturing practice and Good lab practices (GMP and GLP). Use of genetically modified organisms (crippling organisms) and their release to the environment.

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MSBT304 Bioethics, Biosafety, IPR & Bioentrepreneurship

UNIT-III: Fundamentals of IPR

Intellectual property rights: Meaning, Types of IP: Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications, Protection of GMOs, Importance of IPRs in the fields of science and technology.

UNIT-IV: Patents

Patents – Concepts and principles of patenting – Patentable subject matter, Indian Patent Act 1970, Procedure of obtaining patents, Rights of patents, Infingement of patent rights, Remedies for infringement of patent rights. Patenting of biological materials- Patents for higher plants and higher animals, patenting of transgenic organisms, patenting of isolated genes and DNA, sequences.

UNIT–V Bioentrepreneurship

Introduction to Bio-entrepreneurship: Meaning - Entrepreneur, Entrepreneurship, Green-Entrepreneurship, Bio-Entrepreneurship, Types of Entrepreneur – Innovative, Imitating, Fabian, Drone. Structure of Biobased technology companies, Sources of funds, Idea generation to New Product Development, Sales & amp; Market Research in biotech Industries, Budget and planning process. Success and failure stories of Biotech entrepreneurs.

BOOKS:

1. Ganguli, P. (2001). Intellectual Property Rights: Unleashing the Knowledge Economy. New Delhi: Tata McGraw-Hill Pub.
2. National IPR Policy (2020), Department of Industrial Policy & Promotion, Ministry of Commerce, GoI.
3. Onetti, A., & Zucchella, A. (2014). Business Modeling for Life Science and Biotech Companies: Creating Value and Competitive Advantage with the Milestone Bridge. Routledge.
4. Sateesh. M.K.(2008). Bioethics and Biosafety. L.K International publishing House Pvt Ltd.
5. Shantharam, D., Jane F Montgomery (1999). Biotechnology, Biosafety & Biodiversity: Scientific & Ethical issues for Sustainable development. Enfield, N.H. : Science Publishers.
6. Shimasaki, C. D. (2014). Biotechnology Entrepreneurship: Starting, Managing, and Leading Biotech Companies. Academic Press.

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			THEORY			PRACTICAL		Th	T	P	CREDITS
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MSBTL306	**DC**	**Genomics and Proteomics and Plant and Animal Biotechnology Laboratory**	0	0	0	30	20	0	0	8	4

Legends: **L**-Lecture; **T**-Tutorial/Teacher Guided Student Activity; **P-**Practical; **C** - Credit;
***Teacher Assessment** shall be based following components: Quiz / Assignment / Project / Participation in Class, given that no component shall exceed more than 10 marks.

PRACTICAL [Genomics]

1. *In silico* identification of transcription factor binding sites.
2. *In silico* identification of small and long non coding RNA.
3. Computational prediction of miRNA target genes.

PRACTICAL [Plant and Animal biotechnology]

1. In vitro androgenesis and gynogenesis in plants (Daturastramonium).
2. Isolation of plant protoplast by enzymatic and mechanical methods and fusion by PEG.
3. Agrobacterium culture and transformation of any dicot species.
4. Selection of transformants and reporter gene (GUS) assays.
5. Generation of RAPD and ISSR profile.
6. PCR amplification of 'n' number of genotypes of a species for studying the genetic variation among the individuals of a species using random primers.
7. Micropropagation : initiation, multiplication and subculture.
8. Initiation of suspension culture and identification of common secondary metabolites production.
9. Animal cell culture: Preparation of (serum and non-serum supplemented) media, cell culture, assessment of viability and counting using trypan blue exclusion method
10. Primary culture of fibroblast cells/liver cells/testis-leydig cells.
11. Determination of Glutathione S-Transferase (GST) enzyme activity in cytotoxicity induced cells.
12. Estimation of lipid peroxides (Malondialdehyde) in cytotoxicity induced cells.
13. MTT assay for cell viability and growth.

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MSBTL307	**DC**	**Environmental Biotechnology Laboratory**	0	0	0	30	20	0	0	4	2

Legends: **L**-Lecture; **T**-Tutorial/Teacher Guided Student Activity; **P**-Practical; **C** - Credit;
***Teacher Assessment** shall be based following components: Quiz / Assignment / Project / Participation in Class, given that no component shall exceed more than 10 marks.

PRACTICAL [Environmental Biotechnology]

1. Bioremediation of inorganic pollutants and phytoremediation of metals
2. Characterization of waste water:
    a. Physical: odour, colour, turbidity, temperature, salinity
    b. Chemical: acidity, alkalinity, sulphate, copper, COD
3. Analysis of drinking water by MTT and MFT
4. Biological characterization: BOD
5. Production of SCP
6. Estimation of phosphatase activity of soil: acid and alkaline
7. Microbial decolourization of dye
7. Biodeterioration of lignocellulosic waste and pharmaceutical products:
    - Determination of microbial load
    - Characterization of biodeteriorating microorganisms
8. Characterization of Rhizobium as biofertilizer

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