



University of Engineering and Management
Institute of Engineering & Management, New Town



Syllabus for B. Tech Admission Batch 2022
6th semester

Subject Name: Waste Management & upcycling

Credit: 3

Lecture Hours: 36

Subject Code: PECBT601

Coursera Course link.

Sustainable landscape restoration

<https://www.coursera.org/learn/landscape-restoration-sustainable-development?>

Life cycle assessment

<https://www.coursera.org/learn/life-cycle-assessment>

Capstone- Creating A Sustainability Proposal

<https://www.coursera.org/learn/sustainability-proposal>

Study material link.

https://docs.google.com/document/d/12nXvXGNLqdgQv80OjW36LzfzzMLfTvAC/edit?usp=drive_link&oid=117367197800556919374&rtpof=true&sd=true

Module number	Topic	Sub-topics	Mapping with Industry and International Academia	Lecture Hours	Corresponding Lab Assignment
1	Waste management	The definition of waste, and its classification in the context of EU legislation, policy and other drivers for change, including the planning and	<i>International Academia:</i> https://ocw.mit.edu/courses/1-85-water-and-wastewater-treatment-engineering-spring-2006/	8	1. Understanding the pollution level of used water bodies by estimating the dissolved oxygen content of water

	<p>Liquid waste collection, treatment and disposal systems</p> <p>Air Pollution management and treatment</p>	<p>permitting regime for the delivery of waste management solutions</p> <p>Segregation and mixing schemes; Pre-treatment and its role in the industrial wastewater management; Overview of wastewater treatment technologies and development of wastewater treatment schemes; Operation and maintenance of effluent treatment plants; and Case study of an industrial wastewater management system.</p> <p>Overview of industrial emissions; Air pollution control systems and overview of air pollution control technologies; Development of schemes for the collection, treatment and discharge industrial emissions</p>	<p>https://ocw.mit.edu/courses/res.11-004-11-educate-introduction-to-engineering-concepts-spring-2022/pages/environmental-engineering/</p> <p>AICTE-prescribed syllabus: https://www.aicte-india.org/sites/default/files/Model%20Curriculum%20for%20UG%20Degree%20Course%20in%20Biotechnology.pdf</p> <p>Industry Mapping: These concepts are required for the industry to comply the regulatory norms. To set-up the system of waste to resource conversion and waste treatment.</p>		
2	Technologies for Waste treatment	waste incineration and energy from waste, pyrolysis and gasification, anaerobic digestion, composting and mechanical biological treatment of wastes, managing biomedical waste.	<p>International Standards https://ocw.mit.edu/course/res.11-004-11-educate-introduction-to-engineering-concepts-spring-2022/pages/environmental-engineering/</p>	7	<ol style="list-style-type: none"> 1. Understanding the need of better waste disposal in water bodies by determining the biochemical oxygen demand 2. Understanding the need of better waste disposal in water bodies by determining the chemical oxygen demand

			<p><i>AICTE prescribed syllabus:</i> https://www.aicte-india.org/sites/default/files/Model%20Curriculum%20for%20UG%20Degree%20Course%20in%20Biotechnology.pdf</p> <p><i>Industry Mapping:</i> These are extremely important industrial processes used in many industries for both waste treatment and waste to resource conversion.</p>		
3	Public health	<p>Health considerations in the context of operation of facilities, handling of materials and impact of outputs on the environment; Advances in waste recycling and recovery technologies to deliver added value products; Landfill engineering and the management of landfill leachate and the mining of old landfills</p>	<p><i>International Standards:</i> https://ocw.mit.edu/courses/20-104j-chemicals-in-the-environment-toxicology-and-public-health-be-104j-spring-2005/</p> <p><i>AICTE prescribed syllabus:</i> https://www.aicte-india.org/sites/default/files/Model%20Curriculum%20for%20UG%20Degree%20Course%20in%20Biotechnology.pdf</p> <p><i>Industry Mapping:</i> This concepts are important for all industrial units in dealing with the waste they generate</p>	7	<ol style="list-style-type: none"> 1. To understand the quality of supplied water by determining the calcium and magnesium hardness 2. To understand the quality of supplied water by determining the chloride ion concentration

4	Interface of waste and resource management	Interface of waste and resource management in the context of sustainable waste management in global cities and developing countries; and Use of decision support tools including multi-criteria analysis, carbon foot-printing and life- cycle analysis, as appropriate	<p>International Standards: https://ocw.mit.edu/courses/1-34-waste-containment-and-remediation-technology-spring-2004/ https://ocw.mit.edu/courses/ec-716-d-lab-waste-fall-2015/</p> <p>AICTE prescribed syllabus: https://www.aicte-india.org/sites/default/files/Model%20Curriculum%20for%20UG%20Degree%20Course%20in%20Biotechnology.pdf</p> <p>Industry Mapping: Life cycle analysis and Carbon foot print analysis these are very contemporary concepts for all industrial units</p>	7	1. To study the maintenance of water resource by physical examination of the quality of pond water
5	Waste Upcycling	Waste Upcycling, waste reuse, Waste down cycling, waste upcycling a social enterprise, Case study in each area. Innovative technologies for sustainable waste management	<p>International Standards: https://ocw.mit.edu/courses/ec-716-d-lab-waste-fall-2015/</p> <p>AICTE prescribed syllabus: https://www.aicte-india.org/sites/default/files/Model%20Curriculum%20for%20UG%20Degree%20Course%20in%20Biotechnology.pdf</p>	6	1. Understanding the quality of water in rural water bodies receiving agricultural run off by estimating the total available phosphate

			<p>Industry Mapping:</p> <p>https://fastforward.news/p/8-companies-with-innovative-upcycling</p> <p>Lot of entrepreneurs are into upcycling of waste and this is most recent form of value addition on waste</p>		
--	--	--	--	--	--

**Submitted by Dr Susmita Mukherjee and Dr. Sonali Paul, IEM New Town*

Subject Name: Synthetic & Systems Biology

Credit: 3

Lecture Hours: 24

Subject Code: PCCBT602

Pre-requisite: Basic concepts of biochemistry, molecular biology, microbiology, biology and mathematics

Relevant Links:

[Study material](#)

[Coursera](#)

[NPTEL](#)

COURSE OBJECTIVES:

1. To introduces students to the rapidly evolving field of Systems & synthetic biology.
2. To make students understand the basic to advanced knowledge in Bioengineering.

COURSE OUTCOMES:

CO1	The students will have tremendous application potentials of synthetic biology in the fields of biofuels, biomedicine, and other areas
CO2	The students will be able to assemble DNA and genes into biological circuits to make a biosensor or even engineer organisms
CO3	The students will learn the concept of synthetic biology and its widespread applications in research
CO4	The students will also appreciate that biological systems are highly dynamic and not static and can be manipulated by various design strategies
CO5	The students would be able to understand various tools in gene detection
CO6	To students would understand the concepts of OMICS

Subject Code: PCCBT602

Module number	Topic	Sub-topics	Mapping with Industry and International Academia	Lecture Hours	Corresponding Lab Assignment
1	Introduction to Synthetic biology & Systems biology	Introduction to synthetic biology. Background of Gene Regulatory Mechanisms (Gene Parts- Gene Structure, Promoters, Terminators, Enhancers, Inducers, Repressors, Transcription Factors, Co-factors, transcriptional and post-transcriptional regulation, post-translational modifications). Genetic Engineering and Genome Editing, Various Omics & role in systems biology - genomics, proteomics, transcriptomics, metabolomics	International standard IAP/Spring 2024 Course 20: Biological Engineering (mit.edu) Philosophy of Systems and Synthetic Biology (Stanford Encyclopedia of Philosophy) <i>AICTE prescribed syllabus</i> https://www.aicte-india.org/flipbook/p&ap/biotechnology/ <i>IndustryMapping: OmicsLogic Learn - Our Courses</i>	4	1. Virtual screening of restriction digestion enzymes
2	Elements of synthetic biology	Gene shuffling for large scale pathway assembly and	International standard IAP/Spring 2024 Course 20: Biological Engineering (mit.edu)	8	1. Primer Designing

	- Tools, circuits, BioBricks	engineering; Choices for microbial hosts for industrial applications– bacteria, yeast, insect. Gene editing methods – CRISPR/ Cas; Gene sequencing – Pyrosequencing, Nanopore sequencing. Bacterial circuits: feed- back, feed-forward, toggle switch, signal propagators and band filter, synchronized oscillators. Introduction to Bio Bricks & its applications. Microarrays & systems biology - a basic introduction	Philosophy of Systems and Synthetic Biology (Stanford Encyclopedia of Philosophy) AICTE prescribed syllabus https://www.aicte-india.org/flipbook/p&ap/biotechnology/ Industry Mapping: OmicsLogic Learn - Our Courses iGEM Technology		
3	Mathematical modelling & simulation	Noise in Gene Expression. Mathematical Modeling and Simulation. Biosensors. Application of software tools for modelling gene expression. Various markup languages used in systems biology. Introduction to various metabolic pathway databases.	International standard IAP/Spring 2024 Course 20: Biological Engineering (mit.edu) Philosophy of Systems and Synthetic Biology (Stanford Encyclopedia of Philosophy) AICTE prescribed syllabus https://www.aicte-india.org/flipbook/p&ap/biotechnology/ Industry Mapping: OmicsLogic Learn - Our Courses How Can Synthetic Biology Be Applied to Plants? - Hudson Robotics, Inc.	8	1. Metabolic Pathway analysis by KEGG server
4	Commercial Applications	Biomedicine, Biomaterials, Biofuels and Bioremediation; Production of artemisinin as case study. Building the new bio-economy. Introduction to Biofoundries & circuits. Role of automation and robotics in biofactories; Green chemistry - use	International Standards: IAP/Spring 2024 Course 20: Biological Engineering (mit.edu) Philosophy of Systems and Synthetic Biology (Stanford Encyclopedia of Philosophy) AICTE prescribed syllabus	2	1. Preparing competent cells 2. Transformation of cells

		of plants for engineering biologics & small molecules. Biosurfactants as an example of microbial cell factory based production. Global events & competitions- iGEM, synbiobeta.	https://www.aicte-india.org/flipbook/p&ap/biotechnology/ Industry Mapping: OmicsLogic Learn - Our Courses iGEM Technology How Can Synthetic Biology Be Applied to Plants? - Hudson Robotics, Inc.		
5	Regulations & ethics	Safety & bioethics, legal & IP elements involved in synthetic biology applications for human, animals and plants.	International Standards: IAP/Spring 2024 Course 20: Biological Engineering (mit.edu) Philosophy of Systems and Synthetic Biology (Stanford Encyclopedia of Philosophy) <i>AICTE prescribed syllabus</i> https://www.aicte-india.org/flipbook/p&ap/biotechnology/ Industry Mapping: How Can Synthetic Biology Be Applied to Plants? - Hudson Robotics, Inc.	2	No laboratory based experiments

Subject Name: Bioseparation Engineering

Credit: 2

Lecture Hours: 24

Subject Code: PCCBT601

Pre-requisite: Basic concepts of biochemistry, molecular biology, microbiology, biology and mathematics

Relevant Links:

[Study material](#)

[Coursera](#)

[NPTEL](#)

COURSE OBJECTIVES:

1. To understand the principles of various analytical techniques used in purification of products.
2. To make the students understand the application of techniques in industry

COURSE OUTCOMES:

CO1	The students would acquire knowledge in the area of separation technologies for the biomolecules
CO2	The students would be able to understand workflow for the separation of DNA, RNA, proteins, secondary metabolites
CO3	The students would also be able to assimilate recent research findings, advancement and development in the relevant subject
CO4	The students will learn how to separate and purify to homogeneity molecules and biological macromolecules of interest using different technologies
CO5	The course will also introduce how to scale up the separation in a cost effective manner
CO6	To students will be able to understand its application at industrial level.

Subject Code: PCCBT601

Module number	Topic	Sub-topics	Mapping with Industry and International Academia	Lecture Hours	Corresponding Lab Assignment
1	Basic Concepts	Basic concepts of Bio-separation Technology, Separation characteristics of proteins and enzymes – size, stability, properties; purification methodologies Characteristics of bio- products; Flocculation and conditioning of broth, overview of reaction processes involved in separation, numerical examples illustrating the process. Mechanical separation processes; Filtration at constant pressure and at constant rate; empirical equations for batch and continuous filtration, centrifugal	<p>International standard Bioseparations science and engineering in SearchWorks catalog (stanford.edu)</p> <p><i>AICTE prescribed syllabus</i> https://www.aicte-india.org/flipbook/p&ap/biotechnology/</p> <p>IndustryMapping: Importance of Enzyme Immobilization (agscientific.com)</p> <p>Principals of various protein precipitation methods - BQC - Bioquochem</p>	5	<ol style="list-style-type: none"> 1. Batch Sedimentation 2. Cell Disruption by Ultra Sonication 3. Cell Disruption by Enzymatic Method

		and cross-flow filtration, Centrifugation: basic principles, design characteristics; ultracentrifuges: principles and applications.			
2	Techniques Involved in Separation Processes	Foam-fractionation; Solvent extraction of bio-processes, aqueous two-phase extraction, adsorption-desorption process; Salt precipitation; Chromatographic separation based on size, charge hydrophobic interactions and metal ion affinity. HPLC, Affinity chromatography, inhibitors: their preparation and uses, method of linkages, Electrophoresis SDS-PAGE (Polyacrylamide Gel), horizontal and vertical type, methods, case studies	<p>International standard Bioseparations science and engineering in SearchWorks catalog (stanford.edu)</p> <p><i>AICTE prescribed syllabus</i> https://www.aicte-india.org/flipbook/p&ap/biotechnology/</p> <p>Industry Mapping: Importance of Enzyme Immobilization (agscientific.com) Applications of Chromatography - Chrom Tech, Inc.</p> <p>List of Solvent extraction /Sectors with Industry Classification (finology.in)</p>	8	<p>1. Estimation of Protein by Bradford's Method</p> <p>2. Aqueous two phase Extraction</p>
3	Membrane based separation processes	Micro-filtration, Reverse osmosis, Ultrafiltration and affinity ultrafiltration, concentration polarization, rejection, flux expression, membrane modules, dead-ended and cross-flow mode, material balances and numerical problems, biological applications.	<p>International standard Bioseparations science and engineering in SearchWorks catalog (stanford.edu)</p> <p><i>AICTE prescribed syllabus</i> https://www.aicte-india.org/flipbook/p&ap/biotechnology/</p> <p>Industry Mapping: Exploring Industrial Filtration Types & Applications R.P. Fedder (rpfedder.com)</p> <p>3 Industries That Use Liquid Filtration Systems - chemsealinc</p>	8	<p>1. Flocculation</p> <p>2. Filtration</p>

			Types of Industrial Filtration and Their Benefits Interfil		
4	Industrial Applications	Industrial aspects of separation of biomolecules, Material balances, mathematical analysis and modeling, relative advantages and disadvantages of separation methods, Case studies	<p>International Standards: Bioseparations science and engineering in SearchWorks catalog (stanford.edu)</p> <p>AICTE prescribed syllabus https://www.aicte-india.org/flipbook/p&ap/biotechnology/</p> <p>IndustryMapping: Mathematical Modelling in Industry and Society Mathematics - UCL – University College London</p>	3	<p>1. Protein Concentration by Salting Out</p> <p>2. Detection of amino acid concentration</p>

TEXT BOOK:

1. [Bioprocess Engineering , Schulaer & Kargi](#)

Subject Name: Animal and plant biotechnology Credit: 2
Subject Code: PCCBT603 Lecture Hours: 24

[Study material- Animal and plant biotechnology](#)

<https://www.coursera.org/learn/industrial-biotech>

Animal Biotechnology course in NPTEL- https://onlinecourses.swayam2.ac.in/cec22_bt07/preview

Plant Biotechnology course in NPTEL- <https://archive.nptel.ac.in/courses/102/103/102103016/>

Module Number	Topic	Sub Topics	Mapping with Industry and International Academia	Lecture Hours	Corresponding Lab Assignment
1	Animal cell culture and Animal Biotechnology	<ul style="list-style-type: none"> Introduction to cell culture, primary cell culture, Development of cell line by enzymatic disaggregation, Culture media and growth conditions, differentiation. Cell type and characterization, cryopreservation; cryopreservation; Common cell culture contaminants. Application of animal cell culture in: Cytotoxicity and viability assays; 	<p>International academia: https://ocw.mit.edu/courses/20-109-laboratory-fundamentals-in-biological-engineering-spring-2010/pages/labs/module-3-day-2-initiate-cell-culture/ https://ocw.mit.edu/courses/20-109-laboratory-fundamentals-in-biological-engineering-fall-2007/pages/labs/guide_tissueculture/ AICTE prescribed syllabus https://www.aicte-india.org/flipbook/p&ap/biotechnology/</p> <p>Industry mapping: Cell culture is one of the most important techniques in cellular and molecular biology</p>	8	<ol style="list-style-type: none"> Preparation of tissue culture medium Preparation of cell suspension culture

		<p>●Embryo transfer: Artificial insemination, Superovulation, Embryo transfer, In vitro fertilization-Pregnancy diagnosis-Sexing of embryos, Embryo splitting; Cryopreservation of embryo;</p>	<p>since it provides a platform to investigate the biology, biochemistry, physiology and metabolism of wild-type cells and diseased cells. Cultured cells are used for the manufacturing of vaccines, therapeutic proteins and antibodies, and cell therapy products</p> <p>https://www.atcc.org/resources/culture-guides/animal-cell-culture-guide</p> <p>International academia: https://ocw.mit.edu/courses/7-016-introductory-biology-fall-2018/resources/lecture-16-recombinant-dna-and-cloning/</p> <p><i>AICTE prescribed syllabus</i> https://www.aicte-india.org/flipbook/p&ap/biotechnology/</p> <p>Industry mapping : Used to obtain offspring from animals as an alternative to natural mating. The most common reproductive biotechnology in animals is artificial insemination (AI), in conjunction with sperm preservation/ cryopreservation.</p> <p>https://www.dssimage.com/applications-specialities/ivf.html</p>		<p>Page </p>
--	--	--	--	--	---------------

2	<p>Growth and scale up of animal cell and Application of Animal Biotechnology</p>	<ul style="list-style-type: none"> Animal cell growth characteristics and kinetics; Cell culture reactors; Scale-up in suspension; Scale and complexity; Mixing and aeration; Rotating chambers; Perfused suspension cultures; Fluidized bed reactors for suspension culture; Scale-up in monolayers; Multisurface propagators; Multiarray disks, spirals and tubes; Roller culture; Micro-carrier attached growth; Cell culture in continuous, perfusion and hollow fibre reactor; Microencapsulation; Growth monitoring; Mass Organ culture technology; 	<p><i>International academia:</i> https://ocw.mit.edu/courses/7-342-how-to-build-an-animal-cell-fate-and-identity-in-development-and-disease-fall-2017/ https://ocw.mit.edu/courses/hst-176-cellular-and-molecular-immunology-fall-2005/ https://ocw.mit.edu/courses/7-342-a-double-edged-sword-cellular-immunity-in-health-and-disease-fall-2018/ https://ocw.mit.edu/courses/7-342-how-to-build-an-animal-cell-fate-and-identity-in-development-and-disease-fall-2017/</p> <p><i>AICTE prescribed syllabus</i> https://www.aicte-india.org/flipbook/p&ap/biotechnology/</p>	8	<ol style="list-style-type: none"> Cell isolation: Mechanical separation Chemical based extraction of enzyme . Impact of toxicity on RNA extracted from control and treated fish liver Toxicological, environmental monitoring

		<p>Tissue engineering and its application –production of complete organ - kidney – eyes - heart – brain; Immune system in health and disease, tissue and organ transplant, Vaccinology, Regenerative medicine.Biotechnology in animal Production</p> <p>● Manipulation of Growth hormone –somatotropic hormone-Thyroid hormone; Probiotics as growth promoters-Ideal characteristics of probiotics, Mode of action-uses of probiotics-Manipulation of lactation –Lactogenesis galactopoiesis-Manipulation</p>	<p>Industry mapping: From food and pharmaceuticals to fuel and chemicals, it is used across a wide range of sectors.</p> <p>https://www.a-star.edu.sg/bti/research/cell-line-development/animal-cell-bioprocessing#:~:text=The%20Animal%20Cell%20Bioprocessing%20group,vectors%2C%20vaccines%20and%20cultivated%20meats.</p> <p>Scalable manufacturing and commercialisation of products made using animal cell culture. The products include recombinant proteins, viral vectors, vaccines</p> <p>International academia: https://ocw.mit.edu/courses/7-341-the-microbiome-and-drug-delivery-cross-species-communication-in-health-and-disease-spring-2018/pages/readings/ https://ocw.mit.edu/courses/hst-535-principles-and-practice-of-tissue-engineering-fall-2004/</p> <p>Industry mapping: Have huge application in food and pharmacology industry https://eaglebio.com/product/growth-hormone-hgh-elisa-assay-kit/</p>		<p>studies using fish model</p> <p>Page </p>
--	--	---	---	--	---

		of wool growth- Manipulation of rumen microbial digestive system	AICTE – prescribed syllabus: https://www.aicte-india.org/sites/default/files/Model%20Curriculum%20for%20UG%20Degree%20Course%20in%20Biotechnology.pdf		
3	Plant tissue culture and crop development	<p>History of plant tissue culture, plasticity and totipotency.. Sterilization methods used in plant tissue culture. Types of nutrient media and plant growth regulators in plant regeneration. Pathways for in vitro regeneration: organogenesis, somatic and gametic embryogenesis; protoplast isolation, culture and regeneration; culture of other explants, somatic hybridization; Haploid and triploid production and their applications. Genetic fidelity of plants raised through tissue culture.</p> <ul style="list-style-type: none"> ● Application of tissue culture for crop improvement. Production of bioactive secondary metabolites by plant tissue culture. The need of crop 	<p>International academia: https://ocw.mit.edu/courses/1-74-land-water-food-and-climate-fall-2020/pages/reconciling-demand-and-supply-i/new-technologies-and-practices/</p> <p>https://courseware.cutm.ac.in/courses/plant-tissue-culture-engineering/</p> <p>AICTE prescribed syllabus https://www.aicte-india.org/flipbook/p&ap/biotechnology/</p> <p>Industry Mapping: Used for rapid vegetative multiplication of ornamental plants, genetically modified plants and fruit trees.</p> <p>https://www.mitconbiopharma.com/training/bio-tech-training/certificate-course-in-plant-tissue-culture/</p> <p>International academia: https://ocw.mit.edu/courses/7-05-general-biochemistry-spring-2020/resources/lecture-19-introduction-metabolism-polysaccharides-bioenergetics-intro-pathways/</p>	I	<ol style="list-style-type: none"> 1. Induction of callus from leaf explants 2. Androgenesis: anther culture

		<p>improvement. Conventional methods of crop improvement, selection, mutation, polyploidy and clonal selection.</p>	<p>https://ocw.mit.edu/courses/1-74-land-water-food-and-climate-fall-2020/pages/framing-the-discussion/</p> <p>https://ocw.mit.edu/courses/1-74-land-water-food-and-climate-fall-2020/pages/reconciling-demand-and-supply-i/environmental-impacts-of-agriculture/</p> <p><i>AICTE prescribed syllabus</i> https://www.aicte-india.org/flipbook/p&ap/biotechnology/</p> <p>Industry Mapping: Involves scientific techniques such as Genetically Modified Organisms, Bt Cotton, Pest Resistant Plants. It helps in modifying plants, animals, and microorganisms and improve their agricultural productivity</p> <p>https://extension.colostate.edu/topic-areas/agriculture/genetically-modified-gm-crops-techniques-and-applications-0-710/</p>		
4	Principles and methods of genetic transformation	<ul style="list-style-type: none"> ● Introduction to Agrobacterium biology and biotechnology. Mechanism of T-DNA transfer to plants 	<p>International academia: https://ocw.mit.edu/courses/7-16-experimental-molecular-biology-biotechnology-ii-spring-2005/</p>	8	1. Somatic embryogene Page

	<p>and Genome editing</p>	<p>and Agro infection. Methods for direct gene transfer, Marker and reporter genes; Promoters used in plant vectors. Plant viral vectors, social and legal issues associated with transgenic plants. Case studies for genetic engineering in plants for traits of agronomic value, biotic, abiotic stresses and herbicide tolerance.</p> <p>● Transgenic crops for production of antibodies, viral antigens and peptide</p>	<p>https://ocw.mit.edu/collections/environment/</p> <p><i>AICTE prescribed syllabus</i> https://www.aicte-india.org/flipbook/p&ap/biotechnology/</p> <p>Industry Mapping: An important tool in plant biotechnology to transfer foreign genes of interest to plant cells to create transgenics with economically important traits.</p> <p>https://www.mybiosource.com/learn/testing-procedures/agrobacterium-mediated-gene-transfer/</p> <p>International academia: https://ocw.mit.edu/courses/7-016-introductory-biology-fall-2018/resources/lecture-16-recombinant-dna-and-cloning/</p> <p>https://openlearninglibrary.mit.edu/courses/course-v1:MITx+15.480x+3T2021/courseware/6636360795f24bebbf7adc188c0d0bda/5234c51187a5460a841a750ab905b0c9/?activate_block_id=block-v1%3AMITx%2B15.480x%2B3T2021%2Btype%40sequential%2Bblock%405234c51187a5460a841a750ab905b0c9</p> <p><i>AICTE prescribed syllabus</i></p>		<p>sis- study of different stages of cells</p> <p>Page </p>
--	---------------------------	---	---	--	--

		<p>hormones in plants, Plant Biotechnology for biofuels. Discovery of CRISPR-Cas system and its applications. Recent innovations in the technology and case studies where CRISPR- Cas has been used for plant improvement.</p>	<p>https://www.aicte-india.org/flipbook/p&ap/biotechnology/</p> <p>Industry Mapping: Provides a more accurate approach to genetic modification. Combat Agricultural challenges including biotic stress resistance, fungal and bacterial disease resistance, and viral resistance.</p> <p>https://www.bio-rad.com/en-in/applications-technologies/crispr-cas-gene-editing-teaching-resources?ID=Q58I0DWDLBV5</p>		
--	--	--	--	--	--

Text Book

Text Books/References:

1. Culture of Animal Cells by R.I. Freshney. Chapter- 1-12
2. Animal Cell Biotechnology 2007, Humana Press by Portner R. Chapter- 1, 2, 3, 5, 7
3. Plant Biotechnology: An Introduction to Genetic Engineering by Adrian Slater, Nigel W. Scott, Mark R. Fowler. Oxford University Press, 2008. Chapter 2-6

Submitted by Dr. Sonali Paul and Dr. Pratik Talukder, IEM New Town