First Semester Courses in MSc-Biotechnology 2023-2024

Contents:

APPROVED SYLLABUS

ST. XAVIER'S COLLEGE-AUTONOMOUS * MUMBAI-400 001 *

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#.MSc. Part I. Biotechnology Semester I **Course Code: PSBTY6001EL1**

Name of the course: Microbial and Nano Biotechnology
Credits : 4
Number of lectures – 60

Course Objectives:

- To develop an understanding of application of microbes in the pharmaceutical industry and environment remediation.
- To explore the diversity of microorganisms and their roles in biotechnological processes, including biofuel production, bioremediation, and fermentation.
- To introduce about the synthesis, properties, and applications of nanomaterials in various biotechnological applications, such as drug delivery, imaging, and sensing.

Course Outcomes (COs)

Course Title and Code	**Microbial and Nano Biotechnology**	**PSBTY6001EL1**	
CO No.	**Course Outcomes** *On completion of the course , the student will be able to*	**PSOs Addressed**	**Cognitive Level**
CO-1	Appreciate relevance of microorganisms in Industrial Biotechnology and demonstrate the knowledge of fundamental principles for basic methods in production technique for bio-based products.	PSO-1,3,6,7	U,Ap, E
CO-2	Understand the use of microbial resources and its applications in pharmaceutical industry	PSO-2,3,7	U,Ap
CO-3	Understand and apply microbiological, methods for detection and control of environmental pollution.	PSO-2,3,4,7	U,Ap, E
CO-4	Understand the concepts in nanotechnology , nanomaterials and its properties	PSO-1,3,6,7	U,An,Ap
CO-5	Understand , apply and analyse the role of nanomaterials and nanotechnology in healthcare and environment problem mitigations.	PSO-3,4,6,7	U,An,Ap

CONTENT

Unit I: Basics of Microbial Technology — 15 lectures

Isolation and screening of microbes important for industry-Selection of Microbes for industrial use-Isolation of microbes from nature and screening of biological activities-Actinomycetes, Bacteria, Fungi, Developing and Semi-automating Screening Tests, Culture Preservation, Cryopreservation, Inoculum Development, Strain improvement methods: Recombinant Methods, Non recombinant (Mutagenesis, fusion, recombination etc.),

Small scale fermentation aspects: Introduction and Scope, Fermentation Vessels, Shakers, Media /Composition and Gas Exchange, Sampling and Analysis, Advantages/Disadvantages of Liquid and Solid-State Fermentation, Growth and Production of Enzymes, Small Scale Process Control

Unit II: Applications of Microbial Technology — 15 lectures

Pharmaceutical applications: Recombinant protein and pharmaceuticals production in microbes – common bottlenecks and issues (technical/operational, commercial and ethical); Attributes required in industrial microbes (Streptomyces sp.,Yeast) for biologicals production; Generating diversity and introduction of desirable properties in industrially important microbes (Streptomyces/Yeast); Microbial cell factories; Downstream processing approaches used in industrial production process (Streptomyces sp., Yeast).

Environmental application: Ore leaching; Biodegradation - biomass recycle and removal; Bioremediation - toxic waste removal and soil remediation; Global Biogeochemical cycles; Environment sensing (sensor organisms/ biological sensors); Food and healthcare industries - food processing and food preservation, antibiotics and enzymes production, Nonrecombinant ways of introducing desirable properties in Generally recognized as safe (GRAS) microbes to be used in food (e.g., Yeast) - exploiting the existing natural diversity or the artificially introduced diversity through conventional acceptable techniques.

Unit III: Introduction to Nanomaterials **15 lectures**

Various types of nanomaterials: Three-dimensional, two dimensional, one-dimensional and zero-dimensional nanomaterials.Carbon nanotubes, Graphene, Carbon dots, metal nanoparticles, metal oxide-based nanomaterials, semiconductor nanomaterials,quantum dots, hybrid nanoparticles, Bio-nanomaterials, polymer nanoparticles, lipid nanoparticles etc.Synthesis methodologies, Top down and bottom up approaches for nanomaterial synthesis

Properties of nanomaterials: Structural properties, chemical properties, surface functionalization, physical properties. Characterization of nanomaterials by various analytical methods.

Unit IV: Nanotechnology Applications in Healthcare and Agriculture **15 lectures**

Nanotechnology in healthcare: Nanopharmaceuticals, Nano nutraceuticals, Diagnosis, sensors and biosensors, Delivery vehicles, biomedical applications of nanomaterials. Multimodal nanoparticles, targeted drug delivery, theranostics.

Nanotechnology in agriculture and environment: Nanotechnology based tools to enhance agricultural productivity, Nano Based Agri and Food Products, Nanopesticides and Nanofertilizers, Nano-enabled technologies and abiotic stress management, Nanobiotechnology for Crop improvement, Biosensors for monitoring environmental changes and bioremediation

List of Recommended Reference Books

1. Lee, Y. K. (2013). Microbial Biotechnology: Principles and Applications. Hackensack, NJ: World Scientific.
2. Crueger, W. and Annelise, C. (1990) Biotechnology: A Textbook of Industrial Microbiology. 2nd Edition, Verlag, Munich
3. Nelson, K. E. (2015). Encyclopedia of Metagenomics. Genes, Genomes and Metagenomes: Basics, Methods, Databases and Tools. Boston, MA: Springer US.
4. Bernad R. Glick and Jack J. Pasternak. Molecular Biotechnology Principles and Applications of Recombinant DNA. WCB, 2002
5. Glazer, A.N. and Nikaido, H. (2008). Microbial Biotechnology. Cambridge University Press.
6. Young Chu- Lee Introduction to Bionanotechnology, Springer Publications (2020)

7. Current Research Reviews
8. Journals: (a) Nature, (b) Nature Biotechnology, (c) Applied microbiology and biotechnology, (d) Trends in Biotechnology, (e) Trends in Microbiology, (f) Current opinion in Microbiology, (g) Biotechnology Advances, (h) Genome Research)

Evaluation (Theory): Total marks per course - 100

I. Formative Assessment 'for' Learning (continuous internal assessment - CIA to improve learning).
CIA- 40 marks
Continous evaluation using various scientific communication methods

II. Summative Assessment 'of' Learning (focus on outcomes, quantitative data for outcomes of instruction).
End Semester Examination – 60 marks
One question from each unit for 15 marks, with internal choice.

Eg: Template for the Core course End Semester examination in Semester I for the Elective course

UNITS	KNOWLEDGE	UNDERSTANDING	APPLICATION and ANALYSES	TOTAL MARKS- Per unit
1	5	5	5	15
2		8	7	15
3	5	5	5	15
4		8	7	15
-TOTAL - Per objective	10	26	24	60
% WEIGHTAGE	16.67	43.33	40	100%

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#.MSc. Part I. Biotechnology Semester I **Course Code: PSBTY6002EL1**

Name of the course: Plant Biotechnology
Credits : 4 (Total number of lectures – 60)
Course Objectives:

- The Course will provide an advanced understanding of the principles, techniques, and applications of biotechnology as applied to plants.
- This course gives an opportunity to students to find out ways of exploiting the plants using biotechnological interventions for value addition or for novel plant products for human use.
- The course aims to introduce the concepts and significance of plant biotechnology in agriculture, food security, and environmental sustainability.
- The course comprehends the importance of tissue culture for mass production of disease-free plants and genetic transformation, production of pharmaceutical proteins and other valuable products using transgenic plants .

Course Outcomes (CO)

Course Title and Code	**Plant Biotechnology**		**PSBTY6002EL1**
CO No.	**Course Outcomes** ***On completion of the course , the student will be able to***	**PSOs Addressed**	**Cognitive Level**
CO-1	Demonstrate a comprehensive understanding of concepts in plant metabolism and plant tissue culture	PSO-1,3,6,7	U,Ap, E
CO-2	Design experiments using plant tissue culture techniques, including micropropagation, somatic embryogenesis, and protoplast isolation.	PSO-2,3,7	U,Ap
CO-3	Design experimental studies to understand metabolic pathways in order to validate existing and produce new scientific information about the same	PSO-2,3,4,7	U,Ap, E
CO-4	Develop and implement strategies for engineering crop traits, such as stress tolerance, nutrient enhancement, and yield improvement.	PSO-1,3,6,7	U,An,Ap

CO-5	Evaluate the potential benefits and risks of genetically modified crops and assess their societal and environmental impacts.	PSO- 3,4,6,8	U,An,Ap
CO-6	Identify and critically evaluate innovative technologies for their potential applications in plant research and agriculture.	PSO-1,3,6,8	U,An,Ap

CONTENT

Unit1: Plant Metabolism — 15 lectures

- Bioenergetics-basic principles; equilibria and concept of free energy; coupled interconnecting reactions in metabolism, types of metabolic pathways, the main class of metabolic reactions (using few already studied pathways)
- Carbohydrate metabolism and regulation in plants
- Overview of plant secondary metabolism - Main Secondary metabolites, Function of Secondary Metabolites (alkaloid, terpenoids, phenolics)
- Compartmentation of SMs biosynthesis- Cytosol, Mitochondria, Vesicles, Endoplasmic reticulum: chloroplast

Unit II: Plant Tissue Culture — 15 lectures

- Totipotency; Plant growth regulators
- Regeneration and micropropagation of plants: clonal propagation, organogenesis, shoot-tip and meristem culture, haploid culture, triploid culture, protoplast culture; Somaclonal variation;
- Tissue culture and Cell suspension culture system: methodology, growth kinetics and nutrient optimization; Precursors and elicitors
- Plant Transformation methods (emphasis on Agrobacterium mediated transformation); Hairy root culture;

Unit III: Plant Cell Technology — 15 lectures

Secondary Metabolite production: Principles, design and operation of bioreactors: specific design criteria for plant systems; Isolation, characterization and production of secondary metabolites from different plant cell types; Downstream process.

- Plant Biotechnology interventions for mitigating Abiotic -Biotic stress
  - Enhancing cold and heat stress tolerance; secondary effects of abiotic stress – production of ROS; genes involved in scavenging of ROS,
  - Enhancing drought and salt stress tolerance;

  - Enhancing resistance against fungal pathogens; anti-microbial proteins; enhance viral resistance- pathogen derived resistance; herbicide resistance.
- Plant biotechnology in improving fruit ripening and enhancing photosynthesis; Golden rice- nutritionally improved rice through biotechnology; Bt cotton, Bt brinjal and Golden mustard, transgenic sweet potato; Modification of taste and appearance- sweetness, starch and preventing discoloration

Unit IV: Plants as Biofactories **15 lectures**

- Molecular farming, Production of Industrial enzymes, biodegradable plastics, therapeutic proteins, edible vaccines, and antibiotics using transgenic technology.
- Plant-based bioremediation: applications of bioremediation for salinity, heavy metal-contaminated soils, radioactive contamination, etc
- Biofertilizers and Biopesticides- Plant growth promoting bacteria.
- Phytoremediation -Phyto mining
- Plant based Biosensors and Bioindicators for environmental monitoring.

List of Recommended Reference Books

- Cseke L.J., Kirakosyan A., Kaufman P.B., Warber S.L., Duke J.A. and Brielmann H.L. Natural Products from Plants, 2nd edition, Taylor & Francis group, 2006.
- Buchanan B; Gruissem W et al (2nd Ed.) Biochemistry and Molecular Biology of Plants John Wiley & Sons 2015
- Brun T.A. (2006). Gene Cloning and DNA Analysis. An Introduction, Oxford, Blackwell Pub.
- Bernard R. Glick, Jack J. Pasternak, Cheryl L. Patten. (2010) Molecular Biotechnology: Principles and Applications of Recombinant DNA. ASM Press.
- Primrose, S.B. & Twyman, R.M.: Principles of gene manipulation and genomics. (7th ed.) Malden. Blackwell Publishing, 2006. 1-4051-3544-3--(575.1Pri/Twy)
- Chawla, H. S. (2000). Introduction to Plant Biotechnology. Enfield, NH: Science.
- Razdan, M. K. (2003). Introduction to Plant Tissue Culture. Enfield, NH: Science.
- Slater, A., Scott, N. W., & Fowler, M. R. (2008). Plant Biotechnology: an Introduction to Genetic Engineering. Oxford: Oxford University Press.

Evaluation (Theory): Total marks per course - 100

I. Formative Assessment 'for' Learning (continuous internal assessment - CIA to improve learning).
CIA- 40 marks
Continous evaluation using various scientific communication methods

II. Summative Assessment 'of' Learning (focus on outcomes, quantitative data for outcomes of instruction).
End Semester Examination – 60 marks
One question from each unit for 15 marks, with internal choice.

Eg: Template for the Core course End Semester examination in Semester I for the Elective course

UNITS	KNOWLEDGE	UNDERSTANDING	APPLICATION and ANALYSES	TOTAL MARKS- Per unit
1	5	5	5	15
2	5	5	5	15
3		8	7	15
4		8	7	15
-TOTAL - Per objective	10	26	24	60
% WEIGHTAGE	16.67	43.33	40	100%

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Second Semester Courses in MSc-Biotechnology 2023-2024

Contents:

#.MSc. Part I. Biotechnology Semester II **COURSE: PSBTY6003EL1**

Name of the course: Molecular Oncology
Credits : 4 (Total number of lectures – 60)

Course Objectives:

1. The primary objective of the course is to provide students with a comprehensive understanding of the molecular basis of cancer, including its causes, progression, and potential therapeutic interventions.
2. The course will introduce the learner to advanced technologies and screens, used in cancer research, diagnosis and treatment.

Course Outcomes (COs)

Course Title and Code	**Molecular Oncology**	**PSBTY6003EL1**	
CO No.	**Course Outcomes** *On completion of the course , the student will be able to*	**PSOs Addressed**	**Cognitive Level**
CO-1	Describe the fundamental molecular processes underlying cancer initiation, progression, and metastasis.	PSO-1,2,6	U,Ap
CO-2	Demonstrate knowledge of strategies for cancer diagnosis and therapeutics	PSO-1,6	U,Ap
CO-3	Discuss the concept of personalized medicine in oncology and the development of targeted therapies.	PSO- 2,3	An, Ap
CO-4	Analyse and interpret biological data related to Cancer from accessible databases.	PSO-3,4,6.7	U, An, Ap
CO-5	Apply acquired knowledge to critically analyze and propose strategies for understanding cancer biology, improving therapeutic interventions, and demonstrate readiness for ongoing learning and adaptation to new developments.	PSO-3,4,6.7,8	U, An, Ap

CONTENT

Unit 1: Fundamentals of Cancer — 15 lectures

- Nature of cancer, classification of cancers and tumors, cancer epidemiology
- Etiology: Tobacco and cancer development, cancer susceptibility syndromes, viruses and cancer (RNA and DNA viruses), inflammation and cancer, chemical & physical carcinogens, carcinogenesis, types of carcinogenesis, diet and cancer.
- Cell Cycle regulation and Apoptosis
- Molecular Biology of Cancer
    - Oncogenes, Tumor suppressor genes
    - Role of Telomerases
    - Epigenetics in Cancer
    - Non coding RNAs in Cancer
    - Genomic stability and development of cancer

Unit 2: Invasion, Metastasis and Tumor Immunology — 15 lectures

- Tumorigenesis- Multistep process (stem cell theory, chronic inflammation)
- Angiogenesis and its implication in tumor progression
- Pathogenesis of Metastasis, EMT
- Tumor Immunology-
    - Anti-tumor immune response of regulatory T cells, NK cells,
    - Immune surveillance theory
    - Evasion of immune surveillance by cancer cells
    - Tumor antigens
    - Immunoediting

Unit 3: Cancer Diagnosis and Therapeutics — 15 lectures

- Methods of Diagnosis
    - Blood Chemistry, Cytology, Biopsy
    - Cytogenetics Immunophenotyping, Marker studies
    - Imaging
    - Sequencing technologies in detection of cancer causing alterations
    - Detection of recognized genetic aberrations
- Conventional Cancer treatment – radiation, chemotherapy, and surgery
- Targeted Therapy – Check point inhibitors, Hormone therapy, Monoclonal Antibodies
- Immunotherapy
- Natural Products in Cancer therapeutics
- Current Combination Therapy Approaches
- Therapeutics in Clinical Trials
- Predictive biomarkers for personalized onco-therapy

Unit 4: Cancer - Data analysis **15 lectures**

- Introduction to High Throughput Sequencing and its Application in Cancer
- Introduction and concept of cancer genomics
- Cancer genome analysis project; Cancer genomics data sets visualization
- Cosmic database (catalog of somatic mutations in cancer), data types, features, and data retrieval for analysis
- Gene expression
    - Gene expression databases, Gene expression omnibus as an example for expression data analysis, UCSC genome browser
    - My cancer genome database resources
    - Gene expression analysis/profiling/tools, expression atlas
- Cancer epigenetics and whole genome haplotyping

List of Recommended Reference Books

- Lewin, Benjamin; Krebs, Jocelyn E.; Goldstein, Elliott S. & Kilpatrick, Stephen T.: Genes XI. New Delhi. Jones and Bartlett India Pvt. Ltd., 2015. 978-93-80853-71-0--(575.1Lew)
- Watson, James D., Baker, Tania A., Bell, Stephen P. & Gann, Alexander: Molecular biology of the gene. (6th ed.) New York. Pearson Education Inc., 2008. 0-321-50781-9--(574.88Wat)
- Lodish, Harvey F.; Berk, Arnold; Kaiser, Chris A. & Krieger, Monty: Molecular cell biology. (7th ed.) New York. W.H. Freeman and Company, 2013. 978-1-4641-0981-2--(574.87Lod)
- Alberts, Bruce, Alexander Johnson, Julian Lewis, David Morgan, Martin Raff, Keith Roberts and Peter Walter: Molecular Biology of the cell (6th Ed) Garland Science Publishing., 2015
- Weinberg, R.A. (2013). The Biology of Cancer (2nd ed.). W.W. Norton & Company.
- Databases and Relevant current research articles

Evaluation (Theory): Total marks per course - 100

I. Formative Assessment 'for' Learning (continuous internal assessment - CIA to improve learning).
CIA- 40 marks
Continous evaluation using various scientific communication methods

II. Summative Assessment 'of' Learning (focus on outcomes, quantitative data for outcomes of instruction).
End Semester Examination – 60 marks
One question from each unit for 15 marks, with internal choice.

Eg: Template for the Core course End Semester examination in Semester II for the Elective course

UNITS	KNOWLEDGE	UNDERSTANDING	APPLICATION and ANALYSES	TOTAL MARKS- Per unit
1	5	5	5	15
2	5	5	5	15
3	5	5	5	15
4		8	7	15
-TOTAL - Per objective	15	23	22	70
% WEIGHTAGE	25	38.33	36.67	100%

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#.MSc. Part I. Biotechnology Semester II **Course Code: PSBTY6004EL1**

Name of the course: Regulations in Biotechnology and IPR
Credits : 4 (Total number of lectures – 60)

Course Objectives:

- The course aims to provide students with a comprehensive understanding of the legal, ethical, and regulatory aspects that govern the field of biotechnology, including the management and protection of intellectual property.
- It will allow the learner to understand the global and regional regulatory frameworks governing biotechnology research, development, and commercialization.
- The course will provide an insight into the basics of patent law as it applies to biotechnological inventions.

Course Outcomes (CO)

Course Title and Code	**Regulations in Biotechnology and IPR**	**PSBTY6004EL1**	
CO No.	**Course Outcomes** ***On completion of the course , the student will be able to***	**PSOs Addressed**	**Cognitive Level**
CO-1	Describe the key global and regional regulatory frameworks that govern biotechnology research, development, and commercialization.	PSO-1,3,6,7	U, Ap, E
CO-2	Comprehend biosafety regulations and guidelines governing the handling, containment, and transport of GMOs and hazardous materials and apply biosafety principles to ensure environmental and public safety.	PSO-1,3,6,7	U, Ap, E
CO-3	Define intellectual property (IP) and differentiate between patents, copyrights, trademarks, and trade secrets and understand the importance of IP protection in fostering innovation and incentivizing creativity.	PSO-1,3,6,7	U, Ap, E
CO-4	Interpret patent-related terminology, including patentability, prior art, claims, and infringement and analyze patent	PSO-1,3,6,7	U, Ap, E

	documents to extract relevant information about biotechnological inventions.		
CO-5	Apply regulatory knowledge and IP concepts to analyze case studies and real-world scenarios.	PSO-1,3,6,7	U, Ap, E
CO-6	Recognize ethical considerations and dilemmas inherent in biotechnological research, product development, and IP protection, analyze case studies to evaluate ethical implications and make informed decisions.	PSO-1,3,6,7	U, Ap, E

CONTENT

Unit 1: Biosafety and Bioethics **15 lectures**

- Biosafety- introduction; historical background; introduction to biological safety cabinets; primary containment for biohazards; biosafety levels; GRAS organisms, biosafety levels of specific microorganisms; recommended biosafety levels for infectious agents and infected animals; definition of GMOs . LMOs, primary containment of biohazards, BSCs, Clean Room technology
- Principles of safety assessment of transgenic plants – sequential steps in risk assessment; concepts of familiarity and substantial equivalence; , Risk assessment- environmental risk assessment and food and feed safety assessment, problem formulation – protection goals, compilation of relevant information, *risk characterization and development of analysis plan (*management and communication including GMP, GLP, and HACCP)*; risk assessment of transgenic crops vs cisgenic plants or products derived from* RNAi, genome editing tools
- Bioethics- Introduction, ethical conflicts in biological sciences - interference with nature, bioethics in health care - patient confidentiality, informed consent, euthanasia, artificial reproductive technologies, prenatal diagnosis, genetic screening, gene therapy, transplantation.
- Bioethics in research – cloning and stem cell research, Human and animal experimentation, animal rights/welfare, Agricultural biotechnology - Genetically engineered food, environmental risk, labeling and public opinion. Sharing benefits and protecting future generations - Protection of environment and biodiversity – biopiracy

Unit 2 : Principles of Biotechnology Regulation **15 lectures**

- The U.S. , E.U. and Indian approaches on Biotechnology research, Intentional introduction into environment, GM Food, labelling etc.
- Framework for Regulations: Convention on Biological Diversity, Cartagena Protocol on Biosafety, WTO Agreements, Codex Alimentarius, Plant Genetic Resources for Food and Agriculture. Judicial response to disputes on biotechnology trade and development, Role of IBSC, RCGM, GEAC, and others
- National Biotechnology Regulatory Bill 2013
- The DNA Technology (Use and Application) Regulation Bill – 2019
- Recombinant DNA Research and Biocontainment guidelines-2017
- Field trails – biosafety research trials – standard operating procedures - guidelines of state governments; GM labeling – Food Safety and Standards Authority of India (FSSAI)

Unit3: Basic Concepts of IPR **15 lectures**

- Biotechnology and the law: objective, evolution, Commercial potential of biotech inventions, rational for IPR protection, Permissible and non-permissible Biotechnology patenting in India
- Patenting biotech inventions: objectives, concepts of novelty and concepts of inventive step, microorganisms, and moral issues in patenting biotech inventions
- Patenting issues related to Biosimilars
- Protection of geographical indications: objectives, justification, international position, multilateral treaties, national level, the Indian position
- Protection of traditional knowledge: objective, the concept of traditional knowledge, holders, issue concerning, bio-prospecting and bio-piracy, alternative ways, protectability, need for a sui generis regime, traditional knowledge on the international arena, traditional knowledge at WTO, traditional knowledge at the national level, traditional knowledge digital library
- Plant varieties protection: objectives, justification, criteria for protection, international position, plant varieties protection in India, plant varieties protection under TRIPs
- Case studies

Unit 4: Concepts and Process of Patenting **15 lectures**

- Basics of patents: types of patents; Indian Patent Act 1970; recent amendments; WIPO Treaties; Budapest Treaty; Patent Cooperation Treaty (PCT) and implications; procedure for

filing a PCT application; role of a Country Patent Office; filing of a patent application; precautions before patenting-disclosure/non-disclosure - patent application- forms and guidelines including those of National Bio-diversity Authority (NBA) and other regulatory bodies, fee structure, time frames; types of patent applications: provisional and complete specifications; PCT and conventional patent applications; international patenting-requirement, procedures and costs; financial assistance for patenting.

- Introduction to existing schemes; publication of patents-gazette of India, status in Europe and US; patent infringement- meaning, scope, litigation, case studies and examples; commercialization of patented innovations; licensing – outright sale, licensing, royalty;
- Patenting by research students and scientists-university/organizational rules in India and abroad, collaborative research - backward and forward IP; benefit/credit sharing among parties/community, commercial (financial) and non-commercial incentives
- Patent reviews and Case studies
- Patent databases - country-wise patent searches (USPTO, EPO, India)
- Searching ,analysing Patents and Report formation

List of Recommended Reference Books

- Bernard R. Glick, Jack J. Pasternak, Cheryl L. Patten. (2010) Molecular Biotechnology: Principles and Applications of Recombinant DNA. ASM Press.
- Rajul K Gupta (2017) Food Safety in the 21st Century: Public Health Perspective, Academic Press.
- Biosafety in Microbiology and biomedical laboratories, 5th Ed. (2009): CDC, NIH publication. HHS publication (21-1112)
- http://dbtbiosafety.nic.in
- Secretariat of the Convention on Biological Diversity (2000). Cartagena Protocol on Biosafety to the Convention on Biological Diversity: text and annexes. Montreal.
- Traavik. T and Lim Li Ching, (2007): Biosafety first. Tapir Academic Press
- Alexandra George (2006) Globalisation and Intellectual Property, Ashgate publishing company
- Colin Ratledge and Bjorn Kristiansen Basic Biotechnology, Cambridge University Press- 2nd Ed,2001
- David Pressman (2016) Patent It Yourself 18th edition, Nolo Publishers

- Maarten Bode, (2008) Taking traditional knowledge to the market, Orient Longman Publishers
- Prabudha Ganguly, (2001) Intellectual Property rights- unleashing the knowledge economy, Tata McGraw Hill Publishing Company Ltd.
- Sudeep Chaudhuri (2005), the WTO and India's Pharmaceutical industry, Oxford University Press.
- Vandana Shiva (2002), Protect or Plunder? Understanding Intellectual Property Rights, Zed Books.
- Recent research articles.

Evaluation (Theory): Total marks per course - 100

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