Courses which focuses on Professional Ethics, Gender, Human Values, Environment & Sustainability and other value framework

Department : *Biotechnology*

Programme Name : *M.Sc.*

Academic Year : 2021-2022

Courses which focuses on Professional Ethics, Gender, Human Values, Environment & Sustainability and other value framework:

Sr. No.	Course Code	Name of the Course
01.	MBT 206T	Research Methodology and Scientific Communication Skills
02.	MBT 207T	Environmental Biotechnology
03.	MBT 303T	Critical Analysis of Classical Papers
04.	MBT 304T	Bioentrepreneurship
05.	MBT 305T	Intellectual Property Rights, Biosafety and Bioethics

Scheme and Syllabus

Syllabus
M.Sc.Biotechnology
(2021-22)

M.Sc. Biotechnology PG Semester I				
Code	Course opted	Subjects	Hours/ week	Credits
MBT 101 T	Core -1	Biochemistry	03	3
MBT 102T	Core -2	Cell and Molecular Biology	03	3
MBT 103T	Core -3	Plant and Animal Biotechnology	03	3
MBT 104T	Core -4	Microbiology	02	2
MBT 105T	Core-5	Genetics	02	2
MBT 106T	Core-6	Biostatistics	03	3
		Laboratory		
MBT 107L	Lab 01	Biochemistry and Analytical Techniques	08	4
MBT 108L	Lab 02	Microbiology	04	2
MBT 109L	Lab 03	Plant and Animal Biotechnology	04	2
		Total	32	24
M.ScBiotechnologyPG Semester II				
Code	Course opted	Subjects	Hours/ week	Credits
MBT 201 T	Core -1	Genetic Engineering	03	3
MBT 202T	Core -2	Immunology	03	3
MBT 203T	Core -3	Bioinformatics	03	3
MBT 204T	Core-4	Genomics and Proteomics	02	2
MBT 205T	Core -5	Molecular Diagnostics	02	2
MBT 206T	Core -6	Research Methodology and Scientific Communication Skills	02	2
MBT 207T	Elective-1	Environmental Biotechnology	02	2
MBT 208T	Elective-1	Human Genomics		
MBT 209T	Elective-1	Nanobiotechnology		
*MBT 210S	Elective	MOOCs course to be selected/opted from SWAYAM portal (SWAYAM-BIOTECH-1)		
		Laboratory		
MBT 211L	Lab 01	Molecular Biology and Genetic Engineering	08	4
MBT 212 L	Lab 02	Immunology	06	3
		Total	31	24
M.ScBiotechnologyPG Semester III				
Code	Course opted	Subjects	Hours/ week	Credits
MBT 301 T	Core -1	Bioprocess Engineering and Technology	03	3
MBT 302T	Core -2	Emerging Technologies	02	2
MBT 303T	Core -3	Critical Analysis of Classical Papers	02	2
MBT 304T	Core-4	Bioentrepreneurship	02	2
MBT 305T	Core -5	Intellectual Property Rights, Biosafety and Bioethics	02	2
MBT 306T	Core -6	Project Proposal Preparation and Presentation	02	2
MBT 307T	Core -7	Research Seminar	02	2

MBT 308T	Elective	Microbial Technology	02	2
MBT 309 T	Elective	Computational Biology		
MBT 310 T	Elective	Drug Discovery and Development		
MBT 311 T	Elective	Vaccines		
MBT 312 T	Elective	Protein Engineering		
MBT 313 T	Elective	Medical Microbiology and Infection Biology		
MBT 314S	Elective	MOOCs course to be selected/opted from SWAYAM portal (SWAYAM-BIOTECH-1)		
*MBT 3 15T	Open Elective	**Application in Biotechnology** (The students will have to opt an open elective course from the basket of elective courses offered by other departments of University)	05	5
		Laboratory		
MBT 315L	Lab 01	**Laboratory VI: Bioprocess Engineering and Technology**	08	4
MBT 316 L	Lab 02	**Laboratory VII: Bioinformatics**	04	2
		Total	34	28

M.Sc. Biotechnology PG Semester IV

Code	Course opted	Subjects	Hours/ week	Credits
MBT 401	Core -1	Dissertation	32	20
		Total	32	20
			Total Credits	96

Note:

- The students will undertake industrial tour/visit during first year of M.Sc. programme as part of skill development. After visit students will be required to submit a report/certificate for record.
- The summer/winter training 4 – 8 weeks is compulsory for DBT sponsored students and optional for other M.Sc. students. After training, students will be required to submit the certificate for record.

* Open elective course will be offered in the odd or even semester as approved by the university.

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3. Glick, B.R., Pasternak, J.J., & Patten, C.L. (2010). *Molecular Biotechnology: Principles and Applications of Recombinant DNA*. Washington, DC: ASM Press.
4. Coleman, W.B., & Tsongalis, G.J. (2010). *Molecular Diagnostics: for the Clinical Laboratorian*. Totowa, NJ: Humana Press.

Research Methodology and Scientific Communication Skills

Credits: 2

Course Objectives

The objectives of this course are to give background on history of science, emphasizing methodologies used to do research, use framework of these methodologies for understanding effective lab practices and scientific communication and appreciate scientific ethics.

Student Learning Outcomes

Students should be able to:

- Understand history and methodologies of scientific research, applying these to recent published papers;
- Understand and practice scientific reading, writing and presentations;
- Appreciate scientific ethics through case studies.

Unit I **History of science and science methodologies** 8 lectures	Empirical science; scientific method; manipulative experiments and controls; deductive and inductive reasoning; descriptive science; reductionist vs holistic biology.
Unit II **Preparation for research** 2 lectures	Choosing a mentor, lab and research question; maintaining a lab notebook.
Unit III **Process of communication** 5 lectures	Concept of effective communication- setting clear goals for communication; determining outcomes and results; initiating communication; avoiding breakdowns while communicating; creating value in conversation; barriers to effective communication; non-verbal communication-interpreting non-verbal cues; importance of body language, power of effective listening; recognizing cultural differences; Presentation skills-formal presentation skills; preparing and presenting using over-head projector, PowerPoint; defending interrogation; scientific poster preparation & presentation; participating in group discussions; Computing skills for scientific research - web browsing for information search; search engines and their mechanism of searching; hidden Web and its importance in scientific research; internet as a medium of interaction between scientists; effective email strategy using the right tone and conciseness.
Unit IV **Scientific communication** 9 lectures	Technical writing skills - types of reports; layout of a formal report; scientific writing skills - importance of communicating science; problems while writing a scientific document; plagiarism, software for plagiarism; scientific publication writing: elements of a scientific paper including abstract, introduction, materials & methods, results, discussion, references; drafting titles and framing abstracts; publishing scientific papers- peer review process and problems, recent developments such as open access and non-blind review; plagiarism; characteristics of effective technical communication; scientific presentations; ethical issues; scientific misconduct.

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Environmental Biotechnology

Credits 2

Course Objectives

This course aims to introduce fundamentals of Environmental Biotechnology. The course will introduce major groups of microorganisms- tools in biotechnology and their most important environmental applications. The environmental applications of biotechnology will be presented in detail and will be supported by examples from the national and international literature.

Student Learning Outcomes

On completion of course, students will be able to understand use of basic microbiological, molecular and analytical methods, which are extensively used in environmental biotechnology.

Unit I **Introduction to environment** 6 lectures	Introduction to environment; Pollution: air, water, soil, noise; pollution indicators; Climate change, Biodiversity and its conservation; bio geochemical cycles; microbial ecology.
Unit II **Waste Management** 8 lectures	Waste management: domestic, industrial, and hazardous wastes (storage, transportation, treatment and disposal); solid waste management, wastewater characteristics and treatment, treatment strategies for effluent generated by distillery, paper and pulp industries, textile industries; waste to energy, recycling and reuse.
Unit III **Bioremediation** 8 lectures	Bioremediation: Fundamentals, technological aspects and strategies, bioremediation of metals, radionuclides, organic pollutants/xenobiotic; Application of bacteria and fungi in bioremediation; Phytoremediation: Fundamentals and description of major methods of application (phytoaccumulation, phytovolatilization, rhizofiltration, phytostabilization).
Unit IV **Biotechnology and agriculture** 11 lectures	Biopesticides, Bioinsecticides, Biofungicides, Bioherbicides: genetic modifications, mode of actions; Biofertilizers: Symbiotic systems between plants–microorganisms, Plant growth promoting rhizobacteria (PGPR) – uses, practical aspects and problems in application.
Unit V **Biofuels** 8 lectures	Biofuels: production of biogas; bioethanol; biodiesel; Utilizable biomass, microorganisms and biotechnological interventions for optimization of production, Microbial Fuel Cells, Microbiologically enhanced oil recovery (MEOR); Bioleaching of metals; Bioplastic.

Critical Analysis of Classical Papers

Credits

2

Course Objectives

The objectives of this course are to familiarizestudentswithclassicliterature to make them appreciate how ground-breaking discoveries were made without, necessarily,useofhigh-endtechnologies.

Student Learning Outcomes

Students should be able to train in the exercise of hypothesis building and methods of addressing the hypothesis with readily available technology.

How does the Course Module work? Students may be divided in groups and each group may be responsible for one classicalpaper.Eachweekthereamaybeal.5hourpresentationcumdiscussionforeachofthepapers.Attheendofthe semestereachstudentwillbeaskedtowriteamini-review(2-3pageslong)onanyoneclassicalpaper,otherthanthe one he/shepresented/discussed.

A list of sixteen classic papers and some suggested reference materials:

Syllabus
Molecular Biology

1. Studies on the chemical nature of the substance inducing transformation of Pneumococcaltypes:Inductionoftransformationbydeoxyribonucleicacid fraction isolated from *Pneumococcus* typeIII.
   Avery OT, Macleod CM, McCarty M.; J Exp Med. 1944 Feb 1;79(2):137-58.
   Note: This paper demonstrates that DNA is the transforming Principle originally described by Fredrick Griffith.
2. Independent functions of viral protein and nucleic acid in growth of bacteriophage HersheyAD,andChaseM.;JGenPhysiol.1952May;36(1):39-56.
   Note: Note: This paper demonstrates that DNA, and not protein, component of phages enter bacterial cells.
3. Molecularstructureofnucleicacids;astructurefordeoxyribosenucleicacid WatsonJD,andCrickFH;Nature.1953Apr25;171(4356):737-8
   Note: In this one page paper Watson and Crick first described the structure of DNA double helix
   Study help - Watson_Crick_Nature_1953_annotated
4. Transposable mating type genes in*Saccharomycescerevisiae*
   James Hicks, Jeffrey N. Strathern& Amar J.S. Klar; Nature 282, 478-483,1979Note: Thispaperprovidedevidencefor'cassettehypothesis'ofyeastmatingtype switches *i.e.* interconversion of mating types in yeast *(S. cerevisiae)* occurs by DNArearrangement.
5. Messelson&Stahlexperimentdemonstratingsemi-conservativereplicationofDNA. Meselson M and Stahl FW.; ProcNatlAcadSci U S A. 1958 Jul 15;44(7):671-82
   Note: Theexperimentdemonstratingsemi-conservativemodeofDNAreplicationis referred to as "the most beautiful experiment inbiology"
6. *Invivo*alterationoftelomeresequenceandsenescencecausedbymutated *Tetrahymena*telomerase RNAs
   Guo-LiangYu,JohnD.Bradley,LauraD.Attardi&ElizabethH.Blackburn; Nature 344, 126-132,1990
   Note: This paper demonstrates that the telomerase contains the template for telomere synthesis

Syllabus
Cell Biology

1. A protein-conducting channel in the endoplasmic reticulum
   SimonSMAND BlobelG.;Cell.1991May3;65(3):371-80
   Note: This paper demonstrates the existence of a protein conducting channel
   Study help - A brief history of Signal Hypothesis

2. Identification of 23 complementation groups required for post-translational events in the yeast secretorypathway
Novick P, Field C, Schekman R.; Cell. 1980 Aug;21(1):205-15
Note: In this groundbreaking paper Randy Schekman's group used a mutagenesis screen for fast sedimenting yeast mutants to identify genes involved in cell secretion
3. Ayeastmutantdefectiveatanearlystageinimportofsecretoryproteinprecursors into the endoplasmicreticulum
Deshaies RJ and Schekman R.; *J* Cell Biol. 1987 Aug;105(2):633-45
Note: Using another yeast mutation screen Schekman lab identifies Sec61, a component of ER protein Conducting Channel (PCC)
Suggested reference paper - A biochemical assay for identification of PCC.
4. Reconstitution of the Transport of Protein between Successive Compartments of theGolgi
BalchWE,DunphyWG,BraellWA,RothmanJE.;Cell.1984Dec;39(2Pt1):405-16
Note: This paper describes setting up of an *in vitro* reconstituted system for transportbetweengolgistacks*w*hichevent*u*allyp*a*vedthe*w*ayforidentificationof mostofthemoleculerplayersinvolvedinthesestepsincludingNSF,SNAPetc.
5. Acompleteimmunoglobulingeneiscreatedbysomaticrecombination
BrackC,HiramaM,Lenhard-SchullerR,TonegawaS.;Cell.1978Sep;15(1):1-14
Note: This study demonstrates DNA level molecular details of somatic rearrangement of immunoglobulin gene sequences leading to the generation of functionally competent antibody generating genefollowingrecombination.
6. Anovelmultigenefamilymayencodeodorantreceptors:amolecularbasisfor odorrecognition
Buck L and Axel R; Cell. 1991 Apr 5;65(1):175-87
Note: Thispapersuggeststhatdifferentchemicalodorantsassociatewithdifferent cell-specific expression of a transmembrane receptor in *Drosophila* olfactory epitheliumthereal*a*rgefamilyofodorat*r*eceptorsisexpressed.
7. Kinesinwalkshand-over-hand
YildizA,TomishigeM,ValeRD,SelvinPR.;Science.2004Jan30;303(5658):676-8
Note: This paper shows that kinesin motor works as a two-headed dimeric motor walking hand-over-hand rather than like an inchworm on microtubule tract using the energy ofATPhydrolysis.

Syllabus
Developmental Biology/ Genetics

1. Mutations affecting segment number and polarityin *Drosophila*
Christiane Nusslein-Volhardand Eric Weischaus; Nature 287, 795-801, 1980
Note: Thissinglemutagenesisscreenidentifiedmajorityofthedevelopmentallyimpor tantgenesnotonlyinfliesbutinothermetazoansaswell.
2. InformationforthedorsaI--ventralpatternofthe*Drosophila*embryoisstored as maternalmRNA
Anderson KV and Nusslein-Volhard C; Nature. 1984 Sep 20-26;311(5983):223-7
Note: This landmark paper demonstrated that early dorsal-ventral pattern information is stored as maternal mRNA in flies and devised the method of identifying genes encoding such genes
3. Hedgehog signalling in the mouse requires intraflagellar transport proteins
HuangfuD,LiuA,RakemanAS,MurciaNS,NiswanderL,AndersonKV.;
Nature. 2003 Nov6;426(6962):83-7
Note: One of the architects of original fly mutagenesis screens conducted a mouse mutagenesis screen which identified a gene Kif3a as a major component of hedgehog signaling pathway. Eventually this discovery revolutionizes our understanding of mechanisms of action of signaling pathways by demonstrating central role of cillia in it.
Suggested Reference paper - Design and execution of a embryonic lethal mutation screen in mouse.

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Bioentrepre-neurship

Credits 3

Course Objectives

Research and business belong together and both are needed. In a rapidly developing life science industry, there is an urgent need for people who combine business knowledge with the understanding of science & technology.

Bio-entrepreneurship, an interdisciplinary course, revolves around the central theme of how to manage and develop life science companies and projects. The objectives of this course are to teach students about concepts of entrepreneurship including identifying a winning business opportunity, gathering funding and launching a business, growing and nurturing the organization and harvesting there wards.

Student Learning Outcomes

Students should be able to gain entrepreneurial skills, understand the various operations involved in venture creation, identify scope for entrepreneurship in biosciences and utilize the schemes promoted through knowledge centers and various agencies. The knowledge pertaining to management should also help students to be able to build up a strong network within the industry.

Unit I **Innovation and entrepreneurship in bio-business** 8 lectures	Introduction and scope in Bio-entrepreneurship, Types of bio-industries and competitive dynamics between the sub-industries of the bio-sector (*e.g.* pharmaceuticals *vs.* Industrial biotech), Strategy and operations of bio-sector firms: Factors shaping opportunities for innovation and entrepreneurship in bio-sectors, and the business implications of those opportunities
Unit II **Management and funding agencies** 4 lectures	Management definition, scope, function, levels, roles, Entrepreneurship development programs of public and private agencies including Small & Medium Enterprises (MSME),DBT, BIRAC, Make in India, strategic dimensions of patenting & commercialization strategies
Unit III **Bio markets and Marketing** 4 lectures	Negotiating the road from lab to the market, strategies and processes of negotiation with financiers, government and regulatory authorities, Pricing strategy, market development expansion, Ansoff Matrix, market development tools and concepts, PTM matrix
Unit IV **Finance and accounting** 4 lectures	Basic contract principles, different types of agreement and contract terms typically found in joint venture and development agreements, Dispute resolution skills. Business plan preparation including statutory and legal requirements, Business feasibility study, Collaborations & partnership, Information technology
Unit V **Technology management** 8 lectures	Quality control & transfer of foreign technologies, Knowledge centers and Technology transfer agencies, Understanding of regulatory compliances and procedures of Central Drugs Standard Control Organization (CDSCO),differences between Good Laboratory Practice (GLP) regulations, Good Clinical Practice (GCP), and Good Manufacturing Practice (GMP) regulations

Recommended Textbooks and References:

1. Adams,D.J.,&Sparrow,J.C.(2008).*EnterpriseforLifeScientists:Developing InnovationandEntrepreneurshipintheBiosciences*.Bloxham:Scion.
2. Shimasaki,C.D.(2014).*BiotechnologyEntrepreneurship:Starting,Managing,and LeadingBiotechCompanies*.Amsterdam:Elsevier.AcademicPressisanimprint ofElsevier.

3. Onetti, A., &Zucchella, A. *Business Modeling for Life Science and Biotech Companies:CreatingValueandCompetitiveAdvantagewiththeMilestoneBridge.* Routledge.
4. Jordan,J.F.(2014).*Innovation,Commercialization,andStart-UpsinLifeSciences.* London: CRCPress.
5. Desai, V.(2009).*TheDynamicsofEntrepreneurialDevelopmentandManagement.* New Delhi: Himalaya Pub.House.

Intellectual Property Rights, Biosafety and Bioethics

Credits

2

Course Objectives

The objectives of this course are:

- To provide basic knowledge on intellectual property rights and their implications in biological researchandproductdevelopment;
- To become familiar withIndia'sIPRPolicy;
- To learn biosafety and risk assessment of products derived from biotechnology and regulation of suchproducts;
- To become familiar with ethical issues in biological research. This course will focus on consequences of biomedical research technologiessuchascloningofwholeorganisms,genetic modifications, DNAtesting.

Student Learning Outcomes On completion of this course, students should be able to:

- Understand the rationale for and against IPR andespeciallypatents;
- Understand why India has adopted an IPR Policy and be familiar with broad outline of patentregulations;
- Understand different types of intellectual property rights in general and protection of products derived from biotechnology research and issues related to application and obtainingpatents;
- Gain knowledge of biosafety and risk assessment of productsderived from recombinant DNA research and environmental release of genetically modifiedorganisms, national and international regulations;
- Understand ethical aspects related to biological,biomedical,healthcareandbiotechnologyresearch.

Unit I

IntroductiontoIPR

5 lectures

Introduction to intellectual property; patents, trademarks, copyright & related rights, industrial design, traditional knowledge, geographical indications, protection of new GMOs; International framework for the protection of IP; IP as a factor in R&D; introduction to history of GATT, WTO, WIPO and TRIPS; plant variety protection and farmers rights act; concept of 'prior art'; invention in context of "prior art"; patent databases - country-wise patent searches (USPTO, India); analysis and report formation.

Unit II

Patenting

5 lectures

Basics of patents: types of patents; History about patent; WIPO Treaties; Budapest Treaty; Patent Cooperation Treaty (PCT) and implications; types of patent applications: provisional and complete specifications; PCT and conventional patent applications; 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; international patenting-requirement, 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.

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Unit III
Biosafety
5 lectures

Biosafety and Biosecurity - 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; principles of safety assessment of transgenic plants – sequential steps in risk assessment; concepts of familiarity and substantial equivalence; risk – environmental risk assessment and food and feed safety assessment; problem formulation– protection goals, compilation of relevant information, risk characterization and development of analysis plan; risk assessment of transgenic crops vscisgenic plants or products derived from RNAi, genome editing tools.

Unit IV
National and International regulations
5 lectures

International regulations – Cartagena protocol, OECD consensus documents and Codex Alimentarius; Indian regulations – EPA act and rules, guidance documents, regulatory framework–RCGM, GEAC, IBSC and other regulatory bodies; Draft bill of Biotechnology Regulatory authority of India-containments–biosafety levels and category of rDNA experiments; field trails – biosafety research trials – standard operating procedures - guidelines of state governments; GM labeling – Food Safety and Standards Authority of India (FSSAI).

Unit V
Bioethics
5 lectures

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.

Recommended Textbooks and References:

1. Gangjli,P.(2001).*IntellectualPropertyRights:UnleashingtheKnowledgeEconomy.* New Delhi: Tata McGraw-Hill Pub.
2. *NationalIPRPolicy*,DepartmentofIndustrialPolicy&Promotion,Ministryof Commerce,GoI
3. *CompleteReferencetoIntellectualPropertyRightsLaws*.(2007). Snow White PublicationsOct.
4. Kuhse,H.(2010).*BioethicsanAnthology*.Malden,MA:Blackwell.
5. OfficeoftheControllerGeneralofPatents,Design&Trademarks;Departmentof Industrial Policy & Promotion; Ministry of Commerce & Industry; Government of India.http://www.ipindia.nic.in/
6. KarenF.GreifandJonF.Marx,*CurrentControversiesintheBiologicalSciences -Case Studies of Policy Challenges from New Technologies*, MIT Press
7. World Trade Organisation.http://www.wto.org
8. World Intellectual Property Organisation.http://www.wipo.int
9. International Union for the Protection of New Varieties ofPlants. http://www.upov.int
10. National Portal of India.http://www.archive.india.gov.in
11. National Biodiversity Authority.http://www.nbaindia.org
12. RecombinantDNASafetyGuidelines,1990DepartmentofBiotechnology,Ministry ofScienceandTechnology;Govt ofIndia.Retrievedfromhttp://www.envfor.nic.in/ divisions/csurv/geac/annex-5.pdf
13. Wolt,J.D.,Keese,P.,Raybould,A.,Fitzpatrick,J.W.,Burachik,M.,Gray,A.,Wu, F.(2009).*ProblemFormulationintheEnvironmentalRiskAssessmentforGenetically ModifiedPlants*.Transgenic Research,19(3),425-436.doi:10.1007/s11248-009-9321-9
14. Craig,W.,Tepfer,M.,Degrassi,G.,&Ripandelli,D.(2008).*AnOverviewofGeneral FeaturesofRiskAssessmentsofGenetically ModifiedCrops*.Euphytica, 164(3), 853-880. doi:10.1007/s10681-007-9643-8