MODERN EDUCATION SOCIETY'S

Nowrosjee Wadia College, Pune (Autonomous)

T.Y.B.Sc. Biotechnology

Semester V

Syllabus

w.e.f. Academic year 2024-2025

Semester V

Course code	Course Title	Credits	Number of Lectures	Marks
BT-501	Industrial Microbiology	2 Credits	30	50 (35 External +15 Internal
BT-502	R- DNA technology	2 Credits	30	50 (35 External +15 Internal
BT-503	Plant Tissue Culture	2 Credits	30	50 (35 External +15 Internal
BT-504	Animal Tissue Culture	2 Credits	30	50 (35 External +15 Internal
BT-505	Applied biotechnology I	2 Credits	30	50 (35 External +15 Internal
BT-506	Biodiversity and Systematics	2 Credit	30	50 (35 External +15 Internal
BT-507	SEC – I : Summer Industrial Internship / Review writing/ Start up Design or Case study Report	2 Credits	30	50 (35 External +15 Internal
BT-508	SEC – II: Project formulation and presentation	2 Credits	30	50 (35 External +15 Internal

PRACTICAL

BT-509	Practical in Industrial Microbiology	2 Credits	15 P	50 (35 External +15 Internal
BT-510	Practical in Plant Tissue Culture and Animal Tissue Culture	2 Credits	15 P	50 (35 External +15 Internal
BT-511	Practical in R- DNA technology and Biodiversity	2 Credit	15 P	50 (35 External +15 Internal
Total Credit (Theory + Practical)		**22 Credit**		

Semester VI

Course code	Course Title	Credits	Number of Lectures	Marks
BT-601	Enzyme and Enzyme Technology	2 Credits	30	50 (35 External +15 Internal
BT-602	Agriculture Biotechnology	2 Credits	30	50 (35 External +15 Internal
BT-603	Applied Biotechnology II	2 Credits	30	50 (35 External +15 Internal
BT-604	Food and Pharmaceutical Biotechnology	2 Credits	30	50 (35 External +15 Internal
BT-605	Bioinformatics	2 Credits	30	50 (35 External +15 Internal
BT-606	Bio safety and Bioethics and IPR	2 Credits	30	50 (35 External +15 Internal
BT-607 & 608	SEC – III & SEC – IV : Project	4 Credit	60	100 (70 External +30 Internal

PRACTICAL

BT-609	Practical in Enzyme Technology	2 Credits	15 P	50 (35 External +15 Internal
BT-610	Practical in Agriculture Biotechnology and Bioinformatics	2 Credits	15 P	50 (35 External +15 Internal
BT-611	Practical in Food and Pharmaceutical Biotechnology	2 Credits	15 P	50 (35 External +15 Internal
Total Credit (Theory + Practical)		**22 Credit**		

Semester V

Course Code: BT 501 **Course Name: Industrial Microbiology**

Credit : 2 (30 Lectures)

Unit	Topic	No. of lectures
I	**Introduction to Industrial Microbiology:** • Concept of Fermentation Process- Definition, Historical perspective, • Typical Lay out of a typical fermentation unit. • Types of fermentations: Submerged, Surface, Solid State, Dual, Batch, Continuous, Fed Batch	**4**
II	**Screening and Strain Improvement Techniques**: • Isolation and Screening of industrially important microorganisms - Definition and Objectives • Primary and Secondary Screening with suitable example • Strain Improvement: Objectives Methods for strain improvement with examples (mutants with altered permeability, auxotrophic mutants, analogue resistant)	**4**
III	**Bioreactor Design**: • Characteristics of an ideal Fermenter, • Construction material used, surface treatment of the material • Design of a typical Batch Fermenter, Aerator and Agitator-types, Baffles, Seals and valves used, steam traps. • Different designs of bioreactors: Air Lift (internal and external loop), Packed Bed reactor, Fluidized bed reactor	**3**
IV	**Large Scale media and sterilization:** **Media components and optimization** • Carbon sources: Cane and Beet molasses, Malt, Corn, Starch, oils, hydrocarbons, alcohols. • Nitrogen sources: Corn steep liquor, Soybean meal, peanut meal, • Buffering agents, Chelators, Water, Precursors, Inhibitors, Inducers Antifoams. • Concept of Medium Optimization : Placket and Burman design **ii. Media Sterilization**: • Principles, Del factor, Indicator organism for design of sterilization cycle, • Equipments used in sterilization: Batch and Continuous, **iii. Air sterilization**: • Principles, Mechanism of capture of particles in air, Fixed (absolute) and non-fixed pore (depth) filters	**6**
V	**Measurement and Control of different Bioprocess parameters:** Temperature, pH, Foam, Dissolved oxygen, Microbial biomass Concept of Scale up and scale down	**4**

VI	**Downstream Processing of fermentation product- Methods and equipment's** Definition: Unit operations and downstream processing, General strategy of product recovery a. Precipitation (Agents used: Salts, Organic solvents, polyelectrolytes, acids and bases) b. Filtration (Plate Frame. Rotary Vacuum, Filter Aids, Flocculating agents) c. Centrifugation (types used in Industry: basket, tubular bowl, disc bowl) d. Cell Disruption (Physico–mechanical and chemical methods). e. Solvent extraction- Liquid liquid extraction f. Drying : Drum and spray	**5**
VII	**Large Scale Manufacturing Process-** Baker's yeast, Organic acid (Citric Acid), Vit B12, lysine, alcohol ,Enzyme- amylase	**4**

REFERENCE BOOKS:

1. Wulf Cruger and Anneliese Crueger, Biotechnology: A Textbook of Industrial Microbiology, 2nd edition, Panima Publishing Corporation, 2004.
2. Stanbury P., Whitaker *A.*, Stephen H. Principles of Fermentation Technology 3rd Edition Butterworth-Heinemann 2017 https://biokamikazi.files.wordpress.com/2013/09/principles_of_fermentation_technology-stanburry_whittaker.pdf
3. Casida Jr, L.E., Industrial Microbiology, 1st edition, New Age International (P) Ltd, 2007.
4. Presscott, Dunn, IndustrialMicrobiology, 1st edition, Agrobios (India), CBS Publication, 2004.
5. A.H. Patel, Industrial Microbiology, 1st edition, MacMillan Publication, 2008.
6. Mathuriya S Abhilasha Industrial BiotechnologyANE books, 2009
7. Prescott SC and Dunn CG Industrial Microbiology Jodhpur Agrobios.2011 http://rims.ruforum.org/B5C1BA5D7194/industrial-microbiology-prescott-dunn.pdf
8. Biochemical Engineering Fundamentals by James E. Bailey and David F. Ollis 2ndedition, McGraw Hill, (1986) http://str-tn.org/biochemical_engineering_fundamentals_bailey.pdf
9. Doran P Bioprocess Engineering Principles Academic Press Ltd 2nd edition2013 http://site.iugaza.edu.ps/mwhindi/files/ebooksclub.org Bioprocess_Engineering_Principles.pdf

Course Code: BT 502 **Course Name: Recombinant DNA Technology**
Credit : 2 (30 Lectures)

Units	Topic	Lectures (30)
I	**Introduction to Recombinant DNA Technology:** • Historical perspective • Concept and significance • A basic layout of R-DNA laboratory	2
II	**Molecular tools used in Recombinant DNA Technology:** • DNA modifying enzymes – Restriction enzymes, Ligases, Polymerases, Alkaline Phosphatases, Nucleases (Mode of Actions & applications)	4
III	**Vectors used in Recombinant DNA Technology:** • Plasmid Vectors • Bacteriophages: λ (Lambda)and M13 • Overview of Expression vectors • Agrobacterial Vectors – Ti plasmid • Chimeric Vectors - Cosmids, Phasmids, Phagemids • Introduction of YAC& BAC.	6
IV	**Construction of Genomic and cDNA Library:** • Genomic and cDNA library • Applications of libraries	4
V	**PCR:** • Introduction • Steps involved in PCR • Real time PCR • Applications	4
VI	**Sequencing of Genes and Genomes:** • Maxam- Gilbert Method • Sanger's enzymatic method • Automated DNA sequencing • Next Generation sequencing	5
VII	**Applications of Recombinant DNA Technology:** • Recombinant Biotherapeutics (Insulin production) • Gene therapy • Introduction to CRISPR/Cas9 as genome editing tool	5

Reference Books :

1. Gene Cloning and DNA Analysis –An Introduction. T.A. Brown. Eighth Edition (2020). Wiley Blackwell.
2. Genetic Engineering. By SmitaRastogi and NeelamPathak. Oxford University Press

(2009).

3. Principles of Gene Manipulation & Genomics, 7th Edition (2006), Primrose andTwyman, Blackwell Publishing, USA.
4. Molecular Biology of the Gene, 7th Edition (2013), James D. Watson, Tania Baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Lodwick, Pearson Education, Inc.
5. Genomes 3. T.A. Brown. Third Edition (2008). Garland Science Taylor and Francis Group, New York and London.
6. Web resources

Course Code: BT503 **Course Name: Plant Tissue culture**

Credit: 2 (30 Lectures)

Unit	Topic	No. of Lecture
I	**Concept of Plant Tissue culture** • Concepts of Cell theory & Cellular totipotency, • Scientists contribution to plant tissue culture.	1
II	**Basics Facilities of Plant Tissue culture** • Laboratory design of plant tissue culture laboratory – Research lab and Commercial Lab, Different work areas, Principle and Working of equipment & instruments required in PTC.	3
III	**Aseptic Techniques** • Washing & preparation of glassware, Packing & sterilization of Glassware, plastic ware and instruments, Media sterilization and surface sterilization, Precautions to maintain aseptic conditions in PTC Lab	2
IV	**Media Preparation** • Media Composition, General methodology for medium preparation. Different types media used in PTC, Plant growth regulators and their roles for growth and development in PTC	4
V **a**	**Techniques of Plant tissue culture** • **Organ culture technique**: Introduction, Protocol, factors affecting w.r.t. Root tip culture, Leaf culture, Shoot tip &Meristem culture, Importance of Organ culture	**2**
b	• **Micropropagation:** Concept of differentiation, Dedifferentiation and redifferentiation Different Stages of Micropropagation Applications of Micropropagation	**3**
c	• **Callus culture technique**: Introduction, Types of callus, Factors affecting, protocol, Morphology & internal structure of callus, Maintenance of callus, Applications and limitations	**2**
d	• **Suspension culture technique**:	**2**

	Introduction, Types, Culture medium, Protocol, Synchronization, maintenance of cultures. Assessment of growth measurements and Viability, Applications and limitations	
e	• **Organogenesis** : Introduction, Types of organogenesis (direct and indirect), Protocol, Factors affecting Organogenesis ,Applications and limitations	**2**
f	• **Somatic embryogenesis:** Introduction, types of embryogenesis (direct and indirect), Stages of somatic embryogenesis. Induction, development and maturation of SE. Factors affecting somatic embryogenesis Advantages and disadvantages	**2**
g	• **Anther and pollen culture**: Introduction, Pre-treatments and Protocol, Pathways of development, Factors affecting, Advantages and disadvantages	**2**
h	• **Ovary, Ovule, embryo and endosperm culture**.: Introduction, Types of culture, Protocol, Factors affecting, Applications and limitations	**2**
i	• **Protoplast –Isolation, Culture and Fusion:** Introduction, Different methods, Protocol, Factors affecting, Applications and limitations	**2**
j	• Applications of plant tissue culture in research and commercial Industry	**1**

References:

1. Razdan M.K. (2009) - Introduction to Plant Tissue culture (Oxford & IBH Publ, New Delhi)
2. Bhojwani S.S. & Razdan M.K. (1996) (2016)- Plant Tissue Culture : Theory & Practice(Elsevier, New Delhi)
3. Jha TB & Ghosh B (2017) – Plant tissue culture: Basic and applied (Universities Press, Hyderabad) and latest editions
4. Plant Tissue culture (2010) – Kalyan Kumar De (New central Book Agency Calactta)
5. Methods In Plant Tissue culture – (2003) U Kumar Agrobios India
6. Plant cell culture Technology—MM Yeomen (2012) Blackwell

Course Code: BT- 504 **Course Name: Animal Tissue Culture**
Credit: 2 (30 Lectures)

Unit	Topic	Lectures (30)
I	**Introduction to Animal Tissue Culture** • History and development of Animal Tissue Culture • Scientists contributions to Animal Tissue Culture	3
II a	**Basic concepts in Animal Tissue Culture and Types of cultures in ATC** • Primary Culture • Secondary Culture • Cell lines • Organ Culture, Organotypic culture/Histotypic Culture • Concept of monolayer culture/suspension culture	5
b	**ATC Laboratory and Equipment** • Laboratory design • Equipment • Lab wares	2
c	**Nutrition and Physiology of cultured cells** • Nutritional requirement and physiology of cultured cells • Principles of media formulation • Serum containing medium and serum free medium: Advantages and Disadvantages	4
d	**Aseptic conditions** • Maintenance of aseptic conditions. • Contamination, types of contaminants • Methods of detection of contaminants • Cross contamination	3
VI	**Primary cell culture** • Methods of establishing primary cell culture • Source selection and establishment of fibroblast and lymphocyte culture	3
VII	**Cell lines** • Evolution of cell line • Finite and transformed cell lines • Mammalian and insect cell line growthconditions • Subculture and characterization of cell line • Cell passage number and significance	3
VIII		3

	Organ Culture • Types of organ culture • Organotypic and Histotypic culture	
IX	**Cell Repositories and Cell banks** • Cryopreservation of cells • Cell repositories and cell distribution	**2**
X	**Applications** • Applications of Animal cell cultures in different fields	**2**

References:

1. Freshney R.I. Culture of Animal Cells: A Manual of Basic Techniques and SpecializedApplications. 7 th Edition. Wiley Blackwell; USA: 2015
2. Principles and Practice of Animal Tissue Culture by Sudha Gangal, 2 nd Edition.
3. Shenoy M 2007 Animal cell culture Animal Biotechnology ch 1, p (New Delhi: Firewall)
4. Bhat S.M. Animal Cell Culture Concept and Application. Alpha Science InternationalLimited; Oxford: 2011.
5. Walsh G. Biopharmaceuticals – Biochemistry and Biotechnology. 2nd ed. John Wiley andSons; Chichester: 2003
6. Castilho L.R., Moraes A.M., Augusto E.F.P. Animal Cell Technology. Taylor & FrancisGroup; New York: 2008. From Biopharmaceuticals to Gene Therapy.
7. Web resources

Course Code: BT 505 **Course Name: Applied biotechnology I**
Credit : 2 C (30 Lectures)

Unit	Topic	No. of Lecture
I	**Biotechnology in Agriculture Waste Recycling** • **Waste Management**: Definition- Solid waste suitable for composting – Methods of composting – vermicomposting -Mineralization process in composting – Biochemistry of composting – Factors involved - Infrastructure required – maturity parameters – value addition – application methods • **Biomass Briquetting :** Definition – potential agro residues and their characteristics for briquetting – fundamental aspects and technologies involved in briquetting – economic analysis of briquetting – setting up of briquetting plant- appliances for biomass briquettes.	**7**
II	**Biotechnology in Diagnosis Molecular Diagnostics** • Introduction to Molecular Diagnostics • Significance, Scope, Rise of diagnostic industry • Biomarkers in disease diagnostics: Role of markers in Disease diagnosis. examples • Immunodiagnostic techniques: DNA reporters, fluorogenic reporters, electro-chemiluminescent tags & label free immunoassays. • PCR in molecular diagnostics • Cellular and functional genomics in diagnostics.	**8**
III	**Marine Biotechnology** • Marine Biotechnology: Significance • Marine derived pharmaceuticals: Marine bio-resources, secondary metabolites, marine proteins and lipids • Marine actinobacterial metabolites & their pharmacological potential • Barophilic organisms & their applications • Seaweeds for removal of metal pollutants • Green Fluorescence Proteins, Red Fluorescence Proteins: characteristics and applications • Chitosan: products and applications • Microalgae: Biotechnological approaches for production of important microalgae	**8**
IV	**Nanobiotechnology** • Introduction, what is Nanotechnology and Nanobiotechnology, • Principles of nanoparticle synthesis using living organisms and characterization,	**7**

	• Different morphological forms of nanomaterials (nanospheres, Nano capsules, dendrimers), • Applications of nano-materials in drug delivery, importance of nanomedicine, Biochips.	

REFERENCES:

1. Nanobiotechnology: Concepts, applications and Perspectives, Christof M. Niemeyer (editor), Clad AMirkin (Editor), Wiley VCH, First edition, 2004.
2. Nanobiotechnology: Bioinspired Devices and Material of Future by Oded Shoseyov and Ilan levy, Human Press, First edition, 2007.
3. The Nanobiotechnology Handbook, YubingXie, CRC press,
4. Introduction to Nanoscience, S.M. Lindsay, Oxford universal Press, First Edition, 2010
5. Introduction to Nanotechnology, Charles Poole and Frank Owen, Wiley, First Edition, 2006
6. Nanocomposites Science and Technology Pulickel M. Ajayan, Linda Schadler, Paul Braun, Wiley-VCH Verlag, 2003.
7. Food Biotechnology by Shetty,2006, CRC, NY
8. An introduction to plant tissue Culture by Kalyan Kumar De.
9. Genetic Engineering By Nicholl, 2006, Cambridge Univ. Press.
10. P.D. Grover and S.K. Mishra, Biomass Briquetting: Technology and Practices. Published by FAO Regional Wood Energy Development Programme in Asia, Bangkok, Thailand, 2006.
11. Raymond C Loehr, Agricultural Waste Management- problems, processes and approaches. First edition, Academic press, 2004.
12. Buckingham and Flaw's, "Molecular Diagnostics: Fundamentals, Methods and Clinical Applications", F.A. Davis Company; First edition , 2007.
13. Molecular Diagnostics: For the Clinical Laboratorian / Edition 2 William B. Coleman (Editor), Gregory J. Tsongalis (Editor) Publisher: Springer-Verlag New York, LLC.
14. Web Resources:
15. https://advances.sciencemag.org/content/6/39/eabb762
16. https://www.frontiersin.org/articles/10.3389/fenrg.2020.598803/full
17. https://www.frontiersin.org/articles/10.3389/fmars.2021.629629/full
18. https://www.webmd.com/vitamins/ai/ingredientmono-625/chitosan
19. https://www.intechopen.com/books/biomass-volume-estimation-and-valorization-for-energy/metal-removal-by-seaweed-biomass

Course Code: BT 506 **Course Name: Biodiversity and systematics**
Credit: 2 (30 Lectures)

Unit	Topic	Lecture (30)
1	**Biodiversity** Introduction to Biodiversity, Concept, definition, species diversity, ecosystem diversity, genetic diversity, diversity gradients **Global Biodiversity** Major Biodiversity areas of the world, Biodiversity Hot Spots	3
2	**Population ecology** Population dynamic, Population density & relative abundance, Population age distribution, Growth forms & carrying capacity, Survivorship curves, Population structure : isolation & territoriality	3
3	**Habitat Ecology:** Habitat & niche, Types of Habitats, Insular habitats, and their flora & fauna, Extreme Habitats and their flora & fauna Ecological equivalence, Indices of biodiversity analysis, Basic behavioral patterns,	3
4	**Urban Biodiversity** Biodiversity in cities & towns, Concept of opportunistic species , Biomimetics, Species adapted to Human environment	2
5	**Conservation of Biodiversity** Conservation strategies – *in situ* and *ex situ* methods – advantages, limitations and applications, Threats to biodiversity, major causes, extinction's, vulnerability of species to extinction, **Institutions and their role in conservation;** Zoological survey of India, Botanical survey of India, Forest research Institute, **Role of NGOs in conservation:** Important NGOs in India & their contributions, Important NGO movements: Chipko movement, PaniPanchayats, Seed Movement.	5
6	**Uses of biodiversity:** source of food, medicine, raw material, aesthetic, cultural and ecosystem services, strategies for sustainable exploitation of biodiversity.	2
7	**Wildlife Trade and Laws** Wildlife protection Act of India, CITES , TRAFFIC, RED Data Book and its importance, IUCN threat categories,	2

8	Taxonomy : Need for taxonomy and nomenclature, principles and Objective	3
10	Introduction to classification systems	4
11	**Important Tools and techniques in Systematics:** Techniques in morphological, histological, embryology and anatomical Analysis, Molecular tools in taxonomy	3

References:

1. An Advanced Text Book On- Biodiversity- Principle And Practices (2004)
2. Krishnamurthy K V Oxford and IBH Publishing, Delhi
3. Biological Systematics: Principles And Applications (2002) Randall T. Schu Cornell University Press, USA
4. Ecology: Principles and Applications (1998) J. L. Chapman, M. J. Reiss Cambridge University Press, Cambridge
5. Environmental Biotechnology (2010) Rana Rastogi Publications, Meerut
6. Environmental Science (2011) Santra S.C. New Central Book Agency, Kolkata
7. Fundamentals of Ecology (2009) (2014) Dash 3rd edition, Tata McGraw-Hill Education, New Delhi
8. Fundamentals of Molecular Biology (2009) Pal & Ghaskadbi Oxford Universit Press, New Delhi
9. Fundamentals of Plant Systematics (1986) Radford A E Harper and Row, New York
10. Global Biodiversity Strategies (1992) Courrier Kathleen (Editor) World Resource Institute, USA
11. Phylogenetic Systematics (1999) W Hennings, D Dwight Davis, R Zangerl University of Illinois Press, Champaign, IL
12. Plant Systematics (2010) Michael G. Simpson Academic Press, Salt Lake City, UT, USA
13. Plant Systematics- A Phylogenetic Approach (2008) Walter S Judd Sinauer Associates, Sunderland
14. Systematics And Biogeography (2010) David M. Williams, Malte C. Ebach Springer, New York
15. Text Book of Biodiversity (2003) Krishnamurthy K V Science Publishers, Jodhpur
16. Biodiversity conservation in managed and protected areas Katwal/Banerjee Agrobios, India2002
17. Biodiversity and its conservation in India Negi, S.S. Indus Publishing Co., New Delhi. 1993 (2008)
18. Available web resources

Course code BT 509 **Subject-Practical Course in Industrial Microbiology**
(2 credit course) **Total practical - 15**

Sr.no	List of Practical	No. of practical
1	Screening and isolation of antibiotic producing organism from soil (Crowded plate and Giant colony method) Isolation of antibiotic resistant mutants by Gradient plate technique	4
2	Lab scale Production, Recovery (Filtration, Precipitation, distillation, solvent extraction) and estimation (Titrimetric, colorimetric, bioassay) of: i) Primary metabolite: Organic acid ii) Secondary metabolite: Antibiotic	4
3	Lab scale production, recovery and estimation of Ethanol	2
4	Study of various parts and working of Lab Bench fermenter	1
4	Preparation of wine and estimation of alcohol content, total titrable acidity and volatile acidity of wine	3
4	Visit to a Fermentation based Unit	1

References:

1. Practical Manual on Fermentation Technology, edsKulandaivel& S. JanarthananI K, International Publishing House Pvt. Ltd,2012
2. Experiments in Microbiology, Plant Pathology and Biotechnology ,K.R. Aneja, New age International, 2017

Web Resources

https://www.researchgate.net/publication/344465390_PRACTICAL_MANUAL_CUM_WORKBOOK_on_INDUSTRIAL_MICROBIOLOGY

Course Code: BT 507 Course Name: Practical Course plant tissue culture and Animal Tissue culture

Credit: 2 C

Practical Sr. No.	**Practical in Plant Tissue Culture** **Title of Experiment**	**Total Practical 15**
1	**Lab-ware Preparation for Aseptic transfer**	**1**
	• Washing of Glass ware/ plastic ware • Glassware preparation for sterilization capping, packing & sterilization, safety precautions • Discarding of contaminated glassware and washing of it	
2	**Stock solution preparation**	**1**
	• Stock solutions calculations and preparation • Growth hormone calculation and preparation	
3	**Media Preparation**	1
	• Calculation for media Preparation • Media preparation	
4	**Callus culture Technique**	**1**
	• Callus culture technique-Initiation of culture, callus morphology & internal structure.	
5	**Meristem Culture**	**1**
	• Initiation of shoot tip & axillary bud culture	
6	**Embryo culture**	**2**
	• To germinate *in vitro* monocot and dicot embryo	
Practical in Animal Tissue Culture		
7	• **ATC laboratory design and equipment used in ATC**	**1**
	• Structure and design ATC Laboratory • Equipment used: Laminar Air Flow, CO_2 incubator, Inverted microscope, Autoclave, Filter sterilization assembly, Centrifuge, Refrigerator, pH meter, etc.	

8	• **Introduction to Aseptic Conditions**	**3**
	• Importance maintaining aseptic conditions. • Glassware washing, packing and sterilization • (Filter sterilization assembly, forceps, glass pipettes, petri plates, beakers, conical flasks etc.) • Media preparation and Sterilization (Demo using filter sterilization assembly)	
9	• **Initiation of Primary Culture**	**2**
	• Initiation of Primary Culture from chick embryo by trypsinization	
10	• **Maintenance of cell line**	**2**
	• Observation of cell line and feeding of media • Sub-culturing: viable cell count, split ratio	

References:

1. Razdan M.K. (2009) - Introduction to Plant Tissue culture (Oxford & IBH Publ, New Delhi)
2. Bhojwani S.S. & Razdan M.K. (1996) (2016)- Plant Tissue Culture : Theory & Practice (Elsevier, New Delhi
3. Plant tissue culture: Basic and applied Jha TB &Ghosh B (2017) –(Universities Press, Hyderabad) and latest editions
4. Plant Tissue culture (2010) – Kalyan Kumar De (New central Book Agency Calactta)
5. Methods In Plant Tissue culture – (2003) U Kumar Agrobios India
6. Plant cell culture Technology—MM Yeomen (2012) Blackwell
7. A Laboratory Mannual of Plant Biotechnology (2009) –S S Purohit Agrobias India
8. Freshney R.I. Culture of Animal Cells: A Manual of Basic Techniques and Specialized Applications. 7 th Edition. Wiley Blackwell; USA: 2015
9. Principles and Practice of Animal Tissue Culture by Sudha Gangal, 2 nd Edition.

Subject Code: BT- 511: Practical Course in R-DNA Technology &Biodiversity
(2 Credit Course) Total Practical = 15 P (15x3hrs)

	Practical in R-DNA Technology	
Sr. No.	**Title of Experiment**	**No. of practical**
1.	Plasmid DNA Isolation and Gel Electrophoresis	2
2.	DNA Ligation and Gel electrophoresis	1
3	• Restriction Digestion of the DNA sample and Gel electrophoresis	2
4	Transformation of *E. coli* Cells: • Preparation of Competent Cells • Transformation technique • Selection of Recombinants	3
5	PCR Reaction and Gel Electrophoresis	2
	Practical in Biodiversity	
1	To study Quadrate and transact methods for plant diversity analysis and Calculation of species diversity, richness and abundance from the data	1
2	a) To study the phytogeographic map of India locate major sanctuaries, national parks. Botanical Gardens of India b) Reserve forest, protected areas of Pune and Maharashtra	1
3	Point count for bird/butterfly/insect diversity	1
4	Prepare an audio-visual presentation to communicate conservation to the youth & general public on some environment issues (e.g. : Destruction of local biodiversity site like mangrove or sea shore or a forest patch, Human-wildlife conflict, Developmental activity that has potential threat to local biodiversity.)	1
5	To measure the species richness on the field in areas in which the grass/vegetation is regularly and irregularly cut.	1

Reference Books:

1) Frederick M. Ausubel, Roger Brent, Robert E. Kingston, David D. Moore, J. G. Seidman, John A. Smith, Kevin Struhl, Short Protocols in Molecular Biology, Wiley, 2002
2) Brenda D. Spangler, Methods in Molecular Biology and Protein Chemistry: Cloning and Characterization of an Enterotoxin Subunit, Wiley, 2002
3) Molecular cloning – A laboratory manual – (Vol. 1-3), 4th edition, (2012), Green and Sambrook, Cold Spring Harbor Laboratory Press, USA
4) Federick M. Ausubel, Current Protocols in Molecular Biology, John Wiley and Sons, 2014

SEMESTER VI

Subject Code: BT- 601 **Course Name: Enzyme and Enzyme Technology**
Credit : 2 C (30 Lectures)

Units	Topic	Lectures
I	**Introduction to Enzymes:** • Properties of enzymes; definition of active sites, enzyme units, specific activity; purity of enzyme. • Protein nature of enzymes and Non-protein enzymes- Ribozymes and DNAzymes • Metalloenzymes and metal activated enzymes.	**3**
II	**Enzyme Catalysis:** • Mechanism of enzyme catalysis: Acid base catalysis, Covalent Catalysis, Metal ion catalysis, Proximity and orientation effect • Mechanism of action of Serine proteases: Chymotrypsin	**4**
III	**Enzyme Kinetics:** • Factors affecting the enzyme activity- Enzyme & Substrate Concentration, pH and Temperature. • Kinetics of Single substrate enzyme catalysed reaction. • Michealis- Menten equation, Km, Vmax, Lineweaver-Burk plot, Turnover number, Kcat	**6**
IV	**Enzyme Regulation:** • Regulation on the basis of Activity: Feedback Regulation, Allosteric Regulation, Covalent modification and Proteolytic activation of Zymogens • Multienzyme complexes and Isoenzymes • Organization of enzymes in Cells: Compartmentation of metabolic pathways for eg Fatty acid Catabolism & Anabolism, Enzymes in Membrane with suitable examples. • Mechanism of enzyme Degradation: Lysosomal and non-lysosomal pathways.	**8**
V	**Immobilization of Enzymes** • Carrier matrices & its properties. • Methods of enzyme immobilization. • Whole Enzyme/cells immobilization. • Applications of immobilized enzymes.	**3**
VI	**Industrial and clinical applications of enzymes** • **Industrial Enzymes:** Thermophilic enzymes (Reverse transcriptase), Amylases, Lipases, Proteolytic enzymes in Meat and leather industry, cellulose degrading enzymes, Metals degrading enzymes.	**6**

	• **Clinical Enzymes:** Enzymes as thrombolytic agent, Anti-inflammatroy agents, Streptokinase, Asparginase, LDH, Transaminases (AST), Amylases, Phosphatases, Cholinesterases. • **Biosensor:** Components of enzyme biosensor: eg. Glucose oxidase.	

Recommended Textbooks and References

1. Outlines of Biochemistry: 5th Edition, (2009), Erice Conn & Paul Stumpf ; John Wiley and Sons, USA
2. Fundamentals of Biochemistry. 3rd Edition, (2008), Donald Voet& Judith Voet , John Wiley and Sons, Inc. USA
3. Principles of Biochemistry, 4th edition (1997), JefforyZubey, McGraw-Hill College, USA
4. Biochemistry:7th Edition, (2012), Jeremy Berg, LubertStryer, W.H.Freeman and company,NY
5. Lehninger , Principles of Biochemistry. 5th Edition (2008), David Nelson & Michael Cox, W.H. Freeman and company, NY.
6. Biochemistry. 5th Edition, (copu right 2013), Reginald Garett and Charles Grisham, Brook/Cole, Cengage Learning, Boston, USA.
7. Enzymes: Biochemistry, Biotechnology & Clinical chemistry, (2001) Palmer Trevor, Publisher: Horwood Pub. Co., England.
8. Biochemistry: 7th Edition, (2012), Jeremy Berg, LubertStryer, W.H.Freeman and company, NY
9. Enzyme inhibition and activation. Enzymes 3 Dixon, M., and E. C. Webb. (1979): 126-136.
10. Understanding Enzymes, 4th ed., Palmer, T. Prentice Hall/Ellis Horwood, London (1995).
11. Fundamentals of Enzymology. . Price, Nicholas C., and Lewis Stevens.Oxford Science Publications. Second edition. New York, 2001.
12. Biocatalysts and enzyme technology. . Buchholz, Klaus, Volker Kasche, and Uwe Theo Bornscheuer. John Wiley & Sons, 2012.
13. Enzymes: a practical introduction to structure, mechanism, and data analysis. Copeland, Robert A. John Wiley & Sons, 2004.

Course Code: BT 602 **Course Name: Agriculture Biotechnology**
Credit : 2 C (30 Lectures)

Unit	Topic	No. of Lecture
I	**Agriculture Biotechnology** • Introduction, Scope, Importance, Role of agricultural biotechnology in India and world, concept of Urban agriculture • Classical vs modern Agricultural biotechnology • Concepts and applications of e-agriculture and use of ICT in Agriculture. • Biotechnology for Diagnostic Application: Variety purity testing, Pathogen diagnosis	6
II	**Development of draught and herbicide tolerant verities** • Development of abiotic stress tolerant varieties (drought, saline) • Developing herbicide resistance in crops: Target of herbicide action and Detoxification of herbicides	5
III	**Greenhouse Technology and Protected Cultivation** • Types of green house, importance, functions and features of green house. Scope and development of greenhouse technology. • Computer controlled environment. heating, cooling and ventilation system,	5
V	**Bio-Pesticides and Biofertilizer Production Technology** • Bio-Pesticides: Definition, scope and importance of Bio-pesticides • Important industries producing different biopesticides • New technologies and microbial control of promising plant species for pest control. • Biofertilizers: Introduction, definition, types, development of of biofertilizers, Quality control of biofertilizers, • Use of Genetically Engineered Microorganisms for improvement of biofertilizers. • Biotechnology for recycling Horticultural waste as manures and livestock feed. Phyto sanitation. • Principles of using non-conventional fertilizers: Example Silicon	8
VI	• Introduction to molecular marker assisted plant breeding. • Transgenic plants: Introduction and importance (with examples) • Developing transgenic plants for disease resistance: Gene transfer techniques in plants	6

	• Transgenic plants for disease resistance (examples) • Developing herbicide resistance in crops: Target of herbicide action and detoxification of herbicides	

References:

1. A.Mahadvan and R. Sirdhar (2006) Methods in physiological plant pathology 3rd Edition.
2. S. Sadasivam and A. Manikam (1992), Biochemical methods for Agricultural Sciences. Wiley Eastern Ltd. New Delhi.
3. Hand book of phytological methods, Cambridge Uni. Press, London 4 New direction in biological control by baker, R.R and . E. Dann (EDS)1990,Wileylies, New York.
4. Biological control by Natural enemies by Debach,P and Rosen,D,1991,Cambridge University press, Cambridge, U.K.
5. Principles of Insect Pest Management by Dhaliwal,G.S and Arora,R.2006,Kalyani Publisher, New Delhi.
6. Botanicals and Biopesticides by Parmar, B. P and C.Devakumar,1993,Westvill publishing house. New Delhi.
7. Soil microorganisms by N. S. Subba Rao, Oxford and IBH Publication Co. New Delhi
8. Advances in Agril. Microbiology by N.S. Subbarao, Oxford and IBH Publication Co, New Delhi
9. Cereal Biotechnology by Peter C. Morris and James H. Bryce, Woodhead publishing Limited, publication 2000.
10. Greenhouse Management of Horticultural Crops by S. Prasad and U. Kumar, Kalyani Publishers.
11. Greenhouse Technology and Management by Manohar. 2006. International Book Distribution Co., Lucknow.
12. Greenhouse Environment by Mastalez, J.W. 1999. John-Wiley and Sons, New York.
13. Greenhouse Management: Forcing of Flowers, Vegetables and Fruits by Taft, L. R. 2001. Daya Publication House, New Delhi.
14. Green House Operation & Management by Nelson, 2007.
15. Plant Breeding Principles and Methods by B. D. Singh
16. Marker Assisted Plant Breeding: Principles and Practices, by B. D. Singh
17. Introduction to Plant Biotechnology, 3rd Edition, Chawala H. S.
18. Available Web resources

Course Code: BT 603 **Course Name: Applied biotechnology II**

Credit : 2 C (30 Lectures)

S.No.	Topic	No. of Lecture
I	**Biotechnology in Environment** • **Generation of plant origin alternate fuels:** - 1st Generation Biofuels: Bio-alcohol (Corn, sugarcane). Syngas, Biodiesel, Biogas - 2nd Generation Biofuels: Cellulosic Biofuel, Biohydrogen, Bioethanol - 3rd Generation Biofuels: Algae fuel • Biotransformation of recalcitrant metabolites (with example) • Ecological Impact of microbes • Green technology: Definition and concepts and implication, role of green technologies towards a sustainable development	**07**
II	**Biotechnology in Human Welfare** • Application to Forensic science: Principle of DNA fingerprinting, Application of DNA profiling in forensic medicine for solving crimes and paternity disputes • Genetically modified (GM) crops and foods: Health concerns • Human genome project – its implications in health and diseases • GUaRDIAN: Genomics for Precision Medicine in India • Rice 3K project	**08**
III	**Systems and Synthetic Biology in Biotechnology** • Introduction to Systems Biology, • Principles of Systems Biology, modelling in systems biology, applications of systems Biology in Biotechnology. • Introduction to Synthetic Biology, • Principles and applications and scope of synthetic Biology for production of Bioactive metabolites.	**08**
IV	**Stem Cell technology** • Introduction, what is a stem cell, types • Therapeutic applications of stem cells in human degenerative diseases (examples), • Stem cell policy and ethics. • Cord blood banking and long-term storage of stem cells.	**07**

Reference Books and Web sources

1. Systems and synthetic Biology by Vikram Singh and Pawan K. Dhar, Springer Publication. 2015 (Available as Google Book)

2. Metabolic Engineering for Bioactive Compounds Strategies and Processes by Kalia, Vipin Chandra, Saini, Adesh Kumar. Springer Publication. 2017
3. Advances in Synthetic Biology by Vijai Singh. Springer Publication. 2020
4. Stem cells by C.S Potten., Elsevier, 2006.
5. Essentials of Stem Cell Biology by Robert Lanza., fourth edition. Elsevier 2014.
6. Stem cell biology and Gene Therapy by Peter Quesenberry., First Edition, Wiley-Liss, 1998.
7. Embryonic Stem cells – Protocols by KursadTurksen., Second Edition Humana Press, 2002.
8. Stem Cells: From Bench to Bedside by AriffBongso, EngHinLee., World Scientific Publishing Company, 2005.
9. Stem cells in clinic and Research by Ali Gholamrezanezhad., Intech, 2013
10. Michael J. Pelczar, Microbiology, Tata McGraw-Hill
11. Arceivala, S.L. 2014. Green Technologies: For a Better Future. Mc-Graw Hill Publications
12. Thangavel, P. & Sridevi, G. 2015. Environmental Sustainability: Role of Green Technologies. Springer Publications.
13. Woolley, T. & Kimmins, S. 2002. Green Building Handbook (Volume 1 and 2). Spon Press
14. Introduction to Environmental Science Author: Anjaneyulu.
15. Biotechnological Applications in Environmental Management : Author: Trivedy R. K., Sadhana Sharma
16. Principles and Applications of Environmental Biotechnology for a Sustainable Future Editors Ram Lakhan Singh Springer
17. Web resources from Google, Pubmed, Medline etc.

Course Code: BT 604 Course Name: Food and Pharmaceutical Biotechnology
Credit : 2 C (30 Lectures)

B	**Food Biotechnology**	
UNIT	**TOPIC**	**Lectures**
I	**Basics of Food and Human Nutrition** • Structure and functions of macro-and micro nutrients and its role in human nutrition • Overview of i. Food additives with respect to their technological functions ii. Enzymes as food processing aids iii. Nutraceuticals iv. Food contaminants and adulterants and their effects on human health v. Food allergens and allergenicity • Importance of diet in alleviating health risks, especially non-communicable diseases	5
II	**Food Microbiology & General Principles of Food Hygiene** ● Sources of microorganisms in food and overview of food borne pathogens ● General principles and techniques used in microbiological examination of foods: culture media, immunoassay, PCR ● Probiotics and their role in food processing and human nutrition ● General principles of food safety management system (FSMS) and HACCP system to prevent food borne illness.	4
III	**Food packaging Technology**: • Functions of packaging, types of packaging materials, selection of packaging material for different foods, ● Biodegradable plastics, edible packaging and bio-composites, environmental concerns recycling and disposal of plastic waste, food packaging laws and regulations, barcodes and other marking	2
IV	**Non-Alcoholic Beverages**: ● Definition of non-alcoholic beverages, current trends of non-alcoholic beverages (use in health benefits, stress reliever, immune system booster) ● Juice based beverages (coconut water, sweet toddy, sugar cane juice, coconut milk, flavoured syrups), fruit beverages, tea (Kombucha) coffee, cocoa, spices, plant extract etc.,	2
V	**Quality assurance and Certification**	2

	• Introduction to quality, Role of QC (Quality control) and QA (Quality assurance), Concept of TQM (Total Quality Management), • Food safety and standards authority of India (FSSAI), Accreditation and certification introduction certification bodies in India BIS, AGMARK	
B	**Pharmaceutical Biotechnology**	
VI	**Brief introduction to Pharmaceutical Biotechnology** • Introduction to pharmaceutical biotech, use of microbes in pharmaceutical industries • Applications of pharmaceutical biotechnology, therapeutic and clinical.	2
VII	**Concept of Drug Discovery and Development** • Microbial Drug Discovery, Recombinant, Biochemical • and Molecular level screening systems and their construction/ design strategies • Rational Drug Discovery • Preclinical and Clinical trials; Estimation of toxicity: LD50 and ED50;	7
VIII	**Regulatory aspects in pharmaceuticals** • Introduction to pharmacopoeia; FDA regulation and IP, BP, USP; Reimbursement of drugs and biological; • Legislative perspectives in biopharmaceuticals; • GMP in pharmaceuticals; • ICH and WHO guidelines for quality control • Formulation of following pharmaceutical preparation as per IP: i. Antibiotics (with any one example) ii. Steroids (with any one example) iii. Vitamins (with any one example).	6

References:

1. Food Microbiology, 5th edition, William C. Frazier and Dennis C. Westoff, McGraw Hill Education India.
2. Training Manual for Food Safety Regulators (Vol I), Introduction to Food And Food Processing (2010), Food Safety and Standard authority of India.
3. Training Manual for Food Safety Regulators (Vol II) - Food Safety Regulators and Food Safety Management (2010), Food Safety and Standard authority of India.
4. Training Manual for Food Safety Regulators (Vol III) - Food Regulatory Enforcement and compliance through Inspection (2010), Food Safety and Standard authority of India.
5. Training Manual for Food Safety Regulators (Vol IV) - Ensuring Food Safety and Standards through Food Sampling & Analysis (2010), Food Safety and Standard authority of India.

6. Beverages: Technology, Chemistry, and Microbiology Varman and Sutherland Springer, 1994
7. Food Safety and Standards Act, 2006 Commercials Law Publications, New Delhi
8. Food Safety and Standards Act, 2006 FSSAI, New Delhi
9. Hugo, WB and Russell, AD, Pharmaceutical Microbiology,(2003).Blackwell Science Oxford, UK
10. Krogsgaard L, Lilijefors T. and Madsen, U. Textbook of Drug Design and Discovery, (2004). Taylor and Francis, London.
11. Geoffrey Hanlon and Norman Hodges. Essential Microbiology for pharmacy and pharmaceutical science. (2013). Wiley Blackwell.
12. FDA Compliance Program 7382.845 Inspections of Medical Device Manufacturers, February 2, 2011.
13. ANSI/AAMI/ISO 11737-1:2018/(R) 2011, Sterilization of health care products
14. Microbiological methods – Part 1: Determination of the population of microorganisms on product. 3. PDA Technical Report No. 21, Bioburden Recovery Validation. 1990
15. S. P. Vyas & V. K. Dixit. Pharmaceutical Biotechnology. (2003) CBS Publishers & Distributors, New Delhi.
16. Bhatia R and Ichhpujani RL. Quality Assurance in Microbiology. (1995). CBS Publishers, New Delhi. 6. Gregory Gregoriadis. Drug Carriers in biology & Medicine. (2001). Academic Press New York.
17. Satoskar R. S. and S. D. Bhandarkar (1991) Pharmacology and Pharmacotherapeutics, 12th Edition. Vol. 1 and 2. Popular Prakashan, Mumbai.

Course Code: BT- 605 **Course Name: Bioinformatics**
Credit: 2 C (30 Lectures)

Unit	Topic	No.of Lecture
I	**Introduction to Bioinformatics**	**2**
	• History and development of Bioinformatics • Relation of Bioinformatics to Biotechnology	
II	**Biological Databases**	**8**
	• Types of databases (Primary, Composite, and Secondary) • Nucleic acid databases (NCBI, DDBJ,GENBANK and EMBL). • Protein databases (PDB, Swissprot, UniProt). • Structure databases (CATH, SCOP, and PDBsum) • Literature database: Pubmed, MEDLINE	
III	**Data Generation Tools**	**5**
	• What is data generation and its significance • Basic tools of data generation: (NGS Genome Sequencing, Protein sequencing, NMR Spectroscopy, and Microarray)	
IV	**Retrieval of Data**	6
	• Classification and Presentation of Data. Quality of data, private and public data sources. • File Format (Genbank, DDBJ, FASTA, PDB, SwissProt). • Introduction to Metadata and search; Indices and Boolean	
V	**Sequence Alignments and Visualization**	**7**
	• Introduction to Sequences, alignments and Dynamic Programming; • Local alignment and Global alignment (algorithm and example) • Pairwise alignment (BLAST and FASTA Algorithm) and multiple sequence alignment (Clustal-W)	
VI	**Protein structure and visualization tools**	**2**
	• Basics of protein structure and visualization tools: SPDBV, PyMol etc.	

Reference Books

1. Claverie, J.M. and Notredame C. 2003 Bioinformatics for Dummies. Wiley Editor.
2. Letovsky, S.I. 1999 Bioinformatics. Kluwer Academic Publishers.
3. Baldi, P. and Brunak, S. 2001 Bioinformatics: The machine learning approach, The MITPress.
4. Setubal, J. and Meidanis, J. 1996 Introduction to Computational Molecular Biology. PWSPublishing Co., Boston.
5. Lesk, A.M. 2005, 2nd edition, Introduction to Bioinformatics. Oxford University Press.
6. Fogel, G.B. and Corne, D.W., Evolutionary Computation in Bioinformatics.
7. Mount, D.W., Bioinformatics: 2001, Sequence and Genome Analysis. CSHL Press.
8. Durbin R., Eddy S., Krogh A. and Mithchison G. 2007 Biological Sequence Analysis, Cambridge University Press.
9. Web resources and online computational tools available at NCBI, Swissprot, Uniprot etc.

Course Code: BT- 606 **Course Name: Bio safety, Bioethics and Intellectual Property Rights**

Credit: 2 C (30 Lectures)

Unit	Topic	lecture
I-Bioethics	• Basic Principles of Bioethics; • Overview of National Regulations of Bioethics and International considerations. • Regulatory bodies for Bioethics in India	3
	• Role of Institutional Ethical Committee	1
	• Bioethics in Plants, Animals and Microbial Genetic Engineering.	3
II- Biosafety	• Introduction to biosafety. • Concepts, symbols and significance in experimental biological sciences • International laws on Biosafety	3
	• Levels of Biosafety (BSL-1 to 3) for Specific microorganisms. • Introduction to Biological Safety Cabinets.	2
	• Introduction to the concept of containment level and Good Laboratory Practices (GLP)	3
III- Intellectual Property Rights (IPR)	• Introduction to Intellectual Property Rights (IPR) and Indian Patent Law. • World Trade Organization and its related intellectual property provisions.	3
	• History of GATT & TRIPS Agreement. • WIPO-Objectives and its role • Intellectual property and its legal protection in research	3
	• Significance of IPR in Biotechnology; Budapest Treaty; , Protection of GMOs	4
	• Tools of IPR and terminologies in IPR-Patent, Copyright, Trademarks and Trade secrets • Geographical Indications (with examples)	5

Reference Books:

1. Matthew Rimmer, Intellectual Property and Biotechnology: Biological Inventions (2008)
2. Kshitij Kumar Singh, Biotechnology and Intellectual Property Rights: Legal and Social Implications Springer (India) (2014)
3. Bioethics: the basics, Alastair V. Campbell, Routledge; 2 edition (19 June 2017)

4. IPR, Biosafety and Bioethics, DeepaGoel and ShominiParashar, Pearson; 1 edition (1 January 2013)
5. Diane O. Fleming; Debra A. Long; Biological Safety: Principles and Practices, ASM Press; 4th edition, 20062.
6. Nancy Ann SilbergeldJecker; Albert R. Jonsen; Robert A. Pearlman; Bioethics: Introduction to History, Methods, and Practice; Jones & Bartlett Publishers; II edition, 2007
7. Lim Li Ching; TerjeTraavik; Biosafety First: Holistic Approaches to Risk and Uncertainty in Genetic Engineering and Genetically Modified Organisms; Tapir Academic Press, 2007
8. 21st Century Complete Guide to Biosafety and Biosecurity (CD-ROM): by U.S. Government, Publisher: Progressive Management, 2004
9. Wadehra, B.L. Law Relating To Intellectual Property, (2011), Fifth Edition, Universal Law Publishing Co.Pvt. Ltd.
10. GanguliPrabuddh, Intellectual Property Rights , (2001), Tata McGraw-Hill Publishing Company Ltd.

Subject Code: BT- 609 **Course Name: Practical in Enzyme and Enzyme Technology**
Credit: 2 C

Sr.No.	Title of Experiment	No. of practical
1.	Isolation of Alpha / Beta Amylase from suitable sources	1
2.	Determination of Enzyme activity • Preparation of Std of graph of Maltose • Calculation of enzyme activity • Preparation of standard curve of protein (Albumin) by Folin's-Lowry method • Calculation of specific activity	5
2.	Effect of following parameters on Enzyme activity • Temperature • pH • Time	3
3.	• Effect of Substrate concentration on enzyme activity and determination of Km and Vmax	2
4	• Enzyme Immobilisation using gel entrapment method	2
5	• Detection of Serum enzymes: SGOT/SGPT /Alkaline phosphatase	2

Recommended Textbooks and References

1. An Introduction to Practical Biochemistry.3rd Edition, (2001), David Plummer, Tata McGraw Hill Edu.Pvt.Ltd. New Delhi, India
2. Biochemical Methods.1st , (1995), S.Sadashivam, A.Manickam, New Age International Publishers, India
3. Bisswanger, Hans. Practical enzymology. John Wiley & Sons, 2013. 2. Wilchek, Meir, and 4. Edward A. Bayer. "Methods in enzymology." (1990). 3. Sawhney, S. K., and Randhir Singh.
4. Introductory practical biochemistry. Alpha Science Int'l Ltd., 2000.
5. A textbook of practical biochemistry- Joshi A. Reshmi
6. Practical clinical biochemistry- Harold Varley

Course Code: BT 610 **Course Name: Practical in Agriculture Biotechnology and Bioinformatics**

Credit : 2 C

	Practical in Agriculture Biotechnology	
Practical No.	**List of practical**	**Practicals**
1	Production of Spirulina/Azolla culture	**2**
2	Estimation of chlorophyll and protein from Spirulina/Azolla culture	**2**
3	Isolation of *Rhizobium* from root nodules of leguminous crop and development of Rhizobium or Azotobacter Biofertilizer	**2**
4	Demonstration of effect of Biofertilizer (above prepared Rhizobium or Azotobacter) on plant growth using pot culture	**1**
5	Demonstration of effect of herbicide (anyone) on plant growth using pot culture	**1**
6	Visit to functional greenhouse/ Composting Unit/Mushroom cultivation unit and report writing.	**1**
	Practical in Bioinformatics	
1	**Introduction to biological databases and retrieving the information** • NCBI, EMBL, DDBJ • PDB, SCOP, CATH	**2**
2	Literature search using PubMed and Medline	**1**
3	**Introduction of sequence alignment:** Introduction to pairwise sequence Alignment: Use of BLAST and FASTA tools for Pairwise sequence alignment.	**2**
4	**Introduction to Multiple Sequence Alignment:** CLUSTAL-W	**1**

References:

1. Plant cell culture Technology—MM Yeomen (2012) Blackwell
2. A Laboratory Mannual of Plant Biotechnology (2009) –S S Purohit Agrobias India\
3. Biotechnology by Singh, B. D. 2000. Kalyani Publishers, Ludhiana.
4. Cereal Biotechnology by Peter C. morris and James H. Bryce, Woodheadpublishing Limited, publication 2000.
5. www. agbios.com 2) www. dbt.nic.in, 3) www. bcil.nic.in,
6. Online Database web resources and computational tools

Course Code: BT- 611 **Course Name: Practical in Food and Pharmaceutical Biotechnology**

Credit: 2 C (15PX3 hrs)

Sr.no	List of Practical	Practical
1	Isolation colony characterization and Gram characteristics of bacteria from fermented food (curd/ idli batter/ dhokla batter)	1
2	Testing of food adulteration (milk/ milk products/haldi or any food sample)	1
3	Determination of moisture in food sample. /Determination of ash in food sample	1
4	Determination of total poly phenol content in any non- alcoholic beverage	1
5	Detection and isolation of anti- infectives from plant i. Extraction of bioactive principles from plant and activityfractionation ii. Estimation of its antimicrobial activity using standard(CLSI) guidelines	2
6	Antibiotic Potency test- Plate diffusion method (Minimum Inhibitory Concentration)	1
7	Visit to Food/ Pharmaceutical industry	1

BT-507 SEC – I: Summer Industrial Internship / Review writing/ Start up Design/Case study Report (2 Credits)

The students of BSc. Biotechnology at the end of fourth semester may opt for any one of the following (Maximum 30 Hrs)

- **Summer Industrial Internship or**
- **Institutional Internship Project or**
- **Review writing or**
- **Start-up Design or**
- **Case study Report**

Objectives of Course: To provide extensive exposure of hands-on experience to the student in industry/University/Research Institute/Organization and acquire the experience work culture/environment and opportunities available therein.

Guidelines for Industrial Internship

- The student may opt for any one activity from the mentioned list as per his/her intended area of specialization/interest or in any functional/allied area of Biotechnology
- The activity can be carried out in an authorized Industry/University / Institute /Corporate Entity / NGO / Government Undertaking etc.
- In case of internship program, the student must take written approval from the Head of the institute, /Head of the Department before joining the internship programme.
- A mentor/ co-guide from the parent department should be appointed for all students. The students are expected to discuss the topic/area of their interest with their respective Mentor/guides and co guides.
- The course (activity) may be a research topic – based on primary / secondary data or may be an operational assignment involving working by the student on a given task/assignment/project/ etc. in an organization / industry that may or may not involve wet lab experimental work depending on the selected assignment.
- Student are expected to maintain a Progress Diary (duly signed by the guide/supervisor) that should contain the work carried out and the progress achieved regularly.
- All the students have to prepare and submit a written Report, as per the time line given by the University/College, at the end of the internship.
- Each participant will make at least two hard bound copies of internship report in the recommended format to be submitted to the parent and the host organization

The report of Internship should contain:

i. Certificate of completion of Internship by the Company/Industry/Institute etc. duly signed by competent authority
ii. Certificate by Head of the Department and faculty guide

iii. Formal feedback from the company guide if any.
iv. Summary of the internship program.
v. Outline of the problem/task undertaken.
vi. Research methodology & data analysis and report (in case of research topics only)
vii. Relevant review of the previous work /data on the taken topic.
viii. References in appropriate referencing styles.
ix. Outcome

GUIDELINES FOR CASE STUDIES:

- Students may undertake case studies in the field of Biotechnology or allied subjects under the guidance of a faculty in the parent institute/ other institutes (research or educational)/hospital /industry or any suitable and relevant organization.
- Students must submit two copies of report (duly signed by the supervisor, co guide and Head of the institution) explaining the detailed methodology, analysis, relevance/significance of the case study undertaken.

GUIDELINES FOR REVIEW WRITING:

- Students may undertake review writing in the field of Biotechnology or allied subjects under the guidance of a faculty in the parent institute
- A review article or literature review should be a survey of previously published research on a topic.
- The objective of a literature review should be to provide a critical evaluation of the data available from existing studies and identify potential research areas to explore.
- Students must submit two copies of the review (duly signed by the supervisor, co guide and Head of the institution) and written by following standard format of review writing.

GUIDELINES FOR STARTUP DESIGN:
While designing the start-up plan in Biotechnology, students are advised to consider the following points

1. An overview of your innovative startup idea (Title and one-page description about novelty).
2. A description of your product and/or service and its application (One Page).
3. Your goals and objectives for the startup. Time line of startup plan (one year/three years/five years?) .....(2 Pages)
4. Your proposed target markets. Who are your ideal customers? (One Paragraph)
5. Your competition and what differentiate your startup business. Who are you up against, and what unique selling proposition will help you succeed? (One page)
6. Financial outlook for your startup business. If you're using the startup business plan for financing purposes, explain exactly how much money you want (broad item wise), how you will use it, and how that will make your startup business more profitable. (One page)

Assessment: Based on completed report/work
(External- 35 Marks, Internal -15; Marks = 50 Marks)

BT-508 SEC – II: Project formulation and presentation
&
BT-607 & BT-608 (Project)

The students may opt for this course in the fifth semester, and it will continue in the sixth semester, Making it a total of 6 credit course. **(BT-508, BT-607 & 608: Project)**

It Involves Laboratory/ experimental/ field work under the guidance of a supervisor, leading to presentation of a comprehensive report based on the experiential learning, through focused skill building activity.

The objective of this course is to help students in organization of research ideas, material, and objectives for their dissertation and development of communication skills.

After completion of this course, the students should present a detailed project report comprising of

i. A scientific topic and relevant design of hypothesis
ii. Aims, objective and Significance
iii. Review of literature
iv. Methodology/Technology used
v. Experimental outcome and critical analyses
vi. Summary and conclusion
vii. References in appropriate referencing styles.

In the Vth and VIth Sem, a student will submit the Project report and will be assessed as per the following guidelines.

Guidelines for assessment:

SEM V	**Course**	**External**	**Internal**	**Contents of the Report**
	BT-508	**35**	**15**	i. Topic selected ii. Aims & objective and Significance iii. literature review IV. Plan of work
SEM VI	**BT-607 & BT-608**	**70**	**30**	i. Methodology/Technology used ii. Experimental outcome and critical analyses iii. Summary and conclusion iv. References in appropriate referencing styles. Oral Presentation & Viva