Savitribai Phule Pune University

(Formerly University of Pune)

Two Year Degree Program in Biotechnology

(Faculty of Science & Technology)

Revised Syllabi for

M.Sc. (Biotechnology) Part-I

(For Colleges Affiliated to Savitribai Phule Pune University)

Choice Based Credit System Syllabus
(Based on Guidelines of NEP-2020)

To be implemented from Academic Year 2023-2024

Title of the course: M.Sc. (Biotechnology)

Objectives to be achieved:

- To help the students to build interdisciplinary approach
- To empower students to excel in various research fields of Life Sciences
- To inculcate sense of scientific responsibilities for social and environment awareness.
- To acquaint the students with thrust areas of biotechnology
- To adapt the National Education Policy-2020, that offers opportunities to learn core subjects and to explore additional avenues of learning beyond the core subjects for complete development of an individual.

Course Structure:

M.Sc. Biotechnology (Part-I)

Semester -I

	Course Type	Credit	Theory	Subject Code	Title of Paper
Semester -I	Mandatory (14 Credit)	4	Theory	BT 501 MJ	Bacteriology, parasitology and virology
		2	Theory	BT 502 MJ	Advanced cell Biology
		2		BT 503 MJ	Advanced Molecular Biology
		2	Theory	BT 504 MJ	Advanced Immunology
		2	Practical	BT 505 MJP	Practical in Bacteriology, Parasitology and virology and immunology
		2	Practical	BT 506 MJP	Practical in Cell and Molecular Biology
	Elective (4 Credit)	2+2	Theory & Practical	BT 507 MJ BT 507 MJP	Environmental Biotechnology
				BT 508 MJ BT 508 MJP	Food Biotechnology
				BT 509 MJP BT 509 MJP	Biostatistics
				BT 510 MJ BT 510 MJP	Rasayana: An Ancient gerontology
	Research Methadology (4 Credit)	4	Theory & Practical	BT 511 RM BT 511 RMP	Research Methodology
Total		22			

Semester -II

	Course Type	Credit	Theory	Subject Code	Title of Paper
Semester - II	Mandatory (14 Credit)	4	Theory	BT 551 MJ	Advanced Biological Chemistry
		4	Theory	BT 552 MJ	Genetic Engineering
		2	Theory	BT 553 MJ	Advanced Genetics
		2	Practical	BT 554 MJP	Practical in Advanced Biological Chemistry
		2	Practical	BT 555MJP	Practical in Genetic Engineering
	Elective (4 Credit)	2+2	Theory & Practical	BT 556 MJ BT 556 MJP	Nanotechnology
				BT 557MJ BT 557 MJP	Stem cells and regenerative technology
				BT 558 MJ BT 558 MJP	Tissue Engineering
				BT 559 MJ BT 559 MJP	Herbal Medicine
	OJT (4 Credit)	4	Practical	BT 560 OJT	Industrial ‘On Job training’
Total		22			

Semester I

Course Code: BT 501 MJ Bacteriology, Parasitology and Virology 4 Credits

Total Lectures: 60

Course outcomes:

After completion of the course

- Student will acquire a multifaceted knowledge in the area of Bacteriology, Parasitology and Virology and its importance in Biotechnology studies
- Student will understand the microbial diversity and its applications
- Student will understand the concepts and importance of Virology studies at national and international level.
- Student will acquire in depth knowledge of various diseases caused by viruses and preventive measures for the same.
- Student will understand the significance of studies of bacterial, parasitic and viral infections.
- Student will acquire knowledge about economic importance of microbes.

Unit	Syllabus	No. of Lectures
	BACTERIOLOGY AND PARASITOLOGY	
I	**Taxonomy and Diversity of Bacteria:** • Taxonomy and binomial nomenclature • Types of bacterial classification systems • Molecular and Recent approaches to polyphasic bacterial taxonomy, • Evolutionary chronometers, rRNA sequencing in microbial evolution, genetic basis of evolution, evolution of physiological diversity. • Concept of 'unculturable' bacterial diversity and strategies for their culture • The measures and indices of microbial diversity • Metabolic Diversity in Bacteria • Archaebacteria- General characteristics, phylogenetic overview and molecular adaptations • Microbial growth and reproduction in bacteria	08
II	**Ultrastructure of Bacteria :** • Cell wall (Gram positive, Gram negative and Archea), • Cell membrane (Gram positive, Gram negative and Archea), • EndoSpore (Structure, Process of formation, germination and genetic basis), • Flagella (Structure, Chemotaxis mechanism) • Other cell appendages- (Capsule and Pilli) and Cell inclusions • Siderophores – Structure, Function and Significance	08
III	**Bacterial Genetics:** Concept of replication, mutation, regulation, genetic recombination and application	05
IV	**Applied Bacteriology:** • Bacteriology and Public health: Mycobacteria and Enterobacteria (Role as human pathogens with example) Antibiotic resistsnce	04

	mechanisms, Quorum Sensing (Concept and significance in Biofilm and pathogenicity of Bacteria), Probiotics • Bacteriology and Agriculture: Agrobacterium, Nitrogen Fixation, Biofertlizers and Biopesticides, Biosensors • Bacteriology and environment: Bioremediation of Petroleum and Xenobiotics (One example each) • Microbial Fuel Cells	
V	**Introduction to Parasitology:** • Basic concept of Parasitism • Host parasite interaction : Cellular, physiological and molecular basis of host-parasite interactions	03
VI	**Parasite diversity:** • Protozoa, Helminths, Nematodes, Cestodes (Life cycles, Modes of parasitic transmission, evasion of host defence mechanisms) • Epidemiology of parasitic diseases and role of parasitic vectors	07
	VIROLOGY	
VII	**Introduction to viruses:** General properties of viruses, Morphology and ultrastructure of Viruses Morphology and Life cycle of lamdaphage Virus related structures – Viroids and Prions **Classification of viruses:** ICTV system, Baltimore system	06
VIII	**Replication of viruses:** • Mechanism of virus adsorption: Kinetics of receptor binding. • Cellular interactions, endocytosis, virus uncoating mechanism, cellular basis of transformation and Host cell 'shut off' • Replication sites and their characterization • Genome replication • Translation of viral proteins • Protein-nucleic acid interactions and genome packaging • Maturation and exit of progeny virions	06
IX	**Cultivation of viruses:** • In embryonated chicken eggs • Experimental animal models in virology • In vitro methods of cultivation using cell cultures – primary and secondary cell lines suspension cell cultures and monolayer cell culture	03
X	**Diagnosis of viral infections:** • Microscopic detection, Serological and Molecular methods for diagnosis, Infectivity assays	03
XI	**Antiviral Agents:** • Physical and Chemical agents • Therapeutic agents, Vaccines as therapeutics • Interferons	03
XII	**Viral diseases:** • Viral diseases of public health concern: Emerging and re-emerging viral diseases with example (H1N1, SARS-CoV, Nipah virus and Marburg virus), Current outbreaks • Diseases caused by animal, plant and poultry viruses and their Importance with examples	04

Selected Readings:

1. Ingraham J. L. and Ingraham C.A. (2004). Introduction to Microbiology. 3rd Edition.Thomson Brooks / Cole.
2. Madigan M.T., Martinko J.M. (2006). Brock's Biology of Microorganisms. 11thEdition. PearsonEducation Inc.
3. Prescott L.M., Harley J.P., AND Klein D.A. (2005). Microbiology, 6th Edition.MacGraw Hill Companies Inc.
4. Salle A.J. (1971) Fundamental Principles of Bacteriology. 7th Edition. Tata MacGrawPublishing Co.
5. Stanier R.Y., Adelberg E.A. and Ingraham J.L. (1987) General Microbiology, 5thEdition.Macmillan Press Ltd.
6. Tortora G.J., Funke B.R., Case C.L. (2006). Microbiology: An Introduction. 8thEdition. Pearson Education Inc.
7. Bush, A.O., Fernandez, J.C., Esch, G.W., & Seed, J.R. (2001) Parasitism: The diversity and ecology of Animal parasite. Cambridge University Press.
8. Chaterjee, K.D. (2009) Parasitology: Protozoology & Helminthology. CBS Publishers & Distributors Private Limited. 6. Cheng, T.C. (1986) General Parasitology. Academic Press.
9. Arora D.R. and Arora B. (2005).Medical Parasitology. CBS Publishers and Distributors, New Delhi.
10. Chandler A.C. and Read C.P. (1961). Introduction to Parasitology. John, Wiley and Sons, Inc. Chatterji K.D. Parasitology (Protozoology & Helminthology). Medical Publishers, Calcutta, India.
11. Belding D. L. Mereditch .(1956). Textbook of Parasitology. New York
12. Paniker's Textbook of Medical ParasitologyM.D. Paniker, C. K. Jayaram, M.D. Ghosh, Sougata
13. Flint Jane. S. (1999), Principles of Virology 3rd edition, ASM (American Society of Microbiology) Press Publisher, 2 volumes. USA.
14. Bernard.N. Fields, Lippincott and Williams Wilkins, USA Field's Virology - 2 volumes,5th edition, (2006),

Semester I

Course Code: BT 502 MJ Advanced Cell Biology 2 Credits

Total Lectures: 30

Course outcomes:
After completion of the course,

- Students are expected to gain an advanced understanding of the fundamental concepts of cellular and sub-cellular organization.
- Students will develop an advanced understanding of the cellular transport and signaling
- Students will gain an advanced understanding of the cell cycle and cell death.

Unit	Syllabus	No. of Lectures
I	**Cell structure and transport** • Overview of cell and its organization • CellularTransport-Transportacrossplasmamembrane,Mechanismofvesiculartransport • Organelles and membrane trafficking: Protein sorting and transport in Endoplasmic Reticulum, Golgi apparatus and Lysosome, Mitochondria, Chloroplast • Mechanism of nerve transmission-electrical and chemical transmission.	08
II	**Cell communication** • Cell signaling: signalling molecules/messengers and their receptors • Signal transduction pathways: JAKSTAT, RAS-MAP Kinase TGF-β, NF-kB Pathway, G-protein coupled receptors. • Cell–matrix interactions: matrix structural protein; collagen, desmosome and hemidesmosome. • Matrix polysaccharide; glycosaminoglycans(GAGs), adhesion protein; fibronectin • Cell–cell interactions: Cell adhesion molecules: selectins, integrins, immunoglobulin(Ig) superfamily c adherins • Cell junctions: tight communication, anchoring junction	12
III	**Cell cycle and cell death** • Cell cycle and its regulation: An overview of mechanics of cell division(mitosis and meiosis) • Cell cycle checkpoints: role of cyclins,cyclin dependent kinase and inhibitors. • Assembly and disassembly of cytoskeletal elements, role in cell division • Cell death pathways and its mechanism, Extrinsic and intrinsic pathway and Granzyme mediated pathway, Apoptosis: role of Caspases, Pro-apoptotic and antiapoptotic proteins	10

	• Etiology of cancer: Transformation and anomalies, the development and causes of cancer, Oncogenes and tumor suppressor genes	

Selected Reading:

1. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2008). Molecular Biology of the Cell (5th Ed.). New York: Garland Science.
2. Lodish, H. F. (2016). Molecular Cell Biology (8th Ed.). New York: W.H. Freeman.
3. Cooper, G. M., & Hausman, R. E. (2013). The Cell: a Molecular Approach (6th Ed.). Washington: ASM; Sunderland.
4. Hardin, J., Bertoni, G., Kleinsmith, L. J., & Becker, W. M. (2012). Becker's World of the Cell. Boston (8th Ed.). Benjamin Cummings.

Semester I

Course Code: BT 503 MJ Advanced Molecular Biology 2 Credits

Total Lectures: 30

Course Outcomes:
After completion of the course,

- The student will gain an understanding of chemical and molecular processes that occur in and between cells.
- The student will understand and will be able to describe and explain processes and their meaning for the characteristics of living organisms.

Unit	Syllabus	No. of Lectures
I	Nucleic acids – Structure, Chemical and Physical Properties, Spectroscopic and thermal properties, Eukaryotic chromosome and its high-resolution organisation, DNA-histone interactions-formation of chromatin fibres-Hetero/ Euchromatin- structural transition-Histone-H1-significance in regulation of expression. Polytene and lamp brush chromosomes.	5
II	DNA replication, Overview, Bacterial and Eukaryotic replication, Role of Telomerase, Topoisomerase and its type.	3
III	DNA damage, Repair and Recombination– Mutagens (Physical and Chemical), UV, Ionizingradiation, Base analogues, Nitrous acid, Alkylating agents, Acridinedyes. Photoreactivation, Alkyl transferase, Excision repair, Mismatch repair, SOS DNA Recombination &its type: (1) General or homologous recombination, (2)Illegitimate or nonhomologous recombination, (3) Site-specific recombination, and (4) Replicative recombination.	8
4.	Genetic code and its properties	2
5.	Transcription and its regulation in both prokaryotic and eukaryotic systems. Posttranscriptional modifications	6
6	Translation and its regulation in both prokaryotic and eukaryotics ystems. Posttranslational modifications	6

Selected Readings:

1. MolecularBiologyoftheGene:WatsonJamesD.,BakerTaniaA.,BellStephenP., GannAlexander, Levine Michael, LosickRichard.
2. TheWorldoftheCell:WayneM.Becker,LewisJ.Kleinsmith,JeffHardin,Gregory PaulBertoni
3. CellAndMolecularBiology:DeRobertisE.D.P.
4. Karp'sCellandMolecularBiology:GeraldKarp,JanetIwasa,WallaceMarshall
5. Lewin'sEssentialGenes:JocelynE.Krebs

6. Essential Cell Biology: Bruce Alberts, Karen Hopkin, Alexander D.Johnson,DavidMorgan,MartinRaff,KeithRoberts,PeterWalter
7. Molecular Biology of the Cell: Bruce Alberts, Alexander D. Johnson, JulianLewis,DavidMorgan,Martin Raff,KeithRoberts,PeterWalter
8. The Cell:AMolecularApproach:GeoffreyCooper

Semester I

Course Code: BT 504 MJ Advanced Immunology 2 Credits

Total Lectures: 30

Course outcomes:

After completion of the course,

- Student will learn the immune organization and its function
- Student will understand the concept of antigen-antibody reaction.
- Student will acquire knowledge about in-vitro tests used in immunological diagnosis of various diseases.
- Student will understand the clinical significance of immunology studies
- Student will acquire knowledge about vaccine technology and its significance in prevention of infectious diseases

Unit	Syllabus	No. of Lectures
I	**Fundamentals of Immune system** • Functional anatomy of the immune system: Cells, Tissues and organs of immune system, Components and mechanism of innate and acquired immunity • Antigens: Immunogens, haptens, antigenic determinants, factors influencing immunogenicity • Immunoglobulins: Structure, classes and function, multigene organization of immunoglobulin genes • The complement system: Components and complement activation • Major Histocompatibility Complex: Organization and inheritance of MHC, Structure and function of MHC class-I and class-II, MHC genes • Immune response	06
II	**Regulation of Immune response:** • B-cell receptor, Immunoglobulin super family; principles of cell signaling; B cell maturation, activation and differentiation; class switching and generation of antibody diversity • T-cell maturation, activation and differentiation and T-cell receptors; functional T Cell subsets, TCR-CD3 complex in immune activation and signal transduction pathways; ADCC • cytokines: properties, receptors, cytokine network and therapeutic uses • Antigen processing and presentation • Immunological tolerance: Central and peripheral tolerance, Mechanisms of tolerance • Tissue repair and homeostasis of the immune system.	08
III	**Immuno-diagnostic Techniques** • Principle, types and applications of agglutination, precipitation and complement mediated immune reactions • Advanced immunological techniques: RIA, ELISA, Western blotting, ELISPOT assay, immune fluorescence microscopy, flow cytometry and immunoelectron microscopy	06

	• Biosensor assays for assessing ligand –receptor interaction; • CMI techniques: lympho proliferation assay, mixed lymphocyte reaction.	
IV	**Clinical Immunology** • Hypersensitivity: Types and mechanism with suitable example • Auto immunity: Mechanisms and therapy • Transplantation Immunology- Principles of transplantation, therapeutic approaches to control rejection. • Tumor immunology: tumor antigens; immune response to tumors and tumor evasion of the immune system, cancer immunotherapy • Immunodeficiency disorders	06
V	**Vaccinology:** • Active and passive immunization; • Types of vaccines: live, killed, attenuated, subunit vaccines • Adjuvants: Role and properties • Vaccine technology: Recombinant DNA and protein based vaccines, plant-based vaccines, peptide vaccines, conjugate vaccines; T cell based vaccine, Monoclonal antibodies, Chimeric antibodies, Antibody engineering	04

Selected Readings:

1. Kindt, T.J., Goldsby, R. A., Osborne, B. A., &Kuby, J. (2006). KubyImmunology.New York: W.H. Freeman.
2. Brostoff, J., Seaddin, J. K., Male, D., &Roitt, I. M. (2002). Clinical Immunology. London: Gower Medical Pub.
3. Robert R. Rich, MD Thomas A. Fleisher, MD William T. Shearer, MD and Harry W. Schroeder II. (2008) Clinical Immunology: Principles and Practice.
4. Murphy, K., Travers, P., Walport, M., & Janeway, C. (2012). Janeway'sImmunobiology. New York: Garland Science.
5. Parham, P. (2005). The Immune System. New York: Garland Science
6. Paul, W. E. (2012). Fundamental Immunology. New York: Raven Press.
7. SudhaGangal and ShubhangiSontakke, Textbook of basic and clinical immunology, 1st edition (2013), University Press, India

Semester I

Course Code: BT 505 MJP **2 Credits**

No. of Practicals 15

Practical in Bacteriology, Parasitology, Virology and Immunology

Sr. No.	List of Practicals	No. of Practicals
1	Isolation of Mesophlic bacteria from natural / food samples. Identification of the bacteria to at least Genus level using biochemical methods as per Bergey's manual	03
2	Determination of Antibiotic susceptibility	01
3	Demonstration of parasites in unstained preparations	01
4	Smear preparation, staining and identification (with reasons) of parasites from available sourses.	01
5	Propagation of viruses in animal / embryonated egg	01
6	Plaque assay and Plaque reduction neutralization test	01
7	Titration of virus by Haemagglutination test	01
8	Immunodiffusion – ODD, SRID	01
9	Rocket Immunoelectrophoresis	01
10	Quantitative agglutination test (Widal)	01
11	Qualitative and QuantitativeELISA	02
12	Western blotting (Demonstration)	01

Semester I

Course Code: BT 506 MJP **2 Credits**

No. of Practicals: 15

Practical in Cell and Molecular Biology

Sr. No.	List of Practicals	No. of Practicals
1	Isolation of mitochondria and assay of SDH activity	2
2	Isolation of lysosome and assay of acid phosphatase activity	2
3	Separation of leucocytes by dextran method.	1
4	Investigate the effect of solute concentration on osmosis in potato/ beetroot	1
5	Study of programmed cell death during development of chick embryo/xylem development in shoot tip region.	1
6	Karyotyping and Ideogram construction in onion roots using Colchicin treatment	2
7	Isolation of DNA/ RNA a)Bacteria; b)Animal, and c)Plant Assessing the purity of isolated DNA by A_{260}/A_{280} and Agarose Gel Electrophoresis	3
8	Estimation of concentration of isolated DNA by DPA method	1
9	Estimation of concentration of isolated RNA by Orcinol method	1
10	Visit to animal house or any Research Laboratory or related biotech Industry, Reportwriting.	1

Semester I

Course Code: BT 507 MJ Environmental Biotechnology 2 Credits
Total Lectures: 30

Course Outcomes

After completion of the course

- Students will gain a comprehensive understanding of the various threats to the environment.
- Students will acquire knowledge of the fundamentals of bioenergy resources, their exploitation for sustainability of the environment.
- Students will be familiar with biotechnological approaches for waste management, and they will develop the ability to assess the potential of biotechnological solutions in mitigating environmental pollution.
- Students will get up-to-date knowledge about the national and international environmental rules and policies.

Unit	Syllabus	No. of Lectures
I	**Introduction to environmental Science:** • Introduction to environment-biotic and abiotic components and its interaction, Biodiversity and its significance, Environmental issues (Global and regional threats to the environment) and its impact on biodiversity and human, Overview of environmental Pollution(Air, Water and Soil) transport, diffusion and its impact on environment • Future scenarios of the global environment, causes and consequences of climate change (greenhouse effect and global warming, Ozone hole, Sea level rise), Carbon footprints, Carbon sequestration (biological) and Carbon credit • Role of biotechnology in solving environmental issues.	06
II	**Bio-energy resources**: • Bio-energy resources and their exploitation: Overview of biomass as an energy source, Thermal characteristics of biomass as fuel. • Scientific aspects and prospects of biofuel production (biodiesel, bioethanol, biogas, biohydrogen- industrial processes, microorganisms and biotechnological interventions)	05
III	**Biotechnology for waste management:** • Introduction to use of biological agents in pollution control, advantages, limitations and applications • Waste water (Sewage) management: Sources of waste water and its impact on environment, Biological waste water treatment methods • Solid waste management: Sources and types, impact of solid waste disposal, recycle, reuse and recovery solutions (Solid waste management with composting, vermicomposting) • Types of bioremediation and factors affecting: natural, engineered, *Ex-situ* and *in-situ,* Principles and methods in: bio-stimulation, bio-	10

	augmentation. • Principles and methods in: phycoremediation, phytoremediation (phytoaccumulation, phytovolatilization, rhizofiltration, phytostabilization). • Xenobiotic degradation, Biomining/Bioleaching, Biomethanation	
Unit IV	**Environmental monitoring, Laws & policies:** • Applications of remote sensing and GIS in environmental monitoring • International laws and policy in the view of global concerns, objectives of laws/regulations, importance: overview of Stockholm conference, Montreal protocol, Major outcomes of Rio conference (The Convention on Biological Diversity, The Framework Convention on Climate Change), ISO14000series, Kyoto protocol, Paris agreement and Meetings of the Conference of the Parties(COP/CMP/CMA). • National laws and policy: In the view of national concerns, objectives of laws/regulations, importance etc. • The Environment Protection Act1986, Hazardous Wastes (Management, Handling and Transboundary Movement) Rules • Environmental impact assessment act, process of environmental impact assessment- introduction, objectives, classification, guidelines, casestudy • Indian eco-standards	09

Selected Reading:

1. Evans G. M. and Furlong J. C. (2003), Environmental Biotechnology: Theory and Applications, Wiley Publishers.
2. RitmannB. and McCarty P. L., (2000), Environmental Biotechnology: Principle & Applications, 2nd Ed., McGraw Hill Science.
3. Scragg A., (2005) Environmental Biotechnology. Pearson Education Limited.
4. DevinnyJ. S., DeshussesM. A. and Webster T. S., (1998), Biofiltration for Air Pollution Control, CRC Press.
5. Rehm H. J. and Reed G., (2001), Biotechnology – A Multi-volume Comprehensive Treatise, Vol. 11, 2nd Ed., VCH Publishers Inc.
6. Peavy H. S., Rowe D. R. and TchobanoglousG., (2013), Environmental Engineering, McGraw-Hill Inc.

Semester I

Course Code: BT 507 MJP **2 Credits**

No. of Practicals: 15

Practicals in Environmental Biotechnology

Sr. No.	List of Practicals	No. of Practicals
1	Genotoxicity assay on polluted water- Onion root tip and pollen germination assay.	2
2	Isolation of microorganisms from different habitats/niches and enumeration of its bioremediation potential	2
3	Removal/estimation of pollutant from soil/water samples by biostimulation/bioaugmentation/phytoremediation	1
4	Qualitative estimation of biodegradation of pesticide/insecticide/fungicide.	1
5	Estimation of Total suspended solids of waste water	1
6	Determination of dissolved oxygen concentration of water sample	1
7	Determination of chemical oxygen demand(COD) of sewage sample.	1
8	Determination of biological oxygen demand of sewage sample	1
9	Acquisition of “GoogleEarth” images for the known and unknown area for land use -land cover mapping.	1
10	Review on EIA case study.	1

Semester I

Course Code: BT 508 MJ **Food Biotechnology** **2 Credits**

Total Lectures: 30

Course outcomes:

After completion of the course,

- Students will gain knowledge of the different types of microorganisms involved in food spoilage and their control methods, facilitating informed decision-making in food preservation.
- Students will understand the biochemical changes caused by microorganisms and be aware of safety measures to prevent food borne illnesses.
- Students will be familiar with fermentation technology and its applications in producing a variety of food products, enhancing their understanding of biotechnological processes in the food industry.
- Students will comprehend the concepts of nutrigenomics and nutraceuticals, along with the health applications of it, being aware of ethical and regulatory considerations in biotechnological product development.

Unit	Syllabus	No. of Lectures
I	**Introduction to food science:** Basics of food constituents- carbohydrates, proteins, lipids, vitamins, minerals, water Food additives and their role. Intentional and unintentional additives	2
II	**Microbial biotechnology:** • Microbes in food spoilage &its control-Typesofmicroorganismnormallyassociatedwithfood:mold,yeast,andbacteria • Biochemicalchangescausedbymicroorganismsinspoilageofvarioustypesoffoodproducts. • Foodpoisoningandmicrobial toxins, foodborneintoxicantsandmycotoxins. • Control of various microbes causing food spoilage • Fermentationtechnology-useofmicrobesintheproductionofalcoholicbeverages(Beer,Wine),bread,yogurt,organic acid (Lacticacid),pigments,flavors, sweeteners • ApplicationsofAmylases,Proteases,Lipases,Cellulases,Pectinasesenzymesin foodprocessing.	8
III	**Food processing and preservation:** Introduction to food processing of various foods including dairy, bakery, brewing, fruit and vegetable products, oilseeds, meat, fish, poultry; pro and prebiotics and nutraceuticals. Principles of food preservation by dehydration, thermal treatments like pasteurization, sterilization, canning, retorting etc., low temperature i.e., chilling and freezing, chemical preservation/ bio-preservation, traditional methods like salting/ syruping, pickling, fermentation etc.	6

IV	**Nutrigenomics**: • Concept of nutrigenomics • Prebiotics and Probiotics: Food Sources- Prebiotics [Dietary fiber, Oligosaccharides (Galacto-oligosaccharides,Fructo-oligosaccharides),ResistantStarch,Sugaralcohols]andprobiotics [Yogurt and allied products, Yakult, Sauerkraut/kimchi and tempeh] • Strainsofmicroorganismsusedasprobiotics • Roleinhealthanddisease,Mechanismofaction,levelsofprobioticsrequiredfort herapeutic efficacy. • Application of nutrigenomics in food industry, ethical concern, safety and regulatory issues of biotechnological products	6
V	**Nutraceuticals:** • Concept of nutraceuticals and functional foods • Organic food, production and advantages • GM food, Benefits & Controversies • Major nutraceuticals and their health applications- Bioactive peptides, Curcumin, Conjugated Linoleic acid, Glucosamine, Carnitine, Creatine • Quality Improvement: concepts of quality control and quality assurance in food industries, TQM, principals of TQM • Food Laws and Regulations: Food laws and standards: National and International food laws, Mandatory and voluntary food laws. • Indian Food Regulations and Certifications: Food Safety and Standards Act, FSSAI Rules, Duties and responsibilities of Food Safety Authorities	8

Selected Reading:

1. AnthonyPometto(2005).FoodBiotechnology,2ndEdition.CRCPress.
2. ByongHLee(2014). FundamentalsofFoodBiotechnology,2ndEdition,Wiley-Blackwell.
3. Goldberg,I1994.FunctionalFoods:DesignerFoods,Pharmafoods,NutraceuticalsChapman& Hall.
4. Gibson,GRandWilliam,CM.2000.Functionalfoods-ConcepttoProduct.Woodheadpublishing.
5. Aluko,R.E.(2012).Functional Foods and Nutraceuticals.Springer
6. InteazAlli.2004.FoodQualityAssurance:Principles and Practices. CRCPress,BocaRaton,FL, USA.
7. RonaldH.Schmidt and GaryERodrick.2003. FoodSafetyHandbook. JohnWiley&Sons,Inc., Hoboken. New Jersey, USA.

Semester I

Course Code: BT 508 MJP **2 Credits**

No. of Practicals: 15

Practicals in Food Biotechnology

Sr. No.	List of Practicals	No. of Practicals
1	Determination of Gluten content and adulterant ($NaHCO_3$) in wheat flour samples	2
2	Production of aflatoxin from spoiled food and its qualitative analysis.	2
3	Production of wine/beer/flavor	2
4	Production of bacterial/fungal enzyme and its application in food processing.	3
5	Production and evaluation of probiotic food	2
6	Estimation of salt content in butter	1
7	Proximate analysis of food sample: Determination of moisture, carbohydrate and protein content of food	2
8	Visit to food processing industry like distilleries and breweries	1

Semester I

Course Code: BT 509 MJ **Biostatistics** **2 Credits**

Total Lectures: 30

Course outcomes:

After completion of the course,

- Students will understand the importance of statistics in Biological sciences.
- Students will learn to summarize and categorize statistical data.
- Students will apply appropriate statistical tests on different types of data.
- Students will learn the interpretation of results and its application in biological systems.

Unit	Syllabus	No. of Lectures
I	**IntroductiontoStatistics:** • Measures of central tendency–mean,mode,median and their properties • Measures of dispersion–variance, standard deviation, coefficient of variance symmetry and skewness ,measures of skewness, kurtosis • Sampling and sampling distributions–concept of sample and population,statistic,methodsofsampling,standard error	06
II	**Correlation and regression** • Bivariate correlation, positive correlation, negative correlation • Measures of correlation–scatter diagram, Karl-Pearson's coefficient ofc orrelation, Spearman'srank correlation coefficient • Regression–Equations of regression lines using least square method, regression estimate and its standard error.	09
III	• Experimental statistics-Design of experiments • Principles of design –randomization, replication, localcontrol, treatment group andcontrol group. • Guidelines for designing the experiments, size of plot, number of replications Completelyr and omized design (CDR), randomized block design (RBD)	06
IV	• Testing of hypothesis and analysis of variance • Hypothesis, statistical hypothesis, critical region, level of significance, p-value, normal distribution • T-test: t-test for mean, equality of two means, paired t-test, unpaired t-test. • chi-square test: chi square test for goodness of fit, independence of attributes, • Analysis of variance table (ANOVA) • Introduction to statistical analysis software- e.g. SPSS,	09

Selected Reading:

1. Billingsley,P.(1986).ProbabilityandMeasure. NewYork:Wiley.
2. Rosner,B.(2000).FundamentalsofBiostatistics.Boston,MA:DuxburyPress
3. Daniel,W.W.(1987).Biostatistics,aFoundationforAnalysisintheHealthSciences.NewYork:Wiley.
4. P.S.S.SunderraoandJ.Richards-AnintroductiontoBiostatistics,PrenticeHallPvt.Ltd.India
5. CampbellR.C.-StatisticsforBiologists, CambridgeUniversityPress,Cambridge.

Semester I

Course Code: BT 509 MJP **2 Credits**

No. of Practicals: 15

Practicals in Biostatiostics

Sr. No.	List of Practicals	No. of Practicals
1	Measurement of central tendency(mean,mode and median)	2
2	Measure of variance, standard deviation, coefficient of variance and standard error	2
3	Measures of skewness and measures of Kurtosis	1
4.	Determination of Karl-Pearson's coefficient of correlation from the given data	1
5	Determination of Spearman's rank correlation coefficient from the given data	1
6	Determination of regression lines and calculation of correlation coefficient– grouped and ungrouped data	2
7	Examples based on t –test	2
8	Drawing a simple random sample with the help of table of random numbers	1
9	Chi-square test for goodness of fit and independent attributes	1
10	Analysis of variance on the given data(ANOVA)	2

Semester I

Course Code: BT 510 MJ Rasayana: An ancient Gerontology 2 Credits

Total Lectures: 30

Course outcomes:

After completion of the course,

- Students will understand the need for devotion to help older adults .
- Students will acquire the knowledge about key to long life

Unit	Syllabus	No. of Lectures
I	Introduction to Modern day Gerontology, Timeline, Rasayana ancient Gerontology practices –7000-year-old science, Science that provides - Long Healthy Life through, Prevention of aging and longevity, Immunity against diseases, Mental competence, Increased vitality, Enhanced lustre	8
II	Tridosha	4
III	Types of Rasayana according to Sushruta SamhitaCi.Sthan27:1-2: Ajasrika, Kamya, Naimittika and their description. Types according to scope: Kamya Rasayana (Promoter of normal health); Pranakamya (Life vitality and longevity); Medhakamya(Intellect); Srikamya(Complexion and lustre)	6
IV	Theories of Rasayana The Wear and Tear Theory The NeuroEndocrine Theory The Genetic Control Theory Calorie restriction Theory Telomere and Ageing Theory The Glycation theory of ageing The Free radical theory	8
V	Rasayana Preparation for each of the four Kamya Rasayana, Pranakamya, Medhakamya, Srikamya.	4

Selected Readings:

1. AnilKumarSinghet.al.Rasayanatherapy:Amagiccontributionofayurvedaforhealthylonglife.DOI:10.7897/2277-4343.05109
2. ‘Rasayana’ ayurvedic herbs for longevity and rejuvenation – H.S. Puri,Taylor&FrancisGroup(ISBN:0-415-28489-9)
3. Dr. MukundSabnis, Concept of Rasayana, a book on Anti-ageing theoriesbased on Ayurved and Modern Medicine.
4. Dr.BinduChauhan,RasayanaaholisticapproachtoAyurved.
5. VagishwarShukla,Ayurvedkaitihas Granthamala 3(ChaukhamaPublications)

Semester I

Course Code: BT 510 MJP **2 Credits**

No. of Practicals: 15

Practicals in Rasayana: An ancient Gerontology

Sr. No.	List of Practicals	No. of Practicalss
Rasayana Preparations		
1	Amalki	3
2	Ashwagandha	3
3	Bhrami	2
4	Guduchi	2
5	Mandukparni	2
6	Vacha	3

Semester I

Course Code: BT 511 RM **Research Methodology** **2 Credits**

Total Lectures: 30

Course outcomes:

After completion of the course,

- Students will understand the concepts of research and research methodology
- Students will acquire the knowledge of data collection and analysis
- Students will demonstrate a comprehensive understanding of research communication concepts, enabling them to effectively convey scientific information in written form.
- Students will understand the principles of ethics and plagiarism in research, ensuring integrity and responsible conduct in scientific communication and publication.

Unit	Syllabus	No. of Lectures
I	**Introduction to Research Methods:** Types of research philosophies (positivist, interpretivist, pragmatist and realistic), various steps in scientific research. Scientific temper and attitude. Experimental design, defining controls; reductionist and holistic approaches of scientific research.	05
II	**Scientific Methodology:** Problem identification, critical thinking, hypothesis formulation and hypothesis testing (power analysis), types of reasoning, theory and scientific law	03
III	**Data Collection and analysis**: Types of data, methods and techniques of data collection, Methods of primary data collection (observation/ experimentation/ questionnaire/ interviewing/ case/ pilot study) Methods of secondary data collection (internal/ external), schedule method **Research data organization:** Creating, analyzing, formatting data & content using spreadsheets, managing lab work books. **DataAnalysis:** Data distributions, statistical tests for comparison of sample means and sample variance-t-test, non-parametric tests, correlation and regression, F, t and Z distribution; goodness of fit, chi-square. Data processing software. Multidimensional Use of Excel; Sigmastat; GraphPad Prism; SPSS, SAS, R software.	08
IV	**Research in Practice:** Literature review, journals, conference proceedings, journal impact factor, citation index, h, g, h-g index.	04
V	**Research Ethics:** Social implications of research, bio-safety issues, Animal experimentation ethics and human experimentation ethics.	03

	Ethics in scientific communication, patent submissions. Data fudging, plagiarism, and scientific misconduct: Use of URKUND, Turnitin and iThenticate software	
VI	**Scientific Communication:** Importance of scientific communication. Types of scientific communications. **Different modes of scientific communication**: **Scientific Writing:** Characteristic of good scientific writing, structure and content, style, literature references, Bibliography. **Report Writing**: Types of research reports, guidelines for writing a report, report format. Details of research proposal writing. Research paper writing (IMRAD format). Thesis writing. **Oral forms of scientific Communication:** Popular and scientific talks, poster presentations, organizing presentation material, use of audiovisual aids in presentation, elements of presentation preparation: objective, subject, audience, length of talk managing and delivering presentations.	07

Selected Readings:

1. Hofmann H., 2010, Scientific Writing and Communication Papers, Proposals, and Presentations. New York: Oxford University Press.
2. Ferris T.L.J., Sitnikova E., and Duff A. H., 2010, Building graduate capabilities to communicate research and plans successfully, Int. J. Eng. Educ., vol. 26, no. 4, pp. 891-899.
3. Michael Alley, 2018, The Craft of Scientific Writing, fourth edition,Springer.
4. Stephen B. Heard, 2018, The Scientists Guide To Writing, Princeton University Press.
5. Graziano A. M., Raulin M. L. 2012, Research Methods: A Process of Inquiry Pearson Publication, Delhi.
6. Barass R., 2002, Scientists Must Write: A Guide to Better Writing for Scientists, Engineers and Students, Routledge Publication,UK.
7. Resnik D. B., 1998, The Ethics of Science: An Introduction, Routledge Publication, UK.
8. Fisher R A, 1971, The Design of Scientific Experiment, Collier Macmillan Publishers, London.
9. John D'Angelo, Ethics in Science: Ethical Misconduct in Scientific Research (2012),CRC Press, USA
10. Ganguli Prabuddh, Intellectual Property Rights (2001), Tata McGraw-Hill Publishing Company Ltd., Delhi7.

Semester I

Course Code: BT 511 RMP **2 Credits**

No. of Practicals: 15

Practicals in Research Methodology

Sr. No.	List of Practicals	No. of Practicals
1	Research Data collection and analysis (Various tools for literature survey)	02
2	Hypothesis writing and design of a research question	01
3	Designing of an experiment	01
4.	Use of plagiarism check softwares	02
5	Use of data analysis softwares (Excel, SPSS)	02
6	Use of software / web based reference manager tools (Mendeley, Endnote, Zotero)	02
7	Review paper writing/ Report writing	02
8	Presentation of scientific research paper from reputed journal.	01
9	Process involved in submission of a manuscript to a peer-reviewed indexed research journal	02

Semester II

Course Code: BT 551 MJ Advanced Biological Chemistry 4 Credits

Total Lectures: 60

Course outcomes:

After completion of the course,

- Student will understand the significance of Biochemistry
- Student will acquire the knowledge of the chemistry of carbohydrates, lipids, proteins and amino acids
- Student will understand the catalytic role of enzymes, the importance of enzyme inhibitors in the design of new drugs, therapeutic and diagnostic applications of enzymes.

Unit	Syllabus	No. of Lectures
I	**Carbohydrates:** Carbohydrates: Classification, monosaccharides, D and Ldesignation, open chain and cyclic structures, epimers and anomers, mutarotation, reactions of carbohydrates (due to functional groups - hydroxyl, aldehyde and ketone. Aminosugars, Glycosides. Structure and biological importance of disaccharides (sucrose, lactose, maltose, isomaltose, trehalose), trisaccharide's (raffinose, melezitose), structural polysaccharides (cellulose, chitin, pectin) and storage polysaccharides (starch, inulin, glycogen). Glycosaminoglycans, Bacterial cell wall polysaccharides. Outlines of glycoproteins, glycolipids and blood group substances. Carbohydrate metabolism and Regulation (LocalandGlobal): Glycolysis, Citric Acid Cycle, HMP Pathway, ED Pathway, Gluconeogenesis, Glycogen metabolism	16
II	**Lipids:** Lipids: Classification, saturated and unsaturated fatty acids, structure and properties of fats and oils (acid, saponification and iodine values, rancidity). Genera lproperties and structures of phospholipids, sphingolipids, Cholesterol. Prostaglandins- structure, types and biological role. Lipoproteins- types andfunctions, Fatty Acid Catabolism and its regulation (α,β, ω oxidation) of MUFA and PUFA. Lipid Biosynthesis	14
III	**Amino Acids and Proteins:** Classification, structure, stereochemistry, chemical reactions of amino acids due to carbonyl and amino groups. Titration curve of glycine and px values. Essential and nonessential amino acids, non-protein amino acids. Peptide bond - nature and conformation, Ramachandran plot. Naturally occurring peptides - glutathione, enkephalin.	14

	Proteins: Classification based on solubility, shape and function. Determination of amino acid composition of proteins. General properties of proteins, denaturation and renaturation of proteins. Structural organization of proteins- primary, secondary, tertiary and quaternary structures (Eg. Haemoglobin, Myoglobin, andAntibody). Proteolysis, Amino Acid Oxidation of non-essential aminoacids, Transamination, deamination, oxidative deamination, Glucose alanine cycle, Urea Cycle and its regulation. In bornerrorsin amino acid metabolism	
IV	**Enzymes:** (a) Classification and nomenclature of enzymes, active site, isoenzymes, multi-enzyme complexes. Enzyme specificity, Measurement and expression of enzyme activity, enzyme assays (b) Role of cofactors in enzyme catalysis: NAD/$NADP^+$,FMN/FAD, coenzyme A, biotin, cobalamine, lipoamide, TPP, pyridoxal phosphate, tetrahydrofolate and metal ions with special emphasis on coenzyme functions. Acid-base catalysis. (c) Factors affecting enzyme activity: Enzyme concentration,substrate concentration, pH and temperature. Derivation ofMichaelis-Menten equation for uni-substrate reactions. Km and its significance. Line Weaver Burk plot and it's limitations. Importance of Kcat/ Km. Eadie-Hofstee plot. (d) Reversible and irreversible inhibition, competitive, non–competitive and uncompetitive inhibitions, determination of Km&Vmax in presence and absence of inhibitor, Allosteric enzymes.	16

Selected Readings:

1. Biochemistry-ZubayC,AddisonñWesley,1986.
2. Biochemistry–Stryer,1998.
3. Biochemistry,AproblemApproach,2ndEdn.Wood,W.B.AddisonWesley1981.
4. Biochemistry,LehningerA.H.
5. TextbookofBiochemistryWest,E.S.,Todd,Mason&Vanbruggen,Macmillian&Co.
6. PrinciplesofBiochemistryWhite-A,Handler,PandSmithE.L.McGrewHill.
7. Organicchemistry,I.L.Finar,ELBS.(1985).
8. OrganicChemistrybyMorrisonandBoyd(2000)PrenticeHall.
9. FundamentalsofBiochemistrybyDonaldVoet(1999).9.BiochemistrybyUSatyanarayana

Semester II

Course Code: BT 552 MJ **Genetic Engineering** **4 Credits**

Total Lectures: 60

Course outcomes:

After completion of the course,

- Students will understand the basic steps of gene manipulations
- Students will acquire the knowledge of the role of enzymes and vectors responsible for gene manipulation, transformation and genetic engineering.
- Students will acquire detailed knowledge of gene transfer methods and identifying suitable hosts for cloning.

Unit	Syllabus	No. of Lectures
I	Introduction, History & Development of Genetic Engineering Molecular cloning and PCR.	2
II	Host cells and Vectors: Salient features of naturally occurring plasmids, plasmids as vectors. λ Phage and its genome, Lytic and Lysogeny. λ Phage as vector, insertional, replacement, and expression vector. M13bacteriophage, its genome, replication, and budding. M13bacteriophage vector. High-capacity vectors, Cosmids, Phagemids, PAC, BAC, YAC, HAC & MAC, Shuttle vectors.	14
III	Enzymes used in genetic engineering: Nucleases and its types, Restriction Endonuclease Nomenclature, Cleavage Patterns. Polynucleotide phosphorylase, dnase (I, II, Mung bean) and their mechanism of action. Phosphatase (acid, alkaline), BAP,CIAP,SAP. Polynucleotide kinase, Ligases, RNase (RNaseA, RNaseH) and their mechanism of action.	16
IV	Methods of Gene transfer and selection of recombinants: Transformation, Conjugation, Transduction (Generalized and Specialized) Electroporation, Particle bombardment, Microinjection, Liposome mediated, DEAE mediated, Ca -phosphate co-precipitation, Agrobacterium mediated and virus mediated.	5
V	Direct selection and indirect selection of recombinants – Antibiotic resistant, Blue white, red-white (insertional inactivation and α -complementation). Nucleic acid hybridization, colony hybridization, Immunological assays, Protein /enzyme based.	8
VI	PCR: cocktail, Salient features of Primer designing, Limitations, types(Inverse,Multiplex,Hotstart,Nested,insitu,long,colony,realtime, Touchdown,bandstab,reverse,degenerate,anchored,miniprimer,solid phase, gradient, and differential display).	10
VII	The outcome: Transgenic plants and animals, Medical and forensic applications of gene manipulation. New World or Nightmare	5

Selected Readings:

1. AnIntroductiontoGeneticEngineering,DesNicholl.1994
2. MolecularCloning,VolumeI,II,&III,SambrookandRussell(CSHLPress)
3. EugeneW. Nester:Agrobacterium:nature’sgeneticengineer.FrontièresinPlantsciences.2014

4. ZerotoGeneticengineeringHero,Dr.JustinPahara,2021
5. Brown,T.A.(2006).Genomes(3rded.).NewYork:GarlandScience Pub.

Semester II

Course Code: BT 551 MJ **Advanced Genetics** **2 Credits**

Total Lectures: 30

Course outcomes:

After completion of the course,

- Students will understand the role of genetics in various fields of Science, Advancing Medical Research, Genetic Engineering and Biotechnology.
- Students will acquire the knowledge about new opportunities for scientific advancements and improvements in various aspects of life.

Unit	Syllabus	No. of Lectures
I	Mendel's Principles of Inheritance. Time line and experiments, laws.	3
II	Pedigree Analysis - Introduction, Symbols used in Pedigree Charts, Modes of Inheritance, Autosomal Dominant (AD), X-Linked Dominant (XD), Autosomal Recessive (AR), X-Linked Recessive (XR), Y-Linked, Sporadic and Non-Heritable Diseases, Calculating Probabilities Using Pedigree Charts	3
III	The Complementation Test – Introduction, Complementation Tests and Allelism, Complementation Groups = Groups of Allelic Mutations, Example 1: Multiple Mutant Complementation Test, Example 2: Double Hit Strain, Transformation Rescue	4
IV	Alleles at a Single Locus, Introduction, Somatic vs. Germline Mutations, Somatic Mutations, Germline Mutations, Haploid vs. Diploid Organisms, Alleles: Hetero-, Homo-, Hemizygosity, Pleiotropy vs. Polygenic Inheritance, Types of Dominance - Complete Dominance, Incomplete Dominance Co-Dominance, Biochemical Basis of Dominance, Classification of Mutants - Morphological Mutants, Lethal Mutants, Biochemical Mutants, Conditional Mutants Muller's Morphs – Amorph, Hypomorph, Hypermorph, Neomorph, Antimorph, Identifying Muller's Morphs	4
V	Linkage and Recombination Frequency – Introduction, Review of Genetic Nomenclature and Symbols, Gene Names and Symbols, Recombination and Recombination Frequency, Inter- and Intrachromosomal Recombination, Inheriting Parental and Recombinant Gametes, Recombination Frequency, Coupling and Repulsion (cis and trans) Configuration, Unlinked Genes vs. Partial Linkage vs. Complete Linkage, Unlinked Genes, Complete Linkage 3 Partial Linkage, Experimental Determination of Recombination Frequency	4
VI	Sex Chromosomes & Sex Linkage – Introduction, Autosomes and Sex Chromosomes, Pseudo-Autosomal Regions on the X and Y Chromosomes, Sex Linkage: An Exception to Mendel's First Law X-Linked Genes: The White Gene in Drosophila Melanogaster, Y-Linked Genes	4

VII	Mapping of Gene Loci – Introduction, Genetic Mapping, Calculating Map Distance, Map Distance Over Long Chromosomes, Genetic Maps are an Approximation, Two-Point and Three-Point Crosses Coincidence and Interference	4
VIII	Physical Mapping of Chromosomes and Genomes – Introduction, Genetic Maps, Examples of Genes in Humans, Cytogenetic Maps, Physical Maps, Human Genome Project (HGP), Restriction Mapping Procedure	4

Selected Readings:

1. Introduction To Genetics - City College of San Francisco – Libre Texts(2022)
2. The New Genetics - U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES National Institutes of Health National Institute of General Medical Sciences (2023)
3. Vogel and Motulsky's Human Genetics, Problems and approaches, 4th edition, Springer (2010)
4. Open Genetics, Nramroop Singh, Thompson rivers University Kamloops, BC, (2020)
5. Genetics and Molecular Biology, Robert Schleif, 2nd edition, The Johns Hopkins University Press Baltimore and London.

Semester II

Course Code: BT 554 MJP **2 Credits**

No. of Practicals: 15

Practicals in Advanced Biological Chemistry

Sr. No.	List of Practicals	No. of Practicals
1	Isolation of Starch from potatoes	1
2	Qualitative identification of carbohydrates and Osazone test	1
3	Estimation of Glucose by DNSAmethod/GOD-POD/ Nelson Somogyi method.	1
4	Isolation of Cholesterol and Lecithin from egg yolk	1
5	Qualitative identification of Lipids	1
6	Saponification, Acid and Iodine number determination	1
7	Estimation of Cholesterol by Liebermann & Burchard regent/ CHOD-POD method	1
8	Isolation of casein from milk/ albumin from egg	1
9.	Qualitative identification of amino acids	1
10	Estimation of amino acids by Ninhydrin	1
11	Estimation of Protein by Biuret's/Lowry/WarburgChristian/ Bradfords methods	2
12	Isolation of amylase from sprouts	1
13	Enzyme assay amylase/βgalactosidase	2

Semester II

Course Code: BT 555 MJP **2 Credits**

No. of Practicals: 15

Practicals in Genetic Engineering

Sr. No.	List of Practicals	No. of Practicals
1	Plasmid DNA isolation and DNAquantitation	1
2	Plating λBacteriophage, enumerating(pfu), and isolation of its DNA	2
3	Plating M-13Bacteriophage, and isolation of its DNA	1
4	Dephosphorylating the plasmid with Alkaline phosphatase.	1
5	Phosphorylating the Dephosphorylating plasmid with polynucleotide kinase	2
6	Restriction Enzyme digestion of plasmid DNA	2
7	Vector and Insert Ligation	1
8	Preparation of competent cells	1
9	Transformation of *E.coli* with standard plasmids, Calculation of transformation efficiency.	2
10	Selection of recombinants by – α – complementation, insertional inactivation	1
11	Colony PCR	1

Semester II

Course Code: BT 556 MJ **Nanobiotechnology** **2 Credits**

Total Lectures: 30

Course outcomes:

After completion of the course,

- Students will be able to develop a solid understanding of the fundamental principles of nanotechnology.
- Students will be able to analyze and explain the potential synergies between nanotechnology and biotechnology to solve complex challenges in various fields.
- Students will identify and differentiate between different types of nanomaterials used in biotechnological applications.
- Students will know the significant advancements of nanobiotechnology in healthcare and biomedicine.

Unit	Syllabus	No. of Lectures
I	**Introduction to Nanotechnology and Nanobiotechnology:** History of nanotechnology, Types of nanoparticles and their properties: quantum dots, polymeric nanoparticles, lipid nanoparticles, metal nanoparticles, metal oxide nanoparticles, composite nanoparticles, concept of nanobiotechnology, Environmental and health impact of nanomaterials, ecotoxicology. Genotoxicity and cytotoxicity evaluation of nanomaterials.	08
II	**Synthesis and characterization of Nanomaterials:** **Chemical methods** - Chemical precipitation and coprecipitation, Sol-Gel synthesis, Microemulsions synthesis, hydrothermal, solvothermal synthesis methods **Physical methods**: Microwave assisted synthesis, core-shell nanostructure, quantum dot (QDs) synthesis **Biological methods**: Overview and concept of microbial/ plant mediated nanoparticle production; methods of microbial/ plant mediated nanoparticle production. **Characterization of Nanomaterials:** Optical(UV-Vis/Fluorescence), X-raydiffraction, imaging and size determination (Electron microscopy-TEM,SEM)	12
III	**A. Applications of Nanomaterials:** Protein targeting-Small molecule/nanomaterial - protein interactions; nanomaterial-cell interactions-manifestations ofsurface modification (polyvalency). Peptide/DNA coupled nanoparticles; lipid and inorganic nanoparticles for drugdelivery; metal/metal oxide nanoparticles (antibacterial/anti-fungal/anti-viralactivities); an isotropic and magnetic particles (hyperthermia). **B. Applications of Nanobiotechnology:** Nanomedicines, nanoparticles for	10

	diagnostics and imaging, foodscience (food processing, food packaging, detection of pathogens). Nanosensors-nanotechnology for water remediation and purification. Nanotechnology in agriculture. Green nanotechnology. Gene therapy.	

Selected Reading:

1. SulabhaK.Kulkarni,(2009),Nanotechnology;Principals and Practices, NewDelhi, CapitalPublishing company.
2. MichaelA.StroscioandMitraDutta,(2004),BiologicalNanostructuresandApplicationofNanostructures in Biology, Kulwer AcademicPublishers.
3. ElisabethS.Papazoglou,AravindParthasarathy,(2007),Bio-Nanotechnology,Morgan&ClaypoolPublishers'series.
4. Rao N. R. (Editor), Achim Müller (Editor), Anthony K. Cheetham (Editor), (2004), The Chemistry of Nanomaterials: Synthesis, Properties and Applications, 2 Volume Set C, Wiley Publisher.
5. Christof M. Niemeyer (Editor), Chad A. Mirkin (Editor), April 2004, Nanobiotechnology: Concepts, Applications and Perspectives, Wiley Publishers.
6. Mark Ratner and Daniel Ratner, Nanotechnology: A Gentle Introduction to Next Big Idea, Low Price edition, Third Impression, Pearson Education.
7. Schmidt G., Wiley Weinheim , (2004), Nanoparticles: From theory to applications.
8. Geoffrey A. Ozin, Andre C. Arsenault, Ludovico Cademartiri, Chad A. Mirkin (2005), Nanochemistry: A Chemical Approach to Nanomaterials – Royal Society of Chemistry, Cambridge UK .

Semester II

Course Code: BT 556 MJP **2 Credits**

No. of Practicals: 15

Practicals in Nanobiotechnology

Sr. No.	List of Practicals	No. of Practicals
1	**Synthesis of metal/metal oxide Nanoparticles by:** a. Physical b. Chemical c. Microbial d. Plant based method	05
2	**Characterization of nanomaterials by spectroscopic method:** i. Analysis of absorption spectra of thin films of Nanomaterials ii. Determination of absorption coefficient for different wavelength iii. Demonstration on X-ray crystallography using web sources or PowerPoint presentation.	04
3	**Applications of nanoparticles:** i. Antibacterial activities of synthesized nanoparticles (MIC/MBC determination) ii. Antifungal activities of synthesized nanoparticles (MIC/MBC determination) iii. Cytotoxicity testing of nanoparticles using MTT/ Trypanblue assay iv. Cytotoxicity testing of nanoparticles using onion root tip assay	06

Semester II

Course Code: BT 557MJ Stem cells and regenerative technology 2 Credits

Total Lectures: 30

Course outcomes:

After completion of the course,

- The students will acquire the knowledge of Stem cell and regenerative medicine
- The students will apply the knowledge to the emerging field of regenerative medicine.

Unit	Syllabus	No. of Lectures
I	Definition of stem cells and their characteristics Types of stem cells: embryonic, adult/somatic, induced pluripotent stem cells (iPSCs) Historical development and milestones in stem cell research	3
II	The stem cell niche: components and functions Signaling pathways that regulate stem cell behaviour Influence of the microenvironment on stem cell fate	4
III	Derivation and culture of embryonic stem cells, Pluripotency and differentiation potential, Applications and controversies surrounding embryonic stem cells	3
IV	Identification and isolation of adult stem cells from various tissues Characteristics and lineage potential of adult stem cells Clinical applications and challenges of using adult stem cells	4
V	Reprogramming somatic cells into iPSCs Similarities and differences between iPSCs and embryonic stem cells Potential uses and limitations of iPSCs in regenerative medicine.	4
VI	Organ-specific stem cells and their roles in tissue homeostasis Strategies for promoting organ regeneration using stem cells Current research and clinical trials in organ regeneration	4
VII	Neural stem cells and their potential for brain and spinal cord repair Cardiac stem cells and their role in heart repair The use of stem cells in immunomodulation and autoimmune disease treatment, Stem cell-based approaches for cancer immunotherapy	4
VIII	Ethical challenges and controversies in stem cell research Guidelines and regulations governing stem cell use Ethical decision-making in regenerative medicine Cutting-edge research and technologies in stem cell biology Challenges and opportunities in translating stem cell research to the clinic,Speculation on the future of regenerative medicine	4

Selected Readings:

1. R.IanFreshney.CultureofAnimalcells,5rdEdition, 2010.AJohnWiley & Sons,Inc.,Publications, USA
2. R.W.Masters.AnimalCellCulture-PracticalApproach,3rdEdithion,2000,OxfordUniversityPress.USA

3. RobertLanzaetal.EssentialsofStemCellBiology",AcademicPress,2nd edition,2006.USA
4. Text book of Animal Husbandary, 8th edition, (1998) G.C. Banerjee,Oxford and IBHPublishinco.Pvt. Ltd. India
5. Molecular Biotechnology: 4th edition. (2010), Glick B.R., Pasternak J.J., Patten C. L.,ASMpress,USA
6. GeneTransfertoAnimalCells,1stedition(2005),R.M.Twyman,Taylor&FrancisUSA

Semester II

Course Code: BT 557 MJP **2 Credits**

No. of Practicals: 15

Practicals in Stem cells and regenerative technology

Sr. No.	List of Practicals	No. of Practicals
1	Precautions in handing and disposing the Biomedical waste	2
2	Collection of Umbilical cord and Isolation of Hematopoietic stem cells(HSC) by density gradient centrifugation (note: magnetic beads, conjugated antibody against HSC i.e.,CD34+can be used)	2
3	Isolation of Mesenchymal stem cells form Wharton's jelly using tissue culture techniques	2
4	Characterization of stem cells	3
5	Expansion of Stem cells Aliquoting and differentiating into: Adipogenic Osteogenic Chondrogenic Myogenic Neurogenic	3
6	Evaluating the successful differentiation of mesenchymal stem cells(MSCs) by Cell Morphology/ Immunocytochemistry, /RT-PCR (RUNX2 and osteocalcingene primers for osteogenic) /Flow Cytometry.	3

Semester II

Course Code: BT 558 MJ **Tissue Engineering** **2 Credits**

Total Lectures: 30

Course outcomes:

After completion of the course,

- The student will understand the future potential of Tissue engineering and its utility in medicine
- The student will be able to understand the importance of biotechnology in tissue engineering

Unit	Syllabus	No. of Lectures
I	Introduction, History, Alexis Carrel, Artificial skin substitutes as first tissue engineered product.	2
II	Cells,Stemcells,Biomaterials:BiodegradablePolymers,Collagen,Gel atin, Hyaluronic acid, Chitosan, Alginate, PEG, Fibrin, Silk, Decellularized extracellular matrix, PuramatrixR	6
III	Scaffolds as templates or moulds & Extracellular Matrices as scaffold coating, hydrogels, biologicaldressings	4
IV	Cellmechanics: deformation, adhesion, migration differentiation, cell signaling. Tissue mechanics: elasticity, viscoelasticity, tissue strength andstiffness. Methods of studying Cell &Tissue mechanics: AFM, Mechanical testing, Rheology, computational modelling.	6
V	Applications: Organ on a chip, Microfluidics, clinical application: Skin tissue, cartilage and bone regeneration, cardiovascular, liver, and neural pancreatic islets, tissue engineering, corneal, trachea and airway tissue engineering, bladder and urethra reconstruction.	4
VI	Ethical (a) and Regulatory (b) Considerations: (a) Informed consent and autonomy, Animal research and Testing, Equity and Access, Human enhancement vs therapy, Safety and risk-benefit analysis, Patent & Access to knowledge, unforeseen consequences, multidisciplinary collaboration, long-term follow-up and monitoring, Environmental Impact. (b)Safety & Efficacy, GMP, Donor Tissue and cell sourcing, Regulatory Harmonization, Health Economics & Reimbursement, Post-marketing Surveillance.	8

Selected Readings:

1. PrinciplesofTissueEngineering–editedbyRobertLanza,RobertLanger, JosephVacanti(1997)
2. TissueEngineering-editedbyJohnP.Fisher(2003)
3. TissueEngineeringandRegenerativemedicine–editedbyPuchVanPham(2019)
4. TissueEngineeringPrinciple,Protocols,andPractical –editedbyNarineSarvazyan(2020)

Semester II

Course Code: BT 558 MJP **2 Credits**

No. of Practicals: 15

Practicals in Tissue Engineering

Sr. No.	List of Practicals	No. of Practicals
1	Precaution in handling and disposing the tissue engineering material	2
2	Puramatrix® based tissue engineering of cartilage 1. Scaffold preparation. 2. Cell isolation and expansion 3. Cell seeding on scaffold 4. Cell culturing 5. Media exchange and monitoring 6. Viability assessment 7. Histological analysis 8. Analysis and discussion.	13

Semester II

Course Code: BT 559 MJ **Herbal Medicine** **2 Credits**

Total Lectures: 30

Course outcomes:

After completion of the course,

- Student will acquire the knowledge of potential of herbal medicines

Unit	Syllabus	No. of Lectures
I	Introduction, History right from 1800s when Friedrich Willhelm Serturner isolated morphine from opium poppy till today, & Development of Herbal medicine, Plant secondary metabolites: Key drivers of pharmacological action in herbal medicine. These are optional for growth but give advantage to Plants.	6
II	Primary and Secondary metabolites. Classification of secondary metabolites, their synthesis.	6
III	Extraction of Secondary metabolites and their Qualitative and Quantitative determination. Technologies for analyzing plant secondary metabolites. In-vitro and in-vivo experiments to evaluate the efficacy of secondary metabolites.	7
IV	Alkaloid drugs, Anthracene derivatives, Bitters, Cardiac glycoside drugs, Coumarins, essential oil & Ole- Gum-resins, Flavonoids, Arbutin, Salicin and Salicoyl Derivatives, Saponins, Cannabinoids and Kavapyrones, Lignans, Pigments, 1,4 – Naphthoquinone, Terpenes, sesquiterpenes & triterpenes.	8
V	Guidelines, regulation under drug and cosmeticAct(CandD)of1945. “ScheduleT”andDepartmentofAYUSHasregulatory authority formanufacturing and marketing herbal drugs.	3

Selected Readings:

1. PlantDruganalysis–H.WagnerandS.Baltd,Springer(1996)
2. PlantSecondarymetabolites,HarinderP.S.Makkaret.al.MethodsinMolecularBiology – 393.
3. Plant Secondary metabolites – Physiochemical Properties and therapeuticapplications,AnilKumarSharma&AjaySharma,HumanaPress

Semester II

Course Code: BT 559 MJP **2 Credits**

No. of Practicals: 15

Practicals in Herbal Medicine

Sr. No.	List of Practicals	No. of Practicals
1	Qualitative determination of Plant Secondary metabolites	1
2	Isolation of Alkaloids from various plants by differential Solubility methods	1
3	Extraction of Flavonoids,Anthocyanins(pigments)from the given plant specimen	1
4	Extraction of Essential oil from Geranium/Artemisia/lavender/Eucalyptus by using Clevenger apparatus	1
5	Separation of mixture of alkaloids/ Flavonoids/proanthocyanins/SaponinsbyTLC/ HPTLC	3
6	Circular TLC for plant secondary metabolite purification	1
7	Estimation of Polyphenols byFolin–Lowry's methods, Flavonoids by $AlCl_3$ using Colorimeter	1
8	Protein denaturation in-vitro assay for inflammation	1
9	Membrane Stability in-vitro assay for inflammation	1
10	Antioxidant assay using DPPH/TPTZ/ Lipid Peroxidation	2
11	Antibacterial and Antifungal activity of Plant secondary metabolites by well Diffusion/Disk Diffusion (KirbyBauer)	2

Semester II

Course Code: BT 560 MJ **4 Credits**

Industrial 'On Job training'

Biotechnology and On-the-Job Training (OJT) go hand in hand, as OJT provides valuable practical experience and exposure to real-world applications in the field of biotechnology. OJT plays a crucial role in preparing biotechnology students for a successful career by bridging the gap between theoretical knowledge and practical skills. It allows students to apply the biotechnological techniques they have learned in the classroom to real-world situations, such as conducting experiments in laboratories, using specialized equipment, and analysing data. Students will get hands-on experience in biotech industry (research laboratories, bioprocessing facilities, pharmaceutical companies, agriculture-based biotech industries, or healthcare institutions).

During OJT studentsinteraction with experienced scientists, researchers, and professionals as well as mentors and supervisorswill provide guidance, their expertise, and insights into industry best practices, it will enhance the students learning experience.During OJT exposure students will understand the importance of compliance and maintaining high-quality standards in biotechnological processes.This exposure not only gives them an opportunity to contribute to real-world research and gain insights into the advancements taking place in the biotech field but also to built-up network with industry professionals, potentially leading to future job opportunities or collaborations.

OJT in biotechnology is a valuable component of the educational journey for biotechnology students. It complements theoretical knowledge with hands-on experience, enabling them to become competent and skilled biotechnology professionals ready to make meaningful contributions to the industry.

Guidelines for On Job Training in Biotechnology-based Industry for M.Sc. Biotechnology Students and Its Evaluation:

1. **OJT Program Structure:**
   i) The duration of the OJT must not be less than 2/4 weeks or as per university directions.
   ii) Students must be allowed to choose any bio-base industry, research/academic institute or any other facility covering different aspects of the bio-based industry, such as research, research and development, production, quality control, and regulatory compliances.
2. **How to grab OJT opportunity?**
   i) PG departments must offer access to relevant literature, scientific databases, and research tools to enhance the learning experience by organizing workshops, seminars, and talks by industry experts and alumni of the department to broaden students' knowledge.
   ii) Students with specific objectives and with the help of teachers and alumni need to identify reputable Biotechnology-based industries offering OJT opportunity and must ensure the availability.
3. **Assigning Mentors and Supervisors:**PG departmentsneed to appoint experienced professionals as mentors/supervisors for the students during the OJT period.He/She should provide guidance, monitor progress, and facilitate learning experiences.
4. **Regular Progress Review and Record Keeping:**Mentor/Mentor's should conduct periodic evaluations to track the students' progress during the OJT and should maintain a detailed record of the tasks performed, skills learned, and achievements during the OJT.

OJT Evaluation: Evaluation of the OJT program is crucial to assess its effectiveness and students' learning outcomes. The evaluation of OJT must be divided into two parts:

i) **Internal evaluation-50% weightage by mentor and supervisor based on**
   a) Attendance
   b) Respect incoming and outgoing time
   c) Follow superior’s instructions
   d) Record keeping
   e) Respect for work assigned and interaction with other fellow members

ii) **External evaluation-50% weightage based on**
   a) Final report submission to the department
   b) Power point presentation based on final report
   c) Project evaluation-quality and out comes
   d) Presentation and communication skills
   e) Knowledge assessment-depth of knowledge and question and answer