

**KAVAYITRI BAHINABAI CHAUDHARI
NORTH MAHARASHTRA UNIVERSITY,
JALGAON**



SYLLABUS FOR

Master of Science

In

BIOTECHNOLOGY

*Choice Based Credit System
(Outcome Based Curriculum)*

PART- I & II
(Semester I, II, III, IV)

w.e.f. 2019-2020

**Summary of Distribution of Credits under CBCS Scheme
for
M.Sc. Biotechnology
at
School of Life Sciences
[at University Campus under Academic Flexibility w.e.f. 2019-20]**

Sr. No	Type of course	Sem I	Sem II	Sem III	Sem IV
01	Core	16	16	16	12
02	Skill based	04	04	-	-
03	School Elective	-	-	04	04
04	Project	-	-	-	04
05	Audit	02	02	02	02
06	Total Credits	22	22	22	22

Subject Type	Core	Skill based	School Elective	Project	Audit	Total
Credits	60	08	08	04	08	88

Total Credits = 88

Department of Biotechnology, School of Life Sciences
Kavayitri Bahinabai Chaudhari North Maharashtra University Jalgaon
M. Sc. Biotechnology

Choice Based Credit System with effect from 2019 -2020

Course credit scheme

Semester	(A) Core Courses			(B) Skill Based / Elective Course			(C) Audit Course (No weightage in CGPA)			Total Credits (A+B+C)
	No. of Courses	Credits (T+P)	Total Credits	No. of Courses	Credits (T+P)	Total Credits	No. of Courses	Credits (Pract.)	Total Credits	
I	4	12 + 4	16	1	0 + 4	4	1	2	2	22
II	4	12 + 4	16	1	0 + 4	4	1	2	2	22
III	4	8 + 8	16	1	4 + 0	4	1	2	2	22
IV	4	8 + 8	16	1	4 + 0	4	1	2	2	22
Total Credits	64			16			8			88

(T, Theory; P, Practical)

Structure of Curriculum

		First Year				Second Year				Total Credit Value
		Semester I		Semester II		Semester III		Semester IV		
		Credit	Course	Credit	Course	Credit	Course	Credit	Course	
Prerequisite and Core Courses										
(A)	Theory	4	3	4	3	4	2	4	2	40
	Practical	4	1	4	1	4	2	4	2	24
(B)	Skill Based/ Subject Elective Courses									
1	Theory /Practical	4	1	4	1	4	1	4	1	16
(C)	Audit Course (No weightage in CGPA calculations)									
1	Practicing Cleanliness	2	1							2
2	Personality and Cultural Development Related Course			2	1					2
3	Technology Related + Value Added Course					2	1			2
4	Professional and Social + Value Added Course							2	1	2
Total Credit Value		14	6	14	6	14	6	14	6	88

List of Audit Courses (Select any ONE course of Choice from Semester II; Semester III and Semester IV)

Semester I (Compulsory)		Semester II (Choose One)		Semester III (Choose One)		Semester IV(Choose One)	
		Personality and Cultural Development		Technology + Value Added Course		Professional and Social + Value Added Course	
Course Code	Course Title	Course Code	Course Title	Course Code	Course Title	Course Code	Course Title
AC-101	Practicing Cleanliness	AC-201A	Soft Skills	AC-301A	Computer Skills	AC-401A	Human Rights
		AC-201B	Sport Activities	AC-301B	Cyber Security	AC-401B	Current Affairs
		AC-201C	Yoga	AC-301C	Seminar / Review Writing	AC-401C	Seminar / Review Writing
		AC-201D	Music	AC-301D	Biostatistics	AC-401D	Intellectual Property Rights (IPR)

Semester-wise Course Structure of M.Sc. Biotechnology

Semester I

Course	Course Type	Course Title	Teaching Hours/ Week			Marks (Total 100)				Credits
			T	P	Total	Internal		External		
						T	P	T	P	
BT-101	Core	Microbial Diversity and Physiology	4	--	4	40	--	60	--	4
BT-102	Core	Biomolecules and Molecular Enzymology	4	--	4	40	--	60	--	4
BT-103	Core	Immunology	4	-	4	40	--	60	--	4
BT-104	Core	Laboratory course-I	--	4+4	8	--	40	--	60	4
BT-105	Skill Based	Laboratory Course –II	--	4+4	8	--	40	--	60	4
AC-101	Audit Course	Practicing Cleanliness		2	2	--	100	--	--	2
Total Credit for Semester I: 22 (T = Theory: 12; P = Practical:4; Skill Based:4; Audit Course:2)										

Semester II

Course	Course Type	Course Title	Teaching Hours/ Week			Marks (Total 100)				Credits
			T	P	Total	Internal		External		
						T	P	T	P	
BT-201	Core	Molecular Biology	4	--	4	40	--	60	--	4
BT-202	Core	Bioinstrumentation and Biostatistics	4	--	4	40	--	60	--	4
BT-203	Core	Bioprocess Engineering and Technology	4	--	4	40	--	60	--	4
BT-204	Core	Laboratory Course –III	--	4+4	8	--	40	--	60	4
BT-205	Skill Based	Laboratory Course –IV	--	4+4	8	--	40	--	60	4
AC-201(A/B/C/D)	Audit Course	Choose one out of Four (AC-201A/ AC-201B/AC-201C/AC-201D) from Personality and Cultural Development	--	2	2	--	100	--	--	2
Total Credit for Semester II: 22 (T = Theory: 12; P = Practical:4; Skill Based:4; Audit course:2)										

Semester III

Course	Course Type	Course Title	Teaching Hours/ Week			Marks (Total 100)				Credits
			T	P	Total	Internal		External		
						T	P	T	P	
BT-301	Core	Genetic Engineering	4	--	4	40	--	60	--	4
BT-302	Core	Plant Biotechnology	4	--	4	40	--	60	--	4
BT-304	Core	Laboratory Course –V	--	4+4	8	--	40	--	60	4
BT-305	Core	Laboratory Course –VI	--	4+4	8	--	40	--	60	4
BT-303	Elective	Advanced Environmental Biotechnology	4	--	4	40	--	60	--	4
BC-303	(Select	Toxicology								
MB-303	any one)	Applied and Environmental Microbiology								
AC-301/A/B/C/D	Audit Course	Choose one out of Four (AC-301A/ AC-301B/ AC-301C/ AC-301D) from Technology + Value Added Courses	--	2	2	--	100	--	--	2
Total Credit for Semester III: 22 (T = Theory: 8; P = Practical:8; Elective:4; Audit Course:2)										

Semester IV

Course	Course Type	Course Title	Teaching Hours/ Week			Marks (Total 100)				Credits
			T	P	Total	Internal		External		
						T	P	T	P	
BT-401	Core	Industrial and Business Biotechnology	4	--	4	40	--	60	--	4
BT-402	Core	Bioinformatics	4	--	4	40	--	60	--	4
BT-404	Core	Laboratory Course –VII	--	4+4	8	--	40	--	60	4
BT-405	Core	Laboratory Course VIII (Project/ Dissertation)	--	4+4	8	--	40	--	60	4
BT-403	Elective	Pharmaceutical Biotechnology	4	--	4	40	--	60	--	4
BC-403	(Select	Industrial Biotech.& Food Biochem.								
MB-403	any one)	Agricultural Microbiology								
AC-401A/B/C/D	Audit Course	Choose one out of Four (AC-401A/ AC-401B/AC-401C/AC-401D) from Professional and Social + Value Added Courses	--	2	2	--	100	--	--	2
Total Credit for Semester IV: 22 (T = Theory: 8; P = Practical+ Project :8; Elective::4; Audit Course:2)										

Program at a Glance

Name of the program (Degree)	: M. Sc. (Biotechnology)
Faculty	: Science and Technology
Duration of the Program	: Two years (four semesters)
Medium of Instruction and Examination	: English
Exam Pattern and 40 marks continuous internal departmental exam/assessment)	: 60 : 40 (60 marks University exam and 40 marks continuous internal departmental exam/assessment)
Passing standards (separate head of passing)	:40% in each exam separately
Evaluation mode	: CGPA
Total Credits of the program of project/dissertation, 08 skill enhancement credits, 08 subject elective credits and 08 audit credits)	: 88 (64 core credits including 4 credits of project/dissertation, 08 skill enhancement credits, 08 subject elective credits and 08 audit credits)

Program Objectives for M.Sc. Program:

Programme Objectives of M.Sc. Biotechnology is to produce competent Biotechnologist. After completion, the students are expected to understand the:

- Basic and applied aspects of molecular biology and plant biotechnology, Biomolecules and Enzymology and applications of basic aspects of microbial diversity.
- Principles, working and application of bioinstruments used in isolation and identification of microbes and structural determination of biomolecules,
- characteristics and significance of algae, fungi, viruses,
- Impact of various groups of microbes on earth atmosphere, human, plant and animal health and technology development,
- structure, properties, pathways, significance and applications of microbial biomolecules,
- basic and applied aspects of Genetic makeup of bacteria, algae, fungi and viruses,
- causes, mechanisms and consequences of defect in gene/genome of microorganisms, and (i) basic concepts of microbial enzymes, enzyme kinetics, regulation of enzyme activity, industrial applications of enzymes, enzyme function in non-aqueous environment.

Program Outcomes (PO) for M.Sc. Program:

Upon successful completion of the M.Sc. program, student will be able to:

PO No.	PO	Cognitive level
PO1	to understand the Basic and applied aspects of molecular biology and plant biotechnology, Biomolecules and Enzymology	2
PO2	Administer the skills in handling scientific instruments, planning and performing in laboratory experiments	3
PO3	Analyse the Impact of various groups of microbes on earth atmosphere, human, plant and animal health and technology development	4
PO4	Develop various skills such as communication, managerial, leadership, entrepreneurship, teamwork, social, research etc., which will help in expressing ideas and views clearly and effectively	3
PO5	Model and formulate the real problems and find solution based-on knowledge acquired	6
PO6	To evaluate how developments in any science subject helps in the development of other science subjects and vice-versa and how interdisciplinary approach helps in providing better solutions and new ideas for the sustainable developments.	5

Program Specific Objectives for M.Sc. Biotechnology program:

- to train the students to apply knowledge of molecular mechanisms of cellular processes in living systems including microbes, plants, and higher order organisms to functional aspects.
- The laboratory training in addition to theory is included to prepare them for careers in the industry, agriculture, and applied research where biological system is increasingly employed.
- Basics and current updates in the areas of Industrial Biotechnology, Process Biotechnology, Agriculture, Environmental & plant Biotechnology are included to equip the students and also sensitize them to scope for research.
- The Masters in Biotechnology Programme will address the increasing need for skilled scientific manpower with an understanding of research ethics involving animals and humans to contribute to application, advancement, and impartment of knowledge in the field of biotechnology globally.

Program Specific Outcomes (PSOs) for M.Sc. Biotechnology program

Students who graduate with a Master of Science in Biotechnology will:

PSO No.	PSO	Cognitive level
PSO1	Demonstrate an understanding of structure and metabolism of macromolecules, understand the regulation of metabolic pathways and understand the role of microbes in industry, health and environment.	2
PSO2	Gain proficiency in laboratory techniques in both microbiology and molecular biology and be able to apply the scientific methods to the processes of experimentation and hypothesis testing.	3
PSO3	Acquire significant knowledge on various aspects related to microbiology including biochemical techniques, immunology, physiology, agriculture, environment, pharmaceutical, molecular biology, applied recombinant DNA technology and technical skills related to microbial metabolites.	4
PSO4	Learn to work as a team as well as independently to retrieve information, carry out Research investigations and result interpretations.	6
PSO5	Develop the ability to understand and practice the ethics surrounding scientific Research.	5
PSO6	Realize the impact of science in society and plan to pursue research.	5

Distribution of Course papers for M. Sc. Part I BIOTECHNOLOGY

Subject Code	Title of the Paper		Duration (Hrs./Wk)	Max. Mark	Exam. Time (Hrs.)
M.Sc. Part I BIOTECHNOLOGY					
Semester I : Theory Courses					
BT-101	Microbial Diversity and Physiology	Core course	04	100	03
BT -102	Biomolecules and Molecular Enzymology	Core course	04	100	03
BT -103	Immunology	Core course	04	100	03
Semester I : Practical Courses					
BT -104	Laboratory Course-I	Core course	04+04	100	06
BT -105	Laboratory Course-II	Skill based	04+04	100	06
AC-101	Practicing Cleanliness	Audit Course	02	100	
Semester II : Theory Courses					
BT -201	Molecular Biology	Core course	04	100	03
BT-202	Bioinstrumentation and Biostatistics	Core course	04	100	03
BT -203	Bioprocess Engineering and Technology	Core course	04	100	03
Semester II : Practical Courses					
BT-204	Laboratory Course-III	Core course	04+04	100	06
BT-205	Laboratory Course-IV	Skill based	04+04	100	06
AC-201A/B/C/D	Choose one out of Four (AC-201A/ AC-201B/ AC-201C/ AC-201D) from Personality and Cultural Development (Audit Course)	Audit Course	02	100	

MSc. Part II

Subject Code	Title of the Paper		Duration (Hrs./Wk)	Max. Mark	Exam. Time (Hrs.)
M.Sc. Part I BIOTECHNOLOGY					
Semester I : Theory Courses					
BT-301	Genetic Engineering	Core course	04	100	03
BT -302	Plant Biotechnology	Core course	04	100	03
BT -303 or BC -303 or MB -303	Advanced Environmental Biotechnology or Toxicology or Applied and Environmental Microbiology	Choose one out of Three Elective	04	100	03
Semester I : Practical Courses					
BT -304	Laboratory Course-V	Core course	04+04	100	06
BT -305	Laboratory Course-VI	Skill based	04+04	100	06
AC-301 A/B/C/D	Choose one out of Four (AC-301A/ AC-301B/ AC-301C/ AC-301D) from Technology + Value Added Courses	Audit Course	02	100	
Semester II : Theory Courses					
BT -401	Industrial and Business Biotechnology	Core course	04	100	03
BT-402	Bioinformatics	Core course	04	100	03
BT -403 BC-403 MB-403	Pharmaceutical Biotechnology Industrial Biotechnology and Food Biochemistry Agricultural Microbiology	Elective Choose any one	04	100	03
Semester II : Practical Courses					
BT-404	Laboratory Course-VII	Core course	04+04	100	06
BT-405	Laboratory Course-VIII	Skill based	04+04	100	06
AC-401 A/B/C/D	Choose one out of Four (AC-401A/ AC-401B/AC-401C/AC-401D) from Professional and Social + Value Added Courses	Audit Course	02	100	

BT-101 - MICROBIAL DIVERSITY AND PHYSIOLOGY

100 Marks [50 Hrs]

Course Objectives:

1. To understand the ubiquitous nature of microbes to build basic concept
2. To give basic knowledge on Prokaryotic and Eukaryotic
3. To provide knowledge on characteristics of various microbes

UNIT I

Classification of microorganism: the five-kingdom concept of classification, Bacteria: Purple and green bacteria; Cyanobacteria; Acetic acid bacteria; Spirilla; Spirochaetes; Pseudomonads; Lactic and propionic acid bacteria; Mycobacteria; Rickettsias. Archaea: Chlamydias and Mycoplasmas, Archaea as earliest Life forms; Halophiles; Methanogens; Hyperthermophilic archaea; Thermoplasma. Eukarya: Algae, Fungi, Slime molds and Protozoa. Viruses: Bacterial, Plant, Animal and Tumor viruses; Discovery, classification and structure of viruses.

UNIT II

Prokaryotic and Eukaryotic cell structures; pure culture techniques- isolation, cultivation, enumeration and preservation of microbes; staining techniques- simple and differential staining. Nutritional requirements and nutritional grouping of microorganisms; Different media (simple, complex and defined)- Growth curve; Axenic culture, Synchronous culture, Continuous culture; Effects of physical and chemical factors on microbial growth.

UNIT III

Microbes in natural habitats - air, water & soil. Industrial application of microbes-Wine, Beer, Cheese, Yogurt. Primary and secondary metabolites and their applications; preservation of food; biogas; bio-fertilizers and bio-pesticides; leaching of ores by microorganisms; microorganisms and pollution control-bioremediation. Microbial ecology: Biogeochemical cycling, Microbes in marine & freshwater environments, Microbes in terrestrial environment, Microbial interactions.

UNIT - IV

Mechanisms involved in transport of nutrients in microbes, Unique pathways of microbial metabolism: ED, PK pathways; Respiration; Fermentations; Amphibolic pathways; Anaplerotic reactions. Bacterial cell wall biosynthesis, Photoautotrophy, Chemolithotrophy, Methylophony, Metabolic diversity among micro-organisms: Photosynthesis in microorganisms; Methanogenesis and acetogenesis; Nitrogen fixation; Hydrocarbon transformation

UNIT V

Phylogenetic relationships between various genera of microbes, Evolutionary chronometers, New approaches to bacterial taxonomy classification including ribotyping: ribosomal RNA sequencing, FISH assay, micrometry, capillary electrophoresis. Methods to assess microbial diversity, Merits and demerits of culture dependent and culture independent methods. Molecular analysis of bacterial community: Denaturing Gradient Gel Electrophoresis (DGGE), Metagenomics.

Recommended Books:

1. Microbiology, L.M. Prescott, J.P. Harley and D.A. Klein, 6/e, 2005. McGraw Hill, Boston.
2. Fundamental Principles of Bacteriology, A.J. Salle, 1999. Tata McGraw - Hill Publishing Company Limited, New Delhi.
3. Medical Microbiology, D. Greenwood, R. Slack and J. Peutherer, 1997. ELST with Churchill Livingstone, Hong Kong.
4. Microbial Ecology. Fundamentals and Applications, R. M. Atlas and R. Bartha, 2000.
5. Microbiology, M.J. Pelzer Jr., E.C.S. Chan and N.R. Kreig, 1993. McGraw Hill Inc., New York.
6. Microbial Functional Genomics, J.Zhou, D.K. Thomson. Y.Xu. J.M. Tiedje. J.Wiley, 2004.

Course Outcomes (COs):		
On completion of this course, the student will be able to:		
CO No.	CO	Cognitive level
C101.1	Differentiate various groups of microbes and microbial taxonomy	2
C101.2	Acquire knowledge on adaptability of extremophiles and microbial diversity	3
C101.3	Acquaint with the scope of microbiology in different diversified areas.	4

BT-102: BIOMOLECULES AND MOLECULAR ENZYMOLOGY

100 Marks [50 Hrs]

Course Objectives:

1. To know the structural organization, characteristics and metabolism of biomolecules
2. To learn microbial metabolic pathways and its enzymatic regulation
3. To acquire knowledge on transport of solute and energy metabolism and to understand basic aspects of microbial enzyme

UNIT-I

Carbohydrates: Classification, structure, function and properties of sugars, storage polysaccharides and cell walls, Glycolysis, gluconeogenesis, HMP shunt and glycogen metabolism. Synthesis of cellulose and starch, Oxidative phosphorylation, Regulation of carbohydrate metabolism.

Lipids: Classification, nomenclature and structure of fatty acids, triacylglycerols, sphingolipids and phospholipids, waxes, glycolipids and sterols. Beta-oxidation of fatty acids, biosynthesis of fatty acids and triacylglycerols, Lipid proteins system, Regulation of lipid metabolism.

UNIT II

DNA: General structure and functions of purines, pyrimidines, nucleosides, nucleotides; hydrolysis of nucleic acids. Strategies of coiling and supercoiling, concept of linking number, twisting number and writhing number, Forms of DNA, The law of DNA constancy and C-value paradox.

Proteins: Classification, Primary, secondary, tertiary and quaternary structure of proteins, Sequencing, stabilizing bonds, Ramchandran Plot. Optical and chemical properties of peptides and small proteins. Hydrolysis of proteins.

UNIT III

Classification and nomenclature of enzymes, Isolation, purification and large-scale production of enzymes, Mechanism of enzyme action: concept of active site and energetic of enzyme substrate complex formation.

Coenzymes and Cofactors: Structure and function of coenzyme - reactions involving TPP, pyrodoxal phosphate, nicotinamide, flavin nucleotide, coenzyme A and biotin.

UNIT IV

Enzyme kinetics: Units of enzyme activity, Specific activity of enzyme and Methods of enzyme assay, Enzyme specificity. Unisubstrate enzyme kinetics; Kinetics of multisubstrate reactions, Significance of V_{max} and K_m . Steady state enzyme kinetics: Effect of substrate concentration on initial velocity, Henry, Michaels Menton hypothesis, L B plot, Briggs Haldane Hypothesis, Hill and Satchard plots.

UNIT-V

Allosteric enzymes; Sigmoidal kinetics and their physiological significance; Symmetric and sequential modes for action of allosteric enzymes and their significance, Multienzyme system. Enzyme inhibition: type of inhibition; Competitive, non competitive and uncompetitive kinetics, Feedback inhibition and feed forward stimulation; Enzyme repression, induction and degradation. The preparation of immobilised enzymes –rationale, choice of matrix, methods of immobilization kinetics and their uses, Whole cell immobilization, Immobilized enzymes and their industrial application, Enzyme engineering and its applications.

Recommended Books:

1. Lehninger's Principles of Biochemistry by Nelson DL and Cox MM, CBS Publications, 2000

2. Biochemistry by Stryer L. (4th Edition). W.H. Freeman & Co., New York, USA, 1992.
3. Fundamentals of Enzymology (3rd edition) by Price NC and Stevens L. Oxford University Press, NY, USA, 2000.
4. Harper's Biochemistry. Ed. Murray RK, Granner DK, Mayes PA and Rodwell VW. Appleton and Lange, Stamford, Connecticut.
5. Fundamentals of Biochemistry. Ed Voet & Voet JG. John Wiley & Sons, Inc., 1999
6. Molecular Biomethods Handbook, R.Rapley & J.M. Walker, 1998. Humana press.
7. Biochemistry 4th edition, G. Zubay, 1998. Mc Millan Publishing Co. New York.
8. Fundamentals of Enzymology : Nicholes C. Price and Lewis Stevens, Oxford Univ. Press.
9. Enzyme Structure and mechanism : Alan Fersht, Reading, USA.
10. Understanding Enzymes : Trevor Palmer

Course Outcomes (COs):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C102.1	Acquire knowledge on metabolism of biomolecules	3
C102.2	to apply the knowledge to explore applications of various enzymes	3
C102.3	Familiarise with amino acids, proteins, lipids, nucleic acids and enzymes	4

BT-103: IMMUNOLOGY

100 Marks [50 Hrs]

Course Objectives:

1. To understand various components of host immune system, its structure and function
2. To acquaint with operational mechanisms of the host defence system, allergy, GVR

UNIT I

Innate immune mechanisms and adaptive immune responses, Organs of immune system: Primary Lymphoid Organs, Secondary Lymphoid Organs, Cell of immune system: Hematopoiesis, Mononuclear cells and granulocyte, Antigen presenting cells lymphocytes and their subsets. Antigens, Super antigen, Heptanes, Factor affecting immunogenicity, Immunoglobulins: molecular structures, types and function, Antigenic determinants on immunoglobulins, Antigen-Antibody interactions

UNIT II

Major Histocompatibility systems: Structure of MHC I and II molecules, Gene Organization of MHC complex in mouse and humans. Recognition of antigens by T and B cells: Antigen processing, Role of MHC molecules in Antigen presentation and co stimulatory signals. T-Cell receptor complex, T-Cell accessory membrane molecules, activation of T -cells, B-cell receptor complex, activation of B-cells.

UNIT III

Complement System, components, Activation pathway and regulation of activation pathway, complement deficiency, Inflammation: its mediators and the process, cell-adhesion molecules and their role in inflammation, lymphocyte homing. Cytokines: Structure and functions, cytokine receptors, therapeutic applications of cytokines.

UNIT IV

Hypersensitivity: definition, IgE mediated hypersensitivity, mechanism of mast cell degranulation, mediators of type I reactions and consequences. Type II reactions, immune complex mediated hypersensitivity and delayed type hypersensitivity. Immunodeficiency Syndrome: Primary Immunodeficiencies and Secondary Immunodeficiencies and their diagnosis and therapeutic approaches. Autoimmunity: Organ specific diseases, systemic disease, mechanism of autoimmunity.

UNIT V

Immunodiagnosics: Precipitation techniques, Agglutination, Fluorescence Techniques, ELISA, RIA, Western Blotting, immunoelectrophoresis, Fluorescent activated cell sorter, immunoelectrofocusing, Monoclonal antibodies: production, characterization and application in diagnosis and therapy.

Recommended Books:

1. Immunology, Richard A. Goldsby, Thomas J. Kindt. Barbara, A. Osborne, Janis Kuby 5th Edition, 2003. W. H. Freeman & Company.
2. Immunology- A short Course, Eli Benamini, Richard Coico, Geoffrey Sunshine.
3. Immunology by Tizzard
4. Fundamentals of Immunology, William Paul.
5. Immunology, L.M. Roitt, J. Brestoff and D.K. Male
6. Immunology by Abbas.
7. Clinical parasitology a practical approach by Zubey
8. Immunological techniques, D.M. Weir, 1992.
9. Current Protocols in Immunology 3 Volumes, Wiley Publications 1994.
10. Monoclonal Antibodies: Principles and Practice, J. W. Goding, 1983. Academic Press
11. Hybridoma Technology in the Biosciences and medicine, T.A. Springer, 1985. Plenum Press NY.
12. Vaccines, New Approaches to immunization, F.Brown, R.M.Chanock, KA Lerner, 1986. Cold spring Harborolab.
13. Topley and Wilson principles of bacteriology, Virology and immunology, G. Wilson, A.Miles, M.T.Paker, 1984. Arnold, Heineman.
14. Basic Immunology by Arun Ingale, NCBA Publication

Course Outcomes (COs):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C103.1	understand fundamental basis of immune system and immune response	2
C103.2	apply host defence, allergy, organ transplant and immunological diseases	3
C103.3	use various immunochemical techniques for diagnosis of diseases.	2

BT-104 Laboratory Course - I

Marks 100

Course Objectives:

1. To familiarize the student in biochemical techniques and learn basic microbial biochemistry
3. To familiarize in General Microbiology techniques
1. Isolation and maintenance of microorganism by plating, streaking and serial dilution method/ slants and sub culture for storage of microorganism.
2. Measurement of growth by colony forming unit and turbidometry.
3. Bacterial growth - Growth curve, factors affecting bacterial growth - pH, Temperature and Salinity/Biochemical tests for identification of bacteria.
4. Isolation of UV-mutant, isolation of antibiotic resistant strains and tryptophan mutant
5. Antimicrobial assay, phenol coefficient, agar plate sensitive method.
6. Analysis of water for potability and determination of MPN
7. Determination of viable count /Correlation of viable counting and optical density of cultures
8. Quantitative assay of protein by Lowry/ Biuret/ Bradford method.

9. Quantitative assay of sugar by DNSA/ Benedict reagent.
10. Determination of Acid Value of fats
11. Quantitative estimation of amino acids.
12. Estimation of DNA by DPA method
13. Estimation of RNA by Orcinol method

Recommended Books:

1. Practical Biochemistry: Principles and techniques (5th Edition) by K. Wilson and J. Walker. Cambridge University Press, Cambridge, 2000.
2. An Introduction to Practical Biochemistry by Plummer D. (3rd Edition) Tata MacGraw Hill Publisher, 2005.
3. Laboratory Manual in Biochemistry by Jayaraman J. New Age International (P) Ltd., Publishers, New Delhi, 1999.
4. Methods in Agricultural Biochemistry (2nd edition) by Sadashivam S and Manikam A. New Age International (P) Ltd, Publishers, New Delhi and Tamil Nadu Agricultural University, Coimbatore, 1996.
5. Microbiology – a Laboratory Manual (4th Edition) by Cappuccino JG and Sherman N. Addison Wesley, 1999.
6. Experiments in Microbiology, Plant Pathology, Tissue Culture and Mushroom Cultivation (2nd Edition) by Aneja KR. Wishwa Prakashan, New Age International Pvt Ltd., 1996.
7. Lab Exercise in Microbiology (3rd edition) by Harley JP and Prescott Lm. WCB/Mac Graw Hill, USA, 1996.
8. Laboratory techniques in Biochemistry and Molecular Biology, Work and Work.
9. A Biologists guide to Principles and Techniques of Practical Biochemistry by Wilson and Goulding
10. A Laboratory Manual in General Microbiology by Benson HJ. WCB Wm C, Brown Publishers.
11. Experiments in Microbiology, Plant Pathology, Tissue Culture and Mushroom Cultivation (2nd Edition) by Aneja KR. Wishwa Prakashan, New Age International Pvt Ltd., 1996.

Course Outcomes (COs):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C104.1	Acquire expertise in basic biochemical techniques	3
C104.2	Get knowledge in the analysis and estimation of biomolecules	4
C104.3	develop expertise in basic analytical techniques of microbiology.	5

BT-105 Laboratory Course - II

Marks 100

Course Objectives:

1. To impart hands on training in enzyme kinetics and immunochemical techniques
 2. To familiarize the student with basic immunology and immunodiagnostic tools
-
1. Blood Film Preparation and identification of cells.
 2. Direct agglutination reaction: determination of human blood group antigens
 3. Double diffusion/ Radial immunodiffusion.
 4. Purification of IgG from serum.
 5. Diagnosis assay for typhoid using Widal test

6. Preparation of antibody-enzyme conjugates.
7. ELISA / Western blotting .
8. Purification of H and O antigen from microorganism.
9. Rocket immunoelectrophoresis
10. Determination of specific activity, enzyme activity, Turn over number, Km and Vmax
11. Effect of pH and temperature on enzyme activity
12. Colorimetric determination of pk
13. Enzyme immobilization

Recommended Books

1. Immunological techniques, D.M. Weir, 1992.
2. Current Protocols in Immunology 3 Volumes, Wiley Publications 1994.
3. Monoclonal Antibodies: Principles and Practice, J. W. Goding, 1983. Academic Press
4. Vaccines, New Approaches to immunization, F.Brown, R.M.Chanock, KA Lerner, 1986. Cold spring Harborlab.
5. Topley and Wilson principles of bacteriology, Virology and immunology, G. Wilson, A.Miles, M.T.Paker, 1984. Arnold, Heineman.
6. Basic and Clinical Immunology, D.P. Stities and J.D. Stobo.
7. Practical Biochemistry: Principles and techniques (5th Edition) by K. Wilson and J. Walker. Cambridge University Press, Cambridge, 2000.
8. An Introduction to Practical Biochemistry by Plummer D. (3rd Edition) Tata MacGraw Hill Publisher, 2005.
9. Experimental Biochemistry: A Student Companion by Rao BS and Deshpande V. I.K. International Pvt Ltd., New Delhi, 2005.
10. Laboratory Manual in Biochemistry by Jayaraman J. New Age International (P) Ltd., Publishers, New Delhi, 1999.

Course Outcomes (COs):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C105.1	undertake enzyme kinetics in industrial application	3
C105.2	apply molecular diagnostic and immunodiagnostic techniques.	4

M.Sc. Part I Semester I Biotechnology: Audit Courses

AC-101: Practicing Cleanliness (Compulsory; Campus-level Audit Course; Practical; 2 Credits)		
Course Objectives (COs): <ul style="list-style-type: none"> • To make students aware of Clean India Mission and inculcate cleanliness practices among them. 		
	<ul style="list-style-type: none"> • Awareness program on <ul style="list-style-type: none"> ○ Swachh Bharat Abhiyan (Clean India Mission) ○ Clean Campus Mission ○ Role of youth in Clean India Mission • Cleaning activities inside and surroundings of Department buildings. • Tree plantation and further care of planted trees • Waste (Liquid/Solid/e-waste) Management, Japanese 5-S practices • Planning and execution of collection of Garbage from different sections of University campus • Role of youth in power saving, pollution control, control of global warming, preservation of ground water and many more issues of national importance. • Cleanest School/Department and Cleanest Hostel contests • Painting and Essay writing competitions 	

Course Outcomes (COs):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
AC101.1	Identify need at of cleanliness at home/office and other public places.	2
AC101.2	Plan and observe cleanliness programs at home and other places.	4
AC101.3	Practice Japanese 5-S practices in regular life.	3

Semester II

BT-201: MOLECULAR BIOLOGY

100 Marks [50 Hrs]

Course Objectives:

1. To extend the knowledge on structure and functions of genetic material
2. To introduce genome organization, transcription and translation process in Prokaryotes and Eukaryotes and study various tools to understand molecular mechanisms.

Unit I-

Concept of Gene, Nature of Gene, Gene cistron relationship in Prokaryotes and Eukaryotes, DNA Replication machinery in Prokaryotes and its comparison with Eukaryotes, Replication fork, fidelity of replication, Enzymes involved in replication: DNA Polymerase; Primases; Ligases; Helicases; Topoisomerases; Gyrase and Single Stranded Binding Proteins.

Molecular methods of DNA replication, Models of replication, theta mode of replication, rolling circle model of replication, unidirectional replication, Bi directional replication, replication of linear DNA. Regulation of DNA replication.

Unit II

Types of DNA damage: deamination, oxidative damage, alkylation, pyrimidine dimmers

DNA mutations: spontaneous and inducible and mutagenic agents

DNA repair pathways: methyl directed mismatch repair, very short patch repair, nucleotide excision repair, base excision repair, recombination, SOS system

Unit III

Transcription in prokaryotes: Initiation, elongation and termination, Transcription in Eukaryotes, Control of transcriptional termination: Attenuation and antitermination, Splicing of RNA, Response Elements, Post-transcriptional Modification

Unit IV

Protein synthesis and processing: Ribosome structure, genetic code, aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetases, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, translational inhibitors.

Post- translational modification of proteins: Types and Significance, Protein targeting, Protein folding.

Unit V

Regulation of gene expression in prokaryotes: Operon concept, induction and repression, Structure and regulation of lactose, arabinose and tryptophan operons.

Regulation of gene expression in eukaryotes, Control of gene expression at transcription and translation level.

Recommended Books:

1. Genes IX Benjamin Lewin
2. Molecular Biology, Turner et al
3. Cell and Molecular Biology: Concepts and Experiments, Gerald Karp
4. An Introduction to Genetic Analysis, Griffiths et al
5. Genome (1999), Brown
6. Concepts of Genetics, Klug and Cummings
7. Proteins, Creighton
8. Molecular Cell Biology, Lodish et al
9. Biochemistry and Molecular Biology of Plants (2000), Buchanan
10. Molecular Biology of the Gene, by James D. Watson, Tania A. Baker, Stephen P. Bell, and
11. Alexander Gann (2007), Publisher: Benjamin Cummings; 6th edition
12. Fundamental Molecular Biology by Elizabeth A. Allison (2007), Publisher: Wiley-Blackwell; 1st edition
13. Molecular Biology by Robert F. Weaver (2007) Publisher: McGraw-Hill College; 4th edition
14. Cell and Molecular Biology: Concepts and Experiments by Gerald Karp (2007) Publisher:

Wiley; 5th edition

15. Molecular Biology of the Cell by Bruce Alberts, Alexander Johnson, Julian Lewis, and

16. Martin Raff Publisher: Garland Science; 5th edition,

Course Outcomes (COs):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C201.1	Receive elaborate knowledge on nucleic acids and molecular mechanisms in Prokaryotes and eukaryotes	3
C201.2	Understand gene expressions and signal sequences in Prokaryotes and eukaryotes	2

BT-202: BIOINSTRUMENTATION AND BIOSTATISTICS

100 Marks [50 Hrs]

Course Objectives:

1. To introduce the student to the variety of biophysical and biochemical techniques
2. To make them familiar with various approaches of analytical techniques and Biostatistics

UNIT-I:

Principles and Applications of Light, Phase Contrast, Fluorescence Microscopy, Scanning and Transmission, Electron Microscopy, Confocal Microscopy, Cytophotometry and Flow Cytometry. Principle and techniques: Preparative, Analytical Centrifuges, ultracentrifuges, Sedimentation analysis RCF and Density Gradient Centrifugation.

UNIT-II:

Chromatography Techniques: Theory and Application of Paper Chromatography, TLC, Gel Filtration Chromatography, Ion Exchange Chromatography, Affinity Chromatography, GLC and HPLC. Basic principles of electrophoresis, Factors affecting separation, Theory and applications of: paper, starch, agarose and Polyacrylamide (native and denaturing) gel electrophoresis (PAGE) and 2DE

UNIT-III

Theory and Application of UV and Visible Spectroscopy, Fluorescence Spectroscopy, NMR, ESR, Atomic Absorption Spectroscopy, X-ray Diffraction, MS, MALDI-TOF, ORD and CD
Radioactivity: Radioisotopes, Radioactive Decay, GM Counter, Liquid Scintillation counter, Solid Scintillation counters, Auto radiography: Principle and applications.

Unit IV

Introduction to Biostatistics, Common terms, notions and applications, Statistical population and Sampling methods. Classification and tabulation of data diagrammatic and graphical presentation, Frequency distribution, Measures of central value, Measures of variability; Standard deviation, standard Error, Range, Mean Deviation, Coefficient of variation, Analysis of variance.

Unit V

Comparison of means: chi square test, students t test, ANOVA with interpretation of data-introduction to MANOVA- statistical tables and their use - significance test and fixing levels of significance-use of statistical software.

Regression: Basic of regression, regression coefficient, regression analysis: Estimation, testing, prediction, checking and residual analysis. Design of Experiments, randomization, local control, complimentary Randomized, randomized block design.

RECOMMENDED BOOKS

1. Physical Biochemistry: Application to Biochemistry and Molecular Biology – Freilder.
2. Biochemical Technique : Theory and Practice , Robyt & White
3. Principle of Instrumental Analysis – Skoog & West
4. Principle & Technique – Practical Biochemistry 5th Ed. (2000) - Walker J. & Wilson K.
5. Biophysical Chemistry – Upadhyay & Nath.

Course Outcomes (COs):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C202.1	acquire knowledge on basic biophysical and biochemical aspects and Biostatistics	3
C202.2	. learn purification of molecules, analytical tools, electrophoretic separation	2
C202.3	learn how to interpret protein mobility on PAGE under native and SDS	2

BT-203 BIOPROCESS ENGINEERING AND TECHNOLOGY

Marks 100 [50 hrs]

Course Objectives:

1. To develop skills to modify, design and operate different types of fermenters and attachments.
2. To understand and implement various fermentation procedures.
3. To train students in scale up fermentation operations.

Unit I

Introduction to bioprocesses engineering. Sources of microorganisms: Culture collection centres. Enrichment, isolation, preservation and maintenance of industrial strains. Screening for the desired product: primary, secondary and High-throughput screening. Improvement of strain producing primary and secondary metabolites. Methods used in strain improvement: mutagenesis, protoplast fusion and genetic engineering. Production of recombinant molecules in heterologous system.

Unit II

Designing of stirred tank reactor: Ideal Properties of Bioreactor, Body Construction, Agitator, Types of impellers, Baffles foam separators, sparger, culture vessel, cooling and heating devices. Probes for on-line monitoring. Computer control of fermentation process, Neural network. Measurement and control of process parameters (pH, temperature, cell density, gas and liquid flow). Reactors for specialized applications: Packed bed reactors, Airlift bioreactors, Fluidized bed reactors and Trickle flow reactors.

Unit III

Growth kinetics: Batch, Fed-batch and Continuous culture. Media: Importance of media in fermentation, C and N substrates for industrial media, media formulation and modification. Sterilization of media, reactor and air: Factors affecting sterilization, Batch and Continuous sterilization, Del factor, D and Z value. Development of inoculum for bacterial, yeast and mycelial processes.

Unit IV

Fluid dynamics: Classification of fluids, Fluid flow and mixing, concept of Reynold's number, Rheological properties of fermentation process. Mass transfer of oxygen and heat in the bioreactor: Concept, significance and determination of mass transfer coefficient, factors affecting oxygen availability. Scale-up of the process.

Unit V

Downstream processing: Strategy for recovery, Harvesting of Biomass, Removal of microbial cells and solid matter, foam separation, filtration, centrifugation, cell disruption. Liquid liquid extraction: Solvents used, two-phase aqueous extraction, supercritical fluid extraction. Drying and crystallization. Bioprocess economics. Comparison between SSC and SLC, Factors affecting solid-state fermentations. Safety consideration in downstream processing.

Recommended Books:

1. Introduction to Industrial microbiology, Cruger-ACS Publication
2. Industrial microbiology- Casida- ACS Publication
3. Comprehensive Biotechnology Vol III Mooyoung Elsevier Publication
4. Biochemical Engineering, Aiba *et al*
5. Biochemical Engineering Fundamentals, Baily and Ollis
6. Fermentation Biotechnology-Principles, Process and Products(1998), Ward,O.P
7. Process Engineering in Biotechnology, Jackson A.T.
8. Bioreaction Engineering Principles, Nielson & Villadson
9. Industrial Microbiology (1992)4th edition,Prescott & Dunn
10. Microbial Biotechnology (1998) Glazer & Nikaido
11. A Text Book of Industrial Microbiology,2nds edition (2002),Cruger and Cruger
12. Manual of Industrial Microbiology & Biotechnology 2nd edition (1999),

Course Outcomes (COs):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C203.1	Describe the design and operation of various types of fermenters...	2
C203.2	Elaborate the theoretical aspects and practical requirements for the growth of microorganisms in industries and R and D organizations	3
C203.3	Describe the theoretical basis of fermentation technology for industrial applications.	2
C203.3	Understand and conduct fermentation process kinetics	2

BT-204 Laboratory Course - III

Marks 100

Course Objectives:

1. To develop skills to modify, design and operate different types of techniques
 2. To understand and implement various chromatography procedures.
 3. To train students in handling organisms and proteins.
-
1. Isolation of genomic DNA from bacteria, animal and plant cells.
 2. Restriction Digestion/Size fractionation of restricted DNA fragments by Agarose Gel Electrophoresis
 3. Isolation of plasmid DNA by using alkaline lysis method.
 4. Determination of T_m of nucleic acid/Quantitation of DNA
 5. Isolation of RNA
 6. Transformation of E. coli
 7. Electrophoresis of proteins
 8. Amino acid separations by paper chromatography
 9. Separation of lipids by thin layer chromatography
 10. Ion Exchange and gel filtration column chromatography
 11. Separation of sub cellular organelles by differential centrifugation
 12. Demonstration of LCMS, HPLC, GC, AAS

Recommended Books:

1. *Practical Biochemistry: Principles and techniques* (5th Edition) by K. Wilson and J. Walker. Cambridge University Press, Cambridge, 2000.
2. *An Introduction to Practical Biochemistry* by Plummer D. (3rd Edition) Tata MacGraw Hill Publisher, 2005.
3. *Laboratory Manual in Biochemistry* by Jayaraman J. New Age International (P) Ltd., Publishers, New Delhi, 1999.
4. *Experiments in Microbiology, Plant Pathology, Tissue Culture and Mushroom Cultivation* (2nd Edition) by Aneja KR. Wishwa Prakashan, New Age International Pvt Ltd., 1996.
5. *Principles of Fermentation Technology* by Stanbury PF, Whitaker A and Hall SJ. Aditya Books (P) Ltd., New Delhi, 1997.
6. *Process Biotechnology: Fundamentals* (2nd Edition) by Mukhopadhyay SN, Viva Books Pvt Ltd., New Delhi, 2004.
7. *Biotechnology: Hand Book* by Board N. Asia Pacific Business Press Inc., New Delhi, 2005.
Solid Substrate Cultivation edited by Doelle HW, Mitchell DA and Rolz CE. Elsevier Applied Science, London, 1992.

Course Outcomes (COs):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C204.1	Describe the genomic DNA from bacteria, animal and plant cells.	2
C204.2	Describe the theoretical basis of chromatography and centrifugation.	2
C203.3	Understand and conduct Transformation process.	2

BT-205 Laboratory Course - IV

Marks 100

Course Objectives:

1. To develop skills to handle an industrially important microorganisms
 2. To understand and implement various fermentation procedures.
 3. To train students in scale up fermentation operations.
-
1. Isolation of actinomycetes, molds and yeasts by enrichment technique
 2. Study of Growth Kinetics of Yeast by turbidometry
 3. Screening and maintenance of industrially important microorganisms
 4. Enrichment and isolation of mutants
 5. Selection of mutants by gradient plate technique
 6. Preparation of inoculum for mycelia cultures
 7. Production of the enzyme/s in shake flask/ Batch bar charts, pie diagrams, graphs (using computer software packages)
 8. Chi-squared test for goodness of fit
 9. fermentation in conical flask
 10. Production of citric acid by fermentation of different carbon sources by *Aspergillus niger*
 11. Alcohol fermentation using different substrates and its downstream process
 12. Determination of TDP
 13. Determination of TDT
 14. Assay of antibiotic using sensitive bacterial strain
 15. Data presentation (tables/figures): 1-D and 2-D

Recommended Books:

1. Introduction to Biochemical Engineering by Rao DG. Tata McGraw-Hill Pub Co Ltd., New Delhi, 2005.
2. Microbial Technology: Fermentation Technology (2nd Edition) Vol. I & II, by Peppler HJ and Perlman D. Academic Press, NY, USA, 2004.
3. Biochemical Reactors by Atkinson B. Pion Ltd, London.
4. Bioprocess Technology: Fundamentals and Applications, KTH, Stockholm.
5. *Biostatistics: A Foundation for Analysis in the Health* (9th edition) by Daniel WW. Wiley and Sons Inc., New York.
6. Fundamentals of Statistics by Gupta SC. Himalaya Publishing House, New Delhi.

Course Outcomes (COs):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C205.1	Describe the design and operation of various types of fermenters.	2
C205.2	Elaborate the theoretical aspects and practical requirements for the growth of microorganisms in industries and R and D organizations.	4
C205.3	Describe the theoretical basis of fermentation technology for industrial applications	2
C205.4	Understand and conduct fermentation process kinetics	2

M.Sc. Part I Semester II (Biotechnology): Audit Courses

	AC-201(A): Soft Skills (Personality and Cultural Development Related Audit course; Practical; 2 Credits) (Optional: Campus-level)	
	<i>Course Objectives (COs):</i> <ul style="list-style-type: none">• To inculcate different soft skills among students.	
Unit 1	Introduction to soft skills Formal definition, Elements of soft skills, Soft vs. Hard skills, Emotional quotient, Goal setting, life skills, Need for soft skills, Communication skills, Etiquettes & Mannerism.	2 hrs.
Unit 2	Self-Assessment Goal setting, SWOT analysis, attitude, moral values, self-confidence, etiquettes, non-verbal skills, achievements, positive attitude, positive thinking and self-esteem. Activity: The teacher should prepare a questionnaire which evaluate students in all the above areas and make them aware about these aspects.	4 hrs.
Unit 3	Communication Skills Types of communication: Verbal, Non-verbal, body language, gestures, postures, gait, dressing sense, facial expressions, peculiarity of speaker (habits). Rhetoric speech: Prepared speech (topics are given in advance, students get 10 minutes to prepare the speech and 5 minutes to deliver, Extempore speech (students deliver speeches spontaneously for 5 minutes each on a given topic), Storytelling (Each student narrates a fictional or real-life story for 5 minutes each), Oral review (Each student orally presents a review on a story or a book read by them) Drafting skills: Letter, Report & Resume writing, business letters, reading & listening skills Activity: The teacher should teach the students how to write the letter, report and build resume. The teacher should give proper format and layouts. Each student will write one formal letter, one report and a resume.	8 hrs.

Unit 4	Formal Group Discussion, Personal Interview & Presentation skills Topic comprehension, Content organization, Group speaking etiquettes, driving the discussion & skills. Preparation for personal interview: dress code, greeting the panel, crisp self-introduction, neatness, etiquettes, language tone, handling embarrassing & tricky questions, graceful closing. Activity: Each batch is divided into two groups of 12 to 14 students each. Two rounds of a GD for each group should be conducted and teacher should give them feedback. Mock interview are to be conducted.	4 hrs.
Unit 5	Aptitude and analytical skills Quantitative aptitude, Numerical reasoning, verbal reasoning, diagrammatic test, situational tests, logical thinking. Analytical skills: Definition, Types, problem solving	8 hrs.
Unit 6	Life skills Time management, critical thinking, sound and practical decision making by dealing with conflicts, stress management, leadership qualities Activity: The teacher can conduct a case study activity to train students for decision making skills. The teacher should conduct a session on stress management and guide students on how to manage stress. The teacher may conduct a stress relieving activity in the class. He/she may counsel students individually to know their problems and guide them on dealing with them effectively.	4 hrs.
Suggested readings:		
<ol style="list-style-type: none"> 1. Basics of Communication In English: Francis Sounderaj, MacMillan India Ltd. 2. English for Business Communication: Simon Sweeney, Cambridge University Press 3. An Introduction to Professional English and Soft Skills: Das, Cambridge University Press 4. Quantitative Aptitude: R.S. Agrawal 		

Course Outcomes (COs):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
AC201A.1	Identify their lacunas about some soft skills and try to overcome the same.	2
AC201A.2	Practice learned soft skills in real life and do their jobs more effectively.	3

AC-201(B): Practicing Sports Activities (Personality and Cultural Development Related Audit course; Practical; 2 Credits) (Optional: Campus-level)				
Course Objectives (COs):				
<ul style="list-style-type: none"> To motivate students towards sports and provide them required training. 				
SR NO.	NAME OF THE SPORT/GAME (Select ONE of the Following)	SYLLABUS OF THE COURSE	TIMING (02 Hours in a Week)	SEMESTER
1	Volleyball	<ul style="list-style-type: none"> General Fitness Basic Fitness Specific Fitness History of the Game Basic Skill of the Game Major Skill of the Game Technique & Tactics of the Game Game Practice 	Morning : 07 to 09 AM OR Evening : 05 to 07 PM	Total 30 Hours in Each Semester
2	Athletics			
3	Badminton			
4	Cricket			
5	Basketball			
6	Handball			
7	Kabaddi			
8	Kho-Kho			
9	Table-Tennis			
10	Swimming			

Course Outcomes (COs):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
AC201B.1	Identify one or more sports of their choice and develop more interest to participate at University/National level sport events.	2
AC201B.2	Practice the learned sports activities regularly in real life.	3

AC-201(C): Practicing Yoga (Personality and Cultural Development Related Audit course; Practical; 2 Credits) (Optional: Campus-level)	
	<p>Course Objectives:</p> <ul style="list-style-type: none"> • To motivate students towards yoga and provide them required training.
	<ul style="list-style-type: none"> • Yog: Meaning, Definition & Introduction, Objectives • Primary Introduction of Ashtanga Yoga • Preparation of Yogabhyas • Omkar Sadhana, Prayer, Guru Vandana • Sukshma Vyayamas • Suryanamaskar (12 Postures) • Asanas : <ul style="list-style-type: none"> ▪ Sitting (Baithaksthiti) - Vajrasana, Padmasan, Vakrasan, Ardha-Pashchimotanasanan ▪ Supine (Shayansthiti) - Uttan Padaasan(Ekpad/Dwipad), Pavanmuktasana, Viparitarani Aasan, Khandarasan, Shavasana ▪ Prone (Viparitshayansthiti) - Vakrahasta, Bhujangasana, Saralhasta Bhujangasana, Shalabhasana(Ekpad/Dwipad), Makarasana ▪ Standing (Dhandsthiti) - Tadasana , TiryakTadasana, Virasana, Ardh Chakrasana • Primary Study of Swasana: Dirghaswasana, Santhaswasana, JaladSwasana - 6 Types • Pranayama : Anuloma-viloma, Bhramari

Course Outcomes (COs):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
AC201C.1	Identify and practice some Yoga asanas regularly in their life to remain healthy.	2
AC201C.2	Provide guidance and practice about Yoga to their friends, parents and relatives.	3

AC-201(D): Introduction to Indian Music
(Personality and Cultural Development Related Audit course; Practical; 2 Credits)
(Optional: Campus-level)

	<p>Course Objectives:</p> <ul style="list-style-type: none"> • To motivate students towards Indian music and provide them minimum required training.
	<ul style="list-style-type: none"> • Definition and brief about generation of Swar, Saptak, Thaata, Raag, Aavartan, Meend, Khatka, Murkee, Taal, Aalaap etc. • Taal and its uses - Treetaal, Daadraa, Zaptaal, Kervaa. • Information of Badaakhyaal, Chhotaakhyaal (one), Sargam, Lakshangeet (information) • Detailed information of Tambora • Detailed information of Harmonium and Tablaa. • Five filmy songs based on Indian Classical Music (Theory and Presentation) • Sound Management - Basic information of Sound Recording (including Practicals) • Composition of Music as per the Story • Preparing news write-ups of the Seminars, Library Musical Programmes held at the nearest Akashwani, by personal visits.

Course Outcomes (COs):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
AC201D.1	Identify different types of Indian music.	3
AC201D.2	Develop more interest to learn and practice Indian music.	4

Course Objectives:

1. To learn about the various enzymes involved in rDNA Technology
2. To know the principles of cDNA construction and amplification methods.
3. Making aware of synthesis of recombinant products

UNIT I

Enzymes in genetic engineering: Restriction Endonucleases - classification, mode of action. Enzymes in modification - Polynucleotide phosphorylase, DNase, Methylases, phosphatases, polynucleotide Kinase, Ligases, S1 Nuclease, RNase and their mechanism of action. Vectors in recombinant DNA technology and its salient features, types of vectors – plasmids: pBR322, pUC18, pET21, cosmids, phages: λ and M13, SV40 Vector, Shuttle, Expression Vectors, Selectable Vectors, Artificial Vectors.

UNIT II

Methods of gene transfer: - Conjugation, Transformation, Transduction, Transposon, Electroporation, Microprojectile system, Liposome mediated transfer, gene gun, Calcium Phosphate method, DEAE dextran method. Molecular mechanism of anti sense technology.

UNIT – III:

Gene Cloning, Cells for cloning: *E.coli*, *S. cerevisiae*, Mammalian fertilized egg cells, Chinese hamster ovary cultured cells. Direct screening & direct selection, indirect screening techniques: HAT (Hybrid Arrested Translation), HST (Hybrid Selected/released Translation), Colony hybridization, Dot Blot hybridization, Immunological assay, Nucleic acid hybridization: DNA Probes, cDNA Probes, RNA Probes.

UNIT IV

Expression strategies for heterologous genes, Expression in plant, Bacteria and yeast, site- directed mutagenesis, genes targeting and protein engineering. Generation of Novel plants foods and GMOs, Gene Bank, Animal pharming.

UNIT V

Techniques and Application: DNA sequencing – Maxam-Gilbert method and Sanger's method, Oligonucleotide synthesis, DNA fingerprinting, Mapping of DNA, Gene Libraries: Genomic, cDNA. DNA foot Printing, Chromosome walking and Chromosome jumping, Transposon tagging, Hazards and impact of genetic engineering on society.

Recommended Books:

1. Principles of gene manipulation (2006) by Sandy Primrose, Richard Twyman, Bob Old, Giuseppe Bertola (Black Well Publication).
2. Molecular cloning: A laboratory manual (2000) by J. Sambrook, E.F. Fritsch and T. Maniatis (Cold Spring Harbor).
3. Gene cloning and DNA analysis: An introduction (2006) by TA Brown (Blackwell Sci. Ltd).
4. Molecular biotechnology (1994) by S.B. Primrose (Blackwell, Scientific Publishers. Oxford).
5. PCR Strategies, M.A. Innis, D.H. Gelfant & J.J. Sninsky, 1995. IRL Press.
6. Recombinant DNA (2nd Ed), J.D. Watson, M. Gillman, J. Witknowski and M. Zoller, 1992. Scientific Americans books, N.Y.

7. Genetic Engineering of Animals, A.Puhler, 1993. VCH Publishes, Weinheim FRG.

Course Outcomes (COs):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C301.1	. learn basic ideas on cloning vehicle	2
C301.2	know more about cDNA and amplification products	4
C301.3	Understand the construction of recombinant DNA and molecular biology tools.	2

BT-302 PLANT BIOTECHNOLOGY

100 marks

Course Objectives: The objectives of this course is to introduce students to the principles, practices and application of animal biotechnology, plant tissue culture, plant and animal genomics, genetic transformation and molecular breeding of plants and animals.

UNIT- I

Introduction to plant cell and tissue culture and historical perspective. Laboratory organization, aseptic manipulations and culture media–composition, preparation and development. Callus culture; Initiation and maintenance of suspension culture- batch and continuous culture, assessment of growth and viability; Static techniques of single cell culture. Micro propagation Organogenesis, somatic embryogenesis and synthetic seeds.

UNIT- II

Meristem culture, shoot tip culture and production of virus free plants. Somaclonal variations, molecular basis of variation and their significance in plant breeding. In vitro production of haploid plants – Androgenesis (anther and pollen culture) and Gynogenesis (ovary and ovule culture). Significance and uses of haploids in agriculture. embryogenesis and embryo rescue technique.

UNIT- III

Protoplast culture and somatic hybridization – Isolation, culture and fusion of protoplast, selection of fusion products and plant regeneration, assessment of somatic hybrid plants, production of cybrids, In vitro germplasm conservation and cryopreservation.

UNIT- IV

Organization of plant genome – Nuclear genome, Chloroplast genome and mitochondrial genome. Transposon and T–DNA tagging. Chloroplast transformation – vector designing, method and advantages, Direct gene transfer in plants, selectable markers, reporter genes and promoters used in plant vectors, molecular characterization of transformants.

Agrobacterium mediated transformation–Ti and Ri plasmids, role of virulence genes, mechanism of T-DNA transfer, vectors based on Ti and Ri plasmids–cointegrate and binary vectors. Gene silencing in transgenic plants.

UNIT- V

Application of DNA technology - transgenic plants with reference to virus and pest resistances - herbicidal resistance - stress tolerance (heat & salt) - cytoplasmic male sterility - resistance to fungi and bacteria - delay of fruit ripening - Ecological risk assessment of genetically modified crops. Plant cells as biofactories for the production of secondary metabolites: bioreactors and immobilized plant cell culture, RFLP maps, linkage analysis, RAPD markers, STS, microsatellites, SCAR (Sequence Characterized Amplified Regions), SSCP, AFLP, QTL.

..

Recommended Books:

1. Plant tissue culture – Theory and Practice (2005) by Bhojwani S. S. and Razdan M. K., Elsevier publication.
2. Elements of Biotechnology by P. K. Gupta, Rastogi pub.
3. Biotechnology in crop improvement (1998) by H. S. Chawla, International Book distributing company.
4. Plant cell, organ and tissue culture (1995) by Gamborg O.L. and Phillips G.C., Springer Verlag pub. Germany.
5. Plant Tissue Culture – Basic & Applied (2005) by Jha T.B. & Ghosh B., Universities press.
6. Plant cell culture – A practical approach (1994) Dixon R.A., Gonzales R.A. Oxford University press, UK.
7. Plant Tissue Culture Smith R.H. (2000), Plant Tissue Culture, Academic Press
8. Evans D.A. (2003), Plant Cell Culture, Taylor & Francis.
9. Plant Genetic Engineering Vol. 1 - 6 (2003) Singh R. P and Jaiwal P. K.(Eds.), Sci tech publishing LLC, USA.
10. Gene transfer to plants by Potrykus I. and Spangenberg G., Springer Verlag, Germany.
11. Plant biotechnology (2000) by Hammond J, McGarvey P. and Yusibov V.(Eds.) Springer verlag, Germany.
12. Plant gene isolation – Principles and practice (1996) by Foster G.D. and Twell D., John Wiley & Sons, USA.
13. Plant Biotechnology – The genetic manipulation of plants (2003) by Slater A., Scott N. and Fowler M., Oxford pub.
14. Practical application of Plant Molecular Biology (1997) by Henry R.J., Chapman and Hall.
15. Plants, genes and agriculture (1994) by Chrispeels M.J., Sadava D.E, Jones & Bartlett pub., UK.
16. Plant Genetic Engineering; Singh RP and Jaiwal PK (eds), Sci tech Publishing LLC.
17. Plant Gene Isolation – Principles and Practice; Foster GD and Twell D, John Wiley & Sons.
18. Gupta P.K. (2004) *Biotechnology and Genomics*. Rastogi Publications, Meerut, India.
19. Owen M.R.L. and Pen J. (Eds) (1996) *Transgenic Plants: A Production System for Industrial and Pharmaceutical Proteins*. John Wiley & Sons, England.

Course Outcomes (COs):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C302.1	to gain fundamental knowledge in plant biotechnology and their applications.	3

Course Objectives:

1. To understand offline/ online strategies adopted for microbial analysis of food
2. To learn about role of microbes in wastewater treatment, as well as liquid and solid waste management
3. To impart knowledge about removal of recalcitrant from contaminated environment

Unit-I:

Solid waste management: Types and sources of solid waste, Management by composting and vermiculture, Materials and Physiochemical characteristics of compost.

Waste water management: Activated sludge process, Nitrification, Denitrification sludge and anaerobic digestion (UASB), Oxidation ditch and Carousal systems.

Air pollution management: Biotechnological approach for air pollution management. Strategy for removal/destruction of SO_x and NO_x

Unit-II:

Bioremediation: Characterization of site for bioremediation, Engineered *In Situ* and Intrinsic *In Situ* bioremediation, *Ex situ* bioremediation, Evaluation of bioremediation, Bioremediation of soil contaminated with oil spills.

Biodegradation: Assimilation, Detoxification, Activation, Bio-availability, Recalcitrance, Cometabolism and Biotransformation. Factors affecting biodegradation, Predicting products of biodegradation, Biodegradation of environmental contaminants (Pesticides, Lignin, Halogenated hydrocarbons)

Unit-III:

Biodiversity (Global and National): Biodiversity hot spots, Biodiversity characteristics of India, Conventions on biological diversity, Causes of biodiversity losses, Extinct and endangered species, Conservation methods, National parks, Sanctuaries, Sacred groves, Gene banks.

Measurement of biodiversity: Types of Biodiversity (α , β and γ), Diversity indices (Simpson's, Shannon index, Sorensen's similarity index)

Unit-IV:

Biosensors: Types of biosensor, Working mechanism and examples of biosensors based on DNA, antibodies, enzymes, microorganisms. Applications of biosensors in the monitoring of heavy metals, BOD, nitrogen compounds, polychlorinated biphenyls, phenolics and organophosphorus compounds.

Biofuels: Advantages of biofuels, Energy from biomass, Biogas, Biohydrogen and Biodiesel.

Biosafety: Biosafety guidelines and regulations with special reference to India, Biosafety and environmental concerns of transgenic plants, animals and nanotechnology.

Unit-V:

Toxicity: Definitions and significance of various concepts e.g. Persistence, Bioaccumulation, Biomagnification, Risk, Toxicity (acute and chronic), Threshold dose. Factors affecting toxicity of a chemical agent. Tests for evaluation of genotoxicity, mutagenicity, and carcinogenicity (Ames test, Micronucleus test and Comet assay).

Antidotal procedures: Antidote therapy, Mode of antidote action, Specific antidotes against iron, cyanide, arsenic, lead, methanol and acetylcholinesterase inhibitors.

Recommended Books:

1. Agarwal S.K. (2005) *Advanced Environmental Biotechnology*. APH Pub Co, New Delhi.
2. Alexander M. (1999) *Biodegradation and Bioremediation*. 2nd Edition, Academic Press, USA.
3. Asthana D.K. and Asthana M. (2001) *Environment: Problems and Solutions*. S. Chand & Co. Ltd., New Delhi.
4. Chatterji A.K. (2002) *Introduction to Environmental Biotechnology*. Prentice Hall of India Pvt Ltd., New Delhi.
5. Evans G.M. and Furlong J.C. (2003) *Environmental Biotechnology: Theory and applications*. John Wiley & Sons, England.
6. Huges W.W. (1996) *Essentials of Environmental Toxicology*. Taylor and Francis.
7. Krishnamurthy K.V. (2003) *Textbook of Biodiversity*. Science Publishers Inc, USA.
8. Mohapatra P.K. (2006) *Textbook of Environmental Biotechnology*. IK International, New Delhi.
9. Rana SVS (2009) *Environmental Biotechnology*. Rastogi Publications, Meerut.
10. Rittmann B.E. and McCarty P.L. (2001) *Environmental Biotechnology: Principles and Applications*. McGraw-Hill, USA.
11. Shaw I.C. and Chadwick J. (1998) *Principles of Environmental Toxicology*. Taylor & Francis Ltd., UK.
12. Thakur I. S. (2006) *Environmental Biotechnology: Basic Concepts and Applications*. IK International Pvt Ltd., New Delhi.
13. Yadav P.R. and Tyagi R. (2006) *Environmental Biotechnology*. Discovery Pub House, New Delhi.

Course Outcomes (COs):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C303.1	Understand significance of microbes in food, wastewater treatment and clean-up	2
C303.2	Describe use of microbes in solid and liquid waste treatment as well as bioremediation of toxicants, thereby acquire knowledge about microbial potentials	4
C303.3	Understand the relevance of microbial standards for food quality assurance.	3

Course Objectives:

1. To introduce the student to the variety of Tissue culture techniques
 2. To make them familiar with various approaches of genetic engineering techniques
-
1. Preparation and sterilization of MS medium, stocks and explants
 2. Callus induction, Regeneration of shoots, Root induction
 3. Meristem culture /Anther culture/ pollen culture/ using various explants
 4. Protoplast isolation, fusion and culture
 5. Somatic embryogenesis
 6. Development of synthetic (Artificial) seeds/ Production of secondary metabolites
 7. Micropropagation of banana, citrus Papaya, Sugarcane etc.
 8. Isolation of pBR-322 from E.coli
 9. Preparation of competent cells
 10. Transformation by calcium chloride method
 11. Screening of bacterial colonies using X-gal and IPTG
 12. Southern blot/ Northern blot / Western blot/ PCR (D)
 13. Isolation and purification of yeast DNA

Recommended Books:

1. Aneja K.R. *Experiments in Microbiology, Plant Pathology, Tissue Culture and Mushroom Cultivation*. 2nd Edition, Wishwa Prakashan, New Age International Pvt Ltd., New Delhi.
2. Reinert J. and Yeoman M.M. (1989) *Plant Cell and Tissue Culture: A Laboratory Manual*.
3. Smith R.H. (1992) *Plant Tissue Culture: Techniques and Experiments*.
4. Henry R.J., Chapman and Hall Practical application of Plant Molecular Biology (1997)
5. Gene Transfer and expression protocols - methods in molecular biology volume 7, E.T. Murray, 1991. Humana Press
6. Genetic engineering by Sandhya Mitra, Macmillan Publication
7. DNA Cloning: A practical approach (1995) by D.M. Glover and B.D. Hames (IRL Press, Oxford).

Course Outcomes (COs):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C304.1	acquire knowledge on basic plant biotechnology aspects	3
C304.2	learn purification of organism/molecules, transformation tools, electrophoretic separation	2
C304.3	learn how to interpret DNA/ protein mobility on various techniques	3

BT-305 Laboratory COURSE –VI

100 marks

Course Objectives:

1. To understand offline/ online strategies adopted for microbial analysis of soil/waste/food
 2. To learn about role of microbes in wastewater treatment, as well as liquid and solid waste management
 3. To impart knowledge about removal of recalcitrant from contaminated environment
-
1. Determination of acidity, alkalinity, salinity of water/soil.
 2. Determination of COD of sewage/industrial waste water.
 3. Estimation of total nitrogen of soil (Kjeldal's method)
 4. Vermicomposting of different waste substrates in laboratory reactors
 5. Co-composting of biosolids and municipal solid waste (MSW) / kitchen waste / paper waste.
 6. Determination of adsorption isotherm (adsorption of acetic acid on charcoal)
 7. Determination of soil microbial activity by CO₂ evolution method
 8. Determination of MIC of pesticide / heavy metal against bacterial culture
 9. Production of biodiesel from microalgae
 10. Testing of cytotoxicity (onion root tip assay/pollen germination) of water polluted with pesticides
 11. Comet assay to assess the DNA damage due to pesticide exposure
 12. Hydroponic plant assay to test phytoaccumulation of heavy metals/xenobiotics
 13. Estimation of metal content in soil, compost, vegetables, drinking water and waste waters using atomic absorption spectroscopy
 14. Estimation of bioavailable / extractable concentration of zinc and cadmium in sediment sample using AAS
 15. Estimation of Biodiversity Index of particular habitat

Course Outcomes (COs):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C305.1	understand significance of microbes in food, wastewater treatment and clean-up	2
C305.2	. describe use of microbes in solid and liquid waste treatment as well as bioremediation of toxicants, thereby acquire knowledge about microbial potentials	4
C305.3	understand the relevance of Production of bioenergy	2

M.Sc. Part II Semester III Biotechnology: Audit Courses

AC-301(A): Computer Skills		
(Technology + Value added Audit course; Practical; 2 Credits)		
(Optional: Campus + Program level)		
<i>Course Objectives (COs):</i>		
<ul style="list-style-type: none"> • To inculcate different daily useful computer skills among students. 		
Unit 1	Elements of Information Technology 1.1 Information Types: Text, Audio, Video, and Image, storage formats 1.2 Components: Operating System, Hardware and Software, firmware 1.3 Devices: Computer, Mobile Phones, Tablet, Touch Screen, Scanner, Printer, Projector, smart boards 1.4 Processor & Memory: Processor functions, speed, Memory types: RAM /ROM /HDD /DVD-ROM/Flash drives, memory measurement metrics	2 hrs
Unit 2	Office Automation-Text Processing 2.1 Views: Normal View, Web Layout View, Print Layout View, Outline View, ReadingLayout View 2.2 Working with Files: Create New Documents, Open Existing Documents, SaveDocuments to different formats, Rename Documents, Close Documents 2.3 Working with Text: Type and Insert Text, Highlight Text, Formatting Text, Delete Text, Spelling and Grammar, paragraphs, indentation, margins 2.4 Lists: Bulleted and Numbered Lists, 2.5 Tables: Insert Tables, Draw Tables, Nested Tables, Insert Rows and Columns, Moveand Resize Tables, Moving the order of the column and/or rows inside a table, TableProperties 2.6 Page Margins, Gutter Margins, Indentations, Columns, Graphics, Print Documents, 2.7 Paragraph Formatting, Paragraph Attributes, Non-printing characters 2.8 Types of document files: RTF, PDF, DOCX etc.	5 hrs
Unit 3	Office Automation-Worksheet Data Processing 3.1 Spreadsheet Basics: Adding and Renaming Worksheets, Modifying Worksheets, 3.2 Moving Through Cells, Adding Rows, Columns, and Cells, Resizing Rows and Columns, Selecting Cells, Moving and Copying Cells 3.3 Formulas and Functions: Formulas, Linking Worksheets, Basic Functions, AutoSum, Sorting and Filtering: Basic Sorts, Complex Sorts, Auto-fill, Deleting Rows, Columns, and Cells 3.4 Charting: Chart Types, drawing charts, Ranges, formatting charts	5 hrs
Unit 4	Office Automation- Presentation Techniques and slide shows 4.1 Create a new presentation, AutoContent Wizard, Design Template, Blank Presentation, Open an Existing Presentation, PowerPoint screen, Screen Layout 4.2 Working with slides: Insert a new slide, Notes, Slide layout, Apply a design template, Reorder Slides, Hide Slides, Hide Slide text, Add content, resize a placeholder or textbox, Move a placeholder or text box, Delete a placeholder or text box, Placeholder or Text box properties, Bulleted and numbered lists, Adding notes 4.3 Work with text: Add text and edit options, Format text, Copy text formatting, Replace fonts, Line spacing, Change case, Spelling check, Spelling options 4.4 Working with tables: Adding a table, Entering text, Deleting a table, Changing rowwidth, Adding a row/column, Deleting a row/column, Combining cells, Splitting a cell, Adding color to cells, To align text vertically in cells, To change table borders, Graphics, Add clip art, Add an image from a file, Save & Print, slide shows, slide animation/transitions.	6 hrs
Unit 5	Internet & Applications: 5.1 Computer Network Types: LAN, PAN, MAN, CAN, WAN, Defining and describing the Internet, Brief history, Browsing the Web, Hypertext and hyperlinks, browsers, Uniform resource locator 5.2 Internet Resources: Email, Parts of email,	4 hrs

	5.3 Protecting the computer: Password protection, Viruses, Virus protection software, Updating the software, Scanning files, Net banking precautions. 5.4 Social Networking: Features, Social impact, emerging trends, issues, Social Networking sites: Facebook, Twitter, linkedin, orkut, online booking services 5.5 Online Resources: Wikipedia, Blog, Job portals, C.V. writing 5.6 e-learning: e-Books, e-Magazines, e-News papers, OCW(open course wares): Sakshat(NPTEL) portal, MIT courseware	
Unit 6	Cloud Computing Basics 6.1 Introduction to cloud computing 6.2 Cloud computing models: SAS, AAS, PAS 6.3 Examples of SAS, AAS, PAS (DropBox, Google Drive, Google Docs, Office 365 Prezi, etc.)	3 hrs
Suggested readings:		
1. TCI, "Introduction to Computers and Application Software", Publisher: Jones & Bartlett Learning, 2010, ISBN: 1449609821, 9781449609825		
2. Laura Story, Dawna Walls, "Microsoft Office 2010 Fundamentals", Publisher: Cengage Learning, 2010, ISBN: 0538472464, 9780538472463		
3. June Jamrich Parsons, Dan Oja, "Computer Concepts Illustrated series", Edition 5, Publisher Course Technology, 2005, ISBN 0619273550, 9780619273552		
4. Cloud computing online resources		

Course Outcomes (COs):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
AC301A.1	Identify their lacunas about some computer skills and try to overcome the same.	2
AC301A.2	Practice the learned computer skills in real life and do their jobs more effectively.	3

AC-301(B): Cyber Security (Technology + Value added Audit course; Practical; 2 Credits) (Optional: Campus + Program level)		
Course Objectives (COs):		
<ul style="list-style-type: none"> To make students aware of different daily useful cyber security skills/rules. 		
Unit 1	Networking Concepts Overview Basics of Communication Systems, Transmission Media, ISO/OSI and TCP/IP models, Network types: Local Area Networks, Wide Area Networks, Internetworking, Packet Formats, Wireless Networks: Wireless concepts, Advantages of Wireless, Wireless network architecture, Reasons to use wireless, Internet	3 hrs
Unit 2	Security Concepts Information Security Overview, Information Security Services, Types of Attacks, Goals for Security, E-commerce Security, Computer Forensics, Steganography. Importance of Physical Security, Biometric security & its types, Risk associated with improper physical access, Physical Security equipments. Passwords: Define passwords, Types of passwords, Passwords Storage – Windows & Linux.	7 hrs
Unit 3	Security Threats and vulnerabilities Overview of Security threats, Hacking Techniques, Password Cracking, Types of password attacks, Insecure Network connections, Wi-Fi attacks & countermeasures, Information Warfare and Surveillance. Cyber crime: e-mail related cyber crimes, Social network related cyber crimes, Desktop related cyber crimes, Social Engineering related cyber crimes, Network related cyber crimes, Cyber terrorism, Banking crimes	7 hrs

Unit 4	Cryptography Understanding cryptography, Goals of cryptography, Types of cryptography, Applications of Cryptography, Use of Hash function in cryptography, Digital signature in cryptography, Public Key infrastructure	5 hrs
Unit 5	System & Network Security System Security: Desktop Security, email security: PGP and SMIME, Web Security: web authentication, Security certificates, SSL and SET, Network Security: Overview of IDS, Intrusion Detection Systems and Intrusion Prevention Systems, Overview of Firewalls, Types of Firewalls, VPN Security, Security in Multimedia Networks, Fax Security.	3 hrs
Unit 6	OS Security OS Security Vulnerabilities updates and patches, OS integrity checks, Anti-virus software, Design of secure OS and OS hardening, configuring the OS for security, Trusted OS.	2 hrs
Unit 7	Security Laws and Standards Security laws genesis, International Scenario, Security Audit, IT Act 2000 and its amendments.	3 hrs
Suggested readings:		
<ol style="list-style-type: none"> 1. Skills Factory, Certificate in Cyber Security, Text Book Special edition, Specially published for KBC NMU, Jalgaon 2. BPB Publication, "Fundamentals of Cyber Security", Mayank Bhushan, Rajkumar Singh Rathore , Aatif Jamshed 3. CreateSpace Independent Publishing Platform, "Cyber Security Basics", Don Franke, ISBN-13: 978-1522952190 ISBN-10: 1522952195 4. Online references 		

Course Outcomes (COs):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
AC301B.1	Practice learned cyber security skills/rules in real life.	3
AC301B.2	Provide guidance about cyber security skills/rules to their friends, parents and relatives.	2

AC-301(C): Seminar + Review Writing	
(Technology + Value added Audit course; Optional: Program-level; Practical; 2 Credits)	
Course Objectives (COs):	
<ul style="list-style-type: none"> • To motivate students to develop skills to search, retrieve, interpret, organize, and present relevant biological information. 	
Writing a Scientific Literature Review:	
<ul style="list-style-type: none"> • Choosing a topic, Deciding the scope of topic, Significance and impact of scientific problem being addressed, Relevance to subject, current issues and social relevance, Strengths and limitations of the study, Enticing broad audience. • Literature Survey and Information to consider in the review: <ul style="list-style-type: none"> ○ Literature search using authentic library resources (print and non-print, digital and virtual) for Almanacs, Encyclopaedia, Dissertations, Theses, Research papers, Review articles, Reference/ Textbooks, and Popular articles (INFLIBNET, Google Scholar, PubMed, Highwire, Google patents, Indian patent database, etc.) ○ Analyzing the literature quality (indexing, peer review, citations, journal impact factor, etc.) • Deciding a writing approach (theoretical, experimental, interpretive, clinical, etc.), prepare the highlights and drawing important conclusion from literature 	

- Sections to include and tips for writing them: Abstract, Introduction, Body, Discussion, Conclusion, References
- Reference styles (MLA, APA, etc.), Use of bibliography/ reference/ citation managers and generators (Reference Manager, EndNote, RefWorks, Mendeley, Zotero, Qiqqa, etc.)
- Ethics of publication: Approval and consent, Data ethics (accuracy, falsification, fabrication, and confidentiality), Plagiarism and self-plagiarism, collaborative authorship, conflict of interest, legal consequences
- Content similarity detection, Use of anti-plagiarism services (Urkund, iThenticate, Turnitin, Copyscape, Grammarly, etc.)

Seminar Activity:

- Students are encouraged to deliver seminars on the topics of research, preferably published research paper in a reputed and indexed journal to develop presentation skills and enable to build confidence which will lead them to read different themes and enhance their scientific approach and knowledge assimilation abilities.
- Presentations must be created and presented by students using digital platform using a suitable software in the presence of student audience and faculty for evaluation

Course Outcomes (COs):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
AC301C.1	Retrieve, analyse, comprehend the scientific information on a given topic and derive logical inferences.	4
AC301C.2	Compile the scientific information on a topic, verify for similarity index or plagiarism.	2
AC301C.3	Deliver the interactive presentation of scientific data before audience and participate in open discussion with confidence.	2

AC-301(D): Biostatistics

(Technology + Value added Audit course; Optional: Program-level; Practical; 2 Credits)

Course Objectives (COs):

- To learn basic statistical concepts/methods and their applications in biological processes and experiments.

Unit 1	Descriptive Statistics and Presentation of Data <ul style="list-style-type: none"> • Types of Data: qualitative and quantitative data; nominal and ordinal data; discrete and continuous data; frequency and non-frequency data, Different types of scale - nominal, ordinal, ratio and interval. • Analysis of univariate Quantitative Data: Concepts of central tendency or location, dispersion, skewness and kurtosis, measures of dispersion: range, quartile deviation, variance, standard deviation. • Analysis of bivariate Data: measures of association, correlation. • Presentation of Data: construction of tables with one or more factors of classification, diagrammatic and graphical representation of non-frequency data, frequency distributions, histogram. • Graphical presentation of data through bar graph, line graph, pie chart, histogram, dot plot, box-plot, multiple line/bar graphs etc. 	8 hrs
Unit 2	Correlation and regression <ul style="list-style-type: none"> • Bivariate data: scatter diagram, coefficient of determination, rank correlation: Spearman's rank correlation coefficient. • Meaning and concept of regression, fitting of simple linear regression and quadratic regression in single predictor variable. 	8 hrs

	<ul style="list-style-type: none"> Multivariate data: multiple regression, coefficient of determination, R-square and its interpretation, testing significance of predictor variables. 	
Unit 3	Testing of hypothesis and basic statistical designs <ul style="list-style-type: none"> Introduction of methods of sampling. Statistical hypothesis, problem of testing of hypothesis, simple and composite hypothesis, types of errors, p-value, conclusions in hypothesis testing. Statistical tests: one sample t-test, paired t-test, test for proportions, chi-square test for testing independence/association of attributes. Design of experiments: introduction to basic terms of design of experiments, standard designs: Completely Randomized Design (CRD), Randomized Block Design(RBD), concept of ANOVA, F-test in ANOVA, interpretation of results from ANOVA. 	8 hrs
Unit 4	PRACTICALS (Emphasis on examples from Biological Sciences) <ul style="list-style-type: none"> Based on graphical Representation Based on measures of Central Tendency & Dispersion Based on Distributions Binomial Poisson Normal Based on t, f, z and Chi-square Based on basic statistical designs 	6 hrs
Suggested readings: <ol style="list-style-type: none"> Le CT (2003) Introductory Biostatistics. 1st edition, John Wiley Miller, Irwin and Miller, Marylees (2006): John E. Freund's Mathematical Statistics with Applications, (7th Edn.), Pearson Education, Asia. Edmondson A and Druce D (1996) Advanced Biology Statistics, Oxford University Press. Danial W (2004) Biostatistics: A foundation for Analysis in Health Sciences, John Wiley and Sons Inc. Design and Analysis of Experiments by Montgomery D.C. (2001), John Wiley. 		

Course Outcomes (COs):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
AC301D.1	Describe and identify data generated from biological processes and experiments.	1
AC301D.2	Use summary statistics: measures of central tendency, measures of dispersion with their interpretations for explain the data more effectively through graphical tools.	3
AC301D.3	Apply knowledge of correlation, regression analysis and testing of hypothesis to real life data and understand their interpretation.	3

SEMESTER-IV

BT- 401 INDUSTRIAL AND BUSINESS BIOTECHNOLOGY

100 marks

Course Objectives:

- 1.The objectives of this course are to teach students about concepts of entrepreneurship including identifying a winning business opportunity, gathering funding and launching a business, growing and
2. nurturing the organization and harvesting the rewards.

UNIT- I

Microbial Production of Organic Acids and Solvents: Production of alcohol by fermentation, Production, recovery and applications of Glycerol, Acetone and butanol, Citric acid, Gluconic acid, Acetic acid, Lactic acid,

UNIT- II

Microbial Production, recovery and applications of Amino Acids: L-Glutamic acid, L-Lysine, L- Phenylalanine and L-Tryptophan, L-Threonine. Microbial Production, recovery and applications of Vitamins: Vitamin-B 12 and Riboflavin. Production of Chemotherapeutic Agents: Production, recovery and applications of antibiotics: Penicillin, Streptomycin, Tetracycline, Erythromycin.

UNIT- III

General features of microbial polysaccharides, Production, recovery and applications of polysaccharides: Xanthan, Dextran and Alginate, Polyhydroxy alkanooates: Chemistry and properties, Polyhydroxybutyrate (PHB), Biopol-a biodegradable plastic, Microbial recovery of petroleum

UNIT- IV

Production and applications of Proteases, Pectinases, Cellulases, Lipase, Glucose isomerase, Penicillin acylase, Microbial transformation, Types of bioconversion reactions: Oxidation, Reduction, Hydrolytic reactions, Condensations, Transformation of steroids and sterols. Transformation of nonsteroidal compounds: L-ascorbic acid, Prostaglandins, Antibiotics,

UNIT- V

Principles of management, Marketing concepts and functions, Time event-time study (CPM and PERT), Concept and Importance of entrepreneurship and self-employment in India, ISO 9000 quality system standards, Biosafety & IPR

Recommended Books:

1. Manual of Industrial Microbiology and Biotechnology, III edition (1999), Arnold L. Demain and Julian Davies, ASM press, Washington DC
2. Food microbiology,
Frazier
3. Industrial Microbiology,
Casida
4. Principles of Fermentation Technology by Whitaker, Stanbury,
Hall

Course Outcomes (COs):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C401.1	to gain entrepreneurial skills, understand the various operations involved in venture creation,	2
C401.2	to identify scope for entrepreneurship in biosciences	2
C401.3	to utilize the schemes promoted through knowledge centres and various agencies.	4

BT-402 BIOINFORMATICS

100 marks

Course Objectives:

1. To impart training about elementary aspects of statistics used in biotechnology
2. To introduce student to the variety of computational methods currently available for predicting functional behaviour of biological system
3. To analyse the output data to predict a biologically relevant function

UNIT- I

Genomics: The impact of bioinformatics and functional genomics on biology in the 'Post genomic era'. Approaches for finding genes and regulatory regions in genomic sequence, structural genomics, Functional genomics, Comparative genomics, oligonucleotide fingerprinting, Gene chips.

UNIT- II

Proteomics : Novel approaches to protein expression analysis: 1D and 2 D Electrophoresis, Immobilized pH gradient, Sample preparation, First dimension criteria, second dimension criteria, Stabilization, Electro blot, Image analysis, Digital imaging, Spot detection and quantification, Gel matching.

Database for 2D gel. Mass Spectrometry for protein and peptide analysis: MALDI-TOF,

Application of proteome analysis to drug development. Protein chips.

UNIT- III

Introduction to biological databases – NCBI, PUBMED, sequence databases: Gene bank, DDBJ, Swissprot, PIR, EMBL, structural databases: PDB, MMDB, specialized databases, sequence retrieval system - SRS, ENTREZ, Expasy.

UNIT- IV

Sequence analysis and phylogeny - sequence and similarity: FASTA, BLAST, sequence alignment: local, global, pair wise and multiple sequence, introduction to scoring matrices- PAM and BLOSSUM, introduction to phylogenetic trees, Protein structure prediction - Secondary structure prediction, 3D Structure prediction.

UNIT-V

Data Mining and Data Visualization, Software for Data Visualization ,CN3D,Rasmol,Mol –Mol, Pymol, Chimera, SWISS PDB Viewer, DISCOVERY STUDIO, and MODELLER, Introduction to Bioperl and Biojava, Online Free web resources.

Recommended Books:

1. Bioinformatics: Sequence and Genome Analysis by David W. Mount, Cold Spring Harbor Laboratory Press
2. Biological Sequence Analysis : Probabilistic Models of Proteins and Nucleic Acids by Richard Durbin, Sean R. Eddy, Anders Krogh, Graeme Mitchison, Cambridge University Press.
3. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, Second Edition by Andreas D. Baxevanis, B. F. Francis Ouellette, Wiley-Interscience
4. Foundations to bioinformatics – Evolution, similar macromolecular components, constancy of gene number and core proteome in closely related organisms
5. Bioinformatics data – nucleic acid sequence, protein sequence, protein structure, genomic, proteomic and metabolomic information
6. Bioinformatics databases – types, design, file formats, access tools with examples
7. Bioinformatics tools and Resources – free online tools, downloadable free tools, software packages, internet, Bioinformatics books and Journals, Bioinformatics web-portals
8. Daniel C. Leibler, (2002), Introduction to Proteomics: Tools for New Biology, Humana Press, Totowa, NJ. Branden, Carl and Tooze John. 1999. Introduction to Protein Structure (2nd. Ed.),Garland Publishing, NY, USA.
9. Mount, David, W., (2001); Bioinformatics: Sequence and Genome Analysis, Cold Spring Harbor Lab. NY,
10. Pennington, S, (Editor), M. J. Dunn (Editor); (2001); Proteomics: From Proteins Sequence to Function, Springer Publications
11. Palzkill, Timothy; (2002); Proteomics, Kluwer Academic Publishers
12. Suhai, Sandor, (ed). (2000); Genomics and Proteomics : Functional and Computational Aspects,Plenum Pub. Corp.
13. Shanmughavel, P. 2005. Principles of Bioinformatics, Pointer Publishers, Jaipur, India.

Course Outcomes (COs):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C402.1	access information from databases and interpret phylogenetic tree to gain insight into evolutionary path	4
C402.2	understand various algorithms	2
C402.3	practice biostatistics for interpretation of experimental data.	4

BT-403 PHARMACEUTICAL BIOTECHNOLOGY

100 marks

Course Objectives:

1. To introduce knowledge about antibiotics, biopharmaceuticals and GMP, ICH process
2. To familiarize the students with spoilage and regulatory aspects as well as quality control issues in pharmaceuticals.

UNIT -I : Chemotherapy

Antimicrobial drug, Mechanism of action of antimicrobial agents. Microbial resistance to antibiotics and antimicrobial agents (Types and Mechanism). Types of Antibiotics: Classification of antibiotics with example. General characteristics of secondary metabolites: Types and medicinal applications

UNIT-II : Chemotherapeutics Agents

Structure, Mechanism of action and Applications of antibacterial drugs: Sulfonamides, Quinolones. Antiviral drugs: Amantadine, Azidothymidine. Antifungal drug: Nystatin, Griseofulvin. Mechanism of action of anticancer drugs, Drugs acting on CNS, Insulin, Blood factor VIII.

UNIT III: Delivery, Discovery and Development of Drug

History, Drug delivery type: oral, nasal, urogenital, rectal, dermal, injection. Drug targeting, Molecular Biology and Combinatorial drug discovery, Rational Drug designing. Computer Aided Drug Discovery, Concept of Chemo-informatics, special toxicity tests like teratogenicity and mutagenicity. Drug delivery systems, Liposomes.

Unit -IV: Toxicity and clinical trials

Estimation of toxicity: Concept of LD50 and ED50 and their significance, Preclinical trials: Pharmacokinetics and Pharmacodynamics of Peptide and Protein drugs, Clinical trial design: Trial size and study population, Randomized control studies. Guides to good manufacturing practice, FDA, CDS, Water for processing, final product fill, Freeze drying, labeling and packaging, Analysis of final product: Protein and DNA based contaminants, Endotoxin detection, Pyrogen detection, Microbial and viral contaminants, Validation studies.

Unit - V: Biopharmaceutical

Biopharmaceuticals of animal, plant and microbial origin, Hematopoietic growth factors and coagulation factors, Interferons and cytokines for anti-infective and cancer therapy, Insulin and growth hormones, Genetically improved vaccines, Recombinant thrombolytic agents: Tissue type

plasminogen activator, Gene therapy, Ex vivo and In vivo gene therapy, Antigene and antisense therapy.

Text & References :

1. Hugo W. B. and Russell A. D. - Pharmaceutical Microbiology -Wiley India
2. AshutoshKar-Pharmacology and Pharmacobiotechnology-New Age
3. FSK Barar- Pharmaceutical- Essentials of Pharmaceuticals- S.Chand
4. B. Glick and J Pasernak -Molecular Biotechnology –ASM Press.
5. Doble- Drug Designing-McGraw Hill
6. S.P. Vyas, Dixit- Pharmaceutical Biotechnology-CBS
7. B. Razdan-Medicinal Chemistry-CBS
8. Satoskar, Bhandarkar- Pharmacology and Pharmacotherapeutics- Popular
9. Purohit, Saluja- Pharmaceutical Biotechnology-Student Edition
10. Ramawat K.G; Merillon J.M - Biotechnology: Secondary Metabolites-Oxford
11. Ed. R.H. Thomson-Chemistry of Natural Products-Springer

Course Outcomes (COs):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C403.1	To get in-depth knowledge on different categories of antibiotics and biopharmaceuticals	2
C403.2	To understand drug design, quality control and regulatory elements of pharmaceutics	2
C403.3	To discriminate conventional and combinatorial tools used in drug discovery	4

BT-404: LAB COURSE VII

100 marks

Course Objectives:

1. To introduce the students with comprehensive information and insights in pharmaceutical biotechnology and the development of biopharmaceuticals in pharmaceutical industry.
2. To familiarize the students with an understanding in both scientific knowledge of designing and producing novel biologics, and business challenges in biopharmaceutical companies, including regulatory issues.

1. Estimation of penicillin/streptomycin by biological assay.
2. Estimation of penicillin/streptomycin by chemical assay.
3. Assay of antimicrobial activity of Penicillin, Chloramphenicol, streptomycin
4. Determination of Minimum Inhibitory Concentration (MIC) of Antibiotic
5. Determination of shelf life of antibiotics (Expired drugs)
6. Sterility testing of commercial pharmaceuticals.
7. Study of microbial spoilage of pharmaceuticals.
8. Pair wise alignment of DNA and Protein
9. To perform multiple sequence alignment of DNA and Protein
10. Protein structure visualization and molecular modeling
11. Secondary structure prediction
12. To perform phylogenetic analysis

Course Outcomes (COs):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C404.1	To get in-depth knowledge on different categories of antibiotics and biopharmaceuticals	3
C404.2	. To understand drug design, quality control and regulatory elements of pharmaceuticals	2
C404.3	To discriminate conventional and combinatorial tools used in drug discovery	4

BT-405 LAB COURSE–VIII (PROJECT)

100 marks

Course Objectives: The main purpose of this course is to help students organize ideas, material and objectives for their dissertation and to begin development of communication skills.

Project (Dissertation)

The project allotted during the fourth semester will be continued and it is expected that the students will design experiments and collect experimental data to deduce conclusions. At the end, they will submit a detailed thesis for evaluation. The students should be introduced to research methodology in the beginning through few lectures.

The approach towards the execution of project should be as follows:

1. Selection of topic relevant to priority areas of biotechnology.
2. Collection of literature from libraries, internet, on-line journals, etc.
3. Planning of research experiments
4. Performing the experiments with scientific and statistical acceptability.
5. Presentation of observations and results.
6. Interpretation of results and drawing important conclusions.
7. Discussion of obtained results with respect to literature reports.
8. Preparation of report (thesis) containing introduction, materials and methods, results and discussion, conclusions, bibliography.
9. Presentation of research data.

Course Outcomes (COs):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C405.1	Conceive a problem based on published research and carry out comprehensive survey of literature	4
C405.2	Plan and carry out task in given framework of dissertation and present the work in written and viva	6
C405.3	Use a holistic view to critically, independently and creatively identify, formulate and deal with complex issues.	6
C405.4	Learn handling of instruments, use of chemicals and how to conduct the experiments	3
C405.5	Learn how to present the project in power point and answer the queries to examiners as well as science of writing	6

M.Sc. Part II Semester IV (Biotechnology): Audit Courses

AC-401(A): Human Rights (Professional and Social + Value Added Audit course; Practical; 2 Credits) (Optional: Campus-level)		
	Course Objectives (CObs): • To make students aware about human rights and human values.	
Unit 1	Introduction to Human Rights 1.1 Concept of Human Rights 1.2 Nature and Scope of Human Rights 1.3 Fundamental Rights and Fundamental Duties 1.4 Interrelation of Rights and Duties	6 hrs.
Unit 2	Human Rights in India 2.1 Meaning and Significance of : 1) Right to Equality 2) Right to Freedom, 3) Right against Exploitation, 4) Right to Freedom of Religion, 5) Cultural and Educational Rights, and 6) Right to Constitutional Remedies. 2.2 Constitutional Provisions for Human Rights 2.3 Declaration of Human Rights 2.4: National Human Rights Commission	8 hrs.
Unit 3	Human Values 3.1: Meaning and Definitions of Values 3.2: Importance of values in the life of Individual 3.3: Types of Values 3.4: Programmes for conservation of Values	8 hrs.
Unit 4	Status of Social and Economically Disadvantaged people and their rights 4.1: Rights of women and children in the context of Social status 4.2: The Minorities and Human Rights 4.3: Status of SC/ST and other Indigenous People in the Indian Scenario 4.4: Human rights of economically disadvantaged Society	8 hrs.
Suggested readings: 1. Human rights education – YCMOU, Nasik 2. Value education – SCERT, Pune 3. Human rights reference handbook – Lucille whare		

Course Outcomes (COs):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
AC401A.1	Practice the learned issues under human rights and human values in real life.	3
AC401A.2	Provide social justices to people around them and provide guidance about human rights to their friends, parents and relatives.	5

AC-401(B): Current Affairs (Professional and Social + Value Added Audit course; Practical; 2 Credits) (Optional: Campus-level)			
<i>Course Objectives (COs):</i>			
<ul style="list-style-type: none"> To make students updated about current affairs of India and world. 			
	Title	Content	Hours
Unit 1	Politics & Economy	<ul style="list-style-type: none"> National & International Political Activity, Organization. Economy & Business, Corporate world 	08
Unit 2	Awards and recognitions	<ul style="list-style-type: none"> National & International Awards and recognitions Books and authors 	07
Unit 3	Science & Technology	<ul style="list-style-type: none"> Software, Automobile, Space Research New inventions and discoveries 	07
Unit 4	Environment & Sports	<ul style="list-style-type: none"> Summit & conference, Ecology & Climate, Organization. National & International Games, Olympics, commonwealth etc. 	08
Suggested readings (Use recent years' data and current literature):			
<ol style="list-style-type: none"> India 2019, by Publications Division Government of India Manorama Year Book by Philip Mathew, India 2019, Rajiv Maharshi Quick General Knowledge 2018 with Current Affairs Update, Disha Experts General Knowledge 2018: Latest Who's Who & Current Affairs by RPH Editorial Board. 			

Course Outcomes (COs):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
AC401B.1	Identify important issues currently/ recently happening in India or world.	5
AC401B.2	Summarize current affairs regularly.	6

AC-401(C): Seminar + Review Writing (Technology + Value added Audit course; Optional: Program-level; Practical; 2 Credits)	
<i>Course Objectives (COs):</i>	
<ul style="list-style-type: none"> To motivate students to develop skills to search, retrieve, interpret, organize, and present relevant biological information. 	
Writing a Scientific Literature Review:	
<ul style="list-style-type: none"> Choosing a topic, Deciding the scope of topic, Significance and impact of scientific problem being addressed, Relevance to subject, current issues and social relevance, Strengths and limitations of the study, Enticing broad audience. Literature Survey and Information to consider in the review: <ul style="list-style-type: none"> Literature search using authentic library resources (print and non-print, digital and virtual) for Almanacs, Encyclopaedia, Dissertations, Theses, Research papers, Review articles, Reference/ Textbooks, and Popular articles (INFLIBNET, Google Scholar, PubMed, Highwire, Google patents, Indian patent database, etc.) Analyzing the literature quality (indexing, peer review, citations, journal impact factor, etc.) Deciding a writing approach (theoretical, experimental, interpretive, clinical, etc.), prepare the highlights and drawing important conclusion from literature Sections to include and tips for writing them: Abstract, Introduction, Body, Discussion, Conclusion, References Reference styles (MLA, APA, etc.), Use of bibliography/ reference/ citation managers and generators (Reference Manager, EndNote, RefWorks, Mendeley, Zotero, Qiqqa, etc.) 	

- Ethics of publication: Approval and consent, Data ethics (accuracy, falsification, fabrication, and confidentiality), Plagiarism and self-plagiarism, collaborative authorship, conflict of interest, legal consequences
- Content similarity detection, Use of anti-plagiarism services (Urkund, iThenticate, Turnitin, Copyscape, Grammarly, etc.)

Seminar Activity:

- Students are encouraged to deliver seminars on the topics of research, preferably published research paper in a reputed and indexed journal to develop presentation skills and enable to build confidence which will lead them to read different themes and enhance their scientific approach and knowledge assimilation abilities.
- Presentations must be created and presented by students using digital platform using a suitable software in the presence of student audience and faculty for evaluation

Course Outcomes (COs):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
AC401C.1	Retrieve, analyse, comprehend the scientific information on a given topic and derive logical inferences.	4
AC401C.2	Compile the scientific information on a topic, verify for similarity index or plagiarism.	2
AC401C.3	Deliver the interactive presentation of scientific data before audience and participate in open discussion with confidence.	2

AC-401(D): Intellectual Property Rights (IPR) (Professional and Social + Value Added Audit course; Practical; 2 Credits) (Optional: Program-level)		
	<i>Course Objectives (COs):</i> <ul style="list-style-type: none"> • To provide basic knowledge on intellectual property rights and their implications. • To understand ethical issues relevant to biology from the perspective of national and international law. 	
Unit 1	History and Introduction to Intellectual Property Rights: Evolution of patent Laws, History of Indian Patent System, Concept of IPR, Designs, Trademarks TM, Trade Secret (TS), Domain Names, Geographical Indications, Copyright	6 hrs.
Unit 2	Classification of patents and ownership: Classification of patents in India, Classification of patents by WIPO, Categories of Patent, Special Patents Ownership of patent, Rights of patent holder and co-owners, Duties of patent holder and co-owners, Transfer of patent Rights, Limitations of patent Rights, Restoration of Patents, Infringement of patent Rights and Offences, Actions against Infringement and Remedies and Relief	6 hrs.
Unit 3	Protection of biological materials and Biodiversity Methods of protection of plant and plant products, Essentialities of plant protection, Plant variety protection and Farmers' Right Act, UPOV convention (plant Varieties) 1961, National Biodiversity Act- 2002, Protection of environment and biodiversity	6 hrs.
Unit 4	Biosafety and good laboratory practices Overview of biosafety, Risk assessment, Cartagena protocol on Biosafety, Biosafety Levels, GMOs and LMOs, Gene flow and environmental impact, opportunities and challenges Roles of Institutional Biosafety Committee, RCGM, GEAC in food and agriculture Risk analysis, assessment and management, International regulatory bodies Importance of good laboratory practices, General good laboratory practices	6 hrs.

Unit 5	Bioethics Introduction, ethical conflicts in biological sciences - interference with nature, bioethics in health care - patient confidentiality, informed consent, euthanasia, artificial reproductive technologies etc Bioethics in research – cloning and stem cell research in human, animal rights/welfare in experimentation Agricultural biotechnology - Genetically engineered food, environmental risk, labeling and public opinion. Sharing benefits and protecting future generations, biopiracy	6 hrs.
---------------	--	---------------

Suggested readings:

1. Complete Reference to Intellectual Property Rights Laws. (2007). Snow White Publication Oct.
2. Deepa Goel, Shomini Parashar (2013) IPR, Biosafety and Bioethics Always learning, Pearson Education India, ISBN 9332514240, 9789332514249
3. Department of Biotechnology <http://dbtindia.gov.in/guidelines-biosafety>
4. Ganguli, P. (2001). Intellectual property rights: Unleashing the knowledge economy. New Delhi: Tata McGraw-Hill Pub.
5. International Union for the Protection of New Varieties of Plants. <http://www.upov.int>
6. Kuhse, H. (2010). Bioethics: An anthology. Malden, MA: Blackwell.
7. National Biodiversity Authority. <http://www.nbaindia.org>
8. National Portal of India. <http://www.archive.india.gov.in>
9. Office of the Controller General of Patents, Design & Trademarks; Government of India. <http://www.ipindia.nic.in/>
10. Wolt, J. D., Keese, P., Raybould, A., Fitzpatrick, J. W., Burachik, M., Gray, A., Wu, F. (2009). Problem formulation in the environmental risk assessment for genetically modified plants. *Transgenic Research*, 19(3), 425-436. doi:10.1007/s11248-009-9321-9
11. World Intellectual Property Organisation. <http://www.wipo.int>
12. World Trade Organisation. <http://www.wto.org>

Course Outcomes (COs):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
AC401D.1	Understand to classify, identify advantages of intellectual property and IPR	3
AC401D.2	Understand the need to protect biological diversity and follow bioethical practices in research work, awareness to protect intellectual property relevant to biology	2
