KAVAYITRI BAHINABAI CHAUDHARI
NORTH MAHARASHTRA UNIVERSITY
JALGAON

SYLLABUS FOR

Master of Science

in

Biochemistry

(w.e.f. Academic Year 2019 – 2020)

School of Life Sciences

Kavayitri Bahinabai Chaudhari North Maharashtra University, Jalgaon

M. Sc. Biochemistry (w. e. f. A. Y. 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	8 + 8	**16**	1	4 + 0	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	3	8 + 4	**12**	2	8 + 0	8	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	
(A)	**Prerequisite and Core Courses**									
	Theory	4	2	4	3	4	2	4	2	36
	Practical	4	2	4	1	4	2	4	1	24
(B)	**Skill Based/ Subject Elective Courses**									
1	Theory /Practical	4	1	4	1	4	1	8	2	20
(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			
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-201 (A)	Soft Skills	AC-301(A)	Computer Skills	AC-401(A)	Human Rights
		AC-201 (B)	Sport Activities	AC-301(B)	Cyber Security	AC-401 (B)	Current Affairs
		AC-201 (C)	Yoga	AC-301(C)	Seminar + Review Writing	AC-401(C)	Seminar + Review Writing
		AC-201 (D)	Music	AC-301(D)	Biostatistics	AC-401(D)	Intellectual Property Rights (IPR)

***Semester-wise Course Structure of M.Sc.- I Biochemistry* (w. e. f. A Y 2019-2020)**

Semester – I

Course	Course Type	Course Title	Teaching Hours/ Week			Marks (Total 100)				Credits
			T	P	Total	Internal		External		
						T	P	T	P	
BC-101	Core	Enzymes & Enzyme Technology	4	--	4	40	--	60	--	4
BC-102	Skill based	Analytical Biochemistry	4	--	4	40	--	60	--	4
BC-103	Core	Microbial Physiology	4	--	4	40	--	60	--	4
BC-104	Core	Lab. Course I (Microbial Techniques)	--	4+4	8	--	40	--	60	4
BC-105	Core	Lab. Course II (Biochemical Techniques)	--	4+4	8	--	40	--	60	4
AC-101	Audit Course	Practicing Cleanliness		2	2	--	100	--	--	2
Total Credit for Semester I: 22 (T = Theory: 08; P = Practical: 8; 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	
BC-201	Core	Human Physiology and Biochemistry of Specialized Tissues	4	--	4	40	--	60	--	4
BC-202	Core	Bioenergetics and Metabolism	4	--	4	40	--	60	--	4
BC-203	Core	Immunology	4	--	4	40	--	60	--	4
BC-204	Core	Lab. Course III ((Enzymology)	--	4+4	8	--	40	--	60	4
BC-205	Skill Based	Lab. Course IV (Applied Microbiology)	--	4+4	8	--	40	--	60	4
AC-201/2/3/4	Audit Course	Choose one out of Four (AC-201/ AC-202/AC-203/AC-204) 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-wise Course Structure of M.Sc.- II Biochemistry* (w. e. f. A Y 2020-2021)**

Semester – III

Course	Course Type	Course Title	Teaching Hours/ Week			Marks (Total 100)				Credits
			T	P	Total	Internal		External		
						T	P	T	P	
BC-301	Core	Molecular Biology	4	--	4	40	--	60	--	4
BC-302:	Core	Plant Biochemistry & Biotechnology	4	--	4	40	--	60	--	4
BC-304:	Core	Laboratory Course - V	--	4+4	8	--	40	--	60	4
BC-305:	Core	Laboratory Course - VI	--	4+4	8	--	40	--	60	4
BC-303	Elective (Select any one)	Toxicology	4	--	4	40	--	60	--	4
MB-303:		Applied and Environmental Microbiology								
BT-303		Advanced Environmental Biotechnology								
AC-301/2/3/4	Audit Course	Choose one out of Four (AC-301/ AC-302/AC-303/AC-304) from Technology + Value Added Courses	--	2	2	--	100	--	--	2
Total Credit for Semester III: 22 (T = Theory: 8; P = Practical:8; Skill Based: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	
BC-401	Core	Genetic Engineering	4	--	4	40	--	60	--	4
BC-402	Core	Fermentation Technology	4	--	4	40	--	60	--	4
BC-404	Core	Lab Course VII	--	4+4	8	--	40	--	60	4
BC-405	Core	Lab Course VIII(Project))	--	4+4	8	--	40	--	60	4
BC-403	Elective (Select any one)	Industrial Biotechnology and Food Biochemistry	4	--	4	40	--	60	--	4
MB-403		Agricultural Microbiology								
BT-403		Pharmaceutical Biotechnology								
AC-401/2/3/4	Audit Course	Choose one out of Four (AC-401/ AC-402/AC-403/AC-404) from Professional and Social + Value Added Courses	--	2	2	--	100	--	--	2
Total Credit for Semester IV: 22 (T = Theory: 8; P = Practical:8; Skill Based:4; Audit Course:2)										

Program at a Glance

Name of the Program (Degree)	:	M. Sc. (Biochemistry)
Faculty	:	Science and Technology
Duration of the Program	:	Two years (four semesters)
Medium of Instruction and Examination	:	English
Exam Pattern	:	60: 40 (60 marks University exam and 40 marks continuous internal departmental exam/assessment).
Passing Standards	:	40% in each exam separately (separate head of passing)
Evaluation Mode	:	CGPA
Total Credits of the program	:	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:

1. To impart the profound theoretical and practical knowledge of the specific science discipline along with the fundamental core concepts
2. To train the students to employ modern techniques, tools, methodologies, equipment, hardware/software etc. to perform objective oriented scientific and planned experiments.
3. To groom the students for all-round development and mould them in a trained workforce to provide teaching-learning, research, business, professional supports in the various science disciplines.
4. To make the student to develop the ability to think analytically, independently and draw logical conclusions to solve real-life problems.
5. To utilize the skills and knowledge gained through the subject to deal with real life situations and problems related to society, environment, research and development etc.

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

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

PO No.	PO	Cognitive level
PO1	Understand the basic concepts, fundamental principles, and the scientific theories related to various scientific phenomena and their relevancies in the day-to-day life.	**2**
PO2	Administer the skills in handling scientific instruments, planning and performing laboratory experiments	**3**
PO3	Analyze the given scientific experimental data critically and systematically, and the ability to draw the objective conclusions.	**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	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 (PSOs):

- To develop understanding of the fundamental concepts, principles and processes underlying the various aspects of living organisms.
- To understand the concepts of molecular biology, immunology, metabolism, microbiology, plant tissue culture and enzymes, fermentation & recombinant DNA technology and their applications in industry.
- To undertake hands on lab work and practical activities which develop problem solving abilities required for successful career in academics/higher studies or in pharmaceutical, agriculture, chemical, food processing and cosmetic industries/sectors.
- To recognize and appreciate the importance of the biochemistry and its applications in academic, social, environmental, economic and commercial context.

Program Specific Outcomes for M. Sc. Biochemistry program

After completion of the M. Sc. Biochemistry program, the students should be able to:

PO No.	PO	Cognitive level
PSO1	Develop a coherent understanding of the fundamental concepts, principles and processes underlying the academic field of biological chemistry and its subfields.	**3**
PSO2	Develop the skills in handling scientific instruments, planning and performing laboratory experiments.	**3**
PSO3	Illustrate problem solving abilities required for successful career in pharmaceuticals, agriculture, medical, chemical, food processing, cosmetics and related industries.	**2**
PSO4	Appraise the experimental data critically and systematically to deduce the conclusions.	**4**
PSO5	Develop communication skills and qualities such as undertaking research, teamwork, social responsibilities, managerial, leadership, entrepreneurship, which will help in expressing ideas and views clearly and effectively.	**3**
PSO6	Recognize the real problems and solve them on the basis of acquired knowledge.	**6**

Course Structure of M.Sc.- I Biochemistry (w. e. f. A Y 2019-2020)

Semester – I

Course	Course Type	Course Title	Teaching Hours/ Week			Marks (Total 100)				Credits
						Internal		External		
			T	P	Total	T	P	T	P	
BC-101	Core	Enzymes & Enzyme Technology	4	--	4	40	--	60	--	4
BC-102	Skill based	Analytical Biochemistry	4	--	4	40	--	60	--	4
BC-103	Core	Microbial Physiology	4	--	4	40	--	60	--	4
BC-104	Core	Lab. Course I (Microbial Techniques)	--	4+4	8	--	40	--	60	4
BC-105	Core	Lab. Course II (Biochemical Techniques)	--	4+4	8	--	40	--	60	4
AC-101	Audit Course	Practicing Cleanliness		2	2	--	100	--	--	2
Total Credit for Semester I: 22 (T = Theory: 08; P = Practical: 8; Skill Based: 4; Audit Course:2)										

Semester – II

Course	Course Type	Course Title	Teaching Hours/ Week			Marks (Total 100)				Credits
						Internal		External		
			T	P	Total	T	P	T	P	
BC-201	Core	Human Physiology and Biochemistry of Specialized Tissues	4	--	4	40	--	60	--	4
BC-202	Core	Bioenergetics and Metabolism	4	--	4	40	--	60	--	4
BC-203	Core	Immunology	4	--	4	40	--	60	--	4
BC-204	Core	Lab. Course III ((Enzymology)	--	4+4	8	--	40	--	60	4
BC-205	Skill Based	Lab. Course IV (Applied Microbiology)	--	4+4	8	--	40	--	60	4
AC-201/2/3/4	Audit Course	Choose one out of Four (AC-201/ AC-202/AC-203/AC-204) 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)										

Course Structure of M.Sc.- II Biochemistry (w. e. f. A Y 2020-2021)

Semester – III

Course	Course Type	Course Title	Teaching Hours/ Week			Marks (Total 100)				Credits
						Internal		External		
			T	P	Total	T	P	T	P	
BC-301	Core	Molecular Biology	4	--	4	40	--	60	--	4
BC-302:	Core	Plant Biochemistry & Biotechnology	4	--	4	40	--	60	--	4
BC-304:	Core	Laboratory Course - V	--	4+4	8	--	40	--	60	4
BC-305:	Core	Laboratory Course - VI	--	4+4	8	--	40	--	60	4
BC-303	Elective (Select any one)	Toxicology	4	--	4	40	--	60	--	4
MB-303:		Applied and Environmental Microbiology								
BT-303		Advanced Environmental Biotechnology								
AC-301/2/3/4	Audit Course	Choose one out of Four (AC-301/ AC-302/AC-303/AC-304) from Technology + Value Added Courses	--	2	2	--	100	--	--	2
Total Credit for Semester III: 22 (T = Theory: 8; P = Practical:8; Skill Based:4; Audit Course:2)										

Semester– IV

Course	Course Type	Course Title	Teaching Hours/ Week			Marks (Total 100)				Credits
						Internal		External		
			T	P	Total	T	P	T	P	
BC-401	Core	Genetic Engineering	4	--	4	40	--	60	--	4
BC-402	Core	Fermentation Technology	4	--	4	40	--	60	--	4
BC-404	Core	Lab Course VII	--	4+4	8	--	40	--	60	4
BC-405	Core	Lab Course VIII (Project))	--	4+4	8	--	40	--	60	4
BC-403	Elective (Select any one)	Industrial Biotechnology and Food Biochemistry	4	--	4	40	--	60	--	4
MB-403		Agricultural Microbiology								
BT-403		Pharmaceutical Biotechnology								
AC-401/2/3/4	Audit Course	Choose one out of Four (AC-401/ AC-402/AC-403/AC-404) from Professional and Social + Value Added Courses	--	2	2	--	100	--	--	2
Total Credit for Semester IV: 22 (T = Theory: 8; P = Practical:8; Skill Based:4; Audit Course:2)										

M. Sc. – I; Semester-I

BC - 101: Enzymes and Enzyme Technology

(Core course; Theory; 4 Credits)

Course Objectives (CObs):

- Students will understand the fundamentals of kinetics, regulation, mechanism of catalysis and role of enzymes in human health and industry.
- Students will gain knowledge of enzyme immobilization and biosensors, their principles and techniques.
- Students will be able to know the practical applications (clinical, biological and industrial) of enzymes.

Unit I:	Enzyme classification, enzyme-substrate complex, concept of active centre/site, effect of temperature, pH and substrate concentration on reaction rate, activation energy, transition state theory. Enzyme activity, International units, specific activity, turnover number. Enzyme kinetics: Michelis - Menten equation and its derivation, significance of Vmax and Km, Bisubstrate reaction , examples and reaction rate equations. Enzyme inhibition, types of inhibitors - competitive, non competitive and uncompetitive inhibition of enzymes, examples and experimental determination.
UnitII:	Enzyme catalysis : factors affecting catalytic efficiency of enzymes, proximity and orientation effect, distortion or strain, acid base and nucleophilic catalysis. Mechanism of catalysis of lysozyme, ribonuclease, chymotrypsin and carboxypeptidase.
Unit III:	Enzyme regulation : general mechanism of enzyme regulation, feedback inhibition, enzyme regulation by cAMP, covalent modification and allosteric regulation of enzymes. Kinetics and physiological significance of allosteric enzymes, symmetric and sequential model for action of allosteric enzymes, Isoenzymes. Enzyme turn over / Degradation : Kinetics, methods for measurement of degradation, factors affecting degradation, mechanism of degradation and significance of enzyme turn over/ degradation.
Unit IV:	Multienzyme complexes - pyruvate dehydrogenase and fatty acid synthetase, properties and advantages of multienzyme complex. Clinical aspects of enzymology : enzymes in diagnosis of diseases, enzyme deficiency and disease, enzyme inhibition and drug design, use of enzyme in determining the concentration of metabolites of clinical importance (glucose, uric acid, cholesterol, triglycerides, creatinine), enzyme therapy.
Unit V:	Enzyme Technology : Use of isolated enzyme in industrial processes, carbohydrate and protein metabolizing enzymes used in industry, use of enzymes in making of alcoholic beverages, bread, cheese , detergent, sweetners and tenderizing of meat and clarification of fruit juice, beer and wine. Enzyme Immobilization : methods of immobilization, adsorption, entrapment, micro encapsulation, covalent binding, cross linking, stabilization of soluble enzyme, application of immobilized enzymes.

	Biosensors : Principle, general features, types of biosensors, electrochemical, conductimetric, thermometric, optical etc., applications of biosensors.

Recommended Books :

1. Fundamentals of Enzymology : N. C. Price and L. Stevens (Oxford University Press)
2. Enzymes : M. Dixon and E. C. Webb (Academic Press)
3. Biochemistry: L. Stryer (W. H. Freeman & company)
4. Lehninger's Principles of Biochemistry: D. L. Nelson and M. M. Cox (W. H. Freeman & company)
5. Biotechnology : U. Satyanarayana (Books and Allied Pvt. Ltd.)

Course Outcomes (COts):

On completion of this course, it is expected that the students will be able to:

CO No.	CO	Cognitive Level
C101.1	Understand the basics and practical aspects of kinetics, regulation, mechanism of catalysis and role of enzymes.	**2**
C101.2	Critically evaluate effects of various physico-chemical parameters of enzyme kinetics.	**5**
C101.3	Develop skills required to effectively use the different enzymes for various applications and clinical correlation of enzymes.	**5**

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BC-102: Analytical Biochemistry (Skill based course)
(Skill Based; Theory; 4 Credits)

Course Objectives (CObs):

- Students will gain knowledge about basic concept of thermodynamics, pH, acids and bases, pKa, buffers and buffering mechanism.
- Students will learn concepts and working of different analytical techniques and their applications.
- Students will understand the basic concepts and principles of biochemical separation and characterization techniques.

Unit I:	Interactions in aqueous system, concept of pH, dissociation and ionization of acids and bases, pKa, buffers and buffering mechanism, Henderson - Hasselbalch equation. Microscopy - principle and applications of phase contrast, fluorescence and Electron microscopy (SEM and TEM).
UnitII:	Spectrophotometry - Beer and Lambert's law. Principle, instrumentation and applications of - UV–visible spectrophotometry, FTIR spectroscopy, NMR spectroscopy, Atomic absorption spectroscopy and X-ray diffraction spectroscopy, Circular Dichroism.
Unit III:	Separation Techniques – Chromatography - basic principle, instrumentation and applications of paper, thin layer, ion exchange, gel filtration, affinity, gas and high performance liquid chromatography, Liquid chromatography-mass spectrometry (LC-MS).
Unit IV:	Separation Techniques - Principle and applications of dialysis and ultrafiltration. Separations of proteins : precipitation: solubility, salting out, precipitation with

	solvents, precipitation organic polymers and with selective denaturation: temperature, pH and organic solvent. Electrophoresis - principle and applications of paper, agarose, polyacrylamide gel, isoelectrofocussing, density gradient gel and pulse field gel electrophoresis.
Unit V:	Centrifugation – principle, types and applications of ultracentrifugation. Tracer techniques - radioactive isotopes, half-life of radioactive compounds, autoradiography, Cerenkov radiation, liquid scintillation counter.

Recommended Books:

1. Physical Biochemistry : D. Freifelder (W. H. Freeman & company)
2. Tools in Biochemistry : D. Cooper (Wiley)
3. Analytical Biochemistry : D. Holmes and H. Peck (Longman)
4. Biophysical Chemistry : Upadhye and Upadhye (Himalaya Publ. House)
5. Physical Biochemistry : K. E. VanHolde (Prentice Hall)

Course Outcomes (COts):

On completion of this course, it is expected that the students will be able to:

CO No.	CO	Cognitive Level
C102.1	Understand the basic concept of thermodynamics, pH, acids and bases, pKa, buffers and buffering mechanism.	**2**
C102.2	Develop understanding about the concepts and working of different analytical techniques and their applications in different industries.	**3**
C102.3	Appraise with the basic concepts and principles of biochemical separation and characterization techniques (centrifugation, chromatography, spectrophotometry, electrophoresis, etc.)	**5**

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BC-103: Microbial Physiology

(Core Course; Theory; 4 Credits)

Course Objectives (CObs):

- To understand fundamentals of microbiology.
- To understand basic microbial techniques.
- To gain knowledge about applications of microbiology in different areas.

Unit I:	History of microbiology**.** Types of culture medium, basis on physical nature, components i.e. synthetic, complex and functions i.e. selective, enrichment, differential etc. and its use in enrichment and isolation of Organotrophs, chemoautotrophs and photosynthetic micro-organisms. principles of microbial nutrition i.e. media components Macro nutrient, Micronutrients, growth factors. New approaches to bacterial taxonomy, conventional and molecular taxonomy. Bergey's manual. Pure culture techniques.
UnitII:	Definition of growth , mathematical expression of growth , growth curve, measurement of growth and growth yield , synchronous growth , continues culture, factors affecting on growth like temperature i.e. Psychrophiles and thermophiles , acidophiles, osmoprotection by osmoprotectants, water availability and oxygen, aerobic anaerobic

	organism, cultivation, toxic forms of oxygen.
Unit III:	Structure and function of cell walls of eubacteria, (peptidoglycan) and related molecules, outer membrane of Gram negative bacteria, Cell membrane structure, transporter proteins, group translocation (phosphotranfersase system,) ATP Binding Cassette mediated transport. Flagellar structure in Gram negative and positive bacteria, Cell surface structure fimbriae, pili, paracrystalline S layer, capsules and slimes, cell inclusions carbon storage polymers and other storage materials, Magnetosomes, bacterial endospores, types, properties, structure and function of gas vesicles. Viruses - discovery, classification and structure of viruses, Lysogeny. DNA viruses, RNA viruses - adenoviruses, retroviruses, Viroids and Prions.
Unit IV:	Disease reservoirs, epidemiological terminologies. Introduction to infectious disease transmission, Introduction to respiratory infections caused by bacteria and viruses, tuberculosis sexually transmitted diseases syphilis, AIDS. Diseases transmitted by animals – rabies, plague, rickettsia, lyme disease, malaria. Mycosis, cutaneous, subcutaneous and systemic, fungal toxicity.
Unit V:	History of antimicrobial agents, types Antimicrobial agents - nutritional analogs, quinolones, Control of microorganism - Sterilant, disinfectant, antiseptics. Antibiotics history, Types of antibacterial i.e. produced by prokaryotic i.e. penicillin, cephalosporins and eukaryotic organisms microlids, aminoglycosides, tetracyclins. Antifungal agents, types and its mode of actions, antiviral drugs and its mode of actions.

Recommended Books:

1. Brock Biology of Microorganisms : M. T. Madigan, J. M. Martinko and J.Parker (Benjamin-Cummings)
2. General Microbiology : R. Y. Stainer, J. L. Ingraham, M. L. Wheelis and P. R. Painter (McMillan)
3. Introduction to Modern Virology : N. J. Dimmock and S. B. Primrose (Blackwell Science Ltd.)
4. Topley and Wilson's Principles of Bacteriology, Virology and Immunity: Topley, Wilson and Arnold Miles (Baltimore, Williams and Wilkins)

Course Outcomes (COts):

On completion of this course, it is expected that the students will be able to:

CO No.	CO	Cognitive Level
C103.1	Understand the basic concepts in microbiology.	**2**
C103.2	Develop understanding of basic microbial techniques.	**3**
C103.3	Appraise with knowledge about applications of microbiology in different areas.	**5**

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BC-104: Laboratory Course – I

(Core Course; Practical; 4 Credits)

Course Objectives (CObs):

- To understand basics of microbiological techniques.
- To gain an understanding about the basic processes in microbiology and their applications.
- To inculcate skills related to designing experiments and effectively communicate the results.

1.	Preparation of solid and liquid for growth of microorganisms.
2.	Isolation of microorganisms by plating, streaking and pour plate method.
3.	Isolation of coliforms from water or sewage sample.
4.	Determination of motility of microorganisms by hanging drop method.
5.	Staining of microorganisms using Monochromatic stain.
6.	Staining of microorganisms by Negative stain method.
7.	Gram's staining of microorganisms.
8.	Staining of microorganisms by Acid fast/ Spore staining.
9.	Biochemical test : sugar/ enzymes/ IMVIC.
10.	Growth curve - measurement of bacterial population by turbidometric method and serial dilution method.
11.	Anti-bacterial activity and MIC of a commercial antibiotic.
12.	Isolation and culture of a common fungal strain.
13.	Measurement of growth by Bacterial Plate count.
14.	Antifungal activity and MIC of a commercial fungicide.
15.	Isolation of Bacteriophages by plaque assay.

Recommended Practical Books:

1. Practical Biochemistry: Principles and techniques : K. Wilson and J. Walker. (Cambridge University Press)
2. An Introduction to Practical Biochemistry : D. Plummer. (Tata McGraw Hill)
3. Laboratory Manual in Biochemistry: J. Jayaraman. (New Age Int. Publishers)
4. Methods in Agricultural Biochemistry: S. Sadashivam and A. Manikam. (New Age Int. Publishers)
5. Microbiology – a Laboratory Manual: J. G. Cappuccino and N. Sherman. (Addison Wesley Publishing Company Inc.)
6. A Laboratory Manual in General Microbiology: H. J. Benson. (McGraw-Hill Higher Education)
7. Experiments in Microbiology, Plant Pathology, Tissue Culture and Mushroom Cultivation: K. R. Aneja. (New Age International Publishers)
8. Lab Exercise in Microbiology: J. P. Harley and L. M. Prescott. (Wm. C. Brown Publishers)

Course Outcomes (COts):

On completion of this course, it is expected that the students will be able to:

CO No.	CO	Cognitive Level
C104.1	Understand the basic processes in microbiology.	**2**
C104.2	Develop expertise in microbial isolation, media preparation, staining techniques and characterization of microorganisms.	**3**
C104.3	Acquire skills related to designing experiments and interpreting data.	**4**

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BC-105: Laboratory Course – II

(Core Course; Practical; 4 Credits)

Course Objectives (CObs):

- To understand practical aspects of different chromatographic techniques.
- To gain knowledge about estimation of important biomolecules and their importance as health indicators.
- To inculcate skills related to designing experiments and effectively communicate the results.

1.	Thin Layer Chromatography (TLC) of Chlorophyll/Tannin/Carotenoids.
2.	Paper Chromatography of Amino acids.
3.	Common identification tests for Carbohydrates.
4.	Common identification tests for Proteins.
5.	Estimation of Carbohydrates by Phenol sulphuric acid method.
6.	Estimation of Carbohydrates by Anthrone's method.
7.	Estimation of Carbohydrates (reducing sugar) by Miller's method.
8.	Estimations of glucose from human serum by GOD method.
9.	Estimation of Proteins/ serum protein by Biuret's method.
10.	Estimations of serum Cholesterol.
11.	Estimation of Proteins by Folin & Lowry's method.
12.	Estimation of Proteins by Bradford's method.
13.	Demonstration of Gas Chromatography (GC), High Performance Thin Layer Chromatography (HPTLC), Spectrophotometer, Size exclusion chromatography, Ion exchange chromatography, Agarose and slab gel electrophoresis.
14.	Preparation of buffers, molar solution, normal solution and ppm solution.

Recommended Practical Books:

1. Practical Biochemistry: Principles and techniques: K. Wilson and J. Walker. (Cambridge Publishing Co.)
2. An Introduction to Practical Biochemistry: D. Plummer. (Tata McGraw Hill)
3. Laboratory Manual in Biochemistry: J. Jayaraman. (New Age Int. Publishers)
4. Methods in Agricultural Biochemistry: S. Sadashivam and A. Manikam. (New Age Int. Publishers)

Course Outcomes (COts):

On completion of this course, it is expected that the students will be able to:

CO No.	CO	Cognitive Level
C105.1	Acquire knowledge of different chromatographic techniques for characterization of biomolecules.	**3**
C105.2	Estimate important biomolecules such as Carbohydrates, Proteins, Amino acids and their importance as human health indicators.	**4**
C105.3	Develop skills related to designing experiments and interpreting the results.	**3**

*****

AC-101: Practicing Cleanliness

(Compulsory; Campus-level Audit Course; Practical; 2 Credits)

Course Objectives (CObs):

- To make students aware of Clean India Mission and inculcate cleanliness practices among them.

▪	Awareness program on o Swachh Bharat Abhiyan (Clean India Mission) o Clean Campus Mission o 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 (COts):

On completion of this course, it is expected that the students 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**

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Semester-II

BC-201: Human Physiology and Biochemistry of Specialized Tissues

(Core course; Theory; 4 Credits)

Course Objectives (CObs):

- To provide knowledge of some basic biochemical processes.
- To learn in details the biochemical basis of function of some specialized tissues.
- To inculcate knowledge related to aspects of human health.

Unit I:	Composition of blood, blood cells, blood plasma, plasma proteins. Biochemistry of blood clotting, clotting factors, intrinsic and extrinsic pathways, mechanism of formation of thrombin, fibrin, fibrin clot, role of vitamin K in clotting process, lysis of fibrin clot. Water balance, regulation of water balance, water balance disorders, electrolyte balance and its regulation.
Unit II:	Regulation of acid-base balance, types and functions of acid-base buffers, mechanism of pulmonary and renal control of acid base balance, clinical abnormalities associated with acid-base imbalance. Hormones : Types, examples, mechanism of action of steroid and protein hormones, secondary messengers, cAMP, calcium, diacyl glycerol, IP3, regulation gene expression by steroid hormones.
Unit III:	Signal transduction cascade, chemoreceptors and types, flagellar rotation, methylation of chemoreceptors. Retinal rod cell, rhodopsin, G protein cascade, biochemistry of vision, recovery and adaptation, visual cycle, colour vision. Tyrosine kinase and growth and differentiation, cancer and signal transduction proteins, ras proteins and their role.
Unit IV:	Biochemistry of muscle contraction, myosin and actin, structure and physiological role, regulation of muscle contraction, role of troponin and tropomyosin, Respiration (Breathing), respiratory air volumes and capacities, control of respiration, factors affecting respiration, principles of gaseous exchange during respiration, transport of oxygen and carbon dioxide in the blood, chloride shift, regulation of respiration, disorders of gas exchange.
Unit V:	Biological membranes and transport, physico-chemical properties of cell membranes, molecular constituents and architecture of membranes, asymmetric organization of membrane lipids and proteins. Ion transport across membranes, types of transport. Membrane channels and pumps, acetylcholine receptor channel, ligand and voltage gated channel, generation of action potential during nerve impulse transmission. Active transport, Na/K pump, structure, mechanism of action and significance.

Recommended Books :

1. Molecular Cell Biology : Darnell, Lodish and Baltimore (W. H. Freeman & company)
2. Biochemistry : L. Stryer (W. H. Freeman & company)
3. Lehninger's Principles of Biochemistry : D. L. Nelson and M.M. Cox (W. H. Freeman & company)
4. Text Book of Medical Physiology : A.C. Guyton (Saunders)
5. Human Anatomy and Physiology : J. W. Hole Jr.(McGraw-Hill Higher Education)

Course Outcomes (COts):

On completion of this course, it is expected that the students will be able to:

CO No.	CO	Cognitive Level
C201.1	Develop understanding about mechanisms of some of the basic biochemical processes taking place in living organisms including human.	**3**
C201.2	Connect with Physiology and biochemistry of specialized issues.	**4**
C201.3	Convince themselves to take up higher studies and research in the areas related to human health.	**5**

*****

BC–202: Bioenergetics and Metabolism

(Core course; Theory; 4 Credits)

Course Objectives (CObs):

- To provide knowledge of basic concepts of metabolism.
- To gain knowledge about the control of biological processes.
- To develop an understanding of biological energetics.

Unit I:	Concept of atom, molecules and chemical bonds, Laws of thermodynamics, various aspects of energy (free energy, enthalpy, entropy and free energy changes), oxidation and reduction reactions: biological perspective, High energy compounds, structure and significance of ATP, ATP synthetase complex, detailed study of oxidative phosphorylation, substrate level phosphorylation.
Unit II:	Classification, structure and properties of carbohydrates and their building blocks (sugars), detailed study including energetics, regulation and significance of glycolysis, citric acid cycle and gluconeogenesis. Alternate pathways of carbohydrate metabolism (pentose phosphate pathway, glyoxylate cycle and glucuronic acid cycle), Biosynthesis and degradation of glycogen and starch.
Unit III:	Classification, structure and properties of lipids and their building blocks(fatty acids), β - oxidation of even and odd number carbon atom fatty acids, their energetics, regulation and significance. Biosynthesis of fatty acids, fatty acid synthase complex, regulation of fatty acid biosynthesis. Desaturases and elongases and their role, Biosynthesis of triacylglycerols, phospholipids. Formation and utilization of ketone bodies, metabolism of circulating lipids.
Unit IV:	Classification, structure and properties of proteins and their building blocks (aminoacids), biosynthesis and degradation of amino acid and their regulation. Transamination and oxidative deamination. Urea cycle and its regulation. Inborn errors of amino acid metabolism.
Unit V:	Types, structure and properties of nucleic acids and their building blocks(purines and pyrimidines), Biosynthesis and catabolism of purines and pyrimidines and their regulation. Ribonucleotide reductase, biosynthesis of ribonucleotides and deoxyribonucleotides. Inhibitors of nucleic acid biosynthesis.

Recommended Books :

1. Biochemistry: L. Stryer (W. H. Freeman & company)
2. Lehninger's Principles of Biochemistry: D. L. Nelson and M. M. Cox (W. H. Freeman & company)
3. Harpers Biochemistry: R. K. Murray et al. (eds) (McGraw Hill)
4. Principles of Biochemistry: G. L. Zubay (McGraw Hill)

Course Outcomes (COts):

On completion of this course, it is expected that the students will be able to:

CO No.	CO	Cognitive Level
C202.1	Understand basic concepts of metabolism and energetics and their vital role in living organisms including human.	**2**
C202.2	Plan future study and research because this is an active area of biological research that involves energy transfer and applications in structural biology.	**4**
C202.3	Illustrate how biosynthetic processes are controlled and integrated with metabolism of the cell as well as gene regulation and biochemical aspects of evolution.	**4**

*****

BC-203: Immunology

(Core course; Theory; 4 Credits)

Course Objectives (CObs):

- To understand the basic concepts of immunology.
- To gain knowledge about health and diseases and scope of immunology.
- To acquire skill related to various immune-techniques and their role in diagnosis.

Unit I:	Overview of immunology, concepts of health and diseases, scope of immunology. Cells and tissues of the immune system: Hematopoietic stem cells, Lymphocytes, antigen presenting cells, bone marrow , thymus , lymph nodes and lymphatic system, spleen, cutaneous immune system , mucosal immune system.
Unit II:	Immunity and its types, Elements of innate immunity, Adaptive immunity and its features. Immunoglobulins, structure, types and function, Antigenic determinants on immunoglobulins: Isotype, allotype, and idiotype. clonal selection theory, introduction to the organization and expression of Ig genes, generation of antibody diversity, primary and secondary immune response, Antigens, Requirements for immunogenicity: Foreignness, Size, Chemical complexity, Dosage and route of administration. Superantigens, haptens and adjuvant,. Cytokines and its types, role.
Unit III:	Complement and its role in immune response, the classical, lectin and alternative complement pathways, biological consequences of complement activation. Major Histocompatibility Complex : Structure, properties and cellular distribution of

	MHC gene products, Antigen processing and presentation to T cells : Cytosolic and endocytic pathway.
Unit IV:	B cell maturation, activation and differentiation. B cell receptor. T cell maturation and activation, T cell receptor and its types, co-receptor molecules. Hypersensitivity and its types, autoimmunity mechanism and examples.
Unit V:	Antigen antibody interactions - Ab affinity, avidity and cross reactivity. Immuno-techniques: Precipitation reaction in fluids and gels – Radial immunodiffusion and Double immunodiffusion. Agglutination reactions, Coomb's test. Immunoassays : RIA, ELISA and its types, western blotting, immuno-electrophoresis.

Recommended Books :

1. Immunology : J. Kuby, R. Goldsby, T. Kindt and B. Osrorne. (W.H Freeman and Co.)
2. Fundamental Immunology : R. Coleman, M. Lombard and R. Sicard. (William C Brown)
3. Cellular and Molecular Immunology : A. Abbas and A. Lichtman. (WB Saunders Company)
4. Immunology for Life Scientists : Lesley Jane Eales. (Wiley-Interscience)
5. Immunology :K.R.Joshi and N. O. Osamo.(Agrobios)
6. Introduction to immunology : J. W. Kimball. (Macmillan)
7. Immunology : D. M. Weir and J. Steward.(ELBS)

Course Outcomes (COts):

On completion of this course, it is expected that the students will be able to:

CO No.	CO	Cognitive Level
C203.1	Summarize immunology, concepts of health and diseases, and scope of immunology.	**2**
C203.2	Correlate different surface membrane barriers and their protective functions.	**4**
C203.3	Familiarize with various immunological techniques and evaluate their role/application in differential diagnosis of diseases.	**5**

*****

BC-204: Laboratory Course – III

(Core course; Practical; 4 Credits)

Course Objectives (CObs):

- To understand kinetics and mechanisms of action of enzymes.
- To become familiar with the basic methods of studying enzymes.
- To acquire experimental knowledge to find appropriate employment or to continue further studies in enzyme biochemistry and related disciplines.

1.	Determination of activity of proteases (enzyme activity).
2.	Determination of activity of amylases (enzyme activity).
3.	Determination of activity of lipases (enzyme activity).
4.	Study of general purification steps in enzymology; precipitation, dialysis.
5.	Preservation of enzymes.
6.	Purification of enzyme (s) (β - amylases) from plant (sweet potato).
7.	Purification of enzyme(s) from microbial source (*Bacillus* sp. ,/ *Aspergillus* sp.).

8.	Determination of K_m and V_{max} of enzyme diastase by double reciprocal plot.
9.	Determination of specific activity of enzyme (amylase).
10.	Studies on effect of inhibitors, activators on enzyme activity.
11.	Estimation of alanine transaminase (ALT) from human serum.
12.	Estimation of aspargine transaminase from human serum.
13.	Determination of serum alkaline phosphatase human serum.
14.	Immobilization of enzymes.

Recommended Practical Books:

1. Practical Biochemistry: Principles and techniques: K. Wilson and J. Walker. (Cambridge Publishing Co.)
2. An Introduction to Practical Biochemistry: D. Plummer. (Tata McGraw Hill)
3. Laboratory manual in Biochemistry: J. Jayaraman. (New Age Int. Publishers)
4. Methods in Agricultural Biochemistry: S. Sadashivam and A. Manikam. (New Age Int. Publishers)

Course Outcomes (COts):

On completion of this course, it is expected that the students will be able to:

CO No.	CO	Cognitive Level
C204.1	Examine and illustrate enzyme kinetics, purification and activity determination of enzymes.	**3**
C204.2	Acquire knowledge and skill of different techniques in enzymology.	**3**
C204.3	Estimate important human health indicating enzymes from serum i. e. alanine transaminase, asparagine transaminase, alkaline phosphatase.	**4**

*****

BC-205: Laboratory Course – IV(Skill based)

(Skill based course; Practical; 4 Credits)

Course Objectives (CObs):

- To understand methods of quality control in microbiology.
- To become familiar with important techniques in food and probiotics preservation.
- To gain skills and acquire experimental knowledge to find appropriate employment or to continue further studies.

1.	Determination of Total viable count of food sample.
2.	Sterility testing by bacterial spore strips.
3.	Determination of Thermal death point of food pathogen.
4.	Determination of thermal death time of food pathogen.
5.	Isolations of pathogens by using specific medium.
6.	Characterization of pathogen by catalase, oxidase, DNase, lecithinase test.
7.	Determination of blood groups and Blood film preparation for detection of blood pathogens.
8.	Detection of fibril antigens (WIDAL by slide test).

9.	Malarial antigen detection test.
10.	Isolations of *Rhizobium* from plant nodules.
11.	Isolations of *Azotobacter*/nitrogen fixer from soil.
12.	Isolation of plant bacterial / fungal pathogen.
13.	Isolation of phosphate solubilizers from soil.
14.	Gradient plate technique for isolation and screening of pesticide degrader.
15.	Water analysis by MPN method.

Recommended Practical Books:

1. Lab Exercise in Microbiology: J. P. Harley and L. M. Prescott. (Wm. C. Brown Publishers)
2. Methods in Agricultural Biochemistry: S. Sadashivam and A. Manikam. (New Age Int. Publishers)
3. Microbiology – a Laboratory Manual: J. G. Cappuccino and N. Sherman. (Addison Wesley Publishing Company Inc.)
4. A Laboratory Manual in General Microbiology: H. J. Benson. (McGraw-Hill Higher Education)
5. Experiments in Microbiology, Plant Pathology, Tissue Culture and Mushroom Cultivation : K. R. Aneja. (New Age International Publishers)

Course Outcomes (COts):

On completion of this course, it is expected that the students will be able to:

CO No.	CO	Cognitive Level
C205.1	Develop understanding about quality control of food microbiology, water microbiology and agriculture microbiological products.	**3**
C205.2	Appraise with important techniques in food and probiotics preservation such as sterility testing , TDT and its determination.	**4**
C205.3	Develop skill for characterization of human and plant pathogens by morphological and biochemical tests and medical microbiology techniques.	**6**

*****

AC-201(A): Soft Skills

(Personality and Cultural Development RelatedAudit course; Practical; 2 Credits)
(Optional: Campus-level)

Course Objectives (CObs):

- To inculcate different soft skills among students.

Unit I:	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.
Unit II:	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.

Unit III:	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.
Unit IV:	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.
Unit V:	Aptitude and analytical skills; Quantitative aptitude, Numerical reasoning, verbal reasoning, diagrammatic test, situational tests, logical thinking. Analytical skills: Definition, Types, problem solving
Unit VI:	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.

Recommended Books:

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 (COts):

On completion of this course, the students 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 RelatedAudit course; Practical; 2 Credits)
(Optional: Campus-level)

Course Objectives (CObs):

- 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	• 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 (COts):

On completion of this course, the students 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 RelatedAudit course; Practical; 2 Credits)
(Optional: Campus-level)

Course Objectives (CObs):

- To motivate students towards yoga and provide them required training.

- Yog: Meaning, Definition & Introduction, Objectives
- Primary Introduction of Ashtanga Yoga
- Preparation of Yogabhyas
- Omkar Sadhana, Prayer, Guru Vandana
- Sukshma Vyayamas
- Suryanamaskar (12 Postures)
- Asanas :
  - Sitting (Baithaksthiti) - Vajrasana, Padmasan, Vakrasan, Ardha-Pashchimotanasanan
  - Supine (Shayansthiti) - Uttan Padaasan(Ekpad/Dwipad), Pavanmuktasana, Viparitakarani 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 (COts):

On completion of this course, the students 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 RelatedAudit course; Practical; 2 Credits)

(Optional: Campus-level)

Course Objectives (CObs):

- To motivate students towards Indian music and provide them minimum required training.

	• Definition and brief about generation of Swar, Saptak, Thaat, 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 (COts):

On completion of this course, the students 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**

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Semester-III

BC - 301: Molecular Biology

(Core course; Theory; 4 Credits)

Course Objectives (CObs):

- To inculcate an understanding of scientific processes of molecular biology.
- To gain understanding of finer details of the important phenomenon in molecular biology.
- To prepare the students to take up higher studies and research in the areas related to molecular biology.

Unit I:	Replication- general principles, isolation and properties of DNA polymerases, proof reading, continuous and discontinuous synthesis. Asymmetric and dimeric nature of DNA polymerase I, II & III, exonuclease activity in eukaryotic DNA polymerases. DNA: Superhelicity, linking number, topological properties, mechanism of action of topoisomerases. DNA damage and repair: Types of DNA damage, repair pathways– methyl directed mismatch repair, very short patch repair, nucleotide excision repair, base excision repair, SOS repair mechanism.
Unit II:	Transcription: General principles, basic apparatus, steps in RNA synthesis, inhibitor of transcription, control of transcription by interaction between RNA polymerase & promoter region, sigma factor, attenuation & anti termination. Maturation & processing of RNA: Methylation, cutting and trimming of rRNA, capping, polyadenylation and splicing of mRNA, catalytic RNA. Protein Biosynthesis: Steps in translation, role of various factors, various steps of translation, post translational modification, inhibitors of protein synthesis. Wobble hypothesis, Salient features of protein biosynthesis in eucaryotes, Heme controlled inhibitor and diphtheria toxin mediated inhibition of protein biosynthesis.
Unit III:	Regulation of gene expression: Operon concept, lac operon, catabolite repression , inducers & co-repressors, regulation by attenuation- trp operon. Lambda phage regulation, lytic and lysogenic pathway, autogenous regulation, stringent response. Translational repression, DNA inversion and alternating expression.
Unit IV:	Eukaryotic chromosome and gene expression, histone proteins, nucleosome, DNA packing, DNA replication, DNA polymerases, telomers, mitochondrial and chloroplast DNA, repeating sequences, Cot1/2 values, transcriptionally active regions, transcription regulatory proteins, leucine zipper and zinc finger, DNA binding protein.
Unit V:	Protein Targeting: Synthesis of exported protein on membrane bound ribosome, signal hypothesis, SRP & its role , chaperon proteins, targeting of proteins to organelles (lysosomes, mitochondria, chloroplast, ER, nucleus, and plasma membrane). Receptor mediated endocytosis, clathrin- structure and role, endosome and its role. Protein destruction.

Recommended Books:

1. Genes: B. Lewin (Oxford University Press).
2. Lewin's Genes XI : J. E. Krebs, S. T. Kilpatrick, E. S. Goldstein (Jones and Bartlett Publishers, Inc.

3. Biochemistry: L. Stryer (W.H. Freeman & co.).
4. Lehninger Principles of Biochemistry: D. L. Nelson & M. M. Cox (Macmillan Worth Publishers).
5. Molecular Cell Biology: J. Darnell, H. Lodish & D. Baltimore (Scientific American Books).
6. Fundamentals of Biochemistry: D. Voet, J. Voet & C. Prati (John Wiley & Sons).

Course Outcomes (COts):

On completion of this course, it is expected that the students will be able to:

CO No.	CO	Cognitive Level
C301.1	Understand the fundamentals of molecular biology and molecular processes occurring in and between cells.	**2**
C301.2	Appraise with in-depth knowledge of biological processes through the exploration of underlying molecular mechanisms.	**4**
C301.3	Decide to take up higher studies and research in the areas related to molecular biology.	**5**

*****

BC - 302: Plant Biochemistry and Biotechnology

(Core course; Theory; 4 Credits)

Course Objectives (CObs):

- To gain knowledge about mechanisms of some of the basic physiological processes taking place in plants.
- To understand the fundamentals of plant tissue culture.
- Comprehend the knowledge of plant propagation and its agricultural as well as industrial applications.

Unit I:	Photosynthesis: Structure of chloroplast, photosynthetic pigments, excitation of chlorophyll molecule, photosystem I & II – location, mechanism of quantum capture & energy transfer between photosystems, photolysis of water, photoprotective mechanisms.
Unit II:	Photosynthesis: CO_2 fixation: C_3, C_4 and CAM pathways, bacterial photosynthesis, photorespiration. Plant Hormones: Introduction. Biochemical nature, mode of action and physiological effects/role of Auxins, Cytokinins, Gibberellins &Abscisic acid. Secondary metabolites: Introduction. Incubation systems: culture room, green house and shade house, advantages and limitations of each system.
Unit III:	Introduction to plant biotechnology: history, concept of totipotency, heterogeneity, cytodifferentiation, organogenesis. Preparation of explant. Tissue culture media: general introduction, composition, sterilization.
Unit IV:	Initiation, maintenance and importance of callus culture, suspension culture and single cell culture. Micropropagation: principle, regeneration by-shoot tip, meristem, axillary shoot. Hardening of tissue cultured plants. Organ Culture: principle, protocol and importance of root, stem, leaf, flower, ovary, embryo and anther culture.

Unit V:	Protoplast culture: principle, isolation and culture of protoplast, importance of protoplast culture. Protoplast fusion-principle, methods, mechanism and importance. Somatic embryogenesis-principle, induction, importance. Artificial seeds-concept, preparation, uses and limitations. Somaclonal variations: concept, mechanism causing somaclonal variation, isolation and applications of somaclonal variants. Applications, scope and importance of plant cell, tissue and organ culture in agriculture, horticulture, forestry, industries.

Recommended Books:

1. Plant Biochemistry : Hans-Walter Heldt (Academic Press)
2. Handbook of Photosynthesis : Mohammed Pessarakli (Editor) (CRC Press)
3. Introduction to Plant Biochemistry : T. W.Goodwin and E. L. Mercer (Pergamon Press)
4. The Biochemistry of Energy Utilization in Plants : D. T. Dennis (**Blackie & Son)**
5. Plant Biochemistry : P. M. Dey and Harborne (Academic Press)
6. Applied and Fundamental Aspects of Plant Cell, Tissue and Organ Culture: J. Reinert and Y. P. S. Bajaj.(Springer-Verlag)
7. Plant Cell Biotechnology: R. Endress (Springer-Verlag).
8. Biotechnology in Agriculture: M. S. Swaminathan.(Macmillan Publishers India)
9. Agricultural Biotechnology: S. S. Purohit (Agro Botanica).
10. Plant Biotechnology: J. Hammond, P. McGravery and V. Yusibov (Eds.) (Springer-Verlag).
11. Plant Tissue Culture: K. K. De (New central Book Agency).

Course Outcomes (COts):

On completion of this course, it is expected that the students will be able to:

CO No.	CO	Cognitive Level
C302.1	Understand the mechanisms of some of the basic physiological processes taking place in plants.	**2**
C302.2	Appraise with the fundamentals of plant tissue culture, plant propagation and their biotechnological applications.	**4**
C302.3	Plan to take up higher studies and research in the areas related to plant physiology and plant tissue culture.	**4**

*****

BC - 303: Toxicology

(Elective course; Theory; 4 Credits)

Course Objectives (CObs):

- To understand toxicology, history, types and sources of toxic material.
- To understand theoretical aspects of exposure, absorption, metabolism and excretion of toxins.
- To gain knowledge about principles and methods of toxicity analysis.

Unit I:	Principles of toxicology: definition, purpose and history of toxicology, types of toxicity: acute, chronic. Mechanism of acute toxicity. Introduction to toxicity at the level of organ system. Chronic toxicity: dermato toxicity, gastrointestinal toxicity, respiratory tract toxicity, hepatotoxicity, nephrotoxicity, cardiotoxicity, heamatotoxicity, Immuno toxicity, Neurotoxicity and Reproductive toxicity. Different types of toxins and their sources: soil, air and food.

Unit II:	Factors influencing toxicity: route of exposures of toxicant, absorption, distribution and excretion of toxicant, age, chemical nature, species dietary conditions. Concept of toxin depots, Biotransformation: Phase I reaction - oxidation, reduction, hydrolysis, and hydration. Phase II reactions: conjugation, methylation, glutathione and amino acid conjugation.
Unit III:	Evaluation of toxicity: Bioassays, types of bioassays, Introduction to interactions of toxins with environment/body: synergism, antagonism and potentiation and their significance. Animal model used in toxicology studies, dose determination, dose response curve, LD_{50} or LC_{50} and chronic exposures. Toxicity rating by Hodge and Sterner scale and Smith Sterner and Gosselin scale. Ames test.
Unit IV:	Toxicology of Alcohol, caffeine and nicotine: Biological properties, health effects, regulatory standards and conclusion. Introduction of metal toxins: mercury, lead and arsenic. history, effects, exposure, solutions to reducing exposure. Introduction to toxic effect of solvent, radiotoxicity, asbestos and insecticides: history, biological properties, products, health effect, reducing exposure and regulatory standards.
Unit V:	Biological toxin: properties and effects of animal toxins-snake and scorpion, plants toxins – Ricin toxins, mycotoxins and its types and toxic effect. Solid waste management: sources , types, consequences of solid waste, solid waste treatment. Modern and traditional methods: composting, incineration, land filling and modern technologies: wet oxidations treatments, plasma torch detoxification, and pyrolysis.

Recommended Books:

1. Principles and Methods of Toxicology: A. Wallace Hayes (Edt.) (CRC Press)
2. Hamilton and Hardy's Industrial Toxicology: R. D. Harbison (Mosby).
3. Basic toxicology – Fundamental Target Organs and Risk Assessment: F. C. Lu (CRC Press)
4. Environmental biology: K. C. Agrawal (Agro Botanica).
5. Casarett and Doull's Toxicology: C. D. Klaassen, M. O. Amdur, J. Doull (Macmillan Publishing Co.).
6. Environmental toxicology – Human Exposure and Their Health Effects: M. Lipmann (Ed.) (Wiley Interscience)
7. Fundamental Toxicology for Chemists: J. H. Duffus and H. G. J. Worth (Eds.) (Royal Society of Chemistry).
8. A Small Dose of Toxicology: The Health Effects of Common Chemicals:

Course Outcomes (COts):

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

CO No.	CO	Cognitive Level
C303.1	Understand the history, types and sources of toxic material,methods of analysis, rating of toxicity of different toxins.	**2**
C303.2	Appraise with the metabolism of toxinsand detoxification.	**4**
C303.3	Describe the use of animal model used for toxicity analysis experiments, factors affecting toxicity, types of bioassays.	**4**

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BC - 304: Laboratory Course – V

(Core course; Practical; 4 Credits)

Course Objectives (CObs):

- To develop concept of plant tissue culture techniques.
- To acquire skills related to plant propagation by advanced techniques.
- To get acquainted with basic laboratory setup, handling of explant tissue, media preparation and establishing the culture.

1.	Plant tissue culture laboratory organization.
2.	Comparative efficacy of chemical sterilents for sterilization of plant material.
3.	Induction and characterization of callus.
4.	Isolation of secondary metabolite from the callus tissue of medicinally important plant.
5.	Regeneration (caulogenesis and rhizogenesis) of plant from callus.
6.	Micropropagation through shoot tip/meristem culture.
7.	Regeneration of high yielding banana plantlet from rhizome.
8.	Somatic embryogenesis from suitable explant.
9.	Isolation and determination of bioefficacy of phosphate solubilizing microorganisms.
10.	Isolation and determination of bioefficacy of nitrogen fixing microorganisms.
11.	Separation of plant secondary metabolites (alkaloid/steroid/flavonoid) by TLC/ HPTLC.
12.	Estimation of chlorophyll a, chlorophyll b and total chlorophyll from leaf sample.
13.	Estimation of PS II activity in isolated chloroplasts.
(Any ten experiments to be performed.)	

Recommended Books:

1. An Introduction to Plant Tissue Culture: Kalyan Kumar De (New Central Book Depot).
2. Plant Cell and Tissue Culture- A Laboratory Manual: J. Reinert and M. M. Yeoman(Springer-Verlag)
3. Plant Tissue Culture- Techniques and Experiments: R. Smith (Academic Press)
4. Methods in Plant Molecular Biology: M. A. Schuler and R. E. Zielinski (Academic Press)
5. A Laboratory Manual of Plant Biotechnology: S. S. Purohit (AgroBotanica).
6. Methods in Plant Tissue Culture: U. Kumar (Agrobios).

Course Outcomes (COts):

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

CO No.	CO	Cognitive Level
C304.1	Illustrate the skills involved in culturing the plant cell, tissue and organ.	**4**
C304.2	Develop comprehensive knowledge of advanced plant propagation techniques.	**3**
C304.3	Prepare themselves to plan to take up higher studies, research and jobs in the areas related to plant physiology and plant tissue culture.	**6**

*****

BC - 305: Laboratory Course – VI

(Core course; Practical; 4 Credits)

Course Objectives (CObs):

- To provide students with basic understanding of molecular architecture of pro- and eu-karyotic cells.
- To acquire skills for estimation / analysis of standard methods of estimation of biomolecules.
- To implement experimental protocols and to adapt them to carry out simple investigations.

1.	Isolation of chromosomal / genomic DNA from Bacteria / Yeast / plant / animal cell /tissue.
2.	Estimation of DNA by DPA method.
3.	Estimation of RNA by orcinol.
4.	Agarose gel electrophoresis of DNA.
5.	Induction of *lac* operon in *E. coli.*
6.	Determination of Tm of DNA.
7.	Determination of G+C content of DNA.
8.	Calculation of arithmetic mean, mode and median.
9.	Calculation of standard deviation.
10.	Techniques of analysis of variance – one way and two way.
11.	"Chi-squared" goodness-of-fit test.
12.	Sequence analysis using BLAST.
13.	Protein structure prediction –PDB.
14.	Multiple sequence alignment – Clustal X.

Total 12 experiments to be performed.
(Any 6 experiments each from one to seven and eight to fourteen).

Course Outcomes (COts):

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

CO No.	CO	Cognitive Level
C305.1	Gain an insight and appraised with the basic techniques in molecular biology.	**4**
C305.2	Embrace the know how of estimation of biomolecules and implementation of experimental protocols.	**5**
C305.3	Prepare themselves to plan to take up higher studies and research in the areas related to molecular biology.	**6**

*****

AC-301(A): Computer Skills

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

Course Objectives (CObs):

- To inculcate different daily useful computer skills among students**.**

Unit I:	Elements of Information Technology; Information Types: Text, Audio, Video, and Image, storage formats Components: Operating System, Hardware and Software, firmware Devices: Computer, Mobile Phones, Tablet, Touch Screen, Scanner, Printer, Projector, smart boards Processor & Memory: Processor functions, speed, Memory types: RAM /ROM /HDD /DVD-ROM/Flash drives, memory measurement metrics
Unit II:	Office Automation-Text Processing; Views: Normal View, Web Layout View, Print Layout View, Outline View, Reading Layout View Working with Files: Create New Documents, Open Existing Documents, Save Documents to different formats, Rename Documents, Close Documents Working with Text: Type and Insert Text, Highlight Text, Formatting Text, Delete Text, Spelling and Grammar, paragraphs, indentation, margins. Lists: Bulleted and Numbered Lists, Tables: Insert Tables, Draw Tables, Nested Tables, Insert Rows and Columns, Move and Resize Tables, Moving the order of the column and/or rows inside a table, Table Properties Page Margins, Gutter Margins, Indentations, Columns, Graphics, Print Documents, Paragraph Formatting, Paragraph Attributes, Non-printing characters Types of document files: RTF, PDF, DOCX etc.
Unit III:	Office Automation-Worksheet Data Processing; Spreadsheet Basics: Adding and Renaming Worksheets, Modifying Worksheets, Moving Through Cells, Adding Rows, Columns, and Cells, Resizing Rows and Columns, Selecting Cells, Moving and Copying Cells Formulas and Functions: Formulas, Linking Worksheets, Basic Functions, AutoSum, Sorting and Filtering: Basic Sorts, Complex Sorts, Auto-fill, Deleting Rows, Columns, and Cells. Charting: Chart Types, drawing charts, Ranges, formatting charts.
Unit IV:	Office Automation- Presentation Techniques and slide shows; Create a new presentation, AutoContent Wizard, Design Template, Blank Presentation, Open an Existing Presentation, PowerPoint screen, Screen Layout 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 Work with text: Add text and edit options, Format text, Copy text formatting, Replace fonts, Line spacing, Change case, Spelling check, Spelling options Working with tables: Adding a table, Entering text, Deleting a table, Changing row width, 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.
Unit V:	Internet & Applications; 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 Internet Resources: Email, Parts of email, Protecting the computer: Password protection, Viruses, Virus protection software, Updating the software, Scanning files, Net banking precautions.

	Social Networking: Features, Social impact, emerging trends, issues, Social Networking sites: Facebook, Twitter, linkedin, Orkut, online booking services Online Resources: Wikipedia, Blog, Job portals, C.V. writing e-learning: e-Books, e-Magazines, e-News papers, OCW(open course wares): Sakshat (NPTEL) portal, MIT courseware
Unit VI:	Cloud Computing Basics; Introduction to cloud computing Cloud computing models: SAS, AAS, PAS Examples of SAS, AAS, PAS (DropBox, Google Drive, Google Docs, Office 365 Prezi, etc.)

Recommended Books:

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 (COts):

On completion of this course, the students 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**

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AC-301(B): Cyber Security

(Technology + Value added Audit course; Practical; 2 Credits)

(Optional: Campus + Program level)

Course Objectives (CObs):

- To make students aware of different daily useful cyber security skills/rules.

Unit I:	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
Unit II:	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 equipment.

	Passwords: Define passwords, Types of passwords, Passwords Storage – Windows & Linux.
Unit III:	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
Unit IV:	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
Unit V:	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.
Unit VI:	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.
Unit VII:	Security Laws and Standards; Security laws genesis, International Scenario, Security Audit, IT Act 2000 and its amendments.

Recommended Books:

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: 978-1522952190ISBN-10: 1522952195
4. Online references

Course Outcomes (COts):

On completion of this course, the students 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**

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AC-301(C): Seminar + Review Writing

(Technology + Value added Audit course; Practical; 2 Credits)

Course Objectives (CObs):

- To motivate students to develop skills to search, retrieve, interpret, organize, and present relevant biological information.

➢	**Writing a Scientific Literature Review:**
	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: o 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.) o 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 (COts):

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

CO No.	CO	Cognitive level
AC301C.1	Retrieve, analyze, 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**

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AC-301(D): Biostatistics

(Technology + Value added Audit course; Practical; 2 Credits)

Course Objectives (CObs):

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

Unit I:	Descriptive Statistics and Presentation of Data; 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.
Unit II:	**Correlation and regression;** 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. Multivariate data: multiple regression, coefficient of determination, R-square and its interpretation, testing significance of predictor variables.
Unit III:	Testing of hypothesis and basic statistical designs; 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.
Unit IV:	PRACTICALS (Emphasis on examples from Biological Sciences); 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
Recommended Books: 1. Le CT (2003) Introductory Biostatistics. 1st edition, John Wiley 2. Miller, Irwin and Miller, Marylees (2006): John E. Freund's Mathematical Statistics 3. with Applications, (7th Edn.), Pearson Education, Asia.	

4. Edmondson A and Druce D (1996) Advanced Biology Statistics, Oxford University Press.
5. Danial W (2004) Biostatistics: A foundation for Analysis in Health Sciences, John Wiley and Sons Inc.
6. Design and Analysis of Experiments by Montgomery D.C. (2001), John Wiley.

Course Outcomes (COts):

On completion of this course, the students 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 to 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**

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Semester-IV

BC - 401: Genetic Engineering

(Core course; Theory; 4 Credits)

Course Objectives (CObs):

- To provide students with basic understanding of the concepts in genetic engineering.
- To appraise to multifaceted tools and techniques used in genetic engineering.
- To familiarize the students about applications of genetic engineering in various fields.

Unit I:	Genetic engineering: Concept. Restriction enzymes – nomenclature, properties, types, mode of action. Restriction modification system. Cloning vectors: Plasmids, bacteriophages, cosmids, phagemids. Artificial chromosomes. Binary and shuttle vectors, expression vectors.
Unit II:	Cloning: Steps involved, strategies for each step with details of – cDNA synthesis of generation of DNA, joining cDNA to vector DNA by homopolymer tailing , transformation with rDNA, transfection with r-phage DNA, screening by immunochemical and nucleic acid hybridization method.
Unit III:	DNA library: cDNA and genomic DNA library. Mapping: S1 nuclease mapping, restriction mapping and their applications. Mutagenesis: Site directed mutagenesis and its applications. Polymerase chain reaction, RFLP, RAPD, AFLP and their applications.
Unit IV:	Transformation in plants: feature of Ti and Ri plasmid, basis of tumour formation, mechanism of DNA transfer, role of virulence genes, use of reporter genes. Viral vectors and their applications, particle bombardment, electroporation, microinjection. Application of plant transformation for productivity, performance, herbicide resistance, long shelf life of fruits and vegetables. *Arabidopsis thaliana*: as a "model organism". GM crops. Transgenic animals.
Unit V:	Blotting techniques : Southern blotting, Northern blotting, Western blotting, Dot blot. DNA sequencing : enzymatic, chemical and automated. DNA chip technology and microarrays: Types and production of chips. Applications of microarrays on DNA chips. RNAi. Gene silencing and antisense technology. Gene therapy: Vectors for gene therapy, gene editing and gene replacement. Scope and applications of genetic engineering in medicine, agriculture and industry. Introduction to Biosafety and Bioethics.

Recommended Books:

1. Recombinant DNA: J. D. Watson, M. Gilman, J. Witkowski and M. Zoller(Scientific American Books – distributed by W. H. Freeman and co.).
2. Lewin's Genes XI : J. E. Krebs, S. T. Kilpatrick, E. S. Goldstein (Jones and Bartlett Publishers, Inc.
3. Genes: B. Lewin (Oxford University Press).
4. Biochemistry: L. Stryer (W.H. Freeman & co.).
5. Lehninger Principles of Biochemistry: D. L. Nelson & M. M. Cox (Macmillan Worth Publishers).
6. Methods in Molecular Biology, Vol. 92 – PCR in bioanalysis: S. J. Metzer (Humana press).
7. Gene function – *E. coli* and its heritable elements: R. C. Glass (Croom Helm).

8. Principles of Genetics: E. J. Gardner, M. J. Simmons, D. P. Snustad (John Wiley & Sons Inc.).
9. Genetic Engineering: R. Williamson (Academic press Inc.).
10. Molecular Cloning – a laboratory manual : J. Sambrook, E. F. Frithsch and T. Maniatis (Cold Spring Harbor Laboratory Press).
11. The Indian Environment Protection Act, 1986 (Govt. of India).
12. Rules for manufacture, use / import / export / and storage of hazardous microorganisms or cells act, 1989 (Govt. of India).
13. Food Safety and Standards Act. 2006 (Govt. of India).

Course Outcomes (COts):

On completion of this course, it is expected that the students will be able to:

CO No.	CO	Cognitive Level
C401.1	Develop an understanding of the fundamentals of genetic engineering.	**3**
C401.2	Gain knowledge of various tools and techniques implied in genetic engineering experiments.	**4**
C401.3	Prepare themselves to plan to take up higher studies and research in the areas related to molecular biology, pharmaceutical industry and genetic engineering.	**6**

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BC - 402: Fermentation Technology

(Core course; Theory; 4 Credits)

Course Objectives (CObs):

- To provide an understanding of fundamentals of fermentation process.
- To understand basic principle and concept of isolation, screening of organisms and their use in fermentative process.
- To familiarize the methods of selection, designing of media and microbes for industrial production of fermentative products.

Unit I:	Introduction to fermentation technology, chronological development of fermentations industry. The ranges of fermentation processes: microbial biomass, microbial enzymes and their source, industry and applications, primary metabolites and its commercial significance, recombinant products, transformation products. Components of fermentations and its importance.
Unit II:	Screening of organism: primary and secondary screening of antibiotics, organic acids and vitamins. Modern screening methods for industrially important microbes. Nisbet guideline for overproduction media. Improvement of industrially important organisms: criteria for choice industrial important organisms, methods of isolations of auxotrophic mutants by Abe / Devis method, Szybalski methods. Strain improvement by leaky, morphological, analogue, precursor, resistant mutants and by recombinations. Examples of primary metabolite production by using auxotrophs. Preservation methods: low temperature, liquid nitrogen, lyophilization, dehydration, dry soil preservation, quality control of preserved cultures, Culture collection centers and

	their role, importance and functions.
Unit III:	Medium for industrial fermentations: criteria's for designing fermentation medium by stoichiometric equations, dry cell mass components, cellular yield coefficient. media components, carbon sources: carbohydrates, oils & fats, hydrocarbons, nitrogen source, minerals, antifoams: types, criteria for antifoam selection. Application and role of precursors, inducers and inhibitors in industrial medium. Media optimization by using Plackett Burman design.
Unit IV:	Inoculum development for industrial fermentation**,** criteria to inoculate organism, criteria for transfer of inoculum. Development of inoculums for yeast, fungi, actinomycetes and bacteria. Sterilization of industrial fermentation medium: methods of sterilization: steam, radiation, filtration. Batch and continuous sterilization.
Unit V:	Solid state fermentation (SSF): advantages, disadvantages, comparison with submerged fermentation, factors affecting on SSF, bioreactors and product of SSF. Dual fermentation - examples, need and significance Downstream processing: cell separation, disintegration**,** extraction – liquid- liquid, two phase liquid. precipitation, purification, crystallization: spray drying, drum drying, packaging. Specific examples of fermentation product recovery.

Recommended Books:

1. Principle of Fermentation Technology: P. F. Stransberry, A. Whitaker & S. J. Hall (Aditya Books).
2. Industrial Microbiology: L. E. Casida JR (New Age International Publishers Ltd.).
3. Industrial Microbiology: S. C. Prescott & C. G. Dunn (Agrobios).
4. Solid Substrate Cultivation: H. W. Doelle, D. A. Mitchell & C. E. (Elsevier Applied Science).
5. Biotechnology of Antibiotics: Vandamme Drugs and Pharmaceuticals, Vol. 22 (Ed.) (Marcel Dekker Inc.).
6. Biotechnology of Filamentous Fungi: D. B. Franklinstein and C. Ball (Bitterworth-Heinemann).
7. Process Biotechnology – Fundamentals: Mukhopadhay (Viva Books Pvt. Ltd.).
8. Microbial Technology - Fermentation Technology, Vol. I & II: A. H. J. Peppler & D. Perlmann (Academic Press).

Course Outcomes (COts):

On completion of this course, it is expected that the students will be able to:

CO No.	CO	Cognitive Level
C402.1	Develop an understanding about the process of fermentation.	**3**
C402.2	Appraise with the techniques of screening, preservations of organisms and their use in production and recovery of fermentative products.	**4**
C402.3	Gain knowledge and able to explain industrial production of fermentative products.	**4**

*****

BC - 403: Industrial Biotechnology and Food Biochemistry

(Electivecourse; Theory; 4 Credits)

Course Objectives (CObs):

- To know industrially important fermentative products.
- To understand the concept, principle and need of GMP, QC, norms related to production, preservation and transfer of biological material.
- To understand the principle, process and need of food biochemistry, fortification and modern concepts like functional food.

Unit I:	Introduction to Industrially significant fermentations: penicillin and riboflavin- history, importance, microorganism, media, culture conditions and recovery. Introduction to some industrially important fermentation products: erythropoietin, insulin, lovastatin, single cell proteins, pigments, biofertilizer: nitrogen fixer, phosphate solubilizers, ACCD producer.
Unit II:	Introduction to quality control, good manufacturing practices (GMP). Principle of production and quality control of biologicals, National control of biological products and international movement of biological materials. Quality control of BCG, DPT, typhoid , Hepatitis B vaccines.
Unit III:	Introduction to animal tissue culture; Application of a tissue culture, limitation of tissue culture, Designing of the tissue culture laboratory; equipment and glassware used in animal tissue culture, Aseptic techniques. Tissue culture media, Types of culture, primary explants culture, cell culture, organ culture, viable cell counting methods.
Unit IV:	Modern concepts of Food biochemistry: Principles of food preservation using high temperature, low temperature and drying. Food additives like acids, sweeteners, colors, non nutritional additives, antimicrobials. Naturally occurring flavor compounds, flavor compounds in foods, flavor formation during food processing, Biotechnological production of flavors. Toxic compound contamination in food. Introduction to food fortification: Global evidence, practices and standards Fortification by food category: fortification of rice, wheat flour, edible oil, milk , double fortified salt (DFS), processed food. Fortification in government programmes: fortification in Mid-Day meal scheme, fortification in Integrated Child Development Services (ICDS), fortification in public distribution system.
Unit V:	Concepts of functional food, history, prebiotics and probiotics, concept of Nutrigenomics and nutrigenetics, Safety and standards for licensing and registration of food businesses, food products standards and food additives, contaminants, toxins and residues, food safety standards for laboratory and sampling analysis of alcoholic beverages, organic food and food fortification.

Recommended Books:

1. Principal and Practices of Animal Tissue Culture: Sudha Ganangal (University Press).
2. Quality Assurance in Microbiology: Rajesh Bhatia and R. Ichhpujani (CBS publisher and distributers).
3. Food Microbiology, William Frazier and Dennis Wethoff (Tata MCHill Publ Ed IV).
4. Animal Cell Culture – Practical Approach: R. W. Jhon (Masters Oxford).
5. Culture of Animal Cell: R. I. Freshney (Wiley - Liss).

6. WHO Report recommended composition of Influenza Virus Vaccines for use in the 2012-2013 northern hemisphere influenza season February 2012.
7. WHO good manufacturing practices for active pharmaceutical ingredients World Health Organization WHO Technical Report Series, No. 957, 2010.
8. Methods in Cell Biology - Vol. 57 - animal cell culture methods: J. P. Mathon and D. Barnes (Eds.) (Academic Press).
9. Industrial Microbiology: L. E. Casida JR (New Age International Publishers Ltd.).
10. Microbial Technology, Fermentation Technology, Vol. I & II: A. H. J. Peppler & D. Perlmann (Academic Press).
11. Food Biochemistry and Food Processing. Edited by Benjamin K. Simpson et al (Wily Blackwell).

Course Outcomes (COts):

On completion of this course, it is expected that the students will be able to:

CO No.	CO	Cognitive Level
C403.1	Understand important industrial products, modern concepts of food biochemistry and basics of animal tissue culture.	**2**
C403.2	Appraise with the national and international norms related to production of fermentative products.	**4**
C403.3	Gain knowledge and able to explain food fortifications, additives and their importance, food quality and modern concepts like functional food.	**4**

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BC - 404: Laboratory Course - VII

(Core course; Practical; 4 Credits)

Course Objectives (CObs):

- To develop an ability to conduct molecular biology and genetic engineering experiments, as well as to analyze and interpret data.
- To acquire technical skills to perform molecular biology and genetic engineering experiments.
- To gain practical knowledge about designing of media, culture and maintenance of cell lines.

1.	Isolation and characterization of plasmid DNA.
2.	Restriction digestion of DNA and analysis by agarose gel electrophoresis.
3.	Amplification of DNA by polymerase chain reaction (PCR).
4.	Separation of peptides by PAGE.
5.	Preparation of competent bacterial cells and their transformation by using plasmid.
6.	*Agrobacterium* mediated transformation of plant material.
7.	Demonstration of Southern blotting technique.
8.	Estimation of dissolved oxygen and BOD of water.
9.	Citric acid production by fermentation.
10.	Antibiotic production by fermentation.
11.	Analysis of proline in infected plants.
12.	Estimation of Lysine in cereal grains.

13.	Preparation of media for animal tissue culture & culturing of cells.
14.	Maintenance of cell line.
15.	Test for cell viability.

Total 12 experiments to be performed.
(Any 6 experiments each from one to seven and eight to fourteen).

Recommended Books:

1. Molecular Cloning – A Laboratory Manual –Vol. I, II & III: Sambrook and Russel (Cold Springer Harbour Laboratory Press).
2. Practical Biochemistry - Principles and Techniques: K. Wilson and J. Walker (Cambridge Press).
3. An Introduction to Practical Biochemistry: D. T. Plummer (Tata Mc Hill).
4. Methods in Agriculture al Biochemistry: S. Sadashivam and A. Manikam (New Age Publication).
5. Laboratory Manual in General Microbiology: H. J. Binson (Wm C Brown Publishers).
6. Laboratory Manual in Biochemistry: J. Jayraman (New Age Publication Ltd.)
7. Laboratory Exercises in Microbiology: J. P. Harly and L. M. Prescott (WBC / Mac Hill).

Course Outcomes (COts):

On completion of this course, it is expected that the students will be able to:

CO No.	CO	Cognitive Level
C404.1	Become technically sound for conducting molecular biology, genetic engineering experiments as well as develop an ability to analyze and interpret results.	**4**
C404.2	Demonstrate the skill in important basic molecular biology and genetic engineering techniques, and appraise with basics of animal tissue culture.	**5**
C404.3	Will equip the students to plan their career in the areas related to molecular biology, genetic engineering and animal tissue culture.	**6**

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BC - 405: Laboratory Course – VIII (Project Work / Dissertation)

(Core course; Practical; 4 Credits)

Course Objectives (CObs):

- The intention of the project work is to make students develop a little deeper knowledge and understanding in the context of a specific topic.
- The overall objective is to enable students think independently on a specific topic, design and perform a set of experiments to display the knowledge and capability required for independent work.
- It also aims at managing time effectively while working independently, appropriate referencing, analyzing the results and develop skills in report writing.

The project is allotted during the Forth semester. The students will get an opportunity to become a part of ongoing research activities in the respective supervisor's laboratory and can explore experience in different areas of microbiology viz. agriculture, food, medicine and pharmaceutical, etc. The students will acquire skill to write, compile and analyze data, and

present the detailed technical/scientific report. At the end of successful project semester training, potentially the students become employable in the industries/organizations.

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

1. Selection of topic relevant to priority areas of biotechnology.
2. Collection of literature on the topic of research from libraries, internet, on-line journals, planning of research experiments
3. Performing the experiments with scientific and statistical acceptability.
4. Presentation of observations and results.
5. Interpretation of results and drawing important conclusions.
6. Discussion of obtained results with respect to literature reports.
7. Writing monthly progress report
8. Preparation of report (Dissertation) containing introduction, materials and methods, results and discussion, conclusions, bibliography and submission of at least 3 copies (1 copy retained in the department and after examination submitted to Library, 1 copy submitted to the guide and 1 copy kept with the candidate).
9. Presentation of research data during university examination and submission of project dissertation in a bound form.

1. Internal examination (40 marks): Components of continuous internal assessment: Submission of monthly progress report and signed by supervisor (at least 4 reports) (2 marks per report = 8 marks), Literature collected, experiment planning and design (10 marks), Experiments conducted (10 marks), outcome of the experiments and viva (8 marks) and regular attendance (4 marks) recorded: Research Supervisors
2. External examination (60 marks) and Components of external assessment: Subject matter (5 marks), Review of literature (10 marks), Writing of dissertation submitted in bound form at the time of examination (Title page, Certificate, Plagiarism report, Main content: Abstract, Introduction, Literature, Materials and methods, results and discussion and conclusion with relevant references) (15 marks), Presentation structure (PPT format) (8 marks), Overall presentation reflecting contribution of work (4 marks), Response to questions (15 marks).

Recommended Readings:

Refer the topic in research papers, review articles published in peer reviewed and SCI indexed journals, reference books, abstracts, etc. related to topic of project dissertation

Course Outcomes (COts):

On completion of this course, it is expected that the students will be able to:

CO No.	CO	Cognitive Level
C405.1	Devise a problem on the basis of literature survey.	**4**
C405.2	Develop deep understanding of the topic of research.	**3**
C405.3	Acquire the skill to design and execute experiments independently.	**6**
C405.4	Learn to analyze, co-relate and interpret the data and build up skills and temperament of scientific research and writing.	**6**

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AC-401(A): Human Rights

(Professional and Social + Value Added Audit course; Campus-level;Practical; 2 Credits)

Course Objectives (CObs):

- To make students aware about human rights and human values.

Unit I:	Introduction to Human Rights; Concept of Human Rights Nature and Scope of Human Rights Fundamental Rights and Fundamental Duties Interrelation of Rights and Duties
Unit II:	Human Rights in India; 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. Constitutional Provisions for Human Rights Declaration of Human Rights National Human Rights Commission
Unit III:	Human Values; Meaning and Definitions of Values Importance of values in the life of Individual Types of Values Programmes for conservation of Values
Unit V:	Status of Social and Economically Disadvantaged people and their rights; Rights of women and children in the context of Social status The Minorities and Human Rights Status of SC/ST and other Indigenous People in the Indian Scenario Human rights of economically disadvantaged Society

Recommended Books:

1. Human rights education – YCMOU, Nasik
2. Value education – SCERT, Pune
3. Human rights reference handbook – Lucille Whare

Course Outcomes (COts):

On completion of this course, it is expected that the students 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 justice to people around them and provide guidance about human rights to their friends, parents and relatives.	**5**

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AC-401(B): Current Affairs

(Professional and Social + Value Added Audit course; Campus-level; Practical; 2 Credits)

Course Objectives (CObs):

- To make students updated about current affairs of India and world.

Unit I:	Politics & Economy; National & International Political Activity, Organization. Economy & Business, Corporate world
Unit II:	Awards and recognitions; National & International Awards and recognitions Books and authors
Unit III:	Science & Technology; Software, Automobile, Space Research New inventions and discoveries
Unit V:	Environment & Sports; Summit & conference, Ecology & Climate, Organization. National & International Games, Olympics, commonwealth etc.

Recommended Books (Use recent years' data and current literature):

1. India 2019, by Publications Division Government of India.
2. Manorama Year Book by Philip Mathew.
3. India 2019, Rajiv Maharshi.
4. Quick General Knowledge 2018 with Current Affairs Update, Disha Experts.
5. General Knowledge 2018: Latest Who's Who & Current Affairs by RPH Editorial Board.

Course Outcomes (COts):

On completion of this course, it is expected that the students 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**

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AC-401(C): Seminar + Review Writing

(Professional and Social + Value Added Audit course; Program-level; Practical; 2 Credits)

Course Objectives (CObs):

- To motivate students to develop skills to search, retrieve, interpret, organize, and present relevant biological information.

Writing a Scientific Literature Review:

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:

- 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 (COts):

On completion of this course, it is expected that the students will be able to:

CO No.	CO	Cognitive level
AC401C.1	Retrieve, analyze, 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**

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AC-401(D): Intellectual Property Rights (IPR)

(Professional and Social + Value Added Audit course; Program-level; Practical; 2 Credits)

Course Objectives (CObs):

- To provide basic knowledge on intellectual property rights and their implications.
- To understand ethical issues relevant to biology from the perspective of national and internatior law.

Unit I:	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.
Unit II:	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.
Unit III:	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.
Unit IV:	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.
Unit V:	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.

Recommended Books:

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 (COts):

On completion of this course, it is expected that the students 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**

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