Program Handout for

B.Sc. Biotechnology

(Revised w.e.f. 2020-2021)

Department of Biosciences
Faculty of Science
Integral University, Lucknow

INTEGRAL UNIVERSITY LUCKNOW
DEPARTMENT OF BIOSCIENCES
B.Sc. Biotechnology

PROGRAM EDUCATIONAL OBJECTIVES (PEO's)

- Bachelor course in biotechnology offers the synergism of basic concepts of biology, biotechnology, molecular biology, genomics, Recombinant DNA technology, microbiology, biochemistry and bioinformatics with technological applications.
- The main objective of this degree course is to produce graduates with enhanced skills, knowledge and research aptitude to carry out higher studies, entrepreneurship or research and development in the various health, research and industrial areas.
- Develop proficiency in application of current aspects of biotechnology, molecular biology, Recombinant DNA technology, bioinformatics and genomics.
- Students will be able to use state of the art techniques relevant to academia and industry, generic skills and global competencies including knowledge and skills that enable the students to undertake further studies in the field of biotechnology, molecular biology, Recombinant DNA technology, genomics, microbiology, biochemistry or any other related field.
- Imparting an education that includes communication skills, the ability to work in a team with leadership quality, devoted to societal problems with an ethical attitude.

PROGRAM OUTCOMES (PO's)

[PO.1] **Critical Thinking**- Students will demonstrate an understanding of major concepts in all disciplines of biology, biochemistry, biotechnology microbiology and bioinformatics. Understand the basic concepts, fundamental principles, and the scientific theories related to various scientific phenomena and their relevancies in the day-to-day life.

[PO.2] **Effective Communication**- Development of various communication skills such as reading, listening, speaking, etc., which will help in expressing ideas and views clearly and effectively.

[PO.3] **Social Interaction**- Development of scientific outlook not only with respect to science subjects but also in all aspects related to life.

[PO.4] **Effective Citizenship**- Imbibe moral and social values in personal and social life leading to highly cultured and civilized personality.

[PO.5] **Ethics**- Follow the ethical principles and responsibilities to serve the society.

[PO.6] **Environment and Sustainability**- Understand the issues of environmental contexts and sustainable development.

[PO.7] **Self-directed and Lifelong learning**- Students will be capable of self-paced and self-directed learning aimed at personal development and for improving knowledge/skill development.

PROGRAM SPECIFIC OUTCOMES (PSO's)

[PSO.1] The course offers basic foundation in biotechnology that enables students to understand concepts in biochemistry, molecular biology, microbiology, genetic engineering and industrial technology.

[PSO.2] Students will be able to design, execute, record and analyse the results of experiments in field of molecular biology, genomics, Recombinant DNA technology, biochemistry, microbiology and genetic engineering enabling them to work effectively in a group in the classroom, laboratory, industries and field-based situations.

[PSO.3] Prepares the students for immediate entry to the workplace with sound theoretical, experimental knowledge in the area of health and pharmaceuticals, biochemicals, biofuels, environment related, food and dairy, cosmetics, biopolymers and related multidisciplinary fields.

[PSO.4] Become efficient in using standard operating procedures and will be well versed with the regulations for safe handling and use of chemicals as well as IPR and biosafety issues related to experiments in field of biochemistry, microbiology and genetic engineering.

INTEGRAL UNIVERSITY LUCKNOW
DEPARTMENT OF BIOSCIENCES

EVALUATION SCHEME (CBCS)
B.Sc. Biotechnology Semester-I

Course Code	Course Title	Type of Paper	Periods/Week			Evaluation Scheme				Max. Marks	Credits	Total Credit	Attributes						
			L	T	P	UE	TA	Total	ESE				Employability	Entrepreneurship	Skill	Gender	Environment & sustainability	Human values	Professional ethics
LN104	Essential Professional Communication	Foundation	3	1	0	40	20	60	40	100	3:1:0	4	√	√	√			√	√
MT106	Mathematics	Foundation	3	1	0	40	20	60	40	100	3:1:0	4	√		√				
CS109	Concept of Computers	Foundation	3	1	0	40	20	60	40	100	3:1:0	4	√	√	√		√		√
CH112	Fundamental of Inorganic Chemistry	Core	3	1	0	40	20	60	40	100	3:1:0	4	√		√				
BS101	Plant Sciences	Core	3	1	0	40	20	60	40	100	3:1:0	4					√		
CH113	Chemistry Lab-I	Practical	0	0	6	40	20	60	40	100	0:0:3	3	√	√	√				
BS102	Plant Sciences Lab	Practical	0	0	6	40	20	60	40	100	0:0:3	3			√		√		
		Total								700		26							

INTEGRAL UNIVERSITY LUCKNOW
DEPARTMENT OF BIOSCIENCES

EVALUATION SCHEME (CBCS)
B.Sc. Biotechnology Semester-II

Course Code	Course Title	Type of Paper	Periods/Week			Evaluation Scheme				Max. Marks	Credits	Total Credit	Attributes						
			L	T	P	UE	TA	Total	ESE				Employability	Entrepreneurship	Skill	Gender	Environment & sustainability	Human values	Professional ethics
ES115	Fundamentals of Environmental Studies	Foundation	3	1	0	40	20	60	40	100	3:1:0	4					√		√
CH114	Fundamental of Organic Chemistry	Core	3	1	0	40	20	60	40	100	3:1:0	4	√		√				
BS111	Animal Science	Core	3	1	0	40	20	60	40	100	3:1:0	4	√		√		√		
BS112	Fundamentals of Biochemistry	Core	3	1	0	40	20	60	40	100	3:1:0	4							
BS113	Fundamental of Microbiology	Core	3	1	0	40	20	60	40	100	3:1:0	4	√		√		√		
CH115	Chemistry Lab-II	Practical	0	0	6	40	20	60	40	100	0:0:3	3	√	√	√				
BS114	Animal Sciences lab.	Practical	0	0	6	40	20	60	40	100	0:0:3	3	√		√		√		
		Total								700		26							

INTEGRAL UNIVERSITY LUCKNOW
DEPARTMENT OF BIOSCIENCES

EVALUATION SCHEME (CBCS)
B.Sc. Biotechnology Semester-III

Course Code	Course Title	Type of Paper	Periods/Week			Evaluation Scheme				Max. Marks	Credits	Total Credit	Attributes						
			L	T	P	UE	TA	Total	ESE				Employability	Entrepreneurship	Skill	Gender	Environment & sustainability	Human values	Professional ethics
CH215	Fundamentals of Physical Chemistry	Core	3	1	0	40	20	60	40	100	3:1:0	4	√		√				
BS201	Metabolism	Core	3	1	0	40	20	60	40	100	3:1:0	4			√				
BS202	Biophysical Chemistry	Core	3	1	0	40	20	60	40	100	3:1:0	4	√	√	√				
BS203	Cell Biology & Genetics	Core	3	1	0	40	20	60	40	100	3:1:0	4							
BS204	IPR & Biosafety	Core	3	1	0	40	20	60	40	100	3:1:0	4	√	√	√		√	√	√
BS205	Microbiology Lab	Practical	0	0	6	40	20	60	40	100	0:0:3	3	√	√	√		√		
BS206	Cell Biology & Genetics Lab	Practical	0	0	6	40	20	60	40	100	0:0:3	3	√		√				
		Total								700		26							

INTEGRAL UNIVERSITY LUCKNOW
DEPARTMENT OF BIOSCIENCES

EVALUATION SCHEME (CBCS)
B.Sc. Biotechnology Semester-IV

Course Code	Course Title	Type of Paper	Periods/Week			Evaluation Scheme				Max. Marks	Credits	Total Credit	Attributes						
			L	T	P	UE	TA	Total	ESE				Employability	Entrepreneurship	Skill	Gender	Environment & sustainability	Human values	Professional ethics
BS211	Immunology	Core	3	1	0	40	20	60	40	100	3:1:0	4	√		√				
BS212	Molecular Biology	Core	3	1	0	40	20	60	40	100	3:1:0	4							
BS213	Fundamentals of Environmental Biotechnology	Core	3	1	0	40	20	60	40	100	3:1:0	4	√	√	√		√		
BS214	Industrial Biotechnology	Core	3	1	0	40	20	60	40	100	3:1:0	4	√	√	√				
BS215	Food Biotechnology	Core	3	1	0	40	20	60	40	100	3:1:0	4	√	√			√		
BS216	Immunology Lab	Practical	0	0	6	40	20	60	40	100	0:0:3	3	√	√	√				
BS217	Industrial and Environmental Biotechnology Lab	Practical	0	0	6	40	20	60	40	100	0:0:3	3	√	√	√		√		
	Total									700		26							

INTEGRAL UNIVERSITY LUCKNOW
DEPARTMENT OF BIOSCIENCES

EVALUATION SCHEME (CBCS)
B.Sc. Biotechnology Semester-V

Course Code	Course Title	Type of Paper	Periods/Week			Evaluation Scheme				Max. Marks	Credits	Total Credit	Attributes						
			L	T	P	UE	TA	Total	ESE				Employability	Entrepreneurship	Skill	Gender	Environment & sustainability	Human values	Professional ethics
BS301	IAnimal Biotechnology	Core	3	1	0	40	20	60	40	100	3:1:0	4	√		√				
BS302	Plant Biotechnology	Core	3	1	0	40	20	60	40	100	3:1:0	4	√	√					
BS303	Genetic Engineering	Core	3	1	0	40	20	60	40	100	3:1:0	4	√		√		√		
BS304	Medical Biotechnology	Core	3	1	0	40	20	60	40	100	3:1:0	4	√	√	√		√		
BS305	Electives: (Any one of the following) Genomics, Proteomics and Metabolomics	Elective	3	1	0	40	20	60	40	100	3:1:0	4	√	√	√		√		
BS306	Applied Biotechnology												√	√	√		√	√	√
BS307	Tissue culture Lab	Practical	0	0	6	40	20	60	40	100	0:0:3	3	√	√	√				
BS308	Genetic Engineering Lab	Practical	0	0	6	40	20	60	40	100	0:0:3	3	√	√	√				
	Total									700		26							

INTEGRAL UNIVERSITY LUCKNOW
DEPARTMENT OF BIOSCIENCES

EVALUATION SCHEME (CBCS)
B.Sc. Biotechnology Semester-VI

Course Code	Course Title	Type of Paper	Periods/Week			Evaluation Scheme				Max. Marks	Credits	Total Credit	Attributes						
			L	T	P	UE	TA	Total	ESE				Employability	Entrepreneurship	Skill development	Gender	Environment & sustainability	Human values	Professional ethics
BS311	Bioinformatics	Core	3	1	0	40	20	60	40	100	3:1:0	4	√	√	√				
BS312 BM337	Elective courses (Any one of the following) Bionanotechnology Entrepreneurship Development	Elective	3	1	0	40	20	60	40	100	3:1:0	4	√ √	√	√ √			√	√
BS314	Bioinformatics Lab	Practical	0	0	4	40	20	60	40	100	0:0:2	2	√		√				
BS315	Project & Training* (3 months)		0	0	4					300	0:0:4	4	√		√				√
BS316	Educational Tour (8-10 days)		0	0	2					100	0:0:2	2			√			√	
		Total								700		16							

*** The Evaluation scheme for the Project Work**

	Course Code	Dissertation	Presentation	Viva/Discussion	Total
Project	BS315	200	50	50	300

 # Note: The students of B.Sc. Biotechnology have to undergo the educational/Industrial tour in industry/research institution for practical awareness at the end of 6th semester

B.Sc. Biotechnology

Syllabi of all courses with CO, CO-PO and CO-PSO mapping

B. Sc. BIOTECHNOLOGY 1st year/ 1st semester

1. Name of the Department: Biosciences					
2. Course Name	**PLANT SCIENCES**		**L**	**T**	**P**
3. Course Code	**BS101**		3	1	0
4. Type of Course (use tick mark)	**Core (√)**	**Foundation Course ()**		**Departmental Elective ()**	
5. Pre-requisite (if any)	10+2 with Biology	**6. Frequency (use tick marks)**	Even **()**	Odd (√)	Either Sem ( )	Every Sem ( )
7. Total Number of Lectures, Tutorials, Practicals					
Lectures = 30	**Tutorials = 10**	**Practical = 00**			

8. COURSE OBJECTIVES: The objective of this course is to develop the understanding of the basics of botany and the concept of origin of life and evolution, diversity in plants, structure and functioning of plant cells and tissues, morphology and physiology of plants and plant growth.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Develop and understand the concept of origin of life and evolution
CO2	To comprehend the diversity of plant forms as Algae, bryophytes, pteridophytes, gymnosperms and angiosperms
CO3	To have basic knowledge about the structure and organisation of plant cells and tissues
CO4	To understand the basic structural organisation, morphology and anatomy of plants
CO5	To have knowledge about the physiological functions in plants.

10. Unit wise detailed content

Unit-1	**Number of lectures = 08**	**Title of the unit: Origin of life: Origin of life, Evolution**

Darwinism, Lamarckism, Classification of living organisms: Whittaker's five-kingdom concept: Monera, Protista, Fungi, Plantae and Animalia.

Unit-2	**Number of lectures = 08**	**Title of the unit: Plant kingdom**

Plant taxonomy-aims and objectives of taxonomy, General characters and economic aspects of Algae, Fungi, Bryophytes, Pteridophytes, Gymnosperms, Angiosperms.

Unit-3	**Number of lectures = 08**	**Title of the unit: Cellular organization**

Structure and function of animal and plant cells, Types of plant cells: parenchyma, collenchyma and sclerenchyma, Plant tissues: xylem and phloem.

Unit-4	**Number of lectures = 08**	**Title of the unit: Organization of plant body**

Flower: Parts, Functions, Floral whorls, Flower as a modified shoot, Fruits: Formation, Types, Parthenocarpy, Seed: Structure, Formation, Seed Physiology: Dormancy, breaking of dormancy, Germination, Modifications of stems, leaves and roots, Anatomy of dicot and monocot stems, leaves and roots, Secondary growth and annual rings.

Unit-5	**Number of lectures = 08**	**Title of the unit: -Plant physiology**

Diffusion and water potential, Osmosis, Ascent of sap, Absorption of mineral salts, Photosynthesis, Light and dark reactions, C3 and C4 plants; Plant growth hormones and their mode of action, Photomorphogenesis, plant movements, Photoperiodism, Growth response to temperature, Vernalization.

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	*Develop and understand the concept of origin of life and evolution*	**3**	**1**				**1**	**1**
CO2	*To comprehend the diversity of plant forms as Algae, bryophytes, pteridophytes, gymnosperms and angiosperms*	**3**	**1**				**1**	**1**
CO3	*To have basic knowledge about the structure and organization of plant cells and tissues*	**3**	**1**				**1**	**1**
CO4	*To understand the basic structural organization, morphology and anatomy of plants*	**3**	**1**				**1**	**1**
CO5	*To have knowledge about the physiological functions in plants.*	**3**	**1**				**1**	**1**

3: Strong contribution, 2: Average contribution , 1: Low contribution
12. Books recommended
1. Biology PH Raven & G.B Johnson 2. Biological science DJ Taylor NPO Green GW Stout 3. A textbook of Botany S.N Pandey, P.S Trivedi 4. Plant Physiology by Taiz & Zeiger. 5. Devlin R.M. Fundamentals of Plant Physiology (Mac. Millan) 6. Malik C.P. Plant Physiology, Kalyani Publishers 7. Bold H.C. The Plant Kingdom, Prentice -Hall India 8. Dutta A.C. A Class book of Botany, Oxford University Press

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	POS2	PSO3	PSO4
CO1	**3**	**1**				**1**	**1**	**3**			
CO2	**3**	**1**				**1**	**1**	**3**			
CO3	**3**	**1**				**1**	**1**	**3**			
CO4	**3**	**1**				**1**	**1**	**3**			
CO5	**3**	**1**				**1**	**1**	**3**	**2**		
BS101	**3**	**1**				**1**	**1**	**3**	**2**		

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

1. Name of the Department: Chemistry						
2. Course Name	**FUNDAMENTALS OF INORGANIC CHEMISTRY**			**L**	**T**	**P**
3. Course Code	**CH112**			3	1	0
4. Type of Course (use tick mark)				**Core ( )**	**DE ( )**	**FC (√)**
5. Pre-requisite (if any)	10+2 with Chemistry	**6. Frequency (use tick marks)**	Even ( )	Odd (√)	Either Sem ( )	Every Sem ( )

7. Total Number of Lectures, Tutorials, Practicals

Lectures = 30	Tutorials = 10	Practical = Nil

8. COURSE OBJECTIVES: The purpose of this course is to learn about how to classify elements in different groups and periods, various bonding parameters and how can predict the shape and geometry of the molecules. Different acid-base reactions, naming and stereochemistry of complexes.

9. COURSE OUTCOMES (CO): ***After the successful course completion, learners will develop following attributes:***

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Justify periodic law and the periodic table to describe trends in atomic properties and make predictions about the physical and chemical behavior of various elements.
CO2	Select the type of bonding and their chemical and physical properties including electronegativities, bond distances and bond energies using different parameters.
CO3	Predict the geometry and shape of molecules by applying VB & VSEPR theories.
CO4	Identify acid/base reactions, pH determination.
CO5	Write the IUPAC names of complexes and explain the stereochemistry.

10. Unit wise detailed content

Unit-1	Number of lectures = 08	Title of the unit: Periodic Properties

An introduction to modern periodic table, periodicity in properties of elements: Atomic and ionic radii, ionization energy, electron Affinity, electronegativity, effective nuclear charge, shielding effect.

Unit-2	Number of lectures =08	Title of the unit: Chemical Bonding-I

Introduction, causes of chemical combination, electronic theory of valency, general characteristics of electrovalent bond, covalent bond, coordinate bond, metallic bonding and hydrogen bonding.

Unit-3	Number of lectures = 08	Title of the unit: Chemical Bonding-II

Hybridization and shapes of simple molecules and ions. Valence Shell Electron Pair Repulsion (VSEPR) theory to NH_3, SF_4, ClF_3, ICl_4^- and H_2O. Molecular Orbital theory for homonuclear and heteronuclear diatomic molecules.

Unit-4	Number of lectures = 08	Title of the unit: Acid and Bases

Elementary idea of Bronsted-Lowry and Lewis concept of acids and bases (Proton-donor acceptor and electron donor acceptor systems), Relative strengths of Lewis acids bases and the effect of substitutes and the solvent on them.

Unit-5	Number of lectures = 08	Title of the unit: Coordination Compounds

Double salts and coordination compounds, Werner's coordination theory, IUPAC nomenclature of coordination compounds, Discussion of inner and outer orbital complexes, Isomerism (structural, optical and geometrical).

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	Justify periodic law and the periodic table to describe trends in atomic properties and make predictions about the physical and chemical behavior of various elements.	**3**	**2**	**1**	**1**	**1**	**1**	**3**
CO2	Select the type of bonding and their chemical and physical properties including electronegativities, bond distances and bond energies using different parameters.	**3**	**2**	**1**	**1**	**2**	**1**	**3**
CO3	Predict the geometry and shape of molecules by applying VB & VSEPR theories.	**3**	**1**	**1**	**1**	**1**	**1**	**2**
CO4	Identify acid/base reactions, pH determination.	**3**	**1**	**2**	**1**	**1**	**1**	**2**
CO5	Write the IUPAC names of complexes and explain the stereochemistry.	**3**	**1**	**1**	**2**	**1**	**1**	**3**

3 Strong contribution, 2 Average contribution , 1 Low contribution

12. Brief description of self-learning / E-learning component

1. https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/104101090/lec1.pdf
2. https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/104106096/lec9.pdf
3. https://ocw.mit.edu/high-school/chemistry/exam-prep/structure-of-matter/chemical-bonding/
4. https://www.youtube.com/watch?v=ZNo6gfCAgWE
5. https://nptel.ac.in/content/syllabus_pdf/104105033.pdf

13. Books recommended:

1. Advanced Inorganic Chemistry Vol-I & II, Satya Prakash, G.D. Tuli, S.K. Basu, R.D. Madan, S. Chand & Co. Ltd.
2. Test book of Inorganic Chemistry, P.L. Soni, Sultan Chand & Sons
3. Simplified Course in Inorganic Chemistry, Madan & Tuli, S. Chand & Co. Ltd.
4. Concise Inorganic Chemistry, J.D. Lee, Black Well Sciences
5. Selected Topics in Inorganic Chemistry, Wahid U Malik, GD Tuli, RD Madan, S Chand Publication.

B. Sc. BIOTECHNOLOGY 1st year/ 1st semester						
1.Name of the Department: Biosciences						
2.Course Name	**PLANT SCIENCES LAB**			**L**	**T**	**P**
3.Course Code	**BS102**			0	0	6
4.Type of Course (use tick mark)		**Core(✓)**	**Foundation Course ( )**		**Departmental Elective ( )**	
5.Pre-requisite (if any)	10+2 with biology	**6.Frequency (use tick marks)**	Even **( )**	Odd (✓)	Either Sem ( )	Every Sem( )
7.TotalNumberofLectures,Tutorials,Practicals						
Lectures=00		**Tutorials=00**		**Practical=10**		

8. COURSE OBJECTIVES: The objective of this course is to develop the understanding of the structure and functioning of Plant Cells, tissues and morphology, anatomy and physiology of plants.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Have basic knowledge of anatomy of dicots and monocots
CO2	Gain knowledge about the structure of a flower and various types of inflorescence.
CO3	Know about the different types of seeds and fruit
CO4	Get basic knowledge of the structure of bryophyte, pteridophyte, gymnosperm
CO5	Identify algae and fungi and have basic knowledge of their structure

10. Syllabus

Exp-01	Transverse section of dicot and monocot stems
Exp-02	Transverse section of dicot and monocot leaves
Exp-03	Transverse section of dicot and monocot roots
Exp-04	Morphology study of flower parts, inflorescence, seed, fruit types
Exp-05	Study of one example each of bryophyte, pteridophyte, gymnosperm
Exp-06	Study of one example each of algae and fungi

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	*Have basic knowledge of anatomy of dicots and monocots*	**3**	3	1			1	2
CO2	*Gain knowledge about structure of a flower and various types of inflorescence.*	**3**	3	1			1	2
CO3	*know about the different types of seeds and fruit*	**3**	3	1			1	2
CO4	*get basic knowledge of the structure of bryophyte, pteridophyte, gymnosperm*	**3**	3	1			**1**	2
CO5	*identify algae and fungi and have basic knowledge of their structure*	**3**	**3**	**1**			**1**	**2**

3: Strong contribution, 2: Average contribution , 1: Low contribution

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	POS2	PSO3	PSO4
CO1	**3**	3	1			1	2	**3**		**2**	
CO2	**3**	3	1			1	2	**3**		**2**	
CO3	**3**	3	1			1	2	**3**		**2**	
CO4	**3**	3	1			**1**	2	**3**		**2**	
CO5	**3**	**3**	**1**			**1**	**2**	**3**		**2**	
BS102	**3**	**3**	**1**			**1**	**2**	**3**		**2**	

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

1. Name of the Department: Chemistry						
2. Course Name	**FUNDAMENTALS OF ORGANIC CHEMISTRY**			**L**	**T**	**P**
3. Course Code	**CH114**			3	1	0
4. Type of Course (use tick mark)				**Core ( )**	**DE ( )**	**FC (√)**
5. Pre-requisite (if any)	10+2 with Chemistry	**6. Frequency (use tick marks)**	Even (√)	Odd ( )	Either Sem ( )	Every Sem ( )

7. Total Number of Lectures, Tutorials, Practicals		
Lectures = 30	**Tutorials = 10**	**Practical = Nil**

8. COURSE OBJECTIVES: To learn about IUPAC rules for the nomenclature of various organic compounds, prediction of geometry, stereochemistry and mechanisms of reactions by taking some specific name reactions

9. COURSE OUTCOMES (CO): ***After the successful course completion, learners will develop following attributes:***

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Understand different organic compounds with respect to the functional groups and become eligible to write the name of the organic compounds scientifically (IUPAC)
CO2	Predict the state of hybridization, geometry of molecule and various electron displacement effects.
CO3	An understanding of nucleophiles, electrophiles including the prediction of mechanisms for various organic reactions.
CO4	Design the synthesis of newer organic compounds by applying various name reactions.
CO5	Interpret the reactivity and stability of an organic molecule based on structure, including conformation and stereochemistry

10. Unit wise detailed content

Unit-1	Number of lectures = 08	Title of the unit: Classification of organic compounds

Nomenclature of organic compounds, Functional groups, Homologous series, IUPAC recommendations for naming simple aliphatic, alicyclic and aromatic compounds, Polyfunctional compounds, Heterocyclic compounds.

Unit-2	Number of lectures =08	Title of the unit: Basic concepts of bonding in organic chemistry

Hybridisation, tetravalency of carbon, geometry of molecules; methane, ethane, ethylene, acetylene and benzene, Factors affecting covalent bond; Electron displacement effects, inductive, electromeric, resonance, hyperconjugation and steric effects.

Unit-3	Number of lectures = 08	Title of the unit: Mechanisms of Organic Reactions

Reaction intermediates (Carbocation, carbanion and free radicals), Types of attacking reagents (electrophiles and nucleophiles), Types of Organic Reactions: Substitution reactions; electrophillic, nucleophillic (mechanims of nucleophilic substitution reaction of alkyl halides, SN1 and SN2 and reactions, with energy profile diagrams) and free radicals, Addition reactions; electrophillic, nucleophillic and free radical, Elimination reactions; E1& E2.

Unit-4	Number of lectures = 08	Title of the unit: Name Reactions

Aldol Condensation, Cannizzaro reaction, Beckmann rearrangement, Hoffmann rearrangement, Diels-Alder reaction, Clemmensen reduction, Wolff Kishner reduction

Unit-5	Number of lectures = 08	Title of the unit: Stereochemistry

Concept of isomerism, types of isomerism; structural, geometrical and optical isomerism, E and Z system of nomeclature, conformational analysis of n-butane.

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	Understand different organic compounds with respect to the functional groups and become eligible to write the name of the organic compounds scientifically (IUPAC)	**3**	**2**	**1**	**1**	**1**	**1**	**2**
CO2	Predict the state of hybridization, geometry of molecule and various electron displacement effects.	**3**	**2**	**1**	**1**	**2**	**1**	**2**
CO3	An understanding of nucleophiles, electrophiles including the prediction of mechanisms for various organic reactions.	**2**	**1**	**1**	**2**	**1**	**1**	**2**
CO4	Design the synthesis of newer organic compounds by applying various name reactions.	**3**	**1**	**2**	**1**	**1**	**1**	**2**
CO5	Interpret the reactivity and stability of an organic molecule based on structure, including conformation and stereochemistry	**3**	**1**	**1**	**2**	**1**	**1**	**1**

3 Strong contribution, 2 Average contribution , 1 Low contribution

12. Brief description of self-learning / E-learning component

1. https://nptel.ac.in/courses/104106119/
2. https://nptel.ac.in/courses/104101115/
3. https://nptel.ac.in/courses/104103110/
4. https://nptel.ac.in/courses/104103023/
5. https://nptel.ac.in/courses/104105086/

13. Books recommended:

1. Advanced Organic Chemistry, Bahl & Bahl, S. Chand & Co. Ltd.
2. Organic Chemistry Vol.I & II, I.L. Finar
3. Fundamentals of Organic Chemistry, Nafis Haider, S. Chand & Co. Ltd.
4. A text book of Organic Chemistry, Bahl & Bahl, S. Chand & Co. Ltd.
5. Organic Chemistry Vol.I, II & III, Dr. Jagdamba Singh, L.D.S. Yadav, Pragati Prakashan

B. Sc. BIOTECHNOLOGY 1st year/ 2nd semester

1. Name of the Department: Biosciences					
2. Course Name	**ANIMAL SCIENCE**		**L**	**T**	**P**
3. Course Code	**BS111**		3	1	0
4. Type of Course (use tick mark)	**Core (✓)**	**Foundation Course ()**		**Departmental Elective ()**	
5. Pre-requisite (if any)	10+2 with Biology	**6. Frequency (use tick marks)**	Even **(✓)**	Odd ()	Either Sem ( )	Every Sem ( )
7. Total Number of Lectures, Tutorials, Practicals					
Lectures = 30	**Tutorials = 10**	**Practical = 00**			

8. COURSE OBJECTIVES: The objective of this course is to develop the understanding of interrelationships within and between anatomical and physiological systems of the human body and the importance of economic zoology

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Animal Tissue system of animals, membrane potential
CO2	Digestive system, muscle system, nervous system
CO3	Respiratory system, cardiovascular system, excretory and reproductive system
CO4	Host-parasite relationship, global features of parasites
CO5	Economic zoology, beneficial and harmful organisms, Vermiculture, Aquaculture, Sericulture, Apiculture.

10. Unit wise detailed content

Unit-1	**Number of lectures = 08**	**Title of the unit:** Animal tissue types

epithelial, connectives, muscle and nervous tissues, Animal Physiology: Membranes and Epithelial transport systems in animals, Membrane structure and function, Equilibrium potentials, Resting membrane potential, Ionic steady state.

Unit-2	**Number of lectures = 08**	**Title of the unit:** Digestive system, Muscle system

Muscles and Movement, Skeletal, cardiac and smooth muscle, Nervous system: Action potentials and voltage dependent ion channels, Passive membrane properties, action potential propagation, Synapses, central and peripheral nervous system.

Unit-3	**Number of lectures = 08**	**Title of the unit: Respiratory system**

Haemoglobin and oxygen transport, carbon dioxide transport and chloride shift, Circulatory & Cardiovascular System: Heart and circulation, Excretory system: Nephron, Reproductive system: testis, ovary, Spermatogenesis, hormonal regulation of female reproductive cycle.

Unit-4	**Number of lectures = 08**	**Title of the unit: Host parasite relationship**

Global feature of parasite and host interaction Protozoan parasite, Nematode parasite, Platyhelminthes parasite.

Unit-5	**Number of lectures = 08**	**Title of the unit: Economic Zoology**

Beneficial and harmful organisms, Vermiculture, Aquaculture, Sericulture, Apiculture.

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	*Animal Tissue system of animals, membrane potential*	**3**	**1**					**1**
CO2	*Digestive system, muscle system, nervous system*	**3**	**1**					**1**
CO3	*respiratory system, cardiovascular system, excretory and reproductive system*	**3**	**1**					**1**
CO4	*host-parasite relationship, global features of parasite*	**3**	**1**				**3**	**1**
CO5	*Economic zoology, beneficial and harmful organisms, Vermiculture, Aquaculture, Sericulture, Apiculture.*	**3**	**1**				**3**	**1**

3: Strong contribution, 2: Average contribution , 1: Low contribution

12. Books recommended:

1. Fox S I – Human Physiology, (McGraw Hill, 1998, ISBN: 0071157069)
2. Moffett D and Schauf C L – Human Physiology: Foundations & Frontiers, (Mosby, 1993, ISBN: 801669030)
3. Seeley R, Stephens T and Tate P – Anatomy & Physiology, (McGraw-Hill, 1999, ISBN: 0071169881)
4. Sherwood L – Human Physiology: From Cells to Systems, (Wadsworth Publishing, 2000, ISBN: 0534568262)
5. Tortora G J Principles of Anatomy & Physiology, (John Wiley & Sons, 1999, ISBN: 0471366927)

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	POS2	PSO3	PSO4
CO1	3	1					1	3			
CO2	3	1					1	3			
CO3	3	1					1	3			
CO4	3	1				3	1	3	2		
CO5	3	1				3	1	3			2
BS111	3	1				2	1	3	1		1

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

B. Sc. BIOTECHNOLOGY 1st year/ 2nd semester						
1. Name of the Department: Biosciences						
2. Course Name	**FUNDAMENTALS OF BIOCHEMISTRY**			**L**	**T**	**P**
3. Course Code	**BS112**			3	1	0
4. Type of Course (use tick mark)		**Core (✓)**	**Foundation Course ()**		**Departmental Elective ()**	
5. Pre-requisite (if any)	10+2 with Biology	**6. Frequency (use tick marks)**	Even **(✓)**	Odd ()	Either Sem ( )	Every Sem ( )
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 30		**Tutorials = 10**	**Practical = 00**			

8. COURSE OBJECTIVES: The objective of this course is to develop the understanding of basics of biomolecules including carbohydrates, Amino acid & protein, lipids, Nucleic Acid and Vitamins.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Understand the basics of carbohydrate, its classification
CO2	Understand the basics of Amino acids & proteins
CO3	Have knowledge of basics of lipids
CO4	Understand the basics of Nucleic Acids
CO5	Understand the basics of Vitamins

10. Unit wise detailed content

Unit-1	**Number of lectures = 08**	**Title of the unit: - Introduction to Biomolecules**
: Carbohydrates, Proteins, Lipids and Nucleic acids.		
Unit-2	**Number of lectures = 08**	**Title of the unit:** - Carbohydrates
Structure, classification and properties of Monosaccharides, Disaccharides, and Polysaccharides (starch, glycogen, peptidoglycan, cellulose).		
Unit-3	**Number of lectures = 08**	**Title of the unit: Amino acids and Proteins**
Structure, classification and properties of amino acids, Structures and functions of proteins (Hb and Myoglobin).		
Unit-4	**Number of lectures = 08**	**Title of the unit: Lipids**
Structure, classification and properties of Fatty acids, Glycerolipid, Cholesterol, Sphingolipid, phospholipids, lipoproteins, glycoproteins, isoprene		
Unit-5	**Number of lectures = 08**	**Title of the unit: - Nucleic acids**
Purines and pyrimidines, nucleosides, nucleotides, polynucleotides, DNA, types and function, RNA types and functions, Forces stabilizing nucleic acid structure		

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	*Understand the basics of carbohydrate, its classification*	**3**	**1**					**1**
CO2	*Understand the basics of Amino acids & proteins*	**3**	**1**					**1**
CO3	*Have knowledge of basics of lipids*	**3**	**1**					**1**
CO4	*Understand the basics of Nucleic Acids*	**3**	**1**					**1**
CO5	*Understand the basics of Vitamins*	**3**	**1**					**1**

3: Strong contribution, 2: Average contribution , 1: Low contribution

13. Books recommended:

1. Principles of Biochemistry- AlbertL. Lehninger CBS Publishers & Distributors
2. Biochemistry – Lubert stryer Freeman International Edition.
3. Biochemistry – Keshav Trehan Wiley Eastern Publications
4. Fundamentals of Biochemistry-J.L. Jain, S.Chand and Company

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	POS2	PSO3	PSO4
CO1	3	1					1	3	2	1	
CO2	3	1					1	3	2	1	
CO3	3	1					1	3	2	1	
CO4	3	1					1	3	2	1	
CO5	3	1					1	3	2	1	
BS112	3	1					1	3	2	1	

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

B. Sc. BIOTECHNOLOGY 1st year/ 2nd semester						
1. Name of the Department: Biosciences						
2. Course Name	**FUNDAMENTALS OF MICROBIOLOGY**			**L**	**T**	**P**
3. Course Code	**BS113**			3	1	0
4. Type of Course (use tick mark)		**Core (✓)**	**Foundation Course ()**		**Departmental Elective ()**	
5. Pre-requisite (if any)	10+2 with Biology	**6. Frequency (use tick marks)**	Even **(✓)**	Odd ( )	Either Sem ( )	Every Sem ( )
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 30		**Tutorials = 10**	**Practical = 00**			

8. COURSE OBJECTIVES: The objective of this course is to develop the understanding of basics of microbiology, classification of microbes, control of microorganisms, microbes in extreme environments and microbial interactions and basics of Recombination in Prokaryotes

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Know the basics of microbiology
CO2	Have knowledge of the general classification of microbes
CO3	understand basics of Control of Microorganisms
CO4	study bacteriophages and microbes in extreme environments and microbial interactions
CO5	know the basics of recombination in Prokaryotes

10. Unit wise detailed content

Unit-1	**Number of lectures = 08**	**Title of the unit: - -History and classification of microbiology**

Pasteur's experiments, Various forms of microorganisms (bacteria, fungi, viruses, protozoa, PPLOs); Nutritional classification of microorganisms; Nature of the microbial cell surface, gram positive and gram negative bacteria; Growth curve.

Unit-2	**Number of lectures = 08**	**Title of the unit: - Control of Microorganisms**

Physical agents (Autoclave, Hot air oven, Laminar airflow and membrane filter.), chemical agents (Alcohol, Halogens and Gaseous agents, antibiotics), Radiation Methods (UV rays). Pathogenesis of microorganisms: Some common pathogenic microorganisms: Bacterial (tuberculosis, gall), viral (SARS, TMV), fungal (red rot of sugar cane, dermatitis) and protozoan (malaria).

Unit-3	**Number of lectures = 08**	**Title of the unit: Microbes in extreme environments and microbial interactions:**

The thermophiles alkalophiles, acidophiles and symbiosis and antibiosis among microbial population, N2 fixing microbes in agriculture and forestry.

Unit-4	**Number of lectures = 08**	**Title of the unit: Recombination in Prokaryotes**

Transformation, Conjugation and Transduction.

Unit-5	**Number of lectures = 08**	**Title of the unit: - Bacteriophage and staining**

Lytic and lysogenic cycle. Stains and staining techniques: Principles of staining, Types of stains – simple stains, structural stains and Differential stains.

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	*Know the basics of microbiology*	**3**	**1**				**2**	**2**
CO2	*have knowledge of the general classification of microbes*	**3**	**1**				**2**	**2**
CO3	*Understand basics of Control of Microorganisms*	**3**	**1**				**2**	**2**
CO4	*study bacteriophages and microbes in extreme environment and microbial interactions*	**3**	**1**				**3**	**1**
CO5	*know the basics of recombination in Prokaryotes*	**3**	**1**				**1**	**1**

3: Strong contribution, 2: Average contribution , 1: Low contribution

12. Books recommended:

1. Introduction to Microbiology, Ingraham, 2ed.
2. Brock Biology of Microorganisms, Madigan et al, 9th ed.
3. General Microbiology, R.Y. Stanier, J.L. Ingraham, M.L.Wheelis and P.R. Painter, Macmillian
4. Microbiology VI Edition, M.J. Pelczar, E.C.S. Chan and N.R. Kreig, Tata McGraw Hill
5. Principles of Microbiology, R.M. Atlas, Wm C. Brown Publisher.
6. The Microbial World, Roger Y. Stanier, Prentice Hall
7. Howe.C. (1995) Gene Cloning and manipulation, Cambridge University Press, USA
8. Lewin, B., Gene VI New York, Oxford University Press.
9. Sambrooket al (2000) Molecular cloning Volumes I, II, & III Cold spring Harbor Laboratory Press, New York, USA
10. Walker J.M. and Gingold, E.B. (1983) Molecular Biology & Biotechnology (Indian Edition) Royal Society of Chemistry U.K

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	POS2	PSO3	PSO4
CO1	**3**	**1**				**2**	**2**	**3**	**2**		
CO2	**3**	**1**				**2**	**2**	**3**	**1**		
CO3	**3**	**1**				**2**	**2**	**3**	**2**	**1**	1
CO4	**3**	**1**				**3**	**1**	**3**	**2**	**1**	1
CO5	**3**	**1**				**1**	**1**	**3**	**2**		
BS113	**3**	**1**				**2**	**2**	**3**	**2**	**1**	**1**

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

B. Sc. BIOTECHNOLOGY 1st year/ 2nd semester

1.Name of the Department: Biosciences

2.Course Name	**ANIMAL SCIENCES LAB**	**L**	**T**	**P**	
3.Course Code	**BS114**	0	0	6	
4.Type of Course (use tick mark)	**Core(√)**	**Foundation Course ( )**	**Departmental Elective( )**		
5.Pre-requisite (if any)	10+2 with Biology	**6.Frequency(use tick marks)**	Even **(√)**	Odd ( )	Either Sem ( )	EverySem( )

7.TotalNumberofLectures,Tutorials,Practicals

Lectures=00	**Tutorials=00**	**Practical=10**

8. COURSE OBJECTIVES: Develop the understanding of basics of biomolecules, cell structure, assay of enzymes, transportation and Osmosis

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	**ATTRIBUTES**
CO1	Perform assay of biomolecules as carbohydrate, Amino acids, protein and cholesterol
CO2	Study the Cell structure of prokaryotes and perform isolation of nuclei
CO3	Can do Cell harvesting and Cell lysis
CO4	Perform assay enzymes as Salivary amylase
CO5	Understand basics of cell Transportation and Osmosis

10.Syllabus

Exp-01	Spot test for carbohydrates
Exp-02	Estimation of reducing sugars by Benedict's Method
Exp-03	Spot tests for Amino Acids
Exp-04	Protein estimation
Exp-05	Estimation of Cholesterol
Exp-06	Cell structure-prokaryotes and eukaryotes
Exp-07	Isolation of nuclei from goat liver
Exp-08	Cell harvesting–methodology
Exp-09	Cell lysis–methodology
Exp-10	Cell viability by Trypan Blue
Exp-11	Salivary amylase assay
Exp-12	Transportation of salts and sugars by dialysis membrane
Exp-13	Osmosis by potato osmometer

11. CO-PO mapping

COs	**Attributes**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
CO1	*Perform assay of biomolecules as carbohydrate, amino acids, protein and cholesterol*	**3**	3	1				3
CO2	*Study the Cell structure of prokaryotes and perform isolation of nuclei*	**3**	3	1				**3**
CO3	*Can do Cell harvesting and Cell lysis*	**3**	3	1				3
CO4	*Assay enzymes Salivary amylase*	3	**3**	1				3
CO5	*Understand basics of cell Transportation and Osmosis*	**3**	**3**	**1**			**1**	**3**

3: Strong contribution, 2: Average contribution , 1: Low contribution

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	POS2	PSO3	PSO4
CO1	**3**	3	1				3	**3**	**1**	**2**	
CO2	**3**	3	1				**3**	**3**	**1**	**2**	
CO3	**3**	3	1				3	**3**	**1**	**2**	
CO4	3	**3**	1				3	**3**	**1**	**2**	
CO5	**3**	**3**	**1**			**1**	**3**	**3**	**1**	**2**	
BS114	**3**	3	1			1	3	**3**	**1**	**2**	

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

B. Sc. BIOTECHNOLOGY 2nd year/ 3rd semester

1. Name of the Department: Biosciencess

2. Course Name	**METABOLISM**	**L**	**T**	**P**
3. Course Code	**BS201**	3	1	0

4. Type of Course (use tick mark)	**Core (✓)**	**Foundation Course ()**		**Departmental Elective ()**	
5. Pre-requisite (if any)	10+2 with Biology	**6. Frequency (use tick marks)**	Even **( )**	Odd (✓)	Either Sem ( )	Every Sem ( )

7. Total Number of Lectures, Tutorials, Practicals

Lectures = 30	**Tutorials = 10**	**Practical = 00**

8. COURSE OBJECTIVES: The objective of this course is to develop the understanding of **c**haracteristics of Enzymes, enzyme inhibition and kinetics, carbohydrate metabolism, significance of glycolysis and ETC, untreated diabetes, lipid metabolism and production of ketone bodies, protein metabolism, role of urea cycle and errors of protein metabolism, biosynthesis and degradation of purine and pyrimidine

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	**ATTRIBUTES**
CO1	Understand the characteristic of Enzymes, enzyme inhibition and kinetics
CO2	Know the basics of carbohydrate metabolism, significance of glycolysis and ETC, untreated diabetes
CO3	Know the basics of Lipid metabolism and production of ketone bodies
CO4	Know the basics of Protein metabolism, role of urea cycle and errors of protein metabolism
CO5	Know the biosynthesis and degradation of purine and pyrimidine

10. Unit wise detailed content

Unit-1	**Number of lectures = 08**	**Title of the unit: Enzymes**

Classification, properties and factors influencing enzyme activity, coenzymes, prosthetic group and co-factors, Lock & key hypothesis, induced fit hypothesis, Enzyme kinetics: Michaelis Menten equation, Lineweaver-Burk plot, Enzyme inhibition, Allosteric enzymes.

Unit-2	**Number of lectures = 08**	**Title of the unit: Carbohydrate metabolism**

Glycolysis, TCA cycle, Electron Transport Chain and Oxidative phosphorylation, Gluconeogenesis and Glycogen metabolism.

Unit-3	**Number of lectures = 08**	**Title of the unit: lipid metabolism**

Degradation of fatty acids: □ oxidation; Ketone bodies, acidosis, ketosis, cholesterol synthesis.

Unit-4	**Number of lectures = 08**	**Title of the unit: protein metabolism**

Urea Cycle, transport of ammonia, deamination and transamination reactions. Inborn errors of protein metabolism.

Unit-5	**Number of lectures = 08**	**Title of the unit: Nucleic acid metabolism**

Purine and Pyrimidine biosynthesis and degradation.

11. CO-PO mapping

COs	**Attributes**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
CO1	*Understand the characteristic of Enzymes, enzyme inhibition and kinetics*	**3**	**1**					**2**
CO2	*Know the basics of carbohydrate metabolism, significance of glycolysis and ETC, untreated diabetes*	**3**	**1**					**2**
CO3	*Know the basics of Lipid metabolism and production of ketone bodies*	**3**	**1**					**2**
CO4	*Know the basics of Protein metabolism, role of urea cycle and errors of protein metabolism*	**3**	**1**					**2**
CO5	*Know the biosynthesis and degradation of purine and pyrimidine*	**3**	**1**					**1**

3: Strong contribution, 2: Average contribution , 1: Low contribution

13. Books recommended:

1.. Principles of Biochemistry- AlbertL. Lehninger CBS Publishers & Distributors
2. Biochemistry – Lubert stryer Freeman International Edition.
3. Biochemistry – Keshav Trehan Wiley Eastern Publications
4. Fundamentals of Biochemistry-J.L.Jain S.Chand and Company
5. Biochemistry- Prasaranga, Bangalore University
6. Fundamental of Biochemistry – Dr.A.C.Deb
7. Textbook of Organic Chemistry (A Modern Approach)
8. The Biochemistry of Nucleic acid – Tenth Edition-Roger L.P.Adams, John T. Knowler and David P.Leader, Chapman and Hall Publications

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	POS2	PSO3	PSO4
CO1	**3**	**1**					2	**3**	**2**	**1**	
CO2	**3**	**1**					**2**	**3**	**2**	**1**	
CO3	**3**	**1**					2	**3**	**2**	**1**	
CO4	**3**	**1**					2	**3**	**2**	**1**	
CO5	**3**	**1**					**1**	**3**	**2**		
BS201	**3**	1					2	**3**	**2**	**1**	

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

B. Sc. BIOTECHNOLOGY 2nd year/ 3rd semester

1. Name of the Department: Biosciencess

2. Course Name	**BIOPHYSICAL CHEMISTRY**	**L**	**T**	**P**
3. Course Code	**BS202**	3	1	0

4. Type of Course (use tick mark)		**Core (✓)**	**Foundation Course ()**		**Departmental Elective ()**	
5. Pre-requisite (if any)	10+2 with Biology	**6. Frequency (use tick marks)**	Even **( )**	Odd (✓)	Either Sem ( )	Every Sem ( )

7. Total Number of Lectures, Tutorials, Practicals

Lectures = 30	**Tutorials = 10**	**Practical = 00**

8. COURSE OBJECTIVES: The objective of this course is to develop the understanding of electromagnetic radiation, absorption spectrum, Beer's law and Lambert's law, principle, working and applications of spectrophotometer, concepts of chromatography and concept of partition coefficient and application of various chromatographic techniques, Centrifugation and Electrophoresis-Principles and applications, Importance of radioactivity in biological studies, GM counters and Scintillation counting.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	**ATTRIBUTES**
CO1	Understand the basics of biophysics, chemical bonds and concept of thermodynamics.
CO2	Understand the basics and types of spectroscopy.
CO3	know basic principle, methodology and application of various chromatographic techniques
CO4	study centrifugation and electrophoresis - principles and applications
CO5	Understand the importance of radioactivity in biological studies, GM counters and Scintillation counting.

10. Unit wise detailed content

Unit-1	**Number of lectures = 08**	**Title of the unit: Basics of Biophysics**

Chemical bonding – Ionic bond, covalent bond, hydrogen bond and peptide bond, Van Der-Waals forces, Principles of thermodynamics.

Unit-2	**Number of lectures = 08**	**Title of the unit: Analytical techniques**

Spectrophotometry and colorimetry, Spectroscopic techniques: UV-visible spectroscopy, NMR, IR, Fluorescence and atomic absorption spectroscopy, X-ray crystallography.

Unit-3	**Number of lectures = 08**	**Title of the unit: Chromatography**

Paper, thin-layer, column, HPLC, GLC and molecular sieving.

Unit-4	**Number of lectures = 08**	**Title of the unit: Centrifugation**

Principles, types, instrumentation and applications. Electrophoresis: Principles and applications (PAGE and Agarose gel electrophoresis).

Unit-5	**Number of lectures = 08**	**Title of the unit: Radioactivity**

Types, their importance in biological studies, measure of radioactivity, GM counters and Scintillation counting.

11. CO-PO mapping

COs	**Attributes**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
CO1	*understand the basics of biophysics, chemical bonds and concept of thermodynamics*	**3**	**1**					**2**
CO2	*understand the basics and types of spectroscopy*	**3**	**1**					**2**
CO3	*know basic principle, methodology and application of various chromatographic techniques*	**3**	**1**					**2**
CO4	*study Centrifugation and Electrophoresis-Principles and applications*	**3**	**1**					**2**
CO5	*Understand Importance of radioactivity in biological studies, GM counters and Scintillation counting*	**3**	**1**					**2**

3: Strong contribution, 2: Average contribution , 1: Low contribution

13. Books recommended:

1. Narayanan, P (2000) Essentials of Biophysics, New Age Int. Pub. New Delhi.
2. Bliss, C.J.K (1967) Statistics in Biology, Vol. I c Graw Hill, New York.
3. Campbell R.C (1974) Statistics for Biologists, Cambridge Univ. Press, Cambridge.
4. Daniel (1999) Biostatistics (3rd Edition) Panima Publishing Corporation.
5. Swardlaw, A.C (1985) Practical Statistics for Experimental Biologists, John Wiley and Sons, Inc. NY
6. Khan (1999) Fundamentals of Biostatistics Publishing Corporation

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	POS2	PSO3	PSO4
CO1	3	1					2	3	2	3	
CO2	3	1					2	3	2	3	
CO3	3	1					2	3	2	3	
CO4	3	1					2	3	2	3	
CO5	3	1					2	3	2	3	
BS202	3	1					2	3	2	**3**	

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

B. Sc. BIOTECHNOLOGY 2nd year/ 3rd semester						
1. Name of the Department: Biosciences						
2. Course Name	**CELL BIOLOGY AND GENETICS**			**L**	**T**	**P**
3. Course Code	**BS203**			3	1	0
4. Type of Course (use tick mark)		**Core (√)**	**Foundation Course ()**		**Departmental Elective ()**	
5. Pre-requisite (if any)	10+2 with Biology	**6. Frequency (use tick marks)**	Even **( )**	Odd (√)	Either Sem ( )	Every Sem ( )
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 30		**Tutorials = 10**	**Practical = 00**			

8. COURSE OBJECTIVES: This course is designed to enable the students to understand the cell structure and its functions, signal transduction and genetics.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Develop an understanding of the cell structure and their functions, cytoskeleton and prokaryotic and eukaryotic cells
CO2	Learn about Cell Division, Membrane transport, transduction, cell senescence and Programmed Cell Death.
CO3	Learn about Chromosomes, Chromosomal Variations, Chromosome mapping, structural and numerical aberrations
CO4	Learn about basic genetics, epistasis, Concepts of allosomes and autosomes, Linkage and Crossing Over.
CO5	Learn about mutations, human Genetics, DNA damage and repair.

10. Unit wise detailed content

Unit-1	**Number of lectures = 08**	**Title of the unit: Cell as a Basic unit of Living Systems**

Discovery of cell, The Cell theory Ultrastructure of an eukaryotic cell – (both plant and animal cell). Structure and functions of cell organelles, Cytoskeletal structures (Microtubules, Microfilaments); cell motility.

Unit-2	**Number of lectures = 08**	**Title of the unit: Cell Division**

Cell cycle, mitosis and meiosis, Membrane transport: active and passive transport, introduction to signal transduction and its molecular mechanism, cell senescence, Programmed Cell Death.

Unit-3	**Number of lectures = 08**	**Title of the unit: Chromosomes: Structural Organization**

centromere, telomere, chromonema, euchromatin and heterochromatin, chemical composition and karyotype, nucleosome model, Special types of chromosomes: Salivary gland and Lampbrush chromosomes, Chromosomal Variations, Chromosome mapping, structural and numerical aberrations.

Unit-4	**Number of lectures = 08**	**Title of the unit: Mendelism**

Mendel's laws of heredity, Test cross, Incomplete dominance and simple problems, Interaction of Genes**:** Supplementary factors, Comb pattern in fowls, Complementary genes: Flower color in sweet peas, Multiple factors: Skin color in human beings, Epistasis: Plumage colour in poultry, Multiple allelism: Blood groups in human beings, Concepts of allosomes and autosomes, XX-XY, XX-XO, ZW-ZZ, ZO-ZZ type, Linkage and Crossing Over, Mechanism and importance.

Unit-5	**Number of lectures = 08**	**Title of the unit: Mutations**

Spontaneous and induced mutations, Physical and chemical mutagens, Mutation at the molecular level, Mutations in plants, animals, and microbes for economic benefit of man. Human Genetics: Karyotype in man, inherited disorders: Allosomal (Klinefelter syndrome and Turner's syndrome), Autosomal (Down syndrome and Cri-Du- Chat syndrome). DNA Damage and Repair: Causes and Types of DNA damage, Major mechanisms of DNA repair: photoreactivation, nucleotide and base excision repairs, mismatch repair, SOS repair.

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	*Develop an understanding of the cell structure and their functions, cytoskeleton and prokaryotic and eukaryotic cells*	**3**	**1**					**2**
CO2	*Learn about Cell Division, Membrane transport, transduction, cell senescence and Programmed Cell Death.*	**3**	**1**					**2**
CO3	*Learn about Chromosomes, Chromosomal Variations, Chromosome mapping, structural and numerical aberrations*	**3**	**1**					**2**

CO4	*Learn about basic genetics, epistasis, Concepts of allosomes and autosomes, Linkage and Crossing Over.*	**3**	**1**					**2**
CO5	*Learn about mutations, human Genetics, DNA damage and repair.*	**3**	**1**					**2**

3: Strong contribution, 2: Average contribution , 1: Low contribution

12. Books recommended:

1. Molecular Biology of cell – Bruce Alberts et al, Garland publications
2. Animal Cytology & Evolution – MJD, White Cambridge University Publications
3. Molecular Cell Biology – Daniel , Scientific American Books.
4. Cell Biology – Jack D.Burke, The William Twilkins Company.
5. Principles of Gene Manipulations – Old & Primrose, Black Well Scientific Publications.
6. Cell Biology & Molecular Biology – EDP Roberties & EMF Roberties, Sauder College.
7. Principles of Genetics – E.J.Gardener, M.J.Simmons and D.P.Snustad, John Wiley & Sons Publications

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	POS2	PSO3	PSO4
CO1	**3**	**1**					**2**	**3**	**2**		
CO2	**3**	**1**					**2**	**3**	**2**		
CO3	**3**	**1**					**2**	**3**	**2**		
CO4	**3**	**1**					**2**	**3**	**2**		
CO5	**3**	**1**					**2**	**3**	**2**		
BS203	**3**	1					2	**3**	**2**		

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

B. Sc. BIOTECHNOLOGY 2nd year/ 3rd semester						
1. Name of the Department: Biosciences						
2. Course Name	**IPR AND BIOSAFETY**			**L**	**T**	**P**
3. Course Code	**BS204**			3	1	0
4. Type of Course (use tick mark)		**Core (✓)**	**Foundation Course ()**		**Departmental Elective ()**	
5. Pre-requisite (if any)	10+2 with Biology	**6. Frequency (use tick marks)**	Even **( )**	Odd (✓)	Either Sem ( )	Every Sem ( )
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 30		**Tutorials = 10**	**Practical = 00**			

8. COURSE OBJECTIVES: The objective of this course is to develop the understanding of Intellectual property, IPR, Biosafety, GMO and bioethics.

9. COURSE OUTCOMES (CO):
After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Have basic concept of Intellectual Property and its types
CO2	Know detailed description of various types of IPRs, its protection and infringement
CO3	Have knowledge of International treaties and case studies
CO4	Display understanding of Biosafety, GMOs and various Institutional committees
CO5	Have knowledge of Bioethics and its legal implications

10. Unit wise detailed content

Unit-1	**Number of lectures = 08**	**Title of the unit: Concept of Intellectual Property. Kinds of Intellectual Property**

Patents, Copyrights, Designs, Trademarks, Geographical Indication. Infringement of IPR, Its protection and Remedies Licensing and its types.

Unit-2	**Number of lectures = 08**	**Title of the unit: Requirement of a patentable novelty**

Issues related to IPR protection of software and database; IPR protection of life forms; International convention in IPR; Geographical indication; Distinction among various forms of IPR; Rights / protection, infringement or violation, remedies against infringement: civil and criminal.

Unit-3	**Number of lectures = 08**	**Title of the unit: Obtaining patent**

Invention step and prior art and state of art procedure; Detailed information on patenting biological products and biodiversity; Appropriate case studies; Indian Patent Act 1970 (amendment 2000); Major changes in Indian patent system as post TRIPS effects; Budapest treaty.

Unit-4	**Number of lectures = 08**	**Title of the unit: Biosafety**

Primary Containment for Biohazards; Biosafety Levels; Biosafety guidelines - Government of India; Definition of GMOs; Roles of Institutional Biosafety Committee, RCGM, GEAC etc. for GMO applications in food and agriculture; Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication

Unit-5	**Number of lectures = 08**	**Title of the unit: Bioethics**

Introduction, necessity and limitation; Ethical conflicts in Biotechnology; Different paradigms of bioethics: National and International; Bioethics of genes; Bioethics in health care: Bioethical dilemmas in medical and surgical treatment; Legal implications in bioethics.

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	*Have basic concept of Intellectual Property and its types cells*	**3**	**1**		**3**	**3**		**3**
CO2	*Know detailed description of various types of IPRs, its protection and infringement*	**3**	**1**		**3**	**3**		**3**
CO3	*Have knowledge of International treaties and case studies*	**3**	**1**		**3**	**2**		**3**
CO4	*Display understanding of Biosafety, GMOs and various Institutional committees*	**3**	**1**		**3**	**3**	**3**	**3**
CO5	*Have knowledge of Bioethics and its legal implications*	**3**	**1**	**2**	**3**	**3**	**3**	**3**

3: Strong contribution, 2: Average contribution , 1: Low contribution

12. Books recommended:

1. Genome, T.A. Brown, John Willey & Sons Inc.
2. Molecular Biology of the Cell, B. Alberts, D. Bray, J. Lewis, M. Raff, K. Roberts and J.D. Watson, Garland Publishing
3. Molecular Cell Biology, H. Lodish, A.Berk, S. Zipursky, P Matsundaira, D. Baltimore and J.E. Barnell, W.H. Freeman and Company.
4. Molecular Biology of the Gene, J.D. Watson, A.M. Weiner and N.H. Hopkins, Addison- Wesley Publishing.
5. Introduction to Practical Molecular Biology, P.D. Dabre, John Wiley and Sons Inc.
6. Biotechnology- B.D. Singh.

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	POS2	PSO3	PSO4
CO1	**3**	**1**		**3**	**3**		**3**	**3**	**1**	**1**	3
CO2	**3**	**1**		**3**	**3**		**3**	**3**	**1**	**1**	3
CO3	**3**	**1**		**3**	**2**		**3**	**3**	**1**	**1**	3
CO4	**3**	**1**		**3**	**3**	**3**	**3**	**3**	**1**	**1**	3
CO5	**3**	**1**	**2**	**3**	**3**	**3**	**3**	**3**	**1**	**1**	3
BS204	**3**	1	1	**3**	3	2	3	**3**	**1**	**1**	3

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

B. Sc. BIOTECHNOLOGY 2nd year/ 3rd semester						
1.Name of the Department: Biosciences						
2.Course Name	**MICROBIOLOGY LAB**			**L**	**T**	**P**
3.Course Code	**BS205**			0	0	6
4.Type of Course (use tick mark)		**Core(✓)**	**Foundation Course ( )**		**Departmental Elective( )**	
5.Pre-requisite (if any)	10+2 with Biology	**6.Frequency(use tick marks)**	Even **( )**	Odd (✓)	Either Sem ( )	EverySem( )

7.TotalNumberofLectures,Tutorials,Practicals

Lectures=00	Tutorials=00	Practical=10

8. COURSE OBJECTIVES: After completion of the course, a student will be able to develop the understanding of basic microbiology, Instruments used to study and work on microbes, Staining Techniques, Enzyme assay and Biochemical tests–starch hydrolysis, gelatin liquefaction, Cleaning and sterilization of glassware, Media preparation and Isolation of bacteria and fungi from various sources, Growth curve of bacteria, Isolation and purification and estimation of DNA and RNA

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Develop an understanding of Instruments: Compound microscope, Autoclave, Hot air oven, pH meter, Laminar airflow, centrifuge and Staining Techniques as Simple, Negative staining, Gram staining, Endospore staining, fungal staining.
CO2	Have knowledge of enzyme assay and Biochemical tests–starch hydrolysis, gelatin liquefaction. the cellular organization of prokaryotic and eukaryotic cells
CO3	Understand processes involved in culturing of microbes as Cleaning and sterilization of glassware, media preparation, isolation of bacteria and fungi from soil/ air/water/ other sources
CO4	Understand the growth pattern of bacteria
CO5	Have clear understanding of processes involved in Isolation and purification and estimation of DNA and RNA

10.Syllabus

Exp-01	Isolation and purification of genomic DNA. Estimation of DNA and RNA
Exp-02	Enzyme assay (one example)
Exp-03	Biochemical tests–starch hydrolysis, gelatin liquefaction.
Exp-04	Cleaning and sterilization of glassware.
Exp-05	Study of instruments: Compound microscope, Autoclave, Hot air oven, pH meter, Laminar airflow and centrifuge
Exp-06	Media preparation: Nutrients agar, Nutrient broth and LB.
Exp-07	Staining Techniques: Simple, Negative staining, Gram staining, Endospore staining, fungal staining.
Exp-08	Isolation of bacteria and fungi from soil/ air/water – dilution and pour plate methods
Exp-09	Study of *Rhizobium* from root nodules of legumes
Exp-10	Growth curve of bacteria

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	*Develop an understanding of Instruments: Compound microscope, Autoclave, Hot air oven, pH meter, Laminar airflow, centrifuge and Staining Techniques as Simple, Negative staining, Gram staining, Endospore staining, fungal staining.*	**3**	3	1			3	3
CO2	*Have knowledge of enzyme assay and Biochemical tests–starch hydrolysis, gelatin liquefaction. the cellular organization of prokaryotic and eukaryotic cells*	**3**	3	1				3

CO3	*Understand processes involved in culturing of microbes as Cleaning and sterilization of glassware, media preparation, isolation of bacteria and fungi from soil/ air/water/ other sources*	**3**	3	1			2	3
CO4	*Understand the growth pattern of bacteria*	**3**	3	1			2	3
CO5	*Have clear understanding of processes involved in Isolation and purification and estimation of DNA and RNA*	**3**	**3**	**1**			**1**	**3**
3: Strong contribution, 2: Average contribution , 1: Low contribution								

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	POS2	PSO3	PSO4
CO1	**3**	3	1			3	3	**3**	**2**	**2**	3
CO2	**3**	3	1				3	**3**	**2**	**2**	3
CO3	**3**	3	1			2	3	**3**	**2**	**2**	3
CO4	**3**	3	1			2	3	**3**	**2**	**2**	3
CO5	**3**	**3**	**1**			**1**	**3**	**3**	**2**	**2**	3
BS205	**3**	3	1			2	3	**3**	**2**	**2**	3

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

B. Sc. BIOTECHNOLOGY 2nd year/ 3rd semester										
1.Name of the Department: Biosciences										
2. Course Name	**CELL BIOLOGY & GENETICS LAB**						**L**	**T**	**P**	
3. Course Code	**BS206**						0	0	6	
4. Type of Course (use tick mark)	**Core(✓)**			**Foundation Course ( )**		**Departmental Elective( )**				
5.Pre-requisite (if any)	10+2 with Biology	**6.Frequency(use tick marks)**	Even **( )**	Odd (✓)	Either Sem ( )	EverySem( )				
7.TotalNumberofLectures,Tutorials,Practicals										
Lectures=00	**Tutorials=00**	**Practical=10**								

8. COURSE OBJECTIVES: The objective of this course is to develop the understanding of use of Micrometer and calibration, measurement of onion epidermal cells and yeast, Cell division processes : Mitotic and meiotic studies, Chromosomes: polytene chromosomes, Karyotype analysis – with the help of slides and how to make Blood smear – differential staining and Buccal smear – Barr bodies.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Comprehend the use of Micrometer and calibration, measurement of cells.
CO2	Have knowledge and can evaluate Cell division: Mitosis and meiosis
CO3	Analyze Chromosomes.
CO4	Have knowledge of types of chromosomes as polytene chromosomes
CO5	Make and analyze Blood smear – differential staining, Buccal smear – Barr bodies

10. Syllabus

Exp-01	Use of Micrometer and calibration, measurement of onion epidermal cells and yeast.
Exp-02	Cell division: Mitotic and meiotic studies in grasshopper testes, onion root tips and flower bud
Exp-03	Chromosomes: Mounting of polytene chromosomes
Exp-04	Buccal smear – Barr bodies
Exp-05	Karyotype analysis – with the help of slides
Exp-06	Study of polytene chromosomes by slides
Exp-07	Blood smear – differential staining

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	*Comprehend the use of Micrometer and calibration, measurement of cells.*	**3**	3	1				3
CO2	*Have knowledge and can evaluate Cell division: Mitosis and meiosis*	**3**	3	1				3
CO3	*Analyze Chromosomes.*	**3**	3	1				3
CO4	*Have knowledge of types of chromosomes as polytene chromosomes*	**3**	3	1				3
CO5	*Make and analyze Blood smear – differential staining, Buccal smear – Barr bodies*	**3**	**3**	**1**				**3**

3: Strong contribution, 2: Average contribution , 1: Low contribution

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO	PO	PO	PO	PO	PO	PO	PO	PS	PO	PS	PS

CO											
CO1	**3**	3	1				3	**3**	**3**	**3**	3
CO2	**3**	3	1				3	**3**	**1**	**2**	1
CO3	**3**	3	1				3	**3**	**1**	**2**	1
CO4	**3**	3	1				3	**3**	**1**	**2**	1
CO5	**3**	**3**	**1**				**3**	**3**	**2**	**3**	3
BS206	**3**	3	1			1	3	**3**	**2**	**2**	2

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

B. Sc. BIOTECHNOLOGY 2nd year/ 4th semester

1. Name of the Department: Biosciences

2. Course Name	**IMMUNOLOGY**	**L**	**T**	**P**
3. Course Code	**BS211**	3	1	0

4. Type of Course (use tick mark)		**Core (✓)**	**Foundation Course ()**		**Departmental Elective ()**	
5. Pre-requisite (if any)	10+2 with Biology	**6. Frequency (use tick marks)**	Even **(✓)**	Odd ()	Either Sem ( )	Every Sem ( )

7. Total Number of Lectures, Tutorials, Practicals

Lectures = 30	**Tutorials = 10**	**Practical = 00**

8. COURSE OBJECTIVES: The objective of this course is to develop the understanding of basics of Immunology, types of Immune Responses, antigens and antibodies, histocompatibility, vaccines and Immunization

9. COURSE OUTCOMES (CO):
After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	**ATTRIBUTES**
CO1	Know the history and scope of Immunology.
CO2	Understand the types of Immunity: Passive, Active, Innate and Acquired immunity, Humoral and Cell Mediated Immunity and the cell and organs of immune responses and their functions, B & T cells.
CO3	Have basic knowledge of Antigens as haptens, epitopes and Factors influencing immunogenicity, and Antibodies structure, types, production and functions of immunoglobulins, Clonal selection theory and Antigen Antibody reactions as Precipitation, Immunoelectrophoresis, Haem-agglutination, RIA and ELISA.
CO4	Comprehend Histocompatibility, structure of MHC class I, II & III antigens and their mode of antigen presentation, MHC restriction Complement system: Components, Classical and alternate pathways of complement activation, Hypersensitivity, Autoimmunity
CO5	Understand Passive and Active immunization, Types of Vaccines: Inactivated, Attenuated, Recombinant and Subunit Vaccines, Peptide and DNA Vaccines.

10. Unit wise detailed content

Unit-1	**Number of lectures = 08**	**Title of the unit: Basics of Immunology**

History and scope of Immunology, Types of Immunity: Passive, Active, Innate and Acquired immunity, Humoral and Cell Mediated Immunity.

Unit-2	**Number of lectures = 08**	**Title of the unit: Immune Responses**

Cell and organs of immune responses and their functions, B & T cells

Unit-3	**Number of lectures = 08**	**Title of the unit:** Antigens and Antibodies

Antigens: haptens, epitopes and Factors influencing immunogenicity, Antibodies: Structure, types, production and functions of immunoglobulins Clonal selection theory. Antigen Antibody reaction: Precipitation, Immunoelectrophoresis, Haem-agglutination, RIA and ELISA.

Unit-4	**Number of lectures = 08**	**Title of the unit: Histocompatibility**

structure of MHC class I, II & III antigens and their mode of antigen presentation, MHC restriction; Complement system: Components, Classical and alternate pathways of complement activation, Hypersensitivity, Autoimmunity.

Unit-5	**Number of lectures = 08**	**Title of the unit: Vaccines and Immunization**

Passive and Active immunization, Types of Vaccines: Inactivated, Attenuated, Recombinant and SubUnit Vaccines, Peptide and DNA Vaccines.

11. CO-PO mapping

Cos	**Attributes**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
CO1	*Know the history and scope of Immunology.*	**3**	**1**					**3**
CO2	*Understand the types of Immunity: Passive, Active, Innate and Acquired immunity, Humoral and Cell Mediated Immunity and the cell and organs of immune responses and their functions,*	**3**	**1**					**3**

	B & T cells.							
CO3	*Have basic knowledge of Antigens as haptens, epitopes and Factors influencing immunogenicity, and Antibodies structure, types, production and functions of immunoglobulins, Clonal selection theory and Antigen Antibody reactions as Precipitation, Immunoelectrophoresis, Haem-agglutination, RIA and ELISA.*	**3**	**1**				**2**	**3**
CO4	*Comprehend Histocompatibility, structure of MHC class I, II & III antigens and their mode of antigen presentation, MHC restriction Complement system: Components, Classical and alternate pathways of complement activation, Hypersensitivity, Autoimmunity*	**3**	**1**			**2**		**3**
CO5	*Understand Passive and Active immunization, Types of Vaccines: Inactivated, Attenuated, Recombinant and SubUnit Vaccines, Peptide and DNA Vaccines.*	**3**	**1**		**3**	**2**		**3**
3: Strong contribution, 2: Average contribution , 1: Low contribution								

13. Books recommended:

1. William, E. Paul (1989) Fundamental Immunology, 2nd Edition Raven Press, New York.
2. William, R. Clark (1991) the Experimental Foundations of Modern Immunology (4th Edition) John Wiley and Sons, New York.
3. Basic Immunology, A.K. Abbas and A.H. Lichtman, Saunders W.B. Company
4. Fundamentals of Immunology, W. Paul, Lippincott Williams and Wilkins
5. Immunology, W.L. Anderson, Fence Creek Publishing (Blackwell).
6. Immunology: A Short Course, E. Benjamin, R. Coico and G. Sunshine, Wiley-Liss Inc.

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	POS2	PSO3	PSO4
CO1	**3**	**1**					**3**	**3**	**2**		
CO2	**3**	**1**					**3**	**3**	**3**	**2**	
CO3	**3**	**1**				**2**	**3**	**3**	**3**	**3**	
CO4	**3**	**1**			**2**		**3**	**3**	**3**	**2**	
CO5	**3**	**1**		**3**	**2**		**3**	**3**	**3**	**2**	1
BS211	**3**	1		**1**	1	1	3	**3**	**3**	**2**	1

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

B. Sc. BIOTECHNOLOGY 2nd year/ 4th semester

1. Name of the Department: Biosciences

2. Course Name	**MOLECULAR BIOLOGY**	**L**	**T**	**P**
3. Course Code	**BS 212**	3	1	0

4. Type of Course (use tick mark)	**Core (✓)**	**Foundation Course ()**		**Departmental Elective ()**	
5. Pre-requisite (if any)	10+2 with Biology	**6. Frequency (use tick marks)**	Even **(✓)**	Odd ()	Either Sem ( )	Every Sem ( )

7. Total Number of Lectures, Tutorials, Practicals

Lectures = 30	**Tutorials = 10**		**Practical = 00**

8. COURSE OBJECTIVES: The objective of this course is to develop the understanding of concept of gene, pseudogene, cryptic gene and split gene, DNA replication and regulation in prokaryotes and eukaryotes, transcription in prokaryotes and eukaryotes, translation in prokaryotes and eukaryotes, post translation and transcriptional mechanism and gene expression in prokaryotes using Lap operon and in Eukaryotes by Trp operon.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	**ATTRIBUTES**
CO1	Understand concept of gene, pseudogene, cryptic gene and split gene
CO2	Understand DNA replication and regulation in prokaryotes and eukaryotes
CO3	Understand Transcription in prokaryotes and eukaryotes, Translation in prokaryotes and eukaryotes
CO4	Understand Post translation and transcriptional mechanism.
CO5	Understand Gene expression in prokaryotes using Lap operon and in Eukaryotes by Trp operon.

10. Unit wise detailed content

Unit-1	**Number of lectures = 08**	**Title of the unit: Central Dogma of Molecular Biology**

Organization of Genetic Material: split genes, overlapping genes; pseudogenes, cryptic genes, Insertion elements and transposons. Gene organization and expression in Mitochondria and Chloroplasts.

Unit-2	**Number of lectures = 08**	**Title of the unit: DNA Replication**

Prokaryotic and Eukaryotic – Enzymes and proteins involved in replication, Theta model and Rolling circle model.

Unit-3	**Number of lectures = 08**	**Title of the unit: Transcription**

Transcription in prokaryotes and Eukaryotes: Mechanism, Promoters and RNA polymerase, transcription factors, Post-transcriptional modifications of eukaryotic mRNA

Unit-4	**Number of lectures = 08**	**Title of the unit: Genetic code**

Properties and Wobble hypothesis. Translation: Mechanism of translation in Prokaryotes and Eukaryotes, Post-translational modifications of proteins.

Unit-5	**Number of lectures = 08**	**Title of the unit: Regulation of Gene expression**

Regulation of Gene expression in Prokaryotes: Operon concept (Lac), Regulation of Gene expression in Eukaryotes: transcriptional activation, galactose metabolism in yeast

11. CO-PO mapping

COs	**Attributes**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
CO1	*Understand concept of gene, pseudogene, cryptic gene and split gene*	**3**	**1**					**1**
CO2	*Understand DNA replication and regulation in prokaryotes and eukaryotes*	**3**	**1**					**1**
CO3	*Understand Transcription in prokaryotes and eukaryotes, Translation in prokaryotes and eukaryotes*	**3**	**1**					**1**
CO4	*Understand Post translation and transcriptional mechanism.*	**3**	**1**					**1**
CO5	*Understand Gene expression in prokaryotes using Lap operon and in Eukaryotes by Trp operon.*	**3**	**1**					**1**

3: Strong contribution, 2: Average contribution , 1: Low contribution

13. Books recommended:

1. Howe.C. (1995) Gene Cloning and manipulation, Cambridge University Press, USA
2. Lewin, B., Gene VI New York, Oxford University Press.
3. Sambrooket al (2000) Molecular cloning Volumes I, II, & III Cold spring Harbor Laboratory Press, New York, USA

4. Walker J.M. and Gingold, E.B. (1983) Molecular Biology & Biotechnology (Indian Edition) Royal Society of Chemistry U.K
5. Karp.G (2002) Cell & Molecular Biology, 3rd Edition, John Wiley & Sons; INC.

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	POS2	PSO3	PSO4
CO1	**3**	**1**					**1**	**3**	**3**		
CO2	**3**	**1**					**1**	**3**	**3**		
CO3	**3**	**1**					**1**	**3**	**3**		
CO4	**3**	**1**					**1**	**3**	**3**		
CO5	**3**	**1**					**1**	**3**	**3**		
BS212	**3**	1					1	**3**	**3**		

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

B. Sc. BIOTECHNOLOGY 2nd year/ 4th semester					
1. Name of the Department: Biosciences					
2. Course Name	**FUNDAMENTALS OF ENVIRONMENTAL BIOTECHNOLOGY**	**L**	**T**	**P**	
3. Course Code	**BS 213**	3	1	0	
4. Type of Course (use tick mark)	**Core (✓)**	**Foundation Course ()**	**Departmental Elective ()**		
5. Pre-requisite (if any)	10+2 with Biology	**6. Frequency (use tick marks)**	Even **(✓)**	Odd ()	Either Sem ( )	Every Sem ( )
7. Total Number of Lectures, Tutorials, Practicals					
Lectures = 30	**Tutorials = 10**	**Practical = 00**			

8. COURSE OBJECTIVES: The objective of this course is to develop the understanding of environmental biotechnology, bioremediation, waste management, bioleaching, conventional and modern fuels

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Have knowledge of modern fuels and their environmental impact
CO2	Comprehend the Structural and Functional dynamics of microbes, their diversity, activity and growth, community profiling their uses as biosensors, bioreporters, Microchips. Also know about Methanogenesis: methanogenic, acetogenic and fermentative bacteria- technical processes and conditions
CO3	Gain insight on Bioremediation and Phytoremediation of soil & water contaminated with oil spills, heavy metals and detergents and use of microbes in degradation of lignin and cellulose using and of pesticides and other toxic chemicals by microorganisms, Degradation of aromatic and chlorinated hydrocarbons and petroleum products.
CO4	Have knowledge of treatment of municipal waste and Industrial effluents, Biofertilizers: Role of symbiotic and asymbiotic nitrogen fixing bacteria in the enrichment of soil, algal and fungal biofertilizers (VAM).
CO5	Have basic understanding of Enrichment of ores by microorganisms (gold, copper, and Uranium), Environmental significance of Genetically modified microbes, plants and animals.

10. Unit wise detailed content

Unit-1	**Number of lectures = 08**	**Title of the unit: Conventional and modern fuels**
Modern fuels and their environmental impact – Methanogenic bacteria, Biogas, Microbial hydrogen Production, Conversion of sugar to alcohol Gasohol.		
Unit-2	**Number of lectures = 08**	**Title of the unit: Structural and Functional dynamics of microbes**
Diversity, activity and growth, community profiling, biosensors, bioreporters, Microchips. Methanogenesis: methanogenic, acetogenic and fermentative bacteria- technical processes and conditions.		
Unit-3	**Number of lectures = 08**	**Title of the unit: Bioremediation**
Bioremediation of soil & water contaminated with oil spills, heavy metals and detergents, Degradation of lignin and cellulose using microbes, Phytoremediation, Degradation of pesticides and other toxic chemicals by microorganisms, Degradation of aromatic and chlorinated hydrocarbons and petroleum products.		
Unit-4	**Number of lectures = 08**	**Title of the unit: Waste Management**
Treatment of municipal waste and Industrial effluents, Biofertilizers: Role of symbiotic and asymbiotic nitrogen fixing bacteria in the enrichment of soil, algal and fungal biofertilizers (VAM).		
Unit-5	**Number of lectures = 08**	**Title of the unit: Bioleaching**
Enrichment of ores by microorganisms (gold, copper, and Uranium), Environmental significance of Genetically modified microbes, plants and animals.		

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	*Have knowledge of modern fuels and their environmental impact*	**3**	**1**				**3**	**1**
CO2	*Comprehend the Structural and Functional dynamics of microbes, their diversity, activity and growth, community profiling their uses as biosensors, bioreporters, Microchips. Also know about Methanogenesis: methanogenic, acetogenic and fermentative bacteria- technica processes and conditions*	**3**	**1**				**2**	**1**

CO3	*Gain insight on Bioremediation and Phytoremediation of soil & water contaminated with oil spills, heavy metals and detergents and us of microbes in degradation of lignin and cellulose using and of pesticides and other toxic chemicals by microorganisms, Degradation of aromatic and chlorinated hydrocarbons and petroleum products.*	**3**	**1**				**3**	**3**
CO4	*Have knowledge on treatment of municipal waste and Industrial effluents, Biofertilizers: Role of symbiotic and asymbiotic nitrogen fixing bacteria in the enrichment of soil, algal and fungal biofertilizer (VAM).*	**3**	**1**				**3**	**3**
CO5	*Have basic understanding of Enrichment of ore by microorganism (gold, copper, and Uranium), Environmental significance of Genetically modified microbes plants and animal*	**3**	**1**		**1**	**2**	**3**	**1**
3: Strong contribution, 2: Average contribution , 1: Low contribution								

13. Books recommended:

1. Microbial Biotechnology (1995) Alexander n. Glazer Hiroshi Nikaido W.H.Freeman and Company
2. Molecular biotechnology: Principles and Applications of Recombinant DNA –Bernaral R. Glick and Jack J. Pastemak ASM Press. Washington, D.C (1994).
3. Fungal Ecology and Biotechnology (1993) Rastogi Publications, Meerut.

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	POS2	PSO3	PSO4
CO1	**3**	**1**				**3**	**1**	**3**	**3**	**3**	1
CO2	**3**	**1**				**2**	**1**	**3**	**3**	**3**	1
CO3	**3**	**1**				**3**	**3**	**3**	**3**	**3**	1
CO4	**3**	**1**				**3**	**3**	**3**	**3**	**3**	1
CO5	**3**	**1**		**1**	**2**	**3**	**1**	**3**	**3**	**3**	1
BS213	**3**	1		**1**	1	3	2	**3**	**3**	**3**	1

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

B. Sc. BIOTECHNOLOGY 2nd year/ 4th semester						
1. Name of the Department: Biosciences						
2. Course Name	**INDUSTRIAL BIOTECHNOLOGY**			**L**	**T**	**P**
3. Course Code	**BS 214**			3	1	0
4. Type of Course (use tick mark)		**Core (✓)**	**Foundation Course ()**		**Departmental Elective ()**	
5. Pre-requisite (if any)	10+2 with Biology	**6. Frequency (use tick marks)**	Even **(✓)**	Odd ()	Either Sem ( )	Every Sem ()
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 30		**Tutorials = 10**	**Practical = 00**			

8. COURSE OBJECTIVES: After completion of the course, a student will be able to develop the understanding of industrial aspects of biotechnology.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Know the basics of industrial fermentation technology
CO2	Develop an understanding of Fermentation medium and sterilization techniques
CO3	Understand Industrial fermentation process, types of fermentation
CO4	Have knowledge of Process development, upstream and downstream processing
CO5	Know about Production of Industrial fermented products

10. Unit wise detailed content

Unit-1	**Number of lectures = 08**	**Title of the unit: Introduction to industrial biotechnology**
Introduction to industrial biotechnology, Basic principles of fermentation technology, Screening and isolation of microorganisms, Maintenance of strains improvement.		
Unit-2	**Number of lectures = 08**	**Title of the unit: Fermentation media, Natural and synthetic media, Sterilization techniques**
Heat, Radiation and Filtration method.		
Unit-3	**Number of lectures = 08**	**Title of the unit: Fermenters, Process of Aeration, Agitation, Temperature regulation and Filtration method, Types of fermentation**
Shake flask fermentation, Downstream processing (DSP), Disintegration of cells, Separation, Extraction, Concentration and purification of products.		
Unit-4	**Number of lectures = 08**	**Title of the unit: Process Development**
Shake flask fermentation, Downstream processing (DSP), Disintegration of cells, Separation, Extraction, Concentration and purification of products.		
Unit-5	**Number of lectures = 08**	**Title of the unit: Production of Microbial products**
Brief account of the following products obtained by industrial microbiological fermentation: Alcoholic Beverage: Beer, Organic acid: Citric acid, Antibiotic: Penicillin, Amino acids: Glutamic acid, Vitamin: vitamin B12.		

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	*Know the basics of industrial fermentation technology*	**3**	**1**			**1**	**2**	**3**
CO2	*Develop an understanding of Fermentation media and sterilization techniques*	**3**	**1**				**2**	**3**
CO3	*Understand Industrial fermentation process, types of fermentation*	**3**	**1**				**2**	**3**
CO4	*Have knowledge of process development, upstream and downstream processing*	**3**	**1**				**2**	**3**
CO5	*Know about production of industrial fermented products*	**3**	**1**				**2**	**3**

3: Strong contribution, 2: Average contribution , 1: Low contribution

12. Books recommended:

1. Bisen P.S (1994) Frontiers in Microbial Technology, 1st Edition, CBS Publishers. Books (P) Ltd.
2. Crueger W. & Crueger A. (2000) A text of Industrial Microbiology, 2nd Edition, Panima
3. Glaser A.N & Nilaido.H (1995) Microbial Biotechnology,W.H Freeman & Co.
4. Kumar H.D (1991) A text book on Biotechnology (2nd Edition). Affiliated East West Press Private Ltd. New Delhi.

5. Prescott & Dunn (2002) Industrial Microbiology, Agrobios (India) Publishers. Publishers, Boston. Publishing Corp.
6. Stanbury P.F, Whitaker H, Hall S.J (1997) Principles of Fermentation Technology., Aditya

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	POS2	PSO3	PSO4
CO1	**3**	**1**			**1**	**2**	**3**	**3**	**3**	**3**	1
CO2	**3**	**1**				**2**	**3**	**3**	**3**	**3**	1
CO3	**3**	**1**				**2**	**3**	**3**	**3**	**3**	
CO4	**3**	**1**				**2**	**3**	**3**	**3**	**3**	1
CO5	**3**	**1**				**2**	**3**	**3**	**3**	**3**	1
BS214	**3**	1			1	2	3	**3**	**3**	**3**	1

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

B. Sc. BIOTECHNOLOGY 2nd year/ 4th semester						
1. Name of the Department: Biosciences						
2. Course Name	**FOOD BIOTECHNOLOGY**			**L**	**T**	**P**
3. Course Code	**BS 215**			3	1	0
4. Type of Course (use tick mark)		**Core (✓)**	**Foundation Course ()**		**Departmental Elective ()**	
5. Pre-requisite (if any)	10+2 with Biology	**6. Frequency (use tick marks)**	Even **(✓)**	Odd ()	Either Sem ( )	Every Sem ( )
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 30		**Tutorials = 10**	**Practical = 00**			

8. COURSE OBJECTIVES: This course aims to impart an insight into the classification, ingredients and additives of food. Importance of studying this paper is highlighted reflecting on the current changing needs of the students by providing the latest information of food processing and preservation techniques. The students will acquire knowledge about the production of fermented food and beverages. The course also extends comprehensive knowledge about international and national food laws and standards.

9. COURSE OUTCOMES (CO): ***After the successful course completion, learners will develop following attributes:***

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Recognize sources of microorganisms and food borne illness.
CO2	To learn food processing and preservation techniques.
CO3	Comprehend the interrelationships among different components of beverages technology
CO4	To learn about culture, microscopic, and sampling methods including membrane filters, microscope colony counts, most probable numbers, Direct microscopic count, Microbiological examination of surfaces and Air sampling
CO5	Understand the food laws and standards, Quality and safety assurance in the food and dairy industry, BIS product certification and licensing quality systems.

10. Unit wise detailed content

Unit-1	**Number of lectures = 08**	**Title of the unit: Classification of food, major ingredients of food, Microbial role in food process, operation and production**
New protein foods SCP, mushroom, food yeasts, algal proteins. Food additives like coloring, flavours and vitamins.		
Unit-2	**Number of lectures = 08**	**Title of the unit: General principles underlying spoilage of foods**
Microbial food poisoning and its prevention or control; Food processing and Preservation techniques. Food adulteration and contamination of food with harmful microorganisms.		
Unit-3	**Number of lectures = 08**	**Title of the unit: Organisms and their use for production of fermented foods and beverages**
pickles, wine, cheese, yogurt and vinegar. Therapeutic and nutritive value of fermented products.		
Unit-4	**Number of lectures = 08**	**Title of the unit: Determining microorganisms and their products in foods**
culture, microscopic, and sampling methods; membrane filters, microscope colony counts, most probable numbers (MPN), Direct microscopic count, Microbiological examination of surfaces, Air sampling.		
Unit-5	**Number of lectures = 08**	**Title of the unit: Food laws and standards**
Indian and international food safety laws and standards; Quality and safety assurance in food and dairy industry; BIS Laboratory Services and Certification by BIS.		

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	*Recognize sources of microorganisms and food borne illness*	**3**	**1**				**1**	**3**
CO2	*To learn food processing and preservation techniques.*	**3**	**1**				**1**	**3**
CO3	*Comprehend the interrelationships among different components of beverages technology*	**3**	**1**				**1**	**3**
CO4	*To learn about culture, microscopic, and sampling methods including membrane filters, microscope colony counts, most probable numbers, Direct microscopic count, Microbiological examination of surfaces and Air sampling*	**3**	**1**				**2**	**3**
CO5	*Understand the food laws and standards, Quality and safety assurance in the food and dairy industry, BIS product certification and licensing quality systems.*	**3**	**1**	**1**	**2**	**3**	**2**	**3**

3: Strong contribution, 2: Average contribution , 1: Low contribution

13. Books recommended:

1. Frazier, Food Microbiology, TMH Publications.
2. May JM "Modern food microbiology", CBS Publishers and distributors, New Delhi.
3. Heller, Genetic Engineering of Food: Detection of Genetic Modifications – Wiley Publications.
4. Rehm, Biotechnology Set – Wiley Publications
5. Potter NN and Hotchkiss "Food Science" CBS Publ.
6. Potter N "Technology of Food preservation", CBS.
7. Marwaha SS and Arora "Food processing: Biotechnological Applications", Asitech Publ.
8. Hobbs BC and Roberts D "Food poisoning and food hygiene", Edward Arnold (A division of Hodder and Stoughton), London.
9. Robinson RK "The microbiology of milk", Elsevier Applied Science, London.

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	POS2	PSO3	PSO4
CO1	**3**	**1**				**1**	**3**	**3**	**2**	**3**	3
CO2	**3**	**1**				**1**	**3**	**3**	**2**	**3**	1
CO3	**3**	**1**				**1**	**3**	**3**	**2**	**3**	
CO4	**3**	**1**				**2**	**3**	**3**	**2**	**3**	3
CO5	**3**	**1**	**1**	**2**	**3**	**2**	**3**	**3**	**2**	**3**	3
BS215	**3**	1		**1**	1	3	2	**3**	**2**	**3**	2

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

B. Sc. BIOTECHNOLOGY 2nd year/ 4th semester						
1.Name of the Department: Biosciences						
2. Course Name	**IMMUNOLOGY LAB**			**L**	**T**	**P**
3. Course Code	**BS216**			0	0	6
4. Type of Course (use tick mark)		**Core(✓)**	**Foundation Course ( )**		**Departmental Elective( )**	
5.Pre-requisite (if any)	10+2 with Biology	**6.Frequency(use tick marks)**	Even **(✓)**	Odd ( )	Either Sem ( )	EverySem( )
7.TotalNumberofLectures,Tutorials,Practicals						
Lectures=00		**Tutorials=00**		**Practical=10**		

8. COURSE OBJECTIVES: This course aims to develop the understanding of basics of immunology, types of Blood grouping, cell counts, ELISA, Ouchterlony Double diffusion (ODD) and Separation of serum from blood & precipitation of Immunoglobulins

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Analyze Blood grouping
CO2	Perform and analyze differential counting of WBC and detergent lysis of RBC
CO3	Perform and analyze Dot Elisa, ELISA .
CO4	Have knowledge of and can perform Ouchterlony Double diffusion assay.
CO5	Perform and analyze separation of serum from blood & precipitation of Immunoglobulin.

10. Syllabus

Exp-01	Blood grouping
Exp-02	Differential Count of WBC
Exp-03	Detergent lysis of RBC
Exp-04	Dot Elisa
Exp-05	ELISA – Demonstration
Exp-06	Ouchterlony Double diffusion (ODD)
Exp-07	Separation of serum from blood & precipitation of Immunoglobulins

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	*Analyze Blood grouping*	**3**	3	1				**3**
CO2	*Perform and analyze differential counting of WBC and detergent lysis of RBC*	**3**	3	1				**3**
CO3	*Perform and analyze Dot Elisa, ELISA.*	**3**	3	1				**3**
CO4	*Have knowledge of and can perform Ouchterlony Double diffusion assay.*	**3**	3	1				3
CO5	*Perform and analyze separation of serum from blood & precipitation of Immunoglobulins.*	**3**	**3**	**1**				**3**

3: Strong contribution, 2: Average contribution , 1: Low contribution

12. Books recommended:

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	POS2	PSO3	PSO4
CO1	**3**	**1**				**3**	**1**	**3**	**3**	**3**	1
CO2	**3**	**1**				**2**	**1**	**3**	**3**	**3**	1
CO3	**3**	**1**				**3**	**3**	**3**	**3**	**3**	1
CO4	**3**	**1**				**3**	**3**	**3**	**3**	**3**	1
CO5	**3**	**1**		**1**	**2**	**3**	**1**	**3**	**3**	**3**	1
BS216	**3**	1		**1**	2	3	2	**3**	**3**	**3**	1

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

B. Sc. BIOTECHNOLOGY 2nd year/ 4th semester

1.Name of the Department: Biosciences

2. Course Name	**INDUSTRIAL AND ENVIRONMENTAL BIOTECHNOLOGY LAB**	**L**	**T**	**P**
3. Course Code	**BS217**	0	0	6

4. Type of Course (use tick mark)		**Core(✓)**	**Foundation Course ( )**		**Departmental Elective( )**	
5.Pre-requisite (if any)	10+2 with Biology	**6.Frequency(use tick marks)**	Even **(✓)**	Odd ( )	Either Sem ( )	EverySem( )

7. TotalNumberofLectures,Tutorials,Practicals

Lectures=00	**Tutorials=00**	**Practical=10**

8. COURSE OBJECTIVES : This course aims to develop the understanding of basics of Algal and fungal culture, estimation of Nitrogen, citric acid, lactic acid, heavy metals, BOD and COD, and examination of bacteria by MPN Count Method

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Culture algae and fungi
CO2	Perform and analyze estimation of citric acid and lactic acid.
CO3	Perform and analyze estimation of Total Nitrogen by Kjeldahl method.
CO4	Can perform Bacterial Examination of Water by MPN Count Method and estimate of BOD and COD
CO5	Estimate heavy metals (Iron, chromium and arsenic) in water sample

10. Syllabus

Exp-01	Algal and fungal culture – Yeast and *Aspergillus*
Exp-02	Estimation of citric acid from *Aspergillus* culture.
Exp-03	Estimation of lactic acid.
Exp-04	Estimation of Total Nitrogen by Kjeldahl method.
Exp-05	Bacterial Examination of Water by MPN Count Method
Exp-06	Estimation of BOD and COD (2 Samples)
Exp-07	Estimation of heavy metals (Iron, chromium and arsenic) in water sample.

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	*Culture algae and fungi*	**3**	3	1			3	3
CO2	*Perform and analyze estimation of citric acid and lactic acid.*	**3**	3	1				3
CO3	*Perform and analyze estimation of Total Nitrogen by Kjeldahl method.*	**3**	3	1			2	3
CO4	*Can perform Bacterial Examination of Water by MPN Count Method and estimate of BOD and COD*	**3**	3	1			3	**3**
CO5	*Estimate heavy metals (Iron, chromium and arsenic) in water samples.*	**3**	**3**	**1**			**3**	**3**

3: Strong contribution, 2: Average contribution , 1: Low contribution

12. Books recommended:

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	POS2	PSO3	PSO4
CO1	**3**	3	1			3	3	**3**	**3**	**3**	2
CO2	**3**	3	1				3	**3**	**3**	**3**	1
CO3	**3**	3	1			2	3	**3**	**3**	**3**	1
CO4	**3**	3	1			3	**3**	**3**	**3**	**3**	2
CO5	**3**	**3**	**1**			**3**	**3**	**3**	**3**	**3**	1
BS217	**3**	3	1			3	3	**3**	**3**	**3**	2

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

B. Sc. BIOTECHNOLOGY 3rd year/ 5th semester

1. Name of the Department: Biosciences

2. Course Name	**ANIMAL BIOTECHNOLOGY**	**L**	**T**	**P**
3. Course Code	**BS 301**	3	1	0

4. Type of Course (use tick mark)	**Core (✓)**	**Foundation Course ()**		**Departmental Elective ()**	
5. Pre-requisite (if any)	10+2 with Biology	**6. Frequency (use tick marks)**	Even **( )**	Odd (✓)	Either Sem ( )	Every Sem ( )

7. Total Number of Lectures, Tutorials, Practicals

Lectures = 30	**Tutorials = 10**	**Practical = 00**

8. COURSE OBJECTIVES: The course has been designed to make students aware of basic animal biotechnology techniques, their applications in Cell culture, Production of transgenic, Expression of Cloned proteins and vaccines

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	**ATTRIBUTES**
CO1	Get proper knowledge about the history and Scope of Animal Tissue Culture, Culture Media, Simulating natural conditions for growth of animal cells.
CO2	Gain knowledge about Primary Culture, cell lines and Secondary Culture, transformed animal cells and continuous cell lines, Monolayer formation, Synchronization.
CO3	Learn about transfection of animal cell lines, Selectable markers and Transplantation of Cultured Cells. Microinjection, In vitro fertilization and Stem cell technology.
CO4	Learn about the basics of expression of Cloned proteins in animal cells and Production of Vaccines in animal Cells.
CO5	Have knowledge of Production and Applications of monoclonal antibodies, and Transgenic Animals

10. Unit wise detailed content

Unit-1	**Number of lectures = 08**	**Title of the unit: History and Scope of Animal Tissue Culture**

Culture Media, Simulating natural conditions for growth of animal cells, Natural media: Plasma Clot, biological fluids tissue extract, Importance of Serum in media, Chemical defined media, serum free media.

Unit-2	**Number of lectures = 08**	**Title of the unit: Primary Culture**

Cell lines, and cloning, isolation and mechanical disaggregation of tissue, enzyme. Secondary Culture: transformed animal cells and continuous cell lines. Monolayer formation, Synchronization.

Unit-3	**Number of lectures = 08**	**Title of the unit: Transfection of animal cell lines**

Selectable markers and Transplantation of Cultured Cells. Microinjection, *In vitro* fertilization. Stem cell technology.

Unit-4	**Number of lectures = 08**	**Title of the unit: Expression of Cloned proteins in animal cell**

Expression vector, over production and downstream processing of the expressed proteins, Production of Vaccines in animal Cells.

Unit-5	**Number of lectures = 08**	**Title of the unit:** Production and Applications of monoclonal antibodies

HAT selection, Transgenic Animals: Techniques and Applications and Transgenic mice and sheep.

11. CO-PO mapping

COs	**Attributes**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
CO1	*Get proper knowledge about the history and Scope of Animal Tissue Culture, Culture Media, Simulating natural conditions for growth of animal cells.*	**3**	**1**			**1**		**2**
CO2	*Gain knowledge about Primary Culture, cell lines and Secondary Culture, transformed animal cells and continuous cell lines. Monolayer formation, Synchronization.*	**3**	**1**			**2**		**2**
CO3	*Learn about transfection of animal cell lines, Selectable markers and Transplantation of Cultured Cells. Microinjection, In vitro fertilization and Stem cell technology.*	**3**	**1**		**2**	**3**		**3**
CO4	*Learn about the basics of expression of Cloned proteins in animal cells and Production of Vaccines in animal Cells.*	**3**	**1**		**2**	**3**		**3**
CO5	*Have knowledge of Production and Applications of monoclonal antibodies, and Transgenic Animals*	**3**	**1**		**1**	**3**	**1**	**3**

3: Strong contribution, 2: Average contribution , 1: Low contribution
12. Books recommended:
1. Ian Freshney Animal cell culture.(4th Edition) 2. Buttler. Elements of Biotechnology – P.k. Gupta (1st Edition -2000) Rastogi Publications. 3. Davis, Cell culture techniques.

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	POS2	PSO3	PSO4
CO1	**3**	**1**			**1**		**2**	**3**	**3**	**3**	
CO2	**3**	**1**			**2**		**2**	**3**	**3**	**3**	
CO3	**3**	**1**		**2**	**3**		**3**	**3**	**3**	**3**	
CO4	**3**	**1**		**2**	**3**		**3**	**3**	**3**	**3**	1
CO5	**3**	**1**		**1**	**3**	**1**	**3**	**3**	**3**	**3**	1
BS301	**3**	1		**2**	3	1	3	**3**	**3**	**3**	1

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

B. Sc. BIOTECHNOLOGY 3rd year/ 5th semester						
1. Name of the Department: Biosciences						
2. Course Name	**PLANT BIOTECHNOLOGY**			**L**	**T**	**P**
3. Course Code	**BS 302**			3	1	0
4. Type of Course (use tick mark)		**Core (✓)**	**Foundation Course ()**		**Departmental Elective ()**	
5. Pre-requisite (if any)	10+2 with Biology	**6. Frequency (use tick marks)**	Even **( )**	Odd (✓)	Either Sem ( )	Every Sem ( )
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 30		**Tutorials = 10**	**Practical = 00**			

8. COURSE OBJECTIVES: The course has been designed to make students aware of basic plant biotechnology techniques and their applications in plant growth and development, and large scale production of natural products from plant source

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Learn about media preparation for In-vitro propagation of plants and different aseptic techniques used therin.
CO2	The students will learn the role of techniques haploid plant production and its significance.
CO3	The students will learn about the protoplast isolation and somatic hybridization of protoplast and its application.
CO4	The students will learn about the role of plant tissue culture in agriculture, horticulture and forestry
CO5	The students will learn about the transgenic plants and different strategies to make recombinant and its application.

10. Unit wise detailed content

Unit-1	**Number of lectures = 08**	**Title of the unit: Aseptic Techniques**

Aseptic Techniques, Nutrient media, and use of growth regulators (Auxins, Cytokinins and Gibberellins). Callus and suspension culture.

Unit-2	**Number of lectures = 08**	**Title of the unit: Haploid plant production**

Microspore and ovule culture, Organ Culture and their applications, Organogenesis and Somatic Embryogenesis: Techniques and applications.

Unit-3	**Number of lectures = 08**	**Title of the unit: Protoplast Culture**

Somatic hybridization, methods of protoplast fusion chemical and electro fusion, practical application of somatic hybridization. Somaclonal variation and their significance, *In vitro* production of secondary metabolites: Techniques and significance.

Unit-4	**Number of lectures = 08**	**Title of the unit: Role of tissue culture in agriculture, horticulture and forestry, Transgenic plants, Technique of transformation**

Agrobacterium-mediated and physical methods (Microprojectile bombardment and electroporation).

Unit-5	**Number of lectures = 08**	**Title of the unit: Applications**

Applications of transgenic plants, Edible Vaccines.

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	*Learn about media preparation for In-vitro propagation of plants and different aseptic techniques used therein.*	**3**	**1**				**2**	**1**
CO2	*The students will learn the role of techniques haploid plant production and its significance.*	**3**	**1**				**2**	**1**
CO3	*The students will learn about the protoplast isolation and somatic hybridization of protoplast and its application.*	**3**	**1**				**2**	**1**
CO4	*The students will learn about the role of plant tissue culture in agriculture, horticulture and forestry*	**3**	**1**	**2**	**1**		**2**	**3**
CO5	*The students will learn about the transgenic Plants and different strategies to make recombinant and its application.*	**3**	**1**	**1**		**2**	**2**	**2**

3: Strong contribution, 2: Average contribution , 1: Low contribution

12. Books recommended:

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	POS2	PSO3	PSO4
CO1	**3**	**1**				**2**	**1**	**3**	**3**	**3**	
CO2	**3**	**1**				**2**	**1**	**3**	**3**	**3**	
CO3	**3**	**1**				**2**	**1**	**3**	**3**	**3**	
CO4	**3**	**1**	**2**	**1**		**2**	**3**	**3**	**3**	**3**	
CO5	**3**	**1**	**1**		**2**	**2**	**2**	**3**	**3**	**3**	1
BS302	**3**	1	1	**1**	1	2	2	**3**	**3**	**3**	1

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

B. Sc. BIOTECHNOLOGY 3rd year/ 5th semester						
1. Name of the Department: Biosciences						
2. Course Name	**GENETIC ENGINEERING**			**L**	**T**	**P**
3. Course Code	**BS 303**			3	1	0
4. Type of Course (use tick mark)		**Core (✓)**	**Foundation Course ()**		**Departmental Elective ()**	
5. Pre-requisite (if any)	10+2 with Biology	**6. Frequency (use tick marks)**	Even **( )**	Odd (✓)	Either Sem ( )	Every Sem ( )
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 30		**Tutorials = 10**	**Practical = 00**			

8. COURSE OBJECTIVES: The course has been designed to make students aware of DNA manipulative enzymes and Gene cloning vectors, Screening and selection of recombinants, Techniques used as Polymerase chain reaction (PCR), Site directed mutagenes is (SDM), Nucleic acid sequencing and Application of r-DNA techniques

COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Get proper knowledge about the DNA manipulative enzymes: Restriction enzymes and DNA ligases, and Gene cloning vectors.
CO2	Gain knowledge about In vitro construction of recombinant DNA molecules, passenger and vector DNA, and Transformation
CO3	Learn about screening and selection of recombinant host cells, Gene Libraries, cloning techniques, Expression of cloned DNA
CO4	Learn about the basics of Electrophoretic techniques, Polymerase chain reaction (PCR), Site directed mutagenesis (SDM), Nucleic acid sequencing: Blotting techniques.
CO5	have knowledge of Application of r-DNA technique in human health, Production of Insulin, Production of recombinant vaccines: Hepatitis B, Production of human growth hormone.

10. Unit wise detailed content

Unit-1	**Number of lectures = 08**	**Title of the unit: DNA manipulative enzymes**
Restriction enzymes and DNA ligases, Gene cloning vectors: Plasmids, Bacteriophage and Chimeric plasmids.		
Unit-2	**Number of lectures = 08**	**Title of the unit: rDNA**
In vitro construction of recombinant DNA molecules (pBR332, pUC19), Isolation of passenger and vector DNA, creation of r-DNA, Transformation of r-DNA by different methods.		
Unit-3	**Number of lectures = 08**	**Title of the unit: Screening and selection of recombinant host cells**
Immunological screening and colony hybridization, Gene Libraries: Genomic DNA and cDNA cloning techniques, Expression of cloned DNA in *E. coli*.		
Unit-4	**Number of lectures = 08**	**Title of the unit Techniques**
Electrophoretic techniques, Polymerase chain reaction (PCR), Site directed mutagenesis (SDM), Nucleic acid sequencing: Sanger's method, Blotting techniques: Southern, Western and Northern blot.		
Unit-5	**Number of lectures = 08**	**Title of the unit: Applications**
Application of r-DNA technique in human health, Production of Insulin, Production of recombinant vaccines: Hepatitis B, Production of human growth hormone.		

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	*get proper knowledge about the DNA manipulative enzymes: Restriction enzymes and DNA ligases, and Gene cloning vectors.*	**3**	**1**					**2**
CO2	*gain knowledge about In vitro construction of recombinant DNA molecules, passenger and vector DNA, and Transformation*	**3**	**1**					**2**
CO3	*learn about screening and selection of recombinant host cells, Gene Libraries, cloning techniques, Expression of cloned DNA*	**3**	**1**					**2**
CO4	*Learn about the basics of Electrophoretic techniques, Polymerase chain reaction (PCR), Site directed mutagenesis (SDM), Nucleic acid sequencing: Blotting techniques.*	**3**	**1**					**2**

CO5	*have knowledge of Application of r-DNA technique in human health, Production of Insulin, Production of recombinant vaccines: Hepatitis B, Production of human growth hormone.*	**3**	**1**		**2**	**2**	**1**	**3**

3: Strong contribution, 2: Average contribution , 1: Low contribution

13. Books recommended:

1. Glick, B.R & Pasternak J.J (1994) Molecular Biotechnology, Princi[ples and Applications of Recombinant DNA, American Society for Microbiology, Washington D.C
2. Christopler H. (1995) Gene cloning and Manipulating, Cambridge University Press
3. Nicholl, D.S.T (1994) An Introduction of Genetic Engineering, Cambridge University Press.
4. Old. R.W. and Primrose, S.B. (186) Principles of Gene manipulation, An introduction to genetic engineering (3rd Edition) Black well Scientific Publications
5. Watson J.D. Hopkins, N.H Roberts, J.W.Steitz J.
6. A and Weiner A.M(1988). Molecular biology of society for Microbiology
7. Lewin b. (1994) Genes VI, New York, Oxford University Press

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	POS2	PSO3	PSO4
CO1	**3**	**1**					**2**	**3**	**3**	**3**	
CO2	**3**	**1**					**2**	**3**	**3**	**3**	
CO3	**3**	**1**					**2**	**3**	**3**	**3**	
CO4	**3**	**1**					**2**	**3**	**3**	**3**	
CO5	**3**	**1**		**2**	**2**	**1**	**3**	**3**	**3**	**3**	1
BS303	**3**	1		**1**	1	1	3	**3**	**3**	**3**	1

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

B. Sc. BIOTECHNOLOGY 3rd year/ 5th semester						
1. Name of the Department: Biosciences						
2. Course Name	**MEDICAL BIOTECHNOLOGY**			**L**	**T**	**P**
3. Course Code	**BS 304**			3	1	0
4. Type of Course (use tick mark)		**Core (✓)**	**Foundation Course ()**		**Departmental Elective ()**	
5. Pre-requisite (if any)	10+2 with Biology	**6. Frequency (use tick marks)**	Even **( )**	Odd (✓)	Either Sem ( )	Every Sem ( )
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 30		**Tutorials = 10**	**Practical = 00**			

8. COURSE OBJECTIVES: The course has been designed to make students aware of Zoonoses, Fungi and viruses, Pathology of diseases, Therapies and Medico-legal aspects

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Get knowledge about classification of pathogenic microbes, protozoan parasites, and medical bacteriology.
CO2	Get to know about viral diseases and medical mycology and preventive measures.
CO3	To understand how blood cells are formed, blood cancer, about the brain as well as brain tumour. Pathology of AIDS, Japanese encephalitis, yellow fever, dengue and TB.
CO4	To understand various therapeutics measures including antibiotics.
CO5	To get knowledge about medico-legal aspects of medical biotechnology

10. Unit wise detailed content

Unit-1	**Number of lectures = 08**	**Title of the unit: Definition of Zoonoses**
Classifications of pathogenic microbes, Leptospira, Brucella, bacillus anthracis, Medical Parasitology: Amebiasis, Cryptosporidiosis, Giardiasis, Malaria, Toxoplasmosis, Trichomoniasis, Medical Bacteriology: Staphylococcus, Streptococcus and enterococcus, Pneumococcus, Mycobacterium, Bacillus, Salmonella, Shigella, Pseudomonas and Non-fermenters, Vibrio.		
Unit-2	**Number of lectures = 08**	**Title of the unit: Medical Virology**
Adenoviruses, Pox viruses, Hepadnaviruses, Arboviruses, Retroviruses, Medical Mycology: Fungi, Yeast, Pathogenic fungi, superficial Mycoses, cutaneous Mycoses, subcutaneous Mycoses, Systemic Mycoses.		
Unit-3	**Number of lectures = 08**	**Title of the unit: Pathology of diseases**
Blood formation, Anemia; Blood loss anemia, Magaloblastic anemia, Leukaemia, The Parts of Brain, Brain Tumours, Stem cells: stem cell or Bone marrow transplant, , Pathology of Tuberculosis, Yellow Fever, Japanese Encephalitis, Dengue, Acquired Immune Deficiency Syndrome (AIDS).		
Unit-4	**Number of lectures = 08**	**Title of the unit: Therapies**
Introduction to chemotherapy and radiotherapy, Human Gene Therapy. Antibiotics: Classification of Antibiotics, Combinations of Antibiotics, Doses of Antibiotics, Side Effects of Antibiotics, General Principles for use of Antibiotics.		
Unit-5	**Number of lectures = 08**	**Title of the unit: Medico-legal aspects**
Social: genetic discrimination: insurance and employment, human cloning, foeticide, sex determination, Ethical: somatic and germ line gene therapy, clinical trials, the right to information, ethics committee function.		

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	*Get knowledge about classification of pathogenic microbes, protozoan parasites, and medical bacteriology.*	**3**	**1**				**1**	**3**
CO2	*Get to know about viral diseases and medical mycology and preventive measures.*	**3**	**1**				**1**	**3**
CO3	*To understand how blood cells are formed, blood cancer, about the brain as well as brain tumour. Pathology of AIDS, Japanese encephalitis, yellow fever, dengue and TB.*	**3**	**1**				**1**	**3**
CO4	*To understand various therapeutics measures including antibiotics.*	**3**	**1**				**1**	**3**
CO5	*To get knowledge about medico-legal aspects of medical biotechnology*	**3**	**1**	**1**	**3**	3		**3**

3: Strong contribution, 2: Average contribution , 1: Low contribution

12. Books recommended:

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	POS2	PSO3	PSO4
CO1	**3**	**1**				**1**	**3**	**3**	**3**	**3**	
CO2	**3**	**1**				**1**	**3**	**3**	**3**	**3**	
CO3	**3**	**1**				**1**	**3**	**3**	**3**	**3**	
CO4	**3**	**1**				**1**	**3**	**3**	**3**	**3**	
CO5	**3**	**1**	**1**	**3**	3		**3**	**3**	**3**	**3**	3
BS305	**3**	1	1	**1**	1	3	3	**3**	**3**	**3**	1

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

B. Sc. BIOTECHNOLOGY 3rd year/ 5th semester						
1. Name of the Department: Biosciences						
2. Course Name	**Genomics, Proteomics & Metabolomics**			**L**	**T**	**P**
3. Course Code	**BS 305**			3	1	0
4. Type of Course (use tick mark)		**Core ( )**	**Foundation Course ()**		**Departmental Elective (√)**	
5. Pre-requisite (if any)	10+2 with Biology	**6. Frequency (use tick marks)**	Even **( )**	Odd (√)	Either Sem ( )	Every Sem ( )
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 30		**Tutorials = 10**	**Practical = 00**			

8. COURSE OBJECTIVES: The course has been designed to make students aware of Genome sequencing, genome databases, Genome analysis, Proteomics and Metabolomics

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Get knowledge of Genome sequencing and Sequencing technology.
CO2	Gain knowledge about Major genome databases, Genome analysis and Comparative genomics Functional genomics
CO3	Learn about basic proteomics technology
CO4	Learn about the basics of Technologies used in metabolomics
CO5	Have knowledge of Applications of genomics and proteomics in various fields of life

10. Unit wise detailed content

Unit-1	**Number of lectures = 08**	**Title of the unit: Genome sequencing**

Sanger sequencing, Pyrosequencing, Illumina/Solexa, SOLiD System. Pros and cons of sequencing Maxam-Gilbert sequencing, Whole shotgun genome sequencing

Unit-2	**Number of lectures = 08**	**Title of the unit: Structural and functional genomics**

Classical ways of genome analysis, large fragment genomic libraries; Physical mapping of genomes; sequence assembly and annotation; Comparative genomics Functional genomics: DNA chips and their use in transcriptome analysis; Mutants and RNAi in functional genomics

Unit-3	**Number of lectures = 08**	**Title of the unit: Proteomics**

Introduction to basic proteomics technology; Bioinformatics in proteomics; Proteome analysis. Proteomics classification. Yeast-two-hybrid system, cDNA microarrays 1D-SDS-PAGE , 2D-SDS PAGE. Detection and quantitation of proteins in gels. Pros and cons of various staining methodsBasics of mass spectrometry. MALDI TOFF and ESI, and their application in proteomics, Tandem MS/MS spectrometry, Peptide sequencing by tandem mass spectrometry, Affinity purification of protein TAP tag.

Unit-4	**Number of lectures = 08**	**Title of the unit: Metabolomics**

Technologies in metabolomics, Role of Spectroscopy, Electrophoretic and Chromatographic techniques in metabolic profiling Nutrigenomics

Unit-5	**Number of lectures = 08**	**Title of the unit: Applications**

Applications of genomics and proteomics in agriculture, human health and industry

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	*Get knowledge of Genome sequencing and Sequencing technology.*	**3**	**1**					**1**
CO2	*Gain knowledge about major genome databases, genome analysis, comparative and functional genomics*	**3**	**1**					**2**
CO3	*Learn about basic proteomics technology*	**3**	**1**					**1**
CO4	*Learn about the basics of Technologies in metabolomics*	**3**	**1**					**1**
CO5	*Have knowledge of applications of genomics and proteomics*	**3**	**1**					**1**

3: Strong contribution, 2: Average contribution , 1: Low contribution

12. Books recommended:

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	POS2	PSO3	PSO4
CO1	**3**	**1**					**1**	**3**	**3**	**3**	
CO2	**3**	**1**					**2**	**3**	**3**	**3**	
CO3	**3**	**1**					**1**	**3**	**3**	**3**	
CO4	**3**	**1**					**1**	**3**	**3**	**3**	
CO5	**3**	**1**					**1**	**3**	**3**	**3**	1
BS305	**3**	1					2	**3**	**3**	**3**	1

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

B. Sc. BIOTECHNOLOGY 3rd year/ 5th semester

1. Name of the Department: Biosciences

2. Course Name	**APPLIED BIOTECHNOLOGY**	**L**	**T**	**P**
3. Course Code	**BS 306**	3	1	0

4. Type of Course (use tick mark)		**Core ( )**	**Foundation Course ()**		**Departmental Elective (√)**	
5. Pre-requisite (if any)	10+2 with Biology	**6. Frequency (use tick marks)**	Even **()**	Odd (√)	Either Sem ( )	Every Sem ( )

7. Total Number of Lectures, Tutorials, Practicals

Lectures = 30	**Tutorials = 10**	**Practical = 00**

8. COURSE OBJECTIVES: The objective of this course is to make students familiar with principle, methodology and application of Drug and target identification, target validation, Bioprospecting and conservation: importance of biodiversity, General theory of free radical and antioxidants, Significance of IPR; Requirement of a patentable novelty and Detailed, information on patenting biological products and biodiversity

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	**ATTRIBUTES**
CO1	Get proper knowledge about Genomics and Proteomics and gene expression.
CO2	Gain knowledge about Drug Discovery and Designing: Drug and target identification, target validation
CO3	Learn about Bioprospecting and conservation: importance of biodiversity
CO4	Learn about the basics of Free Radical Biology: General theory of free radical and antioxidants
CO5	Have knowledge of Significance of IPR; Requirement of a patentable novelty and Detailed, information on patenting biological products and biodiversity.

10. Unit wise detailed content

Unit-1	**Number of lectures = 08**	**Title of the unit: Genomics and Proteomics**

Introduction to genomics, Genome annotation, Human genome project and its application, Introduction to Proteomics: Protein expression and its analysis

Unit-2	**Number of lectures = 08**	**Title of the unit: Drug Discovery and Designing**

Drug and target identification, target validation, Molecular docking studies and its Insilco tools e.g. Autodock, GOLD.

Unit-3	**Number of lectures = 08**	**Title of the unit: Bioprospecting and conservation**

Importance of biodiversity. biodiversity informatics, databases in biological materials. International efforts and issues of sustainability

Unit-4	**Number of lectures = 08**	**Title of the unit: Free Radical Biology**

General theory of free radical and antioxidants. Free radical mediated damage to lipids, proteins and DNA; Natural antioxidants and their applications

Unit-5	**Number of lectures = 08**	**Title of the unit: IPR and Patenting**

Significance of IPR; Requirement of a patentable novelty; Issues related to IPR protection of software and database; IPR protection of life forms; International convention in IPR; Obtaining patent; Invention step and prior art and state of art procedure; Detailed information on patenting biological products and biodiversity.

11. CO-PO mapping

COs	**Attributes**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
CO1	*Get proper knowledge about Genomics and Proteomics and gene expression.*	**3**	**1**					**1**
CO2	*Gain knowledge about Drug Discovery and Designing: Drug and target identification, target validation*	**3**	**1**					**2**
CO3	*Learn about Bioprospecting and conservation: importance of biodiversity*	**3**	**1**			**1**	**3**	**3**
CO4	*Learn about the basics of Free Radical Biology: general theory of free radical and antioxidants*	**3**	**1**					**2**
CO5	*Have knowledge of Significance of IPR; Requirement of a patentable novelty and Detailed, information on patenting biological products and biodiversity.*	**3**	**1**			**3**	**2**	**3**

3: Strong contribution, 2: Average contribution , 1: Low contribution

12. Books recommended:

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	POS2	PSO3	PSO4
CO1	**3**	**1**					**1**	**3**	**3**	**3**	
CO2	**3**	**1**					**2**	**3**	**3**	**3**	
CO3	**3**	**1**			**1**	**3**	**3**	**3**	**3**	**3**	1
CO4	**3**	**1**					**2**	**3**	**3**	**3**	
CO5	**3**	**1**			**3**	**2**	**3**	**3**	**3**	**3**	3
BS306	**3**	1			1	1	3	**3**	**3**	**3**	1

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

B. Sc. BIOTECHNOLOGY 3rd year/ 5th semester						
1.Name of the Department: Biosciences						
2.Course Name	**TISSUE CULTURE LAB**			**L**	**T**	**P**
3.Course Code	**BS307**			0	0	6
4.Type of Course (use tick mark)	**Core(✓)**		**Foundation Course ( )**		**Departmental Elective( )**	
5.Pre-requisite (if any)	10+2 with Biology	**6.Frequency(use tick marks)**	Even **( )**	Odd (✓)	Either Sem ( )	Every Sem( )
7.TotalNumberofLectures,Tutorials,Practicals						
Lectures=00	**Tutorials=00**	**Practical=10**				

8. COURSE OBJECTIVES: The objective of this course is to develop the understanding of Basics of Tissue and cell culture

9. COURSE OUTCOMES (CO):
After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Preparation of plant culture media and its sterilization
CO2	Initiation and maintenance of Callus and suspension Culture, cell culture
CO3	Plant propagation through axillary bud culture and adventitious bud culture.
CO4	Isolation of lymphocytes from blood samples. In vitro maintenance of helminth parasites.
CO5	In vitro germination of seeds.

10.Syllabus

Exp-01	Preparation of plant culture media and its sterilization
Exp-02	*In vitro* germination of seeds.
Exp-03	Initiation and maintenance of Callus and suspension Culture
Exp-04	Plant propagation through axillary bud culture.
Exp-05	Plant propagation through adventitious bud culture.
Exp-06	Isolation of lymphocytes from blood samples.
Exp-07	*In vitro* maintenance of helminth parasites.
Exp-08	*In vitro* maintenance of cell lines.

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	*Preparation of plant culture media and its sterilization*	**3**	3	1			1	3
CO2	*Initiation and maintenance of Callus and suspension Culture, cell culture*	**3**	3	1				3
CO3	*Plant propagation through axillary bud culture and adventitious bud culture.*	**3**	3	1			1	3
CO4	*Isolation of lymphocytes from blood samples. In vitro maintenance of helminth parasites.*	**3**	3	1				3
CO5	*In vitro germination of seeds.*	**3**	**3**	**1**			**3**	**3**
3: Strong contribution, 2: Average contribution , 1: Low contribution								

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO	PO	PO	PO	PO	PO	PO	PO	PS	PO	PS	PS

CO											
CO1	**3**	3	1			1	3	**3**	**3**	**3**	
CO2	**3**	3	1				3	**3**	**3**	**3**	
CO3	**3**	3	1			1	3	**3**	**3**	**3**	
CO4	**3**	3	1				3	**3**	**3**	**3**	
CO5	**3**	**3**	**1**			**3**	**3**	**3**	**3**	**3**	
BS307	**3**	3	1			1	3	**3**	**3**	**3**	

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

B. Sc. BIOTECHNOLOGY 3rd year/ 5th semester						
1.Name of the Department: Biosciences						
2.Course Name	**GENETIC ENGINEERING LAB**			**L**	**T**	**P**
3.Course Code	**BS308**			0	0	6
4.Type of Course (use tick mark)		**Core(✓)**	**Foundation Course ( )**		**Departmental Elective( )**	
5.Pre-requisite (if any)	10+2 with Biology	**6.Frequency(use tick marks)**	Even **( )**	Odd (✓)	Either Sem ( )	EverySem( )
7.TotalNumberofLectures,Tutorials,Practicals						
Lectures=00		**Tutorials=00**		**Practical=10**		
8. COURSE OBJECTIVES: The objective of this course is to develop the understanding of basics of RDT and PCR						

9. COURSE OUTCOMES (CO):
After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Isolate genomic DNA from bacteria, plant and animal tissues
CO2	Isolate plasmid DNA (*E. coli*)
CO3	Perform restriction digestion of DNA
CO4	Perform Agarose Gel Electrophoresis
CO5	Understand basics of PCR

10.Syllabus

Exp-01	olation of genomic DNA from bacteria, plant and animal tissue
Exp-02	olation of plasmid DNA (*E. coli*)
Exp-03	striction digestion of DNA
Exp-04	Agarose Gel Electrophoresis
Exp-05	monstration of PCR

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	*Isolate genomic DNA from bacteria, plant and animal tissues*	**3**	**3**	**1**				**3**
CO2	*Isolate plasmid DNA (E. coli)*	**3**	**3**	**1**				**3**
CO3	*Perform restriction digestion of DNA*	**3**	**3**	**1**				**3**
CO4	*Perform Agarose Gel Electrophoresis*	**3**	**3**	**1**				**3**
CO5	*Understand basics of PCR*	**3**	**3**	**1**				**3**

3: Strong contribution, 2: Average contribution , 1: Low contribution

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4
CO1	**3**	**3**	**1**				**3**	**3**	**3**	**3**	
CO2	**3**	**3**	**1**				**3**	**3**	**3**	**3**	

CO3	**3**	**3**	**1**				**3**	**3**	**3**	**3**	
CO4	**3**	**3**	**1**				**3**	**3**	**3**	**3**	
CO5	**3**	**3**	**1**				**3**	**3**	**3**	**3**	
BS308	**3**	3	1				3	**3**	**3**	**3**	

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

B. Sc. BIOTECHNOLOGY 3rd year/ 6th semester

1. Name of the Department: Biosciences					
2. Course Name	**BIOINFORMATICS**	**L**	**T**	**P**	
3. Course Code	**BS 311**	3	1	0	
4. Type of Course (use tick mark)	**Core (✓)**	**Foundation Course ()**	**Departmental Elective ()**		
5. Pre-requisite (if any)	10+2 with Biology	**6. Frequency (use tick marks)**	Even **(✓)**	Odd ()	Either Sem ( )	Every Sem ( )
7. Total Number of Lectures, Tutorials, Practicals					
Lectures = 30	**Tutorials = 10**	**Practical = 00**			

8. COURSE OBJECTIVES: The objective of this course is to develop the understanding of basics of Application of Bioinformatics, Sequence Formats, Sequence Alignment, Data mining and Application of Bioinformatics

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Know basics of Bioinformatics
CO2	Have knowledge of GenBanks, EMBL, DDBJ, Swissprot, PIR/NBRF, IG, GCG, FAST
CO3	Know about basics of Sequence Alignment
CO4	Get insight visualization
CO5	Understand basics of Gene finding tools, Phylogenetic tree, Protein structure visualization, Protein structure prediction, homology modeling.

10. Unit wise detailed content

Unit-1	**Number of lectures = 08**	**Title of the unit: Introduction to Bioinformatics**
Bioinformatics an introduction, Biological database types, sequence databases - nucleotide and protein sequence databases.		
Unit-2	**Number of lectures = 08**	**Title of the unit: Sequence Formats**
GenBank, EMBL, DDBJ, Swissprot, PIR/NBRF, IG, GCG, FASTA		
Unit-3	**Number of lectures = 08**	**Title of the unit: Sequence Alignment**
Pairwise Sequence Alignment, Multiple Sequence Alignment, Dynamic Programming, Progressive Alignment, Smith-Waterman Algorithm, Needleman-Wunsch Algorithm, Scoring Matrices		
Unit-4	**Number of lectures = 08**	**Title of the unit: Data mining in Bioinformatics**
Introduction to data mining, Categories of data mining, Data mining methods, Knowledge discovery, Data modeling, Data visualization, Application of data mining in bioinformatics.		
Unit-5	**Number of lectures = 08**	**Title of the unit: Application of Bioinformatics**
Introduction to Gene finding tools, Phylogenetic tree, Protein structure visualization, Protein structure prediction, homology modeling.		

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	*Know basics of Bioinformatics*	**3**	**1**					**1**
CO2	*Have knowledge of GenBanks, EMBL, DDBJ, Swissprot, PIR/NBRF, IG, GCG, FAST*	**3**	**1**				**1**	**1**
CO3	*Know about basics of Sequence Alignment*	**3**	**1**					**1**
CO4	*Get insight to to data mining, modeling and Data visualization,*	**3**	**1**				**1**	**1**
CO5	*Understand basics of Gene finding tools, Phylogenetic tree, Protein structure visualization, Protein structure prediction, homology modeling.*	**3**	**1**				**1**	**1**

3: Strong contribution, 2: Average contribution , 1: Low contribution

12. Books recommended:

1. Developing Bioinformatics Computer Skill-O Reilly, 1st Indian Edition, SPD publication.
2. An Intro. To Genetic Analysis – Anthony J.F. Griffiths et al ., 1st Ed.
3. Genomics Protocols-Michael Starkey and Ramnath Elaswarapu
4. Bioinformatics-Methods and Protocols-Stephen Misner & Stephen Krawetz

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	POS2	PSO3	PSO4
CO1	**3**	**1**					**1**	**3**	**3**	**3**	
CO2	**3**	**1**				**1**	**1**	**3**	**3**	**3**	
CO3	**3**	**1**					**1**	**3**	**3**	**3**	
CO4	**3**	**1**				**1**	**1**	**3**	**3**	**3**	
CO5	**3**	**1**				**1**	**1**	**3**	**3**	**3**	
BS311	**3**	1				1	1	**3**	**3**	**3**	

Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

B. Sc. BIOTECHNOLOGY 3rd year/ 6th semester						
1. Name of the Department: Biosciences						
2. Course Name	**BIONANOTECHNOLOGY**			**L**	**T**	**P**
3. Course Code	**BS 312**			3	1	0
4. Type of Course (use tick mark)		**Core ()**	**Foundation Course ()**		**Departmental Elective (√)**	
5. Pre-requisite (if any)	10+2 with Biology	**6. Frequency (use tick marks)**	Even **(√)**	Odd ()	Either Sem ( )	Every Sem ( )
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 30		**Tutorials = 10**	**Practical = 00**			

8. COURSE OBJECTIVES: The objective of this course is to develop the understanding of Basics of nanotechnology and overview of nanoscale materials, Nanomaterials: Biosensors: Biophotonics and Bioimaging and Principles of toxicology;

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Understand the basics of nanotechnology and overview of nanoscale materials
CO2	Understand the basics of Nanomaterials
CO3	Understand the basics of Biosensors
CO4	Understand the basics of Biophotonics and Bioimaging
CO5	Understand the Principles of toxicology

10. Unit wise detailed content

Unit-1	Number of lectures = 08	Title of the unit: Introduction

Introduction to nanotechnology and overview of nanoscale materials, effect of length scale on properties, introduction to bionanotechnology, challenges and opportunities associated with biology on the Nanoscale, bionanotechnology systems, biological and medical applications of Bionanomaterials.

Unit-2	Number of lectures = 08	Title of the unit: Nanomaterials

Introduction to nanomaterials. DNA based nanostructures. General surface and colloid chemistry, principles, experimental techniques, surface potential, DLVO theory; Characteristics of nanoparticles, chemical speciation of dissolved species, Environmental behaviour of nanoparticles.

Unit-3	Number of lectures = 08	Title of the unit: Biosensors

Introduction to biosensors, the biological component, the sensor surface, Immobilization of the sensor molecule, Transduction of the sensor signal: Optical, Electrochemical and Mechanical sensors, Sensor stabilization.

Unit-4	Number of lectures = 08	Title of the unit: Biophotonics and Bioimaging

Overview of imaging biological systems, from the cellular level through to whole-body medical imaging, Introduction to biophysics, basic physical concepts in imaging, Major techniques using ionizing and non-ionizing radiation: fluorescence and multi-photon microscopy, spectroscopy, OCT, MRI, X-ray CT, PET and SPECT imaging.

Unit-5	Number of lectures = 08	Title of the unit: Nanotoxicology

Principles of toxicology; toxicology models, experimental toxicology studies; activation and detoxification mechanisms, impor tance of biological membrane in toxicology; Toxicology and bioaccumulation of particles. Biological activity of nanomaterials.

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	*Understand the basics of nanotechnology and overview of nanoscale materials*	**3**	**1**					**1**
CO2	*Understand the basics of nanomaterials*	**3**	**1**					**1**
CO3	*Understand the basics of biosensors*	**3**	**1**				**2**	**1**
CO4	*Understand the basics of biophotonics and bioimaging*	**3**	**1**				**1**	**1**
CO5	*Understand the principles of toxicology*	**3**	**1**			**1**	**3**	**1**

3: Strong contribution, 2: Average contribution , 1: Low contribution

13. Books recommended:

1. Engines of Creation, K E Drexler, Oxford Paperbacks, New York
2. Nanosystems: Molecular Machinery, Manufacturing and Computation, K E Drexler, Wiley, ISBN 0471575186
3. Our Molecular Future: How Nanotechnology, Robotics, Genetics and Artificial Intelligence Will Transform the World, Prometheus ISBN 1573929921
4. Web Resources: www.nanotechweb.org; www.nano.gov; www.nanotec.org.uk
5. Nanobiotechnology-Concepts, Applications and Perspectives edited by CM Niemeyer and CA Mirkin, Wiley-VCH ISBN 3-527-30658-7
6. NanoBiotechnology Protocols in Methods in Molecular Biology Series Edited by SJ Rosenthal and DW Wright, Humana Press, ISBN: 1-58829-276-2
7. Understanding Nanotechnology Scientific American, ISBN: 0446679569 Prey (a novel) by Michael Crichton, ISBN: 0066214122

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	POS2	PSO3	PSO4
CO1	**3**	**1**					**1**	**3**	**3**	**3**	
CO2	**3**	**1**					**1**	**3**	**3**	**3**	
CO3	**3**	**1**				**2**	**1**	**3**	**3**	**3**	
CO4	**3**	**1**				**1**	**1**	**3**	**3**	**3**	
CO5	**3**	**1**			**1**	**3**	**1**	**3**	**3**	**3**	1
BS312	**3**	1			1	2	1	**3**	**3**	**3**	1

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

B. Sc. BIOTECHNOLOGY 3rd year/ 6th semester						
1.Name of the Department: Biosciences						
2.Course Name	**BIOINFORMATICS LAB**			**L**	**T**	**P**
3.Course Code	**BS314**			0	0	6
4.Type of Course (use tick mark)		**Core(✓)**	**Foundation Course ( )**		**Departmental Elective( )**	
5.Pre-requisite (if any)	10+2 with Biology	**6.Frequency(use tick marks)**	Even **(✓)**	Odd ( )	Either Sem ( )	EverySem( )

7.TotalNumberofLectures,Tutorials,Practicals

Lectures=00	Tutorials=00	Practical=10

8. COURSE OBJECTIVES: The objective of this course is to develop the understanding of sequence databases, Retrieving sequences, Simple sequence comparison using DOTPLOT, Pairwise Sequence Alignment , FASTA & BLAST search, Multiple Sequence Alignment (ClustalX & Treeview), Protein Structure Visualization (RASMOL, Swiss-PDB Viewer) and Gene Finding tools (Grail or Genscan)

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Learn about types of sequence databases (Nucleotide & Protein)
CO2	Know about Retrieving sequences from the databases and simple sequence comparison using DOTPLOT
CO3	Have knowledge of Pairwise Sequence Alignment (NW and SW approach), FASTA & BLAST search and Multiple Sequence Alignment (ClustalX & Treeview)
CO4	Have basic knowledge of Protein Structure Visualization (RASMOL, Swiss-PDB Viewer)
CO5	Have basic knowledge about Gene Finding tools (Grail or Genscan)

10.Syllabus

Exp-01	Introduction to types of sequence databases (Nucleotide & Protein)
Exp-02	Retrieving sequences from the databases
Exp-03	Simple sequence comparison using DOTPLOT
Exp-04	Pairwise Sequence Alignment (NW and SW approach)
Exp-05	FASTA & BLAST search
Exp-06	Multiple Sequence Alignment (ClustalX & Treeview)
Exp-07	Protein Structure Visualization (RASMOL, Swiss-PDB Viewer)
Exp-08	Gene Finding tools (Grail or Genscan)

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	*Learn about types of sequence databases (Nucleotide & Protein)*	**3**	3	1				3
CO2	*Know about Retrieving sequences from the databases and simple sequence comparison using DOTPLOT*	**3**	3	1			1	3
CO3	*Have knowledge of Pairwise Sequence Alignment (NW and SW approach), FASTA & BLAST search and Multiple Sequence Alignment (ClustalX & Treeview)*	**3**	3	1				3
CO4	*Have basic knowledge of Protein Structure Visualization (RASMOL, Swiss-PDB Viewer)*	**3**	3	1			**1**	3
CO5	*Have basic knowledge about Gene Finding tools (Grail or Genscan)*	**3**	**3**	**1**			**1**	**3**

3: Strong contribution, 2: Average contribution , 1: Low contribution

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	POS2	PSO3	PSO4
CO1	**3**	3	1				3	**3**	**3**	**3**	
CO2	**3**	3	1			1	3	**3**	**3**	**3**	
CO3	**3**	3	1				3	**3**	**3**	**3**	
CO4	**3**	3	1			**1**	3	**3**	**3**	**3**	
CO5	**3**	**3**	**1**			**1**	**3**	**3**	**3**	**3**	
BS304	**3**	1	1			1	3	**3**	**3**	**3**	

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

B. Sc. BIOTECHNOLOGY 3rd year/ 6th semester						
1.Name of the Department: Biosciences						
2.Course Name	**PROJECT & TRAINING**					
3.Course Code	**BS315**					
4.Type of Course (use tick mark)		**Core(√)**	**Foundation Course ( )**		**Departmental Elective( )**	
5.Pre-requisite (if any)	10+2 with Biology	**6.Frequency(use tick marks)**	Even **(√)**	Odd ( )	Either Sem ( )	Every Sem( )
7. Total Credits = 04						
8. COURSE OBJECTIVES: The main objective of this course is to acquaint the student with various techniques used in contemporary research in biotechnology or allied areas.						
9. COURSE OUTCOMES (CO): ***After the successful course completion, learners will develop following attributes:***						

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	To be able to define a research problem.
CO2	To conduct bench work.
CO3	To prepare the research report and its oral demonstrations.
CO4	To coorealate theoretical knowledge of techniques with practical application
CO5	To promote lifelong learning

10. Students would carry out individual projects as in house training for ***3 months***. The detailed project report/dissertation should be submitted in the Department followed by presentation and viva.

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	*To be able to define a research problem.*	3	2		1	1		3
CO2	*To conduct bench work.*	3	3	2	1	3		3
CO3	*To prepare the research report and its oral demonstrations.*	3	3	2	1	3		3
CO4	*To coorealate theoretical knowledge of techniques with practical application*	3	3					3
CO5	*To promote lifelong learning*	3	3					3

3: Strong contribution, 2: Average contribution , 1: Low contribution

- Students are allocated a dissertation topic individually under the supervision of faculty of the department.
- The dissertation must be similar to the thesis style and encompass:
  (i) Introduction / Rationale and Review of Literature
  (ii) Materials and Methods,
  (iii) Results,
  (iv) Discussion and (v) Bibliography.
- The dissertation should be submitted in type-written, bound form to the department for record.

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	POS2	PSO3	PSO4
CO1	3	2		1	1		3	**3**	**3**	**3**	
CO2	3	3	2	1	3		3	**3**	**3**	**3**	3
CO3	3	3	2	1	3		3	**3**	**3**	**3**	
CO4	3	3					3	**3**	**3**	**3**	
CO5	3	3					3	**3**	**3**	**3**	1
BS315	**3**	3	1	**1**	2		3	**3**	**3**	**3**	1

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

B. Sc. BIOTECHNOLOGY 3rd year/ 6th semester

1.Name of the Department: Biosciences

2.Course Name	**EDUCATIONAL TOUR**
3.Course Code	**BS316**

4.Type of Course (use tick mark)		**Core(✓)**	**Foundation Course ( )**		**Departmental Elective( )**	
5.Pre-requisite (if any)	10+2 with Biology	**6.Frequency(use tick marks)**	Even **(✓)**	Odd ( )	Either Sem ( )	EverySem( )

7. Total Credits = 02

. COURSE OBJECTIVES: The main objective of this course is to provide the students an exposure to various research activities in the country and acquaint the student with state of the art technique/instruments used in various research institutions and industries of national repute. The student needs to submit a report after completion of the tour.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Develop understanding of state of the art techniques/instruments used in various reputed research institutions. and industries
CO2	Take part in Group discussion and learn Team work.
CO3	Enhance communication and social skills by communication with peers.
CO4	Student shall be able to plan and improve the Technical Report writing skills
CO5	Have created Interest to pursue lifelong learning.

10. The students would be taken to a national scientific laboratory or industry for one week.

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	*Develop understanding of state of the art technique/instruments used in various reputed research institutions.*	**3**	**1**	**1**				**3**
CO2	*Take part in Group discussion and learn Team work.*	**3**	**2**	**2**	**1**			**3**
CO3	*Enhance communication and social skills by communication with peers.*	**3**	**2**	**2**	**1**			**3**
CO4	*Student shall be able to plan and improve the Technical Report writing skills*	**3**	**2**					**3**
CO5	*Have created Interest to pursue lifelong learning.*	**3**			**1**		**2**	**3**

3: Strong contribution, 2: Average contribution , 1: Low contribution

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	POS2	PSO3	PSO4
CO1	**3**	**1**	**1**				**3**	**3**	**3**	**3**	1
CO2	**3**	**2**	**2**	**1**			**3**	**3**	**3**	**3**	
CO3	**3**	**2**	**2**	**1**			**3**	**3**	**3**	**3**	
CO4	**3**	**2**					**3**	**3**	**3**	**3**	
CO5	**3**			**1**		**2**	**3**	**3**	**3**	**3**	1
BS316	**3**	2	1	**1**		1	3	**3**	**3**	**3**	1

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

B.Sc. Biotechnology

Program Articulation Matrix: (Mapping of Courses with POs and PSOs)

PO-PSO / Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	POS2	PSO3	PSO4
LN104											
MT106											
CS109											
CH112											
BS101	3	1				1	1	3	2		
CH113											
BS102	3	3	1			1	2	3		2	
ES115											
CH114											
BS111	3	1				2	1	3	1		1
BS112	3	1					1	3	1		
BS113	3	1					1	3	2	1	
CH115											
BS114	3	3	1			1	3	3	1	2	
CH-215											
BS-201	3	1					2	3	2	1	
BS-202	3	1					2	3	2	3	
BS-203	3	1					2	3	2		
BS-204	3	1	1	3	3	2	3	3	1	1	3
BS-205	3	3	1			2	3	3	2	2	3
BS-206	3	3	1			1	3	3	2	2	2
BS-211	3	1		1	1	1	3	3	3	2	1
BS-212	3	1					1	3	3		
BS-213	3	1		1	1	3	2	3	3	3	1
BS-214	3	1			1	2	3	3	3	3	1
BS-215	3	1		1	1	3	2	3	2	3	2
BS-216	3	1		1	2	3	2	3	3	3	1
BS-217	3	3	1			3	3	3	3	3	2
BS301	3	1		2	3	1	3	3	3	3	1
BS302	3	1	1	1	1	2	2	3	3	3	1
BS303	3	1		1	1	1	3	3	3	3	1
BS304	3	1	1	1	1	3	3	3	3	3	1

BS305	3	1					2	3	3	3	1
BS306	3	1			1	1	3	3	3	3	1
BS307	3	3	1			1	3	3	3	3	
BS308	3	3	1				3	3	3	3	
BS311	3	1				1	1	3	3	3	
BS312	3	1			1	2	1	3	3	3	1
BM337											
BS314	3	1	1			1	3	3	3	3	
BS-315	3	3	1	1	2		3	3	3	3	1
BS316	3	2	1	1		1	3	3	3	3	1
B.Sc. Biotechnology	**3**	**2**	**1**	**1**	**1**	**2**	**2**	**3**	**2**	**2**	**1**

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation