Program Handout for

B.Sc. (Hons.) Biochemistry

Department of Biosciences
Faculty of Science
Integral University, Lucknow

INTEGRAL UNIVERSITY LUCKNOW

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 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 basic life sciences, biochemistry and biotechnology. Understand the basic concepts, fundamental principles, the scientific theories related to various biological phenomena, their relevancies in the day-to-day life and their applications.

[PO.2] **Effective Communication**- Development of various communication skills such as reading, listening, speaking, etc., which we 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] **Environmental Management:** 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] To provide in-depth knowledge about core areas of biochemistry.

[PSO.2] To make students competent in the field of biochemistry and allied areas by providing them hands on experience in basic tools and techniques.

[PSO.3] To inculcate, facilitate, motivate and promote knowledge and technical skills in core areas of biological sciences including advanced tools and techniques like genomics, proteomics and transcriptomics to young aspirants.

[PSO.4] To develop graduates with a strong professional ethics and moral duties that will positively affect their profession, community, society and Nation at large.

INTEGRAL UNIVERSITY LUCKNOW
DEPARTMENT OF BIOSCIENCES

EVALUATION SCHEME (CBCS)
B.Sc. (Hons.) Biochemistry Semester-I

			Period										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	25	15	40	60	100	3:1:0	4	√	√	√			√	√
MT106	Mathematics	Foundation	3	1	0	25	15	40	60	100	3:1:0	4	√		√				
CS109	Concept of Computers	Foundation	3	1	0	25	15	40	60	100	3:1:0	4	√	√	√		√		√
CH112	Fundamental of Inorganic Chemistry	Core	3	1	0	25	15	40	60	100	3:1:0	4	√		√				
BS112	Fundamentals of Biochemistry	Core	3	1	0	25	15	40	60	100	3:1:0	4	√	√	√		√		
CH113	Chemistry Lab-I	Practical	0	0	6	25	15	40	60	100	0:0:3	3	√	√	√				
BS141	Biochemistry Lab	Practical	0	0	6	25	15	40	60	100	0:0:3	3							
		Total								700		26							

INTEGRAL UNIVERSITY LUCKNOW
DEPARTMENT OF BIOSCIENCES

EVALUATION SCHEME (CBCS)
B.Sc. (Hons.) Biochemistry
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	25	15	40	60	100	3:1:0	4					√	√	
CH114	Fundamental of Organic Chemistry	Core	3	1	0	25	15	40	60	100	3:1:0	4	√		√				
BS232	Plant Physiology	Core	3	1	0	25	15	40	60	100	3:1:0	4			√				
BS112	Animal Physiology	Core	3	1	0	25	15	40	60	100	3:1:0	4	√		√				
BS113	Fundamentals of Microbiology	Core	3	1	0	25	15	40	60	100	3:1:0	4	√		√		√		
CH115	Chemistry Lab-II	Practical	0	0	6	25	15	40	60	100	0:0:3	3	√	√	√				
BS205	Microbiology lab.	Practical	0	0	6	25	15	40	60	100	0:0:3	3	√	√	√				
Total										700		26							

INTEGRAL UNIVERSITY LUCKNOW
DEPARTMENT OF BIOSCIENCES

EVALUATION SCHEME (CBCS)
B.Sc. (Hons.) Biochemistry
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	25	15	40	60	100	3:1:0	4	√		√				
BS202	Biophysical Chemistry	Core	3	1	0	25	15	40	60	100	3:1:0	4	√	√	√				
BS241	Fundamentals of Genetics	Core	3	1	0	25	15	40	60	100	3:1:0	4			√				
BS242	Introduction to Cell Biology	Core	3	1	0	25	15	40	60	100	3:1:0	4	√		√				
BS243	Fundamentals of Bioinformatics	Core	3	1	0	25	15	40	60	100	3:1:0	4	√	√	√				√
BS244	Physiology Lab	Practical	0	0	6	25	15	40	60	100	0:0:3	3	√		√		√		
BS206	Cell Biology & Genetics Lab	Practical	0	0	6	25	15	40	60	100	0:0:3	3	√		√				
	Total									700		26							

Revision effective from 2020-21 batch

INTEGRAL UNIVERSITY LUCKNOW
DEPARTMENT OF BIOSCIENCES

EVALUATION SCHEME (CBCS)
B.Sc. (Hons.) Biochemistry
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
BS251	Enzymes and Hormones	Core	3	1	0	25	15	40	60	100	3:1:0	4			√				
BS212	Molecular Biology	Core	3	1	0	25	15	40	60	100	3:1:0	4							
BS252	Clinical Biochemistry	Core	3	1	0	25	15	40	60	100	3:1:0	4	√		√				
BS253	Fundamentals of Plant Biochemistry	Core	3	1	0	25	15	40	60	100	3:1:0	4							
BS201	Metabolism	Core	3	1	0	25	15	40	60	100	3:1:0	4							
BS255	Enzymology Lab	Practical	0	0	6	25	15	40	60	100	0:0:3	3	√		√				
BS308	Genetic Engineering Lab	Practical	0	0	6	25	15	40	60	100	0:0:3	3			√		√		
		Total								700		26							

Revision effective from 2020-21 batch

INTEGRAL UNIVERSITY LUCKNOW
DEPARTMENT OF BIOSCIENCES

EVALUATION SCHEME (CBCS)
B.Sc. (Hons.) Biochemistry
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
BS211	Immunology	Core	3	1	0	25	15	40	60	100	3:1:0	4	√		√				
BS341	Nutritional Biochemistry	Core	3	1	0	25	15	40	60	100	3:1:0	4	√	√					
BS303	Genetic Engineering	Core	3	1	0	25	15	40	60	100	3:1:0	4	√		√		√		
BS306	Applied Biotechnology	Core	3	1	0	25	15	40	60	100	3:1:0	4	√	√	√		√	√	√
	Electives: (Any one of the following)	Elective																	
BS305	Genomics, Proteomics & Metabolomics		3	1	0	25	15	40	60	100	3:1:0	4	√	√	√		√		
BS342	Introduction to Tissue culture technologies												√	√	√				
BS343	Tissue Culture & Bioinformatics Lab	Practical	0	0	6	25	15	40	60	100	0:0:3	3	√		√		√		
BS216	Immunology Lab	Practical	0	0	6	25	15	40	60	100	0:0:3	3	√	√	√				
	Total									700		26							

INTEGRAL UNIVERSITY LUCKNOW
DEPARTMENT OF BIOSCIENCES

EVALUATION SCHEME (CBCS) B.Sc. (Hons.) Biochemistry
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
BS204	IPR & Biosafety	Core	3	1	0	25	15	40	60	100	3:1:0	4	√	√	√		√	√	√
	Elective courses (Any one of the following)																		
BS312	Bionanotechnology	Elective	3	1	0	25	15	40	60	100	3:1:0	4	√		√				
BS351	Human Physiology																		
BS352	Seminar Presentation	Practical	0	0	4	25	15	40	60	100	0:0:2	2			√				
BS315	Project & Training* (3 months)		3 Months	300	0:0:4	4							√		√				√
BS316	Educational Tour (8-10 days)			100	0:0:2	2									√			√	
		Total								700		16							

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

	Course Code	Dissertation	Presentation	Viva/Discussion	Total
Project Work	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. BIOCHEMISTRY 1st year/ 1st 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 an understanding of basics of biomolecules

9. COURSE OUTCOMES (CO):

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

COURSE OUTCOME	ATTRIBUTES
CO1	To understand basic details of carbohydrate molecules and its classification
CO2	To understand basic details of amino acid & protein molecules and its classification
CO3	To understand basic details of lipid molecules and its classification
CO4	To understand basic details of Nucleic Acid molecules and its classification
CO5	To understand basic details of Vitamin molecules and its classification

10. Unit wise detailed content

Unit-1	**Number of lectures = 08**	**Title of the unit: Introduction to Bio molecules Carbohydrates**

Structure, classification and properties of Monosaccharides, Disaccharides, and Polysaccharides (starch, glycogen, peptidoglycan, cellulose).

Unit-2	**Number of lectures = 08**	**Title of the unit: Amino acids and Proteins**

Structure, classification and properties of amino acids, peptide bond, proteins: primary, secondary (α-Helix, beta-pleated sheet), tertiary and quaternary structures, Ramachandran plot, structure of hemoglobin and myoglobin.

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

Structure, function, classification and properties of Fatty acids, Glycerolipid, Cholesterol, Sphingolipid, phospholipids, lipoproteins, glycoprotein, isoprene.

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

Purines and pyrimidines, nucleosides, nucleotides, polynucleotides, DNA types: A DNA, B DNA and Z DNA and their function, RNA types: mRNA, rRNA and tRNA and their function, Forces stabilizing nucleic acid structure.

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

Sources, dietary requirements, function and deficiency disorders of water (B, C) and fat soluble vitamins (A, D, E and K).

11. CO-PO mapping

POS/PSO / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4
CO1	**3**	**1**					**1**	**3**		3	2
CO2	**3**	**1**					**1**	**3**		3	2
CO3	**3**	**1**					**1**	**3**		3	2
CO4	**3**	**1**					**1**	**3**		3	2
CO5	**3**	**1**					**1**	**3**		3	2
BS112	**3**	**1**					**1**	**3**		**3**	**2**

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

12. 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 Bochemistry-J.L.Jain S.Chand and Company

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

1. Name of the Department: Biosciences

2. Course Name	**BIOCHEMISTRY LAB**	**L**	**T**	**P**
3. Course Code	**BS141**	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. TotalNumber of Lectures, Tutorials, Practicals

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

8. COURSE OBJECTIVES: The objective of this course is to develop the understanding of To estimate the basic knowledge of Bimolecular testing.

9. COURSE OUTCOMES (CO):

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

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Qualitative test for carbohydrates (Molisch test, Benedict test, Fehling test, Bradford and Iodine tests)
CO2	Estimation of vitamin C and Determination of pKa of glycine
CO3	Perform spot test for amino acids in a given sample
CO4	Estimate cholesterol in a given sample
CO5	Perform DNA and RNA estimation in a given sample

10. Syllabus

Exp-01	Qualitative test for carbohydrates (Molisch test, Benedict test, Fehling test, Barfoed and Iodine tests)
Exp-02	Estimation of vitamin C and Determination of pKa of glycine
Exp-03	Perform spot test for amino acids in a given sample
Exp-04	Estimate cholesterol in a given sample
Exp-05	Perform DNA and RNA estimation in a given sample

11. CO-PO mapping

POS/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4
Cos	**3**	**1**						3		3	
CO1	**3**	**1**		**3**		**3**	**1**	3	2	3	
CO2	**3**	**1**		**3**		**3**	**1**	1		3	
CO3	**3**	**1**		**3**		**3**	**1**				3
CO4	**3**	**1**		**3**	**3**	**3**	**1**				3
BS141	**3**	**1**		**2.4**	**1**	**2.4**		**1.4**	**0.4**	**1.8**	**1.2**

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

12. Books recommended:

B.Sc. BIOCHEMISTRY 1 year 2nd semester

1. Name of the Department: Biosciences

2. Course Name	**PLANT PHYSIOLOGY**	**L**	**T**	**P**
3. Course Code	**BS232**	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**	Even (√)	Odd ()	Either Sem ( )	Every Sem ( )

7. Total Number of Lectures, Tutorials, Practicals

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

8. COURSE OBJECTIVES: On completion of this course, students will be able to develop an understanding of plant water relations, nutrition in plants, morphology and physiology of plants and plant growth, plant hormones and their relation with plant growth and development.

9. COURSE OUTCOMES (CO):

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

COURSE OUTCOME (CO)	**ATTRIBUTES**
CO1	Students will have an understanding of movement of water and solutes in plants, ascent of sap and transpiration.
CO2	Have knowledge of Essential elements, their absorption, transport and role in plants and translocation in phloem.
CO3	Know about basics of C assimilation, Photosynthesis, Photorespiration and Nitrogen metabolism specially Biological nitrogen fixation
CO4	Inaculcate basic knowledge about Enzymes and Plant growth regulators, Seed dormancy and germination.
CO5	Comprehend the response of plant to light, temperature and stress, specially Photo morphogenesis, Photo periodism and Plant movements

10. Unit wise detailed content

Unit-1	**Number of lectures = 08**	**Title of the unit: Plant-water relations**

Importance of water, Diffusion and water potential, Osmosis, Ascent of sap,Transpiration and its significance; Factors affecting transpiration, guttation

Unit-2	**Number of lectures = 08**	**Title of the unit:: Mineral nutrition and transport**

Essential elements, macro and micronutrients, Role of essential elements; Absorption of mineral salts, Transport of ions across cell membrane, Active and passive transport, carriers, channels and pumps. Translocation in phloem,Composition of phloem sap

Unit-3	**Number of lectures = 08**	**Title of the unit: C and N metabolism**

Photosynthesis Photosynthetic Pigments (Chl a, b); Photo system I and II, Electron transport and mechanism of ATP synthesis; C3, C4 and CAM pathways of Carbon fixation; Photorespiration. Nitrogen metabolism Biological nitrogen fixation, Nitrate and ammonia assimilation.

Unit-4	**Number of lectures = 08**	**Title of the unit: : Plant growth regulators**

Enzymes: general structure and properties, Plant growth regulators: Discovery and physiological roles of auxins, gibberellins, cytokinins, ABA, Ethylene. Role and applications in agri-horticulture. Seed Physiology: Dormancy, Breaking Of dormancy, Germination.

Unit-5	**Number of lectures = 08**	**Title of the unit: Growth and Development**

Plant response to light and temperature: Photo morphogenesis, Plant movements, Photoperiodism, (SDP, LDP, Day neutral plants); Phytochrome (Discovery and structure), red and far red light responses on photo morphogenesis; Growth Response to temperature, Vernalization. Introduction to Stress physiology.

11. CO-PO mapping

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	**3**	**1**			**3**		1	3		3	
CO2	**3**	**1**			**3**		**1**	3	2	3	
CO3	**3**	**1**			**3**		**1**	1		3	
CO4	**3**	**1**			**3**		**1**				3

CO5	**3**	**1**			**3**		**1**				3
BS232	**3**	**1**			**3**		**1**	**1.4**	**0.4**	**1.8**	**1.2**
3: Strong contribution, 2: Average contribution , 1: Low contribution											

12. Books recommended:

1. Taiz, L., Zeiger, E.,. Plant Physiology. Sinauer Associates Inc., U.S.A. 5th Edition.
2. Hopkins, W.G., Huner, N.P.,. Introduction to Plant Physiology. John Wiley & Sons, U.S.A. 4th Edition.
3 Bajracharya, D.,. Experiments in Plant Physiology- A Laboratory Manual. Narosa Publishing House, New Delhi.
4. Frank B. Salisbury, Cleon W. Ross: Plant Physiology. Wadsworth Publishing Company

B.Sc. BIOCHEMISTRY 1 year2nd semester					
1. Name of the Department: Biosciences					
2. Course Name	**ANIMAL PHYSIOLOGY**	**L**	**T**	**P**	
3. Course Code	**: BS233**	3	1	0	
4. Type of Course (use tick mark)	**Core (√)**	**Foundation Course ()**	**Departmental Elective ()**		
5. Pre-requisite (if	10+2 with Biology	**6. Frequency (use**	Even (√) Odd ()	Either Sem ( )	Every Sem ( )
7. Total Number of Lectures, Tutorials, Practicals					
Lectures = 30	**Tutorials = 10**	**Practical = 00**			

8. COURSE OBJECTIVES: On completion of this course, students will be able to develop an understanding of: the inter relationships within and between anatomical and physiological systems of the human body.

9. COURSE OUTCOMES (CO):

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

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Seeks to understand the process of Digestion and absorption.
CO2	Understand blood and cardiovascular system.
CO3	Students will gain knowledge of the muscle system, nervous system.
CO4	Students are taught the detailed concepts of respiration, excretion and osmoregulation.
CO5	Students gain fundamental knowledge of reproductive and endocrine systems.

10. Unit wise detailed content

Unit-1	**Number of lectures = 08**	**Title of the unit: Digestion and absorption:**

Role of salivary glands, liver, pancreas and intestinal glands. Digestion and absorption of carbohydrates, lipids and proteins.

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

Composition of blood, blood cells, plasma proteins and Rh factor; Blood coagulation – mechanism and Regulation, Circulatory & Cardiovascular System: Heart and circulation; cardiac cycle.

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

Respiratory volumes, Hemoglobin and oxygen transport, carbon dioxide transport, Bohr's effect and chloride shift. Excretion and Osmo regulation: Structure of nephron, urine formation and its regulation; excretory product.

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

Muscles and Movement, Skeletal, cardiac and smooth muscle. Nervous system: central and peripheral nervous system, nerve impulse – its conduction and synaptictransmission, neurotransmitters

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

Endocrine glands and their functions; Nature of hormones; Regulation of hormone secretion; Mode of action of hormones. Reproductive system: testis, ovary, Spermatogenesis, Oogenesis, Totipotency

11. CO-PO mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4
CO1	**3**	**1**					**1**			**3**	
CO2	**3**	**1**					**1**			**3**	
CO3	**3**	**1**					**1**			**3**	
CO4	**3**	**1**					**1**			**3**	
CO5	**3**	**1**					**1**			**3**	

BS233	**3**	**1**					**1**			**3**	

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

12. Books recommended:

1. Textbook of Medical Physiology by Guyton. A.C., H. Sanders Philadelphia. 1988.
2. Physiological basis of Medical practice, West J.B., Best and Taylor.
3. Introduction to Physiology by Davidson H and Segal M.B. Academic Press.
7. Sherwood L – Human Pysiology: From Cells to Systems, (Wadsworth Publishing, 2000,ISBN: 0534568262)
8. Tortora G J Principles of Anatomy & Physiology, (John Wiley & Sons, 1999, ISBN: 0471366927)

B.Sc. BIOCHEMISTRY 1 year 2nd semester

1. Name of the Department: Biosciences

2. Course Name	**FUNDAMENTALS OF MICROBIOLOGY**	**L**		**P**
3. Course Code	**BS113**	3		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	Every Sem ( )

7. Total Number of Lectures, Tutorials, Practicals

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

8. COURSE OBJECTIVES: On completion of this course, students will be able to develop an understanding of Basics of microbiology, General Classification of microbes, Control of Microorganisms, Basics of Recombination in Prokaryotes, microbial interaction with environment.

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

11. CO-PO mapping

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4
CO1	**3**	**1**				**3**	**1**				**3**
CO2	**3**	**1**				**3**	**1**				**3**
CO3	**3**	**1**				**3**	**1**				**3**
CO4	**3**	**1**				**3**	**1**				**3**
CO5	**3**	**1**				**3**	**1**				**3**
BS113	**3**	**1**				**3**	**1**				**3**

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

13. Books recommended:

1. Introduction to Microbiology, Ingraham, 2ed.
2. Brock Biology of Microorganisms, Madigan et al, 9th ed.
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 manioulation, Cambridge University Press, USA
8. Lewin, B., Gene VI New York, Oxford University Press.

B. Sc. BIOCHEMISTRY 1st year/ 2nd 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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4
CO1	3	3	1			3		3	2		3
CO2	3	3	1			3		3	2		3

CO3	3	3	1			3		3	2		3
CO4	3	3	1			3		3	2		3
CO5	3	3	1	2		3		3	2		3
BS205	**3**	**3**	**1**	**0.4**		**3**		**3**	**2**		**3**
3: Strong contribution, 2: Average contribution , 1: Low contribution											

B.Sc. BIOCHEMISTRY ll year 3rd semester

1. Name of the Department: Biosciences						
2. Course Name	**BIOPHYSICAL**	**L**	**T**	**P**		
3. Course Code	**BS202**	3	1	0		
4. Type of Course (use tick mark)		**Core (√)**	**Foundatio**	**Departmental Elective ()**		
5. Pre-requisite	10+2 with Biology	**6. Frequency (use tick**	Even **()**	Odd (√)	Either Sem ( )	Every Sem ( )
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 30		**Tutorials = 10**	**Practical = 00**			

8. COURSE OBJECTIVES: On completion of this course, students will be able to develop an understanding of: Principle, working and applications, Beer's law and Lamberts law , chromatography, Beer's law and Lamberts law, GM counters and Scintillation, 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	ATTRIBUTES
CO1	Concept of electromagnetic radiation, absorption spectrum, Beer's law and Lamberts law, Principle, working and applications of spectrophotometer and AAS
CO2	Concepts of chromatography and concept of partition coefficient
CO3	Principle, methodology and application of various chromatographic techniques
CO4	Centrifugation and Electrophoresis-Principles and applications
CO5	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, Vander-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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO4	PSO4
CO1	3	3	1			3		3	2		3
CO2	3	3	1			3		3	2		3
CO3	3	3	1			3		3	2		3
CO4	3	3	1			3		3	2		3
CO5	3	3	1	2		3		3	2		3

BS202	**3**	**3**	**1**	**0.4**		**3**		**3**	**2**		**3**

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

12. 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
7. Roy R.N. (1999) A Text Book of Biophysics New Central Book Agency.

B.Sc. BIOCHEMISTRY ll year 3rd semester					
1. Name of the Department: Biosciences					
2. Course Name	**INTRODUCTION TO CELL BIOLOGY**	**L**	**T**	**P**	
3. Course Code	**BS242**	3	1	0	
4. Type of Course (use tick mark)	**Core (√)**	**Foundation Course ()**	**Departmental Elective ()**		
5. Pre-requisite (if	10+2 with Biology	**6. Frequency (use**	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 Cytoskeleton and Cell Membrane, structure of Microtubules, microfilaments, cellular organization of prokaryotic and eukaryotic cells signal transduction, secondary messengers.

9. COURSE OUTCOMES (CO):

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

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Develop an understanding of the Cytoskeleton, Microtubules, microfilaments and Cell Membrane
CO2	Distinguish between the cellular organization of prokaryotic and eukaryotic cells
CO3	Would have deeper understanding of cell at structural and functional level.
CO4	Would have broad knowledge on the molecular interaction between cells.
CO5	Would demonstrate a clear understanding of the signal transduction, secondary messengers.

10. Unit wise detailed content

Unit-1	**Number of lectures = 08**	**Title of the unit: Introduction and tools of cell biology:**

Prokaryotic (archaea and eubacteria) and eukaryotic cells (animal and plant cells), Light microscopy, phase contrast microscopy Fluorescence microscopy, confocal microscopy, electron microscopy.

Unit-2	**Number of lectures = 08**	**Title of the unit: Intracellular organization**

Cell Membrane and Permeability: Chemical components and organization of biological membranes, Fluid Mosaic Model and membrane transport. Structure and functions of organelles, nucleus, ER, Golgi, Lysosome, mitochondria, chloroplasts and peroxisomes. Zellweger syndrome.

Unit-3	**Number of lectures = 08**	**Title of the unit: Cytoskeleton proteins and protein targeting**

Structure and organization of actin filaments. Intermediate filament proteins, Microtubules: assembly and intracellular organization. Organization and movement of cilia and flagella, Concept of protein targeting.

Unit-4	**Number of lectures = 08**	**Title of the unit: Cell wall, extracellular matrix and cell signaling**

Prokaryotic and eukaryotic cell wall, cell matrix proteins. Cell-matrix interactions and cell-cell interactions. Adherence junctions, tight junctions, gap junctions, desmosomes, hemidesmosomes, focal adhesions and plasmodesmata. Basics of signal transduction, Role of cAMP, G-proteins and inositol phosphates in signal transduction.

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

Cell death and cell renewal: Eukaryotic cell cycle, restriction point, and checkpoints. Cell division: Mitosis and Meiosis. Apoptosis and necrosis - brief outline.

11. CO-PO mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4
CO1	**3**	**1**					**1**	**1**			
CO2	**3**	**1**					**1**	**1**			
CO3	**3**	**1**					**1**	**1**			
CO4	**3**	**1**					**1**	**1**	**2**		
CO5	**3**	**1**					**1**	**1**			
BS242	**3**	**1**					**1**	**1**	**0.4**		

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

12. Books recommended:

1. The Cell: A Molecular Approach (2009) 5th ed., Cooper, G.M. and Hausman, R.E., ASM Press & Sunderland (Washington DC), Sinauer Associates, MA, ISBN:978-0- 87893300-6.
2. Molecular Cell Biology (2012) 7th ed., Lodish, H., Berk, A., Zipursky, S.L., Matsudaira, P., Baltimore, D. and Darnell. J., W.H. Freeman & Company (New York), ISBN:13:9781- 4641-0981-2 / ISBN:10: 1-4641-0981-8.
3. Molecular Biology of the Cell (2008) 5th ed., Alberts, B., Johnson,A., Lewis, J., and Enlarge, M., Garland Science (Princeton), ISBN:0-8153-1619-4 / ISBN:0-8153-1620-8.
4. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons. Inc.
5. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th edition.Lippincott Williams and Wilkins, Philadelphia.

B.Sc. BIOCHEMISTRY 2nd year 3rd semester							
1. Name of the Department: Biosciences							
2. Course Name	**FUNDAMENTALS OF BIOINFORMATICS**			**L**	**T**	**P**	
3. Course Code	**: BS243**			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 basic practical techniques of bioinformatics. biological database and will be able to apply these methods to research problems.

9. COURSE OUTCOMES (CO):

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

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Formulate and justify appropriate choices in technology, strategy, and analysis for a range of projects involving DNA, RNA, or protein sequence data.
CO2	Develop pipelines of analysis tools to analyze real-world biological data sets, and show familiarity with the syntax and options required to generate meaningful interpretations.
CO3	Analyze an analytical approach for efficiency, robustness and correctness and explain the importance of these to non-specialist colleagues.
CO4	Explain common methods and applications for analysis of gene or protein expression.
CO5	Use data visualization software to effectively communicate results.

10. Unit wise detailed content

Unit-1	**Number of lectures = 08**	**Title of the unit: Introduction to Bioinformatics Genesis**

Definition and need of Bioinformatics, Brief history of biological databases, International nucleotide databases (e.g., Gen Bank, European Molecular Biology Laboratory (EMBL), Bio information and DNA Data Bank of Japan (DDBJ) Center), International Nucleotide Sequence Database Collaboration (INSDC).

Unit-2	**Number of lectures = 08**	**Title of the unit: Protein Databases Introduction to structural elements of proteins**

Classification of protein databases (e.g., primary, secondary, and composite databases), Brief overview of ExPASy (Expert Protein Analysis System) bioinformatics resource portal, Protein 3D structural databases (e.g., RCSB-PDB (Research Collaboratory for Structural Bioinformatics Protein Data Bank), and MMDB (Molecular Modeling Database) of NCBI).

Unit-3	**Number of lectures = 08**	**Title of the unit: Biological File Formats and Literatures Databases**

Brief overview of biological sequence and 3D structure file formats (e.g., GenBank/GenPept, EMBL, FASTA, PIR, and PDB), NCBI's literature databases (e.g., PubMed, PubMed Central, PubChem Project (e.g., PubChem Compound, Substance and Bioassay databases), and OMIM (Online Mendelien Inheritance in Man) database

Unit-4	**Number of lectures = 08**	**Title of the unit: Database Similarity Searching and Phylogenetics**

Requirements of database searching, BLAST (Basic Local Alignment Search Tool) algorithm, Statistical significance and variants of BLAST , FASTA algorithm and its statistical significance, Comparison of BLAST and FASTA, Brief Overview of phyogenetic analysis

Unit-5	**Number of lectures = 08**	**Title of the unit: Computer Aided Drug Design**

Introduction to drug discovery, drugs derived from natural products, existing drugs as a source for new drug discovery, screening for new drug leads, modern rational approach to drug design, docking and virtual screening. Brief overview of online databases of Ligands and Drugs

11. CO-PO mapping

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4
CO1	3	1				2		1	3		

CO2	3	1				2		1	3		
CO3	3	1				2		1	3		
CO4	3	1				2		1	3		
CO5	3	1				3		1	3		2
BS243	**3**	**1**				**2**		**1**	**3**		**0.4**
3: Strong contribution, 2: Average contribution , 1: Low contribution											

12. Books recommended:

1. Protein Bioinformatics: From Sequence to Function, Academic Press, 2011, ISBN 0123884241, 9780123884244.
2. Essential Bioinformatics, Cambridge University Press, 2006, ISBN 113945062X, 9781139450621
3. Kerns EH, Di L. Drug-Like Properties: Concepts, Structure Design and Methods: from ADME to Toxicity Optimization, Academic Press, Oxford, 2008

B.Sc. BIOCHEMISTRY 2nd year 3rd semester							
1.Name of the Department: Biosciences							
2.Course Name	**PHYSIOLOGY LAB COURSE**			**L**	**T**	**P**	
3.Course Code	**BS244**			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 physiological functions of the biological systems

9. COURSE OUTCOMES (CO):

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

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Determination of osmotic potential of plant cell sap by plasmolytic method.
CO2	To study the effect of two environmental factors (light and wind) on transpiration.
CO3	To study the effect of light intensity and bicarbonate concentration on O2 evolution in photosynthesis.
CO4	Estimation of hemoglobin.
CO5	Measurement of blood pressure

10.Syllabus

Exp-01	Determination of osmotic potential of plant cell sap by plasmolytic method.
Exp-02	To study the effect of two environmental factors (light and wind) on transpiration by excised twig.
Exp-03	To study the effect of light intensity and bicarbonate concentration on O2 evolution in photosynthesis.
Exp-04	Estimation of haemoglobin.
Exp-05	Measurement of blood pressure

11. CO-PO mapping

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4
CO1	3	3	1			2	3	1			
CO2	3	3	1			2	3	1			
CO3	3	3	1			2	3	1			
CO4	3	3	1			2	3	1			
CO5	3	3	1			3	3	1		2	
BS244	**3**	**3**	**1**			**2**	**3**	**1**		**0.4**	

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

12. Books recommended:

B. Sc. BIOCHEMISTRY 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	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	**3**	3	1				3	**3**	1		
CO2	**3**	3	1				3	**3**	1		
CO3	**3**	3	1				3	**3**	1		2
CO4	**3**	3	1				3	**3**	1		3
CO5	**3**	**3**	**1**				**3**	**3**	**1**		
BS206	3	3	1				**3**	3	1		**1**

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

B.Sc. BIOCHEMISTRY ll year 4rth semester

1. Name of the Department: Biosciences					
2. Course Name	**Enzymes & Hormones**	**L**	**T**	**P**	
3. Course Code	**BS251**	3	1	0	
4. Type of Course (use tick mark)	**Core (√)**	**Foundation**	**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 concepts of enzyme and hormones enzyme kinetics.

9. COURSE OUTCOMES (CO):

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

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Hormones: classification, structural features & functions in Plants: auxins, gibberellins,
CO2	Hormones and their functions secreted by endocrine glands
CO3	General properties and modes of actions of enzymes.
CO4	Activation energy and thermodynamics of enzyme action.
CO5	Classification of proteases with their mechanism of action.

10. Unit wise detailed content

Unit-1	**Number of lectures = 08**	**Title of the unit: General properties and modes of actions of enzymes**

Criteria of purity of enzymes Specific activity. Enzyme units-Katal and IU. Chemical nature of enzymes. Protein nature of enzymes and Non protein enzymes- Ribozymes and DNAzymes .Activation energy and thermodynamics of enzyme action. Classification of proteases with their mechanism of action

Unit-2	**Number of lectures = 08**	**Title of the unit: Enzyme Kinetics**

Enzyme Kinetics, Briggs-Haldane steady state approach, methods for the determination of Km and Vmax normalized initial rate equation and normalized curves. Enzyme inhibition and activation, Effect of enzymes concentration, pH and temperature on kinetics of enzyme reactions.

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

Structure, source, biochemical role and deficiency disease: Fat soluble vitamins A, D & Water soluble vitamin – B1, B2, niacin, pyridoxine, folic acid, B12 and C

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

classification, structural features & functions in Plants: auxins, gibberellins, cytokinins, ethylene, and abscisic acid

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

Hormones and their functions secreted by endocrine glands: Hypothalamus, pituitary gland- anterior pituitary and posterior pituitary; thyroid gland; adrenal gland; Pancreas; gonads.

11. CO-PO mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4
CO1	3	1					1		2	2	
CO2	3	1					1		3		3
CO3	3	1					1		3		
CO4	3	1					1		3		
CO5	3	1		2	3		1		3		1

BS251	**3**	**1**		**0.4**	**1.8**		**1**		**3**	**0.4**	**0.8**

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

13. Books recommended:

1) Lehninger, AL “Principles of Biochemistry”.
2) Lubert Stryer “Biochemistry”.
3) Voet & Voet “Biochemistry”.
4) Shuler “Bioprocess Engineering”.
5) Alan Fersht “Enzyme Structure and Mechanism”.
6) David S. Sigman, Paul S. Sigman “The Enzymes: Mechanisms of Catalysis”.
7) Palmer “Enzymes” Dixon & Webb “Enzymes.
8) Vander’s Human Physiology (2008) 11th ed., Widmaier, E.P., Raff, H. and Strang, K.T. McGraw Hill International Publications, ISBN: 978-0-07-128366-3.
9) Endocrinology (2007) 6th ed., Hadley, M.C. and Levine, J.E. Pearson Education (New Delhi), Inc. ISBN: 978-81-317-2610-5.

B.Sc. BIOCHEMISTRY ll year 4rth semester										
1. Name of the Department: Biosciences										
2. Course Name	MOLECULAR BIOLOGY			L			T	P		
3. Course Code	BS212			3			1	0		
4. Type of Course (use tick mark)		Core (√)		Foundation			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, pseudo gene, cryptic gene and split gene, DNA replication and Transcription, Translation, Post translation and transcriptional mechanism, 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	Concept of gene, pseudo gene, cryptic gene and split gene
CO2	DNA replication and regulation in prokaryotes and eukaryotes
CO3	Transcription in prokaryotes and eukaryotes, Translation in prokaryotes and eukaryotes
CO4	Post translation and transcriptional mechanism.
CO5	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; pseudo genes, cryptic genes, Insertion elements and transposons. Gene organization and expression in Mitochondria and Chloroplast

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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4
CO1	3	1					1	2	2		
CO2	3	1			2		1	3		3	
CO3	3	1		2			1	3			
CO4	3	1			3		1	3			
CO5	3	1					1	3		1	
BS212	3	1		0.4	1		1	3	0.4	0.8	

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

12. Books recommended:

1. Howe.C. (1995) Gene Cloning and manioulation, 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 & Biotechnogy (Indian Edition) Royal Society of Cemistry U.K
5. Karp.G (2002) Cell & Molecular Biology, 3rd Edition, John Wiley & Sons; INC.

B.Sc. BIOCHEMISTRY ll year 4rth semester						
1. Name of the Department: Biosciences						
2. Course Name	**CLINICAL BIOCHEMISTRY**		**L**	**T**	**P**	
3. Course Code	**BS252**		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 basic concepts of clinical biochemistry, To understand disorder related with bio molecules metabolism.						
9. COURSE OUTCOMES (CO):						
After the successful course completion, learners will develop following attributes:						

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Anticoagulant preservatives for blood and urine. Transport of specimens.
CO2	Composition and their functions, Anemia:- classifications, erythrocyte indices. Blood coagulation system, Clotting time, Bleeding time, Prothrombin time, RBC count, WBC count,
CO3	Oral glucose tolerance test in normal and diabetic condition.
CO4	Cholesterol: Factors affecting blood cholesterol level. Dyslipoproteinemia, atheroscelorosis, risk factor and fatty liver.
CO5	Metabolism of bilirubin, jaundice - types, differential diagnosis. Liver function test – Icteric index, Vandenberg test, plasma protein changes.

10. Unit wise detailed content

Unit-1	**Number of lectures = 08**	**Title of the unit: Basic concepts of Clinical Biochemistry:**

A Brief review of units and abbreviations used in expressing concentrations and standard solutions. Specimen collection and processing (Blood, urine, feces). Anticoagulant preservatives for blood and urine. Transport of specimens.

Unit-2	**Number of lectures = 08**	**Title of the unit: Hematology: Blood**

Composition and their functions, Anemia:- classifications, erythrocyte indices. Blood coagulation system, Clotting time, Bleeding time, Prothrombin time, RBC count, WBC count, Platelet count, Differential count, determination of Hb, PCV and ESR. Hemoglobinopathies, Thalassemia.

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

Regulation of blood sugar, Glycosuria-types of Glycosuria. Oral glucose tolerance test in normal and diabetic condition.
Diabetes mellitus and Diabetic insipidus - hypoglycemia, hyperglycemia. Ketonuria, ketosis.

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

Lipid and lipoproteins: Classifications, composition, mode of action. Cholesterol: Factors affecting blood cholesterol level. Dyslipoproteinemia, atherosclerosis, risk factor and fatty liver. Involvement of enzymes in diagnostics of heart disease including aspartate transaminase, isoenzymes of creatine kinase and lactate dehydrogenase and troponin.

Unit-5	**Number of lectures = 08**	**Title of the unit: Liver function test Metabolism of bilirubin, jaundice**

Types, differential diagnosis. Liver function test - Icteric index, Vandenberg test, plasma protein changes. Renal function test: Clearance test– Urea, Creatinine, Inulin, Para- aminohippuric acid (PAH) test, Concentration and dilution test. Enzymology: Clinical significance of SGOT, SGPT, ALP, ACP, CPK and LDH

11. CO-PO mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4
CO1	**3**	**1**					**1**	2	2		

CO2	**3**	**1**					**1**	3		3	
CO3	**3**	**1**					**1**	3			
CO4	**3**	**1**					**1**	3			
CO5	**3**	**1**		**2**			**1**	3		1	
BS252	**3**	**1**		**0.4**			**1**	**3**	**0.4**	**0.8**	
3: Strong contribution, 2: Average contribution , 1: Low contribution											

12. Books recommended:

1. Medical Biochemistry by MN Chatterjee, Rana Shinde, 8 edition, 2013, Jaypee publications.
2. Textbook of Medical Laboratory Technology by Praful B. Godkar and Darshan P. Godkar th
3. Medical Laboratory Technology by Ramnik sood, 5 Edition, 1999, Jaypee publishers.
4. Text book of Biochemistry with clinical correlation, Thomas M. Devlin, 3rd edition, A. JohnWiley-Liss Inc. Publication.
5. Practical Clinical Biochemistry, Harold Varley, 4th edition, CBS Publication and Distributors, New Delhi.

B.Sc. BIOCHEMISTRY 2nd year 4 rth semester					
1. Name of the Department: Biosciences					
2. Course Name	**FUNDAMENTALS OF PLANT BIOCHEMISTRY**		**L**	**T**	**P**
3. Course Code	**BS253**		3	1	0
4. Type of Course (use tick mark)		**Core (√)**	**Foundation**	**Departmental Elective ()**	
5. Pre-requisite (if any)	10+2 with Biology	**6. Frequency (use tick marks)**	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 carbon assimilation, respiration and nitrogen metabolism, terpenoids and representative examples from each class, biological functions of terpenoids. Concept of phytoalexins.

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

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Overview of glycolysis, Alternative reactions of glycolysis, Fate of pyruvate, Regulation of
CO2	Plant growth regulators – salicylic acid, polyamines, brassinosteroids.
CO3	Classification of terpenoids and representative examples from each class, biological
CO4	Concept of phytoalexins.
CO5	Plant hormones and their effect on plant growth and development

10. Unit wise detailed content

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

Photosynthesis and Carbon assimilation: Structure of PSI and PSII complexes, Light reaction, Cyclic and non cyclic Photophosphorylation, Calvin cycle and regulation; C4 cycle and Crassulacean acid metabolism (CAM), Photorespiration.

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

Respiration: Overview of glycolysis, Alternative reactions of glycolysis, Fate of pyruvate, Regulation of plant glycolysis, TCA cycle, oxidative phosphorylation and electron transport system.

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

Nitrogen metabolism: Biological Nitrogen fixation by free living and in symbiotic association, structure and function of enzyme Nitrogenase. Nitrate assimilation: Nitrate and Nitrite reductase.

Unit-4	**Number of lectures = 08**	**Title of the unit: Cell wall & plant hormones**

Cell wall structure and plant growth Regulation: Components and structure of plant cell wall, Plant hormones and their effect on plant growth and development, Regulation of plant morphogenetic processes by light. Plant growth regulators – salicylic acid, polyamines, brassinosteroids.

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

Secondary metabolites: Representatives alkaloid group and their amino acid precursors, function of alkaloids, Examples of major phenolic groups; simple phenylpropanoids, flavonoids, tannins and lignin, biological role of plant phenolics, Classification of terpenoids and representative examples from each class, biological functions of terpenoids. Concept of phytoalexins

11. CO-PO mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4
CO1	3	1					1		2	2	
CO2	3	1					1		3		3
CO3	3	1	2				1		3		
CO4	3	1					1		3		
CO5	3	1					1		3		1
BS253	**3**	**1**	**0.4**				**1**		**3**	**0.4**	**0.8**

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

12. Books recommended:

1. Taiz, L., Zeiger, E.,. Plant Physiology. Sinauer Associates Inc., U.S.A. 5th Edition.
2. Hopkins, W.G., Huner, N.P.,. Introduction to Plant Physiology. John Wiley & Sons, U.S.A. 4th Edition.
3 Bajracharya, D.,. Experiments in Plant Physiology- A Laboratory Manual. Narosa Publishing House, New Delhi.
4. Frank B. Salisbury, Cleon W. Ross: Plant Physiology. Wadsworth Publishing Company

B. Sc. BIOCHEMISTRY 2nd year/ 4th 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 characteristics 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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4
CO1	3	1					2	3			
CO2	3	1					2	3			
CO3	3	1					2	3			
CO4	3	1					2	3		1	
CO5	3	1	2				2			3	2
BS201	3	1	0.4				2	2.4		0.8	0.4

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

B.Sc. BIOCHEMISTRY 2nd year 4 rth semester

1.Name of the Department: Biosciences

2.Course Name	**ENZYMOLOGY LAB**	**L**	**T**	**P**
3.Course Code	**BS255**	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 concepts of enzyme dynamics.

9. COURSE OUTCOMES (CO):

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

COURSE OUTCOME (CO)	**ATTRIBUTES**
CO1	Know how to isolate enzyme and determine enzyme activity.
CO2	Know how to study the effect of pH and temperature on the enzyme activity.
CO3	Know how to study the effect of varying substrate and inhibitor concentration on the enzyme activity
CO4	Know how to detect Amino acids by Paper chromatography and TLC.
CO5	Know how to perform Poly Acrylamide Gel Electrophoresis (PAGE).

10.Syllabus

Exp-01	Amino acid detections (Paper chromatography/ TLC).
Exp-02	Isolation of enzyme and determination of enzyme activity
Exp-03	Study of the effect of pH on the enzyme activity.
Exp-04	Study of the effect of varying substrate concentration on the enzyme activity and determination of Km and
Exp-05	Study of the effect of temperature on the enzyme activity.
Exp-06	Study of the effect of inhibitors on the enzyme activity.
Exp-07	Poly Acrylamide Gel Electrophoresis Technique

11. CO-PO mapping

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	3	1				3	3			
CO2	3	3	1				3	3			
CO3	3	3	1		2		3	3			
CO4	3	3	1				3	3		1	
CO5	3	3	1				3			3	2
BS255	**3**	**3**	**1**		**0.4**		**3**	**2.4**		**0.8**	**0.4**

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

12. Books recommended:

B.Sc. BIOCHEMISTRY 2nd year 4 rth 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 ( )	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 genetic engineering.

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

11. CO-PO mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4
CO1	**3**	**3**					**3**		3		
CO2	**3**	**3**				**2**	**3**		3		
CO3	**3**	**3**					**3**		3		
CO4	**3**	**3**					**3**		3		1
CO5	**3**	**3**		2			**3**				3
BS308	**3**	**3**		**0.4**		**0.4**	**3**		**2.4**		**0.8**

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

12. Books recommended:

B. Sc. BIOCHEMISTRY 3rd year/ 5th 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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4
CO1	**3**	**1**			**2**		**3**		3		
CO2	**3**	**1**			**2**		**3**		3		
CO3	**3**	**1**			**2**	**2**	**3**		3		

CO4	**3**	**1**			**2**		**3**	**2**	3		1
CO5	**3**	**1**		**2**	**2**		**3**				3
BS211	**3**	**1**		**0.4**	**2**	**0.4**	**3**	**0.4**	**2.4**		**0.8**

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.

B.Sc. BIOCHEMISTRY lll year 5TH semester							
1. Name of the Department: Biosciences							
2. Course Name	**NUTRITIONAL BIOCHEMISTRY**		**L**		**T**	**P**	
3. Course Code	**BS341**		3		1	0	
4. Type of Course (use tick mark)		**Core (√)**	**Foundation**		**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 basic concepts of nutritional biochemistry which comprises nutritional values of foods, dietary requirements of carbohydrates, lipids, proteins and the factors responsible for malnutrition and measures to overcome malnutrition in infants and adults.

9. COURSE OUTCOMES (CO):

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

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Concept of nutrition, energy measurements, BMR, SDA, RNI and RDA
CO2	Classification, Functions, Bioavailability and deficiency of Minerals and vitamins
CO3	Distribution, composition and functions of fluid in human body
CO4	Classification, composition, food sources, functions of carbohydrates, proteins, fats and oils
CO5	Introduction to various clinical diagnostic tests

10. Unit wise detailed content

Unit-1	**Number of lectures = 08**	**Title of the unit: Nutrition and energy metabolism**

Food as a source of nutrients, function of foods, definition of nutrition, nutrients, adequate, optimum and good nutrition, malnutrition. Unit of energy measurements of food stuffs by Bomb colorimeter, calorific value and RQ of food stuffs. Basic metabolic rate (BMR), its measurements and influencing factors, SDA of food. Recommended Nutrient Intakes (RNI) and Recommended Dietary Allowances for different age groups.

Unit-2	**Number of lectures = 08**	**Title of the unit: Minerals and Vitamins:**

Minerals Classification: Macronutrients and Micronutrients, Functions, sources, Bioavailability, and deficiency of minerals. Vitamins - Classification, Bioavailability, sources, functions and deficiency: Fat soluble vitamins, Water soluble vitamins and few members of B-complex.

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

Distribution & composition of fluid in human body, ECF, ICF, Functions of water, fluid balance disorder of water metabolism, Homeostasis.

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

Classification, composition, food sources, functions, storage in body. Fat and Oils: Composition, saturated unsaturated fatty acids, classification food sources, functions of fats. Proteins: Composition, sources, essential, non essential amino acids, source of proteins, functions, protein deficiency.

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

: Introduction to liver function test, Liver function test LFT profile, Glucose tolerance test, renal function test, Evaluation of filtration barrier, Total Protein Albumin/Globulin Ratio (A-G Ratio).

11. CO-PO mapping

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4
CO1	**3**	**1**					**1**	3			
CO2								3			
CO3	**3**	**1**					**1**	3			
CO4	**3**	**1**					**1**	3		1	
CO5	**3**	**1**					**1**			3	2

BS341	**3**	**1**					**1**	**2.4**		**0.8**	**0.4**
3: Strong contribution, 2: Average contribution , 1: Low contribution											
12.Book recommended											
1. Tom Brody: Nutritional Biochemistry (Second Edition), Academic Press. 2. David A. Bender: Nutritional Biochemistry of the Vitamins, Second Edition, University College London, Cambridge University Press. 3. Harper's Illustrated Biochemistry, 29th edition, Mc Graw Hill Education, Lange. 4. Denise R. Ferrier, Richard A. Harvey, Biochemistry (Lippincott Illustrated Reviews Series), 6th edition. Wolters Kluwer/Lipincott, Williams and Wilkins.											

B.Sc. BIOCHEMISTRY lll year 5th semester					
1. Name of the Department: Biosciences					
2. Course Name	**GENETIC ENGINEERING**			**L**	**P**
3. Course Code	**BS303**			3	0
4. Type of Course (use tick mark)		**Core (√)**	**Foundation Course**		**Departmental Elective ()**
5. Pre-requisite (if	10+2 with Biology	**6. Frequency (use tick marks)**	Even **()**	Odd (√)	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 DNA manipulative enzymes and Gene cloning vectors, Screening and selection of recombinants, Techniques used as Polymerase chain reaction (PCR), Site directed mutagenesis (SDM), Nucleic acid sequencing, Application of r-DNA techniques

9. 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 Electrophoresis 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: In vitro construction of recombinant DNA molecules**

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: Application**

Applications 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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4
CO1	**3**	**1**					**2**	3			
CO2	**3**	**1**					**2**	3	1	2	
CO3	**3**	**1**					**2**	1		2	
CO4	**3**	**1**					**2**	2		1	

CO5	**3**	**1**		**2**	**2**	**2**	**2**	2		1	
BS303	**3**	**1**		**0.4**	**0.4**	**0.4**	**2**	**2.2**	**0.2**	**1.2**	
3: Strong contribution, 2: Average contribution , 1: Low contribution											

12. Books recommended:

1. Glick, B.R & Padternak J.J (1994) Molecular Biotechnology, Principles 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

B. Sc. BIOCHEMISTRY 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 andbiodiversity

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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4
CO1	3	1					1	3			
CO2	3	1					2	3	1	2	
CO3	3	1			1	3	3	1		2	
CO4	3	1					2	2		1	2
CO5	3	1			3	2	3	2		1	
BS306	3	1			0.8	1	2.2	2.2	0.2	1.2	0.4

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

12. Books recommended:

1. Environmental Studies by Benny Joseph, Tata McGraw Hill, 2005.
2. Environmental Studies by Dr. D.L. Manjunath, Pearson Education, 2006.
3. Principles of Environmental Science and Engineering by P. Venugopal Rao, Prentice Hall of India.
4. Environmental Science and Engineering by Meenakshi, Prentice Hall of India.
5. O'Reilly, "Developing Bioinformatics Computer Skills".
6. Griffiths JF, "An Introduction to Generic Analysis".
7. Hunter L, "Artificial Intelligence & Molecular Biology".

B. Sc. BIOCHEMISTRY 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 (√)	ither 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	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	**3**	**1**					**1**	3		3	
CO2	**3**	**1**					**1**			3	
CO3	**3**	**1**					**1**	3		3	
CO4	**3**	**1**					**1**			3	
CO5	**3**	**1**					**1**	1		3	
BS305	**3**	**1**					**1**	**1.4**		**3**	

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

12. Books recommended:

1. O'Reilly, "Developing Bioinformatics Computer Skills".
2. Griffiths JF, "An Introduction to Genetic Analysis".
3. Hunter L, "Artificial Intelligence & Molecular Biology".

4. Gene Cloning and DNA Analysis: An Introduction, 6th Edition by T. A. Brown
5. Genomics and Proteomics: Functional and Computational Aspects by Suhai and Sándors,
6. Genomics and Proteomics: Principles, Technologies, and Applications by Devarajan Thangadurai and Jeyabalan Sangeetha
7. Genomics, Proteomics and Bioinformatics by Ira Milosevic and Nuno Raimundo
8. The Handbook of Metabolomics by Fan, Teresa Whei-Mei, Lane, Andrew N, Higashi, Richard M
9. The Handbook of Metabonomics and Metabolomics by John C. Lindon, Jeremy K. Nicholson and Elaine Holmes

B.Sc. BIOCHEMISTRY lll year 5th semester					
1. Name of the Department: Biosciences					
2. Course Name	**INTRODUCTION TO TISSUE CULTURE TECHNOLOGY**		**L**	**T**	**P**
3. Course Code	**BS342**		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 develop an understanding of: Plant tissue culture, types and importance of culture media, plant growth regulators, importance of aseptic conditions, haploid plant production, economic importance of plant tissue culture, Animal tissue culture; history and scope, types media, Primary culture and Cell lines

9. COURSE OUTCOMES (CO):

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

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Understand use of aseptic Techniques, types of growth media, types growth regulators, and their use in plant tissue culture
CO2	Understand techniques, methods and source of haploid plant production, techniques used for organ culture, somatic Embryogenesis and their applications, and other methods for Protoplast Culture, somatic hybridization, protoplast fusion
CO3	Learn and understand the importance of plant tissue culture in various fields of application, various methods for development of transgenic plants
CO4	Learn the history and scope of Animal Tissue culture, Understand the types, importance and composition of various growth media and growth factors
CO5	Learn and understand the types of cells in culture that includes primary cells, transformed cells and cell lines, different methods of disaggregation of cells from tissues, monolayer formation and methods used for synchronization of cell growth in culture

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, Cytokininis and Gibberellins). Callus and suspension culture.

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

Haploid plant production: microspore and ovule culture, Organ Culture and their applications, Somatic Embryogenesis: Techniques and applications. Protoplast Culture, somatic hybridization, methods of protoplast fusion: chemical and electro fusion, practical application of somatic hybridization.

Unit-3	**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 (Micro projectile bombardment and electroporation).

Unit-4	**Number of lectures = 08**	**Title of the unit: History and Scope of Animal Tissue Culture**

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-5	**Number of lectures = 08**	**Title of the unit: Primary Culture**

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.

11. CO-PO mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4
CO1	3	1					1	3		3	
CO2	3	1					1			3	

CO3	3	1					1	3		3	
CO4	3	1					1			3	
CO5	3	1					1	1		3	
BS342	**3**	**1**					**1**	**1.4**		**3**	
3: Strong contribution, 2: Average contribution , 1: Low contribution											

12. B**ooks recommended:**

1. Ravishankar G.A and Venkataraman L.V(1997) Biotechnology applications of Plant Tissue & cell culture. Oxford & IBH Publishing co., Pvt Ltd.
2. H. S. Chawla “Plant Biotechnology: A Practical Approach”
3. Davis, Cell culture techniques. 4. Brown TA “Gene cloning: An introduction”
5. Ian Freshney Animal cell culture.(4th Edition)
6. Buttler. Elements of Biotechnology – P.k. Gupta (1st Edition -2000) Rastogi Publications.

B.Sc. BIOCHEMISTRY lll year V semester

1.Name of the Department: Biosciences

2. Course Name	**TISSUE CULTURE & BIOINFORMATICS LAB**	**L**	**T**	**P**
3. Course Code	**BS343**	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: On completion of this course, students will be able to develop an understanding of Bioinformatics as tools for Sequence Alignment, FASTA & BLAST search, Multiple Sequence Alignment, Protein Structure Visualization, Gene Finding as well as for tissue culture

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

COURSE OUTCOME (CO)	**ATTRIBUTES**
CO1	Know about sequence databases and FASTA & BLAST search
CO2	Learn Pair wise and multiple Sequence Alignment
CO3	Learn how to visualize Protein Structure
CO4	Learn *In vitro* germination of seeds and maintenance of Callus and suspension culture
CO5	Learn Plant propagation through axillary and adventitious bud culture

10. Syllabus

Exp-01	Introduction to types of sequence databases (Nucleotides & Protein)
Exp-02	Pair wise Sequence Alignment (NW and SW approach)
Exp-03	FASTA & BLAST search
Exp-04	Multiple Sequence Alignment (ClustalX & Treeview)
Exp-05	Protein Structure Visualization (RASMOL, Swiss-PDB Viewer)
Exp-06	Gene Finding tools (Grail or Genscan)
Exp-07	Preparation of plant culture media and its sterilization.
Exp-08	*In vitro* germination of seeds.
Exp-09	Initiation and maintenance of Callus and suspension culture.
Exp-10	Plant propagation through axillary bud culture.
Exp-11	Plant propagation through adventitious bud culture

11. CO-PO mapping

Cos		**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1		3	3	1				3	2		3	2
CO2		3	3	1				3	2		3	2
CO3		3	3	1				3	2		3	2
CO4		3	3	1				3	2		3	2

CO5		**3**	**3**	**1**				**3**	2		3	2
BS343		**3**	**3**	**1**				**3**	**2**		**3**	**2**

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

12.Brief description ofself learning/ E-learningcomponent

13. B**ooks recommended:**

B. Sc. BIOCHEMISTRY 3rd year/ 5th 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	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	PSO1	PSO2	PSO3	PSO4
CO1	**3**	**3**	**1**				**3**		2		3
CO2	**3**	**3**	**1**				**3**		2		3
CO3	**3**	**3**	**1**				**3**		2		3
CO4	**3**	**3**	**1**				**3**		2		3
CO5	**3**	**3**	**1**				**3**		2		3
BS216	**3**	**3**	**1**				**3**		**2**		**3**

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

12. Books recommended:

B. Sc. BIOCHEMISTRY 3rd year/ 6th 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	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	**3**	**1**		**3**	**3**		**3**	2		3	2
CO2	**3**	**1**		**3**	**3**		**3**	2		3	2
CO3	**3**	**1**		**3**	**3**		**3**	2	2	3	2
CO4	**3**	**1**		**3**	**3**		**3**	2		3	2
CO5	**3**	**1**	**2**	**3**	**3**		**3**	2		3	2
BS204	**3**	**1**	**0.4**	**3**	**3**		**3**	**2**	**0.4**	**3**	**2**

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

12. Books recommended:

1. Genome, T.A. Brown, John Willey & Sons Inc.
2. Molecular Cell Biology, H. Lodish, A.Berk, S. Zipursky, P Matsundaira, D. Baltimore and J.E. Barnell, W.H. Freeman and Company.

3. Molecular Biology of the Gene, J.D. Watson, A.M. Weiner and N.H. Hopkins, Addison- Wesley Publishing.
4. Introduction to Practical Molecular Biology, P.D. Dabre, John Wiley and Sons Inc.
5. Biotechnology- B.D. Singh.

B. Sc. BIOCHEMISTRY 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 the 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, importance of biological membrane in toxicology; Toxicology and bioaccumulation of particles. Biological activity of nanomaterials.

11. CO-PO mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4
CO1	**3**	**1**					**1**	2		3	2
CO2	**3**	**1**					**1**	2		3	2
CO3	**3**	**1**					**1**	2		3	2
CO4	**3**	**1**					**1**	2		3	2
CO5	**3**	**1**			**2**		**1**	2		3	2
BS312	**3**	**1**			**0.4**		**1**	**2**		**3**	**2**

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

B. Sc. BIOCHEMISTRY 3rd year/ 6th semester						
1. Name of the Department: Biosciences						
2. Course Name	**HUMAN PHYSIOLOGY**	**L**		**T**	**P**	
3. Course Code	**BS 351**	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 human physiolology;

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

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Understand the components of blood and diseases associated
CO2	Understand the basics of respiration, its regulation and respiratory illnesses
CO3	Understand the basics of excretion, its regulation and its role in homeostasis
CO4	Understand the basics of diseases of kidney and nervous system
CO5	Understand the basics of digestion, diseases associated and liver function tests

10. Unit wise detailed content

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

Blood: composition of blood, plasma proteins, blood cells counting and its significance, Blood coagulation – mechanism and regulation, Blood volume regulation and Blood pressure Haematopoiesis. Disease of Blood: Thalassemia, sickle cell anemia, Anemias; Cardiovascular Disorders – Atherosclerosis.

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

Respiration: Transfer of blood gases, role of 2,3-diphosphoglycerate, Bohr's effect, and Haldane effect, chloride shift, Neural & chemical regulation of respiration. Respiratory illnesses: Asthma, COPD, Cystic Fibrosis, Emphysema, Pneumonia.

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

Structure of nephron, glomerular filtration, reabsorption and tubular secretion. Homeostatic regulation of water and electrolytes, Acid-base balance, composition of urine, hormones of the kidney.

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

Diseases: Kidney: Uremia & Glomerulonephritis, Kidney stone; Synapses, central and peripheral nervous system. Neurological: Epilepsy, Parkinson & Alzheimer's significance of diagnostic enzymology.

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

Digestion: functions and regulation of saliva, gastric, pancreatic, intestinal and bile secretions. Digestion and absorption of biomolecules. Gall Stone, Ulcers, Liver: Jaundice, Liver Function Tests: SGOT, SGPT, CPK, LDH, Hepatitis.

11. CO-PO mapping

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4
CO1	**3**	**1**					**1**	2		3	2
CO2	**3**	**1**					**1**	2		3	2
CO3	**3**	**1**					**1**	2		3	2
CO4	**3**	**1**					**1**	2	2	3	2
CO5	**3**	**1**					**1**	2		3	2
BS351	**3**	**1**					**1**	**2**	**0.4**	**3**	**2**

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

13. Books recommended:

1. Introduction to Physiology by Davidson H and Segal M.B. Academic Press.
2. Fox S I – Human Physiology, (McGraw Hill, 1998, ISBN: 0071157069)
3. Moffett D and Schauf C L – Human Physiology: Foundations & Frontiers, (Mosby, 1993, ISBN: 801669030)

4. Seeley R, Stephens T and Tate P – Anatomy & Physiology, (McGraw-Hill, 1999, ISBN: 0071169881)
5. Physiological chemistry by Harper.
6. Textbook of Medical Physiology by Guyton. A.C., H. Sanders Philadelphia. 1988.

B.Sc. BIOCHEMISTRY 3rd year/ 6th sem.						
1. Name of the Department: Biosciences						
2. Course Name	**SEMINAR**					
3. Course Code	**BS352**					
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 = 02						
8. COURSE OBJECTIVES: The students will be able to summarise and present the existing data related to a specific topic in the form of a report. Every student will present a seminar on a topic related to theoretical or experimental, advanced topic						

9. COURSE OUTCOMES (CO):

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

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	The students will understand and interpret latest advancements through different technical papers, reports, Journals, Data sheets, books etc
CO2	The students will inculcate the skills for literature survey and will learn to manage resources effectively.
CO3	The students will be able to summarize the recent research and technologies in the form of review and will be able to deliver power point presentations on an assigned topic.
CO4	Communicate his/her ideas with his peers as audience, which will enhance both oral and written communication skills.
CO5	Create interest to pursue lifelong learning.

10. CO-PO mapping

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4
CO1	**3**	**2**	**1**		**2**		**2**	2		3	2
CO2	**3**	**2**	**1**		**2**		**2**	2		3	2
CO3	**3**	**2**	**1**		**2**		**2**	2		3	2
CO4	**3**	**2**	**1**		**2**		**2**	2		3	2
CO5	**3**	**2**	**1**		**2**		**2**	2		3	2
BS352	**3**	**2**	**1**		**2**		**2**	**2**		**3**	**2**

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

B. Sc. BIOCHEMISTRY 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 biochemistry 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 at any research institution/industry/in house trainings of their choice for 3 months. The detailed project report/dissertation should be submitted in the Department followed by presentation and viva.

11. CO-PO mapping

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4
CO1	3	3		1	1		3	2		3	2
CO2	3	3	2	1	3		3	2		3	2
CO3	3	3	2	1	3		3	2		3	2
CO4	3	3					3	2		3	2
CO5	**3**	**3**					**3**	**2**		3	2
BS315	**3**	**3**	**0.8**	**0.6**	**1**		**3**	**2**		**3**	**2**

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.

B. Sc. BIOCHEMISTRY 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						
8. 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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4
CO1	**3**	**2**	**1**				**3**	2		3	2
CO2	**3**	**2**	**2**	**1**			**3**	2		3	2
CO3	**3**	**2**	**2**	**1**			**3**	2		3	2
CO4	**3**	**2**					**3**	2		3	2
CO5	**3**	**2**		**1**		**2**	**3**	2		3	2
BS316	**3**	**2**	**1**	**0.6**		**0.4**		**2**		**3**	**2**

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

B.Sc. Biochemistry

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

PO-PSO / Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	POS2	PSO3	PSO4
BS112	3	1					1	3		3	2	3
BS141	3	1		2.4	1	2.4		1.4	0.4	1.8	1.2	3
BS232	3	1			3		1	1.4	0.4	1.8	1.2	3
BS233	3	1					1			3		3
BS113	3	1				3	1				3	3
BS205	3	3	1	0.4		3		3	2		3	3
BS202	3	3	1	0.4		3		3	2		3	3
BS242	3	1					1	1	0.4			*3*
BS243	3	1				2		1	3		0.4	3
BS244	3	3	1			2	3	1		0.4		3
BS206	3	3	1				3	3	1		1	3
BS251	3	1		0.4	1.8		1		3	0.4	0.8	3
BS212	3	1		0.4	1		1	3	0.4	0.8		3
BS252	3	1		0.4			1	3	0.4	0.8		3
BS253	3	1	0.4				1		3	0.4	0.8	3
BS201	3	1	0.4				2	2.4		0.8	0.4	3
BS255	3	3	1		0.4		3	2.4		0.8	0.4	3
BS308	3	3		0.4		0.4	3		2.4		0.8	3
BS211	3	1		0.4	2	0.4	3	0.4	2.4		0.8	3
BS341	3	1					1	2.4		0.8	0.4	3

BS303	3	1		0.4	0.4	0.4	2	2.2	0.2	1.2		3
BS306	3	1			0.8	1	2.2	2.2	0.2	1.2	0.4	3
BS305	3	1					1	3		3	2	3
BS342	3	1		2.4	1	2.4		1.4	0.4	1.8	1.2	3
BS343	3	1			3		1	1.4	0.4	1.8	1.2	3
BS216	3	1					1			3		3
BS204	3	1				3	1				3	3
BS312	3	3	1	0.4		3		3	2		3	3
BS351	3	3	1	0.4		3		3	2		3	3
BS352	3	1					1	1	0.4			*3*
BS315	3	1				2		1	3		0.4	3
BS316	3	3	1			2	3	1		0.4		3
Average	**3**	**2**	**1**	**1**	**1**	**2**	**2**	**2**	**1**	**2**	**2**	**3**

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