Program Handout for

M.Sc. Biochemistry

(w.e.f. 2007-08; revised version 2020-2021)

Department of Biosciences
Faculty of Science
Integral University, Lucknow

INTEGRAL UNIVERSITY LUCKNOW
DEPARTMENT OF BIOSCIENCES
M.Sc. Biochemistry

PROGRAM EDUCATIONAL OBJECTIVES (PEO's)

- To provide in-depth knowledge about core areas of biosciences such as biotechnology, biochemistry and microbiology.
- To make students competent in the field of biosciences and allied areas by providing them hands on experience in basic tools and techniques.
- To instil the ability for research and entrepreneurship in the students along with strong ethics and communication skills.
- 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.
- To equip and motivate the students to pursue higher education and research in reputed institutes at national and international level in the field of science.
- To develop trained human resource in the field of advanced translational research.
- To provide students with an understanding of the role of science in societal development.
- To develop graduates with a strong professional ethics and moral duties that will positively affect their profession, community, society and Nation at large.

PROGRAM OUTCOMES (PO's)

[PO.1] **Critical Thinking:** Take informed actions after identifying the assumptions that frame our thinking and actions, checking out the degree to which these assumptions are accurate and valid, and looking at our ideas and decisions (intellectual, organizational and personal) from different perspectives.

[PO.2] **Effective Communication:** Speak, read, write and listen clearly in person and through electronic media in English and in one Indian language, and make meaning of the world by connecting people, ideas, books, media and technology.

[PO.3] **Social Interaction:** Elicit views of others, mediate disagreements and help reach conclusions in group settings.

[PO.4] **Effective Citizenship:** Demonstrate empathetic social concern and equity centred national development, and the ability to act with an informed awareness of issues and participate in civic life through volunteering.

[PO.5] **Ethics:** Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them.

[PO 6] **Research related skills**: Will develop ability to identify problems, give justifications for solutions by lab investigations & critical analysis by using appropriate research related biological skills.

[PO.7] **Environment and Sustainability:** Understand the issues of environmental contexts and sustainable development.

[PO.8] **Self-directed and Life-long Learning**: Acquire the ability to engage in independent and life-long learning in the broadest context socio-technological changes.

PROGRAM SPECIFIC OUTCOMES (PSO's)

[PSO.1] To acquire in-depth knowledge of Biochemistry, molecular and cellular biology and bioinformatics and the ability to apply this and provide cost efficient solutions.

[PSO.2] An ability to translate knowledge of Biochemistry to address environmental, intellectual, societal and medical challenges faced by humankind.

[PSO.3] Empower the students to acquire technological knowhow by connecting disciplinary and interdisciplinary aspects of biochemistry.

[PSO.4] Recognize the importance of Bioethics, IPR, entrepreneurship, using statistical tools, Communication and management skills, written and oral reports, scientific publications so as to usher next generation of Indian biochemists.

INTEGRAL UNIVERSITY LUCKNOW
DEPARTMENT OF BIOSCIENCES

EVALUATION SCHEME (CBCS)
M.Sc. Biochemistry Semester-I

Course Code	Course Title	Type of Paper	Periods/Week			Evaluation Scheme				Max. Marks	Credits	Total Credit	Attributes						
			L	T	P	UE	TA	Total	ESE				Employability	Entrepreneurship	Skill development	Gender	Environment & sustainability	Human values	Professional ethics
BS401	Biomolecules: Structure & Functions	Core	3	1	0	40	20	60	40	100	3:1:0	4							
BS421	Bioinformatics and Applied Statistics	Core	3	1	0	40	20	60	40	100	3:1:0	4	√		√				
BS403	Essentials of Molecular Biology	Core	3	1	0	40	20	60	40	100	3:1:0	4							
BS404	Biophysical & Biochemical Methods	Core	3	1	0	40	20	60	40	100	3:1:0	4	√		√				
BS422	Essentials of Microbiology	Core	3	1	0	40	20	60	40	100	3:1:0	4	√	√	√		√		
BS423	Biochemistry/ Microbiology lab.	Practical	0	0	12	40	20	60	40	100	0:0:6	6	√	√	√		√		
	Total									600		26							

Course	Course Code	Associated labs	ESE	Credits
Biochemistry/Microbiology lab.	BS423	Biochemistry lab.	25	4
		Microbiology lab	15	2

Revision effective from 2020-21 batch

INTEGRAL UNIVERSITY LUCKNOW
DEPARTMENT OF BIOSCIENCES

EVALUATION SCHEME (CBCS)
M.Sc. 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 development	Gender	Environment & sustainability	Human values	Professional ethics
BS411	Gene Expression & Regulation	Core	3	1	0	40	20	60	40	100	3:1:0	4							
BS412	Enzymology & Enzyme kinetics	Core	3	1	0	40	20	60	40	100	3:1:0	4							
BS413	Metabolism & Bioengertics	Core	3	1	0	40	20	60	40	100	3:1:0	4							
BS431	Cytology & Cell Signalling	Core	3	1	0	40	20	60	40	100	3:1:0	4			√				
Elective courses (Any one of the following)		Elective	3	1	0	40	20	60	40	100	3:1:0	4							
BS415	Molecular Genetics																		
BS416	Environmental Biology																√		
BS417	Pharmaceutical Biology												√	√					
BS432	Analytical Biochemistry and Enzymology Lab	Practical	0	0	12	40	20	60	40	100	0:0:6	6	√	√	√				
BS419	Educational/Industrial tour									S/U					√				
	Total									600		26							

Course	Course Code	Associated labs	ESE	Credits
Analytical Biochemistry and Enzymology Lab	BS432	Analytical Biochemistry lab.	50	3
		Enzymology lab	50	3

 # Note: The students of M.Sc. Biochemistry have to undergo the educational/Industrial tour in Biotechnology based industry/research institution for practical awareness at the end of 2nd semester. [S - satisfactory/ U- unsatisfactory].

INTEGRAL UNIVERSITY LUCKNOW
DEPARTMENT OF BIOSCIENCES

EVALUATION SCHEME (CBCS)
M.Sc. 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 development	Gender	Environment & sustainability	Human values	Professional ethics
BS521	Genetic Engineering	Core	3	1	0	40	20	60	40	100	3:1:0	4	√		√				
BS522	Plant Biochemistry	Core	3	1	0	40	20	60	40	100	3:1:0	4			√				
BS503	Immunology	Core	3	1	0	40	20	60	40	100	3:1:0	4			√				
BS523	Physiological & Clinical Biochemistry	Core	3	1	0	40	20	60	40	100	3:1:0	4	√	√	√				
BS524	Applied Biotechnology, IPR & Biosafety	Core	3	1	0	40	20	60	40	100	3:1:0	4	√	√	√				√
BS525	Immunology and Molecular Biology Lab.	Practical	0	0	12	40	20	60	40	100	0:0:6	6	√		√				
	Total									600		26							

Course	Course Code	Associated labs	ESE	Credits
Immunology & Molecular biology lab	BS525	Immunology lab	50	3
		Molecular biology lab	50	3

INTEGRAL UNIVERSITY LUCKNOW
DEPARTMENT OF BIOSCIENCES

EVALUATION SCHEME (CBCS)
M.Sc. 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 development	Gender	Environment & sustainability	Human values	Professional ethics
Elective courses (Any one of the following)		Elective	3	1	0	40	20	60	40	100	3:1:0	4							
BS531	Nutritional Biochemistry												√	√	√				
BS512	Free Radical Biology																		
BS513	Food Biotechnology												√				√		
BS514	Seminar	Core	3	1	0	40	20	60	40	100	2	2							
BS515	Project Work	Practical	0	0	12	40	20	60	40	400	8	8	√		√				√
Total										600		14							

* The Evaluation scheme for the Project Work:

	Course Code	Dissertation	Presentation	Viva/Discussion	Total
Project Work	BS-515	200	100	100	400

INTEGRAL UNIVERSITY LUCKNOW

M.Sc. BC Ist yr,
Semester: Ist

BS401 Biomolecules: Structure & Functions

L T P C
3 1 0 4

Course Objectives:

The course aims to provide students with an understanding of biomolecules, the basic building blocks of living organisms, their structural underpinnings, unique properties, biological roles and functions and interrelations. Emphasis is on the association between structure and function of various biomolecules at a chemical level with a biological perspective.

Course Outcome (CO)

CO1 The students will learn about the chemical structures of carbohydrate, and their structural and metabolic role in cellular system.

CO2 The students will learn about structure and function of membrane and storage lipids, circulating lipids and inflammatory lipid mediators etc.

CO3 The course will aid the students in understanding accessory molecules like vitamins, plant and animal hormones, plant secondary metabolite like terpenes etc.

CO4 The students will be acquainted about amino acids found regularly in proteins and uncommon amino acids. They will learn in detail about primary, secondary, tertiary and quaternary structure of proteins.

CO5 The students will understand the structure and function of nucleosides and nucleotides. They will also learn about the different types of DNA and RNA found in the various cellular systems and their functional relevance.

Unit	Course Contents:	Mapped CO	hours
I	**Carbohydrates** Classification, characteristics and functions of simple carbohydrates; Structure and properties of mono, oligo and polysaccharides; Complex carbohydrates: Types, structure and general function; Chemistry of amino sugars, blood sugar compounds, sugar nucleotides	**CO.1**	**8**
II	**Fatty acids** General formula, nomenclature and chemical properties; Lipid classification: simple,complex; General structure and functions of major lipid subclasses - acyl glycerols, phosphoglycerides, sphingolipids, waxes, terpenes, steroids and prostaglandins & free fatty acids; Circulating lipids - chylomicrons. LDL, HDL and VLDL.	**CO.2**	**8**
III	**Vitamins** Structure, properties, deficiency, symptoms and functions including biochemical reactions. Hormones: Structure, properties & functions of animal & plant hormones.	**CO.3**	**8**
IV	**Proteins** Chemical structure and general properties of amino acids; Protein classification, size, shape, sequence of proteins; Primary, secondary, tertiary and quaternary structure of proteins.	**CO.4**	**8**

V	**Nucleic acids** Structure of purines, pyrimidines, nucleosides and nucleotides; Physical & biochemical properties of DNA; Types of DNA: A, B and Z DNA, their structure and significance; Physical & biochemical properties of RNA: tRNA, rRNA, mRNA and hnRNA; Primary, secondary, and tertiary structures of RNA	**CO.5**	**8**

References

- Lehninger, AL “Principles of Biochemistry”
- Lubert Stryer “Biochemistry”
- Voet & Voet “Biochemistry”
- Baltimore “Molecular Cell Biology”
- Robert K., M Murray, Daryl K. Granner, Peter A. Mayes, Victor W. Rodwell, Appleton & Lange, Robert K. Murray “Harper's Biochemistry”

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

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	POS2	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			
BS401	**3**	**1**				**-**	**-**	**1**	**3**			

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

INTEGRAL UNIVERSITY LUCKNOW

M.Sc. BC I[st] yr,
Semester: I[st]

BS421 Bioinformatics and Applied Biostatistics

L T P C
3 1 0 4

Course Objectives:
The objective of the course is learning and understanding the detailed developments and applications of the field of Bioinformatics in varied areas of biological research. The course generally focuses on genomics, proteomics and computational biology studies and their relevance on research platform. Moreover, this course will also be helpful in the learning and understanding the application of various biostatistical methods and tools in research.

Course Outcome (CO)

CO.1 The student will learn about the Computer basics like Operating systems, Programming in Visual Basic, Data Access, Internet and Nucleic acid Sequence and protein Data Banks.

CO.2 The course will help to understand the Database Similarity Searches like BLAST, FASTA etc., Multiple sequence alignments, Primer Designing, Homology

CO.3 The student will learn the basics of handling of data, measures of central tendency like mean, median and mode, Measures of dispersion like mean

CO.4 The course will aid in learning Tests of significance like Null hypothesis and alternative hypothesis, t –test, F-test, Chi-square test, Correlation and Regression analysis.

CO.5 The student will get idea about correlation and regression analysis

Unit	Course Contents:	Mapped CO	hours
I	**Computer basics** Operating systems; Software, DOS; Programming in Visual Basic: Introduction to application development using Visual Basic; Standard Controls; Data Access Using Data Control; Internet; LAN; WAN; Web servers; Introduction to Nucleic acid Sequence and protein Data Banks: SWISSPROT; Signal peptide data bank: Genbank	**CO.1**	**8**
II	**Database Similarity Searches** BLAST, FASTA, PSI-BLAST, algorithms; Multiple sequence alignments - CLUSTAL, PRAS. Primer Designing; Homology Modeling; Phylogenetic analysis & Drug Designing; Determination of Secondary & Tertiary of proteins.	**CO.2**	**8**
III	**Handling of data** tabulation and diagrammatic representation of data – bar diagram and pie diagram. Measures of central tendency: mean, median and mode. Measures of dispersion: range, quartile deviation, mean deviation and standard deviation. Coefficient of variation	**CO.3**	**8**
IV	**Tests of significance** Null hypothesis and alternative hypothesis, Z-test, Student's distribution, Paired t – test, F-test for equality of population variances. Contingency table, Chi-square test for goodness of fit and independence of attributes.	**CO.4**	**8**

V	**Correlation analysis** Positive and negative correlation, Karl person's coefficient of correlation, Spearsman's rank coefficient of correlation. Regression analysis: regression lines X on Y and Y on X.	**CO.5**	**8**

References

- O'Reilly "Developing Bioinformatics computer skills"
- J.F. Griffiths "An intro to generic Analysis"
- Lawrence hunter "Artificial Intelligence & molecular biology"
- Andreas D. Baxevanis "Bioinformatics: A practical Guide to the analysis of genes and proteins"
- Stephen A., Ph.D. Krawetz David D., Ph.D. Womble "Introduction to Bioinformatics: A Theoretical and Practical Approach"

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

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	POS2	PSO3	PSO4
CO1	3	1						3	3		3	
CO2	3	1		3		3		3	3	2	3	
CO3	3	1		3		3	1	3	1		3	
CO4	3	1		3		3	1	3				3
CO5	3	1		3	3	3	1	3				3
BS421	**3**	**1**		**3**	**1**	**3**	**1**	**3**	**2**	**1**	**2**	**2**

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

M.Sc. BC Ist yr,
Semester: Ist

BS403 Essentials of Molecular Biology

L T P C
3 1 0 4

Course Objectives:

The objective of the course is learning and understanding the fundamentals of molecular biology like nucleic acid as genetic material, replication, gene organization and its regulation etc. The application of the course lays the foundation to understand the disease processes.

Course Outcome (CO)

CO.1 The students will learn about nucleic acid as genetic information carriers, Possible modes of replication, and roles of helicase, primase, gyrase, topoisomerase, DNA Polymerase, DNA ligase, and Regulation of replication.

CO.2 Understand the detailed mechanism and regulation of Eukaryotic DNA replication, along with Mitochondrial and Chloroplast DNA Replication.

CO.3 The students will learn about mechanism and regulation of transcription in prokaryotes along with Reverse transcription.

CO.4 Understanding the classes of DNA sequences, Genome-wide and Tandem repeats, Retroelements, Transposable elements, Centromeres, Telomeres, Satellite DNA, Minisatellites, Microsatellites; Applications of satellite DNA and Split genes.

CO.5 Understanding of the movable genes, transposons and mechanism of transposition.

Unit	Course Contents:	Mapped CO	hours
I	**Nucleic acid as genetic information carriers** Details of Griffith experiment, Avery, McLeod and McCarty experiment, Hershey and Chase experiment; Possible modes of replication: Details of Meselson and Stahl experiment; Prokaryotic DNA replication: Initiation, elongation and termination; Origin of replication; Roles, properties and mechanism of action of DnaA, Helicase, HD protein, Primase, DNA gyrase, Topoisomerase, DNA Polymerase, DNA ligase, Leading and lagging strands; Okazaki fragments; RNA primers; Regulation of replication; Fidelity of replication; σ or Rolling circle replication in ϕX174.	**CO.1**	**8**
II	**Eukaryotic DNA replication** Initiation, elongation and termination; Multiple initiation sites; Autonomously replicating sequence; Significance of Origin recognition complex, Minichromosome maintenance proteins, DNA dependent DNA polymerases α, δ, ε, Nucleases, DNA ligase and Telomeres in eukaryotic nuclear DNA replication; Regulation of eukaryotic DNA replication; Mitochondrial and Chloroplastic DNA replication.	**CO.2**	**8**
III	**Transcription in prokaryotes** Outline of the process - Initiation, elongation and termination; Prokaryotic promoter; DNA dependent RNA polymerase (RNA polymerase): Physical properties, X-Ray crystallographic structure, Subunits, Types of σ subunit; Recognition of promoter; Binding and initiation sites; Melting of DNA; Direction of chain growth; Abortive	**CO.3**	**8**

	initiations; Promoter clearance; Rho dependent and Rho independent termination of transcription; Sigma cycle; RNA - dependent DNA polymerase and Reverse transcription.		
IV	**Classes of DNA sequences** Unique DNA sequences, Repetitive DNA sequences; Zero time binding DNA; Reasons for generation of reiterative DNA sequences; Highly repetitive and Moderately repetitive DNA sequences; Direct and Inverted repeats; Genome - wide and Tandem repeats; Overview of repetitive DNA sequences: Pseudogenes, LINEs, SINEs, Retroelements, Transposable elements, rRNA, tRNA and Histone genes, Centromeres, Telomeres, Satellite DNA, Minisatellites, Microsatellites; Applications of satellite DNA. Methods of distinguishing or separating double stranded and single stranded DNA; C-value and C-value paradox; Split genes: Exons and Introns	**CO.4**	**8**
V	**Movable genes** Transposons: Simple and Composite transposons, Mechanism of transposition, Example of transposons: Ds/ Ac family of transposon, Ty of yeast, Copia, P and FB element of Drosophila, LINES and SINES.	**CO.5**	**8**

References

- Lewin “Genes”
- Freifelder, DM “Molecular Biology”
- Brown, TA “Genomes”
- Watson, JD “Molecular Biology of the cell”
- Twyman, R.M.Advanced Molecular Biology”
- Brown, TA”Gene cloning: An introduction”
- Old & Primrose “Principles of Gene Manipulation”
- Primrose, SB “Molecular Biotechnology”
- Jose B. Cibelli, Robert P. Lanza, Keith Campbell, Michasel D. West “Principles of Cloning”
- Voet & Voet “Biochemistry”
- Lubert Stryer “Biochemistry”

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

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	POS2	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			
BS403	**3**	**1**				**-**	**-**	**1**	**3**			

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

MSc. BC Ist yr,
Semester: Ist

BS404 Biophysical & Biochemical Methods

L T P C
3 1 0 4

Course Objectives:

The objective of this course is to provide students with basic understanding and applications of bioinformatics. The course will provide basic concepts behind the sequence and structural alignment, database searching, protein structure prediction and computer-based drug designing. The course will also introduce the basic concepts of ethics and safety that are essential for various branches of science involving technical procedures and protection of intellectual property and related rights.

Course Outcome (CO)

CO.1 The course will help students to acquaint with basic principles and applications of various sophisticated instruments like phase contrast, fluorescence, electron microscopy, confocal microscopy, fluorescent activated cell sorting, and Freeze drying.

CO.2 The students will get theoretical knowledge of Radioisotopes and its uses in the biological system as well as the principle and practical applications of Geiger-Muller counter, Liquid scintillation counter, autoradiography, X-ray crystallography, and Biosensors

CO.3 The students will learn about Instrumentation, working and principle of Centrifugation & Electrophoresis.

CO.4 Learn various types of chromatography techniques for solving industrial and research problems

CO.5 Students will be able to acquire the knowledge of techniques like UV-VIS spectroscopy, NMR, CD, ORD in biological research

Unit	Course Contents:	Mapped CO	hours
I	**Microscopy** Microscopy: Simple, compound, phase contrast, fluorescence, electron microscopy (TM, SM & STM) and confocal microscopy, fluorescent activated cell sorting (FACS), Freeze drying.	**CO.1**	**8**
II	**Radiotracer technology** Radiotracer technology: Use of radioactive isotopes in biological system, detection and measurement of isotopes, Geiger-Muller counter, Liquid scintillation counter, autoradiography, X-ray crystallography. Biosensors: Basic techniques, enzyme electrode, microbial biosensors.	**CO.2**	**8**
III	**Centrifugation & Electrophoresis** Centrifugation & Electrophoresis: Centrifugation: types of rotors, techniques and their applications: differential, zonal, density gradient and ultra centrifugation. Electrophoresis: Principle, techniques and applications: capillary electrophoresis, paper and gel electrophoresis (PAGE, Agarose, Pulse Field gel electrophoresis, 2D-PAGE), Isoelectric focusing, isotachophoresis, Protein Sequencing, N & C terminal, Edman degradation.	**CO.3**	**8**
IV	**Chromatography** Chromatography: Adsorption, paper, partition, ion-exchange, reverse phase, gel filtration, affinity, gas chromatography and HPLC and FPLC..	**CO.4**	**8**

V	**Photometry** Photometry: Theory, instrumentation and applications of visible photometry. Basic Principles of Spectroscopy: UV & Visible, atomic absorption, nuclear magnetic resonance, mass spectrometry, CD, ORD	**CO.5**	**8**

References

- Keith Wilson John Walker John M. Walker “Principles and Techniques of Practical Biochemistry”
- Joseph Sambrook David W. Russell Joe Sambrook “Molecular Cloning: A Laboratory Manual”
- William M., Ph, D. O’Leary Robert Dony Wu” Practical Handbook of Microbiology”
- Brown, TA “Gene cloning: An introduction”

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

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	POS2	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	
BS404	**3**	**1**	**-**	**-**	**-**	**3**	**-**	**1**	**-**	**-**	**3**	**-**

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

INTEGRAL UNIVERSITY LUCKNOW

MSc. BC I[st] yr,
Semester: I[st]

BS422 Essentials of Microbiology

L T P C
3 1 0 4

COURSE OBJECTIVES: The objective of the course is learning and understanding the fundamentals of Microbiology like important characteristics and biology of bacteria, fungi, mycoplasma, viruses etc. Moreover, this course is designed to learn basic knowledge of fermentation process and industrial application of microbes for the production various useful products such as enzymes and solvents.

Course Outcome (CO)

CO1 Understand the basics of microbiology like Characterization and classification of microorganisms, cultivation, nutrition, physiology and growth of microbial cells, Genetic recombination in bacteria.

CO2 The student will learn and understand the basics of mycology and Production of mutants and their characterization.

CO3 The student will learn about Bacterial toxins, and mode of action of bacterial protein toxins. Host Microbe Interactions, Viruses of bacteria, plant and animal cells, Mycoplasma and viriods.

CO4 The student will learn about Media for Industrial Fermentation, Large scale production and commercial applications of enzymes, such as Amylase and Protease.

CO5 The student will learn about Media for Industrial Fermentation, Large scale production and commercial applications of solvents and antibiotics.

Unit	Course Contents:	Mapped CO	hours
I	**Characterization and classification of microorganisms** Morphology and structure of bacteria, gram positive and gram negative bacteria, cultivation of bacteria, nutrition, physiology and growth of microbial cells. Reproduction and growth, synchronous growth, continuous culture of microorganisms. Pure cultures and cultural characteristics. Genetic recombination in bacteria, conjugation, transformation and transduction	**CO.1**	**8**
II	**Structure of fungus** yeast and mold. Fundamentals of control of microbial growth, control by physical and chemical agents. Production of mutants by chemical and physical agents and their characterizations	**CO.2**	**8**
III	**Bacterial toxins** Classification, structure and mode of action of bacterial protein toxins. Host Microbe Interactions. Viruses of bacteria, plant and animal cells, structure classification life cycle, Mycoplasma and viriods, diseases Viruses – General structure, properties and classification.	**CO.3**	**8**
IV	**Media for Industrial Fermentation** Substrates for bioconversion processes, preparation, sterilization, design. Large scale production and commercial applications of enzymes: proteases and amylases.	**CO.4**	**8**
V	**Title of the unit: Large scale production and commercial applications of solvents and antibiotics:** acetic acid, ethanol, acetobutanol, penicillin and streptomycin.	**CO.5**	**8**

References

- Pelczar MJ Jr.; Chan ECS and Kreig NR.; Microbiology; 5th Edition; Tata McGraw Hill; 1993.
- Maloy SR; Cronan JE Jr.; and Freifelder D; Microbial Genetics; Jones Bartlett Publishers; Sudbury; Massachusetts; 2006.
- Crueger and A Crueger; (English Ed.; TDW Brock); Biotechnology: A textbook of Industrial Microbiology; Sinaeur Associates; 1990.
- G Reed; Prescott and Dunn"s; Industrial Microbiology; 4th Edition; CBS Publishers;
- 1987.M.T. Madigan and J.M. Martinko; Biology of Microorganisms; 11th Edition; Pearson Prentice Hall; USA; 2006.

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

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	POS2	PSO3	PSO4
CO1	3	1				3	3	1	2		2	
CO2	3	1				3	1	1	3	1	2	
CO3	3	1					3	1	3			
CO4	3	1					3	1		3	3	
CO5	3	1			2	3	1	1		2	3	
BS422	**3**	**1**	**-**	**-**	**1**	**2**	**3**	**1**	**2**	**2**	**2**	**-**

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

INTEGRAL UNIVERSITY LUCKNOW

M.Sc. BC I[st] yr,
Semester: I[st]

BS423 Biochemistry & Microbiology lab

L T P C
0 0 12 6

Course Objectives:
The lab is designed to train the students in basic and some advanced techniques of Biochemistry like isolation, purification, and estimation of biomolecules. It also deals with microbial techniques of isolation, purification and maintenance of microbial cultures.

Course Outcome (CO)

CO.1 The student will get practical knowledge on preparation of buffers and measurement of pH.

CO.2 The student will learn qualitative testing of carbohydrates, proteins & Amino Acids, and Comparative evaluation of protein analysis by various methods.

CO.3 The students will learn to determine Calcium (Ca) and inorganic phosphorus (P), and estimate glycogen in a given sample.

CO.4 The student will learn sterilization, preparation of various culture media and purification techniques.

CO.5 Identification of isolated bacteria, and Growth curve of microorganisms

S.No.	Experiments:	Mapped CO
1	Preparation of buffers and measurement of pH.	**CO.1**
2	Qualitative tests of carbohydrates: Molish's Test, Fehling's Test; Benedict's Test; Barfoed's Test; Phenyl Hydrazine Test; Seliwanoff's Test; mucic acid Test, bial's test; Iodine Test, Nelson-Somogyi Method.	**CO.2**
3	Qualitative tests of proteins & Amino Acids: Millon's test, Biuret test; Ninhydrin Test; Xanthoproteic Test; Hopkin's Cole Test.	**CO.2**
4	Comparative evaluation of different methods of protein analysis: UV, Lowry, Biuret, Bradford.	**CO.2**
5	Determination of Calcium (Ca) and inorganic phosphorus (P).	**CO.3**
6	Isolation and estimation of Glycogen.	**CO.3**
7	Methods of sterilization and preparation of various culture media.	**CO.4**
8	Purification techniques: Serial dilution, pour plate and streak plate method.	**CO.4**
9	Identification of isolated bacteria: Gram staining other staining methods, metabolic characterization.	**CO.5**
10	Growth curve of microorganisms	**CO.5**

References

- Keith Wilson John Walker John M. Walker "Principles and Techniques of Practical Biochemistry Chirikjian "Biotechnology Theory & Techniques"
- William M., O'Leary Robert Dony Wu "Practical Handbook of Microbiology"

- Tortora “Microbiology”
- Cappucino “Microbiology Manual”

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

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	POS2	PSO3	PSO4
CO1	3	3	3	1	1	3		3	3		2	2
CO2	3	3	3	1	1	3		3	3		3	2
CO3	3	3	3	1	1	3		3	3		3	2
CO4	3	3	3	1	1	3	2	3	3		3	2
CO5	3	3	3	1	1	3	2	3	3		3	2
BS432	**3**	**3**	**3**	**1**	**1**	**3**	**1**	**3**	**3**	**-**	**3**	**2**

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

INTEGRAL UNIVERSITY LUCKNOW

M.Sc. BC I[st] yr,
Semester: II[nd]

BS411 Gene Expression & Regulation

L T P C
3 1 0 4

Course Objectives:

The objective of the course is to introduce to the students the basic knowledge about how genes are transcribed and how translation takes place in prokaryotes and eukaryotes and how these processes are regulated, so that students can apply this knowledge in enhancing their analytical and problem solving skills..

Course Outcome (CO)

CO.1 To understand the gene expression and regulation in Eukaryotes.

CO.2 To gain better knowledge about Post - transcriptional / Cotranscriptional processing (Maturation of precursors of rRNA, mRNA, tRNA.

CO.3 Learn about the Translation in prokaryotes and eukaryotes and Properties of Genetic code.

CO.4 To study the Post - translational processing: Basics of Protein folding.

CO.5 To study about the Regulation of gene expression and concept of operon.

Unit	Course Contents:	Mapped CO	hours
I	**Transcription in eukaryotes** Transcription in eukaryotes: Synthesis of pre-mRNA: Outline of process - Initiation, elongation and termination, RNA Pol II promoter, Enhancer elements, Subunit structure of RNA Pol II, Roles of RNA polymerase II, Transcription factors, Nucleosome modifiers, Mediator complexes, Chromatin remodellers, Elongation factors in transcription; Cleavage and polyadenylation; Synthesis of pre-rRNA and pre-tRNA: Outline of process, RNA Pol I and III promoters sequences, RNA Pol I and III; DNA-binding motifs: Helix-turn-Helix, Zinc Finger, LeucineZipper, Homeodomain.	**CO.1**	**8**
II	**Post - transcriptional / Cotranscriptional processing** Post - transcriptional / Cotranscriptional processing (Maturation of precursors of rRNA, mRNA, tRNA): End modifications (Addition of 5` cap and 3" Poly A tail in mRNA), RNA splicing - Self splicing and Spliceosome mediated splicing, Cutting events or action of ribonucleases, Covalent modifications, RNA editing, Alternative splicing.	**CO.2**	**8**
III	**Translation in prokaryotes and eukaryotes** Outline of the process - Initiation, elongation and termination; Adapter role of tRNA, Evidences for a triplet code; Properties of Genetic code; Ubiquitous code and deviations; Synonymous codons; Codon family and Codon pairs; Nonsense and Sense codons; Degeneracy: Significance of Isoacceptor tRNAs and Wobble hypothesis; Codon bias; Amino acyl tRNA synthetase: Classification, Specificity,	**CO.3**	**8**

	Reaction catalyzed; A, P and E sites of ribosome; Start and stop codons, Ribosome binding site; Formation of initiation complex; Transpeptidation and Translocation; Ribosome cycle; Roles of Initiation factors, Elongation factors, Release factors, Aminoacyl tRNA synthetase, tRNA, rRNA, GTP, Peptidyl transferase site and Factor binding site of ribosomes in translation.		
IV	**Post - translational processing** Post - translational processing, Basics of Protein folding, Intein splicing, Chemical modification, Proteolytic cleavage, Zymogen activation; Polycistronic and monocistronic.	**CO.4**	**8**
V	**Regulation of gene expression** Regulation of gene expression; Concept of operon: Lac, Trp and Ara operons, Significance of repressor, Attenuation; Inhibitors of transcription and translation.	**CO.5**	**8**

References

- Lehninger, AL “Principles of Biochemistry”
- Lubert Stryer “Biochemistry”
- Voet & Voet “Biochemistry”
- Baltimore “Molecular Cell Biology”
- Robert K., M Murray,Daryl K. Granner, Peter A. Mayes, Victor W. Rodwell, Appleton & Lange, Robert K. Murray “Harper's Biochemistry” Lewin “Genes”. Freifelder, DM “Molecular Biology” Brown, TA “Genomes”
- Watson, JD “Molecular Biology of the cell”
- Twyman, RM “Advanced Molecular Biology” Brown, TA ”Gene cloning: An introduction” Old & Primrose “Principles of Gene Manipulation”
- Primrose, SB “Molecular Biotechnology”
- Jose B. Cibelli Robert P. Lanza Keith Cambell Michasel D. West “Principles of Cloning”
- Voet & Voet “Biochemistry”
- Lubert Stryer “Biochemistry”

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

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	POS2	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			
BS411	**3**	**1**				**-**	**-**	**1**	**3**			

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

INTEGRAL UNIVERSITY LUCKNOW

M.Sc. BC Ist yr,
Semester: IInd

BS412 Enzymology & Enzyme kinetics

L T P C
3 1 0 4

Course Objectives:
This course has been designed to teach the student majoring in science all the major aspects of the study of enzymes. The course focuses on the theories of enzyme kinetics, the mechanisms of enzyme catalysis, and immobilization of enzyme.

Course Outcome (CO)

CO.1 To understand the general properties of enzymes and their classification & nomenclature.

CO.2 To understand the theories of enzyme kinetics.

CO.3 To understand the mechanisms of enzyme catalysis and enzyme inhibition & activation.

CO.4 To understand the Multisubstrate enzyme kinetics.

CO.5 To understand the enzyme Immobilization and its clinical & industrial use.

Unit	Course Contents:	Mapped CO	hours
I	**Classification and nomenclature of enzymes** General properties of enzymes. Mechanism of enzyme action: Chymotrypsin, ribonuclease, activation of transition metal cation, activation by alkaline earth metal cation, nicotinamide nucleotide, flavin nucleotide and adenosine phosphate.	**CO.1**	**8**
II	**Enzyme kinetics** Michaelis-Menten initial rate equation based on equilibrium assumption, Briggs-Haldane steady state approach, integrated form of the Michaelis equation, methods for the determination of K_m and V_{max} normalized initial rate equation and normalized curves, Haldane relationship.	**CO.2**	**8**
III	**Effect of factors and inhibitors on enzyme kinetics** Effect of enzymes concentration, pH and temperature on kinetics of enzyme reactions. Enzyme inhibition and activation: Types of reversible inhibitors, qualitative analysis of data, derivation of equations for different types of inhibitions, determination of inhibitor constant, determination of activator constant.	**CO.3**	**8**
IV	**Multisubstrate enzyme kinetics** Multisubstrate enzyme kinetics: random bi-bi, and ping pong reactions. Intracellular localization of enzymes, purification of enzymes and tests for homogeneity.	**CO.4**	**8**
V	**Applied Enzymology** Immobilization; kinetics of immobilized systems. Isozymes. Allosteric enzymes. Industrial and clinical scope of enzymes.	**CO.5**	**8**

References

- Lehninger, AL “Principles of Biochemistry”
- Lubert Stryer “Biochemistry”
- Voet & Voet “Biochemistry”
- Shuler “Bioprocess Engineering”
- Alan Fersht “Enzyme Structure and Mechanism”
- David S. Sigman, Paul S. Sigman “The Enzymes: Mechanisms of Catalysis”
- Palmer “Enzymes”
- Dixon & Webb “Enzymes””

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

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	POS2	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	
BS412	**3**	**1**				**3**		**1**	**3**		**1**	

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

INTEGRAL UNIVERSITY LUCKNOW

M.Sc. BC Ist yr,
Semester: IInd

BS413 Metabolism & Bioengertics

L T P C
3 1 0 4

Course Objectives:
The objective of this course is to enable the students to provide basic knowledge about catabolism, anabolism, regulation of metabolism and pathway analysis. It also gives understanding of how enzymes and metabolites in living system work to produce energy and synthesizing different biomolecules. The course also extends comprehensive knowledge about biochemical pathways involved in intermediary metabolism of carbohydrate, protein, lipid and nucleic acid.

Course Outcome (CO)

CO.1 The student will be able to learn Carbohydrate catabolism and its association with cellular energy production. They will learn different metabolic pathways and cycles for the degradation of carbohydrates.

CO.2 The student will be acquainted with carbohydrate anabolism in plants and animal cells. They will be able to understand different metabolic pathways for the biosynthesis of carbohydrates like glucose and glycogen.

CO.3 The student will get familiar to the biosynthesis of membrane glyco- and phospholipids like glycerolipids and sphingolipids; and storage lipids like triglycerides etc. They will also learn the biosynthesis of plasmalogens and cholesterol.

CO.4 The student will also learn about the breakdown or degradation of fatty acids via various mechanisms like alpha, beta and omega oxidation and its connection with cellular energy generation. He will also be familiar with ketone bodies and acidosis/ketosis. They will also learn about the degradation of cholesterol and importance of bile salts and pigments.

CO.5 The student will learn and understand about the biosynthesis and degradation of amino acids; and inborn errors (genetic diseases) of metabolism. He will also learn about the de novo biosynthesis of purines and pyrimidine nucleotides and salvage pathways; and degradation of nucleotides.

Unit	Course Contents:	Mapped CO	hours
I	**Carbohydrate catabolism** Glycolytic pathway and Non- glycolytic pathways, Hexose monophosphate pathway, Tricarboxylic acid cycle. Anaplerotic sequences in metabolism, glycogenolysis, Krebs- Kornberg pathway, Glyoxylate pathway. Glucose catabolism in cancerous tissue, Energy production by aerobic and anaerobic respiration:	**CO.1**	**8**

	Electron transport chain, oxidative phosphorylation.		
II	**Biosynthesis of carbohydrates** Gluconeogenesis, glycogen synthesis, reductive pentose phosphate pathway, carbon dioxide assimilation in C3 and C4 plants.	**CO.2**	**8**
III	**Lipid biosynthesis** Synthesis of saturated and unsaturated fatty acids, biosynthesis of triacylglycerols glycerophospholipids and membrane phospholipids, plasmologens, sphingolipids, cholesterol..	**CO.3**	**8**
IV	**Lipid metabolism** Degradation of fatty acids: α, β, ω oxidation; Ketone bodies, acidosis, ketosis, Cholesterol degradation.	**CO.4**	**8**
V	**Nucleic acid metabolism** Biosynthesis of purines and pyrimidines, degradation of nucleosides, nucleotides and nucleic acids, Salvage pathways. Biosynthesis and biodegradation of amino acids. Inborn errors of metabolism.	**CO.5**	**8**

References

- Lehninger AL “Principles of Biochemistry”
- Lubert Stryer “Biochemistry”
- Voet & Voet “Biochemistry”
- Shuler “Bioprocess Engineering”
- Alan Fersht “Enzyme Structure and Mechanism”.
- David S. Sigman Paul S. Sigman “The Enzymes: Mechanisms of Catalysis”

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

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	POS2	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			
BS413	**3**	**1**	**-**	**-**	**-**	**-**	**-**	**1**	**3**	**-**	**-**	**-**

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

INTEGRAL UNIVERSITY LUCKNOW

M.Sc. BC I[st] yr,
Semester: II[nd]

BS431 Cytology & Cell signalling

L T P C
3 1 0 4

Course Objectives:
The objectives of the course are to learn and understand the fundamentals of cell biology like cell organelles, cytoskeleton, cellular transport, cell-extracellular matrix interaction, cell division, and protein trafficking and signal transduction etc..

Course Outcome (CO)

CO1	The student will learn about structural organization of prokaryotic and eukaryotic cells, ultrastructure and functions of cell organelles and cell wall.
CO2	The student will learn about the structural and functional aspects of cytoskeleton, cell membrane, various means of transport of molecules across cell membrane, exocytosis, receptor mediated endocytosis.
CO3	The student will learn about cell division: mitosis and meiosis; Cell cycle: check points, role of cyclin and cyclin dependent kinases in cell cycle regulation.
CO4	Students would be able to understand various kinds of cell-cell and cell-extracellular matrix interactions, as well as basics of intracellular signal transduction.
CO5	The course will aid in gaining insight on protein trafficking in cells, protein sorting, vesicular transport and protein targeting to various cellular organelles.

Unit	Course Contents:	Mapped CO	hours
I	**Cell classification** Cell classification, cell variability (size, shape, complexity, functions). Structural organization of prokaryotic and eukaryotic cells. The ultra structure and functions of cell wall, nucleus, mitochondria, chloroplast, endoplasmic reticulum, microsomes, Golgi apparatus, lysosomes & peroxisomes	**CO.1**	**8**
II	**The cytoskeleton** The cytoskeleton – microtubules and microfilaments. Structure and functions of cell membrane, Transport across cell membrane: Diffusion, Facilitated diffusion, Active transport; transport proteins, exocytosis, receptor mediated endocytosis, osmoregulation	**CO.2**	**8**
III	**Cell division** Cell division: mitosis and meiosis; Cell cycle: check points, role of cyclin and cyclin dependent kinases in its regulation	**CO.3**	**8**
IV	**Cell Extracellular matrix interactions** Cell- Extracellular matrix interactions: Plasmodesmata, Gap junction, Tight junction, Adherens, Cohesin, Elastin, Collagen, Fibronectins, Laminins, Integrins; Basics of signal transduction: Role of calcium, cAMP, G-protein, inositol phosphates, phospholipases and protein kinases in signal transduction	**CO.4**	**8**

V	**Protein traffic in cells:** Protein sorting and signal sequences; protein translocation in ER and vesicular transport to Golgi, lysosomes and plasma membrane; protein import into nuclei, mitochondria, chloroplasts and peroxisomes.	**CO.5**	**8**

References

- Pelczar MJ Jr.; Chan ECS and Kreig NR.; Microbiology; 5th Edition; Tata McGraw Hill;1993.
- Maloy SR; Cronan JE Jr.; and Freifelder D; Microbial Genetics; Jones Bartlett Publishers; Sudbury; Massachusetts; 2006.
- Crueger and A Crueger; (English Ed.; TDW Brock); Biotechnology: A textbook of Industrial Microbiology; Sinaeur Associates; 1990.
- 4. Prescott and Dunn"s; Industrial Microbiology; 4th Edition; CBS Publishers; 1987.
- 5. M.T. Madigan and J.M. Martinko; Biology of Microorganisms; 11th Edition; Pearson; USA; 2006

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

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	POS2	PSO3	PSO4
CO1	**3**	**1**						**2**	2	2		
CO2	**3**	**1**				**3**		**2**	3			
CO3	**3**	**1**				**3**		**2**	3			
CO4	**3**	**1**				**3**		**2**	3			
CO5	**3**	**1**				**3**		**2**	3			
BS431	**3**	**1**	**-**	**-**	**-**	**3**	**-**	**2**	**3**	**1**	**-**	**-**

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

INTEGRAL UNIVERSITY LUCKNOW

M.Sc. BC I[st] yr,
Semester: II[nd]

BS415 Molecular Genetics

L T P C
3 1 0 4

Course Objectives:
The aim of the course is to provide students with an understanding of both classical and modern concepts in genetics with special emphasis on the areas of chromosome structure and function, molecular and developmental genetics, DNA damage and repair and chromosomal aberrations. The course will also provide in-depth knowledge of cancer etiology, Human Genome project and genetic diversity including Legal and Ethical Issues in Genetics.

Course Outcome (CO)

CO.1 Students would understand the Genome organization and DNA packaging including Chromosome structure and function in both prokaryotes and eukaryotes.

CO.2 Students would be able to understand the Genetic Control of Development in *C. elegans, Drosophila, Neurospora crassa, Arabidopsis thaliana.*

CO.3 Students would understanding the principles of Mendelian genetics, extensions and applications.

CO.4 To understand the Physical and Chemical Mutagens, Drug metabolism and detoxification; DNA damage: Types of mutations, DNA repair mechanism, and the role of various oncogenes in cancer etiology

CO.5 Able to understand The Human Genome project and genetic diversity including Legal and Ethical Issues in Genetics

Unit	Course Contents:	Mapped CO	hours
I	**Genome organization and DNA packaging** Genome organization and DNA packaging; Nuclear decondensation (in both prokaryotes and eukaryotes); Chromosome structure and function; Numerical and structural changes in chromosomes; Cytogenetics: chromosome aberration..	**CO.1**	**8**
II	**Genetic Control of Development** Genetic Control of Development in *C. elegans*, Drosophila, *Neurospora crassa, Arabidopsis thaliana*.	**CO.2**	**8**
III	**Principles of Mendelian inheritance** Principles of Mendelian inheritance, Linkage and genetic mapping; Extrachromosomal inheritance, Sex-linked inheritance and genetic disorders, Somatic cell genetics, Population genetics.	**CO.3**	**8**
IV	**Mutation and cancer** Physical and Chemical Mutagens, Drug metabolism and detoxification; DNA damage: Types of mutations, DNA repair mechanisms: Y-family DNA Polymerases; Micronuclei; FISH; COMET Assay. Etiology of cancer: Oncogenes; proto-oncogenes; Viral and cellular oncogenes; tumour suppressor genes from humans; Structure; function and mechanism of action of pRb and p53 tumour suppressor proteins.	**CO.4**	**8**

V	**Applied Genetics** The Human Genome Project; gene therapy, integration of DNA into mammalian genome, Expression of foreign genes in transgenic animals, Genetic Testing-DNA Fingerprinting; Genetic Diversity - Conservation Genetics; Legal and Ethical Issues in Genetics; Genetic Counseling	**CO.5**	**8**

References

- Gardener “Principles of Genetics”
- Tom Strachan, T. Strachan, Andrew Read, Andrew P. Read “Human Molecular Genetics”
- William S. Klug Michael R. Cummings “Concepts of Genetics (7th Edition)”
- Ricki Lewis “Human Genetics: Concepts and Applications”
- Leland Hartwell Leroy Hood Michael L. Goldberg Ann E. Reynolds Lee M. Silver Ruth C. Veres Ricki Lewis “Genetics: From Genes to Genomes”
- Debra Davis “Animal Biotechnology: Science-Based Concerns”
- Anthony Atala, Robert P. Lanza “Methods of Tissue Engineering”
- Nigel Jenkins “Animal Cell Biotechnology: Methods and Protocols”
- Carl Pinkert “Transgenic Animal Technology: A Laboratory Handbook”

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

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	POS2	PSO3	PSO4
CO1	**3**	**1**						**1**	3			
CO2	**3**	**1**				**2**		**1**	3			
CO3	**3**	**1**				**2**		**1**	3			1
CO4	**3**	**1**				**1**		**1**	3		2	
CO5	**3**	**1**			**2**	**1**	**1**	**1**		3	3	3
BS415	**3**	**1**			**1**	**2**	**1**	**1**	**3**	**1**	**1**	**1**

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

INTEGRAL UNIVERSITY LUCKNOW

M.Sc. BC I[st] yr,
Semester: II[nd]

BS416 Environmental biology

L T P C
3 1 0 4

Course Objectives:

The course content aims to make the Students identify and explain the environmental factors responsible for the pollution. It also helps in understanding how biotechnology can provide solutions for environmental problems and understand legal aspects related with environmental issues and environmental protection. This course enables the students to select the appropriate method for the treatment of wastewater and solid waste management as well as can apply Suitable bioremediation methods for the treatment.

Course Outcome (CO)

CO.1 Comprehend environmental issues and role of biotechnology in the cleanup of contaminated environments

CO.2 Comprehend fundamentals of biodegradation, biotransformation and bioremediation of organic contaminants and toxic metals

CO.3 Apply biotechnological processes in waste water and solid waste management.

CO.4 Demonstrate innovative biotechnological interventions to combat environmental challenges

CO.5 Biodeterioration concept of different organic and in-organics materials and their control.

Unit	Course Contents:	Mapped CO	hours
I	**Microbiology of air and aquatic environments** Microbiology of air and aquatic environments - Bacteriological indicators of pollution, Bacteriological examination of water, nuisance bacteria in water systems. Chemical and microbiological characteristics, Biological Oxygen Demand (BOD), Microorganisms and pollution problems and interaction with human bodies.	**CO.1**	**8**
II	**Environmental pollution** Definition, source and types of pollution (air, water and soil). Xenobiotic toxicity/ genotoxicity, Mode of action of pesticides, fungicides and insecticides; Mutation detection by Ames, microsomal assay. Bioaccumulation and bioremediation, Biosensors, DNA probes and their environmental applications, Toxicogenomics.	**CO.2**	**8**
III	**Recycling of organic waste** Recycling of organic waste: Major sources of recyclable materials including agricultural waste. Key technology in recycling of crop residues, human and animal wastes. Composting and vermicomposting; Production and application. Role of microbes in composting and biogas production. Municipal solid waste treatment and management.	**CO.3**	**8**

IV	**Microbes of toxic environments** Microbes of toxic environments: Microbial biotransformation/ degradation of organic pollutants in soil. Microbial degradation and persistence of xenobiotics, pesticides, herbicides, heavy metals and radio isotopic materials. Pesticides toxicity to microbes and plants. Acid mine drainage, coal desulphurization.	**CO.4**	**8**
V	**Biodeterioration-concept** Biodeterioration-concept, biodeterioration of wood, stonework, pharmaceutical products, rubber, plastic, paints, lubricants, cosmetics, control of biodeterioration.	**CO.5**	**8**

References

- Environmental biotechnology (Industrial pollution Management).Jogdand S.N., Himalaya pub. house.
- Waste water treatment – Rao M.N. and A.K.Datta
- Industrial pollution Control, Vol. 1, E. Joe, Middle Brooks.
- The treatment of industrial wastes, 2nd Ed. Edmund D. Besselievere and Max Schwartz.
- Water and water pollution hand book, Vol. 1, Leonard L., Ciaccio
- Ec Eldowney S, Hardman DJ, Waite DJ, Waite S. (1993). Pollution: Ecology and Biotreatment Longman Scientific Technical. Grant WD, Long PL. (1981) Environmental Microbiology.
- Blackie Glasgow and London. Paul EA, Clark FF Soil Microbiology and Biochemistry, Academic Press, San Diego.
- Rogers JE and Writman WB (1991) Microbial production and consumption and green house gases: Methane: Nitrogen oxides and Halomethanes. ASM, Washington DC.

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

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	POS2	PSO3	PSO4
CO1	**3**	**1**				**2**	**3**	**1**	3			
CO2	**3**	**1**				**2**	**3**	**1**	3	1	2	
CO3	**3**	**1**				**2**	**3**	**1**	1		2	
CO4	**3**	**1**				**2**	**3**	**1**	2		1	
CO5	**3**	**1**				**2**	**3**	**1**	2		1	
BS416	**3**	**1**				**2**	**3**	**1**	**3**	**1**	**2**	

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

INTEGRAL UNIVERSITY LUCKNOW

M.Sc. BC I[st] yr,
Semester: II[nd]

BS417 Pharmaceutical biology

L T P C
3 1 0 4

Course Objectives:
This course enables the students to learn the various aspects of pharmaceutical sciences. In this course, students get exposed to the insights into various therapeutic strategies against infectious and non-infectious diseases i.e. via monoclonal antibodies (mABs), peptide based therapeutics, liposome/emulsion-based drug delivery systems, PEG-conjugates-based drug delivery and various factors affecting the drug delivery, its release, and absorption.

Course Outcome (CO)

CO.1 Understand the principle of monoclonal antibodies generation, their mode of action, and their application in targeting various diseases.

CO.2 Formulate therapeutic proteins and peptides, their encapsulation with other macromolecules and implications in drug delivery.

CO.3 Prepare lipid-based drug delivery systems as well as PEG-conjugates for fast drug delivery and release inside the body.

CO.4 Develop the strategies of pulmonary drug delivery.

CO.5 Apply the knowledge of polymers for production of biopharmaceuticals with controlled drug delivery.

Unit	Course Contents:	Mapped CO	hours
I	**Monoclonal antibodies** Monoclonal antibodies: applications, generation, recombinant antibodies, production methods, Pharmaceutical, regulatory and commercial aspects.	**CO.1**	**8**
II	**Formulation of proteins and peptides** Formulation of proteins and peptides: making small protein particles, precipitation of proteins, quality control issues, multi-phase drug delivery system; Preparation of collagen, gelatin particles, albumin microparticles.	**CO.2**	**8**
III	**Proteins and phospholipids** Proteins and phospholipids: structural properties of phospholipids, injectable lipid emulsions, liposomes, cochleal phospholipids structures; Polymeric systems for oral protein and peptide delivery.	**CO.3**	**8**
IV	**Pulmonary drug delivery systems for biomacromolecules** Pulmonary drug delivery systems for biomacromolecules; Lipid based pulmonary delivery; Solid colloidal particles; Polycyanoacrylates; Poly (ether-anhydrides); Diketopiperazine derivatives; Poly ethylene glycol conjugates; Factors affecting	**CO.4**	**8**

	pulmonary dosing		
V	**Polymers used for controlled drug delivery** Polymers used for controlled drug delivery: Hydrophobic polymers poly(esters), poly(cyanoacrylate), poly (ortho esters), poly (phosphazenes), Hydrophobic polymers poly (alkyl methacrylates), poly (methacrylates), poly (acrylates)], alginates, chitosan, polyethylene glycol. Gene therapy: the current viral and non-viral vectors.	**CO.5**	**8**

References

- Groves MJ „Pharmaceutical Biotechnology", Taylor and Francis Group.
- Crommelin DJA, Robert D, Sindelar „Pharmaceutical Biotechnology".
- Kayser O, Muller R „Pharmaceutical Biotechnology".
- Banga AK „Therapeutic peptides and proteins

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

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	POS2	PSO3	PSO4
CO1	3	1		1		3		2	3		3	
CO2	3	1		1		3		2			3	
CO3	3	1		1		3		2	3		3	
CO4	3	1		1		3		2			3	
CO5	3	1		1		3		2	1		3	
BS417	**3**	**1**		**1**		**3**	**-**	**2**	**2**		**3**	

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

INTEGRAL UNIVERSITY LUCKNOW

M.Sc. BC I[st] yr,
Semester: II[nd]

BS432 Analytical Biochemistry & Enzymology Lab

L T P C
0 0 12 6

Course Objectives:
The lab is designed to train the students in basic techniques of Analytical Biochemistry like detection and estimation of biomolecules, determination of isoelectric point of protein, and protein separation. It also deals with the assay of clinically important enzymes and determination of factor affecting enzyme activity.

Course Outcome (CO)

CO.1 The students will learn about amino acid detections, estimation of starch in wheat flour and glucose and fructose estimation in biological sample.

CO.2 The students will learn to find out isoelectric point of protein and Separation of protein by Poly Acrylamide Gel Electrophoresis.

CO.3 The students will learn to perform assay of clinically important enzyme: serum alkaline phosphatase, serum creatine phosphokinase and serum acid phosphatase.

CO.4 The student will learn to study the effect of factors affecting enzyme activity and determination of Km.

CO.5 The student will learn to isolate and estimate RNA

S.No.	Experiments:	Mapped CO
1	Amino acid detections (Paper chromatography/ TLC)	**CO.1**
2	Estimation of starch in wheat flour and percentage recovery of starch.	**CO.1**
3	Glucose estimation by Anthrone method, fructose estimation by resorcinol method in biological sample.	**CO.1**
4	To find out isoelectric point of protein.	**CO.2**
5	Separation of serum protein by Poly Acrylamide Gel Electrophoresis.	**CO.2**
6	Assay of clinically important enzyme: serum Alkaline phosphatase (ALP), serum Creatine phosphokinase (CPK) & serum acid phosphatase.	**CO.3**
7	Study of the effect of varying substrate concentration and pH on the enzyme activity and determination of Km.	**CO.4**
8	Isolation and estimation of RNA.	**CO.5**

References

- Keith Wilson John Walker John M. Walker “Principles and Techniques of Practical Biochemistry
- Chirikjian “Biotechnology Theory & Techniques”

- Joseph Sambrook, David W. Russel, Joe Sambrook “Molecular Cloning: A Laboratory Manual”
- William M, O’Leary Robert, Dony Wu “Practical Handbook of Microbiology”

- Brown, TA “Gene cloning: An introduction”
- Sadasivam “Biochemical Methods”
- Plumer “Practicals”

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

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	POS2	PSO3	PSO4
CO1	3	3	3		1	3		3	3		3	2
CO2	3	3	3		1	3		3	3		3	2
CO3	3	3	3		1	3		3	3		3	2
CO4	3	3	3		1	3		3	3		3	2
CO5	3	3	3		1	3		3	3		3	2
BS432	**3**	**3**	**3**		**1**	**3**		**3**	**3**		**3**	**2**

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

INTEGRAL UNIVERSITY LUCKNOW

M.Sc. BC I[st] yr,
Semester: II[nd]

BS419 Educational/Industrial Tour

L T P C
0 0 0 0

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 of visit after completion of the tour, based on which satisfactory or unsatisfactory non-creditable grades are given to the students.

Course Outcome (CO)

CO.1 Develop understanding of state of the art techniques/instruments used in various reputed research institutions and industries.

CO.2 Take part in Group discussion and learn Team work.

CO.3 Enhance communication and social skills by communication with peers.

CO.4 Student shall be able to plan and improve the Technical Report writing skills

CO.5 Have created Interest to pursue lifelong learning.

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

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	POS2	PSO3	PSO4
CO1	3	1	1			2		3	2	1	3	3
CO2	3	2	2	1				1				3
CO3	3	2	2	1				1			1	3
CO4	3	2				2		2	2			3
CO5	3			1				3				3
BS419	**3**	**2**	**1**	**1**		**1**	**-**	**2**	**1**		**1**	**3**

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

INTEGRAL UNIVERSITY LUCKNOW

M.Sc. BC II[nd] yr,
Semester: III[rd]

BS521 Genetic Engineering

L T P C
3 1 0 4

Course Objectives:
The course is designed to make the students understand the concept and basic steps in gene cloning, to acquaint them with various vectors and enzymes used in recombinant DNA technology, transformation and screening techniques. They will also be acquainted with modern techniques such as PCR technology, Real-Time PCR, DNA fingerprinting etc.

Course Outcome (CO)

CO1 The students will be introduced to Rapid DNA and RNA sequencing techniques, High throughput Sequencing, and Microarray.

CO2 The students will learn about the Principle & applications of PCR, Real time PCR, Blotting and hybridization (Southern, western, northern).

CO3 The students will be introduced DNA fingerprinting, Molecular Markers, Recombinant DNA methods, Features of commonly used vectors, strategies

CO4 Learn about Recombinant DNA methods – Features of commonly used vectors, strategies for cloning in various vectors and identification of bacterial colonies containing recombinant plasmids and bacteriophage vectors, restriction enzymes

CO5 The students will learn about Genetic engineering and prospects of improving crop productivity. Application in relation to protein quality and disease resistance, resistance to environmental stresses- salt and drought

Unit	Course Contents:	Mapped CO	hours
I	**Rapid DNA and RNA sequencing techniques** Sanger method, Maxam and Gilbert procedure, automated DNA sequencing, pyrosequencing; Genomics: High throughput Sequencing: shot gun cloning, Clone contig cloning, Microarray: protein and DNA	**CO.1**	**8**
II	**PCR, Blotting and hybridization** Principle & applications of PCR; RACE, DD-RTPCR, Degenerate PCR, TA cloning, Realtime PCR. Blotting and hybridization (Southern, western, northern).	**CO.2**	**8**
III	**DNA fingerprinting** DNA fingerprinting: Molecular Markers: RFLP, RAPD, AFLP, ARDRA, SCAR, STS, microsatellites.	**CO.3**	**8**
IV	. **Recombinant DNA methods** Recombinant DNA methods – Features of commonly used vectors, strategies for cloning in various vectors and identification of bacterial colonies containing recombinant plasmids and bacteriophage vectors, restriction enzymes	**CO.4**	**8**

V	**Genetic engineering** Genetic engineering and prospects of improving crop productivity. Application in relation to protein quality and disease resistance, resistance to environmental stresses- salt and drought. Methods for the production of transgenic animals: Liposome-mediated, calcium phosphate precipitation, microinjection, electroportaion, microprojectile bombardment.	**CO.5**	**8**

References

- Lewin “Gene”
- Freifelder, DM “Molecular Biology”.
- Brown, TA “Genome”.
- Watson, JD „Molecular Biology of the cell“.
- Twyman, R.M. “Advanced Molecular Biology”
- Brown, T.A. “Gene cloning: An introduction”
- Old & Primrose “Principles of Gene Manipulation”
- Primrose, SB “Molecular Biotechnology”
- Jose B. Cibelli Robert P. Lanza Keith Campbell Michasel D. West “Principles of Cloning”
- Rastogi & Pathak “Genetic Engineering”

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

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	POS2	PSO3	PSO4
CO1	3	1				3		1	1	1	3	
CO2	3	1				3		1		1	3	
CO3	3	1				3		1	2	2	3	
CO4	3	1				3		1	1		3	
CO5	3	1				3	2	1	1	3	3	
BS521	**3**	**1**				**3**	**1**	**1**	**1**	**2**	**3**	

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

INTEGRAL UNIVERSITY LUCKNOW

M.Sc. BC II[nd] yr,
Semester: III[rd]

BS522 Plant Biochemistry

L T P C
3 1 0 4

Course Objectives:

The main objective of this course is to impart students an understanding of plant biochemistry. The course includes biochemistry of plant hormones, cell wall, secondary metabolites, carbon and nitrogen fixation and assimilation in plants.

Course Outcome (CO)

CO1	The students will be introduced to the structure, biosynthesis and mechanism of action of major plant hormones, plant growth regulators, and photoreceptors in higher plants
CO2	The students will be able to understand the chemical and physical composition and biosynthesis of cellulose and lignin.
CO3	The students will learn about the secondary plant metabolism, biosynthesis and function of major secondary plant product classes like terpenoids, alkaloids and flavonoids etc.
CO4	The students will learn about nitrogen metabolism, mechanism of nitrate and nitrite reduction, and fixation of nitrogen.
CO5	This course will help the students to gain knowledge electron transport in higher plants and its relation with the carbon fixation pathways, Light regulation of photosynthetic enzymes, Calvin cycle, CAM, C4 pathways, and photorespiration.

Unit	Course Contents:	Mapped CO	hours
I	**Plant growth hormones** Structure, biosynthesis and mechanism of action of major plant growth hormones (Auxins, Gibberelins, Cytokinins, Ethylene and Abscissic acid). Plant growth regulators: Photoreceptors in higher plants: Phytochromes, Cytochromes and UV receptors.	**CO.1**	**8**
II	**Plant cell wall** chemical and physical composition and biosynthesis of cellulose and lignin, brief study of cell wall degradation, formation and growth of cell wall after cell division, role of cytoskeleton (brief study of herbicides effecting cytoskeleton). Seed development and germination (biochemical aspects and control).	**CO.2**	**8**
III	**Secondary plant metabolism** biosynthesis and function of major secondary plant product classes, chlorophyll (shikimate pathway), isoprenoids, alkaloids and lignin.	**CO.3**	**8**
IV	**Nitrogen metabolism** nitrate and nitrite reduction. Details of structure, control and catalysis of nitrate reductase and nitrite reductase. Fixation of molecular dinitrogen, details of nitrogenase structure and function	**CO.4**	**8**

V	**Carbon fixation pathways** Electron transport in higher plants and its relation with the carbon fixation pathways. Light regulation of photosynthetic enzymes. Calvin cycle: details of Rubisco structure, biosynthesis and assembly, regulation and mechanism of action, brief study of enzymes involved in regulation. Carbon concentrating mechanism in higher plants, general account and significance, CAM, details of the pathway. C4 pathways, detailed study of PEP carboxylase. Photorespiration: importance of photorespiration as a protectant against photoinhibition	**CO.5**	**8**

References

- Lehninger AL “Priciples of Biochemistry”
- Lubert Stryer “Biochemistry”
- Voet & Voet “Biochemistry”
- Shuler “Bioprocess Engineering”
- Alan Fersht “Enzyme Structure and Mechanism”.
- David S. Sigman Paul S. Sigman ”The Enzymes: Mechanisms of Catalysis”.
- Biochemistry of plants by Bucknan and Bucknan.

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

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	POS2	PSO3	PSO4
CO1	3	1				2		1	3			
CO2	3	1				2	1	1	3			
CO3	3	1				2		1	3			
CO4	3	1				2	2	1	3			
CO5	3	1				2	1	2	3			
BS522	**3**	**1**				**2**	**1**	**2**	**3**			

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

INTEGRAL UNIVERSITY LUCKNOW

M.Sc. BC II[nd] yr,
Semester: III[rd]

BS503 Immunology

L T P C
3 1 0 4

Course Objectives:
The objective of this course is to provide students with detailed understanding of historical aspects of immunology, different cells of the immune system and their role in immune protection and application of immunological techniques. The course will provide knowledge about autoimmunity, hyper sensitivity, complement system, and vaccination etc. One of the major goals of this course is to provide basic understanding of immunology and immune responses in response to various infectious and non-infectious diseases i.e. cancer, diabetes, neurological disorders etc.

Course Outcome (CO)

CO.1 Understand the fundamentals of immune system

CO.2 Understand antigen-antibody interactions and various immunological techniques based on these interactions.

CO.3 Understand the mechanism of generation of diversity in immune response

CO.4 Understand the Differentiation and activation of B and T lymphocytes, antigen presentation, and significance of MHC.

CO.5 Students will gain knowledge about the importance of complement, tolerance and hyperactivation of immune response.

Unit	Course Contents:	Mapped CO	hours
I	**Fundamentals of Immunology** Fundamentals of Immunology: Cells and organs of immunity: Memory, specificity, diversity, self vs. non-self discrimination, Structure of primary and secondary lymphoid organs, Cell mediated vs. humoral immunity, T and B-lymphocytes; Nature of antigen and antibody: Antigen vs. Immunogen, Structure of antibody: constant and variable regions, Fab and Fc; isotype, allotype and idiotype; Abzymes.	**CO.1**	**8**
II	**Antigen-antibody interactions** Antigen-antibody interactions and its measurement: Direct binding assays, Agglutination and precipitation, radioimmunoassay and ELISA, fluorescence analysis, Hybridoma technology, applications of monoclonal antibodies in biomedical research, clinical diagnosis and treatment	**CO.2**	**8**
III	**Generation of diversity in the immune response** Generation of diversity in the immune response: Clonal selection theory-concept of antigen specific receptors, genes encoding antigen specific receptors on T and B-	**CO.3**	**8**

	lymphocytes, genetic rearrangement, class switch, Comparison of receptors and B and T lymphocytes.		
IV	**Differentiation of B and T lymphocyte** Differentiation of B and T lymphocyte. Activation of T cells and B cells by antigen: Antigen processing, Antigen presentation to T cells, Products and factors released by T cell activation-interleukins, interferons, B cell activating factors, T cell and B cell interactions leading to antibody synthesis. Central role of major histocompatibility complex (MHC), genes and products in immune response: T cell recognition of antigen and MHC products, Structure of MHC gene complex and its products polymorphism of MHC gene products, Associated MHC functions-allograft, graft vs. host and mixed leucocyte responses.	**CO.4**	**8**
V	**Tolerance vs. activation of immune response** Tolerance vs. activation of immune response. Complement- components of classical and alternative pathways. Hypersensitivity: Types I, II, III and IV responses. Autoimmunity.	**CO.5**	**8**

References

- Coleman, R.M, “Fundamental Immunology”
- Richard A. Goldsby Thomas J. Kindt Janis Kuby Barbara A. Osborne “Immunology”.
- Peter Parkham Peter Parham “The Immune System”.
- Abul K Abbas, Andrew H. Lichtman, Abdul K. Abbas, Jordan S. Pober “Cellular & Molecular Immunology”
- Janeway Charles A., Travers Paul, Walport Mark, Shlomchik Mark, Immunobiology Lehninger AL “Principles of Biochemistry”.

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

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	POS2	PSO3	PSO4
CO1	3	1				3		2	3	2		
CO2	3	1				3		2	3	2	3	
CO3	3	1				3		1	3	2		
CO4	3	1				3			3	2		
CO5	3	1				3		1	3	2		
BS503	**3**	**1**				**3**	**-**	**1**	**3**	**2**	**1**	

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

INTEGRAL UNIVERSITY LUCKNOW

M.Sc. BC II[nd] yr,
Semester: III[rd]

BS523 Physiological & Clinical Biochemistry

L T P C
3 1 0 4

Course Objectives:
To develop the understanding about advanced techniques used in molecular biology and biotechnology and their applications.

Course Outcome (CO)

CO1	The student will learn and understand the basics of circulatory system including haematopoiesis, homeostasis, and diseases of blood.
CO2	The student will learn and understand the fundamentals of digestive system.
CO3	The student will learn and understand the fundamentals of Respiratory system and Neural & chemical regulation of respiration.
CO4	The course will aid to understand the basics of excretory system like structure of nephron, glomerular filtration, reabsorption and tubular secretion, homeostatic regulation of water and electrolyte.
CO5	The course will also aid to learn about kidney diseases like uremia & glomerulonephritis; liver diseases like Jaundice, Hepatitis, Neurological diseases like Epilepsy, Parkinson & Alzheimer's disease.

Unit	Course Contents:	Mapped CO	hours
I	**Blood** Composition of blood, leucocytes, thrombocytes and erythrocytes, plasma proteins, blood cells counting and its significance, Blood coagulation – mechanism and regulation, Blood volume regulation, Haematopoiesis, Homeostasis. Disease of Blood: Thalassemia, sickle cell anemia, Anemias; Cardiovascular Disorders – Atherosclerosis	**CO.1**	**8**
II	**Digestion** Digestion: functions and regulation of saliva, gastric, pancreatic, intestinal and bile secretions. Digestion and absorption of carbohydrates, lipids and proteins	**CO.2**	**8**
III	**Respiration** Transfer of blood gases – Oxygen and carbon dioxide, role of 2,3-diphosphoglycerate, Bohr's effect and chloride shift, buffer systems of plasma, carbon dioxide-bicarbonate buffer system, Neural & chemical regulation of respiration.	**CO.3**	**8**
IV	**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	**CO.4**	**8**

V	**Diseases** Kidney: Uremia & Glomerulonephritis; Liver: Jaundice, Liver Function Tests: SGOT, SGPT, CPK, LDH, Hepatitis. Neurological: Epilepsy, Parkinson & Alzheimer's significance of diagnostic enzymology	**CO.5**	**8**

References

- Text-book of Biochemistry with clinical correlations by Thomas M. Devlin, 2nd Edition, J. Wiley and
- Sons (1986).
- Physiological chemistry by Harper.
- Textbook of Medical Physiology by Guyton. A.C., H. Sanders Philadelphia. 1988.
- Physiological basis of Medical practice, West J.B., Best and Taylor.
- Introduction to Physiology by Davidson H and Segal M.B. Academic Press.

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

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	POS2	PSO3	PSO4
CO1	3	1	3	3		3		3	3	2	3	
CO2	3	1	3	3		3		3	3	2	3	
CO3	3	1	3	3		3		3	3	2	3	
CO4	3	1	3	3		3		3	3	2	3	
CO5	3	1	3	3		3		3	2	3	3	
BS523	**3**	**1**	**3**	**3**		**3**		**3**	**3**	**2**	**3**	

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

INTEGRAL UNIVERSITY LUCKNOW

M.Sc. BC II[nd] yr,
Semester: III[rd]

BS524 Applied Biotechnology, IPR & Biosafety

L T P C
3 1 0 4

Course Objectives:

The main objective of this course is to impart students an understanding of Plant biotechnology and its application in agriculture; Medical biotechnology and its application in gene therapy, stem cell therapy and antibody therapy; Industrial biotechnology and its application in food, dairy, leather, cosmetic and pharmaceutical industries; Animal biotechnology and its application in cell cultures, organ and animal cloning etc. Moreover, the course also includes the basic concept of IPR and its significance in biological research along with a detailed understanding of Biosafety, biohazards, and biosafety guidelines in biological research.

Course Outcome (CO)

CO1	The student will learn about the basic concept of Plant Biotechnology and applications in agriculture like micro-propagation, haploid plants, embryo culture, hybrids, cybrids etc.
CO2	The student will learn about fundamentals of Medical Biotechnology and its application in stem cell therapy, gene therapy, antibody therapy etc.
CO3	Understanding application of biotechnology in food, beverage, dairy, paper and pulp, leather, detergent, cosmetic, and pharmaceutical industries etc. along with application in animal cell
CO4	The student will learn about IPR, its types and its importance
CO5	The student will learn about biosafety and bioethics

Unit	Course Contents:	Mapped CO	hours
I	**Plant Biotechnology** Applications of Biotechnology in agriculture: micro-propagation, haploid plants, embryo culture, hybrids, cybrids, in vitro production of secondary metabolites. Production of edible vaccines, plantibodies.	**CO.1**	**8**
II	**Medical Biotechnology** Introduction to stem cells, Stem cell therapy, gene therapy, antibody therapy, Free radical: Basic concept, role of free radicals in development of diseases: Mechanisms of Protein oxdidation, Lipid peroxidation and DNA oxidation.	**CO.2**	**8**
III	**Industrial Biotechnology** Applications in food, beverage, dairy, paper and pulp, leather, detergent, cosmetic, pharmaceutical industries, Single Cell Protein. Animal Biotechnology –Animal cell culture, serum free culture, cell cultures for the production of pharmaceuticals. Organ and animal cloning and their significance	**CO.3**	**8**

IV	**IPR** Introduction to intellectual property rights; Intellectual property laws; significance of IPR. Forms of IPR like patent, design copyright and trademark. Requirement of a patentable novelty; Issues related to IPR protection of software and database; IPR protection of life forms. Obtaining patent; Invention step and prior art and state of art procedure; Detailed information on patenting biological products and biodiversity. trade related aspects of Intellectual Property Rights and Budapest treaty.	**CO.4**	**8**
V	**Biosafety** Historical Backround; Introduction to Biological Safety Cabinets; 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. Bioethics: Introduction, necessity and limitation; Ethical conflicts in Biotechnology; Different paradigms of bioethics	**CO.5**	**8**

References

- Joseph Sambrook David W. Russell Joe Sambrook “Molecular Cloning: A Laboratory Manual”.
- Chirikjian “Biotechnology Theory & Techniques”
- Lewin “Genes”
- Animal cell culture by Ian Freshney
- Brown, TA “Gene cloning: An introduction”
- Industrial Microbiology by Prescott and Dunn
- Comprehensive Biotechnology by Murray Moo Young.
- Free Radicals in Chemistry and Biology, Milan Lazár

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

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	POS2	PSO3	PSO4
CO1	**3**	**1**	**1**	**3**	**1**	**1**				2	3	
CO2	**3**	**1**	**1**	**3**	**1**	**2**		**1**	3	2	3	
CO3	**3**	**1**	**1**	**3**	**2**	**2**		**2**	3	3	3	
CO4	**3**	**1**	**3**	**3**	**3**	**2**		**3**				3
CO5	**3**	**1**	**3**	**3**	**3**	**3**	**1**	**3**		2	2	3
BS524	**3**	**1**	**2**	**3**	**2**	**2**	**1**	**2**	**2**	**2**	**3**	**2**

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

INTEGRAL UNIVERSITY LUCKNOW

M.Sc. BC II[nd] yr,
Semester: III[rd]

BS525 Immunology And Molecular Biology Lab.

L T P C
0 0 12 6

Course Objectives:

The course is designed to train the students in basic and some advanced techniques of Immunology like qualitative and quantitative analyses of antigen-antibody interaction. It also deals with Molecular biology techniques of isolation and purification of bacterial plasmid and chromosomal DNA and their application in cloning

Course Outcome (CO)

CO1	The student will practically learn and understand the antigen-antibody interaction by Double Immunodiffusion method, Ouchterlony's Method, Immunoelectrophoresis, Western Blotting
CO2	The student will practically learn Blood Group determination.
CO3	The student will practically learn isolation of DNA and agrose gel electrophorosis
CO4	The course will aid to learn Restriction digestion of DNA and its application in cloning and to perform PCR.
CO5	The student will practically learn and understand Competitive and Direct Binding ELISA

S.No.	Experiments:	Mapped CO
1	To identify sensitivity of antigen & antibody by double Immunodiffusion method	**CO.1**
2	To identify sensitivity of antigen & antibody by Ouchterlony's Method, Immunoelectrophoresis,	**CO.1**
3	Western Blotting	**CO.1**
4	Blood Group determination.	**CO.2**
5	Isolation of plasmid DNA	**CO.3**
6	Isolation of genomic DNA from E. coli	**CO.3**
7	Agarose gel electrophoresis of DNA	**CO.3**
8	Restriction digestion of DNA	**CO.4**
9	Ligation	**CO.4**
10	PCR	**CO.4**
11	ELISA-Competitive and Direct Binding ELISA	**CO.5**

References

- Keith Wilson John Walker John M. Walker "Principles and Techniques of Practical Biochemistry"
- Chirikjian "Biotechnology Theory & Techniques"
- Joseph Sambrook David W. Russel Joe Sambrook "Molecular Cloning: A Laboratory Manual"
- William M., Ph.D. O'Leary Robert Dony Wu "Practical Handbook of Microbiology"

- Brown, TA “Gene cloning: An introduction

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

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	POS2	PSO3	PSO4
CO1	3	3	1			3		3	3	1	3	2
CO2	3	3	1			3		3	3	1	3	2
CO3	3	3	1			3		3	3	1	3	2
CO4	3	3	1			3		3	3	1	3	2
CO5	3	3	1		2	3	1	3	3	1	3	2
BS525	**3**	**3**	**1**		**1**	**3**	**1**	**3**	**3**	**1**	**3**	**2**

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

INTEGRAL UNIVERSITY LUCKNOW

M.Sc. BC IInd yr,
Semester: Ivth

BS531 Nutritional Biochemistry

L T P C
3 1 0 4

Course Objectives:
The objective of this course is to learn and understand the basic concepts of nutritional biochemistry which comprises nutritional values of foods, dietary requirements of carbohydrates, lipids and proteins, nutritional significance of minerals. Moreover, this course is also designed to understand the factors responsible for malnutrition and measures to overcome malnutrition in infants and adults

Course Outcome (CO)

CO1	The student will learn and understand the basic concepts of nutrition, and nutritional values of foods, and Basal metabolic rate and measurement of energy requirements.
CO2	The student will also learn and underst and the dietary requirement of carbohydrates, lipids and proteins and their biological significance.
CO3	The course will also aid to learn the nutritionalrequirement and significance of dietary minerals like calcium, phosphorus, magnesium, iron, iodine, zinc and copper and vitamins like vitamin B complex, C and A, D, E & K
CO4	The student will be learn about the Condition of malnutrition its prevention, and recommended dietary allowances.
CO5	The students will be able to understand the concept of Obesity, Starvation and Protein metabolism in prolonged fasting.

Unit	Course Contents:	Mapped CO	hours
I	**Basic concept** Function of nutrients. Measurement of the fuel values of foods. Direct and indirect calorimetry. Basal metabolic rate: factors affecting BMR, measurement and calculation of BMR. Measurement of energy requirements	**CO.1**	**8**
II	**Elements of nutrition** Dietary requirement of carbohydrates, lipids and proteins. Biological value of proteins. Concept of protein quality. Protein sparing action of carbohydrates and fats. Essential amino acids, essential fatty acids and their physiological functions	**CO.2**	**8**
III	**Minerals** Nutritional significance of dietary calcium, phosphorus, magnesium, iron, iodine, zinc and copper. Vitamins – Dietary sources, biochemical functions, requirements and deficiency diseases associated with vitamin B complex, C and A, D, E & K vitamins.	**CO.3**	**8**

IV	**Malnutrition** Prevention of malnutrition, improvement of diets. Recommended dietary allowances, nutritive value of common foods. Protein-calorie malnutrition. Requirement of proteins and calories under different physiological states- infancy, childhood, adolescence, pregnancy, lactation and ageing.	**CO.4**	**8**
V	**Obesity** Definition, Genetic and environmental factors leading to obesity. Starvation: Techniques for the study of starvation. Protein metabolism in prolonged fasting.	**CO.5**	**8**

References

- Tom Brody: Nutritional Biochemistry (Second Edition), Academic Press.
- DAVID A. BENDER: Nutritional Biochemistry of the Vitamins, SECOND EDITION, University College London, Cambridge University Press.
- Harper's Illustrated Biochemistry, 29th edition, Mc Graw Hill Education, Lange.
- Denise R. Ferrier, Richard A. Harvey, Biochemistry (Lippincott Illustrated Reviews Series), 6th edition. Wolters Kluwer/ Lipincott, Williams and Wilkins

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

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	POS2	PSO3	PSO4
CO1	**3**	**1**		**3**		**3**		**3**	3	2	3	
CO2	**3**	**1**		**3**		**3**		**3**	3	2		
CO3	**3**	**1**		**3**		**3**		**3**	3	2		
CO4	**3**	**1**		**3**		**3**		**3**	3	2	1	
CO5	**3**	**1**		**3**		**3**		**3**	3	2	3	
BS531	**3**	**1**		**3**		**3**	**-**	**3**	**3**	**2**	**2**	

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

INTEGRAL UNIVERSITY LUCKNOW

M.Sc. BC IInd yr,
Semester: Ivth

BS512 Free Radical Biology

L T P C
3 1 0 4

Course Objectives:
The main objective of this course is to impart students an understanding of free radicals, their properties, cause of generation of free radicals, damage caused by free radicals and free radical associated diseases. Moreover, role of antioxidants and antioxidant enzymes in neutralizing the free radicals have also been included for the development of better therapeutic intervention against free radical associated diseases.

Course Outcome (CO)

CO.1 Understand free radicals, their classification, physical and chemical properties, sources, biological significance.

CO.2 Understand the mineral biochemistry and their association with free radicals

CO.3 Students will learn about enzymatic and non-enzymatic antioxidants, their sources, and their role in targeting various diseases.

CO.4 Students will learn the free radical-mediated oxidation of various macromolecules and their role in tissue injury.

CO.5 Reconstitution of damaged molecules and membranes and the role of de-novo enzymes in the third line of defense.

Unit	Course Contents:	Mapped CO	hours
I	**Introduction to free radicals** Introduction to free radicals, classification, physical and chemical properties, generation of free radicals- environmental factors and biological factors, biological significance.	**CO.1**	**8**
II	**Mineral biochemistry and Free radicals** Mineral biochemistry and Free radicals: Calcium, phosphorus, magnesium. Trace elements: Iron, Iodine, Zinc, Copper.	**CO.2**	**8**
III	**Prooxidants, antioxidants, nutritional antioxidants** Prooxidants, antioxidants, nutritional antioxidants, sources of antioxidants: microbial, plant, marine. Role of free radicals in the development of diseases: Alzheimer's, Parkinson's, Cancer.	**CO.3**	**8**
IV	**Role of free radicals in development of diseases** Role of free radicals in development of diseases: Mechanisms of Protein oxdidation, Lipid peroxidation, DNA oxidation. Types of oxidized lesions and their biological importance	**CO.4**	**8**

V	**Defense mechanisms against free radicals** Role of antioxidants in the prevention of diseases. First line of defense: superoxide dismutase (SOD), catalase, glutathione peroxidase, glutathione reductase and xanthine oxidase, Second line of defense: glutathione (GSH), vitamin C, uric acid, albumin, bilirubin, vitamin E, carotenoids, flavonoids and ubiquinol	**CO.5**	**8**

References

- Free Radicals in Chemistry and Biology,
- Milan Lazár Free Radicals in Biology and Medicine (Paperback),
- Barry Halliwell, John Gutteridge DNA & Free Radicals (Textbook Binding)by Barry Halliwell (Author),
- Okezie I. Aruoma (Editor) An Introduction to Free Radical Chemistry, A.F. Parsons

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

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	POS2	PSO3	PSO4
CO1	**3**	**1**				**1**		**1**	3			
CO2	**3**	**1**				**1**		**1**	3	2		
CO3	**3**	**1**				**1**		**1**	3	2		
CO4	**3**	**1**				**1**		**1**	3	2		
CO5	**3**	**1**				**1**		**1**	3	2		
BS512	**3**	**1**				**1**	**-**	**1**	**3**	**2**		

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

INTEGRAL UNIVERSITY LUCKNOW

M.Sc. BC IInd yr,
Semester: Ivth

BS513 Food Biotechnology

L T P C
3 1 0 4

Course Objectives:
This course was designed to enable the students to understand various aspects of food biotechnology including food spoilage, food preservation techniques, food borne diseases, dairy products, their contamination, and associated milk-borne diseases, the importance of different flavors in food industry, food laws and standards, and BIS Certification of food products.

Course Outcome (CO)

CO.1 Learn the basic concepts of food spoilage and preservation techniques.

CO.2 Learn about the chemical and microbiological examination milk constituents, milk grading, contamination and milk-borne diseases.

CO.3 Learn about the microbial flavors in the food industry.

CO.4 Understand the food laws and standards, Quality and safety assurance in the food and dairy industry, and BIS product certification and licensing quality systems.

CO.5 Determine the microorganisms and their metabolites in different foods using distinct techniques.

Unit	Course Contents:	Mapped CO	hours
I	**Food as substrate for Microorganisms** Food as substrate for Microorganisms; General principles underlying spoilage of foods and different methods of preservation of foods, Microbial food poisoning and infection; investigation of foodborne outbreaks, prevention and control.	**CO.1**	**8**
II	**Microbiology and spoilage** Microbiology and spoilage of meat and meat products, fish and poultry, fruits and vegetables, sugar and sugar products, canned foods, process of canning of foods.	**CO.2**	**8**
III	**Milk and milk products** Milk and milk products: Clean milk production, collection, cooling and transportation of milk, Therapeutic value and nutritive value of fermented milk products; Spoilage of milk and milk products; Milkborne diseases; antimicrobial systems in milk; sources of contamination of milk; Chemical and microbiological examination of milk; grading of milk; Starter lactic cultures; management and preparation of starter cultures; starter defects.	**CO.3**	**8**
IV	**Microbial flavors in Dairy and Food industry** Microbial flavors in Dairy and Food industry; Food adulteration and contamination of food with harmful microorganisms; food laws and standards; Indian and International food safety laws and standards; Quality and safety assurance in food	**CO.4**	**8**

	and dairy industry; food and dairy arithmetic; standardization of products and costing; BIS Laboratory Services; BIS product certification and licensing quality systems; Certification by BIS.		
V	**Determining Microorganisms and their Products in Foods** Determining Microorganisms and their Products in Foods: Culture, Microscopic, and Sampling Methods, Conventional; SPC, Membrane Filters, Microscope colony Counts, Agar Droplets, Dry Films, Most probable Numbers (MPN), Dye-reduction, Roll Tubes, Direct, Microscopic Count (DMC), Microbiological Examination of surfaces, Air Sampling, Metabolically Injured Organisms.	**CO.5**	**8**

References

- Food Science. Fifth ed.Norman, Potter, CBS Publ.
- Technology of Food preservation. Norman potter, CBS.
- Milk and Milk Products, Clarence Henry Eckles TMH Publ.
- Food Microbiology – Frazier 5. Food Microbiology – J.De and De
- 6 Food processing :Biotechnological Applications, S.S. Marwaha and Arora, Asitech Publ.
- 7. Outlines of Dairy Technology – Sukumar De 8. Adams MR and Moss MO, Food Microbiology, The Royal Society of Chemistry, Cambridge.
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- 10. Banwart GJ, Basic food microbiology, Chapman & Hall, New York.
- 11. Frazier WC and Westhoff DC. Food microbiology, TATA McGraw Hill Publishing Company Ltd, New Delhi.
- 12. Hobbs BC and Roberts D, Food poisoning and food hygiene, Edward Arnold (A division of Hodder and Stoughton), London.
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- 15. Robinson RK, Dairy Microbiology, Elsevier Applied Science, London.

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

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	POS2	PSO3	PSO4
CO1	**3**	**1**		**1**		**2**		**1**	3	2	1	-
CO2	**3**	**1**		**2**		**2**	**2**	**1**	3	-	2	-
CO3	**3**	**1**		**1**		**2**		**1**	3	2	3	-
CO4	**3**	**1**	**2**	**3**		**2**		**1**	2			3
CO5	**3**	**1**				**2**	**1**	**1**	1		3	-
BS513	**3**	**1**	**1**	**2**	**-**	**2**	**1**	**1**	**3**	**1**	**2**	**1**

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

INTEGRAL UNIVERSITY LUCKNOW

M.Sc. BC II[nd] yr,
Semester: Iv[th]

BS514 Seminar

L T P C
3 1 0 2

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.

Course Outcome (CO)

CO.1 The students will understand and interpret latest advancements through different technical papers, reports, Journals, Data sheets, books etc

CO.2 The students will inculcate the skills for literature survey and will learn to manage resources effectively.

CO.3 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.

CO.4 Communicate his/her ideas with his peers as audience, which will enhance both oral and written communication skills.

CO.5 Create interest to pursue lifelong learning.

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

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	POS2	PSO3	PSO4
CO1	3	2			1	2	1	2	3	-		3
CO2	3					2		2	-	-		3
CO3	3	2	1			2		2	3		2	3
CO4	3	3	3					2	-			3
CO5	3							3	2			
BS514	**3**	**2**	**1**		**1**	**2**	**1**	**3**	**2**		**1**	**3**

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

INTEGRAL UNIVERSITY LUCKNOW

M.Sc. BC IInd yr,
Semester: Ivth

BS515 Project Work

L T P C
0 0 12 8

Course Objectives:
The main objective of this course is to develop independence in experimental design and interpretation and to develop research skills. To promote education and research in biotechnology and provide academic and professional excellence for immediate productivity in industrial, governmental, or clinical settings for an ultimate benefit of society and environment.

Course Outcome (CO)

CO.1 Perform literature review, identify state of the art in that field.

CO.2 To be able define the problem and develop synopsis of a defined research problem

CO.3 Establish a methodology using advanced tools / techniques for solving the problem including project management and finances.

CO.4 To prepare the research report and its oral demonstrations.

CO.5 Have gained practical experience in project management in biotechnological industry, be able to use various techniques in contemporary research for project, perform numerical analysis and Interpret the results

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

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	POS2	PSO3	PSO4
CO1	3					3	1	3	2	-		-
CO2	3					3	1	3	2	-		-
CO3	3					3		3			3	
CO4	3	2				3		3	-			3
CO5	3		2	3		3		3	3		3	3
BS515	**3**	**1**	**1**	**1**	**-**	**3**	**-**	**3**	**2**		**2**	**2**

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

INTEGRAL UNIVERSITY LUCKNOW

M.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
BS401	3	1				-	-	1	3	3	1	
BS421	3	1		3	1	3	1	3	2	1	2	2
BS403	3	1				-	-	1	3			
BS404	3	1				3	-	1			3	
BS422	3	1			1	2	3	1	2	2	2	3
BS423	3	3	3	1	1	3	1	3	2	-	3	2
BS411	3	1				-	-	1	3			
BS412	3	1				2		1	3		1	
BS413	3	1				-	-	1	3			
BS431	3	1			1	2	3	1	3	1	1	
BS415	3	1			1	2	1	1	3	1	1	1
BS416	3	1				2	3	1	3	1	2	
BS417	3	1		1		3	-	2	2		3	
BS432	3	3	3	1	1	3	1	3	2		3	2*
BS419(audit course)	3	2	1	1		1	-	2	1		1	3
BS521	3	1				3	-	1	1		3	
BS522	3	1				2	1	2	2	2	3	
BS503	3	1				-	-	1	3		1	
BS523	3	1			2	3	-	1	1	1	3	
BS524	3	1		1	1	2	1	1	3		1	
BS525	3	3	1		1	3	1	3	1		3	2*
BS531	3	1		3	1	3	-	1	1		3	
BS512	3	1				1	-	1	3			
BS513	3	1	1	2	-	2	1	1	3		2	
BS514	3	2	1			2	-	3	2		1	3
BS515	3	1	1	1	-	3	-	3	2		2	2
M.Sc. Biochemistry	**3**	**2**	**2**	**2**	**2**	**3**	**2**	**2**	**3**	**2**	**2**	**3**

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

(* - For all labs)