Program Handout for

M.Sc. Biotechnology

(w.e.f. 2004-05; revised version 2020-2021)

Department of Biosciences
Faculty of Science
Integral University, Lucknow

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 understand fundamental principles of molecular and cellular biology, biochemistry and bioinformatics.

[PSO.2] Modern approaches in biotechnology: the 'omics technologies including proteomics, transcriptomic, metabolomics and bioprocessing

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

[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 biotechnologists.

INTEGRAL UNIVERSITY LUCKNOW
DEPARTMENT OF BIOSCIENCES

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

Course Code	Course Title	Type of Paper	Periods/Week			Evaluation Scheme				Max. Marks	Credits	Total Credit	Attributes						
			L	T	P	UE	TA	Total	ESE				Employability	Entrepreneurship	Skill development	Gender	Environment & sustainability	Human values	Professional ethics
BS401	Biomolecules: Structure & Functions	Core	3	1	0	0	20	60	40	100	3:1:0	4							
BS402	Bioinformatics and IPR & Biosafety	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	√		√				
MT403	Biostatistics & Biomathematics	Core	3	1	0	40	20	60	40	100	3:1:0	4	√						
BS405	Biochemistry/Bioinformatics 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/Bioinformatics lab.	BS405	Biochemistry lab.	25	4
		Bioinformatics lab	15	2

Revision effective from 2020-21 batch

INTEGRAL UNIVERSITY LUCKNOW
DEPARTMENT OF BIOSCIENCES

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

Course Code	Course Title	Type of Paper	Periods/Week			Evaluation Scheme				Max. Marks	Credits	Total Credit	Attributes						
			L	T	P	UE	TA	Total	ESE				Employability	Entrepreneurship	Skill 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							
BS414	Microbiology	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												√		√				
BS418	Microbiology / Enzymology Lab.	Practical	0	0	12	40	20	60	40	100	0:0:6	6	√	√	√		√		
BS419	Educational/Industrial tour									S/U					√				
	Total									600		26							

 # Note: The students of M.Sc. Biotechnology 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. Biotechnology Semester-III

Course Code	Course Title	Type of Paper	Periods/Week			Evaluation Scheme				Max. Marks	Credits	Total Credit	Attributes						
			L	T	P	UE	TA	Total	ESE				Employability	Entrepreneurship	Skill development	Gender	Environment & sustainability	Human values	Professional ethics
BS-501	rDNA- Technology	Core	3	1	0	40	20	60	40	100	3:1:0	4	√		√				
BS-502	Bioprocess Engineering & Industrial Biotechnology	Core	3	1	0	40	20	60	40	100	3:1:0	4	√	√	√		√		
BS-503	Immunology	Core	3	1	0	40	20	60	40	100	3:1:0	4	√		√				
BS-504	Advanced Molecular Techniques	Core	3	1	0	40	20	60	40	100	3:1:0	4	√		√				
BS-505	Cell Biology	Core	3	1	0	40	20	60	40	100	3:1:0	4							
BS-506	rDNA Technology/Immunology Lab.	Practical	0	0	12	40	20	60	40	100	0:0:6	6	√		√				
	Total									600		26							

INTEGRAL UNIVERSITY LUCKNOW
DEPARTMENT OF BIOSCIENCES

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

Course Code	Course Title	Type of Paper	Periods/Week			Evaluation Scheme				Max. Marks	Credits	Total Credit	Attributes						
			L	T	P	UE	TA	Total	ESE				Employability	Entrepreneurship	Skill 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							
BS511	Applied Biotechnology												√		√				
BS-512	Free Radical Biology																		
BS-513	Food Biotechnology												√	√			√		
BS-514	Seminar	Core	3	1	0	40	20	60	40	100	2	2							
BS-515	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. BT I[st] yr,
Semester: I[st]

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. BT I[st] yr,
Semester: I[st]

BS402 Bioinformatics and IPR & Biosafety

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 the 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 Comprehend and the knowledge of bioinformatics in the biotechnology research and industry

CO.2 Apply key concepts of different bioinformatics tools and analyse sequence and structure of bio-macromolecule data.

CO.3 Apply bioinformatics for pattern analysis, primer designing, drug designing, phylogenetic analysis etc

CO.4 Comprehend benefits of GM technology and related issues as well as recognize the importance of protection of new knowledge and innovations and its role in business.

CO.5 Interpret basics of biosafety and bioethics and its impact on all the biological sciences and the quality of human life.

Unit	Course Contents:	Mapped CO	hours
I	**Computer basics** Operating systems; Hardware, Software, DOS; Programming in Visual Basic: Introduction to application development using Visual Basic; Working with Code and Forms; Variables, Procedures and Controlling Program Executor; Standard Controls; Data Access Using Data Control; Internet; LAN; WAN; Web servers.	**CO.1**	**8**
II	**Introduction to Nucleic acid & Protein Sequence Data Banks** Introduction to Nucleic acid and Protein Sequence Data Banks: Genbank; EMBL nucleotide sequence data bank, NBRF-PIR, SWISSPROT; Signal peptide data bank. Database Similarity Searches: BLAST, FASTA, PSI-BLAST algorithms; Pair wise sequence alignment - NEEDLEMAN and Wunsch; Smith Waterman algorithms; Multiple sequence alignments - CLUSTAL, PRAS	**CO.2**	**8**
III	**Patterns, motifs and Profiles in sequences** Patterns, motifs and Profiles in sequences: Derivation and searching; Derived Databases of patterns; Motifs and profiles: Parasite, Blocks, Prints-S, Pam, etc. Primer Designing; Homology Modeling; Promoter scanning; Splice site Prediction; Phylogenetic analysis & Drug Designing; Determination of Secondary & Tertiary of proteins.	**CO.3**	**8**

IV	**Introduction to intellectual property rights** 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 & Bioethics** 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

- 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						1	3		3	
CO2	3	1		3		3		1	3	2	3	
CO3	3	1		3		3		1	1		3	
CO4	3	1		3		3		1				3
CO5	3	1		3	3	3	1	1				3
BS402	**3**	**1**		**3**	**1**	**3**	**1**	**1**	**2**	**1**	**2**	**2**

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

INTEGRAL UNIVERSITY LUCKNOW

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

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

Sc. BT 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

Sc. BT I[st] yr,
Semester: I[st]

MT403 Biostatistics & Biomathematics

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	**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.1**	**8**
II	**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.2**	**8**
III	**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.3**	**8**
IV	**Differential Calculus** Derivative and its physical significance, basic rules for differentiation. Integral	**CO.4**	**8**

	Calculus: basic rules for integration, method of substitution and method of by parts. Definite integral & simple examples based on its properties. Applications in Biology and Chemistry.		
V	**Determinants and its properties, evaluations of 3x3 determinants**. Matrices: Definition and types of matrices, transpose of a matrix, addition, subtraction and multiplication of matrices, matrix inversion, solution of simultaneous equations by matrix method. 8Interpolation: Newton's forward and backward formula, Lagranges formula.	**CO.5**	**8**

References

- D. Freedman, R.Pisani, R.Purves, J.M.Lachin, "Biostatistical method: the assessment of relative risks"
- P.S.S. Sunder Rao and J.Richard, "An introduction to Bilstatistics", Prentice Hall of India, N.Delhi
- Pillai & Bagavathi, "Statistics-theory and practice", S. Chand
- H.K. Dass, "Engineering Mathematics", S.Chand
- H.C. Saxena, "Text book of Numerical Analysis", S.Chand

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

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

BS405 Biochemistry/Bioinformatics lab

L T P C
0 0 12 6

Course Objectives:
The objective of this course is to develop the understanding and basic knowledge of bimolecular testing and bioinformatics.

Course Outcome (CO)

CO.1 To know method for qualitative testing of carbohydrates (Molisch test, Benedict test, Fehling test, Bradford and Iodine tests) and fructose estimation

CO.2 To know method for qualitative and quantitative testing of proteins & Amino Acids and finding out isoelectric point of protein

CO.3 To know method for separation of amino acids and sugars by TLC and paper chromatography

CO.4 Estimate cholesterol and DNA in a given sample

CO.5 To learn how to use and develop bioinformatics application software

S.No.	Experiments:	Mapped CO
1	Qualitative tests of carbohydrates: Carbohydrate: 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.1**
2	Qualitative tests of proteins: Proteins & Amino Acids: Millon's test, Biuret test; Ninhydrin Test; Xanthoproteic Test; Hopkin's Cole Test.	**CO.2**
3	Estimation of fructose by resorcinol method	**CO.1**
4	Estimation of protein by Biuret method	**CO.2**
5	Estimation of protein by Folin's-Lowry's method	**CO.2**
6	Estimation of cholesterol in egg	**CO.4**
7	Estimation of DNA by DPA method	**CO.4**
8	Chromatography: Separation of amino acids, and sugars by TLC & paper chromatography	**CO.3**
9	To find out isoelectric point of protein	**CO.2**
10	Usage & Development of Bioinformatics Application Software	**CO.5**

References

- Keith Wilson, John Walker, John M. Walker “Principles and Techniques of Practical Biochemistry”
  Chirikjian “Biotechnology Theory & Techniques”
- Joseph Sambrook, David W. Russell, 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	1			3		3	2		3	2
CO2	3	3	1			3		3	2		3	2
CO3	3	3	1			3		3	2		3	2
CO4	3	3	1			3		3	2		3	2
CO5	3	3	1	2		3		3	2		3	2
BS405	**3**	**3**	**1**	**1**		**3**		**3**	**2**		**3**	2

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

INTEGRAL UNIVERSITY LUCKNOW

M.Sc. BT 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. BT 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**				**2**		**1**	**3**		**1**	

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

INTEGRAL UNIVERSITY LUCKNOW

M.Sc. BT 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. BT Ist yr,
Semester: IInd

BS414 Microbiology

L T P C
3 1 0 4

Course Objectives:
The objectives of this course are to introduce the students to the field of microbiology with emphasis on microbial growth, reproduction, microbial diversity, morphology and nutrition; basic techniques implied in microbiology including concept of aseptic work, isolation, identification, and cultivation of microbes from different habitats/sources.

Course Outcome (CO)

CO.1 Students would be able to identify or classify the microbial diversity i.e. bacteria, fungi, virus etc. on the basis of their characteristics, Learn microbiological techniques, and apply to study microbial phylogeny

CO.2 Students would learn the nutritional types of microorganisms, measure and control microbial growth, isolate, maintain and preserve microorganisms for various applications

CO.3 Students would know the defining characteristics of the major groups of microorganisms and means of adaptation for various diverse groups of microorganisms

CO.4 Students would understand the interactions between microbes, hosts and environment.

CO.5 Students would gain insights on mechanism of action of antibiotics, classify the medically important microorganisms i.e. non-pathogenic and pathogenic microbes, and understand their mode of survival and antibiotics resistance mechanisms.

Unit	Course Contents:	Mapped CO	hours
I	**Concepts in classification of microorganisms** Classical and modern methods and concepts; Domain and Kingdom concepts in classification of microorganisms; Criteria for classification: morphology, cytology, genetic relatedness, host specialization, serology; Concept of Classification of Bacteria according to Bergey‟s manual.	**CO.1**	**8**
II	**Microbial culture techniques and growth** Isolation, maintenance, sterilization and culture techniques; Microbial growth and nutrition; Factors effecting growth; Definition of growth; Mathematical expression of growth; Measurement of growth and growth yields; Synchronous and non - synchronous growth; Continuous culture.	**CO.2**	**8**
III	**Ultrastructure of Microbes and adaptation** Ultrastructure of Eubacteria (E.coli), Archaea (Methanococcus), Unicellular Eukaryotes (Yeast) and Structure and genetic system of viruses - Bacterial viruses in general; Plant (TMV, CaMV) and Animal viruses (HIV). Physiological adoption and life style of Prokaryotes and the Extremophiles.	**CO.3**	**8**

IV	**Microbial interactions** Microbial interactions - Symbiosis, Synergism, Commensalism, Ammensalism, Predation and Parasitism; Ecological impacts of microbes: Microbes and Nutrient cycles; concept of quorum sensing.	**CO.4**	**8**
V	**Medically important micro-organisms and antibiotics** Classification of medically important micro-organisms: Non-pathogenic and Pathogenic Microbes, Production of antibiotics, mode of action of antibiotics; different mechanism of antibiotic resistance. Prebiotics and Probiotics.	**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		3	
CO3	**3**	**1**					**3**	**1**	3			
CO4	**3**	**1**					**3**	**1**	3			
CO5	**3**	**1**			**2**	**3**	**1**	**1**	3		1	
BS414	**3**	**1**			**1**	**2**	**3**	**1**	**3**	**1**	**1**	

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

INTEGRAL UNIVERSITY LUCKNOW

M.Sc. BT 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			
CO4	**3**	**1**				**1**		**1**	3		1	
CO5	**3**	**1**			**2**	**1**	**1**	**1**			3	2
BS415	**3**	**1**			**1**	**2**	**1**	**1**	**3**		**1**	**1**

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

INTEGRAL UNIVERSITY LUCKNOW

M.Sc. BT 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. BT Ist yr,
Semester: IInd

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. BT I[st] yr,
Semester: II[nd]

BS418 Microbiology / Enzymology Lab

L T P C
0 0 12 6

Course Objectives:
The objective of this course is to enable the students to learn the various techniques to handle microbiological samples. There has been an exclusive demand for microbial metabolites and pharmaceutical products which can be used to improve human health and wellbeing. These techniques equip the students to work in research related to microbiological testing..

Course Outcome (CO)

CO.1 The student will learn methods of sterilization and preparation of various culture media, microbial enumeration and purification techniques

CO.2 The student will learn Identification of isolated bacteria, sensitivity testing for antibiotics/ antifungal agents and growth curve of microorganisms

CO.3 Perform protein separation by PAGE

CO.4 Perform enzyme isolation and activity determination

CO.5 Understand the effect of various factors on enzyme activity

S.No.	Experiments:	Mapped CO
1	Methods of sterilization and preparation of various culture media.	**CO.1**
2	Enumeration of microorganisms from water/soil samples, colony purification	**CO.1**
3	Purification techniques: Serial dilution, pour plate and streak plate method	**CO.1**
4	Identification of isolated bacteria: Gram staining other staining methods, metabolic characterization	**CO.2**
5	Sensitivity of various organisms towards Antibiotic/Antifungal agents.	**CO.2**
6	Growth curve of microorganisms	**CO.2**
7	Protein separation by Poly Acrylamide Gel Electrophoresis	**CO.3**
8	Isolation of enzyme and determination of enzyme activity	**CO.4**
9	Study of the effect of pH on the enzyme activity.	**CO.5**
10	Study of the effect of varying substrate concentration on the enzyme activity and determination of Km.	**CO.5**
11	Study of the effect of temperature on the enzyme activity.	**CO.5**
12	Study of the effect of inhibitors on the enzyme activity.	**CO.5**

References

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

- Joseph Sambrook David W. Russell Joe Sambrook “Molecular Cloning: A Laboratory Manual” William M., O'Leary Robert Dony Wu “Practical Handbook of Microbiology”
- Brown, TA “Gene cloning: An introduction”
- 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		3	1	3	2		3	2
CO2	3	3	3	1		3	2	3	2		3	2
CO3	3	3	3			3		3	2		3	2
CO4	3	3	3			3		3	2		3	2
CO5	3	3	3		2	3		3	2		3	2
BS418	**3**	**3**	**3**	**1**	**1**	**3**	**1**	**3**	**2**		**3**	**2**

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

INTEGRAL UNIVERSITY LUCKNOW

M.Sc. BT 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 after completion of the tour.

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	1		3	3
CO2	3	2	2	1				1				3
CO3	3	2	2	1				1				3
CO4	3	2				2		2				3
CO5	3			1				3				3
BS419	**2**	**2**	**1**	**1**		**1**	**-**	**2**	**1**		**1**	**3**

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

INTEGRAL UNIVERSITY LUCKNOW

M.Sc. BT IInd yr,
Semester: IIIrd

BS501 rDNA Technology

L T P C
3 1 0 4

Course Objectives:
The objective of this course is to give students a basic understanding of various components required for gene cloning.

Course Outcome (CO)

CO.1 Know the role of the several molecular tool applied in gene cloning for construction of recombinant molecules (DNA and Vectors)

CO.2 Several techniques involved in production of CDNA and Genomic library and primer synthesis

CO.3 Classification and properties of an ideal plasmid , plasmid as cloning vector

CO.4 Different types of cloning vectors used in genetic engineering

CO.5 Different types of screening and selection procedure of identifying recombinants

Unit	Course Contents:	Mapped CO	hours
I	**Cloning Procedure** Outline of cloning procedure, Host controlled restriction and modification: Restriction endonucleases and cognate methylases, Class I, II & III restriction enzymes, Nomenclature, Recognition sites, Variants of Type II Restriction enzyme, Unit of restriction enzymes, Restriction digestion: Partial and Complete Digestion, Star activity, Restriction mapping, Formation of chimeric DNA, Homopolymer tailing, Synthetic Linkers, Adaptors and DNA ligase; Filling in and Trimming back; Significance of T4 DNA polymerase & Klenow Fragment, Alkaline phosphatase, Reverse transcriptase in cloning.	**CO.1**	**8**
II	**RNA/DNA synthesis and labelling** Purification of mRNAs; mRNA abundance; Synthesis of cDNA:, Various methods for first and second strand DNA synthesis; cDNA and Genomic library construction; Chemical synthesis of oligonucleotides by Phosphoramidite and Photolithographic methods; Preparation of probe DNA by radioactive and nonradioactive labeling methods: Nick translation, End filling, Random primer methods.	**CO.2**	**8**
III	**Plasmids** Plasmids: Plasmid classification on basis of phenotypic traits: Cryptic, Fertility, Resistance, Bacteriocinogenic, Degradative, Virulence; Conjugative / non conjugative plasmids; Relaxed and stringent control of copy number; Plasmid incompatibility; Plasmid host range, Mobilizable plasmids and Triparental mating; Plasmid as cloning vector (recombinant plasmids): Properties of ideal plasmid cloning vectors, pBR322, pUC & pGEM3Z series, , Binary and Cointegrate vectors derived from Ti plasmid of Agrobacterium; Transcriptional and translational fusion vectors; Fusion proteins; Selectable markers; Reporter genes.	**CO.3**	**8**
IV	**Phage as cloning vector**	**CO.4**	**8**

	Phage as a cloning vector: Advantage of using phage lambda vector, Genome map of phage lambda, In vitro packaging, Insertional and replacement vectors: λgt10, λgt11, λEMBL3, λEMBL4, λEMBL3A, λEMBL4A; Cosmid vectors; M13 phage and its role in single stranded DNA production, M13 series of vectors; Phagemids; Yeast as cloning vector: Basic principles of development of yeast vectors, 2μ plasmid, YEP, YRP YCP, YIP; Artificial chromosomes: YACs, BACs and PACs.		
V	**Screening and selection of recombinants** Basic techniques in mammalian cell culture; Cell culture media; Serum free media; maintenance of the culture and cell lines; Cloning in mammalian cells; transgenics, viral v Screening and selection of recombinants: Functional (genetic) complementation (Blue-white screening, Red-white screening), Nutritional complementation, Gain of function, Colony hybridization, Plaque hybridization, Southern blotting and hybridization, Dot blot, Zoo blot, Plus-Minus screening, Northern blotting, Immunological screening, Western blotting, South-Western blotting, North-Western blotting, HART, HAT.	**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”
- Genetic Engineering Rastogi & Pathak 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”

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		3	
CO2	*3*	1				3		1			3	
CO3	*3*	1				3		1	2		3	
CO4	3	1				3		1	1		3	
CO5	3	1				3		1	1		3	
BS501	**3**	**1**				**3**	**-**	**1**	**1**		**3**	

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

INTEGRAL UNIVERSITY LUCKNOW

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

BS502 Bioprocess Engineering & Industrial Biotechnology

L T P C
3 1 0 4

Course Objectives:
This course was designed to acquire knowledge on basics of thermodynamics of reactor systems with special emphasis on bioreactor design, operation, flow patterns, and analysis of enzyme kinetics in biochemical engineering reactions along with downstream processing.

Course Outcome (CO)

CO.1 Learn about engineering calculations. Know different principles and concepts governing Fluid flow in a reactor system.

CO.2 Students will be able to apply mass and energy balances to calculate the concentration of different gases in the fermenter off-gas, amount of reactant used, amount of oxygen etc.

CO.3 Understand the techniques used for isolation and purification of desired products

CO.4 Operate and optimize the factors affecting fermentation for producing industrial products.

CO.5 Treat the solid waste and effluent treatment

Unit	Course Contents:	Mapped CO	hours
I	**SI Units** SI units; Dimension analysis; Fluid flow; Fluid statics; Bernoulli's equations.	**CO.1**	**8**
II	**Mass and energy balance in biological processes, Heat transfer** Mass and energy balance in biological processes, Heat transfer: Different modes of heat transfer coefficient; Boiling & evaporation; Heat exchanger design..	**CO.2**	**8**
III	**Screening and strain improvement** Isolation, maintenance and preservation of industrial strains. Strain improvement, screening and selection of industrially important microbes. Media for Industrial Fermentation, sterilization.	**CO.3**	**8**
IV	**Design and analysis of fermenter; Downstream Processing** Design and analysis of fermenter; Types of fermenters, evaluation of fermentation parameters, Downstream Processing: Filtration, centrifugation, cell disruption, extraction, drying, crystallization and characterization. Large scale production and commercial applications of enzymes: proteases and amylases; solvents: acetic acid, ethanol, acetobutanol.	**CO.4**	**8**
V	**Applied microbial technology** Solid waste treatment and management, Effluent Treatment: Aerobic and anaerobic water treatment processes: activated sludge, trickling filter, fluidized expanded bed reactor, Upflow anaerobic sludge blanket reactor. Bioleaching, Bioremediation, Biodegradable plastics, Biofuels / Biodiesel, Biopesticides, Biofertilizers and Vermitechnology	**CO.5**	**8**

References

- Doran, PM “Bioprocess Engineering Principles”
- Pirt, SJ “Principles of Microbe and Cell Cultivation” Whitaker “principles of Fermentation Technology”
- Bailey & Ollis “Biochemical Engineering Fundamentals”
- Moo –Young “Comprehensive Biotechnology” Cruger & Cruger “Biotechnology: A text book of Industrial Microbiology”
- Prescott & Dunn “Industrial Microbiology”
- Bruce Rittman Perry L. McCarty “Environmental Biotechnology: Principles and Applications”

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	2	2	
CO3	3	1				2		1		3	3	
CO4	3	1				2		1		3	3	
CO5	3	1				2	3	2		2	3	
BS502	**3**	**1**				**2**	**1**	**2**	**2**	**2**	**3**	

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

INTEGRAL UNIVERSITY LUCKNOW

M.Sc. BT 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			
CO2	3	1				3		2	3		3	
CO3	3	1				3		1	3			
CO4	3	1				3			3			
CO5	3	1				3		1	3			
BS503	**3**	**1**				**3**	**-**	**1**	**3**		**1**	

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

INTEGRAL UNIVERSITY LUCKNOW

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

BS504 Advanced Molecular Techniques

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)

CO.1 Learn Polymerase chain reaction (PCR) and its application. Modifications of PCR. Site directed mutagenesis and its types.

CO.2 Various methods of gene silencing in plants and animals: RNA interference, antisense technology and ribozymes.

CO.3 Genome sequencing, various types of sequencing technologies and sequencing approaches. Pros and cons of different sequencing technologies.

CO.4 Molecular markers and their types. Advantage, disadvantage and application of various types of molecular markers. Principle and application of Proteomics techniques like yeast two hybrid system, protein microarray etc.

CO.5 Principle, instrumentation and application of various methods used for introduction of DNA into living cells like chemical transformation etc.

Unit	Course Contents:	Mapped CO	hours
I	**Principle & applications of PCR** Principle & applications of PCR; RACE, DD-RTPCR, Degenerate PCR TA cloning, Realtime PCR, Scorpion PCR, Site Directed Mutagenesis: oligonucleotide directed, PCR based Mutagenesis, Error prone PCR.	**CO.1**	**8**
II	**Gene silencing** Antisense RNA technique, Sense cosuppression in plants and animals, RNAi, in gene silencing, ribozymes.	**CO.2**	**8**
III	**Rapid DNA and RNA sequencing techniques** 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	**CO.3**	**8**
IV	**Molecular Markers** Molecular Markers: RFLP, RAPD, AFLP, SCAR, STS, microsatellites, SCAR, SSCP, Yeast two-hybrid system, DNase I foot printing., microarray, Protein Microarray.	**CO.4**	**8**
V	**introduction of DNA into living cells** Overview of the methods for introduction of DNA into living cells: Chemical transformation, microprojectile bombardment, electroporation and microinjection.	**CO.5**	**8**

References

- Brown TA “Gene cloning: An introduction”
- Old & Primrose “Principles of Gene Manipulation”
- Jose B. Cibelli Robert P. Lanza Keith Cambell Michasel D. West “Principles of Cloning”
- H. S. Chawla “Plant Biotechnology: A Practical Approach”
- Adrian Slater, Nigel W. Scott, Mark R. Fowler “Plant Biotechnology: The Genetic Manipulation of Plants”
- Richard A. Dixon Robert A. Gonzales “Plant Cell Culture: A Practical Approach” S.H. Mantell, J.A. Matthews, R.A. McKee “Principles of Plant Biotechnology: An Introduction to Genetic Engineering in Plants”
- Angela Stafford Graham Warren “Plant Cell and Tissue Culture (Biotechnology Series)”
- Brown TA “Gene cloning: An Introduction”
- Old & Primrose “Principles of Gene Manipulation” Bhojwani and Razdan “Plant Tissue Culture

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	1		3	
CO2	3	1			2	3		1	1		3	
CO3	3	1			2	3		1		3	3	
CO4	3	1			2	3		1	1		3	
CO5	3	1			2	3		1			3	
BS504	**3**	**1**			**2**	**3**	**-**	**1**	**1**	**1**	**3**	

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

INTEGRAL UNIVERSITY LUCKNOW

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

BS505 Cell Biology

L T P C
3 1 0 4

Course Objectives:
This course imparts in depth knowledge of cell structure, functions and cellular processes including the signaling pathways involved in growth and development. Also the course connects the cellular functioning with the application of technology and molecular genetics, enabling the students to explore and identify novel research leads for the greatest benefit of mankind.

Course Outcome (CO)

CO.1 Students will understand the structures and purposes of basic components (membranes and organelles) of prokaryotic and eukaryotic cells, as well as transport of molecules and ions across cells.

CO.2 Students will understand cellular components underlying cell division and cell cycle.

CO.3 Students will learn about cell communication and signaling through distinct signaling pathways that will help them to discover novel therapeutic targets/agents.

CO.4 Students will understand pathways and mechanisms of intracellular protein targeting.

CO.5 They will be able to understand the procedure of RDT based technologies cell culture and their various applications for humankind.

Unit	Course Contents:	Mapped CO	hours
I	**Ultrastructure and Organization of eukaryotic cell** Structural organization of Cytoskeleton (Microtubules, Microfilaments, actins etc.); Structure and functions of cell membrane, Transport across cell membrane: Diffusion, Facilitated diffusion, Active transport.	**CO.1**	**8**
II	**Cell division and cell cycle** Mitosis and Meiosis; Cell cycle: Check points, role of cyclin and cyclin dependent kinases in its regulation, Programmed cell death, aging and senescence.	**CO.2**	**8**
III	**Cell communication and signaling** Cell - cell and 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.3**	**8**
IV	**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.4**	**8**
V	**Applied Cell Biology** Basic techniques in mammalian cell culture; Cell culture media; Serum free media; maintenance of the culture and cell lines; Cloning in mammalian cells; transgenics, viral vectors, Stem cell and their applications, gene knockout technology	**CO.5**	**8**

References

- Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Dennis Bray, Karen Hopkin, Keith Roberts, Peter Walter “Essential Cell Biology”
- Baltimore “Molecular Cell Biology”
- Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter “Molecular Biology of the Cell”
- Lodish H, Baltimore D, Berk A, Zipursky SL, Matsudaira P, Darnell J. (1995). Molecular cell biology.
- Cooper ““Molecular Cell Biology”
- Karp & Karp “Molecular Cell Biology”

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**				**2**		**1**	3			
CO3	**3**	**1**				**2**		**1**	3			
CO4	**3**	**1**				**2**		**1**	3			
CO5	**3**	**1**		**3**	**2**	**3**	**1**	**1**			3	
BS505	**3**	**1**		**1**	**1**	**2**	**1**	**1**	**3**		**1**	

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

INTEGRAL UNIVERSITY LUCKNOW

M.Sc. BT IInd yr,
Semester: IIIrd

BS506 rDNA/Immunology 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)

CO.1 The student will practically learn to isolate plasmid DNA and genomic DNA and will learn to perform Agarose gel electrophoresis of DNA

CO.2 The student will practically learn quantitation and Restriction digestion of DNA

CO.3 The course will aid to learn cloning of DNA

CO.4 . The student will learn to study the production and characterization of products (as antibiotics) from microbes

CO.5 The student will practically learn and understand the antigen-antibody interaction by Double Immunodiffusion method, Ouchterlony's Method, Immunoelectrophoresis, Western Blotting and ELISA

S.No.	Experiments:	Mapped CO
1	Isolation and characterization of DNA from Bacteria/ Phage/Plants / Animals	**CO.1**
2	Quantitative Estimation of genomic DNA: Determination of Absorption Spectra of genomic DNA	**CO.2**
3	Restriction digestion of DNA and assigning restriction sites	**CO.2**
4	Preparation of competent cells	**CO.3**
5	Cloning of foreign DNA into plasmid vector	**CO.3**
6	Transformation with recombinant plasmid DNA	**CO.3**
7	Isolation of plasmid DNA by alkaline lysis as well as by Quick Method followed by Agarose Gel Electrophoresis	**CO.1**
8	Identification of recombinants	**CO.3**
9	Microbial Production, Separation & Purification of Organic Acids, Enzymes, Proteins, Antibiotics and Characterization of Primary & Secondary Metabolites	**CO.4**
10	To identify sensitivity of antigen & antibody by double Immunodiffusion: Ouchterlony's Method, Immunoelectrophoresis, Blood Group determination.	**CO.5**

References

- Keith Wilson John Walker John M. Walker “Principles and Techniques of Practical Biochemistry” Chirikjian “Biotechnology Theory & Techniques”
- 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”
- Plummer David T., (1988), An introduction to practical biochemistry, 3rd Ed., Tata McGraw-Hill Publishing Co. Ltd. New Delhi, 109-121
- Talwar G. P. (1983) *Handbook of Immunology*, Vikas Publishing Pvt. Ltd. New Delhi

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	1		3	2
CO2	3	3	1			3		3	1		3	2
CO3	3	3	1			3		3	1		3	2
CO4	3	3	1			3		3	1		3	2
CO5	3	3	1		2	3	1	3	1		3	2
BS506	**3**	**3**	**1**		**1**	**3**	**1**	**3**	**1**		**3**	**2**

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

INTEGRAL UNIVERSITY LUCKNOW

M.Sc. BT IInd yr,
Semester: Ivth

BS511 Applied Biotechnology

L T P C
3 1 0 4

Course Objectives:
This course has been designed to recollect some basic but very important concepts in biotechnology as well as plant and animal cell culture with advanced knowledge of various recent developments taking it to the industrial level. This course also aimed to teach the students about the application of transgenic plants, cloning mechanisms, IVF, and commercial production of vaccines..

Course Outcome (CO)

CO.1 Understand the techniques of microbial, plant and animal cell culture

CO.2 Understand the basic mechanisms of protoplast biology, in-vitro selection of mutants, the process of plant organ development and their application in agriculture and horticulture.

CO.3 Understand the development of transgenic plants with special acquired protective mechanisms against drought, salt stress, pathogens, herbs and development of edible vaccines.

CO.4 Understand the cloning strategies, antigen recognition and presentation by B and T lymphocytes and their application in vaccine development.

CO.5 Understand the techniques of *in-vitro* fertilization and embryo transfer technique, test tube babies

Unit	Course Contents:	Mapped CO	hours
I	**Introduction to Tissue and organ culture** Introduction to Tissue and organ culture, Establishment and maintenance of callus and suspension cultures, cellular differentiation and regulation of morphogenesis; somatic embryogenesis.	**CO.1**	**8**
II	**Isolation and culture of protoplast** Isolation and culture of protoplast, DNA uptake by protoplast, protoplast fusion and somatic hybridization; in vitro selection of mutants- mutants for salts, disease, cold, drought, herbicide and other stress conditions; systems for somatic hybrids / cybrids; Haploid production: Androgenesis; anther and microspore culture, Gynogenesis: Embryo culture and rescue in agricultural and horticultural crops, Virus free plants through meristem culture; shoot tip culture, Plant micropropagation,Somaclonal variation.	**CO.2**	**8**
III	**Applications of transgenic plants** Applications of transgenic plants: Developing insect resistance, disease-resistance, herbicide resistance, salt and submergence stress, fruit ripening, Edible vaccines. Cloning in plant and cells.	**CO.3**	**8**

IV	**T cell cloning and IVF** T cell cloning mechanisms of antigen recognition by T arid B lymphocytes, Application of T cell cloning in vaccine development; In vitro Fertilization and Embryo transfer technique, test tube babies.	**CO.4**	**8**
V	**Therapeutic and prophylactic biotechnology** Principles and strategy for developing vaccines; newer methods of vaccine preparation, sub-unit vaccines, transplants, drug designing, drug targeting, microencapsulation in medicine.	**CO.5**	**8**

References

- H. S. Chawla “Plant Biotechnology: A Practical Approach”
- Adrian Slater, Nigel W. Scott, Mark R. Fowler “Plant Biotechnology: The Genetic Manipulation of Plants”
- Richard A. Dixon Robert A. Gonzales “Plant Cell Culture: A Practical Approach”
- S.H. Mantell, J.A. Matthews, R.A. McKee “Principles of Plant Biotechnology: An Introduction to Genetic Engineering in Plants”
- Angela Stafford Graham Warren “Plant Cell and Tissue Culture (Biotechnology Series)”
- Brown TA “Gene cloning: An Introduction”
- Old & Primrose “Principles of Gene Manipulation”
- Bhojwani and Razdan “Plant Tissue Culture”
- Brown TA “Gene cloning: An introduction”
- Old & Primrose “Principles of Gene Manipulation”

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**	1		3	
CO2	**3**	**1**		**3**		**3**		**1**			3	
CO3	**3**	**1**		**3**		**3**		**1**			3	
CO4	**3**	**1**		**3**	**3**	**3**		**1**			3	
CO5	**3**	**1**		**3**		**3**		**1**	1		3	
BS511	**3**	**1**		**3**	**1**	**3**	**-**	**1**	**1**		**3**	

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

INTEGRAL UNIVERSITY LUCKNOW

M.Sc. BT 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			
CO3	**3**	**1**				**1**		**1**	3			
CO4	**3**	**1**				**1**		**1**	3			
CO5	**3**	**1**				**1**		**1**	3			
BS512	**3**	**1**				**1**	**-**	**1**	**3**			

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

INTEGRAL UNIVERSITY LUCKNOW

M.Sc. BT 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.
- 9. Andrews AT, Varley J, Biochemistry of milk products, Royal Society of Chemistry.
- 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.
- 13. May JM, Modern food microbiology, CBS Publishers and distributors, New Delhi.
- 14. Robinson RK, The microbiology of milk. Elsevier Applied Science, London.
- 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	-	1	-
CO2	**3**	**1**		**2**		**2**	**2**	**1**	2	-	1	-
CO3	**3**	**1**		**1**		**2**		**1**	3		2	-
CO4	**3**	**1**	**2**	**3**		**2**		**1**	2		1	1
CO5	**3**	**1**				**2**	**1**	**1**	1		3	-
BS513	**3**	**1**	**1**	**2**	**-**	**2**	**1**	**1**	**3**		**2**	**-**

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

INTEGRAL UNIVERSITY LUCKNOW

M.Sc. BT IInd yr,
Semester: Ivth

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. BT 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**	**1**	**3**	**2**		**2**	**2**

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

Program Articulation Matrix: (Mapping of Courses with POs and PSOs)
M.Sc. Biotechnology

PO-PSO / Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	POS2	PSO3	PSO4
BS401	3	1				-	-	1	3	3	1	
BS402	3	1		3	1	3	1	1	2	1	2	2
BS403	3	1				-	-	1	3			
BS404	3	1				3	-	1			3	
MT403	3	1				3	-	1				3
BS405	3	3	1	1		3		3	2		3	2
BS411	3	1				-	-	1	3			
BS412	3	1				2		1	3		1	
BS413	3	1				-	-	1	3			
BS414	3	1			1	2	3	1	3	1	1	
BS415	3	1			1	2	1	1	3		1	1
BS416	3	1				2	3	1	3	1	2	
BS417	3	1		1		3	-	2	2		3	
BS418	3	3	3	1	1	3	1	3	2		3	2
BS419(audit course)	2	2	1	1		1	-	2	1		1	3
BS501	3	1				3	-	1	1		3	
BS502	3	1				2	1	2	2	2	3	
BS503	3	1				-	-	1	3		1	
BS504	3	1			2	3	-	1	1	1	3	
BS505	3	1		1	1	2	1	1	3		1	
BS506	2	3	1		1	3	1	3	1		3	2*
BS511	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	1	3	2		2	2
M.Sc. Biotechnology	**3**	**2**	**2**	**2**	**2**	**3**	**2**	**2**	**3**	**2**	**2**	**3**

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