B.Sc. (Honors) in Biotechnology (Semester System) Under the Framework of Honors School System

Choice Based Credit System (CBCS)

SEMESTER I

PANJAB UNIVERSITY, CHANDIGARH OUTLINES OF TESTS, SYLLABI AND COURSES OF READING FOR CHOICE BASED CREDIT SYSTEM B.Sc. (HONORS) BIOTECHNOLOGY UNDER THE FRAMEWORK OF HONORS SCHOOL SYSTEM (SEMESTER SYSTEM) EXAMINATION, 2019-2020

OUTLINES OF TESTS

OBJECTIVE OF THE COURSE

To teach the fundamental concepts of Biotechnology and their applications. The syllabus pertaining to B.Sc. (Honors) Biotechnology (3 Year course & 6 Semesters) in the subject of Biotechnology under Honors School Framework has been upgraded as per provision of the UGC module for CHOICE BASED CREDIT SYSTEM and demand of the academic environment. The syllabus contents are duly arranged unit wise and contents are included in such a manner so that due importance is given to requisite intellectual and laboratory skills according to UGC module for CHOICE BASED CREDIT SYSTEM pertaining to B.Sc. Honors (Biotechnology).

Semester I

CORE COURSE (BIOTECHNOLOGY)

Theory Papers:

Core Course-1 (BTC-C 1)	General Microbiology	100 Marks (4 credits)
Core Course-2 (BTC-C 2)	Molecular Biology	100 Marks (4 credits)

Practicals:

Core Course-1 Practical (BTC-C 1 Lab):	General Microbiology	50 Marks (2 credits)
Core Course-2 Practical (BTC-C 2 Lab):	Molecular Biology	50 Marks (2 credits)

GENERIC ELECTIVE (BIOTECHNOLOGY)

Theory Papers:

Each student from other disciplines may opt any two of the **Generic Electives (GE)** offered by the Science Departments of Panjab University out of following:

Generic Elective -1 (BTC-GE 1)	100 Marks (4 credits)

Practicals:

Generic Elective -1 Practical (BTC-GE 1 Lab)	50 Marks (2 credits)

ABILITY ENHANCEMENT COMPULSORY COURSE FOR BIOTECHNOLOGY STUDENTS

Theory Papers:

Each student of Biotechnology Department has to opt one **Ability Enhancement Compulsory Course (AECC)** of the following:

1. English Communication (AECC 1) 50 Marks (2 credits)

650 Total Marks (26 Total credits)

GENERIC ELECTIVE

- Course under these will be offered only if a minimum of 10 students opt for the same
- Students of Biotechnology will opt for GE from course offered by other Department under CBCS programme.

CORE COURSES

BTC-C 1 (General Microbiology) course will be taught by Department of Microbiology under IBMSER programme.

BTC-C 2 (Molecular Biology) course will be taught by Department of Biotechnology under IBMSER programme.

EVALUATION

1. There shall be one Mid Term Examination of 20% Marks (20 Marks) in each semester.
2. End-semester examination will be of 80% of total Marks (80 Marks).
3. Each practical examination shall be of 3 hours duration.
4. There shall be continuous internal assessment for practicals of 20% Marks (10 Marks). The final examination will be of 80% Marks (40 Marks).

Pattern of end-semester question paper

(i) Nine questions in all with equal weightage (16 marks). The candidate will be asked to attempt **five questions.**
(ii) One Compulsory question (consisting of short answer type questions) covering whole syllabus. There will be no choice in this question.
(iii) The remaining eight questions will have **Four Units** comprising two questions from each Unit.
(iv) Students will attempt one question from each unit and the compulsory question.

Computation of Semester Grade Point Average (SGPA)

Course	Credit	Grade Point	Credit Point
	4+2=6	X= (Marks%/10)	6X

SGPA=Total Credit point in the semester/total credits

Grade and Grade Points:

Letter Grade	O	A^+	A	B^+	B	C	P	F	Ab
Grade Point	10	9	8	7	6	5	4	0	0

CORE COURSES (BIOTECHNOLOGY)
SEMESTER I

SEMESTER I

BTC –C 1: (General Microbiology) - To be taught by the Department of Microbiology

THEORY

Total Lectures: 60

Credits: 4

Objective : *To give an overview of fundamental and applied aspects of microbiology viz. history, microbial world and its diversity, taxonomy nomenclature, growth kinetics, metabolism, microbial genetics, antimicrobial agents and role of microorganisms in human health, environment , food and industries.*

Instructions for the Paper Setters and Examiners:

Examiner will set a total of nine questions comprising two questions from each unit and one compulsory question of short answer type covering the whole syllabus. The students will attempt one question from each unit and the compulsory question. All questions may carry equal marks, unless specified.

UNIT I (15 Periods)

Introduction of Microbiology and Microbial Systematics

History and Development of Microbiology as a discipline, Scope and relevance Microscopy and observation of microbes: Light microscopy: bright field microscope, dark field microscope, phase contrast microscope, fluorescence microscope. Electron microscopy: The transmission electron microscope, Scanning electron microscope.

Systems of classification:

Binomial Nomenclature, Whittaker's five kingdom and Carl Woese's three kingdom classification systems and their utility. Numerical taxonomy, Phylogenetic and serotype classification. Difference between prokaryotic and eukaryotic microorganisms

UNIT II (15 Periods)

Diversity of Microbial World

General characteristics of different microbes groups:

Acellular microorganisms (Viruses, Viroids, Prions)

Cellular microorganisms .

2a Bacteria: Characteristics of bacteria and occurrence: Prokaryotic bacterial cell structure and function; nutrition; growth kinetics. General principles of bacterial genetics, mutations, gene transfer and recombination

2b Algae: General characteristics of algae including occurrence, structure, reproduction. Applications in agriculture, industry, environment and food.

2c Fungi: General characteristics of fungi including habitat, distribution, nutritional requirements, fungal cell ultra-structure, reproduction and applications in industry, agriculture, environment and food

2d Protozoa: General characteristics with special reference to Amoeba, Paramecium, Plasmodium, Leishmania and Giardia.

UNIT III (15 Periods)

Microbes in Human Health & Environment

Medically important pathogens & beneficial microorganism: Normal microflora of human body & its role in health. Causative agents for common human diseases, beneficial microorganisms counter acting the human pathogens and their interaction with the host. Antimicrobial chemotherapy: Drugs and their mechanism of action, antibiotic resistance and its transmission.

Environmental microbiology: important microbial interactions – mutualism, commensalism, parasitism. microorganisms used as biopesticides, biofertilizers, in biodegradation, biodeterioration and bioremediation (*e.g.,* hydrocarbons in oil spills). Water, air and sewage microbiology-an overview.

UNIT IV (15 Periods)

Microbes in Industry and Foods

Industrial Microbiology: Primary and secondary metabolites, types of fermentations and microbes producing important industrial products through fermentations. Batch, continuous and fed-batch cultivation. Genetic engineering of industrial microbes.

Food and Dairy Microbiology : Microorganisms as food (SCP), microorganisms in food fermentations (dairy and non dairy based fermented food products) and probiotics. Microorganisms in food spoilage and food borne infections.

BTC-C 1 General Microbiology
PRACTICALS

Credits : 2

1. General Introduction and familiarization to important microbiological instruments in the laboratories.
2. Introduction to microscopes and their working.
3. Microorganisms are ubiquitous: Finger printing.
4. Introduction to sterilization: Dry heat and moist heat and filtration.
5. Simple staining, Gram staining, negative staining, cell wall staining, capsule staining, flagellar staining, acid fast staining, spore staining.
6. Preparation of media (nutrient broth and nutrient agar) for the growth of microorganisms.
7. General Methods: Pour plating, spread plating, streaking and dilutions.
8. Determine the size of bacteria.
9. Motility of bacteria: Hanging drop and soft agar
10. Isolation of microorganisms from different sources: Soil, curd, root nodules, sore throat.
11. Bacterial CFUs in mineral water bottle.
12. Phenol coefficient: To study the antibacterial effect of various chemical compounds.
13. To study the antibacterial effect of antibiotics.

SUGGESTED READING

1. Tortora, G. J., Funke, B. R., & Case, C. L. (2015). *Microbiology: An introduction* (12th ed.). San Francisco, CA: Pearson Benjamin Cummings Pub. Co.
2. Madigan, M. T., Martinko, J. M., Bender K. S., Buckley, D. H., Stahl, D. A., Brock, T. (2014). *Brock Biology of Microorganisms* (14th ed.). Boston: Pearson Benjamin Cummings.
3. Cappuccino, J. G., & Sherman, N. (2013). *Microbiology: A laboratory manual* (10th ed.). California: Pearson education Limited.
4. Willey, J., Sherwood, L. & Woolverton, C. J. (2016). *Prescott's Microbiology* (10th ed.). New York City, NY: McGrew Hill International
5. Atlas, R. M. (1996). *Principles of microbiology* (2nd ed.). William C Brown publishers
6.. Pelczar, M. J. (1993). *Microbiology* (6th ed.). Singapore: McGrew Hill Book Company.
7.. Stanier, R.Y., Ingraham, J. L., Wheelis, M. L., & Painter, R. R. (1992). *General microbiology* (5th ed.). London, UK: McMillan Press.

SEMESTER I

BTC –C 2: (Molecular Biology) - To be taught by the Department of Biotechnology
THEORY

Total Lectures: 60 **Credits: 4**

Objective: *To impart in depth knowledge of i) essential processes of replication, transcription and translation, ii) structure of DNA and mRNA iii) DNA damage and repair iv) regulation of gene expression*

Instructions for the Paper Setters and Examiners:

Examiner will set a total of nine questions comprising two questions from each unit and one compulsory question of short answer type covering the whole syllabus. The students will attempt one question from each unit and the compulsory question. All questions may carry equal marks, unless specified.

UNIT I **(15 Periods)**

DNA structure and replication

DNA as genetic material, Structure of DNA, Types of DNA, Replication of DNA in prokaryotes and eukaryotes: Semiconservative nature of DNA replication, Bi-directional replication, DNA polymerases, the replication complex: Pre-priming proteins, primosome, replisome, Rolling circle replication, Unique aspects of eukaryotic chromosome replication, Fidelity of replication.

UNIT II **(10 Periods)**

DNA damage, repair and homologous recombination

DNA damage and repair: causes and types of DNA damage, mechanism of DNA repair: Photoreactivation, base excision repair, nucleotide excision repair, mismatch repair, translation synthesis, recombinational repair, non-homologous end joining. Homologous recombination: models and mechanism.

UNIT III **(17 Periods)**

Transcription and RNA processing

RNA structure and types of RNA, Transcription in prokaryotes: Prokaryotic RNA polymerase, role of sigma factor, promoter, Initiation, elongation and termination of RNA chains Transcription in eukaryotes: Eukaryotic RNA polymerases, transcription factors, promoters, enhancers, mechanism of transcription initiation, promoter clearance and elongation RNA splicing and processing: processing of pre-mRNA: 5' cap formation, polyadenylation, splicing, rRNA and tRNA splicing.

UNIT IV **(18 Periods)**

Regulation of gene expression and translation

Regulation of gene expression in prokaryotes: Operon concept (inducible and repressible system), Genetic code and its characteristics, Prokaryotic and eukaryotic translation: ribosome structure and assembly, Charging of tRNA, aminoacyl tRNA synthetases, Mechanism of initiation, elongation and termination of polypeptides, Fidelity of translation, Inhibitors of translation, Posttranslational modifications of proteins

BTC-C2: (Molecular Biology)

PRACTICALS **Credits: 2**

1. Model building of different nucleotides and making A-T ,G-C pairs
2. Preparation of solutions for Molecular Biology experiments.
3. Isolation of chromosomal DNA from bacterial cells.
4. Estimation of DNA,RNA and Proteins
5. Agarose gel electrophoresis of genomic DNA
6. SDS polyacrylamide gel electrophoresis of protein samples
7. Study of lac operon

SUGGESTED READING

1. Karp, G. (2010). *Cell and molecular biology: concepts and experiments* (6th ed.). USA: John Wiley & Sons.
2. De Robertis, E.D.P., & De Robertis, E. M .F. (2006). *Cell and molecular biology* (8th ed.). Philadelphia: Lippincott Williams and Wilkins.
3. Becker, W. M., Kleinsmith, L. J., Hardin. J., & Bertoni, G. P. (2009). *The world of the cell*. (7th ed.). San Francisco, CA: Pearson Benjamin Cummings.
4. Watson, J. D., Baker, T. A., Bell, S. P., Gann, A., Levine, M., & Losick, R. (2008). *Molecular biology of the gene* (6th ed.). Cold Spring Harbour: Pearson.

GENERIC ELECTIVE SUBJECTS
(*Offered by Biotechnology Department) ***for students of other departments***
SEMESTER I

BTC-GE 1*: Recombinant DNA Technology

SEMESTER 1
GENERIC ELECTIVE SUBJECTS
(Offered by Biotechnology Department) ***for students of other departments***

BTC –GE 1: (Recombinant DNA Technology)

THEORY

Total Lectures: 60 **Credits: 4**

Objective: *Recombinant DNA Technology refers to the process of manipulating the characteristics and functions of the original genes of an organism. The objective of this process is to introduce new physiological and physical features or characteristics. The students will learn the mechanism of introducing genes from one organism into the other and the potential implications of doing so.*

Instructions for the Paper Setters and Examiners:

Examiner will set a total of nine questions comprising two questions from each unit and one compulsory question of short answer type covering the whole syllabus. The students will attempt one question from each unit and the compulsory question. All questions may carry equal marks, unless specified.

UNIT I **(15 Periods)**

Introduction to genetic engineering. Why gene cloning and DNA analysis is important? Molecular tools and applications- restriction enzymes, Restriction and modification system, restriction mapping. ligases, polymerases, alkaline phosphatase. Gene Recombination and Gene transfer: Vectors Systems (plasmids, λ phage biology and its vectors, M13 phage and its vectors, cosmid, phagemid, artificial chromosomes, Transformation, Microinjection, Electroporation,

UNIT II **(15 Periods)**

Isolation and purification of DNA from bacteria, plants, animals and soil.Preparation and comparison of genomic and cDNA library, different strategies of gene cloning, linkers, adapters and homopolymer tailing, screening of recombinants: gene inactivation and blue white selection, Southern and Northern hybridization. Gene identification: Nucleic acid hybridization, immuno screening, functional complementation, DNA sequencing

UNIT III **(15 periods)**

Gene expression: expression vectors with respect to different promoters (lac, tac, T5, T7, lamda), signal sequences (omp), tags (His, GST, MBP and IMPACT), selection of host with respect to promoter, Processing of recombinant proteins: soluble proteins, inclusion body, Protein refolding, Therapeutic products produced by genetic engineering-blood proteins, human hormones, immune modulators and vaccines (one example each).

UNIT IV **(15 periods)**

Principle and applications of Polymerase chain reaction (PCR), primer-design, and RT- (Reverse transcription) PCR. Random and site-directed mutagenesis, PCR based cloning, Reporter assay, RNase protection assay, DNA fingerprinting, application of genetic engineering in animals and plants, Safety measures and regulations for recombinant work.

BTC –GE 1: (Recombinant DNA Technology)

PRACTICALS **Credits: 2**

1. Isolation of chromosomal DNA from plant cells
2. Qualitative and quantitative analysis of DNA using spectrophotometer
3. Plasmid DNA isolation
4. Restriction digestion of DNA
5. Making competent cells
6. Transformation of competent cells.
7. Replica plating and Blue white selection
8. Southern blotting
9. Demonstration of PCR

SUGGESTED READING

1. Brown, T. A. (2006). *Gene cloning and DNA analysis* (5th ed.). Oxford, UK.: Blackwell Publishing.
2. Clark, D. P. & Pazdernik, N. J. (2009). *Biotechnology- applying the genetic revolution*. USA: Elsevier Academic Press.
3. Glick, B. R., & Pasternak, J. J (2003). *Molecular biotechnology- principles and applications of recombinant DNA*. Washington: ASM Press.
4. Primrose, S. B., & Twyman, R. M. (2006). *Principles of Gene Manipulation and Genomics* (7th ed.). Oxford, U.K.: Blackwell Publishing.
5. Sambrook, J., Fritsch, E. F., & Maniatis, T. (2001). *Molecular cloning- a laboratory manual* (3rd ed.). Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.

B.Sc. (Honors) in Biotechnology (Semester System) Under the Framework of Honors School System

Choice Based Credit System (CBCS)

SEMESTER II

Semester II

CORE COURSE (BIOTECHNOLOGY)

Theory Papers:

Core Course-1 (BTC-C 3)	Biomolecules	100 Marks (4 credits)
Core Course-2 (BTC-C 4)	Cell Biology	100 Marks (4 credits)

Practicals:

Core Course-1 Practical (BTC-C 3 Lab):	Biomolecules	50 Marks (2 credits)
Core Course-2 Practical (BTC-C 4 Lab):	Cell Biology	50 Marks (2 credits)

GENERIC ELECTIVE (BIOTECHNOLOGY)

Theory Papers:

Each student from other disciplines may opt any two of the **Generic Electives (GE)** offered by the Science Departments of Panjab University out of following:

Generic Elective -(BTC-GE 2) 100 Marks (4 credits)

Practicals:

Generic Elective -1 Practical (BTC-GE 2 Lab) 50 Marks (2 credits)

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ABILITY ENHANCEMENT COMPULSORY COURSE FOR BIOTECHNOLOGY STUDENTS

Theory Papers:

Each student of Biotechnology Department has to opt one **Ability Enhancement Compulsory Course (AECC)** of the following:

1. Environmental Science (AECC 2) 50 Marks (2 credits)

650 Total Marks (26 Total credits)

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GENERIC ELECTIVE

- Course under these will be offered only if a minimum of 10 students opt for the same
- Students of Biotechnology will opt for GE from course offered by other Department under CBCS programme.

CORE COURSES

BTC-C 3 (Biomolecules) course will be taught by Department of Biochemistry under IBMSER programme.

BTC-C 4 (Cell Biology) course will be taught by Department of Biophysics under IBMSER programme.

EVALUATION

1. There shall be one Mid Term Examination of 20% Marks (20 Marks) in each semester.
2. End-semester examination will be of 80% of total Marks (80 Marks).
3. Each practical examination shall be of 3 hours duration.
4. There shall be continuous internal assessment for practicals of 20% Marks (10 Marks). The final examination will be of 80% Marks (40 Marks).

Pattern of end-semester question paper

(i) Nine questions in all with equal weightage (16 marks). The candidate will be asked to attempt five questions.

(ii) One Compulsory question (consisting of short answer type questions) covering whole syllabus. There will be no choice in this question.

(iii) The remaining eight questions will have **Four Units** comprising two questions from each Unit.

(iv) Students will attempt one question from each unit and the compulsory question.

Computation of Semester Grade Point Average (SGPA)

Course	**Credit**	**Grade Point**	**Credit Point**
	4+2=6	X= (Marks%/10)	6X

SGPA=Total Credit point in the semester/total credits

Grade and Grade Points:

Letter Grade	**O**	**A^+**	**A**	**B^+**	**B**	**C**	**P**	**F**	**Ab**
Grade Point	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**0**	**0**

CORE COURSES (BIOTECHNOLOGY)

SEMESTER II

SEMESTER II

BTC –C 3: (Biomolecules) - To be taught by the Department of Biochemistry

THEORY

Total Lectures : 60 **Credits : 4**

Objective: *To familiarize the students with major biomolecules namely carbohydrates, lipids, proteins and nucleic acids which are important for the structural organization and functions of the cells. The course encompasses the overall perspective on the biomolecules their characteristic properties and organization in carrying out all the living functions which constitute the life.*

Instructions for the Paper Setters and Examiners:

Examiner will set a total of nine questions comprising two questions from each unit and one compulsory question of short answer type covering the whole syllabus. The students will attempt one question from each unit and the compulsory question. All questions may carry equal marks, unless specified.

UNIT 1 **(15 Periods)**

Carbohydrates

Introduction : Scope of Biochemistry and Molecular Biology. Molecular logic of living systems. ***Water:*** Physical properties and hydrogen bonding of water, structure of liquid water, other properties of hydrogen bonding, solvent properties of water, ionization of water, ion product of water: The pH scale, Acids and Bases, Acid-Base indicators, Buffers.

Carbohydrates: Definition and classification, Families of monosaccharides, Stereoisomerism of monosaccharides, Mutarotation and the anomeric forms of D-glucose. Action of acids and bases on monosaccharides. Structure and functions of important derivatives of monosaccharides, disaccharides, polysaccharides (Glycans); storage polysaccharides, structural polysaccharides.

UNIT II **(15 Periods)**

Lipids

Lipids: Definition and classification. Fatty acids (structures and nomenclature). Essential fatty acids. Important reactions of functional groups present in fatty acids. Characteristics of fatty acids and fats (saponification, iodine, acid, acetyl and peroxide values). Rancidity of fats, refractive index, melting point and boiling point of fats and their physical properties. Waxes, triacylglycerols, phosphoglycerides, sphingolipids, eicosanoids, sterols.

UNIT III **(15 Periods)**

Proteins

Amino Acids: Common structural features: Classification based on the nature of 'R' groups. Special amino acids present in proteins. Stereochemistry of amino acids. Non-protein amino acids. Physical and chemical properties of amino acids. Titration of amino acids. Separation of amino acids by paper chromatography and ion exchange chromatography.

Peptide Bonds: Rigid and planar nature of the peptide bond. Structure and function of some naturally occurring polypeptides. Chemical synthesis of polypeptide.

Proteins: Structural levels Primary, Secondary, Super Secondary structure (motifs) of proteins, Tertiary and Quaternary structures of proteins structure. Determination of primary structure of proteins.

UNIT IV (15 Periods)

Nucleic acids

Nucleic Acids: Structure of purine and pyrimidine bases. Nucleosides and nucleotides. Biologically important nucleotides. Different forms of DNA and RNA. Ribozymes. Denaturation of DNA. Physical and chemical properties of nucleic acids. Methods for isolation, purification and characterization of nucleic acids. Chemical and enzymatic hydrolysis of nucleic acids. DNA as genetic material, experimental evidence.

Porphyrins: Porphyrin nucleus and classification of porphyrins. Important porphyrins occurring in nature. Detection of porphyrins spectrophotometrically. Bile pigments – chemical nature and their physiological significance.

BTC-C 3: Biomolecules
PRACTICALS **Credits : 2**

1. Preparation of standard solution of HCl/ H_2SO_4.
2. Preparation of buffers of known molarity and pH.
3. Estimation of saponification value of fat/oil.
4. Estimation of iodine value of fat/oil.
5. Titration curve of an amino acid and determination of its pKa and isoelectric pH.
6. Isolation of casein from milk.
7. Isolation of starch from potato/gluten from wheat.
8. Qualitative tests for carbohydrates.
9. Qualitative tests for amino acids.
10. Separation of amino acids by thin layer chromatography.

SUGGESTED READING

1. Nelson, D. L., Lehninger, A. L., & Lehninger, C. M. M. (2008). *Principles of biochemistry* (5th ed.). New York: W.H Freeman & Co.
2. Botham, K., Mayes, P., Murray, R. K., & Granner, D. K. (2006). *Harper's illustrated biochemistry* (27th ed.). New York: McGraw-Hill Companies.
3. Voet, D., & Voet, J. G. (2011). *Biochemistry* (3rd ed.). Singapore: John Wiley & Sons Inc.
4. Berg, J. M., Tymoczko, J. L., & Stryer, L. (2012) *Biochemistry* (7th ed.). New York: W. H Freeman & Co.