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

Choice Based Credit System (CBCS)

3rd Year
(SEMESTER V & SEMESTER VI)

COURSE STRUCTURE

SEMESTER V		SEMESTER VI	
C 11	**BTC-C 11:** Animal Biotechnology	**C 13**	**BTC-C 13:** Immunology
C 12	**BTC-C 12:** Recombinant DNA Technology	**C 14**	**BTC-C 14:** Plant Biotechnology
DSE 1 & DSE 2	**BTC-DSE 1:** Developmental Biology **BTC-DSE 2:** Environmental Biotechnology **BTC-DSE 3:** Bioinformatics **BTC-DSE 4:** Genetics **(Any two in Semester V)**	**DSE 3 & DSE 4**	**BTC-DSE 5:** Ecology and Environment Management **BTC-DSE 6:** Microbial Physiology **BTC-DSE 7:** Medical Microbiology **BTC-DSE 8:** Food Biotechnology **(Any two in Semester VI)**

C: Core Courses; DSE: Discipline Specific Elective

Semester V
CORE COURSE (BIOTECHNOLOGY)

Theory Papers:

Core Course-1 (BTC-C 11)	Animal Biotechnology	100 Marks (4 credits)
Core Course-2 (BTC-C 12	Recombinant DNA Technology	100 Marks (4 credits)

Practicals:

Core Course-1 (BTC-C 11 Lab)	Animal Biotechnology	50 Marks (2 credits)
Core Course-2 (BTC-C 12 Lab)	Recombinant DNA Technology	50 Marks (2 credits)

DSE: DISCIPLINE SPECIFIC ELECTIVES (BIOTECHNOLOGY)

Theory Paper:

Each Biotechnology student may opt **any two** of the **Discipline Specific Electives** offered by the Department of Biotechnology, Panjab University out of following:

Discipline Specific Electives-1 (BTC-DSE 1)	100 Marks (4 credits)
Discipline Specific Electives-2 (BTC-DSE 2)	100 Marks (4 credits)

Practicals:

Discipline Specific Electives-1 (BTC-DSE 1 Lab)	50 Marks (4 credits)
Discipline Specific Electives-2 (BTC-DSE 2 Lab)	50 Marks (4 credits)

600 Total Marks (24 Total credits)

DISCIPLINE SPECIFIC ELECTIVES

- Course under these will be offered only if a minimum of 10 students opt for the same
- Each Biotechnology student may opt **any two** of the **Discipline Specific Electives** offered by the Department of Biotechnology, Panjab University.

CORE COURSES

- **BTC-C 11** (Animal Biotechnology) and **BTC-C 12** (Recombinant DNA Technology) will be taught by Department of Biotechnology.

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 V

Semester V
BTC-C 11: (Animal Biotechnology)
THEORY

Total Lectures: 60 **Credits: 4**

Objective: *The major emphasis of this course is to introduce the students to the fields of Animal cell-culturing and their importance to mankind. The students will also learn the techniques involved in organ/animal cloning and biodiversity conservation*

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 **(10 Periods)**

Equipments and materials for animal cell culture technology. Primary and established cell line cultures. Introduction to the balanced salt solutions and simple growth medium. Brief discussion on the chemical, physical and metabolic functions of different constituents of culture medium. Role of carbon dioxide. Role of serum and supplements. Measurement of viability and cytotoxicity, cryopreservation

UNIT II **(10 Periods)**

Gene transfer methods in Animals – Microinjection, embryonic stem cell, gene transfer, Retrovirus & Gene transfer. Introduction to transgenesis. Transgenic Animals – Mice, Cow, Pig, Sheep, Goat, Bird, Insect.

UNIT III **(20 Periods)**

Animal propagation – Artificial insemination, Animal Clones. Conservation Biology – Embryo transfer techniques. Introduction to stem cell technology and its applications. Biotechnology in Pest control, Aquaculture and sericulture

UNIT IV **(20 Periods)**

Genetic modification in Medicine - gene therapy, types of gene therapy, vectors in gene therapy, molecular engineering, human genetic engineering, problems & ethics.

BTC –C 11: (Animal Biotechnology)
PRACTICALS

Credits: 4

1. Fumigation of cell culture lab, sterilization of glassware and equipment
2. Preparation of cell culture media and trypsin solution
3. Observation of adherent (Fibroblastic, epithelial) and suspension cultures (Lymphoblast)
4. Subculturing
5. Cell counting by haemocytometer and plating of cells at 40%, 60% and 80% confluency.
6. Cryopreservation of cell lines
7. Revival of frozen stocks of cell lines

8. Estimation of cell viability by dye exclusion (Trypan blue) and dye uptake (fluorescein diacetate) test
9. Determination of the IC50 value of a drug using MTT assay

SUGGESTED READING

1. Freshney, R. I. (2009). *Culture of animal cells* (6th ed.). New Jersey: John Willey & Sons
2. Brown, T.A. (1998). *Molecular biology Labfax II: Gene analysis* (2nd ed.). California, USA: Academic Press.
3. Butler, M. (2004). *Animal cell culture and technology: the basics* (2nd ed.). New York: Bios scientific.
4. Glick, B.R., & Pasternak, J. J. (2009). *Molecular biotechnology- principles and applications of recombinant DNA* (4th ed.). Washington, USA: ASM press
5. Griffiths, A. J. F., Miller, J. H., Suzuki, D.T., Lewontin, R. C., & Gelbart, W.M. (2009). *An introduction to genetic analysis* (4th ed.). NY, USA: Freeman & Co.
6. Watson, J. D., Myers, R. M., Caudy, A., & Witkowski, J. K. (2007). *Recombinant DNA genes and genomes- A short course* (3rd ed.). NY, USA: Freeman and Co.

Semester V
BTC-C 12: (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 –C 12: (Recombinant DNA Technology)
PRACTICALS

Credits: 2

1. Isolation of chromosomal DNA
2. Qualitative and quantitative analysis of DNA
3. Plasmid DNA isolation/ analysis
4. Restriction digestion pattern of chromosomal and plasmid DNA/ size determination
5. Isolation and purification of DNA fragment from agarose gel
6. Ligation of restriction enzyme digested DNA fragments and vector
7. Preparation of competent cells
    a. For heat shock method
    b. Electrocompetent cells
8. Transformation of competent cells by heat shock method and electroporation/ transformation efficiency
8. Demonstration of alpha complementation and blue white selection
9. Conformation of recombinant plasmid
    i. By plasmid migration
    ii. Fragment analysis by restriction digestion
10. Southern blotting
11. Primer designing and 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.

DSE: DISCIPLINE SPECIFIC ELECTIVES (BIOTECHNOLOGY)
(Offered by Biotechnology Department) ***for biotechnology students only***
SEMESTER V

BTC-DSE 1: Developmental Biology **BTC-DSE 2:** Environmental Biotechnology **BTC-DSE 3:** Bioinformatics **BTC-DSE 4:** Genetics	**Any two in semester V**

Semester V
DISCIPLINE SPECIFIC ELECTIVE (any two in semester V)
BTC-DSE 1: (Developmental Biology)

THEORY

Total Lectures: 60 **Credits: 4**

Objective: *This course has been designed to make the students understand a) the basic aspects of cell cycle and cell division, b) the principles of development processes and c) the development processes in various animal models, progressing from morphogenesis to organogenesis.*

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 **(20 Periods)**

Gametogenesis, Fertilization and Early embryonic development

Introduction to basic aspects of cell cycle and its control. Detailed description of Mitosis and Meiosis Gametogenesis – Spermatogenesis, Oogenesis Fertilization - Definition, mechanism, types of fertilization. cell surface molecules in sperm-egg recognition in animals. Cleavage: Definition, types, patterns & mechanism Blastulation: Process, types & mechanism Gastrulation: Morphogenetic movements– epiboly, emboly, extension, invagination, convergence, de-lamination. Formation & differentiation of primary germ layers

UNIT II **(20 Periods)**

Embryonic Differentiation

Basic concepts of development: Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting. Control of differentiation at the level of genome, transcription and post-translation level Concept of embryonic induction: Primary, secondary & tertiary embryonic induction, Neural induction and induction of vertebrate lens.

UNIT III **(10 Periods)**

Organogenesis

Neurulation, notogenesis, development of vertebrate eye. Fate of different primary germ layers Development of behaviour: constancy & plasticity, Extra embryonic membranes, placenta in Mammals**.**

UNIT IV **(10 Periods)**

Morphogenesis and organogenesis in animals

Cell aggregation and differentiation in *Dictyostelium discoideum*; axes and pattern formation in *Drosophila melanogaster*. Organogenesis – vulva formation in *Caenorhabditis elegans*; environmental regulation of normal development; regeneration in vertebrates, sex determination.

BTC-DSE 1: Developmental Biology
PRACTICALS

Credits: 2

1. To prepare a slide for different stages for mitosis in onion root tip
2. To study the process of meiosis in barley bud
3. Study of life cycle of *C. elegans* from videos/photographs
4. Study of life cycle of *Dictyostelium discoideum* cells from videos/photographs
5. Study of the developmental stages of *Drosophila* from videos/photographs.

SUGGESTED READING

1. Gilbert, S. F. (2006). *Developmental Biology* (8th ed.). Sunderland, Massachusetts, USA: Sinauer Associates, Inc.
2. Balinsky, B.I. (2008). *An introduction to Embryology*. International Thomson Computer Press.
3. Kalthoff, (2000). *Analysis of Biological Development* (2nd ed.). New York: McGraw-Hill Professional.

Semester V
DISCIPLINE SPECIFIC ELECTIVE (any two in semester V)
BTC-DSE 2: (Environmental Biotechnology)

THEORY

Total Lectures: 60 **Credits: 4**

Objectives: *To understand the importance and types of environmental pollution, detection of mutagens. Biotechnological approaches to tackle environmental pollution.*

Practical skills will be imparted to the students through critically designed practicals related to the subject.

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 : Historical importance.
Environment pollution and its types.
Impact of pollution on health

Unit-II **(15 Periods)**

Treatment of waste water treatment, removal of nitrogen and phosphorus, disinfection.
Treatment of polluted air containing volatile toxic gases and biofilteration.
Introduction to toxicology including genetic toxicology, common assays to detect genotoxic compounds
Use of genetic engineering techniques in genetic toxicology.

Unit-III **(15 Periods)**

Solid waste management by composting, vermicomposting, sanitary landfills, treatment of hazardous and bio-medical waste, management of E-waste Methanogenesis

Biodegradation of organic pollutants (organic solvents, pesticides)
Bioremediation (*In situ* and *ex situ* approaches)

Unit-IV **(15 Periods)**

Remediation of metal contaminated soil and aquatic systems by microorganism and plants, mechanism of metal resistance and detoxification Biomining and bioleaching

Plastic menace, biodegradable plastics.
Biosafety levels

ESSENTIAL READINGS

1. Environmental Biotechnology: Principles and applications (2000) Bruce E. Rittmann and Perry L. Mc.Corty, Mc. Graw-Hill Publications, New York.
2. Environmental Biotechnology 2^{nd} Edition, (2005) Alan Scragg, Oxford University Press.
3. Environmental Biotechnology (2005): Concepts and Applications, Hans-Joachim Jordening and Josef Winter. Wiley-VCH Verlag.
4. Environment Microbiology (2000) Raina M Maier, IanL. Pepper and Charles P. Gerba, Academic Press Publication, USA.
5. Principles of Environmental Toxicology (1998) I.C. Shaw and J. Chadwick , Taylor and Fracis Ltd. Publication.

FURTHER READINGS

6. Environmental Biotechnology: Theory and Applications CmBH and Co. Gareth M. Evans and Judith C. Furlong. Wiley Publishers 2003.
7. Basic Environmental Biotechnology by Omenn, G.E., 1987, Plenum Press, N.Y.

BTC-DSE 2: (Environmental Biotechnology)
PRACTICALS

1. Estimation of dissolved oxygen in water samples
2. Determination of BOD in polluted water sample
3. Determination of COD in polluted water
4. Estimation of Chlorine in water samples
5. Detection of coliform bacteria in water samples
6. Estimation of NO_X concentration.
7. Estimation of SO_X concentration.
8. Isolation of pesticide degrading micro organisms from soil
9. Biosorption of dyes from effluents by biomass and its recycling

BTC-DSE 3: (Bioinformatics)

THEORY

Total Lectures: 60 **Credits: 4**

Objective: *This course lays emphasis on the role of computational tools in the field of biotechnology. The students will be exposed to various data basis pertaining to DNA, RNA and protein sequences*

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 (10 Periods)

History of Bioinformatics. The notion of Homology. Sequence Information Sources, EMBL, GENBANK, Entrez, Unigene, Understanding the structure of each source and using it on the web.

UNIT II (20 Periods)

Protein Information Sources, PDB, SWISSPROT, TREMBL, Understanding the structure of each source and using it on the web. Introduction of Data Generating Techniques and Bioinformatics problem posed by them- Restriction Digestion, Chromatograms, Blots, PCR, Microarrays, Mass Spectrometry.

UNIT III (20 Periods)

Sequence and Phylogeny analysis, Detecting Open Reading Frames, Outline of sequence Assembly, Mutation/Substitution Matrices, Pairwise Alignments, Introduction to BLAST, using it on the web, Interpreting results, Multiple Sequence Alignment, Phylogenetic Analysis.

UNIT IV (10 Periods)

Searching Databases: SRS, Entrez, Sequence Similarity Searches-BLAST, FASTA, Data Submission. Genome Annotation: Pattern and repeat finding, Gene identification tools.

BTC-DSE 3: (Bioinformatics)
PRACTICALS

Credits: 2

1. Sequence information resource
2. Understanding and use of various web resources: EMBL, Genbank, Entrez, Unigene,
3. Protein information resource (PIR)
4. Understanding and using: PDB, Swissprot, TREMBL
5. Using various BLAST and interpretation of results.
6. Retrieval of information from nucleotide databases.
7. Sequence alignment using BLAST.
8. Multiple sequence alignment using Clustal W.

SUGGESTED READING

1. Ghosh, Z., & Bibekanand, M. (2008). *Bioinformatics: Principles and Applications*. India: Oxford University Press.
2. Pevsner, J. (2009). *Bioinformatics and Functional Genomics* (2nd ed.). Hoboken, NJ: Wiley-Blackwell.
3. Campbell, A. M., & Heyer, L. J. (2006). *Discovering Genomics, Proteomics and Bioinformatics* (2nd ed.). NY: Cold Springer Laboratory Press & Benjamin Cummings.

BTC-DSE 4: (Genetics)
THEORY

Total Lectures: 60 **Credits: 4**

Objective: *To develop basic skills in eliciting a genetic history, constructing a pedigree, examining, genetic evaluation and genetic counseling and to develop attitudes required for managing genetic diseases and birth defects.*

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: Historical developments in the field of genetics. Organisms suitable for genetic experimentation and their genetic significance. Cell Cycle: Mitosis and Meiosis: Control points in cell-cycle progression in yeast. Role of meiosis in life cycles of organisms. Mendelian genetics: Mendel's experimental design, monohybrid, di-hybrid and tri hybrid crosses, Law of segregation & Principle of independent assortment. Verification of segregates by test and back crosses, Chromosomal theory of inheritance, Allelic interactions: Concept of dominance, recessiveness, incomplete dominance, co-dominance, semi-dominance, pleiotropy, multiple allele, pseudo-allele, essential and lethal genes, penetrance and expressivity.

UNIT II (15 Periods)

Non allelic interactions: Interaction producing new phenotype complementary genes, epistasis (dominant & recessive), duplicate genes and inhibitory genes. Chromosome and genomic organization: Eukaryotic nuclear genome nucleotide sequence composition –unique & repetitive DNA, satellite DNA. Centromere and telomere DNA sequences, middle repetitive sequences- VNTRs & dinucleotide repeats, repetitive transposed sequences- SINEs & LINEs, middle repetitive multiple copy genes, noncoding DNA. Genetic organization of prokaryotic and viral genome. Structure and characteristics of bacterial and eukaryotic chromosome, chromosome morphology, concept of euchromatin and heterochromatin. packaging of DNA molecule into chromosomes, chromosome banding pattern, karyotype, giant chromosomes, one gene one polypeptide hypothesis, concept of cistron, exons, introns, genetic code, gene function.

UNIT III (15 Periods)

Chromosome and gene mutations: Definition and types of mutations, causes of mutations, Ames test for mutagenic agents, screening procedures for isolation of mutants and uses of

mutants, variations in chromosomes structure - deletion, duplication, inversion and translocation (reciprocal and Robertsonian), position effects of gene expression, chromosomal aberrations in human beings, abonormalities– Aneuploidy and Euploidy. Sex determination and sex linkage: Mechanisms of sex determination, Environmental factors and sex determination, sex differentiation, Barr bodies, dosage compensation, genetic balance theory, Fragile-X-syndrome and chromosome, sex influenced dominance, sex limited gene expression, sex linked inheritance.

UNIT IV (15 Periods)

Genetic linkage, crossing over and chromosome mapping: Linkage and Recombination of genes in a chromosome crossing over, Cytological basis of crossing over, Molecular mechanism of crossing over, Crossing over at four strand stage, Multiple crossing overs Genetic mapping. Extra chromosomal inheritance: Rules of extra nuclear inheritance, maternal effects, maternal inheritance, cytoplasmic inheritance, organelle heredity, genomic imprinting. Evolution and population genetics: In breeding and out breeding, Hardy Weinberg law (prediction, derivation), allelic and genotype frequencies, changes in allelic frequencies, systems of mating, evolutionary genetics, natural selection.

BTC-DSE 4: (Genetics)
PRACTICALS

Credits: 2

1. Probability distribution test.
2. To test the 'Goodness of fit' of the data using the Chi- Square statistical method.
3. Processing of human blood for chromosomal separation and karyotyping:
    b) sample processing and culturing
    c) arresting the cells at metaphase
    d) chromosome isolation
    e) slide preparation and staining with Giemsa
    f) visualizing and analysing the chromosomes
4. To arrange the human karyotype and identify the chromosomal disorders.
5. To explore the utility of OMIM search tool for human genetic diseases.
6. Nucleotide sequence search for the genetic diseases using the BLAST tool.

SUGGESTED READING

1. Gardner, S., & Snustad, J. (2006) *Principles of genetics* (8th ed.). NY: John Wiley and Sons. Inc.
2. Snustad, D.P., Simmons, M.J. (2009). *Principles of Genetics* (5th ed.). NJ, USA: John Wiley and Sons Inc.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. (9th ed.). San Francisco, California: Benjamin Cummings.
4. Russell, P. J. (2006). *iGenetics: A molecular approach* (2nd ed.). San Francisco, CA: Pearson Education Inc.
5. Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C., & Carroll, S.B. (2007). *Introduction to Genetic Analysis* (9th ed.). New York, USA: W. H. Freeman & Co.
6. Strachan, T., Read, A. (2011). *Human Molecular Genetics* (4th ed.). NY, USA: Garland Science.