* Syllabus and Evaluation Scheme *

for

M.Sc. BIOTECHNOLOGY
(Semester I to IV)

Department of Biotechnology
Chaudhary Bansi Lal University, Bhiwani
(A State University established under Haryana Act No. 25 of 2014)

(2020-21)

(Date of amendments: July 2020)

Chaudhary Bansi Lal University, Bhiwani
(A State University established under Haryana Act No. 25 of 2014)

M.Sc. Biotechnology Evaluation Scheme

Summary

Program : M.Sc. Biotechnology
Duration : Two years (Four Semesters)
Minimum Attendance Required : **75%**
Total Credits : **106**
Total Marks **:** **2350**

Assessment/Evaluation of Theory examination:

Internal Marks	Major Test (End Semester Exam) Marks	Total Marks
20	80	100
10	40	50

Internal Evaluation:

Minor Test Marks	Attendance Marks	Assignment/ Quizzes Marks	Total Marks
10	5	5	20
5	3	2	10

Duration of Examination:

Minor Test	Major Test
1 or 1.5 hr.	2 or 3 hrs.

To qualify the course, a student is required to secure a minimum of 40% marks in aggregate including the internal evaluation and Major Test (End Semester Examination).

Note: The student should also be involved in Non-CGPA extracurricular activities (Hobbies Clubs). The centralized instructions related to these clubs are available at University website.

Education/Teaching policies: Lectures will be delivered using livelihood methods wherever required to the subject concerned. The syllabus will be covered by different modes such as, Digital aided learning (DAL), Digital and classroom learning (DCL), classroom and lab learning (CLL) and Digital self-learning (DSL). Topics related to the Digital self-learning (DSL) and classroom and lab learning (CLL) have been mentioned exclusively in the syllabus. Blending of curriculum with Indian knowledge system has also been considered while designing the curriculum. Students can opt MOOC courses from SWAYAM portal as per UGC guidelines in each semester.

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GENERAL INSTRUCTIONS FOR OTHER COURSES

1. Research training (19BT 307) **Max. Marks 50**

This course will develop scientific aptitude of the students. The student will identify a problem and possible solutions to it based on his knowledge that is obtained from books, journals and internet. A minimum of 75% attendance is mandatory for this course.

- The study topic will be decided by the student in consultation with the supervisor based on a real problem of human society.
- At the end of the study student will submit a review article based on the topic assigned. In addition, the student will also deliver a seminar to the department that will be evaluated by the internal committee assigned by the head of the department.
- The student will organize the review as following: Title, Abstract, Introduction, Main body text, Conclusion and Future scope. Use headings and sub-headings, graphics wherever necessary. Also provide the list of books/references at the end that are cited in the review.

The following criteria will be considered while evaluating the candidate.

- Presentation - 10 marks
- Knowledge of the subject - 10 marks
- Answers to the questions - 05 marks
- Review article - 25 marks

2. Research report (19BT 405) **Max. Marks 200**

Every student will have to do research work based on the topic assigned by the teacher of the department. At the end of the semester the student will submit a "Report" based on his/her research work. Internal evaluation will be on the basis of pre assigned seminar and monthly progress reports (the format will be provided by the department) to their respective research guide. External evaluation will be carried by external examiner on the basis of presentation, viva-voce, and research report.

Topics for the research report: Teacher may assign research topics to the students in following areas:

i. Lab-oriented
ii. Computer and software-oriented
iii. Survey-oriented
iv. Study-oriented
v. Combination of any of the above mentioned areas

Criteria for Evaluation:

a. Attendance (Minimum attendance required 75%)

Total Attendance (%)	Marks Awarded (Max marks 20)
>75-80	05
>80-85	10
>85-90	15
>90	20

b. Internal Evaluation- 50 Marks

i) Pre study seminar - 20 Marks
ii) Progress reports - 30 Marks

c. External evaluation- 130 Marks

i) Final seminar - 30 Marks
ii) Viva-voce - 20 Marks
iii) Research report - 80 Marks

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Semester-I Credits-26 Marks-550

S. No.	Paper Code	Subject	Course Type	Weekly contact hour			Credits			Examination Scheme			
				T	P	Total	T	P	Total	T	Int	P	Total
1.	19BT 101	Cell Biology	C.C.	04	-	04	04	-	04	80	20	-	100
2.	19BT 102	Biomolecules and Metabolism	C.C.	04	-	04	04	-	04	80	20	-	100
3.	19BT 103	Microbiology	C.C.	04	-	04	04	-	04	80	20	-	100
4.	19BT 104	Molecular Biology	C.C.	04	-	04	04	-	04	80	20	-	100
5.	19BT 105	Biotech Lab I	C.C.	-	16	16	-	08	08	-	-	100	100
6.	19LS 101	Communication Skills	A.E.C.C	02	-	02	02	-	02	40	10	-	50
Total				**18**	**16**	**34**	**18**	**08**	**26**	**360**	**90**	**100**	**550**

T= Theory **P**=Practical **Int**=Internal assessment
A.E.C.C.= Ability Enhancement Compulsory Course **C.C=** Core Course
Tutorials or other courses implemented at the departmental level will be mentioned in the time table.

Semester-II Credits-26 Marks-550

S. No.	Paper Code	Subject	Course Type	Weekly contact hour			Credits			Examination Scheme			
				T	P	Total	T	P	Total	T	Int	P	Total
1.	19BT 201	Immunology	C.C.	04	-	04	04	-	04	80	20	-	100
2.	19BT 202	Bioinformatics	S.E.C.	04	-	04	04	-	04	80	20	-	100
3.	19BT 203	Genetic Engineering	C.C.	04	-	04	04	-	04	80	20	-	100
4.	19BT 204	Developmental Biology	C.C.	04	-	04	04	-	04	80	20	-	100
5.	19BT 205	Biotech Lab II	C.C.	-	16	16	-	08	08	-	-	100	100
6.	19LS 201	Biostatistics	S.E.C.	02	-	02	02	-	02	40	10	-	50
Total				**18**	**16**	**34**	**18**	**08**	**26**	**360**	**90**	**100**	**550**

T= Theory **P**=Practical **Int**=Internal assessment **C.C=** Core Course **S.E.C.**= Skill Enhancement Course
Tutorials or other courses implemented at the departmental level will be mentioned in the time table.

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Semester-III Credits-28 Marks-650

S. No.	Paper Code	Subject	Course Type	Weekly contact hour			Credits			Examination Scheme			
				T	P	Total	T	P	Total	T	Int	P	Total
1.	19BT 301	Plant Biotechnology	C.C.	04	-	04	04	-	04	80	20	-	100
2.	19BT 302	Animal Cell Technology	C.C.	04	-	04	04	-	04	80	20	-	100
3.	19BT 303	Environmental Biotech	C.C.	04	-	04	04	-	04	80	20	-	100
4.	19BT 304	Molecular Modelling	D.S.E.# (**any one**)	04	-	04	04	-	04	80	20	-	100
5.	19BT 305	Biology of infectious diseases											
6.	19BT 306	Biotech Lab III	C.C.	-	16	16	-	08	08	-	-	100	100
7.	19BT 307	Research training	S.E.C	02	-	02	02	-	02	-	50	-	50
8.		Open Elective-I*	O.E.C	02	-	02	02	-	02	80	20	-	100
Total				**20**	**16**	**36**	**20**	**08**	**28**	**400**	**150**	**100**	**650**

T= Theory **P**=Practical **Int**=Internal assessment **C.C**= Core Course **D.S.E.**= Discipline-Specific Elective
O.E.C= Open Elective Course **S.E.C.**= Skill Enhancement Course
# These courses will be offered exclusively when at least five students register for the course.
***** It will be offered by other departments of the university.
Tutorials or other courses implemented at the departmental level will be mentioned in the time table.

Semester-IV Credits-26 Marks-650

S. No.	Paper Code	Subject	Course Type	Weekly contact hour			Credits			Examination Scheme			
				T	P	Total	T	P	Total	T	Int	P	Total
1.	19BT 401	Bioprocess Technology	C.C.	04	-	04	04	-	04	80	20	-	100
2.	19BT 402	Bio techniques	C.C.	04	-	04	04	-	04	80	20	-	100
3.	19BT 403	IPR and Biosafety	D.S.E.# (**any one**)	04	-	04	04	-	04	80	20	-	100
4.	19BT 404	Biotech Management & Entrepreneurship											
5.		Open Elective II*	O.E.C	02	-	02	02	-	02	80	20	-	100
6.	19BT 405	Research Report	S.E.C	-	24	24	-	12	12	-	50	150	200
Total				**14**	**24**	**38**	**14**	**12**	**26**	**320**	**130**	**150**	**600**

T= Theory **P**=Practical **Int**=Internal assessment **C.C**= Core Course **D.S.E.**= Discipline-Specific Elective
O.E.C= Open Elective Course **S.E.C.**= Skill Enhancement Course
# These courses will be offered exclusively when at least five students register for the course.
***** It will be offered by other departments of the university.
Tutorials or other courses implemented at the departmental level will be mentioned in the time table.

Chaudhary Bansi Lal University, Bhiwani
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M.Sc. Biotechnology (Semester-I)

19BT 101
Cell Biology

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Time: 3 hrs

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

Objectives: This course will provide the fundamental knowledge of cell, which is a biochemical system to maintain the structure, metabolism and reproduction in living organisms.

Outcomes: The students will understand cells organelles, division, regulation and its interactions with the environment. These learning will prepare the students to develop their queries into the life processes. This course will enable the students to seek career in the field of medical sciences with a specific focus on the treatment of cell-related diseases, neuroscience, chromatin biology and stem cell therapy. In addition, it will also open avenues in research as cell biologist.

Unit I

Introduction to cell biology: Preface of cell biology; ultrastructure of a typical animal and plant cell[CLL]; detailed structural organization and functions[CLL] of cell wall, nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, ribosome, chloroplast, flagella; cell organelle and human diseases[DSL].

Membrane structure and function: Molecular composition of the cell membrane; structural models of the membrane; importance of membrane fluidity and lipid asymmetry; cell to cell junctions. Membrane transport system: Passive and active transports[CLL]; membrane pumps; ion channels; electrical properties of membrane[DSL].

Unit II

Cytoskeleton and cell motility: Structure, dynamic organization and importance of cytoskeleton; microtubule motors and movement; cell adhesion; extracellular matrix[DSL]; mechanism of protein sorting and transport.

Genomic organization: Morphological and functional elements of eukaryotic chromosome[CLL]; chromatin organization; heterochromatin and euchromatin[DSL].

Unit III

Cell Cycle: Steps in cell cycle; regulation and control of cell cycle; mitosis and meiosis[CLL].

Cell signaling and communication: General principles of cell communication; hormones and their receptors; second messengers; signaling through G-protein coupled receptors; bacterial and plant two-component systems; light signaling in plants; bacterial chemotaxis and quorum sensing; neurotransmission and its regulation[DSL].

Unit IV

Cell death and cell renewal: Biology of aging; apoptosis[CLL], necrosis and autophagy; mechanisms of programmed cell death; stem cells and their clinical applications[DSL]; cell cloning.

Biology of cancer cell: Biology of cancer; cell transformation and cancer; virus-induced cancer; proto-oncogenes, oncogenes and tumor suppressor genes; metastasis; molecular approaches for cancer treatment.

DSL=Digital Self Learning
CLL=Classroom and Lab Learning

Suggested readings:

1. Molecular Biology of the Cell by Bruce Alberts *et al*., Garland Science.
2. Cell Biology by C B Powar, Himalayan Publishing House.
3. Essential Cell Biology by Bruce Albert et al., Garland Science.
4. Molecular Cell Biology by Harvey Lodish et al., W H Freeman & Co, New York.
5. Becker's World of the Cell by W.M Becker et al., Pearson Education.
6. Cell and Molecular Biology by Gerald Karp, John Wiley and Sons, Inc.
7. Cell Biology by P S Verma and V K Agarwal, S Chand Publishing

Please note: The latest edition of these books is proposed or as recommended by the concerned faculty.

Chaudhary Bansi Lal University, Bhiwani
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M.Sc. Biotechnology (Semester-I)

19BT 102
Biomolecules and Metabolism

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Time: 3 hrs.

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

Objectives: The main aim of this course is to consolidate the knowledge of students towards the basic molecules of life and their metabolism. This knowledge will help to explore the area of human physiology and health.

Outcomes: Career opportunities in this study can be in government agencies, private research institutions, hospitals, social and non-profit organizations to conduct research, clinical trials and to find out cures for various diseases particularly metabolic diseases.

Unit I

Preface of Biochemistry: Principles of biophysical chemistry (pH[CLL], buffer[CLL], reaction kinetics, thermodynamics and colligative properties); stabilizing interactions (Van der waals, electrostatic, hydrogen bonding, hydrophobic interaction etc.) [DSL]; water and its properties.

Carbohydrates: Structure and function of biologically important mono, di and polysaccharides, Glycoproteins & glycolipids; Metabolism of carbohydrates: Glycolysis, Citric acid cycle, Gluconeogenesis, Glycogenolysis and its regulation; Pentose phosphate pathway and its regulations [DSL].

Unit II

Proteins: Structure, classifications and properties of amino acids and proteins[CLL]; an overview of amino acid biosynthesis, stability and degradation [DSL]; Ramachandran plot.

Enzymes: Types and classification of enzymes; concept of cofactors and coenzymes [DSL]; enzyme kinetics (Michaelis-Menten equation[CLL], Km, Vmax, turnover number); Lineweaver–Burk plot[CLL]; enzyme inhibition; allosteric enzymes; immobilized enzymes [DSL].

Unit III

Lipids: Structure of fatty acids and lipids; classification of lipids; functions of major lipid subclasses-acyl glycerols, phospholipids, glycolipids, sphingolipids; waxes, terpenes and sterols[DSL].

Lipid metabolism: Fatty acids biosynthesis, degradation and their regulations; ketone bodies synthesis; biosynthesis of TAG , cholesterol , phospholipids and glycolipids; in born errors of metabolism [DSL].

Unit IV

Nucleic acids: Structure and properties of nucleic acid bases[DSL], nucleosides and nucleotides; biosynthesis and degradation of purines and pyrimidines; Salvage pathway .

Vitamins: Structure and biochemical roles of fat and water-soluble vitamins; roles of vitamins as coenzymes[DSL].

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Suggested Readings:

1. Lehninger Principles of Biochemistry by Nelson DL and Cox MM, Freeman and Company, New York
2. Outlines of Biochemistry by Conn EE et al., John Willey and Sons Inc. New York & Toronto.
3. Principle of Biochemistry by Voet D, Voet JG and Pratt CW, John Wiley and Sons Inc. NY.
4. Biochemistry and Molecular Biology by Elliott WH and Elliot DC, Oxford University press Inc. New York
5. Biochemistry by Metzler D.E, Academic Press, London and New York.
6. Biochemistry by Berg JM et al., WH Freeman Publishers, New York
7. Biochemistry by Garret RH et al., Boston

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M.Sc. Biotechnology (Semester-I)

19BT 103
Microbiology

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Time: 3 hrs

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

Objectives: This course will provide the understanding of structure, nutrition, metabolism, growth, classification and identification of microorganisms.

Outcome: Students will get the knowledge of basic microbiological techniques and applications of microbes in food industry and medical sciences. The course will enable students to learn basic techniques in field of microbiology which has various career opportunities as clinical, agricultural and industrial microbiologist.

Unit-I

Introduction to Microbiology: Introduction, branches and applications of microbiology; characteristic features of bacteria, archaea, viruses; general features of fungi, protozoa and algae[DSL]; concept of viroids and prions; structure and functions of essential components of bacteria.

Microbial taxonomy, metabolism and diversity: Microbial classification and taxonomy; conventional and molecular approaches for identification of microorganisms; Bergey's manual of bacteriology; nutritional categories of microbes.

Unit II

Methods in Microbiology: Isolation of microbes from natural and artificial sources[CLL]; various techniques to establish a pure culture[CLL]; different methods of sterilization.

Microbial growth and culturing: Mathematical expression of growth and growth curve; methods of growth measurement; factors affecting microbial growth; types and formulation of aerobic & anaerobic culture; types of culture techniques (batch, semi-continuous, continuous, synchronous, enrichment, special)[CLL]; preservation of microbial cultures; procedure for microbial culture submission to repository[DSL].

Unit III

Morphological and metabolic characteristics of specialized microbes: Nitrogen fixing bacteria[CLL], acetic acid bacteria, nitrifying and denitrifying bacteria[CLL], sulphur oxidizing & reducing bacteria, iron-oxidizing bacteria, hydrogen bacteria; carboxydobacteria and photosynthetic bacteria[DSL].

Unit IV

Genetic variations and mutagenesis: Transformation, conjugation and transduction in bacteria; types of mutations; Ames test for mutagenesis[CLL].

Food and medical microbiology: Food preservation by different methods (high and low temperature, chemical additives and irradiation); basic concept of D-value, Z-value, 12-D and F-value; microbial toxins and food poisoning caused by *Clostridium botulinum, Salmonella sp., Yersinia enterolitica, Vibrio sp., and Bacillus sp.,*; Characteristics of disease causing microbes with special emphasis on mycoplasma, rickettsias, and chlamydias[DSL].

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Suggested readings

1. Microbiology: Principles and Explorations by Black JG, Prentice Hall.
2. Microbiology by Pelczar Jr MJ, Chan ECS, and Krieg NR, 5th edition, Tata McGraw Hill.
3. General Microbiology by Stanier RY, Ingraham JL, Wheelis ML and Painter PR, 5th edition, McMillan.
4. Prescott Microbiology by Willey JM, Sherwood LM, and Woolverton CJ, McGraw Hill Higher Education.
5. Microbiology: An Introduction by Gerard J Tortora et al., Pearson publications.
6. Microbiology: With Diseases by Body System by Robert W Bauman, Pearson publications.
7. Microbiology: With Diseases by Taxonomy by Robert W Bauman, Pearson publications.

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M.Sc. Biotechnology (Semester-I)

19BT 104
Molecular Biology

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Time: 3 hrs

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

Objectives: It focuses on the interactions between the various systems of a cell, including the interrelationships of DNA, RNA and protein synthesis and their regulations.

Outcomes: Students will learn the most significant molecular mechanisms that are used in living organisms. This course will prepare students to seek career in molecular laboratories, as molecular biologists in research institutions and in major diagnostic centers.

Unit I

Replication of genetic material: The origin of genetics and molecular biology; identification of the DNA as the genetic material[DSL]; viral genome; bacterial genome; eukaryotic chromosome.

DNA replication: Replication in prokaryotes & eukaryotes; the replicon, mechanism of DNA replication[CLL], enzymes and accessory proteins involved in DNA replication.

Unit II

Gene transcription and RNA modification: Prokaryotic & eukaryotic transcription: RNA polymerase, general and specific transcription factors, regulatory elements and mechanisms of transcription regulation[CLL]; RNA modification: processing, splicing, 5'Capping, 3'Poly A tailing, RNA editing, base modification[CLL].

Translation: The genetic code[DSL], prokaryotic and eukaryotic translation, the translation machinery[CLL], stages of translation.

Unit III

Mechanisms of DNA Repair: Photo reactivation[DSL], base excision repair, nucleotide excision repair, mismatch excision repair, recombination repair, non-homologous end joining[CLL], translesion/error-prone repair; SOS response.

Recombination & transposition: Homologous recombination and Holliday junction model of recombination[CLL], enzymes and proteins involved in recombination; site specific recombination; illegitimate recombination; Cre-lox recombination[CLL]. Transposons: insertion sequences & bacterial transposons, P elements in *Drosophila*; transposable elements in human[DSL].

Unit IV

Gene regulation in prokaryotes: Transcriptional regulation: inducible and repressible controls[DSL], lac operon, tryptophan operon[DSL]; post transcriptional regulations: leader sequences, attenuators; Co- and post translational regulation: repressor proteins, antisense RNA, feedback inhibition and allosteric control[DSL].

Gene regulation in eukaryotes: Alternative splicing, RNA stability, DNA methylation, histone modification, riboswitches[CLL].

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Suggested Readings:

1. Lewin Genes by Jocelyn E Krebs et al., Jones & Bartlett Learning.
2. Essentials of Molecular Biology by Friefelder D et al., Boston.
3. Genetics: Analysis and Principles by Brooker, Robert J, McGraw-Hill Education.
4. Concepts of genetics by William S Klug et al., Pearson NY.
5. Genetics: A molecular approach by Brown TA, Chapman and Hall, London.
6. Gene Regulation by Gurbachan S, Narosa Publishers.

Please note: The latest edition of these books is proposed or as recommended by the concerned faculty.

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M.Sc. Biotechnology (Semester-I)

19LS 101
Communication Skills

Maximum Marks: 50
Theory Examination: 40
Internal Assessment: 10
Time: 2 hrs.

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

Internal Assessment will be a continuous evaluation process on the basis of the students' expression of effective communication skills through participation in activities like presentations, group-discussions, mock-interviews, etc.

Evaluation scheme in internal examination:

Attendance (marks)	Assignment/Quiz/Group discussion (marks)
03	07

Objectives: To enable the students to achieve professional and scientific expertise with the help of improved communication skills including writing, speaking, presenting and grooming.

Outcomes: Students will be able to express oneself easily and articulately at the end of the course. Opportunities for students having communications skills will get hired as Public Relations Specialists, Meeting/Event Planner, College Alumni and Development Officers, Media Planner, Social Media Manager, Human Resources Specialist, Business Reporter, Health Educator and many more.

Unit I

Human communication: Verbal and non-verbal communications[DSL]; barriers to communication; the seven C's of effective communication; preparation for an interview; preparing CV/Biodata[CLL].

Unit II

Etiquettes of public speaking: Public speaking skills (preparation, body language and voice modulation)[CLL]; oral presentation; debates[DSL]; elocution and extempore; delivering a presentation; greeting and introducing, making requests, giving instructions and directions.

Unit III

Personality development skills: Personal grooming[DSL]; assertiveness; improving self-esteem; significance of critical thinking; confidence building; SWOC analysis; recognizing and managing emotions and situations; stress and anger management; positive thinking[DSL]; developing sense of humour[DSL].

Unit IV

Science/scientific writing (theory and practice): Goals and objectives; ethics in writing structure of documents; language and grammar; illustrations and aids[DSL]; writing proposals and instructions[CLL]; making presentations[CLL]; formatting documents; drafts and revisions; editing and writing popular science/journal article; writing scientific reports.

DSL=Digital Self Learning
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Suggested Readings:

1. English for Effective Communication by Kumar, Sanjay and Pushp Lata, OUP.
2. Developing Communication Skills by Mohan, Krishna and Meera Banerji, Trinity Press.
3. A Course in Communication Skills by Dutt, P. Kirammai et al., Foundation Books, CUP.

Please note: The latest edition of these books is proposed or as recommended by the concerned faculty.

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M.Sc. Biotechnology (Semester-I)

19BT 105
Biotech Lab I

Maximum Marks: 100
Duration of Exam: 08 h

Evaluation scheme in examination:

Practical performance and evaluation	Viva-voce	Practical record
70	20	10

Practical:

1. Ultrastructure of the cell [DAL]
2. Cell staining and visualization under microscope.
3. Mitotic division in root tip cells.
4. Preparation of chromosomes.
5. Effect of different factors on cell membrane permeability.
6. Effect of tonicity on animal and plant cells
7. Reactions of amino acids, sugars and lipids
8. Quantitation of Proteins and Sugars
9. UV, Visible, Fluorescence and IR spectroscopy, Absorption spectra
10. Separation techniques - Centrifugation, Chromatography (Gel permeation, Ion exchange, TLC etc.)
11. Isolation of pure culture
12. Staining and microscopic examination of stained preparations
13. Measurement of microbial growth. Analyzing the effect of temperature, pH and carbon and nitrogen sources on microbial growth.
14. Morphological and Biochemical characterization of microbe
15. Enrichment culture technique
16. Isolation of genomic DNA from animal tissue
17. Agarose gel electrophoresis
18. Quantitative analysis of DNA
19. RFLP analysis

Note: This is the list of suggested practical. The final list of practical will be declared in the running semester.

Chaudhary Bansi Lal University, Bhiwani
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M.Sc. Biotechnology (Semester-II)

19BT 201
Immunology

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Time: 3 hrs.

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

Objectives: The objective of this course is to provide the information regarding cells, molecules and processes associated with the immune system and their role in health & diseases. In addition, an exposure to the recent developments in immunology will also be the integral part of the subject.

Outcomes: The subject will emphasize to develop students' understanding to molecular, cellular and clinical perspectives in the area of immunology. This course will prepare students to seek career in field of immunological diagnosis, vaccine development and numerous other clinical studies.

Unit I

Introduction to immunity: Preface of immunology; innate and acquired immunity; cardinal features of immune system[DSL]; cells and effector molecules of the immune system; hematopoiesis and its regulation; organization and structure of primary and secondary lymphoid organs[CLL].

Antigens antibodies and complement system: Concept of antigen, super antigen, immunogen, epitopes and hapten carrier system; chemical and molecular nature of antigen and factors affecting immunogenicity; structure and classes of antibodies; complement system pathways. Evasion of complement system by the microbes[DSL].

Unit II

Immune receptors and their diversity: Structure and functions of Toll receptor, TCR, BCR, MHC; antigen processing and presentation; self MHC restriction[DSL]; somatic recombination and generation of antibody diversity.

Immune cell maturation and trafficking: Immunological tolerance; lymphocyte trafficking.

Unit III

Activation of immune cells: T cell activation; mechanism of T cell and NK cell mediated target cell lysis; antibody dependent cell mediated cytotoxicity; macrophage mediated cytotoxicity[DSL]; immunity to infectious agents (intracellular parasites, helminthes, viruses) and tumors.

Regulation of immune system: Negative regulators of T cell activation; cytokines and their role in immune regulation.

Unit IV

Transplantation and disorders of immune response: Transplantation and its rejection; autoimmunity; hypersensitivity; immunodeficiencies[DSL].

Immunotechnology: Antigen-antibody interactions, agglutination[CLL], immuno-electrophoresis[CLL], immunoblotting[CLL], ELISA[CLL], ELISPOT, surface plasmon resonance; epitope mapping[CLL]; abzymes; antibody engineering[DSL].

DSL=Digital Self Learning
CLL=Classroom and Lab Learning

Suggested readings:

1. Immunology by Kuby J. W.H. Freeman & Co., New York.
2. Cellular and Molecular Immunology by Abul K Abbas et al., Elsevier, Inc.
3. Immunology: A Short Course by Coico, Richard and Sunshine, Geoffrey. Willey-Blackwell Press.
4. Essential Immunology by Roitt, I.M. Oxford Black Well Science, London.
5. Immunology by Raj Khanna, Oxford Press.
6. Immunology and Immunotechnology by Chakravarty AK, Oxford press.
7. The elements of Immunology by Fahim Halim Khan, Pearson Education

Please note: The latest edition of these books is proposed or as recommended by the concerned faculty.

Chaudhary Bansi Lal University, Bhiwani
(A State University established under Haryana Act No. 25 of 2014)

M.Sc. Biotechnology (Semester-II)

19BT 202
Bioinformatics

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Time: 3 hrs.

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

Objectives: It applies information technology and computer science into the area of biology for the purpose of studying, analyzing, and processing the information related to genomic as well as other biological processes.

Outcomes: Students will learn the integration of computers, software tools, and databases in an effort to address biological questions. This course will help students to work in all sectors of pharmaceutical, biomedical organizations, biotechnology, in research institutions, hospital, industry and even NGOs. They can also be a part of the leading IT Companies as "Bio-informationists" along with career areas such as database design & maintenance, proteomics, pharmacology, sequence assembly & analysis, informatics developer, etc.

Unit I

Introduction to bioinformatics: Branches, scope and research areas of bioinformatics; introduction to various sequence file formats; introduction to PERL: scalar variables, strings and numbers, arrays, hashes, operators, loops, regular expression[CLL]; applications of PERL in bioinformatics[DSL].

Introduction to databases: Classification scheme and features of biological databases; overview of various databases dealing with biological macromolecules[DSL].

Unit II

Major biological databases: Primary databases of nucleic acid and protein: NCBI-Gen bank, EMBL, DDBJ; Swiss Prot, PIR[CLL].

Other databases: Secondary protein database Prosite and PRINTS[CLL]; secondary genomic database OMIM and OMIA, literature database Pub Med, metabolic database KEGG, *Plasmodium* database Plasmo DB, specialized databases including MIPS, TIGR, TAIR[CLL].

Unit III

Sequence comparison methods: Methods for the comparison of two sequences[CLL] viz., dot matrix plots, Needleman Wusch & Smith Waterman algorithms; analysis of computational complexities and the relative merits and demerits of each method[CLL]; theory of scoring matrices and their use for sequence comparison; difference between PAM and BLOSUM[DSL]; sequence similarity tools: CLUSTAL X/W[CLL]; molecular phylogeny[DSL].

Unit IV

Database search algorithms: Methods for searching sequence databases like FASTA and BLAST algorithms; BLAST and its types; PSI-BLAST and RPS-BLAST[CLL]; concept of position specific weight matrices and their use in sequence analysis; theory of profiles and their use with special reference to PSI BLAST[CLL]; Markov chains and models; concept of HMM_S[DSL], Viterbi algorithm; forward algorithm and Baum welch algorithm[CLL].

DSL=Digital Self Learning
CLL=Classroom and Lal Learning

Suggested readings:

1. Essential Bioinformatics by Jin Xiong, Cambridge publisher.
2. Bionformatics: Principles and Applications) by Zhumur Ghosh and Bibekanand Mallick, Oxford University Press.
3. Bioinformatics by Orpita Bosu and Simminder Kaur Thukral, Oxford University Press publisher
4. Introduction to Bioinformatics by M Lesk, Oxford University Press publisher.
5. Fundamental Concepts of Bioinformatics by Dan E Krane, Michael L Raymer, Michaeel L Raymer, Elaine Nicpon Marieb, Benjamin/Cummings.
6. Bioinformatics: Methods and Applications: Genomics, Proteomics and Drug Discovery by P Rastogi and N Mendiritta, Prentice-Hall of India Pvt. Ltd.

Please note: The latest edition of these books is proposed or as recommended by the concerned faculty.

Chaudhary Bansi Lal University, Bhiwani
(A State University established under Haryana Act No. 25 of 2014)

M.Sc. Biotechnology (Semester-II)

19BT 203
Genetic Engineering

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Time: 3 hrs.

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

Objectives: The course also commonly known as recombinant DNA technology is the set of molecular tools and techniques that are used for the manipulation of genes. The course also describes about the applications of genetic engineering such as gene editing and gene therapy.

Outcomes: This course will train the students for the use of molecular tools such as enzymes, various cloning vectors, library preparation, and suitable methods for the manipulation of animals and plants, strategies to study gene expression and recombinant protein production. Being the core area of biotechnology this subject enable students to learn basic of genetic manipulation tools and well trained students can find career options in biotechnological and R&D units.

Unit I

Introduction and scope: Scope of genetic engineering; tools for genetic engineering: restriction and other modifying enzymes; vectors: basic biology of plasmids, bacteriophage vectors, cosmids, phasmids, YAC, BAC and M13; expression vectors[CLL].

Gene cloning strategies: preparation and screening of genomic and cDNA library, mRNA enrichment; PCR based cloning[CLL].

Unit II

Genetic manipulation of animals: Gene knockout and knock-in technologies; gene transfer methods to animal cells; transgenic mice and *Drosophilla*; Genetic manipulation of plants: strategies for gene transfer to plants including *Agrobacterium* mediated transformation; selectable markers for plants[DSL]; mapping the RNA by: primer extension, S1 nuclease, and RNase protection methods; t-DNA and transposon tagging[DSL].

Unit III

Regulation of transgene expression: inducible expression systems; gene silencing by RNAi; strategies for heterologous gene expression in bacteria, yeast, insect, mammals and plant cells; Gene probes: generation, labeling and usage; reporter genes[CLL].

Unit IV

Processing of recombinant proteins: *In vitro* translation; purification, refolding, characterization and stabilization of recombinant proteins; site-directed mutagenesis and protein engineering[DSL]. Analysis of protein-protein interactions by yeast two hybrid system.

Genome editing using engineered nucleases: Zinc finger nucleases (ZFN), Transcription activator-like effector nucleases (TALEN) and clustered regularly interspaced short palindromic repeats (CRISPR); gene therapy: types and methods.

DSL=Digital Self Learning
CLL=Classroom and Lab Learning

Suggested Readings

1. Principles of gene manipulation and genomics by Primose SB and Twyman RM, Blackwell publishing.
2. Gene cloning and DNA analysis–An introduction by Brown TA, Blackwell publisher
3. Biotechnology: expanding horizons by BD Singh, Kalyani Publishers
4. Molecular cloning: A laboratory manual by J Sambrook and Michael R Green.
5. Essential genes by Benzamin Lewin, Pearson education international.

Please note: The latest edition of these books is proposed or as recommended by the concerned faculty.

Chaudhary Bansi Lal University, Bhiwani
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M.Sc. Biotechnology (Semester-II)

19BT 204
Developmental Biology

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Time: 3 hrs.

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

Objectives: In this course students will study the genetic control of cell growth, differentiation and morphogenesis. These are the processes that give rise to tissues, organs and organisms.

Outcomes: This course will impart the vast knowledge of developmental processes to pursue our enquiry into the fundamentals of life. There are a variety of options for students including a career as a researcher in stem cell laboratory, developmental biologist and stem cell banking.

Unit I

Basic concepts of development: Life cycle of *Xenopus*, *Drosophila*, *C. elegans* and mouse; embryonic development and potency, commitment, specification, induction, competence, determination and differentiation [DSL]; formation and differentiation of germ cells; structure, chemistry, dynamics and regulation of sperm locomotion, capacitation and egg-surface targeting; molecular biology, cytology and biochemistry of ovulation; hormonal control of ovulation in mammals[DSL].

Unit II

Fertilization: Molecular and cellular biology of fertilization: acrosome reaction and signal transduction, monospermy and species-specificity[DSL], egg activation, early cleavages and blastocyst formation in mammals, biochemical and cellular changes during the passage down the oviduct to uterus.

Unit III

Embryonic development: Implantation and formation of the placenta in mammals; gastrulation in mammals: formation of primitive streak, morphogenetic movements and neural induction; organogenesis and fetus development; pattern forming genes and expression in *Drosophila*; development of the mammalian brain, cerebral cortex and cell lineages; lens development and fibre differentiation[DSL].

Growth factors: Growth factors and signal cascades for BMP, nodal, Wnt, notch and retinoic acid during gastrulation.

Unit IV

Morphogenesis and organogenesis in plants: Organization of shoot and root apical meristem[CLL]; leaf and floral development in *Arabidopsis.*

Introduction to stem cells: Embryonic stem cells; adult stem cells; molecular basis of pluripotentency and its applications; stem cell niches; stem cell renewal[DSL]; cell cycles regulators in stem cells; epigenetic mechanism of cellular memory; germ line stem cells[DSL]; nuclear cloning and epigenetic reprogramming.

DSL=Digital Self Learning
CLL=Classroom and Lab Learning

Suggested Readings:

1. Developmental Biology by Gilbert SF, Sinauer Asso.
2. Principles of Development by Wolpert L *et al*., Oxford University Press
3. The Art of the Genes- How Organisms Make Themselves by Coen E, Oxford University Press
4. Genetic Analysis of Animal Development by Wilkins AS, Wiley-Liss
5. Biological Physics of the Developing Embryo by Forgacs G & Newman SA, Cambridge University Press.
6. Handbook of Stem Cells by R Lanza, I Weissman, J Thomson, and R Pedersen, Academic Press.
7. Essential of Stem Cell Biology by R Lanza, J Gearhart *et al.*, Elsevier Academic press.

Please note: The latest edition of these books is proposed or as recommended by the concerned faculty.

Chaudhary Bansi Lal University, Bhiwani
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M.Sc. Biotechnology (Semester II)

19LS 201
Biostatistics

Maximum Marks: 50
Theory Examination: 40
Internal Assessment: 10
Time: 2 hrs.

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

Objectives: The course is designed to train the students in basic statistical applications in biology.

Outcome: Students will become able to locate, analyse, evaluate and generate meaningful information from the given data. These students can find career opportunities as data managers and analysts in health sciences, academics, research and Industries.

Unit I

Preliminary concepts: Variables and constants; random samples; discrete and continuous variables; variables in biology[DSL]; accuracy and precision.

Presentation of data: Types of graphs; modes of graphical representation of data; line graph; bar diagram; pie, circle and sector chart; histogram; frequency polygon; frequency curve; frequency distribution; relative and cumulative frequency distribution.

Unit II

Measures of central tendency: Mean; median; mode; empirical relationship between mean, median and mode[DSL]; quartile and percentile.

Measures of dispersion: Variability; range; mean deviation; coefficient of mean deviation; standard deviation; merits, demerits and uses of standard deviation[DSL]; calculation of standard deviation.

Unit III

Regression analysis: Regression coefficients; properties of regression coefficients[DSL]; student's t-test; chi-square test; f-test (one- and two-way ANOVA).

Unit IV

Correlation analysis: Correlation; co-variance; calculation of co-variance; correlation analysis; correlation coefficient calculated from ungrouped data; Spearson's rank correlation coefficient; estimation of correlation coefficient using scattered diagrams.

DSL=Digital Self Learning

Suggested readings:

1. Biostatistical Analysis by Zar, Pearson Education India
2. Textbook of computer applications and biostatistics by SB Bhise *et al*., Trinity Publishing house
3. Statistical Methods by Gupta, S.P, S. Chand & Sons, New Delhi.
4. Biostatistics by P.N. Arora and P.K. Malhan, Himalayan publishing house.
5. Introduction to Biostatistics by Robert R. Sakal and F. James Rohlf, Dover Publications, Inc. New York.
6. Introductory Biostatistics by Chap T. Le: A John Wiley & Sons Publication

Please note: The latest edition of these books is proposed or as recommended by the concerned faculty.

Chaudhary Bansi Lal University, Bhiwani
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M.Sc. Biotechnology (Semester-II)

19BT 205 Maximum Marks: 100
Biotech Lab II Duration of Exam: 08 hrs.

Evaluation scheme in examination:

Practical performance and evaluation	Viva-voce	Practical Record
70	20	10

Practical:

1. Blood film preparation and identification of immune cells
2. Lymphoid organs and their microscopic organization
3. Immunization of animals
4. Separation of serum
5. Double diffusion and Immune-electrophoresis
6. Separation of mononuclear cells by Ficol1-Hypaque
7. Heamagglutination assay
8. ELISA
9. Immunoblotting
10. Immunodiagnostics (demonstration using commercial kits)
11. Retrieve single nucleotide sequence from NCBI serve.
12. Retrieve multiple nucleotide sequences through Entrez.
13. Retrieve Protein sequences from PDB.
14. Analysis of sequence similarity using BLAST.
15. To predict homology of any nucleotide/ protein sequence against respective database.
16. Perform multiple sequence alignment by using Clustal W.
17. Isolation of plasmids and purification
18. Quantitation of nucleic acids.
19. Restriction analysis and construction of restriction map of plasmid
20. Preparation of competent bacterial cells
21. Genetic Transformation of bacteria with a recombinant plasmid
22. PCR amplification
23. To study the different stages of development in frog and chick through permanent slides.
24. To study the spermatogenesis of rat and grasshopper through slides [DAL].
25. To prepare the permanent stained slides of developing stages from fertilized egg of hen [DAL].
26. Study of sex-chromatin Bars body from human buccal mucosa [DAL].
27. Epitope mapping

Note: This is the list of suggested practical. The final list of practical will be declared in the running semester.

Chaudhary Bansi Lal University, Bhiwani
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M.Sc. Biotechnology (Semester-III)

19BT 301
Plant Biotechnology

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Time: 3 hrs.

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

Objectives: The main objective of this course is to familiarize students with techniques of plant tissue culture, genetic manipulations of plants and quality enhancement of plant products through the use of biotechnological tools.

Outcomes: Students' skills will develop in various aspects of plant tissue culture and transgenic plants generation. Plant biotechnologists has huge demand as the plant and seed based industries are continuously emerging for providing superior quality seeds, Genetically-modified (GM) plants. This course enables students to learn basics of plant biotechnology and they can find career opportunities in government as well as private agricultural research institutions.

Unit I

Introduction to plant biotechnology: Concepts and scope of plant biotechnology in sustainable agriculture and food security; related tools of plant biotechnology; status of transgenic plant research in India[DSL]; terminator seed technology.

Plant tissue culture: Laboratory organization; media preparation and sterilization techniques[CLL]; concept of cellular differentiation and totipotency: regeneration and somatic embryogenesis; somaclonal and gametoclonal variations.

Unit II

Micropropagation: Methods, applications and limitations; haploid plant production through plant tissue culture[CLL].

Virus free plants: Production of virus-free plants (VFP); applications of VFP[DSL].

Unit III

Biochemical productions and generation of hybrids: Biochemicals production from cultured plant cells; germplasm conservation: cryopreservation, slow growth cultures[DSL]; distant hybridization: embryo rescue and *in vitro* pollination; somatic hybridization: protoplast isolation, fusion, and regeneration of hybrids[CLL].

Unit IV

Gene transfer methods in plants: Plasmid mediated, electroporation, cation precipitation, liposomes, microinjection and particle gum technology; molecular genetics of T-DNA transfer from *Agrobacterium* to plants[CLL].

Production of transgenic plant: Transgenic plants with herbicide resistance, resistance against biotic (insect, fungal and viral) and abiotic (salinity, drought, chill) factors. Nutritional quality improvement in plants for Starch, oil and protein content; Golden rice and other developments[DSL].

DSL=Digital Self Learning
CLL=Classroom and Lab Learning

Suggested readings

1. Plant biotechnology by BD Singh, Kalyanil Publishers.
2. Plant tissue culture: theory and practices by SS Bhojwani and MK Razdan, Elsevier Publishing.
3. Plant Biotechnology: The genetic manipulation of plants, Oxford press.
4. Plant Roots: the Hidden Half by Dekker. M, CRC press, New York.
5. Plant Physiology and Development by Taiz et al., Sinauer Associates, New York

Please note: The latest edition of these books is proposed or as recommended by the concerned faculty.

Chaudhary Bansi Lal University, Bhiwani
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M.Sc. Biotechnology (Semester-III)

19BT 302
Animal Cell Technology

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Time: 3 hrs.

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

Objectives: This course will emphasize the major areas of learning that will include the cell microenvironment, large scale propagation, cryopreservation, stable transfection, bioengineering and genetic manipulation of animal cell.

Outcomes: This course will strengthen the knowledge and expertise of the students towards biotechnological applications of animal cell and tissue culture methodology. This course will enable the students to seek career in the field of cell culture, tissue engineering, cell therapy, cell banking, instrument and lab designing, bioreactor industry, animal biotechnology and GMO laboratories/industries.

Unit I

Introduction and basics of cell culture: Introduction to animal cell culture and animal biotechnology; types of cultures; advantages and disadvantages of cell culture; therapeutic implications of cell culture[DSL]; biology of cultured cells.

Cell culture requirements: Common and specialized equipments for cell culture laboratory[CLL]; substrate materials and treated surfaces for cell culture; culture vessels; aseptic techniques[CLL]; sterilization[CLL]; physiochemical properties of media[CLL]; constituents of culture medium and their importance[CLL]; serum-free medium[DSL].

Unit II

Cell culture and cloning: Primary cell cultures[CLL]; methods of cell disaggregation; subculture; cell cloning and isolation of clone.

Cell characterization and transformation: Characterizing cells in the culture; cell synchronization by double thymidine block; cell transformation and immortalization, tumorigenicity[DSL].

Unit III

Viability and contamination: Markers for cell viability and apoptosis; cell viability and cytotoxicity assays; viable cell separation and quantitation[CLL]; monitoring and eradication of contamination.

Specialized cultures: Specific culture conditions for differentiated, non-differentiated cells; culture conditions for tumor cells[DSL]; histotypic and organotypic cultures.

Unit IV

Cryopreservation: Principles of cell cryopreservation; thawing and recovery of frozen cells.

Biotechnological advances in cell technology: *In situ* hybridization and somatic cell fusion; producing genetically-engineered animals and their applications; basic concepts of tissue engineering; applications of tissue engineering[DSL].

DSL= Digital Self Learning
CLL=Classroom and Lab learning

Suggested readings

1. Culture of animal cells by Freshney, R.I., Willey-Blackwell Press.
2. Animal cell technology by Ashok Mukhopadhyay. I. K. International Publishing House.
3. Gene transfer to animal cells by R. M. Twyman. Taylor & Francis group.
4. Animal cell culture & technology by Butler, M. Taylor & Francis.
5. Animal cell culture by John M. Davis. Willey-Blackwell Press.

Please note: The latest edition of these books is proposed or as recommended by the concerned faculty.

Chaudhary Bansi Lal University, Bhiwani
(A State University established under Haryana Act No. 25 of 2014)

M.Sc. Biotechnology (Semester-III)

19BT 303
Environmental Biotechnology

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Time: 3 hrs.

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

Objectives: This course aims to teach students the scientific principles of treatment technologies to clean up contaminated environments and to generate valuable resources for the society.

Outcomes: The students will become familiar with different types of biotechnological methods to improve the environment. Students can find positions in teaching, research and private industries especially involved in developing bio-fertilizers, biopesticides, biofuels and providing services such as environmental-consultancy and protection agencies.

Unit I

Environmental pollution: Types and sources of environmental pollution; methods of monitoring and controlling the pollution[CLL]; toxic chemicals & their effects on environment; pesticides in water; biochemical aspects of arsenic, lead, carbon monoxide, ozone and PAN, pesticides; concept of acid rain; green-house effect[DSL]; ozone depletion and heat island effect[DSL].

Unit II

Solid wastes management: Composition and properties of municipal solid wastes; storage and processing at source: sanitary land filling, recycling, aerobic, anaerobic and vermi composting; thermal processing; energy recovery from organic waste[DSL].

Specialized waste management: Hospital and hazardous waste management; management & handling rules of 1989 & 2000 (amendments)[DSL]; Disaster management; fly ash generation & utilization; strategies of wastewater management.

Unit III

Effluent treatment: Effluent from organic and inorganic chemical industries; primary, secondary, tertiary & advance treatment of various effluents; treatment strategies for effluent generated by fermentation industry, pesticide manufacturing industries, dye industries, tanneries, pharmaceuticals, thermal power plants, food and dairy industries, iron and steel industries; effluent treatment for petrochemicals[DSL].

Unit IV

Technological advancement in pollution control: Uses of treating industrial effluents with solar radiations with special emphasis on removal of chromium, phenol, mercury, nitrogen etc. from industrial effluents; phytoremediation; biofertilizers[DSL]; biopesticides; integrated waste management; biofuels.

DSL= Digital Self Learning
CLL=Classroom and Lab learning

Suggested Readings

1. Environmental Biotechnology: Principles and Applications by Bruce Rittman, Perry L. McCarty, McGraw-Hill.
2. Environmental Biotechnology: Concepts and Applications by Hans-Joachim Jordening, Josef Winter, John Wiley and Sons.
3. Environmental Biotechnology: Basic concepts and Applications by Indu Shekhar Thakur, IK Internationals Pvt. Ltd.
4. Environmental Microbiology by SK Agarwal, APH Publishing corporation, New Delhi
5. Introduction to Environmental biotechnology by AK Chatterji, PHI Learning private limited, New Delhi.

Please note: The latest edition of these books is proposed or as recommended by the concerned faculty.

Chaudhary Bansi Lal University, Bhiwani
(A State University established under Haryana Act No. 25 of 2014)

M.Sc. Biotechnology (Semester-III)

19BT 304
Molecular Modeling

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Time: 3 hrs.

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

Objectives: Molecular docking is one of the most frequently used methods in structure-based drug design, due to its ability to predict the binding-conformation of small molecule ligands to the appropriate target binding site. The drug designing software and programs are used to examine molecular modeling of gene, gene expression, gene sequence analysis and 3D structure of proteins.

Outcomes: Students will learn the use of drug designing software and programs to examine molecular modeling of gene, gene expression, gene sequence analysis and 3D structure of proteins. This course will enable the students to seek career in the field of teaching, research and as Bioinformaticist in the health sector, Bioanalytics, Clinical Pharmacologist, Computational Biophysicists and Pharmaceutical Scientist in different drug designing industries and Pharma companies.

Unit I

Protein and secondary structure prediction: Basic concept and types of secondary structure of protein and its conformational parameters; protein structure databases PDB and MMDB[CLL]; software for secondary structure prediction of proteins and visualization tools[CLL]; limitations of structure prediction[DSL].

Unit II

Molecular modeling: Methods of molecular modeling: homology modeling, model refinement, evaluation of the model[CLL]; applications of modeling[DSL]; overview of programs for comparative protein structure modeling[CLL], threading and its types, *Ab initio* method[CLL], its advantages, disadvantages and applications.

Unit III

Drug discovery: Technologies and strategies for drug discovery[CLL]; areas influencing the drug discovery[DSL]; concept of pharmacogenetics and pharmacogenomics; polymorphism of CP450 enzymes affecting drug response[CLL]; role of SNP in pharmacogenomics[CLL]; personalized medicine[CLL]; importance of personalized medicine[DSL].

Unit IV

Drug designing : Characteristics of a drug molecule; target identification and characterization; structure and ligand based drug designing[CLL]; concept of pharmacophore, QSAR, and docking[CLL]; ADMET[DSL].

DSL=Digital Self Learning
CLL=Classroom and Lal Learning

Suggested readings:

1. Bionformatics: Principles and Applications by Zhumur Ghosh and Bibekanand Mallick, Oxford University Press publisher.
2. Drugs: From Discovery to Approval by Rick NG, Wiley Blackwell.
3. Bioinformatics: Methods and Applications: Genomics, Proteomics and Drug Discovery by P Rastogi and N Mendiritta, Prentice-Hall of India Pvt. Ltd.
4. Computational Drug Design: A guide for Computational and medicinal Chemists by David C. Young, Wiley.
5. Pharmacogenomics and Personlaized medicine by Nadine Cohne, Humana Press.

Please note: The latest edition of these books is proposed or as recommended by the concerned faculty.

Chaudhary Bansi Lal University, Bhiwani
(A State University established under Haryana Act No. 25 of 2014)

M.Sc. Biotechnology (Semester-III)

19BT 305
Biology of Infectious Disease

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Time: 3 hrs.

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

Objectives: This course deals with the medical and health aspects of microbes. Here students will learn the outcomes of microbial diseases, their modes of transmission and impact on public health. In addition, diagnosis, therapy and the challenges in this area will be also the part of learning.

Outcomes: Students will acquire the knowledge about the infectious diseases and their associated challenges. This course will prepare students to seek their career in field of medical sciences, pharma industry, disease diagnosis and epidemiological studies.

Unit I

Introduction to infectious diseases: Preface of infectious diseases; terminology and categories of diseases; normal and pathogenic microbiota; classification of infectious diseases[DSL]; reservoirs of infectious diseases and their modes of transmission; stages of infectious disease.

Host-pathogen interaction: Nature and manifestations of infectious diseases; portals of infectious agents entry and exit; role of adhesion in infection[DSL]; virulence factors of infectious agents; entry processes of different pathogens like bacteria, viruses and protozoans into host; pathogens mediated alteration of host cell behavior and damage.

Unit II

Symptoms, pathogenesis, diagnosis, treatment and prevention for the representative infections[CLL]:
Bacteria: Tetanus, typhoid, tuberculosis. Fungi: Superficial, subcutaneous, systemic and opportunistic mycoses. Viruses: Hepatitis, influenza, herpes simplex virus. Protozoa: Amoebiasis, plasmodiasis, leishmaniasis.

Unit III

Diagnosis of Infectious diseases: Rational behind the modern approaches for diagnosis of infectious diseases, basic concepts of gene probes, dot hybridization and PCR assays; diagnosis of infectious diseases based on monoclonal antibodies[DSL], protein profiling and protein microarray.

Drug therapy and resistance: Action mechanisms of antibiotics, antivirals and antifungal agents; molecular mechanisms of drug resistance.

Unit IV

Vaccination against infectious diseases: Active and passive immunization; conventional killed and live attenuated vaccines; DNA and protein based vaccines; subunit and conjugate vaccines; virus like particles; edible vaccines; rational vaccine design based on clinical requirements and reverse vaccinology; role and properties of adjuvants; nano particles in vaccine delivery system[DSL].

Epidemiology of infectious diseases: Epidemiology and public health; disease burden; frequency of disease; investigation of epidemics; hospital-acquired (nosocomial) infections; immune compromised states and infectious diseases; biological warfare agents[DSL].

DSL= Digital Self Learning
CLL=Classroom and lab learning

Suggested Readings

1. Microbiology: An Introduction by Gerard J Tortora et al., Pearson publications.
2. Microbiology: With Diseases by Body System by Robert W Bauman, Pearson publications.
3. Microbiology: With Diseases by Taxonomy by Robert W Bauman, Pearson publications.
4. Prescott's Microbiology by Joanne M. Willey et al., McGraw-Hill publications.
5. Handbook of Disease Causing Microbes by Paul, Jaishree, Ane Books.
6. Introduction to Molecular Vaccinology by Giese, Matthias, Springer

Please note: The latest edition of these books is proposed or as recommended by the concerned faculty.

Chaudhary Bansi Lal University, Bhiwani
(A State University established under Haryana Act No. 25 of 2014)

M.Sc. Biotechnology (Semester-III)

19BT 306
Biotech Lab III

Maximum Marks: 100
Duration of Exam. 08 hrs.

Evaluation scheme in examination:

Practical performance and evaluation	Viva-voce	Practical Record
70	20	10

Practical:

1. Preparation of plant tissue culture media
2. Surface sterilization of explants
3. Organ culture. Induction of callus, callus propagation, organogenesis
4. DNA isolation from plant tissues
5. PCR
6. Preparation of cell culture medium and sterilization
7. Heat inactivation of serum
8. Primary cell culture
9. Cell counting and cell viability
10. Subculture
11. Infinite cell culture
12. Cryopreservation of cells and thawing
13. Measurement of cell cytotoxicity
14. Detection of coliforms to determine of the purify of potable water
15. Estimation of nitrate in drinking water
16. Estimation of Co^{2+} and Ni^{2+} by colorimetry/spectrophotometry.
17. Estimation of sulphates by turbidometry.
18. Sampling techniques: wastewater analysis for physico-chemical characteristics such as pH, conductivity, TDS, DO, BOD, COD, alkalinity, nutrients, hardness, satiability of solids.
19. Retrieving protein structure from PDB.
20. To predict homology of any protein sequence/ protein structure.
21. To Perform Homology Modelling using Swiss Modeller.
22. Model evaluation tools
23. To study SNP databases
24. Identification of disease vectors
25. Detection of different infectious diseases by commercially available kits
26. Detection of malaria parasite in Geimsa stained blood smear
27. Antibiotic sensitivity (bacterial)
28. Effect of hand hygiene on microbial growth

Note: This is the list of suggested practical. The final list of practical will be declared in the running semester.

Chaudhary Bansi Lal University, Bhiwani
(A State University established under Haryana Act No. 25 of 2014)

M.Sc. Biotechnology (Semester-IV)

19BT 401
Bioprocess Technology

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Time: 3 hrs.

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

Objectives: The main objective of the course is to create general understanding amongst the students about the basic principles of microbial commercial fermentations.

Outcomes: This course will provide knowledge to solve critical problems related to the process of fermentations. After this course, students can work at positions in teaching, research and fermentation industries especially involved in the preparation of microbial products such as pharmaceutical industries, food industries, chemical industries etc.

Unit I

Introduction to fermentation technology; basic concepts of upstream and downstream processes; isolation, screening and maintenance of productive strains[DSL]; strain improvement; inoculum development; industrial media formulation and criteria for the selection of raw materials; sterilization of media and fermenter; process development; scale up of the process from lab to industry; extraction of fermented products[CLL].

Unit II

Basic design of fermentor; role and designing of individual parts: baffles, spargers, impellers, culture vessel, cooling and heating devices; designing reactors for specialized applications: airlift reactors and packed bed reactors; concept and utility of fluidized bed reactors and tube reactors[DSL]; computer control of fermentation process with reference to pH, temperature, redox potential and oxygen; foam production and control.

Unit III

Applications of fermentation technology: Production of antibiotics (with special emphasis on penicillin), organic acids (citric acid), vitamins (Vit. B12), amino acids (glutamic acid), anti-cancer agents, antioxidant drugs (Coenzyme Q10), industrial alcohol[DSL], exopolysaccharides (xanthan gum) [DSL]; food fermentations: production of bread, cheese, beverages (beer and wine).

Unit IV

Biotransformation of steroids; mineral recovery using microbes; production of biofuels and single cell protein; rationale behind the usage of microbial enzymes in industry; strategies used for large-scale enzyme production[DSL]; methods for immobilization of enzymes and their applications in industry; enzyme engineering and its importance.

DSL= Digital Self Learning
CLL=Classroom and Lab Learning

Suggested readings:

1. Bioprocess Technology: Fundamentals and Applications. Stockholm KTH.
2. Fermentation Biotechnology: Industrial Perspectives by Chand.
3. Biochemical Engineering Fundamentals by Bailey and Ollis, Tata McGraw Hill, N.Y.
4. Advances in Biochemical Engineering by TK Bhosh, A Fiechter and N Blakebrough. Springer Verlag Publications, New York.
5. Biotechnology- A textbook of Industrial Microbiology by Creuger and Creuger, Sinaeur Associates.
6. Bioprocess Engineering Principles by Doran, Acad. Press, London.

Please note: The latest edition of these books is proposed or as recommended by the concerned faculty.

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M.Sc. Biotechnology (Semester IV)

19BT-402
Biotechniques

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Time: 3 hrs.

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

Objectives: This course aims to provide broad understanding of principles, applications and instrumentation related to the biophysical and biochemical techniques to the students.

Outcomes: Students will become capable of using techniques in the various fields of research. The course enables students to make their career as instrument expert in medical, chemical and pharmaceutical sciences.

Unit I

Microscopy: Principles and applications of light, phase contrast, fluorescence, confocal, scanning and transmission electron microscopy; preparation of sample for microscopy[CLL].

Cell separation and flowcytometry: Types of centrifuges[CLL]; density gradient centrifugation; ultracentrifugation; $FACS_{CAN}$; cell sorter[DSL].

Unit II

Chromatography: Principles and applications of gas chromatography, high pressure liquid chromatography (HPLC), fast protein liquid chromatography (FPLC), super-critical fluid (SFC) chromatography and reversed-phase chromatography[CLL].

Electrophoresis: Principles and applications of gel electrophoresis and 2D-PAGE[CLL]; coomassie and silver staining of gel; 2D-gel analysis; differential in gel electrophoresis (DIGE); electrophoretic mobility shift assay (EMSA)[CLL].

Unit III

Spectroscopy: Principles and applications of infrared, Raman, atomic absorption and X-ray diffraction spectroscopy; NMR; electron spin resonance (ESR), mass spectrometry (LC-MS, GC-MS, PMF).

Blotting techniques and electrophysiological methods: Southern[CLL], Northern[DSL] and Western blotting; patch-clamp recording, ECG, MRI, CAT

Unit IV

Applications of biotechniques: Quality measurement and quantitation of DNA and RNA[CLL]; principle and working of different types of PCRs[CLL]; protein sequencing; microarrays (DNA and protein); comparative genome hybridization (CGH); single nucleotide polymorphisms (SNPs)[DSL]; phage display.

DSL=Digital Self Learning
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Suggested Readings:

1. Molecular Cloning: a Laboratory Manual by J sambrook, EF Fritsch and T Maniatis, Cold Spring Harbor Laboratory Press, New York.
2. Principal and Practice of Bioanalysis by Richard E Venn, Taylor and Francis.
3. Principles and Techniques-Practical Biochemistry by Walker J and Wilson K, Cambridge University Press, London.
4. Radioisotopes in Biology-A Practical Approach by Slater RJ, Oxford University Press, New York
5. Introductory Practical Biochemistry by Sawhney SK and Singh R, Alpha Science International.
6. Biophysical Chemistry : Principles & Techniques by Upadhayaye A, Upadhyaye K and Nath N, Himalaya Publication House, New Delhi.
7. Physical Biochemistry; Principles and applications by David Sheehan, Wiley Press.

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M.Sc. Biotechnology (Semester-IV)

19BT 403
IPR and Biosafety

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Time: 3 hrs

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

Objectives: The main objective of this course is to familiarize the students with the issues of intellectual property rights and disputes arising due to biotechnological patents. The course also emphasizes on biosafety of GMOs and other ethical issues.

Outcomes: Students will become aware of biosafety, bioethics and IPR. They are now expected to follow the regulatory framework in their future venture to ensure product safety and benefit the society. The course enables students to make their career as Patent Officer, Patent filing agent or IP consultant.

Unit I

Introduction to intellectual property: Types of IP: patents, trademarks, copyright & related rights, industrial design, traditional knowledge and geographical indications; establishment and functions of GATT, WTO and WIPO; main features of TRIPS agreement; WIPO treaties and PCT[DSL].

Unit II

Concept of 'prior art': Invention in context of "prior art"; patent databases[CLL]; basics of patents: types of patents, Indian Patent Act 1970 and recent amendments; types of patent applications: PCT and convention patent applications; patent application forms and guidelines, fee structure, and time frames; international patenting-requirements, procedures and costs; patent infringement- meaning, scope, litigation; patent dispute case studies and examples[DSL].

Unit III

Introduction to bioethics: Bioethical issues related to genetically-modified organisms and gene therapy/gene editing; international bioethics advisory committees and their tasks (IBC, IBA, IBS etc.); ethical issues in human cloning[DSL]; ethics for using animals in research; social and ethical implications of biological weapons.

Unit IV

Introduction to biosafety: biological safety cabinets[CLL]; primary containment for biohazards; biosafety levels for microorganisms, infectious agents and infected animals; biosafety guidelines of Government of India; GMOs & LMOs; International regulations of GMOs: Cartagena protocol, OECD, consensus documents and codex alimentarius; Indian regulations of GMOs: EPA act and rules, guidelines[DSL]; regulatory framework for GMO in India and roles of RCGM, GEAC, IBSC etc.

DSL=Digital Self Learning
CLL=Classroom and Lab Learning

Suggested Readings:

1. Laws relating to Intellectual Property Rights by VK Ahuja, Lexis Nexis Publishers.
2. IPR, Biosafey and Bioethics by Deepa Goel and Somini Prashar, Pearson.
3. An Introduction to Ethical, Safety and Intellectual Property Rights Issues in Biotechnology by Padma Nabisan, Elsevier Publishing.
4. Biotechnology and Intellectual Property Rights by Kshitij Kumar Singh, Springer.
5. A Guide to Biotechnology Law and Business by Robert A. Bohrer,Carolina Academic Press.

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M.Sc. Biotechnology (Semester-IV)

19BT 404
Bio-Entrepreneurship & Management

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Time: 3 hrs.

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

Objectives: The main objective of this course is to motivate the students to develop the Biotech industry to apply their bench/lab knowledge to the field and generating the job opportunities.

Outcomes: Students will develop the quality talent and skills that help them to lead their lives as successful professionals. After completing degree, students may start their own business and become entrepreneur in India or abroad.

Unit I

Taking decision on starting a venture; statutory and legal requirements for starting a company/venture; budget planning and cash flow management; support mechanism for entrepreneurship in India[DSL].

Unit II

Assessment of market demand; changes and gaps for potential product(s) of interest; branding issues; pricing/policies/competition; negotiations strategies with government/law enforcement authorities and companies/Institutions for technology transfer; use of IT in improving and upgrading business performance [CLL]; available software for better financial management; e-business setup[DSL].

Unit III

Structure of a biotechnology company; scientific principles; start-up of the biotechnology company; support mechanism for entrepreneurship in India; legal and moral issues in biotechnology[DSL].

Unit IV

Leadership skills; managerial skills; organization structure, pros & cons of different structures; team building , teamwork [DSL]; appraisal; rewards in small scale set up; managing technology transfer; regulations for transfer of foreign technologies; technology transfer agencies[DSL].

DSL=Digital Self Learning
CLL=Classroom and Lab Learning

Suggested readings:

1. Principles of Management by PC Tripathi and PN Reddy, Tata McGraw Hill
2. Management by Stephen Robbins, Pearson Education/PHI.
3. Management Fundamentals – Concepts, Application, Skill Development by Robert- Lusier Thomson.
4. Dynamics of Entrepreneurial Development & Management by Vasant Desai – Himalaya Publishing House
5. Entrepreneurship Development by PM Charantimath, Small Business Enterprises: Pearson Education.
6. Entrepreneurship Development by SS Khanka, S Chand & Co.

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