FACULTY OF LIFE SCIENCES

SYLLABUS

FOR

M.Sc. (BIO-TECHNOLOGY)

(Credit Based Evaluation & Grading System)

(Semester: I - IV)

Examinations: 2019-20

GURU NANAK DEV UNIVERSITY AMRITSAR

M.Sc. (Biotechnology) (Semester System)
(Credit Based Evaluation & Grading System)

Programme Code: BTB

Semester – I

Course No.	C/E/I	Course Title	L	T	P	Total Credits
BTL401	C	Introductory Biomathematics and Biostatistics	3	0	0	3
BTL402	C	Biochemistry	3	0	0	3
BTL403	C	Analytical Techniques	3	0	0	3
BTL404	C	Immunology	3	0	0	3
BTL405	C	General Microbiology & Microbial Genetics	3	0	0	3
BTL406	C	Computer Applications	3	0	0	3
BTP421	C	Lab in Biochemistry & Analytical Techniques	0	0	4	4
BTP422	C	Lab in General Microbiology	0	0	4	4
		Total Credits	**18**		**8**	**26**

Semester – II

Course No.	C/E/I	Course Title	L	T	P	Total Credits
BTL451	C	Plant Tissue Culture	3	0	0	3
BTL452	C	Animal Tissue Culture	3	0	0	3
BTL453	C	Molecular Biology	3	0	0	3
BTL454	C	Genetic Engineering- Tools and Techniques	3	0	0	3
BTL455	C	Bioprocess Engineering & Technology	3	0	0	3
BTL456	C	Introduction to Bioinformatics	3	0	0	3
BTP471	C	Lab in Plant Tissue Culture	0	0	4	4
BTP472	C	Lab in Immunology & Animal Tissue Culture	0	0	4	4
	I	Interdisciplinary Courses to be offered from outside the department	4	0	0	4
		Total Credits	**22**	**0**	**8**	**30**

NOTE: PSL-053 ID Course Human Rights & Constitutional Duties (Compulsory Paper). Students can opt. this paper in any semester except the 1st Semester. This ID Paper is one of the total ID Papers of this course.

NOTE : ALL THEORY PAPERS HAVE 100 MARKS (MID SEMESTER MARKS : 20 & END SEMESTER MARKS : 80)

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Semester – III

Course No.	C/E/I	Course Title	L	T	P	Total Credits
BTL501	C	Fermentation Technology	3	0	0	3
BTL502	C	Genetic Engineering-Applications	3	0	0	3
BTD521	C	Research Project Status Report	0	0	2	2
BTP522	C	Lab in Bioprocess Engineering & Fermentation Technology	0	0	4	4
BTP523	C	Lab in Genetic Engineering	0	0	4	4
BTD524	C	Seminar/Journal Club/Assignment	0	0	1	1
BTL531*	E	Advances in Plant Biotechnology	3	0	0	3
BTL532*	E	Medical Biotechnology	3	0	0	3
BTL533*	E	Microbial Biotechnology	3	0	0	3
	I	Interdisciplinary Courses to be offered from outside the department	4	0	0	4
		Total Credits	**16**	**0**	**11**	**27**

Note:

1. **PSL-053 ID Course Human Rights & Constitutional Duties (Compulsory Paper) Students can opt. this paper in any odd semester. This ID Paper is one of the total ID Papers of this course.**
2. **BTL531, BTL532 AND BTL533 are elective courses offered by the Department. Student can choose any two out of these three electives and accordingly credits will be added.**

Semester – IV

Course No.	C/E/I	Course Title	L	T	P	Total Credits
BTL551	C	Genomics and Proteomics	3	0	0	3
BTD571	C	Research Project	0	0	20	20
	I	Interdisciplinary Courses to be offered from outside the department	4	0	0	4
		Total Credits	**7**	**0**	**20**	**27**

NOTE : ALL THEORY PAPERS ARE OF 100 MARKS (MID SEMESTER MARKS :20 & END SEMESTER MARKS : 80)

M.Sc. (Biotechnology) (Semester – I)
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BTL 401: Introductory Biomathematics and Biostatistics

Credits (3-0-0)

Time: 3 Hours **Max. Marks: 100**

Mid Semester Marks : 20

End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

Scientific notation, significant digits, rounding off. Scientific notation, Sampling, problem identification, concept of population and sample, random sampling, Data collection. Binomial Theorem, Pascal rule and Pascal triangle.

SECTION-B

Measures of central tendency, mean, arithmetic mean, geometric mean & harmonic mean, medium, mode, quartile, decile, percentile, dispersion, mean deviation, standard deviation, geometric standard deviation, standard error, coefficient of variation, variance, coefficient of determinant, moments, normal distribution, skewness and kurtosis

SECTION-C

Pearson's correlation coefficient, linear correlation and regression, correlation and regression analysis of exponential curve, Power function, log function, logarithmic regression, Dose response curve, Reciprocal regression analysis, double reciprocal regression analysis, logistic regression analysis, monomolecular regression, Gompertz growth function and Gompertz decay function and its analysis.

SECTION-D

Probability, Testing of hypothesis, Null and alternative hypothesis, Type-I and Type-II errors, level of significance, chi-square (X2) test, student 't' test, 'F' test, Probability distribution function, standard normal distribution, Poisson distribution, binomial distribution, student 't' distribution, chi square (X2) distribution, Analysis of variance, ANOVA-one way ANOVA. Wilcoxon test : Wilcoxon signed rank test, wilcoxon rank sum test.

Reference Books:

1. Kothari, C.R. (2004) Research Methodology Methods and Techniques, New Age International Publications, New Delhi
2. Arora, P.N. & Malhan, P.K. : Biostatistics (Himalaya Publication House)

M.Sc. (Biotechnology) (Semester – I)
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BTL 402: Biochemistry

Credits (3-0-0)

Time: 3 Hours **Max. Marks: 100**
Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

Section-A

Sugars - mono, di, and polysaccharides; Suitability in the context of their different functions cellular structure, energy storage, signaling; Glycosylation of other biomolecules – glycoproteins and glycolipids; glycolysis, citric acid cycle, oxidative phosphorylation, pentose phosphate pathway, Overview of photosynthesis

Section-B

Lipids –Classification, structure, properties and function, Nucleosides, nucleotides, nucleic acids - structure, diversity and function

Section-C

Amino Acids & Peptides:-Classification, chemical reactions and physical properties. Proteins:-Classification, primary, secondary, α-helix and β sheet structure, quaternary and domain structure, Disulphide bridges, Ramachandran plot.

Section-D

Enzyme catalysis – general principles of catalysis; Quantitation of enzyme activity and efficiency; Enzyme characterization and Michaelis-Menten kinetics, enzyme inhibition.

Books Recommended:

1. Freifelder, D. (1982). Physical Biochemistry. Application to Biochemistry and Molecular Biology, W.H. Freeman & Co.
2. Zubay, G.L., Parson, W.W. and Vance, D.E. (1995). Principles of Biochemistry, W.C. Brown Publishers.
3. Berg, J.M., Tymoczko, J.L. and Stryer, L. (2001). Biochemistry, 5th edition, Freeman, USA.
4. Boyer, R. (2001). Concepts in Biochemistry, 2nd edition, Brooks/Col, U.S.A.
5. Voet, D. and Voet, J. (2004). Biochemistry 3rd edition, John Wiley and Sons

M.Sc. (Biotechnology) (Semester – I)
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BTL 403: Analytical Techniques

Credits (3-0-0)

Time: 3 Hours **Max. Marks: 100**
Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

Basic Techniques
Chemical foundation of biology, pH, pKa, acids, bases, buffers, Hydrogen bonding, vander waals and Hydrophobic interactions, Methods of cell disintegration; Detergents; Membrane techniques : Dialysis, Ultrafiltration

Chromatography Techniques
TLC and Paper chromatography; Chromatographic methods for macromolecule separation - Gel permeation, Ion exchange, Hydrophobic, Reverse-phase and Affinity chromatography; HPLC and FPLC

SECTION-B

Centrifugation
Basic principles; Mathematics & theory (RCF, Sedimentation coefficient etc); Types of centrifuge -Microcentrifuge, High speed & Ultracentrifuges; Preparative centrifugation; Differential & density gradient centrifugation; Analytical centrifugation; Determination of molecular weight by sedimentation velocity & sedimentation equilibrium methods

Electrophoretic Techniques
Theory and application of Polyacrylamide and Agarose gel electrophoresis; Capillary electrophoresis; 2D Electrophoresis; Gradient electrophoresis; Pulsed field gel electrophoresis

SECTION-C

Radioactivity
Radioactive & stable isotopes; Rate of radioactive decay; Units of radioactivity; Measurement of radioactivity; Geiger-Muller counter; Solid & Liquid scintillation counters (Basic principle & technique); Brief idea of radiation dosimetry; Autoradiography; Applications of isotopes in biochemistry; Radiotracer techniques

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SECTION-D

Spectroscopy Techniques
UV, Visible and Raman Spectroscopy; Theory and application of Circular Dichroism; NMR Fluorescence : FRET, FRAP

Protein crystallization:
Theory and methods; Principle of Mass spectrometry: API-electrospray and MALDI- TOF; DNA & Peptide Synthesis. SPR : Theory & Application.

Texts/References:

1. Freifelder D., Physical Biochemistry, Application to Biochemistry and Molecular Biology, 2nd Edition, W.H. Freeman & Company, San Fransisco, 1982.
2. Keith Wilson and John Walker, Principles and Techniques of Practical Biochemistry, 5 th Edition, Cambridge University Press, 2000.
3. D. Holme & H. Peck, Analytical Biochemistry, 3rd Edition, Longman, 1998.
4. R. Scopes, Protein Purification - Principles & Practices, 3rd Edition, Springer Verlag, 1994.
5. Selected Readings from Methods in Enzymology, Academic Press.

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BTL 404: Immunology

Credits: (3-0-0)

Time: 3 Hours **Max. Marks: 100**
Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

Section-A

Components of innate and acquired immunity; Haematopoesis; Organs and cells of the immune system- primary and secondary lymphoid organs; Lymphocyte circulation; Lymphocyte homing; Mucosal and Cutaneous associated Lymphoid tissue.(MALT & CALT);

Section-B

Antigens – immunogens; haptens; nature of antigens; Immunoglobulins-basic structure, classes & subclasses of immunoglobulins, antigenic determinants; antigen-antibody interactions. Major Histocompatibility Complex – Immune responsiveness and disease susceptibility; Complement system Cytokines and their role in immune regulation.

Section-C

B-cell receptor; Immunoglobulin superfamily; B cell maturation, activation and differentiation; Generation of antibody diversity; T-cell receptors and T-cell maturation, activation and differentiation; Functional T Cell Subsets;.

Section-D

Regulation of immune response: Antigen processing and presentation- endogenous antigens, exogenous antigens, non-peptide bacterial antigens and super-antigens, generation of humoral and cell mediated immune responses; Cell mediated cytotoxicity: Mechanism of T cells and NK cell mediated lysis; Antibody dependent cell mediated cytotoxicity; Macrophage mediated cytotoxicity; Immunity to Infection: Bacteria, viral, fungal and parasitic infections; Hypersensitivity – Type I-IV; Autoimmunity- MHC and TCR in autoimmunity.

Books Recommended:

1. Abbas, A.K., Litchman, A.H. (2012). Basic Immunology: Functions and Disorders of the Immune System, 4thEd. (updated edition), Philadelphia, Pennsylvania: W.B. Saunders Company Publishers.
2. Benjamini, E., Coico, R. and Sunshine, G. (2009). Immunology: A Short Course, 6th Ed., New York, Wiley-Blackwell.
3. Roit, I.M., Delves, P. Seamus M. and Burton D. Essential Immunology, 13th Ed., Willey-Blackwell.
4. Roitt, I., Brostoff, J. and Male, D. (2012). Immunology, 8th Ed., Mosby
5. Kanfmann S.H.E., Sher, A., Ahmed, R. (2002). Immunology of Infections Diseases, ASM Press, Washington.
6. Goldsby, R.A., Kindt, T.J., Osborne, B.A. (2006). Kuby Immunology, 6th Ed., W.H. Freeman and Company, New York.

M.Sc. (Biotechnology) (Semester – I)
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BTL 405: General Microbiology & Microbial Genetics

Credits (3-0-0)

Time: 3 Hours **Max. Marks: 100**
Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

Section-A

Principles of Microbiology: Principles & applications of bright field, dark field, phase contrast, fluorescence and scanning tunneling microscopy.

Methods in microbiology; pure culture techniques, theory & practice of sterilization, principles of microbial nutrition, microbial culture media, enrichment culture techniques, culture collection, purification & preservation.

Section-B

Bacterial Classification and Diversity: Importance of taxonomy conventional and modern methods.; classification of bacteria according to Bergey's Manual, polyphasic approach of bacterial classification, 16S rRNA, genomic similarity - content of guanine (G)+ cytosine (C) (%GC)., DNA-DNA homology, Fatty acid analysis;archaea as the earliest life forms, archaea vs eubacteria, bacteria producing important secondary metabolites.

Section-C

Prokaryotic Cells: Structure-function: Cell walls of eubacteria and related molecules, outer membrane of gram-negative and gram-positive bacteria bacteria, capsules, slime layers, Pili, fimbriae & flagella, sporulation & regeneration of bacteria.

Microbial Growth: definition of growth, mathematical expression of growth, growth curve, diauxic & synchronous growth, continuous culture, growth as affected by environmental factors like temperature, acidity, alkalinity, water availability & oxygen.

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Section-D

Bacterial Genetics and Virology: Transformation, transduction, conjugation, RecA, plasmids, their replication, copy number and compatibility, drug resistance; transposons, General characteristics, classification, ultra structure, isolation, purification & assay of viruses, viroids; virulent and temperate bacteriophages, λ- lytic cascades and lysogenic repression.

Books Recommended:

1. Pelczar, M.J. Jr., Chan ECS and Krieg, N.R. (1993). Microbiology: Concepts and Applications, McGraw Hill, NY.
2. Stanier, R.Y., Ingraham, J.L., Wheelis, M.L. and Painter, P.R. (1995). The Microbial World, 5th edition, The Macmillan Press Ltd.
3. Ronald, A.M. (1995). Principles of Microbiology, Ist edition, Mosby Year-book Inc., St. Louis, Missouri.
4. Prescott, L.M., Harley, J.P. and Klein, D.A. (2002). Microbiology, 5th edition, McGraw Hill Inc.
5. Madigan M.T. & Martunko J M, Dunlap P.V. and Clark D.P. (2008). Brock Biology of Microorganisms, 12th Ed., Benjamin Cummings.
6. Maloy S.R., Gonnan Jand, Freifelder D. (2000). Microbial Genetics, Narosa Publishing House.
7. Streips, U.N. and Yasbin R.E. (2002), Modern Microbial Genetics, 2nd Ed., Wiley-Liss, Inc, New York

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BTL 406: Computer Applications

Credits (3-0-0)

Time: 3 Hours **Max. Marks: 100**
Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

Section-A

Introduction to digital computers: organization; low-level and high-level languages, binary number system. Getting started with PERL, Perl's Benefits, Downloading & installing perl in Linux/Windows environment, How to run perl Programs in linux/windows environment, Error Messages, Debugging, Perl interpreters, Perl scripts. CPAN (Comprehensive Perl Archive Network)

Section-B

Scalar Values and scalar variables, Assignment, Statements, Blocks, Arrays, Hashes, Operators, Operator precedence, Conditional and logical operators, Binding operators. loops, I/O: Input from STDIN, Built in File handlers, Input from file, Input from file named on command line, Output to file, Regular expression, Pattern matching, Meta symbols, Pattern modifiers, Subroutines and modules, built-in functions.

Section-C

Applications of Perl in Bioinformatics: Representing strings and sequenced data in Perl, Program to store a DNA sequence, Concatenating DNA fragments, DNA to RNA transcription, Reading proteins from files, Finding motifs, Counting nucleotides, Exploding strings into arrays, Operating on strings.

Section-D

Generating random numbers, A program to simulate DNA mutation, Generating random DNA, Analyzing DNA, Translating DNA into proteins, Reading DNA from Files in FASTA format, Separating Sequence and Annotation GenBank, sequence and annotation, Parsing annotation, indexing GenBank with database. Introduction to Bioperl.

Text/Reference Books:

1 James D.Tisdall, (2001). “Beginning Perl for Bioinformatics,”O”Rilley and Associates

2 Cynthia Gibas & Per Jamesbeck, (2000). “ Developing Bioinformatics Computer Skills, “O”Rilley & Associates.

3 Rex A.Dawyer, “Genomic Perl”, Cambridge University Press.

4 Randal L.Schawrtz and Tom Phoneix, (2000). Learning Perl, 3rd Edition: “O” Rilley

5. D. Curtis Jamison. Perl Programming for Biologists. Hoboken, N.J.: Wiley-Liss, 2003.

6. James D.Tisdall, (2003). “Mastering Perl for Bioinformatics, “O”Rilley and Associates.

M.Sc. (Biotechnology) (Semester – I)
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BTP 421: LAB IN BIOCHEMISTRY & ANALYTICAL TECHNIQUES

Credits (0-0-4)

PRACTICAL

pH & Buffer Solutions

1. Use of pH meter
2. Preparation and calculation of buffering capacity and range of Phosphate & Tris buffer

Colorimetry and Spectrophotometry

3. Protein estimation by Spectrophotometer.
4. Protein estimation by Lowry's method.
5. Estimation of sugars by Anthrone method.
6. Estimation of protein by Bradford method.

Analysis of Fats/Oils

7. Determination of acid value of a fat.
8. Determination of saponification value of a fat.
9. Determination of Iodine number of a fat.

Protein purification using Chromatographic Techniques

10. Lysis of cell using sonicator and separation of supernatant using centrifugation.
11. Purification using affinity chromatography
12. Purification by gel permeation chromatography.
13. Purification of Proteins by ion-exchange chromatography.

Electrophoresis Techniques

14. Native-polyacrylamide Gel Electrophoresis.
15. SDS-polyacrylamide Gel Electrophoresis & staining using different methods (Coummassie blue/Silver staining/reverse staining)

Enzyme Characterization

16. Estimation of enzyme activity.
17. Determination of Michaelis Menten constant of enzyme.
18. Effect of temperature on enzyme activity.
19. Effect of pH on enzyme activity.

Books Recommended:

1. Cooper, T.G (1977). The Tools of Biochemistry, John Wiley & Sons, N.Y.
2. Freifelder, D. (1982). Physical Biochemistry. Applications to Biochemistry & Molecular Biology, W.H. Freeman & Co.
3. Sadasivam, S. and Manickam, A. (1992). Biochemical Methods for Agricultural Sciences, Wiley Eastern Limited, New Delhi.
4. Sawhney, S.K. and Singh, R. (2001). Introductory Practical Biochemistry. Narosa Pub. House, New Delhi.
5. Plummer, D.T. (1990). An Introduction to Practical Biochemistry 3rd ed. Tata McGraw-Hill Publishing Co. Ltd., New Delhi.

M.Sc. (Biotechnology) (Semester – I)
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BTP 422: LAB IN GENERAL MICROBIOLOGY

Credits (0-0-4)

PRACTICAL

1. Light Microscopy – Principle, various parts, uses and care.
2. Isolation and purification of microorganisms (bacteria) from soil/water/air by streak plate method and serial dilution.
3. Size measurement of the purified bacterial strain.
4. To perform the Gram staining of the purified bacterial culture.
5. To perform the negative staining of the purified bacterial culture.
6. To perform acid fast staining.
7. To perform spore staining by the Schaeffer Fulton method.
8. To perform capsule staining to distinguish between capsular material and the bacterial cell.
9. To test for the antibiotic sensitivity of the bacterial sample.
10. To perform the MIC test for antibiotic sensitivity of a bacterial strain against a specific antibiotic.
11. To perform standard growth curve of purified bacterial strain.
12. To study the effect of temperature and pH on growth of microorganisms.
13. To study the motility of bacterial strain using the hanging drop technique.
14. To isolate antibiotic producing microorganisms.
15. Preservation of a microbial strain.

Books Recommended:

1. Claus, W.G. and Claus, G.W. (1991). Understanding microbes: Laboratory Text Book for Microbiology, W.H. Freeman Company.
2. Benson, H.J. (1994). Microbiological Applications, 6th ed., Win, C. Brown Publishers, England.
3. Cappucino, J.G. (1999). Microbiology-A laboratory manual, 4th ed., Harlow, Addition-Wesley.

M.Sc. (Biotechnology) (Semester – II)
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BTL 451: PLANT TISSUE CULTURE

Credits (3-0-0)

Time: 3 Hours **Max. Marks: 100**

Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

Section-A

Concepts & basic techniques in tissue culture, Micropropagation, stages of micropropagation, direct and indirect regeneration, Organogenesis & somatic embryogenesis, Factors affecting Organogenesis & somatic embryogenesis, Importance of variability, somaclonal and gametoclonal variations, practical application of somaclonal variations. Freeze preservation & cryopreservation in germplasm storage, factors affecting revival of frozen cells, slow growth & DNA banking for germplasm conservation.

Section-B

Embryo culture / embryo rescue and ovary culture. Endosperm culture, production of triploids, anther and pollen culture, Factors affecting anther and pollen culture, Significance of haploids in agriculture, Production and application of artificial seeds,

Section-C

Initiation and maintenance of callus and suspension cultures, single cell clones, Plant secondary metabolites a general account, important pathways of secondary metabolite production (phenylpropanoid pathway and shikimate pathway etc), Regulation and accumulation of secondary metabolites, Biotransformation and elicitation

Section-D

Protoplast isolation, fusion & culture, somatic hybridization, selection of hybrid cells and regeneration of hybrid plants, symmetric and asymmetric hybrids, cybrids and role of protoplast culture and somatic hybridization in improvement of crop plants.

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Books Recommended:

1. George, E.F. (1993). Plant Propagation by Tissue Culture, 2nd ed., Part-I, The Technology, Exegetics Ltd
2. Razdan, M. K. (1994). An Introduction to Plant Tissue Culture. Oxford & IBH Publishing Co., New Delhi.
3. Bhojwani, S.S. and Razdan, M.K. (1996). Plant Tissue Culture. Theory and Practice, Elsevier.
4. Tong-Jen, Fu, Gurmeet Singh & Wayne R. Curtis. Plant Cell & Tissue Culture for the Production of Food Ingredients. Kluwer Acad, N.Y.
5. Ramawat, K.G. and Merillon, J.M. (1999). Biotechnology: Secondary Metabolites, Science Publishers, U.S.
6. Purohit, S. S. (2000). Biotechnology Fundamentals & Application. 3rd ed., Agrobios (India), New Delhi.

M.Sc. (Biotechnology) (Semester – II)
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BTL 452: ANIMAL TISSUE CULTURE

Credits: (3-0-0)

Time: 3 Hours **Max. Marks: 100**
Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

Section-A

Concept of aseptic techniques in ATC; design and layout of ATC lab, Equipment for ATC lab. Laboratory safety and Biohazards, balanced salt solution and tissue culture media.

Section-B

Detection of contamination, preservation, storage and shipment of cells. Growth of cells in the serum free hormone(s) supplemented medium, Role of CO_2 in culture medium.

Section-C

Dispersion and disruption of tissue, monolayer and suspension culture techniques, measurement of growth and viability of cells in culture, maintenance of cultured cell line, primary and established cell line cultures, cell separation.

Section-D

Cell culture characteristics, scale up methods for propagation of anchorage dependent and suspension cell culture, concept of Bioreactors for mass culture of mammalian cells, microcarrier culture. Three dimensional culture system. Cell synchronization, cell transformation, cell immobilization techniques,

Books Recommended:

1. Spier, R. R. and Griffiths, J. B. (2012). Animal Cell Biotechnology, 6th Ed.Academic Press, London.
2. Gareth, E. J. (2012). Human Cell Culture Protocols, Ed. 3rd Humana Press.
3. Julio, E., Celis (2008). Cell Biology-A Laboratory Hand Book, Vol. I-IV, 3rd Ed., Academic Press, New York.
4. Butler, M. Animal Cell Technology, 2nd Ed., BIOS Scientific Publishers, U.K.
5. Freshney, R. T. (2010). Culture of Animal Cells, John Wiley and Sons, New York.

M.Sc. (Biotechnology) (Semester – II)
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BTL 453: MOLECULAR BIOLOGY

Credits (3-0-0)

Time: 3 Hours **Max. Marks: 100**

Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

Section-A

DNA: the vehicle of inheritance, DNA replication, Repair and Recombination: Replication initiation, elongation and termination in prokaryotes & eukaryotes, enzymes and accessory proteins involved in DNA replication, Fidelity; DNA repair- photoreactivation, nucleotide and base excision repair, mismatch repair, SOS response, gene amplification, mobile genetic elements, nucleic acid hybridization – cot curves.

Section-B

Prokaryotic transcription; transcription unit, promoters: constitutive and inducible, initiation, termination- rho dependent and independent. Eukaryotic transcription, promoters for RNA polymerase I, II and III, transcription factors, regulatory elements & mechanism of transcription regulation, post-transcriptional modifications: processing of hnRNA, rRNA & tRNA; 5'cap formation, 3'-end processing, polyadenylation and splicing.

Section-C

Genetic code, prokaryotic & eukaryotic translation, the translation machinery, isoaccepting tRNA, wobble hypothesis, mechanism of initiation, elongation & termination, ribosome recycling factor, tm RNA, regulation of translation, co & post translation modification of proteins and intracellular protein targeting import into nucleus, mitochondria and peroxiome, non-ribosomal polypeptide synthesis, prions.

Section-D

Regulation of gene expression in prokaryotes and eukaryotes; (operon concept; lac, trp and ara operons), RNA interference, Viral & cellular oncogenes, tumor suppressor genes from humans, structure, function & mechanism of action of p53 tumor suppressor proteins, Molecular mechanism of antisense molecules, ribozymes, applications of antisense & ribozyme technologies.

Books Recommended:

1. Rawn, J. D. (1989). Biochemistry, 2nd edition, Neil Patterson Publications, U. S. A. , North Carolina,
2. Damal, J., Lodish, H., and Baltimore, D. (1990). Molecular Cell Biology, 2nd ed., Scientific American Books, Distributed by W. H. Freeman and Co., New York.
3. Adams, R. L. P., Knowler, J. T., and Leader, D. P. (1992). The Biochemistry of Nucleic acids, 11th ed., Champman and Hall, The New York/London/Tokyo/Melbourne/Madras.
4. Stryer, L. (1995). Biochemistry, 4th ed., W. H. Freeman and Co., New York.
5. Nelson, D. L. & Cox, M. M. (2005). Lehninger Principles of Biochemistry, 4th ed., Worth Publishers, New York.
6. Watson J., Baker T., Bell S., Gann A, Levine M and Loscik R. (2008). Molecular Biology of the Gene. 6th Ed. Pearson Education.
7. Krebs J.E., Goldstein E.S. and Kilpatrick ST (2009), Lewin's Genes, Jones and Bartlett Publishers, U.K.

M.Sc. (Biotechnology) (Semester – II)
(Credit Based Evaluation & Grading System)

BTL 454: Genetic Engineering-Tools & Techniques

Credits (3-0-0)

Time: 3 Hours **Max. Marks: 100**

Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

Section-A

Restriction Enzymes; DNA ligase, Klenow enzyme, T4 DNA polymerase, Polynucleotide kinase, Alkaline phosphatase; Cohesive and blunt end ligation; Labeling of DNA: Nick translation, Random priming, Radioactive and non-radioactive probes (digoxigenin and biotin), Cloning vectors: Plasmids,M13, phagemids, insertion and replacement lambda vectors;

Section-B

Cloning vectors: Cosmids, Artificial chromosome vectors (YACs; BACs); yeast vectors, Expression vectors: principle of recombinant protein expression as His- and GST-tags by cloning in pET and pGEX; Expression strategies for heterologous genes: codon optimization, Hosts: expression in bacteria and yeast, Inclusion bodies; Methodologies to reduce formation of inclusion bodies, in vitro transcription & *in vitro* translation, siRNA technology.

Section-C

Linkers; Adaptors; Homopolymeric tailing, strategies for making cDNA libraries; Transformation; Northern and Southern, hybridization, cloning differentially expressed genes (mRNA differential display and subtractive cloning). DNA-Protein Interactions (Electromobility shift assay)

Section-D

PCR and Its Applications
Primer design; DNA polymerases (Taq & Pfu); Types of PCR – multiplex, nested, reverse transcriptase, real time PCR, touchdown PCR, hot start PCR, colony PCR, cloning of PCR products; SOEing; Site specific mutagenesis;

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(Credit Based Evaluation & Grading System)

Text/References

1. S.B. Primrose, R.M. Twyman and R.W.Old; Principles of Gene Manipulation. 6th Edition, S.B.University Press, 2001.
2. J. Sambrook and D.W. Russel; Molecular Cloning: A Laboratory Manual, Vols 1-3, CSHL, 2001.
3. Brown TA, Genomes, 3rd ed. Garland Science 2006
4. Selected papers from scientific journals.

M.Sc. (Biotechnology) (Semester – II)
(Credit Based Evaluation & Grading System)

BTL 455: BIOPROCESS ENGINEERING & TECHNOLOGY

Credits (3-0-0)

Time: 3 Hours **Max. Marks: 100**

Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

Introduction:
Historical development from Petri-plate, shake flask, Lab level bioprocess, pilot level to industrial level bioprocess engineering. Growth parameters, growth rate, specific growth rate and biomass doubling, degree of multiplication, growth yield, Ydx/ds, Ydx/do2, metabolic quotient, effect of substrate concentration on growth rate, Monod growth relation, saturation constants and its importance, biomass estimation. Sterilization : Introduction, medium sterilization, design of batch sterilization process, del factor, sterilization cycle, Richards rapid method for design of sterilization cycles, batch sterilization, scale up of batch sterilization, continuous sterilization, sterilization of feed, sterilization of wastes, Filter sterilization, filter sterilization of media and air, Depth filters design, theory of depth filter.

SECTION-B

Bioreactor Designing
Introduction, Basic designing and function of a bioreactor. Aspectic operation and contamination. Sterilization of bioreactors. Aeration and agitation, temperature probes. Dissolve oxygen probe, pH probe. Standardization of dissolve oxygen probe and pH probe.

SECTION-C

Instrumentation and Control:
Introduction, Methods of Measuring process, Temperature, Mercury and electrical resistant thermometers, Thermistors, flow measurement: pressure measurement, foam sensing, manual, automatic, proportional, integral and derivative controls.

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SECTION-D

Aeration and Agitation

Introduction, The oxygen requirement for industrial bioreactors, oxygen demand and supply and balance between them, volumetric oxygen transfer, determination of Kla values, sulphite oxidation techniques, gassing out techniques: static method and dynamic method, oxygen balance method. Fluid rheology: Bingham plastic, pseudo plastic, Dilatants, Casson body. Factors affecting KLa values in bioreactors, the effect of medium rheology on KLa values, scale up and scale down of airation and agitation.

Book:

1. Principles of Fementation Technology, Peter F. Stanbury; A. Whitaker; S.J. Hall. Aditya Books (P) Ltd. New Delhi

M.Sc. (Biotechnology) (Semester – II)
(Credit Based Evaluation & Grading System)

BTL 456: INTRODUCTION TO BIOINFORMATICS

Credits (3-0-0)

Time: 3 Hours **Max. Marks: 100**

Mid Semester Marks : 20

End Semester Marks : 80

Mid Semester Examination: 20% weightage

End Semester Examination: 80% weightage

Instructions for the Paper Setters:

Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

Introduction to Bioinformatics; Human Genome Project; Introduction to biological databases: Types of databases, e.g. PUBMED, MEDLINE Nucleic acid and protein databases: GenBank, SWISS PROT/ UNIPROT.

Significance of Genome Database : PLASMODB.

Data format, searching of database using keywords, submission tools at NCBI

SECTION-B

Scoring matrices, PAM, BLOSUM; Sequence alignment: Local and global alignment concepts; Dot matrix sequence comparison; Dynamic programming; Needleman-Wunch algorithm, Smith-Waterman algorithm

SECTION-C

Database search for homologous sequences : BLAST and its types, PSSM, PSI- BLAST, Multiple sequence alignment; Phyllogenetic analysis; Motifs and Pattern Databases: PROSITE, Pfam; Clustering, PCA.

SECTION-D

Protein sequence analysis tools, HMM, secondary structure prediction, concept of ANN, Tertiary structure prediction: homology modelling, fold recognition, ab initio methods. Structure visualization and analysis tools, rasmol, chimera, spdviwer, Structural databases: PDB, PDBsum, SCOP, CATH

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Books:

1. Cynthia Gibas & Per Jamesbeck, (2000). " Developing Bioinformatics Computer Skills," O' Rilley & Associates.
2. Campbell and Heyer, Discovering Genomics, Proteomics & Bioinformatics, 2nd Edition, Benjamin Cummings, 2002.
3. Bourhe P. E. and Weissig H. (2003). Structural Bioinformatics (Methods of structural Analysis). Wiley-Liss.
4. Mount D. W. (2004). Bioinformatics & Genome Analysis. Cold Spring Harbor Laboratory Press.
5. Wayne W. Danile(2004), Biostatistics: A foundation for Analysis in the Health Sciences, 8 th Edition Wiley

M.Sc. (Biotechnology) (Semester – II)
(Credit Based Evaluation & Grading System)

BTP 471: LAB IN PLANT TISSUE CULTURE

Credits (0-0-4)

1. Laboratory design setup for PTC unit.
2. Preparation, sterilization of media (Liquid & solid).
3. Surface sterilization, sealing of cultures, sources of contamination and their check measures.
4. Organ explant culture and micropropagation techniques.
5. Callus induction, propagation and differentiation.
6. Histological study of callus cells.
7. Suspension cultures.
8. Nurse culture techniques.
9. To observe practically various forms of undesirable characteristics in cultures such as:
   i) Vitrification
   ii) Stunting of shoots
   iii) Abnormal embryoids.
   iv) Etiolated shoots.
10. Preparation of synthetic seeds and their shelf life studies.
11. Micrografting Techniques.
12. Acclimatization of *in vitro* raised plantlets.
13. Comparison of *ex vitro* and *in vitro* rooting with respect to % survival.
14. To culture shoots on liquid media and derive a comparative account with reference to solid media grown cultures.
15. Protoplast isolation and culture.
16. Agrobacterium mediated transformation of plant cells.

M.Sc. (Biotechnology) (Semester – II)
(Credit Based Evaluation & Grading System)

BTP 472: LAB IN IMMUNOLOGY & ANIMAL TISSUE CULTURE

Credits (0-0-4)

1) Total leukocyte count
2) Differential leukocyte count
3) Haemagglutination assay
4) Isolation of mononuclear cells from peripheral blood and viability test by dye exclusion method
5) Separation of serum from blood
6) Separation of peritoneal macrophages from mouse/rat
7) Double immunodiffusion test using specific antibody and antigen
8) Dot Immuno blot assay (DIBA)
9) ELISA
10) Polyacrylamide gel electrophoresis and western blotting
11) Separation and purification of antibodies from serum
12) Growth and maintenance of cell line(s)
13) Trypsinization method for recovery of cells from monolayer
14) Doubling time of a given cell line and cell cycle analysis by Flow Cytometry
15) Cytotoxic assay method for a given cell line and testing by trypan blue dye exclusion method
16) Immunohistochemical localization of proteins and imaging using Confocal Microscope

Books Recommended:

1. Gareth, E. J. (1996). Human Cell Culture Protocols, Humana Press.
2. Jones, G.E. (1996). Human Cell Culture Protocols. Humana Press, New York.
3. Julio, E. Celis (1998). Cell Biology-A laboratory hand book, vol. I-IV, 2nd ed., Academic Press, New York.
4. Celis, J.E. (1998). Cell Biology: A laboratory handbook Vol-I, Academic Press, U.K.
5. Patel, D.(2001). Separating Cells, BIOS, U.K.
6. Hay, F.C., Westwood, O.M.R. (2002). Practical Immunology, 4th ed., Blackwell Sciences, U.K.
7. Freshney, R.I.(2006). Animal Cell Culture 5th ed., Oxford University Press, USA.

M.Sc. (Biotechnology) (Semester – III)
(Credit Based Evaluation & Grading System)

BTL 501: FERMENTATION TECHNOLOGY

Credits (3-0-0)

Time: 3 Hours **Max. Marks: 100**
Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

Introduction
Introduction to Fermentation processes, Media for Industrial Fermentation : Introduction, typical media, medium formulation for growth and production, energy source, carbon source, nitrogen source, minerals, growth and production factors. Oxygen requirement, antifoam, medium optimization.

SECTION-B

Isolation & Screening
Isolation, Screening, characterization and preservation of industrially important micro organisms, growth and production media, isolation & screening methods, improvement program of industrial microorganisms, mutants and mutational program for industrial micro organisms, recombinant of industrial micro organisms, preservation and maintenance of industrial micro organisms, quality control of preserved industrial micro organisms.

SECTION-C

Down stream Processing
Recovery and purification of fermentation products, removal of microbial cells, cell aggregation and flocculation, foam separation, precipitation, filtration, different types of filters and filter aids, industrial centrifugation and industrial centrifuges, basket centrifuge, tubular bowl centrifuge, solid bowl centrifuge, multi chamber centrifuge, disc bowl centrifuge,. Cell disruption: physical method, chemical method, liquid-liquid extraction, aqueous two phase extraction, super critical fluid extraction.

SECTION-D

Effluent Treatment and Fermentation Economics
Disposal, treatment processes, physical chemical and biological treatments, aerobic processes. Trickling filters, towers, biological aerated filters (BAFs), rotating drums, fluidized bed system, activated sludge processes, anaerobic treatment, up flow anaerobic sludge blankets (UASB), By-products, fermentation economics & market potential.

Book:

1. Principles of Fementation Technology, Peter F. Stanbury; A. Whitaker; S.J. Hall. Aditya Books (P) Ltd. New Delhi.

M.Sc. (Biotechnology) (Semester – III)
(Credit Based Evaluation & Grading System)

BTL 502: GENETIC ENGINEERING–APPLICATIONS

Credits (3-0-0)

Time: 3 Hours **Max. Marks: 100**

Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

Plant Transformation technology: The basis of tumour formation, features of Ti plasmids, mechanisms of DNA transfer, co-integrate and binary vectors, use of 35S and other promoters, selectable marker genes, reporter genes, Agrobacterium and direct gene transfer method : particle bombardment, electroporation, microinjection. *In planta* transformation, Promoter trapping, activation tagging. Chloroplast transformation: advantages, vectors, selectable markers promoters, transgene validation.

SECTION-B

Applications of plant transformation : Herbicide resistance for phosphoinothricin, glyphosate; Insect resistance: Bt Genes, protease inhibitors, alpha amylase inhibitor; Virus resistance: coat protein mediated ; Disease resistance; chitinase, antifungal proteins, thionines, Nematode resistance, RNAi silencing; Enhancing shelf life of fruits, use of ACC synthase, poly-galactouranase, ACC oxidase; Male sterile lines: bar and barnase systems; terminator gene technology. Nutritional improvement: golden rice, folate content, protein, vitamins.

SECTION-C

Molecular markers: RAPD, SSLP markers, STS, microsatellites, SCAR (sequence characterized amplified regions), SSCP (single strand conformational polymorphism), AFLP, DNA fingerprinting and its applications in forensic, disease prognosis, genetic councelling, pedigree, varietal analysis, etc., animal trafficking and poaching, germplasm maintenance and biodiversity.

SECTION-D

Transgenic strategies for abiotic stress tolerance in plants : Trehalose, Proline, transcription factors (NAC, CBF, HARDY), Na-H antiporter, vesicle transport (TaVAP).

Text/References
Books Recommended:

1. Gupta, P. K. (1996). Elements of Biotechnology, Rastogi and Co., Meerut.
2. Henry, R. J. (1997). Practical Applications of Plant Molecular Biology, Chapman and Hall.
3. Research Papers.

M.Sc. (Biotechnology) (Semester – III)
(Credit Based Evaluation & Grading System)

BTD 521: Research Project Status Report

Credits (0-0-2)

The Research Project Status Report Course No. BTD 521 will be evaluated (as a Seminar) by a Board of three internal examiners. Research Project Status Report will be accepted if found satisfactory.

M.Sc. (Biotechnology) (Semester – III)
(Credit Based Evaluation & Grading System)

BTP 522: LAB IN BIOPROCESS ENGINEERING & FERMENTATION TECHNOLOGY

Credits: (0-0-4)

1. Bioreactors assembling and dismantling.
2. Sterilization of fermentor and formentation media.
3. pH probe standardization.
4. Dissolve oxygen probe standardization.
5. Determinations of thermal death point (TDP) and thermal death time (TDT) of micro organisms for designing of sterilization.
6. Study the effect agitation on aeration and determination of KLa volumetric oxygen transfer rate in the bioreactor by dynamic gassing out technique.
7. Isolation screening and characterization of cellulase producing micro organisms.
8. Isolation screening ad characterization of alkaline protease producing micro organisms.
9. Cell immobilization and study the bio reaction enzyme kinetics before and after immobilization.

Book:

1. B. Atkinson Biochemical Engineering and Biotechnology Hand Book Mac Millan Press 2009

M.Sc. (Biotechnology) (Semester – III)
(Credit Based Evaluation & Grading System)

BTP 523: LAB IN GENETIC ENGINEERING

Credits (0-0-4)

PRACTICAL

1. Isolation of genomic DNA from plant tissues.
2. Isolation of genomic DNA from *E. coli* cells.
3. Spectrophotometric analysis of DNA.
4. Restriction digestion of DNA.
5. Separation of digested fragments by agarose gel electrophoresis.
6. Transfer of resolved DNA fragments from agarose gel to nylon/nitrocellulose membrane.
7. Hybridization of nylon/nitrocellulose blots.
8. Isolation of plasmid.
9. Making competent cells of *E.coli*.
10. Transformation of competent *E.coli* cells.
11. Cloning of foreign DNA insert in plasmid (PET Vector).
12. Isolation of total RNA.
13. Expression of fusion protein (His-tagged/MBD-tagged)
14. PCR.

Book Recommended:

1. Maniatis, T., Fritch, E.F. and Sambrook, J. (2001). Molecular cloning 3rd ed.: A laboratory manual, Ist edition. Cold Spring Harbour Laboratory, Cold Spring Harbour, New York.

M.Sc. (Biotechnology) (Semester – III)
(Credit Based Evaluation & Grading System)

BTD 524 : SEMINAR / JOURNAL CLUB / ASSIGNMENT

Credits (0-0-1)

M.Sc. (Biotechnology) (Semester – III)
(Credit Based Evaluation & Grading System)

Elective Paper
BTL 531: ADVANCES IN PLANT BIOTECHNOLOGY

Credits (3-0-0)

Time: 3 Hours **Max. Marks: 100**
Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

Hairy Root Research: Recent Scenario and Exciting Prospects
Production of hairy root cultures, hairy roots for high-value metabolite production, metabolic engineering of bioactive substances in plant hairy root culture, application of hairy root in phytoremediation, Scale-up process.

SECTION-B

Gene Silencing Techniques and Crop Improvement
Overview of different strategies for gene silencing, RNA interference, construction of RNA interference vectors, applications of RNA interference in crop improvements

SECTION-C

Reactive Oxygen Species (ROS) in Plants
Origins of the reactive oxygen species (ROS) network, the dynamics of ROS signaling, networking of ROS signaling with other signaling pathways, ROS in biotic and abiotic stress, ROS in plant growth and development.

SECTION-D

Hormonal Regulation of Plant Growth and Development
Signaling pathways of auxin and brassinosteroid. Interplay of different hormones for plant growth and development.

References:

1. Cellular and Molecular Biology of Plant Seed Development. Larkins, Brian A.; Vasil, Indra K. (Eds.), Vol. 4, 1997, ISBN 978-0-7923-4645-6
2. Mei-Liang Zhou, Xue-Mei Zhu, Ji-Rong Shao,Yi-Xiong Tang & Yan-Min Wu (2011) Production and metabolic engineering of bioactive substances in plant hairy root culture. Appl Microbiol Biotechnol 90:1229–1239
3. Klaus Apel and Heribert Hirt (2004) Reactive Oxygen Species: Metabolism, Oxidative Stress, and Signal Transduction. Annu. Rev. Plant Biol. 2004. 55:373–99
4. Ron Mittler, Sandy Vanderauwera, Nobuhiro Suzuki, Gad Miller, Vanesa B. Tognetti, Klaas Vandepoele, Marty Gollery, Vladimir Shulaev, Frank Van Breusegem (2011) ROS signaling: the new wave? Trends in Plant Science. 16 (6), 300-309
5. Matthew, L. (2004), RNAi for plant functional genomics, Comparative and Functional Genomics, 5, 240-244.
6. Umesh Balkrishna Jagtap, Ranjit Gajanan Gurav and Vishwas Anant Bapat Role of RNA interference in plant improvement. Naturwissenschaften (2011) 98:473–492
7. William M Gray (2004) Hormonal Regulation of Plant Growth and Development. PLoS Biology. 2 (9) e311
8. Stephen Depuydt and Christian S. Hardtke (2011) Hormone Signalling Crosstalk in Plant Growth Regulation. Current Biology 21: R365–R373
9. Research Papers.

M.Sc. (Biotechnology) (Semester – III)
(Credit Based Evaluation & Grading System)

Elective Paper
BTL 532: MEDICAL BIOTECHNOLOGY

Credits: (3-0-0)
Time: 3 Hours **Max. Marks: 100**
Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

Cellular therapy; Stem cells: definition, properties and potency of stem cells; Sources: embryonic and adult stem cells; Concept of tissue engineering; Histotypic and Organotypic culture for tissue engineering; Cancer immunotherapy; Role of cytokines and monoclonal antibodies in cancer therapy

SECTION-B

Clinical transplantation immunology and immunosuppressive therapy; Vaccine development; recombinant vaccines and clinical applications. Gene therapy; Overview of inherited and acquired diseases for gene therapy; Retro and adeno virus mediated gene transfer; Liposome and nanoparticles mediated gene delivery

SECTION-C

Recombinant proteins for clinical applications: Erythropoietin; Insulin analogs and its role in diabetes; Recombinant human growth hormone; Streptokinase and urokinase in thrombosis; Recombinant coagulation factors, Vaccine and its type
Protein engineering for therapeutic protein design

SECTION-D

Steps in drug designing, In silico drug designing, structure based drug designing, methods of docking; concept of ADME; QSAR; Biomarkers : Applications of biomarkers

Books:

1. Spier, R.R. and Grifftths, J.B. (1994). Animal Cell Biotechnology, 6th Ed., Academic Press, London.
2. Krogsgaard-larsen P. , Liljefors T., Madsen U. and Larsen K, Liljefors T. Madsen U. (2016). Textbook of Drug Design and Discovery, 5 th Ed. Taylor and Francis Publications, Washington D.C.
3. Palson, O.B. and Bhatia, N.S. (2016). Tissue Engineering. Dorling Kindersley (India) Pvt. Ltd.
4. Robert L. and other (2009) .Essentials of Stem Cell Biology. 3 rd Ed. Academic Press, London.
5. Research Papers and Review Articles

M.Sc. (Biotechnology) (Semester – III)
(Credit Based Evaluation & Grading System)

Elective Paper
BTL 533: Microbial Biotechnology

Credits (3-0-0)

Time: 3 Hours **Max. Marks: 100**
Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A
Introduction to microbial technoloogy, Microbial metabolites : Primary & Secondary.

SECTION-B
Introduction to microbial genomes, phylogenetic relationships between various genera of microbes- 16SrRNA sequencing and Ribosomal Database project. Prokaryotic genome organization, chromids, Bacterial and viral metagenomics, synthetic genomics, microbial sequencing projects, comparative genomics of relevant organisms such as pathogens and non-pathogens, human microbiome project.

SECTION-C
Microbial biofilms, polyketide synthase, antibiotic resistance, extremophiles and extremophilic biocatalysts, lantibiotics, biosynthesis of nanomaterials, probiotics, microbial degradation of xenobiotics, viral enzymes in modern biotechnology and clinical applications.

SECTION-D
Microbial bio-products : penicillin G, Microbial Enzymes : amylases, cellulases, cellobiohydrolase, endoglucanase, cellobiase, β-glucosidase, proteases. Microbial cultures.

Book:
Research Papers

M.Sc. (Biotechnology) (Semester – IV)
(Credit Based Evaluation & Grading System)

BTL 551: GENOMICS & PROTEOMICS

Credits (3-0-0)

Time: 3 Hours **Max. Marks: 100**

Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

Whole genome analysis: Preparation of genomic library in vectors, ordered cosmid libraries, BAC libraries, shotgun libraries, comparative genomics (Arabidopsis, rice and panda); Pharmacogenomics, introduction to metabolomics.

SECTION-B

DNA sequencing: conventional sequencing (Sanger, Maxam and Gilbert), pyrosequencing, next generation sequencing, automated sequencing, translation to large scale projects, epigenomics, cancer genomes.
FISH, Comparative Genomic Hybridization (CGH), SKY (Spectral Karyotyping).

SECTION-C

DNA Microarrays: Chemical DNA synthesis, Printing of oligonucleotides and PCR products on glass slides, nitrocellulose paper. Fluorescence based assay formats and signal amplification strategies, Analysis of single nucleotide polymorphism using DNA chips.
Gene Identification and Expression Analysis: DNA microarrays, ESTs, SAGE, MPSS.

SECTION-D

Proteome analysis: Two dimensional separation of total cellular proteins, isolation and sequence analysis of individual protein spots by mass spectroscopy. Protein microarrays, differential display proteomics, yeast 2-hybrid system, FRET, bimolecular fluorescence complementation assay.

References:

1. Peruski, L.F. Jr. and Peruski, A.H. (1997). The Internet and New Biology: Tools for Genomic and Molecular Research ASM.
2. Schena, M.ed. (1999). DNA Microarrays: a practical approach. Oxford University Press.
3. Hunt, S. and Livesey, F. ed. (2000). Functional Genomics: A practical approach. Oxford University Press.
4. Sharma, T.R. (2009). Genome analysis and Bioinformatics. A practical approach, IK International Publishers, New Delhi.
5. Recent articles in journals.

M.Sc. (Biotechnology) (Semester – IV)
(Credit Based Evaluation & Grading System)

BTD 571: RESEARCH PROJECT

Credits (0-0-20)

The Research Project Course No. BTD 571 will be evaluated by a Board of three internal examiners. Research Project will be graded as satisfactory/Not Satisfactory.