K. C. E. Society's
Moolji Jaitha College
An 'Autonomous College' Affiliated to
K.B.C. North Maharashtra University, Jalgaon.
NAAC Reaccredited Grade - A (CGPA : 3.15 - 3rd Cycle)
UGC honoured "College of Excellence" (2014-2019)
DST(FIST) Assisted College

KNOWLEDGE IS POWER
ESTD. 1945

के. सी. ई. सोसायटीचे
मूळजी जेठा महाविद्यालय
क.ब.चौ. उत्तर महाराष्ट्र विद्यापीठ, जळगाव संलग्नित
'स्वायत्त महाविद्यालय'
नॅकद्वारा पुनर्मानांकित श्रेणी – 'ए' (सी.जी.पी.ए. : ३.१५ – तिसरी फेरी)
विद्यापीठ अनुदान आयोगाद्वारा घोषित 'कॉलेज ऑफ एक्सलन्स' (२०१४-२०१९)
डी.एस.टी. (फीस्ट) अंतर्गत अर्थसहाय्य प्राप्त

Date :- 01/08/2023

NOTIFICATION

Sub :- CBCS Syllabi of M. Sc. in Biotechnology (Sem. I & II)

Ref. :- Decision of the Academic Council at its meeting held on 26/07/2023.

The Syllabi of M. Sc. in Biotechnology (First and Second Semesters) as per **NATIONAL EDUCATION POLICY - 2020** and approved by the Academic Council as referred above are hereby notified for implementation with effect from the academic year 2023-24.

Copy of the Syllabi Shall be downloaded from the College Website (www.kcesmjcollege.in)

Sd/-
Chairman,
Board of Studies

To :

1) The Head of the Dept., M. J. College, Jalgaon.
2) The office of the COE, M. J. College, Jalgaon.
3) The office of the Registrar, M. J. College, Jalgaon.

Near Samarth Colony, Jalgaon - 425 002. (Maharashtra, India) | Ph. : +91 257 - 2237363, 2234281 | e-mail : mjcollege@kces.in | Website : mjcollege.kces.in
समर्थ कॉलनी जवळ, जळगांव – ४२५ ००२. (महाराष्ट्र, भारत) । दूरध्वनी क्र. : +९१ २५७–२२३७३६३, २२३४२८१ । ई–मेलः mjcollege@kces.in । वेबसाईटः mjcollege.kces.in

Khandesh College Education Society's

Moolji Jaitha College, Jalgaon

An "Autonomous College"

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SYLLABUS

SYLLABUS

M.Sc. I

Biotechnology

Under Choice Based Credit System (CBCS)

and

as per NEP-2020 Guidelines

[w.e.f. AcademicYear:2023-24]

Preface

Skilled human resource is a prerequisite in higher education, and it is to be acquired through in-depth knowledge of theoretical concepts and hands-on laboratory methods of the subject. The present syllabus of M.Sc. part I in the subject of Biotechnology has been prepared as per the guidelines of UGC, NEP-2020 and Government of Maharashtra. It cultivates theoretical and practical knowledge of different fields of among the students of Biotechnology. The contents of the syllabus have been prepared to accommodate the fundamental aspects and advanced developments in various disciplines of Biotechnology and to complement the needs of various applied sectors of Biotechnology. Besides this, the students will be enlightened with knowledge in the newer areas of Bioinstrumentations, Biomolecules, Microbial Genetics, virology, Immune response, tissue culture, microbial fermentations, IPR, Patents, bioethics etc. Furthermore, the syllabus is structured to cater to Biotechnology present and future needs in the research field, industrial and environmental sectors, Entrepreneurship etc., emphasizing imparting hands-on skills. Hence, the curriculum is endowed with more experiments that shall run hand-in-hand with theory. The detailed syllabus of each paper is appended with a list of suggested readings.

The overall curriculum of one/ two-year covers general concepts in biotechnology, biomolecules and microbial metabolism, cell biology, extremophiles, molecular biology and microbial genetics, and immunology, industrial and applied microbiology, environmental microbiology, and also covers various advanced bio techniques such as bioinformatics, immunotechniqes, Tissue culture and biosensors etc. Furthermore, the syllabus is structured to cater to Biotechnology present and future needs in the research field, Industrial and Environmental Sector, Entrepreneurship etc., emphasizing imparting hands-on skills. Hence, the curriculum is endowed with more experiments that shall run hand-in-hand with theory. The detailed syllabus of each paper is appended with a list of suggested readings.

Program Outcomes (PO) for M.Sc. Program:

Program outcomes associated with an MSc degree are as follows:

1. Student possess an in-depth understanding of advanced theories, concepts, and methodologies in their specific field of study.
2. Student should demonstrate advanced technical skills and proficiency in utilizing specialized equipment, software, and methodologies relevant to their field of study.
3. Student should be capable of critically analyzing complex problems and synthesizing information from various sources.
4. Student should be proficient in effectively communicating scientific information to both technical and non-technical audiences. They should be able to present their experimental findings through oral presentations, scientific writing, and the use of appropriate visual aids.
5. Student should demonstrate leadership qualities and the ability to work effectively as part of a team.
6. Student should have developed advanced research skills and the ability to independently design and conduct rigorous scientific investigations. They should be able to analyze scientific literature, formulate research questions, develop research plans, collect and analyze data, draw valid conclusions and know about IPR.
7. Student should understand and adhere to ethical principles and professional standards in their field.
8. Student should recognize the importance of continuous learning and professional development. They should have the skills and motivation to stay updated with advancements in their field, engage in lifelong learning, and pursue further academic or professional opportunities.

Program Specific Outcome PSO (M.Sc. Biotechnology):

After completion of this course, students are expected to learn/understand the:

No	PSO
1	Various biomolecules, there transport, diverse metabolic reactions and bioenergetics
2	Bioanalytical, biophysical, biomolecule purification and immunological techniques
3	Molecular biology concerning DNA replication, central dogma, gene regulation and r DNA technique
4	Concept of environmental biotechnology, biodiversity and its conservation
5	Techniques of plant / animal tissue culture and biotechnology of animal and plants
6	Bioprocess technology for agriculture, Food, pharmaceutical, fermentation and environmental sectors
7	Newer and applied areas such as bioinformatics, biostatistics and cancer biology
8	Research methodology, IPR, Bioentreprenuership, bioethics, professional development

Credit distribution structure for two years/one-year PG MSc programme

Level	Sem	Major (Core) Subjects		Minor Subjects	OJT/Int, RP	Cumulative Credits/Sem	Degree/ Cumulative Cr.
		Mandatory (DSC)	Elective (DSE)				
6.0	I	DSC-1 (4T) DSC-2 (4T) DSC-3 (4T) DSC-4 (2P)	DSE-1(2T) A/B DSE-2(2P) A/B	RM (4T)		22	First year PG OR One year PG diploma after 3year UG
	II	DSC-5 (4T) DSC-6 (4T) DSC-7 (4T) DSC-8 (2P)	DSE-3(2T) A/B DSE-4(2P) A/B		OJT/Int (4)	22	
	Cum. Cr.	28	8	4	4	44	
	Exit option: PG diploma (44 Credits) after three year UG degree						
6.5	III	DSC-9 (4T) DSC-10 (4T) DSC-11 (4T) DSC-12 (2P)	DSE-5(2T) A/B DSE-6(2P) A/B	--	RP (4)	22	Second year PG after 3 year UG OR PG degree after 4 year UG
	IV	DSC-13 (4T) DSC-14 (4T) DSC-15 (2P) DSC-16 (2P)	DSE-7(2T) A/B DSE-8 (2P) A/B	...	RP (6)	22	
	Cum. Cr.	54	16		4+10	88	
2 Years-4 Sem. PG Degree (80-88 credits) after Three Year UG Degree or 1 Year-2 Sem PG Degree (40-44 credits) after Four Year UG Degree							

Sem- Semester, **DSC**- Department Specific Course, **DSE**- Department Specific Elective, **T**- Theory, **P**- Practical, **RM**- Research Methodology, **OJT**- On Job Training, **Int**- Internship, **RP**- Research Project, **Cum. Cr.** : Cumulative Credits

Multiple Entry and Multiple Exit options:

The multiple entry and exit options with the award of UG certificate/ UG diploma/ or three-year degree depending upon the number of credits secured;

Levels	Qualification Title	Credit Requirements		Semester	Year
		Minimum	Maximum		
6.0	One-year PG Diploma program after 3 Yr Degree	40	44	2	1
6.5	Two-year master's Degree program After 3-Yr UG Or PG Degree after 4- Yr UG	80	88	4	2

Examination Pattern for MSc

Theory Question Paper Pattern:

- 60 (External) +40 (Internal) for 4 credits
    - External examination will be of three hours duration
    - There shall be 5 questions each carrying equal marks (12 marks each) while the tentative pattern of question papers shall be as follows;
    - Q1 Attempt any 3 out of 4 sub-questions; each 4 marks
    - Q 2, Q3, Q4 and Q5 Attempt any 2 out of 3 sub-question; each 6 marks.
- 30 (External) +20 (Internal) for 2 credits
    - External examination will be of 1½ hours duration
    - There shall be 3 questions Q1 carrying 6 marks and Q2, Q3 carrying 12 marks each. while the tentative pattern of question papers shall be as follows;
    - Q1 Attempt any 2 out of 3 sub-questions; each 3 marks
    - Q 2 and Q3 Attempt any 2 out of 3 sub-question; each 6 marks.

Rules of Continuous Internal Evaluation:

The Continuous Internal Evaluation for theory papers shall consist of two methods:

1. Continuous & Comprehensive Evaluation (CCE): CCE will carry a maximum of 30% weightage (30/15 marks) of the total marks for a course. Before the start of the academic session in each semester, the subject teacher should choose any three assessment methods from the following list, with each method carrying 10/5 marks:

i. Individual Assignments
ii. Seminars/Classroom Presentations/Quizzes
iii. Group Discussions/Class Discussion/Group Assignments
iv. Case studies/Case lets
v. Participatory & Industry-Integrated Learning/Field visits
vi. Practical activities/Problem Solving Exercises
vii. Participation in Seminars/Academic Events/Symposia, etc.
viii. Mini Projects/Capstone Projects
ix. Book review/Article review/Article preparation
x. Any other academic activity
xi. Each chosen CCE method shall be based on a particular unit of the syllabus, ensuring that three units of the syllabus are mapped to the CCEs.

2. Internal Assessment Tests (IAT): IAT will carry a maximum of 10% weightage (10/5 marks) of the total marks for a course. IAT shall be conducted at the end of the semester and will assess the remaining unit of the syllabus that was not covered by the CCEs. The subject teacher is at liberty to decide which units are to be assessed using CCEs and which unit is to be assessed on the basis of IAT.

The overall weightage of Continuous Internal Evaluation (CCE + IAT) shall be 40% of the total marks for the course. The remaining 60% of the marks shall be allocated to the semester-end examinations.

The subject teachers are required to communicate the chosen CCE methods and the corresponding syllabus units to the students at the beginning of the semester to ensure clarity and proper preparation.

Practical Examination Credit 2: Pattern (30+20)

External Practical Examination (30 marks):

- Practical examination shall be conducted by the respective department at the end of the semester.
- Practical examination will be of 3 hours duration and shall be conducted as per schedule.
- There shall be 05 marks for journal and viva-voce. Certified journal is compulsory to appear for practical examination.
- Practical examination will be of minimum 3 hours duration and shall be conducted as per schedule for 2 consecutive days in case of practical where incubation condition, allied aspects are essential.

Internal Practical Examination (20 marks):

- Internal practical examination of 10 marks will be conducted by department as per schedule given.
- For internal practical examination student must produce the laboratory journal of practicals completed along with the completion certificate signed by the concerned teacher and the Head of the department.
- There shall be continuous assessment of 30 marks based on student performance throughout the semester. This assessment can include quizzes, group discussions, presentations and other activities assigned by the faculty during regular practicals. For details refer internal theory examination guidelines.
- Finally 40 (10+30) marks performance of student will be converted into 20 marks.

M.Sc. Biotechnology Course Structure

Semester	Course Module	Credit	Hours/ week	TH/ PR	Code	Title
I	DSC	4	4	TH	BIT-DSC-511	Biomolecules and metabolic reactions
	DSC	4	4	TH	BIT -DSC-512	Bioanalytical and Biophysical Techniques
	DSC	4	4	TH	BIT-DSC-513	Molecular biology and gene regulation
	DSE	2	2	TH	BIT-DSE-514A	Biodiversity and its conservation
	DSE	2	2	TH	BIT-DSE-514B	Cell and Cancer Biology
	DSC	2	**4**	**PR**	BIT-DSC-515	Practical course on Biochemistry and Molecular biology
	DSE	2	**4**	**PR**	BIT-DSE-516A	Practical course on bio-diversity and bio techniques
	DSE	2	**4**	**PR**	BIT-DSE-516B	Practical course on cell biology
	DSC	4	4	TH	BIT-RM-517	Research Methodology for Biotechnology
II	DSC	4	4	TH	BIT-DSC-521	Advances in Immunology
	DSC	4	4	TH	BIT-DSC-522	Plant and animal tissue culture
	DSC	4	4	TH	BIT-DSC-523	r DNA technology
	DSE	2	2	TH	BIT-DSE-524A	Plant biotechnology
	DSE	2	2	TH	BIT-DSE-524B	Bioprocess Technology
	DSC	2	**4**	**PR**	BIT-DSC-525	Practical course on Plant and animal tissue culture
	DSE	2	**4**	**PR**	BIT-DSE-526A	Practical course on plant biotechnology
	DSE	2	**4**	**PR**	BIT-DSE-526B	Practical course on bioprocess technology
	DSC	4	**8**	**OJT**	BIT-OJT-527	Internship / On Job Training

DSC	**:**	Department-Specific Core course
DSE	**:**	Department-Specific elective
TH	**:**	Theory
PR	**:**	Practical

M.Sc. I
(Biotechnology)
Semester I

MSc I (Biotechnology)
Semester I
BIT-DSC-511: Biomolecules and metabolic reactions

Total Hours: 60 **Credits: 4**

Course objectives	• To know the metabolism of carbohydrates and lipids. • To learn the metabolism of amino acids and nucleotide • To study basic concepts in enzymology and enzyme kinetics • To understand enzyme regulation and Immobilization	
Course outcomes	After successful completion of this course, students are expected to: • Correlate metabolism pathway for carbohydrates and lipids with its bioenergetics • Relate metabolism pathway for amino acid and nucleotide and its bioenergetics • Learn theories of enzyme catalysis, enzyme classification and kinetics • Apply the knowledge of inhibitions and regulations for enzyme production	
Unit	**Contents**	**Hours**
Unit I	**Carbohydrates and lipids** • Carbohydrates: Classification, types, Optical isomerism, Mutarotation, Basic structure and functions of monosaccharides, Oligosaccharides, polysaccharides. • Carbohydrate metabolism: glycolytic pathway (EMP, HMP, TCA), gluconeogenesis and its regulation, • Heteropolysaccharides of bacterial cell walls; Proteoglycans; Glycoproteins; Lectins. • Lipids: Classification, structure, properties and function of fatty acids; Phospholipids; Glycolipid; Lipoprotein • Biosynthesis of fatty acids, cholesterol biosynthesis, ketone body formation, interconversion of phospholipids • Oxidation of fatty acids, α, β and ω types, β - oxidation of fatty acid and its regulation and energetics of β oxidation	**15**
Unit II	**Nucleic acids and proteins** • Nucleic acids - Structure and properties of purines and pyrimidine bases • Biosynthesis: de novo and salvage pathways, catabolism of purines and pyrimidines • Amino acids: deamination, transamination, transdeamination, decarboxylation, urea cycle, ketogenic and glucogenic amino acids • Classification and different structural levels (Primary, secondary, tertiary & quaternary) of proteins, stabilizing bonds, Ramachandran plot, principles of amino acid sequencing, • Metabolism of aromatic amino acids, histidine, cysteine and serine • Protein engineering	**15**

Unit III	**Enzyme catalysis** • Terminology in enzymology: units of enzyme activity, specific activity of enzyme, method of enzyme activity, enzyme specificity, turn over number of an enzyme, • Classification of enzymes as per IUB • Enzyme catalysis – general principles of catalysis and different mechanisms of catalysis, quantitation of enzyme activity and efficiency • Example of enzyme catalytic mechanism (e.g Serine Proteases) • Coenzyme and cofactors (Structure and function of TPP, PLP, FMN) • Unisubstrate and multi-substrate enzyme kinetics, Steady state enzyme kinetics: MM hypothesis, Briggs Haldane hypothesis and LB plot, Eddie-Hofstee and Hanes plot	**15**
Unit IV	**Enzyme Inhibition and Regulation** • Allosteric enzyme: Symmetric and sequential mode of action, • Enzyme inhibition: Competitive, non-Competitive and uncompetitive inhibition, transition state analogues • Enzyme repression, induction and degradation, Feedback inhibition and feed-forward induction, • Enzyme engineering	**15**

References

- Voet, V. & Voet, J. G., (2004). Biochemistry, 3rd edition, John Wiley, New York
- Lehninger, A. L. (2004). Principles of Biochemistry, 4th edition, W.H Freeman and Company,
- Stryer L., (2002). Biochemistry, 5th edition, W.H. Freeman and Company,
- Jain, J. L. (2003). Fundamentals of biochemistry, S. Chand and Co. New Delhi
- Satyanarayana, U. & Chakrapani. (2007). Biochemistry, Books and Allied P . Ltd. Kolkata
- Voet Donald, Voet Judith G. & Pratt Charlotte W. (2006), Fundamentals of Biochemistry 2nd ed., John Wiley & Sons, INC.

MSc I (Biotechnology)
Semester I
BIT -DSC-512: Bioanalytical and Biophysical Techniques

Total Hours: 60 **Credits: 4**

Course objectives	• To acquaint knowledge about basic laboratory techniques • To know advanced microscopy techniques • To learn separation and chromatographic techniques for macromolecules • To study immunological and radioactive techniques	
Course outcomes	After successful completion of this course, students are expected to: • Implement the knowledge of basic laboratories instrument • Acquaint with advance microscopy to observe biological samples • Capable of using separation methods for different macromolecules • Apply the knowledge of immunological and radioactive techniques	
Unit	**Contents**	**Hours**
Unit I	**Basic Techniques** o Laboratory: design, maintenance, documentation and sterilization o Preservation of materials: types of fixatives, macerations, peeling, mounting. o Microtome: types of microtome, serial sectioning. o Staining: types and procedure of staining (bacterial, plant and animal cell). o Principle and application of basic instruments in a laboratory o pH meter, colourimeter, centrifuge, LAF, autoclave, hot air oven, incubator o Caliberation of: balance, LAF, autoclave and pH Meter o Aseptic handling of biological material	**15**
Unit II	**Microscopy** o Basic principle of microscopy: ray diagram, magnification, resolution, numerical aperture o Types and working of light microscope, electron microscope (SEM and TEM), dark field microscopy, fluorescence microscopy, phase contrast microscope, confocal microscopy, inverted microscopy, Atomic Force Microscopy. o Micrometry: principles and techniques, calibration of micrometer scale, metric units,	**15**
Unit III	**Separation Techniques & Spectroscopy** Principle, working, components and application of following o Chromatographic techniques:	**15**

	○ Paper and gel filtration chromatography ○ Ion exchange and affinity chromatography, ○ HPLC and gas chromatography. ○ Electrophoresis: gel electrophoresis (one and two-dimensional) ○ PAGE, SDS-PAGE, Agarose. ○ Blotting techniques: southern, northern, western and south western blotting. ○ Spectroscopic techniques: UV-Vis, FTIR, NMR and mass spectrometry	
Unit IV	**Immunological and Radioactive Techniques** ○ Radial immune diffusion, Ouchterlony double diffusion, ○ Immunofluorescence, Immune electrophoresis ○ Radio labelling agents and radioactive techniques ○ Properties of different types of radioisotopes in biological systems, radio degradation, half-life period, radio dating, radio labelling, auto radiography, dosimetry, and safety guidance.	**15**

References

- Krishnamurthy, K.V. (1988). Methods in Plant Histochemistry. S. Wiswanathan Printers & Publishers
- De Roberti's & De Roberti's., (2005). Cell and Molecular Biology, Lippincott Williams, Philadelphia. [B.I Publications Pvt. Ltd. New Delhi].
- Powar, C.B., (2005). Cell Biology,Third Edition, Himalaya Publishing, Mumbai.
- Verma, P.S & Agarwal, V.K. (2006). Cell Biology, Genetics, Molecular Biology,Evolution, Ecology. S. Chand & Company, New Delhi.
- Upadhyay, Upadhyay, & Nath, (2010). Biophysical chemistry Principals and Techniques Himalaya publication Mumbai.
- Jacquelyn, G. Black, (2011). Microbiology principles and exploration 6th edition, john Wiley and sons USA.
- Sadasivam, S., Manikam A. (2018). "Biochemical analysis" New age publication, New Delhi.
- Coleman, R. M, Lombard, M. F & Sicard, R. E., (1989), Fundamental Immunology, 2nd Ed., W. C. Brown Publishers, USA.

MSc I (Biotechnology)
Semester I
BIT-DSC-513: Molecular biology and gene regulation

Total Hours: 60 **Credits: 4**

Course objectives	• To learn DNA synthesis and repair mechanism • To know process of Transcription • To study steps involved in Translation • To understand the mechanism of Gene regulation	
Course outcomes	After successful completion of this course, students are expected to: • Know the methods of DNA synthesis, its damage and repair mechanism • Relate the process of transcription and post transcription • Narrate the process of translation and its regulation • Recite the structure and regulatory mechanism of different operon	
Unit	**Contents**	**Hours**
Unit I	**DNA replication, damage and repair** • DNA Structure and Replication: DNA replication machinery in Prokaryotes and eukaryotes, Replication fork. • Enzyme of DNA Replication: DNA polymerase (I, II, III), primases, ligases, helicases, topoisomerases, gyrases and SSBP. • Models of DNA Replication: theta mode of replication, rolling circle model of replication, unidirectional replication, Bidirectional replication, replication of linear, Regulation of DNA replication and inhibitors of DNA replication. • DNA damage: deamination, oxidative damage, alkylation, pyrimidine dimmers, mechanical and chemical damage • DNA mutations: Spontaneous and inducible and mutagenic agents. • DNA repair pathways: Methyl-directed mismatch repair, very short patch repair, nucleotide excision repair, base excision repair, recombination (Specific and Nonspecific), mismatch, SOS.	**15**
Unit II	**Transcription** o Types of RNA polymerase (prokaryotic and eukaryotic), process of transcription o mRNA processing, editing: capping, adenylation, splicing, RNA transport o Transcriptional regulation: transcriptional bursting/pulsing, specificity factors, enhancers, repressors, activators and general transcription factors o Post-transcriptional modifications: RNA degradation, nuclear transport, mRNA localization, anti-sigma factors, RNAi (siRNA, miRNA and CRISPR mechanism)	**15**
Unit III	**Translation** • Genetic code and its properties • Ribosome (structure and composition), Activation of tRNA, tRNA	**15**

	synthetase • Steps: Initiation: factors and their regulation, Elongation, Termination Inhibitors • Post translational modification of proteins and protein degradation Translational regulation: Cytoplasmic polyadenylation, UTR sequence elements, RNA binding proteins, ribosomal regulation, non-sense mediated RNA decay, 5` decapping	
Unit IV	**Gene regulation** o Concept, structure and regulatory mechanism of Operon o Structure and regulation of following operons o Lactose (lac) operon o Galactose (gal) operon o Arabinose (ara) operon o Typtophan (trp) operon o Histidine (his) operon o Regulation of lytic and lysogenic pathway in lamda bacteriophage o Gene regulation in eukaryotes: DNA rearrangements, Chromatin modification, Cis-acting site, RNA Silencing.	**15**

References

- Alberts, B, Johnson A, Lewis J, Raff Martin, Roberts K & Walter P. (2007). Molecular Biology of the Cell. Garland Publ., NewYork.
- Pawar C. B. (2003). Generics Vol I,II, III, Himalaya Publishing House, Mumbai
- Hawes, C. & Satiat-Jeunemaitre, B. (2001). Plant Cell Biology: Practical Approach. Oxford University Press,Oxford.
- Hirt, R. P. & Horner, D. S. (2004). Organelles, Genomes and Eukaryote Phylogeny: An evolutionary synthesis in the age of genomics. CRCPress.
- Karp, G. (2008). Cell and Molecular Biology: Concepts and Experiments. John Wiley & Sons.
- Lodisch, H., Berk, A., Kaiser, C. A., Krieger, M., Scott, M. P., Bretscher, A., Ploegh, H. & Matsudaire, P. (2008). Molecular Cell Biology. WH Freeman & Co., NewYork.
- Ruzin, S. E. (1999). Plant Micro-technique and Microscopy. Oxford Univ. Press, Oxford.
- Wischnitzer, S. (1989). Introduction to Electron Microscopy. PergamonPress,

MSc I (Biotechnology)
Semester I
BIT-DSE-514A: Biodiversity and its conservation

Total Hours: 30 **Credits: 2**

Course objectives	• To acquaint students with biodiversity • To learn concept of biodiversity conservation	
Course outcomes	After successful completion of this course, students are expected to: • Inculcate knowledge about levels, patterns and Factors influencing on biodiversity • Understand various ways to conserve the biodiversity.	
Unit	**Contents**	**Hours**

Unit I	**Introduction about Biodiversity**
	• Levels of biodiversity: alpha, beta and gamma diversity
	• Values and ethics of biodiversity
	• Global patterns of biodiversity, hotspots of biodiversity and mega diversity country
	• Concepts of species and hierarchical taxa, biological nomenclature, classical &quantitative methods of taxonomy of plants, animals and microorganisms.
	• Biogeographic zones in India
	• Factors influencing local and regional biodiversity
	• Biodiversity documentation
	• Molecular methods of classification:
	  • Ribotyping, Denaturing Gradient Gel Electrophoresis (DGGE), Temperature
	  • Gradient Gel Electrophoresis, (TGGE), Amplified rDNA Restriction Analysis
		15

Unit II	**Biodiversity conservation** • Population viability analysis • Threat to species diversity: Rare, endangered species, Red Data Book, IUCN Guidelines for Red List categories and criteria, Red List of Indian Flora and Fauna • Biodiversity conservation approaches: Ex-situ and In situ conservation strategies. • Selection criteria for protection of species: species quality, Selection criteria for protection of habitats–hotspots, Conservation indices. • Concept of protected area network, Criteria for measuring conservation value of areas • Sanctuary, National Park and Biosphere reserves • Design and management of protected areas; Threats to wildlife conservation and wildlife trade; Tools for wildlife research, Wildlife threat. • Use of Radiotelemetry and Remote sensing in wildlife research	**15**

References

- Pelczar, M. J. Jr., Chan, E. C. S. & Kreig NR, (1993) Microbiology, 5th Edition, Tata McGraw Hill,.
- Maloy, S. R, Cronan, J. E Jr., & Freifelder D, (2006). Microbial Genetics, Jones Bartlett Publishers, Sudbury, Massachusetts,
- Crueger & A Crueger, (1990). Biotechnology: A Textbook of Industrial Microbiology, Sinaeur Associates,.
- Reed G, Prescott & Dunn's, (2006). Industrial Microbiology, 4th Edition, CBS Publishers, 1987.
- Madigan M.T. & Martinko J.M., (2005). Biology of Microorganisms, 11th Edition, Pearson Prentice Hall, USA,.
- Holt J.S. Kreig N.R., Sneath P.H.A & Williams S.T. (1994). Bergey's Manual of Systemic Bacteriology 9th Edn. William and Wilkins, Baltimore.

MSc I (Biotechnology)
Semester I
BIT-DSE-514B: Cell and Cancer Biology

Total Hours: 30 **Credits: 2**

Course objectives	• To learn the concepts in cell biology • To know the cell cycle and cancer biology	
Course outcomes	After successful completion of this course, students are expected to: • To understand the cellular organization and function at a molecular level. • Compare the relationship between cell cycle and cancer biology	
Unit	**Contents**	**Hours**
Unit I	**Cell Biology** • Structure and functions, Prokaryotic and Eukaryotic cells. • Ultrastructure of Archaea (Methanococcus) • The structural and functional organizations of cell membrane, ionic transport (Passive and active transport), the extracellular matrix of eukaryotes, cell wall. • Structure and functions of endoplasmic reticulum, golgi complex, ribosome lysosomes, peroxisomes (glyoxysomes), chloroplast and plastids and mitochondria. • Nucleus and Nuclear ingredients, Proteins associated with nuclei. • Packaging of genetic material: nucleosome model, • Organization of chromatin: chromosome structure. o Cytoskeleton – components of Cytoskeleton, Microtubules, Intermediate filaments Microfilaments with respect to Plant and Animal Cell,	**15**

	○ Transport across Cell Membranes in Plant and Animal Cell.	
Unit II	**Cell division and cancer biology** • Cell Cycle: ○ Interphase and M phase (mitosis and meiosis), Cell cycle regulation, checkpoints in cell cycle; regulators of cell cycle. ○ Apoptosis: intrinsic and extrinsic pathways. • Cancer biology ○ types of cancer; development of cancer, cells; Oncogenes, protooncogenes, function of oncogene products. ○ Tumor suppressor genes, function of tumor suppression gene products, role of oncogene and tumor suppressor gene in development. ○ Molecular diagnosis of cancer.	15

References

- Lodisch, H., Berk A, Kaiser CA, Krieger M, Scott MP, Bretscher A, Ploegh H and Matsudaire P (2008) Molecular Cell Biology. WH Freeman & Co., New York.
- Verma P. S. and Agrawal V. K. (2018) Cell biology, genetics, molecular biology, evolution and ecology, S. Chand, New Delhi.
- De Roberties E. D. P. and De Roberties E. M. F. (2005) Cell and molecular biology (8th Ed), Lippincott Williams and Wilkins, Philadelphia.
- Rasoti, S. C. (2005). Cell biology, New Age Int., New Delhi.
- Madigan, M. T. and Martinko J. M., (2005). Biology of Microorganisms, 11th Edition, Pearson Prentice Hall, USA.
- Pawar, C. B. (2007). Cell biology, Himalaya Publishing House, Mumbai.

MSc I (Biotechnology)
Semester I
BIT-DSC-515: Practical course on Biochemistry and Molecular biology

Total Hours: 60 **Credits: 2**

Course objectives	• To understand buffers preparation and detection of biomolecules • To study qualitative and quantitative techniques in biochemical analysis • To isolate, detect and amplify nucleic acid • To study blotting techniques for protein and nucleic acid
Course Outcomes	After successful completion of this course, students are expected to: • Make basic biochemistry preparations and detection • Interpret biochemical analysis of sugar and protein • Hands on qualitative and quantitative estimations nucleic acid • Use the modern tools creatively to estimate nucleic acid

Sr. No.	Contents	Hours
1	Preparation of buffers of various pH and determination of pKa of a buffer system	4
2	Isolation and characterization of bacterial pigment	4
3	Qualitative analysis of biomolecules by Thin Layer Chromatography: Sugars	4
4	Qualitative analysis of biomolecules by paper Chromatography: amino acids	4
5	Quantitative estimation of Total carbohydrate - Phenol sulphuric acid method.	4
6	Quantitative estimation of amino acids by ninhydrin method.	4
7	Quantitative estimation of free fatty acids by titration	4
8	Quantitative estimation of lipids using Iodine number and acid value	4
9	Isolation and estimation of bacterial/ Fungal DNA using DPA method	4
10	Isolation and estimation of RNA from yeast cells using Orcinol method	4
11	Detection and quantification of purity of DNA/ Protein using a spectrophotometer	4
12	Isolation of plasmid from bacterial cell (e.g. *E. coli*)	4
13	Detection of plasmid-encoded function/s using a plasmid curing technique	4
14	PCR amplification of DNA.	4
15	Blotting technique :Western/Southern/Northern blot	4

References

- Thomas, G. M. & Shalkhammer, (2004). Analytical Biotechnology, Springer, New Delhi
- Thimmaiah, S. R. (2006). Standard Methods of Biochemical Analysis, Kalyani Publishers, New Delhi.
- Plummer, D. T. (2001). An Introduction to Practical Biochemistry, 3rd edn., McGraw Hill Ltd. New Delhi
- Sawhey, S.K. & Singh, R. (2002). Introductory Practical Biochemistry, Narosa Publication House, New Delhi.
- Jayramann, J. (2008). Laboratory Manual in Biochemistry, New Age International, New Delhi.
- Schmauder, H.P, Schweizer, M. & Schewizer, L.M. (2003). Methods in Biotechnology, Taylor and Francis Ltd., London.

MSc I (Biotechnology)
Semester I
BIT-DSE-516A: Practical course on bio-diversity and bio techniques

Total Hours: 60 **Credits: 2**

Course objectives	• To learn Good laboratory practices • To isolate and enumerate microbes from environment • To know advance instrumentation • To study practical approach for biodiversity	
Course Outcomes	After successful completion of this course, students are expected to: • Apply good practices for laboratory • Learn method to enrich and quantify microbes form various sample • Acquaint knowledge about advance instruments and tools. • Develop the skill to explore biodiversity	
Sr. No.	**Contents**	**Hours**
1	Basic safety rules, Cleanliness, media preparation, sterilization, culturing methods and dilution technique	4
2	To observe zooplanktons from stagnant water and sketch	4
3	Enumerate microorganism from rhizospheric and non rhizosperic soil to calculate R: S ratio	4
4	Quantifying heterotrophic bacteria using the membrane filter technique	4
5	Isolation of Cyanobacteria enrichment technique	4
6	Isolation of Rhizobia from root nodules of leguminous plants	4
7	Cultivation of anaerobic microbe by suitable method	4
8	Isolation of endophytic fungi from plant	4
9	Isolation of seed microflora	4
10	Study of growth curve by turbidometric method (Bacteria/yeast)	4
11	Separation of protein by electrophoresis	4
12	Construction of phylogenetic tree using web tools	4
13	Demonstration of UV-Vis Spectrophotometer, FTIR, HPLC, GC, AAS	4
14	Quadrat sampling for biodiversity	4
15	Survey of plant/ animal/ microbial biodiversity in the campus/ filed	4

References

- Singh Prakash (2014). Laboratory Protocols in Applied Life Sciences, CRC Press.
- Wilson, K. & Walker, J. (2005). Practical Biochemistry: Principles and techniques (6th Edition) by Cambridge University Press, Cambridge.
- Plummer, D. (2005). An Introduction to Practical Biochemistry by. (3rd Edition) Tata MacGraw Hill Publisher.

- Patil, Ulhas K. & Muskan Kalyani, (2009). Essentials of Biotechnology, Ik international, New Delhi Jayaraman J (2011) Laboratory Manual in Biochemistry. New Age International (P) Ltd., Publishers, New Delhi.

MSc I (Biotechnology)
Semester I
BIT-DSE-516B: Practical course on Cell biology

Total Hours: 60 **Credits: 2**

Course objectives	• To study cell and its special features • To isolate cell organelles • To estimate cell content • To study cell division and permanent slide preparation	
Course Outcomes	After successful completion of this course, students are expected to: • Measure cell size, observe nuclear material and special cell features • Isolate chloroplast and mitochondria from cell • Estimate carotene and chlorophyll • Demonstrate cell cycle, cell division and prepare permanent slides for microscopy	
Sr. No.	**Contents**	**Hours**
1	Measurement of the size of a given cell using a micrometre	4
2	Counting of cells/ spores using counting chambers	4
3	Microscopic observation of nuclear material by Giemsa staining	4
4	Microscopic observation of cells (plant, animal, bacterial)	4
5	Microscopic observation of special cell features (flagella/cilia, fungal spore, bud in yeast, heterocyst)	4
6	Isolation of chloroplast from a suitable source	4
7	Isolation of mitochondria from a suitable source	4
8	Isolation and culture of plant protoplast	4
9	Estimation of total carotene	4
10	Estimation of chlorophyll	4
11	Microscopic observation of mitosis and cell cycle in onion root tip cells	4
12	Microscopic observation of the miosis cycle	4
13	Preparation of microscopic slide of dicot leaf and identification of types	4

	of cells	
14	Preparation of permanent microscopic slides of plant/animal/microbial cell	4
15	Demonstration of microtomy for thin sectioning	4

References

- Thimmaiah, S. R. (2006). Standard methods of biochemical analysis, Kalyani Publication, New Delhi.
- Purohit, S. S. (2005). Practical plant Biotechnology, Student edition, Jodhpur.
- Aneja, K. R. (2001). Experiments in Microbiology, plant pathology, tissue culture and mushroom production technology, New Age international ltd. New Dehli.
- Sharma, Kanika (2007). Manual of Microbiology Tools and Techniques, Ane Books India, New Delhi.
- Tembhare, D. B. (2008). Techniques in life Sciences, Himalaya Publishing House, New Delhi.

MSc I (Biotechnology)
Semester I
BIT-RM-517: Research Methodology for Biotechnology

Hours: 60 **Credits: 4**

Course objectives	• To acquaint the student with fundamental research • To learn concept of research problems literature review • To study research design and concept of hypothesis • To introduce the technique of research documentation and anti-plagiarism	
Course outcomes	After successful completion of this course, students are expected to: • Cogitate with types and general process of research • Construct the research problem and write literature review • Create hypothesis and frame research design • Use the methods of report writing and apply anti-plagiarism	
Unit	**Contents**	**Hours**
Unit I	**Fundamentals of research** o Objectives of research o Type of research: • Descriptive vs. Analytical, Applied vs. Fundamental, Quantitative vs. Qualitative, Conceptual vs. Empirical, Exploring or Formulative Research, Diagnostic Research, Surveys, Case Study, Field Studies o Criteria for good research o General research process • Define the research problem, literature survey, formulating hypotheses, research design, data collection and analysis, interpretation and preparation of the report	**15**

Unit II	**Research problems and review of the literature** o Defining and selecting problems, necessities and techniques. o Need of research review o Sources of literature and search strategies o Research reading and note taking o Bibliography, webliography and literature citation	**15**
Unit III	**Research design and hypothesis** o Concepts: types of variables, hypothesis, control, treatment, experimental units etc. o Types of research design: exploratory, descriptive and diagnostic, hypothesis-testing o Basic principles of experimental designs o Important experimental designs: Informal and formal o Hypothesis: Concept, need, characterization, testing, decision rule, two-tailed and one-tailed test	**15**
Unit IV	**Data collection, analysis and reporting** o Sampling types and criteria of selection of technique o Methods and tools of data collection (primary, secondary) o Processing of data: Editing, coding, classification and tabulation o Statistics in research: central tendency, dispersion, skewness, measures of relation o Interpretation: meaning, importance, technique and precaution o Structure and Content of Discussion o Report writing: steps, type, components and formatting o Numbering and captioning of figures o Presentation of research: oral and research paper Plagiarism: Concept, prevalence, factors, strategies to tackle and detection	**15**

References

- Ramamurthy, G. C. (2011). Research methodology, cogent learning solution.inc Dreamtech Press.
- Joshua, O. Miluwi & Hina, Rashid R. M. (2015). Principle Method and Practices, Mangalam Publication.
- Krishnaswamy O. P., Reddy, D. Obul (2010) Research Methodology and Statistical Analysis, Himalaya Publishing House.
- Venkatamunireddy, R. (2011). Fundamental of research, Deep and Deep publication
- Wilson, P. D. K., Wilson, K., & Walker, J. (Eds.). (2000). Principles and techniques of practical biochemistry. Cambridge University Press.
- Gurumani, N. (2019). Scientific thesis writing and paper presentation. MJP Publisher, Chennai.
- Gurumani, N. (2014). Research methodology for biological science, MJP Publisher, Chennai.
- Kothari, C. R. (2004). Research methodology: Methods and techniques. New Age International.
- Malmfors, B., Garnsworthy, P., & Grossman, M. (2003). Writing and presenting scientific papers. Nottingham University Press.

M.Sc. I
(Biotechnology)
Semester II

MSc I (Biotechnology)
Semester II
BIT-DSC-521: Advances in Immunology

Total Hours: 60 **Credits: 4**

Course objectives	• To study mechanism of immune response • To learn hyperimmune responses • To know the immune response to diseases • To understand immuno-histochemical techniques	
Course outcomes	After successful completion of this course, students are expected to: • Learn the difference in various types of immune responses • Understand details of different types of hypersensitivity and autoimmunity • Know about immune response related to infections, tumor and immunodeficiency diseases • Categorize different immunological techniques for various diseases	
Unit	**Contents**	**Hours**
Unit I	**Mechanisms of immune response** • Cell-mediated Immune response: T-cell, Types of T cells, T cell activation • Humoral Immune response: B cell. Plasma cell, B cell activation (T-dependent and T- independent pathway) • Complement system - Pathway and Role, Complement deficiency. • Inflammatory response - Functions, Types and Mechanisms. • Immunotolerance: General features of immunologic tolerance, T and B lymphocyte tolerance, tolerance induced by foreign protein antigens	**15**
Unit II	**Hyperimmune response** • Hypersensitivity: Types (I-IV) and mechanism of each type. • Autoimmune diseases: Mechanisms for induction of autoimmunity, Organspecific and systemic, treatment of autoimmune diseases.	**15**
Unit III	**Immune response to infections and diseases** • Immunity against bacterial, viral, Fungal and protozoal infections. • Tumour immunology: Types of tumours, oncogenesis and tumour antigens (TATAs, TSTA), Immune response to tumours. • Immunodeficiency diseases (e.g. SCID, CVI, AIDS)	**15**
Unit IV	**Histochemical and immune techniques** • Production and applications of monoclonal antibodies • Detection of Ag/Ab - ELISA, RIA, Western blot, Immunoprecipitation, immunofluorescence and Flow Cytometry , In situ localization by FISH and GISH	**15**

References

- Goldsby, R. A., Kindt, T. J., Osborne, B. & Kuby, A. (2003). Immunology, 5th edn., W. H. Freeman and Company, New York.
- Roitt, I. (2000). Essentials of Immunology, 5th ed., Blackwell ELBS Science Publication, Oxford.

- Paul, W. E (2003). Fundamental Immunology, 5th edn., Lippincott Williams and Wikins Publishers, USA.
- Tizard, I. R. (1995). Immunology: An Introduction, Saunders College Publishing, Philadelphia.
- Banerjee, A. K. & Banerjee, N. (2006). Fundamentals of Microbiology and Immunology, New Central Book Agency (Pvt.) Ltd., Kolkata.
- Coleman, R.M., Lombard, M.F. & Sicard, R.E. (2000) Fundamental Immunology, 4th edn., WmC Publications, London.
- Rao, C. V. (2007). Immunology, Narosa Publishing House, New Delhi.
- Shastri, N. V. (2005). Principal of Immunology, Himalaya Publication House, Mumbai.
- Barrett, James T. (1998). Microbiology & Immunology Concepts, Lippincott Williams & Wilkins, Philadelphia, PA.
- Janeway, Charles, Travers, Paul, Walport, Mark & Shlomchik, Mark (2004). Immunobiology, Garland Science.

MSc I (Biotechnology)
Semester II
BIT-DSC-522: Plant and animal tissue culture

Total Hours: 60 **Credits: 4**

Course objectives	• To acquaint basic knowledge about Plant tissue culture • To accustom methods in plant tissue culture • To apprise basic knowledge about Animal tissue culture • To acclimatize methods in Animal tissue culture	
Course outcomes	After successful completion of this course, students are expected to: • Relate information, require for PTC laboratory • Acquaint knowledge about protoplast culture and somatic hybridization • Infer techniques, require for Animal tissue culture • Apply the techniques for animal cell culturing	
Unit	**Contents**	**Hours**
Unit I	**Introduction to plant tissue culture** o Laboratory organization of PTC and aseptic techniques o Basic structure and growth of a plant o Benefits and application of plant tissue culture o Definition: Ex-plant, callus, differentiation, re-differentiation, Totipotency o Culture media composition o Basic techniques of plant tissue culture o In vitro germplasm conservation and Cryopreservation.	**15**
Unit II	**Methods in Plant tissue culture** o Callus culture and Cell culture o Protoplast culture	**15**

	○ Isolation of protoplast, culture of protoplast, regeneration of protoplast, subprotoplasts, ○ Somatic hybridization: fusion of protoplast, mechanism of fusion, selection of hybrid cells, cybrids, applications and limitation ○ Organ culture (In vitro production of haploid plants): Androgenesis (anther and pollen culture) and Gynogenesis (ovary and ovule culture). ○ Micropropagation: Techniques, multiplication by axillary buds and apical shoots (Meristem and Shoot tip culture), Bud culture, factors affecting micropropagation, organogenesis, somatic embryogenesis, application and limitations ○ Synthetic seeds: principle, production and application ○ Somaclonal variations: basis of variation, isolation and application	
Unit III	**Introduction to Animal Cell and Tissue Culture** ○ Animal tissue culture laboratory: facilities, aseptic condition and risk ○ Applications of animal cell culture. ○ Advantages and limitation of animal tissue culture ○ Cultural media: Physicochemical properties and composition ○ Cultured cells: ○ Characteristics, ○ Cell adhesion, proliferation and differentiation ○ Initiation and development of cell culture ○ Senescence and apoptosis	**15**
Unit IV	**Animal cell culture** ○ Primary cell culture: ○ Disintegration technique (mechanical and enzymatic) ○ Primary explant technique ○ Cell line ○ Finite and continuous cell line ○ Nomenclature and maintances ○ Subculture: Monolayer and suspension ○ Stem cell culture ○ Scale up in suspension and monolayer	**15**

References

- Satyanarayan, U. (2017). Biotechnology, Book and Allied Limited, Kolkata.
- Sing, B. D. (2005). Biotechnology, Kalyani publisher, New Delhi.
- Arora, M. P. (2003). Biotechnology, Himalaya Publishing House, Mumbai.
- Ramavat, K. G. (2008). Plant biotechnology, S. Chand and Co., New Delhi
- Freshney, R. Ian. (2006). Culture of Animal Cells: A Manual of Basic Techniques, John Wiley and Sons, Inc., New York
- Chawla, H. S. (2009). Introduction to Plant Biotechnology, 3rd edition, CRC press
- Gangal Sudha (2007). Principles and Practice of Animal Tissue Culture, Universities Press India Pvt. Ltd.
- Gupta, P. K. (2004). Biotechnology and Genomics, Rastogi Publication Meerut.
- Jogdand, S. N. (2012). Advances in Biotechnology, Himalaya Publishing House, Mumbai.

MSc I (Biotechnology)
Semester II
BIT-DSC-523: r DNA technology

Hours: 60 **Credits: 4**

Course objectives	• To learn about rDNA Technology • To know the techniques used in gene transfer. • To make aware of techniques in gene cloning and recombinant selection • To study various analytical techniques in r-DNA technology	
Course outcomes	After successful completion of this course, students are expected to: • Acquaint tools of rDNA technology such as enzymes, vectors and applications • Illustrate creative use of modern tools and techniques for rDNA technology. • Differentiate cloned cells by various screening techniques. • Elaborate the latest techniques in rDNA technology	
Unit	**Contents**	**Hours**
Unit I	**Introduction to Recombinant DNA Technology** • Historical perspective of r- DNA technology • Mechanism of Enzyme associated with r-DNA technology: Nucleases, ligases, polymerases, Topoisomerase, Restriction endonucleases • Types of vectors in r-DNA technology and their salient features: plasmids (pBR322, pUC18), cosmids, phages vector (M13, SV40), Viral vector (retro and adeno vectors) Artificial vectors - BAC, YAC and PAC, Special vectors: Shuttle vectors, Expression vectors, Dominant Selectable vectors, • Genomic library and cDNA library • Application of r-DNA technology - DNA fingerprinting. Genetic disease, Detection and Diagnosis Gene therapy, gene delivery systems, viral and nonviral. Bio-pharming and recombinant vaccines. CRISPR technology, DNA marker technology in plants	**15**
Unit II	**Gene Transfer techniques (15 L)** • Biological methods – Conjugation, transformation, transduction and transfection. • Physical methods - Electroporation, micro-projectile system, gene gun and biolistics. • Chemical methods- Liposome mediated transfer, calcium phosphate method and DEAE-dextran. • Molecular methods - molecular mechanism of antisense technology, • Advanced Tools in genetic engineering: CRISPR, Genome re-coding, lentivirus and Cre/ loxP system	**15**

Unit III	**Gene cloning and recombinant selection (15 L)** • General steps for Gene cloning • Cells for cloning: E. coli, S. cerevisiae, mammalian fertilized egg cells and Chinese hamster ovary cultured cells. • Direct screening and selection. • Indirect screening techniques: HAT (Hybrid Arrested Translation), HST (Hybrid Selected released Translation), Colony hybridization, Dot Blot Hybridization, Immunological assay, Nucleic acid hybridization; DNA Probes, cDNA Probes, RNA Probes. • Expression strategies for heterologous genes- Expression in plants, Bacteria and Yeast.	**15**
Unit IV	**Analytical Techniques in r-DNA technology** • Sequencing methods- Maxam Gibert method, Sanger's method, automated DNA sequencing, Messing's Shot Gun method, NGS methods- pyro-sequencing and ABi- solid method. • Mapping of DNA: o Physical mapping, Genetic mapping, Conjugation mapping, Recombination mapping, Complementation mapping and Restriction Mapping	**15**

References

- Nicholl, D. S. T. (2002). An Introduction to Genetic Engineering, 2nd edn., Cambridge University Press, Cambridge, UK.
- Malacinski, G. M. (2003). Essential of Molecular Biology, 4th edn, Jones &Barlett Publishers, Boston.
- Alcamo, I. E. (2001). DNA Technology, Academic Press, London, UK.
- Brown, T. A. (1995). Essential Molecular Biology, Vol. I (A Practical Approach), IRL Press, Oxford.
- Terence A Brown, (2015). Gene Cloning and DNA Analysis: An Introduction, 7^ Edn. John Wiley & Sons Ltd, UK.
- Primrose, S. B. & Wardlow, A. C. (1982). Source Book for Experiments for the Teaching of Microbiology, Academic Press, London.
- Sambrook & Russell Molecular Cloning Vol. 1, 11 and III, CSHL Press, USA.
- Weaver, R. F. (1999). Molecular Biology, WCB McGraw-Hill Co., Inc., NY.
- Timothy Palzkill, (2002). Proteomics. Springer US.
- Channarayappa, (2006). Molecular Biotechnology: Principles & Practice, Universities Press (India) Pvt. Ltd, Hyderabad.

MSc I (Biotechnology)
Semester II
BIT-DSE-524A: Plant biotechnology

Total Hours: 30 **Credits: 2**

Course objectives	• To acquaint knowledge about Plant Biotechnology • To explore various application of plant Biotechnology	
Course outcomes	After successful completion of this course, students are expected to: • Gain an advance level of understanding in comprehensive component of plant Biotechology. • Correlate the application of plant Biotechology for sustainable agriculture	
Unit	**Contents**	**Hours**
Unit I	**Introduction to Plant Biotechnology** o History of plant Biotechnology, conservation of plant using biotechnology, plant genome organization: structural feature of representative plant gene. Gene families in plant. o Transgenic plants – History and concept o Mechanism of T-DNA transfer, Vectors based on Ti and Ri–plasmids– Cointegrate and Binary vectors. o Chloroplast transformation – Vector designing, Method and Advantages o Agrobacterium mediated transformation–Ti and Ri plasmids o Transgene stability, expression and Gene silencing. o Molecular markers in plant genome analysis: Types of molecular markers and its application	**15**
Unit II	**Application of plant Biotechnology** o Transgenic plants with reference to Virus and Pest resistances - Herbicidal resistance - Stress tolerance (heat and salt) - Cytoplasmic male sterility o Plant cells as bio factories for the production of secondary metabolites o Resistance to fungi and bacteria - Delay of fruit ripening - Ecological risk assessment of genetically modified crops o Plant derived: biodegradable plastics and vaccines o Bioreactors and immobilized plant cell culture	**15**

References

- Bhojwani, S. S. & Razdan M. K. (2005). Plant tissue culture – Theory and Practice, Elsevier Publication.
- Gupta, P. K., (1999) Elements of Biotechnology by Rastogi Publications.
- Chawla, H. S. (1998). Biotechnology in Crop Improvement by, International Book Distributing Co.
- Gamborg, O. L. & Phillips G.C. (1995). Plant Cell, Organ and Tissue Culture, Springer Verlag, Germany.

- Jha, T. B. & Ghosh B. (2005). Plant Tissue Culture – Basic & Applied, Universities Press.
- Dixon, R. A., & Gonzales R. A. (1994). Plant Cell Culture – A Practical Approach Oxford University Press, UK.
- Evans, D. A., Taylor & Francis. (2000). Plant Tissue Culture Academic Press Plant Genetic Engineering Vol. 1 - 6 (2003) by Singh R.P. and Jaiwal P.K.(Eds.), Sci Tech Publishing LLC, USA.
- Potrykus, I. & Spangenberg, G. Gene Transfer to Plants Springer Verlag, Germany.
- Hammond, J., McGarvey, P., & Yusibov, V. (2000). Plant Biotechnology Springer Verlag, Germany.

MSc I (Biotechnology)
Semester II
BIT-DSE-524B: Bioprocess Technology

Total Hours: 30 **Credits: 2**

Course objectives	• Acquaint knowledge about bioreactor and fermentation process. • Learn the process for Bioenergy production and use.	
Course outcomes	After successful completion of this course, students are expected to: • Develop understanding of fundamental and applied aspects of Bioprocess technology. • Infer different bioenergy processing and its application.	
Unit	**Contents**	**Hours**
Unit I	**Industrial and pharmaceutical Bioprocess** • Bioreactor: Principle, Ideal properties of Bioreactor, Designing, Agitator, Impeller, Baffles: foam separators, sparger, culture vessel, cooling and heating devices, Kinetics and analysis • Bioreactor process management and control: sensor, control system, probes for on-line monitoring, computer control of fermentation process, measurement and control of process. • Strain improvement of primary and secondary metabolites with examples protoplast fusion techniques, Mutagenesis, Genetic Engineering for Strain Improvement • Industrial production of chemicals: alcohols (ethanol), Acids (citric acid and gluconic acid), solvents (glycerol, acetone, butanol), Antibiotics (penicillin, streptomycin, tetracycline), Amino acid (lysine and glutamic acid), Enzyme (any one) • Use of Plant and animal as natural bioreactor for production of heterologous protein.	**15**

Unit II	• **Bioenergy processing** ○ Biogas production: Substrate (I-IV generations), digester, biogas plant, models for biogas production, Microbiology and Biochemistry of biogas production, factor affecting biogas yield, limitation and precaution ○ Bioethanol: Substrate, Microorganism and Biochemistry of bioethanol production, product recovery, advantage of Bioethanol over petrol. ○ Biodiesel: Source (Lipid and Hydrocarbon), Transesterification, production of Biodiesel, advantage and limitation ○ Biohydrogen: Using anaerobic bacteria, photosynthetic algae, legume plant and in vitro photosynthetic hydrogenase system.	**15**

References

- Stanbury, Peter F., Whitaker, Allan; Hall, Stephen J., (1994). Principles of Fermentation Technology, II Edn, Butterworth-Heinemann Publishers.
- Okafor Nduka., (2007). Modern Industrial Microbiology and Biotechnology, Science Publishers,USA.
- Mukhopadhyay, S. N. (2004). Process Biotechnology Fundamentals, 2nd edn., Viva Books, Mumbai,
- Shuler M. L. & Kargi F., (2008). Bioprocess Engineering-Basic Concepts, 2ndEdn. Prentice-Hall.
- Lodish, M. R. (2001.) Bioseperation Engineering, Wiley Interscience, NY.
- SreeKrishna, V., (2007). Bioethics and Biosafety in Biotechnology, New Age International (P)Ltd., Publ., Mumbai.
- Goodfrey, T. and Reichelt, JR., (1997). Industrial Enzymology, 2nd edn., McMillan Publ. Co.,London.
- Modi, H. A. (2009). Fermentation Technology (Vol-II), Pointer Publication, Jaipur.

MSc I (Biotechnology)
Semester II
BIT-DSC-525: Practical course on Plant and animal tissue culture

Total Hours: 60 **Credits: 2**

Course objectives	• To Acquaint knowledge about tissue culture laboratory setup • To know the media preparation and methods use for plant tissue culture. • To study various methods required in animal tissue culture. • To understand principle and application of cell assay.
Course Outcomes	After successful completion of this course, students are expected to: • Familiarize basic knowledge required for plant tissue culture laboratory

	• Gain information about media and technique used in plant tissue culture • Comprehend the skill required for animal tissue culture • Illustrate implication in cell assay use in plant and animal tissue culture laboratory	
Sr. No.	**Contents**	**Hours**
1	Acquaintance with tissue culture laboratory, Culture place: culture cubicles P1 to P4; Laminar flow system	4
2	Preparation and sterilization of MS medium, stocks and explants	4
3	Role of additives on various explants culture	4
4	Effect of plant growth regulators on various explants for callus induction, cell suspension culture, growth analysis, cell plating efficiency	4
5	Callus induction	4
6	Root induction	4
7	Regeneration of shoots	4
8	Endosperm/ Meristem / Anther (production of haploids)/ Pollen culture	4
9	Somatic embryogenesis	4
10	Extraction and qualitative detection of phytochemicals alkaloids, phenols and glycosides	4
11	Preparation of media for animal cell culture	4
12	Live and dead cell assay by trypan blue method.	4
13	Cellular proliferation and cytotoxicity assay by MTT method	4
14	Demonstration of apoptosis	4
15	Visit to plant and animal tissue culture laboratory.	4

References

- Aneja, K. R., (2007). Experiments in Microbiology, Plant Pathology, Tissue Culture and Mushroom Cultivation, 4th Edition, Wishwa Prakashan, New Age International Pvt Ltd.,New Delhi.
- Reinert, J. & Yeoan, M. M. (1989). Plant Cell and Tissue Culture: A Laboratory Manual, springer velag publication, New York.
- Smith, R. H. (1992). Plant Tissue Culture: Techniques and Experiment, Academic publication.
- Henry, R. J. (1997). Practical application of Plant Molecular Biology, Chapman & Hall, London.
- Murray, E. T. (1991). Gene Transfer and Expression Protocols - Methods is Molecular Biology, Vol. 7, Humana Press

- Mitra Sandhya., (2000). Genetic Engineering, Macmillan Publication
- Glover, D.M. & Hames, B. D. (1995). DNA Cloning: A Practical Approach, IRL Press, Oxford.

MSc I (Biotechnology)
Semester II
BIT-DSE-526A: Practical course on plant biotechnology

Total Hours: 60 **Credits: 2**

Course objectives	• To learn advance methods used in plant tissue culture. • To isolate agriculture important microorganism • To get aware about various way to isolate plant organelles. • To study techniques used for estimation of plant products.
Course Outcomes	After successful completion of this course, students are expected to: • Reiterate knowledge about plant tissue culture. • Design to isolate and screen agriculture microbes. • Deduce methodology for extraction of plant organelles. • Appraise plant product via several techniques.

Sr. No.	Contents	Hours
1	Determination of IAA oxidase activity	4
2	Study of Stomatal Physiology	4
3	Production of plant secondary metabolites	4
4	Estimation of leg haemoglobin from root nodule of leguminous plant.	4
5	Preparation and Application of Biofertilizers	4
6	Isolation of Rhizobium sp.from root nodule of leguminous plant.	4
7	Isolation and identification of plant pathogen (*Xanthomonas citri*) from infected citrus fruit or leaf	4
8	Isolation of plant genomic DNA by modified CTAB method	4
9	Isolation of chloroplast from spinach leaves	4
10	Protoplast isolation	4
11	Fusion and culture of protoplast	4
12	Development of synthetic (Artificial) seeds	4
13	Micropropagation of banana/ citrus Papaya	4

14	Extraction of beta carotene in carrots	4
15	Estimation of ascorbic acid from lemon	4

References

- Aneja, K. R., (2007). Experiments in Microbiology, Plant Pathology, Tissue Culture and Mushroom Cultivation, 4th Edition, Wishwa Prakashan, New Age International Pvt Ltd., New Delhi.
- Reinert, J. & Yeoan, M. M., (1989). Plant Cell and Tissue Culture: A Laboratory Manual, springer velag publication, New York.
- Smith, R. H., (1992). Plant Tissue Culture: Techniques and Experiment, Academic publication.
- Henry, R. J., (1997). Practical application of Plant Molecular Biology, Chapman & Hall, London.
- Murray, E. T., (1991). Gene Transfer and Expression Protocols - Methods is Molecular Biology, Vol. 7, Humana Press.
- Mitra Sandhya (2000). Genetic Engineering, Macmillan Publication
- Glover, D. M. & Hames, B.D., (1995) DNA Cloning: A Practical Approach, IRL Press, Oxford.

MSc I (Biotechnology)
Semester II
BIT-DSE-526B: Practical course on bioprocess technology

Total Hours: 60 **Credits: 2**

Course objectives	• To isolate and screen industrial important microorganisms. • To make aware about procedure for microbial byproduct production. • To learn methods used for enzyme production and purification • To study techniques for generation of bioenergy.	
Course Outcomes	After successful completion of this course, students are expected to: • Appreciate relevance of microorganism from industrial context. • Critically analyze microbial byproduct • Gain working knowledge about enzyme production and purification • Relate the substrate, biomass type and fuel characterization.	
Sr. No.	**Contents**	**Hours**
1	Isolation of industrially important microorganisms for microbial processes (citric / lactic/ antibiotic/ amylase/ cellulase) (**ANY TWO**)	4
2	Isolation cultivation of anaerobic bacteria using suitable method	4
3	Inoculum development, recovery and its quantification	4

4	Production of the enzyme in shake flask/ SSF	4
5	Purification of enzyme: Salting in and Salting out	4
6	Purification of enzyme: Dialysis	
7	Production of citric acid by fermentation of different carbon sources using *Aspergillus niger*	4
8	Alcohol using different substrates and its recovery	4
9	Production of Antibiotic (any one) and its quantification	4
10	Assay of antibiotic using sensitive bacterial strain.	4
11	Production of biogas using cow or cattle dung	4
12	Demonstration of production of biodiesel from environmental waste	4
13	Demonstration of production of biohydrogen	4
14	Demonstration of working of laboratory bioreactor	4
15	Visit to industry (Food/ dairy/Pharma/winery) OR field visit	4

References

- Rao, D. G., (2005). Introduction to Biochemical Engineering, McGraw-Hill Pub Co Ltd., New Delhi.
- Peppler, H. J. & Perlman, D. (2001). Microbial Technology: Fermentation Technology (2nd Edition) Vol. I and II Academic Press, NY, USA.
- Atkinson, B. (2000). Biochemical Reactors, Pion Ltd, London.
- Boyer, R. F. (2000). Modern experimental biochemistry 3rd Edition, Benjamin Cummings. San-Francisco
- Singh Prakash (2014). Laboratory Protocols in Applied Life Sciences, CRC Press, London.
- Brown Alfred & Smith Heidi., (2014). Benson's Microbiological Applications, Laboratory.
- Manual in General Microbiology, MCGraw Hill Publications, New York.
- Topley, W. W. C. & Sir Graham S. Wilson., (2010). Topley and Wilson's Microbiology and Microbial Infections, Wiley Publication.

MSc I (Biotechnology)
Semester II
BIT-OJT-527: On Job Training / Internship

Hours: 120 **Credits: 4**

Course objectives	• To provide the students with actual work experience • To make aware prescribe standards and guidelines at work • To develop the employability of participating student • To avail an opportunities to eventually acquire job experiences
Course outcomes	After successful completion of this course, students are expected to: • Get actual work experience with office and virtual exposure to various management styles, technical, industrial, and procedural systems • Acquaint the knowledge related to working hours, work protocols and guidelines • Understand the roles and responsibilities of employee as well as team work • Justify job experiences that match their potentials, skills, and competencies
	Internship An internship is a professional learning experience that offers meaningful, practical work related to a student's field of study or career interest. An internship gives a student the opportunity for career exploration and development, and to learn new skills. **On the job training** On the job training is a form of training provided at the workplace. During the training, employees are familiarized with the working environment they will become part of. Employees also get a hands-on experience using machinery, equipment, tools, materials, etc.