List of New Course(s) Introduced

Department : *Biotechnology*

Program Name : *M.Sc.*

Academic Year : 2016-17

List of New Course(s) Introduced

Sr. No.	Course Code	Name of the Course
1.	LBTM 304	A . Bioprocess Engineering and Technology
2.	LBTM 304	B. Molecular Docking
3.	LBTM 304	C. Molecular Diagnostics
4.	LBTM 304	D. Plant Metabolic Engineering
5.	LBTM 401	Immunotechniques
6.	LBTM 402	Environmental Technology
7.	LBTM 403	A. Microbial and Fermentation Technology
8.	LBTM 403	B. Chemoinformatics and Drug Designing
9.	LBTM 403	C. Plant Genetic Engineering and Molecular Breeding

Signature & Seal of HoD

विभागाध्यक्ष, जैव प्रौद्योगिकी विभाग
Head, Department of Biotechnology
गुरु घासीदास विश्वविद्यालय, बिलासपुर (छ.ग.)
Guru Ghasidas Vishwavidyalaya, Bilaspur (C.G.)

Minutes of Meetings (MoM) of Board of Studies (BoS)

Academic Year : 2016-17

School : ***School of Studies of Interdisciplinary Education and Research***

Department : ***Biotechnology***

Date and Time : ***01-07-2015 – 03:00 pm***

Venue : ***Room of Head, Department of Biotechnology***

MINUTES OF THE MEETING OF BOARD OF STUDIES IN BIOTECHNOLOGY HELD ON 01/07/2015

A meeting of the BOS was held on 01.07.2015 at 3 pm to discuss the following:

1. To discuss and approve the course structure and scheme of examination of Int. UG/PG and M.Sc. courses in Biotechnology as per CBCS scheme of the UGC effective from academic session 2015-2016.
2. Any other matter by permission of the Chair.

The following member were present:

(i)	Prof. B.N. Tiwary, Head	Chairman
(ii)	Dr. Renu Bhatt, Associate Professor	Member
(iii)	Dr. D.K. Parihar, Assistant Professor	Member

A copy of the draft of course structure and scheme of examination was sent in advance by email for persual and comment to Prof. Ashok Kumar, Department of Biotechnology, BHU, the external subject expert. However, no reply was received till the time of meeting on 01.07.2015.

At the very outset the HOD and Chairman of BOS welcomed all the esteemed members and placed the draft prepared to revise course structure and scheme of examination in the light of UGC directives as per CBCS scheme to be implemented from 2015-2016. Further the chairman brought to the notice of all members about the resolution of meeting called by the Dean on **23.06.2015** regarding following changes to be made for undergraduate courses:

1. There should be 03 core subjects at entry level of integrated courses in addition to AECC (Ability Enhancement Core Courses) and elective courses.
2. There should be at least 02 groups in each undergraduate course of every Department of the school. The students may opt any one of the two groups for Biotechnology (Hons.)

The course structure and scheme of examination was approved by all members.

The chairman categorically pointed out that in UG courses only 03 core subjects have to be defined and the student shall have choice to opt for any of the subject to pursue, the Honors degree course in 05th sem.

The BOS resolved to have two groups

Group A : Biotechnology-Chemistry-Zoology

Group B: Biotechnology-Chemisrty-Botany

Each of the groups shall have a maximum of 30 seats, i.e. within the total approved seat of 60 in Biotechnology Honors. The number of students of other Departments of School of Life Sciences, opting Biotech as one of the core subjects in no case shall exceed 60.

However, one of the esteemed members, Dr. D.K. parihar, showed his descent mentioning that segregating students in Botany and Zoology will lead to incomplete and inadequate knowledge of Biological sciences, as this is an integral component of Biotechnology.

The meeting ended with a vote of thanks by the Chair.

Dr. Renu Bhatt
(Member)

Dr.D. K. Parihar
(Member)

Prof. B.N. Tiwary 01.07.2015
(Chairman)

In the meeting of BOS-Biotechnology held on 01-07-2015, the following courses were revised in the of Syllabus of B. Sc. and M.Sc. Course work:

Sr. No.	Course Code	Name of the Course
1.	LBTC 301	BIOSTATISTICS
2.	LBTC 401	IMMUNOLOGY
3.	LBTM 301	ANIMAL BIOTECHNOLOGY
4.	LBTM 302	ADVANCED IMMUNOLOGY
5.	LBTM 303	PLANT BIOTECHNOLOGY

The following new courses were introduced in the Syllabus of B. Sc. and M.Sc. Course:

Course Code	Course Name
LBTC 402	Biophysical Techniques
LBTM 304	A . Bioprocess Engineering and Technology
LBTM 304	B. Molecular Docking
LBTM 304	C. Molecular Diagnostics
LBTM 304	D. Plant Metabolic Engineering
LBTM 401	Immunotechniques
LBTM 402	Environmental Technology
LBTM 403	D. Microbial and Fermentation Technology
LBTM 403	E. Chemoinformatics and Drug Designing
LBTM 403	F. Plant Genetic Engineering and Molecular Breeding

Signature & Seal of HoD

विभागाध्यक्ष, जैव प्रौद्योगिकी विभाग
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Scheme and Syllabus

Semester III

Code	Course Opted	Subject	Hours/ Semester	Hours/ Week	Credits
LBTm-301	Core-1	Animal Biotechnology	48	3	3
LBTm-302	Core-2	Advanced Immunology	48	3	3
LBTm-303	Core-3	Plant Biotechnology	48	3	3
LBTm-304	Elective	Paper-4a.: BioprocessEngineering and Technology Paper-4b.: Molecular modeling Paper-4c.:Molecular Diagnostics Paper-4d.: Plant Metabolic Engineering	48	3	3
LBTm-305	Core-1 & 2	Laboratory V Based on Core-1 & 2	96	6	3
LBTm-306	Core-3 & Elective	Laboratory VI Based on core-3 & elective	96	6	3
LBTm-307		Review writing and Seminar	32	2	2
		Total	**416**	**26**	**20**

Semester IV

Code		Subject	Hours/ Semester	Hours/ Week	Credits
LBTm-401	Core-1	Immunotechniques	48	3	3
LBTm-402	Core-2	Environmental Technology			
LBTm-403	Elective Paper	Paper-4a.: Microbial and fermentation technology Paper-4b.: Chemoinformaticss and drug designing Paper-4c.:Gene therapy and Nano medicine Paper-4d.: Plant Genetic Engineering and molecular breeding	48	3	3
LBTm-404	Core-1 & 2	Laboratory VII Based on Core-1 & 2	96	6	3
LBTm-405		Project Dissertation & Viva	288	18	6+3
LBTm-406	Soft Skill Development-2	Entrepreneurship & Management inBiotechnology	48	3	3
		Total	**528**	**42**	**21**

Baskets of Electives: Microbial Technology, Bioinformatics, Animal Biotechnology and Plant Biotechnology

* B.Sc Biotechnology (Hons.) students shall opt one Elective from theBasket of electives offered by the Department.

*Project work/ Field Study will be based on major elective paper (s) opted by the student, in consultation with the faculty concerned and on recommendation of the Head of the Department.

Bioprocess Engineering & Technology

Course Code:
Course Credit: (3-0-0) 3

Unit - 1
Introduction to bioprocess engineering, bioreactors, isolation, preservation and maintenance of industrial microorganisms, kinetics of microbial growth and death, media formulation for industrial fermentation, Air and media sterilizationDesigning of a fermenter/Bioreactor

Unit - 2
Types of fermentation process, analysis of batch fed batch and continuous bioreactions, biotransformation, stability of microbial reactors, specialized bioreactors (pulsed, fluidized, photo bioreactors etc.), Measurement and control of bioprocess parameters

Unit - 3
Downstream processing: introduction, removal of microbial cells and solid matters, foam separation, precipitation, filtration, centrifugation, cell disruption, liquid-liquid extraction, chromatography, membrane process, drying and crystallization

Unit - 4
Industrial production of chemicals: alcohols, acids (citric, acetic), solvents (glycerols, acetone, butanol), antibiotics (penicillin, streptomycin, tetracycline) amino acids (lysine, glutamic acid), single cell proteins

Unit - 5
Food Biotechnology: Food spoilage and preservation process, dairy products, wine, beer and other alcoholic Beverages, petro crops, Mushroom-types, isolation and culture

Evaluation Scheme:

S.No.	Examination	Duration	% of Marks
1	Internal Assessment I	1hour	30
2	Internal Assessment II	1hour	30
3	End Semester	3 hours	60
4	Attendance/Assignment/Class performance	Each semester	10

Note: The best one out of two Internal Assessments will be taken into consideration.

Suggested Readings

1. General Microbiology: Sullia SB and Shantharam S
2. Microbial Biotechnology: Glaser AN and NilaidoH
3. Industrial Microbiology : Prescott & Dunn
4. A text of Industrial Microbiology: Crueger W and Crueger A
5. Priciples of Fermentation Technology: Stanbury PF, Ehitaker H, Hall SJ
6. Industrial Biotechnology: SN Jogdan

Course: Molecular Modeling
Course Code:
Course Credit: 3 0 0 (3)

Unit - 1
The fundamental concepts of molecular modeling (chemical building blocks, structure, superstructure, folding, etc.); the physical forces that shape macromolecules; structural databases (protein data bank, SCOP database, CATH database and other structure based databases)

Unit - 2
Protein structure prediction: computational methods for secondary structure prediction (Chou-Fasmann, GOR and Neural Networks) and reliability (Q3 value and SOV score); prediction of tertiary structures of protein (Homology and Threading methods); structure quality assessment

Unit - 3
Protein structures comparison and alignment: comparison algorithm & optimization, multiple structural alignment. Analysis of 3D structures: secondary structure assignment, assignment of hydrogen bonds, coulomb hydrogen bond calculation, empirical hydrogen bond calculation, assignment methods of secondary structure (DSSP, STRIDE, DEFINE, P-Curve)

Unit - 4
Identifying structural domains in protein: first and second generation algorithms for domain assignments, domain assignment based on graph theoretical methods, prediction of binding sites and characterization; Inferring protein function from structure: enzyme/non-enzyme classification, gene ontologies, ab initio prediction, structural comparison, structural motifs.

Unit - 5
Ab initio protein structure prediction: Potential Energy Function (bond length potential, aond angle potential, torsional potential, van der wals potential and coulomb potential), Energy minimization techniques: concept of local and global minima, energy minimization protocol, energy minimization algorithms (steepest descent, conjugate gradient, Newton Raphson); Molecular Dynamics simulations, Monte Carlo Simulations, Calculation of Free energy using simulation techniques.

Evaluation Scheme:

S.No.	Examination	Duration	% of Marks
1	Internal Assessment I	1 hour	30
2	Internal Assessment II	1 hour	30
3	End Semester	3 hours	60
4	Attendance/Assignment/Class performance	Entire semester	10

Note: The best one out of two International Assessments will be taken into consideration.

Suggested Readings

1. Introduction to Protein Structure, Branden &Tooze, Garland Publishing, Inc, New York
2. Molecular Modeling, Holtje and Folkers, G. Weinheim New York
3. Molecular Moelling : Principles & Applications, Andrew R. Leach, Prentice Hall
4. Principles of Protein Structure,Schlutz, G.H., and Schirmer, R.H. (1987) Springer Verlag, New York.

Course: Molecular Diagnostics
Course Code:
Course Credit: (3-0-0) 3

Unit- 1
Enzyme Immunoassays: Comparison of enzymes available for enzyme immunoassays, conjugation of enzymes. Solid phases used in enzyme immunoassays. Homogeneous and heterogeneous enzyme immunoassays.Use of polyclonal or monoclonal antibodies in enzymes immuno assays. Applications of enzyme immunoassays in diagnostic microbiology

Unit - 2
Molecular methods in clinical microbiology: Applications of PCR, RFLP, Nuclear hybridization methods, Single nucleotide polymorphism and plasmid finger printing in clinical microbiology

Unit - 3
Laboratory tests for microbial infection, Antimicrobial Susceptibility tests: Micro-dilution and macro-dilution broth procedures. Diffusion test procedures.Tests for bactericidal activity. Automated procedures for antimicrobial susceptibility tests

Unit- 4
Rapid diagnostic approach including technical purification and standardization of antigen and specific antibodies.Immunodiagnostic tests.Immuno florescence.Radioimmunoassay, Immunohistochemistry.

Unit- 5
Genetic disorders, Molecular techniques to detect genetic disorders, Genetic test for Thalassemia, Fanconianemia, Sickle Cell anemia, Fragile-X syndrome, Alzheimer's disease.

Evaluation Scheme:

S.No.	Examination	Duration	% of Marks
1	Internal Assessment I	1hour	30
2	Internal Assessment II	1hour	30
3	End Semester	3 hours	60
4	Attendance/Assignment/Class performance	Each semester	10

Note: The best one out of two Internal Assessments will be taken into consideration.

Suggested Reading:

1. Immunology: Kuby
2. Molecular Diagnostics: For the Clinical Laboratorian Hardcover: William B. Coleman, Gregory J. Tsongalis
3. Fundamentals of Molecular Diagnostics: David E. Bruns, Edward R. Ashwood
4. Molecular Biotechnology: Pasternak
5. Textbook of Clinical Chemistry and Molecular Diagnostics: Carl A. Burtis, Edward R. Ashwood, David E. Bruns
6. Introduction to Molecular Diagnostics (DX-INSIGHTS)
7. Biophysical chemistry: Upadhya&Nath
8. A Biologist Guide to Principle and Techniques: Willson K and Gounding KH

Course: Plant Metabolic Engineering
Course Code:
Course Credit: (3-0-0) 3

Unit-1
The concept of secondary metabolites, Historical and current views, Importance of secondary metabolites in medicine and agriculture, Introduction to various pathways

Unit-2
Flavanoid pathway: The basic structure, Stereochemistry, Chemical synthesis of different intermediates, The biochemical pathway, Different regulatory points, Intermediate pools and their significance in horticulture, agriculture and medicine, Regulatory genes, Regulation of gene expression

Unit-3
Terpenoid pathway: The basic structure, Stereochemistry, Chemical synthesis of different intermediates, The biochemical pathway, Different regulatory points, Intermediate pools and their significance in horticulture, agriculture and medicine, Regulatory genes, Regulation of gene expression

Unit-4
Polyketoid pathway: The basic structure, Stereochemistry, Chemical synthesis of different intermediates, The biochemical pathway, Different regulatory points, Intermediate pools and their significance in horticulture, agriculture and medicine, Regulatory genes, Regulation of gene expression

Unit-5
Production of secondary metabolites from plant cell cultures; Processes for enhancing the production of secondary metabolites. Technology of plant cell culture for production of chemicals; Bioreactors systems and models for mass cultivation of plant cells, Plant Therapeutic proteins, Edible vaccine, Bioplastic.

Evaluation Scheme:

S.No.	Examination	Duration	% of Marks
1	Internal Assessment I	1 hour	30
2	Internal Assessment II	1 hour	30
3	End Semester	3 hours	60
4	Attendance/Assignment/Class performance	Each semester	10

Note: The best one out of two Internal Assessments will be taken into consideration.

Suggested reading:

1. Tissue Culture: Bhan
2. Plants from test tubes. An introduction to Micropropogation: LydianeKyte& John Kleyn
3. A test book book on Biotechnology: Kumar H.D
4. Applied and fundamental Aspects of Plant Cell, Tissue and Organ Culture: Reinert J. and Bajaj Y.P.S

Course: Environmental Biotechnology
Course Code:
Course Credit: (3-0-0) 3

Unit - 1
Components of Environment - Hydrosphere, lithosphere, atmosphere and biosphere – definitions with examples; Interaction of man and environment; Environmental Studies as a multidisciplinary subject

Unit - 2
Global Environmental Problems - Green House Effect, Acid rain, Ozone depletion, salination, biodiversity loss; chemical and radiation hazards.

Unit - 3
Environmental pollution and degradation - Pollution of air, water and land with reference to their causes, nature of pollutions, impact and control strategies; noise pollution; Habitat Pollution by Chlorinated Hydrocarbons (DDT, PCBs, Dioxin etc)

Unit - 4
Environmental Management - Concept of health and sanitation, environmental diseases – infectious (water and air borne) and pollution related, health hazards due to pesticide and metal pollution, waste treatment, solid waste management

Unit - 5
Bioremediation - Oil spills, Wastewater treatment, chemical degradation, heavy Metals

Evaluation Scheme:

S.No.	Examination	Duration	% of Marks
1	Internal Assessment I	1hour	15
2	Internal Assessment II	1hour	15
3	End Semester	3 hours	30
4	Attendance/Assignment/Class performance	Each semester	5

Note: The best one out of two Internal Assessments will be taken into consideration.

Suggested Readings

1. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology: Verma PS and AgrawalVK
2. Environmental Biotechnology:Chhatargy
3. Environmental Pollutions: Peavy and Rowe
4. Environemental Biology: VermaPS and Chand S
5. Environmental Biotechnology: InduShekhar

Course: Immunotechnology
Course Code:
Course Credit: (3-0-0) 3

Unit - 1
Production and engineering of antibodies: Production of monoclonal and polyclonal antibodies, hybridoma technology, specific and cross reactivity, Anti-immunoglobulin antibodies; Antibody engineering, abzymes, Antigen-antibody interaction as a basis of precipitation and agglutination reactions, blood typing, RIA, ELISA, Microscopy, Imaging-Immunohistochemistry, Immunoprecipitation and co-immunoprecipitation, Immunoblotting

Unit -2
Isolation and enrichment of specific immune cells, ELISPOT, Flow-cytometer and FACS for quantitative/qualitative analysis and sorting of different immune cell subsets, Cell functional assays-lymphoproliferation, Cell cytotoxicity, mixed lymphocyte reaction, apoptosis

Unit -3
Immune response and bacterial, parasitic and viral infections, congenital and acquired immunodeficiency; tolerance and autoimmune diseases, Transplantation and Tumor Immunology, diagnosis and therapeutic approaches. Cytokine related diseases: diagnosis and therapeutic application of cytokines

Unit -4
Manipulation of the immune response: Regulation of unwanted immune responses and immunomodulation against autoimmunity, transplantation rejections, cancer therapy, Vaccination strategies: Active immunization: Sub unit vaccines; Recombinant DNA and protein based vaccines, Peptide vaccines, conjugate vaccines; Passive Immunization: Antibody, Transfusion of immuno-competent cells, Stem cell therapy; Cell based vaccines, Immunoinformatics and vaccine design

Unit - 5
Adoptive cell transfer therapy; Animal models: Transgenic mice and gene knockout by targeted disruption, *in vivo* cell tracking techniques, Cell imaging techniques-*in vitro* and *in vivo*. Molecular diagnosis of immunological disorders: ex. DiGeorge syndrome, humoral immunodeficiency, cellular immunodeficiency (due to defects in IFNg receptor a and b chain, MHC Class I)

Evaluation Scheme:

S.No.	Examination	Duration	% of Marks
1	Internal Assessment I	1 hour	30
2	Internal Assessment II	1 hour	30
3	End Semester	3 hours	60
4	Attendance/Assignment/Class performance	Each semester	10

Note: The best one out of two Internal Assessments will be taken into consideration.

Suggested Readings

1. Immunobiology: Kenneth Murphy
2. Cellular and Molecular Immunology: Abbas AK, Lichtman AH and Pillai S
3. Immunology: Kuby
4. Essential Immunology: Roit I

Course: Microbial & Fermentation Technology
Course Code:
Course Credit: (3-0-0) 3

Unit-1
History and scope of microbial biotechnology, the bioreactor/fermenter-types and parts, scale-up, media design for fermentation processes, Economic aspects of fermentation

Unit-2
Biotechnological application of microorganisms, Production of chemicals and pharmaceuticals (bioconversion), Production of microbial enzymes and their applications, Microbes in mining, Ore leaching, oil recovery, Application of microbes inpharmaceutical industry

Unit-3
Role of microorganisms in the production and transformation of food and beverages -Food fermentation - Bread leavening - by yeast – by other micro organisms– chemicalleavening, Brewing: Manufacture of Beer- microbiological aspects. Wine - Kinds of wines, manufacture, microbial spoilage, Distilled liquors. Vinegar -methods of manufacture

Unit-4
Fermented vegetables - Pickles - Fermented dairy products – Fermented milk , cheese, butter and other milk products - spoilage of milk - preservation of milk.

Unit-5
Biofertilizers- manufacture, formulation and utilization, Microbes as Biofertilizers -Chemically fixed Nitrogen versus biologically fixed Nitrogen, biopesticides.

Evaluation Scheme:

S.No.	Examination	Duration	% of Marks
1	Internal Assessment I	1hour	30
2	Internal Assessment II	1hour	30
3	End Semester	3 hours	60
4	Assignment/Class performance	Each semester	10

Note: The best one out of two Internal Assessments will be taken into consideration.

Suggested Readings

1. Microbial Biotechnology: Alexandern, Glazer Hiroshi Nikaido
2. Molecular Biotechnology: Principles and Applications of Recombinant DNA:Bernaral R Glick and Jack J. Pastemak
3. Principles of Fermentation Technology:Whittaker & Stan bury
4. Bioprocess Engineering Principles : Operational Modes of Bioreactors, BIOTOL series - Butter worth, Heinemann
5. Bioreactor Design and Product Yield, BIOTOL series - Butter worth Heinemann
6. Bioprocess Engineering : Systems, Equipment & Facilities : LydersenNA Delia and KM Nelson,
7. Bioseparationand Bioprocessing: Subramaniam,G

Course: Chemoinformatics & Drug Designing
Course Code:
Course Credit: (3-0-0) 3

Unit -1
Defining chemical informatics; a glimpse of the future of chemical informatics. Representing 2D structures: Kinds of 2D structure representation; atom lookup and connection tables; graph theory; SMILES; SD files; Fragment codes & Fingerprints; descriptors. 2D chemical database applications. Types of searching; substructure searching with SMARTS; similarity searching with fingerprints; demonstrations of searching systems

Unit -2
Representing 3D structures. Sources of 3D information; experimental 3D databases; conformational flexibility; distance matrices; estimation of 3D structure; conformational search and minimization; 3D descriptors and fingerprint; representation of proteins

Unit -3
Molecular Descriptors: 2D descriptors. Kinds of descriptor; "mathematical" and topological indices; biological descriptors and their application in ADME/Tox; biological properties; property prediction software, 3D descriptors, data verification and manipulation

Unit - 4
Quantitative structure-property relationships(QSPR):Feature selection, Model building, examples of QSPR studies and application. QSAR in drug design: QSAR methodology, biological and physicochemical parameters, QSAR applications in drug design, QSAR model selection and validation, CoMFA, 3D and nD-QSAR methods

Unit - 5
Pharmacophore and Drug Discovery: pharmacophore generation, database building and conformer generation, query generation and submission, searches in the database, software for pharmacophore generation, application and limitation of pharmacophore concept. De-novo design system: generating the constraints model, finding structure, sorting and selection, synthetic accessibility, experimental validation. Computational models for ADME/Tox. The application of predictive models to pharmacology and toxicity testing.

Evaluation Scheme:

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1	Internal Assessment I	1hour	30
2	Internal Assessment II	1hour	30
3	End Semester	3 hours	60
4	Attendance/Assignment/Class performance	Each semester	10

Note: The best one out of two Internal Assessments will be taken into consideration.

Suggested Readings
1. An Introduction to Chemoinformatics: AR Leach and VJ Gillet
2. Handbook of Chemoinformatics: John Gasteiger
3. Chemo-informatics A Textbook:Johann Gasteiger and Thomas Engel

Course: Plant Genetic Engineering & Molecular breeding
Course Code:
Course Credit: (3-0-0) 3

Unit-1
Plant Transformation Technology: *Agrobacterium* based vectors,*Agrobacterium* mediated gene transfer; viral vectors and their application. Direct gene transfer methods; chemical methods, electroporation, microinjection, particle bombardment

.Unit-2
Genetic engineering for biotic stress tolerance: Insects, fungi, bacteria, viruses, weeds; abiotic stress tolerance: drought, flooding, salt, heavy metals and temperature

Unit-3
Genetic engineering for increasing crop productivity by manipulation of Photosynthesis, Nitrogen fixation, Nutrient uptake efficiency

Unit-4
Genetic engineering for quality improvement: Protein, lipids, carbohydrates, vitamins & mineral nutrients

Unit-5
Introduction to molecular markers, construction of Molecular maps, Molecular tagging of genes/traits, Marker-assisted selection of qualitative and quantitative traits, The concept of map-based cloning and their use in transgenics

Evaluation Scheme:

S.No.	Examination	Duration	% of Marks
1	Internal Assessment I	1 hour	30
2	Internal Assessment II	1 hour	30
3	End Semester	3 hours	60
4	Attendance/Assignment/Class performance	Each semester	10

Note: The best one out of two Internal Assessments will be taken into consideration.

Suggested readings

1. Biotechnology applications of Plant Tissue & cell culture: Ravishankar G.A and Venkataraman L.V
2. Tissue Culture: Bhan
3. Plants from test tubes. An introduction to Micropropogation (3rd Edition) timber Press, Partland.
4. A test book book on Biotechnology: Kumar H.D
5. Plants, Genes and agriculture, Jones and Barlett Publishers, Boston. Chrispeel M.J. and Sdava D.E.
6. Applied and fundamental Aspects of Plant Cell, Tissue, and Organ Culture, Reinert J. and Bajaj Y.P.S