GONDWANA UNIVERSITY

GADCHIROLI

CHOICE BASE CREDIT SYSTEM (CBCS)

SYLLABUS FOR

M.Sc.

TWO-YEARS DEGREE COURSE

IN

BIOTECHNOLOGY

From

Academic Year

2017-2018

CHOICE BASED CREDIT SYSTEM (CBCS)

SEMESTER PATTERN

M.Sc. Biotechnology (PG) Program under Faculty of Science

(Affiliated Colleges)

(W.e.f. Academic Year 2016-17)

Appendix-1

Scheme of teaching and examination under semester pattern Choice Based Credit System (CBCS) for M.Sc. Program in Biotechnology.

	Core Course	**Ability Enhancement**	**Skill Based Course**	**Discipline Specific Elective**
SEM III	Core 1 Th. Paper 1 (4 Credits) (4 Hours/Week)	Seminar I (1 Credit) (2 Hours/Week)		
	Core 2 Th. Paper 2(4 Credits) (4 Hours/Week)			
	Core 3 Th. Paper 3 (4 Credits) (4 Hours/Week)			
	Core 4 Th. Paper 4 (4 Credits) (4 Hours/Week)			
	Pract. Core Pr. 1 {Based on Core Th. 1&2} (4 Credits) (3-8 Hours/Week)			
	Pract. Core Pr. 2 {Based on Core Th. 3&4} (4 Credits) (3-8 Hours/Week)			

Total 25 Credits

	Core Subject	**Ability Enhancement**	**Skill Based Course**	**Discipline Specific Elective**
SEM IV	Core 5 Th. Paper 5 (4 Credits) (4 Hours/Week)	Seminar II (1 Credit) (2 Hours/Week)		
	Core 6 Th. Paper 6 (4 Credits) (4 Hours/Week)			
	Core 7 Th. Paper 7 (4 Credits)			
	Core 8 Th. Paper 8 (4 Credits) (4 Hours/Week)			
	Pr. Core Pr. 3 {Based on Core Th. 5&6} (4 Credits) (3-8 Hours/Week)			
	Pr. Core Pr. 4 {Based on Core Th. 7&8} (4 Credits) (3-8 Hours/Week)			

Total 25 Credits

Scheme of teaching and examination under semester pattern Choice Based Credit System (CBCS) for M.Sc. Program.

Semester III

Code	Theory / Practical	Teaching Scheme Hrs/ week			Credit	Examination Scheme					
						Duration in hrs.	Max. Marks		Total	Minimum Marks	
		Theory	Practical	Total			External	Internal		Theory	Practical
Core 1	Paper 1	4	-	4	4	3	80	20	100	40	
Core 2	Paper 2	4	-	4	4	3	80	20	100	40	
Core 3	Paper 3	4	-	4	4	3	80	20	100	40	
Core 4	Paper 4	4	-	4	4	3	80	20	100	40	
Pract. Core 1 & 2	Practical 1	-	8	8	4	3-8*	80	20	100	40	40
Pract. Core 3 & 4	Practical 2	-	8	8	4	3-8*	80	20	100	40	40
Seminar 1	Seminar 1	2	-	2	1			25	25	10	
TOTAL		**18**	**16**	**34**	**25**		**480**	**145**	**625**	**170**	**80**

Semester IV

Code	Theory / Practical	Teaching Scheme Hrs/ week			Credit	Examination Scheme					
						Duration in hrs.	Max. Marks		Total	Minimum Marks	
		Theory	Practical	Total			External	Internal		Theory	Practical
Core 5	Paper 5	4	-	4	4	3	80	20	100	40	
Core 6	Paper 6	4	-	4	4	3	80	20	100	40	
Core 7	Paper 7	4	-	4	4	3	80	20	100	40	
Core 8	Paper 8	4	-	4	4	3	80	20	100	40	
Pract. Core 5 & 6	Practical 3	-	8	8	4	3-8*	80	20	100	40	40
Pract. Core 7 & 8	Practical 4	-	8	8	4	3-8*	80	20	100	40	40
Seminar 2	Seminar 2	2	-	2	1			25	25	10	
TOTAL		**18**	**16**	**34**	**25**		**480**	**145**	**625**	**170**	**80**

Project Work/Dissertation Scheme / Guidelines for the Students, Supervisors and Examiners

Every student is required to carry out a project work in semester IV. The project can be of following types. A) Experimental Project Work; OR B) Field Based Project Work; OR C) Review writing based Project Work.

Experimental Project Work and Field Based Project Work:

Student can carry out Experimental / Field Based Project Work on a related research topic of the subject /course. It must be an original work and must indicate some degree of experimental work / Field work. On the basis of this work, student must submit the Project Report (typed and properly bound) in two copies at least one month prior to commencement of the final Practical / lab Examination of Semester IV. The project report shall comprise of Introduction, Material and Methods, Results, Discussion, Summary,

Conclusion and, References along with the declaration by the candidate that the work is original and not submitted to any University or Organization for award of the degree and certificate by the supervisor and forwarded through Head / Course-coordinator / Director of the Department / Centre or the Principal of the College.

Review writing based Project Work.

Student can carry out review writing Based Project Work on a related topic of the subject / course. It must be a review of topic based on research publications. Student shall refer peer reviewed original research publications and based on findings, write a summary of the same. The pattern of review writing shall be based on reputed reviews published in a standard, peer reviewed journals. On the basis of this work, student must submit the Project Report (typed and properly bound) in two copies at least one month prior to commencement of the final Practical / lab Examination of Semester IV. The project report shall comprise of Abstract, Introduction, detailed review, Discussion, Summary, Conclusion and, References along with the declaration by the candidate that the work is original and not submitted to any University or Organization for award of the degree and certificate by the supervisor and forwarded through Head / Course-coordinator / Director of the Department / Centre or the Principal of the College.

*The supervisors for the Project Work shall be from the following.

A person shall be an approved faculty member in the relevant subject. OR

Scientists of National Laboratories / Regional Research Laboratories/ Experts from R&D in Industry who are approved by competent authority in such facilities by the Union Government / the State Government / Gondwana University / Other Universities recognized by UGC.

The Project Work will carry total 100 marks and will be evaluated by both external and internal examiner in the respective Department / Center / Affiliated College.

The examiners will evaluate the Project Work/Dissertation taking into account the coverage of subject matter, arrangement and presentation, references, etc.

For written Project work	**40**	**Marks – Evaluated jointly by External & Internal examiner**
Oral Presentation	20	Marks – Evaluated jointly by External & Internal examiner
For Viva-Voce	20	Marks – Evaluated by External examiner
Internal Assessment	20	Marks – Evaluated by Internal examiner
Total	100	

Seminar

Guidelines for Students, Supervisors and Examiners

In each semester, the student will have to deliver a seminar on any topic relevant to the syllabus / subject encompassing the recent trends and development in that field / subject. The topic of the seminar will be decided at the beginning of each semester in consultation with the supervising teachers. The student has to deliver the seminar which will be followed by discussion. The seminar will be open to all the teachers of the department, invitees, and students.

The students should submit the seminar report typed and properly bound in two copies to the head of the department. The said shall be evaluated by the concerned supervisor / head of the department. The marks of the seminar shall be forwarded to the university within due period through head of the Department. The record of the seminar should be preserved till the declaration of the final result.

Internal Assessment:

1. The internal assessment marks shall be awarded by the concerned teacher.
2. The internal assessment marks shall be sent to the University after the Assessment in the prescribed format.
3. For the purpose of internal assessment, the University Department / College shall conduct any three assignments described below. Best two scores of a student in these tests shall be considered to obtain the internal assessment score of that student.
4. If the student does not appear for the Practical Exam, he shall be declared failed in Practical Examination irrespective of marks obtained in Internal Practical Assessment. However, the Internal

Practical Assessment marks will be carried forward for his next supplementary Practical Exam.

5. General guidelines for Internal Assessment are:
   a) The internal assessment marks assigned to each theory paper as mentioned in Appendix 1 shall be awarded on the basis of assignments like class test, attendance, home assignments, study tour, industrial visits, visit to educational institutions and research organizations, field work, group discussions or any other innovative practice / activity.
   b) There shall be three assignments (as described above) per course.
   c) There shall be no separate /extra allotment of work load to the teacher concerned. He/ She shall conduct the Internal assessment activity during the regular teaching days / periods as a part of regular teaching activity.
   d) The concerned teacher / department / college shall have to keep the record of all the above activities until six months after the declaration of the results of that semester.
   e) **At the beginning of each semester, every teacher /department/college shall inform his/her students unambiguously the method he / she proposes to adopt and the scheme of marking for internal assessment. (Prescribed in syllabus of respective Subjects).
   f) Teacher shall announce the schedule of activity for internal assessment in advance in consultation with HOD / Principal.

   **To be included in syllabus by BOS.

Practical Examination

1. Each practical carries 100 marks. The scheme of marking shall be as per given in the syllabi of respective subjects.
2. Practical performance shall be jointly evaluated by the External and Internal Examiner. In case of discrepancy, the External Examiner's decision shall be final.
3. Duration of practical examination will be as per given in the syllabi of respective subjects.

The Practical Record of every student shall carry a certificate as shown below, duly signed by the teacher-in-charge and the Head of the Department. If the student fails to submit his / her certified Practical Record duly signed by the Teacher-In-Charge and the Head of the Department, he / she shall not be allowed to appear for the Practical Examination and no Marks shall be allotted to the student.

4. The certificate template shall be as follows:

C E R T I F I C A T E

Name of the college / institution _

Name of the Department: _

This is to certify that this Practical Record contains the bonafide record of the Practical work of Shri / Shrimati / Kumari _ of M. Sc. _ _ _ _ _ _ _

_ _ _ _ _ _ _ Semester _ _ _ _ _ _ _ _ _ _ during the academic year _ _ _ _ _ _ _. The candidate has satisfactorily completed the experiments prescribed by Gondwana University Gadchiroli for the subject _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _

Dated _ _ _ / _ _ _ / _ _ _ _ _

Signature of the teacher who taught the examinee Head of the Department

1. _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ 2. _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _

General Rules and Regulations regarding pattern of question paper for the semester end examination: ***A) Pattern of Question Paper***

1. There will be four units in each paper.
2. Maximum marks of each theory paper will be 80.
3. Question paper will consist of five questions, each of 16 marks.
4. Four questions will be on four units with internal choice (One question on each unit).
5. Fifth question will be compulsory with questions from each of the four units having equal weightage and there will be no internal choice.

Sem. No.	Paper No.	Paper Title
III	I	**ANIMAL BIOTECHNOLOGY**
	II	**PLANT BIOTECHNOLOGY**
	III	**GENETIC ENGINEERING**
	IV	**APPLIED BIOTECHNOLOGY**
		Practical Based on Paper I & II
		Practical Based on Paper III & IV
IV	I	**ENVIRONMENTAL BIOTECHNOLOGY**
	II	**APPLIED ENVIRONMENTAL BIOTECHNOLOGY AND ECOLOGY**
	III	**ETHICS, PATENTING AND BIOENTREPRENEURSHIP**
	IV	**RESEARCH METHODOLOGY AND BIOSTATISTICS**
		Practical Based on Paper I & II
		Practical Based on Paper III & IV

SEMESTER III

Semester-III
Paper-I
Animal Biotechnology

Course Code		Topic/Title	Credit
	Unit-I	**Introduction to Animal Cell Culture** A. Animal cell culture: Equipments and materials for animal cell culture technology, various systems of tissue culture, advantages and limitations. B. Culture media: Natural media, synthetic media, balanced salt solutions. C. Brief discussion on the chemical, physical and metabolic functions of different constituents of culture medium, role of CO_2, serum and supplements. D. Characteristics of cells in culture: contact inhibition, anchorage dependence, cell-cell communication.	04
	Unit-II	**Methods of Animal Cell and Tissue Culture** A. Isolation of animal cell material: various methods of separation of cell types, advantages and limitations. B. Primary culture: behavior of cells, properties, utility, explant culture; suspension culture. C. Established cell line cultures: definition of cell lines, maintenance and management; cryopreservation, germplasm conservation, cell adaptation. D. Three dimensional cultures	
	Unit-III	**Scaling up of Animal Cell Culture** A. Apoptosis: measurement of cell death. apoptosis (death domain, role of cytochrome C) B. Cell synchronization and cell manipulation C. Cell transformation, cell cloning D. Tissue engineering- design and engineering of tissue, tissue modeling. E. Stem cell cultures, embryonic stem cells and their applications.	
	Unit-IV	**Application of Animal Tissue Culture** A. Mass production of biologically important compounds (eg. vaccines), cytotoxicity and diagnostic tests. B. Manipulation of reproduction in animals: artificial insemination, embryo transfer (multiple ovulation, multiple ovulation with embryo transfer) C. *In vitro* fertilization technology: embryo cloning and embryonic stem cell. embryo transfer in human. D. Application of animal cell culture: transgenic animals- mice, large animals, xenotransplantation, use of transgenic animals in disease interruption.	

Semester-III
Paper-II
Plant Biotechnology

Course Code		Topic/Title	Credit
	Unit-I	**Introduction to Plant Tissue Culture** A. Brief introduction to conventional plant breeding B. Introduction to cell and tissue culture technique. C. Tissue culture media (composition and preparation) D. Role of growth hormone in plant tissue culture (auxins, cytokinins) E. Callus and suspension cultures: initiation and maintenance of callus and suspension cultures; single cell clones.	04
	Unit-II	**Techniques of Plant Tissue Culture** A. Organogenesis. embryogenesis; transfer and establishment of whole plants in soil. B. Shoot tip culture: rapid clonal propagation and production of virus free plants. C. Embryo culture and embryo rescue. D. Hybrid plants: protoplast isolation, culture and fusion. E. Selection of hybrid cells and regeneration of hybrid plants, symmetric and asymmetric hybrid, cybrid. F. Production of haploid plants: anther and pollen cultures for production of haploid plants.	
	Unit-III	**Plant Transformation Technology** A. Basis of tumor formation, hairy root. B. General features of Ti and Ri plasmids. C. Mechanism of DNA transfer, role of virulence genes, use of Ti and Ri as vectors, binary vectors. D. Methods of nuclear transformation, biological and physical transformation methods. E. Chloroplast transformation.	
	Unit-IV	**Application of Plant Tissue Culture** A. Applications of plant transformation for productivity and performance B. Herbicide resistance -phosphoinothricine glyphosate, sulfonyl urea, atrazin C. Insect resistance- Bt genes. D. Virus resistance, coat protein mediated nucleocapsid gene. E. Fungal resistance, disease resistance, nematode resistance. F. Improvement of crop yield and quality - Long shelf life of fruits and flowers. G. Male sterile lines. H. Transgenic plants as a food- golden rice, pomato, sugarcane, sweet corn.	

Semester-III
Paper-III
Genetic Engineering

Course Code		Topic/Title	Credit
	Unit-I	**Introduction to Genetic Engineering and Gene Selection** A. Isolation of DNA from the source (plant, animal, microbes) B. DNA manipulation enzymes: nucleases (exonucleases and endonucleases), ligases, polymerases and topoisomerases. C. Restriction enzymes and their types, restriction modification system, DNA modification enzymes D. Gene isolation and purification: general methods (shotgun method for producing gene library, cloning specific genes by hybridization and reverse transcriptase methods, direct selection of a gene)	04
	Unit-II	**Cloning Vectors and rDNA Preparation** A. Cloning vectors: plasmids as vectors, general characteristics of plasmids, bacterial vector plasmids, yeast vector plasmids, yeast artificial chromosomes. viral vectors (lambda, M13). cosmid vectors, phagemid vectors. B. Insertion of DNA and ligation: Berg's terminal transferase method (dA:dT joints); Boyer-Cohen-Chang experiment (cohesive ends), butt joints (T4 DNA ligase); current ligation techniques (blunt-end ligation, complementary end ligation) linkers, adaptors, homopolymer tailing.	
	Unit-III	**Molecular Probe and DNA Sequencing** A. Gene libraries and molecular probes: molecular probes for detecting nucleic acids and proteins. genomic DNA library, cDNA library. B. Nucleic acid hybridization (southern hybridisation, northern hybridisation). Antibody probes (western blotting, immunoprecipitation and south-western screening). C. DNA sequencing: Sanger-Coulson dideoxynucleotide method, Maxam-Gilbert chemical cleavage method, multiplex DNA sequencing, automated DNA sequencing.	
	Unit-IV	**Insertion of Foreign DNA into Host Cells** A. Transformation: DNA uptake by bacterial cells. B. Transfection: chemical and physical methods, viral vectors. polyethylene glycol, DEAE-dextran, calcium phosphate coprecipitation, dimethyl sulfoxide, liposomes, microinjection, macroinjection, electroporation, biolistics, somatic cell fusion, viral vectors (single- and two-strain packaging). C. Gene transfer by pronuclear microinjection	

Semester-III
Paper-IV
Applied Biotechnology

Course Code		Topic/Title	Credit
	Unit-I	**Gene Amplification and Expression** A. Salient features of expression vectors. B. Expression of foreign gene: expression of eukaryotic genes in bacteria, expression of foreign genes in yeast, insect and mammalian cells. C. Processing of recombinant proteins: refolding and stabilization. D. Protein engineering- addition of disulphide bond, changing amino acids, modification of metal cofactors, changing protease activity, active site modification. E. Amplification of DNA: polymerase chain reaction	04
	Unit-II	**Gene Theory and Therapeutic Products** A. Production of monoclonal bodies by phage display technique using filamentous phage vectors. B. Gene therapy: somatic and germline, random and targeted gene replacement, *in vivo* and *ex vivo* gene delivery, retrovirus gene transfer system, advantages and disadvantages of adenovirus, adeno-associated virus, herpes virus vectors, gene correction, replacement/augmentation, editing, regulation and silencing. gene therapy of human diseases.	
	Unit-III	**Production of Commercial Products by GMOs** A. Role of rDNA technology in production of alcohol B. Role of rDNA technology in production of vitamin- (ascorbic acid, vitamin B12) C. Role of rDNA technology in production of vaccine- (vaccinia viral vaccine, polio vaccine) D. Role of rDNA technology in production of hormone- (insulin, oxytocin) E. Role of rDNA technology in production of antibiotics- (streptomycin, penicillin)	
	Unit-IV	**Plant Secondary Metabolites and Nanobiotechnology** A. Plant secondary metabolites: phenylpropanoid pathway, shikimate pathway, alkaloids, industrial enzymes, biodegradable plastics, polyhydroxybutyrate, therapeutic proteins, lysosomal enzymes, oleosin partitioning technology. B. Green house technology: principle and application C. Concept of nanobiotechnology and application of nanobiotechnology in medicine.	

Practical-V (ANIMAL AND PLANT BIOTECHNOLOGY)

Compulsory Practical

1. Callus propagation, organogenesis.
2. Development of primary cell lines/maintenance of established cell lines.
3. Plant protoplast isolation, fusion and protoplast culture.

Optional Practical

1. Preparation of animal cell culture media.
2. Initiation of primary culture from chick embryo
3. Preparation of single cell suspension from spleen / liver / thymus.
4. Cell counting and cell viability.
5. Trypsinization of monolayer and subculturing.
6. Preparation of plant tissue culture media.
7. Surface sterilization.
8. Organ culture.
9. Anther culture: production of haploids.
10. Micropropagation of banana/citrus/papaya/sugarcane.
11. Embryo culture of different plant species
12. Effect of various growth hormones on cell divisions and cell proliferation
13. Cytological examination of regenerated plants
14. *Agrobacterium* culture and selection of transformants.
15. Hardening of tissue culture raised plants

Note: In addition to the 3 compulsory practicals, at least 6 optional practicals must be conducted within the semester.

Practical VI (GENETIC ENGINEERING AND APPLIED BIOTECHNOLOGY)

Compulsory Practical

1. Recombinant DNA technology: *in vitro* DNA ligation and transformation of *E. coli*.
2. Isolation of polyA + RNA
3. Demonstration of technique of PCR

Optional Practical

1. Recombinant DNA technology: characterization of transformants.
2. Cell transformation by viruses.
3. Northern blotting
4. Preparation of probes
5. Isolation of lambda phage DNA.
6. Construction of restriction map of plasmid DNA.
7. Cloning in plasmid/phagemid vectors.
8. Gene expression in *E. coli* and analysis of gene product
9. Demonstration of technique of RT-PCR
10. Replica plating technique.
11. Induction of beta-galactosidase in strains of *E. coli* (I+ and I-).
12. Production of polyhydroxybutyrate (PHB) and its analysis.
13. Production of industrial enzyme and its biochemical assay.
14. Production of rDNA by ligation method.
15. Extraction of DNA from plant source.

Recommended Book List for Theory and Practical for Semester III

1. BIOTECHNOLOGY, U. SATYANARAYAN, BOOKS AND ALLIED, 2007

2. BIOTECHNOLOGY, B. D. SINGH, KALYANI PLB, 2007

3. COMPREHENSIVE BIOTECHNOLOGY, RAMAWAT K. G., SHAILY GOYAL, S. CHAND, 2001

4. TECHNIQUES IN LIFE SCIENCES, DR. D. B. TEMBHARE, HIMALAYA PUBLICATION, 2004

5. PLANT CELL CULTURE, R. N. DIXON, OXFORD UNI. PRESS NEWYORK, 2004

6. INDUSTRIAL BIOTECHNOLOGY, S. N. JOGDAND, HIMALAYA PUBLISHING HOUSE, 2006

7. ADVANCES IN BIOTECHNOLOGY, S. N. JOGDAND, HIMALAYA PUBLISHING HOUSE, 2007

8. BIOTECHNOLOGY, B. D. SINGH, KALYANI PUBLICATION LUDHIANA2007

9. BIOTECHNOLOGY, MOHAN P. ARORA, HIMALAYA PUBLISHING HOUSE,2007

10. ANIMAL BIOTECHNOLOGY, M.M. RANGA, HIMALAYA PUBLISHING HOUSE, 2007

11. GENE BIOTECHNOLOGY, S.N. JOGDAND, HIMALAYA PUBLISHING HOUSE, 2007

12. ANIMAL CELL CULTURE, JOHN R. W. MASTERS, OXFORD UNI. PRESS NEWYORK, 2007

13. MOLECULAR CLONING VOL-I, SAMBROOK AND RUSSEL, COLD SPRING HARBOR LAB. PRESS, 2007

14. GENES VI, BENJAMIN LEWIN, OXFORD UNI. PRESS NEWYORK, 1998

15. MOLECULAR BIOLOGY-I RECOMBINANT DNA, T. A. BROWN, ACADEMIC PRESS, 1998

16. BIOTECHNOLOGY A LAB. MANUAL, JEFFERY M. BECKER, ACADEMIC PRESS, 1998

17. PLANT BIOTECHNOLOGY-PRACTICAL MANUAL, C.C.GIRI,ARCHANA GIRI, I.K.INT.PUB HOUSE 2007

18. AN INTRODUCTION TO MOLECULAR BIOTECNOLOGY, MICHEL WINK, WILEY VCH VERLOG PUB. 1999

19. PLANT BIOTECHNOLOGY ANDITS APPLICATION, ASHAVINI KUMAR,SHEKHA ROY, I.K.INT.PUB HOUSE 2007

20. CULTURE OF ANIMAL CELLS, IAN FRESHNEY, A JOHN WILLEY 2007

21. GENOME, ALAM BERNOT, JOHN WILLEY AND SONS 2007

22. CELL BIOLOGY ,GENETICS,MOLECULAR BIOLOGY EVOLUTION AND ECOLOGY, P.S.VERMA S.CHAND 2007

23. PLANT PHYSIOLOGY, LINCOLN TALZ, SINADUAR ASSOSIATES, 2006

24. PLANT BIOTECHNOLOGY, K.G.RAMAWAT, S.CHAND, 2008

25. TEXT BOOK OF BIOTECHNOLOGY, R.C.DUBEY, S.CHAND, 2009

26. TECHNIQUES FOR ENGINEERING GENES, BUTTERWORTH,HEINEMANM, OPEN UNIVERSITY PUBL, 2004

27. BIOTECHNOLOGY LABORATORY COURSE, BUCKER, OPEN UNIVERSITY PUBL, 2004

28. INVITRO CULTIVATION OF OF ANIMAL CELLS, BUTTERWORTH,HEINEMANM, OPEN UNIVERSITY PUBL, 2004

29. BIOTECHNOLOGICAL INNOVATIONS IN ANIMALPRODUCTIVITY, BUTTERWORTH,HEINEMANM, OPEN UNIVERSITY PUBL, 2004

30. TISSUE CULTURE, RAJENDRA REDDY,J.P.ABHAI SHANKAR, COMMAN WEALTH PUB, 2008

31. EXPERIMENTAL BIOTECHNOLOGY, MADHAV SHARMA,NIRMAL TRIPATR, CRESCENT PUB CORPORATION, 2008

32. GENETICS, MONROE W.STRICKBERGER, PEARSON EUD., 2008

33. ANIMAL CELL CULTURE, JOHN R. W. MASTERS, OXFORD UNI. PRESS NEWYORK, 2000

34. GENETICS VOL-II, C. B. PAWAR, HIMALAYA PBL., 2004

35. EXPERIMENTS IN MICROBIOLOGY, PLANT PHYSIOLOGY AND BIOTECHNOLOGY, K. ANEJA, 2007

36. BIOCHEMICAL METHODS, SADASHIVAM,2006

SEMESTER IV

Semester-IV
Paper-I
Environmental Biotechnology

Course Code		Topic/Title	Credit
	Unit-I	**Global Environmental Problems** A. Environmental education, need for environmental education. B. Environmental pollutants: classification of pollutants. C. Air pollution- air quality, sources, ecology and pollutants. D. Water pollutants- types of water pollution, water pollutants (organic, inorganic, microbial, radioactive), eutrophication. E. Ozone depletion, green-house effect and acid rain.	
	Unit-II	**Interaction of Environmental Components** A. Ecosystem structure and functions, abiotic and biotic component. B. Ecological pyramids-types. C. Biotechnological processes: bioconversion, bioaccumulation, bioconcentration, biomagnification, and biodegradation. D. Degradation of xenobiotics in environment: ecological considerations, decay behavior and degradative plasmids	04
	Unit-III	**Bioresources and Bioenergy** A. Biogeochemical cycles: - (nitrogen, carbon, phosphorous and sulphur) B. Need for Bioresources C. Bio-Energy: non conventional or renewable sources of energy D. Energy from biomass: petroleum plants, alcohol, biogas and hydrogen. E. Biochips, biofilters, biofuel cells and their uses.	
	Unit-IV	**Soil Fertility and Pest Management** A. Biological nitrogen fixation- symbiotic and non-symbiotic nitrogen fixation, mechanism, *nif* gene, Role of rDNA technology in nitrogen fixation. B. Biofertilizers- bacterial biofertilizers, algal biofertilizers, C. Biopesticide and integrated pest management: D. Aquatic ferns as biofertilizers, fungi as biofertilizers, earthworm as biofertilizers.	

Semester-IV
Paper-II
Applied Environmental Biotechnology and Ecology

Course Code		Topic/Title	Credit
	Unit-I	**Measurement of Water Pollution** A. Waste water: composition, types B. Measurement of water pollution- BOD(biological oxygen demand), COD(chemical oxygen demand) C. Detection of pathogenic organism: laboratory methods (MTFT, MFT) D. Techniques to detect fecal from non-fecal bacteria: IMViC test	04
	Unit-II	**Waste Water Treatment** A. Waste water treatment: classification, types B. Biological waste water treatment: aerobic, anaerobic, activated sludge, trickling filter, rotating biological contactor, anaerobic digester. C. Waste water treatment by biofilms. D. Treatment scheme of industries: dye, pulp and paper, petroleum, dairy, distillery, tannery, sugar industries.	
	Unit-III	**Biodegradation and Bioremidiation** A. Xenobiotics in environment: biodegradation of hydrocarbons, substituted hydrocarbons, surfactant, pesticides, lignin, tannin, synthetic dyes, B. Bioabsorption and bioleaching of heavy metals: cadmium, lead, mercury, metal binding targets, advantages and disadvantages of bioleaching. C. Biomethylation of elements (methylation of mercury and arsenic) D. Genetic aspects of heavy metal resistance in cyanobacteria and fungi.	
	Unit-IV	**Ecology** A. Mineral resources and their conservation-terrestrial mineral resources. B. Ecological aspects of mining. C. Biodiversity- biotechnological methods of conservation, cryopreservation and micropropagation. D. Forest conservation-forest cover, deforestation, afforestation (protective and exploitative forestry) E. Wildlife management-tiger reserve in India. F. Brief idea of land use planning and management.	

Semester-IV
Paper-III
Ethics, Patenting and Bioenterpreneurship

Course Code		Topic/Title	Credit
	Unit-I	**Ethics** A. Ethics: benefits of biotechnology B. Recombinant therapeutic products for human health care. C. Genetic modifications and food consumption, D. Release of genetically engineered organisms, E. Applications of human genetic rDNA research, human embryonic stem cell research. F. Environmental legislation, quality control in biotechnology.	04
	Unit-II	**Patenting and Biosafty** A. Patenting: patent and trademark, B. Intellectual property rights, plant breeders rights, C. Biotechnology in developing countries. D. Biotechnology products and processes, E. Biosafty and its implementation, F. Quality control in biotechnology.	
	Unit-III	**Bio-Entrepreneurship-I** A. Concept of bio-Entrepreneurship: definition, factors necessary for entrepreneurship, desirable in a startup. B. Pillars of bio-entrepreneurship, promoting bio-entrepreneurship C. Biotech company roadmap- biofertilizer company. D. Legal regulatory and other business factors for entrepreneurship.	
	Unit-IV	**Bio-Entrepreneurship-II** A. Funding of biotech business-financing alternatives, VC funding, funding for biotech business in India, exit strategy, licensing strategies, and valuation. B. Bio-Entrepreneurship efforts in India, difficulties, organization supporting biotech growth in India, area of scope, funding agencies in India, biotech policy initiatives. C. Role of knowledge centers- universities and research institution, role of technology and upgradation.	

Semester-IV
Paper-IV
Research Methodology and Biostatistics

Course Code		Topic/Title	Credit
	Unit-I	**Introduction to Research Methodology** A. Introduction of research B. Objective of research C. Motivation in research D. Steps in research process E. Research design: concepts and type of research design F. Design of research of the basis of application – pure and applied	04
	Unit-II	**Direction to Research Methodology** A. Design of research on the basis of methodology – exploratory and descriptive B. Descriptive research – qualitative and quantitative. C. Quantitative – field studies (field experiments and laboratory experiments) D. Sampling and data collection: techniques of sampling (random, stratified, systematic, multistage) E. Primary and secondary sources of data	
	Unit-III	**Introduction to Biostatistics** A. Methods of sampling, sampling error, non-sampling errors, standard error. B. Measures of central tendency: mean, mode, and median. C. Measures of dispersion: range, mean deviation, standard deviation. D. Probability.	
	Unit-IV	**Application of Biostatistics in Research** A. Chi-square test, meaning of correlation and regression. B. Cluster analysis: phylogenetic clustering by simple matching coefficients. C. Presentation of statistical data: tabulation (simple tables, frequency distribution table); charts and diagrams (bar charts, histograms, pie charts, dendrogram).	

Practical's

Practical VII (ENVIRONMENTAL BIOTECHNOLOGY, PATENTING, RESEARCH METHODOLOGY AND BIOSTATISTICS)

Compulsory Practical

1. Detection of coliforms for determination of the purity of potable water.
2. Determination of chemical oxygen demand (COD) of sewage sample.
3. Production of microbial fertilizers (*Rhizobium/Azotobacter*).
4. Preparation of research proposal and presentation.

Optional Practical

1. Determination of total dissolved solids of water
2. Determination of hardness and alkalinity of water sample.
3. Determination of dissolved oxygen concentration of water sample
4. Determination of biological oxygen demand of sewage sample
5. Calculation of mean, mode, and median.
6. Calculation of standard deviation and standard error.
7. Determine the efficiency of removal of air pollutant using fibrous air filter.
8. Isolation of xenobiotic degrading bacteria by selective enrichment technique
9. Test for the degradation of a aromatic hydrocarbons by bacteria
10. Survey of degradative plasmids in microbes growing in polluted environment
11. Estimation of heavy metals in water/soil by atomic absorption spectrophotometry,
12. Estimation of nitrate in drinking water.
13. Preparation and formulation of microbial biopesticide (bacteria, fungi)
14. Effect of *Mycorrhizal* fungi on growth promotion of plants.
15. Study of patenting procedure.
16. Preparation of proposal for patenting.
17. Determination of percentage of green house gases in environment.

NOTE: In addition to 4 compulsory practicals at least 6 optional practicals must be conducted within the semester.

PROJECT/DISSERTATION

DISSERTATION/PROJECT WORK SCHEME/GUIDELINES FOR THE STUDENTS, SUPERVISORS AND EXAMINERS:

Every student is required to carry out Experimental/Field Based Project Work (this is in lieu of practical II of semester IV) on a related research topic of the subject/ course. It must be an original work and must indicate some degree of experimental work. On the basis of this work, student must submit the project Report typed and properly bound) in two copies at least one month prior to commencement of the final Practical/lab examination of Semester IV. The project report shall comprise of Introduction, Material and Methods, Result, Discussion, Summary, Conclusion and, Reference along with declaration by candidate that the work is original and not submitted to any other University or Organization for award of degree and certificate by the supervisor and forwarded through head/Course-coordinator/Director of the Department/Centre or the Principle of the college.

The topic for project work will be assigned to the student by supervisor at the beginning of third semester. The topic will be forwarded to the controller of examination by the head of the department.

The project Work will be evaluated by both external and internal examiner in the respective Department/Center/Affiliated College.

Project must contain following subsection:-

1. Introduction,
2. Aims and objectives,

3. Short literature review,
4. Materials and methods,
5. Experiments and results,
6. Discussion,
7. Conclusion and references.

50% marks each shall be evaluated by external and internal examiner respectively