Kavayitri Bahinabai Chaudhari
North Maharashtra University, Jalgaon

SYLLABUS
for
Master of Science
(M. Sc.) II

Biotechnology

Choice Based Credit System
(Outcome Based Curriculum)
For

Affiliated Colleges of
Kavayitri Bahinabai Chaudhari North Maharashtra University
Jalgaon 425 001 (MS)

Second Year 2022 - 2023

Program at a Glance

Name of the program (Degree)	**:**	*M. Sc.*
Subject	**:**	*Biotechnology*
Faculty	**:**	*Science and Technology*
Duration of the Program	**:**	*Two years (four semesters)*
Medium of Instruction and Examination	**:**	*English*
Credits of the program	**:**	*Total 88 credits (64 core credits including 4 credits of project/dissertation, skill enhancement- 08, subject elective credits 08 and audit 08 credits*
Examination Pattern	**:**	*The 60 : 40 (60 marks University assessment (exam) and 40 marks continuous internal college assessment (exam)*
Evaluation mode	**:**	*CGPA*
Passing standards	**:**	*The 40% in each exam separately (separate head of passing)*
Result	**:**	*As per the University's rules of CGPA system*

Prologue

The requirement for trained and skilled human resource is the need of time in the higher education and industry to match with rapid pace of technology development. Students need to acquire thorough knowledge of theoretical concepts and hands-on laboratory methods in the subject. Thus, it is imperative to revise and update the curriculum to accommodate the fundamental aspects as well as advanced developments in various disciplines of ***Biotechnology*** *and to complement the needs of its applied sectors. The program is designed to provide skilled manpower in this subject, facilitate to improve linkages with industries, and intended to offer practical skills needed to pursue the jobs in a chosen profession. Beside this, the students will be enlightened with knowledge in the newer areas of Bioinformatics, Bioinstrumentations, Biomolecules, Genetics, Immunology, etc.. Students are taught how to plan experiments, perform them carefully, analyse*

the data accurately, and present the results both, qualitatively and quantitatively through their dissertations or the project work. The students are encouraged to deliver seminars on the topics of research to develop presentation skills and enable to build confidence which will lead them to read about different themes and enhances their assimilation abilities. A project component in the final semester will enable students to select a research problem, plan to execute experiments related to it, collect data and analyse it, and present the results in the form of an oral presentation as well as a thesis. This not only equips the student for a career in research as well as industry, but also fosters self- confidence and self-reliance in the student as he/she learns to work and think independently. At the end of the programme the student will be well-versed in this subject as well as be familiar with the most recent advances in the field of Life Sciences, and will have gained hands-on experience in this subject of study. The student will be able to take up a suitable position in academia or industry and will be equipped to pursue a career in research or be an entrepreneur, if so desired.

Process of Curriculum Design

The Choice-Based Credit System (CBCS) provides a framework within which there is flexibility in the design of courses and their content, simultaneously also providing the student a choice of the courses he/she wishes to study. The courses are assigned credits based on teaching hours, which in turn is linked to course content and structure. When revising the syllabi for the courses, the courses to be implemented as well as the content of each course was extensively discussed and debated on, over meetings between the faculty members and the students. Several alumni contributed to useful inputs. Furthermore, the opinions of prospective employers of the corporate sector were also sought and obtained. The opinions of experts were taken into consideration as well. The syllabi presented here are the culmination of the combined efforts of the faculty members, feedback obtained from students, alumni, external experts and members of industry.

The student will acquire knowledge about different branches of Biotechnology such as Genetic Engineering, plant biotechnology, and Microbial Diversity, Molecular Biology, Pharmaceutical Biotechnology and familiar with various applications of Biotechnology such as Applied and Environmental Biotechnology, Industrial Biotechnology, Agricultural Biotechnology and Food Biotechnology . The student can design and execute experiments related to Basic Biotechnology, Molecular Biology, Recombinant DNA Technology, and Microbial Genetics and can execute a

short research project incorporating techniques of Basic and Advanced Biotechnology under supervision.

Program Objectives for M.Sc. Program:

1. *To impart the profound theoretical and practical knowledge of the specific science discipline along with the fundamental core concepts*
2. *To train the students to employ modern techniques, tools, methodologies, equipment, hardware/software etc. to perform objective oriented scientific and planned experiments.*
3. *To groom the students for all-round development and mold them in a trained workforce to provide teaching-learning, research, business, professional supports in the various science disciplines.*
4. *To make the student to develop the ability to think analytically, independently and draw logical conclusions to solve real-life problems.*
5. *To utilize the skills and knowledge gained through the subject to deal with real life situations and problems related to society, environment, research and development etc.*

Structure of M.Sc. program in Biotechnology

M.Sc. Biotechnology program is of two years duration and is conducted into four semesters. Since inception, the program was mostly student centric. Now in lieu of accreditation standards of NAAC, the university adopted outcome-based education approach. The various courses of the program are designed to include classroom teaching, laboratory work, project, seminars, assignments, etc. Three categories of courses are being offered in this program: (A) Prerequisites and Core courses (12 theory and 8 practical's of 4 credit each as mandatory courses), (B) Skill Based/ Subject Elective courses (04 courses of 4 credits each) and (C) Audit courses (4 Courses of 2 credits each). The core courses of 4 credits include theory as well as practical. The core courses embody a research-based course that leads to a project dissertation. The student is required to accumulate 22 credits each semester, a total of 88 credits, to fulfil the requirements for a M.Sc. degree. Forty percent of the total marks for each course will be awarded through internal assessment. Final examinations for four credit courses will be of three hours duration while

examinations for each laboratory- based courses will be held over two days of three hours (incubation based practicals) each or one day of 5-6 hours each. However, there could be certain changes in the number of classes of theory and practicals, ways of teaching either through online or offline mode and even the examination pattern owing to the prevailing situation like pandemic and as per the need by following the rules and regulations.

Duration

The duration of M.Sc. degree program shall consist of two academic years divided in to four semesters. Each Semester consist of 90 working days. Each theory and practical course should be completed in about 50 lectures.

Medium of instruction

The medium of instruction and examination for each course shall be English.

Credit to contact hour

One credit is equivalent to 15 periods of 60 minutes each for theory course lecture. While credit weightage for self-learning based on e-content shall be 50% or less than that for lectures.

Attendance

The student enrolled for M.Sc. biotechnology must have 75% attendance in each course in order to appear for term end examinations, otherwise the candidate may not be allowed to appear for term end examination as per ordinance.

Examination

Each theory and practical course will be of 100 marks comprising of 40 marks internal (20 marks of 2 internal examinations) and 60 marks external examination. Separate head of passing in Internal and External examination is mandatory. In case of failure in internal examination of particular course, student will have to appear for the same in next semester as per the schedule of the examination. In case a student fails in particular course in a semester and the same course(s) are revised/removed from curriculum in due course, the student will have to appear as per new curriculum and or pattern in subsequent semester at his own responsibility observing the course equivalence..

Term end examination (60 marks) will be of three hours duration for each theory course. There shall be 5 questions each carrying equal marks (12 marks each).

Internal examination (40 marks each semester)

Internal assessment of the student by respective teacher will be comprehensive and continuous, based on written test. The written test shall comprise of both objective and subjective type questions. Two internal tests (20 marks each) will be conducted during semester as a part of continuous assessment.

Practical Examination

Practical examination shall be conducted at the end of the semester. Practical examination will be of minimum 6 hours duration and shall be conducted as per schedule (10 am to 5 pm on schedule date or can be scheduled 10 am - 1pm/ 2 – 5 pm for 2 consecutive days) in case of Biotechnology practicals where incubation condition, allied aspects are essential. There shall be 5 marks for laboratory record book and well written certified journal, 10 marks for viva-voce and minimum three experiments (major and minor). Certified journal is compulsory to appear for practical examination. There shall be one expert and two examiners (external and internal) per batch for the practical examination.

Summary of Distribution of Credits under CBCS Scheme

for M.Sc. at Affiliated Colleges [w.e.f. 2021-22]

Sr. No	***Type of course***	***Sem I***	***Sem II***	***Sem III***	***Sem IV***
01	*Core*	***16***	***16***	***16***	***12***
02	*Skill based*	***04***	***04***	***-***	***-***
03	*Elective*	***-***	***-***	***04***	***04***
04	*Project*	***-***	***-***	***-***	***04***
05	*Audit*	***02***	***02***	***02***	***02***
06	*Total Credits*	***22***	***22***	***22***	***22***

Subject Type	***Core***	***Skill based***	***Elective***	***Project***	***Audit***	***Total***
Credits	***60***	***08***	***08***	***04***	***08***	***88***

Total Credits = 88

Affiliated Colleges of
Kavayitri Bahinabai Chaudhari North Maharashtra University Jalgaon
M. Sc. Biotechnology

Choice Based Credit System with effect from 2021 -2022

Course credit scheme

Semester	(A) Core Courses			(B) Skill Based / Elective Course			(C) Audit Course (No weightage in CGPA)			Total Credits (A+B+C)
	No. of Courses	Credits (T+P)	Total Credits	No. of Courses	Credits (T+P)	Total Credits	No. of Courses	Credits (Pract.)	Total Credits	
I	4	12 + 4	**16**	1	0 +4	4	1	2	2	**22**
II	4	12 + 4	**16**	1	0 + 4	4	1	2	2	**22**
III	4	8 + 8	**16**	1	4 + 0	4	1	2	2	**22**
IV	4	8 + 8	**16**	1	4 + 0	4	1	2	2	**22**
Total Credits	**64**			**16**			**8**			**88**

(T, Theory; P, Practical)

Structure of Curriculum

		First Year				Second Year				Total Credit Value
		Semester I		Semester II		Semester III		Semester IV		
		Credit	Course	Credit	Course	Credit	Course	Credit	Course	
(A)	**Prerequisite and Core Courses**									
	Theory	4	3	4	3	4	2	4	2	40
	Practical	4	1	4	1	4	2	4	2	24
(B)	**Skill Based/ Subject Elective Courses**									
1	Theory /Practical	4	1	4	1	4	1	4	1	16
(C)	**Audit Course (No weightage in CGPA calculations)**									
1	Practicing Cleanliness	2	1							2
2	Personality and Cultural Development Related Course			2	1					2
3	Technology Related + Value Added Course					2	1			2
4	Professional and Social + Value Added Course							2	1	2
	Total Credit Value	14	6	14	6	14	6	14	6	88

List of Audit Courses (Select any ONE course of Choice from Semester II)			
Semester I (Compulsory)		**Semester II** (Choose One)	
		Personality and Cultural Development	
Course Code	**Course Title**	**Course Code**	**Course Title**
AC-101	Practicing Cleanliness	AC-201A	Soft Skills
		AC-201B	Sport Activities
		AC-201C	Yoga
		AC-201D	Music

Distribution of Course papers for M. Sc. Part I BIOTECHNOLOGY

Semester I

Course	Course Type	Course Title	Teaching Hours/ Week			Marks (Total 100)				Credits
			T	P	Total	Internal		External		
						T	P	T	P	
BT-101	Core	Microbial Diversity and Physiology	4	--	4	40	--	60	--	4
BT-102	Core	Biomolecules and Molecular Enzymology	4	--	4	40	--	60	--	4
BT-103	Core	Immunology	4	-	4	40	--	60	--	4
BT-104	Core	Laboratory course-I	--	4+4	8	--	40	--	60	4
BT-105	Skill Based	Laboratory Course –II	--	4+4	8	--	40	--	60	4
AC-101	Audit Course	Practicing Cleanliness		2	2	--	100	--	--	2
Total Credit for Semester I: 22 (T = Theory: 12; P = Practical:4; Skill Based:4; Audit Course:2)										

Semester II

Course	Course Type	Course Title	Teaching Hours/ Week			Marks (Total 100)				Credits
			T	P	Total	Internal		External		
						T	P	T	P	
BT-201	Core	Molecular Biology	4	--	4	40	--	60	--	4
BT 202	Core	Bioinstrumentation and Biostatistics	4	--	4	40	--	60	--	4
BT-203	Core	Bioprocess Engineering and Technology	4	--	4	40	--	60	--	4
BT-204	Core	Laboratory Course –III	--	4+4	8	--	40	--	60	4
BT-205	Skill Based	Laboratory Course –IV	--	4+4	8	--	40	--	60	4
AC-201(A/B/C/D)	Audit Course	Choose one out of Four (AC-201A/ AC-201B/AC-201C/AC-201D) for Personality and Cultural Development	--	2	2	--	100	--	--	2
Total Credit for Semester II: 22 (T = Theory: 12; P = Practical:4; Skill Based:4; Audit course:2)										

EA: External Assessment, IA : Internal Assessment

Subject Code	Title of the Paper		Duration (Hrs./Wk)	Max. Mark	Exam. Time (Hrs.)
M.Sc. Part I BIOTECHNOLOGY					
Semester I : Theory Courses					
BT-101	Microbial Diversity and Physiology	Core course	04	100	03
BT -102	Biomolecules and Molecular Enzymology	Core course	04	100	03
BT -103	Immunology	Core course	04	100	03
Semester I : Practical Courses					
BT -104	Laboratory Course-I	Core course	04+04	100	06
BT -105	Laboratory Course-II	Skill based	04+04	100	06
AC-101	Practicing Cleanliness	Audit Course	02	100	
Semester II : Theory Courses					
BT -201	Molecular Biology	Core course	04	100	03
BT-202	Bioinstrumentation and Biostatistics	Core course	04	100	03
BT -203	Bioprocess Engineering and Technology	Core course	04	100	03
Semester II : Practical Courses					
BT-204	Laboratory Course-III	Core course	04+04	100	06
BT-205	Laboratory Course-IV	Skill based	04+04	100	06
AC-201A/B/C/D	Choose one out of Four (AC-201A/ AC-201B/ AC-201C/ AC-201D) for Personality and Cultural Development (Audit Course)	Audit Course	02	100	

M.Sc. Biotechnology program objectives

After completion, the students are expected to understand the:

(a) basic and applied aspects of molecular biology and plant biotechnology, Biomolecules and Enzymology and applications of basic aspects of microbial diversity.

(b) principles, working and application of bioinstruments used in learning Biotechnology,

(d) characteristics and significance of algae, fungi, viruses,

(e) impact of various groups of microbes on earth atmosphere, human, plant and animal health and technology development,

(f) structure, properties, pathways, significance and applications of microbial biomolecules,

(g) basic and applied aspects of Genetic makeup of bacteria, algae, fungi and viruses,

(h) causes, mechanisms and consequences of defect in gene/genome of microorganisms, and

(i) basic concepts of microbial enzymes, enzyme kinetics, regulation of enzyme activity, industrial applications of enzymes, enzyme function in non-aqueous environment.

Semester III Biotechnology

BT-301 GENETIC ENGINEERING

100 MARKS

Course Objectives:

1. To learn about the various enzymes involved in rDNA Technology
2. To know the principles of cDNA construction and amplification methods.
3. Making aware of synthesis of recombinant products

1.

UNIT I

Enzymes in genetic engineering: Restriction Endonucleases - classification, mode of action. Enzymes in modification - Polynucleotide phosphorylase, DNase, Methylases, phosphatases, polynucleotide Kinase, Ligases, S1 Nuclease, RNase and their mechanism of action.Vectors in recombinant DNA technology and its salient features, types of vectors – plasmids: pBR322, pUC18, pET21, cosmids, phages: λ and M13, SV40 Vector, Shuttle, Expression Vectors, Selectable Vectors, Artificial Vectors.

UNIT II

Methods of gene transfer**:** - Conjugation, Transformation, Transduction, Transposion, Electroporation, Microprojectile system, Liposome mediated transfer, gene gun, Calcium Phosphate method, DEAE dextran method. Molecular mechanism of anti sense technology.

UNIT – III:

Gene Cloning, Cells for cloning: *E.coli, S. cerevisiae*, Mammalian fertilized egg cells, Chinese hamster ovary cultured cells. Direct screening & direct 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.

UNIT IV

Expression strategies for heterologous genes, Expression in plant, Bacteria and yeast, site- directed mutagenesis, genes targeting and protein engineering. Generation of Novel plants foods and GMOs, Gene Bank, Animal pharming.

UNIT V

Techniques and Application: DNA sequencing – Maxam-Gilbert method and Sanger's method, Oligonucleotide synthesis, DNA fingerprinting, Mapping of DNA, Gene Libraries: Genomic, cDNA. DNA foot Printing, Chromosome walking and Chromosome jumping, Transposon tagging, Hazards and impact of genetic engineering on society.

2. **Recommended Books:**

1. Principles of gene manipulation (2006) by Sandy Primrose, Richard Twyman, Bob Old, Giuseppe Bertola (Black Well Publication).
2. Molecular cloning: A laboratory manual (2000) byu J. Sambrook, E.F. Fritsch and T. Maniatis (Cold Spring Harbor).

3. Gene cloning and DNA analysis: An introduction (2006) by TA Brown (Blackwell Sci. Ltd).
4. Molecular biotechnology (1994) by S.B. Primrose (Blackwell, Scientific Publishers. Oxford).
5. PCR Strategies, M.A.Innis, D.H. Gelfant & J.J.Sninskey, 1995. IRL Press.
6. Recombinant DNA (2nd Ed), J.D.Watson, M.Gillman, J.Witknow Ski and M.Zoller, 1992. Scientific Americans books, N.Y.
7. Genetic Engineering of Animals, A.Puhler, 1993. VCH Publishes, Weninheim FRG.

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C301.1	. learn basic ideas on cloning vehicle	**2**
C301.2	know more about cDNA and amplification products	**4**
C301.3	Understand the construction of recombinant DNA and molecular biology tools.	**2**

3. BT-302 PLANT BIOTECHNOLOGY

4. **100 marks**

Course Objectives: The objectives of this course is to introduce students to the principles, practices and application of animal biotechnology, plant tissue culture, plant and animal genomics, genetic transformation and molecular breeding of plants and animals.

UNIT- I

Introduction to plant cell and tissue culture and historical perspective. Laboratory organization, aseptic manipulations and culture media–composition, preparation and development. Callus culture; Initiation and maintenance of suspension culture- batch and continuous culture, assessment of growth and viability; Static techniques of single cell culture. Micro propagation Organogenesis, somatic embryogenesis and synthetic seeds.

UNIT- II

Meristem culture, shoot tip culture and production of virus free plants. Somaclonal variations, molecular basis of variation and their significance in plant breeding. In vitro production of haploid plants – Androgenesis (anther and pollen culture) and Gynogenesis (ovary and ovule culture). Significance and uses of haploids in agriculture. embryogenesis and embryo rescue technique.

UNIT- III

Protoplast culture and somatic hybridization – Isolation, culture and fusion of protoplast, selection of fusion products and plant regeneration, assessment of somatic hybrid plants, production of cybrids, In vitro germplasm conservation and cryopreservation.

UNIT- IV

Organization of plant genome – Nuclear genome, Chloroplast genome and mitochondrial genome. Transposon and T–DNA tagging. Chloroplast transformation – vector designing, method and advantages, Direct gene transfer in plants, selectable markers, reporter genes and promoters used in plant vectors, molecular characterization of transformants.
Agrobacterium mediated transformation–Ti and Ri plasmids, role of virulence genes, mechanism of T-DNA transfer, vectors based on Ti and Ri plasmids–cointegrate and binary vectors. Gene silencing in transgenic plants.

UNIT- V

Application of DNA technology - transgenic plants with reference to virus and pest resistances - herbicidal resistance - stress tolerance (heat & salt) - cytoplasmic male sterility - resistance to fungi and bacteria - delay of fruit ripening - Ecological risk assessment of genetically modified crops.Plant cells as biofactories for the production of secondary metabolites: bioreactors and immobilized plant cell culture, RFLP maps, linkage analysis, RAPD markers, STS, microsatellites, SCAR (Sequence Characterized Amplified Regions), SSCP, AFLP, QTL.

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Recommended Books:

1. Plant tissue culture – Theory and Practice (2005) by Bhojwani S. S. and Razdan M. K., Elsevier publication.
2. Elements of Biotechnology by P. K. Gupta, Rastogi pub.
3. Biotechnology in crop improvement (1998) by H. S. Chawla, International Book distributing company.
4. Plant cell, organ and tissue culture (1995) by Gamborg O.L. and Phillips G.C.,Springer Verlag pub. Germany.
5. Plant Tissue Culture – Basic & Applied (2005) by Jha T.B. & Ghosh B.,Universities press.
6. Plant cell culture – A practical approach (1994) Dixon R.A., Gonzales R.A.Oxford University press, UK.
7. Plant Tissue Culture Smith R.H. (2000), Plant Tissue Culture, Academic Press
8. Evans D.A. (2003), Plant Cell Culture, Taylor & Francis.
9. Plant Genetic Engineering Vol. 1 - 6 (2003) Singh R. P and Jaiwal P. K.(Eds.), Sci tech publishing LLC, USA.
10. Gene transfer to plants by Potrykus I. and Spangenberg G., Springer Verlag,Germany.
11. Plant biotechnology (2000) by Hammond J, McGarvey P. and Yusibov V.(Eds.) Springer verlag, Germany.
12. Plant gene isolation – Principles and practice (1996) by Foster G.D. and Twell D., John Wiley & Sons, USA.
13. Plant Biotechnology – The genetic manipulation of plants (2003) by Slater A.,Scott N. and

Fowler M., Oxford pub.

14. Practical application of Plant Molecular Biology (1997) by Henry R.J.,Chapman and Hall.
15. Plants, genes and agriculture (1994) by Chrispeels M.J., Sadava D.E, Jones &Bartlett pub., UK.
16. Plant Genetic Engineering; Singh RP and Jaiwal PK (eds), Sci tech Publishing LLC.
17. Plant Gene Isolation – Principles and Practice; Foster GD and Twell D, John Wiley & Sons.
18. Gupta P.K. (2004) *Biotechnology and Genomics*. Rastogi Publications,Meerut, India.
19. Owen M.R.L. and Pen J. (Eds) (1996) *Transgenic Plants: A ProductionSystem for Industrial and Pharmaceutical Proteins.* John Wiley & Sons,England.

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C302.1	to gain fundamental knowledge in plant biotechnology and their applications.	**3**

BT-303 ADVANCED ENVIRONMENTAL BIOTECHNOLOGY

100 marks

Course Objectives:

1. To understand offline/ online strategies adopted for microbial analysis of food
2. To learn about role of microbes in wastewater treatment, as well as liquid and solid waste management
3. To impart knowledge about removal of recalcitrant from contaminated environment

Unit-I:

Solid waste management: Types and sources of solid waste, Management by composting and vermiculture, Materials and Physiochemical characteristics of compost.

Waste water management: Activated sludge process, Nitrification, Denitrification sludge and anaerobic digestion (UASB), Oxidation ditch and Carousal systems.

Air pollution management: Biotechnological approach for air pollution management. Strategy for removal/destruction of SO_x and NO_x

Unit-II:

Bioremediation: Characterization of site for bioremediation, Engineered *In Situ* and Intrinsic *In Situ* bioremediation, *Ex situ* bioremediation, Evaluation of bioremediation, Bioremediation of soil contaminated with oil spills.

Biodegradation: Assimilation, Detoxification, Activation, Bio-availability, Recalcitrance, Cometabolism and Biotransformation. Factors affecting biodegradation, Predicting products of biodegradation, Biodegradation of environmental contaminants (Pesticides, Lignin, Halogenated hydrocarbons)

Unit-III:

Biodiversity (Global and National): Biodiversity hot spots, Biodiversity characteristics of India, Conventions on biological diversity, Causes of biodiversity losses, Extinct and endangered species, Conservation methods, National parks, Sanctuaries, Sacred groves, Gene banks.

Measurement of biodiversity: Types of Biodiversity (α, β and γ), Diversity indices (Simpson's, Shannon index, Sorensen's similarity index)

Unit-IV:

Biosensors: Types of biosensor, Working mechanism and examples of biosensors based on DNA, antibodies, enzymes, microorganisms. Applications of biosensors in the monitoring of heavy metals, BOD, nitrogen compounds, polychlorinated biphenyls, phenolics and organophosphorus compounds.

Biofuels: Advantages of biofuels, Energy from biomass, Biogas, Biohydrogen and Biodiesel.

Biosafety: Biosafety guidelines and regulations with special reference to India, Biosafety and environmental concerns of transgenic plants, animals and nanotechnology.

Unit-V:

Toxicity: Definitions and significance of various concepts e.g. Persistence, Bioaccumulation, Biomagnification, Risk, Toxicity (acute and chronic), Threshold dose. Factors affecting toxicity of a chemical agent. Tests for evaluation of genotoxicity, mutagenicity, and carcinogenicity (Ames test, Micronucleus test and Comet assay).

Antidotal procedures: Antidote therapy, Mode of antidote action, Specific antidotes against iron, cyanide, arsenic, lead, methanol and acetylcholinesterase inhibitors.

Recommended Books:

1. Agarwal S.K. (2005) *Advanced Environmental Biotechnology*. APH Pub Co, New Delhi.
2. Alexander M. (1999) *Biodegradation and Bioremediation*. 2nd Edition, Academic Press, USA.
3. Asthana D.K. and Asthana M. (2001) *Environment: Problems and Solutions.* S. Chand & Co. Ltd., New Delhi.
4. Chatterji A.K. (2002) *Introduction to Environmental Biotechnology*. Prentice Hall of India Pvt Ltd., New Delhi.
5. Evans G.M. and Furlong J.C. (2003) *Environmental Biotechnology: Theory and applications.* John Wiley & Sons, England.
6. Huges W.W. (1996) *Essentials of Environmental Toxicology.* Taylor and Francis.
7. Krishnamurthy K.V. (2003) *Textbook of Biodiversity.* Science Publishers Inc, USA.
8. Mohapatra P.K. (2006) *Textbook of Environmental Biotechnology*. IK International, New Delhi.
9. Rana SVS (2009) *Environmental Biotechnology*. Rastogi Publications, Meerut.
10. Rittmann B.E. and McCarty P.L. (2001) *Environmental Biotechnology: Principles and Applications*. McGraw-Hill, USA.
11. Shaw I.C. and Chadwick J. (1998) *Principles of Environmental Toxicology.* Taylor & Francis Ltd., UK.
12. Thakur I. S. (2006) *Environmental Biotechnology: Basic Concepts and Applications*. IK International Pvt Ltd., New Delhi.

13. Yadav P.R. and Tyagi R. (2006) *Environmental Biotechnology*. Discovery Pub House, New Delhi.

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C303.1	Understand significance of microbes in food, wastewater treatment and clean-up	**2**
C303.2	Describe use of microbes in solid and liquid waste treatment as well as bioremediation of toxicants, thereby acquire knowledge about microbial potentials	**4**
C303.3	Understand the relevance of microbial standards for food quality assurance.	**3**

5.

6. **BT-304**

LABORATORY COURSE –V **100 marks**

Course Objectives:

1. To introduce the student to the variety of Tissue culture techniques
2. To make them familiar with various approaches of genetic engineering techniques

1. Preparation and sterilization of MS medium, stocks and explants
2. Callus induction, Regeneration of shoots, Root induction
3. Meristem culture /Anther culture/ pollen culture/ using various explants
4. Protoplast isolation, fusion and culture
5. Somatic embryogenesis
6. Development of synthetic (Artificial) seeds/ Production of secondary metabolites
7. Micropropagation of banana, citrus Papaya, Sugarcane etc.
8. Isolation of pBR-322 from E.coli
9. Preparation of competent cells
10. Transformation by calcium chloride method
11. Screening of bacterial colonies using X-gal and IPTG
12. Southern blot/ Northern blot / Western blot/ PCR (D)
13. Isolation and purification of yeast DNA

7. **Recommended Books:**

1. Aneja K.R. *Experiments in Microbiology, Plant Pathology, Tissue Culture and Mushroom Cultivation.* 2nd Edition, Wishwa Prakashan, New Age International Pvt Ltd., New Delhi.
2. Reinert J. and Yeoan M.M. (1989) *Plant Cell and Tissue Culture: A Laboratory Manual.*
3. Smith R.H. (1992) *Plant Tissue Culture: Techniques and Experiments.*
4. Henry R.J.,Chapman and Hall Practical application of Plant Molecular Biology (1997)
5. Gene Transfer and expression protocols - methods is molecular biology volume 7, E.T. Murray, 1991. Humana Press
6. Genetic engineering by Sandhya Mitra ,Macmillan Publication
7. DNA Cloning: A practical approach (1995) by D.M. Glover and B.D. Hames (IRL Press, Oxford).

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C304.1	acquire knowledge on basic plant biotechnology aspects	**3**
C304.2	.learn purification of organism/molecules, transformation tools, electrophoretic separation	**2**
C304.3	learn how to interpret DNA/ protein mobility on various techniques	**3**

BT-305 Laboratory COURSE –VI 100 marks

Course Objectives:

1. To understand offline/ online strategies adopted for microbial analysis of soil/waste/food
2. To learn about role of microbes in wastewater treatment, as well as liquid and solid waste management
3. To impart knowledge about removal of recalcitrant from contaminated environment

1. Determination of acidity, alkalinity, salinity of water/soil.
2. Determination of COD of sewage/industrial waste water.
3. Estimation of total nitrogen of soil (Kjeldal's method)
4. Vermicomposting of different waste substrates in laboratory reactors
5. Co-composting of biosolids and municipal solid waste (MSW) / kitchen waste / paper waste.
6. Determination of adsorption isotherm (adsorption of acetic acid on charcoal)
7. Determination of soil microbial activity by CO_2 evolution method
8. Determination of MIC of pesticide / heavy metal against bacterial culture
9. Production of biodiesel from microalgae
10. Testing of cytotoxicity (onion root tip assay/pollen germination) of water polluted with pesticides
11. Comet assay to assess the DNA damage due to pesticide exposure
12. Hydroponic plant assay to test phytoaccumulation of heavy metals/xenobiotics
13. Estimation of metal content in soil, compost, vegetables, drinking water and waste waters using atomic absorption spectroscopy
14. Estimation of bioavailable / extractable concentration of zinc and cadmium in sediment sample using AAS
15. Estimation of Biodiversity Index of particular habitat

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C305.1	understand significance of microbes in food, wastewater treatment and clean-up	**2**
C305.2	. describe use of microbes in solid and liquid waste treatment as well as bioremediation of toxicants, thereby acquire knowledge about microbial potentials	**4**
C305.3	understand the relevance of Production of bioenergy	**2**

M.Sc. Part II Semester III Biotechnology: Audit Courses

AC-301(A): Computer Skills **(Technology + Value added Audit course; Practical; 2 Credits)** **(Optional: Campus + Program level)**		
Course Objectives (CObs): • To inculcate different daily useful computer skills among students.		
Unit 1	**Elements of Information Technology** 1.1 Information Types: Text, Audio, Video, and Image, storage formats 1.2 Components: Operating System, Hardware and Software, firmware 1.3 Devices: Computer, Mobile Phones, Tablet, Touch Screen, Scanner, Printer, Projector,smart boards 1.4 Processor & Memory: Processor functions, speed, Memory types: RAM /ROM /HDD /DVD-ROM/Flash drives, memory measurement metrics	**2 hrs**
Unit 2	**Office Automation-Text Processing** 2.1 Views: Normal View, Web Layout View, Print Layout View, Outline View, ReadingLayout View 2.2 Working with Files: Create New Documents, Open Existing Documents, SaveDocuments to different formats, Rename Documents, Close Documents 2.3 Working with Text: Type and Insert Text, Highlight Text, Formatting Text, Delete Text,Spelling and Grammar, paragraphs, indentation, margins 2.4 Lists: Bulleted and Numbered Lists, 2.5 Tables: Insert Tables, Draw Tables, Nested Tables, Insert Rows and Columns, Moveand Resize Tables, Moving the order of the column and/or rows inside a table, TableProperties 2.6 Page Margins, Gutter Margins, Indentations, Columns, Graphics, Print Documents, 2.7 Paragraph Formatting, Paragraph Attributes, Non-printing characters 2.8 Types of document files: RTF, PDF, DOCX etc.	**5 hrs**
Unit 3	**Office Automation-Worksheet Data Processing** 3.1 Spreadsheet Basics: Adding and Renaming Worksheets, Modifying Worksheets, 3.2 Moving Through Cells, Adding Rows, Columns, and Cells, Resizing Rows and Columns, Selecting Cells, Moving and Copying Cells 3.3 Formulas and Functions: Formulas, Linking Worksheets, Basic Functions, AutoSum, Sorting and Filtering: Basic Sorts, Complex Sorts, Auto-fill, Deleting Rows, Columns, and Cells 3.4 Charting: Chart Types, drawing charts, Ranges, formatting charts	**5 hrs**
Unit 4	**Office Automation- Presentation Techniques and slide shows** 4.1 Create a new presentation, AutoContent Wizard, Design Template, Blank Presentation,Open an Existing Presentation, PowerPoint screen, Screen Layout 4.2 Working with slides: Insert a new slide, Notes, Slide layout, Apply a design template,Reorder Slides, Hide Slides, Hide Slide text, Add content, resize a placeholder or textbox, Move a placeholder or text box, Delete a placeholder or text box, Placeholder orText box properties, Bulleted and numbered lists, Adding notes 4.3 Work with text: Add text and edit options, Format text, Copy text formatting, Replacefonts, Line spacing, Change case, Spelling check, Spelling options 4.4 Working with tables: Adding a table, Entering text, Deleting a table, Changing rowwidth, Adding a row/column, Deleting a row/column, Combining cells ,Splitting a cell,Adding color to cells, To align text vertically in cells, To change table borders,Graphics, Add clip art, Add an image from a file, Save & Print, slide	**6 hrs**

	shows, slideanimation/transitions.	
Unit 5	**Internet & Applications:** 5.1 Computer Network Types: LAN, PAN, MAN, CAN, WAN, Defining and describing theInternet, Brief history, Browsing the Web, Hypertext and hyperlinks, browsers,Uniform resource locator 5.2 Internet Resources: Email, Parts of email, 5.3 Protecting the computer: Password protection, Viruses, Virus protection software,Updating the software, Scanning files, Net banking precautions. 5.4 Social Networking: Features, Social impact, emerging trends, issues, Social Networking sites: Facebook, Twitter, linkedin, orkut, online booking services 5.5 Online Resources: Wikipedia, Blog, Job portals, C.V. writing 5.6 e-learning: e-Books, e-Magazines, e-News papers, OCW(open course wares): Sakshat(NPTEL) portal, MIT courseware	**4 hrs**
Unit 6	**Cloud Computing Basics** 6.1 Introduction to cloud computing 6.2 Cloud computing models: SAS, AAS, PAS 6.3 Examples of SAS, AAS, PAS (DropBox, Google Drive, Google Docs, Office 365 Prezi, etc.)	**3 hrs**

Suggested readings:

1. TCI, "Introduction to Computers and Application Software", Publisher: Jones & Bartlett Learning, 2010, ISBN: 1449609821, 9781449609825
2. Laura Story, Dawna Walls, "Microsoft Office 2010 Fundamentals", Publisher: Cengage Learning, 2010, ISBN: 0538472464, 9780538472463
3. June Jamrich Parsons, Dan Oja, "Computer Concepts Illustrated series", Edition 5, Publisher Course Technology, 2005, ISBN 0619273550, 9780619273552
4. Cloud computing online resources

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
AC301A.1	Identify their lacunas about some computer skills and try to overcome the same.	**2**
AC301A.2	Practice the learned computer skills in real life and do their jobs more effectively.	**3**

AC-301(B): Cyber Security

(Technology + Value added Audit course; Practical; 2 Credits)

(Optional: Campus + Program level)

Course Objectives (CObs):

- To make students aware of different daily useful cyber security skills/rules.

Unit 1	**Networking Concepts Overview** Basics of Communication Systems, Transmission Media, ISO/OSI and TCP/IP models, Network types: Local Area Networks, Wide Area Networks, Internetworking, Packet Formats, Wireless Networks: Wireless concepts, Advantages of Wireless, Wireless network architecture, Reasons to use wireless, Internet	**3 hrs**
Unit 2	**Security Concepts** Information Security Overview, Information Security Services, Types of Attacks,	**7 hrs**

	Goals for Security, E-commerce Security, Computer Forensics, Steganography. Importance of Physical Security, Biometric security & its types, Risk associated with improper physical access, Physical Security equipments. Passwords: Define passwords, Types of passwords, Passwords Storage – Windows & Linux.	
Unit 3	**Security Threats and vulnerabilities** Overview of Security threats, Hacking Techniques, Password Cracking, Types of password attacks, Insecure Network connections, Wi-Fi attacks & countermeasures, Information Warfare and Surveillance. Cyber crime: e-mail related cyber crimes, Social network related cyber crimes, Desktop related cyber crimes, Social Engineering related cyber crimes, Network related cyber crimes, Cyber terrorism, Banking crimes	**7 hrs**
Unit 4	**Cryptography** Understanding cryptography, Goals of cryptography, Types of cryptography, Applications of Cryptography, Use of Hash function in cryptography, Digital signature in cryptography, Public Key infrastructure	**5 hrs**
Unit 5	**System & Network Security** System Security: Desktop Security, email security: PGP and SMIME, Web Security: web authentication, Security certificates, SSL and SET, Network Security: Overview of IDS, Intrusion Detection Systems and Intrusion Prevention Systems, Overview of Firewalls, Types of Firewalls, VPN Security, Security in Multimedia Networks, Fax Security.	**3 hrs**
Unit 6	**OS Security** OS Security Vulnerabilities updates and patches, OS integrity checks, Anti-virus software, Design of secure OS and OS hardening, configuring the OS for security, Trusted OS.	**2 hrs**
Unit 7	**Security Laws and Standards** Security laws genesis, International Scenario, Security Audit, IT Act 2000 and its amendments.	**3 hrs**

Suggested readings:

1. Skills Factory, Certificate in Cyber Security, Text Book Special edition, Specially published for KBC NMU, Jalgaon
2. BPB Publication, "Fundamentals of Cyber Security", Mayank Bhushan, Rajkumar Singh Rathore , Aatif Jamshed
3. CreateSpace Independent Publishing Platform, "Cyber Security Basics", Don Franke, ISBN-13: 978-1522952190ISBN-10: 1522952195
4. Online references

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
AC301B.1	Practice learned cyber security skills/rules in real life.	**3**
AC301B.2	Provide guidance about cyber security skills/rules to their friends, parents and relatives.	**2**

AC-301(C): Seminar + Review Writing

(Technology + Value added Audit course; Optional: Program-level; Practical; 2 Credits)

Course Objectives (CObs):

- To motivate students to develop skills to search, retrieve, interpret, organize, and present relevant biological information.

Writing a Scientific Literature Review:

- Choosing a topic, Deciding the scope of topic, Significance and impact of scientific problem being addressed, Relevance to subject, current issues and social relevance, Strengths and limitations of the study, Enticing broad audience.
- Literature Survey and Information to consider in the review:
  - Literature search using authentic library resources (print and non-print, digital and virtual) for Almanacs, Encyclopaedia, Dissertations, Theses, Research papers, Review articles, Reference/ Textbooks, and Popular articles (INFLIBNET, Google Scholar, PubMed, Highwire, Google patents, Indian patent database, etc.)
  - Analyzing the literature quality (indexing, peer review, citations, journal impact factor, etc.)
- Deciding a writing approach (theoretical, experimental, interpretive, clinical, etc.), prepare the highlights and drawing important conclusion from literature
- Sections to include and tips for writing them: Abstract, Introduction, Body, Discussion, Conclusion, References
- Reference styles (MLA, APA, etc.), Use of bibliography/ reference/ citation managers and generators (Reference Manager, EndNote, RefWorks, Mendeley, Zotero, Qiqqa, etc.)
- Ethics of publication: Approval and consent, Data ethics (accuracy, falsification, fabrication, and confidentiality), Plagiarism and self-plagiarism, collaborative authorship, conflict of interest, legal consequences
- Content similarity detection, Use of anti-plagiarism services (Urkund, iThenticate, Turnitin, Copyscape, Grammarly, etc.)

Seminar Activity:

- Students are encouraged to deliver seminars on the topics of research, preferably published research paper in a reputed and indexed journal to develop presentation skills and enable to build confidence which will lead them to read different themes and enhance their scientific approach and knowledge assimilation abilities.
- Presentations must be created and presented by students using digital platform using a suitable software in the presence of student audience and faculty for evaluation

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
AC301C.1	Retrieve, analyse, comprehend the scientific information on a given topic and derive logical inferences.	**4**
AC301C.2	Compile the scientific information on a topic, verify for similarity index or plagiarism.	**2**
AC301C.3	Deliver the interactive presentation of scientific data before audience and participate in open discussion with confidence.	**2**

AC-301(D): Biostatistics

(Technology + Value added Audit course; Optional: Program-level; Practical; 2 Credits)

Course Objectives (CObs):

- To learn basic statistical concepts/methods and their applications in biological processes and experiments.

Unit 1	**Descriptive Statistics and Presentation of Data** • Types of Data: qualitative and quantitative data; nominal and ordinal data; discrete and continuous data; frequency and non-frequency data, Different types of scale - nominal, ordinal, ratio and interval. • Analysis of univariate Quantitative Data: Concepts of central tendency or location, dispersion, skewness and kurtosis, measures of dispersion: range, quartile deviation, variance, standard deviation. • Analysis of bivariate Data: measures of association, correlation. • Presentation of Data: construction of tables with one or more factors of classification, diagrammatic and graphical representation of non-frequency data, frequency distributions, histogram. • Graphical presentation of data through bar graph, line graph, pie chart, histogram, dot plot, box-plot, multiple line/bar graphs etc.	**8 hrs**
Unit 2	**Correlation and regression** • Bivariate data: scatter diagram, coefficient of determination, rank correlation: Spearman's rank correlation coefficient. • Meaning and concept of regression, fitting of simple linear regression and quadratic regression in single predictor variable. • Multivariate data: multiple regression, coefficient of determination, R-square and its interpretation, testing significance of predictor variables.	**8 hrs**
Unit 3	**Testing of hypothesis and basic statistical designs** • Introduction of methods of sampling. • Statistical hypothesis, problem of testing of hypothesis, simple and composite hypothesis, types of errors, p-value, conclusions in hypothesis testing. • Statistical tests: one sample t-test, paired t-test, test for proportions, chi-square test for testing independence/association of attributes. • Design of experiments: introduction to basic terms of design of experiments, standard designs: Completely Randomized Design (CRD), Randomized Block Design(RBD), concept of ANOVA, F-test in ANOVA, interpretation of results from ANOVA.	**8 hrs**
Unit 4	**PRACTICALS (Emphasis on examples from Biological Sciences)** • Based on graphical Representation • Based on measures of Central Tendency & Dispersion • Based on Distributions Binomial Poisson Normal • Based on t, f, z and Chi-square • Based on basic statistical designs	**6 hrs**

Suggested readings:

1. Le CT (2003) Introductory Biostatistics. 1st edition, John Wiley
2. Miller, Irwin and Miller, Marylees (2006): John E. Freund's Mathematical Statistics
3. with Applications, (7th Edn.), Pearson Education, Asia.
4. Edmondson A and Druce D (1996) Advanced Biology Statistics, Oxford University Press.
5. Danial W (2004) Biostatistics: A foundation for Analysis in Health Sciences, John Wiley and Sons Inc.
6. Design and Analysis of Experiments by Montgomery D.C. (2001), John Wiley.

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
AC301D.1	Describe and identify data generated from biological processes and experiments.	**1**
AC301D.2	Use summary statistics: measures of central tendency, measures of dispersion with their interpretations for explain the data more effectively through graphical tools.	**3**
AC301D.3	Apply knowledge of correlation, regression analysis and testing of hypothesis to real life data and understand their interpretation.	**3**

8. SEMESTER-IV

9 . BT- 401 INDUSTRIAL AND BUSINESS BIOTECHNOLOGY

10. **100 marks**

Course Objectives:

1.The objectives of this course are to teach students about concepts of entrepreneurship including identifying a winning business opportunity, gathering funding and launching a business, growing and

2. nurturing the organization and harvesting the rewards.

UNIT- I

Microbial Production of Organic Acids and Solvents: Production of alcohol by fermentation, Production, recovery and applications of Glycerol, Acetone and butanol, Citric acid, Gluconic acid, Acetic acid, Lactic acid,

UNIT- II

Microbial Production, recovery and applications of Amino Acids: L-Glutamic acid, L-Lysine, L- Phenylalanine and L-Tryptophan, L-Threonine. Microbial Production, recovery and applications of Vitamins: Vitamin-B12 and Riboflavin. Production of Chemotherapeutic Agents: Production, recovery and applications of antibiotics: Penicillin, Streptomycin, Tetracycline, Erythromycin.

UNIT- III

General features of microbial polysaccharides, Production, recovery and applications of polysaccharides: Xanthan, Dextran and Alginate, Polyhydroxy alkanoates: Chemistry and properties, Polyhydroxybutyrate (PHB), Biopol-a biodegradable plastic, Microbial recovery of petroleum

UNIT- IV

Production and applications of Proteases, Pectinases, Cellulases, Lipase, Glucose isomerase, Penicillin acylase, Microbial transformation, Types of bioconversion reactions: Oxidation, Reduction, Hydrolytic reactions, Condensations, Transformation of steroids and sterols. Transformation of nonsteroidal compounds: L-ascorbic acid, Prostaglandins, Antibiotics,

UNIT- V

Principles of management, Marketing concepts and functions, Time event-time study (CPM and PERT), Concept and Importance of entrepreneurship and self-employment in India, ISO 9000 quality system standards, Biosafety & IPR

11. **Recommended Books:**

1. Manual of Industrial Microbiology and Biotechnology, III edition (1999), Arnold L. Demain and Julian Davies, ASM press, Washington DC
2. Food microbiology, Frazier
3. Industrial Microbiology, Casida
4. Principles of Fermentation Technology by Whitaker, Stanbury, Hall

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C401.1	to gain entrepreneurial skills, understand the various operations involved in venture creation,	**2**
C401.2	to identify scope for entrepreneurship in biosciences	**2**
C401.3	to utilize the schemes promoted through knowledge centres and various agencies.	**4**

12. BT-402 BIOINFORMATICS

13. **100 marks**

Course Objectives:

1. To impart training about elementary aspects of statistics used in biotechnology
2. To introduce student to the variety of computational methods currently available for predicting functional behaviour of biological system
3. To analyse the output data to predict a biologically relevant function

UNIT- I

Genomics: The impact of bioinformatics and functional genomics on biology in the 'Post genomic era'. Approaches for finding genes and regulatory regions in genomic sequence, structural genomics, Functional genomics, Comparative genomics, oligonucleotide fingerprinting, Gene chips.

UNIT- II

Proteomics : Novel approaches to protein expression analysis**:** 1D and 2 D Electrophoresis, Immobilized pH gradient, Sample preparation, First dimension criteria,

second dimension criteria, Stabilization, Electro blot, Image analysis, Digital imaging, Spot detection and quantification, Gel matching.

Database for 2D gel. Mass Spectrometry for protein and peptide analysis: MALDI-TOF,

Application of proteome analysis to drug development. Protein chips.

UNIT- III

Introduction to biological databases – NCBI, PUBMED, sequence databases: Gene bank, DDBJ, Swissprot, PIR, EMBL, structural databases: PDB, MMDB, specialized databases, sequence retrieval system - SRS, ENTREZ, Expasy.

UNIT- IV

Sequence analysis and phylogeny - sequence and similarity: FASTA, BLAST, sequence alignment: local, global, pair wise and multiple sequence, introduction to scoring matrices- PAM and BLOSSUM, introduction to phylogenetic trees, Protein structure prediction - Secondary structure prediction, 3D Structure prediction.

UNIT-V

Data Mining and Data Visualization, Software for Data Visualization ,CN3D,Rasmol,Mol – Mol, Pymol, Chimera, SWISS PDB Viewer, DISCOVERY STUDIO, and MODELLER, Introduction to Bioperl and Biojava, Online Free web resources.

14. **Recommended Books:**

1. Bioinformatics: Sequence and Genome Analysis by David W. Mount, Cold Spring Harbor Laboratory Press
2. Biological Sequence Analysis : Probabilistic Models of Proteins and Nucleic Acids by Richard Durbin, Sean R. Eddy, Anders Krogh, Graeme Mitchison, Cambridge University Press.
3. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, Second Edition by Andreas D. Baxevanis, B. F. Francis Ouellette, Wiley-Interscience

4. Foundations to bioinformatics – Evolution, similar macromolecular components, constancy of gene number and core proteome in closely related organisms
5. Bioinformatics data – nucleic acid sequence, protein sequence, protein structure, genomic, proteomic and metabolomic information
6. Bioinformatics databases – types, design, file formats, access tools with examples
7. Bioinformatics tools and Resources – free online tools, downloadable free tools, software packages, internet, Bioinformatics books and Journals, Bioinformatics web-portals
8. Daniel C. Leibler, (2002), Introduction to Proteomics: Tools for New Biology, Humana Press, Totowa, NJ. Branden, Carl and Tooze John. 1999. Introduction to Protein Structure (2nd. Ed.),Garland Publishing, NY, USA.
9. Mount, David, W., (2001); Bioinformatics: Sequence and Genome Analysis, Cold Spring Harbor Lab. NY,
10. Pennington, S, (Editor), M. J. Dunn (Editor); (2001); Proteomics: From Proteins Sequence to Function, Springer Publications
11. Palzkill, Timothy; (2002); Proteomics, Kluwer Academic Publishers
12. Suhai, Sandor, (ed). (2000); Genomics and Proteomics : Functional and Computational Aspects,Plenum Pub. Corp.
13. Shanmughavel, P. 2005. Principles of Bioinformatics, Pointer Publishers, Jaipur, India.

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C402.1	access information from databases and interpret phylogenetic tree to gain insight into evolutionary path	**4**
C402.2	understand various algorithms	**2**
C402.3	practice biostatistics for interpretation of experimental data.	**4**

15.

16. BT-403 PHARMACEUTICAL BIOTECHNOLOGY

17. 100 marks

Course Objectives:

1. To introduce knowledge about antibiotics, biopharmaceuticals and GMP, ICH process

2. To familiarize the students with spoilage and regulatory aspects as well as quality control issues in pharmaceuticals.

UNIT -I :. Chemotherapy

Antimicrobial drug, Mechanism of action of antimicrobial agents. Microbial resistance to antibiotics and antimicrobial agents (Types and Mechanism). Types of Antibiotics: Classification of antibiotics with example. General characteristics of secondary metabolites: Types and medicinal applications

UNIT-II : Chemotherapeutics Agents

Structure, Mechanism of action and Applications of antibacterial drugs: Sulfonamides, Quinolones. Antiviral drugs: Amantadine, Azidothymidine. Antifungal drug: Nystatin, Griseofulvin. Mechanism of action of anticancer drugs, Drugs acting on CNS, Insulin, Blood factor VIII.

UNIT III: Delivery, Discovery and Development of Drug

History, Drug delivery type: oral, nasal, urogenital, rectal, dermal, injection. Drug targeting, Molecular Biology and Combinatorial drug discovery, Rational Drug designing. Computer Aided Drug Discovery, Concept of Chemo-informatics, special toxicity tests like teratogenecity and mutagenecity. Drug delivery systems, Liposomes.

Unit -IV: Toxicity and clinical trials

Estimation of toxicity: Concept of LD50 and ED50 and their significance, Preclinical trials: Pharmacokinetics and Pharmacodynamics of Peptide and Protein drugs, Clinical trial design: Trial size and study population, Randomized control studies. Guides to good manufacturing practice, FDA, CDS, Water for processing, final product fill, Freeze drying, labeling and packaging, Analysis of final product: Protein and DNA based contaminants, Endotoxin detection, Pyrogen detection, Microbial and viral contaminants, Validation studies.

Unit - V: Biopharmaceutical

Biopharmaceuticals of animal, plant and microbial origin, Hematopoietic growth factors and coagulation factors, Interferons and cytokines for anti-infective and cancer therapy, Insulin and growth hormones, Genetically improved vaccines, Recombinant thrombolytic agents: Tissue type plasminogen activator, Gene therapy, Ex vivo and In vivo gene therapy, Antigene and antisense therapy.

Text & References :

1. Hugo W. B. and Russell A. D. - Pharmaceutical Microbiology -Wiley India
2. AshutoshKar-Pharmacology and Pharmacobiotechnology-New Age
3. FSK Barar- Pharmaceutical- Essentials of Pharmaceuticals- S.Chand
4. B. Glick and J Pasernak -Molecular Biotechnology –ASM Press.
5. Doble- Drug Designing-McGraw Hill
6. S.P. Vyas, Dixit- Pharmaceutical Biotechnology-CBS
7. B. Razdan-Medicinal Chemistry-CBS
8. Satoskar, Bhandarkar- Pharmacology and Pharmacotherapeutics- Popular
9. Purohit, Saluja- Pharmaceutical Biotechnology-Student Edition

10. Ramawat K.G; Merillon J.M - Biotechnology: Secondary Metabolites-Oxford
11. Ed. R.H. Thomson-Chemistry of Natural Products-Springer

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C403.1	To get in-depth knowledge on different categories of antibiotics and biopharmaceuticals	**2**
C403.2	To understand drug design, quality control and regulatory elements of pharmaceutics	**2**
C403.3	To discriminate conventional and combinatorial tools used in drug discovery	**4**

18. **BT-404: LAB**

COURSE VII

19. **100 marks**

Course Objectives:

1. To introduce the students with comprehensive information and insights in pharmaceutical biotechnology and the development of biopharmaceuticals in pharmaceutical industry.
2. To familiarize the students with an understanding in both scientific knowledge of designing and producing navel biologics, and business challenges in biopharmaceutical companies, including regulatory issues.

1. Estimation of penicillin/streptomycin by biological assay.
2. Estimation of penicillin/streptomycin by chemical assay.
3. Assay of antimicrobial activity of Penicillin, Chloramphenicol, streptomycin
4. Determination of Minimum Inhibitory Concentration (MIC) of Antibiotic
5. Determination of shelf life of antibiotics (Expired drugs)
6. Sterility testing of commercial pharmaceuticals.
7. Study of microbial spoilage of pharmaceuticals.
8. Pair wise alignment of DNA and Protein
9. To perform multiple sequence alignment of DNA and Protein
10. Protein structure visualization and molecular modeling
11. Secondary structure prediction
12. To perform phylogenetic analysis

20.

21.

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
C404.1	To get in-depth knowledge on different categories of antibiotics and biopharmaceuticals	**3**
C404.2	. To understand drug design, quality control and regulatory elements of pharmaceutics	**2**
C404.3	To discriminate conventional and combinatorial tools used in drug discovery	**4**

22. BT-405 LAB COURSE–VIII (PROJECT)

23. 100 marks

Course Objectives: The main purpose of this course is to help students organize ideas, material and objectives for their dissertation and to begin development of communication skills.

Project (Dissertation)

24. The project allotted during the fourth semester will be continued and it is expected that the students will design experiments and collect experimental data to deduce conclusions. At the end, they will submit a detailed thesis for evaluation. The students should be introduced to research methodology in the beginning through few lectures.

The approach towards the execution of project should be as follows:

1. Selection of topic relevant to priority areas of biotechnology.
2. Collection of literature from libraries, internet, on-line journals, etc.
3. Planning of research experiments
4. Performing the experiments with scientific and statistical acceptability.
5. Presentation of observations and results.
6. Interpretation of results and drawing important conclusions.
7. Discussion of obtained results with respect to literature reports.
8. Preparation of report (thesis) containing introduction, materials and methods, results and discussion, conclusions, bibliography.
9. Presentation of research data.

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO	CO	Cognitive

No.		level
C405.1	Conceive a problem based on published research and carry out comprehensive survey of literature	**4**
C405.2	Plan and carry out task in given framework of dissertation and present the work in written and viva	**6**
C405.3	Use a holistic view tocritically, independently and creatively identify, formulate and deal with complex issues.	**6**
C405.4	Learn handling of instruments, use of chemicals and how to conduct the experiments	**3**
C405.5	Learn how to present the project in power point and answer the queries to examiners as well as science of writing	**6**

M.Sc. Part II Semester IV (Biotechnology): Audit Courses

	AC-401(A): Human Rights **(Professional and Social + Value Added Audit course; Practical; 2 Credits)** **(Optional: Campus-level)**	
	Course Objectives (CObs): • To make students aware about human rights and human values.	
Unit 1	**Introduction to Human Rights** 1.1 Concept of Human Rights 1.2 Nature and Scope of Human Rights 1.3 Fundamental Rights and Fundamental Duties 1.4 Interrelation of Rights and Duties	**6 hrs.**
Unit 2	**Human Rights in India** 2.1 Meaning and Significance of **:** 1) Right to Equality 2) Right to Freedom, 3) Right against Exploitation, 4) Right to Freedom of Religion, 5) Cultural and Educational Rights, and 6) Right to Constitutional Remedies. 2.2 Constitutional Provisions for Human Rights 2.3 Declaration of Human Rights 2.4: National Human Rights Commission	**8 hrs.**
Unit 3	**Human Values** 3.1: Meaning and Definitions of Values 3.2: Importance of values in the life of Individual 3.3: Types of Values 3.4: Programmes for conservation of Values	**8 hrs.**
Unit 4	**Status of Social and Economically Disadvantaged people and their rights** 4.1: Rights of women and children in the context of Social status 4.2: The Minorities and Human Rights 4.3: Status of SC/ST and other Indigenous People in the Indian Scenario 4.4: Human rights of economically disadvantaged Society	**8 hrs.**
Suggested readings: 1. Human rights education – YCMOU, Nasik 2. Value education – SCERT, Pune		

3. Human rights reference handbook – Lucille whare

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
AC401A.1	Practice the learned issues under human rights and human values in real life.	**3**
AC401A.2	Provide social justices to people around them and provide guidance about human rights to their friends, parents and relatives.	**5**

	AC-401(B): Current Affairs (Professional and Social + Value Added Audit course; Practical; 2 Credits) (Optional: Campus-level)		
	Course Objectives (COBs): • To make students updated about current affairs of India and world.		
	Title	**Content**	**Hours**
Unit 1	Politics & Economy	• National & International Political Activity, Organization. • Economy & Business, Corporate world	08
Unit 2	Awards and recognitions	• National & International Awards and recognitions • Books and authors	07
Unit 3	Science & Technology	• Software, Automobile, Space Research • New inventions and discoveries	07
Unit 4	Environment & Sports	• Summit & conference, Ecology & Climate, Organization. • National & International Games, Olympics, commonwealth etc.	08

Suggested readings (Use recent years' data and current literature):

1. India 2019, by Publications Division Government of India
2. Manorama Year Book by Philip Mathew,
3. India 2019, Rajiv Maharshi
4. Quick General Knowledge 2018 with Current Affairs Update, Disha Experts
5. General Knowledge 2018: Latest Who's Who & Current Affairs by RPH Editorial Board.

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
AC401B.1	Identify important issues currently/ recently happening in India or world.	**5**
AC401B.2	Summarize current affairs regularly.	**6**

AC-401(C): Seminar + Review Writing (Technology + Value added Audit course; Optional: Program-level; Practical; 2 Credits)
Course Objectives (COBs): • To motivate students to develop skills to search, retrieve, interpret, organize, and present relevant biological information.
Writing a Scientific Literature Review: • Choosing a topic, Deciding the scope of topic, Significance and impact of scientific problem being addressed, Relevance to subject, current issues and social relevance, Strengths and limitations of the study, Enticing broad audience.

- Literature Survey and Information to consider in the review:
    - Literature search using authentic library resources (print and non-print, digital and virtual) for Almanacs, Encyclopaedia, Dissertations, Theses, Research papers, Review articles, Reference/ Textbooks, and Popular articles (INFLIBNET, Google Scholar, PubMed, Highwire, Google patents, Indian patent database, etc.)
    - Analyzing the literature quality (indexing, peer review, citations, journal impact factor, etc.)
- Deciding a writing approach (theoretical, experimental, interpretive, clinical, etc.), prepare the highlights and drawing important conclusion from literature
- Sections to include and tips for writing them: Abstract, Introduction, Body, Discussion, Conclusion, References
- Reference styles (MLA, APA, etc.), Use of bibliography/ reference/ citation managers and generators (Reference Manager, EndNote, RefWorks, Mendeley, Zotero, Qiqqa, etc.)
- Ethics of publication: Approval and consent, Data ethics (accuracy, falsification, fabrication, and confidentiality), Plagiarism and self-plagiarism, collaborative authorship, conflict of interest, legal consequences
- Content similarity detection, Use of anti-plagiarism services (Urkund, iThenticate, Turnitin, Copyscape, Grammarly, etc.)

Seminar Activity:

- Students are encouraged to deliver seminars on the topics of research, preferably published research paper in a reputed and indexed journal to develop presentation skills and enable to build confidence which will lead them to read different themes and enhance their scientific approach and knowledge assimilation abilities.
- Presentations must be created and presented by students using digital platform using a suitable software in the presence of student audience and faculty for evaluation

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
AC401C.1	Retrieve, analyse, comprehend the scientific information on a given topic and derive logical inferences.	**4**
AC401C.2	Compile the scientific information on a topic, verify for similarity index or plagiarism.	**2**
AC401C.3	Deliver the interactive presentation of scientific data before audience and participate in open discussion with confidence.	**2**

	AC-401(D): Intellectual Property Rights (IPR) **(Professional and Social + Value Added Audit course; Practical; 2 Credits)** **(Optional: Program-level)**	
	Course Objectives (CObs): • To provide basic knowledge on intellectual property rights and their implications. • To understand ethical issues relevant to biology from the perspective of national and international law.	
Unit 1	**History and Introduction to Intellectual Property Rights:**	**6 hrs.**

	Evolution of patent Laws, History of Indian Patent System, Concept of IPR, Designs, Trademarks TM, Trade Secret (TS), Domain Names, Geographical Indications, Copyright	
Unit 2	**Classification of patents and ownership:** Classification of patents in India, Classification of patents by WIPO, Categories of Patent, Special Patents Ownership of patent, Rights of patent holder and co-owners, Duties of patent holder and co-owners, Transfer of patent Rights, Limitations of patent Rights, Restoration of Patents, Infringement of patent Rights and Offences, Actions against Infringement and Remedies and Relief	**6 hrs.**
Unit 3	**Protection of biological materials and Biodiversity** Methods of protection of plant and plant products, Essentialities of plant protection, Plant variety protection and Farmers' Right Act, UPOV convention (plant Varieties) 1961, National Biodiversity Act- 2002, Protection of environment and biodiversity	**6 hrs.**
Unit 4	**Biosafety and good laboratory practices** Overview of biosafety, Risk assessment, Cartagena protocol on Biosafety, Biosafety Levels, GMOs and LMOs, Gene flow and environmental impact, opportunities and challenges Roles of Institutional Biosafety Committee, RCGM, GEAC in food and agriculture Risk analysis, assessment and management, International regulatory bodies Importance of good laboratory practices, General good laboratory practices	**6 hrs.**
Unit 5	**Bioethics** Introduction, ethical conflicts in biological sciences - interference with nature, bioethics in health care - patient confidentiality, informed consent, euthanasia, artificial reproductive technologies etc Bioethics in research – cloning and stem cell research in human, animal rights/welfare in experimentation Agricultural biotechnology - Genetically engineered food, environmental risk, labeling and public opinion. Sharing benefits and protecting future generations, biopiracy	**6 hrs.**

Suggested readings:

1. Complete Reference to Intellectual Property Rights Laws. (2007). Snow White Publication Oct.
2. Deepa Goel, Shomini Parashar (2013) IPR, Biosafety and Bioethics Always learning, Pearson Education India, ISBN 9332514240, 9789332514249
3. Department of Biotechnology http://dbtindia.gov.in/guidelines-biosafety
4. Ganguli, P. (2001). Intellectual property rights: Unleashing the knowledge economy. New Delhi: Tata McGraw-Hill Pub.
5. International Union for the Protection of New Varieties of Plants. http://www.upov.int
6. Kuhse, H. (2010). Bioethics: An anthology. Malden, MA: Blackwell.
7. National Biodiversity Authority. http://www.nbaindia.org
8. National Portal of India. http://www.archive.india.gov.in
9. Office of the Controller General of Patents, Design & Trademarks; Government of India. http://www.ipindia.nic.in/
10. Wolt, J. D., Keese, P., Raybould, A., Fitzpatrick, J. W., Burachik, M., Gray, A., Wu, F. (2009). Problem formulation in the environmental risk assessment for genetically modified plants. Transgenic Research, 19(3), 425-436. doi:10.1007/s11248-009-9321-9
11. World Intellectual Property Organisation. http://www.wipo.int
12. World Trade Organisation. http://www.wto.org

Course Outcomes (COts):

On completion of this course, the student will be able to:

CO No.	CO	Cognitive level
AC401D.1	Understand to classify, identify advantages of intellectual property and IPR	**3**
AC401D.2	Understand the need to protect biological diversity and follow bioethical practices in research work, awareness to protect intellectual property relevant to biology	**2**

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Epilogue

Skills imparted:

This is the first-year syllabus of the two-year post-graduate course in Biotechnology. Overall, the curriculum is designed in such way that the student will get basic and applied knowledge of the subject. One of the major objectives considered during designing is to create human resource which is technically sound with knowledge having practical utility. The included basic subjects in theory and practical would be helpful to find out unseen facts in various problems in day to day life. The subjects like genetic engineering, and bioinstrumentation are designed in such a way that students will get theoretical and practical knowledge of modern scientific advances in the field. To make skillful human resource with precision, the important allied courses are also included. This course after completion of 2 years would give not only the practical knowledge of industry and industrial processes but also make aware the students with the global environmental problems like pollutions, contamination, infections and food quality.

Practical courses are based on theory courses and are designed to improve research-oriented skills of students.

Job opportunity: The designed curriculum offers job opportunities in various sectors like,

- Pharmaceutical industry: Clinical, medicine, vaccine, QC division
- Biotech industry: Recombinant product, QC, QA
- Agrochemical & pesticide industry
- Chemical industry: synthesis, testing
- Environmental protection industry & Agencies
- Research leading up to Ph. D. degree
- Marketing of biological & pharmaceutical products
- Food and nutraceutical industry, Govt. agencies

Entrepreneurship: This is another avenue available for the candidates making them sound in technical knowledge of Biotechnology upon completion of this two year post graduate course that could be useful in Entrepreneurship in Biotechnology.

Equivalence

M.Sc. Biotechnology (Affiliated Colleges)

Old syllabus AY 2018-2019	New CBCS pattern syllabus 2021-22
SEM-I	
BT-101: Microbial Physiology and Diversity (T)	**BT-101**: Microbial Diversity and Physiology (T)
BT-102: Biochemistry (T)	**BT-102**: Biomolecules and Molecular Enzymology (T)
BT-103: Immunology (T)	**BT-103**: Immunology (T)
BT-104: Methods in Microbiology and Biochemistry (P)	**BT-104**: Laboratory Course-I (P)
BT-105: Methods in Enzymology and Immunology (P)	**MB-105**: Laboratory Course-II (P)
SEM-II	
BT-201: Molecular Biology (T)	**BT-201**: Molecular Biology (T)
BT-202: Bioanalytical Tools (T)	**BT-202**: Bioinstrumentation and Biostatistics (T)
BT-203: Bioprocess Technology (T)	**BT-203**: Bioprocess Engineering and Technology (T)
BT-204: Methods in Molecular Biology & Biochemistry (P)	**BT-204**: Laboratory Course-III (P)
BT-205: Methods in Industrial Biotechnology (P)	**BT-205**: Laboratory Course-IV (P)

AY: Academic Year, (T) : Theory, (P): Practical