Kavayitri Bahinabai Chaudhari North Maharashtra University, Jalgaon

'A' Grade
NAAC Re-Accredited
(3rd Cycle)

Structure of Syllabus

Program B. Sc.

T. Y. B. Sc. (Biotechnology)

Choice Based Credit System (CBCS)

(2020-21)

T.Y. B.Sc. (Biotechnology)

Preamble

Biotechnology has emerged as a multi-disciplinary subject that comprises many specialized areas including Microbiology, Biochemistry, Physics, Engineering, Technology etc. The subject has impacted in almost every segment of human life. The degree course of Bachelor of Science with Choice Based Credit System (CBCS) in Biotechnology has been designed with a multi-faceted approach so as meet the ever growing challenges in the field of Molecular Biology, Genetics, Immunology, Animal Tissue Culture, Bioengineering and Bioprocess Technology, Food and Pharmaceutical, Agriculture and Plant Biotechnology. The study program in Biotechnology as one of the core subjects is designed to cultivate a scientific attitude and an interest towards the modern area of Biotechnology. The beneficiaries of this course are entitled to get enriched with a wide range of theoretical and practical knowledge in the above fields. The aim is to inculcate interest in the subject and apply the knowledge gained for society, employment, business, as well as research. The subjects incorporated shall be updated with the novel technologies and innovative methods to go hand in hand with the developing demands of Life Sciences. The integration of various courses in the program is aimed to develop proficiency in the theory as well as practical experiments, common equipment, laboratory, along with the collection and interpretation and presentation of scientific data in proper manner. It will help the students to become curious and critic in their outlook. The course is empowered with skills focused to gain proficiency in handling equipment and learning the norms and precautions needed to be strictly administered in a Biotechnology Laboratory. The B. Sc. course shall build graduates that shall apply the knowledge gained for collection and interpretation of data in research. They shall also be acquainted with skills for presentation of data in a standard scientific style. The course has the greatest asset to envisage the beneficiaries with the practical and theoretical skills needed in the subject once they qualify the degree and face the open challenges of Biotechnology in the world. The upcoming global challenges have been taken into consideration with priority during the designing of the course. This shall attract students to opt the subject so as foresee a sound knowledge in the subject and satisfy their curiosities. The motive is to lay a strong foundation for the student in the subject that shall help him grow and reach his targets in the global educational hub. The content of the syllabus has been prepared to accommodate the fundamental aspects as well as advanced developments in various disciplines of Biotechnology and to complement the needs of various applied sectors of Biotechnology.

There are 08 core courses which encompass all important aspects of the discipline of Biotechnology and are all compulsory courses. There are 04 choice-based Discipline Specific Elective (DSE) courses designed to give the students a chance to apply their knowledge of microbiology to study societal problems. The students have a freedom to select the courses of their choice. There are 02 Skill based Elective Courses (SEC) included to develop skills in areas related to employability in diagnostics, health, food and pharmaceutical industries, agriculture and environment.

The present syllabus is restructured anticipating the future needs of Biotechnology with more emphasis on imparting hands-on skills. The main thrust is laid on making syllabus compatible with developments in Education, Research and Industrial sectors. The Theory and Practical courses in new restructured program will lead to impart skill-set essentials to further Biotechnology.

The candidates opting for the course shall get enough opportunities to select courses of his/her choice. This will bestow full justice to their interests. Restructuring of the syllabus has been done to suffice the needs of a choice-based credit system that shall strengthen the student's intellectual status at large. Board of Studies in Life Sciences has taken efforts to fulfil the components of Teaching-Learning-Evaluation process to a maximum extent during the compilation of the syllabi. The syllabus is vividly endowed with course objectives and learning outcomes for every subject. The guidelines laid down by University Grants Commission (UGC), New Delhi for the CBCS have been given due justice during the restructuring of the syllabi.

Hence, Board of Studies in Life Sciences in its meeting accepted the revised syllabus for T.Y.B.Sc. (Biotechnology) based on Choice Based Credit System of UGC guidelines. The path for a bright future of Biotechnology has been build up with a hope to achieve the goals in the form of fruitful program outcomes in the coming days.

There are 08 core courses which encompass all important aspects of the discipline of Biotechnology and are all compulsory courses. 04 choice-based Discipline Specific Elective (DSE) courses are designed which give the students a chance to apply their knowledge of Biotechnology to study societal problems. The students have a freedom to select the courses of their choice while Skill based Elective Courses (SEC) are also included to develop skills in areas which are related to employability in diagnostics, health, food and pharmaceutical industries, agriculture and environment.

Programme Outcome (PO):

As an outcome, the graduate students are expected to gain the following competencies upon completion of this program B.Sc.

- Students will understand the concepts and significance in the field of Biochemistry / Biotechnology / Microbiology that can be used for solving the real time problems.
- Students will acquire skills and ability in their field and find professional opportunities in industry, agriculture and higher studies.
- Students will have improved personal qualities and transferable skills to help them to groom as responsible citizens.

Program Specific Objectives (PSO):

- Graduate in Biotechnology shall acquire the basic knowledge of Biotechnology and can be eligible for pursuing higher education/ postgraduate education.
- Students will gain knowledge and develop specialized skill in the different area of Biotechnology.
- Graduate candidates will develop a sense of societal and ethical responsibility pertaining to bioinformatics, health, agriculture, dairy, genetic engineering, and fermentation industry.
- The knowledge shall promote our graduates to stand independently amidst the growing technological innovations in the subject.

Learning Objectives (LO):

- To acquaint the students with various disciplines of Biotechnology
- To articulate foundation and pillar level knowledge of Biotechnology for the beneficiaries to apply them for advanced studies in the subject.
- To enhance the practical skills with a sound theoretical background
- To apply the knowledge gained for higher education, research and profession of their choice.
- To analyze their interests among the various disciplines and implement them in their professional endeavours.

Programme Structure:

The programme includes 8 Discipline Specific Core Courses (DSC) of 3 credits each 4 each for the two semesters (Semester V and VI). There shall be inclusion of 02 Skill Enhancement Course (SEC) of 3 credits each, one for each Semester. The course has incorporated 4 Discipline Specific Elective Course (DSE) of 3 credits each, two for each Semester. The student shall have liberty to choose one of the two courses. There shall be 6 Discipline specific Core Practical courses of 2 credits each; 3 courses for each semester.

Eligibility:

Students completing Second Year CBCS (Semester III and IV) of B.Sc. (44 credits) shall be eligible for the admission to T.Y.B.Sc. (CBCS) Degree course.

Course Fee: As per University norms

Duration: The duration of B.Sc. (Biotechnology) degree program shall consist of three years.

Medium of instruction: The medium of instruction for the course shall be English.

Credit to contact hour/Duration of Lecture: 45 Lectures of 60 minutes or 54 Lectures of 50 minutes shall be conducted for 08 Discipline Specific Core courses, 02 Skill Enhancement Courses and 02 Discipline Specific Elective courses of 3 credits each. Each theory and

practical course must be completed in 45 and 60 lectures, respectively of 60 minutes duration. The score allotted for 06 Discipline Specific Core practical courses is 2 credits for each course.

Attendance:
The candidates appearing for the final year examinations of B.Sc. Biotechnology need to fulfill a regular attendance record in theory and practical of not less than 80 %. Failing to fulfill the criteria, the student shall not be eligible for appearing for the T.Y.B.Sc. (CBCS) examination.

Exam Pattern

- Each theory and practical course will be of 100 marks comprising of 40 marks internal (College assessment) and 60 marks external examination (University assessment).
- Theory 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) while the tentative pattern of question papers shall be as follows;
- Question 1 (12 marks): 9 sub-questions, each of 2 marks; answerable in 2 -3 line and based on entire syllabus, attempt any 6 out of 9 questions.
- Question 2, 3 and 4 (12 marks each): based from Unit I, II, and III, respectively, each question has 3 sub-questions of 6 marks each and answer only 2 sub-questions from each Q2, Q3, and Q4 in brief.
- Question 5 (12 marks): answer only 3 out of 5 in brief, based from all 3 units, Each 4 marks.

Internal examination (40 marks each semester):

Internal assessment (College 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.

Practical Examination:
Practical examination shall be conducted by the respective college at the end of the semester. Practical examination will be of minimum 5-6 hours duration and shall be conducted as per schedule (10 am to 5 pm on schedule date or can be scheduled 10 am -1 pm / 2 pm- 5 pm for 2 consecutive days) in case of biotechnology practical where incubation condition, allied aspect is essential. There shall be 5 marks for laboratory logbook and well written 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/ two expert and two examiners (external and internal) per batch for the practical examination.

Scheme

Scheme for T.Y.B.Sc. Program under the Faculty of Science and Technology includes in continuation with the First and Second Years two semesters namely Semester V and VI. Each semester shall include four Core courses, one Skill based course one Elective course, three Core practicals and one non-credit Elective Audit course.

Scheme for B.Sc. Program under Faculty of Science and Technology

Sr. No	Year → / Course ↓	First Year				Second Year				Third Year				Total Credit Value
		Sem I		Sem II		Sem III		Sem IV		Sem V		Sem VI		
1	Core Courses (16)	**Credits each**	**Courses**	**Credits each**	**Courses**	**Credits each**	**Courses**	**Credits each**	**Courses**	**Credits each**	**Courses**	**Credits each**	**Courses**	
	i. Theory	4	4	4	4	4	3	4	3	3	4	3	4	4x14=56 3x8=24
	ii. Practical	2	4	2	4	2	3	2	3	2	3	2	3	2x14=28 2x6=12
2	Ability Enhancement Compulsory Course (AECC) (2)	2	1	2	1	2	1	2	1					2x2x2x2 =08
3	Skill Enhancement Course (SEC) (4)					2	1	2	1	3	1	3	1	2x2=04 3x2=06
4	Discipline Specific Elective (DSE) (6)									3	1	3	1	3x2=06
5	Elective Audit									No credit	Any 1	No credit	Any 1	--
6	Total Credit Value (Credit x No. of courses)	26		26		22		22		24		24		**144**

Structure of Curriculum of T.Y.B.Sc. (Biotechnology) Semester V

Discipline	Course Type	Course Code	Course Title	Credits	Hours/ Week (Clock Hours)	Total Teaching hours	Marks	
							CA	UA
DSC	Core I	BT-501	Genetics and Molecular Biology	3	3	45	40	60
	Core II	BT-502	Agriculture Biotechnology	3	3	45	40	60
	Core III	BT-503	Animal Tissue Culture	3	3	45	40	60
	Core IV	BT-504	Bioengineering	3	3	45	40	60
SEC	Skill Based	BT-505	Food Biotechnology	3	3	45	40	60
DSE	Elective Course (Anyone)	BT-506A	Environmental Biotechnology-I	3	3	45	40	60
		BT-506 B	Bioinformatics					
DSC	Core (Practical)	BT-507	Practical Course: Industrial Biotechnology	2	4 / batch	60	40	60
		BT-508	Practical Course: Animal Biotechnology and Immunology	2	4 / batch	60	40	60
		BT-509	Practical Course: Applied and Environmental Biotechnology	2	4 / batch	60	40	60
AU	Elective Audit Course	AC-501A	NSS	No credit	2	30	100	--
		AC-501B	NCC					
		AC-501C	Sports					

DSC: Discipline Specific Core Courses/Core Practical

SEC: Skill Enhancement Course

DSE: Discipline Specific Elective Course

AU : Audit course

CA : College assessment (Internal examination)

UA : University assessment (External examination)

NCC: National Cadet Corps

NSS: National Service Scheme

Structure of Curriculum of T.Y.B.Sc. (Biotechnology) Semester VI

Discipline	Course Type	Course Code	Course Title	Credits	Hours/ Week (Clock Hours)	Total Teaching hours	Marks	
							CA	UA
DSC	Core I	BT-601	Recombinant DNA Technology	3	3	45	40	60
	Core II	BT-602	Plant Biotechnology	3	3	45	40	60
	Core III	BT-603	Immunology	3	3	45	40	60
	Core IV	BT-604	Bioprocess Technology	3	3	45	40	60
SEC	Skill Based	BT-605	Pharmaceutical Biotechnology	3	3	45	40	60
DSE	Elective course (Anyone)	BT-606 A	Environmental Biotechnology-II	3	3	45	40	60
		BT-606 B	Biostatistics					
DSC	Core (Practical)	BT-607	Practical Course: Plant Biotechnology	2	4 / batch	60	40	60
		BT-608	Practical Course: Genetics and Bioinformatics	2	4 / batch	60	40	60
		BT-609	Practical Course: Pharmaceutical Biotechnology	2	4 / batch	60	40	60
AU	Elective Audit Course	AC-601A	Soft Skill	No credit	2	30	100	--
		AC-601B	Yoga					
		AC-601C	Practicing Cleanliness					

DSC: Discipline Specific Core Courses/Core Practical

SEC: Skill Enhancement Course

DSE: Discipline Specific Elective Course

AU : Audit course

CA : College assessment (Internal examination)

UA : University assessment (External examination)

Skill Enhancement Course (SEC):
To increase the potentiality of Biotechnology students in industries and to make them more employable, Food Biotechnology and Pharmaceutical Biotechnology have been introduced. This course will improve skills required in food and pharmaceuticals industries essential for Biotechnology students which will leverage their career in not only in industries, but also help them for their higher studies.

Discipline Specific Elective Course (DSE):
Elective course will give students choice to study the course of their interest. In 5^{th} semester, student can choose either Environmental Biotechnology-I or Bioinformatics. Whereas in 6^{th} semester they have choice between Environmental Biotechnology-II or Biostatistics. Student who has selected Environmental Biotechnology-I for 5^{th} semester, compulsorily must take Environmental Biotechnology-II in 6^{th} semester while one who has selected Bioinformatics shall opt for Biostatistics in 6^{th} semester.

Audit Course (AU):
The syllabi for audit courses will be common for all courses and shall be available separately.

Equivalence of the courses for T. Y. B. Sc. (Biotechnology)

Old Syllabus (w. e. f. June 2017) (Semester pattern 60:40)		**Equivalent New Syllabus (June 2020) CBCS pattern (Semester pattern 60:40)**	
Course Code	**Paper**	**Course Code**	**Paper**
Semester V			
BT-351	Genetics	**BT-501**	Genetics & Molecular Biology
BT-352	Agricultural Biotechnology	**BT-502**	Agriculture Biotechnology
BT-353	Animal Biotechnology	**BT-503**	Animal Tissue Culture
BT-354	Industrial Biotechnology	**BT-504**	Bioengineering
BT-355	Food Biotechnology	**BT-505**	Food Biotechnology
BT-356	Environmental Biotechnology	**BT-506A**	Environmental Biotechnology-I
		BT-506B	Bioinformatics
BT-357	Practical Course- Industrial Biotechnology	**BT-507**	Practical Course- Industrial Biotechnology
BT-358	Practical Course- Animal Biotechnology & Immunology	**BT-508**	Practical Course- Animal tissue culture & Immunology
BT-359	Practical Course- Food and Environmental Biotechnology	**BT-509**	Practical Course- Applied and Environmental Biotechnology
Semester VI			
BT-361	Gene Biotechnology and Bioinformatics	**BT-601**	Recombinant DNA Technology
BT-362	Plant Biotechnology	**BT-602**	Plant Biotechnology
BT-363	Immunology	**BT-603**	Immunology
BT-364	Advanced Bioprocess technology	**BT-604**	Bioprocess Technology
BT-365	Pharmaceutical Biotechnology	**BT-605**	Pharmaceutical Biotechnology
BT-366	Biodiversity and Biometry	**BT-606A**	Environmental Biotechnology-II
		BT-606B	Biostatistics
BT-367	Practical Course- Plant biotechnology	**BT-607**	Practical Course- Plant biotechnology
BT-368	Practical Course- Genetics and Bioinformatics	**BT-608**	Practical Course- Genetics and Bioinformatics
BT-369	Practical Course- Pharmaceutical Biotechnology	**BT-609**	Practical Course- Pharmaceutical Biotechnology

T.Y.B.Sc. (Biotechnology) Semester-V

Discipline Specific Core (DSC) Course

DSC-I: BT-501: Genetics and Molecular Biology

Total Hours: 45 **Credits: 3**

Course objective

- To provide basic knowledge about the fundamental molecular process of living cells
- To introduce the students to the principles of ecology and genetic disorders.

Learning outcome

After successful completion of this course, students are expected to:

- Enrich knowledge base of biological processes through the investigation of the underlying molecular mechanisms.
- Students will gain an understanding of chemical and molecular processes that occur in and between cells.
- Aims at understanding structure, synthesis and replication of nucleic acids.

Unit	Title	Topic Particular	Lectures
Unit I	**Basic Molecular Biology**	• DNA: topological properties (linking, writhing, twisting number), • Base flipping, Palindrome, Inverted repeats and stem and loop. • Overview of DNA replication • RNA: Structure, types, functions • Denaturation and renaturation kinetics of nucleic acids • Proteins: Domain and motifs Histone proteins.	**11**
Unit II	**Transcription**	• RNA polymerase (prokaryotic and eukaryotic), • Process of transcription, Promoters and Transcription factors • mRNA processing, editing capping, adenylation, splicing, Exon shuffling, RNA Editing, mRNA transport • Regulation of Transcription: repressors and inhibitors • Transcriptional bursting/pulsing, specificity, enhancers, activators, co-activators and general transcription factors	**12**
Unit III	**Translation**	• Steps in translation: Initiation, Elongation, Termination • RNA-RNA interaction in translation, polyribosomes • Ribosome (structure and composition), Activation of tRNA, tRNA synthetase • Regulation of translation: Cytoplasmic polyadenylation, UTR sequence elements, RNA binding proteins, ribosomal regulation, non-sense mediated RNA decay, 5` decapping.	**11**

Unit IV	**Genetics, ecology and genetic disorders**	• Crossing over: Concept, mechanism, types. • Sex linked inheritance: Types of sex linkage, X and Y linked inheritance • Population, gene pool, gene frequency, genetic drift, speciation. • Hardy-Weinberg law • Concept and types of Eugenics and Euphenics • Disorders due to mutant genes: Causes, mechanism, diagnosis and treatment of Phenylketonuria urea, alkaptonuria and sickle cell	**11**

References

- Berg J. M., Tymoczko J. L., Gatto Jr. G. J., Stryer L. (2015), Biochemistry, 8th Edn, W. H. Freeman and Company, New York.
- Brown T.A. (2016) Gene Cloning and DNA Analysis: An Introduction", 7th Edition, Wiley-Blackwell Publishers, UK ISBN: 978-1-119-07256-0
- E.D. D. De Robertis, E.M.F. De Robertis, Jr. (2012) Cell and Molecular Biology, Wolters Kluwer India Pvt. Ltd.
- Krebs J. E., Goldstein E. S., Kilpatrick S. T. (2018), Lewin's Genes XII, Jones and Barlett Learning.
- Lewin B (2013) Gene XI, Pearson Prentice Hall, Pearson Education, Inc., NT, USA.
- Lodish, H. Berk, A.., Zipursky, S.L., Matsudaria, P., Baltimore, D., and Darnell, J.
- Malacinski GM (2003) Essentials of Molecular Biology, 4th edn., Jones & Batiett, London. (ISBN: 0-7637-2133-6).
- Lodish Harvey, Berk Arnold, Zipursky S Lawrence, Matsudaira Paul, Baltimore David, and Darnell James (2000) Molecular Cell Biology. Media connected, W. H. Freeman and Company, New York.
- Verma P. S., Agarwal V.K. (2014) Cytology, S. Chand and Company Pvt. Ltd.
- Watson JD, Baker JA, Bell SP, Gann A, Lewin M, Losick R (2004) Molecular biology of gene, 7th edition. cold spring harbor, New York

Discipline Specific Core (DSC) Course

BT-502: Agriculture Biotechnology

Total Hours: 45 **Credits: 3**

Course objective

- This course presents application of plant biotechnology in agriculture, Nitrogen fixation and Biofertilizer, Rhizosphere microflora and its role in the rhizosphere.
- The course presents understanding of Plant pathology and disease control, horticulture and floriculture

Learning outcome

After successful completion of this course, students are expected to:

- Understand applications of biotechnology in agriculture, plant disease control and floriculture.
- Understand Nitrogen fixation and Biofertilizer, Rhizosphere microflora and its role in the rhizosphere.
- Understand the basics of Plant pathology and disease control, horticulture and floriculture

Unit	Title	Topic Particular	Lectures
Unit I	**Rhizosphere microflora and its role in the rhizosphere**	• Introduction: Rhizosphere and plant growth promoting rhizobacteria • PGPR forms (Intracellular and extracellular) • PGPR mechanism: Potassium solubilization, siderophore production, phytoharmone production, mycorrhizae and its significance, Indirect- production of antibiotics, lytic enzymes and exo-polysaccharide. • Functions of PGPR (biocontrol properties, bioinoculants, abiotic stress resistance, co inoculants • Drawbacks of PGPR	**12**
Unit II	**Nitrogen Fixation and Biofertilizer**	• Symbiotic nitrogen fixation - Legume-*Rhizobium* symbiosis, host specificity, nodule Development, mechanism of nitrogen fixation, Nitrogenase complex • Non-symbiotic nitrogen fixation - Diazotrophy, sites of nitrogen fixation in *Cyanobacteria, Azotobacter, Azospirillum.* • Assimilation of sulphur and phosphorus by plants • Biofertilizer- Concept, inoculum development for (Rhizobium and phosphate solubilizers) • Comparative account of biofertilizer and chemical fertilizer	**12**
Unit III	**Plant pathology and disease control**	• Classification of plant diseases based on symptoms. • Plant diseases - Causative agent, symptoms, pathogenesis and control of i) Bacterial blight (Telya) of Pomegranate; ii) Bacterial blight of cotton iii) Whip smut of sugar cane	**11**

		• Control methods a) Chemical control b) Eradication c) Biological (bacterial and fungal cultures) d) Integrated pest management (IPM) - development of insect resistant plant (BT crops), refugia, and ecological approach as a part of IPM.	
Unit IV	**Horticulture and Floriculture**	• Concept of horticulture and floriculture • Techniques in horticulture • Use of biotechnology in horticulture and floriculture • Floriculture market in India • Types of Green house, importance, functions and features of green house and their management.	**10**

References

- Bilgrami K.S and Dube H.G. (1994), Textbook of Modern Plant Pathology, Vikas Publications, New Delhi.
- Gupta P.K. (1998), Genetics and Biotechnology in Crop Improvement, Rastogi Publications, Meerut.
- Pathak V.N, Khatri N.K., Pathak M. (1996), Fundamentals of Plant Pathology, Agrobotanical Publications, Bikaner.
- Powar C.B., Daginawala H.F., (1990), General Microbiology,Vol. II, Himalaya Publishing House,Mumbai.
- Purohit S.S. (2002), Agricultural Biotechnology, Agrobios India, Jodhpur.
- Satyanarayana U. (2007), Biotechnology, Books and Allied Pvt. Ltd. Kolkata.
- Vyas S., and Modi H. A. (1998), Biofertilizer and Organic Farming, Akta Prakashan, Nadiad, G.S, Meerut.

Discipline Specific Core (DSC) Course

BT-503: Animal Tissue Culture

Total Hours: 45 **Credits: 3**

Course objective

- To introduce the students to the basic principles of Animal tissue and cell culture
- The course will describe as to how animal cell culture is carried out for research and diagnostic purposes.
- How transgenic animals are generated, what are the pros and cons along with ethical issues associated with transgenesis.

Learning outcome

After successful completion of this course, students are expected to:

- Understand fundamental principles of animal cell and tissue culture
- Gain an understanding of cell culture techniques and their applications
- Understand concept of transgenesis, transgenic animals and their application as well as the human health care biotechnology

Unit	Title	Topic Particular	Lectures
Unit I	**Introduction to Animal Cell and Tissue Culture**	• History and scope of animal cell and tissue culture. • Principle, merits and demerits of animal cell/tissue culture • Laboratory facilities for Animal tissue culture. Culture media: a) Natural media b) Defined media. • Primary and established cell lines and their characterization • Primary culture, cultured cells and evolution of cell lines and their maintenance. • Large scale cultivation of mammalian cell. • Applications of animal cell culture to human health, medical and therapeutic purposes Pharmaceutical products of animal cell culture	**12**
Unit II	**Transformation in animal cells**	• Cell transformation - In vitro culture of oocytes/ embryos • DNA microinjection. • Embryogenic stem cell transfer. • In-vitro culture of oocytes and embryo Cell/embryo cryopreservation, • Measurement of cell death - Apoptosis,	**11**
Unit III	**Transgenic Animals and Cloning**	• Introduction to transgenic laboratory animals. • Principles and methods of development of transgenic animals • Animal cloning: Principle and methods with suitable example. • Transgenic domestic animals: traits affecting productivity, domestic animals as bioreactors • transgenic animals and biosafety • Economics aspects of transgenic animals	**11**

Unit IV	**Human Healthcare Biotechnology**	• Genetic screening: methods of testing w.r.t. genetic disorders. • Molecular analysis of Huntington's disease, sickle cell anemia and cystic fibrosis • Prenatal diagnosis and its application • Gene Therapy: introduction, types of gene therapy • The mechanics and site of gene therapy • Applications of gene therapy: against cancer and molecular surgery	**11**

References

- Arora M.P. (2003), Biotechnology, Himalaya Publishing House, Mumbai.
- Freshney R. Ian (2006), Culture of Animal Cells: A Manual of Basic Techniques, John Wiley and Sons, Inc., New York.
- Gangal Sudha (2007), Principles and Practice of Animal Tissue Culture, Universities Press India Pvt. Ltd.
- Gupta P.K (2004), Biotechnology and Genomics, Rastogi Publication Meerut.
- Ignacimuthu S (1995), Basic Biotechnology, Tata McGraw Hill Publishing Co. Ltd., New Delhi.
- Purohit S.S. (2002), Agricultural Biotechnology, Agrobios India, Jodhpur.
- Satyanarayana U. (2007), Biotechnology, Books and Allied Pvt. Ltd. Kolkata.

Discipline Specific Core (DSC) Course

BT-504: Bioengineering

Total Hours: 45 **Credits: 3**

Course objective

- This paper is introduced to acquire requisite skills for the design and development of bioreactors, media, sterilization, microbial growth etc.

Learning outcome

After successful completion of this course, students are expected to:

- Understand fundamental principles Bioprocess and bioengineering
- Understood Fermentation media, sterilization, as well as media optimization Understand concept of transgenesis, transgenic animals and their application as well as the human health care biotechnology
- Understood the basics of fermentation technology and learnt the concept of screening, optimization and maintenance of cultures.

Unit	Title	Topic Particular	Lectures
Unit I	**Basics of Bioengineering**	• Definition of Bioprocesses engineering. Introduction to simple engineering calculations, Mass & Energy Balances • Selection of mutants: producing improved level of primary metabolites with suitable example- - which do not produce feedback inhibitors or repressors. - which do not recognize presence of inhibitors or repressors.	**12**
Unit II	**Fermentation media and optimization**	• Carbon sources: Cane and Beet molasses, Malt, Corn, Starch, oils, hydrocarbons, alcohols. • Nitrogen sources: Corn steep liquor, Soybean meal, peanut meal, distillers soluble, • Antifoams: types, mode of action, advantages and disadvantages. • Inoculum media and Production media • Medium Optimization: Classical Approach, Plackett and Burman design	**12**
Unit III	**Air & Media sterilization**	• Air Sterilization Principles, Mechanisms of capture of particles in Air, Depth & Screen Filters, Sizing, Testing & validation of filters for air. • Principles of Media Sterilization- Decimal reduction, • Design of sterilization cycle using kinetics of thermal death of microbes, Equipment's used in sterilization.	**11**
Unit IV	**Microbial growth and culture system**	• Culture system- a. Batch culture system b. Fed batch culture system c. Semi continuous culture system	**10**

		d. Continuous culture system • Microbial growth kinetics in bioprocess	

References

- Dubey R.C (2006), A Text Book of Biotechnology, S. Chand and Co. Ltd, New Delhi.
- Kalaichelvan P.T; I Arul Pandi (2007), Bioprocess Technology, MJP Publishers, Chennai.
- Peter F. Stanbury. Principles of Fermentation Technology, 2nd Edn, Elsevier (A Division of Reed Elsevier India Pvt. Limited), 2009
- Prescott, S.C. and Dunn, C. G., (1983) Industrial Microbiology, Reed G. AVI tech books.
- Satyanarayan, U., Biotechnology, (2009), Books and Allied Pvt. Ltd.

Skill Enhancement Course (SEC)

SEC: BT-505: Food Biotechnology

Total Hours: 45 **Credits: 3**

Course objective

- The course provides understanding of Microbial analysis of milk, Microbial production of fermented food viz. cheese, bread etc.
- Causes of food spoilage, Spoilage of fruit, Vegetables, Dairy product
- Food Preservation –Chemical Method, Physical method

Learning outcome

After successful completion of this course, students are expected to:

- Understand fundamental principles food and milk microbiology
- Understood fermented products, and pasteurization of milk
- Understood the basics of food spoilage, food preservation, and fermented food.

Unit	Title	Topic Particular	Lectures
Unit I	**Milk**	• Milk - Definition, composition and types. • Fermented milk products - Yoghurt and cheese. • Preservation of milk by heat treatment (Pasteurization and ultra-high temperature). • Physicochemical characterization of milk. • Milk spoilage: MBRT and Resazurin test.	**10**
Unit II	**Food Spoilage**	• Primary sources of microorganisms in food. • Food borne Bacteria/ Microbes in food – Bacteria, Molds and Yeasts. • Intrinsic and extrinsic factors affecting food micro flora. • Food Processing –Introduction, Objective, causes and effect. • Food Preservation- Chemical and Physical Method. • Food Additives: - Preservative, colour, and stability. • Food adulteration: - (Internal and Incidental).	**12**
Unit III	**Food Preservation**	• Packaging & Labelling of foods. • HACCP system to prevent food borne illness. • Food pathogen, toxins and their detection in food. • Biosensors for food quality assessment. • ELISA assay for detection and quantitation of toxins in food.	**11**
Unit IV	**Fermented Food**	• Fermented food- Idli and Bread. • Causes of food spoilage. • Spoilage of fruit, vegetables, meat, eggs, dairy product. • Fungal toxins: Afflation. • Bacterial Toxins: - Bacterium and staphylococcal toxins.	**12**

References

- Adam M.R and Moss M.O (2003), Food Microbiology, New Age International Pub. New Delhi.
- Frazier W.C and Westhoff D.C (2005), Food Microbiology, 4th Edi. Tata Mc Graw Hill Pub Company Ltd. New Delhi.
- Harrigan W. F (1998), Laboratory methods in Food Microbiology, 3rd Edi. Academic Press. New York.
- Jay J.M. (1992), Modern Food Microbiology, 4th Ed. Chapman and Hall, New York
- Vijaya Ramesh K. (2007), Food Microbiology, MJP Publishers, Chennai.
- Kalidas Shetty, Taylor & Francis (2006) Food Biotechnology, Taylor & Francis Group, LLC
- Powar C.B and Daginawala H.F (2003), General Microbiology, Vol. II, Himalaya Pub. House, Mumbai.
- Sivsankar B (2002), Food Processing and Preservation, Prentice Hall of India Pvt. Ltd. New Delhi.

Discipline Specific Elective (DSE) Course

BT-506A: Environmental Biotechnology-I

Total Hours: 45 **Credits: 3**

Course objective

- An exposure to environmental perspectives.
- Insight into the management of wastewater, biodegradation techniques bioremediation and xenobiotics.

Learning outcome

After successful completion of this course, students are expected to:

- Domestic wastewater treatment, Classification of Wastewater treatment
- Biodegradation-Concept, Biodegradation of hydrocarbon, Measurement of biodegradation
- Bioremediation-Concept, Methods of Bioremediation (In-situ and Ex-situ Bioremediation)
- Understand Xenobiotic and recalcitrant, Metabolism of Xenobiotics

Unit	Title	Topic Particular	Lectures
Unit I	**Wastewater Treatment**	• Domestic wastewater treatments – i) Primary Treatment ii) Secondary Treatment iii) Tertiary Treatment • Aerobic Biological Treatment – Activated Sludge Process, Rotating Biological Contactors, Trickling Filters • Anaerobic Biological Treatment – Packed bed reactor, Air lift membrane bioreactor, Fluidized bed reactor • Important microorganisms and their role in wastewater treatment • Plasmid borne metabolic activities of microbes.	**12**
Unit II	**Xenobiotic**	• Introduction - Concept and Definition • Recalcitrancy • Xenobiotics degradation – i) Pesticide degradation (Principle with suitable example) ii) Herbicide degradation (Principle with suitable example) • Metabolism of xenobiotics - Cytochrome P450 system • Metabolic reactions - Phase I and Phase II	**11**
Unit III	**Bioremediation**	• Introduction –Definition and Concept • Methods of bioremediation (*In-situ* and *Ex-situ* Methods) • Bioremediation of soil – Bioremediation of saline and alkaline soil • Phytoremediation – Concept and Types • Applications of bioremediation	**11**
Unit IV	**Biodegradation Techniques**	• Concept and Definition • Types - Ready, ultimate and inherent	**11**

		biodegradation • Aerobic degradation pathways in microbes • Anaerobic degradation pathways in microbes • Biodegradation of hydrocarbon with suitable examples	

References

- Asthana D.K. and Asthana M. (2001), Environment: Problems and Solutions, S. Chand and Company Ltd, New Delhi
- Chatterji A.K. (2002), Introduction to Environmental Biotechnology, Prentice Hall of India Pvt. Ltd, New Delhi.
- Gupta P.K. (2004), Biotechnology and Genomics, Rastogi Publication, Meerut.
- Jogdand S.N.(2006), Environmental Biotechnology, 3rd Edn., Himalaya Publishing House, Mumbai
- Kalaichelvan P.T., I Arul Pandi (2007), Bioprocess Technology, MJP Publishers, Chennai.
- Rittmann B. E. And McCarty P. L. (2001), Environmental Biotechnology Principles And Applications, McGraw Hill, USA

Discipline Specific Elective (DSE) Course

BT-506(B): Bioinformatics

Total Hours: 45 **Credits: 3**

Course objective

- The primary goal of this course is to uncover how various tools and techniques of bioinformatics can be utilized in studies pertaining to macromolecules (DNA, RNA, protein).
- After completing this course students will be able to analyse, interpret and study fundamental biological data stored in databases.

Learning outcome

After successful completion of this course, students are expected to:

- Understand fundamentals of computer and internet and world wide web
- Understand the classification database used in bioinformatics Primary and secondary.
- BLAST, gene bank, EMBL, DDBJ, NCBI
- Principles and applications of evolutionary analysis of biological data

Unit	Title	Topic Particular	Lectures
Unit I	**Fundamentals of computer and internet**	• Introduction to Computer system – Hardware's and Software's, operating system (OS). • Concept of the World Wide Web (www), Browsers. • Introduction of the Internet – Definition, History, Basic Concept. • Introduction of Bioinformatics - Definition, history and scope of bioinformatics.	**12**
Unit II	**Biological Databases**	• Overview of Bioinformatics. • Different types of data retrieval and submission. • Introduction to Biological Databases • Sequence database – Primary and Secondary Databases • Nucleic acid sequence database -NCBI (GenBank), EMBL, DDBJ. • Protein / amino acid sequence database - PIR-PSD, SwissProt, TrEMBL	**12**
Unit III	**Online biological data analysis**	• Data analysis using bioinformatics tools. • Sequence comparisons and alignment • Scoring Matrices - • Introduction to FASTA • Introduction and application of BLAST– types of BLAST [BLASTn, BLASTp, BLASTx, t BLASTn, tBLASTx] • Pairwise Sequence Alignments - ▪ Global Alignments - Needleman Wunsch Algorithm ▪ Local Alignments - Smith Waterman Algorithm	**11**

Unit IV	**Evolutionary analysis of biological data**	• Introduction to concepts of phylogenetic tree analysis. • Parts of phylogenetic tree - Root, Branch, Nodes, Clade, Taxon (OUT), Ingroup and Outgroup. • Overview of submission, publication, retrieval of analysed data using bioinformatics tools.	**10**

References

- Baxevanis A.D and Ouellette B.F.F. (2002) Bioinformatics: a practical guide to the analysis of genes and proteins. 2nd Ed. John Wiley & Sons, Inc. Publications, New York.
- Baxevanis A.D, Davison D.B, and Petsko G.A. (2004) Current protocols in bioinformatics. John Wiley & Sons, Inc. Publications, New York.
- Orengo C, Jones D and Thornton J. (2003) Bioinformatics: genes, proteins and computers. Bios Scientific Publishers, Ltd. Oxford.
- Michael R, Barnes and Ian C. Gray. (2003) Bioinformatics for Geneticists. John Wiley & Sons, Ltd.
- Attwood T. K. et al (2007) Introduction To Bioinformatics, Pearson India
- Rastogi SC, Mendiritta N, Rastogi P. (2013) Bioinformatics: Methods and Applications, Prentice-Hall of India Pvt.Ltd
- https://www.ncbi.nlm.nih.gov/

Discipline Specific Core (DSC) Course Practical		
BT 507 Practical Course: Industrial Biotechnology		
Total hours: 60		**Credits: 2**
Sr. No	**Topic**	**Lectures/ Hours**
Course Objectives: • To acquaint with microbial fermentations • Gain knowledge about upstream and downstream process.		
Learning outcomes After successful completion of this course, students are expected to: • Learn principles underlying fermentation processes. • Know various stages in bioprocess that involve upstream and downstream process. • Understand actual fermentation process of some metabolites		
1.	Study of different parts of fermenter	04
2.	Fermentative production of antibiotics/ vitamins	04
3.	Determine thermal death time of given bacteria	04
4.	Fermentative production of enzyme – Amylase/lipase	04
5.	Fermentative production of alcohol using *Sacharomyces cerevisiae*	04
6.	Fermentative production of wine using fruit juice.	04
7.	Fermentative production of organic acid (Citric acid)	04
8.	Estimation of fermentative product (Acetic acid from vinegar)	04
9.	Estimation of ascorbic acid from given food sample/fermented broth by titrimetric method	04
10.	Estimation of penicillin/streptomycin by chemical assay	04
11.	Estimation of penicillin/streptomycin by biological assay	04
12.	Preparation of Sauerkraut by microorganisms	04
13.	Visit to any food /fermentation industry	04
Suggested Readings	• Aneja K. R. (2003) Experiments in Microbiology, Plant Pathology, Tissue Culture and Mushroom Cultivation. Wishwa Prakashan, New Delhi. • Davis J and Freito F Physical and chemical methods of wastewater analyasis. • Gaud R.S., Gupta G. D., Gokhale S.B. (2018) Practical Biotechnology. Nirali Prakashan, Pune • Sadasivam S. & Manickam A (2005) Biochemical Methods, II edn. New Delhi. • Schmauder H-P (2003) Methods in Biotechnology. Taylor & Francis Ltd • Zito S and Gupta S K (2006) A Handbook of Practical and Clinical Immunology, Vol I & II, 2nd Edn. CBS Publishers. • Zito S W Pharmaceutical Biotechnology (1997) A programmed Text. 2nd edn. Technomic publishing Lancaster.	

Discipline Specific Core Course (DSC) Practical

BT-508: Practical Course: Animal Biotechnology and Immunology

Total hours: 60		Credits: 2

Course Objectives:

- To acquaint with Animal cell cultures
- Gain knowledge media and growth conditions require for animal cell culture.
- To train to different immunological techniques.

Learning outcomes

After successful completion of this course, students are expected to:

- achieve skill in animal cell culture techniques
- Learn principles underlying immunological techniques
- Know various immunological techniques and blood group detection.

Sr. No	Topic	Lectures/ Hours
1	Animal cell culture media preparation, sterilization, washing and packing	04
2	Staining of animal tissue by Haematoxylin / Periodate staining	04
3	Observation and identification of different cell types in peripheral blood	04
4	Survival curve of bacteria against UV radiations and chemical mutagens	04
5	Study of nucleic acid separation by Agarose Gel Electrophoresis	04
6	Study of Immuno-Diffusion by Ouchterlony Double Diffusion technique	04
7	Detection of antigen, antibody reaction by ELISA tests	04
8	Preparation of O and H antigen of *Salmonella.*	04
9	Study of agglutination reaction and its significance performing Widal test	04
10	Immobilization of whole cell (yeast) in calcium alginate	04
11	Study of ABO antigens by blood typing	04
12	Visit to Animal cell culture /Diagnostic laboratory	04

Suggested Readings

- Aneja K. R.(2003) Experiments in Microbiology, Plant Pathology, Tissue Culture and Mushroom Cultivation. Wishwa Prakashan, New Delhi.
- Claverie J M and Notredame C (2003) Bioinformatics: A Beginner's Guide. John Wiley & Sons.
- Purohit S. S. (2006) A Laboratory Manual in Plant Biotechnology, India.
- Rashidi H. H. and Buehler L. K. (2005) Bioinformatics Basics: Applications in Biological Science and Medicine. CRS Press, USA.
- Sadasivam S. and Manickam (2005) A Biochemical Methods, 2nd edn. New Delhi.

- Schmauder Hans-Peter (2003) Methods in Biotechnology. Taylor & Francis Ltd
- Schuler M A and Zielinski R E (1989) Methods in Plant Molecular Biology. Academic Press, Inc. USA
- Talwar G P and Gupta S K (2006) A Handbook of Practical and Clinical Immunology, Vol I & II, 2nd Edn. CBS Publishers.
- Vyas S P ad Kohli D. V. (2010) Methods in Biotechnology and Bioengineering. CBS Publishers & Distributors.

Discipline Specific Core Course (DSC) Practical		
BT-509: Practical Course: Applied and Environmental Biotechnology		
Total hours: 60		**Credits: 2**
Sr. No	**Topic**	**Lectures/ Hours**
Course Objectives: • To acquaint with microbial cell from fermented food. • Gain knowledge different water analysis methods. • To train to check different milk quality analysis techniques.		
Learning outcomes After successful completion of this course, students are expected to: • Isolation and characterization of food fermenting organism, • Understand various aspects of environmental biotechnology like BOD, COD • Understand the soil contents.		
1	Isolation and characterization of food fermenting organism from idli batter	04
2	Analysis of mycotoxin (Aflatoxin) in fungus contaminated food material	04
3	Microscopic examination of food/milk by breed method	04
4	Quality checking of milk - MBRT method	04
5	Evaluation of Pasteurization of milk - Phosphatase test	04
6	Determination of Total Viable Count from milk	04
7	Determination of Biological Oxygen Demand (BOD) of polluted water	04
8	Determination of Chemical Oxygen Demand (COD) of polluted water	04
9	Isolation of metal interacting bacteria from industrial effluent.	04
10	Determination of total carbohydrates and phosphorus of soil	04
11	Demonstration of total nitrogen estimation by Kjeldahl's method	04
12	Visit to wastewater treatment plant of any industry	04
Suggested Readings • Plummer D T. (1992) An Introduction to Practical Biochemistry, Tata McGraw Hill Publisher, New Delhi. • Purohit S.S. (1995), A Laboratory Manual of Plant Biotechnology, Agrobotonica Pub. India. Pvt. Ltd., Bikaner • Reddy M. G., Reddy M. N., Saigopal D. V. R. and Mallaiah K. V. (2008) Laboratory experiments in Microbiology, Himalaya Publishing House, Mumbai • Sadashivam S. and Manickam A. (1996), Biochemical Methods, 2nd Edi. New Age International, New Delhi. • Schmauder Hans Peter (1997), Methods in Biotechnology, Taylor and Francis, London. • Schuler M. A. and Zielinski R. E. (1989), method in plant molecular biology.		

T.Y.B.Sc (Biotechnology) Semester-VI

Discipline Specific Core (DSC) Course

BT-601: Recombinant DNA Technology

Total Hours: 45 **Credits: 3**

Course objective

- Provide Basic knowledge of principles of genetic engineering, enzymes, vector types, Methods of gene transfer
- Provide an understanding on application of genetic engineering techniques in basic and applied experimental biology and conducting experiments

Learning outcome

After successful completion of this course, students are expected to:

- Basic principles of genetic engineering, enzymes, vector types, Methods of gene transfer
- Gene cloning, indirect and direct screening
- Expression strategies for heterologous genes, gene bank, animal farming
- Techniques and application DNA sequencing

Unit	Title	Topic Particular	Lectures
Unit I	**Basics of rDNA technology**	• **Genetic engineering**: concept, principle and applications. • **Enzymes:** Restriction endonucleases and its types, DNA methylases, DNA polymerase, DNA ligases, Kinases, Phosphatases, topoisomerases. • **Cloning vectors:** Choice and its properties, Bacterial vectors: plasmid, Bacteriophage, Cosmids, Phagemids, BACs. Eukaryotic vectors: YACs, Ti, SV40 • **Cloning hosts:** Prokaryotic and eukaryotic hosts: properties • **Applications of genetic engineering**: Agriculture, Industry, Environment and Pharmaceutical (with one suitable example of each)	12
Unit II	**Techniques in rDNA Technology**	• Techniques in r DNA technology: Agarose gel electrophoresis, Autoradiography • Gene transfer techniques: Transfection, Electroporation, Microinjection, Biolistic. • Blotting techniques – Southern, Northern, Western and Dot blotting	11
Unit III	**Methods in molecular biology**	• **DNA sequencing**: Sangers method, Maxam and Gilbert method, Automated DNA sequencing • **PCR** – Principle and techniques, applications. Types (Nested, Inverse, Anchored, Reverse, Real-time, Asymmetric) • **Analysis of polymorphism**: RFLP, RAPD, SNPs • **DNA fingerprinting** – Principle, Methodology and applications	11
Unit IV	**rDNA technology:**	• Applications of r-DNA Technology in:	11

	Applications	Health and Medicine: Insulin, Interferon, Hepatitis vaccine, Agriculture: BT, Herbicide resistance • Gene mapping - Co-transformation and interrupted mating experiment	

References

- Arora M.P (2003), Biotechnology, Himalaya Publishing House, Mumbai
- Berg J. M., Tymoczko J. L., Gatto Jr. G. J., Stryer L. (2015), Biochemistry, 8th edition, W. H. Freemand and Company, New York.
- Brown T. A. (2016) Gene Cloning and DNA Analysis: An Introduction", 7th Edition, Wiley-Blackwell Publishers, UK ISBN: 978-1-119-07256-0.
- Bruce A. (2008), Molecular Biology of the Cell, 5th Edition. Publisher: Garland Science, New York.
- Clavene J.M and Notredame C (2003), Bioinformatics: A Beginner's Guide, Wiley-Dreamtech India Pvt.ltd., New Delhi.
- Dubey R.C (2006), A Text Book of Biotechnology, S. Chand and Co. Ltd, New Delhi.
- Jogdand S.N (2006), Gene Biotechnology, Himalaya Publishing House, Mumbai.
- Joshi P (2002), Genetic Engineering and its applications, Agrobios Pub, Jodhpur.
- Krebs J. E., Goldstein E. S., Kilpatrick S. T. (2018), Lewin's Genes XII, Jones and Barlett Learning.
- Mitra Sandhya (2006), genetic Engineering, MacMillan India Ltd, Delhi.
- Satyanarayana U. (2007), Biotechnology, Books and Allied Pvt. Ltd. Kolkata.
- Strickberger M.W. (2015), Genetics, 3rd edition, Pearson, India.

Discipline Specific Core (DSC) Course

BT-602: Plant Biotechnology

Total Hours: 45 **Credits: 3**

Course objective

- This course will provide knowledge about different techniques of plant biotechnology utilized for conservation and mass propagation of rare and endangered plant species to the students.
- The course will enlighten student about principles of plant tissue culture including *in vitro* culture of different plant parts.
- The course will provide detail pertaining to tools and processes involved in generation of transgenic plants.

Learning outcome

After successful completion of this course, students are expected to:

- Understand concept of totipotency, organization of plant tissue culture, aseptic technique of PTC, meristem culture, organ culture
- Principles and applications of phytohormones
- Transgenic plants- methods, analysis, applications
- Concept of transformation and role of Agrobacterium

Unit	Title	Topic Particular	Lectures
Unit I	**Introduction to Plant Tissue Culture**	• Totipotency- Definition and concept. • Laboratory organization of PTC. • Designing of culture media for PTC. • Phytohormones-Definition, Classification, Physiological effects and functions of Auxins, Cytokinins and Gibberellins • Aseptic techniques of PTC	10
Unit II	**Aseptic techniques of PTC**	• Callus and meristem culture. • Organ Culture • Root culture • Anther culture • Pollen culture and protoplast culture • Somatic embryogenesis	12
Unit III	**Transgenic plants**	• Transgenic plants - History and concept • Methods of developing transgenic plants - Electroporation, microinjection, particle bombardment, liposome mediated gene transfer • *Agrobacterium* mediated gene transfer (details of the Ti plasmid and its transfer into plant cells • Analysis of transgenic plant material – selectable marker and reporter gene	12
Unit IV	**Applications of transgenic Plants and IPR**	• Herbicide resistance (Glyphosphate and Atrazine) • Resistance against insects and pests (Bt endotoxin and protease inhibitor) • Plant cells as bio factories for the production of secondary metabolites (biopolymer and protein) • Ecological risk assessment of genetically modified crops	11

		• Intellectual property rights in plant varieties (Plant breeders' rights)	

References

- Gupta P. K. (2005), Elements of Biotechnology, Rastogi Publication Meerut.
- Ignacimuthu S. (1997), Applied plant biotechnology, Science Publishers, U.S.
- Ramavat K. G. (2008), Plant biotechnology, S. Chand and Co., New Delhi.
- Gupta P. K. (2005), Molecular biology and genetic engineering, 1st edition, Rastogi Publication Meerut.
- Verma S. K., Verma M. (1995), A Textbook of Plant Physiology, Biochemistry and Biotechnology, S. Chan and company ltd, New Delhi.
- Satyanarayana U. (2008), Biotechnology, Books and Allied (P) Ltd, Kolkata.
- Jain V. K. (1983), Fundamentals of Plant Physiology, 3rd edition, S. Chan and company ltd, New Delhi
- Chawla H.S. (2009), Introduction to Plant Biotechnology, 3rd edition, CRC press.
- Jogdand S.N. (2012), Advances in Biotechnology, Himalaya Publishing House, Mumbai.

Discipline Specific Core (DSC) Course

BT-603: Immunology

Total Hours: 45 **Credits: 3**

Course objective

- At the end of the course, students will be able to appreciate the strengths and weaknesses of our immune (defence) system.
- The course will provide sound knowledge of how immune system deals with various pathogens, different processes and cell types involved in prevention of disease along with the principle and applications of immune techniques.

Learning outcome

After successful completion of this course, students are expected to:

- Basic principles of Immune system, types of immunity, primary and secondary lymphoid organ.
- Antigen presentation, immune response lymph organs, complements system, immunological disorders.
- Ag-ab interactions, precipitation, agglutination, RIA, ELISA, monoclonal antibodies.

Unit	Title	Topic Particular	Lectures
Unit I	**Cells and Organs of Immune System**	• Blood cells: Morphology, formation and function, regulation of hematopoiesis • Primary lymphoid organs (Structure and function of Thymus and Bone marrow) • Secondary lymphoid organs (Structure and function of Spleen and Lymph node) • Primary and secondary immune response	**10**
Unit II	**Immune Mechanism**	• Antigen processing and presentation: Need of antigen presentation, APC's, Pathways • (Endogenous and Exogenous) • Inflammatory response: Role of lymphocytes in inflammation • Cell Mediated Immunity (T cell types, T cell activation, mechanism) • Humoral immunity (B- cell Proliferation, Differentiation) • Cytokines: Properties and role with examples • Complement system: Classical and Alternative pathway, Complement deficiency, • Biological activities of complement activation.	**12**
Unit III	**Immunological Disorders**	• Hypersensitivity: Types and mechanism in detail (Type I to IV) • Autoimmune diseases: a. Anemia b. Rheumatoid arthritis c. Diabetes • Myasthenia gravis	**11**
Unit IV	**Immunological Technique**	• Radio-Immuno Assay (RIA) • Enzyme Linked Immuno Sorbent Assay (ELISA): Direct and indirect ELISA	**12**

		• Immunofluorescence: Direct and indirect • Immunoelectrophoresis • Complement fixation • Western blot • Immunodiffusion	

References

- Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 6th edition Saunders Publication, Philadelphia.
- Ananthnarayan, P., Paniker, C. K.J., (1990), Textbook of Microbiology, Orient Longman, Madras.
- Banker, D (1980), Modern Practice in Immunization, 3rd Ed., Popular Prakashan Pvt. Ltd., Bombay.
- Glazier, A. M., Nikaido, H., (1995), Microbial Biotechnology, W. H. Freeman and Co., New York.
- Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 6th edition W.H. Freeman and Company, New York.

Discipline Specific Core (DSC) Course

BT-604: Bioprocess Technology

Total Hours: 45 **Credits: 3**

Course objective

- To understand the role of a bioprocess engineer in chemical, pharmaceutical and wine industry.
- The student would be able to understand the integrated bioprocess, design reactors, process economics, quality aspects, IPR and patenting,
- To develop concepts to scale-up bioprocesses for industry as well as research organizations.

Learning outcome

After successful completion of this course, students are expected to:

- Basic principles of upstream and downstream process of different commercially important products: enzymes, antibiotics, organic acids
- Understand Quality and economic aspects ion fermentation
- Understand the principles and role of biotechnologist in QC, QA, IPR and patenting.

Unit	Title	Topic Particular	Lectures
Unit I	**Fermentation products**	Fermentation processes with respect to - Microorganisms involved, inoculum preparation, medium used, fermentation process and recovery of: • Enzyme: Amylase • Organic acid: Citric acid • Antibiotic: Cephalosporin • Vitamin - Vitamin B_{12} • Beverages: Wine	12
Unit II	**Biotransformation and immobilization**	• Biotransformation: Concept and types of biotransformation reactions. • Biotransformation of steroids, Antibiotics, Arachidonic acid to prostaglandins with respect to their applications in pharmaceutical industry. • Immobilization of enzyme: solid support, Methods of immobilization. • Commercial applications of immobilized enzymes in food industry, pharma, dairy &other applications.	12
Unit III	**Quality and economic aspects of biological products**	• Sterility testing. • Pyrogen testing. • Carcinogenicity testing. • Toxicity testing • Good Laboratory Practices (GLP • Fermentation economics: Cost estimates, capital cost estimates, operating cost estimates. process design	10
Unit IV	**Intellectual Property Rights**	• Introduction to Patent, steps involved in filling, trade secret, • Copy rights and Trademark, Designs and Geographical Indication. • Introduction to - GATT (General Agreement of Tariff and Trades) and	11

		• TRIPS (Trade-Related Aspects of Intellectual Property Rights agreement) • Patenting of microorganisms, transgenic organisms, higher plants and higher animals.	

References

- Patel, A. H., Industrial Microbiology, 2nd edition, (2016), Laxmi Publications, New Delhi.
- Pauline Doran, Bioprocess Engineering Principles, 2nd Edition, (2012), Academic Press.
- Peter F. Stanbury. (2009) Principles of Fermentation Technology, 2E, Elsevier India Pvt. Limited.
- Satyanarayan, U., (2009) Biotechnology, Books and Allied Pvt. Ltd.
- Schuler, M. and Kargi, F. (2002) Bioprocess Engineering - Basic Concepts, 2nd edition, Prentice Hall.
- http://copyright.gov.in/frmContactUs.aspx
- www.ipindia.nic.in

Skill Enhancement Course (SEC)

SEC: BT-605: Pharmaceutical Biotechnology

Total Hours: 45 **Credits: 3**

Course objective

- To introduce undergraduate students the basic concepts of pharmaceutical biotechnology.
- The course will provide the basic information about various terms, concept, production and analytical techniques of pharmaceutical biotechnology.

Learning outcome

After successful completion of this course, students are expected to:

- Gain basic knowledge applications of biotechnology in the field of pharmaceuticals.
- Will understand the concept of drug discovery, drug designing.
- Will get knowledge of various medicinally important secondary metabolites as well as the role of recombinant DNA technology for the improvement of productivity and efficacy.

Unit	Title	Topic Particular	Lectures
Unit I	**Introduction to pharmaceutical biotechnology**	• Introduction of pharmaceutical biotechnology / Biopharmaceuticals. • Introduction to drug design and discovery • Stages in the drug discovery process. • Computer-Aided Drug Design (CADD) • Concept of Prodrug • Applications of pharmaceutical biotechnology.	11
Unit II	**Secondary metabolites of plant and microorganisms**	• Introduction of secondary metabolites. • metabolites of plant – Phenolics, Alkaloids, Saponins, Terpenes, Lipids and Carbohydrates • Secondary metabolites of microorganisms – Antibiotics, Antitumor agents, • Pharmacological and nutraceutical agents, Enzymes and enzyme inhibitors and agricultural and animal health products	11
Unit III	**Advances in pharmaceutical biotechnology**	• Recombinant DNA technology (RDT) • Techniques of gene manipulation, cloning strategies, cloning and expression vectors, recombinant selection and screening, expression in *E.coli* and yeast. • Applications of the RDT in the production of in the production of recombinant proteins (rProteins) a) Regulatory proteins interferon, interleukins etc. b) Blood products – Erythropoietin. c) Hormones: Insulin.	12
Unit IV	**Vaccines**	• Definition and Characteristics of ideal vaccine, • Types of vaccines with one example, • Modern vaccines:	11

		a) Recombinant vaccines: Hepatitis – B, b) Edible vaccines: concept with suitable example c) Subunit vaccines d) DNA vaccines.	

References

- Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 6th edition W.H. Freeman and Company, New York.
- Hussein, R. A., and El-Anssary, A. A. (2018). Plants secondary metabolites: the key drivers of the pharmacological actions of medicinal plants. Herbal Medicine.
- Liljefors, T., Krogsgaard-Larsen, P., & Madsen, U. (Eds.). (2002). Textbook of drug design and discovery. CRC Press.
- Schäfer, H., and Wink, M. (2009). Medicinally important secondary metabolites in recombinant microorganisms or plants: progress in alkaloid biosynthesis. *Biotechnology Journal: Healthcare Nutrition Technology*, 4(12), 1684-1703.
- Thirumurugan, D., Cholarajan, A., Raja, S. S., & Vijayakumar, R. (2018). An introductory chapter: secondary metabolites. Second metab—sources Appl, 1-21.
- Zaroff, S., and Tan, G. (2019). Hybridoma technology: the preferred method for monoclonal antibody generation for in vivo applications.

Discipline Specific Elective (DSE) Course

BT-606A: Environmental Biotechnology-II

Total Hours: 45 **Credits: 3**

Course objective

- This course will provide the students basic knowledge of Methods and applications of taxonomy.
- The course will enlighten student about principles of bioprospecting, biomonitoring of soil and air.
- The course will provide detail pertaining Principles of Toxicology and Biodiversity and its Conservations.

Learning outcome

After successful completion of this course, students are expected to:

- Understand basic knowledge of Methods and applications of taxonomy, nomenclature with respect to plants, animals and prokaryotes
- Principles and applications bioprospecting, biomonitoring of soil and air
- Detail understanding of pprinciples of toxicology and Biodiversity and its conservations

Unit	Title	Topic Particular	Lectures
Unit I	**Methods in taxonomy**	• Evolutionary classification, taxonomic hierarchy, concept of species • Numerical taxonomy, dendrogram and cladogram • Chemotaxonomy, nomenclature with respect to plants, animals and prokaryotes (suitable examples) • Application of taxonomical methods in biodiversity	**10**
Unit II	**Bioprospecting**	• Concept and examples of bioindicators (plants, algae, rotifers, earthworms, protozoa and microbes) and biomonitoring. • Biomonitoring of aquatic environment • Biomonitoring of soil environment. • Biomonitoring of air quality (pollen bioassay) • Principle and applications of biosensors in environmental analysis.	
Unit III	**Principles of Toxicology**	• Concept, classification, toxic effects, definition and estimation of LD_{50}. • Evaluation of toxicity: Acute, sub-acute and chronic toxicity testing, mutagenic assay (Ames assay), reproductive toxicity tests. • Metabolism of Xenobiotics: Cytochromes P_{450} system, Phase – I and Phase –II metabolic reactions. • Environmental toxicities with special reference to DDT, organophosphorous and organochlorine pesticides, heavy metals.	
Unit IV	**Biodiversity and its Conservations**	• Species concept, species diversity and ecostability (plant, animal and microbial),	

		Red Data Book, Endangered Species. • Hot spots of biodiversity, biodiversity at national level. • Causes and implications of loss of biodiversity • Conservation of biodiversity: *in-situ* and *Ex-situ* methods (principle and applications) • Convention on biodiversity (Earth Summit, Rio de Janeiro) • National Biodiversity Authority constitution and role.	

References

- Agrawal K. C. (1999) Biodiversity. Agro Botanica, Bikaner.
- Arora M. P.(2017) Biotechnology, Himalaya publishing house, Mumbai
- Asthana D. K. and Asthana M. (1998) Environment – Problems and solutions.
- Chatterji A. K.(2011) Introduction to Environmental Biotechnology
- Evans G. M and Furlong J. C. (2010) Environmental Biotechnology Theory and application.
- Gupta P. K. (2017) Biotechnology & Genomics in Crop Improvement Rastogi Publications. Meerut
- Ignacimuthu S (2007) Basic Biotechnology, Tata McGraw Hill Pub. Co. Ltd
- Kale V and Bhusari K (2010) Applied Microbiology Himalaya Publishing house.
- Purohit S.S.(1995) Agricultural Biotechnology Agro Botanica, Bikaner

Discipline Specific Elective (DSE) Course

BT-606B : Biostatistics

Total Hours: 45 **Credits: 3**

Course objective

- Provide detail knowledge about basic principles in biophysics, data collection and analysis
- To enrich the students how to utilize various tools of biostatics in interpretation of biological data.
- The course covers other core areas of biostatistics including probability, correlation and regression.

Learning outcome

After successful completion of this course, students are expected to:

- Students will be able to characterize data and understand different sampling methods.
- Use descriptive tools to summarize and display biological data
- Identify appropriate statistical methods to be applied in each research setting, apply these methods, and acknowledge the limitations of those methods

Unit	Title	Topic Particular	Lectures
Unit I	**Introduction of biostatistics, sampling and probability**	• Introduction: Meaning, definition, Importance of the study of biostatistics, Biostatistics and its role in medical and agricultural biotechnology, Variables and their types, Measurement scales. • Defining population and selecting samples: Definition, Types- simple, random, stratified, cluster and double sampling. • Need for sampling - Criteria for good samples, Application of sampling • Probability and Standard Distributions: Meaning of probability of standard distribution, the binominal distribution, the normal distribution,	12
Unit II	**Systematic organization and Display of data**	• Tabulation of Data: Types of data- qualitative and quantitative, Frequency tables and histograms, frequency polygons, smooth frequency polygon, cumulative frequency curve, Normal probability curve, bar charts and pie charts • Importance and application of following: Testing of Hypotheses Level of significance, Degrees of freedom, Chi-square test, test of Goodness of fit & student t-test and p – value**.**	12
Unit III	**Measures of central tendency**	• Need for measures of central Tendency and Definition • The Arithmetic Mean • The Geometric Mean • The Harmonic Mean • The Median, The Mode	11
Unit IV	**Measures of Dispersion**	• Range, mean deviation, standard deviation and variance	10

		• Correlation and regression: Significance and correlation coefficient	

References

- Introduction to Biostatistics, (2004) Larry Winner, Department of statistics, University of Florida.
- Marc M. Triola and Mario F. Triola, (2006) Biostatistics for the biological and Health sciences.
- Michael Harris, Gordon Taylor (2003), Medical statistics made easy, an imprint of the Taylor & Francis group, UK.
- Michael R. Chernick, Robert H. Friis, (2003) Introductory biostatistics for health science, a John Wiley and son's publication.

Discipline Specific Core (DSC) Practical (Sem-VI)

BT-607: Practical Course: Plant Biotechnology

Total hours: 60 | **Credits: 2**

Course Objectives:

- To acquaint with preparation of biofertilizer.
- Gain knowledge regarding plant tissue culture media formulations.
- To train to different techniques concerned to plant tissue culture.

Learning outcomes

After successful completion of this course, students are expected to:

- Isolate and characterization of: *Xanthomonas citri*, *Rhizobium* sp, preparation and efficiency testing of biofertilizer.
- Preparation of stock solutions, explant sterilization, media preparation and sterilization, callus culture, shoot tip culture.

Sr. No	Topic	Lectures/ Hours
1	Isolation and identification of *Xanthomonas citri* from infected citrus fruit or leaf.	04
2	Isolation of *Rhizobium* sp. from root nodule of leguminous plant.	04
3	Preparation and efficiency testing of biofertilizer-pot assay	04
4	Determination of IAA oxidase activity	04
5	Preparation of plant tissue culture explant and its sterilization	04
6	Preparation of stock solutions of plant tissue culture media	04
7	Preparation of plant tissue culture media	04
8	Callus culture using suitable explant of medicinal plant	04
9	Shoot tip culture in banana OR Any medicinal plant	04
10	Micropropagation of medicinal plant by meristem culture	04
11	Preparation of synthetic/ artificial seeds	04
12	Visit to plant tissue culture facilities / biofertilizer industry	04

Suggested Readings

- Gaud R.S. (2007) Practical Biotechnology Nirali Prakashan, Pune
- Parija S. C. (2007) Textbook of Practical Microbiology, Ahuja Publishing House New Delhi
- Plummer D T. (1992) An Introduction to Practical Biochemistry, Tata McGraw Hill Publisher, New Delhi.
- Purohit S.S. (1995), A Laboratory Manual of Plant Biotechnology, Agrobotonica Pub. India. Pvt. Ltd., Bikaner
- Reddy M. G., Reddy M. N., Saigopal D. V. R. and Mallaiah K. V. (2008) Laboratory experiments in Microbiology, Himalaya Publishing House, Mumbai
- Schuler M A and Zielinski R E (2012) Methods in Plant Molecular Biology. Academic Press; 1 edition.
- Sharma P D (2018) Ecology and Environment. Rastogi Publications, Meerut.
- Smith R H (2012) Plant tissue culture: techniques and experiments Academic Press; 3rd Edn
- Vyas S P ad Kohli D. V. (2010) Methods in Biotechnology and Bioengineering. CBS Publishers & Distributors

Discipline Specific Core (DSC) Practical

BT-608: Practical Course: Genetics and Bioinformatics

Total hours: 60		Credits: 2

Course Objectives:

- To learn the laws in genetics
- To understand the principle and methods of genetics and bioinformatics.
- To acquaint the students with the different database in bioinformatics.

Learning outcomes

After successful completion of this course, students are expected to:

- Understand and verification of Mendel's laws using color beads
- Shall able to perform DNA isolation, perform transformation and conjugation in bacteria.
- Understand biological database and database search on web, shall access database Preparation of stock solutions, searching for gene and protein sequences.

Sr. No	Topic	Lectures/ Hours
1	Monohybrid and Dihybrid crosses in Pea/Drosophila demonstrating Mendel's law of	04
2	Inheritance.	04
3	Problems set in Mendelian inheritance, single point, two-point crosses and gene mapping in bacteria	04
4	Study of conjugation in bacteria	04
5	Development of competent cell system and study of transformation in bacteria	04
6	Isolation of DNA from Bacterial cell/ Plant cell	04
7	Demonstration of various domains (search engines) for bioinformatics through internet	04
8	Amplification of DNA fragment using PCR.	04
9	Concept of databases: Accessing database	04
10	Demonstration on Multiple sequence alignments.	04
11	Searching for gene and protein sequences and accessing information from web	04
12	Protein structure using RASMOL/ RASWIN	04

Suggested Readings

- Harley, J.P. and Prescott, L. M (1996) Lab. Exercises in Microbiology, 3rd Ed, WCB /McGraw Hill Inc.
- Jayararnan, I (1981) Lab.oratory Manual in Biochemistry, Wiley Eastern Ltd., New Delhi.
- Kalaichelvan P.T. and Dandiya P.C (2004), Microbiology and Biotechnology: A Laboratory Manual, MJP Publishers, Chennai.
- Parija S. C., Textbook of Practical Microbiology, Ahuja Publishing House New Delhi
- Plummer D T. (1992) An Introduction to Practical Biochemistry, Tata McGraw Hill Publisher, New Delhi.
- Purohit S.S. (1995), A Laboratory Manual of Plant Biotechnology, Agrobotonica Pub.

India. Pvt. Ltd., Bikaner
- Reddy M. G., Reddy M. N., Saigopal D. V. R. and Mallaiah K. V. (2008)
- Laboratory experiments in Microbiology, Himalaya Publishing House, Mumbai
- Sadashivam S. and Manickam A. (1996), Biochemical Methods, 2nd Edi. New Age International, N. Delhi.

Discipline Specific Core (DSC) Practical

BT-609: Practical Course: Pharmaceutical Biotechnology

Total hours: 60		**Credits: 2**

Course Objectives:

To acquaint with knowledge about Quality Control test in pharmaceutical industry.

Learning outcomes

After successful completion of this course, students are expected to:

- Understand and perform sterility testing of pharmaceutical products, chemical and biological, MIC
- Understand and perform MLT, validation of LAF, membrane filtration and sterility testing.

Sr. No	**Topic**	**Lectures/ Hours**
1	Good Manufacturing Practices (GMP) and Good Laboratory Practices (GLP) in pharmaceutical industry.	
2	Sterility testing of pharmaceutical products injectable/Ophthalmic solution	04
3	Chemical assay of antibiotic (Streptomycin/penicillin)	04
4	Determination MIC of antibiotics against test microorganism	04
5	Microbiological assay of Streptomycin or Penicillin by cup plate/ paper disc method	04
6	Determination of Minimum Inhibitory Concentration (MIC) of Antibiotic	04
7	Microbial limit test (MLT) of pharmaceutical product	04
8	Validation of autoclave using biological indicator	04
9	Validation of laminar air flow cabinet	04
10	Isolation of antibiotic resistant bacterial population by gradient plate method	04
11	Sterility testing by membrane filter technique	04
12	Visit to pharmaceutical industry	04

Suggested Readings

- Davis J. and Freito F. (1970) Physical and chemical methods of wastewater analysis. FAO Bulletin, Rome, Italy.
- Gaud R.S.(2007) Practical Biotechnology Nirali Prakashan, Pune
- Sadasivam S. and Manickam A (2005) Biochemical Methods, 2nd edn. New Delhi.
- Schmauder Hans-Peter (2003) Methods in Biotechnology. Taylor & Francis Ltd
- Talwar G P and Gupta S K (2006) A Handbook of Practical and Clinical Immunology, Vol I & II, 2nd Edn. CBS Publishers.
- Zito S W (2006) Pharmaceutical Biotechnology: A programmed Text. 2nd Edn. Technomic Publishing Co., Inc., USA.

Skills acquired and Job prospects for the Biotechnology students

Biotechnology has aroused in past few decades owing to application of knowledge regarding the living systems for the betterment of the mankind. Degree program in Biotechnology teaches students how the living organisms including microbes, plants and animals could be used to produce something very useful for the human being at large. A significant attraction of the course is the ability to combine in-depth scientific knowledge with practical laboratory skills and the career opportunity in all biological sectors.

After successful completion of three years degree course in Biotechnology, student will be well versed with laboratory skills and transferable skills.

Laboratory Skills:

- Laboratory safety practices
- Skillful handling of microbial, animal and plant cell cultures and aseptic techniques
- Skillful handling of bioreactor and its use
- Molecular kit based and protocol-based analysis
- Handling of Bioinformatics software and results interpretation.
- Advanced techniques like- Chromatography, Electrophoresis, Spectrometry etc.
- Diagnostic techniques, microbial analysis of food, dairy, pharma products.
- Analysis and interpretation of results and logical thinking

Transferable Skills:

During the course student will develop skills other than laboratory skills that are transferable across the number of career areas essential in food, pharma biotechnology-based industries and even for higher studies. These are:

- Analytical skill, Observational skill
- Planning and Time management
- Mathematical and IT skills
- Creative thinking, Problem solving
- Report writing skill, Presentation skill

Job Opportunities:

After successful completion of B.Sc. in Biotechnology, student may continue further studies like M.Sc. in Biotechnology and then Ph.D. in Biotechnology and make career in research field. Students have opportunities in private as well as public (Government) sectors.

Private Sector:

Biotechnologist can work in quality control, quality assurance and R & D divisions of companies like-Biotechnology based industries like Pharmaceutical companies, Chemical manufacturing companies, Food and Drink(includes brewing), Health and Beauty Care,

Medical Instrument companies, Agricultural companies, Research Companies and Laboratories etc.

Public Sector:

Cancer research institutes, Environmental Pollution Control, Forensic Science, Hospitals, Public Health Entities, Public Health Laboratories, Agriculture and fisheries etc.

Job profiles:

Biotechnologist, Biologist, Biomedical Scientist, Biotechnologist, plant or animal tissue culture scientist, Chemical Examiners, Chemist, Clinical Scientist, Food Scientist, Forensic Scientist, Laboratory Technician, Research Associates, Research Officers, Research Scientist etc.

Opportunities in higher studies

After successful completion of B.Sc. in Microbiology, student may continue further studies like M.Sc. in Biotechnology / Biochemistry and pursue higher studies. Even students can pursue other courses where graduation is essential.

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