North Maharashtra University, Jalgaon

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

Structure of syllabus

B. Sc. [Biotechnology]

F. Y. B. Sc.

Choice Based Credit System (CBCS)

[2018 - 19]

F. Y. B. Sc. Biotechnology (CBCS pattern)

Prologue

The 21st Century is recognized as the Century of Biotechnology. Biotechnology is established as an advanced interdisciplinary applied science in last few years. Biotechnology has pervaded in almost every arena touching practically every human activity. The applied aspect of Biotechnology is now getting established with its applications in Industry, Agriculture, Health and Environment. Biotechnology sector in academic, research and industry front is expanding at rapid rate and set to augur the next major revolution in the world. For this, Biotechnology demands a trained, skilled human resource to establish the industry and research sectors.The cumulative demand for trained and skilled workforce in the area of Biotechnology necessitate in depth functional acquaintance of biological science through hands-on training to the students.

Hence, the syllabus orientation should be altered to keep pace with developments in the education and industrial sector. The need of the hour is to design appropriate syllabi that emphasize on teaching of technological as well as the economic aspects of modern biology.

Theory augmented with practical skill sets will support a graduate to benefit the opportunities in the applied fields (research, industry or institutions), without any additional training. Thus, the university/ college itself will be developing the trained and skilled man-power.
B.Sc. program in Biotechnology as one of the core subject is designed to cultivate a scientific attitude and interest towards the modern areas of biotechnology in particular and life science in general so that the students become critical and curious in their outlook. The courses are designed to impart the essential basics in Plant Science, Animal Science, Microbiology Biochemistry, Chemistry and Biotechnology.

Being an interdisciplinary subject, the present syllabus will amalgamate the principles of physical, chemical and biological sciences along with advanced technology. The undergraduate curricula are prepared to impart primarily basic knowledge of the respective subject from all possible angles so that postgraduate syllabus will emphasize more on applied aspect.

The present syllabi is restructured anticipating the future needs of Biotechnology Sector with more emphasis on imparting hands-on skills. The main thrust is laid on making syllabus compatible with developments in academics, research and industrial sectors. The Theory and Practical course in new restructured course will lead to impart skill-set essentials to further Biotechnology Sector. The curriculum aims to impart basic knowledge with more emphasis on its applications to make the students industry ready.

- To acquaint with the concepts in various allied subjects
- To improve students' knowledge
- To help the students to build interdisciplinary approach
- To instill sense of scientific responsibilities and social and environment awareness
- To help students build-up a progressive and successful career

On this premise, Board of Studies in Life Sciences in its meeting held on 23/06/2018 resolved to accept the revised syllabus for F.Y.B.Sc. (Biotechnology) based on Choice Based Credit System (CBCS) of UGC guidelines.

Scheme for B.Sc. program (Faculty of Science and Technology)

		First Year				Second Year				Third Year				Total Credit value
		Semester I		Semester II		Semester III		Semester IV		Semester V		Semester 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					4 X 14=56
	(ii) Practical	2	4	2	4	2	3	2	3					2 X 14=28
2	**Ability enhancement compulsory course (AECC) (2)**	2	1	2	1									2 X 2 =04
3	**Skill Enhancement Course (SEC)** (4)					2	1	2	1	2	1	2	1	2 X 4 = 16
4	**Discipline Specific Elective DSE (6)**													
	(i) Theory									4	3	4	3	4 X 6 =24
	(ii) Practical									2	3	2	3	2 X 6 =12
	Total Credit value (Credit x No. of Courses)	**26**		**26**		**20**		**20**		**20**		**20**		**132**

Course Structure:

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

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

The present syllabus has been prepared to (i) accommodate the advanced topic on the Biotechnology discipline, (ii) build the basic science knowledge at the level of first year of Biotechnology and (iii) reflect the changing needs of the students, pertaining to the fields of Chemistry, Bioinformatics and Computational skills. The detailed syllabus for each paper is appended with a list of suggested readings.

At first year of under-graduation, students are given exposure to basic science to build the foundation of advance Biotechnology. For this purpose, more focus on relevant experimentation on the topics are included in practical course. In practical course, students will be trained in preparing laboratory manuals, standard operating practices and log books.

At second year under-graduation, students will be introduced to different areas necessary to form the basis of biotechnology like genetics, immunology, molecular biology, and bioprocess biotechnology. The relevant practicals are included to enrich their knowledge.

At third year under-graduation, six theory and three practical papers each for two semesters are included to uncover all applied areas of Biotechnology.

The courses codes and titles for the courses are as given below: BT: Biotechnology,

Core Courses [CC] (12 Courses)

Semester	CC - A and B	Paper code	Paper I	Paper code	Paper II	Practical paper code	Practical Paper
I	CC A I	BT 101	Cell Biology	BT102	Biochemical Tools	BT103	Practical paper I
II	CC AII	BT 201	Biomolecules	BT 202	Basic Microbiology	BT 203	Practical paper II
III	CC A III	BT 301	Basic Genetics	BT 302	Bioprocess Technology	BT 303	Practical Paper III
IV	CC A IV	BT 401	Molecular Biology	BT 402	Immune response	BT 403	Practical Paper IV

Discipline Specific Elective [DSE] (Six each semester)

	DSE	Paper code	Paper I	Paper code	Paper II	Practical paper code	Biotechnology Practical Paper
V	A I	BT 501	Advanced Genetics	BT 502	Immunology	BT 503	Practical Paper V
	A II	BT 504	Cell Physiology	BT 505	Cellular Metabolism	BT 506	Practical Paper VI

	A III	BT 507	Microbial Biotechnology	BT 508	Environmental Biotechnology	BT 509	Practical Paper VII
VI	A IV	BT 601	Plant Biotechnology	BT 602	Animal Biotechnology	BT 603	Practical Paper VIII
	A V	BT 604	Genetic Engineering	BT 605	Molecular Diagnostics	BT 606	Practical Paper IX
	A VI	BT 607	Bioinformatics	BT 608	Enzyme Technology	BT 609	Practical Paper X

More Options to Discipline Specific Elective

DSE	Paper I	Paper II	Practical Paper
DSE 4	Drug Design	Pharmaceutical Biotechnology	Practical Paper
DSE 5	Developmental Biology	Aquaculture Biotechnology	Practical Paper
DSE 6	Virology	Toxicology	Practical Paper
DSE 7	Nano-biotechnology	Food Biotechnology	Practical Paper
DSE 8	Project Dissertation Course		

Skill enhancement courses (SEC) (any Four):

Student has choice to study any four courses from respective semester subject to the availability of particular course at respective college

Semester	SEC	Course Title	SEC	Course Title
III	SEC I	Algal and Mushroom Cultivation	SEC II	Lignocellulosic Biomass Conversion Techniques
IV	SEC III	Animal and Plant Tissue Culture Techniques	SEC IV	Bioanalytical Instrumentation
V	SEC V	Biostatistics	SEC VI	Bioethics and Biosafety
VI	SEC VII	Intellectual Property Rights	SEC VIII	Business Management

Scheme for F. Y. B. Sc. (Biotechnology)

Semester	**CORE COURSE**				**Ability Enhancement Compulsory Course (AECC)**		
	DSC		Credits	Lectures		Credits	Lectures
I	DSC - 1 A: Core Course I: **Biotechnology**	Paper I Paper II Practical Paper	2 2 2	30 30 60	**AECC** 1: English/Marathi/Communication	2	60
	DSC - 2 A: Core Course II	Paper I Paper II Practical Paper	2 2 2	30 30 60			
	DSC - 3 A: Core Course III	Paper I Paper II Practical Paper	2 2 2	30 30 60			
	DSC - 4 A: Core Course IV	Paper I Paper II Practical Paper	2 2 2	30 30 60			
II	DSC - 1 B Core Course I: **Biotechnology**	Paper I Paper II Practical Paper	2 2 2	30 30 60	**AECC** 2: Environmental Science	2	60
	DSC- 2 B Core Course II	Paper I Paper II Practical Paper	2 2 2	30 30 60			
	DSC- 3 B: Core Course III	Paper I Paper II Practical Paper	2 2 2	30 30 60			
	DSC- 4 B: Core Course IV	Paper I Paper II Practical Paper	2 2 2	30 30 60			

Student has choice to study three subsidiary subjects from **DSC 2, DSC 3 and DSE 4** among Chemistry/ Botany/ Zoology /Geography during I, II, III and IV semester; subject to availability of course at respective college.

Duration of Lecture: 30 Lectures of 60 minutes or 36 Lectures of 50 min. Each theory and practical course has to be completed in 30 and 60 lectures, respectively of 60 min duration

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.

- **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). The pattern of question papers shall be:
  - **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 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 -1pm/ 2 – 5 pm for 2 consecutive days) in case of microbiology practicals where incubation condition, allied aspect are essential. There shall be 5 marks for laboratory log book 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 expert and two examiners (external and internal) per batch for the practical examination

Equivalence for F.Y. B.Sc. (Biotechnology) is furnished in the following table:

Old Syllabus (w. e. f. June 2015- 2016) (Semester pattern 60:40)	**New Syllabus (w. e. f. June 2018 -19) CBCS pattern (Semester pattern 60:40)**
BT-111 Foundations of Biotechnology	BT-101 Cell Biology
BT-112 Methods in Biotechnology	BT-102 Biochemical Tools
BT-121 Biomolecules	BT-201 Biomolecules
BT-122 Microbial Techniques	BT-202 Basic Microbiology

F. Y. B. Sc. (Biotechnology)
Semester – I

Semester	CC -A and B	Paper code	Paper I	Paper code	Paper II	Paper code	Biotechnology Practical Paper
I	CC A I	BT101	Cell Biology	BT102	Cell Physiology	BT103	Practical paper I
II	CC A II	BT201	Biomolecules	BT202	Basic Microbiology	BT203	Practical paper II

CC A I: Paper I
BT101: Cell Biology (Theory)

Total Hours: 30 **Credits: 2**

Unit	Title	Particular Topic	Lectures
Course objective	**To introduce biotechnology and its various applications in various fields of human life and to apprise about basic concepts in cell biology**		
Learning outcome	**Students are expected to:** ▪ **learn basic knowledge pertinent to cell as unit, cell organelles and its architecture** ▪ **know the structural and functional details of cell** ▪ **find answers related to the scope of biotechnology** ▪ **understand how science works** ▪ **aware about biotechnology and its application in various fields**		
I	**Introduction to biotechnology**	▪ Introduction to biotechnology and historic perspectives ▪ Scope of biotechnology in Agriculture, Industry, Medical and Environment ▪ Introduction to Genetic engineering, Bioinformatics and Nano-biotechnology ▪ Applications of Biotechnology: Agriculture, Pharmaceutical, Environment, Fermentation. ▪ Commercial opportunities in Biotechnology sector at national and international level ▪ Safety and ethics in Biotechnology	**08**
Unit II	**Cell Biology**	▪ Cell: Introduction and classification of organisms by cell structure, Prokaryotic and Eukaryotic cell, cytosol, compartmentalization of eukaryotic cells, cell fractionation. ▪ Cell membrane and permeability: Chemical components of biological membranes, organization and Fluid Mosaic Model, cell recognition and membrane transport. ▪ Membrane Vascular system, cytoskeleton and cell motility: Structure and function of microtubules, Microfilaments, ▪ Cell cycle, Mitosis and Meiosis	**12**
Unit III	**Cell organelles**	▪ Cell disruption and methods of cell disruption ▪ Endoplasmic reticulum: Structure, function including role in protein segregation	**10**

		▪ Golgi complex: Structure, biogenesis and functions including role in protein secretion. Lysosomes: Vacuoles and micro bodies: Structure and functions ▪ Ribosomes: structure of prokaryotic and eukaryotic, and functional role in protein synthesis. ▪ Mitochondria: Structure and function, Mitochondrial DNA, biogenesis. ▪ Chloroplasts: Structure and function, Chloroplast DNA, biogenesis ▪ Nucleus: Structure and function, chromosomes and their structure, euchromatin and heterochromatin	
	Suggested readings	1. Karp, G. (2010) Cell and Molecular Biology: Concepts and Experiments, 6th Edition, John Wiley & Sons. Inc. 2. De Robertis, E.D.P. and De Robertis, E.M.F. (2006) Cell and Molecular Biology, 8th edition, Lippincott Williams and Wilkins, Philadelphia. 3. Cooper, G.M. and Hausman, R.E. (2009) The Cell: A Molecular Approach, 5th edition, ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA. **4.** Becker, W.M., Kleinsmith, L.J., Hardin, J. and Bertoni, G.P. (2009) The World of the Cell, 7th edition, Pearson Benjamin Cummings Publishing, San Francisco.	

CC A I: Paper I
BT102: Biochemical Tools (Theory)

Total Hours: 30 **Credits: 2**

Unit	Title	Topic Particular	Lectures
Course objective	**To complement the students with routine biochemical tools adopted in biotechnology studies**		
Learning outcome	**Students are expected to be able to:** ▪ **Demonstrate theory and practical skills in different types of microscopy and their handling techniques and staining procedures** ▪ **Understand the fundamental biochemical concepts and familiarize with standard solution, buffer and reactions** ▪ **Describe the concepts of pH and its biological significance, buffers, Henderson-Hasselbalch equation, biological buffer systems and their importance** ▪ **Know the terms and terminologies related to basic biochemical aspects**		
I	**Biochemical concept**	▪ Structure of atoms and molecules, and chemical bonds (covalent, ionic, Hydrogen, van der waal's, hydrophobic ▪ Overview of major elements involved in formation of biomolecules: C,N,P,S,O,H	**10**

		▪ Water: chemical composition, interactions with biomolecules, solvent properties ▪ Concept and type of biochemical reactions, mechanism of reactions ▪ Solution, and type of solutions (homo- and hetero-geneous), standard solutions ▪ Concept of pH, pOH, buffer system, type of buffer solutions, buffer system for blood, biological buffers, weak acid and weak base, dissociation constant of weak acid and base, *pKa*, pH and pH scale, titration curve, Henderson-Hasselbatch equation and buffers used in chemical reactions ▪ Titration, types of titration: acid base titration, precipitation titration, redox titration, complexometric titration ▪ Enzymes concept, active site, Transition state theory, classification and Coenzymes, applications	
Unit II	**Microscopy**	▪ Concept of microscopy: Resolution, magnification, Numerical aperture, and illumination systems in microscope ▪ Lens aberrations and its correction system ▪ Light microscope: principle, ray diagram, components, working and applications of Bright field, dark field and phase contrast microscope ▪ Electron microscope: Principle, ray diagram, construction, working and applications of TEM and SEM ▪ Sample preparation for electron microscope and ultramicrotomy	**10**
Unit III	**Stains and staining techniques**	▪ Concept of dyes and biological stains ▪ Type of stains, mordents, accentuators, fixatives ▪ Staining techniques: Simple (Monochromatic, and Negative), differential (Gram's and acid fast staining), Lactophenol cotton blue staining for fungi, ▪ Histochemical techniques: plant and animal cell staining, Haematoxylin staining, Periodate staining (PAS), Thionyl staining and Fluorescence staining	**10**
	Suggested readings	1. Channarayappa (2006) Molecular Biotechnology: Principles and Practices, Universities Press Pvt. Ltd., Hyderabad 2. Wiley, JM, Sherwood, LM and Woolverton, CJ. (2013) Prescott's Microbiology. 9th Edition. McGraw Hill International, New York	

		3. Frobisher M. Hinsdill, Crabtree and Goodheart (1974). Fundamentals of Microbiology, 9th edition, WB Saunder's Co. USA. 4. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms, 14th edition, Pearson International Edition, New Delhi 5. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company, New York 6. Tortora, Funke and Case (2010). Microbiology, 10th edition, Brenjamin Cummings Inc, California. 7. Ulhas Patil, JS Kulkarni, AB Chaudhari and SB Chincholkar (2016). Foundations in Microbiology 9th edition, Nirali Prakashan, Pune 8. Modi, H. A. (2014) Elementary Microbiology, Vol. 1 and 2, Akshar Prakashan, Ahmedabad	

CC A I: Practical Paper I
BT103: Practical Paper I (Practical)

Total Hours: 60 **Credits: 2**

Sr., no.	Title of the Practical	Hours
Course objective	**To acquaint students with instruments operation, safety aspects and train the students on the practical components of the theory courses**	
Learning outcome	**Students are expected to:** ▪ **Demonstrate practical skills in microscopy, laboratory equipment and their handling techniques and staining procedures** ▪ **Know various stages of cell division and also understand the significance of each event during meiosis and mitosis** ▪ **Perform routine tasks safely and effectively**	
1	▪ First aid, Hazardous Chemicals, Antidotes to hazardous and toxic chemicals, Safety measures in laboratory,	**4**
2	▪ Handling of instruments: Autoclave, Laminar air flow, Centrifuges, spectrophotometer, and	**4**
3	▪ Use and care of compound microscope	**4**
4	▪ Calibration of Weighing balance, Micropipettes and Laboratory glass wares	**4**
5.	▪ Principles of Colorimetry: (i) Verification of Beer's law, estimation of protein and (ii) study relation between absorbance and % transmission	**4**
6.	▪ Study the structure of plant cell through temporary mounts of onion/any plant of choice	**4**
7.	▪ Study the cell division in onion root tip/ insect gonads (temporary and permanent mounts	**4**
8.	▪ Monochrome and Negative Staining of bacterial cell	**4**
9.	▪ Gram's staining of bacteria	**4**
10	▪ Preparation of buffer solution	**4**
11.	▪ Preparation of 1N solution of HCl and NaOH	**4**

12	▪ Periodate staining	**4**
13	▪ Lactophenol Blue staining of Fungi	**4**
14	▪ Demonstration study of plastid types using microscope	**4**
15	▪ Demonstration of use of pH meter	**4**
Suggested readings	1. Atlas, R. M. (1997) Principles of Microbiology, 2nd edition, WM.T.Brown Publishers, Dubuque, USA. 2. Cappucino J and Sherman N. (2010) Microbiology: A Laboratory Manual, 9th edition, Pearson Education Limited, New Delhi 3. Parija S.C. (2005) Text Book of Practical Microbiology, 1st edition, Ahuja Publishing House, New Delhi. 4. Dubey RC and Maheshwari DK (2004) Practical Microbiology, 1st edition, S. Chand and Co., Delhi. 5. Harley, J. P. and Prescott L. M. (2002) Laboratory Exercises in Microbiology, 5th edition, The McGraw-Hill Co., New York 6. Benson H. (2001) Microbiological Applications Lab Manual, 8th edition, The McGraw-Hill Companies, New York 7. Aneja K.R. (1996) Experiments in Microbiology, 3rd edition, Wishwa Prakashan, New Delhi.	

Note: Mandatory to perform at least 12 - 13 practicals

F. Y. B. Sc. (Biotechnology) SEMESTER – II

CC A I: Paper II
BT 201: Biomolecules (Theory)

Total Hours: 30 **Credits: 2**

Unit	Title	Topic Particular	Lectures
Course objective	To complement the students with the basic concept about biomolecules		
Learning outcome	**Students are expected to:** ▪ **Overview of major biomolecules –carbohydrates, lipids, proteins, aminoacids, nucleic acids, classification, structure, function of the above mentioned biomolecules** ▪ **Specify the biological significance of biomolecules in metabolism**		
I	**Carbohyd--rates**	▪ Definition, classification (glyceraldehydes, Simple Aldose, Simple Ketoses, D-glucose, Conformation of D-glucose) and biological functions of carbohydrates. D and L isomers, dextrorotatory and levorotatory, reducing sugar and mutarotation ▪ Structure, Function and properties of Monosaccharides, Disaccharides and Polysaccharides, Homo- and Hetero-Polysaccharides, Mucopolysaccharides, ▪ Structure and biological significance of lactose, sucrose and maltose ▪ Polysaccharides: Homo- Cellulose, Glycogen and Starch; Plant lignocellulose and Bacterial peptidoglycan, Glycoprotein's and their biological functions	**10**

Unit II	**Lipids**	▪ Classification, nomenclature and properties of fatty acids, essential fatty acids. ▪ Definition, classification and biological functions of simple, compound and derived lipids ▪ Structure and biological significance of phospholipid and cholesterol, Saturated (palmetic acid), Non-saturated (oleic acid) ▪ Use as signal, cofactor, pigment	**08**
Unit III	**Proteins and nucleic acid**	▪ Amino acids: Definition, physical and chemical properties, classification ▪ Protein : Structure; primary, secondary, tertiary and quaternary, Bonds stabilizing structural conformation, Denaturation and renaturation of proteins, Different types of proteins in the living system, Protein sequencing by Sanger, Edman's method ▪ Structural Components of Nucleic acids: Nucleosides and Nucleotides, purines and pyrimidines ▪ DNA: Structure (Watson and Crick Model), Chargaff's Rule, forms of DNA ▪ RNA: Structure and Significance of: mRNA, tRNA and rRNA, hnRNA.	**12**
	Suggested readings	1. Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006) Biochemistry, VI Edition, W.H Freeman and Co., 2. Buchanan, B., Gruissem, W. and Jones, R. (2000) Biochemistry and Molecular Biology of Plants, American Society of Plant Biologists. 3. Nelson, D.L., Cox, M.M. (2004) Lehningers' Principles of Biochemistry, 4th Edition, WH Freeman and Company, New York, USA. 4. Hopkins, W.G. and Huner, P.A. (2008) Introduction to Plant Physiology, John Wiley and Sons, 5. Salisbury, F.B. and Ross, C.W. (1991) Plant Physiology, Wadsworth Publishing Co. Ltd.,	

CC A I: Paper II
BT 202: Basic Microbiology B (Theory)

Total Hours: 30 **Credits: 2**

Unit	Title	Topic Particular	Lectures
Course objective	**To complement the students with fundamental concepts in Microbiology**		
Learning outcome	**Students are expected to:** ▪ **Understand the basic microbial structure and study the comparative characteristics of prokaryotes and eukaryotes and familiarize the structural similarities and differences among various microbes** ▪ **Know various Culture media and their applications and also understand various physical and chemical means of sterilization** ▪ **Know general bacteriology and microbial techniques for isolation of pure cultures of bacteria, fungi and algae** ▪ **Learn aseptic techniques and be able to perform routine culture handling tasks safely and effectively** ▪ **Know the various Physical and Chemical growth requirements of bacteria and get equipped with various methods of bacterial growth measurement.**		
I	**Microbial cells**	▪ Concept of microorganisms ▪ Comparative account of prokaryotic and eukaryotic cells, ▪ Morphology and cell structure of Bacteria, virus, Algae, Fungi, and Protozoa ▪ Classification of microorganisms: Whittaker's five kingdom system of classification, Microbial taxonomy, Microbial phylogeny and current classification of bacteria. ▪ Morphological features of Bacteriophage	**10**
Unit II	**Growth and cultivation of microbes**	▪ Concept of Culture: Pure culture, axenic culture, mixed culture ▪ Media and media ingredients (water, peptone, malt extract, meat extract, yeast extract, trace elements, growth factor) ▪ Types of media: complex, synthetic, natural, selective, differential, enriched media ▪ Isolation methods: Streak Plate, Spread Plate, Pour Plate, stab inoculation ▪ Cultivation of fungi: Slide culture technique ▪ Microbial growth: Growth curve, Generation time, synchronous batch and continuous culture, ▪ Measurement of growth and factors affecting growth of bacteria	**10**
Unit III	**Control of microorga--nisms**	▪ Concept of Sterilization, disinfectant, antiseptic, sanitizer, TDR & TDT. ▪ Physical methods (Heat, radiation, filtration) and chemical (Ethylene oxide, formaldehyde) methods of sterilization. Biological indicators of sterilization	**12**

		▪ Definition of Disinfection, characteristics of ideal disinfectant, Mode of action of alcohol, phenolic compounds, halogen, heavy metals, H_2O_2, detergent	
	Suggested readings	1. Alexopoulos, CJ, Mims CW, and Blackwell, M. (1996) Introductory Mycology, 4th edition, John and Sons, Inc., 2. Jay, JM, Loessner, MJ and Golden, DA. (2005) Modern Food Microbiology, 7th edition, CBS Publishers and Distributors, New Delhi 3. Kumar, HD. (1990) Introductory Phycology, 2nd edition, Affiliated East Western Press, 4. Madigan, MT, Martinko, JM and Parker, J. (2009) Brock Biology of Microorganisms, 12th edition, Pearson/Benjamin Cummings, 5. Pelczar, MJ, Chan ECS and Krieg NR. (1993). Microbiology, 5th edition, McGraw Hill Book Company, 6. Stanier, RY, Ingraham, JL, Wheelis, ML, and Painter PR. (2005) General Microbiology, 5th edition, McMillan, 7. Tortora, GJ, Funke, BR, and Case, CL. (2008) Microbiology: An Introduction, 9th edition, Pearson Education. 8. Willey, JM, Sherwood, LM, and Woolverton, CJ. (2008) Prescott, Harley and Klein's Microbiology, 7th edition, McGraw Hill Higher Education,	

CC A I: Practical Paper II
BT 203: Practical Paper II (Practical)

Total Hours: 60 **Credits: 2**

Sr. no.	Title of the Practical	Hours
Course objective	**To complement the students with basic biochemistry, cultivation techniques for microbes and familiarize with algae, fungi**	
Learning outcome	**Students are expected to:** ▪ **Demonstrate theory and practical skills in microscopy and their handling techniques and staining procedures** ▪ **Understand the basic microbial practices and study the comparative characteristics of prokaryotes and eukaryotes** ▪ **Prepare and view specimens using microscopy (bright field microscope).** ▪ **Aware and train in aseptic handling of microbial specimens.** ▪ **Practice safe microbiology, using appropriate protective and emergency procedures.**	
1.	▪ Determination of λ max by using a suitable dye	**4**
2.	▪ Qualitative test for carbohydrates and lipids	**4**
3.	▪ Qualitative test for amino acids and proteins	**4**

4.	▪ Extraction of Starch from Potatoes	**4**
5.	▪ Extraction of Ovalbumin from Egg	
6.	▪ Extraction of Lact-albumin from Milk	
7.	▪ Measurement of bacterial cell size using ocular micrometer and stage micrometer	**4**
8.	▪ Study morphological characteristics of bacteria using microscope	**4**
9.	▪ Preparation of culture media for bacterial cultivation (Nutrient broth and nutrient agar/ MacConkeys broth and MacConkes agar	**4**
10	▪ Study of colony morphological characteristics of bacteria	**4**
11.	▪ Isolation of bacteria by streak plate method from water/soil sample	
12.	▪ Isolation of bacteria by spread plate method from water/soil sample	**4**
13.	▪ Study cultivation of fungi by slide culture technique	**4**
14.	▪ Study of Algae with temporary mounts and permanent slides (e, g. *Spirogyra /Anabena / Nostoc*)	**4**
15.	▪ Demonstrative preparation of paper model of DNA and web-based online observation of 3-D structure of protein	**4**
Suggested readings	▪ Atlas, RM. (1997) Principles of Microbiology, 2nd edition, WM.T.Brown Publishers, ▪ Cappucino, J. and Sherman, N. (2010) Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited, ▪ Parija, S.C. (2005) Text Book of Practical Microbiology. 1st edition, Ahuja Publishing House, New Delhi. ▪ Dubey, RC and Maheshwari, DK (2004) Practical Microbiology, 1st edition, S. Chand and Co., Delhi. ▪ Harley, J. P. and Prescott, L.M. (2002) Laboratory Exercises in Microbiology 5th edition, The McGraw-Hill Companies, ▪ Benson, H. (2001) Microbiological Applications Lab Manual, 8th edition, The McGraw-Hill Companies, ▪ Aneja, K.R. (1996) Experiments in Microbiology, 3rd edition, Wishwa Prakashan, New Delhi.	

Note: Mandatory to perform at least 12 -13 practicals during the semester

Skills acquired and Job prospectus for the Biotechnology students

Biotechnology, being part of Life Science, has established as advanced interdisciplinary applied science. The interdisciplinary networking potential of biotechnology has given it a separate status in fundamental research as well as in modern industrial enterprise. Global and local focus has slowly shifted current knowledge based system to technology driven development and application in life sciences. In the milieu of research and industrialization for economic development and social renaissance, biotechnology emerged out as a major tool to work.

The interdisciplinary nature of biotechnology integrates living systems including animal, plant and microbes and studies from (i) molecular biology to cell biology, (ii) biochemistry to biophysics, (iii) genetic engineering to stem cell research, (iv) bioinformatics to genomics-proteomics, (v) environmental biology to biodiversity, (vi) microbiology to bioprocess engineering, (vii) bioremediation to material transformation and so on. The application of the studies on cell bioprocesses is covered with the help of technology. Green, blue and white revolution was possible due to intrinsic understanding of biotechnology.

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. Beside this, the students will be equipped with knowledge in the newer areas of biotechnology and its application in medical science, agriculture, industry, proteomics, genomics, metabolomics, bioinformatics, nano-biotechnology etc. This will create awareness about biotechnology. At the end of the course, the students are expected to have good working knowledge in the field of Biotechnology. Students will surely have an urge to continue higher studies in Biotechnology and contribute significantly in the development.

Biotechnologists are always in demand as an efficient work force in fundamental research and industries. Education and research sectors require such interdisciplinary trained workforce to develop future generations of science leaders. Career opportunities for graduate students are created and expanding at the biotechnology parks and in manufacturing industries, teaching, research institutes and IT industry.