Kavayitri Bahinabai Chaudhari North Maharashtra University, Jalgaon

Structure of syllabus

Program: B.Sc. Biotechnology

S. Y. B. Sc.

Choice Based Credit System (CBCS)

(2019-20)

S. Y. B. Sc. Biotechnology (CBCS pattern) Semester: III and IV

Prologue

Biotechnology is an advanced interdisciplinary applied science that has pervaded in almost every human activity. Various application of Biotechnology is now established in Industry, Agriculture, Health and Environment. Biotechnology sector in academic, research and industry front are expanding at rapid rate and set to augur the next major revolution in the world. This necessitate cumulative demand for trained and skilled workforce with in depth functional acquaintance of biological science. Hence, the syllabus orientation is done to keep pace with developments in the education and industrial sector.

B.Sc. program in Biotechnology as one of the core subjects is designed to cultivate a scientific attitude and interest towards the modern areas of biotechnology 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 with the objectives to (a) improve students' knowledge, (b) help the students to build interdisciplinary approach, (c) instill sense of scientific responsibilities and social and environment awareness and (d) help student's build-up a progressive and successful career.

The present syllabus tried to 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 are 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 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 On this premise, Board of Studies in Life Sciences in its meeting held on / / resolved to accept the revised syllabus for S. 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					4X14=56
	(ii) Practical	2	4	2	4	2	3	2	3					2X14=28
2	Ability Enhancement Compulsory Course (AECC) (2)	2	1	2	1	2	1	2	1					2 x 2 x 2 x 2 = 08
3	Skill Enhancement Course (SEC) (4)					2	1	2	1	2	1	2	1	2X4=16
4	Discipline Specific Elective DSE (6)													
	(i) Theory									4	3	4	3	4X6=24
	(ii) Practical									2	3	2	3	2X6=12
	Total Credit value (Credit x No. of Courses)	26		26		22		22		20		20		136

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.

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

Core Courses [CC]

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	BT 102	Biochemical Tools	BT 103	Practical paper I
II	CC A II	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

Structure for S. Y. B. Sc. (Biotechnology)

Semester	**Core Course**				**Ability Enhancement Compulsory Course**			**Skill Enhancement Courses**		
III (Total Credits = 22)	**DSC**	**Paper**	**Credits**	**Lectures**	**AECC**	**Credits**	**Lectures**	**SEC**	**Credits**	**Lectures**
	DSC-1C: Core Course I: Biotechnology	Paper I	2	30	AECC I: English/Hindi/MIL Communication III (Advance)	2	30	SEC I: Algae and Mushroom Cultivation	2	30
		Paper II	2	30	AECC II: General knowledge paper	Non-credit				
		Practical Paper	2	60						
	DSC-2C: Core Course II	Paper I	2	30						
		Paper II	2	30						
		Practical Paper	2	60						
	DSC-3C: Core Course III	Paper I	2	30						
		Paper II	2	30						
		Practical Paper	2	60						
IV (Total Credits = 22)	DSC-1D: Core Course I: Biotechnology	Paper I	2	30	AECC I: English/Hindi/MIL Communication III (Advance)	2	30	SEC II: Bioanalytical Instrumentation	2	30
		Paper II	2	30	AECC II: General knowledge paper	Non-credit				
		Practical Paper	2	60						
	DSC-2D: Core Course II	Paper I	2	30						
		Paper II	2	30						
		Practical Paper	2	60						
	DSC-3D: Core Course III	Paper I	2	30						
		Paper II	2	30						
		Practical Paper	2	60						

Student has choice to study two subsidiary subjects from DSC 2, DSC 3 among Chemistry/ Botany/ Zoology /Geography during III and IV semesters; 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 have 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 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, 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 is 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 S.Y. B.Sc. (Biotechnology) is furnished in the following table:

Old Syllabus (June 2016-17) (Semester pattern 60:40)	New Syllabus (w. e. f. June 2019 -20) CBCS pattern (Semester pattern 60:40)
BT - 231: Cell Biology and Metabolism	BT 301 Basic Genetics
BT - 232: Molecular Biology	BT 302 Bioprocess Technology
BT - 241: Biophysics	BT 401 Molecular Biology
BT - 242: Immunology and Bioprocess Technology	BT 402 Immune Response
BT - 233: Practical Course in Biotechnology – I	BT 303 Practical paper III
BT - 243: Practical Course in Biotechnology – II	BT 403 Practical paper IV

S. Y. B. Sc. (Biotechnology) Semester – III and IV

Semester	CC-A and B	Paper code	Paper-I	Paper Code	Paper-II	Practical Paper Code	Practical Paper	Skill Enhancement Courses (SEC)	Ability Enhancement Compulsory Courses (AECC)
III	CC A III	BT 301	Basic Genetics	BT 302	Bioprocess Technology	BT 303	Practical Paper III	SEC I: Algae and Mushroom Cultivation	English/Hindi/MIL Communication III (Advance): Credit 2; General knowledge paper (Noncredit)
IV	CC A IV	BT 401	Molecular Biology	BT 402	Immune Response	BT 403	Practical Paper IV	SEC II: Bioanalytical Instrumentation	English/Hindi/MIL Communication III (Advance): Credit 2; General knowledge paper (Noncredit)

CC A III: Paper I
BT: 301 Basic Genetics (Theory)

Total Hours: 30 **Credits: 2**

Unit	Title	Particular Topic	Lectures
Course Objective	To complement the students with the basic concept about Genetics.		
Learning Outcomes	Students will be able to: • understand basic concept of Gene, DNA. • study mutation and chromosomal variations • learn basic aspect about gametogenesis and cell cycle. • understand the Mendel's laws.		
Unit I Concept of DNA	• Chromosome and genomic organization: Eukaryotic nuclear genome nucleotide sequence, composition –unique & repetitive DNA, satellite DNA. Centromere and telomere • DNA sequences, middle repetitive sequences- VNTRs and dinucleotide repeats, repetitive transposed sequences- SINEs and LINEs, middle repetitive multiple copy genes, noncoding DNA. • Genetic organization of prokaryotic and viral genome. • Structure and characteristics of bacterial and eukaryotic chromosome, chromosome morphology, concept of euchromatin and heterochromatin. packaging of DNA molecule into chromosomes, chromosome banding pattern, karyotype, giant chromosomes, one gene one polypeptide hypothesis, concept of cistron, exons, introns, genetic code, gene function		**10 L**
Unit II Mutation and Chromosomal Variation	• **Chromosome and gene mutations:** Definition and types of mutations, causes of mutations • Ames test for mutagenic agents, screening procedures for isolation of mutants and uses of mutants, Variations in chromosomes structure: deletion, duplication, inversion and translocation (reciprocal and Robertsonian), position effects of gene expression, chromosomal aberrations in human beings, Chromosomal abnormalities: Aneuploidy and Euploidy		**10 L**
Unit III Mendelian Genetics	• **Cell Cycle:** Mitosis and Meiosis: Control points in cell-cycle progression in yeast. Role of meiosis in life cycles of organisms. • **Mendelian genetics:** Mendel's experimental design, monohybrid, di-hybrid and tri hybrid Crosses, Law of segregation and Principle of independent assortment.		**10 L**

	Verification of segregates by test and back crosses, Chromosomal theory of inheritance, Applications of Mendel's Principles and Chromosomal basis of Mendelism • **Allelic interactions:** Concept of dominance, recessiveness, incomplete dominance, co-dominance, semi-dominance, pleiotropy, multiple alleles, Lethal alleles and Null alleles Non-allelic interactions: Interaction producing new phenotype complementary genes, epistasis (dominant and recessive), duplicate genes and inhibitory genes, Phenocopy Organisms suitable for genetic experimentation and their genetic significance. Genetic linkage, Types of Linkage,	
Suggested Readings	1. Gardner, E.J., Simmons, M.J. and Snustad, D.P. (2006) Principles of Genetics. VIII Edition, John Wiley and Sons, New York. 2. Snustad, D.P. and Simmons, M.J. (2009) Principles of Genetics, V Edition, John Wiley and Sons Inc., London 3. Klug, W.S., Cummings, M.R.and Spencer, C.A. (2009) Concepts of Genetics. IX Edition, Benjamin Cummings, New York 4. Russell, P. J. (2009) Genetics: A Molecular Approach. III Edition Benjamin Cummings. **5.** Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. (2009) Introduction to Genetic Analysis, IX Edition, W. H. Freeman and Co. 6. Krebs, J., Goldstein, E. and Kilpatrick, S. (2013) essential Genes,3rd edn., Jones and Bartlett Learning. 7. Pierce, B.A. (2012) Genetics: A Conceptual Approach, 4th edn., WH freeman and Company, New York	

CC A III: Paper II
BT 302: Bioprocess Technology (Theory)

Total Hours: 30 **Credits: 2**

Unit	Title	Particular Topic	Lectures
Course Objective	To understand the basic knowledge in Fermentation Technology and build a foundation for more advanced studies in Bioprocess Technology		
Learning Outcomes	Students will be able to: ➢ develop an understanding of the various aspects of Bioprocess Technology. ➢ aware with screening of Industrially Important Strains and culture collection centres. ➢ understand principles underlying design of Fermenter, Fermentation Process, upstream and downstream processing.		
Unit I : Introduction to Bioprocess Technology	• Concept and significance of bioprocess technology • Range of bioprocess technology and chronological development • Basic principal components of fermentation technology • Screening of industrially important microorganism- primary, secondary, crowded plate method; strain improvements • Working and principle of culture collection centres • National: NCIM, MTCC • International: ATCC		**10 L**

Unit II: Bioreactor	• Design and construction of bioprocess reactor: • Significance of impeller, baffles, sparger, stuffing box • Measurement and control of fermentation parameters: pH, temperature, DO, foaming and aeration • Bioreactors: Types, Working and Applications of- - Stirred tank bioreactor - Airlift bioreactor - Fluidized bed bioreactor - Packed bed bioreactor - Tower bioreactor - Photo bioreactor • Types of Bioprocesses: Solid state and Submerged - Batch fermentation - Continuous Fermentation - Fed Batch fermentation - SSF and SHF	**10 L**
Unit III: Introduction to Upstream and Downstream processes	• Principles of upstream processing - Media preparation, Raw material and criteria - Inoculum development and inoculum characteristics - Sterilization: sterilization of air and media • Introduction to downstream processes - Solid-solid separation: Flocculation, filtration and Centrifugation • Cell disruption: Physical: Homogenizer, ultra-sonication, freezing and thawing Chemical: Enzymatic, Detergent, Alkali treatment, Osmotic lysis - Extraction - Precipitation - Distillation - Evaporation - Chromatographic separation - Spray drying - Super critical separation	**10 L**
Suggested Readings	➢ Stanbury P.F., Whitakar and Hall S.J. (2006) Principles of Fermentation Technology, 2nd Edition, Elsevier Science Ltd. ➢ Casida L.E. Jr. (1991) Industrial Microbiology, New Age Intl Publ., Delhi ➢ Patel A.H. (1996) Industrial Microbiology, MacMillan India Ltd., Delhi. ➢ Waites, M.J., Morgan, N.L., Rockey, J.S. and Higton, G. (2001) Industrial Microbiology: An Introduction, 1st edn., Wiley-Blackwell, London ➢ Glaze, A.N. and Nikaido, H. (1995) Microbial Biotechnology: Fundamentals of applied Microbiology, 1st edn., W.H. Freeman Company ➢ Dubey R.C. and Maheshwari D.K. (2002) A Textbook of Microbiology, S. Chand Publication, New Delhi ➢ Dubey R.C. (2008) A Textbook of Biotechnology, S. Chand and Co. Ltd., New Delhi.	

CC A III: Paper III
BT 303: Practical Paper III (Practical)

Total Hours: 30 Credits: 2

Unit	Title of the Practical	Lectures
Course Objective	To acquaint students with basic genetics and industrial biotechnology also train the students on the practical components of the theory courses.	

Learning Outcomes	Students will be able to: • acquaint with different problems regarding genetics • know various stages of cell division and understand the significance of each event during meiosis and mitosis • develop skill about isolation of industrially important microorganism and familiar with analytical techniques	
1.	Problem sets in: Mendelian inheritance single point and two-point crosses Linkages- Two- and three-point cross.	4
2.	Permanent and temporary mount of mitosis in onion root tip	4
3.	Permanent and temporary mount of meiosis in grasshopper testis/ *Tradescantia* flower	4
4.	Study of polytene chromosome- Slide preparation	4
5.	Karyotyping study with the help of photographs/database	4
6.	Pedigree chart analysis for study of hereditary disorders.	4
7.	Studying effect of colchicine on mitosis	4
8.	Quantitative estimation of protein by Bradford's/Lowry's method	4
9.	Screening of amylase producing microbes	4
10.	Isolation of Auxotrophs by gradient plate method	4
11.	Validation of autoclave using bio-agent (*B. stearotermophilus*)	4
12.	Determination of MIC and MBC of antibacterial agent	4
13.	Estimation of acetic acid from vinegar	4
14.	Cultivation of edible mushroom.	4
15.	Industrial visit/ Excursion tour	4
Note:	Mandatory to complete at least 13 practicals	
Suggested Readings	1. Aneja K.R. (1996) Experiments in Microbiology, Plant Pathology, Tissue Culture and Mushroom Cultivation, New Age International (Pvt.) Ltd., New Delhi. 2. Plummer D.T. (2005) An Introduction to Practical Biochemistry, 4th Edition, Tata McGraw Hill, New Delhi. 3. Sadasivam S. and Manikam A. (1996) Biochemical Methods, 2nd Edition, New Age International (Pvt) Ltd., New Delhi. 4. Jayaraman J. (1999) Laboratory Manual in Biochemistry, New Age International (P) Ltd., New Delhi. 5. Wilson K. and Walker J. (2010) Practical Biochemistry: Principles and Techniques of Biochemistry and Molecular Biology, 5th Edition, Cambridge Uni. Press, Cambridge. 6. Sawhney S.K. and Singh R. (2000) Introductory Practical Biochemistry Narosa Publisher, New Delhi. 7. Nigam, A. and Ayyagiri, A. (2007) Lab Manual in Biochemistry, Immunology and Biotechnology, Tata McGraw Hill, Kolkata 8. Karp, G. (2010) Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley and Sons. Inc., London	

Skill enhancement course (SEC): Semester- III
SEC I: Algae and Mushroom Cultivation

Total Hours: 30 **Credits: 2**

Unit	Title	Topic	Lectures
Course Objectives	➢ To understand commercial development of algal culture ➢ To aware about commercial utilization of algae ➢ To understand diversity of morphological and biochemical ➢ To know role of algae in industries ➢ Know about nutritional and medicinal value of edible mushrooms ➢ Learn about the cultivation techniques off mushrooms ➢ Gain knowledge on the present status of mushroom industry in india		
Learning Outcomes	Students will be able to: ➢ know the classification of different varieties of fungi ➢ understand the techniques used in the cultivation of edible mushroom ➢ know the harvesting of a mushroom crop ➢ learn about the post harvesting treatment of a mushroom crop ➢ gain adequate knowledge on comparative account of various algae ➢ determine the techniques used for cultivation of algae ➢ understand cultivation methods with algae biofuel technologies ➢ know about commercial and transportation issues of algae biomass		
Unit I Mushroom Cultivation	• Basic characteristic of fungi, classification, Cultivation and preservation of mushroom • making mushroom compost, finishing the compost, spawning casing, pinning, cropping • Spawn production, substrate, raw materials, The substrate preparation process • Mushroom cultivation, ventilation system, air humidity, organization of space • The cultivation process – incubation phase, fructification phase • Preparation of growing unit / hygiene • Hygiene of a growing unit problems in the production (*in situ*) and quality control		**15**
Unit II Algae Cultivation	• Ecology and characteristic features of algae • Algae Classification, cultivation and nutritional requirements • Methods of algae cultivation • Cultivation, harvesting, drying, extraction and processing of algae • Single cell protein and its nutritive value e.g. *Spirulina* • Post-harvest management: packing, storage and quality control • Quantification of cultured algae • Efficacy/ economic importance of algae cultivation Parasitic and symbiotic algae		**15**
Suggested Readings	1. Pathak, V.N. Yadav, N. and Gour, M. (2011) Mushroom Production and Processing Technology, Agrobios (India). ISBN 10: 8177540068 2. Kannaiyan, S. and Ramasamy K. (1980) A Hand Book of Edible Mushroom, Today and Tomorrows Printers and Publishers, New Delhi 3. Nita Bahl (1984) Handbook on Mushrooms, Oxford and IBH Publishing Co. 4. Tripathi, D.P. (2005) Mushroom Cultivation, Oxford and IBH Publishing Co. Pvt. Ltd, New Delhi. 5. Stein, J.R. (1973) Handbook of Phycological Methods. Culture methods and growth measurements. Cambridge University Press, Cambridge		

	6. Graham, L.E., Graham, J.M., Wilcox, L.W. and Cook, M.E. (2015) Algae, 3rd edition, LJLM Press, Madison, ISBN 978-0-9863935-3-2

CC A IV: Paper I
BT 401: Molecular Biology (Theory)

Total Hours: 30 **Credits: 2**

Unit	Title	Particular Topic	Lectures
Course Objective	To complement the student with concepts of Molecular Biology		
Learning Outcomes	Students will be able to: ➢ understand basic structure of DNA ➢ understand central dogma of molecular biology ➢ understand the process of replication, transcription, translation. ➢ Learn regulation of all molecular processes.		
Unit I DNA structure and replication	• Central dogma of Molecular Biology • DNA as genetic material, Structure of DNA, Double helix and Triple helix, Cot curve, organization of eukaryotic DNA, Types of DNA • Replication of DNA in prokaryotes and eukaryotes: Semiconservative nature of DNA replication, Bi-directional replication, DNA polymerases, • Replication complex: Pre-priming proteins, primosome, replicosome, Rolling circle replication, • Unique aspects of eukaryotic chromosome replication, Fidelity of replication		**10 L**
Unit II DNA damage, repair and homologous recombination	• **DNA damage and repair:** causes and types of DNA damage, mechanism of DNA repair: • Photoreactivation, base excision repair, nucleotide excision repair, mismatch repair, translesion synthesis, recombinational repair, nonhomologous end joining • Homologous recombination: models and mechanism		**10 L**
Unit III Transcription and RNA processing, Translation and Regulations	• **RNA structure and types of RNA, Transcription in prokaryotes:** Prokaryotic RNA polymerase, role of sigma factor, promoter, Initiation, elongation and termination of RNA chains • **Transcription in eukaryotes:** Eukaryotic RNA polymerases, transcription factors, promoters, enhancers, mechanism of transcription initiation, promoter clearance and elongation RNA splicing and processing: processing of pre-mRNA: 5' cap formation, polyadenylation, splicing, rRNA and tRNA splicing. • **Prokaryotic and eukaryotic translation:** ribosome structure and assembly, Charging of tRNA, amino acyl tRNA synthetases, Mechanism of initiation, elongation and termination of polypeptides • **Regulation of gene expression in prokaryotes:** Operon concept (inducible and repressible system), Genetic code and its characteristics.		**10 L**
Suggested Readings	1. Karp, G. (2010) Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley and Sons. Inc., London 2. de Robertis, E.D.P. and de Robertis, E.M.F. (2006) Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.		

	3. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009) The World of the Cell, VII Edition. Pearson Benjamin Cummings Publishing, San Francisco. **4.** Watson, J. D., Baker T.A., Bell, S. P., Gann, A., Levine, M., and Losick, R., (2008) Molecular Biology of the Gene, VI Edition, Cold Spring Harbour Lab. Press, Pearson Publishers. **5.** Gardner E.J., Simmons, M.J. and Snustad, D.P. (20008) Principles of Genetics, 8th edn., Wiley India

CC A IV: Paper II
BT 402: Immune Response (Theory)

Total Hours: 30 **Credits: 2**

Unit	Title	Particular Topic	Lectures
Course Objective	To complement the students with basics human immunology and related response		
Learning Outcomes	Students will be able to: ➢ know the cellular ontogeny and organ involvement in immunity ➢ explain the principles of self-tolerance and autoimmunity ➢ know how the immune system can fight infections and cancer, including examples of immunodeficiency diseases ➢ know the difference between innate and adaptive immunity ➢ understand what antigens are and how they are presented ➢ understand the mechanisms involved in control of immune responses		
Unit I Basics of Immunology	• Introduction to Immune System; Haematopoiesis • Blood cell; Morphology, formation and function of Phagocytosis and Opsonisation. • Primary and secondary Immune response • Lymphoid organs (Bone marrow, Thymus, Lymph node, spleen, GALT, CALT) and Immune cells (Stem, T, B, NK, Macrophages, Dendric cells) • Properties of immune system; specificity, Diversity, self-versus Non-self-discrimination. • Innate and acquired immune response • Cellular and Humoral Immunity. • Immune responses; Primary and Secondary, Immunological memory, Immunological tolerance and Hypersensitivity.		**10 L**
Unit II Antigen and Antibody	• Concept of antigen, types of antigen: antigen and Immunogenic, Antigenic determinants, hapten, T-dependent and T-independent antigens, toxoid • Blood group antigen: A, B, O, D and Bombay blood group, Rh and D variants • Factors affecting antigenicity • Immunoglobulin: Structure, Types and properties, Antigenic determinants (Isotypic, allotypic, idiotypic)		**10 L**
Unit III Immuno-prophylaxis	• Active immunization: Vaccines and Vaccination: adjuvants, Cytokines, DNA vaccines, recombinant vaccines, bacterial vaccines, viral vaccines. • Passive immunization: types with examples and Immunization Schedule • Autoimmune diseases and Immunodeficiency: AIDS • ABO blood grouping and its significance.		**10 L**
Suggested Readings	➢ Coleman R.M, Lombard M.F, Sicard R.E., Rencocca, N.J. (1989) Fundamentals of Immunology, W.C. Brown Publishers. ➢ Delves P, Martin S, Burton D, Roitt I.M. (2006) Roitt's Essential Immunology, 11th edition, Wiley-Blackwell Scientific Publication, Oxford.		

	➢ Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology, 6th edition, W.H. Freeman and Company, New York. ➢ Peakman M, and Vergani D. (2009) Basic and Clinical Immunology, 2nd edition, Churchill Livingstone Publishers, Edinburg. ➢ Richard, C. and Geiffrey, S. (2009) Immunology, 6th edn., Wiley Blackwell Publ.

CC A IV: Paper III
BT 403: Practical Paper IV (Practical)

Total Hours: 30 **Credits: 2**

Unit	Title of the Practical	Lectures
Course Objective	To complement the students with basic immunology, Molecular Biology and familiarize with serological techniques.	
Learning Outcomes	**Students will be able to:** ➢ understand basics in serological practicals and its handling. ➢ aware of molecular biology techniques about isolation of genetic material. ➢ aware and train spectrophotometric estimations of metabolites ➢ know about the basic concept in immunology.	
1.	Preparation of reagents for molecular biology.	
2.	Blood group detection and Rh typing.	
3.	Determination of total RBC count from blood sample by haemocytometer	
4.	WBC staining by Leishman's stain	
5.	Total Leucocyte count by Newbaur haemocytometer	
6	Study of antigen antibody interaction: Ouchterlony double diffusion	
7.	Estimation of haemoglobin content from the blood.	
8.	Determination of blood clotting time.	
9.	Isolation of DNA from bacterial cell/ Plant cells/ Animal Cells/yeast	
10.	Estimation of DNA by DPA method	
11.	Isolation of RNA from suitable sample	
12.	Estimation of RNA by Orcinol method	
13.	Spontaneous mutation by Fluctuation analysis	
14.	Repair of DNA damage due to UV by Photo reactivation test	
15.	Visit to Local pathology Lab/Blood bank/ Industry	
Note:	**Mandatory to complete 13 Practicals**	
Suggested Readings	1. Aneja K.R. (1996) Experiments in Microbiology, Plant Pathology, Tissue Culture and Mushroom Cultivation, New Age International (P) Ltd, New Delhi. 2. Plummer D.T. (1992) An Introduction to Practical Biochemistry, 3rd Edition, Tata McGraw Hill, Delhi. 3. Sadasivam S. and Manikam A. (1996) Biochemical Methods, 2nd Edition, New Age International (P) Ltd., New Delhi. 4. Jayaraman J. (1999) Laboratory Manual in Biochemistry, New Age International (P) Ltd., New Delhi. 5. Wilson K. and Walker J. (2010) Practical Biochemistry: Principles and Techniques of Biochemistry and Molecular Biology, 5th Edition, Cambridge Uni. Press, Cambridge. **6.** Sawhney S.K. and Singh Randhir (2000) Introductory Practical Biochemistry, Narosa Publisher, New Delhi. 7. Nigam, A. and Ayyagiri, A. (2007) Lab Manual in Biochemistry, Immunology and Biotechnology, Tata McGraw Hill, Kolkata	

	8. Karp, G. (2010) Cell and Molecular Biology: Concepts and Experiments, 6th edn., John Wiley and Sons, Inc.

Skill Enhancement Course (SEC): Semester- IV
SEC II: Bioanalytical Instrumentation

Total Hours: 30 **Credits: 2**

Unit	Title/ Particular Topic	Lectures
Course Objectives	➢ Explain the functioning, maintenance and safety aspects of the basic apparatus used in a Biotechnology lab. ➢ Explain the principles and applications of Bioanalytical instrumentation ➢ Utilize the knowledge for the separation of proteins/peptides by selecting appropriate separation techniques ➢ Characterize certain functionalities of biomolecules by using techniques.	
Learning Outcomes	Students will be able to: ➢ acquire comprehensive knowledge of the equipment used in Life sciences will be offered in the course an overview of the instruments used in isolation and separation of molecules will also be provided ➢ enable the students to understand all aspects of Bioinstrumentation and tools and techniques used therein	
Unit I Introduction of Bio-analytical tool	• Introduction: Analytical techniques, analyte, principle, construction, working and applications of pH meter, centrifuge, light and dark field microscope • Overview of bioinformatics and bioinformatics tools for sequence analysis, Database types, Sequence assembling using computers, Phylogenetics	**10**
Unit II Biotechniques	• Bioanalytical tools: Sample preparation, principle, construction, working, method development, optimization, analysis of results and applications • Chromatographic techniques: Adsorption, Partition and Affinity, Gel filtration, Ion exchange, GLC and HPLC • Spectroscopic techniques: Colorimetric, Spectrophotometric and spectrofluorometric • Electrophoretic techniques: Native, and SDS PAGE, IF, 2D, Agarose gel	**20**
Suggested Readings	1. Gunzler, Helmut and Williams, Alex (2001) Handbook of Analytical Techniques, 1st edn., Wiley-VCH, ISBN-13: 978-3527301652 **2.** Upadhyay, A., Upadhyay, K. and Nath, N. (2000) Biophysical Chemistry, Himalaya Publisher, Nagpur. **3.** Friefelder A. D. (1993) Physical Biochemistry, 2nd Edn., W. H. Freeman and Co., New York, USA. **4.** Skoog, D.A., Hollier, F.J. and Nieman, I.A. (1998) Principles of Instrumental Analysis, Harcourt Brace College Publishers, Orlando. **5.** Wilson, K. and Walker, J. (2000) Practical Biochemistry: Principles and Techniques, 5th Edn., Cambridge University Press, Cambridge. **6.** Willard, H.H. and Merrit, Jr. L.L. (1986) Instrumental Methods of Chemical Analysis, CBS Publishers, New Delhi. **7.** Wilson, K. and Goulding, K.H. (2010) Biologists Guide to Principle and Techniques of Practical Biochemistry, 7th edn., Cambridge University Press, Cambridge. **8.** Mikkelsen, S.R. and Corton, E. (2004) Bioanalytical Chemistry, Wiley Inter Science, New York, USA,	

Skills acquired and Job prospectus for the Biotechnology students

Biotechnology, being part of Life Science, established as 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 for the service of mankind.

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 help 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 expanding at the biotechnology parks and in manufacturing industries, teaching, research institutes and IT industry.