Ahmednagar Jilha Maratha Vidya Prasarak Samaj's

New Arts, Commerce and Science College, Ahmednagar

(Autonomous)

(Affiliated to Savitribai Phule Pune University, Pune)

Choice Based Credit System (CBCS)

Framework for Syllabus

Bachelor of Science (B. Sc. Biotechnology)

Implemented from

Academic year 2023-24

F.Y. B. Sc. Biotechnology

Semester - I

Course Type	Course Code	Course Title	Credits
DSCC -01	BSC-BT 101T	Fundamentals of Chemistry-I	02
DSCC -02	BSC-BT 102T	Fundamentals of Physics-I	02
DSCC-03	BSC-BT 103T	Biochemistry I	02
DSCC-04	BSC-BT 104T	Biophysics and Bioinstrumentation	02
DSCC-05	BSC-BT 105T	Plant Biology	02
DSCC-06	BSC-BT 106T	Animal Biology	02
DSCC-07	BSC-BT 107T	Basic Microbiology	02
DSCC-08	BSC-BT 108T	Biomathematics and Biostatistics-I	02
DSPC- 01	BSC-BT 109P	Practical in Chemistry and Biochemistry-I	1.5
DSPC- 02	BSC-BT 110P	Practical in Botany and Zoology	1.5
DSPC- 03	BSC-BT 111P	Practical in Microbiology and Biostatistics	1.5
DSPC- 04	BSC-BT 112P	Practical in Physics and Biophysics	1.5
		Total Credits	**22**

Semester - II

Course Type	Course Code	Course Title	Credits
DSCC- 09	BSC-BT 201T	Fundamentals of ChemistryII	02
DSCC- 10	BSC-BT 202T	Biochemistry II	02
DSCC- 11	BSC-BT 203T	Bioinstrumentation	02
DSCC- 12	BSC-BT 204T	Applied Plant Biology	02
DSCC- 13	BSC-BT 205T	Applied Animal Biology	02
DSCC- 14	BSC-BT 206T	Applied Microbiology	02
DSCC- 15	BSC-BT 207T	Biomathematics andBiostatistics-II	02
DSCC- 16	BSC-BT 208T	Information Technology	02
DSPC- 05	BSC-BT 209P	Practical in Chemistry and Biochemistry II	1.5
DSPC- 06	BSC-BT 210P	Practical in Applied Botany and Zoology	1.5
DSPC- 07	BSC-BT 211P	Practical in Microbiologyand Bioinstrumentation	1.5
DSPC- 08	BSC-BT 212P	Practical in Information Technology and Biostatistics	1.5
		Total Credits	**22**

S.Y. B. Sc. (Biotechnology)

Semester -III

Course Type	Course Code	Course Title	Credits
DSCC- 17	BSC-BT 301T	Cell Biology I	02
DSCC- 18	BSC-BT 302T	Cell Biology II	02
DSCC- 19	BSC-BT 303T	Metabolic Pathways	02
DSCC- 20	BSC-BT 304T	Genetics	02
DSCC- 21	BSC-BT 305T	Immunology	02
DSCC- 22	BSC-BT 306T	Ecology and Environmental Biotechnology	02
DSPC- 09	BSC-BT 307P	Practical in Cell Biology	02
DSPC- 10	BSC-BT 308P	Practical in Genetics and Immunology	02
DSPC- 11	BSC-BT 309P	Practical in Metabolic and Ecology and EnvironmentalBiotechnology	02
AECC 01	BSC-BT 310	Critical Thinking and Scientific Temper	02
AECC-02	BSC-BT 311	English/ Hindi Communication	02
GE-01	BSC-BT 312	Laboratory Management (Biosafety and Instrumentation)	02
GE-02 (Practical)	BSC-BT 313P	Practicals in Laboratory Management	02
		Total Credits	**26**

S.Y. B. Sc. (Biotechnology)

Semester – IV

Course Type	Course Code	Course Title	Credits
DSCC- 23	BSC-BT 401T	Biodiversity and Evolution	02
DSCC- 24	BSC-BT 402T	Molecular Biology I	02
DSCC- 25	BSC-BT 403T	Molecular Biology II	02
DSCC- 26	BSC-BT 404T	Plant Development	02
DSCC- 27	BSC-BT 405T	Animal Development	02
DSCC- 28	BSC-BT 406T	Bioanalytical Techniques	02
DSPC- 12	BSC-BT 407P	Practical in Molecular Biology	02
DSPC- 13	BSC-BT 408P	Practical in Animal and Plant Development	02
DSPC- 14	BSC-BT 409P	Practical in Biodiversity and Evolution and Bioanalytical Techniques	02
AECC 01	BSC-BT 410	Environmental awareness	02
AECC 02	BSC-BT 411	LanguageCommunication	02
GE-01	BSC-BT 412	Oenology	02
GE-02 (Practical)	BSC-BT 413P	Practical in Oenology	02
		Total Credits	**26**

T.Y. B. Sc. (Biotechnology)

Semester -V

Course Type	Course Code	Course Title	Credits
DSEC- 1	BSC-BT 501T	Recombinant DNA Technology	02
DSEC- 2	BSC-BT 502T	Plant Tissue Culture	02
DSEC- 3	BSC-BT 503T	Animal Tissue Culture	02
DSEC- 4	BSC-BT 504T	Microbial Biotechnology	02
DSEC- 5	BSC-BT 505T	Food Biotechnology	02
DSEC- 6	BSC-BT 506T	Medical Biotechnology	02
DSEC-7 Practical	BSC-BT 507P	Practicals in Recombinant DNA Technology	02
DSEC-8 Practical	BSC-BT 508P	Practicals in Plant Tissue Culture and Animal Tissue Culture	02
DSEC-9 Practical	BSC-BT 509P	Practicals in Microbial and Food Biotechnology	02
SEC -01*	BSC-BT 510T	SEC-I Scientific Writing and Communication	02
SEC - 02 Practical *	BSC-BT 511P	SEC-II Project Formulation and Presentation	02
		Total Credits	**22**

T.Y. B. Sc. (Biotechnology)

Semester -VI

Course Type	Course Code	Course Title	Credits
DSEC- 10	BSC-BT 601T	Enzyme Technology	02
DSEC- 11	BSC-BT 602T	Pharmaceutical Biotechnology	02
DSEC- 12	BSC-BT 603T	Bioinformatics	02
DSEC- 13	BSC-BT 604T	Industrial Microbiology	02
DSEC- 14	BSC-BT 605T	Applied Biotechnology	02
DSEC- 16	BSC-BT 606T	Biosafety, Bioethics and IPR	02
DSEC- 17 Practical	BSC-BT 607P	Practicals in Enzyme Technology	02
DSEC- 18 Practical	BSC-BT 608P	Practicals in Bioinformatics and Pharmaceutical Biotechnology	02
DSEC- 19 Practical	BSC-BT 609P	Practicals in Industrial Microbiology	02
SEC -3 Project*	BSC-BT 610Pr	SEC – III Project	02
SEC - 4 Project*	BSC-BT 611Pr	SEC – IV Project	02
		Total Credits	**22**

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Choice Based Credit System (CBCS)

Bachelor of Science (B.Sc. Biotechnology)

Syllabus of

T. Y. B. Sc Biotechnology

Implemented from

Academic year 2023-24

Ahmednagar Jilha Maratha Vidya Prasarak Samaj's New Arts, Commerce and Science College, Ahmednagar (Autonomous)

Board of Studies in Biotechnology

Sr. No.	Name	Designation
1.	Dr. Shubhangi S. Moharekar	Chairman
2.	Dr. Sanjay T. Moharekar	Member
3.	Dr. Sarika R. Deshmukh	Member
4.	Mr. Ashish S. Wani	Member
5.	Dr. Bimalendu B. Nath	Vice-Chancellor Nominee
6.	Prof. Dr. Nitin S. Desai	Academic Council Nominee
7.	Dr. Jyoti P. Jadhav	Academic Council Nominee
8.	Mr. Nitin Shirole	Industry Expert
9.	Mr. Sachin R. Adsare	Alumni
10.	Dr. Aparnna A. Kulkarni	Member (co-opt)
11.	Mr. Girish P. Kukreja	Member (co-opt)

1. Prologue/ Introduction of the programme:

Biotechnology has expanded and established as an advanced interdisciplinary applied science. The study of Life itself is at the core of it and 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 to not only current "Century of Knowledge" but also on to technology development and application in life sciences. In the milieu of research and industrialization for economic development and social change, biotechnology is an ideal platform to work. The interdisciplinary nature of biotechnology integrates living systems including animal, plant and microbes and their studies from molecular biology to cell biology, from biochemistry to biophysics, from genetic engineering to stem cell research, from bioinformatics to genomics-proteomics, from environmental biology to biodiversity, from microbiology to bioprocess engineering, from bioremediation to material transformation and so on. The ce and application of these studies on living organisms and their bioprocesses is extensively covered in this field with the help of technology. Green revolution and white revolution was possible in India thanks to the deeper and intrinsic understanding of biotechnology.

The restructures syllabus is a choice based credit system with semester pattern. Biotechnology has grown extensively in last couple of decades. The syllabi till today had been sufficient to cater to the needs of students for building up their careers in industry and research. However, with the changing scenario at local and global level, we feel that 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 economical aspects of modern biology. The proposed credit based curriculum ensures the requirement of academia and industry. Theory supplemented with extensive practical skill sets will help a graduate student to avail 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. Biotechnology being an interdisciplinary subject, this restructured syllabus will combine the principles of physical, chemical and biological sciences along with developing advanced technology.

Biotechnology curricula are operated at two levels viz. undergraduate and postgraduate. The undergraduate curricula are prepared to impart primarily basic knowledge of the respective subject from all possible angles while postgraduate syllabus emphasizes on more applied courses. In addition, students are to be trained to apply this knowledge particularly in day-to-day applications of biotechnology and to get a glimpse of research.

The basic aim of the revised course curriculum is to integrate various disciplines of life sciences which will cater the needs of human resources in academia and industry. The Overall objective of the Program is to promote education and research in biotechnology and provide academic and professional excellence for immediate productivity in academics, government organization, biomedical sectors, health and nutrition settings for ultimate benefit of society and sustainable development.

2. Programme Outcomes (POs)

Students enrolled in the program complete a curriculum that exposes and trains students in a full range of essential skills and abilities. They will have the opportunity to master the following objectives.

The objectives of the course curriculum are:

- To introduce the concepts in various allied subjects
- To enrich students' knowledge in basic and applied aspects of life sciences.
- To help the students to build interdisciplinary approach in teaching/ learning and in research.
- To inculcate the sense of scientific responsibilities and social awareness
- To help students build-up a progressive and successful career in academia and industry.

The present course curriculum will generate skilled human resource required in academia and Industry. In general, as a result of this program, the student will be able to achieve basic and advance knowledge based proficiency in applied subjects of life sciences, create and develop students with interdisciplinary mind set for learning science, improve problem solving aptitude using scientific methods in biotechnology and allied subjects, will adopt scientific approach for implications of biotechnology in society, environment and education, will demonstrate knowledge and learn various biological processes at cellular and molecular level and get expertise in the different techniques used in the fields of Biotechnology.

Programme Structure and Course Titles

Sr. No.	Class	Semester	Course Code	Course Title	Credit
1.	F. Y. B.Sc.	I	BSC-BT 101T	Fundamentals of Chemistry-I	02

2.	F. Y. B.Sc.	I	BSC-BT 102T	Fundamentals of Physics-I	02
3.	F. Y. B. Sc.	I	BSC-BT 103T	Biochemistry I	02
4.	F. Y. B.Sc.	I	BSC-BT 104T	Biophysics and Bioinstrumentation	02
5.	F. Y. B.Sc.	I	BSC-BT 105T	Plant Biology	02
6.	F. Y. B.Sc.	I	BSC-BT 106T	Animal Biology	02
7.	F. Y. B. Sc.	I	BSC-BT 107T	Basic Microbiology	02
8.	F. Y. B.Sc.	I	BSC-BT 108T	Biomathematics andBiostatistics-I	02
9.	F. Y. B.Sc.	I	BSC-BT 109P	Practical in Chemistry and Biochemistry	1.5
10.	F. Y. B.Sc.	I	BSC-BT 110P	Practical in Botany and Zoology	1.5
11.	F. Y. B.Sc.	I	BSC-BT 111P	Practical in Microbiology and Biostatistics	1.5
12.	F. Y. B.Sc.	I	BSC-BT 112P	Practical in Physics and Biophysics	1.5
13.	F. Y. B.Sc.	II	BSC-BT 201T	Fundamentals of ChemistryII	02
14.	F. Y. B.Sc.	II	BSC-BT 202T	Biochemistry II	02
15.	F. Y. B.Sc.	II	BSC-BT 203T	Bioinstrumentation	02
16.	F. Y. B.Sc.	II	BSC-BT 204T	Applied Plant Biology	02
17.	F. Y. B.Sc.	II	BSC-BT 205T	Applied Animal Biology	02
18.	F. Y. B.Sc.	II	BSC-BT 206T	Applied Microbiology	02
19.	F. Y. B.Sc.	II	BSC-BT 207T	Biomathematics and Biostatistics-II	02
20.	F. Y. B.Sc.	II	BSC-BT 208T	Information Technology	02
21.	F. Y. B.Sc.	II	BSC-BT 209P	Practical In Chemistry and Biochemistry II	1.5
22.	F. Y. B.Sc.	II	BSC-BT 210P	Practical In Applied Botany and Zoology	1.5
23.	F. Y. B.Sc.	II	BSC-BT 211P	Practical In Microbiologyand Bioinstrumentation	1.5
24.	F. Y. B.Sc.	II	BSC-BT 212P	Practical In Information Technology andBiostatistics	1.5
25.	S. Y. B.Sc.	III	BSC-BT 301T	Cell Biology I	02

26.	S. Y. B.Sc.	III	BSC-BT 302T	Cell Biology II	02
27.	S. Y. B.Sc.	III	BSC-BT 303T	Metabolic Pathways	02
28.	S. Y. B.Sc.	III	BSC-BT 304T	Genetics	02
29.	S. Y. B.Sc.	III	BSC-BT 305T	Immunology	02
30.	S. Y. B.Sc.	III	BSC-BT 306T	Ecology and Environmental Biotechnology	02
31.	S. Y. B.Sc.	III	BSC-BT 307P	Practical in Cell Biology	02
32.	S. Y. B.Sc.	III	BSC-BT 308P	Practical in Genetics and Immunology	02
33.	S. Y. B.Sc.	III	BSC-BT 309P	Practical in Metabolic and Ecology and Environmental Biotechnology	02
34.	S. Y. B.Sc.	III	BSC-BT 310	Critical Thinking and Scientific Temper	02
35.	S. Y. B.Sc.	III	BSC-BT 311	English/ Hindi Communication	02
36.	S. Y. B.Sc.	III	BSC-BT 312	Laboratory Management (Biosafety and instrumentation)	02
37.	S. Y. B. Sc.	III	BSC-BT 313	Practicals in Laboratory Management	02
38.	S. Y. B.Sc.	IV	BSC-BT 401T	Biodiversity and Evolution	02
39.	S. Y. B.Sc.	IV	BSC-BT 402T	Molecular Biology I	02
40.	S. Y. B.Sc.	IV	BSC-BT 403T	Molecular Biology II	02
41.	S. Y. B.Sc.	IV	BSC-BT 404T	Plant Development	02
42.	S. Y. B.Sc.	IV	BSC-BT 405T	Animal Development	02
43.	S. Y. B.Sc.	IV	BSC-BT 406T	Bioanalytical Techniques	02
44.	S. Y. B.Sc.	IV	BSC-BT 407P	Practical in Molecular Biology	02
45.	S. Y. B.Sc.	IV	BSC-BT 408P	Practical in Animal andPlant Development	02
46.	S. Y. B.Sc.	IV	BSC-BT 409P	Practical in Biodiversity and Evolution and Bioanalytical Techniques	02
47.	S. Y. B.Sc.	IV	BSC-BT 410	Environmental awareness	02

48.	S. Y. B.Sc.	IV	BSC-BT 411	Language Communication	02
49.	S. Y. B.Sc.	IV	BSC-BT 412A	Oenology	02
50.	S. Y. B.Sc.	IV	BSC-BT 413A-P	Practical in Oenology	02
51.	T. Y. B.Sc.	V	BSC-BT 501T	Recombinant DNA Technology	02
52.	T. Y. B.Sc.	V	BSC-BT 502T	Plant Tissue Culture	02
53.	T. Y. B.Sc.	V	BSC-BT 503T	Animal Tissue Culture	02
54.	T. Y. B.Sc.	V	BSC-BT 504T	Microbial Biotechnology	02
55.	T. Y. B.Sc.	V	BSC-BT 505T	Food Biotechnology	02
56.	T. Y. B.Sc.	V	BSC-BT 506T	Medical Biotechnology	02
57.	T. Y. B.Sc.	V	BSC-BT 507P	Practicals in Recombinant DNA Technology	02
58.	T. Y. B.Sc.	V	BSC-BT 508P	Practicals in Plant Tissue Cultureand Animal Tissue Culture	02
59.	T. Y. B.Sc.	V	BSC-BT 509P	Practicals in Microbial and Food Biotechnology	02
60.	T. Y. B.Sc.	V	BSC-BT 510T	SEC- I Scientific Writing and Communication	02
61.	T. Y. B.Sc.	V	BSC-BT 511P	SEC- II Project Formulation and Presentation	02
62.	T. Y. B.Sc.	VI	BSC-BT 601T	Enzyme Technology	02
63.	T. Y. B.Sc.	VI	BSC-BT 602T	Pharmaceutical Biotechnology	02
64.	T. Y. B.Sc.	VI	BSC-BT 603T	Bioinformatics	02
65.	T. Y. B.Sc.	VI	BSC-BT 604T	Industrial Microbiology	02
66.	T. Y. B.Sc.	VI	BSC-BT 605T	Applied Biotechnology	02
67.	T. Y. B.Sc.	VI	BSC-BT 606T	Biosafety, Bioethics and IPR	02
68.	T. Y. B.Sc.	VI	BSC-BT 607P	Practicals in Enzyme Technology	02
69.	T. Y. B.Sc.	VI	BSC-BT 608P	Practicals in Bioinformatics and Pharmaceutical Biotechnology	02
70.	T. Y. B.Sc.	VI	BSC-BT 609P	Practicals in Industrial Biotechnology	02
71.	T. Y. B.Sc.	VI	BSC-BT 610Pr	SEC – III Project	02
72.	T. Y. B.Sc.	VI	BSC-BT 611Pr	SEC – IV Project	02

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Ahmednagar Jilha Maratha Vidya Prasarak Samaj's New Arts, Commerce and Science College, Ahmednagar (Autonomous)

Syllabus of T. Y. B. Sc. Biotechnology

(Under Faculty of Biotechnology and Wine, Brewing and Alcohol Technology)

Semester – V	Paper - I
Course Code: BSC-BT 501T	**Title of the Course:** Recombinant DNA Technology
Credits: 02	**Total Hours:** 30

Course Outcomes (Cos)

CO1. Students will understand the concepts of recombinant DNA technology.

CO2. Students will learn the construction of genomic and cDNA Library.

CO3. Students will acquire the knowledge of PCR.

CO4. Students will learn the various methods of sequencing.

Detailed Syllabus:

Units	Topic	No. of Hours
I	**Introduction to Recombinant DNA Technology:** historical perspective, concept and significance, a basic layout of R-DNA laboratory	**2**
II	**Molecular tools used in Recombinant DNA Technology:** DNA modifying enzymes – Restriction enzymes, ligases, polymerases, alkaline phosphatases, nucleases (mode of actions	**6**

and applications)

III	**Vectors used in Recombinant DNA Technology:** plasmid vectors, bacteriophages: λ (lambda) and m13, overview of expression vectors, chimeric vectors - cosmids, phasmids, phagemids, introduction of YAC and BAC.	**6**
IV	**Construction of Genomic and cDNA Library:** Genomic and cDNA library, applications of libraries.	**4**
V	**PCR:** Introduction, steps involved in PCR, types, applications of PCR.	**4**
VI	**Sequencing of Genes and Genomes:** Automated DNA sequencing, next generation sequencing.	**3**
VII	**Applications of Recombinant DNA Technology:** Recombinant biotherapeutics production (insulin, interferons, tissue plasminogen activator), gene therapy, introduction to CRISPR/Cas9 as genome editing tool	**5**

Suggested Readings:

1. Brown T.A. (2020) Gene Cloning and DNA Analysis –An Introduction. Eighth Edition. Wiley Blackwell.
2. Rastogi S. and Pathak N. (2009) Genetic Engineering, Oxford University Press
3. Primrose and Twyman R. M. (2006), Principles of Gene Manipulation & Genomics, 7th Edition, Blackwell Publishing, USA.
4. Watson J. D., Baker T., Bell S. P., Gann A., Levine M., Lodwick R. (2013) Molecular Biology of the Gene, 8th Edition, Pearson Education, Inc.
5. Brown T.A. (2008) Genomes 3, Third Edition, Garland Science, Taylor and Francis Group, New York and London.
6. Old R. W., Primrose S. B., and Twyman R. M., (2001) Principles of Gene Manipulation: An Introduction to Genetic Engineering. Oxford: Blackwell Scientific Publications.

7. Green, M. R., and Sambrook, J. (2012) Molecular Cloning: a Laboratory Manual. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.

Semester – V	Paper – II
Course Code: BSC-BT 502T	**Title of the Course:** Plant Tissue Culture
Credits: 02	**Total Hours:** 30

Course Outcomes (Cos)

CO1. Students will understand concept of plant tissue culture.

CO2. Students will study the plant tissue culture laboratory design and organization.

CO3. Students will understand the importance of aseptic techniques in plant tissue culture.

CO4. Students will learn the various techniques of plant tissue culture.

Detailed Syllabus:

Unit	Topics	No. of Hours
I	**Introduction and history of Plant Tissue culture:** Concept of cell theory and cellular totipotency, historical perspective, landmarks in plant tissue culture	2
	Infrastructure and organization of plant tissue culture laboratory: General laboratory, inoculation room and culture room, different work areas, Glasswares, equipments and instruments required in plant tissue culture laboratory.	3
	Aseptic Techniques: Preparation of glassware, packing and sterilization, media sterilization, surface sterilization, aseptic work station, precautions to maintain aseptic conditions in plant tissue culture laboratory	2
	Plant Tissue Culture Media: Nutritional (organic and inorganic) requirements of the explants, PGRs and their *in* vitro roles, types of media and media preparation.	3
	Explant: Explant for plant tissue culture, sterilization of explant and establishment of culture, Response of explant to *in vitro* condition: Concept of differentiation, dedifferentiation and redifferentiation (callus formation, organogenesis (direct and indirect) and embryogenesis (direct and indirect)).	4

II	**Organ culture technique:** Introduction, principle, factors affecting root tip culture, leaf culture, shoot tip and meristem culture.	**2**
	Callus culture technique: Introduction, principle, factors affecting, morphology and internal structure	**2**
	Suspension culture technique: Introduction, principle, types, synchronization, assessment of growth and viability, applications.	**2**
	Micropropagation: Introduction, Stages of micropropagation, pathways and concept of somaclonal variations.	**2** **2**
	Anther and pollen culture: Introduction, principle, pathways of development, factors affecting	
	Ovary, Ovule, Embryo and Endosperm Culture.: Introduction, principle, factors affecting	**2**
	Protoplast–Isolation, Fusion and Culture: Methods of protoplast isolation, protoplast culture, protoplast fusion	**2**
	Applications of plant tissue culture	**2**

Suggested Readings:

1. Razdan M.K. (2009) - Introduction to Plant Tissue culture, Oxford and IBH Publication, New Delhi.

2. Bhojwani S.S. and Razdan M.K. (1996) (2016)- Plant Tissue Culture: Theory and Practice (Elsevier, New Delhi)

3. Jha TB and Ghosh B (2017) – Plant tissue culture: Basic and applied (Universities Press, Hyderabad) and latest editions

4. Plant Tissue culture (2010) – Kalyan Kumar De (New central Book Agency Calactta)

5. Methods In Plant Tissue culture – (2003) U Kumar Agrobios India

6. Plant cell culture Technology—MM Yeomen (2012) Blackwell

Semester – V	Paper – III
Course Code: BSC-BT 503T	**Title of the Course:** Animal Tissue Culture
Credits: 02	**Total Hours:** 30

Course Outcomes (Cos)

CO1. Students will study the laboratory design and infrastructure.

CO2. Students will able to understand the basic concepts in animal tissue culture.

CO3. Students will understand cell repositories and cell banks.

CO4. Students will learn the primary cell culture, histotypic and organotypic cultures.

Detailed Syllabus:

Unit	Topics	No. of Hours
I	**Introduction to Animal Tissue Culture** History and development, scientist's contributions to animal tissue culture.	03
II	**Basic concepts in Animal Tissue Culture** **ATC laboratory and equipment** Laboratory design, equipments, lab wares.	02
	Types of cultures in ATC: Primary culture, secondary culture, cell lines, organ culture, organotypic culture/ histotypic culture, concept of monolayer culture/suspension culture.	05
	Nutrition and Physiology of cultured cells Principles of media formulation, serum containing medium and serum free medium: advantages and disadvantages.	04
	Aseptic conditions: Maintenance of aseptic conditions, contamination, types of contaminants, methods of detection of contaminants, cross contamination.	03
III	**Primary cell culture** Methods of establishing primary cell culture, source selection and establishment of fibroblast and lymphocyte culture.	03

IV	**Cell lines** Evolution of cell line, finite and transformed cell lines, mammalian and insect cell line growth conditions, subculture and characterization of cell line, cell passage number and significance.	**03**
V	**Organ Culture** Types of organ culture, organotypic and histotypic culture, concept of stem cells.	**03**
VI	**Cell Repositories and Cell banks** Cryopreservation of cells, cell repositories and cell distribution.	**02**
VII	**Applications** Applications of animal cell cultures in different fields.	**02**

Suggested Readings:

1. Freshney R.I., (2015) Culture of Animal Cells: A Manual of Basic Techniques and Specialized Applications, 7th ed. Wiley Blackwell, USA.
2. Shenoy M., (2007) Animal cell culture Animal Biotechnology, New Delhi.
3. Bhat S.M., (2011) Animal Cell Culture Concept and Application. Alpha Science International Limited, Oxford.
4. Walsh G. (2003) Biopharmaceuticals – Biochemistry and Biotechnology, 2nd ed. John Wiley and Sons, Chichester.
5. Castilho L.R., Moraes A.M., Augusto E.F.P. (2008) Animal Cell Technology. Taylor and Francis Group, New York.

Semester – V	Paper – IV
Course Code: BSC-BT 504T	**Title of the Course:** Microbial Biotechnology
Credits: 02	**Total Hours:** 30

Course Outcomes (Cos)

CO1. Students will study spoilage of different foods and its preservation techniques.

CO2. Students will able to understand different food borne diseases.

CO3. Students will study the causative agent, symptoms, morphology, pathogenesis, diagnosis and treatment of various diseases.

CO4. Students can understand wastewater treatment methods and different methods of waste water analysis.

CO5. Students will learn applications of microbial Biotechnology.

Detailed Syllabus:

Unit	Topic	No. of Hours
I	**History and Scope of Microbial Biotechnology**	1
II	**Food and Dairy Microbiology**	7

Food Microbiology

Role of microorganisms in food spoilage, factors affecting growth of microbes in food (intrinsic and extrinsic), spoilage of meat and poultry, fruits and vegetable, canned food.

Principles of food preservation.

Methods of preservation- chemical and physical.

Dairy Microbiology

Milk: Definition, composition, normal and abnormal microflora, sources of contamination, international standards.

Milk spoilage- Flavour and colour defects, stormy fermentation, sweet curdling, ropiness

Grading of milk- Direct and indirect tests

Preservation of milk: Pasteurization and efficiency of pasteurization.

Microbial processing of milk- Curd, yogurt, butter, kefir, cheese.

Food borne diseases- Food infection and intoxication

III	**Medical Microbiology** Normal flora, Diseases of various systems Tuberculosis, Leprosy, Typhoid, Polio, Syphilis, Tetanus- causative agent, symptoms, morphology, pathogenesis, diagnosis and treatment.	**7**
IV	**Microbes in Waste Treatment Processes** Water borne diseases: Indicators of fecal pollution, routine bacteriological analysis of water for potability: presumptive, confirmed, completed test, membrane filter technique and Eijkman tests. Bacteriological standards of drinking water (WHO, BSI) Sewage and Industrial waste water: Types of wastes, relevance of COD and BOD determination in analysis of waste water. Methods and principles of treatment of sewage (primary, secondary and tertiary treatment methods. Microbial consortium for effluent treatment	**8**
V	**Applications of Microbial Biotechnology** Geomicrobiology- Ore leaching (methods and examples), MEOR. Bioweapons Biofertilizers and biopesticides and microbial plant growthpromoters (gibberellins and auxins) Microbial sweeteners (Thaumatin, Monelin) Microbial toxins and their applications Microbial polysaccharide Concept of synthetic biology and bio metabolite Genetically Modified Organisms-Norms and applications	**7**

Suggested Readings:

1. Frazier and Westhoff, 2008, Food Microbiology, 4th edition, New York, Tata McGraw Hill Publications.

2. James J., 2005, Modern Food Microbiology, 7th edition, United States, Springer Publications.

3. Jogdand S. N. year, Advances in Biotechnology, Edition, place, Himalaya Publishing House.

4. Eckles C. year, Milk and Milk Products, 3rd edition, New York, Tata McGraw Hill Publications.

5. Prescott, S.C. and Dunn, C.G., 1983, Industrial Microbiology, 4th edition, London, Reed G. AVI tech books.

6. Stanier R.Y, 1987, General Microbiology, 5th edition, UK, Macmillan Publication.

7. Salle A.J., 1943, Fundamental Principles of Bacteriology, 7th edition, New York, McGraw Hill Company.

8. Tortora, G.J., Funke, B.R., Case, C.L, 1992. Microbiology: An introduction, 5th Edition, New York, Benjamin Publication.

9. Davis B.D., Delbacco, 1990, Microbiology, 4th edition, New York, J.B. Lippincott Co.

10. Wolfgang K. J., 1992, Zinsser Microbiology, 20th Edition, New York, McGraw-Hill Professional Publishers.

11. Dey, N.C and Dey, T.K., 1988, Medical Bacteriology, 17thEdition, Calcutta, Allied Agency.

12. Ananthnarayana R. and Panikar J., 1996, Text book of microbiology, 5th edition, Jabalpur, Banarsidas Bhanot

13.Ingraham J.L. and Ingraham C.A., 2004, Introduction to Microbiology, 3nd Edition, Monterey, Thomson Brooks / Cole.

14. Madigan M.T, Martinko J.M., 2006, Brock's Biology of Microorganisms, 11th Edition, New York

15. Salle A.J., 1971, Fundamental Principles of Bacteriology, 7th Edition, New York, Tata MacGraw Publishing Co.

16. Andrew D. E., Mary A. H., Satyanarayan, U., 2008, Standard Methods for the Examination of Water and Wastewater, 21st edition, Kolkata, Publication of the American Public Health Association (APH) edited by Biotechnology Books and Allied Ltd.

17. Sing, B. D., 2010, Biotechnology, edition, New Delhi Kalyani Publishers

Semester – V	Paper - V
Course Code: BSC-BT 505T	**Title of the Course:** Food Biotechnology
Credits: 02	**Total Hours:** 30

Course Outcomes (Cos)

CO1. Students will gain fundamental knowledge of food and its properties.

CO2. Students will able to understand the role of microorganisms in food biotechnology.

CO3. Students will understand the food preservation methods.

CO4. Students will gain the knowledge of food safety, packaging and certification.

Detailed Syllabus:

Unit	Topics	No. of Hours
I	**Basics of Food and Human Nutrition** Nutraceuticals and functional foods: Definition and function of nutraceuticals, functional foods, food supplements, dietary supplements, prebiotics and probiotics, medical foods and foods for special purposes, examples phenylalanine free diet for phenylketonuria patients, lactose free for lactose intolerant. Structure, classification and functions of macro-and micro nutrients and its role in human nutrition Macronutrient deficiency diseases, over nutrition, undernutrition, malnutrition (Kwashiorkor and Marasmus). Food allergens and allergenicity.	8
II	**Food Chemistry, Contamination and Adulteration:** Antinutritional factors: Protease inhibitors, haemagglutinins (lectins), glucosinolates, cyanogens, saponins, gossypol, lathyrogens, antivitamins, antiminerals. bitter substan--ces: tannins and their removal from foods. Food Enzymes: Properties, classification. Sources of microorganisms in food. **Food contaminant and adulterants:** Common Adulterants: Lead chromate, mineral oil, urea, SDS, starch, blotting paper,	8

metanil yellow, Rhodamine argemone, khesari dal, brick powder etc.
Toxins (Cyclopiazonic acid in Buckwheat flour), radioactive nuclides, mycotoxins (Aflatoxin, Ochratoxin, Patulin, DON, Ochratoxins, Sterigmatocystin, Fumonisins, Zearalenone).

III Food preservation **8**

Heat: Principles of heat transfer, blanching, pasteurization, heat sterilization, thermal extrusion, cooking
Concepts of thermal death time, *D* Value, *z*-value, *F*-value, thermal death time curve, 12 D
Water Removal: Forms of water in foods, sorption of water in foods, water activity, drying and evaporation technology, temperature reduction: chilling, freezing.
Non-thermal methods: radiation (ionizing radiation, microwave), ultrasonic and ohmic heating etc.
Chemicals: Class-I and Class-II preservatives, smoke, other chemical additives.

IV Food safety management and packaging: **4**

ISO 22000: HACCP, VACCP and TACCP Principles. Good Manufacturing Practices (GMP), Good Hygienic Practices (GHP), food safety plan, food safety management risk analysis.
Different packaging materials: glass, metals, paper, plastics, biodegradable and edible films and coatings, aseptic packaging and combinations.
Overview of newer packaging technologies: CAP/MAP, irradiated packaging, retort pouch, microwaveable packaging.

V Food safety regulation and certification in India **2**

Food safety and standards authority of India (FSSAI) and other national laws and standards, agricultural produce act, 1937 (grading and marketing), export (quality control and inspection), act 1963 and rules, bureau of Indian standards relevant to food safety (water, infant formula, etc.), legal metrology act, 2009.

Suggested Readings:

1. Foster G.N., 2020, Food Biotechnology CBS Publishers and Distributors.
2. Perry J., Taylor and Francis-2002, Introduction to food Biotechnology 1st Edition, Boca Raton.

3. Skariyachan S., Abhilash M, 2012, Introduction to *Food Biotechnology*

4. Jain N., 2011 Instant *Notes in* Food Biotechnology

5. Thomas B., 2016, Genes, Trade, and Regulation – The Seeds of Conflict in Food Biotechnology.

6. Joshi V. K and Singh R. S., 2013 Food Biotechnology: Principles and Practices I.K International Publishing house Pvt .Limited

7.Gustavo F., Gutierrez –Lopez, 2003, Food Science and Food Biotechnology (Food Preservation Technology) 1st Edition, CRC Press.

8. Pometto A. and Shetty K., 2005 Food Biotechnology, Second Edition (Food Science and Technology) Boca Raton.

9. Dhawan V. 2004, Biotechnology for Food and Nutritional Security.

10. Banwart G.J., 2020, Basic Food Microbiology, 2nd Edition.

11.William C. Frazier D. C., 2017, Food Microbiology, 5th Edition.

Semester – V	Paper – VI
Course Code: BSC-BT 506T	**Title of the Course:** Medical Biotechnology
Credits: 02	**Total Hours:** 30

Course Outcomes (Cos)

CO1. Students will learn the molecular basis of disease.

CO2. Students will understand diagnostic and therapeutic techniques of diseases.

CO3. Students will learn the concept of stem cell therapy.

CO4. Students will learn the applications of nanotechnology in medicine.

Detailed Syllabus:

Unit	Topic	Number of hours
I	**Introduction to molecular basis of genetic diseases:** Introduction, classification, chromosomal disorders-numerical and structural with examples, single gene disorders-sickle cell anemia and thalassemia, polygenic diseases (Type I diabetes, Alzheimer disease).	8
II	**Diagnosis:** Diagnosis using protein and enzyme markers: Enzyme probes Glucose oxidase, Monoamine oxidase. Diagnosis using monoclonal antibodies – hormonal disorders and infectious diseases DNA/RNA based diagnosis: PCR based and use of nucleic acid probes	8
III	**Therapies:** Gene therapy: ex vivo and in vivo gene therapy Strategies of gene therapy: Gene augmentation, antisense therapy Gene therapy trials: ADA deficiency, Cystic fibrosis, HIV Enzyme therapy: Gauchers disease, Hormone replacement therapy: Diabetes	8

IV	**Stem Cell Therapy and Nanotechnology:**	**6**
	Stem cells in therapy-embryonic and adult stem cells, characteristics and properties of stem cells. potential uses of stem cells, cell and tissue engineering, nanotechnology in diagnosis and therapy.	

Suggested Readings:

1) Pasternak JJ. 2005. An introduction to human molecular genetics. 2nd. ed. Hoboken, NJ, USA: Wiley-Liss, John Wiley & Sons, Inc.
2) Nallari, P. and Rao, V.V., 2010, Medical Biotechnology, Oxford University Press, USA.
3) Glick B., Delovitch T.L., Cheryl L., 2014, Medical Biotechnology, Pattern ASM press.
4) Glick B., Cheryl L., 2014 Molecular Biotechnology- Principles and Applications of Recombinant DNA, 4thEdition, Pattern ASM press.
5) Trivedi P. C., Medical Biotechnology, first edition, Avishkar Publisher.
6) Kun L. Y., Medical Biotechnology- Principle and Applications, World Science Publications.

Semester – V	Paper - VII
Course Code: BSC-BT 507P	**Title of the Course:** Practicals in Recombinant DNA Technology
Credits: 02	**Total Hours:** 45

Course Outcomes (Cos)

CO1. Students will learn to perform the isolation of DNA and RNA from various sources.

CO2. Students will learn gel electrophoresis technique.

CO3. Students will understand the concept of restriction digestion and ligation.

CO4. Students will perform transformation process as well as PCR technique.

Detailed Syllabus:

Sr. No.	Title of Experiment	No. of practical
1.	Isolation, quantitation and purity determination of DNA from bacterial source and gel electrophoresis.	1
2.	Isolation, quantitation and purity determination of DNA from plant source and gel electrophoresis.	1
3.	Isolation, quantitation and purity determination of DNA from animal source and gel electrophoresis.	1
4.	Isolation of RNA from animal source and denaturing gel electrophoresis.	1
5.	Plasmid DNA isolation and gel electrophoresis	2
6.	Restriction digestion of the DNA sample and restriction mapping. Problem based on restriction mapping of linear and circular DNA.	2
7.	DNA ligation and gel electrophoresis.	1
8.	Transformation of *E. coli* cells: Preparation of competent Cells Transformation technique Selection of recombinants	3
9.	PCR and gel electrophoresis	2

Suggested Readings:

1. Ausubel F. M., Brent R., Kingston R. E., Moore D. D., Seidman J. G., Smith J. A, Struhl K., 2002, Short Protocols in Molecular Biology, Wiley.
2. Spangler B. D., 2002, Methods in Molecular Biology and Protein Chemistry: Cloning and Characterization of an Enterotoxin Subunit, Wiley.
3. Green and Sambrook (2012) Molecular cloning – A laboratory manual – (Vol. 1-3), 4th edition, Cold Spring Harbor Laboratory Press, USA.
4. Ausubel F. M., 2014, Current Protocols in Molecular Biology, John Wiley and Sons.

Semester – V	Paper -VIII
Course Code: BSC-BT 508P	**Title of the Course:** Practicals in Animal Tissue Cultureand Plant Tissue Culture
Credits: 02	**Total Hours:** 45

Course Outcomes (Cos)

CO1. Students will study the ATC and PTC laboratory design and organization.

CO2. Students will learn media preparation for animal and plant cell cultures.

CO3. Students will understand importance of asepsis.

CO4. Students will learn different techniques of animal as well as plant tissue culture.

Detailed Syllabus:

Sr. No.	Title of Practical	No. of Practicals
	Animal Tissue Culture	
1.	**ATC laboratory design and equipments used in ATC** Structure and design of ATC Laboratory Equipments used: Biosafety cabinet, CO_2 incubator, Inverted microscope, Autoclave, Filter sterilization assembly, Centrifuge, Refrigerator, pH meter, Cell bank storage system, Liquid nitrogen container, etc.	1 2
2.	**Introduction to Aseptic Conditions** Importance of maintaining aseptic conditions. Glassware washing, packing and sterilization (Filter sterilization assembly, forceps, glass pipettes, Petri plates, beakers, conical flasks etc.) Media preparation and sterilization (demo using filter sterilization assembly).	
3.	**Initiation of Primary Culture** initiation of primary culture from chick embryo by trypsinization.	2
4.	**Maintenance of cell line** Observation of cell line and feeding of media	2

Sub-culturing: viable cell count, split ratio

Plant Tissue Culture

5.	Introduction to PTC Laboratory, organization of facility and equipments.	1
6.	Aseptic manipulations – washing, capping, packing and sterilization, laminar flow operation and safety precautions.	1
7.	Preparation of stock solutions and preparation of media	2
8.	Aseptic seed germination and embryo culture	1
9.	Initiation of callus culture and study of callus morphology and internal structure.	1
10.	Initiation of shoot tip/axillary bud culture	1
11.	Initiation of anther culture	1

Suggested Readings:

1. Razdan M.K. (2009) - Introduction to Plant Tissue culture (Oxford and IBH Publ, New Delhi)
2. Bhojwani S.S. and Razdan M.K. (1996) (2016)- Plant Tissue Culture: Theory and Practice (Elsevier, New Delhi
3. Plant tissue culture: Basic and applied Jha TB and Ghosh B (2017) (Universities Press, Hyderabad) and latest editions
4. Plant Tissue culture (2010) – Kalyan Kumar De (New central Book Agency Calactta)
5. Methods in Plant Tissue culture – (2003) U Kumar Agrobios India
6. Plant cell culture Technology—MM Yeomen (2012) Blackwell
7. A Laboratory Mannual of Plant Biotechnology (2009) –S S Purohit Agrobias India
8. Freshney R.I. 2015. Culture of Animal Cells: A Manual of Basic Techniques and Specialized

Applications. 7th Edition. Wiley Blackwell; USA.

9. Gangal S. 2007, Principles and Practice of Animal Tissue Culture 2nd Edition.

Semester – V	Paper – IX
Course Code: BSC-BT 509P	**Title of the Course:** Practicals in Microbial and Food Biotechnology
Credits: 02	**Total Hours:** 45

Course Outcomes (Cos)

CO1. Students will able to determine the quality of milk and efficiency of pasteurized milk.

CO2. Students will able to determined quality of water.

CO3. Students will able to assess important nutraceuticals from food and detect toxins from food.

CO4. Students will learn to analyze canned food.

CO5. Students will able to prepare food product and its preservation.

Detailed Syllabus:

Sr. No.	Title of Experiment	No. of Practical
1	Determination of efficiency of Pasteurization by phosphatase test.	**1**
2	Grading of raw milk (Dye reduction test / DMC).	**1**
3	Assessment of potability of water: a. Presumptive test b. Confirmed test c. Completed test d. Eijkman's test e. IMViC tests	**4**
4	Assessment of some important nutraceuticals in food.	**1**
5	Extraction and estimation of Aflatoxin from food.	**2**
6	Microbial analysis of packaged/ street food.	**1**

7	Microbial analysis of fruits and vegetables.	**2**
8.	Detection of adulteration in food products (milk/honey/pulses/oils/sweets).	**1**
9.	Laboratory preparation of any food product and its preservation.	**1**
10.	Visit to food industry.	**1**

Suggested Readings:

1. Pelczar M.J., Reid R.D., 1958, Laboratory Exercises in Microbiology IX and 173 S. McGraw-Hill Book Co., Inc. New York/Toronto/London. 23 sh 6 d
2. Tortora G. J., Berdell F. , 2015, Microbiology: An Introduction, Africa, Global Edition
3. Madigan M.T., Martinko J.M., Bender K.S., Buckley D.H., Thomas Brock Brock Biology of Microorganisms, 14th Edition.
4. Stanier, Y., Doudoroff, M., and Adelberg, E. A., 1958, General microbiology, London, Macmillan
5. Willey J. and Christopher J., 2016, Prescott's Microbiology, 10th Edition, New York, McGraw Hill
6. Black, J. G., 2017, Microbiology: principles and explorations, 10th edition, John Wiley and Sons.

Semester – V	Paper - X
Course Code: BSC-BT 510T	**Title of the Course:** Scientific Writing and Communication
Credits: 2	**Total Hours:** 30

Course Outcomes (Cos)

CO1. Students will understand the concept of scientific writing.

CO2. Students will learn to prepare manuscript.

CO3. Students will able to understand the guidelines for authors and project writing.

CO4. Students will learn to submit the manuscript in the journals.

Detailed Syllabus:

Sr. No.	Topic	No. of Hour
1.	Scientific method: Concept, hypothesis, theory, law; Design of experiment; Inductive and deductive reasoning. Types of presentation: Oral, poster, written, audio-visual. Aids for presentation.	**5**
2.	Preparing the manuscript, Guidelines for authors. The IMRAD format, Title, byline; Abstract and Summary; Keywords. Introduction: Defining the problem; Literature survey; Justification of study.	**4**
3.	Materials and Methods: Contents, sources, procedures, techniques, reproducibility, Units of measurements, metric system and SI units. Basic statistical techniques, confidence limits, tests, probability, significance.	**5**
4.	Results: Text; How to present data; Tables and illustrations. Writing captions, labels and legends. Discussion: Components and sequence. Analysis, comparison and integration of data. Likely sources of errors in Results; Conclusions and significance. Implications for further study.	**5**

5.	Acknowledgements. Literature citation systems, Sources of references: Journals, books, bibliographies, abstracting journals; Databases.	**4**
6.	Preparing and submitting the manuscript, revising, editing, proofreading, concept of plagiarism, ethics of scientific writing, types of journal, impact factoe, H index, citation index.	**5**
7.	Project report writing	**2**

Suggested Readings:

1. Barrass, R., (2002), Scientists Must Write. 2nd Edition, Routledge, Oxon, UK
2. Day, R.A. and Gastgel B. A., (2006), How to Write and Publish a Scientific Paper. 6th Edition, Greenwood Press, Westport, CT, USA.
3. Goodman, N.W. and Edwards M.B., (2006), Medical Writing: A prescription for clarity. 3rd Edition, Cambridge University Press, Cambridge, UK.
4. Hailman, J.P. and Strier K. B., (2006), Planning, Proposing and Presenting Science Effectively, 2nd Edition, Cambridge University Press, Cambridge, UK.
5. Hawkins, D., (2005), Biomeasurement: Understanding, Analysing and Communicating Data in Biosciences, Oxford University Press, Oxford, UK.
6. Mathews, J.R. and Mathews R.W., (2008), Successful Scientific Writing: A step-by- step guide for the biological and medical sciences, 3rd Edition, Cambridge University Press, Cambridge, UK.
7. McMillan, V.E., (2004), Writing Papers in the Biological Sciences. 4th Edition, Bedford Books/St Martins.
8. Pechenik, J.A., (2006), A Short Guide to Writing About Biology. 6th Edition, Longman, New York.

Semester – VI	Paper - I
Course Code: BSC-BT 601T	**Title of the Course:** Enzyme Technology
Credits: 2	**Total Hours:** 30

Course Outcomes (COs)

CO1. Students will learn the basic concept of enzymes

CO2. Students will study the factors affecting enzyme activity.

CO3. Students will understand the mechanism of enzyme activity regulation

CO4. Students will be able to understand the clinical and industrial applications of enzymes

Detailed Syllabus:

Unit	Topics	No. of hours
I	**Introduction to Enzymes** Properties of enzymes; definition of active sites, enzyme units, specific activity; concept of purity of enzyme. Protein nature of enzymes and Non-protein enzymes- Ribozymes and DNAzymes Metalloenzymes and metal-activated enzymes	3
II	**Enzyme Catalysis** Mechanism of enzyme catalysis: Acid-base catalysis, covalent catalysis, metal ion catalysis, Mechanism of action of serine proteases: Chymotrypsin	4
III	**Enzyme Kinetics** Factors affecting the enzyme activity- Enzyme and substrate concentration, pH, and temperature. Kinetics of single substrate enzyme- catalyzed reaction. Michaelis–Menten equation, Km, Vmax, Lineweaver-Burk plot, Turnover number, Kcat	6

IV.	**Enzyme Regulation** Regulation on the basis of Activity: Feedback regulation, allosteric regulation, covalent modification, and proteolytic activation of Zymogens Multienzyme complexes and Isoenzymes Organization of enzymes in Cells: Compartmentation of metabolic pathways -Fatty acid catabolism and anabolism, enzymes in membrane with suitable examples. Mechanism of enzyme degradation: Lysosomal and non-lysosomal pathways.	**8**
V	**Immobilization of Enzymes** Carrier matrices and their properties, Methods of enzyme immobilization, whole enzyme/cells immobilization Applications of immobilized enzymes	**3**
VI	**Industrial and clinical applications of enzymes** **Industrial Enzymes:** Lipases, proteolytic enzymes in meat and leather industry, cellulose-degrading enzymes, metals degrading enzymes. **Clinical Enzymes:** Enzymes as thrombolytic agents, anti-inflammatory, Streptokinase, Asparginase, LDH, Transaminases (AST), Amylases, Phosphatases, Cholinesterases. **Biosensor:** Components of enzyme biosensor (Glucose oxidase).	**6**

Suggested Readings:

1. Erice C. and Paul S., 2009, Outlines of Biochemistry, 5th Edition, John Wiley and Sons, USA.

2. Donald V. and Judith V., 2008, Fundamentals of Biochemistry, 3rd Edition, John Wiley and Sons, USA.

3. Jeffory Z., 1997, Principles of Biochemistry, 4th edition, McGraw-Hill College, USA.

4. Jeremy B. and Lubert S., 2012, Biochemistry, 7th edition, W.H.Freeman and company, New York.

5. Nelson D. and Cox M., 2008, Lehninger: Principles of Biochemistry, 5th Edition, W.H. Freeman and company, New York.

6. Garett R. and Grisham C., 2013, Biochemistry, 5th edition, Brook/Cole, Cengage Learning, Boston, USA.

7. Trevor P., 2001, Enzymes: Biochemistry, Biotechnology and Clinical chemistry, Horwood Company, England.

Semester – VI	Paper - II
Course Code: BSC-BT 602T	**Title of the Course:** Pharmaceutical Biotechnology
Credits: 2	**Total Hours:** 30

Course Outcomes (COs)

CO1. Students will study the concept of pharmaceutical biotechnology.

CO2. Students will be able to study the drug discovery process

CO3. Students will understand the process of drug approval**.**

CO4**.** Students will learn the regulations in pharmaceutical field.

Detailed Syllabus:

Unit	Topic	No. of hours
I	**Brief Introduction to Pharmaceutical Biotechnology** Introduction to pharmaceutical biotechnology, use of microbes in pharmaceutical industries Therapeutic and clinical applications Physicochemical properties of drugs Drugs from natural sources	5
II	**Concept of Drug Discovery and Development** Drug Discovery- Methods, Biochemical and molecular level screening systems Preclinical and clinical trials Estimation of toxicity: LD_{50} and ED_{50}	8
III	**Biotherapeutics** Biosimilars, biopharmaceuticals. Production of useful proteins in transgenic animals, growth promoting factors, hormones. Vaccine technology – Recombinant vaccine (Hepatitis B, Covid 19).	10

IV	**Regulatory Aspects in Pharmaceuticals** Introduction to pharmacopoeia, FDA regulation and IP, BP, USP, GMP in pharmaceuticals, legislative perspective in biopharmaceuticals. ICH and WHO guidelines for quality control.	**7**

Suggested Readings:

1. Hugo, WB and Russell, AD, Pharmaceutical Microbiology, (2003). Blackwell Science Oxford, UK
2. Krogsgaard L, Lilijefors T. and Madsen, U. Textbook of Drug Design and Discovery, (2004). Taylor and Francis, London.
3. Geoffrey Hanlon and Norman Hodges. Essential Microbiology for pharmacy and pharmaceutical science. (2013). Wiley Blackwell.
4. FDA Compliance Program 7382.845 Inspections of Medical Device Manufacturers, February 2, 2011.
5. ANSI/AAMI/ISO 11737-1:2018/(R) 2011, Sterilization of health care products
6. Microbiological methods – Part 1: Determination of the population of microorganisms on product.
7. PDA Technical Report No. 21, Bioburden Recovery Validation. 1990
8. S. P. Vyas & V. K. Dixit. Pharmaceutical Biotechnology. (2003) CBS Publishers & Distributors, New Delhi.
9. Bhatia R and Ichhpujani RL. Quality Assurance in Microbiology. (1995). CBS Publishers, New Delhi.
10. Gregory Gregoriadis. Drug Carriers in biology & Medicine. (2001). Academic Press New York.
11. Satoskar R. S. and S. D. Bhandarkar (1991) Pharmacology and Pharmacotherapeutics, 12th Edition. Vol. 1 and 2. Popular Prakashan, Mumbai.

Semester – VI	Paper - III
Course Code: BSC-BT 603T	**Title of the Course:** Bioinformatics
Credits: 2	**Total Hours:** 30

Course Outcomes (Cos)

CO1. Students will learn about the bioinformatics databases, data format and data retrieval from the online sources

CO2. Students will gain knowledge of biological data generation tools.

CO3. Students will get in-depth knowledge of alignment methods and its applications.

CO4. Students will learn structural bioinformatics

Detailed Syllabus:

Unit	Topic	Number of Hours
I	**Introduction to Bioinformatics** History and development Relation of Bioinformatics to Biotechnology	3
II	**Data Generation Tools** Introduction, significance Basic tools of data generation: NGS Genome Sequencing, Protein sequencing, NMR Spectroscopy and Microarray	7
III	**Biological Databases** Types of databases (Primary, Secondary and Specialized) Nucleic acid databases (GENBANK, EMBL and DDBJ). Protein databases (Swissprot, UniProt) Structure databases (PDB, CATH, SCOP),	8

	Literature database: Pubmed, MEDLINE, Polymorphism database: OMIM	
IV	**Sequence Alignments and Visualization** Introduction to Sequence alignments Local alignment and Global alignment Pairwise alignment (Dot Matrix, Dynamic Programming, Word Method-Blast, FASTA) and multiple sequence alignment (Clustal-omega)	**8**
V	**Protein structure and visualization tools** Basics of protein structure and visualization tools: RasMol, SPDBV	**4**

Suggested Readings:

1. Claverie, J.M. and Notredame C. 2003 Bioinformatics for Dummies. Wiley Editor.

2. Letovsky, S.I. 1999 Bioinformatics. Kluwer Academic Publishers.

3. Baldi, P. and Brunak, S. 2001 Bioinformatics: The machine learning approach, The MIT Press.

4. Setubal, J. and Meidanis, J. 1996 Introduction to Computational Molecular Biology. PWS Publishing Co., Boston.

5. Lesk, A.M. 2005, 2nd edition, Introduction to Bioinformatics. Oxford University Press.

6. Fogel, G.B. and Corne D.W., 2002, Evolutionary Computation in Bioinformatics, Morgan Kaufmann Publishers

7. Mount, D.W., 2001, Bioinformatics: Sequence and Genome Analysis. CSHL Press.

8. Durbin R., Eddy S., Krogh A. and Mithchison G. 2007 Biological Sequence Analysis, Cambridge University Press.

9. Web resources and online computational tools available at NCBI, Swissprot, Uniprot etc.

Semester – VI	Paper - IV
Course Code: BSC-BT 604T	**Title of the Course:** Industrial Microbiology
Credits: 02	**Total Hours:** 30

Course Outcomes (Cos)

CO1. Students will able to understand fermentation process and types of fermentation.

CO2. Students will study strain improvement techniques

CO3. Students will know the media formulation and its use for large scale manufacturing processes

CO4. Students will learn different methods to optimize and sterilize media and air.

CO5. Students will able to measure and control different bioprocess parameters

CO6. Students will study different methods of downstream processing

Detailed Syllabus:

Unit	Topic	No. of Hours
I	**Introduction to Industrial Microbiology:** Concept of Fermentation Process- Definition, Historical perspective, Typical Layout of a fermentation unit. Types of fermentations: Submerged, Surface, Solid State, Dual, Batch, Continuous, Fed Batch	4
II	**Screening and Strain Improvement Techniques**: Definition and Objectives Isolation and Screening of industrially important microorganisms Primary and Secondary Screening with suitable example Methods for strain improvement with examples (mutants with altered permeability, auxotrophic mutants, analogue resistant)	4

III	**Bioreactor Design**: Characteristics of an ideal Fermenter, Construction material used, surface treatment of the material Design of a typical batch fermenter, aerator and agitator- types, baffles, seals and valves used, steam traps. Different designs of bioreactors: Airlift (internal and external loop), Packed bed reactor, Fluidized bed reactor, Single use bioreactor.	**3**
IV	**Large Scale media and sterilization:** **Media components and optimization** Carbon sources: Cane and beet molasses, malt, corn, starch, oils, hydrocarbons, alcohols. Nitrogen sources: Corn steep liquor, soybean meal, peanut meal, buffering agents, chelators, water, precursors, inhibitors, inducers antifoams. Concept of medium optimization: Placket and Burman design **Media Sterilization**: Principles, Del factor, indicator organism for design of sterilization cycle, Equipments used in sterilization: Batch and continuous. **Air sterilization**: Principles, mechanism of capture of particles in air, fixed (absolute) and non-fixed pore (depth) filters	**6**
V	**Measurement and Control of different Bioprocess Parameters:** Temperature, pH, foam, dissolved oxygen, microbial biomass, concept of scale up and scale down	**4**
VI	**Downstream Processing of fermentation product-** Methods and equipments Unit operations and downstream processing, General strategy of product recovery	**5**

	Precipitation (Agents used: Salts, Organic solvents, polyelectrolytes, acids and bases) Filtration (plate frame, rotary vacuum, filter aids, flocculating agents) Centrifugation (types used in Industry: basket, tubular bowl, disc bowl) Cell Disruption (Physico–mechanical and chemical methods). Solvent extraction- Liquid liquid extraction Drying : Drum and spray	
VII	Large Scale Manufacturing Process- Baker's yeast, organic acid (citric acid), Vit B12, lysine, alcohol. Enzyme- amylase.	**4**

Suggested Readings:

1. Wulf C. and Anneliese C., 2004, Biotechnology: A Textbook of Industrial Microbiology, 2nd edition, *New Delhi*, Panima Publishing Corporation.

2. Stanbury P., Whitaker *A.*, Stephen H. 2017, Principles of Fermentation Technology, 3rd Edition, United Kingdom. (https://biokamikazi.files.wordpress.com/2013/09/principles of fermentation technology stanburry whittaker.pdf)

3. Casida Jr, L.E., 2007, Industrial Microbiology, 1st edition, New Delhi, New Age International (P) Ltd.

4. Prescott S.C. and Dunn C.G., 2004, Industrial Microbiology, 1st edition, Agrobios (India), CBS Publication.

5. Patel A.H., 2008, Industrial Microbiology, 1st edition, London, MacMillan Publication.

6. Mathuriya S. A. 2009, Industrial Biotechnology ANE books.

7. Prescott S.C. and Dunn C.G., 2011, Industrial Microbiology, Jodhpur, Agrobios http://rims.ruforum.org/B5C1BA5D7194/industrial-microbiology-prescott-dunn.pdf.

8. James E. Bailey and David F. Ollis, 1986, Biochemical Engineering Fundamentals, 2nd edition, New York, McGraw Hill.

9. Doran P., 2013, Bioprocess Engineering Principles, 2nd edition, United States, Academic Press Ltd (http://site.iugaza.edu.ps/mwhindi/files/ebooksclub.org Bioprocess Engineering Principles pdf)

Semester – VI	Paper - V
Course Code: BSC-BT 605T	**Title of the Course:** Applied Biotechnology
Credits: 02	**Total Hours:** 30

Course Outcomes (Cos)

CO1. Students will learn the applications of biotechnology in waste recycling.

CO2. Students will able to understand tools and techniques in molecular diagnostics.

CO3. Students will understand importance and applications of marine biotechnology.

CO4. Students will learn the significance of nanobiotechnology.

Detailed Syllabus:

Unit	Topics	No. of Hours
I	**Biotechnology in Agriculture Waste Recycling:** **Waste Management:** Definition, solid waste suitable for composting, methods of composting, vermicomposting, mineralization process in composting, factors involved, infrastructure required, maturity parameters, value addition, application methods. **Biomass Briquetting :** Definition, potential agro residues and their characteristics for briquetting, fundamental aspects and technologies involved in briquetting, economic analysis of briquetting, setting up of briquetting plant, appliances for biomass briquettes.	**07**
II	**Biotechnology in Diagnosis- Molecular Diagnostics:** Introduction to molecular diagnostics, significance, scope, rise of diagnostic industry, biomarkers in disease diagnostics: role of markers in disease diagnosis, examples, immunodiagnostic techniques, DNA reporters, FISH, PCR in molecular diagnostics.	**08**

III	**Marine Biotechnology:** Marine Biotechnology: Significance Marine derived pharmaceuticals: Marine bio-resources, secondary metabolites, marine proteins and lipids Marine actinobacterial metabolites and their pharmacological potential Barophilic organisms and their applications Seaweeds for removal of metal pollutants Green Fluorescence Proteins, Red Fluorescence Proteins: characteristics and applications Chitosan: products and applications Microalgae: Biotechnological approaches for production of important microalgae.	**08**
IV	**Nanobiotechnology:** Introduction- Nanotechnology and Nanobiotechnology, Principles of nanoparticle synthesis using living organisms and characterization, Different morphological forms of nanomaterials (nanospheres, Nano capsules, dendrimers), Applications of nano-materials in drug delivery, importance of nanomedicine, biochips.	**07**

Suggested Readings:

1. Christof M. N., Clad A., 2004, Nanobiotechnology: Concepts, applications and Perspectives, First edition, Wiley VCH.

2. Oded S. and Ilan L., 2007, Nanobiotechnology: Bioinspired Devices and Material of Future, Human Press.

3. Yubing X., 2012, The Nanobiotechnology Handbook, CRC press.

4. Lindsay S.M., 2010, Introduction to Nanoscience, Oxford universal Press.

5. Poole C. and Frank O., 2006, Introduction to Nanotechnology, Wiley

6. Pulickel M., Linda S., Paul B., 2003, Nanocomposites Science and Technology Wiley-VCH

Verlag.

7. Shetty K., 2006, Food Biotechnology CRC, New York.

8. Nicholl, 2006, Genetic Engineering, Cambridge University Press.

9. Grover P.D. and Mishra S.K., 2006, Biomass Briquetting: Technology and Practices. Published by FAO Regional Wood Energy Development Programme in Asia, Bangkok, Thailand.

10. Raymond C L., 2004, Agricultural Waste Management- problems, processes and approaches, Academic press.

11. Buckingham and Flaw, 2007, Molecular Diagnostics: Fundamentals, Methods and Clinical Applications, F.A. Davis Company.

12. William B. C., Gregory J. T., 2010, Molecular Diagnostics: For the Clinical Laboratorian, Edition, Springer-Verlag New York, LLC.

13. Kim S., 2020, Encyclopedia of Marine Biotechnology, John Wiley & Sons Ltd.

Semester – VI	Paper - VI
Course Code: BSC-BT 606T	**Title of the Course:** Biosafety, Bioethics and IPR
Credits: 02	**Total Hours:** 30

Course Outcomes (Cos)

CO1. Students will learn the basic principles of bioethics.

CO2. Students will able to understand various biosafety levels.

CO3. Students will gain the knowledge of intellectual properties.

CO4. Students will learn the process of filing patent.

Detailed Syllabus:

Unit	Topic	Hours
I	**Bioethics** Basic principles of bioethics Regulatory bodies for bioethics in India Role of Institutional Ethical Committee (IEC) Bioethics in plants, animals and microbial genetic engineering	7
II	**Biosafety** Introduction to biosafety Concepts, symbols and significance in experimental biological sciences International laws on biosafety Levels of Biosafety (BSL-1 to 4) for specific microorganisms. Introduction to Biological Safety Cabinets. Introduction to the concept of containment level and Good Laboratory Practices (GLP)	8

III	**Intellectual Property Rights (IPR)** Introduction to Intellectual Property Rights (IPR) Tools of IPR Indian Patent Law. World Trade Organization and its related intellectual property provisions History of GATT and TRIPS agreement. WIPO- Objectives and its role Significance of IPR in Biotechnology; Budapest Treaty; Protection of GMOs	**9**
IV	Patent, Types of patent Procedure of filing of patent, flowchart.	**6**

Suggested Readings:

1. Rimmer, M., 2008, Intellectual property and biotechnology: Biological inventions. Edward Elgar Publishing, United Kingdom.
2. Singh K. K., 2014, Biotechnology and Intellectual Property Rights: Legal and Social Implications, Springer, India.
3. Alastair V., Campbell, R., 2017, Bioethics: the basics, 2nd edition.
4. Goel D. and Parashar S., 2013, IPR, Biosafety and Bioethics, Pearson.
5. Fleming D. O., Long D. A., 2006, Biological Safety: Principles and Practices, 4th edition, ASM Press.
6. Lim L., Ching; Terje Traavik; Biosafety First: Holistic Approaches to Risk and Uncertainty in Genetic Engineering and Genetically Modified Organisms; Tapir Academic Press, 2007
7. Wadehra, B.L. Law Relating to Intellectual Property, (2011), Fifth Edition, Universal Law Publishing Co.Pvt. Ltd.
8. Ganguli P., Intellectual Property Rights, (2001), Tata McGraw-Hill Publishing Company Ltd.

Semester – VI	Paper - VII
Course Code: BSC-BT 607P	**Title of the Course:** Practicals in Enzyme Technology
Credits: 02	**Total Hours:** 45

Course Outcomes (Cos)

CO1. Students will learn the isolation of enzymes

CO2. Students will study the determination of total and specific activity of enzyme.

CO3. Students will understand effect of different parameters on enzyme activity.

CO4. Students will be able to understand the enzyme immobilization technique.

Detailed Syllabus:

Sr. No.	Title of Practical	No. of Practicals
1.	Isolation of Amylase/Invertase from suitable source.	1
2.	Determination of enzyme activity: Preparation of standard plot of Maltose Calculation of enzyme activity Preparation of standard curve of protein (Albumin) by Folin's-Lowry method Calculation of specific activity	5
3.	Effect of following parameters on enzyme activity Temperature pH Incubation time	3
4.	Effect of substrate concentration on enzyme activity and determination of K_m and V_{max}	2
5.	Enzyme immobilization using gel entrapment method and to check its efficiency.	2

6. Detection of serum enzymes: SGOT/SGPT /Alkaline phosphatase 2

Suggested Readings:

1. Jayaraman J., 1981, Laboratory manual in Biochemistry, John Wiley & Sons, New Delhi
2. Plummer D, 1988, An Introduction to Practical Biochemistry, 3rd edition, Tata McGraw Hill New Delhi
3. Nath R.,1990, Practical Biochemistry in Clinical Medicine, 2nd edition, Academic Pubisher, Calcutta.
4. Sadasivam S. and Manickam A.,1996, Biochemical Methods, 2nd edition, New Age International (P) Ltd. Publisher, New Delhi
5. Lasseter B. 2019, Biochemistry in the lab,1st edition, CRC press, United states.
6. Sawhney S., Singh R., 2000, Introductory Practical Biochemistry, 3rd edition, Narosa publication house, New Delhi.

Semester – IV	**Paper VIII**
Course Code: BSC-BT- 608P	**Title of the Course:** Practicals in Bioinformatics and Pharmaceutical Biotechnology
Credits: 2	**Total Practicals : 15**

Course Outcomes (COs):

CO1. Students will learn to access bioinformatics databases and data retrieval from the online sources.

CO2. Students will get in-depth knowledge about pairwise and multiple sequence alignment methods and database similarity searching.

CO3. Students will able analyze and manipulate protein 3D structure.

CO4. Students will learn the operations in pharmaceutical laboratory.

Sr. No.	**Title of experiment**	**No. of Practical**
1.	Introduction to biological databases and retrieving the information Genbank, Uniprot, PDB, PubMed	**2**
2.	Pairwise sequence Alignment- EMBOSS Needle/ LALIGN/Blast	**1**
3.	Multiple Sequence Alignment- Clustal Omega/TCoffee	**2**
4.	Database Similarity Searching – Blast/FASTA	**2**
5.	Protein structure visualization – RasMol, Spdbv	**1**
7.	Extraction of active pharmaceutical ingredient from plant and its characterization by Thin Layer Chromatography	**2**
8.	Determination of Drug Dosage – LD_{50}, IC_{50}	**2**
9.	Bacterial Endotoxine Testing – LAL Test	**1**
10.	Case study on Clinical Trial of any drug	**1**
11.	Visit to Pharmaceutical Industry	**1**

Suggested Readings:

1. Letovsky, S.I. 1999 Bioinformatics. Kluwer Academic Publishers.

2. Baldi, P. and Brunak, S. 2001 Bioinformatics: The machine learning approach, The MIT Press.

3. Setubal, J. and Meidanis, J. 1996 Introduction to Computational Molecular Biology. PWS Publishing Co., Boston.

4. Lesk, A.M. 2005, 2nd edition, Introduction to Bioinformatics. Oxford University Press.

5. Fogel, G.B. and Corne D.W., 2002, Evolutionary Computation in Bioinformatics, Morgan Kaufmann Publishers

6. Mount, D.W., 2001, Bioinformatics: Sequence and Genome Analysis. CSHL Press.

7. Durbin R., Eddy S., Krogh A. and Mithchison G. 2007 Biological Sequence Analysis, Cambridge University Press.

8. Web resources and online computational tools available at NCBI, Swissprot, Uniprot etc.

9. Bhatia R and Ichhpujani RL. Quality Assurance in Microbiology. (1995). CBS Publishers, New Delhi.

10. Gregory Gregoriadis. Drug Carriers in biology & Medicine. (2001). Academic Press New York.

11. Satoskar R. S. and S. D. Bhandarkar (1991) Pharmacology and Pharmacotherapeutics, 12th Edition. Vol. 1 and 2. Popular Prakashan, Mumbai.

Semester – VI	**Paper - IX**
Course Code: BSC-BT 609T	**Title of the Course:** Practicals in Industrial Microbiology
Credits: 02	**Total Hours:** 45

Course Outcomes (COs)

CO1. Students will study laboratory fermenter

CO2. Students will able to perform screening for isolation of desired microbes from sample

CO3. Students will carry out production of different microbial metabolite

CO4. Students will able to perform down streaming of fermented broth

Detailed Syllabus:

Sr.No.	Title of experiment	No. of Practicals
1.	Study of various parts and working of Lab Bench fermenter	1
2.	Primary Screening and secondary screening for antibiotic producing organism from soil (Crowded plate and Giant colony method)	3
3.	Isolation of antibiotic resistant mutants by Gradient plate technique	1
4.	Lab scale Production, Recovery and estimation of Organic acid (citric acid/lactic acid)	3
5.	Lab scale production, recovery and estimation of organic solvent	3
6.	Preparation of wine and estimation of alcohol content, total titrable acidity and volatile acidity of wine.	3
7.	Visit to Winery/Brewery/Distillery.	1

Suggested Readings:

1. Kulandaivel S. Janarthanan I. K., 2012, Practical Manual on Fermentation Technology, India, International Publishing House Pvt. Ltd

2. Aneja K.R., 2017, Experiments in Microbiology, Plant Pathology and Biotechnology, 4 th edition, India, New age International.

3. Chellapandi P., 2007, Laboratory Manual in Industrial Biotechnology, India, Pointer Publishers.

4. Demain A. L., Davies J.E., Atlas R.M. 2007, Manual of Industrial Microbiology and Biotechnology, 2nd, University of Michigan, ASM Press.

Semester – V and VI	
Course Code: BSC-BT- 511Pr, BSC-BT- 610Pr and BSC-BT-611Pr	**Title of the Course:** SEC- II Project Formulation and Presentation, SEC – III Project, SEC – IV Project
Credits: 2 + 2 + 2 = 6	Total Hours: 45 + 45 + 45 = 135

Course Outcomes (Cos)

CO1. Students will learn to do individual research

CO2. Students will understand the methodology of research

CO3. Students will gain the experience of report writing

CO4. Students will able to present their research work.

Detailed Syllabus:

The students may opt for this course in the fifth semester, and it will continue in the sixth semester, Making it a total of 6 credit course. **(**BSC-BT- 511Pr, BSC-BT- 610Pr and BSC-BT-611Pr**: Project)**

It Involves Laboratory/ experimental/ field work under the guidance of a supervisor, leading to presentation of a comprehensive report based on the experiential learning, through focused skill building activity.

After completion of this course, the students should present a detailed project report comprising of

i. A scientific topic and relevant design of hypothesis
ii. Aims, objective and Significance
iii. Review of literature
iv. Methodology/Technology used
v. Experimental outcome and critical analysis
vi. Summary and conclusion
vii. References in appropriate referencing styles.

In the Vth and VIth Sem, a student will submit the Project report and will be assessed as per the following guidelines.

Guidelines for assessment:

SEM V	**Course**	**External**	**Internal**	**Contents of the Report**
	BSC-BT-511Pr	**35**	**15**	i. Topic selected ii. Aims and objective and Significance iii. literature review IV. Plan of work
SEM VI	BSC-BT-610Pr and BSC-BT-611Pr	**70**	**30**	i. Methodology/Technology used ii. Experimental outcome and critical analyses iii. Summary and conclusion iv. References in appropriate referencing styles. Oral Presentation and Viva