



Syllabus for B.Sc. Biotechnology (UG)

CHOICE BASED CREDIT SYSTEM (CBCS)

I & II Semester Biotechnology Papers

Under-Graduate (UG) Program

Framed According to the National Education Policy (NEP 2020)

From the academic year 2021-22

MODEL CURRICULUM

Name of the Degree Program: BSc (Basic/Hons.)

Discipline Core: Biotechnology

Total Credits for the Program: B.Sc. Basic - 136 and B.Sc. Hons. - 176

Starting year of implementation: 2021-22

Program Outcomes: Competencies need to be acquired by the candidate for securing B.Sc. (Basic) or B.Sc. (Hons)

Introduction:

The NEP-2020 offers an opportunity to effect paradigm shift from a teacher-centric to student-centric higher education system in India. It caters skill based education where the graduate attributes are first kept in mind to reverse-design the programs, courses and supplementary activities to attain the graduate attributes and learning attributes. The learning outcomes-based curriculum framework for a degree in **B.Sc. (Honours) Biotechnology** is intended to provide a comprehensive foundation to the subject and to help students develop the ability to successfully continue with further studies and research in the subject while they are equipped with required skills at various stages. Effort has been made to integrate use of recent technology and use of MOOCs to assist teaching-learning process among students. The framework is designed to equip students with valuable cognitive abilities and skills so that they are successful in meeting diverse needs of professional careers in a developing and knowledge-based society. The curriculum framework takes into account the need to maintain globally competitive standards of achievement in terms of knowledge and skills in **Biotechnology** and allied courses, as well develop scientific orientation, spirit of enquiry, problem solving skills, human and professional values which foster rational and critical thinking in the students. This course serves a plethora of opportunities in different fields right from classical to applied aspects in **Biotechnology**.

GRADUATE ATTRIBUTES IN B.Sc. (Hons.) Biotechnology

Some of the characteristic attributes a graduate in **Biotechnology** should possess are:

- Disciplinary knowledge and skills
- Skilled communication
- Critical thinking and problem solving capacity
- Logical thinking and reasoning
- Team Spirit & Leadership Quality
- Digital efficiency
- Ethical awareness / reasoning
- National and international perspective
- Lifelong learning

Flexibility:

- The programmes are flexible enough to allow liberty to students in designing them according to their requirements. Students may choose a single Major, one Major with a Minor, and one Major with two Minors. Teacher Education or Vocational courses may be chosen in place of Minor/s below listed are the various options students may choose from.
- One Major subject/discipline, Two Languages, Generic Electives, Ability Enhancement, Skill Development and Vocational courses including Extracurricular Activities.
- One Major and one Minor subject/discipline along with Languages, Generic Electives, Ability Enhancement, Skill Development and Vocational courses including Extracurricular Activities
- Two Major subject/disciplines along with Languages, Generic Electives, Ability Enhancement, Skill Development and Vocational courses, including Extracurricular Activities.
- One Major subject/discipline and one Vocational course along with Languages, Generic Electives, Ability Enhancement and Skill Development and courses including Extracurricular Activities.
- One Major Discipline and One Education Discipline along with Languages, Generic Electives, Ability Enhancement and Skill Development Courses including Extracurricular Activities.

By the end of the program the students will be able to:

- Understand concepts in Biotechnology and demonstrate interdisciplinary skills acquired in cell biology, genetics, biochemistry, microbiology and molecular biology.
- Demonstrate the laboratory skills in cell biology, basic and applied microbiology with an emphasis on technological aspects.
- Competent to apply the knowledge and skills gained in the fields of Plant biotechnology, animal biotechnology and microbial technology in pharma, food, agriculture, beverages, herbal and nutraceutical industries.
- Critically analyze the environmental issues and apply the knowledge gained in biotechnology for conserving the environment and resolving the problems.

- Demonstrate comprehensive innovations and skills in the field of biomolecules, cell biology molecular biology, bioprocess engineering and genetic engineering of plants, microbes, and animals with respect to applications for human welfare.
- Apply knowledge and skills of immunology, bioinformatics, computational modelling of proteins, drug design and simulations to test the models and aid in drug discovery.
- Critically analyze, interpret data, and apply tools of bioinformatics and multi omics in various sectors of biotechnology including health and food.
- Demonstrate communication skills, scientific writing, data collection and interpretation abilities in all the fields of Biotechnology.
- Learn and practice professional skills in handling microbes, animals and plants and demonstrate the ability to identify ethical issues related to recombinant DNA technology, genetic engineering, animal handling, intellectual property rights, biosafety, and biohazards.
- Explore the biotechnological practices and demonstrate innovative thinking in addressing the current day and future challenges with respect to food, health, and environment.
- Gain thorough knowledge and apply good laboratory and good manufacturing practices in biotech industries.
- Understand and apply molecular biology techniques and principles in forensic and clinical biotechnology.
- Demonstrate entrepreneurship abilities, innovative thinking, planning, and setting up of small-scale enterprises or CROs.

Assessment: Weightage for assessments

Type of Course	Formative Assessment / IA	Summative Assessment
Theory	40	60
Practical	25	25
Projects	40	60
Experiential Learning (Internships/MOOC/ Swayam etc.)	40	60

Progressive Certificate, Diploma, Bachelor's Degree or Bachelor's Degree with Honours provided at the end of each year of exit of the four-years Undergraduate Programme.

	EXIT OPTIONS	Credits Required
1.	Certificate upon the successful completion of the First Year (Two Semesters) of the multidisciplinary Four-years Undergraduate Programme/Five-years Integrated Master's Degree Programme.	44-48
2.	Diploma upon the successful completion of the Second Year (Four Semesters) of the multidisciplinary Four-years Undergraduate Programme/Five-years Integrated Master's Degree Programme.	88-96
3.	Basic Bachelor's Degree at the successful completion of the Third Year (Six Semesters) of the multidisciplinary Four-year Undergraduate Programme/Five-years Integrated Master's Degree Programme.	132-144
4.	Bachelor's Degree with Honours in a Discipline at the Successful Completion of the Fourth Year (Eight Semesters) of the multidisciplinary Four-years Undergraduate Programme/Five-years Integrated Master's Degree Programme	176-192

IIA. Model Program Structures for the Under-Graduate Programs in Bangalore University and its affiliated Colleges.

Biotechnology

Semester	Discipline Core (DSC) (Credits) (L+T+P)	Discipline Elective(DSE) / Open Elective (OE) (Credits) (L+T+P)	Ability Enhancement Compulsory Courses (AECC), Languages (Credits) (L+T+P)		Skill Enhancement Courses (SEC)		Total Credits
					Skill based (Credits) (L+T+P)	Value based (Credits) (L+T+P)	
I	DSC: T1 BTC 101 A1- Cell biology and Genetics (04) DSC-P1 BTC 101 Cell biology and Genetics (02)	OE-T1, BTC 301 Biotechnology for Human Welfare (03)	L1-1(3), L2- 1(3) (4 hrs. each)		SEC-T1, BTC -701, Biotechnological Skills and Analytical Techniques (1+0+2)	Physical Education for Health & Wellness fitness (1)(0+0+2)(1) (0+0+2)	25
II	DSC-T2 BTC 102 A2- Microbiological Methods (04) DSC-P2 BTC 102 Microbiological Methods (02)	OE-T2, BTC 302 Applications of Biotechnology in Agriculture (03)	L1-2(3), L2- 2(3) (4 hrs. each)	Environ- mental Studies (2)	-----	Physical Education - NCC/NSS/R&R (S&	25
Exit option with Certificate in Biotechnology (50 Credits)							

B.Sc. Biotechnology (Basic / Hons.), First Semester

Course Title: DSC-T1BTC101, Cell Biology and Genetics (A1)	
Course Code: DSC-T1 BTC101	L-T-P per week: 4-0-0
Total Contact Hours: 56	Course Credits: 04
Formative Assessment Marks: 40	Duration of ESA/Exam: 03 h
Model Syllabus Authors: Curriculum Committee	Summative Assessment Marks: 60

Course Outcomes (COs): At the end of the course the students will be able to:

1. Understand concepts in Biotechnology and demonstrate knowledge acquired in interdisciplinary skills in cell biology and genetics
2. Comprehend the structure of a cell with its organelles
3. Understand the chromatin structure and its location
4. Understand the basic principles of life, and how a cell divides
5. Explain the organization of genes and chromosomes, chromosome morphology and its aberrations

Course Articulation Matrix: Mapping of Course Outcomes (Cos) with Program Outcomes (Pos 1-12)

Sl. No	Course Outcomes (COs) / Program Outcomes (POs)	T1	1	2	3	4	5	6	7	8	9	10	11
I	Core competency	X											
II	Critical thinking	X											
III	Analytical reasoning	X											
IV	Research skills	X											
V	Team work	X											

Course Articulation Matrix relates course outcomes of course with the corresponding program outcomes whose attainment is attempted in this course. Mark '✓' in the intersection cell if a course outcome addresses a particular program outcome.

B.Sc. Biotechnology (Basic / Hons.), First Semester

Content of Course 01: Theory: DSC-T1BTC101: Cell Biology and Genetics	56 h
Unit – 1: Cell and cellular organelles	14 h
<p>Historical perspectives. Discovery of cell, the cell theory, ultra structure of a eukaryotic cell- (both plant and animal cells), structural organization and functions of cell wall and plasma membrane.</p> <p>Structure and functions of cell organelles: Cytosol, endoplasmic reticulum, golgi complex, mitochondria, chloroplast, ribosomes, lysosomes, peroxisomes, nucleus, nucleolus, vacuole and cytoskeletal structures (microtubules, microfilaments and intermediate filaments).</p>	
Unit – 2: Chromosomes and cell division	14 h
<p>General introduction, discovery, morphology and structural organization – Centromere, secondary constriction, telomere, chromonema, euchromatin and heterochromatin, chemical composition and karyotype. Single-stranded and multi-stranded hypothesis, folded-fibre and nucleosome models.</p> <p>Special type of chromosomes: Salivary gland chromosome and lampbrush chromosomes.</p> <p>Cell cycle, phases of cell division, mitosis and meiosis, cell cycle checkpoints, enzymes involved in regulation, significance of cell cycle, achromatic apparatus, synaptonemal complex, senescence and programmed cell death.</p>	
Unit – 3: Inheritance and gene interaction	14 h
<p>History of genetics: Mendelian theory; Laws of inheritance - dominance, segregation, incomplete dominance, codominance with an example. Law of independent assortment, test cross, back cross and non-Mendelian inheritance.</p> <p>Maternal inheritance: Plastid inheritance in <i>Mirabilis</i>, Kappa particles in paramecium, and Petite characters in yeast, Sex-linked inheritance, Chromosome theory of inheritance.</p> <p>Gene interaction: Supplementary factors: comb pattern in fowls, Complementary genes – flower colour in sweet peas, Multiple factors – skin colour in human beings, Epistasis – plumage colour in poultry, Multiple allelism: blood groups in human beings.</p>	
Unit – 4: Linkage and mutation	14 h
<p>General introduction, coupling and repulsion hypothesis, linkage in maize and <i>Drosophila</i>, mechanism of crossing over and its importance, chromosome mapping-linkage map in maize.</p> <p>Mutations: Types of mutations; spontaneous and induced mutagens: Physical and chemical, mutation at the molecular level, mutations in plants, animals and microbes and its merits and demerits.</p> <p>Structural and numerical chromosomal aberrations.</p> <p>Sex determination in plants and animals. Concept of allosomes and autosomes, XX-XY, XX-XO, ZW-ZZ, ZO-ZZ types.</p> <p>Allosomal (Klinefelter syndrome and Turner's syndrome), autosomal (Down's syndrome and Cri-Du-Chat syndrome) conditions.</p>	

Formative Assessment	
Pedagogy: Lectures, Presentations, videos, Assignments and Weekly Formative Assessment Tests.	
Assessment Occasion	Weightage in marks
Assignment/ Field Report/ Project	15 Marks
Test	20 Marks
Participation in class	05 marks
Total	40 Marks

Cell Biology and Genetics Laboratory Content

Course content 01: Practicals: DSC-P1BTC101: Cell Biology and Genetics

Course Title: Cell Biology and Genetics	Course Credits: 02
Course Code: DSC-P1BTC101	L-T-P per week: 0-0-4
Total Contact Hours: 28	Duration of ESA/Exam: 03 h
Formative Assessment Marks: 25	Summative Assessment Marks: 25

1. Operation and working principle of simple and compound microscope.
2. Use of Micrometry, measurement of onion epidermal cells and yeast.
3. Study of mitosis in onion root tips.
4. Study of meiosis in grasshopper testes/onion/Rhoeo flower buds.
5. Mounting of polytene chromosomes.
6. Buccal smear – Barr bodies.
7. Karyotype analysis – human (normal & abnormal) and onion.
8. Isolation and staining of mitochondria/chloroplast.
9. Enumeration of RBC using Haemocytometer.
10. Simple genetic problems based on theory.
11. Preparation and submission of 5 permanent slides of mitosis & meiosis (by each student).

Pedagogy: Lectures, Presentations, videos, Assignments and Weekly Formative Assessment Tests.

Formative Assessment	
Assessment Occasion	Weightage in Marks
Assignment/Monograph	10
Test	10
Participation in class	05
Total	25

Text Books/References

1. Ambrose, and Dorothy, M., Easty 1970. Cell Biology, ELBS Publications.
2. Benjamin Lewin, 1985. Genes II –Wiley & Sons Publications.
3. Benjamin Lewin, 1987. Genes III Wiley & Sons Publications.
4. Benjamin Lewin, 1994. Genes V. By Oxford University Press, Oxford and New York, 1,272 pp.

5. Bruce Alberts, Alexander Johnson, Julian Lewis, et al., 2014 Molecular Biology of Cell –Garland publications.
6. Daniel L. Hartl, E.W. Jones, Jones, 2005. Genetics: Analysis of Genes and Genomes, Barlett Publishers.
7. De Robertis and EMF Robertis, 1980. Cell Biology & Molecular Biology – EDP Saunder College.
8. Edgar Altenburg, 1970. Genetics, Oxford & IBH publications.
9. Gardener, E.J., Simmons M.J. and Snustad D.P. 1991. Principles of Genetics –John Wiley and Son Publications.
10. Gupta P.K., 2018-19. Genetics - 5th Revised Edition, Rastogi Publication, Meert, India.
11. Harvey Lodish, Arnold Berk, S Lawrence Zipursky, Paul Matsudaira, David Baltimore, and James Darnell. 2000. Molecular Cell Biology - Daniel, Scientific American Books.
12. Jack D Bruke. 2002. Cell Biology, The William Twilkins Company.
13. Monroe W Strickberger, 1976. Genetics, Macmillain Publishers, New York
14. Powar, C.B. 2019. Cell Biology, Himalaya Publications.
15. Sandy, B. Primrose, Richard Twyman, 2006. Principles of Gene Manipulations 7th Edition Black Well Scientific Publications.
16. Sharp, L.W. 1943. Fundamentals of Cytology - New York,McGraw-Hill Book Company, inc.
17. Sinnott, L.C. Dunn, Dobzhansky 1985. Principles of Genetics - McGraw-Hill.
18. White, M.J.D. 1980. Animal Cytology and Evolution, Cambridge University Publications.
19. Willson and Marrison, 1966. Cytology, Reinform Publications.

Content of Course 02: Theory: OE-T1 BTC301: Biotechnology for Human Welfare

Course Title: Biotechnology for Human Welfare	Course Credits: 03
Course Code: OE-T1BTC301	L-T-P per week: 3-0-0
Total Contact Hours: 42	Duration of ESA/Exam: 3 h
Formative Assessment Marks: 30	Summative Assessment Marks: 45
Unit – 1: Industry	14 h
Enzymes for textile industry, breweries, food supplements – single cell protein, vitamins, food processing - cheese, yoghurt making, biodegradable plastics, biofuels.	
Unit – 2: Environment	14 h
Applications of Biotechnology in environmental aspects: waste management, biodegradation of heavy metals, water cleaning, removing oil spills, air and soil pollution, bioremediation, biomining.	
Unit – 3: Human Health and livestock	14 h
Applications in Human Health: Antibiotic production, Molecular diagnostics, vaccines and vaccine delivery, recombinant therapeutics – insulin, gene therapy, forensics. Applications in livestock improvement: transgenic animals, animal vaccine production, Increased milk production, artificial insemination, poultry and fisheries.	

Text Books/References

1. Bhasin, M.K. and Nath, S. 2002. Role of Forensic Science in the New Millennium, University of Delhi,
2. Crueger Wand Crueger, A. 2000. Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi.
3. Eckert, W.G. and Wrightin, R.K. 1997. Introduction to Forensic Sciences, 2nd Edition, CRC Press, Boca Raton.
4. Hans-Joachim Jordening and Jeseff Winter, 2005. Environmental Biotechnology Concepts and Applications.
5. James, S.H. and Nordby, J.J. 2005. Forensic Science: An Introduction to Scientific and Investigative Techniques, 2nd Edition, CRC Press, Boca Raton.
6. Nanda, B.B. and Tiwari, R.K. 2001. Forensic Science in India: A Vision for the Twenty First Century, Select Publishers, New Delhi
7. Patel, A.H. 1996. Industrial Microbiology. 1st edition, Macmillan India Limited.
8. Pradipta Kumar Mohapatra, 2020. Environmental Biotechnology, Dreamtech Press.
9. Stanbury, P.F., Whitaker, A. and Hall, S.J. 2006. Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.

Formative Assessment	
Assessment Occasion	Weightage in Marks
House Examination/Test	15
Written Assignment/Presentation/Project / Term Papers/Seminar	10
Class performance/Participation	05
Total	30

Skill Enhancement Course in Biotechnology

Course 03: Theory: SEC-T1BTC701, Biotechnology Skills & Analytical Techniques

Learning Outcomes:

- Demonstrate skills as per National Occupational Standards (NOS) of “Lab Technician/Assistant” Qualification Pack issued by Life Sciences Sector Skill Development Council-LFS/Q0509, Level3.
- Skills enhancement as per National Occupational Standards (NOS) of “Lab Technician/Assistant” Qualification Pack issued by Life Sciences Sector Skill Development Council-LFS/Q0509, Level 3.
- Knowledge about major activities of biotech industry, regulations and compliance, environment, health and safety (EHS), good laboratory practices (GLP), standard operating procedures (SOP) and GMP as per the industry standards.
- Demonstrate soft skills, such as decision making, planning, organizing, problem solving, analytical thinking, critical thinking and documentation.

Course content:03 theory	
Course Title: SEC-T1BTC701: Biotechnology Skills & Analytical Techniques	
Total Contact Hours: 14 Hours	Duration of ESA:01Hrs.
Formative Assessment Marks:	Summative Assessment Marks: 25
<p>Insights into biotechnology industry: Biotechnology Industry in Indian and Global context- organization in context of large/medium/small enterprises, their structure and benefits.</p> <p>Industry oriented professional skills to be acquired: Planning and organizing skills, decision-making, problem-solving skills, analytical thinking, critical thinking, team management, risk assessment.</p> <p>Interpersonal skills: Writing skills, reading skills, oral communication, conflict-resolution techniques, interpretation of research data, trouble shooting in workplace</p> <p>Digital skills: Basic computer skills (MS Office, excel, power point, internet) for workplace. Professional E-mail drafting skills and power point presentation skills</p> <p>Analytical skills in laboratory: Solutions: molarity, molality, normality, mass percent % (w/w), percent by volume (%v/v), parts per million (ppm), parts per billion (ppb), dilution of concentrated solutions. Standard solutions, stock solution, solution of acids. Reagent bottle label reading and precautions</p>	14 h

Practical content of Biotechnology Skills & Analytical Techniques

Course content:03	
Course Title: SEC-P1BTC701: Biotechnological Skills & Analytical Techniques	
Total Contact Hours: 28 Hours	Duration of ESA:02Hrs.
Formative Assessment Marks: 25	Summative Assessment Marks: 25

- 1. Methods and practices of cleaning and management of lab:** Learning and Practice of Integrated clean-in-place (CIP) and sterilize-in-place (SIP) as per industry standards, material requirements for cleaning specific area, equipment, ventilation area, personal protective requirements
- 2. Procedure of cleaning and storage of lab ware:** Methodology for storage area, cleaning procedure and materials to be used for various surfaces. Signboards, labelling do's & don'ts Knowledge about standard procedures of cleaning or glass ware, plastic ware. Maintenance of inventor
- 3. Principles and practices of lab safety:** Knowledge about safety symbols and hazard signs. Personal safety gears, utility, and disposal. Equipment safety protocols, chemical safety protocols. Documentation of chemical and equipment usage records. Handling hazardous chemicals.
- 4. Best practices of usage and storage of chemicals:** Knowledge and practice in handling of chemicals, labeling and stock maintenance. SOP and material handling. Procedures to maintain chemicals, labelling, storage and disposal.
- 5. Record maintenance as per SOP's:** Labelling of samples and reagents as per SOP's. Recording detail's of work done for research experiments. Importance of study of manuals, health and safety instructions.
- 6. Usage and maintenance of basic equipments of biotechnology lab:** Principles, calibrations and SOPs of weighing balances, pH meters, autoclaves, laminar flows and biosafety cabinets, basic microscopes, homogenizers, stirrers, colorimeters, UV and visible spectrophotometers.
- 7. Preparation of solutions and standards -** Properties and uses of chemicals commonly used in life science laboratories. Maintaining safety standards for handling various solutions and chemicals. Preparation of test reagents and buffers. Protocols for proper mixing of chemicals. Safety precautions while preparation and storage of incompatible chemicals and reagents.
- 8. Preparation of media:** Maintenance and storage of purified water for media (plant tissue culture media, microbiological media and animal cell culture media) preparation. Preparation and storage of concentrated stock solutions. Documentation and disposal of expired stocks. Collection of indents of media requirement, preparation, and storage. Media coding, documentation and purpose of usage.
- 9. Practical methods for decontamination and disposal:** Decontamination methods, safe disposal practices of decontaminated media or materials.
- 10. Laboratory record writing:** Method of record writing, data collection and recording, reporting of result, discussion of result, summary writing, effective power point presentation taking any experiment as example.

11. Industry visit or analytical laboratory visit

Pedagogy: Lectures, Presentations, videos, Assignments and Weekly Formative Assessment Tests.

Formative Assessment	
Assessment Occasion	Weightage in Marks
Assignment/Monograph	10
Test	10
Participation in class	05
Total	25

B.Sc. Biotechnology (Basic / Hons.), Second Semester

Course Title: DSC-T2, BTC102, Microbiological Methods (A2)	
Course Code: DSC-T2BTC102	L-T-P per week: 4-0-0
Total Contact Hours: 56	Course Credits: 04
Formative Assessment Marks: 40	Duration of ESA/Exam: 03 h
Model Syllabus Authors: Curriculum Committee	Summative Assessment Marks: 60

Course Outcomes (COs): At the end of the course the students will be able to:

Course Articulation Matrix: Mapping of Course Outcomes (Cos) with Program Outcomes (Pos 1-12)

Sl. No	Course Outcomes (COs) / Program Outcomes (POs)	T1	1	2	3	4	5	6	7	8	9	10	11
I	Core competency	X											
II	Critical thinking	X											
III	Analytical reasoning	X											
IV	Research skills	X											
V	Team work	X											

Course Articulation Matrix relates course outcomes of course with the corresponding program outcomes whose attainment is attempted in this course. Mark 'X' in the intersection cell if a course outcome addresses a particular program outcome.

B.Sc. Biotechnology (Basic / Hons.), Second Semester

Content of Course 01: Theory: DSC-T2BTC102: Microbiological Methods	56 h
Unit – 1: Instrumentation	14 h
<p>Microscopy: Principles of Microscopy-resolving power, numerical aperture, working principle and applications of light, compound microscope, Dark field microscope, Phase contrast microscope, Fluorescence microscope, confocal microscope. Electron microscopes - TEM and SEM.</p> <p>Analytical techniques: Working principle and applications: centrifuge, ultracentrifuge, spectrophotometer, chromatography: paper and TLC.</p>	
Unit – 2: Sterilization techniques	14 h
<p>Definition of terms - sterilization, disinfectant, antiseptic, sanitizer, germicide, microbicidal agents, microbiostatic agents and antimicrobial agents.</p> <p>Physical methods of control: Principle, construction and applications of moist heat sterilization Boiling, Pasteurization, Fractional sterilization - Tyndallization and autoclave. Dry heat sterilization – Incineration and hot air oven. Filtration– Diatomaceous earth filter, Seitz filter, membrane filter and HEPA;</p> <p>Radiation: Ionizing radiation – γ-rays and non-ionizing radiation – UV rays</p> <p>Chemical methods: Alcohols, aldehydes, phenols, halogen, metallic salts, Quaternary ammonium compounds and sterilizing gases as antimicrobial agents.</p>	
Unit – 3: Microbiological techniques	14 h
<p>Culture Media: Components of media, natural and synthetic media, chemically defined media, complex media, selective, differential, indicator, enriched and enrichment media</p> <p>Pure culture methods: Serial dilution and plating methods (pour, spread, streak); cultivation, maintenance and preservation/stocking of pure cultures; cultivation of anaerobic bacteria</p> <p>Stains and staining techniques: Principles of staining, Types of stains-simple stains, structural stains and differential stains.</p>	
Unit – 4: Antimicrobial agents and assessment of antimicrobial activity	14 h
<p>Modes of action of antimicrobial agents: Antifungal agents; Amphotericin B, Griseofulvin Antiviral agents; Amantadine, Acyclovir, Azidothymine Antibacterial agents; Plazomicin, Ervacycline, Omadacyclin and imipenem Challenges in antimicrobial therapy; Emergence of resistance (MDR, XDR)</p> <p>Assessment of antimicrobial activity: Antibacterial- Disc and agar well diffusion techniques, Microdilution method, Zones of inhibition, MBC, Determination of IC 50. Antifungal- Determination of MFC, Time kill kinetics assay, sorbitol assay, Antiviral- CPE, virus yield reduction assay, TCID, Neutralization assay, Haemagglutination inhibition.</p>	

Formative Assessment	
Assessment Occasion	Weightage in marks
Assignment/ Field Report/ Project	15 Marks
Test	20 Marks
Participation in class	05 marks
Total	40 Marks

Microbiological Methods Laboratory Content

Course 01: Practicals: DSC-P2BTC102: Microbiological Methods

Course Title: Microbiological Methods	Course Credits: 02
Course Code: DSC-P2BTC102	L-T-P per week: 0-0-4
Total Contact Hours: 28	Duration of ESA/Exam: 03 h
Formative Assessment Marks: 25	Summative Assessment Marks: 25

1. To study the principle and applications of important instruments (biological safety cabinets, autoclave, incubator, BOD incubator, hot air oven, light microscope, pH meter) used in the microbiology and biotechnology laboratory.
2. Sterilization of media using autoclave and assessment for sterility.
3. Sterilization of glass wares using hot air oven and assessment for sterility.
4. Sterilization of heat sensitive material by membrane filtration and assessment for sterility.
5. Preparation of culture media for bacteria, fungi and their cultivation.
6. Plating techniques: Spread plate, pour plate and streak plate.
7. Isolation of bacteria and fungi from soil, water and air.
8. Study of *Rhizopus*, *Penicillium*, *Aspergillus* using temporary mounts.
9. Colony characteristics study of bacteria from air exposure plate.
10. Staining techniques: Bacteria – gram, negative, capsule, endospore staining and Fungi – Lactophenol cotton blue staining.
11. Water analysis – MPN test.
12. Biochemical Tests – IMViC, starch hydrolysis, catalase test, gelatin hydrolysis.
13. Bacterial cell motility – hanging drop technique

Pedagogy: Lectures, Presentations, videos, Assignments and Weekly Formative Assessment Tests.

Formative Assessment	
Assessment Occasion	Weightage in Marks
Assignment/Monograph	10
Test	10
Participation in class	05
Total	25

Text Books/References

1. Atlas, R.M. 1997. Principles of Microbiology. 2nd edition. W.M.T. Brown Publishers.
2. Black, J.G. 2008. Microbiology: Principles and Explorations. 7th edition. Prentice Hall
- Bull, A.T. 1987. Biotechnology, International Trends of perspectives.
3. Cappucino, J. and Sherman, N. 2010. Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited.
4. Frobisher, Saunders and Toppan 1974. Fundamentals of Microbiology Publications
5. Madigan, M.T, and Martinko, J.M. 2014. Brock Biology of Micro-organisms. 14th

- edition. Parker J. Prentice Hall International, Inc.
6. Paul A. Ketchum, 1988. Microbiology, Concepts and applications, Wiley Publications.
 7. Pelczar Jr M.J., Chan, E.C.S. and Krieg, N.R. 2004. Microbiology. 5th edition Tata McGraw Hill.
 8. Salley, 1984. Fundamentals of Bacteriology, Tata McGraw Hill Education.
 9. Singh, R.B. 1990. Introductory Biotechnology, C.B.D. India
 10. Srivastava, S and Srivastava, P.S. 2003. Understanding Bacteria. Kluwer Academic Publishers, Dordrecht.
 11. Stanier, R.Y., Ingraham, J.L., Wheelis, M.L. and Painter, P.R. 2005. General Microbiology. 5th edition McMillan.
 12. Tortora, G.J., Funke, B.R. and Case, C.L. 2008. Microbiology: An Introduction. 9th edition Pearson Education.
 13. Willey, J.M., Sherwood, L.M. and Woolverton, C.J. 2013. Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.

Content of Course 02: Theory: OE-T2BTC302: Applications of Biotechnology in Agriculture

Course Title: Applications of Biotechnology in Agriculture	Course Credits: 03
Course Code: OE-T2MBL302	L-T-P per week: 0-0-3
Total Contact Hours: 42h	Duration of ESA/Exam: 3h
Formative Assessment Marks: 30	Summative Assessment Marks: 45
Unit – 1: Agricultural Biotechnology	14 h
Soil and air as a major component of environment. Types, properties and uses of soil and air. Distribution of microorganisms in soil and air. Major types of beneficial microorganisms in soil. Major types of harmful microorganisms in soil.	
Unit – 2: Transgenic plants	14 h
The GM crop debate – safety, ethics, perception and acceptance of GM crops, GM crops case study: Bt-cotton, Bt-brinjal Plants as bio-factories for molecular pharming: edible vaccines, plantibodies, nutraceuticals.	
Unit – 3: Biopesticides	14 h
Baculovirus pesticides, Myco pesticides, Post - harvest protection: Antisense RNA technology for extending shelf life of fruits and shelf life of flowers. Genetic Engineering for quality improvement: Seed storage proteins, Flavours - capsaicin, vanillin	

Text Books/References

1. Chrispeels, M.J. et al. 1994. Plants, Genes and Agriculture-Jones and Bartlett Publishers, Boston.
2. Gamborg, O.L. and Philips, G.C. 1998. Plant cell, tissue and organ culture (2nd ed.) Narosa Publishing House. New Delhi.
3. Gistou, Pand Klu, H. 2004. Hand book of Plant Biotechnology (Vol.I & II). John Publication.
4. Hammound, J.P McGravey and Yusibov. V. 2000. Plant Biotechnology, Springer verlag.
5. Heldt. 1997. Plant Biochemistry and Molecular Biology. Oxford and IBH Publishing Co. Pvt. Ltd. Delhi.
6. Lydiane Kyte and John Kleyn. 1996. Plants from test tubes. An introduction to Micropropagation (3rd ed.). Timber Press, Portland.
7. Murray, D.R. 1996. Advanced methods in plant breeding and biotechnology. Panima Publishing Corporation.
8. Nickoloff, J.A. 1995. Methods in molecular biology, Plant cell electroporation and electro fusion protocols – Humana pressin corp, USA.
9. Sawahel, W.A. 1997. Plant genetic transformation technology. Daya Publishing House, Delhi.

Pedagogy: Chalk and Talk, PPT, Group discussion, Seminars, Field visit

Formative Assessment	
Assessment Occasion	Weightage in Marks
House Examination/Test	15
Written Assignment/Presentation/Project / Term Papers/Seminar	10
Class performance/Participation	05
Total	30

