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ನಗರ ವಿಶ್ವವಿದ್ಯಾಲಯ
BENGALURU
CITY UNIVERSITY
ಆಗು ಏ ಅಕೇತಾ
BE BOUNDLESS

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

Phone : 22961461

BANGALORE UNIVERSITY
DEPARTMENT OF MICROBIOLOGY AND BIOTECHNOLOGY
JNANABHARATHI CAMPUS, BENGALURU-560 056

Date : 9/10/21

Dr. Srinivas C
Professor & Chairman (BOS)
Bengaluru City University

Proceedings of the Board of studies (UG) meeting held on 5th and 9th of Oct-2021 through online mode regarding finalization of UG Microbiology and Biotechnology syllabus of Bengaluru City University as per the NEP regulation.

The chairperson welcomed all the members of the BOS (UG) in the beginning and then the members were invited to discuss on the following subject of the agenda:

1. Approval and correction of the Model Curriculum of Microbiology and Biotechnology subjects syllabus to start undergraduate degree programme B.Sc (Basic/Hons.), in affiliated colleges of Bengaluru City University, Bangalore as per the National Education Policy (NEP) programme from the academic year 2021-22.

The BOS members has been approved the syllabus with minor correction. The suggestions made by the all members were incorporated. The meeting ended with vote of thanks by the Chairperson.

9/10/21
Chairman (BOS)

CHAIRMAN
Department of Microbiology
& Biotechnology
Bangalore University, JB Campus,
Bangalore - 560 056.

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 Bengaluru City 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)	Environmental 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-T1BTC101**	L-T-P per week: 4-0-0
Total Contact Hours: **56**	Course Credits: 0**4**
Formative Assessment Marks: **40**	Duration of ESA/Exam: 0**3 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 'X' 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**
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. **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).	
Unit-2: Chromosomes and cell division	**14 h**
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. **Special type of chromosomes:** Salivary gland chromosome and lampbrush chromosmes. Cell cycle, phases of cell division, mitosis and meiosis, cell cycle checkpoints, enzymes involved in regulation, cell signaling cell communication. significance of cell cycle, achromatic apparatus, synaptonemal complex, senescence and programmed cell death.	
Unit-3: Inheritance and gene interaction	**14 h**
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. **Maternal inheritance:** Plastid inheritance in Mirabilis, Kappa particles in paramecium, and Petite characters in yeast, Sex-linked inheritance, Chromosome theory of inheritance. **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.	
Unit-4: Linkage and mutation	**14 h**
General introduction, coupling and repulsion hypothesis, linkage in maize and Drosophila, mechanism of crossing over and its importance, chromosome mapping-linkage map in maize. **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. Structural and numerical chromosomal aberrations. Sex determination in plants and animals. Concept of allosomes and autosomes, XX-XY, XX-XO, ZW-ZZ, ZO-ZZ types. Allosomal (Klinefelter syndrome and Turner's syndrome), autosomal (Down's syndrome and Cri-Du-Chat syndrome) conditions.	

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 Jesef 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:**01**Hrs.	
Formative Assessment Marks: 10	Summative Assessment Marks: 15	
Insights into biotechnology industry: Biotechnology Industry in Indian and Global context- organization in context of large/medium/small enterprises, their structure and benefits. **Industry oriented professional skills to be acquired:** Planning and organizing skills, decision-making, problem-solving skills, analytical thinking, critical thinking, team management, risk assessment. **Interpersonal skills:** Writing skills, reading skills, oral communication, conflict-resolution techniques, interpretation of research data, trouble shooting in workplace **Digitals kills:** Basic computer skills (MS Office, excel, power point, internet) for workplace. Professional E-mail drafting skills and power point presentation skills **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		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: 0**4**
Formative Assessment Marks: **40**	Duration of ESA/Exam: 0**3 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**
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. **Analytical techniques:** Working principle and applications: centrifuge, ultracentrifuge, spectrophotometer, chromatography: paper and TLC.	
Unit – 2: Sterilization techniques	**14 h**
Definition of terms - sterilization, disinfectant, antiseptic, sanitizer, germicide, microbicidal agents, microbiostatic agents and antimicrobial agents. **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; Radiation: Ionizing radiation – γ-rays and non-ionizing radiation – UV rays **Chemical methods:** Alcohols, aldehydes, phenols, halogen, metallic salts, Quaternary ammonium compounds and sterilizing gases as antimicrobial agents.	
Unit – 3: Microbiological techniques	**14 h**
Culture Media: Components of media, natural and synthetic media, chemically defined media, complex media, selective, differential, indicator, enriched and enrichment media **Pure culture methods:** Serial dilution and plating methods (pour, spread, streak); cultivation, maintenance and preservation/stocking of pure cultures; cultivation of anaerobic bacteria **Stains and staining techniques:** Principles of staining, Types of stains-simple stains, structural stains and differential stains.	
Unit – 4: Antimicrobial agents and assessment of antimicrobial activity	**14 h**
Modes of action of antimicrobial agents: Antifungal agents; Amphotericin B, Griseofulvin Antiviral agents; Amantadine, Acyclovir, Azidothymine Antibacterial agents; Plazomicin, Ervacycline, Omadacyclin and imipenum Challenges in antimicrobial therapy; Emergence of resistance (MDR, XDR) **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.	

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. WM.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

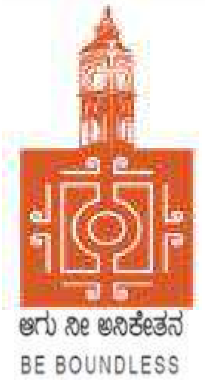
Course Title: Applications of Biotechnology in Agriculture	Course Credits: 03	
Course Code: OE-T2MBL302	L-T-P per week: 0-0-3	
Total Contact Hours: 42h	Duration of ESA/Exam: 3h	
Formative Assessment Marks: 30	Summative Assessment Marks: 45	
Unit – 1: Agricultural Biotechnology		**14 h**
Soil and air 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



BENGALURU CITY UNIVERSITY

CHOICE BASED CREDIT SYSTEM

(Semester Scheme with Multiple Entry and Exit Options for Under Graduate Course- as per NEP 2020)

Syllabus for B.Sc. Biotechnology
III & IV Semester

2022-23 onwards

Assessment:

Weightageforassessments(inpercentage)

TypeofCourse	FormativeAssessment/ IA	SummativeAssessment
Theory	40	60
Practical	25	25
Projects	-	-
ExperientialLearning(Internshipsetc.)	-	-

Contents of Courses for B.Sc. Biotechnology as MajorModelIIA

Semester	Course code	Course Category	Theory /Practical	Credits	PaperTitle	Marks	
						SA	FA
3.	**BTC:103**	DSC-7	Theory	3	Biomolecules	60	40
	BTC:103		Practical	2	Biomolecules	25	25
	BTC:303	OE- 3	Theory	3	NutritionandHealth	60	40
4.	**BTC:104**	DSC-8	Theory	3	MolecularBiology	25	25
	BTC:104		Practical	2	MolecularBiology	60	40
	BTC: 304	OE- 4	Theory	3	IntellectualPropertyRights	25	25
	ExitOptionwithDiplomainBiotechnology(100 Credits)						

ProgramName	**BScBiotechnology**		Semester	**III Sem**
CourseTitle	**Biomolecules**			
CourseNo.	**BTC:301**	**DCS -3T**	No. ofTheoryCredits	**4**
Contacthours	**56hrs**		DurationofESA/Exam	**2.30Hours**
FormativeAssessmentMarks	**40**		SummativeAssessmentMarks	**60**

CoursePre-requisite(s):	
CourseOutcomes(COs):At theend ofthecoursethe studentshould beable to: 1. Acquireknowledgeabouttypesofbiomolecules,structure,andtheirfunctions 2. Willbeabletodemonstratetheskillstoperformbioanalyticaltechniques 3. Applycomprehensive innovations and skillsofbiomolecules to biotechnologyfield	
Content	**Hrs**
Unit–I	**14 Hrs**
a. Carbohydrates: Introduction,sources,classificationofcarbohydrates.Structure,properties andfunction ofcarbohydrates. Monosaccharides – Isomerism and ring structure, Sugar derivatives Oligosaccharides–SucroseandFructose Polysaccharides – Classification as homo and heteropolysaccharides, Homopolysaccharides - storagepolysaccharides(starchandglycogen-structure,reaction,properties),structuralpolysaccharides(celluloseandchitin-structure,properties),Heteropolysaccharides-glycoproteins and proteoglycans. **b. AminoAcids,PeptidesandProteins** Introduction, classification and structure of amino acids. Concept of – Zwitterion, isoelectricpoint,pKvalues.Essentialandnonessentialaminoacids.Peptideandpeptide bond,classificationofproteinsbasedonstructureandfunction,Structuralorganizationofproteins[primary,secondary, tertiary andquaternary].Fibrousandglobularproteins,Denaturationand renaturationofproteinssecondary (α, β) and tertiary structures.	
Unit–II	**14 Hrs**
a. Lipids Classification and function of lipids, properties (saponification value, acid value, iodine number,rancidity),Hydrogenationoffatsandoils,saturatedandunsaturatedfattyacids.Generalstructureandbiologicalfunctionsofphospholipids,sphingolipids,glycolipids,lipoproteins,prostaglandins and cholesterol.	

b. Enzymes Introduction,nomenclatureandclassification,enzymekinetics,factorsinfluencingenzymeactivity,metalloenzymes,activationenergyandtransitionstate,enzymeactivity,specificactivity.Coenzymes and their functions (one reaction involving FMN, FAD, NAD). Enzyme inhibition-Irreversible and reversible (competitive, non-competitive and uncompetitive inhibition with an example each). Zymogens (trypsinogen, chymotrypsinogen and pepsinogen), Isozymes (LDH).	
Unit-III	**14 Hrs**
a. Vitamins Waterandfatsolublevitamins,dietary sourceandbiologicalroleofvitamins. Deficiencymanifestationof vitamin A, B, C, D, EandK **b. Nucleicacids** Structures of purines and pyrimidines, nucleosides, nucleotides in DNA **c. Hormones** Classificationofhormonesbasedonchemicalnatureandmechanismofaction.Chemicalstructureandfunctionsofthefollowinghormones:Glucagon,Cortisone,Epinephrine,Testosteroneand Estradiol.	
Unit-IV	**14 Hrs**
Bioanalyticaltools: **a. Electrophoresis:** Principle, procedure and applications of electrophoresis (Gelelectrophoresis -PAGE, SDS-PAGE& agarosegel electrophoresis). **b. Spectroscopy:** UV-Visspectrophotometry;massandatomicabsorptionspectroscopy.	

CourseArticulationMatrix:Mappingof CourseOutcomes(COs)withProgramOutcomes(POs1-12)

CourseOutcomes(COs)/ProgramOutcomes(POs)	**ProgramOutcomes (POs)**											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Acquire knowledge about types of biomolecules,structure,and their functions	✓				✓							✓
Willbeabletodemonstratetheskillstoperformbioanalytical techniques			✓								✓	✓
Apply comprehensive innovations and skills ofbiomoleculesto biotechnologyfield	✓				✓							✓

Pedagogy: Lectures,Seminars, IndustryVisits,Debates,QuizandAssignments

SummativeAssessment=60Marks	
FormativeAssessmentOccasion/type	**WeightageinMarks**
Attendance	10
Seminar and Assignment	10
Debatesand Quiz	10
Test	10
Total	**60marks + 40marks= 100 marks**

CourseTitle	**Biomolecules(Practical)**		PracticalCredits	**2**
CourseNo.	**BTC:301**	**DSC-3P**	Contacthours	

Content

1. Calculations of Molarity, Molality, Normality, percent by mass % (w/w), Percent byvolume(%v/v),partspermillion(ppm),partsperbillion(ppb)
2. Preparation of standardsolutions.
3. Preparation of buffers – Acetate, phosphate, Tris
4. Estimationof reducing sugarbyDNS method
5. Determination ofα-amylase activitybyDNSmethod
6. Estimationof proteinsby Lowry's/Biuret/Bradford'smethod
7. Estimationofamino acidbyNinhydrinmethod
8. Extractionofprotein fromsoaked/sproutedgreengram bysaltingoutmethod
9. Separationofplant pigmentsbypaper chromatography
10. Separationofamino acids bythin layerchromatography
11. Demonstration of active protein by NativePAGE
12. Determinationof Saponification and iodine numberoflipids

Practicalassessment

Assessment			
Formativeassessment		**SummativeAssessment**	**TotalMarks**
AssessmentOccasion /type	**Weightagein Marks**	**PracticalExam**	
Record	5	**25**	**50**
Test	10		
Attendance	5		
Performance	5		
Total	**25**	**25**	

References

1 DavidPlummer; 2001. 3rdEdition. AnIntroductiontoPracticalBiochemistry,TataMcGrawHillEdu.Pvt.Ltd. NewDelhi,India

2 Sadashivam,S.Manickam, A.1995.BiochemicalMethods,1stEdition,NewAgeInternationalPublishers, India

3 Sawhney, S.K.&RandhirSingh. IntroductoryPracticalbiochemistry,(ed)NarosaPublishing.House,NewDelhi,ISBN 81-7319-302-9

4 BeeduSasidharRao&VijayDespande. ExperimentalBiochemistry:AStudentCompanion,(ed) I.K.InternationalPvt.LTD,NewDelhi.ISBN 81-88237-41-8

5 Thimmaiah, S.K.(ed),KalyaniPublishers,StandardMethodsofBiochemicalAnalysis,LudhianaISBN81-7663-067

Date: SubjectCommitteeChairperson

ProgramName	**BScBiotechnology**		Semester	**III Sem**
CourseTitle	**NutritionandHealth**			
CourseCode	**BTC:303**	**OE-3**	No. ofTheoryCredits	**3**
Contacthours	**Lecture**		DurationofESA/Exam	**Hours**
	Practical			
FormativeAssessmentMarks			SummativeAssessmentMarks	

CoursePre-requisite(s):	
CourseOutcomes(COs):At theend ofthecoursethe studentshould beable to: 1. Studytheconcepts of food, nutrition, diet and health 2. Toapplythe best practices offood intakeand dietaryrequirements 3. Acquireknowledgeon varioussourcesofnutrientsand good cookingpractices	
Content	**45 Hrs**
Unit–I	**14 Hrs**
Introduction Concepts of nutrition and health. Definition of Food, Diet and nutrition, Food groups. Foodpyramids. Functions of food. Balanced diet. Meal planning. Eat right concept. Functional foods,Probiotics, Prebiotics,and antioxidants.	
Unit-II	**14 Hrs**
Nutrients Macro and Micronutrients - Sources, functions and deficiency. Carbohydrates, Proteins, Fats – Sourcesand calories. Minerals–Calcium,Iron,Iodine. Vitamins – Fat soluble vitamins –A, D, E& K. Water soluble vitamins – Vitamin C, Thiamine,Riboflavin,Niacin.Water–Functionsandwaterbalance.Fibre– Functionsandsources.RecommendedDietaryAllowance,BodyMassIndexand Basal Metabolic Rate.	
Unit-III -	**14 Hrs**
NutritionandHealth Methodsofcookingaffectingnutritionalvalue.Advantagesanddisadvantages.Boiling,steaming, pressure cooking. Oil/Fat – Shallow frying, deep frying. Baking. Nutrition andlifestyle.Nutritionalrequirement,dietaryguidelines:Adulthood,Pregnancy,Lactation,Infancy-Complementaryfeeding,Pre-school,Adolescence,geriatric.Nutritionrelatedmetabolicdisorders-diabetes and cardiovascular disease.	

Pedagogy: Lectures,Seminars, IndustryVisits,Debates,QuizandAssignments

SummativeAssessment=60Marks	
FormativeAssessmentOccasion/type	**WeightageinMarks**
Attendance	10
Seminar and Assignment	10
Debatesand Quiz	10
Test	10
Total	**60marks + 40marks= 100 marks**

References

1 SriLakshmiB, (2007),Dietetics.NewAgeInternationalpublishers.NewDelhi

2 SriLakshmiB, (2002),NutritionScience.NewAgeInternationalpublishers.NewDelhi

3 SwaminathanM.(2002),AdvancedtextbookonfoodandNutrition.VolumeI.Bappco

4 Gopalan.C.,RamaSastryB.V.,andS.C.Balasubramanian(2009),NutritivevalueofIndianFoods.NIN.ICMR.Hyderabad.

5 MudambiSRandRajagopalMV,(2008),FundamentalsofFoods,Nutrition&diettherapybyNewAgeInternational Publishers, NewDelhi

Date: SubjectCommitteeChairperson

ProgramName	**BScBiotechnology**		Semester	**IVSem**
CourseTitle	**MolecularBiology**			
CourseNo.	**BTC:104**	**DCS -4T**	No. ofTheoryCredits	**4**
Contacthours	**56hrs**		DurationofESA/Exam	**2Hours**
FormativeAssessmentMarks	40		SummativeAssessmentMarks	60

CoursePre-requisite(s):

CourseOutcomes(COs):At theend ofthecoursethe studentshould beable to:

1. Studytheadvancements in molecularbiologywith latest trends.
2. Willacquirethe knowledgeof structure,functional relationshipof proteinsand nucleicacids.
3. Awareaboutthebasic cellularprocessessuchastranscription,translation,DNAreplicationandrepairmechanisms.

Content	Hrs
Unit–I **Molecularbasisoflife -NucleicAcids** An introduction to DNA and RNA, experimental proof of DNA as genetic material,Structure and functions of DNA and RNA, Watson and Crick model of DNA and forms ofDNA(AandZ).Ribozymes.	**14 Hrs**
Unit-II **DNAReplicationandRepair** ReplicationofDNAinprokaryotesandeukaryote.Enzymesandproteinsinvolvedinreplication,Thetamodel,linearandrollingcirclemodel. DNA Polymerases. **Replication complex:** Pre-priming proteins, primosome, replisome, unique aspects ofeukaryoticchromosomereplication,fidelityofreplication,DNAdamageandrepairmechanism**:**photoreactivation, excision repair, mismatchrepair and SOS repair.	**14 Hrs**
Unit-III **TranscriptionandRNAprocessing** Centraldogma,typesofRNA,Transcriptioninprokaryotes,RNApolymerase,roleof sigmafactor, promoter, Initiation, elongationand terminationofRNAchains. Transcription in eukaryotes: Eukaryotic RNA polymerases, transcription factors, promoters,enhancers,mechanismoftranscriptioninitiation,promoterclearanceandelongationRNAsplicing and processing: processing of pre-mRNA: 5’ cap formation, polyadenylation, splicing,rRNAand tRNAsplicing.	**14 Hrs**
Unit-IV	**14 Hrs**

Regulationof geneexpression andtranslation Geneticcodeanditscharacteristics,Wobblehypothesis.Translation inprokaryotesandeukaryotes, ribosome, enzymes and factors involved in translation. Mechanism of translation-activation of amino acid, aminoacyl tRNA synthesis, Mechanism- initiation, elongation andterminationofpolypeptidechain.Fidelityoftranslation, Inhibitorsoftranslation.Proteinfoldingandmodifications, Post translational modifications of proteins. Operon concept Lac and Trp.	

CourseArticulationMatrix:Mappingof CourseOutcomes(COs)withProgramOutcomes(POs1-12)

CourseOutcomes(COs)/ProgramOutcomes(POs)	**ProgramOutcomes (POs)**											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Studytheadvancementsinmolecularbiologywithlatesttrends	✓				✓							✓
Willacquiretheknowledgeofstructure,functionalrelationshipof proteins and nucleicacids					✓	✓						✓
Awarenessonthebasiccellularprocessessuchastranscription,translation,DNAreplicationandrepairmechanisms	✓				✓				✓			✓

Pedagogy: Lectures,Seminars, IndustryVisits,Debates,QuizandAssignments

SummativeAssessment=60Marks	
FormativeAssessmentOccasion/type	**WeightageinMarks**
Attendance	10
Seminar and Assignment	10
Debatesand Quiz	10
Test	10
Total	**60marks + 40marks= 100 marks**

CourseTitle	**MolecularBiology(Practical)**		PracticalCredits	**2**
CourseNo.	**BTC:104**	**DSC-4P**	Contacthours	

Content

1. Isolation of DNA from yeast/plant/animal sources
2. Estimationof DNAbyDPA method
3. Analysis of DNA by Agarose gel electrophoresis
4. Estimationof RNA byOrcinol method
5. Extractionand partialpurification ofprotein fromanimal sourcebyorganicsolvents.
6. ProteinseparationbySDS-PolyacrylamideGelElectrophoresis(PAGE)
7. Study of Conjugation, TransformationandTransduction,
8. DNAreplication model
9. TypesofRNA (Model)
10. Preparationof forms of DNA model
11. Demonstration of Replica plating technique

Practicalassessment

Assessment			
Formativeassessment		**SummativeAssessment**	**TotalMarks**
AssessmentOccasion /type	**Weightagein Marks**	**PracticalExam**	
Record	5	25	**50**
Test	10		
Attendance	5		
Performance	5		
Total	**25**	**25**	

References

1 Glick,B.RandPasternak,J.J1998.Molecularbiotechnology,PrinciplesandapplicationofrecombinantDNA, Washington D.C. ASM press

2 Howe.C.1995.Genecloningandmanipulation,CambridgeUniversityPress,USA

3 Lewin,B. GeneVINewYork, OxfordUniversityPress

4 Rigby,P.W.J.1987 GeneticEngineeringAcademicPress Inc.Florida,USA

5 Sambrooketal2000.MolecularcloningVolumesI,II&III,ColdspringHarborLaboratoryPressNewYork,USA

6 Walker,J.M.andGingold,E.B.1983.MolecularBiology&Biotechnology(IndianEdition)RoyalSocietyofChemistryU.K

7 Karp.G2002. Cell &MolecularBiology, 3rd Edition, JohnWiley&Sons; I

Date: SubjectCommitteeChairperson

ProgramName	**BScBiotechnology**		Semester	**IVSem**
CourseTitle	**IntellectualPropertyRights**			
CourseCode	**BTC:304**	**OE-4**	No. ofTheoryCredits	**3**
Contacthours	**Lecture**		DurationofESA/Exam	**2 Hours**
	Practical			
FormativeAssessmentMarks	40		SummativeAssessmentMarks	60

CoursePre-requisite(s):SemesterIandIIofcompositeHomeScience.	
CourseOutcomes(COs):At theend ofthecoursethe studentshould beable to: 1. Knowledgeabout needandscopeof Intellectualpropertyrights 2. Acquireknowledgeaboutfilingpatents,process, andinfringement 3. Knowledgeabouttrademarks,industrialdesigns,andcopyright	
Content	**45 Hrs**
Unit–I	**14 Hrs**
IntroductiontoIntellectualpropertyrights(IPR): Genesisandscope.TypesofIntellectualpropertyrights-Patent,Trademarks,Copyright,Design,Tradesecret,Geographicalindicators,Plantvarietyprotection .NationalandInternationalagencies – WIPO, World Trade Organization (WTO), Trade-Related Aspects of IntellectualPropertyRights (TRIPS),GeneralAgreement onTariffsand Trade(GATT).	
Unit-II	**14 Hrs**
Patenting,process,andinfringement Basics of patents - Types of patents; Patentable and Non-Patentable inventions, Process andProduct patent. Indian Patent Act 1970; Recent amendments; Patent Cooperation Treaty (PCT)and implications. Process of patenting. Types of patent applications: Provisional and completespecifications;Conceptof"priorart",patentdatabases(USPTO,EPO,India).Financialassistance, schemes, and grants for patenting. Patent infringement- Case studies on patents(Basmatirice, Turmeric,Neem)	
Unit-III -	**14 Hrs**
Trademarks,Copyright,industrialDesigns	
Trademarks- types, Purpose and function of trademarks, trademark registration, Protection oftrademark.Copyright-Fundamentalsofcopyrightlaw,Originalityofmaterial,rightsofreproduction,industrialDesigns: Protection,Kind ofprotection provided byindustrial design.	

Pedagogy

Summativeassessment=40markstheorypaper,EndsemesterExamdurationofexam2hours	
FormativeAssessmentOccasion/type	**WeightageinMarks**
Assignment	10
Seminar	10
Casestudies	10
Test	10
Total	**40marks**

References

1 ManishArora.2007.Universal'sGuidetoPatentsLaw(English)4th Edition)-Publisher:UniversalLawPublishingHouse

2 KalyanC.Kankanala.2012.FundamentalsofIntellectualProperty.AsiaLawHouse

3 Ganguli,P.2001.IntellectualPropertyRights:Unleashingtheknowledgeeconomy.NewDelhi:TataMcGraw-HillPub

4 Worldtradeorganization -http://www.wto.org

5 WorldIntellectualPropertyorganization–www.wipo.int
OfficeofthecontrollergeneralofPatents,Design&Trademarks -www.ipindia.nic.in

Date: SubjectCommitteeChairperson

BENGALURU CITY UNIVERSITY

CHOICE BASED CREDIT SYSTEM

(Semester Scheme with Multiple Entry and Exit Options for Under Graduate Course)

Syllabus for B.Sc. Biotechnology
(V & VI Semester)

2023-24 onwards

B.Sc. Biotechnology 5th Semester

Program Name	**B.Sc. Biotechnology**		Semester	**5th Semester**
Course Title	**Genetic Engineering (Theory + Practical)**			
Course Code:	**DSC –A9 (T)**	No. of Theory Credits		**04**
Contact hours	**60 hrs**	Duration of ESA/Exam		**03 Hours**
Formative Assessment Marks	**40**	Summative Assessment Marks		**60**

Course Objectives

1. Understand the fundamental principles and techniques of genetic engineering.
2. Explore the applications of genetic engineering in agriculture, medicine, biotechnology,and environmental science.
3. Develop practical skills in genetic engineering techniques and laboratory procedures.
4. Gain knowledge of gene expression regulation and genetic modification methods.
5. Enhance critical thinking and problem-solving skills through discussions and case studies.
6. Stay updated on emerging trends and advancements in genetic engineering.

Course Outcomes:

1. Demonstrate a thorough understanding of the fundamental principles and techniques of genetic engineering.
2. Apply the knowledge of genetic engineering to diverse applications in agriculture, medicine, biotechnology, and environmental science.
3. Perform laboratory procedures and develop practical skills in genetic engineering techniques.
4. Explain gene expression regulation mechanisms and apply genetic modification methods effectively.
5. Evaluate genetic engineering's ethical, social, and legal implications and propose responsible solutions.
6. Stay updated with recent advancements in genetic engineering, critically evaluate emerging trends, and assess their potential impact on various fields.

Genetic Engineering - Content of Theory	60 hrs
Unit I- Fundamentals of Genetic Engineering	**15**
Definition, scope, and historical overview of genetic engineering. Importance and applications in various fields. **DNA Structure and Manipulation** - Techniques for DNA isolation and purification. Methods for quantification and characterization of DNA samples. **RNA Analysis and Gene Expression**- Methods for RNA isolation and purification. Analysis of gene expression. **Recombinant DNA technology** – Introduction to molecular cloning. Overview of cloning vectors. Plasmids, phage, cosmid, BAC, and YAC. Features and applications of cloning vectors in genetic engineering. Enzymes used in recombinant DNA technology: Restriction endonucleases, Polymerases, Ligase, kinases, and phosphatases. Techniques for molecular cloning of DNA or RNA fragments in bacterial and eukaryotic systems.	
Unit II- Practices in Genetic Engineering	**15**
Recombinant Protein Expression and Purification, affinity tags. Techniques for expressing recombinant proteins using bacterial, animal, and plant expression systems. Strategies for protein purification and characterization. Hybridization techniques, Southern, Northern, Western, FISH, Polymerase Chain Reaction (PCR) and its types, molecular probes, DNA sequencing- Sanger's, Next Generation Sequencing **Gene Manipulation Techniques** - Methods of gene delivery. Physical, chemical, and biological methods. Transformation, transfection, electroporation and micro-injection. Gene knockout techniques in bacterial and eukaryotic organisms. **Genome Editing** - Introduction to genome editing techniques- Principles and applications of genome editing techniques. CRISPR-Cas9, site-directed mutagenesis, and other genome editing methods.	
Unit III- Applications of Genetic Engineering	**15**
Introduction to Applications. Overview of the diverse applications of genetic engineering. Gene therapy and its potential in treating genetic disorders. Strategies for gene delivery in therapeutic applications. Diagnostic Applications. DNA fingerprinting and its applications in forensics. Molecular diagnostic techniques and their role in disease diagnosis. Use of genetic engineering in the development of therapeutics and vaccines. Production of biopharmaceuticals using recombinant DNA technology.	
Unit IV- Advances in Genetic Engineering and Ethics	**15**
Industrial Applications. Industrial applications of genetic engineering, such as enzyme production, biofuel production, and bioremediation. Scale-up techniques and process optimization in industrial settings. Introduction to synthetic biology and its integration with genetic engineering. Design and construction of artificial biological systems **Ethical and Regulatory Considerations** - Discussion of ethical implications associated with genetic engineering. Introduction to regulatory guidelines and safety considerations for genetic engineering research and applications	

Pedagogy: Lectures, Seminars, Industry Visits, Debates, Quiz and Assignments

Summative Assessment = 60 Marks	
Formative Assessment / type	**Weightage in Marks**
Attendance	10
Seminar	10
Debates and Quiz	10
Test	10
Total FA	**40**
Total (FA + SA)	**100 marks**

Course Title	**Genetic Engineering**	Practical Credits	**02**
Course Code:	**DSC–A10 (P)**	Contact hours	**60 hrs**

Practical Content

1. **Introduction to Laboratory Techniques -** Safety guidelines and laboratory protocols Aseptic techniques and proper handling of materials. Basic equipment and instrument operationPreparation of reagents and media
2. **Nucleic Acid Extraction and Quantification-** DNA extraction from different sources (e.g., bacteria, plant, animal). RNA extraction and purification methods. Quality assessment and quantification of nucleic acids (spectrophotometry, gel electrophoresis).
3. **Polymerase Chain Reaction (PCR)**
   Primer design and optimization PCR setup and cycling conditions
   Agarose gel electrophoresis for PCR product analysis
4. **Cloning and Plasmid Manipulation**
   Isolation of Plasmid
   Restriction enzyme digestion
   Ligation reactions
   Transformation of bacterial cells with recombinant plasmids
   Colony selection and screening for successful cloning
5. **Gel Electrophoresis and DNA Analysis**
   Agarose gel electrophoresis for DNA fragment separation and analysisDNA size determination using molecular weight markers
   DNA band visualization techniques (e.g., Ethidium bromide staining, DNA intercalating dyes)

Practical Assessment

Formative Assessment		**Summative Assessment**	**Total Marks**
Assessment Occasion/ type	**Weightage in Marks**	**Practical Exams**	
Record	05	25	**50**
Test	10		
Attendance	05		
Performance	05		
Total	**25**	**25**	

References

1. Principles of Gene Manipulation and Genomics (2016) 8th ed., Primrose, SB, and Twyman, R, Wiley Blackwell, ISBN: 978-1405156660.
2. Gene Cloning and DNA Analysis: An Introduction (2019) 7th ed., Brown, TA, Wiley Blackwell, ISBN: 978-1119072560.
3. Genome 4 (2017) 4th ed., Brown, TA, Garland Science, ISBN: 978-0815345084.
4. Introduction to Genomics (2015) 2nd ed., Lesk, AM, Oxford University Press India, ISBN: 978-0198745891.
5. Genomics and Personalized Medicine: What Everyone Needs to Know (2016) 1st ed., Snyder, M, OUP-USA, ISBN: 978-0190234768.
6. Molecular Biology of the Gene (2014) 7th ed., Watson, JD, Baker, TA, Bell, SP, Gann, A, Levine, M, and Losick, R, Pearson, ISBN: 978-0321762436.
7. Principles of Gene Manipulation and Genomics (2019) 9th ed., Primrose, SB, and Twyman, R, Wiley Blackwell, ISBN: 978-1119163774.
8. Genomes (2018) 4th ed., Brown, TA, Garland Science, ISBN: 978-0815345084.
9. Introduction to Genomics and Proteomics (2015) 2nd ed., Burrell, MM, Wiley, ISBN: 978-0470850075.
10. Genomics: The Science and Technology Behind the Human Genome Project (2019) 2nd ed., Gibson, G, and Muse, SV, Oxford University Press, ISBN: 978-0198786207.
11. Genomics and Evolution of Microbial Eukaryotes (2019) 1st ed., Katz, LA, and Bhattacharya, D, Oxford University Press, ISBN: 978-0198830202.
12. Essentials of Genomic and Personalized Medicine (2016) 2nd ed., Ginsburg, GS, and Willard, HF, Academic Press, ISBN: 978-0124078652.
13. Genomic Medicine: Principles and Practice (2014) 2nd ed., Ginsburg, GS, and Willard, HF, Oxford University Press, ISBN: 978-0199334468.
14. Genomic Medicine in Resource-limited Countries: Genomics for Every Nation (2019) 1st ed., Wonkam, A, Puck, JM, and Marshall, CR, Academic Press, ISBN: 978-0128133003.
15. Molecular Genetics and Genomics (2020) 1st ed., Krebs, JE, and Goldstein, ES, Jones & Bartlett Learning, ISBN: 978-1284154544.
16. Bioinformatics and Functional Genomics (2015) 3rd ed., Pevsner, J, Wiley-Blackwell, ISBN: 978-1118581780.
17. Genomic Approaches for Cross-Species Extrapolation in Toxicology (2019) 1st ed., Wichard, J, and Maertens, A, CRC Press, ISBN: 978-0815348023.
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B.Sc. Biotechnology 5th Semester

Program	**B.Sc. Biotechnology**		Semester	**5th Semester**
Course Title	**Plant and Animal Biotechnology (Theory + Practical)**			
Course Code:	**DSC-A11 (T)**		No. of Theory Credits	**04**
Contact hours	**60 hrs**		Duration of ESA/Exam	**3 Hours**
Formative Assessment Marks		**40**	Summative Assessment Marks	**60**

Course Objectives

1. To understand the fundamental aspects of plant and animal biotechnology.
2. Learn about biotechnological tools and techniques used in plant and animal research.
3. Explore methods of introducing foreign genes into plants and animals through transformation techniques.
4. Gain practical skills in plant tissue culture and animal cell culture for improvement.
5. Design strategies for plant genetic manipulation against biotic and abiotic stressors.
6. Hypothesize strategies to increase plant yield and fruit/seed quality.
7. Apply knowledge to real-world challenges in agriculture, veterinary medicine, conservation, and biomedical research
8. Understand the need for animal biotechnology for human welfare.

Course Outcomes:

After completing this course, the student is expected to learn the following:

1. Demonstrate a comprehensive understanding of plant biology, physiology, genetics, andmolecular biology.
2. Apply biotechnological tools and techniques used in plant research and agriculture, such asplant tissue culture, genetic engineering and transgenics.
3. Execute plant tissue culture techniques for callus induction, somatic embryogenesis, andmicropropagation, and apply them in plant breeding and propagation.
4. Perform plant transformation methods and demonstrate the ability to introduce foreign genesinto plants using different techniques.
5. Apply knowledge about ethical considerations and regulatory frameworks associated with plant biotechnology and genetically modified crops.
6. Understand the biology and characterization of cultured cells, including their adhesion, proliferation, differentiation, morphology, and identification.
7. Gain practical skills in basic mammalian cell culture techniques, measuring growth parameters, assessing cell viability, and understanding cytotoxicity.
8. Learn about germplasm conservation techniques and the establishment of gene banks, along with large-scale culture methods for cell lines.
9. Explore organ and histotypic culture techniques, biotransformation, 3D cultures, whole embryo culture, somatic cell cloning, and the ethical considerations surrounding stem cellsand their applications.

Plant and Animal Biotechnology - Content of Theory	60 hrs
Unit–I – Plant Tissue culture methods	**15**
Introduction, history, definition, hypothesis, and concept of totipotency. Principles of plant tissue culture, media and laboratory organization, types of culture, morphogenesis, differentiation, callus, direct, indirect organogenesis, and somatic embryogenesis, synthetic seeds.*In vitro* propagation and micropropagation, Seed culture, embryo culture, Meristem culture, bud culture, limitations and applications. Secondary metabolites, *In vitro*secondary metabolite production, Suspension cultures, cell cultures, growth vs secondary metabolite production, bioreactors and scaling up of secondary metabolite production, limitations, and applications.	
Unit -II Transgenic Plants and biosafety	**15**
Overview of transgenic plants and their significance in agriculture. - Techniques for introducing foreign genes into plants: Agrobacterium-mediated transformation, biolistics, and other methods. Selection and screening of transformed plants. Applications of Transgenic Plants - Improved crop traits through genetic engineering: pest resistance, herbicide tolerance, disease resistance, and abiotic stress tolerance. Biosafety assessment of transgenic plants: potential risks and benefits. International regulatory frameworks for releasing and commercializing genetically modified organisms (GMOs). Ethical and socio-economic impacts of transgenic crops. Intellectual property rights and access to transgenic technologies.	
Unit–III Animal Cell culture methods	**15**
History and laboratory organisation, Media. Cell types and culture characters. Pluripotency, Multipotency, Differentiation, Trans differentiation Reprogramming, Biology and characterization of cultured cells- cell adhesion, proliferation, differentiation,morphology of cells, and identification. The basic technique of mammalian cell culture in vitro, Measuring parameters of growth in cultured cells, cell viability, and cytotoxicity. Large-scale culture of cell lines- monolayer, suspension, and immobilized cultures. Organ and histotypic culture**:** Technique, advantages, limitations, applications. Stem cells: types (embryonic, adult, induced pluripotent), isolation, identification, expansion, differentiation and uses, stem cell engineering,ethical issues.	
Unit -IV Gene transfer in animals and applications	**15**
Gene constructs promoter/ enhancer sequences for transgene expression in animals. Selectable markers for animal cells- thymidine kinase. Transfection of animal cells- calcium phosphate coprecipitation, electroporation, lipofection, peptides, direct DNA transfer, viral vectors, Retrovirus, microinjection. Transgene identification methods. Transgenic and genome-edited animals. Ethical issues in transgenesis. Recent advances and applications in the field. Manipulation of animal reproduction and characterization of animal genes, Embryo transfer in cattle and applications. Somatic cell cloning - cloning of Dolly. Ethical issues. Production of recombinant vaccines.	

Pedagogy: Lectures, Seminars, Industry Visits, Debates, Quiz, and Assignments. Case studies highlight successful applications and challenges in transgenic crop development.

Summative Assessment = 60 Marks	
Formative Assessment /type	**Weightage in Marks**
Attendance	10
Seminar	10
Debates and Quiz	10
Test	10
Total	**60 marks + 40 marks = 100 marks**

Course Title	**Plant and Animal Biotechnology**	Practical Credits	**2**
Course Code	**DSC-A-12 (P)**	Contact hours	**60 hrs**

Content of Practical

1. Laboratory organization of basic and commercial plant tissue culture
2. Media preparation (MS, B5), solid media preparation, and Liquid media preparation
3. Explant preparation – Leaf, bud, rhizome, and meristem
4. Synthetic seed production
5. Callus culture- Initiation and establishment of different types of callus cultures
6. Micropropagation with a suitable example – Stage 0. 1, 2, 3, and 4
7. Staining, cell viability, and cell count of cell cultures
8. Preparation of cell culture media: Preparation of basic cell culture media, such as Dulbecco's Modified Eagle Medium (DMEM), supplemented with fetal bovine serum (FBS), antibiotics, and other required additives.
9. Aseptic techniques and sterile handling: Practicing aseptic techniques, including properly handling tools and equipment, working in a laminar flow hood, and maintaining sterility throughout the cell culture process.
10. Filter sterilization: Practice filter sterilization for sensitive media ingredients.
11. Cell counting and viability assessment: Count cells using a hemocytometer or automated cell counter, and perform viability assays (e.g., trypan blue exclusion) to determine the percentage of viable cells.
12. Cell staining and microscopy: Staining the cultured cells using dyes such as hematoxylin and eosin (H&E), and observe them under a light microscope to study cell morphology and structure.
13. Contamination identification and troubleshooting: Learn to identify and troubleshoot common issues in cell culture, such as contamination by bacteria, fungi, or mycoplasma, and implementappropriate corrective measures.
14. Experimental design and data analysis: Students can design and execute simple experiments, record and analyze data, and interpret the results based on their observations and measurements.

Practical Assessment

Formative Assessment		**Summative Assessment**	**Total Marks**
Assessment Occasion/ type	**Weightage in Marks**	**Practical Exams**	
Record	05	25	**50**
Test	10		
Attendance	05		
Performance	05		
Total	**25**	**25**	

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Program Name	**B.Sc. Biotechnology**	Semester	**5th Semester**
Course Title	**Biotechnology Skills and Analytical Techniques**		

Course No.	**SEC- 4**	No. of Theory Credits	**2+1 (Theory+Practical)**
Contact hours	**45 hrs**	Duration of ESA/Exam	**2 hrs**
Formative Assessment Marks	**20**	Summative Assessment Marks	**30**

Course Outcomes (COs): At the end of the course the student should be able to:

1. Demonstrate skills as per National Occupational Standards (NOS) of the "Lab Technician/Assistant" Qualification Pack issued by the Life Sciences Sector Skill Development Council-LFS/Q0509.
2. Develop knowledge of laboratory safety procedures and protocols and acquire skills in handling and maintaining laboratory equipment and instruments.
3. Operate analytical equipment and instruments as per standard operating procedures (SOP)
4. Knowledge about major activities of the biotech industry, regulations and compliance, environment, health and safety (EHS), good laboratory practices (GLP), and Good Manufacturing Practices (GMP) as per the industry standards.
5. Demonstrate soft skills, such as decision-making, planning, organizing, problem-solving, analytical thinking, critical thinking, and documentation.

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs 1-13)

Course Outcomes (COs)/Program Outcomes (POs)	1	2	3	4	5	6	7	8	9	10	11	12	13
Develop knowledge of laboratory safetyprocedures and protocols and acquireskills in handling and maintaining laboratory equipment and instruments.	✔	✔											
Operate analytical equipment and instruments as per standard operating procedures (SOP)		✔	✔									✔	
Knowledge about major activities of thebiotech industry, regulations and compliance, environment, health and safety (EHS), good laboratory practices (GLP), and Good Manufacturing Practices (GMP) as per the industry standards.		✔							✔		✔		
Demonstrate soft skills, such as decision making, planning, organizing, problemsolving, analytical thinking, criticalthinking and documentation.	✔	✔						✔	✔				

Biotechnology Skills and Analytical Techniques Content	**30 Hrs**
Unit-I Insights into the biotechnology industry and basic professional skills	**15**

Biotechnology Industry in Indian and Global Context- Organization in the context of large/medium/small enterprises, their structure, and benefits. **Industry-oriented professional skills:** Planning and organizing skills, decision-making, problem-solving skills, analytical thinking, critical thinking, team management, and risk assessment. Interpersonal skills: Writing skills, reading skills, oral communication, conflict resolution techniques, interpretation of research data, and troubleshooting in the workplace. **Digital skills:** Basic computer skills (MS Office, excel, power point, internet) for the workplace. Professional E-mail drafting skills and PowerPoint presentation skills. Overview of good manufacturing practices (GMP), Good Documentation practices (GDP), and good laboratory practices (GLP).
Unit- II Basic laboratory skills and Analytical Techniques **15**
Analytical skills in the laboratory: Preparations of 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, and solution of acids. Reagent bottle label reading and precautions. **Analytical techniques:** Basic principle, operation, application, maintenance, calibration, validation, and troubleshooting of instruments- Microscope-Simple, compound, TEM, SEM, fluorescence. Centrifuge and different types, Hot air oven, pH meter, different types of pH electrodes Autoclave, Incubator, BOD, COD, cell counter, Laminar airflow. Spectroscopy-Colorimeter, UV-Visible spectroscopy. Electrophoresis- Agarose Gel electrophoresis, SDS-PAGE, PCR, Conductivity meter, and Potentiometer. Biosafety cabinets.

Pedagogy: Lectures, Seminars, Industry Visits, Debates, Quiz, and Assignments

Course title	**Quality control methods in biology (Practical)**	**Practical credits-1**	**5th Semester**
Course No.	**SEC -4**	Contact hours	4hrs/week
Content			
Unit-1			
Methods and practices of cleaning and management of lab: Learning and Practice of Integratedclean-in-place (CIP) and sterilize-in-place (SIP) as per industry standards, material requirementsfor cleaning specific areas, equipment, ventilation area, personal protective requirements Calibration of and use of micropipette.			
Unit-2			
Preparation of Standard Operating Procedure (SOP) for various equipment in the QC Lab, Best practices of using and storing chemicals: Knowledge and practice in handling chemicals, labeling, and stock maintenance. SOP and material handling. Procedures to maintain chemicals, labeling, storage, and disposal. **Handling and calibration of lab equipment-** weighing balance, Autoclave, Hot air Oven, Incubator, Centrifuge, Water bath, Colony Counter, and stability chamber, Preparation of Normality, Molarity, and buffer solutions			
Unit-3			

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 ofindents of media requirement, preparation, and storage. Media coding, documentation, and purpose of usage.

Demonstration, handling, and troubleshooting of High-Performance Liquid Chromatography and Gas chromatography.

Demonstration of Polymerase Chain Reaction (PCR), Hands-on training on colorimeter and spectrophotometer, Industry visit, or analytical laboratory visit.

Note: Semester end examination is only in the theory component; questions from the practical partcould be included, if any.

References:

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Program Name	**B.Sc. Biotechnology**	Semester	**6th Semester**
Course Title	**Immunology (Theory + Practical)**		
Course Code:	**DSC-A13(T)**	No. of Theory Credits	**04**
Contact hours	**60 hrs**	Duration of ESA/Exam	**3 Hours**
Formative Assessment Marks	**40**	Summative Assessment Marks	**60**

Course Objectives:

1. To understand the various aspects of immunity, elicitation of immune responses, factors determining the outcome of immune responses and major players of immunity, relevancebetween nutritional support and immunity, and immunological techniques.
2. To provide knowledge on essential features of antigens and antibodies and their types and different theories of Antibody formation.
3. To acquire knowledge on types of immunity, phagocytosis, interferons, and the complement system.
4. To explain the concept of hypersensitivity, autoimmunity, and transplantation.
5. To provide knowledge on immune deficiencies and several immunological techniques

Course Outcomes:

At the end of the course, the student should be able to:

1. Demonstrate comprehension of the underlying structure and function of the immunesystem and related disorders.
2. Demonstrate an understanding of the role of cells and molecules in immune reactions andresponses
3. Demonstrate technical skills in immunological tools and techniques
4. Apply the domain-specific knowledge and skills acquired in immunology for innovativetherapies and Immunotechnologies
5. Understand the fundamental concepts of immunity, and the contributions of the organs and cellsin immune responses.
6. Realize how the MHC molecule's function and host encounters an immune insult.
7. Understand the antibodies and complement system
8. Understand the mechanisms involved in the initiation of specific immune responses
9. Differentiate the humoral and cell-mediated immune mechanisms
10. Comprehend the overreaction by our immune system leading to hypersensitive conditions and its consequences
11. Understand unique properties of cancer cells, immune recognition of tumors, immune evasionof cancers

Immunology - Content of Theory	**60 Hrs**
Unit–I Cells and Organs of the Immune System	**15**

Introduction to the Immune System: History of Immunology, Types of Immunity: first and second line of defense, innate and acquired/adaptive immunity, specificity, diversity. Cells of the immune system: Antigen-presenting cells (APCs), Role of B and T-lymphocytes in Humoral immunity and cell-mediated immunity, primary and secondary immune response, Immunization, memory. Organs of the Immune system: Thymus, bone marrow, spleen, Lymph Node, peripheral lymphoid organs	
Unit -II Molecules of the Immune System	**15**
Antigens and haptens: Properties (foreignness, molecular size, heterogeneity). Adjuvants. Antigenicityand Immunogenicity. Affinity and Avidity. B and T cell epitopes, superantigens Immunoglobulins: Classification, structure, and function. Antibody diversity, Monoclonal and polyclonal antibodies. Major histocompatibility complexes: Classification, structure, and function. Antigen processing pathways – Cytosolic and Endocytic, Complement Pathways, Cytokines: Classification and function, Hypersensitivity: Reactions – Types I, II, and III. Delayed Type Hypersensitive Response.	
Unit -III Immunotechniques and vaccines	**15**
Structure and properties of antigens- iso- and allo-antigens, antigen specificity, Cross-reactivity, Precipitation, Immunodiffusion reactions: Radial immunodiffusion, Ouchterlony double diffusion, Immunoelectrophoresis. Agglutination: Agglutination reactions. ELISA, RIA. Immunocytochemistry, Fluorescent Techniques. Vaccines: Conventional, peptide vaccines, subunit, DNA vaccines. Toxoids, antisera, edible vaccines, plantibodies, and Cancer vaccines.	
Unit - IV	**15**
Transplantation immunology: Phases in graft rejection and immuno-suppressors. Autoimmune Disorders: Systemic and Organ-specific Autoimmune disorders with examples Immunodeficiencies: Primary and secondary immunodeficiencies; acquired immunodeficiency syndrome Cancer and the immune system – immune surveillance, immunological escape, cancer antigens, cancerimmunotherapy Microbial diseases in humans**:** Mode of infection, symptoms, epidemiology and control measures of diseases caused by Viruses (Hepatits-B), Bacteria (Typhoid), Fungi (Aspergillosis), Protozoa (Malaria).	

Pedagogy: Lectures, Seminars, Industry Visits, Debates, Quiz and Assignments

Summative Assessment = 60 Marks	
Formative Assessment Occasion/ type	**Weightage in Marks**
Attendance	10
Seminar	10
Debates and Quiz	10
Test	10
Total	**60 marks + 40 marks = 100 marks**

Course Title	**Immunology (Practical)**	Practical Credits	**02**
Course No.	**DSC-A14 (P)**	Contact hours	**60 hrs**
Content of Practical			

1. Hemagglutination of ABO Blood groups
2. Determination of Rh factor
3. Whole Count of WBC using Hemocytometer
4. Cells of the Immune System
5. Radial immunodiffusion
6. Ouchterlony double diffusion
7. ELISA – Demonstrate
8. Serum Immunoelectrophoresis
9. Western Blotting

Practical Assessment			
Formative Assessment		**Summative Assessment**	**Total Marks**
Assessment Occasion/ type	**Weightage in Marks**	**Practical Exams**	
Record	05	25	**50**
Test	10		
Attendance	05		
Performance	05		
Total	**25**	**25**	

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Program Name	**B.Sc. Biotechnology**	Semester	**6th Semester**
Course Title	**Bioprocess and Environmental Biotechnology (Theory)**		
Course Code:	**DSC-A15 (T)**	No. of Theory Credits	**04**
Contact hours	**60 hrs**	Duration of ESA/Exam	**03 Hours**
Formative Assessment Marks	**40**	Summative Assessment Marks	**60**

Course Objectives:

1. Perform simulations of microbial growth and metabolism
2. Design bioreactors for the production of various products.
3. Present knowledge about major metabolic pathways and those related to biofuel production from microbes.
4. Understand the fundamental concepts and principles of environmental biotechnology and Explore the interrelationship between biotechnology and the environment.
5. Gain knowledge of the variousapplications of biotechnology in environmental conservation, pollution control, and sustainability.
6. Learn about microbial processes and their role in environmental biotechnology.
7. Understand the principles of bioremediation and its application in the clean-up of environmental pollutants.
8. Explore the potential of bioenergy production and waste management through biotechnological approaches.
9. Identify and characterize the most important contaminants in the Bioprocess and other industrial wastes.
10. Reuse/recycle the biological waste to clean technology such as energy, biofuel, bio fertilizer through bioremediation

Course out comes:

1. Exploitation of microorganisms for industrial use and their improvement, and formulation of media for efficient growth and production of microbial or cell-based products.
2. The design, operation, and specific applications of various bioreactors.
3. Demonstrate a comprehensive understanding of the fundamental concepts and principlesof environmental biotechnology.
4. Apply knowledge of biotechnological techniques to address environmental challenges,such as pollution control and waste management.
5. Analyze and evaluate environmental biotechnology case studies, research findings, andreal-world applications.
6. Design and implement biotechnological approaches for environmental remediation,utilizing microbial processes and biodegradation principles.
7. Evaluate the ethical and sustainable aspects of environmental biotechnology practices andmake informed decisions regarding their application in environmental conservation.
8. Communicate scientific concepts and research findings related to environmentalbiotechnology effectively, both in written and oral forms, to diverse audiences.

Bioprocess and Environmental Biotechnology – Content of Theory	60 hrs.
UNIT- I – Introduction to bioprocess technology	**15**
Basic principle components of fermentation technology. Strain improvement of industrially important microorganisms. Types of microbial culture and its growth kinetics– Batch, Fed-batch, and Continuous culture. Principles of upstream processing – Media preparation, Inocula development, and sterilization.	
UNIT- II-Bioreactors and downstream processing	**15**
Bioreactors- Significance of Impeller, Baffles, Sparger; Specializedbioreactors- design and their functions: airlift bioreactor, tubular bioreactors, membranebioreactors, tower bioreactors, fluidized bed reactor, packed bed reactors Downstream processing- cell disruption, precipitation methods, solid-liquid separation, liquid-liquid extraction, filtration, centrifugation, chromatography, drying devices (Lyophilization and spray dry technology), crystallization, biosensors-construction and applications, Microbial production of ethanol, amylase and Single Cell Proteins.	
Unit III- Fundamentals of Environmental Biotechnology	**15**
Introduction to Environmental Biotechnology- Principles of Environmental Science. Role of Biotechnology in Environmental Conservation. Microbial Processes in Environmental Biotechnology. Pollution and Biotechnology – Major issues in environmental pollution and the role of biotechnology in addressing them. Biotechnological Methods of Pollution Detection-General bioassay methods for pollution detection. Cell biological methods for assessing pollution levels. Use of biosensors in pollution monitoring. Biotechnological Methods in Pollution Abatement-Reduction of CO2 emission using biotechnologicalapproaches. Addressing eutrophication through biotechnological interventions. Application of cell immobilization techniques in pollution abatement.	
Unit IV- Bioremediation and Waste Management	**15**
Importance of bioremediation in environmental cleanup. Types of contaminants suitable for bioremediation. Microorganisms used in bioremediation. *In-situ* Bioremediation Methods. – Bioaugmentation. Biostimulation. Bioventing.Phytoremediation. *Ex-situ* Bioremediation Methods – Composting, Land farming, Biopile and bioslurry systems. Xenobiotics. Bio metallurgy and bio-mining. Waste water Management. Waste water Characterization and Composition. Biological Processes in Waste water Treatment. Activated Sludge Process and Biological Nutrient Removal, Anaerobic Digestion and Biogas Production. Solid Waste Management.	

Pedagogy: Lectures, Seminars, Industry Visits, Debates, Quiz and Assignments

Summative Assessment = 60 Marks	
Formative Assessment Occasion/ type	**Weightage in Marks**
Attendance	10
Seminar	10
Debates and Quiz	10
Test	10
Total	**60 marks + 40 marks = 100 marks**

Course Title	**Bioprocess and Environmental Biotechnology (Practical)**	Practical Credits	**02**
Course No.	**DSC-A16 (P)**	Contact hours	**60 hrs**

Content of Practical

1. Bacterial growth curve.
2. Calculation of the thermal death point (TDP) of a microbial sample.
3. Study of fermentor- Demonstration.
4. Production of wine.
5. Estimation of the percentage of alcohol, total acidity & volatile acidity in wine.
6. Production and analysis of ethanol.
7. Production and analysis of amylase.
8. Production and analysis of lactic acid.
9. Isolation of industrially important microorganisms from natural resources.
10. Standard analysis of Water.

Practical Assessment

Formative Assessment		**Summative Assessment**	**Total Marks**
Assessment Occasion/ type	**Weightage in Marks**	**Practical Exams**	
Record	05	25	**50**
Test	10		
Attendance	05		
Performance	05		
Total	**25**	**25**	

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Internship for Graduate Programme

Course title	**Internship Discipline specific**
No of contact hours	**90**
No credits	**2**
Method of evaluation	**Presentations/Report submission/Both**

<table>
<tr><td colspan="4">Project Assessment</td></tr>
<tr><td colspan="2">Formative Assessment</td><td>Summative Assessment</td><td rowspan="2">Total Marks</td></tr>
<tr><td>Assessment Occasion/ type</td><td>Weightage in Marks</td><td>Practical Exams</td></tr>
<tr><td>Data maintenance</td><td>10</td><td rowspan="3">Presentation/Report/Both
25</td><td rowspan="4">50</td></tr>
<tr><td>Assessment</td><td>10</td></tr>
<tr><td>Attendance</td><td>05</td></tr>
<tr><td>Total</td><td>25</td><td>25</td></tr>
</table>

- Internship shall be Discipline Specific of 90 hours (2 credits) with duration 4-6 weeks.
- Internship may be full-time/part-time (full-time during semester holidays and part-time in the academic session)
- The student should submit the final internship report (90 hours of Internship) to the mentor for completion of the internship.
- The detailed guidelines and formats shall be formulated by the universities separately as prescribed in accordance to UGC and AICTE guidelines.