ಬೆಂಗಳೂರು ಉತ್ತರ ವಿಶ್ವವಿದ್ಯಾಲಯ

ಟಮಕ, ಕೋಲಾರ – 563103

CHOICE BASED CREDIT SYSTEM

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

SYLLABUS AS PER NEP GUIDELINES

SUBJECT: BIOTECHNOLOGY

2021-22 onwards

BENGALURU NORTH UNIVERSITY
ಬೆಂಗಳೂರು ಉತ್ತರ ವಿಶ್ವವಿದ್ಯಾಲಯ

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**.

RADUATE 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: 2**5**

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: Biofertilizers & Bio pesticides		**14 h**
Biofertiizers; Advantages and brief account on Rhizobium, BGA and phosphate solubilizers. 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

BOS Meeting

Held On 19th, 20th & 21st of October 2022

The Board of Studies in Microbiology and Biotechnology (UG – NEP) deliberated on the syllabus provided by the Karnataka State Higher Education Council for B.Sc Basic and Honours degree under NEP – 2020 through circulation. The board approved two discipline specific core courses each subject with practicals respectively, for the third and fourth semester and two open electives without practicals.

Members

1. **Dr. Rekha Sethi**
   Chairperson, BOS in Microbiology & Biotechnology (UG NEP)
   Principal, Sri Bhagawan Mahaveer Jain College, K.G.F

2. **Dr. Vimala Gandhi**
   Member, BOS in Microbiology & Biotechnology
   SEA College of Science, Commerce & Arts, KR Puram, Bangalore

3. **Mrs. Louisena Vinoth Priya**
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4. **Mrs. Laveneya G**
   Member, BOS in Microbiology & Biotechnology
   Sri Bhagawan Mahaveer Jain College, K.G.F

5. **Mrs. Hazel D'Souza**
   Member, BOS in Microbiology & Biotechnology
   Goodwill Christian College, Bengaluru

The emendation made were as follows

- Mycoplasma included in Unit II of Microbial Diversity
- Agaricus, Trypanosoma, Cosmarium, type study were eliminated in Unit III of Microbial Diversity
- Oncogenic viruses placed in one category
- T7 phage eliminated
- Isolation of Fungi from water eliminated
- No Changes in Open Elective Microbial Entrepreneurship paper and references were added for the same
- Determination of Molar absorption coefficient, isoelectric point removed
- Open Elective – Human Microbiome, Unit III Microbiomes and diseases replaced by Immunity-Different types and vaccines, references added for the same
- Included Mechanism of action of enzymes in Unit II of Biomolecule paper
- Synthesis of Purines and Pyrimidines through the Denova and Salvage pathway were eliminated from Unit III of the Biomolecule paper
- Unit I of Molecular Biology was refined with no major content change
- RNA structure and types of RNA removed from Unit III of Molecular Biology (already covered in Unit I)
- Gene regulation, Lac and trp Operon included

Dr. Rekha Sethi
Chairperson
Board of Studies
Microbiology and Biotechnology (UG-NEP)
Bengaluru North University, Kolar

BENGALURU NORTH UNIVERSITY

Curriculum Framework for Four-Year Undergraduate Multidisciplinary Programme (Honours) in Colleges Affiliated to Bengaluru North University, under NEP 2020.

3rd and 4th Semester Syllabus

for UG Program in

BIOTECHNOLOGY

Submitted to

The Registrar
Bengaluru North University

Submitted by

Dr. Rekha Sethi
CHAIRMAN BOARD OF STUDIES
MICROBIOLOGY & BIOTECHNOLOGY (UG-NEP)
&
MEMBERS OF THE BOS
MICROBIOLOGY AND BIOTECHNOLOGY

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PREAMBLE

The role of education is paramount in nation building. One of the major objectives of UGC is maintenance of standards of higher education. Over the past decades the higher education system of our country has undergone substantial structural and functional changes resulting in both quantitative and qualitative development of the beneficiaries. Such changes have gained momentum with the introduction of Choice Based Credit System (CBCS) which further expects Learning Outcome-Based curriculum to maximize the benefits of the newly designed curriculum. The Learning Outcome- Based Curriculum in Biotechnology will help the teachers of the discipline to visualize the curriculum more specifically interms of the learning outcomes expected from the students at the end of the instructional process. The commission strives to promote the link of students with the society/industry such that majority of the students engage in socially productive activities during their period of study in the institutions and at least half of the graduate students will secure access to employment/self-employment or engage themselves in pursuit of higher education. The model curriculum envisages to cater to the developmental trends in higher education, incorporating multi- disciplinary skills, professional and soft skills such as teamwork, communication skills, leadership skills, time management skills and inculcate human values, professional ethics, and the spirit of Innovation / entrepreneurship and critical thinking among students and promote avenues for display of these talents, linking general studies with professional courses. Besides imparting disciplinary knowledge to the learners, curriculum should aim to equip the students with competencies like problem solving, analytical reasoning and moral and ethical awareness. Introduction of internship and appropriate fieldwork/case studies are embedded in the curriculum for providing wider exposure to the students and enhancing their employability.

Learning outcomes specify what exactly the graduates are expected to know after completing a program of study. The expected learning outcomes are used as reference points to help formulate graduate attributes, qualification descriptors, program learning outcomes and course learning outcomes. Keeping the above objectives of higher education in mind the Learning Outcome-Based Curriculum Framework (LOCF) for the discipline of Biotechnology has been prepared and presented here.

BENGALURU NORTH UNIVERSITY

Program Name	**B.Sc. Discipline**	Total Credits for the Program	**176**
Core	**Biotechnology**	Starting year of implementation	**2021-22**

Program Outcomes: At the end of the program the student should be able to:

(Refer to literature on outcome-based education (OBE) for details on Program Outcomes)

PO1. Understanding concepts of Biotechnology and demonstrate interdisciplinary skills acquired in cell biology, genetics, biochemistry, microbiology, and molecular biology

PO2. Demonstrating the Laboratory skills in cell biology, basic and applied microbiology within emphasis on technological aspects

PO3. 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.

PO4. Critically analyse the environmental issues and apply the biotechnology knowledge gained for conserving the environment and resolving the problems.

PO5. Demonstrate comprehensive innovations and skills in the fields of biomolecules, cell and organelles, molecular biology, bioprocess engineering and genetic engineering of plants, microbes, and animals with respect to applications for human welfare.

PO6. Apply knowledge and skills of immunology, bioinformatics, computational modeling of proteins, drug design and simulations to test the models and aid in drug discovery.

PO7. Critically analyse, interpret data, and apply tools of bioinformatics and multi omics in various sectors of biotechnology including health and Food.

PO8. Demonstrate communication skills, scientific writing, data collection and interpretation abilities in all the fields of biotechnology.

PO9. Learning and practicing professional skills in handling microbes, animals and plants anddemonstrate the ability to identify ethical issues related to recombinant DNA technology, genetic engineering, animals handling, intellectual property rights, biosafety, and biohazards.

PO10. Exploring the biotechnological practices and demonstrating innovative thinking in addressing the current day and future challenges with respect to food, health, and environment.

PO11. Thorough knowledge and application of good laboratory and good manufacturing practices in biotech industries.

PO12. Understanding and application of molecular biology techniques and principles inforensic and clinical biotechnology.

PO13. Demonstrate entrepreneurship abilities, innovative thinking, planning, and setting up small-scale enterprises or CROs

Assessment:

Weight age for assessments (in percentage)

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

Contents of Courses for B.Sc. Biotechnology as Major

Model II A

Semester	Course code	Course Category	Theory/Practical	Credits	Paper Title	Marks	
						S.A	I.A
3.	**BTC: 103**	DSC- 7	Theory	3	Biomolecules	60	40
			Practical	2	Biomolecules	25	25
	BTC:303	OE- 3	Theory	3	Nutrition and Health	60	40
4.	**BTC:104**	DSC- 8	Theory	3	Molecular Biology	25	25
			Practical	2	Molecular Biology	60	40
	BTC:304	OE- 4	Theory	3	Intellectual Property Rights	25	25
	Exit option with Diploma in Biotechnology (100 Credits)						

BENGALURU NORTH UNIVERSITY

Program Name	**BSc Biotechnology**		Semester	**Third Sem**
Course Title	**Biomolecules**			
Course No.	**BTC: 103**	**DCS -3T**	No. of Theory Credits	**4**
Contact hours	**56 hrs**		Duration of ESA/Exam	**2.30 Hours**
Formative Assessment Marks	**40**		Summative Assessment Marks	**60**

Course Pre-requisite (s):

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

1. Acquire knowledge about types of biomolecules, structure, and their functions
2. Will be able to demonstrate the skills to perform bioanalytical techniques
3. Apply comprehensive innovations and skills of biomolecules to biotechnology field

Content	Hrs
Unit–I – a) Carbohydrates: Introduction, sources, classification of carbohydrates. Structure,function and properties of carbohydrates. Monosaccharides – Isomerism and ring structure, Sugar derivatives – amino sugars and ascorbic acid Oligosaccharides – Sucrose and Fructose Polysaccharides – Classification as homo and heteropolysaccharides, Homopolysaccharides - storage polysaccharides (starch and glycogen- structure, reaction, properties), structural polysaccharides (cellulose and chitin-structure,properties),Heteropolysaccharides - glycoproteins and proteoglycans (Brief study). Metabolism:Glycolysis and gluconeogenesis, Kreb's cycle, oxidative phosphorylation. **b) Amino Acids, Peptides and Proteins** Introduction, classification and structure of amino acids. Concept of – Zwitterion, isoelectric point, pK values. Essential and nonessential amino acids. Peptide bond and peptide, classification of proteins based on structure and function, Structural organization of proteins[primary, secondary (α,), tertiary and quaternary]. Fibrous and globular proteins, Denaturation and renaturation of proteins General aspects of amino acid metabolism:Transamination, deamination, decarboxylation and urea cycle.	**14**

Unit -II a) Lipids Classification and function of lipids, properties (saponification value, acid value, iodine number, rancidity), Hydrogenation of fats and oils Saturated and unsaturated fatty acids. General structure and biological functions of - phospholipids, sphingolipids, glycolipids, lipoproteins, prostaglandins, cholesterol, ergosterol. Metabolism: Beta oxidation of fatty acids. Biosynthesis of cholesterol. b) **Enzymes** Introduction, nomenclature and classification, enzyme kinetics, factors influencing enzyme activity metalloenzymes, activation energy and transition state, enzyme activity, specific activity, Mechanism of action, active site, Coenzymes and their functions (one reaction involving FMN, FAD, NAD). Enzyme inhibition- Irreversible and reversible (competitive, non-competitive and uncompetitive inhibitionwith an example each) Zymogens (trypsinogen, chymotrypsinogen and pepsinogen), Isozymes (LDH, Creatine kinase, Alkaline phosphatase and their clinical significance).	**14**
Unit -III -a. **Vitamins** Water and fat soluble vitamins, dietary source and biological role of vitamins Deficiency manifestation of vitamin A, B, C, D, E and K **a) Nucleic acids** Structures of purines and pyrimidines, nucleosides, nucleotides in DNA **b) Hormones** Classification of hormones based on chemical nature and mechanism of action. Chemical structureand functions of the following hormones: Glucagon, Cortisone, Epinephrine, Testosterone and Estradiol.	**14**
Unit –IV - Bioanalytical tools : **a) Chromatography :** Principle, procedure and applications of - paper chromatography, thin layer chromatography, adsorption chromatography, ion exchange chromatography, gel filtration chromatography, affinity chromatography, gas liquid chromatography and high performanceliquid chromatography. **b) Electrophoresis:** Principle, procedure and applications of electrophoresis (paper electrophoresis, gel electrophoresis -PAGE, SDS- PAGE &agarose electrophoresis) and isoelectric focusing. **c) Spectroscopy:** UV-Vis spectrophotometry; mass spectroscopy, atomic absorption spectroscopy.	14

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs 1-12)

Course Outcomes (COs) / Program Outcomes (POs)	Program Outcomes (POs)											
	1	2	3	4	5	6	7	8	9	10	11	12
Acquire knowledge about types of biomolecules, structure, and their functions	✓				✓							✓
Will be able to demonstrate the skills to perform bioanalytical techniques			✓								✓	✓

Apply comprehensive innovations and skills of biomolecules to biotechnology field	✓				✓						✓

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	**Biomolecules**		Practical Credits	**2**
Course No.	**BTC:103**	**DSC-3P**	Contact hours	

Content

1. Calculations of Molarity, Molality, Normality, Mass percent % (w/w), Percent by volume (% v/v), parts per million (ppm), parts per billion (ppb).
2. Preparation of standard buffers– Acetate, phosphate,
3. Estimation of maltose by DNS method
4. Determination of α-amylase activity by DNS method
5. Estimation of proteins by Lowry's /Biruet/Bradford's method
6. Estimation of amino acid by Ninhydrin method
7. Separation of plant pigments by circular paper chromatography
8. Separation of amino acids by thin layer chromatography
9. Native PAGE
10. Determination of Seponification and iodine number of lipids

Practical assessment

Assessment			
Formative assessment		**Summative Assessment**	**Total Marks**
Assessment Occasion / type	**Weightage in Marks**	**Practical Exam**	
Record	5	25	**50**
Test	10		
Attendance	5		
Performance	5		
Total	**25**	**25**	

References	
1	An Introduction to Practical Biochemistry, 3rd Edition, (2001), David Plummer; Tata McGraw Hill Edu.Pvt.Ltd. New Delhi, India
2	Biochemical Methods,1st Edition, (1995), S.Sadashivam, A.Manickam; New Age International Publishers, India
3	Introductory Practical biochemistry, S. K. Sawhney&Randhir Singh (eds) Narosa Publishing. House, New Delhi, ISBN 81-7319-302-9
4	Experimental Biochemistry: A Student Companion, BeeduSasidharRao& Vijay Despande(ed).I.K International Pvt. LTD, NewDelhi. ISBN 81-88237-41-8
5	Standard Methods of Biochemical Analysis, S. K. Thimmaiah (ed), Kalyani Publishers, Ludhiana ISBN 81-7663-067

Dr. Rekha Sethi
Chairperson
Board of Studies
Microbiology and Biotechnology (UG-NEP)
Bengaluru North University, Kolar

BENGALURU NORTH UNIVERSITY

Program Name	**BSc Biotechnology**		Semester	**Third Sem**
Course Title	**Nutrition and Health**			
Course Code		**OE-3**	No. of Theory Credits	**3**
Contact hours	**Lecture**		Duration of ESA/Exam	**Hours**
	Practical			
Formative Assessment Marks			Summative Assessment Marks	

Course Pre-requisite(s):	
Course Outcomes (COs): At the end of the course the student should be able to: 1. Study the concepts of food, nutrition, diet and health 2. To apply the best practices of food intake and dietary requirements 3. Acquire knowledgeabout various sources of nutrients and goodcooking practices	
Content	**45 Hrs**
Unit–I - Introduction	**14 Hrs**
Concepts of nutrition and health. Definition of Food, Diet and nutrition, Food groups. Food pyramids. Functions of food. Balanced diet. Meal planning. Eat right concept. Functional foods, Prebiotics, Probiotics, and antioxidants	
Unit -II - Nutrients	**14 Hrs**
Macro and Micronutrients - Sources, functions and deficiency.Carbohydrates, Proteins, Fats – Sources and calories. Minerals –Calcium, Iron, Iodine. Vitamins – Fat soluble vitamins –A, D, E & K. Water soluble vitamins – vitamin C Thiamine, Riboflavin, Niacin. Water–Functions and water balance. Fibre –Functions and sources. Recommended Dietary Allowance, Body Mass Index and Basal Metabolic Rate.	
Unit -III – Nutrition and Health	**14 Hrs**
Methods of cooking affecting nutritional value. Advantages and disadvantages. Boiling, steaming, pressure cooking. Oil/Fat – Shallow frying, deep frying. Baking. Nutrition through lifecycle. Nutritional requirement, dietaryguidelines:Adulthood, Pregnancy, Lactation, Infancy-Complementary feeding, Pre-school, Adolescence, geriatric. Nutrition related metabolic disorders- diabetes and cardiovascular disease.	

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

References	
1	Sri Lakshmi B, (2007), Dietetics. New Age International publishers. New Delhi
2	Sri Lakshmi B, (2002), Nutrition Science. New Age International publishers. New Delhi
3	Swaminathan M. (2002). Advanced text book on food and Nutrition. Volume I. Bappco

4	Gopalan.C., RamaSastry B.V., and S.C.Balasubramanian (2009), Nutritive value of Indian Foods.NIN.ICMR.Hyderabad.
5	Mudambi S R and Rajagopal M V, (2008), Fundamentals of Foods, Nutrition & diet therapy by New Age International Publishers, New Delhi

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BENGALURU NORTH UNIVERSITY

Program Name	**BSc Biotechnology**		Semester	**Fourth Sem**
Course Title	**Molecular Biology**			
Course No.	**BTC: 104**	**DCS -4T**	No. of Theory Credits	**4**
Contact hours	**56 hrs**		Duration of ESA/Exam	**2.30 Hours**
Formative Assessment Marks			Summative Assessment Marks	

Course Pre-requisite (s):

Course Outcomes (COs): At the end of the course the student should be able to:
1. Study the advancements in molecular biology with latest trends.
2. Will acquire the knowledge of structure, functional relationship of proteins and nucleic acids.
3. Aware about the basic cellular processes such as transcription, translation, DNA replication and repair mechanisms.

Content	Hrs
Unit–I - Molecular basis of life and Nucleic Acids An introduction to DNA, experimental proof of DNA and RNA as genetic material and types of DNA and RNA, Structure and functions of DNA and RNA, forms of DNA (A and Z)	**14 Hrs**
Unit -II - DNA Replication and Repair Replication of DNA in prokaryotes and eukaryote– Enzymes and proteins involved in replication, Theta model, linear and rolling circle model. The replication complex: Pre-primming proteins, primosome, replisome, unique aspects of eukaryotic chromosome replication, Fidelity of replication DNA damage and Repair mechanism: photo reactivation, excision repair, mismatch repair and SOS repair.	**14 Hrs**
Unit -III - Transcription and RNA processing Central dogma, Transcription in prokaryotes RNA polymerase, role of sigma factor, promoter, Initiation, elongation and termination of RNA chains. Transcription in eukaryotes: Eukaryotic RNA polymerases, transcription factors, promoters, enhancers, mechanism of transcription initiation, promoter clearance and elongation RNA splicing and processing: processing of pre-mRNA: 5' cap formation, polyadenylation, splicing, rRNA and tRNA splicing.	14 Hrs

Unit –IV - Regulation of gene expression and translation Genetic code and its characteristics, Wobble hypothesis, Translation- in prokaryotes and eukaryotes- ribosome, enzymes and factors involved in translation. Mechanism of translation- activation of amino acid, aminoacyl tRNA synthesis, Mechanism- initiation, elongation and termination of polypeptide chain. Fidelity of translation, Inhibitors of translation. Post translational modifications of proteins, Gene Regulation-Lac and trp operon.	14 Hrs

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs 1-12)

Course Outcomes (COs) / Program Outcomes (POs)	Program Outcomes (POs)											
	1	2	3	4	5	6	7	8	9	10	11	12
Study the advancements in molecular biology with latest trends	✓				✓							✓
Will acquire the knowledge of structure, functional relationship of proteins and nucleic acids					✓	✓						✓
Aware about the basic cellular processes such as transcription, translation, DNA replication and repair mechanisms	✓				✓				✓			✓

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	**Molecular Biology**		Practical Credits	**2**
Course No.	**BTC: 104**	**DSC-4P**	Contact hours	
Content				

1. Preparation of DNA model
2. Estimation of DNA by DPA method
3. Estimation of RNA by Orcinol method
4. Column chromatography – gel filtration (Demo)
5. Extraction and partial purification of protein from plant source by Ammoniumsulphate precipitation.
6. Extraction and partial purification of protein from animal source by organic solvents.
7. Protein separation by SDS-Polyacrylamide Gel Electrophoresis (PAGE)
8. Charts on- Conjugation, Transformation and Transduction, DNA replication, Types of RNA

Practical assessment

Assessment			
Formative assessment		**Summative Assessment**	**Total Marks**
Assessment Occasion / type	**Weightage in Marks**	**Practical Exam**	
Record	5		
Test	10		

Attendance	5	25	**50**
Performance	5		
Total	**25**	**25**	

References	
1	Glick, B.R and Pasternak J.J (1998) Molecular biotechnology, Principles and application of recombinant DNA, Washington D.C. ASM press
2	Howe. C. (1995) Gene cloning and manipulation, Cambridge University Press, USA
3	Lewin, B., Gene VI New York, Oxford University Press
4	Rigby, P.W.J. (1987) Genetic Engineering Academic Press Inc. Florida, USA
5	Sambrook et al (2000) Molecular cloning Volumes I, II & III, Cold spring Harbor Laboratory Press New York, USA
6	Walker J. M. and Ging old, E.B. (1983) Molecular Biology & Biotechnology (Indian Edition) Royal Society of Chemistry U.K
7	Karp. G (2002) Cell & Molecular Biology, 3rdEdition, John Wiley & Sons; I

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BENGALURU NORTH UNIVERSITY

Program Name	**BSc Biotechnology**		Semester	**Fourth Sem**
Course Title	**Intellectual Property Rights**			
Course Code		**OE-4**	No. of Theory Credits	**3**
Contact hours	**Lecture**		Duration of ESA/Exam	**2.5 Hours**
	Practical			
Formative Assessment Marks			Summative Assessment Marks	

Course Pre-requisite(s): Semester I and II of composite Home Science.

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

1. Knowledge about need and scope of Intellectual property rights
2. Acquire knowledge about filing patents, process, and infringement
3. Knowledge about trademarks, industrial designs, and copyright

Content	45 Hrs
Unit–I - Introduction to Intellectual property rights (IPR): Genesis and scope. Types of Intellectual property rights - Patent, Trademarks, Copyright, Design, Trade secret, Geographical indicators, Plant variety protection. National and International agencies – WIPO, World Trade Organization (WTO), Trade-Related Aspects of Intellectual Property Rights (TRIPS), General Agreement on Tariffs and Trade (GATT).	**14 Hrs**
Unit -II - Patenting, process, and infringement Basics of patents - Types of patents; Patentable and Non-Patentable inventions, Process and Product patent. Indian Patent Act 1970; Recent amendments; Patent Cooperation Treaty (PCT) and implications. Process of patenting. Types of patent applications: Provisional and complete specifications; Concept of "prior art", patent databases (USPTO, EPO, India). Financial assistance, schemes, and grants for patenting. Patent infringement- Case studies on patents (Basmati rice, Turmeric, Neem)	**14 Hrs**
Unit -III - Trademarks, Copy right, industrial Designs Trademarks- types, Purpose and function of trademarks, trademark registration, Protection of trademark. Copy right- Fundamentals of copyright law, Originality of material, rights of reproduction, industrial Designs: Protection, Kind of protection provided by industrial design.	**14 Hrs**

Pedagogy

Summative assessment = 40 marks theory paper, End semester Exam duration of exam 2 hours	
Formative Assessment Occasion / type	Weightage in Marks
Assignment	10
Seminar	10
Case studies	10
Test	10
Total	40 marks

References

1. Manish Arora. 2007. Universal's Guide to Patents Law (English) 4th Edition) -Publisher: Universal Law Publishing House
2. Kalyan C. Kankanala. 2012. Fundamentals of Intellectual Property. Asia Law House
3. Ganguli, P. 2001. Intellectual Property Rights: Unleashing the knowledge economy. New Delhi: Tata McGraw-Hill Pub
4. World trade organization - http://www.wto.org
5. World Intellectual Property organization – www.wipo.intOffice of the controller general of Patents, Design &

Dr. Rekha Sethi
Chairperson
Board of Studies
Microbiology and Biotechnology (UG-NEP)
Bengaluru North University, Kolar

BENGALURU NORTH UNIVERSITY

Curriculum Framework for Four-Year Undergraduate Multidisciplinary Programme (Honours) in Colleges Affiliated to Bengaluru North University, under NEP 2020.

3rd and 4th Semester Syllabus

for UG Program in

MIRCRO BIOLOGY

Submitted to

The Vice Chancellor
Bengaluru North University

Submitted by

Dr. Rekha Sethi
CHAIRMAN BOARD OF STUDIES
MICROBIOLOGY & BIOTECHNOLOGY (UG-NEP)
&
MEMBERS OF THE BOS
MICROBIOLOGY AND BIOTECHNOLOGY

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BENGALURU NORTH UNIVERSITY

Program Name	**B.Sc. Discipline**	Total Credits for the Program	**176**
Core	**Microbiology**	Starting year of implementation	**2021-22**

Program Outcomes: At the end of the program the student should be able to:

(Refer to literature on outcome-based education (OBE) for details on Program Outcomes)

PO1. Knowledge and understanding of concepts of microbiology and its application in pharma, food,agriculture, beverages, nutraceutical industries.

PO2. Understand the distribution, morphology and physiology of microorganisms and demonstrate theskills in aseptic handling of microbes including isolation, identification and maintenance

PO3. Competent to apply the knowledge gained for conserving the environment and resolving the environmental related issues.

PO4. Learning and practicing professional skills in handling microbes and contaminants in laboratories andproduction sectors.

PO5. Exploring the microbial world and analyzing the specific benefits and challenges.

PO6. Applying the knowledge acquired to undertake studies and identify specific remedial measures forthe challenges in health, agriculture, and food sectors.

PO7. Thorough knowledge and application of good laboratory and good manufacturing practices in microbial quality control.

PO8. Understanding biochemical and physiological aspects of microbes and developing broader perspective to identify innovative solutions for present and future challenges posed by microbes.

PO9. Understanding and application of microbial principles in forensic and working knowledge aboutclinical microbiology.

PO10. Demonstrate the ability to identify ethical issues related to recombinant DNA technology, GMOs, intellectual property rights, biosafety and biohazards.

PO11. Demonstrate the ability to identify key questions in microbiological research, optimize research methods, and analyze outcomes by adopting scientific methods, thereby improving the employability.

PO12. Enhance and demonstrate analytical skills and apply basic computational and statistical techniques in the field of microbiology.

Assessment:

Weight age for assessments (in percentage)

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

Contents of Courses for B.Sc. Microbiology as Major

Model II A

Semester	Course code	Course Category	Theory/Practical	Credits	Paper Title	Marks	
						S.A	I.A
3.	MBL-103	DSC- 7	Theory	4	Microbial Diversity	60	40
			Practical	2	Microbial Diversity	25	25
		OE- 3	Theory	3	Microbial Entrepreneurship	60	40
4.	MBL-104	DSC- 8	Theory	3	Microbial Enzymology and Metabolism	25	25
			Practical	2	Microbial Enzymology and Metabolism	60	40
		OE- 4	Theory	3	Human Microbiome	25	25

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Program Name	*BSc Microbiology*		Semester	**Third Sem**
Course Title	**Microbial Diversity**			
Course No.	**MBL-103**	**DCS -3T**	No. of Theory Credits	**4**
Contact hours	**56hrs**		Duration of ESA/Exam	**Hours**
Formative Assessment Marks			Summative Assessment Marks	

Course Pre-requisite (s):.

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

1. Knowledge about microbes and their diversity
2. Study, characters, classification and economic importance of Pro-eukaryotic and Eukaryotic microbes.
3. Knowledge about viruses and their diversity

Content	Hrs
Unit–I	**06 Hrs**
Biodiversity and Microbial Diversity Concept, definition, and levels of biodiversity; Biosystematics – Major classification systems- Numerical and Chemotaxonomy. Study and measures of microbial diversity; Conservation and Economic values of microbial diversity.	
Unit -II	
Diversity of Prokaryotic Microorganisms General characters; Classification; Economic importance; Distribution and factors regulating distribution. **Bacteria and Archaea-** An overview of Bergey's Manual of Systematic Bacteriology.**Bacteria-** *Escherichia coli, Bacillus subtilis, Staphylococcus aureus* **Cyanobacteria-** *Nostoc, Microcystis, Spirulina* **Archea***Thermusaquaticus,* Methanogens **Actinomycetes:** *Streptomyces, Nocordia, Frankia* **Rickettsiae-** *Rickettsia rickettsi* **Chlamydiae –** *Chlamydia trachomatis* **Spirochaetes-** *Trepanemapallidum* **Mycoplasma –** *An overview*	
Unit -III	
Diversity of Eukaryotic Microorganism **Diversity of Eukaryotic Microorganism**: General characters; Classification- Economic importance **Fungi:** Ainsworth classification- detailed study up to the level of classes, Salient features and reproduction. Type study: *Rhizopus, Saccharomyces, Aspergillus, Fusarium*	

Algae: Occurrence, distribution, and symbiotic association- Lichen; thallus organization and types. Type study: *Chlorella,,* Diatoms,*Gracilaraia,* **Protozoa:** Classification up to the level of classes. Type study: *Amoeba, Euglena, Trichomonas, Paramoecium,*	
Unit -IV	
Diversity of Virus General properties and structure, Isolation and purification and assay of virus. Principles of Viral Taxonomy- Baltimore and ICTV and the recent trends. Capsid symmetry- Icosahedral, helical, complex **Animal:** HIV, Corona, Ortho and paramyxovirus **Plants:** TMV, Ring spot virus **Microbial:** T4/lambda/cyano/mycophages. Sub viral particles. Virans and Prions. Ortho and Paramyxo Virus. Oncogenic Virus.	

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs 1-12)

Course Outcomes (COs) / Program Outcomes (POs)	Program Outcomes (POs)											
	1	2	3	4	5	6	7	8	9	10	11	12
Knowledge about microbes and their diversity		✓			✓			✓				
Study, characters, classification and economic importance of Pro-eukaryotic and Eukaryotic microbes		✓	✓		✓							
Knowledge about viruses and their diversity		✓				✓				✓		

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	**Microbial Diversity**		Practical Credits	2
Course No.	**MBL-103**	**DSC-4P**	Contact hours	

Content

1. Study of morphology of bacteria
2. Isolation of bacteria from soil
3. Isolation of bacteria from air and water
4. Isolation of fungi from soil
5. Isolation of fungi from air
6. Cultivation of Cyanobacteria
7. Cultivation of actinomycetes
8. Measurement of microbial cell size by Micrometry
9. Cyanobacteria Nostoc, MicrocyctisSpirulina
10. Study of Algae Chlorella Diatoms, Gracilaria
11. Study of Fungi Rhizopus Saccharomyces Agaricus
12. Study of Protozoa Amoeba Paramoecium Euglena
13. Study of Photographs or Models of HIV, TMV, Corona virus T4 Phage, Paramyxovirus, Oncogenic viruses

Practical assessment

Assessment			
Formative assessment		**Summative Assessment**	**Total Marks**
Assessment Occasion / type	**Weightage in Marks**	**Practical Exam**	
Record	5	25	**50**
Test	10		
Attendance	5		
Performance	5		
Total	**25**	**25**	

References	
1	Black, J.G. 2002. Microbiology-Principles and Explorations. John Wiley and Sons, Inc. New York
2	Brock, T.D. and Madigan, M.T. 1988. Biology of Microorganisms, V Edition. Prentice Hall. New Jersey
3	Dimmock, N. J., Easton, A. J., and Leppard, K. N. 2001. Introduction to Modern Virology. 5thedn. Blackwell publishing, USA
4	Flint, S.J., Enquist, L.W., Drug, R.M., Racaniello, V.R. and Skalka, A.M. 2000. Principles of Virology- Molecular Biology, Pathogenesis and Control. ASM Press, Washington, D.C
5	Prescott, Harley, Klein's Microbiology, J.M. Willey, L.M. Sherwood, C.J. Woolverton, 7th International, edition 2008, McGraw Hill
6	Vashishta B.R, Sinha A.K and Singh V. P. Botany – Fungi 2005, S. Chand and Company Limited, New Delhi
7	Kotpal R.L Protozoa 5th Edition 2008, Rastogi Publications, Meerut, New Delhi.
8	Brock Biology of Microorganisms, M.T. Madigan, J.M. Martinko, P. V. Dunlap, D. P. Clark- 12th edition, Pearson International edition 2009, Pearson Benjamin Cummings

References	
9	Microbiology – An Introduction, G. J. Tortora, B. R. Funke, C. L. Case, 10th ed. 2008, Pearson Education
10	General Microbiology, Stanier, Ingraham et al, 4th and 5th edition 1987, Macmillan education limited
11	Microbiology- Concepts and Applications, Pelczar Jr. Chan, Krieg, International ed, McGraw Hill
12	Alexopoulos, C.J., Mims, C.W., and Blackwell, M. 2002. Introductory Mycology. John Wiley and Sons (Asia) Pvt. Ltd. Singapore. 869 pp
13	Vashishta, B.R Sinha A.K and Singh V. P. Botany - Algae 2005 S. Chand and Company Limited, New Delhi
14	A Textbook of Microbiology, R. C. Dubey, and D. K. Maheshwari, 1st edition, 1999, S. Chand & Company Ltd, New Delhi
15	Foundations in Microbiology, K. P. Talaro, 7th International edition 2009, McGraw Hill

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Board of Studies
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Program Name	**BSc Microbiology**		Semester	**Third Sem**
Course Title	**Microbial Entrepreneurship**			
Course Code		**OE-3**	No. of Theory Credits	**3**
Contact hours	**Lecture**		Duration of ESA/Exam	**Hours**
	Practical			
Formative Assessment Marks	**40**		Summative Assessment Marks	**60**

Course Pre-requisite(s):

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

1. Demonstrate entrepreneurial skills
2. Acquire knowledge industrial entrepreneurship
3. Acquire knowledge about Healthcare Entrepreneurship

CONTENT	**42 HRS**
Unit–I	**14 Hrs**
General Entrepreneurship Entrepreneurship and microbial entrepreneurship - Introduction and scope, Business development, product marketing, HRD, Biosafety and Bioethics, IPR and patenting, Government organization/ institutions/ schemes, Opportunities and challenges.	
UNIT -II	**14 HRS**
Industrial Entrepreneurship Microbiological industries – Types, processes and products, Dairy products, Fermented foods, Bakery and Confectionery, Alcoholic products and Beverages, Enzymes – Industrial production and applications. Biofertilizers and Biopesticides, SCP (Mushroom and Spirulina) etc.	
Unit -III -	**14 Hrs**
Healthcare Entrepreneurship Production and applications: Sanitizers, Antiseptic solutions, Polyhenols (Flavonoids), Alkaloids, Cosmetics, Biopigments and Bioplastics, vaccines, Diagnostic tools and kits.	

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**

References	
1.	Vasantha Desai , Appaniah ,Reddy GopalKrishna (2009) ,Entrepreneurship Development Program -Himalaya Publishing House Mumbai
2.	L.E.Casida .J.R (2005) ,Industrial Microbiology Published by New Age International Pvt Limited -New Delhi
3.	LansingM.Prescott,John P.Harley, and Donald A.Klein (2005), Microbiology Published by Mc Graw Hill Companies Inc,1221 Avenue of the Americas ,NewYork.
4.	Michael.J.Pelczar,J.R,E.C.S.Chan,Noel.R.Krieg(2006),Microbiology, Published by Tata McGraw-Hill Ltd New Delhi
5.	Ananthanarayana and Paniker's (2006) , ATB of Microbiology Published by Orient Longman .Hyderabad

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Program Name	**BSc Microbiology**		Semester	**Fourth Sem**
Course Title	**Microbial Enzymology and Metabolism**			
Course No.	**MBL:104**	**DCS -4T**	No. of Theory Credits	**4**
Contact hours	**56 hrs**		Duration of ESA/Exam	**2 ½ Hours**
Formative Assessment Marks	**40**		Summative Assessment Marks	**60**

Course Pre-requisite (s):.

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

1. Differentiating concepts of chemoheterotrophic metabolim and chemolithotrophic metabolism.
2. Describing the enzyme kinetics, enzyme activity and regulation.
3. Differentiating concepts of aerobic and anaerobic respiration and how these are manifested in the form of different metabolic pathways in microorganisms

Content	**56 Hrs**
Unit–I	**14 Hrs**

Metabolism of Carbohydrates

Chemoheterotrophic Metabolism- Anaerobic respiration and fermentation

Concept of aerobic respiration, anaerobic respiration and fermentation. Sugar degradation pathways i.e. EMP, ED, Pentose phosphate pathway, Phosphoketolase pathway. TCA cycle.

Fermentation - Fermentation balance, concept of linear and branched fermentation pathways. Fermentation pathways: Alcohol fermentation and Pasteur effect; Butyric acid and Butanol-Acetone Fermentation, Mixed acid and 2,3-butanediol fermentation, Propionic acid Fermentation (Succinate pathway and Acrylate pathway), acetate Fermentation

Chemolithotrophic Metabolism:Chemolithotrophy - Hydrogen oxidation, Sulphur oxidation, Iron oxidation, Nitrogen oxidation.

Anaerobic respiration with special reference to disimilatory nitrate reduction and sulphate reduction.

Unit -II	14 Hrs
. **Metabolism of aminoacids, nucleotides and lipids** **1.Nitrogen Metabolism** Introduction to biological nitrogen fixation Ammonia assimilation. Assimilatory nitrate reduction, dissimilatory nitrate reduction, denitrification **2. Biosynthesis of ribonucleotides and deoxyribonucleotides** The de novo pathway. Regulation by feedback mechanisms. Recycling via the salvage pathway **3. Amino acid degradation and biosynthesis** **4. Lipid degradation and biosynthesis** **5.Metabolism of one carbon compounds:**Methylotrophs :i. Oxidation of methane, methanol, methylamines; ii. Carbon assimilation in methylotrophic bacteria and yeasts Methanogens: i. Methanogenesis from H_2, CO_2, CHOH, HCOOH, methylamines; ii. Energy coupling and biosynthesis in methanogenic bacteria Acetogens: Autotrophic pathway of acetate synthesis **6. Metabolism of two-carbon compounds:Acetate**: i. Glyoxylate cycle. **Acetic acid bacteria**: Ethanol oxidation, sugar alcohol oxidation. **Glyoxylate and glycolate metabolism**:i. Dicarboxylic acid cycle, ii. Glycerate pathway iii. Beta hydroxyaspartate pathway **Oxalate** as carbon and energy source	
Unit -III	**14 Hrs**
Basics of Enzymes **Definitions of terms** – enzyme unit, specific activity and turnover number, exo/ endoenzymes, constitutive/ induced enzymes, isozymes. Monomeric, Oligomeric and Multimeric enzymes. Multienzyme complex: pyruvate dehydrogenase; isozyme: lactate dehydrogenase. Ribozymes, abzymes **Structure of enzyme**: Apoenzyme and cofactors, prosthetic group-TPP, coenzyme, NAD, metal cofactors. Classification of enzymes, Mechanism of action of enzymes: active site, transition state complex and activation energy. Lock and key hypothesis and Induced Fit hypothesis. Multisubstrate reactions -Ordered, Random, Ping-pong. **Enzyme catalysis:**Catalytic mechanisms with type examples, catalytic mechanisms and testing - Serine proteases and Lysozyme	

Unit –IV	14 Hrs
Enzyme Kinetics and Regulation Enzyme Kinetics: Kinetics of one substrate reactions. i. Equilibrium assumptions ii. Steady state assumptions iii. Lineweaver-Burk, Hanes-Woolf, Eadie-Hofstee equations and plots.Kinetics of enzyme inhibition. Competitive, non-competitive and uncompetitive inhibition.Effect of changes in pH and temperature on enzyme catalysed reaction.Kinetics of two substrate reactions. Pre steady state kinetics. Kinetics of immobilized enzymes Enzyme regulation:Allosteric enzyme - general properties, Hill equation, KoshlandNemethy and Filmer model, Monod Wyman and Changeux model. Covalent modification by various mechanisms. Regulation by proteolytic cleavage - blood coagulation cascade. Regulation of multi-enzyme complex- Pyruvate dehydrogenase. Feedback inhibition.HIV enzyme inhibitors and drug design	

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs 1-12)

Course Outcomes (COs) / Program Outcomes (POs)	Program Outcomes (POs)											
	1	2	3	4	5	6	7	8	9	10	11	12
Differentiating concepts of chemoheterotrophic metabolim and chemolithotrophic metabolism		✓						✓			✓	
Describing the enzyme kinetics, enzyme activity and regulation.		✓						✓			✓	
Differentiating concepts of aerobic and anaerobic respiration and how these are manifested in the form of different metabolic pathways in microorganisms		✓						✓			✓	

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	**Microbial Enzymology and Metabolism**		Practical Credits	**2**
Course No.	**MBL:104**	**DSC-4P**	Contact hours	

Content

1. Handling of micropipettes and checking their accuracy
2. Isolation of cholesterol and lecithin from egg yolk
3. Identification of fatty acids and other lipids by TLC
4. Determination of degree of unsaturation of fats and oils
5. Isolation of lactose from bovine milk
6. Estimation of total sugars by the phenol-sulphuric acid method
7. Estimation of DNA - DPA method & UV absorbance method
8. Estimation of RNA (Orcinol method)
9. Isolation of glutamic acid from gluten
10. Chemotaxis of *Pseudomonas*
11. Demonstration of alcoholic fermentation
12. Effect of variables on enzyme activity (amylase): a. Temperature b. pH c. substrate concentration d. Enzyme concentration e. Determination of Km of amylase (Lineweaver-Burke plot; Michaelis-Menton graph)

Practical assessment

Assessment			
Formative assessment		Summative Assessment	Total Marks
Assessment Occasion / type	Weightage in Marks	Practical Exam	
Record	5	25	50
Test	10		
Attendance	5		
Performance	5		
Total	25	25	

References

1	Philipp. G. Mannual of Methods for General Bacteriology.
2	David T. Plummer. An Introduction to Practical Biochemistry
3	Biochemistry- A Problem Approach, Wood W. B. Wilson J.H., Benbow R.M. and Hood L.E.2nd ed., 1981, The Benjamin/ Cummings Pub.co
4	Biochemical calculations, Segel I.R., 2nd ed., 2004, John Wiley and Sons
5	Biochemical Calculations, Irwin H. Segel, 2nd Edition John Wiley & Sons

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Program Name	**BSc Microbiology**		Semester	**Fourth Sem**
Course Title	**Human Microbiome**			
Course Code		**OE-4T**	No. of Theory Credits	**3**
Contact hours	**Lecture**		Duration of ESA/Exam	**Hours**
	Practical			
Formative Assessment Marks	**40**		Summative Assessment Marks	**60**

Course Pre-requisite(s):

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

1. Articulate a deeper understanding on biological complexities of human micro biome.
2. Understand broader goals of biological anthropology.
3. Compare and contrast the microbiome of different human body sites and impact human health promotion

Content	**45 Hrs**
Unit–I	**14 Hrs**
INTRODUCTION TO MICROBIOME Evolution of microbial life on Earth, Symbiosis host-bacteria . Microbial association with plants and animals, Symbiotic and parasitic, Normal human microbiota and their role in heatlh. Microbiomes other than digestive system.	
Unit -II	**14 Hrs**
MICROBIOMES AND HUMAN HEALTH Microbiome in early life, Nutritonal modulation of the gut microbiome for metabolic health- role of gut mocrobiomes in human obesity, human type 2 diabetes and longevity. Probiotics-Criteria for probiotics, Development of Probiotics for animal and human use; Pre and synbiotics. Functional foods-health claims and benefits, Development of unctional foods.	

Unit -III	14 Hrs
CULTURING OF MICROBES FROM MICROBIOMES Culturing organisms of interest from the microbiome : bacterial, archaeal, fungal, and yeast, viral. Immunity-Different types, Vaccines	

Pedagogy

Summative assessment = 40 marks theory paper,End semester Exam duration of exam 2 hours	
Formative Assessment Occasion / type	**Weightage in Marks**
Assignment	10
Seminar	10
Case studies	10
Test	10
Total	**40 marks**

References	
1	LansingM.Prescott,John P.Harley, and Donald A.Klein (2005), Microbiology Published by Mc Graw Hill Companies Inc,1221 Avenue of the Americas ,NewYork.
2	Michael.J.Pelczar,J.R,E.C.S.Chan,Noel.R.Krieg(2006),Microbiology, Published by Tata McGraw-Hill Ltd New Delhi
3	Ananthanarayana and Paniker's (2006) , ATB of Microbiology Published by Orient Longman .Hyderabad
4	Jawetz, Melnick & Adelberg's , 26th Edition Medical Mirobiology, published by Mc Graw Hill Companies Inc,1221 Avenue of the Americas ,NewYork.
5	R.C Dubey (2012), A textbook of Microbiology published by S Chand and Company P Ltd, New Delhi - 55

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