VUNIVERSITY UNIVERSITY

Re-accredited with **'A++' GRADE with 3.79/4 CGPA** by NAAC
Recognized by UGC as College of Excellence

DEPARTMENT OF BIOTECHNOLOGY

SYLLABUS FOR UNDERGRADUATE PROGRAMME

(AS PER NEP 2021)

For Batch 2023

Part A			
1	Title of the Academic Program	BSc Biotechnology (Major)	
2	Program Code	**CBT, ZBT,BBT(Biotechnology with Chemistry, Botany and Zoology)**	
3	Name of the College	St. Joseph's College (Autonomous)	
4	Objectives of the College	1. Academic Excellence 2. Character Formation 3. Social Concern	
5	Vision of the College	"Striving for a just, secular, democratic and economically sound society, which cares for the poor, the oppressed and the marginalized"	
6	Mission of the College	M1	St. Joseph's College (Autonomous) seeks to form men and women who will be agents of change, committed to the creation of a society that is just, secular and democratic.
		M2	The education offered is oriented towards enabling students to strive for both academic and human excellence.
		M3	The college pursues academic excellence by providing a learning environment that constantly challenges the students and supports the ethical pursuit of intellectual curiosity and ceaseless enquiry.
		M4	Human excellence is promoted through courses and activities that help students achieve personal integrity and conscientize them to the injustice prevalent in society.
7	Name of the Degree	Bachelor of Science (B.Sc.,)	
8	Name of the Department offering the program	Biotechnology	
9	Vision of the Department offering the program	The Department of Biotechnology strives to introduce students to the joys of learning science, to inspire them to enquire, imagine and excel, and equip them to integrate this learning into living.	
10	Mission of the department offering the Program	• The Department of Biotechnology, through its curricular and research based pedagogical approaches, aims to engage students in conversations about basic concepts and advances in the field of Biotechnology. • The Departments strives to provide students with authentic learning experiences that encompass a spirit of enquiry, research, problem-solving and entrepreneurship. • The Department is also invested in creating among its students a strong awareness of social and environmental problems at both local and global scales, mentoring them to identify meaningful academic and career opportunities, whilst inculcating them a strong sense of academic and personal integrity.	
11	Duration of the Program	3 years (Six semesters)	
12	Total No. of Credits	TO BE ANNOUNCED	
13	Program Educational Objectives (PEOs)	PEO 1	The two major program of Biotechnology with a combination of Chemistry, Zoology and Botany gives students insights into basic and applied aspects of these disciplines, besides equipping them with hands-on laboratory skills and the ability to analyse information based on scientific evidence, while also instilling an awareness of scientific engagement in addressing relevant social

			and environmental issues that affect humankind.
		PEO 2	
		PEO 3	
14	Graduation Attributes		The Following graduate attributes reflect the particular quality and feature or characteristics of an individual, that are expected to be acquired by a graduate through studies at St. Joseph's College. • **Disciplinary knowledge** • **Analytical reasoning** • **Critical thinking** • **Problem solving** • **Communication Skills** • **Research skills** • **Cooperation/Teamwork** • **Reflective thinking** • **Information/digital literacy** • **Self-directed learning** • **Multicultural competence** • **Moral and ethical awareness/reasoning** • **Leadership readiness/qualities** • **Global Outlook**
15	Program Outcomes (POs)	PO1	
		PO2	
		PO3	
		PO4	
16	Program Specific Outcomes (PSOs)	PSO1	Students graduating from the Biotechnology program will gain an understanding of the cellular, genetic, biochemical, and molecular foundations of life, besides attaining domain knowledge of biostatistics, bioinformatics, and immunology as well as applied aspects of biotechnology including genetic engineering, medical, environmental, plant and animal biotechnology, and entrepreneurship.
		PSO2	Students will achieve competency in a variety of laboratory skills including techniques in cell and molecular biology, microbiology, genetic engineering and applied biotechnological aspects, through hands on practical experience and practice, while consistently observing good laboratory practice.
		PSO3	Students will gain exposure to the basics of research, and have an appreciation of research methodology, through faculty supervised term papers and research projects.
		PSO4	The program will enable students to hone their skills of analytical thinking and problem solving, through a series of curricular and research-based pedagogical interventions.
		PSO5	Students will also learn and build on proficiencies in science communication, teamwork and collaboration, enabled by regular innovative assignments and activities.
		PSO6	The program will foster an appreciation of environmental, health associated and sustainability related issues at local and global scales, and the role of scientific acumen and evidence-based engagement in understanding and addressing these problems.

Part B

Si.No	Course details	Credits
1.	Biotechnology	6
2.	Botany /Zoology/Chemistry	6
3.	Open Elective	3
4.	Language 1	3
5.	Language 2	3
6.	Skill based crédits	2
7.	Value based crédits	2

DEPARTMENT OF BIOTECHNOLOGY (UG)
(2021-2024)

Semester 1	Code Number	Title	No. of Hours of Instructions	Number of Hours of teaching per week	Number of credits	Continuous Internal Assessment (CIA) marks	End Semester Marks	Total marks
Theory	BT121	Cell biology and Genetics	56	4	4	40	60	100
Practical	BTP121	Cell biology and Genetics	44	4	2	25	25	50
Open elective		Biotechnology for human welfare	42	3	3	40	60	100
Total Number of credits:					**9**			
Semester 2	Code Number	Title	No. of Hours of Instructions	Number of teaching hrs /week	Number of credits	Continuous Internal Assessment (CIA) marks	End Semester Marks	Total marks
Theory	BT221	Microbiological methods	56	4	4	40	60	100
Practical	BTP221	Microbiological methods	44	4	2	25	25	50
Open elective		Sustainable Agriculture and food security	42	3	3	40	60	100
Total Number of credits:					**9**			

SUMMARY OF CREDITS IN BIOTECHNOLOGY

CORE COURSES (CC)	
Course Title	**Code Number**
Cell Biology and Genetics	BT 121
Microbiological methods	BT 221
DISCIPLINE SPECIFIC ELECTIVE COURSES (DSE)	
Course Title	Code Number
GENERIC ELECTIVE COURSES (GSE)/ Can include open electives offered	
Course Title	Code Number
Biotechnology for human welfare	To be announced
Sustainable Agriculture and food security	To be announced
SKILL ENHANCEMENT COURSE (SEC)	
Course Title	Code Number
VALUE ADDED COURSES (VAC)	
Course Title	Code Number
Online courses offered or recommended by the department to be listed	
Course Title	Code Number

COURSE OUTCOMES AND COURSE CONTENT

Semester	**I**
Paper Code	**BT121**
Paper Title	**Cell Biology and Genetics**
Number of teaching hours per week	**04T + 04P**
Total number of teaching hours per semester	**56**
Number of credits	**04 + 2 (T+P)**

Objective of the Paper: This course introduces students to the structural and functional foundations of prokaryotic and eukaryotic cells and teaches the basics of Mendelian and Population Genetics. The Cell Biology section deals with cellular and organellar structure and function, besides dealing with the molecular events in cell communication and the cell cycle. The Genetics section of the course deals exhaustively with Mendelian genetics and provides an introduction to human genetics.

Unit1: Cell as a Basic unit of Living Systems and Cellular Organelles	14Hrs
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, Cytosol and Cytoskeleton structures (Microtubules, Microfilaments and Intermediate filaments).	
Unit2. Chromosomes and Cell Division	14Hrs
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 Lamp-brushchromosomes. Cell cycle, phases of cell division,mitosis and meiosis, cell cycle check points, enzymes involved in regulation, cell signaling, cell communications, significance of cell cycle, achromatic apparatus, synaptonemal complex, cell Senescence and programmed cell death.	
Unit3. Genetics:	14Hrs
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.	

Unit4. Linkage And Mutation	14Hrs
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'ssyndrome), Autosomal (Down syndrome and Cri-Du-Chat Syndrome)conditions.	

Practical I BTP121: Cell Biology and Genetics

1) Operation and working principle of simple and compound microscope
2) Use of Micrometer,measurement of onion epidermal cells and yeast
3) Study of mitosis from onion root tips
4) Study of meiosis in grasshopper testes/onion or Rhoeo flower buds.
5) Mounting of polytene chromosomes
6) Buccal smear - Barr bodies
7) Karyotype analysis - Human (Normal and Abnormal) and Onion
8) Isolation and staining of Mitochondria/ Chloroplast
9) Enumeration of RBC using Haemocytometer
10) Simple genetic problems based on theory
11) Blood typing

Text Books / References

Reference:

1. Molecular Biology of Cell - Bruce Alberts et al, Garland publications.
2. Animal Cytology and Evolution- MJD, White Cambridge University Publications
3. Molecular Cell Biology-Daniel, Scientific American Books
4. Cell Biology - Jack d Bruke, The William Twilkins Company
5. Principles of Gene Manipulations- Old & Primrose, Black Well Scientific Publications
6. Cell Biology-Ambrose &Dorothy M Easty, ELBS Publications
7. Fundamentals of Cytology- L. W. Sharp, McGraw Hill Company
8. Cytology-Willson&Marrison, Reinform Publications
9. Molecular Biology- Christopher Smith, Faber & Faber Publications
10. Cell Biology & Molecular Biology – EDP De Robertis& EMF Robertis, Saunder College.
11. Cell Biology- C.B Powar, Himalaya Publications
12. Basic Genetics- Daniel L. Hartl, Jones &Barlett Publishers USA
13. Human Genetics and Medicine lark Edward Arnold P London
14. Genetics – Monroe W Strickberger, Macmillain Publishers, New York
15. Genes V - Benjamin Lewin, Oxford University Press.
16. Genes I - Benjamin Lewin, Wiley Eastern Ltd., Delhi
17. Genes II - Benjamin Lewin, Wiley & Sons Publications
18. Genes III- Benjamin Lewin, Wiley & Sons Publications
19. Principles of Genetics- Sinnott, L.C. Dunn, Dobzhansky, McGraw-Hill.
20. Genetics – Edgar Altenburg Oxford & IBH publications

21. Principles of Genetics – E.J. Gardener, M.J. Simmons and D.P. Snustad, John Wiley & Son Publications
22. Genetics- P.K.Gupta, Rastogi Publication, Meert, India.

COURSE OUTCOMES FOR BT121: CELL BIOLOGY AND GENETICS

After successful completion of the course, students will:

CO1	Gain a nuanced understanding of cellular architecture and diversity of prokaryotic and eukaryotic cells, as well as insights into the ultrastructure, and roles of cellular organelles in various cellular functions.
CO2	Develop a deeper appreciation for the complexity and intricacy of cellular structure and function, and be able to form cross disciplinary connections relevant to cell structure and function.
CO3	Have a profound understanding of concepts in classical genetics and its exceptions, as well as a basic knowledge of population genetics and applications of linkage in quantitative genetics.
CO4	Be able to perform a variety of laboratory techniques routinely used for counting, staining and visualizing cells, be able to prepare and identify stages in mitotic and meiotic slides and answer questions pertaining to karyotypes and model organisms.
CO5	Achieve competence in undergraduate level problem solving skills relevant to the disciplines of cell biology and genetics.

OPEN ELECTIVE- SEM I : Biotechnology for Human Welfare

OPEN ELECTIVE: Biotechnology for Human Welfare	**42Hrs**
Unit1: Industry	**10Hrs**
An overviewof application of biotechnology in industry; Enzymes for textile industry, breweries and food food supplements: single cell proteins, vitamins. food processing:cheese, yoghurt making, Biodegradable plastics,biofuels.	
Unit 2: Environment	**8Hrs**
Application of biotechnology in environmental aspects:Waste management, biodegradation of heavy metals,water cleaning, removing of oil spills, bioremediation, air and soil pollution and biomining.	
Unit3: Forensic science and health	**14Hrs**
Forensic science: Application of biotechnology in forensic science: Solving crimes by using DNA finger printing techniques **Health** Antibiotic production, molecular diagnostics, Vaccines and vaccine delivery, recombinant therapeutics- Insulin, gene therapy. human genome project	
Unit 4: Application in livestock improvement	**10Hrs**
Transgenic animals, clones, Animal vaccine production, increased milk production, artificial Insemination, poultry and fisheries.	

Reference:

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

COURSE OUTCOMES AND COURSE CONTENT

Semester	**II**
Paper Code	**BT221**
Paper Title	**Microbiological methods**
Number of teaching hours per week	**04T + 04P**
Total number of teaching hours per semester	**56**
Number of credits	**04 + 2 (T+P)**

Objective of the Paper:

This paper aims to introduce students to basic concepts in Microbiology, with key emphasis on instrumentation and analytical techniques used in microbial laboratories. The course also covers key concepts inantimicrobial agents and assessment of antimicrobial activity, besides providing opportunities for hands on experiments involving isolation, culturing, control and study of microorganisms.

Content of Course: DSC-2T, Microbiological Methods	**56 Hrs**
Unit 1:Instrumentation	**14Hrs**
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 principles and applications: Centrifuge, Ultracentrifuge, Spectrophotometer, Chromatography: Paper and TLC.	
Unit 2: Sterilization techniques	**14Hrs**
Definition of terms; **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- UVrays **Chemical methods:** Alcohol, aldehydes, phenols, halogen, metallic salts, Quaternary ammonium compounds and sterilizing gases as antimicrobial agents.	
Unit 3: Microbiological techniques	**14Hrs**
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	**14Hrs**

Mode of action of antimicrobial agents: Antifungal agents: Amphotericin B, Griseofulvin Antiviral agents: Amantadine, Acyclovir, Azidothymidine Antibacterial agents: Plazomicin, Ervacycline, Omadacyclin and Imipenum. Challenges in antimicrobial therapy; Emergence of antibiotic resistance (MDR, XDR) **Assessment of antimicrobial activity:** Antibacterial-Disc and agar well diffusion techniques, Microdilution method, Zone of inhibition, MCB, Determination of IC 50. Antifungal-Determination of MFC, Time kill kinetics assay, sorbitol assay. Antiviral-CPE, virus yield reduction assay, TCID, Neutralization ASSAY, Hemagglutination inhibition.	

Practical II: BTP221: Microbiological Methods and techniques

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 medium using Autoclave and assessment for sterility
3. Sterilization of glassware 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
    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.

Text Books / References

1. Atlas RM. (1997). Principles of Microbiology. 2nd edition. WM.T. Brown Publishers.
2. Black JG. (2008). Microbiology: Principles and Explorations. 7th edition. Prentice Hall
3. Madigan MT, and Martinko JM. (2014). Brock Biology of Micro-organisms. 14th edition. Parker J. Prentice Hall International, Inc.
4. Pelczar Jr MJ, Chan ECS, and Krieg NR. (2004). Microbiology.
5. 5th edition Tata McGraw Hill.
6. Srivastava S and Srivastava PS. (2003). Understanding Bacteria. Kluwer Academic Publishers, Dordrecht
7. Stanier RY, Ingraham JL, Wheelis ML and Painter PR. (2005). General Microbiology. 5th edition McMillan.
8. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9th edition Pearson Education.
9. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.
10. Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited
11. Microbiology- Concepts and applications by Paul A. Ketchum, Wiley Publications
12. Fundamentals of Microbiology –Frobisher, Saunders & Toppan Publications
13. Introductory Biotechnology-R.B Singh C.B.D. India (1990)

14. Fundamentals of Bacteriology - Salley
15. Frontiers in Microbial technology-P.S. Bison, CBS Publishers.
16. Biotechnology, International Trends of perspectives A. T. Bull, G.
17. General Microbiology –C.B. Powar

COURSE OUTCOMES for BT221: Microbiological Methods

After successful completion of the course, students will:

CO1	Develop an appreciation of the diversity of the microbial world and understand the basic instrumentations used in microbiological laboratories.
CO2	Be able to determine growth parameters in bacteria, understand the basis of molecular interactions and build on them, besides selecting and implementing microbial control methodologies for basic laboratory purposes.
CO3	Acquire competence to design and prepare different culture media, design methodology to isolate and culture microorganisms and have a good grasp of various techniques for identification of bacteria and fungi.
CO4	Have an understanding on how to use antimicrobial agents and perform assessment of antimicrobial activity

OPEN ELECTIVE- 2 sem: Sustainable Agriculture and food security

Course 2 : Theory: Open Elective-Sustainable Agriculture and food security	**42 Hrs**
Unit 1: Food security	**8Hrs**
Current issues: Soil health, pollution, green revolution 2.0, intensive agriculture, climate change, water security, urbanization.	
Unit2: Transgenic plants	**20Hrs**
The GM crop debate – safety, ethics, perception and acceptance of GM crops. GM crops case study: Bt cotton, Bt brinjal 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, Flavors– capsaicin, vanillin. Plants as biofactories for molecular pharming: edible vaccines, plantibodies, nutraceuticals.	
Unit 3: Biopesticides and biofertilizers	**6Hrs**
Biopesticides:Baculovirus Pesticides, Mycopesticides. Biofertilizers: VAM, Nitrogen fixers, phosphate solubilizing bacteria	
Unit 4:Agriculture in the 21st century	**8Hrs**
Precision agriculture, IOT enabled agriculture, micro climate monitoring, Hydroponics, Aeroponics, Aquaponics, plant-based meat, entrepreneurship and small scale bio-enterprises.	

References

1. Chrispeels M.J.et al. Plants, Genes and Agriculture-Jones and Bartlett Publishers, Boston.1994.
2. Gamborg O.L. and Philips G.C.Plant cell, tissue and organ culture (2nd Ed.) Narosa Publishing House. New Delhi.1998
3. Hammound J, P McGravey&Yusibov.V. Plant Biotechnology, Springer verlag.2000
4. Heldt. Plant Biochemistry and Molecular Biology.Oxford and IBH Publishing Co. Pvt.Ltd. Delhi. 1997
5. LydianeKyte and John Kleyn.Plants from test tubes. An introduction to
6. Micropropagation (3 rd. Ed.). Timber Press, Portland. 1996
7. Murray D.R. Advanced methods in plant breeding and biotechnology.Panima Publishing Corporation.1996
8. NickoloffJ.A.Methods in molecular biology, Plant cell electroporation and electrofusion protocols-Humana press incorp, USA. 1995.
9. Prescott, Harley, Klein's Microbiology, J.M. Willey, L.M. Sherwood, C.J. Woolverton, 7th International, edition 2008, McGraw Hill.
10. Foundations in Microbiology, K. P. Talaro, 7th International edition 2009, McGraw Hill.
11. A Textbook of Microbiology, R. C. Dubey and D. K. Maheshwari, 1st edition, 1999, S. Chand & Company Ltd.

Paper pattern-Core papers

Time: 3 hours **Max Marks: 100 marks**

Section A: 2 marks – Answer any 10 – 20 marks (Maximum questions asked -12)
Section B: 7 marks – Answer and 5 – 35 marks(Maximum questions asked -7)
Section C: 15 marks - Answer the following -45 marks
Question 1: (compulsory question)
Question 2: A or B
Question 3: A or B

Open Elective Papers

Time: 2 hours **Max Marks: 60 marks**

Section A: 2 marks – Answer any 10 – 20 marks (Maximum questions asked -12)
Section B: 5 marks – Answer and 4 – 20 marks (Maximum questions asked -6)
Section C: 10 marks – Answer any 2 of the following -20marks (Maximum question asked -3)