SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI

Three Years - Six Semesters Bachelor's Degree Programme

3 Years B.Sc. / 4 Years B.Sc. (Hons.) & 4 Years B.Sc. (Hons. with Research) Programme

Faculty of
Science and Technology
(Science Group)

Subject: Biotechnology

(Semesters I to VI)

Effective from Academic Year 2024-25

(As per NEP 2020)

THREE YEAR UNDERGRADUATE PROGRAMME
B.Sc. BIOTECHNOLOGY
UNDER FACULTY: SCIENCE AND TECHNOLOGY

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Examination, Evaluation and Assessment Scheme

The total marks for each Course shall be based on Continuous Assessment and Semester End Examination. Each theory course of Major, Minor, GE/OE, AEC, IKS, VEC as mentioned in **Teaching Learning Scheme** prepared by the Board of Studies shall be evaluated as per the scheme as mentioned in the following table-

Table: Examination, Evaluation and Assessment Scheme

Vertical No.	The Vertical	Mode of Examination, Evaluation & Assessment	Theory				Theory (Total)		Practical				Practical (Total)	
			External		Internal				External		Internal			
			Max. Marks	Min. Marks	Max. Marks	Min. Marks	Max. Marks	Min. Marks	Max. Marks	Min. Marks	Max. Marks	Min. Marks	Max. Marks	Min. Marks
a	Major	External & Internal	30	9	20	6	50	20	25	10	25	10	50	20
b	Minor		30	9	20	6	50	20	25	10	25	10	50	20
c	Generic/ Open Elective		30	9	20	6	50	20	--	--	--	--	--	--
d	VSC	Internal	--	--	--	--	--	--	--	--	50	20	50	20
	SEC	Internal	--	--	--	--	--	--	--	--	50	20	50	20
e	AEC (Eng. & One MIL Composite)	External & Internal	30	9	20	6	50	20	--	--	--	--	--	--
	IKS (Generic)	External & Internal	30	9	20	6	50	20	--	--	--	--	--	--
	VEC	External & Internal	30	9	20	6	50	20	--	--	--	--	--	--
f	Internship/ Apprenticeship	Internal	Assessment of these verticals shall be based on various activities/practices. It shall be evaluated by giving maximum marks of 50 per 2 Credit Course with separate activity weightages/levels. A detailed SOP for this assessment process shall be prescribed separately.											
	FP/CEP													
	CC													

Assessment criteria for External Practical Course

Sant Gadge baba Amravati University, Amravati

Practical Examination (External)

BSc (Biotechnology) (NEP)

Max Mark: 25 Marks	**Time: 4.00 Hrs**
Q.1. One Major Practical	10M
Q.2. One Minor Practical	5M
Q.3. Spotting	5M
Q.4. External Viva Voce	5M

Assessment criteria for Internal Practical Course

Sant Gadge baba Amravati University, Amravati

Practical Examination (Internal)

BSc Part (Biotechnology) (NEP)

Max Mark: 25 Marks		**Time: 4.00 Hrs**
1.	Assessment criteria 1: Practical Record	5M
2.	Assessment criteria 2: Attendance	5M
3.	Assessment criteria 3: Participation in Any Activities	5M
4.	Assessment criteria 4: Students Overall Performance	5M
5.	Assessment criteria 5: Internal Viva voce	5M

Assessment criteria for Skill Enhancement Course (SEC/VSC)

As Internal Practical Exam

Sant Gadge baba Amravati University, Amravati

Practical Examination (Internal for SEC/VSC)

BSc (Biotechnology) (NEP)

Max Mark: 50 Marks	**Time: 4.00 Hrs**
1. Assessment criteria 1: Performance of any one exercise from the list of experiments.	10M
2. Assessment criteria 2: Spotting	10M
3. Assessment criteria 3: Record & Assignment	10M
4. Assessment criteria 4: Any activity/Field visit/Project	5M
5. Assessment criteria 5: Attendance	5M
6. Assessment criteria 6: Students overall performance	5M
7. Assessment criteria 7: Internal Viva voce	5M

Teaching and Learning Scheme: for the Degree of Bachelor of Biotechnology as Major
Sant Gadge Baba Amravati University, Amravati
FACULTY: SCIENCE AND TECHNOLOGY
Teaching and Learning Scheme: for the Degree of Bachelor of Biotechnology as Major and as Minor
TLE Scheme for FIRST YEAR: SEMESTER – I (BSc I Biotechnology-NEP 2020)

Mode of Teaching	Vertical No.	The Vertical	Type of Course	Course Code	Course Name	Credits	Workload (Hrs/Week)	Vertical workload (Hrs/Week)
Classroom Teaching / Lab Work (Practical)/ Outdoor / Field	a.	Major / Minor	Theory1	106201	Cell Biology	2	2	6
			Lab/Practical-1	106202	Cell Biology	2	4	
	b.	Minor / Major	Theory1	-	-	2	2	6
			Lab/Practical-1	-	-	2	4	
	c.	Generic/Open Elective	Theory1	106401	Microbial Technology	2	2	4
			Theory2	106402	Developmental Biology	2	2	
	d.	VSC	-	-	-	-	-	4
		SEC	Lab/Practical-2	106601	Microbial and cell staining	2	4	
	e.	AEC - English	Theory		Refer University basket	1	1	6
		AEC –MIL	Theory		Refer University basket	1	1	
		IKS-Generic	Theory		Refer University basket	2	2	
		VEC	Theory		Refer University basket	2	2	
	f.	CC	Outdoor		Separate SOP will be released	2	4	4
		TOTAL				**22**	**30**	**30**

TLE Scheme for FIRST YEAR: SEMESTER – II (BSc I Biotechnology-NEP 2020)

Mode of Teaching	Ver. No	The Vertical	Type of Course	Course Code	Course Name	Credits	Workload (Hrs/Week)	Vertical Workload (Hrs/Week)
Classroom Teaching / Lab Work (Practical)/ Outdoor / Field	a.	Major / Minor	Theory2	106203	Bioenergetics, Biomolecules and Metabolism	2	2	6
			Lab/Practical-3	106204	Bioenergetics, Biomolecules and Metabolism	2	4	
	b.	Major / Minor	Theory2		-	2	2	6
			Lab/Practical-5		-	2	4	
	c.	Generic/ Open Elective	Theory3	106403	Elementary forensic science	2	2	4
			Theory4	106404	Bioethics and Biosafety	2	2	
	d.	VSC	Lab/Practical-6	106502	Entrepreneurship approaches in Animal Tissue culture	2	4	8
		SEC	Lab/Practical-7	106602	Clinical Lab Technology	2	4	
	e.	AEC - English	Theory		Refer University basket	1	1	4
		AEC –MIL	Theory		Refer University basket	1	1	
		VEC	Theory		Refer University basket	2	2	
	f.	CC	Outdoor		Separate SOP will be released	2	4	4
		TOTAL				**22**	**32**	**32**

Teaching and Learning Scheme: for the Degree of Bachelor of Biotechnology as Major
Sant Gadge Baba Amravati University, Amravati
FACULTY: SCIENCE AND TECHNOLOGY
Teaching and Learning Scheme: for the Degree of Bachelor of Biotechnology as Major and as Minor

TLE Scheme for 2nd YEAR: SEMESTER – III (BSc II Biotechnology-NEP 2020)

Mode of Teaching	Vertical No.	The Vertical	Type of Course	Course Code	Course Name	Credits	Workload (Hrs/Week)	Vertical Workload (Hrs/Week)
Classroom	a.	Major 1	Theory3	106205	Biochemistry	2	2	8
Teaching / Lab								
Work (Practical)/ Outdoor /		Major 2	Theory	106206	Fundamentals of Inheritance Biology: Genetics	2	2	
			Lab/ Practical-1	106207	Biochemistry & Genetics	2	4	
		IKS Major Specific	Theory	106701	Fundamentals of Microbiology	2	2	
Field	b.	Minor	Theory 3	106301	Biochemistry & Microbiology	2	2	6
			Lab/Practical-1	106302	Practicals in Biochemistry & Microbiology	2	2	
	c.	Generic/Open Elective	Theory1	106404	Adulteration and prevention	2	2	2
	d	VSC	Lab/Practical-2	106503	Bioinformatics	2	4	4
	e.	AEC - English	Theory		Refer University basket	1	1	2
		AEC –MIL	Theory		Refer University basket	1	1	
	f.	CC	Outdoor		Separate SOP will be released	2	4	8
		FP/CES	Project	106801	Refer University basket	2	4	
		TOTAL				**22**	**30**	**30**

TLE Scheme for 2nd YEAR: SEMESTER – IV

(BSc II Biotechnology-NEP 2020)

Mode of Teaching	Vertical No.	The Vertical	Type of Course	Course Code	Course Name	Credits	Workload (Hrs/Week)	Vertical Workload (Hrs/Week)
Classroom Teaching / Lab Work (Practical)/ Outdoor / Field	a.	Major 1	Theory 5	106208	Molecular Biology	2	2	10
		Major 2	Theory 6	106209	Genetic engineering	2	2	
			Lab/Practical-1	106210	Molecular Biology & Genetic Engineering	2	4	
	b.	Minor	Theory 4	106303	Heredity & Evolution	2	2	4
			Lab/ Practical-1	106304	Practicals in Heredity & Evolution	2	2	
	c.	Generic/Open Elective	Theory1	106405	Food Processing & Preservation	2	2	2
	d.	VSC	-	106504	Enzyme technology	2	4	4
		SEC	Lab/Practical-2	106603	Microbial Technology	2	4	
	e.	AEC - English	Theory		Refer University basket	1	1	6
		AEC –MIL	Theory		Refer University basket	1	1	
	f.	CC	Outdoor		Separate SOP will be released	2	4	4
		FP/CES	Project	106802	Refer University basket	2	4	
		TOTAL				**22**	**32**	**30**

TLE Scheme for 2nd YEAR: SEMESTER – IV (BSc II Biotechnology-NEP 2020)

Credits, Workload, Examination, Evaluation and Assessment Scheme
Semester – V (Biotechnology)

Subject	The Vertical	Course Code	Course Title	Credits	Workload	Theory/Practical				Theory/Pract (Total)	
						External		Internal			
						Max. Marks	Min. Marks	Max. Marks	Min. Marks	Max. Marks	Min. Marks
Biotechnology	Major-T	106209	Immunology & Vaccine technology	2	2	30	9	20	6	50	20
Biotechnology	Major-T	106210	Food biotechnology	2	2	30	9	20	6	50	20
Biotechnology	Major-T	106211	Plant biotechnology	2	2	30	9	20	6	50	20
Biotechnology	Major-P	106212	Applied Biotechnology Practical	2	4	25	10	25	10	50	20
Biotechnology	Major-Elective T1	106701	Analytical methods & Instrumentation 1	2	2	30	9	20	6	50	20
Biotechnology	Major-Elective P1	106702(P)	Lab based learning/Practical: Analytical methods & Instrumentation 1	2	4	25	10	25	10	50	20
OR											
Biotechnology	Major-Elective T2	106703	Ethnopharmacology & Drug discovery 1	2	2	30	9	20	6	50	20
Biotechnology	Major-Elective P2	106704(P)	Ethnopharmacology & Drug discovery 1	2	4	25	10	25	10	50	20
OR											
Biotechnology	Major-Elective T3	106705	Biostatistics & Bioinformatics 1	2	2	30	9	20	6	50	20
Biotechnology	Major-Elective P3	106706(P)	Biostatistics & Bioinformatics 1	2	4	25	10	25	10	50	20
OR											
Biotechnology	Major-Elective T4	106707	Medical biotechnology & Nanobiotechnology 1	2	2	30	9	20	6	50	20
Biotechnology	Major-Elective P4	106708 (P)	Medical biotechnology & Nanobiotechnology 1	2	4	25	10	25	10	50	20
Biotechnology	Minor-T	106305	Application of biotechnology	2	2	30	9	20	6	50	20
Biotechnology	Minor-P	106306 (P)	Application of biotechnology	2	4	25	10	25	10	50	20
Biotechnology	VSC-P	106504	AI in LifeScience	2	4	-	-	50	20	50	20
Biotechnology	SEC-P	106605	Forensic biology	2	4	-	-	50	20	50	20
Biotechnology	FP/CES	107251	Biotech Lab (FP/CES in Biotech III)	2	4	-	-	50	20	50	20

TLE Scheme for 2nd YEAR: SEMESTER – IV (BSc II Biotechnology-NEP 2020)
Credits, Workload, Examination, Evaluation and Assessment Scheme
Semester – VI (Biotechnology)

Subject	The Vertical	Course Code	Course Title	Credits	Workload	Theory/Practical				Theory/Practical (Total)	
						External		Internal			
						Max. Marks	Min. Marks	Max. Marks	Min. Marks	Max. Marks	Min. Marks
Biotechnology	Major-T	106213	Animal biotechnology	2	2	30	9	20	6	50	20
Biotechnology	Major-T	106214	Cell Signaling, Cancer Biology and application	2	2	30	9	20	6	50	20
Biotechnology	Major-T	106215	Environmental biotechnology	2	2	30	9	20	6	50	20
Biotechnology	Major-P	106216	Applied Biotechnology 2 LAB/Practical	2	4	25	10	25	10	50	20
Biotechnology	Major-Elective T1	106709	Analytical methods & Instrumentation 2	2	2	30	9	20	6	50	20
Biotechnology	Major-Elective P1	106710 (P)	Analytical methods & Instrumentation 2	2	4	25	10	25	10	50	20
OR											
Biotechnology	Major-Elective T2	106711	Ethnopharmacology & Drug discovery 2	2	2	30	9	20	6	50	20
Biotechnology	Major-Elective P2	106712 (P)	Ethnopharmacology & Drug discovery 2	2	4	25	10	25	10	50	20
OR											
Biotechnology	Major-Elective T3	106713	Biostatistics & Bioinformatics 2	2	2	30	9	20	6	50	20
Biotechnology	Major-Elective P3	106714 (P)	Biostatistics & Bioinformatics 2	2	4	25	10	25	10	50	20
OR											
Biotechnology	Major-Elective T4	106715	Medical biotechnology & Nanobiotechnology 2	2	2	30	9	20	6	50	20
Biotechnology	Major-Elective P4	106716 (P)	Medical biotechnology & Nanobiotechnology 2	2	4	25	10	25	10	50	20
Biotechnology	Minor-T	106307	General Biophysical Methods	2	2	30	9	20	6	50	20
Biotechnology	Minor-P	106308 (P)	General Biophysical Methods	2	4	30	9	20	6	50	20
Biotechnology	VSC-P	106505	Microbes in Human Welfare	2	4	-	-	50	20	50	20
Biotechnology	Internship / Apprenticeship	107252	On Job Training	4	8	-	-	-	-	-	-

Notes:

a. The strength of the batch of the Practical for UG Classes shall be 16 with an addition of 10% with the permission of Hon'ble Vice Chancellor. The number of the students required to constitute a batch or calculate the workload shall be in accordance with the relevant Government Resolution in force at the time, applicable to specific time, region, course type, mode of instruction, and other pertinent factors.

b. 1 Credit shall mean 1 Hour Teaching per Week per Semester (Total 15 Hrs/ Semester), the duration of 1 Teaching Period will be 60 Minutes. For Practical 1 Credit shall mean 2 Hour Teaching per Week per Semester (Total 30 Hrs/ Semester).

c. For Examination and Evaluation of Theory Courses, 40 % Marks shall be assigned to Internal Examination and 60% Marks shall be assigned to end-semester external university examination.

d. Co-curricular Courses: Health and wellness, Yoga Education, Sports and Fitness, Cultural Activities, NSS/NCC, Fine/Applied/Visual/Performing Arts During Semester I, II, III, IV, V and VI. These courses may be taught by Physical Education Director or may be assigned to Language Teacher by the Principal of HEI based on the expertise of the concerned.

e. Value Education Courses to be selected from the Basket of Courses provided by the University. These courses may be assigned to the Language Teacher by the Principal of HEI based on the expertise of the concerned.

f. Generic / Open Elective Courses (GE/OE): Courses to be selected from the Basket of Courses provided by the University

g. Abbreviations: Department Specific Core: DSC, Department Specific Elective: DSE, FSC: Faculty Specific Core, FSE: Faculty Specific Elective, Indian Knowledge System: IKS, Inter Faculty Specific Core: IFSC, Inter Faculty Specific Elective: IFSE, Theory: Th, Practical/Practicum: Pr, Environment Studies: ES, Pre-requisite Course mandatory if applicable: Prq, Laboratory: Lab (Practical), Generic/ Open Electives: OE; Vocational Skill and Skill Enhancement Courses: VSEC; Vocational Skill Courses: VSC; Skill Enhancement Courses: SEC; Ability Enhancement Courses: AEC; Value Education Courses: VEC; OJT: On Job Training: Internship/ Apprenticeship; Field projects: FP; Community Engagement and Service: CES; Co-curricular Courses: CC; RM: Research Methodology; Research Project: RP; MIL: Modern Indian Language

Examination and Assessment Process:

i. The basic principle of the Credit framework is that Credits are a function of the successful completion of a program of study/ vocational education/ training and assessment. No Credit can be earned by the student unless the student is assessed for the achievement of the desired competencies and outcome of a program.

ii. Exit options are provided with Certificate, Diploma and Basic Bachelor's degrees to the students at the end of the second, fourth and sixth semesters of a Four Years

Multidisciplinary Degree Programme. Students will receive a Bachelor's degree with Honors/ Research on successfully completing of all eight semesters of the UG Program either at a stretch or with opted exits & reentries.

iii. For the smooth success of four-year degree programme with multiple entry and exit systems, the examination mode should be based on the combination of innovative trends in formative (informal and formal tests administered during the learning process) and summative (evaluation of students learning at the end of an instructional unit) examination modes in line with the UGC Report on 'Evaluation Reforms in Higher Educational Institutions (2019).

Continuous Assessment Tests (CAT)

For internal assessment, the Continuous Assessment Tests (CAT) shall be conducted as under-

i. Three CAT each of 8 / 10 Marks (Theory) as applicable and 10 Marks (Practical).

- First on completion of 25% Syllabus of the course or on completion of 25 teaching days,
- Second on completion of 50% Syllabus of the course or on completion of 50 teaching days,
- Third on completion of 75% Syllabus of the course or on completion of 75 teaching days.

ii. Each concurrent assessment (CAT-I, II & III) will be mapped to relevant Course Learning Outcome.

iv. Total Performance in CAT (i.e. 40 %) shall be based on the best two out of three in CAT examinations

v. Internal assessment shall be carried out by the respective course teacher by choosing variety of assessment tools/methods such as class test, record book, seminar, case study, field work, mini project work, quiz or any innovative method, which may be deemed to be appropriate for assessing the relevant course outcome.

Contents (BSC 1)

Contents (BSC 2)

Contents (BSC 3)

Sant Gadge Baba Amravati University FACULTY: Science and Technology

Teaching and Learning Scheme (Cell Biology) for the Three-Year UG Degree of Bachelor of Biotechnology (Three Years- Six Semesters Bachelor's Degree Programme)

Course (Theory Curriculum for Major & Minor): **Cell Biology**

Each theory paper of Theory shall be of 2 Credits comprising of 4 Units with Teaching Hours as mentioned in the table.

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
4.5	I	106201	Cell Biology	2	30	2 Hrs	30

Course Objectives :	CO 1: To study the structure and function of prokaryotic and eukaryotic cells. CO 2: To understand the role of cell organelles and biological membranes. CO 3: To learn about cell division and its biological significance. CO 4: To perform basic experiments related to cell structure and function. CO 5: To develop skills in microscopy and cell analysis techniques.			
Course Outcomes:	CO-1: Understand the basic and advanced concepts in Microscopy CO-2: Understand the Cell as a basic structural and functional unit of lifeCO-3: Differentiate prokaryotic and eukaryotic Cell. CO-4: Understand the structure and functions of various cell organellesCO-5: Understand the basics of Cell organization			
Unit System	**Contents**	**Workload Allotted (Hrs)**	**Weightage of Marks Allotted**	**Incorporation of Pedagogies**
Unit I	**Cell: functional unit of life**	8	8	Lectures, Power point presentation, Discussion, Demonstration, Collaborative learning, Problem based learning (PBL), Peer teaching, Experimental learning. Direct instructions
	1.1: Cell: Definition, concept, history of cytology with reference to the cell and cell division			
	1.2: Cell size and shape, its elemental and organic composition, unicellular and multicellular organisms			
	1.3: Types of cells: Prokaryotic and Eukaryotic cells, compartmentalization of eukaryotic cells			
	1.4: Introduction to the cell organelles			
Unit II	**Cell: functional unit of life**	7	7	
	2.1: Structure and functions of: • Nucleus • Endoplasmic Reticulum (Smooth and Rough)			
	2.2: Structure and functions of: • Golgi complex • Ribosomes (prokaryotic and Eukaryotic)			
	2.3: Structure and functions of: • Mitochondria • Plastids (types)- chloroplast (structure and functions)			
	2.4: Structure and functions of: • Lysosomes: Vacuoles and micro bodies • Cell wall			
Unit III	**Cell membrane and cell motility**	8	8	
	3.1: Cell membrane and permeability: Chemical components of biological membranes, organization and Fluid Mosaic Model, cell recognition and membrane			

	transport.			
	3.2: Membrane Vascular system, cytoskeleton and cell motility: Structure and function of microtubules, Microfilaments.			
	3.3: Structure and functions of cilia and flagella			
	3.4: Movement of cilia and flagella			
Unit IV	**Cell Division**	7	7	
	4.1: Cell cycle: G-phase, S-phase and M-phase			
	4.2: Mitosis: concept and phases of mitosis			
	4.3: Meiosis: concept, types and phases			
	4.4: Significance of mitosis & Meiosis and Differences			
References	1) Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6thEdition. John Wiley & Sons. Inc. 2) De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular. 3) Biology. 8th edition. Lippincott Williams and Wilkins, Philadelphia. 4) Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.;Sinauer Associates, MA. 5) Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009. The Worldof the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco. 6) Albert M. Lewis, Introduction to cell biology and microbiology 7) Powar, C. B. and Daginawala, H. F. (2010). General Microbiology Vol. I and II, 2nd edition, Himalaya Publishing House, Mumbai 8) Powar, C.B. (2012). Cell Biology, 3rdedition, Himalaya Publishing House, Mumbai			

Short Questions:

1) What is the basic structural unit of all living organisms?
2) Define the term "cell theory."
3) Name the two main types of cells and briefly describe their differences.
4) What is the function of the cell membrane?
5) Define the term "organelle."
6) Name the three components of the cytoskeleton.
7) What is the primary function of the mitochondria?
8) Briefly explain the difference between prokaryotic and eukaryotic cells.
9) What is the role of the endoplasmic reticulum in the cell?
10) Name the organelle responsible for protein synthesis.
11) Define the term "cellular respiration."
12) What is the function of the Golgi apparatus?
13) Explain the difference between diffusion and osmosis.
14) What is the purpose of the cell cycle?

Long Questions:

1) Explain the cell theory and its significance in biology.
2) Compare and contrast plant and animal cells in terms of structure and organelles.
3) Describe the fluid mosaic model of the cell membrane.
4) Discuss the structure and function of the nucleus in eukaryotic cells.
5) Describe the process of cellular respiration, highlighting its different stages.
6) Explain the stages of the cell cycle and the events that occur in each stage.
7) Discuss the process of mitosis and its significance in cell division.
8) Describe the structure and function of the mitochondria in detail.
9) Explain the principles of diffusion and osmosis, providing examples.
10) Describe the process of transcription and translation in gene expression.
11) Discuss the structure of DNA and its role in heredity.

Multiple choice questions (MCQs) related to cell biology:

1) What is the primary function of the cell membrane?

a. Energy production b. Structural support
c. Cellular communication d. Selective barrier

2) Which organelle is responsible for synthesizing ATP in eukaryotic cells?

a. Endoplasmic reticulum b. Golgi apparatus
c. Mitochondria d. Nucleus

3) What is the main function of ribosomes in the cell?

a.Protein synthesis b. Lipid synthesis
c. ATP production d. DNA replication

4) In which phase of the cell cycle does DNA replication occur?

a. G1 phase b. S phase
c. G2 phase d. M phase

5) Which cellular process is responsible for breaking down and recycling cellular components?

a. Mitosis b. Apoptosis
c. Autophagy d. Cytokinesis

6) What is the primary function of the Golgi apparatus?

a. Protein synthesis b. Lipid synthesis
c. Sorting and modifying cellular products d. ATP production

8) Which cellular structure is composed of microtubules and microfilaments and provides structural support to the cell?

a. Cytoskeleton b. Endoplasmic reticulum
c. Nucleus d. Golgi apparatus

10) Which cellular organelle is involved in detoxification processes and lipid metabolism?

a. Peroxisome b. Lysosome
c. Endoplasmic reticulum d. Golgi apparatus

Sant Gadge Baba Amravati University
FACULTY: Science and Technology
Teaching and Learning Scheme (Cell Biology) for the Three-Year UG Degree of Bachelor of Biotechnology(Three Years- Six Semesters Bachelor's Degree Programme)

Course (Theory Curriculum): Cell Biology (Practical)

Each theory paper of Theory shall be of 2 Credits comprising of 4 Units with Teaching Hours as mentionedin the table.

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
4.5	I	106202	Cell Biology (Practical)	2	30	2 Hrs	30

Course Objectives:	1. To provide students with practical knowledge of cell structure, organization, and functions. 2. To develop skills in the microscopic observation and identification of cellular structures and organelles. 3. To familiarize students with cell division, including mitosis and meiosis, through permanent slides and prepared materials. 4. To develop practical understanding of cell membrane structure, permeability, diffusion, and osmosis. 5. To train students in the preparation of temporary slides, staining techniques, microscopic examination, and interpretation of cell biology experiments.
Course Outcomes:	1. Identify and describe major cellular structures and organelles using microscopic observations and diagrams. 2. Prepare temporary slides and perform basic staining techniques for the study of cells and cellular components. 3. Recognize and explain different stages of mitosis and meiosis from prepared slides. 4. Demonstrate and interpret diffusion, osmosis, and membrane permeability using suitable laboratory experiments. 5. Record, analyse, and interpret experimental observations and relate practical findings to fundamental concepts of cell biology.
	Contents
Experiments	1) To prepare permanent slide by using plant material like leaf, stem or root. 2) Study the effect of temperature and organic solvents on semi permeable membrane. 3) Demonstration of dialysis. 4) Study of plasmolysis and de-plasmolysis. 5) Demonstrate Cell fractionation and identification of cell fraction 6) Study of structure of any Prokaryotic cell. 7) Study of structure of any Eukaryotic cell. 8) Study of Cell division (Meiosis) in onion flower bud. 9) Study of Cell division (Mitosis) in onion root tip. 10) Study of osmosis (Exo and Endo). 11) Demonstration of Centrifugation. Trypan blue exclusion of assay for cell viability.
Text Books:	1. Alberts, B. et al. – *Molecular Biology of the Cell*. Garland Science. 2. Cooper, G. M. & Hausman, R. E. – *The Cell: A Molecular Approach*. Sinauer Associates.

	3. Karp, G. – *Cell and Molecular Biology: Concepts and Experiments*. Wiley. 4. De Robertis, E. D. P. & De Robertis, E. M. F. – *Cell and Molecular Biology*. Lea & Febiger. 5. Verma, P. S. & Agarwal, V. K. – *Cell Biology*. S. Chand Publishing. 6. Gupta, P. K. – *Cell and Molecular Biology*. Rastogi Publications. 7. Raven, P. H. et al. – *Biology*. McGraw-Hill Education

Sant Gadge Baba Amravati University
FACULTY: Science and Technology
Teaching and Learning Scheme
(Three Years- Six Semesters Bachelor's Degree Programme)
Syllabus for: GOEC: MICROBIAL BIOTECHNOLOGY (106401)

Each theory paper of **Theory shall be of 2 Credits comprising of 4 Units with Teaching Hours** as mentioned in the table. The pattern of theory papers shall be as per following template –

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
4.5	I	106401	**MICROBIAL BIOTECHNOLOGY**	2	30	2 Hrs	30

Course Objectives:	CO 1: To Learn about significance of Microbes in human health. CO 2: To learn about Microbial techniques and their applications.
Course Outcomes:	CO-1: Students will be able to **Recognize** importance of diversity of microbes. CO-2: Students will be able to **classify** Components and units of a bioprocess industry. CO-3: Students will **apply** knowledge to produce microbial products. CO-4: students will be able to **plan** strategies of producing Industrially important microbial enzymes and related products. CO-5: Students will be able to **develop** their own Microbial technology lab. CO-6: Students will Impart knowledge on the various industrial bioproducts CO-7: Students will get Familiarize with various sectors of industrial biotechnology

Unit System	Contents	Workload Allotted (Hrs)	Weightage of Marks Allotted	Incorporation of Pedagogies
Unit I	**Introduction to microbial Technology**	8	8	Lectures, Power point presentation, Discussion, Demonstration, Collaborative learning, Problem based learning (PBL), Peer teaching, Experimental learning. Direct instructions
	1.1 Structure and life cycle of representative groups of Bacteria, Fungi, Algae, viruses and eukaryotic organisms; physiology of microorganisms:			
	1.2 Scope of Microbial biotechnology. Microorganisms as factories for the production of novel compounds			
	1.3 Biotechnological potentials of microalgae – food, feed Colourant, fuel and pharmaceutically valuable compounds.			
	1.4 Production of microbial biofertilizers cyanobacteria, Rhizobium, Azotobacter, Rhizobacteria and VAM.			
Unit II	**Industrial Byproducts**	7	7	
	2.1 Isolation, Preservation and Maintenance of Industrial Microorganisms.			
	2.2 Fermenter parts and components; Media for industrial fermentation; Sterilization.			
	2.3 Industrial Bioproducts– microbial synthesis of organic acids (Citric acid), alcohol (ethanol), vitamin(B12) and beverage (wine) ,			

	2.4 Industrially important microbial enzymes: Types, mode of action and industrial applications of microbial amylases and proteases			
Unit III	**Microbes in human health**	8	8	
	3.1 Microbial production of therapeutically important products: o Antibiotics: Penicillin, Streptomycin			
	3.2 Probiotics and prebiotics: Fundamental aspects and health benefits			
	3.3 Production of single cell protein from bacteria, algae and fungi: nutritional value, substrates used, process examples, applications.			
	3.4 Cultivation of edible and medicinal mushrooms: Nutritional and medicinal properties			
Unit IV	**Microbial technology and its application**	7	7	
	4.1 Microbial technology of fermented dairy products: Cheese making, Yoghurt making, Beer brewing			
	4.2 microbes in agrobiotechnology and microbial pesticides;			
	4.3 Microbes in medical biotechnology, microbes in alternative energy			
	4.4 Patenting microbial biotechnology			
	4.5 Opportunity and Career in microbial technology			

References:

1. Lee Y. K., Microbial Biotechnology: Principles and applications. World Scientific Publisher, 2003.

2. Tortora, Funke and Case, Microbiology, An Introduction, 5 th Edition. Benjamin/Cummings Publishing Company, Redwood City, CA, 1995.

3. Board RG, Jones D, Skinner FA, Identification methods in applied and Environmental Microbiology, 1 st Ed. Blackwell Science, 1992.

4. Funke, Study Guide for Microbiology, 5 th Ed. Benjamin/Cummings Publishing Company, Redwood City, CA, 1995.

5. peter F Stanbury, Allan Whitaker, Steohen J Hall, 2013, Principles of Fermentation Technology, Elsevier Science Ltd, Second Edition.

6. Manual of Industrial Microbiology and Biotechnology, III edition, Arnold. L. Demain and Julian Davies, ASM press, Washington DC, 2010.

7. Handbook of Downstream processing, Edin Goldberg, Blackie and Academic Professional, 1997

Model Questions:

Short Type (At least 8):

1. Explain Structure of Bacteria.
2. Explain Structure of Virus.
3. Write note on Scope of Microbial biotechnology
4. Define role of sterilization in microbial growth
5. Enlist the parts of fermenter.
6. Add detailed note on antibiotics production (penicillin),
7. Add detailed note on vitamin(B12)
8. What is Probiotics?
9. Add note Nutritional and medicinal properties of mushroom

Long Type (At least 4):

1. Explain process of production of microbial biofertilizers
2. Write on Fundamental aspects probiotics and its health benefits
3. Explain Production of single cell protein from bacteria
4. Describe Microbial production of therapeutically important products

MCQs for Internal Assessment (At least 8)

1. Which of the following food products come from microbes in biotechnology?
   a. Soy sauce b. Cheese
   c. Alcoholic beverages d. All are correct
2. 1. Which of these bacterial components is least likely to contain useful antigens?
   a. Cell wall b. . Flagella
   c.Ribosomes d. Capsule
3. Which of the following contains structures composed of N-acetylmuramic acid and N-acetylglucosamine?
   a. Mycoplasmas b. Amoeba
   c.E.coli d. Spheroplast
4. GMO stands for _____.
   a. genetically manipulated organism
   b. genetically modified organism
   c. greatly modified organism
   d. genetically manufactured organism
5. The structure of RNA differs from that of DNA, as RNA contains:
   a) The sugar ribose instead of deoxyribose
   b) uracil instead of thymine
   c) it contain Cytosine
   d) a and b
6. Bacterial ribosomes typically consist of two subunits, the larger (50 S) subunit consist of:
   a) single RNA molecule (16 S) and 21polypeptides.
   b) Two RNA molecules (30 S and 50 S) plus 31 different polypeptides.
   c) single RNA molecule (18 S) and 21polypeptides
   d) Two RNA molecules (23 S and 5 S) plus 31 different polypeptides
7. The E. coli chromosome is a closed-circular DNA of length 4.6 million base pairs, which resides in a region of the cell called the:
   a) nucleosome b) nucleotide
   c) nucleoid d) DNA domains

Sant Gadge Baba Amravati University
FACULTY: Science and Technology
Teaching and Learning Scheme (Fundamentals in Immunology and Molecular Biology) for the Three Year UG Degree of Bachelor of Biotechnology
(Three Years- Six Semesters Bachelor's Degree Programme)

Course Template for Theory Curriculum (GOEC): Developmental Biology

Each theory paper of **Theory shall be of 2 Credits comprising of 4 Units with Teaching Hours** as mentioned in the table. The pattern of theory papers shall be as per following template –

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
4.5	I	106402	Developmental Biology	2	30	2 Hrs	30

Course Objectives:	CO 1. The objective of this course is to provide a comprehensive understanding of the concepts of early animal development. CO 2 Students taking this course must develop a critical appreciation of methodologies specifically used to study the process of embryonic development in animals.				
Course Outcomes:	CO 1: On the successful completion of the course, students will be able to- CO 2: Explain the molecular and genetic background of animal development. CO 3: Describe evolutionary history of complex multicellular life forms; CO 4: Compare environmental influence on development and homeostasis of animals. CO 5: Interpret, analyse and present experimental results and conclusions in a scientific manner.				
Unit System	**Contents**		**Workload Allotted (Hrs)**	**Weightage of Marks Allotted**	**Incorporation of Pedagogies**
Unit I	**Gametogenesis and Fertilization**		8	8	Lectures, Power point presentation, Discussion, Demonstration, Collaborative learning, Problem based learning (PBL), Peer teaching, Experimental learning. Direct instructions
	1.1 Definition, scope & historical perspective of development Biology				
	1.2 Gametogenesis – Spermatogenesis, Oogenesis				
	1.3 Fertilization - Definition, mechanism, types of fertilization.				
	1.4 Different types of eggs on the basis of yolk				
Unit II	**Early embryonic development**		7	7	
	2.1 Cleavage: Definition, types, patterns & mechanism.				
	2.2 Blastulation: Process, types & mechanism				
	2.3 Gastrulation: Morphogenetic movements– epiboly, emboly, extension, invagination,				

	convergence, de-lamination			
	2.4 Formation & differentiation of primary germ layers, Fate Maps in early embryos			
Unit III	**Embryonic Differentiation**	7	7	
	3.1 Differentiation: Cell commitment and determination			
	3.2 The epigenetic landscape: a model of determination and differentiation, control of differentiation at the level of genome, transcription and post-translation level			
	3.3 Concept of embryonic induction: Primary, secondary &tertiary embryonic induction,			
	3.4. Neural induction and induction of vertebrate lens.			
Unit IV	**Organogenesis**	8	8	
	4.1 Neurulation, notogenesis, development of vertebrate eye.			
	4.2 Fate of different primary germ layers.			
	4.3 Development of behaviour: constancy & plasticity.			
	4.4 Extra embryonic membranes, placenta in Mammals.			
References:	1. Gilbert, S. F. (2010). Developmental Biology, IX Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA 2. Balinsky B. I. and Fabian B. C. (1981). An Introduction to Embryology, V Edition, International Thompson Computer Press 3. Carlson, R. F. Patten's Foundations of Embryology. 4. Kalthoff (2008). Analysis of Biological Development, II Edition, McGraw-Hill Publishers 5. Lewis Wolpert (2002). Principles of Development. II Edition, Oxford University Press			

Sant Gadge Baba Amravati University
FACULTY: Science and Technology
Teaching and Learning Scheme (Cell Biology) for the Three Year UG Degree of Bachelor of Biotechnology
(Three Years- Six Semesters Bachelor's Degree Programme)

Course (Theory Curriculum) SEC: **Microbial and Cell Staining Techniques**

Each theory paper of Theory shall be of 2 Credits comprising of 4 Units with Teaching Hours as mentionedin the table.

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Mark
4.5	I	106601	**Microbial and Cell Staining Techniques**	2	30	2 Hrs	30

Course Objectives:	CO 1. To perform simple, Gram, and acid-fast staining for microbial identification. CO 2. To apply specialized staining techniques to study bacterial structures. CO 3. To use fluorescent and immunohistochemical staining for cell and tissue analysis. CO 4. To understand and demonstrate advanced imaging methods like FISH and 3D microscopy. CO 5. To develop skills in microscopic observation and interpretation of stained samples.			
Course Outcomes:	CO-1: Understand the fundamental principles of staining techniques CO-2: Demonstrate proficiency in basic microscopy and sample preparation CO-3: Explore advanced staining techniques and emerging trends CO-4: Promote lifelong learning and curiosity CO-5: Develop practical microbiology laboratory skills			
Unit System	**Contents**	**Workload Allotted (Hrs)**	**Weightage of Marks Allotted**	**Incorporation of Pedagogies**
Unit I	**Simple Staining Techniques** Practicals: 1. Perform simple staining using crystal violet, methylene blue, and safranin. 2. Microscopic examination of stained bacterial and eukaryotic cell samples. 3. Step-by-step execution of Gram staining on bacterial smears. 4. Differentiation and microscopic observation of Gram-positive and Gram-negative bacteria. 5. Practice acid-fast staining using Ziehl-Neelsen and Kinyoun methods. 6. Identification of acid-fast organisms in stained samples.	8	8	Lectures, Power point presentation, Discussion, Demonstration, Collaborative learning, Problem based learning (PBL), Peer teaching, Experimental learning. Direct instructions
Unit II	**Specialized Staining Techniques** 1. Perform endospore staining on bacterial samples. 2. Observation of endospore structures under the microscope. 3. Capsule staining techniques on bacterial samples. 4. Microscopic examination of bacterial capsules. 5. Demonstration and practice of flagella staining on bacterial samples. 6. Observation of flagella arrangements. 7. Techniques for negative staining of microbial samples. 8. Microscopic observation of negatively stained specimens.	7	7	
Unit III	**Fluorescent Staining**	8	8	

	1. Demonstration of fluorescent dyes and visualization under a microscope. 2. Virtually demonstrate immunohistochemistry procedures using antibodies. 3. Discuss immunostained samples under the microscope 4. H&E staining of tissue sections. 5. Microscopic examination and interpretation of stained tissues.			
Unit IV	**Advanced Techniques and Emerging Trends**	7	7	
	1. Virtually demonstrate FISH techniques. 2. Introduction to live cell imaging techniques. 3. Observation of live cells using microscopy. 4. Virtual demonstration of 3D imaging methods. 5. Practical application of 3D imaging in microbial and cell samples.			

References:

1. "Microbe" by Michele Swanson, Gemma Reguera, and Hazel Barton
2. "Brock Biology of Microorganisms" by Michael T. Madigan, Kelly S. Bender, Daniel H. Buckley, and W. Matthew Sattley
3. "Color Atlas and Textbook of Diagnostic Microbiology" by Elmer W. Koneman, Stephen Allen, and D. W. Alle
4. "Histology: A Text and Atlas" by Michael H. Ross, Wojciech Pawlina
5. "Molecular Biology of the Cell" by Bruce Alberts, Alexander Johnson, Julian Lewis, David Morgan, Martin Raff, Keith Roberts, and Peter Walter
6. "Techniques in Microbiology: A Student Handbook" by John M. Lammert, Susan M. Russell
7. "Diagnostic Medical Parasitology" by Lynne Shore Garcia
8. "Fluorescence Microscopy: From Principles to Biological Applications" by Ulrich Kubitscheck
9. "Immunohistochemistry: Basics and Methods" by Ralf J. Rieker and Reinhard von Wasielewski
10. "Laboratory Safety for Chemistry Students" by Robert H. Hill Jr. and David C. Finster
11. "Textbook of Microbiology" by Prof. C.P. Baveja
12. "Textbook of Microbiology" by Ananthanarayan and Paniker
13. "A Textbook of Cell Biology" by P.S. Verma and V.K. Agarwal
14. "Microbiology: A Textbook" by R. Ananthanarayan and C.K. Jayaram Paniker

Sant Gadge Baba Amravati University
FACULTY: Science and Technology
Teaching and Learning Scheme for the UG Degree of
Bachelor of Biotechnology
(Three Years-Six Semesters Bachelor's Degree Programme)

Course (Theory Curriculum): Bioenergetics, Biomolecules and Metabolism

Each theory paper of Theory shall be of 2 Credits comprising of 4 Units with Teaching Hours as mentioned in the table.

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
4.5	II	106203	Bioenergetics, Biomolecules and Metabolism	2	30	2Hrs	30

Course Objectives :	1: To provide comprehensive Understanding of Biogenetics, Biomolecules & Metabolism. 2: To acquaint students with bioenergetics, biomolecules and metabolism. 3. To make students understand the importance of biomolecules in life.			
Course Outcomes:	1: Underst and the biogenetics process in the cell. 2: Understand the enzymes, mechanism and their functions. 3: Understand the carbohydrate metabolism. 4: Understand the lipid metabolism. 5:Understand the lipid metabolism disorders.			
Unit System	**Contents**	**Workload Allotted (Hrs)**	**Weightage of Marks Allotted**	**Incorporation of Pedagogies**
UnitI	**Bioenergetics and vitamins**	8	8	
	1.1: Energy and its form, Free energy, pH			
	1.2: Laws of thermodynamics, enthalpy and entropy			
	1.3: Redox potential, ATP bioenergetics			
	1.4: Vitamins: Dietary sources, Deficiency manifestation, biological functions of fat soluble and water-soluble vitamins.			
UnitII	**Enzymes:**	7	7	
	2.1: Definition, Classification and Nomenclature			
	2.2: Terminology: Substrate, prosthetic group, coenzyme, cofactor, active site, inductive enzymes, allosteric enzymes, Isozymes, metalloenzymes, ribozymes			
	2.3: Effect of temperature, pH, substrate Concentration and enzyme concentration on enzyme catalyzed reactions			
	2.4: Mechanism of enzyme action (Lock and Key Model; Induced fit model)			
UnitIII	**Carbohydrate metabolism:**	8	8	
	3.1: Glycolysis and energy account			
	3.2: Glycogenolysis and its importance			
	3.3: Glycogenesis and its importance			
	3.4: Pentose phosphate pathway			
UnitIV	**Lipid metabolism:**	7	7	

	4.1:Fatty acid biosynthesis			
	4.2:Beta-oxidation of fatty acids			
	4.3:Cholesterol synthesis			
	4.4:Lipid metabolism disorders (Gaucher disease; Tay-Sacs disease)			

References:

1. Lehninger Principles of Biochemistry By:David L.NelsonandCox
2. Biochemistry By:Rex Montgomery
3. Harper's Biochemistry By: RobertK.Myrray
4. Enzymes By:Trevor Palmer
5. Enzyme structure and mechanism By:Alan Fersht
6. Principles of Biochemistry By:Donald J. Voet, JudithG. Voet, Charlotte
7. Satyanarayana, U. and Chakrapani U. (2010) Biochemistry, Books and Allied Pvt. Ltd., Kolkata, India.
8. Agarwal, G. R. Agarwal K., Agarwal O. P. (2005) Text Book of Biochemistry, 13th edn., Goel Publishing House, Krishna Prakashan Media Pvt. Ltd., Meerut, India.
9. Jain, J.L., Jain,S. and Jain,N. (2005) Fundamentals of Biochemistry, 6th edn., S. Chand and Company Ltd., Delhi.
10. Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006) Biochemistry, VI Edition, W.H Freeman.

Sant Gadge Baba Amravati University

FACULTY: Science and Technology

Teaching and Learning Scheme for the UG Degree of

Bachelor of Biotechnology

(Three Years-Six Semesters Bachelor's Degree Programme)

Course (Theory Curriculum): Bioenergetics, Biomolecules and Metabolism (Practical)

Each theory paper of Theory shall be of 2 Credits comprising of 4 Units with Teaching Hours as mentioned in the table.

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
4.5	II	106204	Bioenergetics, Biomolecules and Metabolism (Practical)	2	30	2Hrs	30

Course Objectives :	1) To develop basic understanding of the structure, properties and biological functions of biomolecules such as carbohydrates, lipids, proteins and enzymes. 2) To familiarize students with qualitative and quantitative biochemical techniques used for identification and estimation of biomolecules. 3) To understand the principles of enzyme activity and the factors affecting enzymatic reactions. 4) To develop practical skills in the handling of biochemical reagents, laboratory instruments and experimental samples. 5) To introduce students to basic concepts of metabolism, energy production and biochemical transformations through simple laboratory experiments.			
Course Outcomes:	1) Identify carbohydrates, lipids and other biomolecules using appropriate qualitative biochemical tests. 2) Perform basic biochemical assays for estimation of carbohydrates & reducing sugars. 3) Explain&experimentally demonstrate effect of pH & temperature on enzyme activity. 4) Perform basic laboratory techniques such as extraction, chromatography, spectrophotometry and preparation of biochemical samples.Record, analyze and interpret experimental observations and present biochemical results scientifically.			
Content	**Contents**	**Workload Allotted (Hrs)**	**Weightage of Marks Allotted**	**Incorporation of Pedagogies**
Practicals:	1.Qualitative tests for carbohydrates. 2. Qualitative tests for lipids. 3. Qualitative test for amylase. 4. To study the effect of pH on the activity of salivary amylase enzyme. 5. To study the effect of temperature on the activity of salivary amylase enzyme. 6. Extraction and detection of Starch from Potatoes/ maize. 7. Estimation of carbohydrates by DNSA method. 8. Separation of carbohydrates by paper chromatography. 9. Estimation of reducing sugars by DNSA method.			
References	1) Plummer, D. T. – An Introduction to Practical Biochemistry, McGraw-Hill Education. 2) Jayaraman, J. – Laboratory Manual in Biochemistry, New Age International Publishers. 3) Sawhney, S. K. & Singh, R. – Introductory Practical Biochemistry, Narosa Publishing House.Wilson, K. & Walker, J. – Principles and Techniques of Biochemistry and Molecular Biology, Cambridge University Press. 4) Boyer, R. – Biochemistry Laboratory: Modern Theory and Techniques, Pearson. 5) David T. Plummer – Practical Biochemistry, Tata McGraw-Hill.			

Sant Gadge Baba Amravati University
FACULTY: Science and Technology
Teaching and Learning Scheme (Course Titles) for the Three Year UG Degree of Bachelor of Biotechnology
(Three Years- Six Semesters Bachelor's Degree Programme)

Syllabus for GOEC : ELEMENTARY FORENSIC SCIENCE (106403)

Each theory paper of **Theory shall be of 2 Credits comprising of 4 Units with Teaching Hours** as mentioned in the table. The pattern of theory papers shall be as per following template –

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
4.5	II	106403	**ELEMENTARY FORENSIC SCIENCE**	2	30	2 Hrs	30

Course Objectives:	1. To Learn about significance of Forensic Sciences. 2. To learn about applications of forensic science.			
Course Outcomes:	As per Blooms Taxonomy (4 to 6) CO-1: Students will be able to **Recognize** importance of Forensic science and it methodology. CO-2: Students will be able to **classify** criminal record by fingerprints. CO-3: Students will **apply** knowledge to understand Criminal psychology CO-4: Students will be able to **categorize** types of evidences at crime location CO-5: students will be able to **plan** strategies for using chromatographic and spectroscopic techniques in processing crime scene evidence. CO-6: Students will be able to **develop** photography and videography for recording the crime scenes.			
Unit System	**Contents**	**Workload Allotted (Hrs)**	**Weightage of Marks Allotted**	**Incorporation of Peda-gogies**
Unit I	**Introduction to Forensic Science**	8	8	
	1.1 Forensic Science: Definition of Forensic Science, The Role of the Forensic Laboratory, History and Development of Forensic Science in India Multidisciplinary nature, Forensic Technology solving crimes with advanced technology			
	1.2 Forensic Evidences: Concise of Forensic Physical, Biological, Chemical and Psychological evidences, Medico-Legal Cases.			
	1.3 Branches of Forensic Science, Forensic intelligence and Interviews.			
	1.4 Laws and Principles of Forensic Science: Law of Exchange (Locard), Law of Individuality, Law of Comparison, Law of Progressive Changes and Law of Probability, Branches of Forensic Science.			
Unit II0	**GENERAL FORENSIC TOOLS**	7	7	
	2.1 Schematic analysis of Chemical, Biological and Physical samples, Preliminary and Confirmatory methods of analysis, Colour spot tests in Forensic Biological, Chemical and Physical analysis, Microcrystalline test.			
	2.2 Biometrics in Personal Identification: Introduction, Concepts of Biometric Authentication, Role in person Identification, Techniques and			

	Technologies (Finger Print Technology, Face Recognition, IRIS, Retina Geometry, Hand Geometry, Signature Verification).			
	2.3 Forensic Report: Forensic Expert, Forensic Report, Formats of Forensic Report			
	2.4 Ethics in Forensic Science.			
Unit III	**Technological Methods in Forensic Science**	8	8	
	3.1 Microscopy: Fundamental principles. Different types of microscopes. Electron microscope. Forensic applications of microscopy.			
	3.2 Chromatographic and spectroscopic evidence: Sample preparation, Chromatographic methods. Fundamental principles and forensic applications of thin layer chromatography, gas chromatography and liquid chromatography.			
	3.3 Spectroscopic methods. Fundamental principles and forensic applications of Ultravioletvisible spectroscopy, infrared spectroscopy, atomic absorption spectroscopy, atomic emission spectroscopy and mass spectroscopy. X-ray spectrometry.			
	3.4 Electrophoresis – fundamental principles and forensic applications.			
Unit IV	**Forensic Dermatoglyphics**	7	7	
	4.1 Finger printing: Basics of Fingerprinting Introduction and history, Biological basis of fingerprints. Formation of ridges. Fundamental principles of fingerprinting. Types of fingerprints. Fingerprint patterns. Fingerprint characters/minutiae.			
	4.2 Latent prints: Constituents of sweat residue, Preservation of developed fingerprints. Digital imaging for fingerprint enhancement.			
	4.3 footprints: Importance of footprints. Casting of foot prints, Palm prnts. Lip prints - collection and examination of lip prints. Ear prints and their significance.			
	4.4 Forensic photography: Basic principles and applications of photography in forensic science. 3D photography. Photographic evidence. Videography Crime scene and laboratory photography.			
	4.5 Education and Employment systems of Forensic Science in India: Teaching Courses and Research fields in Forensic Science, Scope and jobs in Forensic Science.			
References:	1. Nanda, B.B. and Tewari, R.K. (2001) Forensic Science in India: A vision for the twenty first century Select Publisher, New Delhi. 2. James, S.H and Nordby, J.J. (2003) Forensic Science: An introduction to scientific and investigative techniques CRC Press, 3. Saferstein : Criminalistics (1976) Prentice Hall Inc., USA. 4. Deforest, Gansellen & Lee : Introduction to Criminalistics. 5. Sharma, B.R. (1974) Forensic Science in Criminal Investigation and Trials, Central Law Agency, Allahabad, 1974. 6. Hess, A.K. and Weiner, I.B. (1999) Handbook of Forensic Psychology 2nd Ed. John wiley & sons. 7. Mehta, M.K (1980) Identification of Thumb Impression & Cross Examination of Finger Prints, N.M. Tripathi Pub. Bombay. 8. Moenssens (1975) Finger Prints Techniques, Chitton Book Co. Philadelphia, NY 9. D.A. Skoog, D.M. West and F.J. Holler, Fundamentals of Analytical Chemistry, 6th Edition, Saunders College Publishing, Fort Worth (1992). 10. W. Kemp, Organic Spectroscopy, 3rd Edition, Macmillan, Hampshire (1991). 11. J.W. Robinson, Undergraduate Instrumental Analysis, 5th Edition, Marcel Dekker,			

	Inc., New York (1995). 12. D.R. Redsicker, The Practical Methodology of Forensic Photography, 2nd Edition, CRC Press, Boca Raton (2000).
Model Questions:	Short Type (At least 8), Long Type (At least 4) and MCQs for Internal Assessment (At least 8) wherever applicable as the need of curriculum.
	Short Type (At least 8): 1. Write note on Forensic Evidences 2. Write down the tools used in Crime scene investigation. 3. write note on significance of Finger printing 4. Add note on etics in forensic sciences. 5. Enlist the Branches of Forensic Science, 6. Add detailed note Concepts of Biometric Authentication.
	Long Type (At least 4): 1. Explain Scope and jobs in Forensic Science 2. What is Forensic photography? Explain Basic principles and applications of photography in forensic science 3. Explain Biological basis of fingerprints 4. Describe microscopy techniques use in Forensic science.
	MCQs for Internal Assessment (At least 8) 1. Evidence to substantiate that a rape occurred could include: 1. Blood and semen 2. Hairs 3. Fibers 4. All of the above 2. Which of the following types of cells are not contained in plasma? 1. Phagocytes 2. Leukocytes 3. Erythrocytes 4. Platelets 3. The following technique is used to identify the enzymes in blood samples: (A) Southern blotting (B) Electrophoresis (C) TLC (D) Northern blotting 4. Optical components in UV spectrometer are made up of: (A) Glass (B) Quartz (C) Sodium-Halide Bromide (D) Plastic 5. 1. Deviations from Beer's Law fall into which categories? (A) Real (B) Instrumental (C) Chemical (D) All of the above 6. In GC-MS, a process in which an inert gas is bubbled through the water is known as (A) Trapping (B) Purging (C) Mixing (D) Eluting 7. Who is credited for his practical interest in fingerprints as a means of identifying workers to detect duplicate payment of wages? (A) E.R. Henry (B) William Herschel (C) Francis Galton (D) Henry Faulds 8. Which of the following method is recommended to develop latent fingerprints on human skin? (A) Ninhydrin Method (B) Amido Black Method (C) Silver-Iodine Plate Transfer Method (D) DFO Method

Sant Gadge Baba Amravati University, Amravati

FACULTY: Science and Technology

Teaching and Learning Scheme **(Bioethics and Biosafety)** for the Three Year UG Degree of Bachelor of Biotechnology(Three Years- Six Semesters Bachelor's Degree Programme)

Course (Theory Curriculum) GOEC : **Bioethics and Biosafety**

Each theory paper of Theory shall be of 2 Credits comprising of 4 Units with Teaching Hours as mentionedin the table.

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
4.5	II	106404	Bioethics and Biosafety	2	30	2 Hrs	30

Course Objectives	1) To introduce the fundamental principles of ethics, bioethics, and biosafety and their significance in biological and biomedical sciences. 2) To develop an understanding of ethical issues associated with genetic engineering, GMOs, stem cell research, clinical trials, reproductive technologies, and environmental conservation. 3) To familiarize students with biosafety principles, biosafety levels, laboratory containment measures, and national and international biosafety regulations. 4) To provide knowledge of risk assessment, risk management, occupational health, and quality assurance practices such as Good Laboratory Practices (GLP) and Good Manufacturing Practices (GMP). 5) To promote responsible scientific conduct and enable students to evaluate ethical, legal, social, and environmental implications of modern biological research and biotechnology.
Course Outcomes	1) Explain the basic concepts, principles, and importance of bioethics and biosafety in biological research and biotechnology. 2) Analyze ethical issues related to GMOs, stem cells, clinical research, reproductive technologies, gene therapy, and environmental sustainability. 3) Demonstrate knowledge of biosafety levels, laboratory safety measures, biosafety cabinets, and national and international biosafety regulatory frameworks. 4) Apply principles of risk assessment, risk management, GLP, GMP, and occupational safety in laboratory and industrial settings. 5) Evaluate ethical, legal, and biosafety concerns associated with biotechnology products, pharmaceuticals, vaccines, food products, and environmental release of genetically modified organisms while adhering to responsible research practices.

Unit System	Contents	Workload Allotted (Hrs)	Weightage of Marks Allotted	Incorporation of Pedagogies
Unit I	**Introduction to Bioethics & Biosafety**	8	8	
	1.1 Introduction of Ethics			
	1.2 Bioethics, controversial ethical issues in biological sciences			
	1.3 Ethics involved in GMO, use of plants and animals as genetically modified			

	models			
	1.4 Ethical issues related to environment			
Unit II	**Bioethics in Biomedical sciences**	7	7	
	2.1 Stem Cells and bioethics			
	2.2 Bioethics in clinical trials, studies involving human			
	2.3 Bioethics in IVF, Embryo research, Sex selection			
	2.4 Bioethics in Surrogacy, genetic selection and enhancement, prenatal screening and gene therapy			
Unit III	**Introduction to Biosafety**	8	8	
	3.1 biosafety issues; Biological Safety Cabinets & their types; Primary Containment for Biohazards;			
	3.2 Biosafety Levels of Specific Microorganisms. Biosafety Guidelines: Biosafety guidelines and regulations (National and International);			
	3.3 GMOs/LMOs- Concerns and Challenges; Role of Institutional Biosafety Committees (IBSC), RCGM, GEAC etc. for GMO applications in food and agriculture;			
Unit IV	**Risk Analysis and Guidelines**	7	7	
	4.1 Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication.			
	4.2 Occupational health risks and immunoprophylaxis			
	4.3 GMP and GLP			
	4.4 Safety and ecological assessment of drugs, vaccines, feeds, foods and food products			
	References			
	1. Bioethics Across the Globe by Akira Akabayashi 2. Ethical Guidelines for Biomedical research on Human Subjects, Indian Council of Medical Research, New Delhi,20003. 3. National Ethical Guidelines for Biomedical and Health research in human participants, ICMR, 2017. 4. Biological Safety: Principles and Practices. Edited By; Dawn P. Wooley, Karen B. Byers 5. Biosafety in Microbiological and Biomedical Laboratories. Edited by L. Casey Chosewood, & Deborah E. Wilson.			
Model Questions:	Short Type (At least 8), Long Type (At least 4) and MCQs for Internal Assessment (At least 8) wherever applicable as the need of curriculum.			
	Short Type (At least 8): 1. What are bioethics? List out ethics involved in GMO. 2. Comment on ethics involved in stem cell research. 3. What are different biosafety levels? 4. What are different regulatory authorities for biosafety? 5. What are GMP and GLP? 6. What are occupational health risks?			

	Long Type (At least 4): 1. Give an account on controversial ethical issues in biological sciences? 2. Describe in detail the ethics related to GMO and environment? 3. Explain safety and ecological assessment of drugs, vaccines,. 4. Discuss the ethics in IVF, embryo research and prenatal screening.
	MCQs for Internal Assessment (At least 8) 1) FDA and EPA stands for; A) Foreign drug administration; Environmental protection agency B) Food and drug administration; Environmental protection agency C) Foreign drug association; European protection agency D) Food and drug administration; European protection agency 2) PPE is: A) Personal protective equipment B) Public protective equipment C) Possible protective equipment D) All of the above 3) Chose the most controversial form of genetic engineering in medicine; A) Production of cheap, easily stored vaccine for major childhood diseases B) The use of cloning technology to create organ for transplantation purpose C) Large organ transplantation from other species D) Use of GMO for environmental clean-up in various part of world 4) When working with infectious biological material, the best place to perform the work would be: A) In a Biological Safety Cabinet B) On the laboratory bench C) On a clean bench, wearing a dust mask D) In a Fume Hood 5) IVF stands for; A) Internal variance factor B) In vivo forest C) In vitro fertilization D) In vitro forest 6) Chemical, reagents or broth cultures should be pipetted by _____? A) mouth B) pipetter C) ear D) nose 7) Biosafety rules says that; A) Students can have tea in laboratory B) Students should wear lab coats while working in the laboratory C) Mouth pipetting is allowed D) All of the above 8) Genetically modified crops cannot be released directly in to environment because; A) They are difficult to release B) They are difficult to digest C) They may pose a risk of unintended gene transfer D) All of the above

Sant Gadge Baba Amravati University
FACULTY: Science and Technology
Teaching and Learning Scheme (Course Titles) for the Three Year UG Degree of Bachelor of Biotechnology
(Three Years- Six Semesters Bachelor's Degree Programme)

Course Template for VSC: Entrepreneurship approaches in Animal Tissue culture

Each theory paper of **Theory shall be of 2 Credits comprising of 4 Units with Teaching Hours** as mentioned in the table. The pattern of theory papers shall be as per following template –

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
4.5	II	106502	**Entrepreneurship approaches in Animal Tissue culture**	2	30	2 Hrs	30

The Curriculum of any Course shall be designed as per following template:

Course Objectives:	➢ To provide practical knowledge of animal tissue culture techniques, including aseptic handling, media preparation, cell maintenance, and cryopreservation. ➢ To develop entrepreneurial skills through business model development, market analysis, intellectual property management, and commercialization strategies. ➢ To familiarize students with regulatory requirements, biosafety standards, quality assurance systems, and documentation practices in animal tissue culture industries. ➢ To cultivate ethical awareness and responsible decision-making related to animal tissue culture research, product development, and commercialization. ➢ To enhance innovation, teamwork, communication, and business planning skills for establishing sustainable biotechnology ventures.			
Course Outcomes:	➢ Demonstrate proficiency in fundamental animal tissue culture techniques, including aseptic procedures, media preparation, cell subculturing, and cryopreservation. ➢ Analyze market opportunities, intellectual property issues, and commercialization pathways for animal tissue culture technologies. ➢ Apply regulatory guidelines, GLP, GMP, biosafety principles, and quality assurance practices in laboratory and industrial settings. ➢ Evaluate ethical, legal, and societal issues associated with animal tissue culture and propose responsible solutions. ➢ Develop and **present** a comprehensive business plan for an animal tissue culture-based startup by integrating scientific, regulatory, financial, and entrepreneurial principles.			
Unit System	**Contents Lab practical's**	**Workload Allotted (Hrs)**	**Weightage of Marks Allotted**	**Incorporation of Pedagogies**
Unit I Practicals	**Introduction to Animal Tissue Culture**	8	8	
	1.1: Hands-on experience with aseptic techniques			
	1.2: Preparation of culture media for animal cell culture			
	1.3: Subculturing of animal cells in culture dishes			
	1.4 Cryopreservation, revival, and maintenance of animal cell lines; monitoring cell viability and contamination			

Unit II Practicals	**Business Model Development**	7	7	
	2.1: Group project to develop a business model for a fictional animal tissue culture company, Presentation of the business model to the class for feedback			
	2.2: Research on market trends and opportunities in animal tissue culture, Presentation of findings and recommendations for market entry			
	2.3: Intellectual property rights and patenting in animal tissue culture			
	2.4: Entrepreneurship, startup funding, technology transfer, and commercialization strategies for animal tissue culture products			
Unit III Practicals	**Regulatory Compliance**	8	8	
	3.1 Discussion of regulatory requirements for commercializing animal tissue culture products			
	3.2: Case study analysis of regulatory issues faced by animal tissue culture companies			
	3.3 Compliance and quality assurance in animal tissue culture			
	3.4: Good Laboratory Practices (GLP), Good Manufacturing Practices (GMP), biosafety regulations, and documentation for regulatory approval			
Unit IV Practicals	**Ethical Considerations**	7	7	
	4.1: Group discussion on ethical considerations in animal tissue culture, planning and management of Animal tissue culture			
	4.2: Debate on a controversial ethical issue related to animal tissue culture			
	4.3: Group project to develop a business plan for a startup animal tissue culture company			
	4.4: Presentation of the business plan to a panel of industry experts for evaluation			
References:	● Freshney, R. Ian. Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications. John Wiley & Sons, 2015. ● Masters, John R. Animal Cell Culture: Essential Methods. John Wiley & Sons, 2018. ● "Plant Tissue Culture: Techniques and Experiments" by Roberta H. Smith ● "Biotechnology Entrepreneurship: Starting, Managing, and Leading Biotech Companies" by Craig Shimasaki			

Sant Gadge Baba Amravati University
FACULTY: Science and Technology
Teaching and Learning Scheme (Course Titles) for the Three Year UG Degree of Bachelor of Biotechnology
(Three Years- Six Semesters Bachelor's Degree Programme)

Course Template for SEC : Clinical Lab Technology

Each theory paper of **Theory shall be of 2 Credits comprising of 4 Units with Teaching Hours** as mentioned in the table. The pattern of theory papers shall be as per following template –

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
4.5	II	106602	**Clinical Lab Technology**	2	30	2 Hrs	30

The Curriculum of any Course shall be designed as per following template:

Course Objectives :	1. To introduce students to the organization, safety practices, quality control, and routine operations of clinical diagnostic laboratories. 2. To develop practical skills in hematological, biochemical, and microbiological laboratory techniques used in disease diagnosis. 3. To provide hands-on training in specimen collection, processing, analysis, and interpretation of laboratory investigations. 4. To familiarize students with laboratory instruments, analytical methods, quality assurance systems, and biomedical waste management. 5. To prepare students for employment in clinical, diagnostic, research, and healthcare laboratories by fostering technical competence, professionalism, and ethical laboratory practices.			
Course Outcomes :	1. Demonstrate safe laboratory practices, proper specimen handling, biomedical waste disposal, and effective laboratory management. 2. Perform routine hematological investigations, prepare and examine blood smears, and interpret basic hematological findings. 3. Conduct common clinical biochemical tests using spectrophotometric and colorimetric techniques and accurately interpret laboratory results. 4. Apply microbiological techniques, including aseptic handling, bacterial culture, staining methods, and antimicrobial susceptibility testing for pathogen identification. 5. Analyze and report clinical laboratory findings while adhering to quality assurance standards, ethical practices, and standard operating procedures (SOPs).			
Unit System	**Contents Lab practicals**	**Workload Allotted (Hrs)**	**Weightage of Marks Allotted**	**Incorporation of Pedagogies**
Unit I Practicals	**Introduction to Clinical Laboratory Techniques**			
	1.1: Introduction to laboratory safety procedures#			
	1.2: Familiarization with laboratory equipment and instruments			
	1.3: Basic principles of laboratory organization and management			
	1.4: Specimen collection, labeling, transportation, storage, biomedical waste management, and quality control in clinical laboratories			
Unit II Practicals	**Hematology**			
	2.1: Blood sample collection techniques			
	2.2: Hematological tests: complete blood count			

	(CBC), hemoglobin estimation, hematocrit determination			
	2.3: Blood smear preparation and staining techniques			
	2.4 Examination of blood cells under the microscope			
Unit III Practicals	**Clinical Chemistry**			
	3.1 Introduction to biochemical tests and their clinical significance			
	3.2:Basic principles of spectrophotometry and colorimetry			
	3.3 Performing biochemical tests: glucose estimation, liver function tests (e.g., ALT, AST, ALP), renal function tests (e.g., creatinine, blood urea nitrogen)			
	3.4 Interpretation of biochemical test results			
Unit IV Practicals	**Microbiology**			
	4.1: Aseptic techniques for microbiological culture			
	4.2: Culture and identification of common bacterial pathogens			
	4.3: Antimicrobial susceptibility testing using disk diffusion method			
	4.4: Introduction to staining techniques: Gram staining, acid-fast staining			
References:	1. "Clinical Laboratory Hematology" by Shirlyn B. McKenzie, Lynne Williams, and John N. McKenzie 2. "Clinical Chemistry: Principles, Techniques, and Correlations" by Michael L. Bishop, Edward P. Fody, and Larry E. Schoeff 3. "Clinical Microbiology Procedures Handbook" by Amy L. Leber 4. "Clinical Immunology and Serology: A Laboratory Perspective" by Christine Dorresteyn Stevens and Linda E. Miller 5. "Clinical Laboratory Management" by Lynne S. Garcia 6. "Clinical Laboratory Science Review" by Robert R. Harr			

Sant Gadge Baba Amravati University
FACULTY: Science and Technology

Teaching and Learning Scheme (Biochemistry) for the Three Year UG Degree of Bachelor of Biotechnology

(Three Years- Six Semesters Bachelor's Degree Program)

Syllabus for: Major: Biochemistry

Each theory paper of **Theory shall be of 2 Credits comprising of 4 Units with Teaching Hours** as mentioned in the table. The pattern of theory papers shall be as per following template-

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.0	III	106205	**Biochemistry**	2	30	2 Hrs	30

Course Objectives:	1. To provide a comprehensive understanding of carbohydrate, lipid, protein, and amino acid metabolism, including their biological significance. 2. To explore the major metabolic diseases, their pathophysiology, clinical manifestations, and approaches for management and prevention. 3. To familiarize students with various biochemical techniques, including spectrophotometry, chromatography, electrophoresis, and centrifugation. 4. To develop practical skills in qualitative and quantitative biochemical analysis, preparing students for laboratory research and clinical applications.
Course Outcomes:	1. Students will be able to describe the classification, properties, and metabolism of carbohydrates, lipids, proteins, and amino acids, linking their biological importance to health and disease. 2. Students will understand the mechanisms underlying major metabolic diseases, including their symptoms, diagnostic techniques, and treatment strategies. 3. Students will acquire hands-on experience in biochemical laboratory techniques for analyzing biomolecules, aiding in research and diagnostics. 4. Students will be equipped with problem-solving skills and analytical thinking required for biochemical research, industrial applications, and healthcare settings.

Unit System	Contents	Workload Allotted (Hrs)	Weightage of Marks Allotted	Incorporation of Pedagogies
Unit I	**Carbohydrates and Lipids Metabolism**	8	8	Lectures, Power point presentation, Discussion, Demonstration, Collaborative learning, Problem based learning (PBL), Peer teaching, Experimental learning. Direct instructions
	1.1 Classification, properties, Structure & Biological importance.			
	1.2 Metabolism of carbohydrates, Fermentation			
	1.3 Lipid, its Classification			
	1.4 Properties, Structure, Function, Biological importance & Industrial Significance.			
Unit II	**Amino acid & Proteins**	7	7	
	2.1Classification, properties, Structure & Biological significance of Amino Acids.			
	2.2 General reaction of amino acid metabolism such as: -Transamination, Oxidation Deamination, Decarboxylation, Urea Cycle & its regulation.			
	2.3 Classification of protein, Level of Structure protein, Peptide bonds, Denaturation and Renaturation of proteins.			
	2.4 Biological Functions of fibrous proteins (Keratins, Collagen, Elastins),			

	globular proteins (Hemoglobin & myoglobin), catalytic protein			
Unit III	**<u>Major Metabolic Diseases/Disorders</u>**	7	7	
	3.1 Introduction to Metabolic Diseases, Classification of metabolic disorders			
	3.2 Common Metabolic Disorders; Diabetes Mellitus, Obesity and Metabolic Syndrome, Hyperlipidemia and Cardiovascular Diseases, Inborn Errors of Metabolism (e.g., Phenylketonuria, Gaucher's Disease, Tay-Sachs Disease)			
	3.3 Pathophysiology and Clinical Manifestations: Symptoms, complications, and progression of diseases, Diagnostic approaches (biochemical tests, genetic screening, imaging)			
	3.4 Management and Prevention: Lifestyle modifications (diet, exercise, and weight management), Pharmacological treatments (insulin therapy, lipid-lowering drugs, enzyme replacement therapy), Preventive strategies and public health interventions			
Unit IV	**<u>Techniques in Biochemistry</u>**	8	8	
	4.1 Spectrophotometry:- Principle, Instrumentation & application of UV & Visible Spectrophotometry			
	4.2 Chromatography: - Principle & Application: Paper Chromatography, Thin Layer Chromatography, Ion exchange Chromatography, Affinity Chromatography			
	4.3 Electrophoresis: - Basic principle of Agarose and paper electrophoresis, PAGE, SDS-PAGE, 2-D electrophoresis & its importance.			
	4.4 Centrifugation: - Basic Principle, RCF, Sedimentation coefficient. Types of Centrifuges			
Activities: (Any 02)	1. Assignments 2. Tour/Industrial visit 3. Seminars 4. Participation in any college activity 5. Any minor project			
Reference books	1) Lehninger Principles of Biochemistry – David L. Nelson & Michael M. Cox (Comprehensive and widely used for deep understanding) 2) Biochemistry – Jeremy M. Berg, John L. Tymoczko & Lubert Stryer (Good for conceptual clarity with detailed explanations) 3) Harper's Illustrated Biochemistry – Victor W. Rodwell et al. (Concise with clinical correlations and illustrations) 4) Biochemistry – Donald Voet & Judith G. Voet. 5) Biochemistry for Medical Students – DM Vasudevan, Sreekumari S., Kannan Vaidyanathan (Simplified for medical students with clinical applications) 6) Textbook of Biochemistry with Clinical Correlations – Thomas M. Devlin (Good for integrating biochemistry with medicine)			

Sant Gadge Baba Amravati University
FACULTY: Science and Technology
Teaching and Learning Scheme (Major: Fundamentals of Inheritance Biology: Genetics**) for the Three Year UG Degree of Bachelor of Biotechnology**
(Three Years- Six Semesters Bachelor's Degree Program)

Syllabus for: Major: Fundamentals of Inheritance Biology: Genetics
Each theory paper of **Theory shall be of 2 Credits comprising of 4 Units with Teaching Hours** as mentioned in the table. The pattern of theory papers shall be as per following template

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.0	III	106206	**Major:** Fundamentals of Inheritance Biology: Genetics	2	30	2 Hrs	30

Course Objectives:	1. To understand the fundamental principles of heredity, genetic variation, and molecular genetics. 2. To explore the structure, function, and organization of genes and chromosomes. 3. To study the mechanisms of genetic inheritance and gene expression regulation. 4. To analyze the applications of genetics in biotechnology, medicine, and evolutionary studies. 5. To introduce modern genetic techniques, including genomics, molecular genetics, and bioinformatics. 6. To examine the ethical, legal, and social implications of genetic research and technology.			
Course Outcomes:	1. Remember the basic principles of inheritance, gene expression, and genetic variation. 2. Understand fundamental principles of genetics – including Mendelian and non-Mendelian inheritance, gene interactions, and chromosomal organization. 3. To explore the structure and function of genes, chromosomes, and genomes. 4. Apply genetic concepts to solve problems in inheritance, evolution, and biotechnology. 5. Have conceptual understanding of laws of inheritance, genetic basis of loci, alleles and their linkage. 6. Evaluate the ethical, social, and environmental implications of genetic technologies. 7. Create experimental designs to study genetic phenomena.			
Unit System	**Contents**	**Workload Allotted (Hrs)**	**Weightage of Marks Allotted**	**Incorporation of Pedagogies**
Unit I	**Physical Basis of Inheritance** 1.1 Chromosome- Morphology, Types, Centromere & Telomere Primary and Secondary constriction, Sat-bodies, Karyotype and Idiogram	8	8	Lectures, Power point presentation, Discussion, Problem based learning (PBL), Peer teaching, Experimental
	1.2 Special types of chromosomes- Polytene and Lamp brush			
	1.3 Chromosomal aberrations – Structural aberrations: Deletion (Terminal, Interstitial),, Duplication (Tandem, Reverse tandem and Displaced), Inversion (Pericentric and Paracentric) and Translocation (Simple, Reciprocal, Displaced)			
	1.4 Numerical aberrations: Euploidy and aneuploidy. Significance of chromosomal			

	aberrations.			learning. Direct instructions
Unit II	**Mendelian Principles and Gene Interactions**	7	7	
	2.1 Concepts of Phenotype, Genotype, Heredity, variation, Pure lines and Inbred lines. Mendel's experiments on pea plants			
	2.2 Mendelism: Mendel's law of Dominance, monohybrid and dihybrid cross, law of Segregations and Independent assortment, Incomplete dominance and co-dominance,			
	2.3 Multiple Alleles. Polygenic inheritance and pleotropic gene			
	2.4 Interaction of genes- Complimentary, Supplementary and Epistasis			
Unit III	**Post-Mendelian Genetics and Genetic Variations**	7	7	
	3.1 Linkage – Concept, Linkage group, Types and theories			
	3.2 Crossing over: Concept, Types and theories Molecular mechanism of crossing over - Holiday model, Crossing over			
	3.3 Gene mutations- Spontaneous and Induced Mutation, Mutagen			
	3.4 Cytoplasmic Inheritance- Mitochondrial DNA and Chloroplast DNA			
Unit IV	**Applied and Evolutionary Genetics**	8	8	
	4.1 Population Genetics – Hardy-Weinberg principle, factors affecting genetic equilibrium (mutation, selection, genetic drift, gene flow, non-random mating).			
	4.2 Genetic Disorders – chromosomal disorders (Down's, Turner's, Klinefelter's syndrome), Pedigree analysis			
	4.3 Sex Determination – Mechanisms of sex determination (Humans, Bird and Honey Bees), sex-linked, sex-limited, and sex-influenced traits.			
	4.4 Human Genome Project, functional genomics, and proteomics.			
Activities: (Any 02)	1. Assignments 2. Tour/Industrial visit 3. Seminars 4. Participation in any college activity 5. Any minor project			
Reference books	1. Cytogenetics, 1st Edition, P.K. Gupta. 2013 2. Genetics – Classical to modern, 1st Edition. P.K. Gupta. 2013. 3. Theory and Problems of Genetics. W. D. Stansfield. 2002. Mc Graw Hill publications. 4. Genes- IX, 9th Ed., Benjamin Lewin. Jones and Bartlett Publishers, 2008. 5. Chromosomal Abberrations: Basic and Applied aspects by Obe. G. and A.T. Natarajan (1990) Springer Verlag, Berlin. 6. Cytogenetics, Plant Breeding and evolution by U.Sinha and Sunita Sinha, Vikas Publishing House Private, Limited, 1998. 7. A Textbook of Genetics - Veer Bala Rastogi 8. Molecular Biology of the Gene - James D. Watson 9. Human Molecular Genetics - Tom Strachan & Andrew Read 10. Concepts of Genetics - Klug, Cummings, Spencer, Palladino 11. Genetics: From Genes to Genomes - Hartwell, Goldberg, Fischer, Hood			

Sant Gadge Baba Amravati University
FACULTY: Science and Technology
Teaching and Learning Scheme (Cell Biology) for the Three-Year UG Degree of Bachelor of Biotechnology (Three Years- Six Semesters Bachelor's Degree Program)

Course (Theory Curriculum): **Biochemistry & Genetics (Practical)**
Each theory paper of Theory shall be of 2 Credits comprising of 4 Units with Teaching Hours as mentioned in the table.

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.0	III	106207	**Biochemistry & Genetics (Practical)**	2	30	2 Hrs	30

Course Objectives:	1. To develop practical understanding of basic principles of genetics, heredity, and variation through laboratory exercises. 2. To familiarize students with Mendelian inheritance, genetic crosses, linkage, recombination, and chromosome behavior. 3. To provide hands-on knowledge of biochemical techniques for the qualitative and quantitative analysis of biomolecules. 4. To develop skills in the identification and estimation of carbohydrates, proteins, lipids, enzymes, and nucleic acids using standard laboratory methods. 5. To develop students' ability to perform experiments, maintain laboratory records, analyze results, and interpret biochemical and genetic data.	
Course Outcomes:	1. Apply Mendelian principles to solve genetic crosses and determine expected genotypic and phenotypic ratios. 2. Identify and interpret chromosome behavior, mutations, linkage, recombination, and inheritance patterns using practical exercises and genetic problems. 3. Perform qualitative tests for major biomolecules, including carbohydrates, proteins, lipids, and nucleic acids. 4. Estimate biomolecules and enzyme activity using appropriate biochemical methods, standard curves, and spectrophotometric techniques. 5. Analyze, calculate, record, and interpret experimental data and relate practical observations to fundamental concepts of genetics and biochemistry.	
	Contents	
Experiments	1. Study of Chromosome Morphology & Types – Observation of mitotic and meiotic chromosomes using prepared slides. 2. To prove Mendel's Monohybrid ratio. 3. To prove Mendel's Dihybrid ratio. 4. Study Mendel's Law of Segregation using a single trait 5. Demonstrate Mendel's Law of Independent Assortment using two traits 6. Identify Mendelian traits in humans. (Widow's peak (dominant) vs. straight hairline (recessive)) 7. Pedigree Analysis: To study the inheritance of genetic diseases (e.g., haemophilia, sickle cell anemia). 8. Karyotyping: To identify chromosomal abnormalities. 9. Statistically verify expected vs. observed ratios in a genetic cross. (Chi-Square Test) 10. PTC (Phenylthiocarbamide) Tasting Experiment: Determine dominant vs. recessive inheritance of taste perception by using ptc tasting strips. 11. Genetic Drift Simulation (Bottleneck & Founder Effect Using Marbles) 12. Solving problems related to recombination frequency and linkage mapping. 13. Qualitative test for carbohydrate (Molish Test). 14. Qualitative test for Lipids (Saponification). 15. Qualitative test for proteins and amino Acids. 16. Measurement of pH of given sample by universal indicator solution, pH Meter & pH Strips. 17. Paper Chromatography of amino acids samples. 18. Verification of Beer's Lambert's Law.	

	19. Agarose gel electrophoresis of DNA Sample. 20. Study tour/ visit to industry/visit to laboratory.	
Text Books:	1. Snustad, D. P. & Simmons, M. J. – *Principles of Genetics*. Wiley. 2. Klug, W. S., Cummings, M. R. & Spencer, C. A. – *Concepts of Genetics*. Pearson. 3. Gardner, E. J., Simmons, M. J. & Snustad, D. P. – *Principles of Genetics*. Wiley. 4. Griffiths, A. J. F. et al. – *An Introduction to Genetic Analysis*. W. H. Freeman. 5. Verma, P. S. & Agarwal, V. K. – *Genetics*. S. Chand Publishing. 6. Nelson, D. L. & Cox, M. M. – *Lehninger Principles of Biochemistry*. W. H. Freeman. 7. Berg, J. M., Tymoczko, J. L. & Stryer, L. – *Biochemistry*. W. H. Freeman. 8. Voet, D., Voet, J. G. & Pratt, C. W. – *Fundamentals of Biochemistry: Life at the Molecular Level*. Wiley. 9. Plummer, D. T. – *An Introduction to Practical Biochemistry*. McGraw-Hill. 10. Jayaram, J. – *Laboratory Manual in Biochemistry*. New Age International.	

Sant Gadge Baba Amravati University
FACULTY: Science and Technology
Teaching and Learning Scheme (Fundamentals of Microbiology) for the Three Year UG Degree of Bachelor of Biotechnology
(Three Years- Six Semesters Bachelor's Degree Program)

Syllabus for: Fundamentals of Microbiology (IKS Major Specific)

Each theory paper of **Theory shall be of 2 Credits comprising of 4 Units with Teaching Hours** as mentioned in the table. The pattern of theory papers shall be as per following template

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.0	III	106701	**Fundamentals of Microbiology**	2	30	2 Hrs	30

Course Objectives:	1. To introduce the historical development of microbiology, contributions of key scientists, and the scope of microbiology. 2. To provide an understanding of microbial classification, growth, cultivation, and maintenance techniques. 3. To explore microbial cell structures, staining techniques, and their applications. 4. To familiarize students with sterilization techniques and the role of microbes in various applied fields.			
Course Outcomes:	1. Students will be able to explain the historical developments in microbiology and describe the contributions of key scientists in shaping the field. 2. Students will understand microbial classification, growth dynamics, cultivation techniques, and factors affecting microbial growth. 3. Students will acquire knowledge of microbial cell structure, staining techniques, and their importance in microbial identification. 4. Students will demonstrate an understanding of sterilization techniques and the diverse applications of microbiology in agriculture, medicine, industry, and the environment.			
Unit System	**Contents**	**Workload Allotted (Hrs)**	**Weightage of Marks Allotted**	**Incorporation of Pedagogies**
Unit I	**Introduction to Microbiology and History**			
	1.1 Overview of the history of microbiology – Contributions of Redi, Spallanzani, Needham, Pasteur, Tyndall, Joseph Lister, Koch (Germ Theory), Edward Jenner, and Alexander Fleming (Penicillin).	8	8	Lectures, Power point presentation, Discussion, Peer teaching, Experimental learning. Direct instructions
	1.2 Biogenesis and abiogenesis – Spontaneous generation theory vs. germ theory.			
	1.3 Scope and applications of microbiology in various fields (medical, industrial, agricultural, environmental, and food microbiology).			
Unit II	**Microbial Classification, Growth, and Cultivation**			
	2.1 Classification of microbes – Systems of classification, numerical	7	7	

	taxonomy, identifying characters for classification.			
	2.2 Principles of microbial classification – Systematics of bacteria, nutritional types (definitions and examples).			
	2.3 Oxygen requirement-based classification of microorganisms. Cultivation and maintenance of microorganisms: Nutritional categories of microorganisms, methods of isolation, purification, and preservation.			
	2.4 Microbial growth – Growth curve, generation time, synchronous, batch, and continuous culture. Measurement of growth and factors affecting microbial growth			
Unit III	Microbial Structure and Staining Techniques	8	8	
	3.1 Ultrastructure of microbial cells – Bacterial cell components and their functions.			
	3.2 Staining techniques – Definition of auxochrome, chromophores, and dyes.			
	3.3 Classification of stains – Simple staining, differential staining, structural staining.			
	3.4 Mechanisms of gram staining, acid-fast staining, negative staining, capsule staining, flagella staining, and endospore staining.			
Unit IV	**Sterilization and Applications of Microbiology**	7	7	
	4.1 **Sterilization Techniques:** Definition and concept of sterilization. Physical methods – Dry and moist heat, pasteurization, tyndallization, radiation, ultrasonication, filtration			
	4.2 Chemical Methods of Sterilization: Disinfection, sanitization, antisepsis, sterilants, and fumigation.			
	4.3 **Applied Microbiology:** Microbes in agriculture – Role in nitrogen fixation and composting. Microbes in food – Fermentation, probiotics, and food spoilage			
	4.4 Medical, Environmental, and Industrial Microbiology: Role of microbes in disease, bioremediation, and industrial applications (enzyme, antibiotic, and biofuel production)			
Practical Syllabus	1. Microbiology laboratory instruments (Autoclave, Oven, Incubator, Laminar air flow)			

	2. Sampling and quantification of microorganisms in air, soil and water. 3. Isolation of bacteria [Streak plate, spread plate, pour plate, serial dilution 4. Culture preservation techniques (Slant, Glycerol, Soil Culture, Water Culture) 5. Identification of microorganisms from the habitats by staining 6. Observation of morphology - shape and arrangement of cells. 7. Methods of inoculation of different microbes in selective media. 8. Antimicrobial study (Disc diffusion method) 9. Gram staining 10. Isolation of fungi on pertiplates
Activities: (Any 02)	1. Assignments 2. Tour/Industrial visit 3. Seminars 4. Participation in any college activity 5. Any minor project
Reference books	1. Brock Biology of Microorganisms. By Michael Madigan (ISBN: 978-9332586864) 2. Microbiology by Prescott. By Christopher J. Woolverton, Linda Sherwood (ISBN:978-1-260-21188-7 3. Anantha Narayan and Paniker's Textbook of Microbiology. (ISBN: 9789389211436) 4. Microbiology Book by Pelczar. (ISBN: 9780074623206) 5. A Textbook of Basic and Applied Microbiology by K R Aneja (ISBN: 9789395161572) 6. Microbiology: An Introduction. By Gerard Tortora. (ISBN: 9788131722329)

Sant Gadge Baba Amravati University
FACULTY: Science and Technology
Teaching and Learning Scheme (Biochemistry & Microbiology) for the Three Year UG Degree of Bachelor of Biotechnology
(Three Years- Six Semesters Bachelor's Degree Program)

Syllabus for: Minor: Biochemistry & Microbiology

Each theory paper of **Theory shall be of 2 Credits comprising of 4 Units with Teaching Hours** as mentioned in the table. The pattern of theory papers shall be as per following template

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.0	III	106301	**Biochemistry & Microbiology**	2	30	2 Hrs	30

Course Objectives:	5. To introduce students to the fundamental principles of biochemistry and microbiology. 6. To develop an understanding of biomolecules, enzymes, and microbial physiology. 7. To provide hands-on experience in laboratory techniques related to biochemistry and microbiology. 8. To prepare students for advanced studies and applications in biomedical sciences, biotechnology, and research.			
Course Outcomes:	5. Students will develop a fundamental understanding of biochemical molecules and microbial diversity. 6. They will gain laboratory skills in biochemical analysis and microbial culture techniques. 7. They will learn the importance of microorganisms in health, industry, and environmental sciences. 8. They will be prepared for higher education and careers in biotechnology, microbiology, and medical sciences.			
Unit System	**Contents**	**Workload Allotted (Hrs)**	**Weightage of Marks Allotted**	**Incorporation of Pedagogies**
Unit I	**Biomolecules and Their Functions**	8	8	Lectures, Power point presentation, Discussion, Problem based learning (PBL), Peer teaching, Experimental learning. Direct instructions
	1.1. Introduction to carbohydrates, lipids, proteins, and nucleic acids			
	1.2. Structure and function of enzymes and coenzymes			
	1.3. Metabolism of biomolecules (carbohydrate, lipid, protein metabolism)			
	1.4 Importance of vitamins and minerals in biological processes			
Unit II	**Microbial World and Classification**	7	7	
	2.1. General characteristics of bacteria, viruses, fungi, and protozoa			
	2.2. Classification and nomenclature of microorganisms			
	2.3. Structure and function of bacterial cell components			
	2.4. Overview of microbial nutrition and growth			
Unit III	**Microbial Physiology and Genetics**	7	7	
	3.1. Microbial respiration: aerobic and anaerobic metabolism			
	3.2.DNA replication, transcription, and translation in microorganisms			
	3.3. Gene regulation and microbial mutations			

	3.4. Role of plasmids and bacteriophages in genetic variation			
Unit IV	**Immunology and Applied Microbiology**	8	8	
	4.1. Introduction to the immune system: innate and adaptive immunity			
	4.2. Antigens, antibodies, and their interactions			
	4.3. Industrial and environmental microbiology (fermentation, antibiotics, waste treatment)			
	4.4. Applications of biochemistry and microbiology in medicine and biotechnology			
Activities: (Any 02)	1. Assignments 2. Tour/Industrial visit 3. Seminars 4. Participation in any college activity 5. Any minor project			
Reference books	1. Nelson, D. L. & Cox, M. M. – *Lehninger Principles of Biochemistry*. W. H. Freeman/Macmillan Learning. 2. Berg, J. M., Tymoczko, J. L., Gatto, G. J. & Stryer, L. – *Biochemistry*. W. H. Freeman. 3. Voet, D., Voet, J. G. & Pratt, C. W. – *Fundamentals of Biochemistry: Life at the Molecular Level*. Wiley. 4. U. Satyanarayana & U. Chakrapani – *Biochemistry*. Elsevier. 5. J. L. Jain & Sunjay Jain – *Fundamentals of Biochemistry*. S. Chand Publishing. 6. Tortora, G. J., Funke, B. R. & Case, C. L. – *Microbiology: An Introduction*. Pearson. 7. Madigan, M. T. et al. – *Brock Biology of Microorganisms*. Pearson. 8. Prescott, L. M., Harley, J. P. & Klein, D. A. – *Prescott's Microbiology*. McGraw-Hill. 9. Pelczar, M. J., Chan, E. C. S. & Krieg, N. R. – *Microbiology*. McGraw-Hill. 10. R. C. Dubey & D. K. Maheshwari – *A Textbook of Microbiology*. S. Chand Publishing			

Sant Gadge Baba Amravati University
FACULTY: Science and Technology
Teaching and Learning Scheme (Cell Biology) for the Three-Year UG Degree of Bachelor of Biotechnology (Three Years- Six Semesters Bachelor's Degree Program)

Course (Theory Curriculum) Minor: Biochemistry & Microbiology (Practical)
Each theory paper of Theory shall be of 2 Credits comprising of 4 Units with Teaching Hours as mentioned in the table.

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.0	III	106302	**Biochemistry & Microbiology (Practical)**	2	30	2 Hrs	30

Course Objectives:	1. To develop practical knowledge of the basic principles of biochemistry and microbiology through laboratory experiments. 2. To familiarize students with qualitative and quantitative analysis of biomolecules such as carbohydrates, proteins, lipids, and enzymes. 3. To develop skills in aseptic techniques, preparation of culture media, microbial cultivation, and laboratory safety. 4. To provide practical training in the microscopic observation, staining, identification, and characterization of microorganisms. 5. To develop the ability to perform experiments accurately, record observations, analyse results, and interpret biochemical and microbiological data.
Course Outcomes:	1. Perform qualitative tests and basic quantitative estimations of carbohydrates, proteins, lipids, and other important biomolecules. 2. Prepare culture media and demonstrate aseptic techniques for the safe handling and cultivation of microorganisms. 3. Prepare and observe microbial specimens using staining techniques, including simple and Gram staining, and distinguish major bacterial groups. 4. Understand and analyse microbial growth characteristics, including growth phases and the influence of environmental factors such as temperature and pH. 5. Apply biochemical and microbiological techniques to obtain, record, analyze, and interpret experimental results and relate them to real-world applications in biotechnology, food, agriculture, and health sciences.
	Contents
Experiments	1. Preparation of buffers and pH measurement 2. Qualitative tests for carbohydrates 3. Qualitative tests for lipids 4. Qualitative tests for proteins 5. Estimation of proteins by Biuret and Lowry's method 6. Microscopy techniques: Gram staining and observation of microorganisms 7. Study of bacterial growth curve using spectrophotometry 8. Isolation of bacteria from soil and water samples 9. Identification of fungi using staining techniques 10. Enzyme activity assay (e.g., amylase or catalase test) 11. Antibiotic sensitivity test using Kirby-Bauer method 12. Study of blood groups and antigen-antibody reactions 13. Preparation of culture media and microbial inoculation techniques 14. Fermentation experiment: Alcohol or lactic acid production
Text Books:	1. Nelson, D. L. & Cox, M. M. – *Lehninger Principles of Biochemistry*. W. H. Freeman. 2. Berg, J. M., Tymoczko, J. L. & Stryer, L. – *Biochemistry*. W. H. Freeman. 3. Voet, D., Voet, J. G. & Pratt, C. W. – *Fundamentals of Biochemistry: Life at the Molecular Level*. Wiley. 4. Plummer, D. T. – *An Introduction to Practical Biochemistry*. McGraw-Hill. 5. Jayaram, J. – *Laboratory Manual in Biochemistry*. New Age International. 6. Pelczar, M. J., Chan, E. C. S. & Krieg, N. R. – *Microbiology*. McGraw-Hill. 7. Prescott, L. M., Harley, J. P. & Klein, D. A. – *Prescott's Microbiology*. . 8. Tortora, G. J., Funke, B. R. & Case, C. L. – *Microbiology: An Introduction*. Pearson.

Sant Gadge Baba Amravati University, Amravati
FACULTY: Science & Technology
Teaching and Learning Scheme for the Three-Year UG Degree of Bachelor of Biotechnology(Three Years- Six Semesters Bachelor's Degree Program)

Course (Theory Curriculum) GOEC: Food Adulteration and prevention

Each theory paper of Theory shall be of 2 Credits comprising of 4 Units with Teaching Hours as mentionedin the table.

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.0	III	106404	**Adulteration & Prevention**	2	30	2 Hrs	30

Course Objectives	1. To introduce students to the concepts of food adulteration, its types, and its impact on human health. 2. To familiarize students with various methods of detecting adulterants in common foods and food additives. 3. To provide an understanding of food safety laws, regulatory authorities, and procedures for maintaining food quality. 4. To educate students about consumer rights, legal frameworks, and ethical aspects related to food safety and adulteration.
Course Outcomes	1. Students will gain knowledge about different types of food adulteration and their health implications. 2. They will learn and apply various techniques for detecting adulterants in common food products. 3. They will understand national and international food safety laws, including FSSA, Codex Alimentarius, and consumer protection acts. 4. They will develop awareness about consumer rights, responsibilities, and legal procedures for reporting food adulteration cases.

Unit System	Contents	Workload Allotted (Hrs)	Weightage of Marks Allotted	Incorporation of Pedagogies
Unit I	**Common Foods and Adulteration**	8	8	Lectures, Power point presentation, Discussion, Problem based learning (PBL), Peer teaching, Direct instructions
	1.1 Definition – Types; Poisonous substances, foreign matter, Cheap substitutes, Spoiled parts.			
	1.2 Adulteration through Food Additives – Intentional and incidental.			
	1.3 General Impact on Human Health.			
	1.4 Historical Food legislation in India			
Unit II	**Adulteration of Common Foods and Methods of Detection**	7	7	
	2.1 Means of Adulteration			
	2.2 Methods of Detection of Adulterants in the following Foods; Milk, Oil, Grain, Sugar, Spices and condiments, processed food, Fruits and vegetables.			
	2.3 Food additives – classification, nature and characteristics			
	2.4 Use of additives in food and Sweetening agents (at least three methods of detection for each food item).			

Unit III	**Present Laws and Procedures on Adulteration**	8	8	
	3.1 Highlights of Food Safety and Standards Act 2006 (FSSA) –Food Safety and Standards Authority of India–Rules and Procedures of Local Authorities			
	3.2 Role of voluntary agencies such as, Agmark, I.S.I., Quality-control laboratories of companies			
	3.3. Food safety officer; powers, procedures, role of food analyst most important international laws; Codex alimentarius, FDA, USDA, FAO and WHO			
	3.4 Private testing laboratories, Quality control laboratories of consumer cooperatives.			
Unit IV	**Consumers rights**	7	7	
	4.1 Consumer education, Consumer's problems rights and responsibilities, COPRA 2019.			
	4.2 Offenses and Penalties – Procedures to Complain – Compensation to Victims.			
	4.3 Tips for wise purchasing, redressal measures how to give complaints and proforma of complaints			
	4.4 Importance of adulteration detection in industries & home			
Reference Books	1. A firstcoursei n Food Analysis–A.Y. Sathe,NewAgeInternational(P)Ltd.1999. 2. Food Safety, case studies–Ramesh.V.Bhat,NIN, 1992. 3. https://old.fssai.gov.in/Portals/0/Pdf/Draft_Manuals/Beverages and confectionary. pdf. 4. https://cbseportal.com/project/Download-CBSE-XII-Chemistry-Project 5. Food Adulteration#gsc.tab=0 (Downloadable e material on food adulteration). 6. https://www.fssai.gov.in/. 7. https://indianlegalsolution.com/laws-on-food-adulteration/ 8. https://fssai.gov.in/dart/			

Sant Gadge Baba Amravati University
FACULTY: Science and Technology
Teaching and Learning Scheme (Bioinformatics) for the Three Year UG Degree of Bachelor of Biotechnology
(Three Years- Six Semesters Bachelor's Degree Program)

Syllabus for: VSC: Bioinformatics

Each theory paper of **Theory shall be of 2 Credits comprising of 4 Units with Teaching Hours** as mentioned in the table. The pattern of theory papers shall be as per following template.

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.0	III	106503	**Bioinformatics**	2	30	2 Hrs	50

Course Objectives:	1. To introduce students to the fundamental concepts of bioinformatics and its applications. 2. To develop hands-on experience with bioinformatics tools, databases, and sequence analysis. 3. To enhance computational and analytical skills for biological data interpretation. 4. To prepare students for further studies and research in computational biology and genomics.			
Course Outcomes:	1. Students will develop practical skills in handling biological data using bioinformatics tools. 2. They will gain experience in sequence alignment, phylogenetic analysis, and protein structure prediction. 3. They will understand the role of bioinformatics in drug discovery and computational biology. 4. They will be prepared for advanced research and career opportunities in bioinformatics and biotechnology.			
Unit System	**Contents**	**Workload Allotted (Hrs)**	**Weightage of Marks Allotted**	**Incorporation of Pedagogies**
Unit I	Introduction to Bioinformatics Tools and Databases			Power point presentation, Discussion, Problem based learning (PBL), Peer teaching, Experimental learning. Direct instructions
	1.1. Introduction to biological databases (NCBI, EMBL, DDBJ)			
	1.2. Understanding FASTA format and sequence retrieval from databases			
	1.3Use of BLAST for sequence alignment and homology searching			
	1.4. Introduction to multiple sequence alignment (MSA) using Clustal Omega			
Unit II	**Sequence Analysis and Structure Prediction**			
	2.1. Structure of DNA & Proteins including types			
	2.2. DNA and protein sequence alignment using pairwise alignment tools			
	2.3. Multiple sequence alignment using ClustalW and MEGA software			
	2.4. Types of proteins, Protein structure prediction using in-silico tools			
Unit III	Phylogenetic Analysis and Genomic Data Interpretation			
	3.1. Introduction to phylogeny and Genomic data			
	3.2. Construction of phylogenetic trees			

	using MEGA software			
	3.3. Identification of open reading frames (ORFs) in a given DNA sequence			
	3.4. Introduction to genomic and proteomic analysis tools			
Unit IV	Computational Drug Discovery and Molecular Docking			
	4.1. Introduction to molecular docking and drug discovery concepts			
	4.2. Virtual screening of biomolecules using AutoDock			
	4.3. Identification of active sites in protein structures			
	4.4. Case study on structure-based drug design using bioinformatics tools			
Reference books	1. Bioinformatics: Sequence and Genome Analysis – David W. Mount 2. Bioinformatics: Principles and Applications – Zhumur Ghosh & Bibekanand Mallick 3. Fundamentals of Bioinformatics – S. Baldi & P. Nair 4. Introduction to Bioinformatics – Arthur Lesk			

Sant Gadge Baba Amravati University
FACULTY: Science and Technology
Teaching and Learning Scheme (Microbial Technology) for the Three-Year UG Degree of Bachelor of Biotechnology
(Three Years- Six Semesters Bachelor's Degree Program)
Syllabus for: FP/CES-2 Project – 106801

Level	Semester	Course Code	Credits	Teaching Hours	Exam Duration	Max Marks
5.0	III	106801	2	30	2 Hrs	

Course Objectives:	1.To provide hands-on experience in applying applied biology knowledge to real-world challenges through field-based projects or Community engagement (CE) services. 2. To train students in identifying, analysing, and solving practical problems encountered in applied biology-related fieldwork or community Service activities. 3. To encourage students to integrate applied biology concepts with Interdisciplinary knowledge, technology, and societal needs. 4. To develop students' abilities to document, present, and communicate their field-based or community engagement work effectively to diverse audiences. 5. To install a sense of responsibility and service by involving students in projects that address community issues related to science and technology.
Course Outcomes:	1. Students will be able to apply Biotechnology principles and analytical techniques to investigate and solve real-world problems in field settings. 2. Students will demonstrate proficiency in using experimental tools, instruments, and data analysis methods relevant to their field project or CE service. 3. Students will be able to design, plan, and execute a field project or community service activity from inception to completion, including documentation and reporting. 4. Students will effectively communicate their project findings and outcomes through written reports, presentations, or community engagement events. 5.Students will demonstrate an understanding of the ethical, environmental, and societal impacts of their work, showing a commitment to responsible scientific practice and community wellbeing
Guidelines/SOP for Selection and Implementation of Field Projects / CE Services	
1. Project Selection and Planning	• **Faculty Guidance:** Students will be assigned a faculty mentor to guide their project, providing expertise and resources. • **Project Topic:** The project topic should be relevant to applied biology and align with the student's interests and the available resources. • **Literature Review:** Students are expected to conduct a thorough literature review to understand existing knowledge and identify research gaps. • **Data Collection and Analysis:** Projects often involve experiments, simulations, or data analysis from existing sources, depending on the topic. • **Project Timeline:** The total time allocation for the student to carry out field project is 60 hours.
2. Data Analysis and Interpretation	• Statistical Methods: Students will learn and apply appropriate statistical methods to analyze data. • Interpretation of Results: Data should be interpreted within the context of the project, highlighting significant findings and limitations.
3. Report Writing and Presentation	• Report Format: A structured report format is usually followed, including an abstract, introduction, methodology, results, discussion, and conclusion. • Data Presentation: Data should be presented clearly and accurately using tables, graphs, and figures. • Oral Presentation: Students will be required to present their findings to peers & faculty.
4. CE Services (Community Engagement)	• Community Needs: Projects may focus on addressing specific community needs or challenges relevant to applied biology. • Collaboration: Students can collaborate with local organizations to implement their projects.

	• Impact Assessment: The impact of the project on the community should be evaluated.
5.Evaluation and Assessment	• Project Report: The final report will be assessed based on its content, organization, and the quality of the research. (20 Marks) • Oral Presentation: The presentation will be evaluated on clarity, engagement, and the ability to answer questions. (10 Marks) • Faculty Evaluation: The faculty mentor will assess the student's performance throughout the project. (20 Marks) • Total 50 Mark
6.Examples of Field Projects/CE Services in Applied biology	• Environmental Applied biology: Studying the impact of pollution on local ecosystems or developing renewable energy solutions. • Health Applied biology: Investigating the effects of radiation on human health or developing medical imaging technologies. • Education: Designing applied biology experiments or teaching applied biology to younger students. • Community Outreach: Organizing science workshops or engaging in scientific literacy initiatives. • Research Project: Study related to the subject that contribute to the advancement of knowledge and the well-being of life on Earth.

Sant Gadge Baba Amravati University
FACULTY: Science and Technology
Teaching and Learning Scheme (Major: Molecular Biology) for the Three-Year UG Degree of Bachelor of Biotechnology
(Three Years- Six Semesters Bachelor's Degree Program)
Syllabus for: Major: Molecular Biology

Each theory paper of **Theory shall be of 2 Credits comprising of 4 Units with Teaching Hours** as mentioned in the table. The pattern of theory papers shall be as per following template –

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.0	IV	106208	**Molecular Biology**	2	30	2 Hrs	30

Course Objectives:	1) To provide an in-depth understanding of the molecular mechanisms of gene structure, function, and regulation. 2) To explore the processes of DNA replication, transcription, translation, and gene expression in prokaryotes and eukaryotes. 3) To familiarize students with molecular biology techniques, including recombinant DNA technology and genome editing. 4) To develop analytical and problem-solving skills for applying molecular biology concepts in research, medicine, and biotechnology.
Course Outcomes:	1) Students will be able to understand the central dogma of molecular biology and fundamentals of biogenesis of macromolecules. 2) Experiments to prove DNA is a genetic material concept of Gene, pseudo gene, cryptic gene and split gene 3) Learning about the structure and function of molecules. 4) Study the molecular basis of biological activity. 5) Demonstrate the ability to use discipline specific research techniques.

Unit System	Contents	Workload Allotted (Hrs)	Weightage of Marks Allotted	Incorporation of Pedagogies
Unit I	**Introduction**	8	8	Lectures, Power point presentation, Discussion, Demonstration, Collaborative learning, Problem based learning (PBL), Peer teaching, Experimental learning. Direct instructions
	1.1 Discovery of DNA-The genome of bacteria, bacteria, viruses, plasmids			
	1.2 The genome of mitochondria and chloroplast			
	1.3 Gene transfer in micro-organism-conjugation-transformation			
	1.4 Gene transfer in micro-organism-Transduction-protoplasm if fusion			
Unit II	**Organization of Genome**	7	7	
	2.1 Components of eukaryotic chromatin-Chromatin and chromosome structure			
	2.2 DNA-supercoiling - linking number- Cot curve			
	2.3 C- value paradox - satellite DNA - possible functions			
	2.4 Repetitive sequences - transposons.			
Unit III	**DNA replication**	7	7	
	3.1 Prokaryotic DNA replication - mechanism of replication, enzymes and necessary proteins in DNA replication,			
	3.2 DNA Mutation and Repair - mutation subtypes, mismatch, base-excision, nucleotide-excision and direct repair.			
	3.3 DNA recombination - homologous, non - homologous and site-specific.			
	3.4 DNA transposition, telomeres, telomerase and end replication, role of telomerase in aging and cancer.			
Unit IV	**Translation and Transcription**	8	8	
	4.1 Prokaryotic- RNA polymerases - general and specific transcription factors- regulatory elements.			

	4.2 Transcription termination post-transcriptional modification, Inhibitors of transcription			
	4.3 Genetic code, Prokaryotic translation, translational machinery.			
	4.4: Mechanism of initiation - elongation and termination, Inhibitors of translation.			
Reference books	1. Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M., Losick, R. (2014) Molecular Biology of Gene. Cold Spring harbor, New York. 2. Nelson, D.L. and Cox, M.M. (2012) Lehninger's Principle of Biochemistry. W.H. Freeman, New York. 3. Lodish, H., Berk, A., Kaiser, C.A., Krieger, M., Bretscher, A., Ploegh, H., Amon, A., Martin,K.C. (2016) Molecular Cell Biology. W.H. Freeman, New York 4. Krebs, J.E., Goldstein, E.S., Kilpatrick, S.T. (2014) Lewin's Gene XI. Jones and Bartlett Learning, Massachusetts. 5. Green, M. R. and Sambrook, J. (2012). Molecular Cloning: A Laboratory Manual Vol 1, 2 & 3, CSHL Press. New York			

Sant Gadge Baba Amravati University
FACULTY: Science and Technology
Teaching and Learning Scheme (Major: Genetic engineering) for the Three Year UG Degree of Bachelor of Biotechnology
(Three Years- Six Semesters Bachelor's Degree Program)

Syllabus for: Major: Genetic engineering

Each theory paper of **Theory shall be of 2 Credits comprising of 4 Units with Teaching Hours** as mentioned in the table. The pattern of theory papers shall be as per following template –

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.0	IV	106209	**Genetic engineering**	2	30	2 Hrs	30

Course Objectives:	1. To understand the fundamental principles of genetic engineering and its significance. 2. To familiarize students with DNA manipulation techniques and recombinant DNA technology. 3. To explore the applications of genetic engineering in healthcare, forensics, and industry. 4. To introduce advanced genetic engineering concepts, ethical considerations, and regulatory frameworks.			
Course Outcomes:	1. Explain the fundamentals of genetic engineering and recombinant DNA technology. 2. Perform essential genetic engineering techniques such as DNA extraction, PCR, and gene cloning. 3. Apply genetic engineering principles in biotechnology fields including therapeutics, diagnostics, and forensics. 4. Analyse industrial and ethical aspects of genetic engineering.			
Unit System	**Contents**	**Workload Allotted (Hrs)**	**Weightage of Marks Allotted**	**Incorporation of Pedagogies**
Unit I	**Fundamentals of Genetic Engineering**	8	8	Lectures, Power point presentation, Discussion, Demonstration, Collaborative learning, Problem based learning (PBL), Peer teaching, Experimental learning. Direct instructions
	1.1 Structure and composition of DNA; Techniques for DNA isolation and purification. Methods for quantification and characterization of DNA samples.			
	1.2 Introduction to Recombinant DNA technology; Process and limitation			
	1.3 Enzymes used in recombinant DNA technology: Restriction endonucleases, Polymerases, Ligase, kinases, and phosphatases.			
	1.4 Overview of cloning vectors. Plasmids, phage, cosmid, BAC, and YAC.			
Unit II	**Practices in Genetic Engineering**	7	7	
	2.1 Hybridization techniques, Southern, Northern, Western			
	2.2 Polymerase Chain Reaction (PCR) and its types, DNA sequencing- Sanger's, Next Generation Sequencing			
	2.3 Gene Manipulation Techniques -			

	Methods of gene delivery. Physical, chemical, and biological methods. Transformation, transfection, electroporation and micro-injection.			
	2.4 Gene knockout techniques in bacterial and eukaryotic organisms.			
Unit III	**Applications of Genetic Engineering**	8	8	
	3.1 Overview of the diverse applications of genetic engineering.			
	3.2 Gene therapy and its potential in treating genetic disorders.			
	3.3 DNA fingerprinting and its applications in forensics. Molecular diagnostic techniques and their role in disease diagnosis.			
	3.4 Use of genetic engineering in the development of therapeutics and vaccines. Production of biopharmaceuticals using recombinant DNA technology.			
Unit IV	**Advances in Genetic Engineering and Ethics**	7	7	
	4.1 Industrial applications of genetic engineering: Enzyme production, biofuel production, and bioremediation.			
	4.2 Scale-up techniques and process optimization in industrial settings.			
	4.3 Introduction to synthetic biology and its integration with genetic engineering.			
	4.4 Introduction to regulatory guidelines and safety considerations for genetic engineering research and applications			
Activities: (Any 02)	1. Assignments 2. Tour/Industrial visit 3. Seminars 4. Participation in any college activity 5. Any minor project			
Reference books	1. Molecular Cloning: A Laboratory Manual – Sambrook & Russell. 2. Principles of Gene Manipulation and Genomics – Primrose & Twyman. 3. Molecular Biology of the Gene – Watson et al. 4. Recombinant DNA: Genes and Genomes – James D. Watson. 5. Genetic Engineering – Desmond S. T. Nicholl.			

Sant Gadge Baba Amravati University
FACULTY: Science and Technology
Teaching and Learning Scheme (Cell Biology) for the Three-Year UG Degree of Bachelor of Biotechnology (Three Years- Six Semesters Bachelor's Degree Program)

Course (Theory Curriculum): **Molecular Biology & Genetic Engineering (Practical)**
Each theory paper of Theory shall be of 2 Credits comprising of 4 Units with Teaching Hours as mentioned in the table.

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.0	IV	106210	**Molecular Biology & Genetic Engineering (Practical)**	2	30	2 Hrs	30

Course Objectives:	1. To develop practical understanding of the structure, organization, and functions of DNA, RNA, genes, and genomes. 2. To familiarize students with fundamental molecular biology techniques used for isolation, analysis, and characterization of nucleic acids. 3. To provide hands-on training in DNA/RNA isolation, electrophoresis, PCR, restriction digestion, and related molecular techniques. 4. To introduce students to the basic principles and applications of genetic engineering, recombinant DNA technology, cloning vectors, and gene manipulation. 5. To develop students' ability to perform molecular biology experiments, analyze experimental results, maintain laboratory records, and follow laboratory safety and good laboratory practices.	
Course Outcomes:	1. Isolate and analyze genomic DNA/RNA and assess the quality and quantity of nucleic acid preparations using appropriate laboratory techniques. 2. Perform and interpret basic molecular biology techniques, including agarose gel electrophoresis, PCR, restriction digestion, and DNA visualization. 3. Explain and apply the principles of recombinant DNA technology, including restriction enzymes, DNA ligation, cloning vectors, and transformation. 4. Analyze molecular biology experimental data, including DNA bands, PCR products, restriction patterns, and basic genetic engineering results. 5. Demonstrate appropriate laboratory skills and scientific practices while performing molecular biology and genetic engineering experiments and relate these techniques to biotechnology, research, medicine, and agriculture.	
	Contents	
Experiments	1.Extraction of genomic DNA 2. Extraction of plasmid DNA 3. Spectrophotometric analysis of purity of isolated DNA 4. Agarose gel electrophoresis of plasmid DNA 5. Restriction digestion of chromosomal DNA 6. Restriction digestion of plasmid DNA 7. Isolation of DNA fragment from agarose gel 8. Isolation of RNA 9. Analysis of RNA by formaldehyde - agarose electrophoresis. 10. Agarose gel electrophoresis of genomic DNA 11. Estimation of DNA by spectroscopy. Safety guidelines and laboratory protocols. 12.Aseptic techniques and proper handling of materials, 13. Basic equipment and instrument operation. 14.Preparation of reagents and media 15.Nucleic Acid Quantification 16.DNA extraction from different sources (e.g., bacteria). 17.Primer design and optimization PCR setup 18.Agarose gel electrophoresis 19.Restriction Digestion of Bacterial cell	
Text Books:	1. Alberts, B. et al. – *Molecular Biology of the Cell*. Garland Science.	

	2. Lodish, H. et al. – *Molecular Cell Biology*. W. H. Freeman. 3. Watson, J. D. et al. – *Molecular Biology of the Gene*. Pearson. 4. Cooper, G. M. & Hausman, R. E. – *The Cell: A Molecular Approach*. Sinauer Associates. 5. Karp, G. – *Cell and Molecular Biology: Concepts and Experiments*. Wiley. 6. Brown, T. A. – *Gene Cloning and DNA Analysis: An Introduction*. Wiley-Blackwell. 7. Primrose, S. B. & Twyman, R. M. – *Principles of Gene Manipulation and Genomics*. Wiley-Blackwell. 8. Glick, B. R., Pasternak, J. J. & Patten, C. L. – *Molecular Biotechnology: Principles and Applications of Recombinant DNA*. ASM Press. 9. Nicholl, D. S. T. – *An Introduction to Genetic Engineering*. Cambridge University Press. 10. Old, R. W. & Primrose, S. B. – *Principles of Gene Manipulation*. Blackwell Scientific Publications.	

Sant Gadge Baba Amravati University
FACULTY: Science and Technology
Teaching and Learning Scheme (Heredity and Evolution) for the Three Year UG Degree of Bachelor of Biotechnology
(Three Years- Six Semesters Bachelor's Degree Program)

Syllabus for: Minor: Heredity and Evolution
Each theory paper of **Theory shall be of 2 Credits comprising of 4 Units with Teaching Hours** as mentioned in the table. The pattern of theory papers shall be as per following template –

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.0	IV	106303	**Heredity and Evolution**	2	30	2 Hrs	30

Course Objectives:	1. To understand the principles of genetics and heredity. 2. To explore the molecular basis of inheritance and variation. 3. To study the mechanisms of evolution and natural selection. 4. To provide practical exposure to genetic analysis and evolutionary biology.			
Course Outcomes:	1. Students will gain knowledge of genetic principles and inheritance patterns. 2. They will develop an understanding of evolutionary processes and biodiversity. 3. They will acquire skills in genetic analysis & evolutionary studies through experiments. 4. They will be prepared for higher studies and research in genetics, evolution & biotechnology.			
Unit System	**Contents**	**Workload Allotted (Hrs)**	**Weightage of Marks Allotted**	**Incorporation of Pedagogies**
Unit I	**Principles of Genetics**	8	8	Lectures, Power point presentation, Discussion, Demonstration, Collaborative learning, Problem based learning (PBL), Peer teaching, Experimental learning. Direct instructions
	1.1. Mendelian laws of inheritance (Law of Segregation, Independent Assortment, Dominance)			
	1.2. Extensions of Mendelian genetics: Codominance, incomplete dominance, multiple alleles			
	1.3. Linkage and crossing over: Chromosomal basis of inheritance			
	1.4. Sex determination and sex-linked inheritance			
Unit II	**Molecular Basis of Heredity**	7	7	
	2.1. Structure and function of DNA and RNA			
	2.2.DNA replication, transcription, & translation			
	2.3. Gene mutation and its types			
	2.4. Regulation of gene expression in prokaryotes and eukaryotes			
Unit III	**Evolutionary Theories and Evidence**	7	7	
	3.1. Darwin's theory of natural selection and Neo-Darwinism			
	3.2. Evidence of evolution: Fossil records, comparative anatomy, embryology, & molecular biology			
	3.3. Genetic drift, gene flow, and Hardy-Weinberg equilibrium			
	3.4. Speciation and adaptive radiation			
Unit IV	**Human Evolution & Applications of Genetics**	8	8	
	4.1. Evolution of humans: Hominid fossils and evolutionary timeline			

	4.2. Role of genetics in human diseases and genetic disorders			
	4.3. Genetic engineering and biotechnology applications			
	4.4. Ethical considerations in genetics and evolutionary studies			
Text Books:	1. Principles of Genetics – Robert H. Tamarin 2. Evolution – Douglas J. Futuyma 3. Genetics: A Conceptual Approach – Benjamin A. Pierce 4. Molecular Biology of the Gene – James D. Watson 5. Singh, B. D. (2015). *Genetics*. Kalyani Publishers. 6. Ridley, M. (2004). *Evolution*. 3rd Edition. Blackwell Publishing. 7. Gupta, P. K. (2019). *Genetics*. Rastogi Publications.			

Sant Gadge Baba Amravati University
FACULTY: Science and Technology
Teaching and Learning Scheme (Cell Biology) for the Three-Year UG Degree of Bachelor of Biotechnology (Three Years- Six Semesters Bachelor's Degree Program)

Course (Theory Curriculum): **Molecular Biology & Genetic Engineering (Practical)**
Each theory paper of Theory shall be of 2 Credits comprising of 4 Units with Teaching Hours as mentioned in the table.

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.0	IV	106304	**Practicals in Heredity & Evolution**	2	30	2 Hrs	30

Course Objectives:	1) To provide practical understanding of the fundamental principles of heredity and genetic variation. 2) To develop skills in analysing Mendelian inheritance patterns using experimental and numerical approaches. 3) To familiarize students with chromosomal basis of inheritance, mutations, and genetic abnormalities. 4) To introduce practical methods for studying population genetics and evolutionary processes, including allele and genotype frequencies. 5) To develop an understanding of evolutionary mechanisms, such as natural selection, genetic drift, mutation, gene flow, and speciation.	
Course Outcomes:	1) Analyse and interpret Mendelian inheritance patterns using suitable genetic crosses and probability calculations. 2) Identify and explain chromosomal variations and abnormalities using cytological observations and prepared materials. 3) Calculate allele and genotype frequencies and apply the Hardy–Weinberg principle to population data. 4) Interpret the role of mutation, genetic drift, gene flow, and natural selection in generating genetic variation and driving evolution. 5) Evaluate evolutionary relationships and mechanisms of speciation using genetic, morphological, and population-level evidence.	
	Contents	
Experiments	1. Study of Mendelian inheritance using seed color and shape in pea plants (model-based) 2. Observation of polygenic inheritance using height measurement in a population 3. Blood group determination 4. Extraction of crude DNA (from onion) 5. Demonstration of Agarose gel electrophoresis 6. Study of sex-linked inheritance using pedigree analysis 7. Simulation of genetic drift using population models 8. Study of fossil specimens/models to understand evolutionary trends 9. Demonstration of slides showing metaphase stage 10. Hardy-Weinberg principal demonstration using a mathematical model 11. Study of antibiotic resistance as an example of evolution in bacteria (simulation or case study) 12. Comparative study of human skulls from different evolutionary periods (models/pictures)	
Text Books:	1. Snustad, D. P. & Simmons, M. J. (2016). *Principles of Genetics*. 7th Edition. Wiley. 2. Pierce, B. A. (2020). *Genetics: A Conceptual Approach*. 7th Edition. W. H. Freeman/Macmillan Learning. 3. Griffiths, A. J. F., Wessler, S. R., Carroll, S. B. & Doebley, J. (2015). *Introduction to Genetic Analysis*. 11th Edition. W. H. Freeman. 4. Hartl, D. L. & Jones, E. W. (2009). *Genetics: Analysis of Genes and Genomes*. 7th Edition. Jones & Bartlett Learning. 5. Futuyma, D. J. & Kirkpatrick, M. (2017). *Evolution*. 4th Edition. Sinauer	

	Associates/Oxford University Press. 6. Ridley, M. (2004). *Evolution*. 3rd Edition. Blackwell Publishing. 7. Verma, P. S. & Agarwal, V. K. (2010). *Genetics*. S. Chand Publishing. 8. Gupta, P. K. (2019). *Genetics*. Rastogi Publications. 9. Singh, B. D. (2015). *Genetics*. Kalyani Publishers.	

Sant Gadge Baba Amravati University
FACULTY: Science and Technology
Teaching and Learning Scheme (GOEC : FOOD PROCESSING & PRESERVATION**) for the Three Year UG Degree of Bachelor of Biotechnology**
(Three Years- Six Semesters Bachelor's Degree Program)
Syllabus for GOEC : FOOD PROCESSING & PRESERVATION

Each theory paper of **Theory shall be of 2 Credits comprising of 4 Units with Teaching Hours** as mentioned in the table. The pattern of theory papers shall be as per following template

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.0	IV	106405	**Food Processing & Preservation**	2	30	2 Hrs	30

Course Objectives:	1. To introduce students to the fundamental principles of food processing, including mass and energy balance. 2. To provide an in-depth understanding of thermal and non-thermal food preservation techniques. 3. To develop knowledge of food drying processes, refrigeration, and storage methods for maintaining food quality. 4. To explore modern packaging techniques, including sustainability and cost considerations in food processing.			
Course Outcomes:	1. Students will understand the principles of heat and mass transfer and their applications in food processing. 2. They will gain knowledge of different thermal and non-thermal preservation techniques used in the food industry. 3. They will be able to design and evaluate drying, refrigeration, and freezing systems for food storage. 4. They will develop an awareness of food packaging technologies, ethical considerations, and environmental impacts.			
Unit System	**Contents**	**Workload Allotted (Hrs)**	**Weightage of Marks Allotted**	**Incorporation of Pedagogies**
Unit I	**Introduction to Food Processing**	8	8	Lectures, Power point presentation, Discussion, Demonstration, Collaborative learning, Problem based learning (PBL), Peer teaching, Experimental learning. Direct instructions
	1.1 Principles of Mass And Energy Balance			
	1.2 Transport phenomena with respect to foods; Factors affecting heat and mass transfer;			
	1.3 Study of heat transfer and its application in the design of thermal processes and freezing.			
	1.4 Thermal processing; calculation of process time temperature-schedules.			
Unit II	**Canning Of Food Products**	7	7	
	2.1 Newer methods of thermal processing; batch and continuous.			
	2.2. Application of infra-red microwaves; ohmic heating; control of water activity			
	2.3 Preservation by concentration and dehydration; osmotic methods.			
	2.4 Ethics in Food Science.			
Unit III	**Drying Process For Typical Foods**	7	7	
	3.1 Rate of drying for food products; design parameters of different type of dryers;			
	3.2 properties of air-water mixtures.			

	Psychrometric chart, freezing and cold storage. freeze concentration, dehydro- freezing, freeze drying, IQF			
	3.3 Calculation of refrigeration load, design of freezers and cold storages			
	3.4. Importance & applications of Food Processing & Preservation			
Unit IV	**Non-Thermal Methods**	8	8	
	4.1 Super Critical Technology for Preservation – Chemical preservatives, preservation by ionizing radiations, ultrasonics, high pressure.			
	4.2 Fermentation, curing, pickling, smoking, membrane technology. Hurdle technology.			
	4.3 Basic packaging materials, types of packaging, packaging design, packaging for different types of foods, retort pouch packing			
	4.4 Costs of packaging and recycling of materials.			

Text Books:

1. Sivasankar, B. “Food Processing and Preservation”. Prentice Hall of India, 2002.
2. Khetarpaul, Neelam. “Food Processing and Preservation.” Daya Publications, 2005.
3. Singh, M.K. “Food Preservation” Discovery Publishing, 2007.
4. Fellows, P.J. “Food Processing Technology: Principles and Practice”. 2nd Edition, CRC Wood Head Publishing, 2000.
5. Gopala Rao, Chandra. “Essentials of Food Process Engineering”. B.S. Publications, 2006.
6. Rahman, M. Shafiur. “Handbook of Food Preservation”. Marcel & Dekker, 2006.
7. Zeuthen, Peter and Bogh-Sarensen, Leif. “Food Preservation Techniques”. CRC/Wood Head Publishing, 2003.
8. Ranganna, S. “Handbook of Canning and Aseptic Packaging”. Tata McGraw-Hill, 2000.

Sant Gadge Baba Amravati University
FACULTY: Science and Technology
Teaching and Learning Scheme (Enzyme Technology) for the Three Year UG Degree of Bachelor of Biotechnology
(Three Years- Six Semesters Bachelor's Degree Program)
Syllabus for: VSC: Enzyme Technology

Each theory paper of **Theory shall be of 2 Credits comprising of 4 Units with Teaching Hours** as mentioned in the table. The pattern of theory papers shall be as per following template

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.0	IV	106504	**Enzyme Technology**	2	30	2 Hrs	

Course Objectives:	The objective of the course is to provide a deeper insight into the fundamentals of enzyme structure and function and kinetics of soluble and immobilized enzymes. Also, it deals with current applications and future potential of enzymes.
Course Outcomes:	1. The student will be able to describe structure, functions and the mechanisms of action of enzymes. 2. The student will learn kinetics of enzyme catalyzed reactions and enzyme inhibitory and regulatory process. 3. The student will be able to perform immobilization of enzymes. 4. The student will get exposure of wide applications of enzymes and their future potential.
	Contents
Practicals	1. Laboratory calculations 2. Effect of substrate concentration on enzyme activity 3. Effect of pH, Temperature on enzyme activity 4.Effect of different metal ions on enzyme activity, 5. Study of kinetics of enzyme calculation of Km and Vmax 6. Effect of different inhibitors on enzyme activity 7. Immobilization of enzyme in sodium alginate matrix 8. Effect of pH and temperature on immobilized enzyme activity 9. Kinetic study of immobilized enzymes 10. Purification and calculation of specific activity and turnover number 11. Study of protease activity Study of Lipase activity
Reference books	1. Fundamentals of Enzymology Price and Stevens 2. Enzymes Dixon and Webb 3. Isoenzymes By D. W. Moss 4. Immobilized Biocatalysts W. Hartneir 5. Enzymes by Trevor palmer
Incorporation of Pedagogies	Power point presentation, Discussion, Demonstration, Collaborative learning, Problem based learning (PBL), Experimental learning. Direct instructions

Sant Gadge Baba Amravati University
FACULTY: Science and Technology
Teaching and Learning Scheme (Microbial Technology) for the Three Year UG Degree of Bachelor of Biotechnology
(Three Years- Six Semesters Bachelor's Degree Program)
Syllabus for: SEC: Microbial Technology

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.0	IV	106603	**Microbial Technology**	2	30	2 Hrs	50

Course Objectives:	1. To provide Hands-on production of primary and secondary metabolites. 2. To study tools and technical skills in Estimation of the fermentation products by various methods. 3. To explain the complex processes behind the development production of cheese. 4. To study Isolation & identification of bacteria from different sources of milk product			
Course Outcomes:	5. Perform isolation and characterization of different metabolites from microbial sources. 6. Perform cell immobilization by using different industrial important strains. 7. Perform production of organic acid and solvents. 8. Quantify different fermentation products by using various methods			
Unit System	**Contents**	**Workload Allotted (Hrs)**	**Weightage of Marks Allotted**	**Incorporation of Pedagogies**
Unit I	1.Production of primary and secondary metabolite (one organic acid and one antibiotic)			Power point presentation, Discussion, Demonstration, Collaborative learning, Problem based learning (PBL), Experimental learning. Direct instructions
	2. Biomass production (Baker's yeast and Spirulina)			
Unit II	3. Production of beverages (alcohol, wine)			
	4. Immobilization of yeast on calcium alginate			
Unit III	5.Estimation of the fermentation products by titration method			
	6. Estimation of fermentative product (Acetic acid from vinegar).			
Unit IV	7.Production of cheese using different substrate from microorganism.			
	8. Isolation & identification of bacteria from different milk & water samples.			
	9. Visit to Fermentation Industry			
Reference books	**1**. Industrial Microbiology, Casida L.E (1991) - Wiley Eastern, New Delhi. **2.** Biotechnology: A Textbook of Industrial Microbiology, Crueger W and Crueger A (2000) -, 2nd Edi. Panima Publishing Corporation, New Delhi. **3**. Industrial Microbiology, Patel A.H. (2004) - Macmillan India Ltd.,New Delhi. **4**. Microbial Technology, Vol I and II,Peppler H.J and Perlman D (2006) - Academic Press,New York. **5.** A textbook of Biotechnology, Parihar Pradeep (2007) - Student edition, Jodhpur. **6**. Principles of Fermentation Technology, Stanbury P.F., Whitaker A. and Hall S.J (1997) - Aditya Books Pub., Ltd., New Delhi. **7.** Biotechnology, Satyanarayana U. (2007) Books and Allied Pvt.Ltd.Kolka			

Sant Gadge Baba Amravati University
FACULTY: Science and Technology
Teaching and Learning Scheme (Microbial Technology) for the Three-Year UG Degree of Bachelor of Biotechnology
(Three Years- Six Semesters Bachelor's Degree Program)
Syllabus for: FP/CES-2 Project – 106802

Level	Semester	Course Code	Credits	Teaching Hours	Exam Duration	Max Marks
5.0	IV	106802	2	30	2 Hrs	

Course Objectives:	1.To provide hands-on experience in applying applied biology knowledge to real-world challenges through field-based projects or Community engagement (CE) services. 2. To train students in identifying, analysing, and solving practical problems encountered in applied biology-related fieldwork or community Service activities. 3. To encourage students to integrate applied biology concepts with Interdisciplinary knowledge, technology, and societal needs. 4. To develop students' abilities to document, present, and communicate their field-based or community engagement work effectively to diverse audiences. 5. To install a sense of responsibility and service by involving students in projects that address community issues related to science and technology.
Course Outcomes:	1. Students will be able to apply Biotechnology principles and analytical techniques to investigate and solve real-world problems in field settings. 2. Students will demonstrate proficiency in using experimental tools, instruments, and data analysis methods relevant to their field project or CE service. 3. Students will be able to design, plan, and execute a field project or community service activity from inception to completion, including documentation and reporting. 4. Students will effectively communicate their project findings and outcomes through written reports, presentations, or community engagement events. 5.Students will demonstrate an understanding of the ethical, environmental, and societal impacts of their work, showing a commitment to responsible scientific practice and community wellbeing
Guidelines/SOP for Selection and Implementation of Field Projects / CE Services	
1. Project Selection and Planning	• **Faculty Guidance:** Students will be assigned a faculty mentor to guide their project, providing expertise and resources. • **Project Topic:** The project topic should be relevant to applied biology and align with the student's interests and the available resources. • **Literature Review:** Students are expected to conduct a thorough literature review to understand existing knowledge and identify research gaps. • **Data Collection and Analysis:** Projects often involve experiments, simulations, or data analysis from existing sources, depending on the topic. • **Project Timeline:** The total time allocation for the student to carry out field project is 60 hours.
2. Data Analysis and Interpretation	• Statistical Methods: Students will learn and apply appropriate statistical methods to analyze data. • Interpretation of Results: Data should be interpreted within the context of the project, highlighting significant findings and limitations.
3. Report Writing and Presentation	• Report Format: A structured report format is usually followed, including an abstract, introduction, methodology, results, discussion, and conclusion. • Data Presentation: Data should be presented clearly and accurately using tables, graphs, and figures. • Oral Presentation: Students will be required to present their findings to peers & faculty.
4. CE Services (Community	• Community Needs: Projects may focus on addressing specific community needs or challenges relevant to applied biology.

Engagement)	• Collaboration: Students can collaborate with local organizations to implement their projects. • Impact Assessment: The impact of the project on the community should be evaluated.
5.Evaluation and Assessment	• Project Report: The final report will be assessed based on its content, organization, and the quality of the research. (20 Marks) • Oral Presentation: The presentation will be evaluated on clarity, engagement, and the ability to answer questions. (10 Marks) • Faculty Evaluation: The faculty mentor will assess the student's performance throughout the project. (20 Marks) • Total 50 Mark
6.Examples of Field Projects/CE Services in Applied biology	• Environmental Applied biology: Studying the impact of pollution on local ecosystems or developing renewable energy solutions. • Health Applied biology: Investigating the effects of radiation on human health or developing medical imaging technologies. • Education: Designing applied biology experiments or teaching applied biology to younger students. • Community Outreach: Organizing science workshops or engaging in scientific literacy initiatives. • Research Project: Study related to the subject that contribute to the advancement of knowledge and the well-being of life on Earth.

Sant Gadge Baba Amravati University
FACULTY: Science and Technology
Teaching and Learning Scheme (Major: Theory)
for the Three-Year UG Degree of Bachelor of Biotechnology
(Three Years- Six Semesters Bachelor's Degree Program)

Syllabus for: Major: Immunology and Vaccine technology
Each theory paper of **Theory shall be of 2 Credits comprising of 4 Units with Teaching Hours** as mentioned in the table. The pattern of theory papers shall be as per following template

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.5	V	106209	**Major:** Immunology and Vaccine technology	2	30	2 Hrs	30

Course Objectives:	1. Understand Immune Architecture: To gain a comprehensive knowledge of the cells, tissues, and molecular signals that constitute the human immune system. 2. Master Antigen-Antibody Dynamics: To learn the biochemical principles of how antibodies identify pathogens and how these interactions are applied in medical diagnostics. 3. To enrich knowledge about different kinds of Vaccines and Vaccine delivery system 4. To be familiar with role of bioinformatics for vaccine development 5. To understand the process and technologies for vaccine development and production			
Course Outcomes:	1. Identify Immune Cells: Name and describe the specific cells and organs that defend the body. 2. Explain Immunity: Understand how the body recognizes germs and produces antibodies to fight them. 3. Understand vaccine types and vaccine delivery systems. 4. Select and use in-silico tools to develop new vaccines for different diseases. 5. Demonstrate an understanding of the development and manufacturing of vaccines and regulations in the vaccines production process.			
Unit System	**Contents**	**Workload Allotted (Hrs)**	**Weightage of Marks Allotted**	**Incorp-ration of Peda-gogies**
Unit I	**Fundamentals of the Immune System**	8	8	
	1.1 Overview of Immunity: Comparison between Innate and Adaptive immunity; physical, chemical, and biological barriers of the innate system.			
	1.2 Cells and Organs of the Immune System: Structure and function of Primary lymphoid organs (Bone marrow, Thymus) and Secondary lymphoid organs (Spleen, Lymph nodes).			
	1.3 Antigens and Immunogenicity: Characteristics of antigens, haptens, and adjuvants; factors influencing immunogenicity.			
	1.4 Major Histocompatibility Complex (MHC): Structure and role of MHC Class I and II molecules in antigen presentation.			
Unit II	**Humoral and Cell-Mediated Responses**	7	7	
	2.1 Antibody Structure and Function: Detailed structure of Immunoglobulins (IgG, IgM, IgA, IgE, IgD) and their biological properties.			
	2.2 Antigen-Antibody Interactions: Principles of precipitation, agglutination, and ELISA (Enzyme-Linked Immunosorbent Assay).			

	2.3 B-cell and T-cell Biology: Processes of B-cell activation and T-cell maturation; the role of Helper and Cytotoxic T-cells.			
	2.4 The Complement System: Introduction to the classical and alternative pathways of complement activation.			
Unit III	**Vaccine Design and Development**	7	7	
	3.1 Principles of Vaccination: History of vaccines; active vs. passive immunization; the concept of herd immunity.			
	3.2 Traditional Vaccine Platforms: Production and mechanism of Live-attenuated vaccines, Inactivated (Killed) vaccines, and Toxoids.			
	3.3 Next-Generation Vaccines: Introduction to Recombinant DNA vaccines, Subunit vaccines, and mRNA vaccine technology.			
	3.4 Adjuvants and Delivery Systems: Role of aluminum salts and oil-in-water emulsions			
Unit IV	**Conventional methods of vaccine production**	8	8	
	4.1 Recombinant approaches to vaccine production, Different stages in development of new vaccines and clinical trials- Case studies.			
	4.2 Vaccine Safety and Efficacy: Methods for determining potency, stability, and safety of vaccine formulations.			
	4.3The vaccine industry and Vaccine manufacturing			
	4.4 Regulation and testing of vaccines, Vaccine safety and Legal issues.			

1-Mark Questions

1. Define 'Hapten' and its role in the immune response.
2. What is the primary function of the Thymus in the immune system?
3. Name the five distinct classes of human immunoglobulins.
4. Which cell type is responsible for the secretion of antibodies?
5. Define 'Herd Immunity' in the context of vaccination.
6. What is the specific purpose of an adjuvant in a vaccine formulation?
7. Identify the main difference between active and passive immunization.
8. What does the acronym 'ELISA' stand for in analytical immunology?
9. Define 'Autoimmunity' in a single sentence.
10. What is the primary goal of Phase I clinical trials?

3 -Mark Questions

1. Briefly explain the structural differences between MHC Class I and MHC Class II molecules.
2. Describe the physical and chemical barriers that constitute the first line of innate defense.
3. Outline the basic principle of the classical complement pathway.
4. Compare and contrast live-attenuated vaccines with inactivated (killed) vaccines.
5. Explain the role of Lipid Nanoparticles (LNPs) in the delivery of mRNA vaccines.
6. Summarize the mechanism of a Type I hypersensitivity reaction.
7. Describe how B-cells are activated upon encountering a specific antigen.
8. What are the key criteria used to determine the efficacy of a new vaccine?

6-Mark Questions

1. Provide a detailed account of the various cells involved in the innate immune response and their specific functions.
2. Discuss the structural features of an IgG molecule and how its structure relates to its biological functions.
3. Elaborate on the different phases of clinical trials required for the approval of a new vaccine candidate.
4. Explain the process of T-cell maturation and the functional differences between Helper (CD4+) and Cytotoxic (CD8+) T-cells.

	5. Describe the development and advantages of recombinant DNA vaccines compared to traditional toxoid vaccines. 6. Analyze the host immune response to viral infections and the challenges faced in developing vaccines for highly mutable viruses. 7. Detail the mechanism of antigen presentation and its importance in bridging innate and adaptive immunity. 8. Discuss the principles and applications of precipitation and agglutination reactions in diagnostic immunology.
Text Books:	1. **Kuby Immunology** (by Jenni Punt, Sharon Stranford, et al.) 2. **Janeway's Immunobiology** (by Kenneth Murphy and Casey Weaver) 3. **Roitt's Essential Immunology** (by Peter Delves, Seamus Martin, et al.) 4. **Vaccinology: An Essential Guide** (by Alan D.T. Barrett and Gregg N. Milligan) 5. **Vaccines** (by Stanley Plotkin, Walter Orenstein, et al.) 6. **A Textbook of Immunology** (by Madhavee Latha P., *S. Chand Publications*) 7. **Basics of Immunology** (by Dr. Preeti Sharma and Dr. Pradeep Kumar)

Sant Gadge Baba Amravati University
FACULTY: Science and Technology
Teaching and Learning Scheme (Major: Theory)
for the Three-Year UG Degree of Bachelor of Biotechnology
(Three Years- Six Semesters Bachelor's Degree Program)

Syllabus for: Major: Food Biotechnology
Each theory paper of **Theory shall be of 2 Credits comprising of 4 Units with Teaching Hours** as mentioned in the table. The pattern of theory papers shall be as per following template

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.5	V	106210	**Major:** Food Biotechnology	2	30	2 Hrs	30

Course Objectives:	1. To learn the principals involved in food preservation. 2. To understand the principles that makes a food product safe for consumption 3. To be aware about the principles and current practices of processing techniques and the effects of processing parameters on product quality. 4. Ensure Food Safety & Quality: To gain proficiency in using molecular tools like PCR and biosensors for the rapid detection of pathogens and to implement standardized safety systems like HACCP. 5. Innovate in Functional Nutrition: To explore the development of nutraceuticals and "smart foods" (like pro/prebiotics) that prevent diseases and enhance human health through bioactive compounds.			
Course Outcomes:	1. Handle the basic food safety issues in the food market. 2. Develop and evaluate the quality of new food products using objective and subjective methodologies. 3. Apply basic concepts in biochemistry and food analysis. 4. Identify the conditions under which the important pathogens are commonly inactivated, killed or made harmless in foods. 5. Understand the relevance and significance of food safety, food quality and food-plant sanitation laws and regulations.			
Unit System	**Contents**	**Workload Allotted (Hrs)**	**Weightage of Marks Allotted**	**Incorporation of Pedagogies**
Unit I	**Fundamentals of Food Biotechnology**	8	8	
	1.1 Introduction to Food Biotech: History and scope; role of biotechnology in improving food yield, quality, and shelf-life.			
	1.2 Microorganisms in Food Production: Primary roles of bacteria, yeasts, and molds in the food industry.			
	1.3 Genetically Modified Foods (GMF): Concepts of transgenic plants and animals; examples like Flavr Savr tomato and Golden Rice.			
	1.4 Enzymes in Food Processing: Production and application of key enzymes like amylases, proteases, and lipases in food transformation.			
Unit II	**Fermentation Technology and Bioprocesses**	7	7	
	2.1 Principles of Fermentation: Batch, continuous, and fed-batch fermentation processes; design of a basic food bioreactor.			
	2.2 Fermented Dairy Products: Biotechnology of cheese, yogurt, and kefir production; role of starter cultures.			
	2.3 Fermented Beverages and Foods: Production of wine, beer, and traditional fermented foods (e.g., sauerkraut or soy sauce).			

	2.4 Single Cell Protein (SCP): Production of microbial protein from algae and bacteria as a nutritional supplement.			
Unit III	**Food Preservation and Safety**	7	7	
	3.1 Bio-preservation Techniques: Use of bacteriocins (e.g., Nisin) and organic acids for natural food preservation.			
	3.2 Advanced Preservation Methods: Basics of high-pressure processing, irradiation, and pulsed electric fields in food safety.			
	3.3 Detection of Food Pathogens: Biotechnological tools for rapid detection of pathogens (e.g., PCR-based methods).			
	3.4 HACCP and Regulatory Standards: Introduction to Hazard Analysis Critical Control Point (HACCP) and global food safety regulations (FSSAI/FDA).			
Unit IV	**Principles and Basics of Food Chemistry and their role in Human Nutrition**	8	8	
	4.1 Structure and functions of macro and micro nutrients, Role of macro and micronutrients in human nutrition.			
	4.2 Overview of anti-nutritional factors and their removal from food.			
	4.3 Overview of nutraceuticals and functions foods, Food contamination and adulterants and their effect on human health, Food allergen and allergenicity			
	4.4 Importance of diet in alleviating health risks, especially non communicable disease			
	1-Mark Questions 1. Define 'Food Biotechnology' and its primary goal in the industry. 2. What is a 'Genetically Modified Food' (GMF)? 3. Name one specific enzyme used in the dairy industry and its function. 4. Define 'Starter Culture' in the context of fermentation. 5. What does the term 'Single Cell Protein' (SCP) refer to? 6. Identify the primary microorganism used in the production of bread and beer. 7. Define 'Biopreservation' using a natural example. 8. What is the full form of 'HACCP' in food safety? 9. Define 'Probiotics' and their benefit to human health. 10. What is a 'Functional Food'?			
	3 -Mark Questions 1. Explain the nutritional significance of 'Golden Rice' and how it was developed. 2. Describe the difference between batch and continuous fermentation processes. 3. Outline the role of lactic acid bacteria (LAB) in yogurt production. 4. Briefly explain how Nisin acts as a natural preservative in food products. 5. What are the advantages of using PCR-based methods over traditional culture methods for detecting food pathogens? 6. Describe the selection criteria for a microorganism to be considered a good probiotic strain. 7. Explain the importance of labeling Genetically Modified (GM) foods for consumer awareness. 8. How do prebiotics differ from probiotics in their role in gut health?			
	6-Mark Questions 1. Discuss the various applications of enzymes like amylases and proteases in food processing and their advantages over chemical catalysts. 2. Provide a detailed account of the cheese-making process, highlighting the biotechnological interventions at each stage. 3. Elaborate on the production of Single Cell Protein (SCP) from algae, including its benefits and the challenges in human consumption. 4. Explain the principles of HACCP and how it ensures food safety from "farm to fork" in a processing unit. 5. Discuss advanced non-thermal food preservation techniques, such as High-			

	Pressure Processing (HPP) and Irradiation. 6. Analyze the ethical and environmental concerns surrounding the cultivation and consumption of Transgenic (GM) crops. 7. Describe the extraction and stabilization techniques used for bioactive nutraceuticals like Omega-3 fatty acids or polyphenols. 8. Detail the role of biosensors in the rapid detection of contaminants and pathogens in the food industry.
Text Books:	1. Food Biotechnology (by Anthony Pometto, Kalidas Shetty, et al.) 2. Modern Food Microbiology (by James M. Jay) 3. Biotechnology: Food Fermentation (2 Volume Set) (by V.K. Joshi and Ashok Pandey) 4. Food Science and Food Biotechnology (by G.F.G. Lopez and G.V.B. Canovas) 5. Methods of Analysis for Functional Foods and Nutraceuticals (by W. Hurst) 6. Genetically Modified Foods (by Victor Tutelyan) 7. Textbook of Food Biotechnology (by Anita Malhotra) 8. Food Preservation & Safety: Principles & Practice (1st Ed) by Shirley J. Vangrade, Margy Woodburn, Lowa State University, 2001.

Sant Gadge Baba Amravati University
FACULTY: Science and Technology
Teaching and Learning Scheme (Major: Theory)
for the Three-Year UG Degree of Bachelor of Biotechnology
(Three Years- Six Semesters Bachelor's Degree Program)

Syllabus for: Major: Plant Biotechnology
Each theory paper of **Theory shall be of 2 Credits comprising of 4 Units with Teaching Hours** as mentioned in the table. The pattern of theory papers shall be as per following template

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.5	V	106211	**Major:** Plant Biotechnology	2	30	2 Hrs	30

Course Objectives:	1. Understand the fundamental principles and historical development of plant tissue culture. 2. Acquire knowledge of plant tissue culture methodologies. 3. Explain advanced tissue culture methods and their applications. 4. Understand the principles and applications of gene transfer and genetic engineering. 5. Evaluate the applications and recent advances in plant biotechnology.			
Course Outcomes:	1. Demonstrate proficiency in basic plant tissue culture techniques 2. Prepare and maintain plant tissue culture systems 3. Apply knowledge of specialized culture techniques 4. Analyze and describe gene transfer technologies and transgenic selection systems 5. Assess the role of plant biotechnology in agriculture and industry			
Unit System	**Contents**	**Workload Allotted (Hrs)**	**Weightage of Marks Allotted**	**Incorporation of Pedagogies**
Unit I	**History of plant tissue culture research**	8	8	
	1.1 History & types of plant tissue culture technique (callus culture, meristem culture, Anther culture) Totipotency of cells, differentiation and dedifferentiation.			
	1.2 Methodology - sterilization (physical and chemical methods), Types of culture media for plant tissue culture.			
	1.3 Role of phytohormones, Micro-propagation/clonal propagation of important plants.			
	1.4 Callus & Suspension culture maintenance, growth measurements, morphogenesis in callus culture – organogenesis.			
Unit II	**Methods in Plant Tissue Culture**	7	7	
	2.1 Endosperm culture, Embryo culture, culture requirements, applications, embryo rescue technique			
	2.2 Protoplast culture & Fusion, hardening of tissue cultured plant.			
	2.3 Production of secondary metabolites and types of plant metabolites			
	2.4 Cryopreservation; Germ plasm conservation			
Unit III	**Methods of Gene Transfer**	7	7	
	3.1 Methods of gene transfer: direct and indirect methods			
	3.2 Agrobacterium-mediated gene transfer, Applications of Gene Transfer			
	3.3 Crop engineering, gene editing, CRISPR			

	3.4 Selection of transgenics– selectable marker and reporter genes (Luciferase, GUS, GFP).			
Unit IV	**Applications of Plant Biotechnology**	8	8	
	4.1 Plant genetic engineering for crop improvement, development of herbicide-, insect-, and virus-resistant crops			
	4.2 Genetic modification leading to transgenic crops, cry gene			
	4.3 Transgenic crops viz. such as Bt Cotton, Roundup Ready Soybean. Global Market demand for plant varieties.			
	4.4 Recent advances in plant biotechnology, IPR in plant sciences			
	1-Mark Questions 1. Define totipotency. 2. What is callus culture? 3. Name any one reporter gene used in transgenic selection. 4. What is embryo rescue? 5. Define cryopreservation. 6. What is micropropagation? 7. Expand CRISPR. 8. What is a selectable marker gene? 9. Name the bacterium used in indirect gene transfer in plants. 10. Give one example of a transgenic crop.			
	3 -Mark Questions 1. Explain differentiation and dedifferentiation in plant tissue culture. 2. Describe physical and chemical methods of sterilization used in plant tissue culture. 3. Write a note on the role of phytohormones in tissue culture. 4. Explain the steps involved in micropropagation. 5. Describe the applications of embryo culture. 6. Write a short note on protoplast fusion. 7. Explain the production of secondary metabolites through tissue culture. 8. Differentiate between direct and indirect methods of gene transfer. 9. Describe the principle and applications of CRISPR gene editing. 10. Explain the functions of selectable marker and reporter genes.			
	6-Mark Questions 1. Explain the methodology of plant tissue culture, including sterilization methods and culture media. 2. Discuss callus and suspension cultures, their maintenance, growth measurements, and morphogenesis. 3. Explain endosperm culture, embryo culture, and embryo rescue techniques with their applications. 4. Describe protoplast culture and fusion,& explain hardening of tissue-cultured plants. 5. Discuss the production of secondary metabolites and the importance of cryopreservation and germplasm conservation. 6. Explain direct and indirect methods of gene transfer in plants with suitable examples. 7. Describe Agrobacterium-mediated gene transfer and discuss its applications. 8. Explain crop engineering and CRISPR-based gene editing in plant biotechnology. 9. Discuss the applications of plant biotechnology in the development of transgenic crops such as Bt Cotton, Roundup Ready Soybean, Flavr Savr Tomato, and Golden Rice, highlighting recent advances and IPR issues.			
Text Books:	1. Bhojwani, S.S. and Razdan, M.K. – Plant Tissue Culture: Theory and Practice (Elsevier). 2. Bhojwani, S.S. and Dantu, P.K. – Plant Tissue Culture: An Introductory Text (Springer). 3. Slater, A., Scott, N.W. and Fowler, M.R. – Plant Biotechnology: The Genetic Manipulation of Plants (Oxford University Press).			

	4. Chawla, H.S. – Introduction to Plant Biotechnology (CRC Press). 5. Smith, R.H. – Plant Tissue Culture: Techniques and Experiments (Academic Press). 6. George, E.F., Hall, M.A. and De Klerk, G.-J. – Plant Propagation by Tissue Culture . 7. Razdan, M.K. – An Introduction to Plant Tissue Culture (Oxford & IBH Publishing Co.). 8. Kalyan Kumar De – An Introduction to Plant Tissue Culture (New Central Book Agency). 9. Brown, T.A. – Gene Cloning and DNA Analysis: An Introduction (Wiley-Blackwell). 10. Primrose, S.B. and Twyman, R.M. – Principles of Gene Manipulation and Genomics (Wiley-Blackwell). 11. Glick, B.R., Pasternak, J.J. and Patten, C.L. – Molecular Biotechnology: Principles and Applications of Recombinant DNA (ASM Press). 12. Dubey, R.C. – A Textbook of Biotechnology (S. Chand Publishing). 13. Gupta, P.K. – Biotechnology and Genomics (Rastogi Publications). 14. Kreuzer, H. and Massey, A. – Recombinant DNA and Biotechnology: A Guide for Teachers (ASM Press).

Sant Gadge Baba Amravati University
FACULTY: Science and Technology
Teaching and Learning Scheme (Major: Theory)
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(Three Years- Six Semesters Bachelor's Degree Program)

Syllabus for: Major: Applied Biotechnology 1 Practical

Level	Semester	Course Code	Course Name	Credits	Workload	Exam Duration	Max Marks
5.5	V	106212	**Applied Biotechnology 1 Practical**	2	4	2 Hrs	30

Course Objectives:	1. To Understand the fundamental principles of immunology, vaccine technology, food biotechnology, and plant tissue culture. 2. To Explain the role of biotechnology in healthcare, agriculture, food production, and crop improvement. 3. To Develop basic laboratory skills related to immunological techniques, food fermentation, and plant tissue culture. 4. To Apply biotechnological methods for vaccine development, food safety, plant propagation, and genetic improvement of crops. 5. To Recognize the ethical, regulatory, biosafety, and intellectual property aspects associated with modern biotechnology.
Course Outcomes:	➢ Describe the components and functions of the immune system, antigen-antibody interactions, and the principles of vaccination. ➢ Explain the concepts and applications of food biotechnology, fermentation technology, food preservation, and food safety regulations. ➢ Perform basic laboratory techniques in immunology, food biotechnology, and plant tissue culture following standard laboratory practices. ➢ Demonstrate an understanding of plant tissue culture, gene transfer methods, transgenic crops, and modern plant biotechnology applications. ➢ Evaluate the significance of biotechnology in healthcare, agriculture, and food industries while considering biosafety, regulatory, and ethical issues.
Unit System	**Contents**
Major Experiments (Perform any 7)	1. Study of primary and secondary lymphoid organs using charts/models (Bone marrow, Thymus, Spleen, Lymph node) 2. Determination of human ABO and Rh blood groups by agglutination method 3. Demonstration of ELISA (Direct/Indirect) using kit or simulation 4. Study of vaccine types and vaccine storage (Cold Chain) using available vaccine samples/charts 5. Isolation and observation of microorganisms from curd and yeast by staining and microscopy 6. Preparation of yogurt (curd) using starter culture and study of fermentation process 7. Estimation of amylase activity using starch hydrolysis method 8. Surface sterilization and aseptic inoculation of plant explants under laminar airflow cabinet 9. Preparation of Murashige and Skoog (MS) medium for plant tissue culture 10. In vitro culture of explants and observation of callus induction 11. Observation of different stages of micropropagation (Initiation, Multiplication, Rooting, Hardening) 12. Demonstration of Agrobacterium-mediated gene transfer and GFP/GUS reporter gene using charts/videos/models
Minor Experiments (Perform any 5)	1. Identification of immune cells using permanent slides/charts 2. Study of different immunoglobulins (IgG, IgM, IgA, IgE and IgD) using models/charts 3. Study of MHC Class I and II antigen presentation using diagrams 4. Demonstration of precipitation and agglutination reactions 5. Study of different vaccine platforms (Live, Killed, Toxoid, Subunit, mRNA) using charts 6. Identification of food spoilage microorganisms from preserved specimens

	7. Study of fermented foods and beverages with their microorganisms 8. Demonstration of food preservation techniques (Pasteurization, Drying, Refrigeration, Irradiation) 9. Observation of different plant tissue culture media and plant growth regulators 10. Identification of plant tissue culture equipment and laboratory instruments 11. Study of selectable marker genes and reporter genes (GUS, GFP, Luciferase) using diagrams 12. Case study of Bt Cotton, Golden Rice, Flavr Savr Tomato and Roundup Ready Soybean	
Text Books:	1. Janeway's Immunobiology – Kenneth Murphy and Casey Weaver. Garland Science. 2. Kuby Immunology – Jenni Punt, Sharon A. Stranford, Patricia P. Jones and Judy A. Owen. W.H. Freeman. 3. Vaccines – Stanley A. Plotkin, Walter A. Orenstein and Paul A. Offit. Elsevier. 4. Food Biotechnology – Kalidas Shetty, Gopinadhan Paliyath, Antonio Pometto and Robert Levin. CRC Press. 5. Food Microbiology – Martin R. Adams, Maurice O. Moss and Peter McClure. Royal Society of Chemistry. 6. Plant Tissue Culture: Theory and Practice – S. S. Bhojwani and M. K. Razdan. Elsevier. 7. Plant Biotechnology and Tissue Culture – M. W. Fowler, Warren G. Warren and Adrian Slater. Wiley. 8. Introduction to Plant Biotechnology – H. S. Chawla. CRC Press. 9. Molecular Biotechnology: Principles and Applications of Recombinant DNA – Bernard R. Glick, Jack J. Pasternak and Cheryl L. Patten. ASM Press. 10. Biotechnology: Expanding Horizons – B. D. Singh. Kalyani Publishers.	

Sant Gadge Baba Amravati University
FACULTY: Science and Technology
Teaching and Learning Scheme (Major Elective: Theory)
for the Three-Year UG Degree of Bachelor of Biotechnology
(Three Years- Six Semesters Bachelor's Degree Program)

Syllabus for: Major Elective I: Analytical Methods and Instrumentation-I.
Each theory paper of **Theory shall be of 2 Credits comprising of 4 Units with Teaching Hours** as mentioned in the table. The pattern of theory papers shall be as per following template

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.5	V	106701	**Major Elective I: Analytical Methods and Instrumentation-I.**	2	30	2 Hrs	30

Course Objectives:	➢ To provide fundamental knowledge of different microscopic techniques including simple, phase contrast, dark-field, fluorescence, and electron microscopy (TEM and SEM). ➢ To develop understanding of the principles and applications of separation and identification techniques such as chromatography and electrophoresis. ➢ To explain the basic principles, instrumentation, and applications of centrifugation methods used in biological and biochemical research. ➢ To introduce students to various blotting and labeling techniques and their applications in molecular biology and diagnostics. ➢ To train students in the selection and application of appropriate analytical and separation techniques for biological sample analysis.
Course Outcomes:	After successful completion of the course, students will be able to: ➢ Describe the working principles, instrumentation, and applications of different microscopy techniques including TEM and SEM. ➢ Differentiate and apply various chromatographic and electrophoretic techniques for separation and identification of biomolecules. ➢ Explain the principles of centrifugation and analyze factors affecting sedimentation and separation efficiency. ➢ Perform and interpret different blotting techniques such as Southern, Northern, Western, and Eastern blotting for biomolecular analysis. ➢ Select suitable laboratory techniques for research, diagnostic, and analytical purposes in biological and biochemical sciences.

Unit System	Contents	Workload Allotted (Hrs)	Weightage of Marks Allotted	Incorporation of Pedagogies
Unit I	Microscopy; History, Principles and Applications	6	6	
	1.1 Simple microscopy			
	1.2 Phase contrast microscopy,			
	1.3 Dark-field, florescence			
	1.4 Electron microscopy (TEM and SEM)			
Unit II	Separation & Identification of Materials	9	9	
	2.1 Concept of Chromatography, Partition Chromatography, Paper Chromatography			
	2.2 Adsorption Chromatography, TLC, HPTLC			
	2.3 Affinity Chromatography,			
	2.4 Electrophoresis (Gel Electrophoresis, Paper Electrophoresis).			
Unit III	Centrifugation	8	8	
	3.1 Basic Principle of Centrifugation,			

	Instrumentation of Ultracentrifuge (Preparative, Analytical)			
	3.2 Factors affecting Sedimentation velocity, Standard Sedimentation Coefficient,			
	3.3 Centrifugation of associating systems,			
	3.4 Rate-Zonal centrifugation, sedimentation equilibrium Centrifugation.			
Unit IV	Blotting and labelling	7	7	
	4.1 Introduction to Blotting Techniques			
	4.2 Types of blotting; Southern blotting, northern blotting, Western blotting, eastern blotting			
	4.3 Instruments required for blotting			
	4.4 Applications of each technique			
	1-Mark Questions (One-Sentence Answers) 1. Define microscopy. 2. Expand TEM and SEM. 3. What is phase contrast microscopy? 4. Define chromatography. 5. What is Thin Layer Chromatography (TLC)? 6. Define electrophoresis. 7. What is the sedimentation coefficient? 8. What is rate-zonal centrifugation? 9. Name any two blotting techniques. **10.** What is Western blotting used for?			
	3 -Mark Questions (One-Sentence Answers) 1) Explain the principle and applications of simple microscopy. 2) Differentiate between TEM and SEM. 3) Describe the principle of fluorescence microscopy. 4) Explain the principle of paper chromatography. 5) Differentiate between TLC and HPTLC. 6) Describe the principle of affinity chromatography with its applications. 7) Explain the principle of gel electrophoresis. 8) Discuss the factors affecting sedimentation velocity. 9) Differentiate between preparative and analytical ultracentrifuges. 10) Explain Southern blotting and its applications.			
	6-Mark Questions (One-Sentence Answers) 1) Describe the history, principles and applications of microscopy. Explain simple, phase contrast, dark-field and fluorescence microscopy with suitable diagrams. 2) Explain the principle, construction, working and applications of Transmission Electron Microscopy (TEM) and Scanning Electron Microscopy (SEM). Compare TEM and SEM. 3) Discuss the concept and principles of chromatography. Explain partition chromatography, paper chromatography, adsorption chromatography, TLC and HPTLC with suitable diagrams and applications. 4) Explain affinity chromatography in detail. Discuss its principle, instrumentation, procedure and applications in biological sciences. 5) Describe the principles, instrumentation, procedure and applications of gel electrophoresis and paper electrophoresis. Compare both techniques. 6) Explain the basic principle of centrifugation. Describe the instrumentation and working of preparative and analytical ultracentrifuges with suitable diagrams. 7) Discuss the factors affecting sedimentation velocity. Explain the standard sedimentation coefficient and its significance in biomolecular separation. 8) Describe centrifugation of associating systems. Explain rate-zonal centrifugation and sedimentation equilibrium centrifugation with suitable			

	diagrams and applications. 9) Explain the principle, procedure and applications of Southern, Northern, Western and Eastern blotting techniques. Compare the different blotting methods. 10) Describe the instruments required for blotting techniques and discuss the applications of blotting methods in molecular biology, diagnostics, genetic engineering and biotechnology.
Text Books:	1. Wilson, K. & Walker, J. Principles and Techniques of Biochemistry and Molecular Biology, 9th Edition, Cambridge University Press, 2023. 2. Skoog, D. A., Holler, F. J. & Crouch, S. R. Principles of Instrumental Analysis, 7th Edition, Cengage Learning. 3. Keith Wilson & John Walker. Practical Biochemistry: Principles and Techniques, Cambridge University Press. 4. Freifelder, D. Physical Biochemistry: Applications to Biochemistry and Molecular Biology, W.H. Freeman. 5. Voet, D. & Voet, J. G. Biochemistry, 5th Edition, Wiley. 6. Alberts, B. et al. Molecular Biology of the Cell, 7th Edition, Garland Science. 7. Lehninger Principles of Biochemistry, 8th Edition, W.H. Freeman. 8. R. Ian Freshney. Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications, Wiley-Blackwell.

Sant Gadge Baba Amravati University
FACULTY: Science and Technology
Teaching and Learning Scheme (Major elective: Practical)
for the Three-Year UG Degree of Bachelor of Biotechnology
(Three Years- Six Semesters Bachelor's Degree Program)

Syllabus for: Major Elective: Practical Course Based on Analytical techniques and Instrumentation

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.5	V	106702	**Major Elective:** Practical Course Based on Analytical techniques and Instrumentation	2	30	2 Hrs	30

Course Objectives:	➢ To provide practical knowledge of different microscopic techniques ➢ To develop understanding of the principles and applications of separation and identification techniques such as chromatography and electrophoresis. ➢ To explain the basic principles, instrumentation, and applications of centrifugation methods used in biological and biochemical research. ➢ To introduce students to various blotting and labeling techniques and their applications in molecular biology and diagnostics. To train students in the selection and application of appropriate analytical and separation techniques for biological sample analysis.
Course Outcomes:	After successful completion of the course, students will be able to: ➢ Describe the working principles, instrumentation, and applications of different microscopy techniques including TEM and SEM. ➢ Differentiate and apply various chromatographic and electrophoretic techniques for separation and identification of biomolecules. ➢ Explain the principles of centrifugation and analyze factors affecting sedimentation and separation efficiency. ➢ Perform and interpret different blotting techniques such as Southern, Northern, Western, and Eastern blotting for biomolecular analysis. ➢ Select suitable laboratory techniques for research, diagnostic, and analytical purposes in biological and biochemical sciences.
Unit System	**Contents**
Major Experiments (Perform any 7)	1. Observation of specimens using Phase Contrast Microscopy 2. Study of Electron Microscopy (TEM and SEM) through charts/models/images 3. Study of Gel Electrophoresis of DNA samples 4. Study of Affinity Chromatography using demonstration models/virtual simulation. 5. Use of colorimeter/spectrophotometer for qualitative and quantitative analysis 6. Demonstration/Simulation of Blotting Techniques 7. PAGE for protein separation 8. Demonstration of HPLC 9. Perform gram staining
Minor Experiments (Perform any 5)	1. Study and operation of Simple Light Microscope 2. Separation of plant pigments using Paper Chromatography 3. Separation of amino acids by Ppaper Chromatography 4. Demonstration of Centrifugation Techniques 5. Demonstration of Column Chromatography 6. Separation of cellular components by Differential Centrifugation 7. To study shape of bacteria/fungi under microscopy
Text Books:	a. Wilson, K. & Walker, J. (2023). Principles and Techniques of Biochemistry and Molecular Biology (9th ed.). Cambridge University Press. b. Plummer, D. T. (2017). An Introduction to Practical Biochemistry (6th ed.). McGraw-Hill Education. c. Sawhney, S. K. & Singh, R. (2018). Introductory Practical Biochemistry. Narosa Publishing House. d. Sadasivam, S. & Manickam, A. (2020). Biochemical Methods (4th ed.). New Age International Publishers.

	e. Skoog, D. A., Holler, F. J. & Crouch, S. R. (2018). Principles of Instrumental Analysis (7th ed.). Cengage Learning. f. Harris, D. C. (2020). Quantitative Chemical Analysis (10th ed.). W. H. Freeman and Company. g. Upadhyay, A., Upadhyay, K. & Nath, N. (Latest Edition). Biophysical Chemistry: Principles and Techniques. Himalaya Publishing House. h. Freifelder, D. (1982). Physical Biochemistry: Applications to Biochemistry and Molecular Biology (2nd ed.). W. H. Freeman. i. Sambrook, J. & Russell, D. W. (2001). Molecular Cloning: A Laboratory Manual (3rd ed.). Cold Spring Harbor Laboratory Press. j. Green, M. R. & Sambrook, J. (2019). Molecular Cloning: A Laboratory Manual (4th ed.). Cold Spring Harbor Laboratory Press. k. Boyle, J. J. & Senior, B. W. (2001). Laboratory Manual in Biochemistry. Prentice Hall. l. Ruzin, S. E. (1999). Plant Micro technique and Microscopy. Oxford University Press.	

Sant Gadge Baba Amravati University
FACULTY: Science and Technology
Teaching and Learning Scheme (Major Elective T2: Ethnopharmacology and Drug Discovery:1)
for the Three-Year UG Degree of Bachelor of Biotechnology
(Three Years- Six Semesters Bachelor's Degree Program)

Syllabus for: Major Elective T2: Ethnopharmacology and Drug Discovery:1
Each theory paper of **Theory shall be of 2 Credits comprising of 4 Units with Teaching Hours** as mentioned in the table. The pattern of theory papers shall be as per following template

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.5	V	106703	**Ethnopharmacology and Drug Discovery:1**	2	30	2 Hrs	30

Course Objectives:	1. To provide comprehensive knowledge of ethnopharmacology, ethnomedicine, and the relationship between medicinal plants and indigenous healthcare systems. 2. To understand the importance of medicinal plants, active phytochemicals, and traditional systems of medicine in primary healthcare and therapeutic applications. 3. To introduce the concepts, terminology, classification, and historical development of drugs and modern drug discovery processes. 4. To develop understanding of lead discovery, bioassay techniques, and screening methods used in pharmacological and pharmaceutical research. 5. To familiarize students with sources of drugs, drug targets, recombinant DNA technology, hybridoma technology, and the principles of drug absorption, metabolism, and distribution.
Course Outcomes:	1.Students will be able to explain the concepts, scope, and significance of ethnopharmacology and ethnomedicine in healthcare and drug development. 2.Students will be able to identify medicinal plants, active phytochemicals, and evaluate their therapeutic roles in traditional and modern medicine. 3.Students will be able to classify drugs, understand the history of drug discovery, and describe strategies involved in lead compound identification and screening. 4.Students will be able to explain different sources of drugs, including natural, synthetic, semisynthetic, and biotechnological sources, along with their pharmaceutical importance. 5.Students will be able to understand drug targets, mechanisms of drug action, and principles of pharmacokinetics including drug absorption, metabolism, and distribution.

Unit System	**Contents**	**Workload Allotted (Hrs)**	**Weightage of Marks Allotted**	**Incorporation of Pedagogies**
Unit I	**Introduction to Ethnopharmacology and Ethnomedicine**	8	8	
	1.1 Concept, history, and scope; role of ethnopharmacology			
	1.2 Relationship between plants and indigenous/traditional cultures			
	1.3 Centers of Ethnopharmacology studies in India			
	1.4 AICRPE-All India Coordinated Research Project on Ethnobiology			
Unit II	**Medicinal Plants and Their Ethnomedicinal Uses**	7	7	
	2.1 Introduction to medicinal plants and their active phytochemicals			
	2.2 Medicinal plants their therapeutic roles			
	2.3 Types of traditional medicines			
	2.4 Role of ethnomedicine in primary			

	healthcare			
Unit III	**Drug Discovery**	7	7	
	3.1 Introduction to drugs, concept, terminology			
	3.2 History of drugs and Classification of drugs			
	3.3 Strategies used in drug discovery, lead discovery			
	3.4 Bioassay and types of bioassays. Screening of lead compounds			
Unit IV	**Source and Drug targets**	8	8	
	4.1 Sources of drugs: Natural (plants, microbial, animals, minerals, microorganism)			
	4.2 Synthetic sources (synthetic, semisynthetic Recombinant DNA technology and Hybridoma technology)			
	4.3 Drugs and drug target			
	4.4 Principles of drug absorption, drug metabolism and distribution			
	1-Mark Questions (One-Sentence Answers) 1. Define ethnopharmacology. 2. What is ethnomedicine? 3. Expand AICRPE. 4. Name one traditional system of medicine in India. 5. What are phytochemicals? 6. Define medicinal plants. 7. What is a drug? 8. Define lead compound. 9. What is bioassay? 10. Name one source of natural drugs. 11.What is recombinant DNA technology? 12.Define drug target. 13.What is drug absorption? 14.Name the major organ involved in drug metabolism. 15.What is hybridoma technology?			
	3 -Mark Questions (Short Answer Type) 1. Explain the scope of ethnopharmacology. 2. Write a short note on ethnomedicine. 3. Describe the relationship between plants and indigenous cultures. 4. Explain the importance of medicinal plants in healthcare. 5. Discuss the role of phytochemicals in medicinal plants. 6. Differentiate between Ayurveda and Unani systems of medicine. 7. Write a note on AICRPE and its objectives. 8. Explain the concept of lead discovery in drug development. 9. Describe different sources of drugs. 10. Explain the principle of bioassay. 11.Write a short note on recombinant DNA technology. 12. Describe the role of drug targets in pharmacology. 13. Explain drug metabolism with examples. 14.Discuss the therapeutic roles of medicinal plants. 15.Explain the importance of ethnomedicine in primary healthcare.			
	6-Mark Questions (Long Answer Question Types) 1. Explain the concept, history, and scope of ethnopharmacology in detail. 2. Discuss the relationship between medicinal plants and indigenous/traditional cultures. 3. Describe various centres of ethnopharmacology studies in India and their contributions. 4. Explain the objectives and importance of AICRPE in ethnobiological research.			

	5. Discuss medicinal plants and their active phytochemicals with suitable examples. 6. Explain various traditional systems of medicine and their significance. 7. Describe the role of ethnomedicine in primary healthcare systems. 8. Discuss the history and classification of drugs in detail. 9. Explain strategies used in drug discovery and lead discovery. 10. Describe bioassay methods and screening of lead compounds. 11. Explain different natural and synthetic sources of drugs with examples. 12. Discuss recombinant DNA technology and hybridoma technology in drug production. 13. Explain drug targets and mechanisms of drug action. 14. Describe the principles of drug absorption, metabolism, and distribution. 15. Write an essay on the importance of medicinal plants in modern drug discovery.
Text Books:	1. Pharmacognosy. Kokate, C. K., Purohit, A. P., & Gokhale, S. B. (2014). *Pharmacognosy* (50th ed.). Nirali Prakashan. 2. Practical Pharmacognosy. Khandelwal, K. R. (2008). *Practical pharmacognosy: Techniques and experiments* (19th ed.). Nirali Prakashan. 3. Dictionary of Indian Folk Medicine and Ethnobotany. Jain, S. K. (1991). *Dictionary of Indian folk medicine and ethnobotany*. Deep Publications. 4. Textbook of Pathology. Harsh Mohan. (2015). *Textbook of pathology* (7th ed.). Jaypee Brothers Medical Publishers. 5. Medicinal Chemistry. Singh, H., & Kapoor, V. K. (2011). *Medicinal and pharmaceutical chemistry*. Vallabh Prakashan. 6. Microbiology. Ananthanarayan, R., & Paniker, C. K. J. (2017). *Textbook of microbiology* (10th ed.). Universities Press. 7. Medicinal Natural Products. Dewick, P. M. (2009). *Medicinal natural products: A biosynthetic approach* (3rd ed.). Wiley. 8. Trease and Evans Pharmacognosy. Evans, W. C. (2009). *Trease and Evans pharmacognosy* (16th ed.). Saunders Elsevier. 9. An Introduction to Medicinal Chemistry. Patrick, G. L. (2017). *An introduction to medicinal chemistry* (6th ed.). Oxford University Press. 10. Rang and Dale's Pharmacology. Rang, H. P., Dale, M. M., Ritter, J. M., & Flower, R. J. (2016). *Rang and Dale's pharmacology* (8th ed.). Elsevier.

Sant Gadge Baba Amravati University
FACULTY: Science and Technology
Teaching and Learning Scheme (Major Elective P2 Practical)
for the Three-Year UG Degree of Bachelor of Biotechnology
(Three Years- Six Semesters Bachelor's Degree Program)

Syllabus for: Major Elective P2 Practical: Ethnopharmacology and Drug Discovery:1

Level	Semester	Course Code	Course Name	Credits	Workload	Exam Duration	Max Marks
5.5	V	106704 (P)	**Lab/Practical: Ethnopharmacology & Drug Discovery**	2	4	2 Hrs	30

Course Objectives:	1. To develop knowledge and practical skills in the collection, identification, preservation, and documentation of medicinal plants and ethnobotanical resources. 2. To understand ethnobotanical survey techniques and the role of traditional medicinal knowledge in healthcare and drug discovery. 3. To perform phytochemical analysis, isolation, and characterization of secondary metabolites from medicinal plants using standard laboratory techniques. 4. To evaluate the biological activities of herbal drugs through antimicrobial, cytotoxicity, biochemical, and antioxidant assays. 5. To familiarize students with laboratory methods used in pharmacological screening, haematological analysis, and histopathological evaluation of herbal formulations.
Course Outcomes:	1. Students will be able to collect, identify, preserve, and prepare herbarium specimens of medicinal plants using standard botanical techniques. 2. Students will be able to conduct ethnobotanical surveys and systematically document traditional medicinal knowledge from indigenous communities. 3. Students will be able to perform phytochemical screening, thin layer chromatography (TLC), and isolation of secondary metabolites from medicinal plants. 4. Students will be able to evaluate antimicrobial and cytotoxic activities of herbal drugs using standard microbiological and cell-based assays. 5. Students will be able to analyze biochemical, antioxidant, hematological, and histopathological parameters for assessing the therapeutic and toxicological effects of herbal drugs.
Unit System	**Contents**
Experiments Major:	1. Plant collection and Herbarium preparation techniques. 2. Ethnobotanical survey methodology. 3. Perform Thin Layer Chromatography of medicinal plants 4. Screening of Secondary metabolites from medicinal plants 5. Isolation of Secondary metabolites from medicinal plants 6. Testing of Antimicrobial activity of herbal drug of by disc diffusion method. 7. Antibiotic Potency Test-Plate well diffusion method (Minimum Inhibitory Concentration) 8. Testing of cytotoxicity of herbal drug. 9. Study and identification of common medicinal plants used in traditional medicine (minimum 10 species). 10. Preparation of a herbarium of locally available medicinal plants with botanical name, family and medicinal uses. 11. Collection and documentation of ethnomedicinal information from local communities using a structured questionnaire (demonstration/field visit). 12. Qualitative screening of alkaloids in selected medicinal plant extracts.
Experiments Minor	1. Identify important medicinal plants and describe their ethnomedicinal uses. 2. Prepare herbarium specimens and maintain proper documentation. 3. Perform simple qualitative phytochemical screening of medicinal plants. 4. Prepare plant extracts and simple herbal formulations.

	5. Classify drugs based on their source and therapeutic use. 6. Understand the basic concepts of drug discovery and bioassay. 7. Recognize different traditional systems of medicine. 8. Explain the principles of drug absorption, distribution and metabolism. 9. Document ethnomedicinal knowledge using scientific methods. 10. Develop basic laboratory skills related to ethnopharmacology and medicinal plant research. Qualitative screening of flavonoids in medicinal plant extracts.	
Text Books:	1. Trease and Evans Pharmacognosy.Evans, W. C. (2009). *Trease and Evans pharmacognosy* (16th ed.). Saunders Elsevier. 2. Pharmacognosy. Kokate, C. K., Purohit, A. P., & Gokhale, S. B. (2014). *Pharmacognosy* (50th ed.). Nirali Prakashan. 3. Practical Pharmacognosy. Khandelwal, K. R. (2008). *Practical pharmacognosy: Techniques and experiments* (19th ed.). Nirali Prakashan. 4. Harborne's Phytochemical Methods. Harborne, J. B. (1998). *Phytochemical methods: A guide to modern techniques of plant analysis* (3rd ed.). Chapman & Hall. 5. Medicinal Natural Products. Dewick, P. M. (2009). *Medicinal natural products: A biosynthetic approach* (3rd ed.). Wiley. 6. Microbiology. Pelczar, M. J., Chan, E. C. S., & Krieg, N. R. (2005). *Microbiology*. Tata McGraw-Hill. 7. Textbook of Biochemistry. Satyanarayana, U., & Chakrapani, U. (2017). *Biochemistry* (5th ed.). Elsevier. 8. Cell and Molecular Biology. De Robertis, E. D. P., & De Robertis, E. M. F. (2006). *Cell and molecular biology* (8th ed.). Lippincott Williams & Wilkins. 9. Ethnobotany. Jain, S. K. (1991). *Dictionary of Indian folk medicine and ethnobotany*. Deep Publications. 10. World Health Organization. World Health Organization. (2013). *WHO traditional medicine strategy 2014–2023*. WHO Press.	
Activities (Perform any Two):	1.Visit to Pharmaceutical industry/ Tour 2. Assignment 3. Seminar 4. Participation in any college activity 5. Major Project (Phase: 1)	

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Teaching and Learning Scheme (Major: Theory)
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Syllabus for: Major Elective T3: Biostatistics and Bioinformatics- I
Each theory paper of **Theory shall be of 2 Credits comprising of 4 Units with Teaching Hours** as mentioned in the table. The pattern of theory papers shall be as per following template –

Level	Semester	Course Code	Course Name	Credits	Workload	Exam Duration	Max Marks
5.5	V	106705	**Biostatistics & Bioinformatics- I**	2	4	2 Hrs	30

Course Objectives:	To introduce the basic concepts and importance of biostatistics in biological science. To familiarize students with measures of central tendency and dispersion. To introduce the fundamentals and scope of bioinformatics. To provide knowledge about biological databases and sequence analysis. To familiarize students with computational tools used in biotechnology.			
Course Outcomes:	Understand the fundamental principles and applications of biostatistics. Organize, analyze, and interpret biological data effectively. Apply statistical methods such as mean, median, mode, and standard deviation. Understand the concepts and importance of bioinformatics. Use biological databases such as GenBank and PDB effectively.			
Unit System	**Contents**	**Workload Allotted (Hrs)**	**Weightage of Marks Allotted**	**Incorpo-ration of Pedagogies**
Unit I	**Fundamentals of Biostatistics**	8	8	
	1.1Introduction to Biostatistics and its applications in Biotechnology			
	1.2Types of data and methods of data collection			
	1.3Measures of central tendency: Mean, Median, Mode			
	1.4Graphical representation of data: Histogram, Pie chart, Bar diagram			
Unit II	**Statistical Methods and Applications**	7	7	
	2.1Correlation and regression analysis			
	2.2ANOVA and interpretation			
	2.3Chi-square test and t-test			
	2.4Applications of statistics in biological research			
Unit III	**Fundamentals of Bioinformatics**	7	7	
	3.1Introduction to Bioinformatics and scope			
	3.2Biological databases: GenBank, EMBL, DDBJ, PDB			
	3.3Sequence alignment**:** Local and global alignment			
	3.4BLAST and FASTA tools			
Unit IV	**Bioinformatics Tools and Techniques**	8	8	
	4.1Genome mapping and genome sequencing			
	4.2Protein structure prediction			
	4.3Drug discovery and molecular docking overview			
	4.4Introduction to computational biology			
1 Mark Question	1. Define Biostatistics. 2. What is meant by primary data? 3. Define median. 4. What is a histogram? 5. Define correlation.			

	6. What is the purpose of ANOVA? 7. Expand BLAST. 8. What is GenBank? 9. What is genome sequencing? 10. Define computational biology.
3 Mark Question	1) Explain the applications of Biostatistics in Biotechnology. 2) Differentiate between primary and secondary data. 3) Explain Mean, Median and Mode with suitable examples. 4) Describe the construction and uses of a pie chart. 5) Explain positive and negative correlation. 6) Write a short note on the Chi-square test. 7) Describe the features of GenBank, EMBL and DDBJ databases. 8) Differentiate between local and global sequence alignment. 9) Explain the working principle of BLAST. 10) Write a short note on protein structure prediction.
6 Mark Question	1. Explain different types of data and methods of data collection with suitable examples. 2. Describe measures of central tendency and their biological applications. 3. Explain graphical methods of data representation including histogram, bar diagram and pie chart. 4. Discuss correlation, regression analysis and their significance in biological research. 5. Explain ANOVA, t-test and Chi-square test with suitable biological applications. 6. Discuss the applications of statistics in biological research. 7. Explain the scope and importance of Bioinformatics in modern Biotechnology. 8. Describe biological databases (GenBank, EMBL, DDBJ and PDB) and their applications. 9. Explain sequence alignment, BLAST and FASTA with suitable examples. 10. Discuss genome mapping, genome sequencing, protein structure prediction and their role in drug discovery.
Text Books:	1) Fundamentals of Biostatistics – Bernard Rosner. 2) Biostatistics: A Foundation for Analysis in the Health Sciences – Wayne W. Daniel & Chad L. Cross. 3) Introductory Statistics – Neil A. Weiss. 4) Bioinformatics: Sequence and Genome Analysis – David W. Mount. 5) Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins – Andreas D. Baxevanis & B. F. Francis Ouellette. 6) Essential Bioinformatics – Jin Xiong. 7) Introduction to Bioinformatics – Arthur M. Lesk. 8) Biostatistics – P. N. Arora & P. K. Malhan.

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Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.5	V	106706 (P)	**Biostatistics and bioinformatics I**	2	30	2 Hrs	30

Course Objectives:	➢ To develop basic skills in statistical calculations and data analysis. ➢ To train students in graphical representation of biological data. ➢ To introduce students to biological databases and bioinformatics tools. ➢ To develop skills in sequence retrieval and analysis. ➢ To train students in sequence alignment techniques.
Course Outcomes:	➢ Calculate and interpret statistical parameters such as mean, median, and standard deviation. ➢ Represent biological data using graphs and charts. ➢ Retrieve nucleotide and protein sequences from biological databases. ➢ Perform sequence similarity searches using BLAST.
Unit System	**Contents**
Major Experiments (Perform any 7)	1. Application of t-test in biological data 2. Chi-square test for experimental data 3. Analysis of Variance (ANOVA) 4. Interpretation and presentation of statistical data using MS Excel 5. Calculation of Correlation Coefficient 6. Problems based on Probability 7. Introduction to bioinformatics databases 8. Retrieval of nucleotide sequences from GenBank 9. Retrieval of protein sequences from UniProt 10. Use of FASTA format for sequence analysis 11. Identification of conserved domains in proteins 12. Basic introduction to bioinformatics software tools
Minor Experiments (Perform any 5)	1. Calculation of Mean, Median, and Mode 2. Calculation of Standard Deviation and Variance 3. Preparation of Frequency Distribution Table 4. Graphical Representation of Data using Histogram and Bar Diagram 5. Sequence similarity search using BLAST 6. Multiple sequence alignment using ClustalW 7.Protein structure visualization using PDB database
Activities (Perform any Two):	1. Survey-based statistical data collection and analysis 2. Preparation of charts and graphs using biological data 3. Case study on statistical analysis in healthcare research
Text Books:	1. Fundamentals of Biostatistics – Veer Bala Rastogi 2. Biostatistics and Research Methodology – P. S. S. Sundar Rao and J. Richard 3. Statistical Methods – S. P. Gupta 4. Bioinformatics: Methods & Applications– S. C. Rastogi, N Mendiratta & P Rastogi 5. Introduction to Bioinformatics – S. C. Rastogi

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Teaching and Learning Scheme (Major Elective: Theory: T4)
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Syllabus for: Major Elective: Theory: T4 – Medical Biotechnology & Nanotechnology - 1
Each theory paper of **Theory shall be of 2 Credits comprising of 4 Units with Teaching Hours** as mentioned in the table. The pattern of theory papers shall be as per following template

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.5	V	106707	**Major Elective: Theory: T4 – Medical Biotechnology & Nanotechnology - 1**	2	30	2 Hrs	30

Course Objectives:	➢ Develop a strong conceptual understanding of molecular foundations of medical biotechnology and nanobiotechnology. ➢ Understand recombinant DNA technology, molecular diagnostics and therapeutic biotechnology used in modern medicine. ➢ Explain principles of nanoscience, nanomaterial synthesis and characterization techniques used in biomedical applications. ➢ Analyze interactions between biological systems and engineered biomolecules/nanomaterials for diagnostic and therapeutic purposes. ➢ Evaluate emerging applications of medical biotechnology and nanobiotechnology with consideration of biosafety, ethics and regulatory aspects.
Course Outcomes:	➢ Explain the molecular basis of diseases and describe modern medical biotechnological approaches for diagnosis and therapy. ➢ Apply knowledge of recombinant DNA technology in understanding therapeutic protein and vaccine development. ➢ Interpret principles of nanoscience and classify different nanomaterials used in biomedical systems. ➢ Analyze nano-bio interactions and evaluate characterization techniques for biomedical nanomaterials. ➢ Critically assess biosafety, nanotoxicology, ethical concerns and translational applications in medical biotechnology.

Unit System	Contents	Workload Allotted (Hrs)	Weightage of Marks Allotted	Incorporation of Pedagogies
Unit I	**Molecular Foundations of Medical Biotechnology**	8	8	
	1.1 Introduction to Medical Biotechnology: Concept, scope, historical development and role of biotechnology in healthcare and medicine.			
	1.2 Biomolecular Basis of Human Diseases: Molecular mechanisms of genetic, infectious and metabolic disorders.			
	1.3 Recombinant DNA Technology: Restriction enzymes, cloning vectors, transformation methods and gene manipulation.			
	1.4 Biosafety and Ethical Considerations: Biosafety principles, ethical concerns and regulatory framework in medical biotechnology.			
Unit II	**Molecular Diagnostics and Therapeutic Biotechnology**	7	7	
	2.1 Molecular Diagnostic Technologies: PCR,			

	RT-PCR, DNA sequencing and molecular diagnostic applications.			
	2.2 Recombinant Therapeutic Proteins: Production and medical applications of recombinant insulin, growth hormone and therapeutic enzymes.			
	2.3 Antibody and Vaccine Biotechnology: Monoclonal antibodies, recombinant vaccines and modern vaccine platforms.			
	2.4 Biosimilars and Clinical Applications: Concept, development, approval process and pharmacovigilance of biosimilars.			
Unit III	**Foundations of Nanobiotechnology**	7	7	
	3.1 Introduction to Nanobiotechnology: Concept, scope, historical development and interdisciplinary significance of nanobiotechnology.			
	3.2 Fundamentals of Nanoscience: Nanoscale dimensions, surface area effects, quantum confinement and unique nanoscale properties.			
	3.3 Types of Nanomaterials: Metallic, polymeric, carbon-based and lipid-based nanomaterials.			
	3.4 Synthesis of Nanomaterials: Top-down and bottom-up approaches for nanoparticle preparation.			
Unit IV	**Characterization and Biological Interactions of Nanomaterials**	8	8	
	4.1 Nanomaterial Characterization Techniques: UV-Spectroscopy, FTIR, SEM, TEM, AFM, XRD.			
	4.2 Surface Functionalization of Nanoparticles: Chemical modification, conjugation methods and targeting strategies.			
	4.3 Nano-Bio Interactions: Interaction of nanoparticles with cells, proteins and biological membranes.			
	4.4 Nanotoxicology and Biosafety: Toxicity assessment, biocompatibility and safety regulations.			
Model Question				
	1-Mark Questions (One-Sentence Answers) 1) Define medical biotechnology. 2) What is recombinant DNA technology? 3) What is a cloning vector? 4) Define biosafety. 5) Expand RT-PCR. 6) What is DNA sequencing? 7) Define monoclonal antibody. 8) Define nanotoxicology. 9) What is biocompatibility? 10) Define nano-bio interaction.			
	3 -Mark Questions 1) Explain the scope of medical biotechnology. 2) Differentiate between genetic and metabolic disorders. 3) Describe restriction enzymes. 4) Write short notes on biosafety levels. 5) Explain the principle of PCR. 6) Write short note on FTIR. 7) Describe nanoparticle conjugation.			

	8) Explain protein corona formation. 9) What is nanotoxicity assessment? 10) Explain biosafety regulations in nanotechnology.
	6-Mark Questions 1) Discuss molecular mechanisms involved in human genetic disorders. 2) Explain recombinant DNA technology and its medical applications. 3) Describe biosafety and ethical issues in medical biotechnology. 4) Discuss fundamental principles of nanoscience. 5) Explain various types of nanomaterials and their biomedical applications. 6) Describe methods of nanoparticle synthesis.Discuss modern vaccine biotechnology. 7) Explain the development and regulation of biosimilars. 8) Discuss clinical applications of recombinant therapeutics. 9) Explain the role of biotechnology in modern healthcare. 10) Compare major nanomaterial characterization techniques.
Text Books:	1. Jogdand, S. N. (2006). *Medical biotechnology*. Himalaya Publishing House. 2. Glick, B. R. (2014). *Medical biotechnology* (2nd ed.). ASM Press. 3. Glick, B. R., & Pasternak, J. J. (2010). *Molecular biotechnology: Principles and applications of recombinant DNA* (4th ed.). ASM Press. 4. Nelson, D. L., & Cox, M. M. (2017). *Lehninger principles of biochemistry* (7th ed.). W.H. Freeman and Company. 5. Watson, J. D., Baker, T. A., Bell, S. P., Gann, A., Levine, M., & Losick, R. (2013). *Molecular biology of the gene* (7th ed.). Pearson Education. 6. Watson, J. D., Myers, R. M., Caudy, A. A., & Witkowski, J. A. (2007). *Recombinant DNA: Genes and genomes—A short course* (3rd ed.). W.H. Freeman and Company. 7. Clark, D. P., & Pazdernik, N. J. (2016). *Biotechnology: Applying the genetic revolution* (2nd ed.). Academic Press. 8. Niemeyer, C. M., & Mirkin, C. A. (Eds.). (2004). *Nanobiotechnology: Concepts, applications and perspectives*. Wiley-VCH Verlag GmbH & Co. 9. Poole, C. P., Jr., & Owens, F. J. (2003). *Introduction to nanotechnology*. Wiley-Interscience. 10. Kulkarni, S. K. (2015). *Nanotechnology: Principles and practices* (3rd ed.). Springer India. 11. Mikkelsen, S. R., & Cortón, E. (2016). *Bioanalytical chemistry* (2nd ed.). Wiley. 12. Patrinos, G. P., & Ansorge, W. (Eds.). (2010). *Molecular diagnostics*. Academic Press. 13. Bawa, R., Audette, G., & Rubinstein, I. (Eds.). (2016). *Principles of nanomedicine* (2nd ed.). CRC Press. 14. Gupta, P. K. (2010). *Essentials of medical biotechnology*. Rastogi Publications.

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Teaching and Learning Scheme (Major Elective: Practical)
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Syllabus for: Major Elective: Practical – Medical Biotechnology & Nanobiotechnology 1

Level	Semester	Course Code	Course Name	Credits	Workload	Exam Duration	Max Marks
5.5	V	106708(P)	**Major Elective: Practical – Medical Biotechnology & Nanobiotechnology 1**	2	4	4 Hrs	50

Course Objectives:	After completion of the course, students will be able to: ➢ Develop fundamental practical knowledge of molecular biotechnology techniques used in DNA isolation, gene amplification, recombinant DNA analysis, and molecular diagnostics. ➢ Acquire hands-on laboratory skills in the use of molecular biology tools such as PCR, gel electrophoresis, restriction digestion, bacterial transformation, and immunological assays. ➢ Understand the principles and applications of nanoparticle synthesis, characterization, functionalization, and their biomedical significance. ➢ Analyze nano-bio interactions, biocompatibility, biosafety, and ethical considerations associated with medical biotechnology and nanobiotechnology. ➢ Enhance scientific aptitude through experimental analysis, interpretation of laboratory data, case studies, seminars, research discussions, and technical reporting.
Course Outcomes:	After successful completion of the course, students will be able to: ➢ Perform genomic DNA isolation, purification, amplification, and electrophoretic analysis using standard molecular biology techniques. ➢ Demonstrate proficiency in recombinant DNA technology, molecular diagnostic methods, and immunological techniques relevant to medical biotechnology. ➢ Synthesize and characterize nanoparticles using conventional and green synthesis approaches and interpret characterization data. ➢ Evaluate nanoparticle surface properties, biological interactions, toxicity assessment, and biosafety requirements for biomedical applications. ➢ Apply experimental knowledge to solve practical problems in biotechnology through scientific communication, analytical reasoning, and ethical laboratory practices.
Unit System	**Contents**
Major Experiments (Perform any 7)	1. Isolation of genomic DNA from biological samples: Extraction, purification and qualitative assessment of DNA. 2. Restriction digestion of DNA and agarose gel electrophoresis: Analysis of DNA fragmentation using restriction enzymes. 3. Polymerase Chain Reaction (PCR) amplification of target DNA: Optimization and amplification of selected gene sequences. 4. Analysis of PCR products by gel electrophoresis: Visualization and interpretation of amplified DNA fragments. 5. Bacterial transformation using plasmid vectors: Transformation of competent bacterial cells and screening of transformants. 6. Simulation of recombinant protein expression workflow: Expression design, induction and analysis of recombinant protein production. 7. ELISA for antigen-antibody interaction analysis: Detection and quantification of biomolecules. 8. Demonstration of molecular diagnostic workflow: Clinical sample processing and molecular disease detection. 9. Synthesis of silver nanoparticles by chemical reduction method: Preparation and observation of nanoparticle formation. 10. Green synthesis of nanoparticles using plant extracts: Eco-friendly

	nanoparticle preparation. 11. UV-Visible spectroscopic characterization of nanoparticles: Determination of optical properties. 12. FTIR analysis for functional group identification: Characterization of surface chemistry. 13. Comparative study of top-down and bottom-up nanoparticle synthesis: Evaluation of synthesis strategies. 14. Surface functionalization of nanoparticles: Ligand conjugation and surface modification. 15. Biocompatibility assessment of nanoparticles: Basic cytotoxicity/interaction studies using model biological systems.	
Minor Experiments (Perform any 5)	1. Preparation of standard buffers for molecular experiments 2. Estimation of DNA purity using spectrophotometric methods 3. Observation of agarose gel preparation and staining 4. Identification of cloning vector components 5. Case study analysis of biosimilars 6. Preparation of nanoparticle colloidal suspension 7. Observation of nanoparticle colorimetric changes 8. Interpretation of SEM/TEM micrographs 9. Comparative analysis of nanomaterial types 10. 10. Biosafety documentation and laboratory risk assessment	
Activities (Perform any Two):	1) Seminar Presentation on Recent Advances in Medical Biotechnology Students present recent developments in areas such as gene therapy, mRNA vaccines, stem cell therapy, nanomedicine, or personalized medicine. 2) Case Study Analysis of Biomedical Technologies Group-based analysis of real-life applications such as CRISPR therapy, COVID-19 vaccines, monoclonal antibody therapies, or organ transplantation. 3) Preparation of Scientific Models/Charts/Posters Preparation of educational models or posters on viral vectors, drug delivery systems, tissue engineering, antibody engineering, or pharmacogenomics. 4) Research Article Review and Discussion Students review simplified research papers or review articles related to Medical Biotechnology and present key findings. 5) Industrial/Research Laboratory Visit and Report WritingVisit to biotechnology laboratories, diagnostic centers, pharmaceutical industries, IVF centers, nanotechnology research laboratories followed by submission of a report. 6) Bioethics and Biosafety Group Discussion/Debate Discussion or debate on ethical concerns related to gene editing, synthetic biology, stem cell research, xenotransplantation, and commercialization of biotechnology products.	
Text Books:	1) Sambrook, J., & Russell, D. W. (2001). Molecular cloning: A laboratory manual (3rd ed.). Cold Spring Harbor Laboratory Press. 2) Brown, T. A. (2016). Gene cloning and DNA analysis: An introduction (7th ed.). Wiley-Blackwell. 3) Jogdand, S. N. (2017). Medical Biotechnology. Himalaya Publishing House, Mumbai. 4) Glick, B. R., & Pasternak, J. J. (2018). Molecular Biotechnology: Principles and Applications of Recombinant DNA (5th ed.). ASM Press. 5) Primrose, S. B., & Twyman, R. M. (2013). Principles of Gene Manipulation and Genomics (7th ed.). Wiley-Blackwell. 6) Nelson, D. L., & Cox, M. M. (2021). Lehninger Principles of Biochemistry (8th ed.). W.H. Freeman. 7) Watson, J. D., Baker, T. A., Bell, S. P., et al. (2014). Molecular Biology of the Gene (7th ed.). Pearson. 8) Thieman, W. J., & Palladino, M. A. (2019). Introduction to Biotechnology (4th ed.). Pearson Education. 9) Clark, D. P., & Pazdernik, N. J. (2016). Biotechnology: Applying the Genetic Revolution (2nd ed.). Academic Press.	

	10) Patrinos, G. P., & Ansorge, W. (2010). Molecular Diagnostics. Academic Press. 11) Niemeyer, C. M., & Mirkin, C. A. (2004). Nanobiotechnology: Concepts, Applications and Perspectives. Wiley-VCH. 12) Poole, C. P., & Owens, F. J. (2003). Introduction to Nanotechnology. Wiley-Interscience. 13) Kulkarni, S. K. (2015). Nanotechnology: Principles and Practices (3rd ed.). Springer. 14) Malsch, I. (2005). Biomedical Nanotechnology. CRC Press. 15) Torchilin, V. P. (2007). Handbook of Nanobiomedical Research. World Scientific Publishing. 16) Bawa, R., Audette, G., & Rubinstein, I. (2016). Principles of Nanomedicine (2nd ed.). CRC Press. 17) U.S. Department of Health and Human Services. (2020). Biosafety in Microbiological and Biomedical Laboratories (BMBL) (6th ed.). CDC/NIH.

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Syllabus for: Minor: **Applications of Biotechnology**
Each theory paper of **Theory shall be of 2 Credits comprising of 4 Units with Teaching Hours** as mentioned in the table. The pattern of theory papers shall be as per following template

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.5	V	106305	**Applications of Biotechnology**	2	30	2 Hrs	30

Course Objectives:	1) Remember and define the basic concepts and terminology associated with applied Biotechnology. 2) Understand the role of Biotechnology in agriculture, medicine, industry, and environmental management. 3) Apply biotechnological principles in various industrial and societal applications. 4) Analyze the impact of Biotechnology in improving human health, agriculture, and environmental sustainability. 5) Evaluate modern biotechnological advancements and their industrial significance. 6) Develop scientific awareness and problem-solving skills related to applied Biotechnology.			
Course Outcomes:	1) Explain major applications of Biotechnology in different sectors. 2) Understand agricultural, medical, industrial, and environmental applications of Biotechnology. 3) Describe production processes and technologies used in Biotechnology industries. 4) Analyze the role of Biotechnology in sustainable development and healthcare. 5) Evaluate ethical, biosafety, and societal issues related to Biotechnology applications. 6) Develop preparedness for higher studies and industrial applications in Biotechnology.			
Unit System	**Contents**	**Workload Allotted (Hrs)**	**Weightage of Marks Allotted**	**Incorpo-ration of Pedagogies**
Unit I	Applications in Agriculture	8	8	
	1.1 Plant tissue culture & micropropagation			
	1.2 Transgenic plants and genetically modified crop			
	1.3 Biofertilizers and biopesticides			
	1.4 Molecular markers and crop improvement			
Unit II	Applications in Healthcare	7	7	
	2.1 Recombinant therapeutic products			
	2.2 Molecular diagnostics			
	2.3 Gene therapy and stem cell technology			
	2.4 Monoclonal antibodies and vaccine technology			
Unit III	Industrial Applications	7	7	
	3.1 Fermentation technology			
	3.2 Production of industrial enzymes & antibiotics			
	3.3 Food Biotechnology			
	3.4 Biopharmaceuticals & bioprocess technology			
Unit IV	Advanced Applications	8	8	
	4.1 Environmental Biotechnology & bioremediation			
	4.2 Wastewater treatment and biodegradation			
	4.3 Bioinformatics and nanobiotechnology			

	4.4 Biosafety, bioethics, and Intellectual Property Rights			
1 Mark Questions	1. Define plant tissue culture. 2. What is micropropagation? 3. What is meant by a transgenic plant? 4. Define biofertilizer. 5. What are molecular markers? 6. What is gene therapy? 7. Define monoclonal antibody. 8. What is fermentation technology? 9. Define bioremediation. 10. What is meant by Intellectual Property Rights (IPR)?			
3 Mark Questions	1) Explain the principles and applications of plant tissue culture. 2) Differentiate between transgenic plants and genetically modified crops. 3) Write a short note on biofertilizers and their agricultural importance. 4) Explain the role of molecular markers in crop improvement. 5) Describe the applications of recombinant therapeutic products. 6) Explain the principle and applications of molecular diagnostics. 7) Discuss the significance of monoclonal antibodies in medicine. 8) Explain the industrial production of antibiotics using fermentation technology. 9) Write a short note on food biotechnology. 10) Explain the importance of biosafety and bioethics in biotechnology.			
6 Mark Questions	1. Describe plant tissue culture & micropropagation with suitable diagrams applications. 2. Explain the development, advantages, and limitations of transgenic plants and genetically modified crops. 3. Discuss role of biofertilizers, biopesticides & molecular markers in sustainable agriculture. 4. Explain the production and applications of recombinant therapeutic products, gene therapy, and stem cell technology. 5. Discuss the principle, production, and applications of monoclonal antibodies and modern vaccine technology. 6. Describe the process of fermentation technology and explain the industrial production of enzymes and antibiotics. 7. Explain the role of food biotechnology and biopharmaceuticals in improving human health and industry. 8. Discuss the principles and applications of environmental biotechnology, bioremediation, and wastewater treatment. 9. Explain the applications of bioinformatics and nanobiotechnology in modern biotechnology. 10. Discuss biosafety, bioethics, and IPR in biotechnology with suitable examples.			
Reference Books:	1. Brown, T. A. (2016). Gene cloning and DNA analysis: An introduction (7th ed.). Wiley-Blackwell. 2. Crueger, W., & Crueger, A. (2017). Biotechnology: A textbook of industrial microbiology (3rd ed.). Panima Publishing. 3. Glick, B. R., Pasternak, J. J., & Patten, C. L. (2017). Molecular biotechnology: Principles and applications of recombinant DNA (5th ed.). ASM Press. 4. Kumar, H. D. (2018). Modern concepts of Biotechnology. Vikas Publishing House. 5. Pelczar, M. J., Chan, E. C. S., & Krieg, N. R. (2016). Microbiology. McGraw-Hill. 6. Primrose, S. B., & Twyman, R. M. (2013). Principles of gene manipulation and genomics (7th ed.). Wiley-Blackwell. 7. Rastogi, S. C., Mendiratta, N., & Rastogi, P. (2019). Bioinformatics: Methods and applications (4th ed.). PHI Learning. 8. Singh, B. D. (2018). Biotechnology: Expanding horizons (4th ed.). Kalyani Publishers. 9. Wilson, K., & Walker, J. (2018). Principles and techniques of biochemistry and molecular biology (8th ed.). Cambridge University Press.			

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Syllabus for: Minor: Lab/ Practical: Applications of Biotechnology

Level	Semester	Course Code	Course Name	Credits	Workload	Exam Duration	Max Marks
5.5	V	106306 (P)	Lab/ Practical: Applications of Biotechnology	2	4	2 Hrs	30

Course Objectives:	1) To develop basic skills in statistical calculations and data analysis. 2) To train students in graphical representation of biological data. 3) To introduce students to biological databases and bioinformatics tools. 4) To develop skills in sequence retrieval and analysis. 5) To train students in sequence alignment techniques.
Course Outcomes:	1. Calculate and interpret statistical parameters such as mean, median, and standard deviation. 2. Represent biological data using graphs and charts. 3. Retrieve nucleotide and protein sequences from biological databases. 4. Perform sequence similarity searches using BLAST.
Major Experiments (Perform any 7)	1) Preparation of Murashige and Skoog (MS) medium and aseptic inoculation of explants. 2) In vitro multiplication of plant explants and observation of shoot proliferation. 3) Extraction of DNA from fresh plant leaves using the CTAB method. 4) Amplification of a target DNA fragment and analysis by agarose gel electrophoresis. 5) Digestion of plasmid/DNA using restriction endonucleases and analysis on agarose gel. 6) Isolation of *Rhizobium*/*Azotobacter* from soil or root nodules and characterization. 7) Demonstration of antibiotic production by *Streptomyces* or other microorganisms. 8) Production and assay of amylase/protease from bacterial or fungal cultures. 9) Batch fermentation using yeast and estimation of ethanol production. 10) Biodegradation of dyes or hydrocarbons using selected microorganisms. 11) Estimation of BOD, COD, pH, and microbial load before and after biological treatment. 12) Retrieval of nucleotide/protein sequences from NCBI and sequence alignment using BLAST.
Minor Experiments (Perform any 5)	1) Preparation and sterilization of laboratory media using an autoclave. 2) Preparation of stock solutions for plant tissue culture. 3) Surface sterilization of plant explants. 4) Observation of different stages of callus formation and organogenesis. 5) Demonstration of Agrobacterium-mediated gene transfer (video/model demonstration). 6) Gram staining of biofertilizer microorganisms. 7) Estimation of microbial growth by spectrophotometry (OD measurement). 8) Determination of amylase activity by the starch hydrolysis method. 9) Demonstration of ELISA for disease diagnosis. 10) Agarose gel electrophoresis of DNA samples. 11) Demonstration of vaccine production flowchart and monoclonal antibody production. 12) Bioinformatics exercise: Retrieval of DNA/protein sequences from GenBank and construction of a simple phylogenetic tree using MEGA software.

Activities (Perform any Two):	Survey-based statistical data collection and analysis Preparation of charts and graphs using biological data Case study on statistical analysis in healthcare research	

Text Books:

1. Practical Biotechnology – S. Janarthanan (Universities Press)
2. Laboratory Manual in Biotechnology – P. K. Gupta (Rastogi Publications)
3. Experimental Biotechnology: Practical Manual Series – R. C. Dubey (S. Chand)
4. Biotechnology: Practical Manual – S. C. Rastogi, N. Mendiratta & P. Rastogi (CBS Publishers)
5. Plant Tissue Culture: Theory and Practice – S. S. Bhojwani & M. K. Razdan (Elsevier)
6. Plant Tissue Culture Laboratory Manual – Roberta H. Smith (Academic Press)
7. Molecular Cloning: A Laboratory Manual – Sambrook & Russell (Cold Spring Harbor Laboratory Press)
8. Practical Manual on Industrial Biotechnology – P. C. Trivedi (Aavishkar Publishers)
9. Bioinformatics: Sequence and Genome Analysis – David W. Mount (Cold Spring Harbor Laboratory Press)
10. Biotechnology: Expanding Horizons – B. D. Singh (Kalyani Publishers)

Sant Gadge Baba Amravati University
FACULTY: Science and Technology
Teaching and Learning Scheme (VSC: Practical)
for the Three-Year UG Degree of Bachelor of Biotechnology
(Three Years- Six Semesters Bachelor's Degree Program)

Syllabus for: VSC: AI in LifeScience
Each theory paper of **Theory shall be of 2 Credits comprising of 4 Units with Teaching Hours** as mentioned in the table. The pattern of theory papers shall be as per following template

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.5	V	106504	**VSC: AI in LifeScience**	4	60	2 Hrs	30

Course Objectives:	1. To introduce the basic concepts of Artificial Intelligence in Life Sciences. 2. To familiarize students with AI-based tools used in biological data analysis. 3. To develop practical skills in bioinformatics and AI applications. 4. To understand the role of AI in healthcare and biotechnology. 5. To create awareness about ethical issues and future applications of AI in Life Sciences.
Course Outcomes:	1. Students will understand the fundamentals of AI and its applications in Life Sciences. 2. Students will be able to use basic AI tools for biological data analysis. 3. Students will acquire skills in sequence analysis and biological database handling. 4. Students will understand the applications of AI in healthcare and biotechnology. 5. Students will develop awareness regarding ethical aspects and future scope of AI in Life Sciences.
Unit System	**Contents**
Major Experiments (Perform any 7)	1. Study of basic AI concepts and applications in Life Sciences 2. Use of AI tools for biological information search 3. AI-assisted summarization of scientific articles 4. Study of biological databases using AI tools 5. Sequence search and analysis using AI-based software 6. Basic protein structure prediction using online AI tools 7. Gene identification and annotation using AI platforms 8. Preparation of simple phylogenetic trees using AI tools 9. Study of AI applications in disease diagnosis 10. Analysis of biological images using AI software 11. AI-assisted biological data analysis and graph preparation 12. Preparation of scientific reports and presentations using AI tools
Minor Experiments (Perform any 5)	1. Introduction to AI-enabled software in Life Sciences 2. Search of biological data using AI-assisted platforms 3. Study of online databases for biological information 4. Sequence alignment using simple AI-based tools 5. Protein visualization using online AI tools 6. Study of AI applications in biotechnology laboratories 7. Preparation of charts and graphs using AI software 8. Study of ethical issues related to AI in Life Sciences Seminar presentation on future scope of AI in Life Sciences
Activities (Perform any Two):	1. Seminar Presentation on applications of AI in Life Sciences 2. Group Discussion on ethical issues of AI in biology and healthcare 3. Poster Preparation on AI tools used in biotechnology 4. Assignment Writing on future scope of AI in Life Sciences Hands-on Training 5. Workshop on basic AI-based biological software tools
Text Books:	1. Campbell, A. M. Introduction to Artificial Intelligence in Biology and Medicine. 2. Lesk, A. M. Introduction to Bioinformatics. 3. Rastogi, S. C., Mendiratta, N. and Rastogi, P. Bioinformatics: Methods and Applications.

	4. Bal, H. P. Artificial Intelligence in Life Sciences. 5. Pevsner, J. Bioinformatics and Functional Genomics. 6. Ignacimuthu, S. Basic Bioinformatics. 7. Gupta, P. K. Biotechnology and Bioinformatics. 8. Brown, T. A. Genomes. 9. Mount, D. W. Bioinformatics: Sequence and Genome Analysis. 10. Bharath Ramsundar et al. Deep Learning for the Life Sciences.

Sant Gadge Baba Amravati University
FACULTY: Science and Technology
Teaching and Learning Scheme (Forensic Biology) for the Three-Year UG Degree of Bachelor of Biotechnology
(Three Years- Six Semesters Bachelor's Degree Program)
Syllabus for: SEC: Forensic Biology

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.5	V	106605	**Forensic Biology**	2	30	2 Hrs	50

Course Objectives:	1) To introduce students to the principles and applications of forensic biology in criminal investigations. 2) To develop practical skills in the collection, preservation, and analysis of biological evidence. 3) To familiarize students with forensic laboratory techniques used for species identification, blood analysis, and DNA profiling. 4) To impart knowledge of forensic documentation, chain of custody, and ethical practices in forensic investigations. 5) To enhance analytical and problem-solving skills through forensic case studies and laboratory investigations.			
Course Outcomes:	1) Identify and demonstrate basic forensic biology laboratory techniques and safety practices. 2) Collect, preserve, and document biological evidence such as blood, hair, fibers, and saliva samples. 3) Perform basic forensic tests such as blood grouping, blood smear preparation, and microscopic examination of biological materials. 4) Analyze and interpret simple forensic biological evidence and maintain proper chain of custody records.			
Unit System	**Contents**	**Workload Allotted (Hrs)**	**Weightage of Marks Allotted**	**Incorporation of Pedagogies**
Unit I	Introduction to Forensic Biology & Microscopy 1) Study of basic laboratory safety rules and handling of forensic samples 2) Calibration and use of compound microscope 3) Preparation of simple temporary slides (plant/animal tissues) 4) Identification of basic cell structures under microscope (plant & animal cells)			Power point presentation, Discussion, Demonstration, Collaborative learning, Problem based learning (PBL), Experimental learning. Direct instructions
Unit II	**Forensic Sample Collection & Preservation** 1) Methods of collecting biological evidence (blood, hair, saliva) – demonstration 2) Packaging and labeling of forensic biological samples 3) Preservation techniques for biological evidence (drying, refrigeration) 4) Chain of custody documentation and sample record maintenance			
Unit III	**Forensic Serology & Blood Analysis** 1) Preparation of blood smear and staining (simple staining technique) 2) ABO blood group determination (basic slide method) 3) Detection of blood stains using presumptive tests (e.g., benzidine alternative) 4) Microscopic examination of blood cells (RBC, WBC identification)			
Unit IV	**Hair, Fiber & Basic Biological Evidence** 1) Microscopic study of human hair (root, shaft, medulla) 2) Comparison of animal and human hair samples 3) Identification of textile fibers (cotton, wool, synthetic) under microscope 4) Basic identification of pollen grains and spores as forensic trace evidence			

	Text Books: 1. Forensic Science in Criminal Investigation — B. R. Sharma 2. Criminalistics: An Introduction to Forensic Science — Richard Saferstein 3. Forensic Science: An Introduction to Scientific and Investigative Techniques — Suzanne Bell 4. Principles and Practice of Criminalistics — Paul L. Kirk 5. Modern Forensic Biology — Richard Li 6. Forensic Serology — Richard Li 7. Forensic Biology: Identification and DNA Analysis of Biological Evidence — Kelly M. Pyrek 8. Criminal Investigation: The Art and the Science — Charles L. O'Hara & Gregory L. O'Hara 9. Forensic DNA Typing — John M. Butler 10. Textbook of Forensic Medicine and Toxicology — V. V. Pillay

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI
FACULTY: Science and Technology
PRACTICAL EXAMINATION
B.Sc. III (Biotechnology), SEMESTER – VI (NEP)

Level	Semester	Course Code	Course Code	Credits	Teaching hours	Exam duration	Max Marks:
5.0	**V**	**107251**	**Field Project / Community Engagement Services in Biotechnology**	**2**			**50**

Course objectives

1) To expose students to the practical applications of biotechnology in agriculture, healthcare, environmental conservation, and industry through field-based learning.
2) To develop skills in planning, conducting, and documenting community-based biotechnology projects.
3) To promote scientific awareness and the transfer of biotechnology knowledge for addressing local societal and environmental challenges.
4) To enhance teamwork, communication, leadership, and problem-solving skills through community engagement and outreach activities.
5) To encourage ethical practices, environmental responsibility, and sustainable development using biotechnological approaches.

Course Outcomes

1) Apply biotechnological concepts to solve real-world problems encountered in community and field settings.
2) Conduct field surveys, collect and analyze biological and environmental data, and prepare scientific reports.
3) Design and implement community awareness programs on biotechnology, health, sanitation, agriculture, and environmental sustainability.
4) Demonstrate effective communication, teamwork, leadership, and project management skills while working with diverse stakeholders.
5) Evaluate the societal, ethical, and environmental impacts of biotechnology and propose sustainable, science-based solutions.

Guidelines/ SoP for FP/CEP

For understanding key principles of CE, forms of CE, operational guidelines and implementation strategy please refer https://www.ugc.gov.in/pdfnews/4187860_Revised Final-Guidelines.pdf As per NEP 2020, students of B Sc. III of Semester V need to perform a Field Project (FP) / Community Engagement Program for TWO (2) credits i.e. 50 Marks.
The guidelines regarding the field project are as follows:
1. Students must complete 60 hours of field engagement.
2. Work may be done individually or in groups of up to 4 students, each under a departmental faculty guide.
3. A survey or sample collection methodology must be chosen, with appropriate documentation tools: questionnaires, datasheets, plant specimen formats, etc.
4. Projects can be survey-based, experimental, observational, or intervention-based.
5. Final report to include: Title, Introduction, Materials & Methods, Results, Discussion, Conclusion, References.
6. Minimum 6 pages excluding cover page, certificate, acknowledgement, etc.
7. Poster/PPT presentation is mandatory and will be evaluated by an appointed examiner.
8. For a SURVEY based project-related questionnaire (15 or more questions) shall be prepared. 9. The departmental coordinator/guide shall check the questions and finalize the questionnaire. The question that may create unnecessary complications should be avoided. The questions should be qualitative as well as quantitative.
10. If the project is related to work that does not involve survey work, then the questionnaire part can be replaced accordingly (e.g. Sample collection/Data collection/ Experimental base etc).
11. The total project work including preparation of questionnaire to presentation should be evaluated for 2 credits (50 Marks).
Suggested Forms Of Community-Engaged Practice In Biotechnology

FP/CEP	Course Code: 107251	Field Project / Community Engagement Services in Biotechnology	Max Marks: 50
Q. No.	**Exercise**		**Marks**
1	Field Engagement & Participation (Attendance, hands-on involvement, and community interaction)		15
2	Project Report Quality (Clarity, structure, scientific accuracy, originality, and referencing)		15
3	Data Collection & Analysis (Depth, relevance, and quality of survey/sample collection and its analysis)		10
4	Presentation (Poster or PPT) (Communication of findings, visual clarity, and confidence)		05
5	Social Relevance & Innovation (Creative solutions, awareness campaigns, or community impact beyond data.)		05

Sant Gadge Baba Amravati University
FACULTY: Science and Technology
Teaching and Learning Scheme (Major: Theory)
for the Three-Year UG Degree of Bachelor of Biotechnology
(Three Years- Six Semesters Bachelor's Degree Program)

Syllabus for: Major: Animal Biotechnology
Each theory paper of **Theory shall be of 2 Credits comprising of 4 Units with Teaching Hours** as mentioned in the table. The pattern of theory papers shall be as per following template

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.5	VI	106213	Animal Biotechnology	2	30	2 Hrs	30

Course Objectives:	1) To introduce the basic concepts and scope of Animal Biotechnology. 2) To understand animal cell and tissue culture techniques. 3) To study transgenic animals and their applications. 4) To understand reproductive biotechnology and stem cell technology. 5) To explore ethical, legal and biosafety issues in animal biotechnology.			
Course Outcomes:	1) Students will understand the principles & applications of Animal Biotechnology. 2) Students will acquire knowledge of animal cell culture techniques & media preparation. 3) Students will understand the production and applications of transgenic animals. 4) Students will gain knowledge about reproductive and stem cell technologies. 5) Students will develop awareness regarding ethical and biosafety concerns in Animal Biotechnology.			
Unit System	**Contents**	**Workload Allotted (Hrs)**	**Weightage of Marks Allotted**	**Incorporation of Pedagogies**
Unit I	**Introduction to Animal Biotechnology**	8	8	
	1.1 Scope and importance of Animal Biotechnology			
	1.2 Structure and organization of animal cell			
	1.3 Animal cell culture laboratory design and equipment			
	1.4 Culture media, sterilization and maintenance of animal cell cultures			
Unit II	**Animal Cell and Tissue Culture**	7	7	
	2.1 Primary and secondary cell culture			
	2.2 Cell line characterization and preservation			
	2.3 Organ culture and tissue engineering			
	2.4 Applications of animal cell culture in biotechnology			
Unit III	**Transgenic Animals and Reproductive Biotechnology**	7	7	
	3.1 Production of transgenic animals			
	3.2 Gene transfer methods in animals			
	3.3 Cloning and embryo transfer technology			
	3.4 Applications of transgenic animals in medicine and agriculture			
Unit IV	**Stem Cell Technology and Bioethics**	8	8	
	4.1 Stem cells: Types and applications			
	4.2 Hybridoma technology and monoclonal antibodies			
	4.3 Ethical &biosafety issues in animal biotechnology			
	4.4 Future prospects of Animal Biotechnology			
	1-Mark Questions (One-Sentence Answers) 1. Define Animal Biotechnology.			

	2. What is an animal cell culture? 3. Name any one type of culture media used in animal cell culture. 4. What is sterilization? 5. Define primary cell culture. 6. What is cryopreservation? 7. Define tissue engineering. 8. What is a transgenic animal? 9. Define cloning. **10.** What are stem cells?
	3 -Mark Questions (One-Sentence Answers) 1. Explain the scope of Animal Biotechnology. 2. Describe the structure of an animal cell. 3. Write a note on animal cell culture laboratory equipment. 4. Explain the importance of sterilization in cell culture. 5. Differentiate between primary and secondary cell culture. 6. Explain methods of cell line preservation. 7. Write a short note on organ culture. 8. Describe gene transfer methods in animals. 9. Explain embryo transfer technology. 10. Discuss applications of monoclonal antibodies.
	6-Mark Questions (One-Sentence Answers) 1. Explain the scope and importance of Animal Biotechnology in detail. 2. Describe animal cell culture laboratory design and culture media preparation. 3. Explain primary and secondary cell culture techniques with applications. 4. Discuss tissue engineering and its applications in biotechnology. 5. Describe methods for production of transgenic animals. 6. Explain various gene transfer methods used in animals. 7. Write a detailed note on cloning and embryo transfer technology. 8. Discuss applications of transgenic animals in medicine and agriculture. 9. Explain stem cell technology and its applications. 10. Discuss ethical and biosafety issues in Animal Biotechnology.
Text Books:	Ranga, M. M. Animal Biotechnology. Agrobios Publications. Freshney, R. I. Culture of Animal Cells: A Manual of Basic Technique. Ramadass, P. and Meera, R. Animal Biotechnology. MJP Publishers. Watson, J. D. Recombinant DNA: Genes and Genomes. Gupta, P. K. Biotechnology and Genomics.

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FACULTY: Science and Technology
Teaching and Learning Scheme (Major: Theory)
for the Three-Year UG Degree of Bachelor of Biotechnology
(Three Years- Six Semesters Bachelor's Degree Program)

Syllabus for: Major: Cell Signaling and Cancer Biology
Each theory paper of **Theory shall be of 2 Credits comprising of 4 Units with Teaching Hours** as mentioned in the table. The pattern of theory papers shall be as per following template

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.5	VI	106214	**Cell Signaling and Cancer Biology**	2	30	2 Hrs	30

Course Objectives:	➢ Understand the fundamental concepts of cell signaling, signaling molecules, receptors, and signal transduction pathways in living organisms. ➢ Explain the mechanisms of cell communication, secondary messengers, and the role of cell surface receptors in cellular responses. ➢ Describe the molecular basis of cancer, including carcinogenesis, oncogenes, tumor suppressor genes, and global cancer burden. ➢ Understand the processes involved in cancer progression, angiogenesis, metastasis, and apoptosis. ➢ Familiarize with modern approaches for cancer diagnosis, treatment, precision medicine, and immunotherapy.
Course Outcomes:	➢ Explain the principles of cell signalling, types of signalling mechanisms, signalling molecules, and receptor functions. ➢ Describe signal transduction pathways, cell surface receptors, secondary messengers, cell communication, gap junctions, and extracellular matrix functions. ➢ Analyse the basic concepts of cancer biology, including tumor types, causes of cancer, oncogenes, tumor suppressor genes, and global cancer statistics. ➢ Explain the mechanisms of cancer progression, cell cycle deregulation, apoptosis, angiogenesis, and metastasis. ➢ Discuss various cancer diagnostic techniques and evaluate the principles of chemotherapy, radiation therapy, targeted therapy, and immunotherapy in cancer management.

Unit System	Contents	Workload Allotted (Hrs)	Weightage of Marks Allotted	Incorporation of Pedagogies
Unit I	**Fundamentals of Cell Signaling and Receptors**	8	8	
	1.1 Introduction to Cell Signaling: Importance of cell signaling in living organisms, Components of signaling pathways			
	1.2 Types of cells signaling: Autocrine, Paracrine, Endocrine and Juxtracrine.			
	1.3 Types of signaling molecules: Hormones (Insulin and Thyroxine), Neurotransmitters (Acetylcholine), Growth Factors (Epidermal Growth Factor, Platelet-Derived Growth Factor)			
	1.4 Receptors: Structure and functions of receptors, Types of receptors intracellular and cell surface receptors,			
Unit II	**Signal Transduction and Cell Communication**	7	7	
	2.1 Cell Surface Receptors: Aquaporins, Ion channel receptors, G-protein coupled receptors (GPCRs)			
	2.2 Secondary Messengers in Signal Transduction: cAMP, Calcium ions (Ca^{2+}), IP_3 and DAG.			

	2.3 Cell Communication: Direct and indirect cell communication, Cell recognition and signaling			
	2.4 Gap Junctions and Extracellular Matrix (ECM): Structure and functions of gap junctions, Components and functions of ECM			
Unit III	**Fundamentals of Cancer Biology**	7	7	
	3.1 Introduction to Cancer: Types of Tumors, characteristics of cancer cells.			
	3.2 Causes of Cancer: Exposure to physical carcinogens, chemical carcinogens, and biological agents.			
	3.3 Oncogenes and Tumor Suppressor Genes: Proto-oncogenes and oncogenes, Tumor suppressor genes.			
	3.4 World Cancer Status: Global cancer incidence, mortality, major cancer types, and current trends.			
Unit IV	**Cancer Progression, Diagnosis, and Therapeutic Approaches**	8	8	
	4.1 Cancer Progression: Cell cycle deregulation Apoptosis and cancer			
	4.2 Angiogenesis and Metastasis: Tumor, vascula-rization (angiogenesis), Mechanisms of metastasis			
	4.3 Cancer Diagnosis and Therapy: Diagnostic modalities: CT, MRI, PET scans, histopathology, and serum biomarkers, Chemotherapy and radiation therapy			
	4.4 Precision Medicine and Immunotherapy: Targeted therapy Immunotherapy: immune checkpoint inhibitors and CAR-T cell therapy			
	One-Mark Questions 1. Define cell signaling. 2. What is a ligand? 3. Name any two types of cell signaling. 4. Give one example of a neurotransmitter. 5. What is a G-protein coupled receptor (GPCR)? 6. What is the role of cAMP in signal transduction? 7. Define oncogene. 8. Name one tumor suppressor gene. 9. What is angiogenesis? 10. Name one imaging technique used in cancer diagnosis.			
	Three-Mark Questions 1. Explain the components of a cell signaling pathway. 2. Differentiate between autocrine and paracrine signaling. 3. Describe the functions of cell surface receptors. 4. Write a note on secondary messengers in signal transduction. 5. Explain direct and indirect cell communication. 6. Describe the structure and functions of gap junctions. 7. Discuss the characteristics of cancer cells. 8. Explain the role of proto-oncogenes and oncogenes in cancer. 9. Describe the causes of cancer. 10. Explain the significance of serum biomarkers in cancer diagnosis.			
	Six-Mark Questions ➢ Discuss the types of cells signaling with suitable examples. ➢ Explain the structure, functions, and types of receptors involved in cell signaling.			

	➢ Describe the role of secondary messengers (cAMP, Ca^{2+}, IP_3, and DAG) in signal transduction. ➢ Explain cell communication and the role of extracellular matrix (ECM) in cellular interactions. ➢ Discuss the causes of cancer and the major risk factors involved in carcinogenesis. ➢ Explain the role of oncogenes and tumor suppressor genes (p53 and Rb) in cancer development. ➢ Describe cell cycle deregulation and apoptosis in cancer progression. ➢ Explain the processes of angiogenesis and metastasis in cancer progression. ➢ Discuss the various diagnostic modalities used in cancer detection and monitoring. ➢ Compare chemotherapy, radiation therapy, targeted therapy, and immunotherapy as approaches to cancer treatment
Text Books:	1. Park K. *Park's Textbook of Preventive and Social Medicine*. Banarsidas Bhanot Publishers. 2. Satyanarayana U. and Chakrapani U. *Biochemistry*. Elsevier India. 3. Purohit S.S. *Biotechnology: Fundamentals and Applications*. Agrobios (India). 4. Verma P.S. and Agarwal V.K. *Cell Biology, Genetics, Molecular Biology, Evolution and Ecology*. S. Chand Publishing. 5. Lodish H., Berk A., Kaiser C.A., et al. Molecular Cell Biology. W.H. Freeman and Company. 6. Alberts B., Johnson A., Lewis J., et al. Molecular Biology of the Cell. Garland Science. 7. Hesketh R. Introduction to Cancer Biology. Cambridge University Press. 8. Pecorino L. The Molecular Biology of Cancer: Mechanisms, Targets and Therapeutics. Oxford University Press.

Sant Gadge Baba Amravati University
FACULTY: Science and Technology
Teaching and Learning Scheme (Major: Theory)
for the Three-Year UG Degree of Bachelor of Biotechnology
(Three Years- Six Semesters Bachelor's Degree Program)

Syllabus for: Major: Environmental Biotechnology
Each theory paper of **Theory shall be of 2 Credits comprising of 4 Units with Teaching Hours** as mentioned in the table. The pattern of theory papers shall be as per following template

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.5	VI	106215	**Environmental Biotechnology**	2	30	2 Hrs	30

Course Objectives:	1) To understand the principles and scope of Environmental Biotechnology. 2) To explain the role of microorganisms in pollution control and environmental management. 3) To acquire knowledge of bioremediation and waste treatment technologies. 4) To understand the production of renewable energy and resource recovery from waste. 5) To familiarize students with environmental monitoring tools, biosafety and recent advances.			
Course Outcomes:	1) Explain environmental problems and the role of biotechnology in their management. 2) Apply principles of bioremediation and waste treatment for pollution control. 3) Evaluate different renewable energy technologies based on biological systems. 4) Analyse the use of biosensors, phytoremediation and environmental monitoring techniques. 5) Assess recent developments and biosafety aspects of Environmental Biotechnology.			
Unit System	**Contents**	**Workload Allotted (Hrs)**	**Weightage of Marks Allotted**	**Incorpo-ration of Peda-gogies**
Unit I	**Introduction to Environmental Biotechnology**	8	8	
	1.1 Concept, scope and importance of Environmental Biotechnology.			
	1.2 Environmental pollution: air, water, soil and solid waste pollution.			
	1.3 Microorganisms in environmental management.			
	1.4 Biogeochemical cycles (Carbon, Nitrogen and Phosphorus cycles).			
Unit II	**Bioremediation and Waste Management**	7	7	
	2.1 Principles and types of bioremediations (in situ and ex situ).			
	2.2 Microbial degradation of xenobiotics and pesticides.			
	2.3 Sewage and wastewater treatment processes.			
	2.4 Solid waste management, composting and vermicomposting.			
Unit III	**Energy and Resource Recovery**	7	7	
	3.1 Biofuels: biogas, bioethanol and biodiesel.			
	3.2 Bio methanation and anaerobic digestion from waste.			
	3.3 Microbial fuel cells and renewable energy.			
	3.4 Single-cell protein and value-added products			
Unit IV	**Advanced Applications and Environmental Monitoring**	8	8	

	4.1 Biosensors and bioindicators in environmental monitoring. 4.2 Phytoremediation and constructed wetlands. 4.3 Environmental impact assessment (EIA) and risk assessment. 4.4 Recent advances in Environmental Biotechnology and biosafety regulations.			
One-Mark Questions	1) Define Environmental Biotechnology. 2) What is bioremediation? 3) Expand EIA. 4) What is xenobiotic degradation? 5) Define composting. 6) What is bio methanation? 7) Name one biofuel. 8) What is phytoremediation? 9) Define biosensor. **10)** What is vermicomposting?			
Three-Mark Questions	1) Explain the scope of Environmental Biotechnology. 2) Describe the role of microorganisms in biogeochemical cycles. 3) Differentiate between in situ and ex situ bioremediation. 4) Explain the process of sewage treatment. 5) Write a note on composting. 6) Describe anaerobic digestion. 7) Explain the principle of microbial fuel cells. 8) Write a short note on biosensors. 9) Explain phytoremediation. 10) Discuss the importance of Environmental Impact Assessment.			
Six-Mark Questions	1) Discuss the scope and importance of Environmental Biotechnology. 2) Explain various types of environmental pollution and their control measures. 3) Describe the principles and applications of bioremediation. 4) Explain the process of sewage and wastewater treatment. 5) Discuss microbial degradation of xenobiotics and pesticides. 6) Describe solid waste management methods including composting and vermicomposting. 7) Explain the production of biofuels and their environmental significance. 8) Discuss microbial fuel cells and resource recovery technologies. 9) Explain applications of biosensors & bioindicators in environmental monitoring. 10) Discuss recent advances, biosafety issues and regulations in Environmental Biotechnology.			
Text Books:	1) Raina M. Maier, Ian L. Pepper & Charles P. Gerba – Environmental Microbiology. 2) Rittmann and McCarty – Environmental Biotechnology: Principles & Applications. 3) Evans & Furlong– Environmental Biotechnology: Theory & Application. 4) Daniel A. Vallero – Environmental Biotechnology: A Biosystems Approach. 5) Indu Shekhar Thakur – Environmental Biotechnology:Basic Concept &Applications. 6) P. D. Sharma – Environmental Biology and Biotechnology. 7) Chatterjee – Introduction to Environmental Biotechnology. 8) M. H. Fulekar – Environmental Biotechnology.			

Sant Gadge Baba Amravati University
FACULTY: Science and Technology
Teaching and Learning Scheme (Major/Minor/SEC/VSC: Practical Major)
for the Three-Year UG Degree of Bachelor of Biotechnology
(Three Years- Six Semesters Bachelor's Degree Program)

Syllabus for: Practical Major

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.5	VI	106216	**Lab/Practical**	4	60	2 Hrs	30

Course Objectives:	➢ To provide hands-on training in modern laboratory techniques, instruments, and experimental procedures relevant to the course. ➢ To develop practical skills for the collection, processing, analysis, and interpretation of biological samples and experimental data. ➢ To familiarize students with standard laboratory protocols, biosafety measures, ethical practices, and quality assurance procedures. ➢ To enhance critical thinking, problem-solving abilities, and scientific reasoning through practical experimentation. ➢ To develop scientific communication skills through accurate record keeping, data presentation, report writing, and interpretation of experimental results.
Course Outcomes:	➢ Perform laboratory experiments independently using appropriate techniques, instruments, and standard operating procedures. ➢ Analyse, interpret, and evaluate experimental observations and data using scientific principles. ➢ Demonstrate proficiency in maintaining laboratory safety, biosafety, ethical standards, and proper documentation. ➢ Apply practical knowledge to solve biological, biomedical, and environmental problems using modern biotechnological approaches. ➢ Communicate experimental findings effectively through laboratory records, scientific reports, presentations, and data interpretation.
Unit System	**Contents**
Major Experiments (Perform any 7)	1. Study of Animal Cell Culture Laboratory Equipment. 2. Preparation and Sterilization of Animal Cell Culture Media. 3. Aseptic Techniques in Animal Cell Culture. 4. Subculturing (Passaging) of Animal Cell Lines. 5. Cell Viability Test by Trypan Blue Exclusion Method. 6. Cryopreservation of Animal Cells (Demonstration). 7. Study of Cell Surface Receptors. 8. Observation of Cell Cycle Stages Using Prepared Slides. 9. Identification of Normal and Cancerous Tissue Sections. 10. Study of Cancer Diagnostic Techniques (CT, MRI, PET, Histopathology). 11. Isolation of Soil Microorganisms by Serial Dilution Method. 12. Determination of Biological Oxygen Demand (BOD) of Water. 13. Determination of Chemical Oxygen Demand (COD) of Water. 14. Preparation of Compost/Vermicompost Unit. 15. Estimation of Microbial Population by Standard Plate Count.
Minor Experiments (Perform any 5)	**1.** Identification of Animal Cell Culture Laboratory Equipment. **2.** Preparation of Phosphate Buffered Saline (PBS). **3.** Sterilization of Laboratory Glassware. **4.** Observation of Animal Cells Under Inverted Microscope. **5.** Identification of Stem Cell Types. **6.** Study of Cell Signaling Pathways Using Charts. **7.** Identification of Physical, Chemical and Biological Carcinogens. **8.** Identification of Environmental Pollutants. **9.** Study of Biofuels and Renewable Energy Sources. **10.** Study of Biosensors, Bioindicators and Phytoremediation.

Activities (Perform any Two):	1.Visit to Pharmaceutical industry/ Tour 2. Assignment 3. Seminar 4. Participation in any college activity 5. Major Project (Phase: 1)	
Text Books:	**1.** Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications **2.** Animal Biotechnology **3.** Molecular Biology of the Cell **4.** Molecular Cell Biology **5.** The Biology of Cancer **6.** Cell Signaling **7.** Environmental Biotechnology **8.** Environmental Biotechnology: Principles and Applications **9.** Environmental Microbiology **10.** Wastewater Engineering: Treatment and Resource Recovery	

Sant Gadge Baba Amravati University
FACULTY: Science and Technology
Teaching and Learning Scheme (Major Elective: Theory)
for the Three-Year UG Degree of Bachelor of Biotechnology
(Three Years- Six Semesters Bachelor's Degree Program)

Syllabus for: Major Elective I: Analytical Methods and Instrumentation-II.
Each theory paper of **Theory shall be of 2 Credits comprising of 4 Units withTeaching Hours** as mentioned in the table. The pattern of theory papers shall be as per following template

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.5	VI	106709	**Major Elective I: Analytical Methods and Instrumentation-II.**	2	30	2 Hrs	30

Course Objectives:	1) To provide fundamental and advanced knowledge of modern microscopy techniques including confocal, electron, cryogenic, & atomic force microscopy. 2) To develop understanding of advanced spectroscopic methods and their applications in biological, chemical, and material analysis. 3) To familiarize students with chromatographic separation techniques and their practical applications in analytical and biochemical research. 4) To introduce the principles of radioactivity, radioisotopes, and tracer techniques used in biological and medical sciences. 5) To enhance students' analytical and experimental skills for interpreting data obtained from modern instrumentation techniques.
Course Outcomes:	1) Explain the principles, instrumentation, & applications of advanced microscopy techniques such as CLSM, Cryo-EM, Cryo-ET, Electron Microscopy, & AFM. 2) Analyze and interpret data obtained from spectroscopic techniques including UV-Vis, NMR, MS, ICP-MS, X-ray, IR, and Raman spectroscopy. 3) Differentiate & apply various chromatography techniques such as ion exchange, gel chromatography, LC, GC, HPLC, and UHPLC for separation and analysis. 4) Describe concepts of isotopes, radioactivity, immunoelectrophoresis, isoelectric focusing, & applications of biological radioisotopes in research & diagnostics. 5) Demonstrate competency in selecting appropriate analytical techniques for scientific investigations and solving research-oriented problems

Unit System	Contents	Workload Allotted (Hrs)	Weightage of Marks Allotted	Incorporation of Pedagogies
Unit I	**Advanced microscopy**	7	7	Practicals can be conducted with the help of ICt and animations as well as virtual labs where facilties are limited.
	1.1 Introduction and applications of; Confocal Laser Scanning Microscopy (CLSM)			
	1.2 SEM & TEM & Atomic Force Microscopy			
	1.3 Cryo-EM (Cryogenic Electron Microscopy) & Cryo-ET (Tomography)			
	1.4 Stains, their types and applications			
Unit II	**Spectrophotometric Analysis and applications**	8	8	
	2.1 Introduction & applications of; UV-VIS spectroscopy			
	2.2 IR Spectroscopy, Nuclear Magnetic Resonance (NMR) Spectroscopy,			
	2.3 Mass Spectrometry (MS), ICP-MS,			
	2.4 X-Ray Spectroscopy			
Unit III	Chromatographic Techniques	8	8	
	3.1 Introduction and applications of Ion Exchange Chromatography			

	3.2 Gel Chromatography, LC, GC and application			
	3.3 HPLC and its application			
	3.4 Flash chromatography and application			
Unit IV	**Radioisotopes and their applications**	7	7	
	4.1 Isotopes, Radioactivity			
	4.2 Common Biological Radioisotopes: C-14, P-32, Tritium, I-131			
	4.3 Immunoelectrophoresis, isoelectric focusing			
	4.4 Radioisotope tracer technique			
	1-Mark Questions (One-Sentence Answers) 1. Define Confocal Laser Scanning Microscopy (CLSM). 2. Expand SEM and TEM. 3. What is Cryo-Electron Microscopy (Cryo-EM)? 4. State the principle of UV-Visible spectroscopy. 5. What is Nuclear Magnetic Resonance (NMR)? 6. Define Mass Spectrometry (MS). 7. What is Ion Exchange Chromatography? 8. What is High Performance Liquid Chromatography (HPLC)? 9. Define radioactivity. 10. Name any one biological radioisotope used in research.			
	3 -Mark Questions (One-Sentence Answers) **1.** Explain the principle and applications of Confocal Laser Scanning Microscopy. **2.** Differentiate between SEM and TEM. **3.** Write a short note on Cryo-EM and Cryo-ET. **4.** Explain the principle and applications of UV-Visible spectroscopy. **5.** Describe the principle of IR spectroscopy. **6.** Write a short note on Mass Spectrometry (MS). **7.** Differentiate between Ion Exchange Chromatography and Gel Chromatography. **8.** Explain the principle and applications of HPLC. **9.** Describe the biological applications of Carbon-14 and Phosphorus-32. **10.** Write a short note on Immunoelectrophoresis.			
	6-Mark Questions (One-Sentence Answers) 1. Describe the principles, instrumentation and applications of Confocal Laser Scanning Microscopy, SEM and TEM. 2. Discuss principles, instrumentation & applications of UV-Visible, IR &NMR. 3. Explain principle & applications of MS, ICP-MS & X-ray spectroscopy. 4. Describe the principles, instrumentation and applications of Ion Exchange, Gel Filtration, Liquid and Gas Chromatography. 5. Compare HPLC and UHPLC with suitable applications. 6. Explain isotopes and radioactivity with suitable examples. 7. Discuss the principle, methodology and applications of radioisotope tracer techniques in biological research.			
Text Books:	1. Instrumental Methods of Chemical Analysis – Gurdeep R. Chatwal & Sham K. Anand. 2. Analytical Biochemistry – David J. Holme & Hazel Peck. 3. Biophysical Chemistry – A. Upadhyay, K. Upadhyay & N. Nath. 4. Introduction to Spectroscopy – Donald L. Pavia, Gary M. Lampman, George S. Kriz & James R. Vyvyan. 5. Chromatography: Concepts and Contrasts – James M. Miller. 6. Practical Biochemistry: Principles & Techniques – Keith Wilson & John Walker. 7. Lehninger Principles of Biochemistry – David L. Nelson & Michael M. Cox. 8. Molecular Cloning: A Laboratory Manual – Michael R. Green & Joseph Sambrook.			

Sant Gadge Baba Amravati University
FACULTY: Science and Technology
Teaching and Learning Scheme (Major elective: Practical)
for the Three-Year UG Degree of Bachelor of Biotechnology
(Three Years- Six Semesters Bachelor's Degree Program)

Syllabus for: Major Elective: Practical Course Based on Analytical techniques and Instrumentation-II

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
P	VI	106710 (P)	**Major Elective: Practical Course Based on Analytical techniques and Instrumentation-II**	2	30	2 Hrs	30

Course Objectives:	1) To provide practical knowledge of different microscopic techniques 2) To develop understanding of the principles and applications of separation and identification techniques such as chromatography and electrophoresis. 3) To explain the basic principles, instrumentation, and applications of centrifugation methods used in biological and biochemical research. 4) To introduce students to various blotting and labeling techniques and their applications in molecular biology and diagnostics. 5) To train students in the selection and application of appropriate analytical and separation techniques for biological sample analysis.
Course Outcomes:	1) After successful completion of the course, students will be able to: 2) Describe the working principles, instrumentation, and applications of different microscopy techniques including TEM and SEM. 3) Differentiate and apply various chromatographic and electrophoretic techniques for separation and identification of biomolecules. 4) Explain the principles of centrifugation and analyze factors affecting sedimentation and separation efficiency. 5) Perform and interpret different blotting techniques such as Southern, Northern, Western, and Eastern blotting for biomolecular analysis. 6) Select suitable laboratory techniques for research, diagnostic, and analytical purposes in biological and biochemical sciences.

Unit System	Contents	Incorporation of Pedagogies
Major Experiments (Perform any 7)	1. Observation of specimens using Phase Contrast Microscopy 2. Study of Electron Microscopy (TEM and SEM) through charts/models/images 3. Study of Gel Electrophoresis of DNA samples 4. Study of Affinity Chromatography using demonstration models/virtual simulation. 5. Use of colorimeter/spectrophotometer for qualitative and quantitative analysis 6. Demonstration/Simulation of Blotting Techniques 7. PAGE for protein separation	Wherever actual experiment performance is not possible the practical can be conducted using ICT and animation-based demonstrations.
Minor Experiments (Perform any 5)	1. Study and operation of Simple Light Microscope 2. Separation of plant pigments using Paper Chromatography 3. Separation of amino acids by Thin Layer Chromatography (TLC) 4. Demonstration of Centrifugation Techniques 5. Demonstration of Column Chromatography 6. Separation of cellular components by Differential Centrifugation	
Activities (Perform any Two):	1.Visit to Pharmaceutical industry/ Tour 2. Assignment 3. Seminar 4. Participation in any college activity 5. Major Project (Phase: 1)	

Text Books:	1) Plummer, D. T. (2017). *An Introduction to Practical Biochemistry* (6th Edition). McGraw-Hill Education. 2) Wilson, K., & Walker, J. M. (Eds.). (2018). *Principles and Techniques of Biochemistry and Molecular Biology* (8th Edition). Cambridge University Press. 3) Sambrook, J., & Russell, D. W. (2001). *Molecular Cloning: A Laboratory Manual* (3rd Edition). Cold Spring Harbor Laboratory Press. 4) Freshney, R. I. (2016). *Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications* (7th Edition). Wiley-Blackwell. 5) Suvarna, S. K., Layton, C., & Bancroft, J. D. (2019). *Bancroft's Theory and Practice of Histological Techniques* (8th Edition). Elsevier. 6) Alberts, B., Johnson, A., Lewis, J., et al. (2022). *Molecular Biology of the Cell* (7th Edition). Garland Science. 7) Boyer, R. F. (2018). *Biochemistry Laboratory: Modern Theory and Techniques* (3rd Edition). Pearson. 8) Sawhney, S. K., & Singh, R. (2015). *Introductory Practical Biochemistry*. Narosa Publishing House. 9) Jayaraman, J. (2011). *Laboratory Manual in Biochemistry*. New Age International Publishers.

Sant Gadge Baba Amravati University
FACULTY: Science and Technology
Teaching and Learning Scheme (Major Elective T3: Ethnopharmacology and Drug Discovery:1)
for the Three-Year UG Degree of Bachelor of Biotechnology
(Three Years- Six Semesters Bachelor's Degree Program)

Syllabus for: Major Elective T3 : Ethnopharmacology and Drug Discovery: II

Each theory paper of **Theory shall be of 2 Credits comprising of 4 Units with Teaching Hours** as mentioned in the table. The pattern of theory papers shall be as per following template

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.5	VI	106711	**Ethnopharmacology and Drug Discovery: II**	2	30	2 Hrs	30

Course Objectives:	1) Understand the principles and techniques of ethnopharmacology, including extraction methods and screening of medicinal plant compounds. 2) Apply in vitro and in vivo methods for evaluating pharmacological activities of herbal drugs. 3) Gain knowledge of plant cell culture technology and industrial production of secondary metabolites using bioreactor systems. 4) Understand concepts of herbal drug safety, toxicity evaluation, and regulatory guidelines (OECD standards). 5) Develop understanding of drug development processes including targeted drug delivery, formulation, clinical trials, and pharmaceutical regulations (GMP, QA/QC, FDA).			
Course Outcomes:	1) Describe fundamental concepts of ethnopharmacology, extraction techniques, and screening methods for medicinal plants. 2) Demonstrate knowledge of in vitro and in vivo pharmacological screening methods for evaluating herbal drug activities. 3) Explain plant cell culture technology and industrial-scale production of secondary metabolites using bioreactor systems. 4) Evaluate safety, toxicity, quality assurance, and regulatory guidelines for herbal medicines and nutraceuticals. 5) Analyse the drug development pipeline including targeted drug delivery systems, clinical trials, and pharmaceutical manufacturing regulations.			
Unit System	**Content**	**Work-load Allotted (Hrs)**	**Weightage of Marks Allotted**	**Incorporation of Pedagogies**
Unit I	**Ethnopharmacology**	8	8	
	1.5 Extraction methods of medicinal compounds: maceration, percolation, reflux, Soxhlet extraction, ultrasound-assisted or supercritical fluid extraction			
	1.6 In vitro Screening drug methods: Antimicrobial screening of herbal drugs, Screening for anticancer activity, Screening for antioxidant activity, Screening for anti-urolithiatic activity			
	1.7 In vivo Screening drug methods: anti-inflammation and analgesic activity, antiulcer activity, antidiuretic activity, liver-related disorders.			
	1.8 Basic definition and types of toxicology, Regulatory guidelines for conducting toxicity studies as per OECD.			
Unit II	**Industrial Role and Processing**	7	7	
	2.1 Production of secondary metabolites from plant cell cultures			
	2.2 Technology of plant cell culture for production of chemicals-Bioreactor systems			

	and models for mass cultivation of plant cells.			
	2.3 Quality, safety and efficacy of herbal medicines/ nutraceuticals.			
	2.4 Role of ethnopharmacology in drug development.			
Unit III	**Targeted Drug Delivery Systems and Formulation**	7	7	
	3.1 Concepts, Approaches Involved in Drug Targeting.			
	3.2 Targeted Drug Delivery System and it's applications			
	3.3 Routes of drug administration			
	3.4 Formulation of dosage forms, types of dosage forms			
Unit IV	**Drug manufacturing and Clinical trial design**	8	8	
	4.1 Journey from R and D to plant, QA, QC, scale up process, pilot plant, GMP, FDA			
	4.2 Regulatory certification of GMP, Quality control and Quality assurance			
	4.3 Objectives of Phase I, II, III and IV clinical studies			
	4.4 Documentation of drugs and Pharmacopeia			
	1-Mark Questions (One-Sentence Answers) 1. What is maceration? 2. Define Soxhlet extraction. 3. What is ethnopharmacology? 4. What is meant by in vitro screening? 5. Name one method used for antioxidant activity screening. 6. What is in vivo drug screening? 7. What is toxicity in pharmacology? 8. What is a bioreactor in plant biotechnology? 9. What does GMP stand for? 10 What is a clinical trial?			
	3 -Mark Questions (Short Answer Type) 1. Explain maceration as an extraction method of medicinal compounds. 2. Describe percolation method used in extraction of plant constituents. 3.Write a short note on Soxhlet extraction. 4. What is in vitro screening? Mention any two types used in ethnopharmacology. 5. Explain antimicrobial screening of herbal drugs. 6. Write short notes on antioxidant activity screening methods. 7. Define in vivo screening and mention its importance. 8. Write a short note on anti-inflammatory activity testing in vivo. 9. Define GMP and mention its significance in pharmaceutical manufacturing. 10 What is the role of bioreactors in plant cell culture technology?			
	6-Mark Questions (Long Answer Question Types) 1. Explain different extraction methods of medicinal compounds in detail. 2.Discuss in vitro screening methods used for evaluating herbal drugs. 3. Describe in vivo screening methods for pharmacological evaluation of plant drugs. 4. Explain toxicity studies and OECD guidelines for regulatory testing. 5. Describe production of secondary metabolites using plant cell culture techniques. 6. Explain bioreactor systems and their role in large-scale plant cell cultivation. 7. Discuss quality, safety, and efficacy evaluation of herbal medicines and nutraceuticals. 8. Explain targeted drug delivery systems and their approaches. 9. Describe the process of drug development from R&D to GMP manufacturing. 10. Explain phases of clinical trials (Phase I–IV) and their objectives.			
Text Books:	1. Kokate, C. K., Purohit, A. P., & Gokhale, S. B. (2018). Pharmacognosy. Nirali Prakashan.			

	2. Khandelwal, K. R. (2019). Practical Pharmacognosy: Techniques and Experiments (27th ed.). Nirali Prakashan. 3. Trease, G. E., & Evans, W. C. (2017). Trease and Evans Pharmacognosy (16th ed.). Elsevier India. 4. Iyengar, M. A. (2017). Study of Crude Drugs. Manipal Press. 5.Evans, W. C. (2009). Trease and Evans Pharmacognosy (16th ed.). Elsevier. 6.Harborne, J. B. (1998). Phytochemical Methods: A Guide to Modern Techniques of Plant Analysis (3rd ed.). Springer. 7.Samuelsson, G. (2004). Drugs of Natural Origin: A Textbook of Pharmacognosy. Swedish Pharmaceutical Press. 8.Prasain, J. K., & Barnes, S. (Eds.). (2018). Bioactive Natural Products. CRC Press. 9.Gupta, R. C. (Ed.). (2019). Toxicology for non-toxicologists. Academic Press. 10.Shargel, L., Yu, A. B. C., & Wu-Pong, S. (2016). Applied Biopharmaceutics & Pharmacokinetics (7th ed.). McGraw-Hill Education.

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Sant Gadge Baba Amravati University
FACULTY: Science and Technology
Teaching and Learning Scheme (Major Elective P3 Practical)
for the Three-Year UG Degree of Bachelor of Biotechnology
(Three Years- Six Semesters Bachelor's Degree Program)

Syllabus for: Major Elective P3 Practical: Ethnopharmacology and Drug Discovery: II
Each theory paper of Theory shall be of 2 Credits comprising of 4 Units with Teaching Hours as mentioned in the table. The pattern of theory papers shall be as per following template –

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.5	V	106712 (P)	**Ethnopharmacology and Drug Discovery: II**	2	30	2 Hrs	30

Course Objectives:	1) Understand and perform basic quality control tests used in pharmaceutical product evaluation. 2) Gain knowledge of pharmaceutical regulatory documentation and industry guidelines. 3) Apply bioinformatics tools and molecular docking techniques for computer-aided drug discovery. 4) Develop skills in microbiological and sterility testing methods including MLT and endotoxin testing. 5) Acquire practical knowledge of pharmaceutical dosage form preparation and evaluation along with biopharmaceutical and biotechnology concepts.			
Course Outcomes:	1) Perform quality control tests for pharmaceutical products following standard procedures. 2) Demonstrate understanding of regulatory documentation and compliance requirements in pharmaceutical industries. 3) Apply computational tools such as bioinformatics databases and molecular docking for drug discovery studies. 4) Carry out microbiological testing procedures including sterility testing, MLT, and LAL assay. 5) Prepare and evaluate pharmaceutical dosage forms and understand basic biopharmaceutical and recombinant DNA applications.			
Unit System	**Contents**	**Workload Allotted(Hrs)**	**Weightage of Marks Allotted**	**Incorporation of Pedagogies**
Experiments Major	1. Preparation of herbal extracts by maceration, percolation, and reflux extraction. 2. Extraction of phytochemicals using Soxhlet extraction and ultrasound-assisted extraction (demonstration). 3. Determination of antioxidant activity by DPPH assay. 4. Determination of antioxidant activity by FRAP/ABTS assay. 5. Antimicrobial screening of herbal extracts by agar well/disc diffusion method. 6. In vitro anticancer screening using Brine Shrimp Lethality Assay/MTT assay (demonstration). 7. In vitro anti-inflammatory activity using Egg Albumin (Protein Denaturation) assay. 8. Anti-urolithiatic activity using calcium oxalate dissolution assay. 9. Demonstration of plant cell suspension culture for secondary metabolite production. 10. Preparation of herbal dosage forms (cream, gel, ointment, syrup). 11. Evaluation of quality parameters of herbal formulations (pH, viscosity, spreadability, etc.). 12. Study of GMP, QA, QC, Pharmacopoeia standards,			

	and clinical trial documentation.	
Experiments Minor	1. Authentication of medicinal plant raw materials. 2. Comparative study of extraction methods using flowcharts/models. 3. Demonstration of OECD toxicity study guidelines. 4. Study of bioreactor systems used in plant cell culture. 5. Identification of different herbal dosage forms. 6. Study of routes of drug administration using charts/models. 7. Preparation of a clinical trial design (Phase I–IV) flowchart. Study of Indian Pharmacopoeia, Ayurvedic Pharmacopoeia, and WHO guidelines for herbal medicines.	
Activities (Perform any Two):	1.Visit to Pharmaceutical industry/ Tour 2. Assignment 3. Seminar 4. Participation in any college activity 5. Major Project (Phase : II)	
Text Books:	1. Aulton, M. E., & Taylor, K. M. G. (2018). *Aulton's Pharmaceutics: The Design and Manufacture of Medicines* (6th ed.). Elsevier India. 2. Kokate, C. K., Purohit, A. P., & Gokhale, S. B. (2018). *Pharmacognosy*. Nirali Prakashan. 3. Lachman, L., Lieberman, H. A., & Kanig, J. L. (2017). *The Theory and Practice of Industrial Pharmacy*. CBS Publishers. 5. Sinko, P. J. (2011). *Martin's Physical Pharmacy and Pharmaceutical Sciences* (6th ed.). Lippincott Williams & Wilkins. 6. Shargel, L., Yu, A. B. C., & Wu-Pong, S. (2016). *Applied Biopharmaceutics & Pharmacokinetics* (7th ed.). McGraw-Hill Education. 7. Voet, D., Voet, J. G., & Pratt, C. W. (2016). *Fundamentals of Biochemistry: Life at the Molecular Level*. Wiley. 8. Lesk, A. M. (2019). *Introduction to Bioinformatics* (5th ed.). Oxford University Press. 9. Koeppen, B. M., & Stanton, B. A. (2018). *Berne & Levy Physiology* (7th ed.). Elsevier. 10. Walsh, G. (2018). *Biopharmaceuticals: Biochemistry and Biotechnology* (3rd ed.). Wiley.	

Sant Gadge Baba Amravati University
FACULTY: Science and Technology
Teaching and Learning Scheme (Major: Theory)
for the Three-Year UG Degree of Bachelor of Biotechnology
(Three Years- Six Semesters Bachelor's Degree Program)

Syllabus for: Major Elective T3: Biostatistics and Bioinformatics II
Each theory paper of **Theory shall be of 2 Credits comprising of 4 Units with Teaching Hours** as mentioned in the table. The pattern of theory papers shall be as per following template

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.5	VI	106713	Biostatistics and Bioinformatics II	2	30	2 Hrs	30

Course Objectives:	1) To provide advanced knowledge of statistical methods and distributions. 2) To develop understanding of research methodology and experimental design. 3) To provide advanced knowledge of genomics, proteomics, & computational biology. 4) To familiarize students with molecular modeling and phylogenetic analysis. 5) To introduce data mining and systems biology concepts.			
Course Outcomes:	1) Understand advanced statistical concepts and probability distributions. 2) Apply research methodologies in biological and clinical studies. 3) Understand advanced concepts of genomics and proteomics. 4) Apply computational methods in biological data interpretation.			
Unit System	**Contents**	**Workload Allotted (Hrs)**	**Weightage of Marks Allotted**	**Incorporation of Pedagogies**
Unit I	**Advanced Biostatistics**	8	8	
	1.1Normal distribution and its properties			
	1.2Probability distributions in biological data			
	1.3Standard error and confidence interval			
	1.4Applications of biostatistics in clinical and research studies			
Unit II	**Research Methodology and Biostatistical Applications**	7	7	
	2.1Research design and planning			
	2.2Collection and organization of biolog			
	2.3Use of biostatistics in pharmaceutical industries			
	2.4Ethical considerations in biological research			
Unit III	**Advanced Bioinformatics**	7	7	
	3.1Genomics and proteomics			
	3.2Transcriptomics and metabolomics			
	3.3Computational tools for sequence analysis			
	3.4Applications of bioinformatics in medicine and agriculture			
Unit IV	**Computational Biology and Data Analysis**	8	8	
	4.1Biological data mining techniques			
	4.2Systems biology and network analysis			
	4.3Artificial intelligence and machine learning in bioinformatics			
	4.4Recent advances and future prospects in bioinformatics			
	1-Mark Questions (10) 1. Define normal distribution. 2. What is standard error? 3. Define confidence interval.			

	4. What is research design? 5. What is informed consent? 6. Define genomics. 7. What is proteomics? 8. Name any one sequence alignment tool. 9. Define biological data mining. 10. What is machine learning?
	3-Mark Questions (10) 1. Explain the properties of normal distribution. 2. Differentiate between standard deviation and standard error. 3. Describe the importance of confidence intervals in biological research. 4. Explain the steps involved in research planning. 5. Discuss the applications of biostatistics in pharmaceutical industries. 6. Explain ethical considerations in biological research. 7. Differentiate between genomics and proteomics. 8. Describe transcriptomics and metabolomics. 9. Explain the applications of BLAST in sequence analysis. 10. Discuss the role of AI in bioinformatics.
	1. Explain normal distribution and probability distributions with suitable examples. 2. Discuss standard error, confidence interval, and their significance in biological research. 3. Describe research design, data collection, organization, and ethical considerations in biological research. 4. Explain the role of biostatistics in clinical studies and pharmaceutical industries. 5. Discuss genomics, proteomics, transcriptomics, and metabolomics in detail. 6. Explain computational tools used for biological sequence analysis. 7. Describe biological data mining techniques and their applications. 8. Explain systems biology and network analysis with suitable examples. 9. Discuss the applications of artificial intelligence and machine learning in bioinformatics. 10. Explain recent advances and future prospects of bioinformatics in medicine and agriculture.
Text Books:	1) Statistical Methods – S. P. Gupta 2) Fundamentals of Biostatistics – Veer Bala Rastogi 3) Research Methodology: Methods and Techniques – C. R. Kothari 4) Introduction to Bioinformatics – S. C. Rastogi 5) Bioinformatics: Methods and Applications – S. C. Rastogi, N. Mendiratta and P. Rastogi

Sant Gadge Baba Amravati University
FACULTY: Science and Technology
Teaching and Learning Scheme (Major: Practical)
for the Three-Year UG Degree of Bachelor of Biotechnology
(Three Years- Six Semesters Bachelor's Degree Program)
Syllabus for: Major Elective T3: Biostatistics and Bioinformatics II

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.5	VI	106714 (P)	**Biostatistics and Bioinformatics II**	2	30	2 Hrs	30

Course Objectives:	1) To provide advanced knowledge of computational biology techniques. 2) To train students in genome and proteome data analysis. 3) To provide advanced training in statistical analysis techniques. 4) To develop understanding of probability distributions and regression analysis.	
Course Outcomes:	1) Apply advanced statistical methods for biological data analysis. 2) Perform regression and distribution analysis effectively. 3) Analyze genomic and proteomic data using bioinformatics tools. 4) Perform molecular docking and virtual screening basics.	
Unit System	**Contents**	**Incorporation of Pedagogies**
Major Experiments (Perform any 7)	1. Experimental Design and Sampling Methods 2. Data Analysis using Statistical Software 3. Preparation & Interpretation of Research Data 4. Statistical analysis in clinical and epidemiological studies 5. Research report preparation and presentation 6. Microarray data interpretation 7. Biological data mining techniques 8. Molecular modeling basics 9. Drug target identification using databases Introduction to computational biology software and applications	
Minor Experiments (Perform any 5)	1. Calculation of Standard Error & Confidence Interval 2. Problems based on Normal Distribution 3. Application of Parametric Tests 4. Application of Non-parametric Tests 5. Regression Analysis and Interpretation **6.** Experimental Design and Sampling Methods 7. Genome sequence analysis 8. Protein structure prediction using online tools Molecular docking basics and virtual screening	
Activities (Perform any Two):	1. Workshop on MS Excel for biostatistical calculations 2. Mini project on analysis of experimental biotechnology data 3. Phylogenetic tree construction workshop Protein structure visualization using PDB tools	
Text Books:	1. Research Methodology: Methods and Techniques – C. R. Kothari 2. Biostatistics – P. Ramakrishnan 3. Bioinformatics: Methods& Applications – S. C. Rastogi, Mendiratta & Rastogi 4. Introduction to Bioinformatics – S. C. Rastogi	

Sant Gadge Baba Amravati University
FACULTY: Science and Technology
Teaching and Learning Scheme (Major Elective: Theory: T4)
for the Three-Year UG Degree of Bachelor of Biotechnology
(Three Years- Six Semesters Bachelor's Degree Program)

Syllabus for: Major Elective: Theory: T4 – Medical Biotechnology & Nanotechnology - 2
Each theory paper of **Theory shall be of 2 Credits comprising of 4 Units with Teaching Hours** as mentioned in the table. The pattern of theory papers shall be as per following template

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
6	VI	106715	**Major Elective: Theory: T4 – Medical Biotechnology & Nanotechnology – 2**	2	30	2 Hrs	30

Course Objectives:	After completion of the course, students will be able to: ➢ Provide advanced knowledge of genomic technologies, next-generation sequencing, precision medicine, and gene-based therapeutic strategies. ➢ Develop conceptual understanding of regenerative medicine, stem cell biotechnology, tissue engineering, and advanced immunotherapeutic approaches. ➢ Familiarize students with nanotechnology-based diagnostic and therapeutic systems used in modern healthcare. ➢ Enhance understanding of translational nanobiotechnology including smart nanomaterials, nanomedicine, and clinical applications. ➢ Develop analytical and research-oriented skills for understanding commercialization, regulatory frameworks, and emerging innovations in medical biotechnology.
Course Outcomes:	After successful completion of the course, students will be able to: ➢ Explain advanced genomic technologies and their clinical applications in precision medicine and gene therapy. ➢ Analyze stem cell technologies, tissue engineering strategies, and translational biotechnology approaches. ➢ Evaluate nanotechnology-based diagnostic and therapeutic systems for biomedical applications. ➢ Assess the applications of smart nanomaterials, nanomedicine, and theranostic systems in personalized healthcare. ➢ Critically interpret regulatory, ethical, translational, and commercialization challenges in advanced biotechnology.

Unit System	Contents	Workload Allotted (Hrs)	Weightage of Marks Allotted	Incorporation of Pedagogies
Unit I	**Advanced Genomic and Gene-Based Therapeutics**	8	8	
	1.1 Next Generation Sequencing and Omics: NGS platforms, genomics, transcriptomics and clinical applications.			
	1.2 Precision Medicine and Proteomics: Protein profiling, biomarker discovery and personalized medicine approaches.			
	1.3 Gene Editing Technologies: CRISPR-Cas systems, genome editing strategies and therapeutic applications.			
	1.4 Gene Therapy and Delivery Systems: Viral and non-viral delivery methods and clinical applications of gene therapy.			
Unit II	**Regenerative and Translational Medical Biotechnology**	7	7	
	2.1 Stem Cell Biotechnology: Types,			

	differentiation and therapeutic applications of stem cells.			
	2.2 Tissue Engineering and Regenerative Medicine: Scaffolds, biomaterials and 3D Organ printing.			
	2.3 Advanced Immunotherapy: CAR-T cell therapy, engineered antibodies and immune-based therapeutics.			
	2.4 Translational Biotechnology: Synthetic biology, advanced drug delivery systems and commercialization challenges.			
Unit III	**Nanotechnology in Diagnostics and Therapeutics**	7	7	
	3.1 Nanodiagnostics: Nanobiosensors, nanosensors and diagnostic imaging applications.			
	3.2 Drug Delivery Systems: Nanocarriers, targeted drug delivery and controlled release mechanisms.			
	3.3 Nanoparticles in Therapeutics: Applications in cancer therapy, antimicrobial treatment & gene delivery.			
	3.4 Theranostics: Integrated diagnostic and therapeutic nanoplatforms.			
Unit IV	**Advanced and Translational Nanobiotechnology**	8	8	
	4.1 Nanomedicine and Personalized Healthcare: Role of nanotechnology in precision medicine and patient-specific treatment.			
	4.2 Tissue Engineering and Regenerative Nanobiotechnology: Nanoscaffolds, biomaterials and regenerative applications.			
	4.3 Smart Nanomaterials: Stimuli-responsive nanoparticles and advanced biomedical systems.			
	4.4 Commercial and Regulatory Aspects: Clinical translation, commercialization and regulatory challenges in nanobiotechnology.			
Model Question				
	1-Mark Questions (One-Sentence Answers) 11) Define Next Generation Sequencing (NGS). 12) What is transcriptomics? 13) Define precision medicine. 14) What is CRISPR-Cas9 technology? 15) Define stem cells. 16) What is CAR-T cell therapy? 17) Define nanodiagnostics. 18) What are nanocarriers? 19) Define theranostics. 20) What are smart nanomaterials?			
	3 -Mark Questions 11) Differentiate genomics and proteomics. 12) Explain biomarker discovery. 13) Write short notes on CRISPR-Cas systems. 14) Describe viral and non-viral gene delivery systems.			

	15) Classify stem cells based on potency. 16) Explain scaffold materials used in tissue engineering. 17) Describe nanobiosensors and their applications. 18) Explain targeted drug delivery systems. 19) Write short notes on theranostic nanoplatforms. 20) Discuss commercialization challenges in nanobiotechnology.
	6-Mark Questions 11) Discuss precision medicine and personalized healthcare approaches. 12) Describe gene editing technologies and their therapeutic applications. 13) Explain gene therapy and delivery systems in modern medicine. 14) Elaborate stem cell biotechnology and regenerative medicine applications. 15) Explain tissue engineering and 3D organ printing in biomedical sciences. 16) Discuss CAR-T cell therapy and advanced immunotherapeutics. 17) Explain nanotechnology-based drug delivery systems and controlled release mechanisms. 18) Discuss nanomedicine and personalized healthcare applications.
Text Books:	1. Glick, B.R., & Pasternak, J.J. Molecular Biotechnology. ASM Press. 2. Watson, J.D. et al. Molecular Biology of the Gene. Pearson Education. 3. Brown, T.A. Genomes. Garland Science. 4. Lodish, H. et al. Molecular Cell Biology. W.H. Freeman. 5. Freshney, R.I. Culture of Animal Cells. Wiley-Liss. 6. Atala, A. Regenerative Medicine. Academic Press. 7. Niemeyer, C.M., & Mirkin, C.A. Nanobiotechnology: Concepts, Applications and Perspectives. Wiley-VCH. 8. Poole, C.P., Jr. Introduction to Nanotechnology. Wiley-Interscience. 9. Kulkarni, S.K. Nanotechnology: Principles and Practices. Springer. 10. Bawa, R. Principles of Nanomedicine. CRC Press. 11. Patrinos, G.P. Molecular Diagnostics. Academic Press. 12. Vo-Dinh, T. Nanotechnology in Biology and Medicine. CRC Press. 13. Jain, K.K. The Handbook of Nanomedicine. Humana Press. 14. Ratner, B.D. Biomaterials Science. Elsevier. 15. Shuler, M.L. Bioprocess Engineering. Prentice Hall.

Sant Gadge Baba Amravati University
FACULTY: Science and Technology
Teaching and Learning Scheme (Major Elective: Practical)
for the Three-Year UG Degree of Bachelor of Biotechnology
(Three Years- Six Semesters Bachelor's Degree Program)

Syllabus for: Major Elective: Practical – Medical Biotechnology & Nanobiotechnology 2

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5	VI	106716	**Major Elective: Practical – Medical Biotechnology & Nanobiotechnology 2**	2	60	4 Hrs	50

Course Objectives:	After completion of the course, students will be able to: 1. Develop practical understanding of advanced genomic technologies, sequencing workflows, omics data analysis, and modern gene-editing tools used in medical biotechnology. 2. Provide hands-on exposure to gene delivery systems, proteomic analysis, biomarker identification, and advanced therapeutic biotechnology approaches. 3. Build conceptual and technical competence in regenerative biotechnology including stem cell observation, biomaterial scaffold preparation, and tissue engineering applications. 4. Familiarize students with nanoparticle synthesis, characterization, targeted drug delivery systems, and smart nanomaterials for biomedical applications. 5. Enhance analytical, research, and scientific communication skills through case studies, literature review, laboratory demonstrations, and translational biotechnology activities.
Course Outcomes:	After successful completion of the course, students will be able to: 1. Demonstrate understanding of advanced sequencing technologies, omics data interpretation, and CRISPR-based genome editing workflows. 2. Analyze gene delivery systems, therapeutic protein design, engineered antibodies, and cellular immunotherapy strategies. 3. Apply principles of stem cell biotechnology, tissue scaffold design, and regenerative biomedical engineering. 4. Perform synthesis, characterization, and functional evaluation of nanocarriers and smart nanomaterials for diagnostic and therapeutic applications. 5. Critically evaluate translational, clinical, regulatory, and commercialization aspects of advanced medical biotechnology and nanobiotechnology.
Unit System	**Contents**
Major Experiments (Perform any 7)	**Advanced Genomic and Gene-Based Therapeutics** 1. Demonstration of Next Generation Sequencing Workflow: Library preparation, sequencing principles and data output analysis. 2. Comparative Analysis of Genomic and Transcriptomic Datasets: Interpretation of omics data using bioinformatics tools. 3. Protein Profiling by SDS-PAGE; Separation and analysis of protein expression patterns. 4. Biomarker Identification through Proteomic Data Analysis: Screening and interpretation of disease-associated biomarkers. 5. Simulation of CRISPR-Cas9 Gene Editing Strategy: Design of guide RNA and target gene editing workflow. 6. Demonstration of Viral and Non-Viral Gene Delivery Systems: Comparative analysis of gene transfer approaches. **Regenerative and Translational Medical Biotechnology** **7**. Isolation and Microscopic Observation of Stem Cells (Demonstration): Identification and characterization of stem cell morphology. 8. Preparation and Characterization of Biomaterial Scaffolds: Evaluation of

	scaffold properties for tissue engineering. 9. 3D Tissue Scaffold Modeling / Organ Printing Demonstration: Basic design and visualization of regenerative structures. 10. Simulation of Engineered Antibody Design: Design principles of therapeutic antibodies. 11. Case-based Study of CAR-T Cell Therapy Workflow: Analysis of cellular engineering steps. **Nanotechnology in Diagnostics and Therapeutics** 12. Synthesis of Drug-Loaded Nanoparticles: Preparation of nanocarriers for controlled drug delivery. 13. UV-Visible Characterization of Nanotherapeutic Systems: Determination of nanoparticle optical properties. 14. Preparation and Functionalization of Targeted Nanocarriers: Surface conjugation for site-specific delivery. **Advanced Translational Nanobiotechnology** 15. Fabrication and Evaluation of Stimuli-Responsive Smart Nanomaterials: Analysis of pH/temperature-responsive nanoparticle systems.
Minor Experiments (Perform any 5)	1) Identification of NGS platform components 2) Analysis of sequencing read quality parameters 3) Interpretation of proteomics output data 4) Observation of CRISPR guide RNA design 5) Comparative study of stem cell types 6) Preparation of simple hydrogel biomaterials 7) Observation of nanosensor detection principles 8) Analysis of controlled drug release profiles 9) Interpretation of nano scaffold imaging data 10) Regulatory documentation study for nanomedicine products
Activities (Perform any Two):	1. Seminar Presentation on Emerging Therapeutics 2. Case Study Analysis 3. Research Article Review and Discussion 4. Scientific Poster / Model Preparation 5. Industrial / Research Laboratory Visit
Text Books:	**1.** Glick, B.R., & Pasternak, J.J. *Molecular Biotechnology: Principles and Applications of Recombinant DNA*. ASM Press. **2.** Brown, T.A. *Genomes*. Garland Science. **3.** Watson, J.D., et al. *Molecular Biology of the Gene*. Pearson Education. **4.** Primrose, S.B., & Twyman, R.M. *Principles of Gene Manipulation and Genomics*. Wiley-Blackwell. **5.** Nelson, D.L., & Cox, M.M. *Lehninger Principles of Biochemistry*. W.H. Freeman. **6.** Freshney, R.I. *Culture of Animal Cells: A Manual of Basic Technique*. Wiley-Liss. **7.** Lanza, R., Langer, R., & Vacanti, J. *Principles of Tissue Engineering*. Academic Press. **8.** Atala, A. *Regenerative Medicine*. Academic Press. **9.** Abbas, A.K., Lichtman, A.H. *Cellular and Molecular Immunology*. Elsevier. **10.** Patrinos, G.P. *Molecular Diagnostics*. Academic Press. **11.** Niemeyer, C.M., & Mirkin, C.A. *Nanobiotechnology: Concepts, Applications and Perspectives*. Wiley-VCH. **12.** Kulkarni, S.K. *Nanotechnology: Principles and Practices*. Springer. **13.** Torchilin, V.P. *Handbook of Nanobiomedical Research*. World Scientific. **14.** Bawa, R., Audette, G., & Rubinstein, I. *Principles of Nanomedicine*. CRC Press. **15.** Jain, K.K. *The Handbook of Nanomedicine*. Humana Press.

Sant Gadge Baba Amravati University
FACULTY: Science and Technology
Teaching and Learning Scheme (Major/Minor: Theory)
for the Three-Year UG Degree of Bachelor of Biotechnology
(Three Years- Six Semesters Bachelor's Degree Program)

Syllabus for: Minor: General Biophysical Method
Each theory paper of **Theory shall be of 2 Credits comprising of 4 Units with Teaching Hours** as mentioned in the table. The pattern of theory papers shall be as per following template

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.5	VI	106307	**Minor: General Biophysical Method**	2	30	2 Hrs	30

Course Objectives:	After completion of this course, students will be able to: 1) Understand the principles and applications of major biophysical techniques. 2) Explain the working mechanisms of spectroscopic and microscopic methods. 3) Study separation techniques such as centrifugation, chromatography and electrophoresis. 4) Analyze biomolecules using modern analytical instruments. 5) Apply biophysical methods in biotechnology research and industry.
Course Outcomes:	Students completing this course will be able to: 1) Describe the principles of important biophysical instruments. 2) Perform basic analytical and separation techniques in biotechnology laboratories. 3) Interpret data generated from spectroscopic and electrophoretic methods. 4) Apply biophysical methods in biological research and diagnostics. 5) Develop practical knowledge regarding advanced instrumentation used in biotechnology.

Unit System	Contents	Work-load Allotted (Hrs)	Weightage of Marks Allotted	Incorporation of Pedagogies
Unit I	**Spectroscopic Technique**	8	8	ICT based teaching,PPT,, Demonstration,Seminar, Group discussion etc.
	1.1 Introduction to Biophysical Methods and Instrumentation			
	1.2 Electromagnetic Spectrum and Principles of Spectroscopy			
	1.3 UV-Visible and Infrared Spectroscopy			
	1.4 Fluorescence Spectroscopy and Applications			
Unit II	**Microscopy**	7	7	
	2.1 Principles and Types of Microscopy			
	2.2 Light, Phase Contrast and Fluorescence Microscopy			
	2.3 Electron Microscopy (SEM and TEM)			
	2.4 Confocal Microscopy and Imaging Techniques			
Unit III	**Separation Techniques**	7	7	
	3.1 Principles of Centrifugation and Types of Centrifuges			
	3.2 Differential and Density Gradient Centrifugation			
	3.3 Principles of Chromatographic Techniques			
	3.4 Paper, TLC, Column and HPLC Techniques			

Unit IV	**Electrophoretic and Advance Biophysical Techniques**	8	8	
	4.1 Principles of Electrophoresis			
	4.2 Agarose Gel Electrophoresis and PAGE			
	4.3 Blotting Techniques: Southern, Northern and Western			
	4.4 Biosensors and Applications of Biophysical Methods in Biotechnology			
	1-Mark Questions (One-Sentence Answers) 1. Define biophysical methods. 2. What is spectroscopy? 3. State Beer-Lambert's law. 4. What is chromophore? **5.** Define UV-Visible spectroscopy.			
	3 **-Mark Questions (One-Sentence Answers)** 1. Explain the principle of spectroscopy. 2. Describe UV-Visible spectroscopy 3. Explain the principle of light microscopy. 4. Differentiate between SEM and TEM 5. Explain the principle of centrifugation. 6. Describe differential centrifugation. 7. Explain the principle of electrophoresis. 8. Describe agarose gel electrophoresis			
	6-Mark Questions (One-Sentence Answers) 1. Explain the principle, instrumentation and applications of UV-Visible spectroscopy. 2. Describe the working and applications of electron microscopy with suitable diagrams. 3. Explain the principle and types of centrifugations used in biotechnology. 4. Discuss different types of chromatography and their applications in biomolecule separation. 5. Explain electrophoresis and describe agarose gel electrophoresis and SDS-PAGE techniques.			
Text Books:	1. Principles and Techniques of Biochemistry and Molecular Biology — Keith Wilson and John Walker 2. Physical Biochemistry — David Freifelder 3. Biophysical Chemistry — K. Upadhyay and N. Nath 4. Analytical Biochemistry — David J. Holme and Hazel Peck 5. Instrumental Methods of Chemical Analysis — B. K. Sharma 6. Biophysical Chemistry — A. Upadhyay, K. Upadhyay and N. Nath			

Sant Gadge Baba Amravati University
FACULTY: Science and Technology
Teaching and Learning Scheme (Minor: Practical)
for the Three-Year UG Degree of Bachelor of Biotechnology
(Three Years- Six Semesters Bachelor's Degree Program)

Syllabus for: Minor: General biophysical Method

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.5	VI	106308 (P)	**Minor:** General biophysical Method	2	30	2 Hrs	30

Course Objectives:	1) To develop practical skills in handling biophysical instruments. 2) To understand analytical and separation techniques used in biotechnology. 3) To perform spectroscopic and electrophoretic experiments. 4) To gain laboratory exposure to chromatography and centrifugation methods. 5) To interpret experimental results in biotechnology applications.
Course Outcomes:	1) Students will be able to handle laboratory instruments effectively. 2) Students will perform basic spectroscopy and microscopy experiments. 3) Students will acquire skills in chromatographic and electrophoretic techniques. 4) Students will analyze biomolecules using biophysical methods. 5) Students will develop experimental and analytical abilities in biotechnology laboratories.

Unit System	Contents	Incorporation of Pedagogies
Major Experiments (Perform any 7)	1. Calibration and handling of pH meter 2. Estimation of protein by spectrophotometry 3. Determination of absorption spectrum of biomolecules 4. Separation of amino acids by paper chromatography 5. Thin Layer Chromatography (TLC) of pigments 6. Agarose gel electrophoresis of DNA 7. SDS-PAGE for protein separation Demonstration of centrifugation techniques	
Minor Experiments (Perform any 5)	**Laboratory activity, Group learning** 1. Use and care of microscope 2. Preparation of buffers 3. Measurement of pH of different solutions 4. Observation of microbial samples under microscope. 5. Identification of laboratory instruments Demonstration of chromatography apparatus	
Activities (Perform any Two):	**Seminar, Assignment, ICT based learning** 1. Seminar on modern biophysical instruments 2. Assignment on applications of spectroscopy 3. Laboratory visit report Chart/model preparation on analytical instruments	
Text Books:	1. Principles and Techniques of Biochemistry and Molecular Biology — Keith Wilson and John Walker 2. Physical Biochemistry — David Freifelder 3. Biophysical Chemistry — A. Upadhyay, K. Upadhyay and N. Nath 4. Instrumental Methods of Chemical Analysis — B. K. Sharma 5. Principles of Instrumental Analysis — Douglas A. Skoog, F. James Holler and Stanley R. Crouch 6. Analytical Biochemistry — David J. Holme and Hazel Peck	

Sant Gadge Baba Amravati University
FACULTY: Science and Technology
Teaching and Learning Scheme (VSC Practical: Microbes in Human Welfare)
for the Three-Year UG Degree of Bachelor of Biotechnology
(Three Years- Six Semesters Bachelor's Degree Program)

Syllabus for: VSC: Microbes in Human Welfare

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.5	VI	106505	**VSC: Microbes in Human Welfare**	2	30	2 Hrs	30

Course Objectives:	1. To develop practical knowledge and laboratory skills in isolation, cultivation, identification, and application of beneficial microorganisms associated with food, agriculture, environment, and industry. 2. To understand microbial processes involved in fermentation, bioethanol production, enzyme production, dairy technology, and single cell protein production. 3. To impart hands-on training in microbiological techniques such as serial dilution, microbial enumeration, staining, fermentation analysis, and water quality assessment. 4. To familiarize students with industrial and environmental applications of microorganisms including biofertilizers, bioremediation, wastewater treatment, and renewable energy production. 5. To enhance scientific aptitude, analytical thinking, communication skills, and community awareness through field visits, mini-projects, surveys, poster preparation, and research-based activities.	
Course Outcomes:	1. Demonstrate proficiency in basic microbiological techniques including sterilization, culturing, staining, microbial isolation, and enumeration. 2. Identify and characterize microorganisms associated with food, soil, water, dairy products, algae, and single cell protein production using microscopic and biochemical methods. 3. Analyze microbial quality of food and water samples and evaluate microbial roles in food spoilage, fermentation, and public health. 4. Apply microorganisms for environmental and agricultural applications such as bioremediation, biosorption of heavy metals, biofertilizer production, and soil health assessment. 5. Develop vocational, research, and communication skills through industrial visits, community outreach activities, laboratory projects, scientific surveys, and creative scientific presentations.	
Unit System	**Contents**	
Major Experiments (Perform any 7)	1. Production of Bioethanol from Molasses or Fruit Waste Using Yeast 2. Estimation of Ethanol Produced During Fermentation 3. To separate and purify bioethanol produced during fermentation by simple distillation. 4. Production of Vinegar by Acetic Acid Bacteria 5. Determination of Microbial Load in Fruit Juice Samples 6. Isolation and Identification of Microorganisms from Spoiled Food Samples 7. Microbiological Examination of Milk by Standard Plate Count (SPC) 8. Isolation and Morphological Characterization of Lactobacillus from Curd 9. To prepare yogurt using Lactobacillus as starter cultures. 10. Production and Assay of Industrial Enzymes by Microorganisms (Amylase/Protease) 11. Isolation and Enumeration of Soil Microorganisms by Serial Dilution Technique 12. Cultivation and Microscopic Observation of Algae (Chlorella/Spirulina)	

	13. To study and identify single cell protein (SCP) producing microorganisms such as yeast, algae, and bacteria. 14. To demonstrate the ability of bacteria (Pseudomonas/Bacillus) to remove heavy metals (lead/cadmium) from contaminated water. 15. Microbial Quality Analysis of Packaged Drinking Water	
Minor Experiments (Perform any 5)	1. Determination of Acidity in Vinegar by Titration Method 2. Measurement of pH Changes During Fruit Juice Fermentation 3. Microscopic Observation of Fungi and Bacteria from Spoiled Food Samples 4. Methylene Blue Reduction Test (MBRT) of Milk 5. Gram Staining and Morphological Study of Lactobacillus from Curd. 6. Observation of Curd/Yogurt Fermentation and Texture Development. 7. Starch Hydrolysis Test for Detection of Amylase Producing Microorganisms. 8. Preparation of Serial Dilutions from Soil Samples. 9. Microscopic Observation of Algal Cells 10. Observation of Yeast Cells as SCP-Producing Organisms 11. Demonstration of Biosorption of Heavy Metals by Bacterial Biomass 12. Detection of Coliform Bacteria in Drinking Water by Presumptive Test.	
Activities (Perform any Two):	1. Industrial field visit (Bioethanol/Dairy Plant) 2. Home-scale fermentation project 3. Poster-making — Beneficial Microbes 4. Biofertilizer awareness campaign for farmers 5. Water quality survey of local sources 6. Short documentary/reel on microbes 7. Soil health mini-project (Two soil types) 8. Biogas model building and demonstration 9. Literature review on Single Cell Protein (SCP) 10. Science quiz — Based on practical syllabus	
Text Books:	1. Adams, M. R., & Moss, M. O. (2008). *Food microbiology* (3rd ed.). Royal Society of Chemistry. 2. Aneja, K. R. (2003). *Experiments in microbiology, plant pathology and biotechnology* (4th ed.). New Age International. 3. Dubey, R. C., & Maheshwari, D. K. (2013). *A textbook of microbiology* (2nd ed.). S. Chand & Company. 4. Pandey, A., Soccol, C. R., & Larroche, C. (Eds.). (2008). *Current developments in solid-state fermentation*. Asiatech Publishers/Springer. 5. Pandey, A., Webb, C., Soccol, C. R., & Larroche, C. (Eds.). (2006). *Enzyme technology*. Asiatech Publishers/Springer. 6. Prescott, S. C., & Dunn, C. G. (1987). *Industrial microbiology* (4th ed.). CBS Publishers & Distributors. 7. Purohit, S. S., & Mathur, S. K. (2008). *Biotechnology: Fundamentals, applications and regulations*. Agrobios. 8. Singh, S. N., & Tripathi, R. D. (Eds.). (2007). *Environmental bioremediation technologies*. Narosa Publishing House/Springer India. 9. Srinivasan, R. A., & Ananthaswamy, H. N. (1997). *Dairy microbiology*. Oxford & IBH Publishing. 10. Subba Rao, N. S. (2001). *Soil microbiology* (4th ed.). Oxford & IBH Publishing. 11. Trivedi, P. C. (Ed.). (2000). *Algal biotechnology*. Pointer Publishers. 12. Trivedi, P. C., Pandey, S., & Bhadauria, S. (2010). *Textbook of microbiology*. Pointer Publishers. 13. Trivedi, R. K., & Goel, P. K. (1986). *Chemical and biological methods for water pollution studies*. Environmental Publications. 14. American Public Health Association. (2017). *Standard methods for the examination of water and wastewater* (23rd ed.). APHA.	

Sant Gadge Baba Amravati University
FACULTY: Science and Technology
for the Three-Year UG Degree of Bachelor of Biotechnology
(Three Years- Six Semesters Bachelor's Degree Program)

Guidelines for Internship / Apprenticeship/ On Job Training

Course Type	Semester	Course Code	Course Name	Credits	Workload	Exam Duration	Max Marks
Intern/ Apparent/ OJT	VI	106252	**Internship / Apprenticeship/ On Job Training**	4	8	-	100

Course Objectives:	After completion of the course, students will be able to: 1. To provide hands-on training in Biotechnology-related industries, laboratories, and research organizations. 2. To expose students to industrial practices, instrumentation, quality control, and safety procedures. 3. To enhance problem-solving, teamwork, communication, and technical skills. 4. To create awareness regarding entrepreneurship & employment opportunities in Biotechnology.
Course Outcomes:	Upon successful completion of this course, students will be able to: 1. Apply theoretical Biotechnology concepts in practical and industrial environments. 2. Operate & understand basic analytical instruments and laboratory techniques. 3. Demonstrate professional ethics, laboratory safety, and teamwork. 4. Analyse chemical processes, observations, and experimental data effectively. 5. Prepare technical reports and communicate scientific findings professionally. 6. Explore employability and entrepreneurship skills in Biotechnology related sectors.

Guidelines/ SoP for Internship / Apprenticeship/ OJT

For understanding key principles of Internship/Apprenticeship/OJT operational guidelines and implementation strategy please refer

1. https://www.ugc.gov.in/pdfnews/2051511_Internship-Research-InternshipGuidelines.pdf
2. https://www.sgbau.ac.in/pdf/1092Internship%20Policy.pdf

As per NEP 2020, students of B Sc. III need to undertake Internship / Apprenticeship/ OJT for FOUR (4) credits i.e. 100 Marks.

The guidelines for Internship / Apprenticeship/ OJT are as follows:

1. Credit: 04
2. Duration: 120 Hrs
3. Internship Period: Ideally, the internship should be completed during the summer break between the second and third year. Students who are unable to complete the internship during this period must ensure its completion by the end of the VI semester, either in a part-time manner during Semester V, or during the Diwali break, or winter break or through an alternative arrangement subject to prior approval by the parent institution (University School/College).
4. Internship Categories:

i. Internship for enhancing the employability: Employability is a set of skills and attributes developed through a range of experiences at workshops and workplaces.

ii. Internship for developing the research aptitude: Research internship aims at providing hands-on training to work on research tools, techniques, methodologies, equipment, policy framework and various other aspects in pursuing quality research.

5. Implementation and assessment: For implementation and assessment of this vertical a separate SoP or relevant document that may be provided by the University will be applicable.
6. These can be implemented through:

1. Industries
2. Research labs
3. Government testing laboratories
4. Colleges/departments
5. MSMEs and startups
6. Online/virtual internships with report and viva evaluation

Some Suggested Forms of Internship / Apprenticeship / OJT for biotechnology

1. Research Laboratory Internship
   - Molecular biology techniques (PCR, DNA isolation, gel electrophoresis)
   - Cell and tissue culture
   - Microbial culture and identification
   - Bioinformatics and data analysis
   - Plant biotechnology research
2. Industrial Biotechnology Internship
   - Fermentation technology
   - Bioprocess engineering
   - Quality control and quality assurance
   - Enzyme production
   - Industrial microbiology
3. Pharmaceutical Biotechnology Training
   - Drug development and manufacturing
   - Good Manufacturing Practices (GMP)
   - Vaccine production
   - Quality testing of pharmaceuticals
   - Regulatory affairs
4. Agricultural Biotechnology Internship
   - Plant tissue culture
   - Crop improvement programs
   - Biofertilizer and biopesticide production
   - Seed technology
   - Molecular breeding techniques
5. Medical Biotechnology Internship
   - Clinical laboratory diagnostics
   - Molecular diagnostics
   - Immunological assays
   - Clinical microbiology
   - Biomedical research
6. Environmental Biotechnology Training
   - Wastewater treatment
   - Bioremediation studies
   - Environmental monitoring
   - Solid waste management
   - Biodiversity conservation projects
7. Food Biotechnology Internship
   - Food quality testing
   - Fermented food production
   - Food safety analysis
   - Probiotic product development
   - HACCP implementation
8. Bioinformatics Internship
   - Genome analysis
   - Protein structure prediction
   - Database management
   - Computational biology
   - Next-Generation Sequencing (NGS) data analysis
9. Entrepreneurship and Startup Training
   - Biotechnology business development
   - Product commercialization
   - Intellectual Property Rights (IPR)
   - Technology transfer
   - Startup incubation activities
10. Hospital and Diagnostic Laboratory OJT
    - Clinical sample processing
    - Hematological and biochemical analysis
    - Diagnostic techniques
    - Laboratory management
    - Medical laboratory safety

Expected Internship Deliverables

- Daily work diary/logbook
- Training report
- Presentation/Seminar
- Project report
- Skill assessment by industry/research supervisor

References:

https://www.ugc.gov.in/pdfnews/2051511_Internship-Research Internship-Guidelines.pdf
https://www.sgbau.ac.in/pdf/1092Internship%20Policy.pdf