

# As Per NEP 2020

## University of Mumbai



### Title of the program

- A- U.G. Certificate in Bioanalytical Sciences
- B- U.G. Diploma in Bioanalytical Sciences
- C- B.Sc. (Bioanalytical Sciences)
- D- B.Sc. (Hons.) in Bioanalytical Sciences
- E- B.Sc. (Hons. with Research) in Bioanalytical Sciences

### Syllabus for

### Semester – Sem I & II

Ref : GR dated 20<sup>th</sup> April, 2023 for Credit Structure of UG

**(With effect from the academic year 2024-25 Progressively)**

# University of Mumbai



(As per NEP 2020)

Sr.No.	Heading	Particulars	
<b>1</b>	<b>Title of program</b> O: _____ <b>A</b>	<b>A</b>	U.G. Certificate in Bioanalytical Sciences
	O: _____ <b>B</b>	<b>B</b>	U.G. Diploma in Bioanalytical Sciences
	O: _____ <b>C</b>	<b>C</b>	B.Sc. Bioanalytical Sciences
	O: _____ <b>D</b>	<b>D</b>	B.Sc. (Hons.) in Bioanalytical Sciences
	O: _____ <b>E</b>	<b>E</b>	B.Sc. (Hons. with Research) in Bioanalytical Sciences
<b>2</b>	<b>Eligibility</b> O: _____ <b>A</b>	<b>A</b>	Candidate must have passed Standard XII after 10 + 02 schooling (or equivalent) examination from any recognized board in India with minimum of 50% marks for students belonging to general category and 45% marks for students belonging to Reserved Category in aggregate or equivalent grade with Science, subjects- Physics, Chemistry, Biology and / or Mathematics. Students not having Mathematics will have to undertake a bridge course. OR Passed Equivalent Academic Level 4.0
	O: _____ <b>B</b>	<b>B</b>	Under Graduate Certificate in Bioanalytical Sciences academic Level 4.5
	O: _____ <b>C</b>	<b>C</b>	Under Graduate Diploma in Bioanalytical Sciences Academic Level 5.0
	O: _____ <b>D</b>	<b>D</b>	Bachelors of Bioanalytical Sciences with minimum CGPA of 7.5 Academic Level 5.5
	O: _____ <b>E</b>	<b>E</b>	Bachelors of Bioanalytical Sciences with minimum CGPA of 7.5 Academic Level 5.5
<b>3</b>	<b>Duration of program</b> R: _____	<b>A</b>	One Year

		<b>B</b>	Two Years
		<b>C</b>	Three Years
		<b>D</b>	Four Years
		<b>E</b>	Four Years
<b>4</b>	<b>Intake Capacity</b> R: _____	<b>Minimum 60</b>	
<b>5</b>	<b>Scheme of Examination</b> R: _____	NEP 40% Internal 60% External, Semester End Examination Individual Passing in Internal and External Examination	
<b>6</b>	R: _____ <b>Standards of Passing</b>	40%	
<b>7</b>	<b>Credit Structure</b> Sem. I - R: _____ <b>A</b> Sem. II - R: _____ <b>B</b>	Attached herewith	
	<b>Credit Structure</b> Sem. III - R: _____ <b>C</b> Sem. IV - R: _____ <b>D</b>		
	<b>Credit Structure</b> Sem. V - R: _____ <b>E</b> Sem. VI - R: _____ <b>F</b>		
<b>8</b>	<b>Semesters</b>	<b>A</b>	Sem I & II
		<b>B</b>	Sem III & IV
		<b>C</b>	Sem V & VI
		<b>D</b>	Sem VII & VIII
		<b>E</b>	Sem IX & X
<b>9</b>	<b>Program Academic Level</b>	<b>A</b>	4.5
		<b>B</b>	5.0
		<b>C</b>	5.5
		<b>D</b>	6.0
		<b>E</b>	6.0
<b>10</b>	<b>Pattern</b>	Semester	
<b>11</b>	<b>Status</b>	New	

12	<b>To be implemented from Academic Year Progressively</b>	From Academic Year: 2024-25
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**Sign of the BOS  
Chairman  
Dr. Prafullachandra  
P.Tekale  
Bioanalytical  
Sciences**

**Sign of the  
Offg. Associate Dean  
Dr. Madhav R. Rajwade  
Faculty of Science &  
Technology**

**Sign of the  
Offg. Dean  
Prof. Shivram S. Garje  
Faculty of Science &  
Technology**

## **Preamble**

### **1) Introduction**

The uniqueness of this course is on modular learning with credit-based evaluation. The program is designed by distinguished professionals and experts drawn from varied professional backgrounds. There have been people of experience from the world of academia, research and industry that forms the integrated triad in contemporary learning process. The B.Sc. in Bioanalytical Science will offer a clear knowledge of the underlying concepts of modern Bioanalytical techniques. It will be backed by the experience in application of these techniques in the field of Biology as well as Chemistry. The design of the course affirms the conviction that the students passing this course will help meet the demand for reliable and well informed bioanalysts in the areas of Analytical Sciences, Biotechnology, Clinical Research, Immunology, Molecular Biology and Pharmaceutical industry would be met immaculate.

### **2) Aims and Objectives**

- 1) To impart high quality Science education in a vibrant academic ambience with a faculty of distinguished Teachers and Scientists.
- 2) To prepare students for the country who will take up challenging research and teaching assignments in colleges, universities and industrial research and development in the field of bioanalysis, bioinformatics and Nutraceuticals.
- 3) To amalgamate classical analytical chemical techniques with modern genomic and proteomic technologies of manufacturing and analysis

### **3) Learning Outcomes**

- 1) Evaluate the strengths and future trends in bioanalytical Sciences.
- 2) Apply bioanalytical methods to analyze biomolecules.
- 3) Understanding fundamental principles of biochemistry.
- 4) Describe structure and functions of biomolecules.
- 5) Comprehend the significance of biomolecules in various biological processes and practical applications

### **4) Any other point (if any)**

The programme is designed in such a way that the student learner will retain his/ her overall interest in Chemical sciences and Biological Sciences. The programme will automatically initiate the need for next level learning.

**5) Credit Structure of the Program (Sem I, II, III, IV, V & VI)  
Under Graduate Certificate in Bioanalytical Sciences  
Credit Structure (Sem. I & II)**

R: _____ A										
Level	Semester	Major		Minor	OE	VSC, SEC (VSEC)	AEC, VEC, IKS	OJT, FP, CEP, CC,RP	Cum. Cr. / Sem.	Degree/ Cum. Cr.
		Mandatory	Electives							
4.5	I	6 <b>Paper I: MJ1:</b> Bioanalytical Sciences I		-	2+2	<b>VSC:2,</b> <b>VSCBS1:</b> Lab Safety - 1	AEC:2, VEC:2, IKS:2	CC:2	22	UG Certificate 44
		<b>Paper II: MJ2:</b> Chemical Sciences I				SEC:2 Pharmac ognosy				
		<b>MJBSP1</b> Bioanalytical & Chemical Sciences Practical 1								
R: _____ B										
	II	6 <b>Paper I: MJ3:</b> Bioanalytical Sciences II		2	2+2	<b>VSC:2,</b> <b>VSCBS2:</b> Lab Safety - 2	AEC:2, VEC:2	CC:2	22	
		<b>Paper II: MJ4:</b> Chemical Sciences II				SEC:2 Pharma cognos y				
		<b>MJBSP2</b> Bioanalytical & Chemical Sciences Practical 2								
	<b>Cum Cr.</b>	12	-	2	8	4+4	4+4+2	4	44	
Exit option: Award of UG Certificate in Major with 40-44 credits and an additional 4 credits core NSQF course/ Internship OR Continue with Major and Minor										

## Under Graduate Diploma in Bioanalytical Sciences

### Credit Structure (Sem. III & IV)

R: _____ C											
Level	Semester	Major		Minor	OE	VSC, SEC (VSEC)	AEC, VEC, IKS	OJT, FP, CEP, CC,RP	Cum. Cr. / Sem.	Degree/ Cum. Cr.	
		Mandatory	Electives								
5.0	III	8		4	2	VSC:2,  VSC- Calculations involved in Bioanalysis- I  SEC Electroanal ytical Techniques -I	AEC:2	FP: 2  CC:2	22	UG Diploma 88	
	R: _____ D										
	IV	8		4	2	SEC:2  VSC- Calculations involved in Bioanalysis  SEC Fundament als of Spectrosc opy	AEC:2	CEP: 2  CC:2	22		
	<b>Cum Cr.</b>	28		10	12	6+6	8+4+2	8+4	88		

**Exit option; Award of UG Diploma in Major and Minor with 80-88 credits and an additional 4 credits core NSQF course/ Internship OR Continue with Major and Minor**

## B.Sc. (Bioanalytical Sciences)

### Credit Structure (Sem. V & VI)

R: _____ E											
Level	Semester	Major		Minor	OE	VSC, SEC (VSEC)	AEC, VEC, IKS	OJT, FP, CEP, CC,RP	Cum. Cr. / Sem.	Degree/ Cum. Cr.	
		Mandatory	Electives								
5.5	V	10	4	4		VSC: 2  VSC Chromatogra phy techniques-I  SEC Sample preparation techniques-I		FP/CE P:2	22	UG Degree 132	
	R: _____ F										
	VI	10	4	4		VSC Chromatogra phy techniques-II  SEC Sample preparation techniques-II		OJT :4	22		
	<b>Cum Cr.</b>	48	8	18	12	8+6	8+4+2	8+6+4	132		
<b>Exit option: Award of UG Degree in Major with 132 credits OR Continue with Major and Minor</b>											

[Abbreviation - OE – Open Electives, VSC – Vocation Skill Course, SEC – Skill Enhancement Course, (VSEC), AEC – Ability Enhancement Course, VEC – Value Education Course, IKS – Indian Knowledge System, OJT – on Job Training, FP – Field Project, CEP – Continuing Education Program, CC – Co-Curricular, RP – Research Project ]



# **Semester - I**

**Syllabus**  
**B.Sc. (Bioanalytical Sciences)**  
**(Sem.- I)**

## Mandatory

### Bioanalytical Sciences (SEMESTER I)

Sr. No.	Heading	Particulars
1	<b>Description the course:</b>	This program is designed to provide a basic understanding of Bioanalytical Sciences. Through an academic curriculum of theory and practical courses, we aim to provide not only knowledge but to create interest in the subject. The B.Sc (Bioanalytical Sciences) course is framed to equip students with a basic theoretical foundation, practical skills, and critical thinking abilities necessary to address the challenges and opportunities in the diverse fields of subject. There is continuous evaluation of students based on Quizzes, Class Tests and assignments. Emphasis is given to conceptual understanding of theoretical concepts followed by inclusion of the same in practicals. B.Sc. (Bioanalytical Sciences) programme offers two major, one minor, VSCs, SECs, IKS, AECs, OEs VEC and CC. After successful completion of the first year B.Sc. programme the learner will be awarded a UG Certificate in Bioanalytical Sciences.
2	<b>Vertical:</b>	Major
3	<b>Type :</b>	Theory / Practical
4	<b>Credits :</b>	2 credits (1 credit = 15 Hours for Theory or 30 Hours of Practical work in a semester)
5	<b>Hours Allotted :</b>	30 Hours / 60 Hours
6	<b>Marks Allotted:</b>	50 Marks
7	<b>Course Objectives (CO):</b> CO 1. To Identify major types of biomolecules CO 2. To classify & describe structure of carbohydrates, lipids, proteins, and nucleic acids CO 3. To explain functions of biomolecules in living organisms. CO 4. To develop an Understanding of bond formations and kinetics involved in it CO 5. To apply knowledge of Interactions leading to ionization and pre-requisites CO 6. To develop an understanding of stereochemistry and basics CO 7. To be able to categorize & name the different types of chemical compounds.	
8	<b>Course Outcomes (OC):</b> OC 1 Students will develop understanding of sectors where Bioanalytical techniques are employed and thus awareness about future job roles. OC 2 Students will be able to Evaluate the strengths and future trends in Bioanalytical Sciences OC 3 Students will be able to describe structure, functions of biomolecules and also understand the fundamental principles of Biochemistry OC 4 Students will be able to apply Bioanalytical methods to analyze biomolecules OC 5 Students will be able to develop & comprehend the significance of biomolecules in various biological processes and practical applications OC 6 Students will be able to draw correct structures from the IUPAC names OC 7 Students will develop understanding of types of chemical bonds and bond angles based on hybridization	

	<p>OC 8 Students will be able to carry out Calculations of solutions strength based on dissociation and equilibrium</p> <p>OC 9 Students will be able to apply the knowledge for Structural identifications with respect to chiral carbon atoms and isomers, their importance in the Bioanalytical field</p> <p>OC 10 Students will be able to understand Importance of heat and energy in the chemical reactions</p>
<b>9</b>	<b>Modules</b>

Semester	Paper	Unit	Description	Credits
<b>I</b>	<b>Paper I:</b> <b>MJ1:</b> Bioanalytical Sciences I	<b>I</b>	<b>Introduction to Bioanalytical Sciences</b>	<b>02</b>
		<b>II</b>	<b>Biomolecules</b>	
	<b>Paper II:</b> <b>MJ2:</b> Chemical Sciences I	<b>I</b>	<b>Bonding and structure of compounds</b>	<b>02</b>
		<b>II</b>	<b>IUPAC, stereochemistry and solution concentration</b>	
	<b>MJBSP1:</b> Bioanalytical & Chemical Sciences Practical 1		<b>Practical Component</b>	<b>02</b>

## Paper I: MJ1: Bioanalytical Sciences - I

<b>Unit 1</b>	<b>Introduction to Bioanalytical Sciences</b>	
<b>1.1</b>	Definition and scope of Bioanalytical Sciences, Importance and applications of bioanalysis in different industries, Historical development of bioanalytical techniques.	<b>15L</b>
<b>1.2</b>	Significance in pharmaceutical industry, biotechnology, environmental monitoring, diagnostics, bioinformatics, nanotechnology, regulatory compliances and more.	
<b>1.3</b>	Current challenges and future prospects in bioanalytical sciences.	
<b>Unit 2</b>	<b>Biomolecules</b>	
<b>2.1</b>	Importance of biochemistry, Structural units of biomolecules- Carbohydrates, Lipids, Proteins and Nucleic acids, their physical and chemical properties, nomenclature, Classification of listed biomolecules and key characteristics. Importance of water in cell biochemistry.	<b>15L</b>
<b>2.2</b>	Enzymes: chemical nature, properties, nomenclature, classification	
<b>2.3</b>	Hormones and plant growth substances: classification of hormones. Overview of cell signaling	

## Paper II: MJ2: Chemical Sciences - I

<b>Unit 1</b>	<b>Bonding and structure of compounds</b>	<b>15L</b>
<b>1.1</b>	<u>Ionic bond</u> : Formation of ionic solids, lattice energy, solvation energy, Born-Haber cycle and Kapustinskii's equation (numerical problems expected) structures of some simple ionic solids like alkali halides and stability of ionic structures based on radius ratio rules.	
<b>1.2</b>	<u>Covalent bond</u> : Single and multiple bonding, co-ordinate bond, sigma and pi-bonds. Valence bond theory and Molecular orbital theory postulates.	
<b>1.3</b>	Theory of hybridization, sp, sp <sup>2</sup> , sp <sup>3</sup> , sp <sup>3</sup> d, sp <sup>3</sup> d <sup>2</sup> , sp <sup>3</sup> d <sup>3</sup> with illustration of BeCl <sub>2</sub> , BF <sub>3</sub> , SiCl <sub>4</sub> , PCl <sub>5</sub> , SF <sub>6</sub> , IF <sub>7</sub> , NO <sup>-3</sup> , CO, CO <sub>2</sub> , SO <sub>2</sub> and SO <sub>3</sub> . <u>Shapes of molecules</u> : V.S.E.P.R. theory for NH <sub>3</sub> , ClF <sub>3</sub> , BrF <sub>5</sub> , ICl <sub>2</sub> , TeF <sub>5</sub> , PX <sub>3</sub> (halides).	
<b>Unit 2</b>	<b>IUPAC, stereochemistry and solution concentration</b>	<b>15L</b>
<b>2.1</b>	IUPAC nomenclature of aliphatic polyfunctional compounds, including monocyclic compounds, on the basis of IUPAC priority order.	
<b>2.2</b>	Structural stereochemistry, Stereoisomers, Optical and Geometrical isomers: Study of enantiomers, diastereoisomers, Geometrical isomerism due to restricted rotation around C-C double bond and Substituted cycloalkanes.	
<b>2.3</b>	Ways of expressing concentrations : % w/w, % w/V Molarity(M), Normality (N), Mole fraction (X) Numerical based on it.	

## MJBSP1: Bioanalytical & Chemical Sciences Practical 1

### Paper 1- Bioanalytical Sciences

1. Qualitative analysis of a) carbohydrates b) lipids, c) proteins and nucleic acids.
2. Qualitative analysis of carbohydrates: Glucose, fructose, maltose, lactose, sucrose, starch, dextrin. Tests: Molisch, Iodine, Benedicts, Fehlings, Barfoed's, Seliwanoffs and Osazone formation
3. Qualitative analysis of amino acids: Tests: Xanthoproteic, Millons, Sakaguchi, Hopkin Cole, Lead acetate, Ninhydrin.
4. Quantitative analysis of proteins: (Casein, Albumin, Gelatin, Peptone). Tests: Biuret and Folin Ciocalteau
5. Quantitative analysis for nucleic acids: Orcinol (RNA) , Diphenylamine (DNA)
6. Qualitative analysis of lipids: Test: Bromine water.

### Paper 2 - Chemical Sciences

1. Hybridization of molecules/Complex ions/Drug
2. Make models of five/six membered aromatic compounds
3. Identification of Organic compound (minimum 7 compounds)
4. Oxidation of benzaldehyde using  $\text{KMnO}_4$
5. Hydrolysis of ethyl benzoate
6. Hydrolysis of p-nitroacetanilide
7. Nitration of salicylic acid
8. Acetylation of Salicylic acid

## Vocational Skill Course (VSC)

### Title of the course VSCBS1: Lab Safety - I

Sr. No.	Heading	Particulars	
1	<b>Description the course:</b>	The aim of Vocational Skill Courses (VSC) designed to provide experiential learning for students, which help to develop their technical skill through hands-on training and also developing abilities of critical thinking, analytical skill, collaboration, teamwork, problem-solving and communication which mould their careers.	
2	<b>Vertical:</b>	Vocational Skill Course	
3	<b>Type:</b>	Theory / Practical	
4	<b>Credits:</b>	2 credits (1 credit = 15 Hours for Theory or 30 Hours of Practical work in a semester)	
5	<b>Hours Allotted:</b>	45 Hours (Theory 1 Credit = 15 Hours Practical 1 Credit = 30 Hours)	
6	<b>Marks Allotted:</b>	100 Marks	
7	<b>Course Objectives (CO):</b>	<p>CO 1. To understand the Importance of lab safety</p> <p>CO 2. To develop awareness about safety measures for handling material in laboratory.</p> <p>CO 3. To identify potential hazards in the laboratories</p> <p>CO 4. To develop critical understanding of the various hazards of laboratory</p> <p>CO 5. To gain knowledge on the different disposable methods of the laboratory waste</p>	
8	<b>Course Outcomes (OC):</b>	<p><b>After Completion of the course, the Learner will able to;</b></p> <p>OC 1 Understand emergency procedures and respond to emergency situations</p> <p>OC 2 Acquire knowledge on proper storage, handling and waste disposal methods for consumables.</p> <p>OC 3 Handle various chemicals with the necessary care.</p> <p>OC 4 Identify and assess potential hazards</p> <p>OC 5 Conduct experiments safely.</p> <p>OC 6 Safely handle and transport biological materials with corrective labeling</p> <p>OC 7 Follow Good microbiological lab practices</p>	
9	<b>Modules</b>		
Sem-ester	Component	Description	Credits
I	Theory	Unit 1. Handling chemicals, safety and precautions	01
		Unit 2. MSDS	
	Practical	Practical in Lab Safety – 1	01
II	Theory	Unit 1. Sterilization techniques and handling biological samples	01
		Unit 2. Basic instrumentation	
	Practical	Practical in Lab Safety -2	01



**Semester I**  
**VSCBS1: Lab Safety – 1**

<b>Component</b>	<b>Description</b>	<b>Hours</b>
<b>Theory</b>	<b>1.1 Introduction, basics of Chemical &amp; Lab Safety</b> <ol style="list-style-type: none"> <li>1. Chemical Classifications, Symbols, Storage and Transportation</li> <li>2. Personal Protective Equipment (PPE): including lab coats, gloves, and safety goggles</li> <li>3. Handling Highly Toxic and Hazardous Chemicals, Chemical Spill Response and Decontamination</li> <li>4. Types of fire extinguishers, Safety and biosafety guidelines</li> <li>5. Safety Training and Drills.</li> </ol>	<b>07</b>
	<b>1.2 MSDS</b> <ol style="list-style-type: none"> <li>1. Meaning, terms involved, requirements, indications on the labels, various signs.</li> <li>2. Global requirements of MSDS data, MSDS of some typical compounds. Benzene, chloroform, aniline</li> <li>3. Classification of environmental Hazards, Analysing the criteria for evaluating the environmental hazard</li> <li>4. Applications of the criteria to example substances and mixtures.</li> </ol>	<b>08</b>
<b>Practical</b>	<ol style="list-style-type: none"> <li>1. Introduction to general laboratory practices and common lab instruments - Microscope, oven, incubator and autoclave.</li> <li>2. To understand and practice essential lab safety handling techniques in a chemistry laboratory.</li> <li>3. To demonstrate various decontamination methods for laboratory equipment and surfaces.</li> <li>4. Deriving all relevant information from MSDS Sheet for better experimental planning.</li> </ol>	

**Title of the course**  
**Skill Enhancement Course (SEC)**  
**Course Name : Pharmacognosy**

Sr. No.	Heading	Particulars
1	<b>Description the course:</b>	The aim of Vocational Enhancement course (VEC) is designed to provide co-curricular extension of subject domain in the botany and allied areas.
2	<b>Vertical:</b>	Skill Enhancement Course (SEC)
3	<b>Type:</b>	Theory / Practical
4	<b>Credits:</b>	2 credits (1 credit = 15 Hours for Theory or 30 Hours of Practical work in a semester)
5	<b>Hours Allotted:</b>	60 Hours (Theory 2 Credit = 30 Hours and Practical 1 Credit = 30 Hours)
6	<b>Marks Allotted:</b>	100 Marks
7	<b>Course Objectives (CO):</b>	CO 1. Introduce students to the major concepts and principles in botany. CO 2. Familiarize students with the diversity of plant life and their ecological significance. CO 3. To develop students & skills in laboratory and fieldwork techniques in botany. CO 4. To cultivate an appreciation for the importance of plants in human society and the environment.
8	<b>Course Outcomes (OC):</b>	<b>After Completion of the course, the Learner will able to;</b> OC 1 Identify and describe the structures and parts of plants, including leaves, stems, roots, flowers, and fruits OC 2 Gain knowledge of the classification system for plants OC 3 Better understanding of the medicinal and economic importance of plants, including the role of plants in medicine, agriculture, industry, and everyday life. OC 4 Understand the physiological processes that occur in plants, such as photosynthesis, respiration, transpiration, and reproduction.
9	<b>Modules</b>	

Sem-ester	Component	Description	Credits
I	Theory	Unit 1. Introduction to Botany	01
		Unit 2. Plant Physiology	
	Practical	Based on theory topics listed above	01

<b>Unit 1</b>	<b>Introduction to Botany</b>	<b>15L</b>
1.1	Definition and scope of botany, Historical development of botany as a science	
1.2	Importance of botany in society and the environment	
1.3	Structure and function of plant cells, tissues, and organs, Morphological adaptations in plants	
<b>Unit 2</b>	<b>Plant Physiology</b>	<b>15L</b>
2.1	Photosynthesis and respiration, Plant water relations,	

2.2	Plant hormones and growth regulators	
2.3	Plant reproductive structures and mechanisms	

**Practicals:**

Introduction to the compound light microscope,

2. Preparation of plant tissue slides

3. Observation of plant cell structure: Examination of different plant cell types (e.g., parenchyma,

collenchyma, sclerenchyma) under the microscope.

4. Staining: iodine staining for starch, safranin staining for plant cell walls, and methylene blue staining for protoplasmic contents

# **Semester - II**

## Mandatory

### Bioanalytical Sciences II (SEMESTER II)

Sr. No.	Heading	Particulars
1	<b>Description the course:</b>	This program is designed to provide a basic understanding of Bioanalytical Sciences. Through an academic curriculum of theory and practical courses, we aim to provide not only knowledge but to create interest in the subject. The B.Sc (Bioanalytical Sciences) course is framed to equip students with a basic theoretical foundation, practical skills, and critical thinking abilities necessary to address the challenges and opportunities in the diverse fields of subject. There is continuous evaluation of students based on Quizzes, Class Tests and assignments. Emphasis is given to conceptual understanding of theoretical concepts followed by inclusion of the same in practicals. B.Sc. (Bioanalytical Sciences) programme offers two major, one minor, VSCs, SECs, IKS, AECs, OEs VEC and CC. After successful completion of the first year B.Sc. programme the learner will be awarded a UG Certificate in Bioanalytical Sciences.
2	<b>Vertical:</b>	Major
3	<b>Type :</b>	Theory / Practical
4	<b>Credits :</b>	2 credits (1 credit = 15 Hours for Theory or 30 Hours of Practical work in a semester)
5	<b>Hours Allotted :</b>	30 Hours / 60 Hours
6	<b>Marks Allotted:</b>	50 Marks
7	<b>Course Objectives (CO):</b>	CO 1 To develop an understanding of cell structures and functions. CO 2 To inculcate awareness about physiologies in lower animals and humans CO 3 To have a better understanding of concepts about sterility and microbial growth kinetics. CO 4 To develop an understanding of heterocyclic compounds and related reactions CO 5 To Understand role of organic reactions in synthesis and industry CO 6 To develop an understanding of stereochemistry and basics CO 7 To create Awareness of principles dictating the ionic equilibrium and relevant theories
8	<b>Course Outcomes (OC):</b>	OC 1 Students will be able to Interpret the types of electrolytes and dissociations OC 2 Students will be able to Identify the heterocyclic compounds and concerned reactions OC 3 Students will be able to describe structure, functions of biomolecules and also understand the fundamental principles of Biochemistry OC 4 Students will be able to Describe different types of organic reactions OC 5 Students will be able to recognize factors affecting reaction rates

<b>9</b>	<b>Modules</b>			
<b>II</b>	<b>Paper I:</b> <b>MJ3:</b> Bioanalytical Sciences II	<b>I</b>	<b>Comparative physiology of living systems</b>	<b>02</b>
		<b>II</b>	<b>Basic Microbiology</b>	
	<b>Paper II:</b> <b>MJ4:</b> Chemical Sciences II	<b>I</b>	<b>Ionic Equilibrium</b>	<b>02</b>
		<b>II</b>	<b>Fundamentals of organic reactions</b>	
	<b>MJBSP2:</b> Bioanalytical & Chemical Sciences Practical 2		<b>Practical Component</b>	<b>02</b>

**Paper I: MJ3: Bioanalytical Sciences – II**

<b>Unit 1</b>	<b>Comparative physiology of living systems</b>	<b>15L</b>
<b>1.1</b>	Basics: Types, Gross structure and Ultrastructure, Function and physiology of: Plasma membrane, cell wall and cell membrane, Mitochondria, Chloroplast, Golgi bodies, ER – smooth and rough, Lysosomes, Nucleus and nucleolus, and Ribosomes.	
<b>1.2</b>	Comparative account of different systems- (structure and physiological functions) Circulatory, respiratory, nervous, digestive, endocrine, excretory and reproductive systems in major phyla of animals	
<b>1.3</b>	Physiological regulation of systems.	
<b>Unit 2</b>	<b>Basic Microbiology</b>	<b>15L</b>
<b>2.1</b>	Microbes & their environment, Classification, Factors affecting microbial growth, Techniques to measure, microbial growth, Visualization of microorganisms: Staining and microscopy.	
<b>2.2</b>	Significance and scope of microbiology in various industries, Pharmaceutical microbiology	
<b>2.3</b>	Concepts and applications: Asepsis, sterilization and disinfection.	

## Paper II: MJ4: Chemical Sciences - II

<b>Unit 1</b>	<b>Ionic Equilibrium</b>	<b>15L</b>
<b>1.1</b>	Basic principles, Introduction to Ionic equilibrium, Classification of Electrolytes, Ostwald's Dilution Law, Absolute Velocities and Mobilities of Ions, Activity coefficient, Strong acids and bases, Mono and polyprotic acids and bases, Solubility	
<b>1.2</b>	Complex formation and organic complexes, oxidation and reduction equilibria, and Hydrolysis of salts.	
<b>1.3</b>	Types of salts and their hydrolysis mechanism, solubility products, formula and simple numerical based on it.	
<b>Unit 2</b>	<b>Fundamentals of organic reactions</b>	<b>15L</b>
<b>2.1</b>	Electronic effects in organic molecules: Inductive effect, polarity of a covalent bond, dipole moment and its effect on properties of molecules, Delocalized bonds – Resonance, drawing of resonance structures of different conjugated systems, resonance energy and stability of conjugated systems, hyperconjugation and tautomerism.	
<b>2.2</b>	General Idea to types of reaction: Electrophile , Nucleophile. Introduction and few examples of following types of reaction expected: Addition, Elimination, Substitution, Condensation, Rearrangement, Oxidation-reduction.	
<b>2.3</b>	Aromaticity, reactivity and general methods of synthesis of Aromatic pyrroles, furans, thiophenes and pyridines. Reactions: Benzene and Furan : Halogenation, nitration, sulphonation, ring opening,	



## **MJBSP2: Bioanalytical & Chemical Sciences Practical 2**

### **Paper 1- Bioanalytical Sciences**

1. Media preparation for microbes
2. Aseptic transfer
3. Isolation techniques for bacteria
4. Staining techniques : Monochrome staining, Gram staining, Endospore staining
5. Enumeration of bacteria
6. Study of animal physiology

### **Paper 2 - Chemical Sciences**

1. Complete identification of an organic compound (Minimum 6 compounds) Identification by micro-scale techniques following – Preliminary tests, solubility, Elemental detection, group tests, Physical constant determination
  2. Iodoform of acetone
  3. 2,4-DNP of benzaldehyde
  4. Picric acid derivative of naphthalene
  5. Nitration of acetamide
  6. Preparation of aspirin
  7. Nitration of nitrobenzene
  8. Hydrolysis of an ester /oil
- .

## Vocational Skill Course (VSC)

### Title of the course

### VSCBS1: Lab Safety - 2

Sr. No.	Heading	Particulars
1	<b>Description the course:</b>	The aim of Vocational Skill Courses (VSC) designed to provide experiential learning for students, which help to develop their technical skill through hands-on training and also developing abilities of critical thinking, analytical skill, collaboration, teamwork, problem-solving and communication which mould their careers.
2	<b>Vertical:</b>	Vocational Skill Course
3	<b>Type:</b>	Theory / Practical
4	<b>Credits:</b>	2 credits (1 credit = 15 Hours for Theory or 30 Hours of Practical work in a semester)
5	<b>Hours Allotted:</b>	45 Hours (Theory 1 Credit = 15 Hours Practical 1 Credit = 30 Hours)
6	<b>Marks Allotted:</b>	100 Marks
7	<b>Course Objectives (CO):</b> CO 1 To understand concepts involved in sterilization CO 2 To identify potential hazards in the laboratories CO 3 To develop critical understanding of Handling biological samples safely CO 4 To Identify the need for calibration of glassware and instruments	
8	<b>Course Outcomes (OC):</b> <b>After Completion of the course, the Learner will able to;</b> OC 1 Prepare for proficient handling of basic techniques in a lab OC 2 Demonstrate good sense of calibration of items involved in an experimental set up OC 3 Conduct biological experiments safely OC 4 Follow Good microbiological lab practices	
9	<b>Modules</b>	

Semester	Component	Description	Credits
II	Theory	Unit 1. Sterilization techniques and handling biological samples	01
		Unit 2. Basic instrumentation	
	Practical	Practical in Lab Safety -2	01

## Semester II

Component	Description	Hours
Theory	<b>1.1 Sterilization techniques and handling biological samples</b> 1. Preparations for autoclave, UV sterilization, Filter sterilization, membrane sterilization 2. Biosafety cabinets, types and precautions 3. Handling pathogenic / biohazard samples, Hazardous Waste Disposal	07
	<b>1.2. Basic instrumentation</b> 1. Handling basic instruments in a lab-pH meter, potentiometer, colorimeter, conductometer 2. Calibration-glassware and instruments	08
Practical	1. Calibration of colorimeter using $\text{KMnO}_4$ 2. Preparation for autoclave (glassware + media)- Wrapping. To understand and practice essential lab safety handling 3. Preparation of media and sterilization. 4. Carrying out calibration: a. Glassware- pipette, measuring cylinder, conical flask etc b. Instruments : pH meter and weighing balance	

**Title of the course**  
**Skill Enhancement Course (SEC)**  
**Course Name : Pharmacognosy-II**

Sr. No.	Heading	Particulars
1	<b>Description the course:</b>	The aim of Vocational Enhancement course (VEC) is designed to provide co-curricular extension of subject domain in the botany and allied areas.
2	<b>Vertical:</b>	Vocational Enhancement Course
3	<b>Type:</b>	Theory / Practical
4	<b>Credits:</b>	2 credits (1 credit = 15 Hours for Theory or 30 Hours of Practical work in a semester)
5	<b>Hours Allotted:</b>	60 Hours (Theory 2 Credit = 30 Hours and Practical 1 Credit = 30 Hours)
6	<b>Marks Allotted:</b>	100 Marks
7	<b>Course Objectives (CO):</b>	CO 1. Introduce students to the major concepts and principles in botany. CO 2. Familiarize students with the diversity of plant life and their ecological significance. CO 3. To develop students & skills in laboratory and fieldwork techniques in botany. CO 4. To cultivate an appreciation for the importance of plants in human society and the environment.
8	<b>Course Outcomes (OC):</b>	<b>After Completion of the course, the Learner will able to;</b> OC 1 Identify and describe the structures and parts of plants, including leaves, stems, roots, flowers, and fruits OC 2 Gain knowledge of the classification system for plants OC 3 Better understanding of the medicinal and economic importance of plants, including the role of plants in medicine, agriculture, industry, and everyday life. OC 4 Understand the physiological processes that occur in plants, such as photosynthesis, respiration, transpiration, and reproduction.
9	<b>Modules</b>	

Sem-ester	Component	Description	Credits
II	Theory	Unit 1. Taxonomy Unit 2. Applied botany	01
	Practical	Based on theory topics listed above	01

<b>Unit 1</b>	<b>Taxonomy</b>	<b>15L</b>
1.1	Overview of plant kingdom classification	
1.2	Classification of major plant groups (algae, bryophytes, pteridophytes, gymnosperms, angiosperms)	
1.3	Introduction to plant identification and taxonomy.	
<b>Unit 2</b>	<b>Applied botany</b>	<b>15L</b>

<b>2.1</b>	Overview of applied botany and its significance,	
<b>2.2</b>	Medicinal properties of plants and traditional herbal remedies	
<b>2.3</b>	Current trends and emerging areas of research	

**Practicals:**

1. Conducting a field survey to assess plant diversity and abundance in different habitats
2. Identifying medicinal plants and discussing their traditional uses.
3. Collecting plant specimens and preparing herbarium sheets for documentation.
4. Assessing the pollen morphology
5. Performing the seed viability study

## **REFERENCES**

### **PAPER I**

1. Prescott's Microbiology- Johanne M. Wille. McGraw-Hill Education, 2008
2. Microbiology by Micheal J. Pelczar, Jr, E.C.S.Chan, Noel R. Krieg. McGraw-Hill Education. 2012.
3. Biochemistry- Lipincott illustrated review series-Denise Ferrier. Wolters Kluwer edition, 2013.
4. Lehninger Principles of Biochemistry by Micheal M. Cox and David L. Nelson. Macmillan Publisher, 2017.
5. Principles of Instrumental Analysis. Douglas A. Skoog, F. James Holler, Stanley R. Crouch. Cengage Publisher, 2018.

### **PAPER II**

1. Nomenclature of organic chemistry S.C.Pal:: Alpha publication. 2016.
2. Organic Reactions and Their Mechanisms: P.S Kalsi: 5<sup>th</sup> edition, New Age Publication., 2017.
3. Peter Atkins & Julio de Paulo: Physical Chemistry: Oxford University Press.3<sup>rd</sup> edn. 2018.
4. Organic Chemistry Paula Yurkanis Bruice:: Pearson. 2020
5. Text books of Inorganic Chemistry (FYBSC, SYBSC): Sheth Publications, 2023.

### **Minor**

1. Toxicological chemistry and Biochemistry 3rd edition, Stanley EManahan
2. Casarett and Doull's Toxicology C. Klaassen, M. Amdur, and J. Doull, eds., 9th edition,MsGraw Hill publication
3. Principles and Methods of Toxicology (A. W. Hayes, ed.)3rd edition CRC press
4. Basic Environmental Toxicology (L. Cockerham and B. Shane, eds.)
5. Toxicological chemistry and Biochemistry 3rd edition, Stanley EManahan
6. Casarett and Doull's Toxicology C. Klaassen, M. Amdur, and J. Doull, eds., 9th edition,MsGraw Hill publication
7. Principles and Methods of Toxicology (A. W. Hayes, ed.)3rd edition CRC press
8. Basic Environmental Toxicology (L. Cockerham and B. Shane, eds.)

### **Practical References**

1. Chemical Process Safety: Fundamentals with Applications, by Daniel A. Crowl and Joseph F. Louvar. 1990
2. Microbiology: A Laboratory Manual by James G. Cappuccino and Natalie Sherman, 2011.
3. Biosafety in Microbiological and Biomedical Laboratories (BMBL) by U.S. Department of Health and Human Services, Centers for Disease Control and Prevention (CDC) and National Institutes of Health (NIH). 2020.
4. Principles of Instrumental Analysis, D. A. Skoog, F. James Holler, Stanley R. Crouch (2007)
5. Vogel's Textbook of quantitative chemical analysis, 5<sup>th</sup> edition (1989)
6. Instrumental method of analysis, B.K. Sharma, Goel publishing house. Miscellaneous methods (2005)
7. Modern Analytical Chemistry by David Harvey, McGraw-Hill Higher Education (1999)
8. Vogel's Textbook of Quantitative Chemical Analysis, Fifth Edition, G H Jeffery and J Bassett.
9. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., Textbook of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996.
10. FSSAI manual of methods of analysis of foods: food additives

**QUESTION PAPER PATTERN**  
**(External and Internal)**

## Evaluation Pattern for Major Theory Courses

	<b>Internal Continuous Assessment: 40% (20 Marks)</b>	<b>Semester End Examination: 60% (30 Marks)</b>
	<b>Continuous Evaluation through:</b> Quizzes, Class Tests, presentation, project, role play, creative writing, assignment etc. ( <b>at least 3</b> )	As per paper pattern

### Paper Pattern for 30 marks :

30 Marks per paper Semester End Theory Examination:

1. Duration - These examinations shall be of **one hour and 30 minutes** duration.
2. Theory question paper pattern:
  - a. There shall be **03** questions each of **10 marks** on each unit
  - b. All questions shall be compulsory with internal choice within the questions.

Question	Option	Marks	Questions Based on
Q.1	A) Objective questions 4 out of 6	04	Unit I
	B) Subjective questions 2 out of 3	06	
Q.2	A) Objective questions 4 out of 6	04	Unit II
	B) Subjective questions 2 out of 3	06	
Q.3	A) Objective questions 4 out of 6	04	Mix from Unit 1 & II
	B) Subjective questions 2 out of 3	06	
	<b>Total</b>	<b>30</b>	



## Evaluation Pattern for Major Practical Course

	<b>Internal Continuous Assessment: 40% (20 Marks)</b>	<b>Semester End Examination: 60% (30 Marks)</b>
	Viva/ assignment/ objective question test (15 Marks), Overall performance (5 Marks) = 20 Marks	One experiment for three and half hours (25 marks for experiment and 5 Marks for Journal = 30 Marks)

### PRACTICAL BOOK/JOURNAL

The students are required to perform 75% of the Practical for the journal to be duly certified. The students are required to present a duly certified journal for appearing at the practical examination, failing which they will not be allowed to appear for the examination.

## Evaluation Pattern for VSC Courses

	<b>Internal Continuous Assessment: 40% (20 Marks)</b>	<b>Semester End Examination: 60% (30 Marks)</b>
	<b>Continuous Evaluation through:</b> Quizzes, Class Tests, presentation, project, role play, creative writing, assignment etc. (at least 3)	

### Paper Pattern for 30 marks :

30 Marks per paper Semester End Theory Examination:

- Duration - These examinations shall be of **Three hours** duration in laboratory (**1 hour for Theory and 2 hours for Practical**).



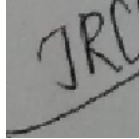

Question	Option	Marks	Questions Based on
Q.1	Based on theory Attempt any two out of three questions (5 marks each)	10	Uni I (Theory Component)
Q.2	Performing experiments in laboratory	20	Unit II (Practical Component)
	<b>Total</b>	<b>30</b>	

**Letter Grades and Grade Points:**

<b>Semester GPA/ Programme CGPA Semester/ Programme</b>	<b>% of Marks</b>	<b>Alpha-Sign/ Letter Grade Result</b>	<b>Grading Point</b>
9.00 - 10.00	90.0 – 100	O (Outstanding)	10
8.00 - < 9.00	80.0 - < 90.0	A+ (Excellent)	9
7.00 - < 8.00	70.0 - < 80.0	A (Very Good)	8
6.00 - < 7.00	60.0 - < 70.0	B+ (Good)	7
5.50 - < 6.00	55.0 - < 60.0	B (Above Average)	6
5.00 - < 5.50	50.0 - < 55.0	C (Average)	5
4.00 - < 5.00	40.0 - < 50.0	P (Pass)	4
Below 4.00	Below 40.0	F (Fail)	0
Ab (Absent)	-	Ab (Absent)	0

This syllabus is applicable to IDOL students as well, w.e.f. 2025-26

### Signatures of Team Members

Name	College Name	Sign
Dr. Prafullachandra Tekale	Dept. of Chemistry, Guru Nanak Khalsa College, Nathala parikha Marg, Matunga, Mumbai-19	
Dr. Deepa Verma	Vishnu Waman Thakur Charitable Trust's Bhaskar Waman Thakur College of Science, Yashvant Keshav Patil College of Commerce, Vidhya Dayanand Patil College of Arts (VIVA College)	
Dr. Jayaprada Rao	Mithibai College of Arts, Chauhan Institute of Science and A.J. College of Commerce and economics, Vile Parle (W), Mumbai - 400056	
Dr. Kavita Pandey	Asst Prof and Head, Dept of Bioanalytical Sciences (FYIC), Guru Nanak Khalsa College, Nathala parikha Marg, Matunga, Mumbai-19	
Dr. Tara Menon	SIES College, Sion. Mumbai-400022	
Dr. Seema Kokitkar	C.K.T. College, Plot No.8, janardhan Bhagat Marg, CIDCO colony, Sector 14, New Panvel (E), 410206	
Dr. Sandhya Menon	Dept. of Bioanalytical Sciences Ramnarain Ruia College, Matunga, Mumbai-19	
Dr. Nandini Girish	Ramnarain Ruia College, Matunga, Mumbai-19	

**Appendix B****Justification for B.Sc. (Bioanalytical Sciences)**

1.	Necessity for starting the course	:	1) Interdisciplinary understanding. 2) Need of the industry. 3) Hands on practical training.
2.	Whether the UGC has recommended the course	:	Yes
3.	Whether all the courses have commenced from the academic year 2023-24	:	No
4.	The courses started by the University are self-financed, whether adequate number of eligible permanent faculties are available?:	:	Yes
5.	To give details regarding the duration of the Course and is it possible to compress the course?:	:	The duration of the program is three years (6 semesters). It is not possible to compress the course.
6.	The intake capacity of each course and no. of admissions given in the current academic year:	:	The intake capacity is variable from college to college based on sanctions received from the University.
7.	Opportunities of Employability / Employment available after undertaking these courses:	:	Yes. Opportunities are available in pharmaceutical and clinical industries.

**Sign of the BOS  
Chairman  
Dr. Prafullachandra  
P.Tekale  
Bioanalytical Sciences**

**Sign of the Offg. Associate  
Dean  
Name of the Associate Dean  
Name of the Faculty**

**Sign of the Offg. Dean  
Name of the Offg. Dean  
Name of the Faculty**