SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI

THREE YEAR/ FOUR-YEAR DEGREE OF BACHELOR OF SCIENCE

Bachelor of Science

SUBJECT: BIOCHEMISTRY

FACULTY: SCIENCE AND TECHNOLOGY

(Courses effective from Academic Year 2026-2027)

Under Uniform NEP 2020

SYLLABUS

Semester I and II

Semester III and IV

Semester V and VI

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Preamble

Biochemistry is a dynamic and interdisciplinary branch of life sciences that explores the chemical processes and molecular mechanisms underlying living organisms. It encompasses the study of biomolecules, cellular organization, metabolism, enzymology, molecular biology, genetics, immunology, and biotechnology. Biochemistry provides the scientific foundation for understanding normal physiological processes, disease mechanisms, drug development, nutrition, agriculture, environmental sustainability, and industrial biotechnology. The discipline has made remarkable contributions to healthcare, pharmaceuticals, diagnostics, food technology, agriculture, and biomedical research through innovations in molecular and biochemical sciences.

The undergraduate B.Sc. Biochemistry programme designed in accordance with the National Education Policy (NEP) 2020, aims to provide students with a strong foundation in both fundamental and applied aspects of biochemistry through a multidisciplinary, skill-oriented, and experiential learning approach. The curriculum integrates theoretical knowledge with laboratory training, research aptitude, innovation, entrepreneurship, and industry-relevant skills to prepare students for higher education, scientific research, healthcare, biotechnology, pharmaceuticals, food industries, and other allied sectors.

The programme emphasizes a comprehensive understanding of the structure, properties, and functions of biomolecules, cellular metabolism, enzyme kinetics, molecular genetics, clinical biochemistry, immunology, biotechnology, and modern biochemical and biophysical techniques. Practical courses are designed to develop proficiency in biochemical analysis, quantitative estimation of biomolecules, enzyme assays, molecular biology techniques, chromatography, spectroscopy, electrophoresis, and other advanced laboratory methodologies, enabling students to acquire analytical, technical, and problem-solving skills.

The B.Sc. Biochemistry programme designed in accordance with the principles of NEP 2020 fosters critical thinking, scientific inquiry, creativity, ethical practices, digital literacy, environmental awareness, and lifelong learning through a multidisciplinary and outcome-based approach. It aims to develop graduates with strong scientific knowledge, technical competence, research aptitude, analytical and entrepreneurial skills, and professional ethics, enabling them to contribute effectively to academia, biomedical and clinical laboratories, pharmaceutical and biotechnology industries, food and nutraceutical sectors, agriculture, environmental sciences, forensic science, and healthcare. The programme also provides a strong foundation for higher education, research, innovation, and lifelong professional development, empowering graduates to address scientific and societal challenges in a rapidly evolving global environment.

Programme Outcomes:

Students of undergraduate general degree programme at the time of graduation would be able to

PO1. Critical Thinking: Take informed actions after identifying the assumptions that frame our thinking and actions, checking out the degree to which these assumptions are accurate and valid, and looking at our ideas and decisions (intellectual, organizational, and personal) from different perspectives.

PO2. Effective Communication: Speak, read, write and listen clearly in person and through electronic media in English and in one Indian language, and make meaning of the world by connecting people, ideas, books, media and technology.

PO3. Social Interaction: Elicit views of others, mediate disagreements and help reach conclusions in group settings.

PO4. Effective Citizenship: Demonstrate empathetic social concern and equity centred national development, and the ability to act with an informed awareness of issues and participate in civic life through volunteering.

PO5. Ethics: Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them.

PO6. Environment and Sustainability: Understand the issues of environmental contexts and sustainable development.

PO7. Self-directed and Life-long Learning: Acquire the ability to engage in independent and life-long learning in the broadest context socio-technological changes.

Programme Specific Outcomes:

Upon completion of the programme successfully, Student would be able to -

PSO1. Understand structure, energy value and function of Biomolecules.

PSO2. Prepare buffers of different pH, can perform chromatography of plant pigments and separate biomolecules by electrophoresis, perform structural analysis of substances using NMR and ESR.

PSO3. Apply knowledge of biomolecule metabolism to diagnose various diseases and their root causes.

PSO4. Formulate and design various biomedical enzyme-based marker kits and apply in winery, leather, dairy and detergent industry.

PSO5. Analyze unknown DNA samples using molecular biology techniques and perform plant tissue culture of medicinally important endangered plant species.

PSO6. Interpret reason of abnormal blood reports, probable cause and effects on human health.

Employability Potential of the Programme:

Biochemistry is the branch of science which deals with study of chemistry of living organisms. Biochemistry focuses on processes happening at molecular level. It focuses on what happening inside our cells, studying components like proteins, lipids, carbohydrates, nucleic acid, vitamins and hormones. The cumulative demand for trained and skilled manpower in the area of Biochemistry requires in depth functional knowledge of modern biology through hands-on training to the students.

The degree of Bachelor of Science in Biochemistry (Choice Based Credit System) aims to introduce various aspects of Biochemistry and interdisciplinary subjects to the students. The program in Biochemistry as one of the core subjects is designed to cultivate a scientific attitude and interest towards the modern areas of Biochemistry in particular and life science in general. This will help the students to become critical and curious in their outlook.

The courses are designed to impart the essential basics in Biochemistry at the initial level of graduation. The basic courses are infused with application in modern life sciences, and awareness on Biochemistry and its influence in human life. The integration of various courses in the program is aimed to develop proficiency in the theory as well as practical experiments, common equipment, laboratory, along with the collection and interpretation and presentation of scientific data in proper manner.

Beside this, the students will be equipped with knowledge in the newer areas of Biochemistry and its application in medical science, agriculture, industry, proteomics, genomics, metabolomics, bioinformatics, nano-biotechnology etc. This will create awareness about Bio-chemistry and contribution of Biochemistry among the society. At the end of the course, the students are expected to have good working knowledge in the field of Bio-chemistry and in addition knowledge gained from courses of interdisciplinary in nature.

Students will surely have an urge to continue higher studies in Biochemistry and contribute significantly in the development. The present syllabus is restructured anticipating the future needs of Biochemistry with more emphasis on imparting hands-on skills. The main thrust is laid on making syllabus compatible with developments in Education, Research and Industrial sectors. The Theory and Practical course in new restructured course will lead to impart skill-set essentials to further Biochemistry.

Biochemistry is the molecular basis of life. Degree program in Biochemistry teaches students how inanimate, lifeless chemicals combine to produce a functional living organism. A significant attraction of the course is the ability to combine in-depth scientific knowledge with practical laboratory skills and the career opportunity in all sectors. After successful completion of three years degree course in Biochemistry, student will be well versed with laboratory skills and transferable skills.

Laboratory Skills:

Students are trained in

•Laboratory safety practices

•Accurate weighing and reagent preparation

•Skilful handling of basic and advanced instruments

•Calibration of basic instruments like pH meter, micropipettes etc

•Advanced techniques like:

1.Chromatography

2.Electrophoresis

3.Spectrometry

4. Polymerase Chain Reaction (PCR)

5.Plant Tissue Culture

6.Animal Tissue Culture

•Logical thinking

• Analysis and interpretation of results

•Collection, organization and presentation of data

Transferable Skills:

During the course student will develop skills other than laboratory skills that are transferable across the number of career areas. These are:

• Analytical skill

•Report writing skill

•Presentation skill

•Time management

•Creative thinking

•Problem solving

•Planning

•Observational skill

Job Opportunities: After successful completion of B.Sc. in Biochemistry, student may continue further studies like M.Sc. in Biochemistry and then Ph.D. in Biochemistry and make career in research field. Students have opportunities in private as well as public sectors.

Private Sector: Biochemist can work in quality control, quality assurance and R & D divisions of companies like- Biotech companies, pharmaceutical companies, Chemical manufacturing companies, Food and Drink (includes brewing), Health and Beauty Care, Medical Instrument companies, Agricultural companies, Research Companies and Laboratories etc.

Public Sectors: Blood Service, Cancer research institutes, Environmental Pollution Control, Forensic Science, Hospitals, National Blood Services, Overseas Development, Public Health Entities, Public Health Laboratories, Agriculture and fisheries etc.

Government Sector: Syllabus has been design keeping in view that students can apply for various government post filled by Maharashtra Public Service Commission (MPSC), Union Public Service Commission (UPSC), Food Corporation of India, Forensic department, Health department and Food and Drug Administration. These departments recruit successful candidates for the post of Food safety officers in food and drug administration, Assistant Chemical Analyzers in forensic laboratories of Maharashtra and other states all over India, Laboratory Technicians in Clinical pathology laboratories Health department and Food Corporation of India, Sanitary inspectors for schools etc.

Job profiles: Biochemist, Biologist, Biomedical Scientist, Biotechnologist, Chemical Examiners, Chemist, Clinical Scientist, Food Scientist, Forensic Scientist, Laboratory Technician, Microbiologist, Research Associates, Research Officers, and Research Scientist etc.

THREE YEARS UNDERGRADUATE PROGRAM

B. Sc. BIOCHEMISTRY under FACULTY: SCIENCE AND TECHNOLOGY

Board of Studies in Biochemistry including Microbiology and Food Science

Dr. Rachana.R. Pachori (Chairman) Professor and Head, Department of Microbiology, R.A. Arts, Shri M.K Commerce and Shri S.R.Rathi Science Mahavidyalaya, Washim	Dr. Anil M. Garode, Ex Professor & Head. Rajmata Jijau Nagar, Chikhli
Dr Vijay S.Wadhai, Professor and Head, Department of Microbiology, Sardar Patel Mahavidyalaya, Chandrapur	Dr Niteen Phirke, Professor and Head, P.G. Department of Microbiology, Sant Gadge Baba Amravati University, Amravati
Dr Kapil Kamble, Professor, P.G. Department of Microbiology, Sant Gadge Baba Amravati University, Amravati	Dr Dnyansagar Bhokare, Professor, Department of Microbiology Shankarlal Khandelwal College, Akola
Dr. Yamini S. Patil, Professor and Head, Department of Microbiology, Shri. D. M. Burungale Science and Arts College, Shegaon.	Dr. Nilima Yashwantrao Bhoge Professor and Head, Department of Food Science Arts Science and Commerce College Chikhaldara Dist Amravati
Dr Kshitij Navinprakash Shah, Professor, Arts science and commerce College Chikhaldara	Dr. Swati Nilesh Zodpe Associate Professor & Head, Dept of Microbiology, Shri. Shivaji College of Arts Commerce and Science Akola
Mr Ajit Babruwahan Patil, Assistant Professor & Head, Dept of Biochemistry, Ghulam Nabi Azad Arts,Commerce and Science College, Barshitakli Dist Akola	Dr.Ashwini A Balode, Assistant Professor & Head, Dept of Biochemistry, Shri. Shivaji College of Arts Commerce and Science Akola

Credit Distribution

Three/Four-year UG Degree Programme (Level 4.5 to 5.5)

Vertical	Vertical Type	I	II		III	IV	V	VI	Total Credits	Grand Total
	(i) Three-year UG Degree Programme (Level 4.5.to 5.5									
A	**Major DSC (60–64)** (Minimum 50% of Total Credits)	4	4	Major	6	8	8	8	38	**48**
				IKS	2				2	
		0	0	Elective	0	0	4	4	8	
B	**Minor (from same faculty of DSC) (18–24)**	4	4		4	4	4	4	24	**24**
C	**Generic/Open Elective (OE)** (Faculty-wise basket other than Major/Minor faculty) (10–12)	4	4		2	2	0	0	12	**12**
D(i)	**Vocational Skill Courses (VSEC)** corresponding to Major/Minor (8–10)	0	2		2	2	2	2	10	**16**
D(ii)	**Skill Enhancement Courses (SEC)**	2	2		0	0	2	0	6	
E(i)	**Ability Enhancement Courses (AEC)** (English + Modern Indian Language)	1+1	1+1		1+1	1+1	0	0	8	**14**
E(ii)	**Indian Knowledge System (IKS) 2 Generic**	2	0		0	0	0	0	2	
E(iii)	**Value Education Courses (VEC)** (Understanding India, EVS, Digital & Technological Solution) 4	2	2		0	0	0	0	4	
F(i)	**Internship / Apprenticeship** corresponding to Major 8 **(OJT)**	0	0		0	0	0	4	4	**18**
F(ii)	**Field Projects / Community Engagement & Service (CEP)** corresponding to Major 4-6	0	0		2	2	2	0	6	
F(iii)	**Co-curricular Courses (CC)** (health & wellness, yoga education, sports, fitness, cultural activities, NSS/ NCC & Fine/ Applied/ Visual/ Performing Arts **8**	2	2		2	2	0	0	8	
	Total Credits per Semester	**22**	**22**		**22**	**22**	**22**	**22**	**132**	**132**

(ii) Four-year UG Degree programme (Level 6.0) Honors Degree in Major or Minor A. Honors Degree in Major or Minor					
	Vertical Type			Semester VII	Semester VIII	
	Major (Offered at Three-year UG Programme)	**Mandatory**		**12-14(2*4+2*2 or 3*4+2)**	**12-14(2*4+2*2 or 3*4+2)**	**28**
		Elective		4	4	8
	Research Methodology (RM)			4	0	8
	On the Job Training (OJT)			0	4	4
	Total			**22**	**22**	**44**
	Cumulative			**(132+44) 176**		
(ii) Four-year UG Degree Programme (Level 6.0) B. Honors with Research Degree in Major or Minor						
	Major (Offered at Three-year UG Programme)			**Semester VII**	**Semester VIII**	
		Mandatory		8-10 (24+2 or *24*)	8-10 (24+2 or *24*)	20
		Elective		4	4	8
	Research Methodology (RM)			4	0	4
	Research Project (RP)			4	8	12
	Total			**22**	**22**	**44**
	Cumulative			**(132+44) 176**		

Teaching and Learning Scheme: for the Degree of Bachelor of Biochemistry as Major
Sant Gadge Baba Amravati University, Amravati
FACULTY: SCIENCE AND TECHNOLOGY
Teaching and Learning Scheme: for the Degree of Bachelor of Biochemistry as Major and as Minor
TLE Scheme for FIRST YEAR: SEMESTER – I (Biochemistry) (Level 4.5)

The Vertical	Type of Course	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
Major / Minor	Theory	103200	Biomolecules	2	2	30	9	20	6	50	20
	Lab/Practical	103201	Practicals in Basic Biochemistry	2	4	25	10	25	10	50	20
Minor / Major	Theory	-	-	2	2	30	9	20	6	50	20
	Lab/Practical	-	-	2	4	25	10	25	10	50	20
Generic/Open Elective	Theory	103202	Biochemistry in Health and Disease	2	2	30	9	20	6	50	20
	Theory	103203	Plant Biotechnology	2	2	30	9	20	6	50	20
VSC	-	-	-	-	-	-	-	50	20	50	20
SEC	Lab/Practical 3	103204	Application Based Practicals in Biochemistry	2	4	-	-	50	20	50	20
AEC - English	Theory		Refer University basket	1	1						
AEC –MIL	Theory		Refer University basket	1	1						
IKS-Generic	Theory		Refer University basket	2	2						
VEC	Theory		Refer University basket	2	2						
CC	Outdoor		Separate SOP will be released	2	4						
TOTAL				**22**	**30**						

TLE Scheme for FIRST YEAR: SEMESTER – II

The Vertical	Type of the Course	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
Major / Minor	Theory	103205	Biophysical and Biochemical techniques	2	2	30	9	20	6	50	20
	Lab/Practical	103206	Quantitative analysis of Biomolecules	2	4	30	9	20	6	50	20
Major / Minor	Theory		-	2	2	25	10	25	10	50	20
	Lab/Practical		-	2	4	30	9	20	6	50	20
Generic/ Open Elective	Theory	103207	Nutritional Biochemistry	2	2	25	10	25	10	50	20
	Theory	103208	Biochemical Toxicology	2	2	30	9	20	6	50	20
VSC	Lab/Practical	103209	Biochemical and Cell Biology Techniques	2	4	-	-	50	20	50	20
SEC	Lab/Practical	103210	Extraction , Separation and Purification of Biomolecules	2	4	-	-	50	20	50	20
AEC - English			Refer University basket	1	1	-	-	50	20	50	20
AEC –MIL			Refer University basket	1	1	-	-	50	20	50	20
VEC			Refer University basket	2	2						
CC			Separate SOP will be released	2	4						
TOTAL				**22**	**32**						

*** Important:**

- VSC Should be Complementary to Major/Minor
- SEC has to be selected from the Basket Provided by University, from the same Faculty/Discipline of the Major/Minor

TLE Scheme for SECOND YEAR: SEMESTER – III (Level 5.0)

Vertical	Type of the Course	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
Major	Major-T	103211	Metabolism I	2	2	30	9	20	6	50	20
Major	Major-T	103212	Metabolism II	2	2	30	9	20	6	50	20
Major	Major-P	103213	Practical Aspects in Metabolic Biochemistry	2	4	30	9	20	6	50	20
IKS	IKS-T	103214	IKS in Biochemistry	2	2	30	9	20	6	50	20
Minor	Minor-T	103215	Basic Metabolism	2	2	30	9	20	6	50	20
Minor-	Minor-P	103216	Practical Applications of Metabolism	2	4	25	10	25	10	50	20
GOEC	GOEC-T	103217	Human Reproductive health and Blood Components	2	2	30	9	20	6	50	20
VSC	VSC-P	103218	Metabolic Biochemistry in Laboratory Diagnostics	2	4	-	-	50	20	50	20
FP/CES	FP/CES	103219	(FP/ CEP in Biochemistry - I)	2	4	-	-	50	20	50	20
CC	CC			2	4	-	-	50	20	50	20

Important: * VSC Should be Complementary to Major ** SEC has to be selected from the Basket Provided by University, from the same Faculty/Discipline of the Major/Minor

LE Scheme for SECOND YEAR: SEMESTER – IV (Level 5.0)

Vertical	Type of the Course	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
Major	Major-T	103220	Basic enzymology	2	2	30	9	20	6	50	20
Major	Major-T	103221	Advanced enzymology	2	2	30	9	20	6	50	20
Major	Major-T *	103229	Endocrinology	2	2	30	9	20	6	50	20
Major	Major-P	103222	Enzyme Technology: Laboratory Methods	2	4	25	10	25	10	50	20
Minor	Minor-T	103223	General enzymology	2	2	30	9	20	6	50	20
Minor	Minor-P	103224	Practical enzymology	2	4	25	10	25	10	50	20
GOEC	GOEC-T	103225	Biochemistry of food Digestion	2	2	30	9	20	6	50	20
VSC	VSC-P	103226	Practicals in Applied Enzyme Technology	2	4	-	-	50	20	50	20
SEC	SEC-P#	103227	Techniques in isolation and characterization of enzymes	2	4	-	-	50	20	50	20
FP/CES	FP/CES	103228	(FP/ CEP in Biochemistry - II)	2	4	-	-	50	20	50	20
CC	CC			2	4	-	-	50	20	50	20

* To be implemented w.e.f. academic session 2026-27 # - Only applicable up to academic session 2025-26

Important:

- **VSC Should be Complementary to Major**
- **SEC has to be selected from the Basket Provided by University, from the same Faculty/Discipline of the Major/Minor**

TLE Scheme for THIRD YEAR: SEMESTER – V (Level 5.5)

Vertical	The Vertical	Course Code	Course Title	Credits	Workload	Theory/Practical Marks				Theory/Practical (Total) Marks	
						External		Internal			
						Max.	Min.	Max.	Min.	Max.	Min.
Major	Major-T	103230	Inheritance Biology	2	2	30	9	20	6	50	20
Major	Major-T	103231	Molecular Biology	2	2	30	9	20	6	50	20
Major	Major-T	103232	Biotechnology	2	2	30	9	20	6	50	20
Major	Major-P	103233	Laboratory Techniques in Genetics, Molecular Biology and Biotechnology	2	4	25	10	25	10	50	20
Major	Major-Elective T	103234	Fundamentals of Plant Biochemistry	2	2	30	9	20	6	50	20
	Major-Elective P	103235	Basic practicals in Plant Biochemistry	2	4	25	10	25	10	50	20
	OR										
	Major-Elective T	103236	Biostatistics and Bioinformatics	2	2	30	9	20	6	50	20
	Major-Elective P	103237	Basic practicals in Biostatistics and Bioinformatics	2	4	25	10	25	10	50	20
Minor	Minor-T	103238	Molecular Biology and Biotechnology	2	2	30	9	20	6	50	20
Minor	Minor-P	103239	Practicals in Molecular Biology and Biotechnology	2	4	25	10	25	10	50	20
VSC	VSC-P	103240	Applied Techniques in Biotechnology	2	4	-	-	50	20	50	20
SEC	SEC-P	103241	Analytical Techniques in Molecular Biology and Genetics	2	4	-	-	50	20	50	20
FP/CEP	FP/CEP	103242	(FP/ CEP in Biochemistry)	2	4	-	-	50	20	50	20
	Non-Credit	---	Foundation of Artificial intelligence	-	2			30+20	9+6	50	20

Important:

- **VSC Should be Complementary to Major**
- **SEC must be selected from the Basket Provided by University, from the same Faculty/Discipline of the Major/Minor**
- As per Sant Gadge Baba Amravati University, Amravati Extra-Ordinary Notification No. No. 241/2025 Dated 24/12/2025 “Foundation of Artificial Intelligence” is the Mandatory **Non Credit Course** compulsory course for all the UG students in fifth semester of all undergraduate programs of all faculties in Sant Gadge Baba Amravati University, Amravati to earn their degree
- NC is Non Credit Course

- Students must select **Any One** of the Major-Elective Courses (T1 to T2) with respective Practical Course in Semester V and **same shall be continued** for Semester VI

TLE Scheme for THIRD YEAR: SEMESTER – VI (Level 5.5)

Vertical	Type of the Course	Course Code	Course Title	Credits	Workload	Theory/Practical Marks				Theory/Practical (Total) Marks	
						External		Internal			
						Max.	Min.	Max.	Min.	Max.	Min.
Major	Major-T	103243	Fundamental Immunology	2	2	30	9	20	6	50	20
Major	Major-T	103244	Basic Clinical Biochemistry	2	2	30	9	20	6	50	20
Major	Major-T	103245	Cell Biology	2	2	30	9	20	6	50	20
Major	Major-P	103246	Integrated Immunology and Clinical biochemistry Laboratory	2	4	25	10	25	10	50	20
Major	Major-Elective T	103247	Introduction to Bacteriology and Microbial Biochemistry	2	2	30	9	20	6	50	20
	Major-Elective P	103248	Microbiological Techniques and Biochemical Analysis	2	4	25	10	25	10	50	20
	OR										
	Major-Elective T	103249	Nutritional Biochemistry	2	2	30	9	20	6	50	20
	Major-Elective P	103250	Biochemical Analysis and Food Chemistry Laboratory	2	4	25	10	25	10	50	20
Minor	Minor-T	103251	Immunology and Clinical Biochemistry	2	2	30	9	20	6	50	20
Minor	Minor-P	103252	Clinical Biochemistry and Immunology laboratory	2	4	30	9	20	6	50	20
VSC	VSC-P	103253	Analysis of Food Antinutritional Factors and Toxicants	2	4	-	-	50	20	50	20
Intern/Apprenticeship	Intern/Apprenticeship	103254	OJT (On the Job Training)	4	8	-	-	50	20	50	20

Important: VSC Should be Complementary to Major and SEC has to be selected from the Basket Provided by University, from the same Faculty/Discipline of the Major/Minor

SWAYAM/NPTEL Courses under NEP 2020

Sr. No.	Semester	Course Title	Course Code*	Credits**	Institution	Agency	Enrollment Ends	Link to Enroll
1	I	Biochemistry and Cell Biology	CEC26_CY12	4	School of Biotechnology, Devi Ahilya Vishwavidyalaya (DAVV), Indore	CEC	31 Aug 2026	https://onlinecourses.swayam2.ac.in/e-learning/preview/cec26_cy12
2	II	Analytical Techniques in Biochemistry	CEC26_CY11	4	AIIMS, New Delhi	NPTEL	31 Aug 2026	https://onlinecourses.swayam2.ac.in/e-learning/preview/cec26_cy11
3	III	Overview and integration of cellular metabolism	NOC26_CY71	3	IIT Kharagpur	NPTEL	27 Jul 2026	https://onlinecourses.nptel.ac.in/e-learning/preview/noc26_cy71
4	IV	Cell and Molecular Biology	NOC26_BT91	3	IIT Guwahati	NPTEL	27 Jul 2026	https://onlinecourses.nptel.ac.in/e-learning/preview/noc26_bt91
5	IV	Basic concepts in Enzymology	CEC26_CY08	4	St. Mary's College Thrissur	CEC	31 Aug 2026	https://onlinecourses.swayam2.ac.in/e-learning/preview/cec26_cy08
6	V	Molecular Biology and cell Signaling	INI26_HC09	4	Aligarh Muslim University	INI	31 Aug 2026	https://onlinecourses.swayam2.ac.in/e-learning/preview/ini26_hc09
7	VI	Immunology	NOC26_BT85	3	IIT Kharagpur	NPTEL	27 Jul 2026	https://onlinecourses.nptel.ac.in/e-learning/preview/noc26_bt85

* **Course codes may vary according to the year and session of enrollment**

** **Credits will be awarded as per provisions of the SWAYAM/NPTEL at the time of actual enrollment.**

Instructions for Enrollment in SWAYAM/NPTEL Courses under NEP 2020

All students of **B.Sc. with Biochemistry as Major or Minor** of all semesters are encouraged to enroll in suitable SWAYAM/NPTEL online courses to enhance their academic knowledge, practical skills, and employability.

General Instructions

1. Students may choose any course of their interest listed in table above for specific semester.
2. Before enrollment, students must ensure that they have an active Academic Bank of Credits (ABC) ID. The same ABC ID should be used while registering for the selected SWAYAM/NPTEL course so that earned credits can be deposited in the Academic Bank of Credits.
3. Students should carefully read the course details including duration, eligibility, syllabus, examination schedule, and credit structure before enrolling.
4. Merely enrolling in a course does not make a student eligible for academic credits. Students must: Complete the course requirements, appear for the proctored examination, and successfully pass the examination as per the norms prescribed by SWAYAM/NPTEL.
5. Credits will be awarded only after successful completion and certification of the course by the concerned agency.
6. Every student must submit the details of the enrolled course to the Department of Biochemistry immediately after registration.
7. Submission of enrollment details to the Department is mandatory to facilitate record maintenance and compliance with university requirements regarding credit transfer and academic documentation.
8. Students are advised to preserve all course-related documents, including Enrollment confirmation, Course progress records, Examination registration receipt, Score card, Final certificate.
9. Students shall be responsible for timely registration for the examination, payment of examination fees (if applicable), and completion of all course requirements within the stipulated period.
10. The Department of shall not be responsible for missed deadlines, incomplete registrations, examination non-appearance, or failure to satisfy the certification requirements of the concerned SWAYAM/NPTEL course.
11. After successful completion of the course, students must submit a copy of the course certificate and score card to the Department of Biochemistry for further processing and reporting to the University.

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 and re-entries.

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).

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/ 60	9/ 18	20/ 40	6/ 12	50/ 100	20/ 40	25/ 50	10/ 20	25/ 50	10/ 20	25/ 50	10/ 20
B	Minor		30/ 60	9/ 18	20/ 40	6/ 12	50/ 100	20/ 40	25/ 50	10/ 20	25/ 50	10/ 20	25/ 50	10/ 20
C	Generic/ Open Elective	Internal			50	20	50	20	--	--	50	20	50	20
D	VSC	Internal			50	20	50	20			50	20	50	20
	SEC	Internal	--	--	50	20	50	20			50	20	50	20
E	AEC(Eng. &One MIL Composite)	Internal			50	20	50	20						
	IKS(Generic)	Internal			50	20	50	20						
	VEC	Internal												
F	Internship/ Apprenticeship	Internal	Assessment of these verticals shall be based on various activities/practices. The evaluation/assessment shall be done by appointing external examiner by principal from Industry/ Organisation/ Academia. The mentor faculty shall be the internal examiner. It shall be evaluated by giving maximum 50 marks per 2 Credit Course with separate activity weightages/ levels. A detailed SOP for this assessment process shall be Prescribed separately.											
	FP/CEP													
	CC													

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.

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

iv. 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.

Conduction of the Examination:

As per the scheme of teaching, learning, examination and evaluation, theory/practical examinations of Semester-I, II, III, IV, V, VI, VII and VIII shall be conducted by the University (except for Internal Examinations as applicable) at the end of each semester.

The theory/practical examinations of all the Semesters shall be held as per the following Schedule

Sr. No.	Name of the Examination	End Sem Examination	Supplementary Examination*
1	Semester-I, III, V and VII	Winter	Summer
2	Semester-II, IV, VI and VIII	Summer	Winter

* The University may evolve mechanism for conducting repeat end semester examination. Such repeat examinations shall have to be conducted within one month of the regular even semester examination and on demand examination.

1. The practical examination of all semesters shall be conducted by the University at the end of each semester. The HEI shall conduct the Practical examination of odd semesters as per the schedule announced by the University. However, the appointment of the External and Internal Examiners shall be done by the Head or Principal of respective HEI to conduct external examination of the odd semester and the same should be communicated to the University before commencement of the practical examination. The University shall conduct the external practical examination of all even semester by appointing external and internal examiners.

2. The examinations specified above shall be held twice in a year at such places and on such dates as may be prescribed by the University.

3. An applicant to an examination specified above, shall pursue a regular course of study in courses prescribed for the examination concerned for not less than one semester in a particular semester in a College/Institute/University department.

4. Provided that the student shall be eligible to appear for examination if -

a) He/she complies with the provisions of the Ordinance pertaining to the Examination in general from time to time.

b) He/she has prosecuted a regular course of study in a university department/college affiliated to the University.

c) He/she has in the opinion of the Principles shown satisfactory progress in his/her studies.

5. The provisions of Ordinance No. 6 and Ordinance No. 9 shall be mutatis-mutandis applicable to every collegiate/non-collegiate student.

6. The fees for each theory examination and practical examination conducted by the university shall be as prescribed by the University, from time to time.

Santa Gadge Baba Amravati University, Amravati

FACULTY: Science and Technology

Teaching and learning scheme: For the Degree of Bachelor of Science

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

FIRST YEAR: SEMESTER-1

Vertical number	The vertical	Type of course	Course code	Course name
a.	Major Biochemistry 103	Theory 1	103200	Biomolecules
		Lab/ Practical I	103201	Practicals in basic Biochemistry
b.	Major/Minor	Theory 1	--	--
		Lab/ Practical I	--	--
c.	Generic/ Open elective 103	Theory 1	103202	Biochemistry in Health and Disease
		Theory 2	103203	Plant Biotechnology
	SEC	Lab/ Practical 3	103204	Application Based Practicals in Biochemistry
	AEC- English	Theory		
e.	AEC-MIL	Theory		
	IKS-Generic	Theory		
	VEC	Theory		
	CC	Outdoor		
	Total			

Course: B. Sc I Semester I (Biochemistry)

103200 Theory 1: Biomolecules I							
Level	**Sem**	**Course Code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Max Marks**
4.5	I	103200	Biomolecules	2	30	2 Hrs	30

Course Objectives:

- To gain knowledge of the structure of biomolecules, including proteins, nucleic acids, lipids, and carbohydrates.
- To learn about the chemical properties and reactions of biomolecules.
- To explore the functional roles of biomolecules in living organisms.

Course Outcome:

At the end of the course, students would be able to

- Understand Chemical structure, properties, types of classification and biological Importance of Carbohydrates.
- Differentiate between saturated and unsaturated fatty acids and suggest good quality edible Oil.
- Study physiochemical properties, types, classification and biological importance of Proteins.

Unit	Content	Hrs	Weightage of Marks Alloted
Unit-I Carbohydrates	a. Definition, classification, asymmetric carbon, optical isomerism, D & L isomerism, Epimerism, ring structure of pentoses & hexoses, ß anomers, mutarotation, b. Reactions of aldehyde, ketone groups & hydroxyl groups, amino sugars, deoxy sugars, types of glycosidic bonds, c. Structures, sources and functions of disaccharides and oligosaccharides. d. Structure and classification of polysaccharides, occurrence & biological importance of polysaccharides like starch, glycogen, cellulose & mucopolysaccharides like heparin, hyaluronic acids, chondroitin sulphates.	7	7

Unit-II Lipids	a. Definition and classification of Lipids Fatty acids: introduction, nomenclature, structure & properties of saturated & unsaturated fatty acids, omega fatty acids, cis & trans isomerism, positional isomerism. b. Triacylglycerols; nomenclature, structure & characterization of fats (hydrolysis, saponification value, acid value, rancidity of fats, iodine number) biological significance of fats. c. Structure & functions of lecithin's, cephalins, phosphoinositides & spingomyelins, glycolipids cerebrosides, gangliosides d. Steroids: Structure, properties & functions of ergosterol, cholesterol, bile acids	8	8
Unit-III Proteins	a. Definition, classification based on solubility, shape, composition & function. Amino acids: classification, structure & isomers of standard amino acids, Zwitter ionic structure and Pi, glucogenic & ketogenic amino acids, non proteinous amino acids (ornithine, citrulline & ß alanine) b. Peptides: structure of peptide bonds, important peptides (structure & functions of glutathione, oxytocin, vasopressin, bradykinin). c. Protein structure: Levels of protein structure, forces stabilizing the tertiary & quaternary structure of proteins. d. Denaturation & renaturation of proteins, salting in and salting out of proteins. Structure & biological functions of fibrous proteins (keratins, collagen, elastins) and globular proteins (haemoglobin & myoglobin)	7	7

Unit-IV Nucleic acids	a. Nucleic acids: Structure of nitrogenous bases, nucleosides, nucleotides, Structure of DNA- Watson Crick model, b. Tm of DNA, G+C content of DNA, Types of DNA- A, B & Z-DNA c. RNA-Primary structure, Types- m-RNA, t-RNA and r-RNA Denaturation & annealing of DNA, evidence that DNA is genetic material, gene, genome, chromosomes	8	8

References

1. Leininger's Principles of Biochemistry (2000) by- Nelson, Cox, M.M. Macmillan, New York. Fundamentals of Biochemistry (1999) by Donald Voet, Judith Voet, Charlotte Pratt, John Wiley & Sons, N.Y. 145 146
2. Biochemistry" by Jeremy M. Berg, John L. Tymoczko, and Lubert Stryer
3. Text Book of Biochemistry by Dr. O. P. Agrawal.
4. Text book of Biochemistry by S.M. Patil and A. B. Patil (NabhPrakashan)
5. Essentials of Biochemistry by Dr. M. C. Pant.
6. Text book of Biochemistry by West and Todd.
7. Practical manual in Biochemistry by Jairaman.
8. Text book of Biochemistry by Sucheta Dandekar.
9. Text book of Biochemistry by U. Sattyanarayan Fundamentals of Biochemistry by J.L. Jain

Model Questions

1. Short Answer Questions

Proteins:

1. Define the primary structure of a protein and its significance.
2. Explain the role of hydrogen bonds in protein folding.
3. How does denaturation affect the structure and function of proteins?
4. Give examples of fibrous protein.
5. Give examples of globular protein.
6. Give classes of amino acid.

Carbohydrates:

1. Define the terms monosaccharide, disaccharide, and polysaccharide.
2. Explain the role of carbohydrates in energy storage and structural support.
3. How are glycogen and starch similar, and how do they differ?
4. Give examples of monosaccharide
5. Give examples of disaccharide
6. What is the monosaccharide unit present in starch and glycogen
7. How many asymmetric carbon atoms are present in glucose
8. How many possible diastereomers are possible from glucose?
9. Define epimers
10. What are anomers? Give example.

Lipids:

1. Define saturated and unsaturated fats and their impact on health.
2. Describe the structure of a phospholipid and its role in cell membranes.
3. Explain the concept of amphipathic molecules in the context of lipids.

4. Name any four fatty acids
5. Define waxes
6. Name fat soluble vitamins.

Nucleic Acids:
1. What are the two types of nucleic acids in living organisms?
2. What is the function of DNA polymerase in DNA replication?
3. Which nucleotide base pairs with adenine in DNA?
4. What is the sugar component of RNA?
5. Define transcription in the context of nucleic acids.

2. Long Answer Questions

Carbohydrates:

1) Provide an in-depth analysis of the structure and function of carbohydrates.
2) Explain monosaccharides, disaccharides, and polysaccharides, and explain their roles in energy storage and cellular structure.
3) Define anomers? Give examples with structure
4) Discuss the concept of glycogen storage in animals.
5) How is glycogen synthesized and broken down, and how does it serve as a short-term energy reserve in the body?

Lipids:
1) Examine the structure and function of phospholipids in cell membranes.
2) How do phospholipids contribute to the fluidity and selective permeability of biological membranes?
3) Discuss the role of triglycerides in energy storage.
4) How are triglycerides mobilized during periods of energy demand, and what are the metabolic consequences of lipid breakdown?
5) Explore the concept of cholesterol in the human body.
6) What are the functions of cholesterol, and how does its level in the bloodstream impact cardiovascular health?
7) Explain the process of lipogenesis and its significance in the context of energy metabolism.
8) How is excess energy stored as lipids, and what factors regulate lipid synthesis?
9) Discuss the role of lipids in signaling pathways.
10) How do lipid-derived signaling molecules, such as prostaglandins, impact physiological processes in the body?

Proteins:
1) Provide a detailed overview of protein structure, including the levels of organization (primary, secondary, tertiary, and quaternary).
2) How does each level of protein structure contribute to the overall function of a protein?
3) Explore the concept of protein folding and the factors that influence protein stability.
4) How do chaperone proteins assist in the proper folding of newly synthesized polypeptides?
5) Examine the concept of protein denaturation.
6) What are the causes of protein denaturation, and how does it impact the structure and function of proteins?

Nucleic Acids:
1) Discuss in detail the structural differences between DNA and RNA
2) Explain the significance of structural features in the functions performed by DNA and RNA in the cell.
3) Draw structures of adenylate, guanylate, cytidylate

4) Draw and explain hydrogen bonding in nucleotides

3. Multiple choice question

1) Which nucleotide base is found in RNA but not in DNA?
A) Adenine
B) Thymine
C) Uracil
D) Cytosine

2) Which of the following is a monosaccharide?
A) Sucrose
B) Starch
C) Glucose
D) Cellulose

3) Which of the following stabilizes the secondary structure of proteins?
A) Disulfide bonds
B) Hydrophobic interactions
C) Peptide bonds
D) Ionic bonds

4) What is a common function of triglycerides in the body?
A) Enzyme catalysis
B) Long-term energy storage
C) Genetic information transmission
D) Cell structure support

5) What is the role of enzymes in biochemical reactions?
A) Store genetic information
B) Speed up chemical reactions
C) Provide structural support
D) Facilitate long-term energy storage

6) What is the quaternary structure of a protein?
A) Sequence of amino acids
B) Three-dimensional arrangement of a single polypeptide chain
C) Arrangement of multiple polypeptide chains
D) Simple protein folding pattern
7) What is a common structural feature of phospholipids?

The distribution of marks for the Internal Assessment shall be as follows:

Internal Assessment (Theory)	
Continuous Assessment Tests Three CAT each of 10 marks (MCQs) • Test 1 on completion of 25% syllabus of the course • Test 2 on completion of 50% syllabus of the course • Test 3 on completion of 75% syllabus of the course Total performance in CAT (i.e. 40%) shall be based on the best two out of three in CAT examinations	10 Marks
Any of the following assessment tools/methods Seminar, case study, field work, mini project work, quiz or any innovative method	10 Marks
Total	**20 Marks**

103202: Lab 1Practicals in Basic Biochemistry

Level	Semester	Course code	Course Name	Credits	Teaching Hours	Exam Duration	Maximum marks
4.5	I	103201	Lab1 : Practicals in Basic Biochemistry	2	60	2Hrs	50 (25+25)

Course Objectives:

- To familiarize students with basic laboratory equipment, safety protocols, and common techniques used in biochemistry experiments.
- To develop hands-on skills in performing fundamental biochemistry experiments, including pipetting, dilution, centrifugation, spectrophotometry
- To introduce students to the principles of experimental design, hypothesis formulation, and the planning of biochemistry experiments.

Course outcome: At the end of the course, students would be able to

1. Develop basic laboratory skills, including proper handling of equipment, pipetting, dilution techniques, and safety precautions.
2. Understand the principles of experimental design and be able to plan and execute simple biochemistry experiments.
3. Gain proficiency in fundamental biochemistry techniques
4. Recognize the practical applications of biochemistry in solving real-world problems related to health, medicine, and industry.

103202: Lab 1Practicals in Basic Biochemistry

1	Qualitative test for carbohydrates and Lipids
2	Qualitative test for amino acids, proteins and Nucleic acid
3	Estimation of sugar by anthrone method
4	Estimation of protein by Biuret method
5	Determination of Acid value of fat.
6	Determination of saponification number of oil.
7	Estimation of ascorbic acid by dye method
8	Estimation of Glycine by formal Titration

References:

1. Principles and Techniques of Biochemistry and Molecular Biology" by Keith Wilson and John Walker
2. Experimental Biochemistry" by William J. Thompson and Lynnelle K. A. Thompson
3. Biochemistry Laboratory: Modern Theory and Techniques" by Rodney F. Boyer
4. Biochemistry Laboratory: Manual For Students" by T. Satyanarayana and U. Chakrapani
5. Laboratory Techniques in Biochemistry and Molecular Biology" by Raphael Ikan
6. David plummer (2011) An introduction to practical biochemistry
7. Practical Biochemistry for Colleges" by A. C. Deb

The distribution of marks for the practical examination shall be as follows:

External Evaluation		Internal Evaluation based on CAT	
Performance of any two Experiments	20 M	Attendance & Students performance	10 M
Viva-voce	05 M	Practical Record Book	05 M
		MCQ/ Spotting (Best 2 out of 3)	10 M
Total	**25 M**	**Total**	**25 M**

GOEC							
Level	**Sem**	**Course Code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Max Marks**
4.5	I	103202	Biochemistry in Health and Disease	2	30	2 Hrs	30

103203 Open Elective 1: Biochemistry in Health and Disease

Course Objective:

- To investigate metabolic disorders, and understand the biochemical basis of these conditions.
- Discuss the relevance of biochemistry in public health, disease prevention, and healthcare practices.

Course Outcomes: Upon completion of the course, students would be able to

1. Understand the molecular mechanisms underlying various diseases, including genetic disorders, metabolic diseases, and cancer
2. Understand the molecular mechanisms of cancer and AIDS
3. Define and understand the concept of syndromes.

Unit System	Contents	Workload
Unit 1- Health and wellness	a. WHO definition of health, Health and hygiene, General health care, Factors affecting health b. Indices and evaluation of health, Disease patterns in developed and developing world c. Classification of diseases-Endemic, Epidemic, Pandemic; Professional health hazards. Disease conditions: Acute disease, chronic disease, Incurable disease, Terminal disease, Illness, disorders, Syndrome, Pre-disease. d. Treatment: Psychotherapy, Medications, Surgery, Medical devices, and Self-care. Dimensions of Health: Physical, Mental, Spiritual, Emotional, Environmental, and Philosophical.	8
UNIT–2 Diseases and disorders	a. Communicable diseases: Tuberculosis, Cholera, Typhoid, Conjunctivitis. b. Sexually transmitted diseases (STD): Information, statistics, and treatment guidelines for STD, Prevention c. Syphilis, Gonorrhea, AIDS. Non-communicable diseases: Malnutrition Undernutrition, Overnutrition d. Nutritional deficiencies; Anemia, Stroke, Rheumatic heart disease, Coronary heart disease, Cancer, blindness, accidents, mental illness	8
UNIT–3 Cancer and important syndrome	a. Cancer, blindness, Iodine deficiency, Fluorosis, Epilepsy,Asthma. b. Genetic disorders: Down's syndrome, Klinefelter's syndrome, c. Turner's syndrome, Thalassemia, Sickle cell anemia. d. Lifestyle disorders: Obesity, Liver cirrhosis, Diabetes mellitus, Hypertension (Causative agents, symptoms, diagnosis, treatment, prognosis, prevention)	7

UNIT– 4 Health and awareness	a. Preventing drug abuse, Oral health promotion by tobacco control. Mental hygiene and mental health: Concepts of mental hygiene and mental health, b. Characteristics of mentally healthy person, Warning signs of poor mental health, Promotive mental health, strategies and services c. Ego defense mechanisms and implications, Personal and social adjustments, Guidance and Counseling. d. Infection control: Nature of infection, Chain of infection transmission, Defenses against infection transmission	7

References:

1. Harper's Illustrated Biochemistry" by Victor W. Rodwell, David A. Bender, Kathleen M. Botham, Peter J. Kennelly, and P. Anthony Weil
2. Lehninger Principles of Biochemistry" by David L. Nelson and Michael M. CoxBiochemistry" by Lubert Stryer, Jeremy M. Berg, and John L. Tymoczko
3. Marks' Basic Medical Biochemistry" by Alisa Peet, Allan Marks, and Michael Lieberman
4. Medical Biochemistry" by John W. Baynes and Marek H. Dominiczak
5. Biochemistry: The Molecular Basis of Life" by Trudy McKee and James R. McKee
6. Biochemistry for Dummies" by John T. Moore and Richard H. Langley
7. Textbook of Biochemistry for Medical Students" by D. M. Vasudevan and S. Sreekumari
8. Clinical Biochemistry Made Ridiculously Simple" by Stephen Goldberg
9. Essential Biochemistry for Medicine" by Mitchell Fry and Harpal Singh Randeva

GOEC							
Level	**Sem**	**Course Code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Max Marks**
4.5	**I**	**103203**	**Plant Biotechnology**	**2 periods**	**30**	**2 Hrs**	**30**

103204 Open Elective 2 - Plant Biotechnology

Course objectives:

- To learn the principles and methods of plant tissue culture, including the regeneration of whole plants from cells and tissues.
- To explore the development of genetically modified plants with enhanced resistance to pathogens and pests through biotechnological interventions.

Course Outcomes:

Upon completion of the course, the student will be able to

1. Understand the biosynthesis of secondary metabolites in plants, such as alkaloids, flavonoids, and terpenoids.
2. Demonstrate a comprehensive understanding of concept plant metabolism and Plant tissue culture
3. Understand the role of stress-related hormones in plant responses.
4. Is then an experiment using plant tissue culture techniques including micropropagation somatic embryo genesis and protoplast isolation

5. Design experimental studies to understand metabolic pathways		
Unit systems	**Contents**	**Workload Allotted in hours**
Unit 1- Plant Metabolism	a. Equilibrium and concept of free energy, Coupled interconnecting reactions in metabolism, Types of metabolic pathways b. Overview of plant secondary metabolism- Main secondary metabolites, Functions of secondary metabolites c. Compartmentation of SMs biosynthesis- Cytosol, mitochondria vesicle d. Golgi bodies, endoplasmic reticulum	8
Unit 2- Plant tissue culture	a. Plant growth regulators b. Regeneration and micropropagation of plants, Clonal propagation, Organogenesis, shoot tip and meristem culture, Haploid culture, Protoplast culture, somaclonal variation c. Tissue culture and cell suspension culture system, methodology growth kinetics and nutrient optimization d. Plant transformation methods, harry root culture	7
Unit 3- Plant cell technology	a. Secondary metabolite production, Principal design and operation of reactor b. Isolation characterization and production of secondary metabolites from different plant cell types c. Enhancing cold hand heat stress tolerance, Secondary effect of abiotic stress, production of ROS, gens involved in scavenging of ROS d. Enhancing drought and salt stress tolerance	8
Unit 4- Genetically modified organisms	a. Plant biotechnology in improving fruit ripening and enhancing photosynthesis b. Golden Rice, Bt cotton, Bt brinjal, transgenic sweet potato c. Enhancing resistance against Fungal Pathogen, Antimicrobial proteins d. Enhanced viral resistance, pathogen derived resistance, Herbicide resistance	7
References:	1. Introduction to Plant Biochemistry" by P.M. Dey and J.B. Harborne 2. Plant Physiology and Biochemistry" by Eduardo Zeiger, Ian Max Møller, and Angus Murphy 3. Principles of Plant Biotechnology: An Introduction to Genetic Engineering in Plants" by H.S. Chawla 4. Plant Biotechnology: The Genetic Manipulation of Plants" by Adrian Slater, Nigel W. Scott, and Mark R. Fowler 5. Biotechnology of Plant Secondary Metabolism: Methods and Protocols" edited by R. Verpoorte 6. Plant Biotechnology: Recent Advancements and Developments" edited by M. Chakraborty and N.K. Srinivas	

	7. Genetic Engineering of Plants: An Agricultural Perspective" by T. A. Brown	

The distribution of marks for the Internal Assessment shall be as follows:

Internal Assessment (Theory)	
Continuous Assessment Tests Three CAT each of 10 marks (MCQs) • Test 1 on completion of 25% syllabus of the course • Test 2 on completion of 50% syllabus of the course • Test 3 on completion of 75% syllabus of the course Total performance in CAT (i.e. 40%) shall be based on the best two out of three in CAT examinations	10 Marks
Any of the following assessment tools/methods Seminar, case study, field work, mini project work, quiz or any innovative method	10 Marks
Total	20 Marks

Practical lab 3, Skill Enhancement Course (SEC) 103204 - Application Based Practicals in Biochemistry							
Level	**Semester**	**Course code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Maximum marks**
4.5	I	103204	Application Based Practical's in Biochemistry	2	60	2Hrs	50 (25+25)

Course Objectives:

- To develop fundamental laboratory skills, including accurate pipetting, dilution techniques, and sample preparation.
- To acquire skills in preparing and optimizing buffers for various biochemical assays and experiments.
- To gain proficiency in using common laboratory instruments and equipment used in biochemistry, such as spectrophotometers, centrifuges, pH meter.

Course outcome: At the end of the course, students would be able to.

1) Acquire the ability to prepare and optimize buffers suitable for various biochemical assays and experiments.
2) Measure pH accurately using a pH meter and adjust the pH of solutions with precision.
3) Demonstrate knowledge and practical experience in isolation of biomolecules
4) Apply spectrophotometric methods for the measurement of absorbance and the determination of λ_{max}

Sr. No.	**Title of the Practical**
1	Preparation of various buffer solution using Handerson Hasselbalch equation
2	Preparation of Normal, Molar and Percentage Solution
3	To determine p^H of sample by various methods
4	Comparison of Acid values of various oils
5	Determination of λ_{max} of at least two sugars
6	Isolation of caesin from milk
7	Isolation of total lipids from egg yolk
8	Isolation of starch from potato

References:

1) Principles of Biochemistry" by Donald Voet, Judith G. Voet, and Charlotte W. Pratt
2) Lehninger Principles of Biochemistry" by David L. Nelson and Michael M. Cox
3) Experimental Biochemistry" by William J. Thompson and Lynnelle K. A. Thompson
4) Biochemical Techniques" by Keith Wilson and John Walker
5) Biochemistry Laboratory: Modern Theory and Techniques" by Rodney F. Boyer
6) Biochemistry Laboratory Manual" by Rodney F. Boyer
7) Practical Skills in Biomolecular Science" by Rob Reed, David Holmes, and Jonathan Weyers
8) Experimental Biochemistry: A Hands-on Approach" by Shawn O. Farrell and Lynn E. Taylor
9) Laboratory Techniques in Biochemistry and Molecular Biology" series by Raphael Ikan

Internal Evaluation for SEC	
Attendance	10 M
Practical Performance	20 M
MCQ/Spotting	10 M
Practical Record book	10 M
Total	**50 M**

Sant Gadge Baba Amravati University, Amravati

Teaching and Learning Scheme: for the Degree of Bachelor of Science (Three Years- Six Semesters Bachelor's Degree Programme)

Programme : B.Sc. (Biochemistry)
Course: B.Sc I Semester II

Vertical No.	The Vertical	Type of Course	Course Code	Course Name
a.	Major Biochemistry 103	Theory-3	103205	Biophysical and Biochemical techniques
		Lab/Practical-4	103206	Quantitative analysis of Biomolecules
	Major /Minor	Theory-3	--	--
		Lab/Practical-4	--	--
b.	Generic/ Open Elective 103	Theory 5	103207	Nutritional Biochemistry
		Theory 6	103208	Biochemical Toxicology
c.	VSC	Lab/Practical-5	103209	Biochemical and Cell Biology Techniques
	SEC	Lab/Practical-6	103210	Extraction, Separation and Purification of Biomolecules
d.	AEC - English	Theory		
	AEC –MIL	Theory		
	IKS-Generic	Theory		
	VEC	Theory		
e.	CC	Outdoor		
	TOTAL			

NEP Syllabus
UG Programme

Programme: B.Sc. (Biochemistry)

Course: B.Sc I Semester II

103207- Biophysical and Biochemical techniques							
Level	**Semester**	**Course code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Max marks**
4.5	II	103205	Biophysical and Biochemical techniques	2	30	2Hrs	30

Course Objective	The objective of the course is to introduce different biophysical techniques to students that are used in biological research for separation, purification and identification from mixture of biomolecules. The emphasis is also on experimental skills in the form of practical exercises so that students can apply this knowledge to improve their understanding of the subject for better utilization of these techniques in research and will also help in their placement.
Course outcomes	After the completion of the course: • Students will acquire knowledge about the principles and applications of separation and purification techniques like centrifugation and chromatography used in a biochemistry laboratory. • Students will learn about the principles and applications of electrophoresis and spectroscopic techniques involved in estimation and identification of biomolecules. • It will also give them an opportunity to get hands-on experience to develop their experimental skills which are required for biological research lab.

Unit	Content	Workload Allotted in Hours	Weightage of Marks Allotted	Pedagogy
Unit-I Chromatography	General Principles & applications of: a. Adsorption chromatography, Ion Exchange chromatography. Molecular sieve, b. Gas liquid chromatography. HPLC, c. Affinity chromatography, Paper chromatography, Thin layer chromatography.	8	8	Chalk and board Power point presentation, Videos, Animation etc.
Unit-II Electrophoresis	Protein and nucleic acid Separations: a. PAGE, Non- denaturing PAGE Nonreducing, SDS-PAGE. 2–D electrophoresis, Preparation of pH gradient gel. b. Procedure of preparation of polyacrylamide gels, importance of buffers in electrophoretic separations, importance of stacking and resolving gels, use of denaturing agents and reducing agents in electrophoresis. Applications of electrophoretic techniques in disease diagnosis. c. Staining techniques- Coomassie staining, PAS staining, silver staining, fluorescent dye staining, d. Submerged gel electrophoresis for the separation of nucleic acids. Nucleic acid staining techniques. Western, southern & northern blotting techniques.	7	7	Chalk and board Power point presentation, Videos, Animation etc

Unit-III Spectroscopic techniques:	a. Beers Lamberts law, Light absorption & its transmittance, determination & application of extinction coefficient b. Principles & application of visible & UV spectroscopic techniques. c. Principles & application of NMR, ESR, d. Principles & application of Mass spectroscopy, Fluorometry& flame photometry.	8	8	Chalk and board Power point presentation, Videos, Animation etc
Unit-IV Microscopy and Centrifugation	a. Microscopy: Different types of microscopes – electron microscopes – TEM, SEM. Fluorescence and confocal microscopes used in fine structure b. Centrifugation Techniques: Introduction, basic principles, and applications of sedimentation. Centrifuges and their use c. small bench centrifuges, large capacity refrigerated centrifuges, high speed refrigerated centrifuges, d. Continuous flow centrifuges, Preparative ultra- centrifuges, analytical ultracentrifuges, and density gradient centrifugation.	7	7	Chalk and board Power point presentation, Videos, Animation etc

References	• Wilson, K. & Walker J. (2010). Principles and Techniques of Biochemistry and Molecular Biology, (7th ed.), Cambridge University Press; ISBN 978-0-521-51635-8. • Boyer, R. F. (2012). Biochemistry Laboratory: Modern Theory and Techniques, (6th ed.), Boston, Mass: Prentice Hall; ISBN-13: 978-0136043027. 9 • Plummer, D. T. (1998). An Introduction to Practical Biochemistry (Yd ed.), Tata McGraw Hill Education Pvt. Ltd. (New Delhi); ISBN: 13: 978-0-07-099487-4 / ISBN:10: 0-07-099487-0 • Cooper, T.G. (2011). The Tools of Biochemistry (2nd · ed.), Wiley-Interscience Publication (New Delhi); ISBN: 13:9788126530168. • Lehinger's Principles of Biochemistry (2000) by- Nelson, Cox, M. M. Macmillan, New York. • Biochemistry 3rd edition (1994) by Lubert Stryer WH Freeman and Co. San Francisco. • Outline of biochemistry (1987), Conn, Stumpf, Bruencing, Doi, JohnWiley & Sons, N.Y. • Text book of Biochemistry by West and Todd. • Practical manual in Biochemistry by Jairaman. • Physical Biochemistry (2nd Ed. 1985) by Vantolde K.E., Prentice Hall, INC, New Delhi. • Biophysical chemistry by Upadhyay, Upadhyay and Nath. • Chromatography: A Laboratory handbook of chromatography and Electrophoretic Methods (III 1975), BY Erich Haffman, Van Nostrand Reinhold, NY. • Fundamentals of Biochemistry (1999) by Donald Voet, Judith Voet,Charlotte Pratt, John Wiley & Sons,

Model Questions	**Long Questions:** 1. Discuss the diverse applications of chromatography in various scientific fields. 2. Elaborate on the principles of electrophoresis and its applications in molecular biology. 3. Discuss the applications of spectroscopy in the analysis of biomolecules. 4. Discuss the advantages and limitations of electron microscopy compared to light microscopy. **Short Questions** 1. Briefly describe the key differences between gas chromatography and liquid chromatography. 2. Briefly explain the procedure of Polyacrylamide Gel Electrophoresis (PAGE). 3. Why is maintaining a specific pH crucial in electrophoretic separations? 4. What information can be obtained by analyzing a UV-Visible absorption spectrum? 5. Briefly describe the principles of NMR spectroscopy. 6. Explain the principles of density gradient centrifugation. 7. Briefly describe the basic principles of analytical ultracentrifugation. 8. What is the role of the stationary phase in adsorption chromatography?
	Multiple Choice questions 1. In adsorption chromatography, separation is based on: a. Charge differences b. Affinity interactions c. Size exclusion d. Adsorption 2. What distinguishes HPLC from traditional liquid chromatography? a. Higher pressure conditions b. Slower flow rates c. Lower resolution d. Limited sample volume 3. What is a key difference between gel electrophoresis and capillary

	electrophoresis? a. Presence of a gel matrix b. Speed of separation c. Dependence on voltage d. Use of a buffer system 4. In DNA electrophoresis, which direction do the DNA fragments migrate? a. Towards the anode (positive electrode) b. Towards the cathode (negative electrode) c. Towards the center of the gel d. Randomly in both directions 5. What is the primary advantage of using fluorescence spectroscopy in biomolecular studies? a. High cost-effectiveness b. Low sensitivity c. High sensitivity and selectivity d. Limited wavelength range 6. In mass spectrometry, what is being measured to determine the mass-to-charge ratio? e. Mass and charge separately f. Only mass g. Only charge h. Molecular weight 7. What is the primary advantage of TEM over scanning electron microscopy (SEM)? a. Higher resolution b. Faster imaging c. Three d. Greater depth of field 8. In continuous flow centrifuges, how is the separation achieved? a. Based on density differences b. Based on charge differences c. Based on molecular size d. Based on magnetic properties

The distribution of marks for the continues assessment test (CAT) shall be as follows:

<table>
<tr><th colspan="3">Internal Assessment (Theory) for 20 marks</th></tr>
<tr><td>MCQ Test 1 base on 25% syllabus</td><td rowspan="3">Consider best 2 out of 3 test
(Total performance is not less 40%)</td><td rowspan="3">10 Marks</td></tr>
<tr><td>MCQ Test 2 base on 50% syllabus</td></tr>
<tr><td>MCQ Test 3 base on 75% syllabus</td></tr>
<tr><td colspan="2">Assignments /Innovative activities /GD/Seminar/ Poster presentation, quiz etc
(any two activity 5 mark each)</td><td>10 Marks</td></tr>
<tr><td colspan="2">Total</td><td>20 Marks</td></tr>
</table>

103209 Lab Practical : 4 Quantitative analysis of Biomolecules (103209)							
Level	**Semester**	**Course code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Maximum marks**
4.5	II	103206	**Quantitative analysis of Biomolecules**	2	30	2Hrs	50 (25+25)
Course Objective	The primary objective of this practical course is to equip students with fundamental laboratory skills and theoretical knowledge in quantitative biochemistry through hands-on analytical techniques. Students will explore the principles of spectrophotometry and colorimetry by verifying Beer-Lambert's law, creating standard calibration curves, and mastering the operation of analytical instruments. Additionally, the course aims to deepen understanding of the specific chemical principles and color-developing reactions used to isolate and quantify essential biomolecules—including proteins (Lowry and Bradford methods), nucleic acids (DNA via Diphenylamine, RNA via Orcinol), lipids (Cholesterol via Zak's method), carbohydrates (Total Sugars), and plant pigments (beta-carotene).						
Course Outcomes:	Upon successful completion of this course, students will be able to competently execute key biochemical quantification assays and independently interpret experimental data. They will demonstrate the practical ability to apply Beer-Lambert's law to verify instrumental linearity, prepare accurate standard solutions, and construct calibration curves to calculate unknown concentrations. Furthermore, students will be capable of selecting and performing the appropriate analytical methods to precisely quantify proteins, distinct nucleic acids, total sugars, lipids, and plant pigments from diverse biological samples, while maintaining proper laboratory safety, precision, and data troubleshooting skills.						

Sr No.	Content of Practical (List of Laboratory Experiments/ Activities etc.)
1	Estimation of Protein by Lowry Method
2	Quantification of DNA by Diphenylamine Method
3	Determination of RNA By Orcinol Method
4	Estimation of Cholesterol by Zak's Method
5	Estimation of β- carotene in carrots
6	Determination of Protein Concentration by Bradford Method
7	Estimation of Total Sugar by Phenol Sulfuric Acid method
8	Verification of Beers law.

References	• Wilson, K. & Walker J. (2010). Principles and Techniques of Biochemistry and Molecular Biology, (7th ed.), Cambridge University Press; ISBN 978-0-521-51635-8. • Boyer, R. F. (2012). Biochemistry Laboratory: Modern Theory and Techniques, (6th ed.), Boston, Mass: Prentice Hall; ISBN-13: 978-0136043027. 9 • Plummer, D. T. (1998). An Introduction to Practical Biochemistry (Yd ed.), Tata McGraw Hill Education Pvt. Ltd. (New Delhi); ISBN: 13: 978-0-07-099487-4 / ISBN:10: 0-07-099487-0 • Cooper, T.G. (2011). The Tools of Biochemistry (2nd · ed.), Wiley-Interscience Publication (New Delhi); ISBN: 13:9788126530168. • Practical manual in Biochemistry by Jairaman. • Chromatography: A Laboratory handbook of chromatography and Electrophoretic Methods (III 1975), BY Erich Haffman, Van Nostrand Reinhold, NY.

The distribution of marks for the practical examination shall be as follows:

External Evaluation		**Internal Evaluation base on CAT**	
Performance of any two	20 marks	Attendance & students' performance	05 Marks
Viva-voce	05 marks	Practical Record book	05 Marks
		MCQ/ Spotting (Consider best 2 out of 3 test)	10 Marks
Total	25 Marks	**Total**	25 Marks

Level	Semester	Course code	Course Name	Credits	Teaching Hours	Exam Duration	Maximum marks
4.5	**II**	**103207**	**Nutritional Biochemistry**	**2**	**30**	**2Hrs**	**30**

Course Objective	The objective of the course is to provide the knowledge regarding nutritional value of food ingredients, nutrition associated problems, balanced diet for human health and certain nutritional biochemical aspects to students. The students can apply the basic knowledge of nutrition to overcome nutritional deficiency of various foods at commercial level by fortification. The better understanding of this subject helpful for students in their placements and research field.
Course outcomes:	• Knowledge about energy requirements and the Recommended Dietary Allowances • Understanding the functions and role of macronutrients, their requirements and the effect of deficiency and excess • Understand the impact of various functional foods on our health • To be able to apply basic nutrition knowledge in making foods choices and obtaining an adequate diet. • Competence in connecting the role of various nutrients in maintaining health and learn to enhance traditional recipes.

Unit	**Content**	**Workload Allotted in hours**	**Weightage Of Marks Allotted**	**Pedagogy**
UNIT–1 Basic concepts of Nutrition	• Introduction, Basic principles of a balanced diet to provide energy and nutrients. • Composition of foods and proximate analysis of foods. Calorific value of foods and Basal metabolism.	8	8	Chalk and board Power point presentation, Videos, Animation etc

	• Basal Metabolic Rate (BMR), Factors affecting BMR, Energy requirements for different physical activities, Specific dynamic action of food, • Nutritive value of proteins. Energy requirements and recommended dietary allowance (RDA) for infants, children, and pregnant women. Protein calorie malnutrition.			
UNIT–2 Macronutrients and Micronutrients	• Carbohydrates-Digestible and non-digestible, Dietary fibres, Essential fatty acids, lipoproteins and cholesterol. Essential amino acids, Fortification of foods, Protein requirement for different categories. • Vitamins: Sources, requirements, functions and deficiency symptoms of Vitamin-C, Thiamine, Riboflavin, Pyridoxine, Folic acid, Vitamin B12. • Absorption of fat-soluble vitamins- A, D, E and K. • Micronutrients: Source, Daily requirement, functions and deficiency disease symptoms of Macrominerals (Ca, P, and Cl) and microminerals/trace elements (I, Fe, Zn and Se).	**7**	**7**	Chalk and board Power point presentation, Videos, Animation etc
UNIT-3 Dietetics	• Food pyramid; Diet planning and introduction to diet therapy. • Nutritional requirements for different age groups, anaemic child, expectant women, and lactating women.	8	8	Chalk and board Power point presentation,

	• Diet planning for prevention and cure of nutritional deficiency disorders. • Diet therapy: Functional foods, Anthropometric measurements,			Videos, Animation etc
Unit-4 Diet Therapy	• Dietary considerations during fever, malaria, and tuberculosis. • Prevention and correction of obesity, underweight, and metabolic diseases by diet therapy. • Dietary interventions to correct and/or manage the gastro-intestinal diseases (indigestion, peptic ulcer, constipation, diarrhoea, steatorrhoea, irritable bowel syndrome. • Functional food-based diet therapy for diabetes, cardiovascular disease and cancer.	**7**	**7**	Chalk and board Power point presentation, Videos, Animation etc
References	1. Clinical Dietetics and Nutrition, 2002, 4 th Edition, Antia FP and Abraham P, Oxford University Press; ISBN-10: 9780195664157. 2. Oxford Handbook of Nutrition and Dietetics, 2011, Webster-Gandy J, Madden A and Holdsworth M. Oxford University Press, Print ISBN13:9780199585823. 3. Krause's Food, Nutrition and Diet therapy, 2003, Mahan KL and Escott-Stump S., Elsevier, ISBN: 9780721697840. 4. Human Nutrition and Dietitics.1986, Passmore R. and Davidson S. Churchill Livingstone Publications, ISBN-10: 0443024863. 5. Rosemary Stanton's Complete Book of Food & Nutrition, 2007, Simon & Schuster Publishers, Australia, ISBN 10: 0731812999 6. Food Science and Nutrition, 2018, RodayS.Oxford University Press Publishers, ISBN: 9780199489084/0199489084. 7. Food Science, 2007, Srilakshmi S. New Age International (P) Limited Publishers, ISBN: 9788122420227/ 8122420222.			
Model Questions	**Long Question:** 1. Discuss the importance of nutrition in maintaining overall health. 2. Explain the role of macronutrients and micronutrients in the human diet. 3. Discuss the principles of planning balanced and nutritious diets			

4. Explore the principles and applications of diet therapy in the management of various health conditions.

Short Questions:

1. What are the essential nutritional requirements for human health?
2. Describe the processes of digestion and absorption in the context of nutrition.
3. Provide examples of protein-rich food sources.
4. Discuss the consequences of iron deficiency and its prevalence.
5. What are dietary guidelines, and why are they important?
6. Explain the role of a dietitian in promoting health and preventing nutrition-related disorders.
7. Explain the significance of nutritional support in critical care settings.
8. Highlight the importance of tailoring diets to individual health needs.

MCQs:

1. The primary unit of measurement for energy derived from food is:
   a. Gram
   b. Calorie
   c. Liter
   d. Milligram

2. Macronutrients include:
   a. Vitamins and minerals
   b. Proteins, fats, and carbohydrates
   c. Water and fiber
   d. Antioxidants

3. Carbohydrates are primarily responsible for:
   a. Providing structural support
   b. Energy storage
   c. Facilitating enzyme reactions
   d. Enhancing immune function

4. Which food is a rich source of vitamin C?
   a. Milk
   b. Meat
   c. Oranges
   d. Nuts

5. The term "meal planning" in dietetics refers to:
   a. Selecting random foods for consumption
   b. Planning meals to meet nutritional needs

	c. Avoiding all snacks d. Fasting for an entire day 6. Dietitians often engage in: a. Selling nutritional supplements b. Providing nutritional counseling c. Performing surgical procedures d. Conducting medical research 7. Enteral nutrition involves: a. Oral intake of regular food b. Parenteral administration of nutrients c. Intravenous infusion of liquids d. Tube feeding directly into the digestive tract 8. In diet therapy, the primary role of a dietitian is to: a. Prescribe medications b. Conduct surgical procedures c. Provide nutritional counseling d. Manage patient records

Level	Semester	Course code	Course Name	Credits	Teaching Hours	Exam Duration	Maximum marks
4.5	**II**	**103208**	**Biochemical Toxicology**	**2**	**30**	**2Hrs**	**30**

Course Objectives	To acquire knowledge, understand and develop an understanding of the kinds of toxicant interactions, their impact on human health.
Course Outcomes	After completion of this course students will be able to • Understand different types of toxins their biological process and effects on various organs/ systems of the human body • Be aware of dose absorption, excretion of the toxic components • Understand impact of toxin on renal, liver, neural systems

	• Identify underlying susceptibility factors which contribute to the ability of chemicals to elicit bio effects which contribute to human disease.

Open Elective –Biochemical Toxicology				
Unit	**Content**	**Workload Allotted in hours**	**Weightage Of Marks Allotted**	**Pedagogy**
UNIT 1 Definition and Scope of Toxicology	• Definition and Scope of Toxicology: Dose-response relationship, synergism and antagonism, determination of ED_{50} & LD50, acute and chronic exposure; clinical signs of systemic toxicity, • Toxicity Influencing factors Xenobiotic metabolism: absorption & distribution, • Phase I reactions; oxidation, reduction, hydrolysis and hydration; • Phase II reactions/conjugation; Glucouronidation, Sulfation, Acetylation, methylation, glutathione and amino acid conjugations, detoxification.	8	8	Chalk and board Power point presentation, Videos, Animation etc
Unit-II Biochemical basis of toxicity	• Biochemical basis of toxicity: Chemical Nature of Toxicants; Biochemical and Genetic mechanism of toxicity, • Biochemistry of Mutagenesis, Biochemsitry of Carcinogenesis; Genetic Susceptibility to Toxicants; Toxic response in Skin, Liver; Cardiovascular system; Endocrine system; Nervous system; Reproduction system; Kidney and Bladder. • Toxicity testing: genetic toxicity testing & mutagenesis assays - bacterial mutation tests, reversion test, ames test and fluctuation tests; • In vivo mammalian mutation tests-host mediated assay & dominant lethal test	7	7	Chalk and board Power point presentation, Videos, Animation etc

Unit-III Pesticide toxicity	• Pesticide toxicity: Insecticides and their classification, mode of action, Insecticides- anti- cholinesterases insecticides, • Role of biopesticides in environmental management. • Metal & Metalloid toxicity: Toxicity of Arsenic, Mercury, Lead, Chromium and Cadmium • Toxic natural products: Mycotoxins; Toxic Substance of Plant; Insect Toxins; Spider Toxins Reptile Toxins & Non reptile Toxins.	8	8	Chalk and board Power point presentation, Videos, Animation etc
Unit-IV Toxic Synthetic and Natural chemicals	• Toxic organic Compounds: toxicity of alkanes; toxicity of unsaturated non aromatic compunds; • Toxicity of Benzene, Naphthalene. Toxic organooxygen Compounds: Toxicity of alcohals, • Toxicity of Phenol, Formaldehyde, Carboxylic acids, Ethers, Acid Anhydrides, Esters • Food toxicology: Role of diet in cardio-vascular diseases and cancer; Toxicology of various types of food additives,	7	7	Chalk and board Power point presentation, Videos, Animation etc
References	1. General and applied toxicology, 1995 by Marrs and Turner Macmillan Press Ltd 2. Basic environmental toxicology 1994 by Lorris G. Corkerhem and Barbara SS Shane CRP Press Inc. 3. Introduction to food technology Takayurki Shibamato & leonard F. Bzeldaanes 4. A textbook of Modern Toxicology 3rd Edition 2004 by Ernest Hodgson 5. Casarett and Doull's Toxicology 7th Edition 2008 By Curtis D. Klaassen 6. Molecular biotechnology 2nd Ed 1994 by Barnard R Glick & JJ Pasternak			
Model Questions	**Long Question:** 1. Discuss the broad scope of toxicology, including its sub-disciplines and applications. 2. Discuss the mechanisms of action of toxic substances at the biochemical level. 3. Discuss the impact of pesticides on human health and the environment.			

4. Discuss factors influencing the perception of toxicity in different chemical sources.

Short Questions:

1. Why is toxicology important in the field of public health?
2. Differentiate between Toxicity vs. Hazard
3. What is enzyme inhibition in the context of biochemical toxicity?
4. Define oxidative stress and its role in toxicity.
5. What is bioaccumulation, and how does it relate to pesticide toxicity?
6. Compare the toxicity of synthetic and natural chemicals.
7. Briefly explain the potential health risks associated with these chemicals.
8. Explain how even natural compounds can pose health risks.

MCQs:

1. The scope of toxicology includes the study of:
   a. Environmental sustainability
   b. Adverse effects of chemicals on living organisms
   c. Astrophysics
   d. Social psychology

2. What is a primary role of a toxicologist?
   a. Studying celestial bodies
   b. Analyzing market trends
   c. Assessing the effects of chemicals on biological systems
   d. Developing computer software

3. The metabolic activation of certain chemicals can:
   a. Reduce toxicity
   b. Increase toxicity
   c. Have no effect on toxicity
   d. Affect only plants

4. Toxicants may target:
   a. Only the nervous system
   b. Specific biochemical pathways or molecules
   c. Exclusively water-soluble compounds

	d. Inanimate objects 5. Integrated Pest Management involves: a. The use of only chemical pesticides b. Comprehensive strategies combining biological, cultural, and chemical controls c. Ignoring the impact on non-target organisms d. Exclusive reliance on genetically modified crops 6. Chronic pesticide exposure refers to: a. Short-term exposure with immediate effects b. Long-term exposure over an extended period c. Exposure only to airborne pesticides d. Exposure limited to specific seasons 7. Generally, biodegradable chemicals are: a. Less toxic b. More toxic c. Neither more nor less toxic d. Only present in natural substances 8. Risk assessment of chemicals involves: a. Only considering synthetic chemicals b. Evaluating potential hazards and exposures c. Ignoring natural chemical risks d. Focusing solely on acute toxicity

The distribution of marks for the Internal Assessment shall be as follows:

Internal Assessment (Theory)	
Continuous Assessment Tests Three CAT each of 10 marks (MCQs) • Test 1 on completion of 25% syllabus of the course • Test 2 on completion of 50% syllabus of the course • Test 3 on completion of 75% syllabus of the course Total performance in CAT (i.e. 40%) shall be based on the best two out of three in CAT examinations	10 Marks
Any of the following assessment tools/methods Seminar, case study, field work, mini project work, quiz or any innovative method	10 Marks
Total	20 Marks

103213 VSC -Lab Practical 5: Biochemical and Cell Biology Techniques (103213) List of Laboratory Experiments/Activities etc.							
Level	**Semester**	**Course code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Maximum marks**
4.5	II	103209	**Biochemical and Cell Biology Techniques**	2	30	2Hrs	50

Course Objective	The objective of the course is to provide vocational training of different biochemical and biophysical techniques to students that are used for isolation, separation and study of various properties of biomolecules. The emphasis is also on experimental skills in the form of practical exercises so that students can apply this knowledge to improve their understanding of the subject for better utilization of these techniques in research and will also help in their placement.
Course Outcomes:	After Completion of this course students will be able to • Separate serum and plasma from whole blood using centrifugation • Perform Mitosis investigation in onion root tip • Visualize Mitochondria, animal and plant cell under microscope • Organic Solvent and ammonium sulfate fractionation of protein • Isolate starch, egg albumin and cellulose

Sr.No.	**List of Laboratory Experiments/Activities etc.**
1.	Efficient Blood Component Separation: Centrifugation
2.	Mitosis Investigation in Onion Root Tips
3.	Isolation and ammonium salt fractionations of proteins from plant tissues.
4	Extraction and solvent precipitation of proteins from plant tissues.
5	Isolation of Egg Albumin
6	Visualization of animal and plant cell by methylene blue
7	Isolation of starch from tubers/roots/cereals.

References	• Wilson, K. & Walker J. (2010). Principles and Techniques of Biochemistry and Molecular Biology, (7th ed.), Cambridge University Press; ISBN 978-0-521-51635-8. • Boyer, R. F. (2012). Biochemistry Laboratory: Modern Theory and Techniques, (6th ed.), Boston, Mass: Prentice Hall; ISBN-13: 978-0136043027. 9 • Plummer, D. T. (1998). An Introduction to Practical Biochemistry (Yd ed.), Tata McGraw Hill Education Pvt. Ltd. (New Delhi); ISBN: 13: 978-0-07-099487-4 / ISBN:10: 0-07-099487-0 • Cooper, T.G. (2011). The Tools of Biochemistry (2nd · ed.), Wiley-Interscience Publication (New Delhi); ISBN: 13:9788126530168. • Practical manual in Biochemistry by Jairaman. • Chromatography: A Laboratory handbook of chromatography and Electrophoretic Methods (III 1975), BY Erich Haffman, Van Nostrand Reinhold, NY.

Internal Evaluation for VSC	
Attendance	05 Marks
Practical performance	20 Marks
Project based on practical	10 Marks
MCQ/ Spotting	10 Marks
Practical Record book	05 Marks
Total	**50 Marks**

103214 SEC : Lab Practical 6: Extraction, Separation and Purification of Biomolecules							
Level	**Semester**	**Course code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Maximum marks**
4.5	II	103210	**Extraction, Separation and Purification of biomolecules**	2	60	2 Hrs	50

Course Objective	The objective of the course is to provide skills of biochemical and biophysical techniques to students that are used for separation and characterization of biomolecules.
Course Outcomes:	After Completion of this course students will be able to • Separate plant pigments using chromatography • Separate proteins using electrophoresis • Separate amino acids, sugars, proteins. Lipids using chromatographical techniques

Sr No	**List of Laboratory Experiments/Activities etc.**
1	Chromatographic Separation: Plant Pigment Analysis
2	Separation of amino acids by paper chromatography.
3	Separation of sugars by paper chromatography.
4	Separation of amino acids by thin layer chromatography.
5	Preparation of cation and anion exchanger column for protein purification.
6	Separation of sugars by silica gel thin layer chromatography.
7	Preparations of various mesh size silica gel column and separation of plant pigments.

References	• Wilson, K. & Walker J. (2010). Principles and Techniques of Biochemistry and Molecular Biology, (7th ed.), Cambridge University Press; ISBN 978-0-521-51635-8. • Boyer, R. F. (2012). Biochemistry Laboratory: Modern Theory and Techniques, (6th ed.), Boston, Mass: Prentice Hall; ISBN-13: 978-0136043027. 9 • Plummer, D. T. (1998). An Introduction to Practical Biochemistry (Yd ed.), Tata McGraw Hill Education Pvt. Ltd. (New Delhi); ISBN: 13: 978-0-07-099487-4 / ISBN:10: 0-07-099487-0 • Cooper, T.G. (2011). The Tools of Biochemistry (2nd · ed.), Wiley-Interscience Publication (New Delhi); ISBN: 13:9788126530168. • Practical manual in Biochemistry by Jairaman. • Chromatography: A Laboratory handbook of chromatography and Electrophoretic Methods (III 1975), BY Erich Haffman, Van Nostrand Reinhold, NY.

Internal Evaluation for SEC	
Attendance	05 Marks
Practical performance	20 Marks
Project based on practical	10 Marks
MCQ/ Spotting	10 Marks
Practical Record book	05 Marks
Total	**50 Marks**

Sant Gadge Baba Amravati University, Amravati

Teaching and Learning Scheme for the Degree of Bachelor of Science

(Three Years Six Semesters Bachelor's Degree Programme)

Programme: B. Sc. (Biochemistry)

Course: B. Sc II Semester III

Mode of Teaching	Vertical No.	The Vertical	Type of Course	Course Code	Course Name
Classroom Teaching/Lab Work (Practical)/ Outdoor / Field	a.	Major Biochemistry	Theory3	103211	Metabolism I
			Theory4	103212	Metabolism II
			Lab/Practical-8	103213	Practical Aspects in Metabolic Biochemistry
		IKS-Major Specific	Theory	103214	IKS in Biochemistry
	b.	Minor	Theory 3	103215	Basic Metabolism
			Lab/Practical-9	103216	Practical Applications of Metabolism
	c.	Generic/ Open Elective	Theory 5	103217	Human Reproductive health and Blood Components.
	d.	VSC	Lab/Practical-10	103218	Metabolic Biochemistry in Laboratory Diagnostics
	e.	AEC - English	Theory		
		AEC –MIL	Theory		
	f.	FP/CES	Project	103219	(FP/ CEP in Biochemistry - I)
		CC	Outdoor		

NEP Syllabus UG Programme

Programme: B. Sc. (Biochemistry)

Course : B. Sc. II Semester III

103211 Theory 3 (Major) Metabolism I							
Level	**Semester**	**Course code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Maximum marks**
5.0	III	103211	Metabolism I	2	30	2 Hrs	30

Course Objectives	• To understand the fundamental principles of metabolic pathways. • To Gain a detailed knowledge of various catabolic and anabolic pathways. • To know the interrelationships between different biomolecules. • To analyze the mechanisms of metabolic control and regulation.
Course Outcomes	Upon completing this course, students will be able.. • To understand major pathways involved in carbohydrate metabolism and the role of these pathways in maintaining blood glucose homeostasis. • To explain fatty acid and membrane lipid and lipoprotein metabolism. • To understand the regulation of various pathways • To calculate the energy yield from the metabolism of a biological compound.

Unit	**Content**	**Workload Allotted in Hours**	**Weightage of Marks Allotted**	**Pedagogy**
Unit I Carbohydrate Metabolism	a. Glycolysis: Steps, regulation, and energetics, Gluconeogenesis, Oxidation of Pyruvate b. TCA cycle: steps and regulation and energetics, Amphibolic nature of TCA Cycle c. HMP pathway and its significance d. Glycogen synthesis in liver and muscles, Glycogenolysis and their regulation	8	8	Chalk and board Power point presentation, Videos, Animation Etc

Unit II Mitochondrial Electron Transport chain	a. The electron Transport chain: Structure of mitochondria, Organization of respiratory chain complexes, sequence, structure and function of the components Fe-s proteins, cytochromes, Q cycle, proton transfer, P/O ratio, EMF, specific inhibitors of ETC b. Oxidative phosphorylation (OP): Chemical coupling hypothesis, Mitchell's hypothesis, F_oF_1 ATP synthase, structure and mechanism of ATP synthesis c. Uncouplers and Inhibitors of oxidative phosphorylation	7	7	Chalk and board Power point presentation, Videos, Animation Etc
Unit III Lipid metabolism	a. Biosynthesis of saturated and unsaturated fatty acids. b. Fatty acid synthase complex, Biosynthesis of triacylglycerols c. Transport of fatty acid into mitochondria. -Oxidation of saturated and unsaturated fatty acids, Bioenergetics of Oxidation d. Production and utilization of Ketone bodies	8	8	Chalk and oard Power point presentation, Videos, Animation etc
Unit-IV Membrane lipid and lipoproteins Metabolism	a. Biosynthesis of Phospholipids (Glycerophospholipid) Phosphatidate, Lecithin, Cephalin, Phosphatidyl inositol b. Biosynthesis of sphingolipids (Ceramide, cerebroside, Sphingomyelin), c. Biosynthesis and regulation of Cholesterol metabolism.	7	7	Chalk and board Power point presentation, Videos, Animation etc

References	
	1. Lehninger, Principles of Biochemistry by David L. Nelson and Michael M. Cox 2. Biochemistr by Jeremy M. Berg, John L. Tymoczko, and Gregory J. Gatto Jr. 3. Biochemistry by Donald Voet and Judith G. Voet 4. Biochemistry by Reginald H. Garrett and Charles M. Grisham 5. Fundamentals of Biochemistry: Life at the Molecular Level by Donald Voet, Judith G. Voet, and Charlotte W. Pratt 6. Marks' Basic Medical Biochemistry: A Clinical Approach by Michael Lieberman and Alisa Peet 7. Harper's Illustrated Biochemistry by Victor W. Rodwell, David A. Bender, Kathleen M. Botham, Peter J. Kennelly, and P. Anthony Weil 8. Textbook on Metabolism by Ravi Dabhade and Dr Pooja Rana, Nirali Publication 9. Principles of Biochemistry by H. Robert Horton, Laurence A. Moran, Gray Scrimgeour, Marc Perry, and David Rawn 10. Biochemistry, U Satyanarayan 11. Biochemistry, Luber Stryer 12. Fundamental of Biochemistry, A.C Deb

Model questions	**1. Short Answer Questions** **Carbohydrate Metabolism** 1. Outline the steps of glycolysis. 2. Give the amphibolic role of TCA cycle. 3. Enlist non- sugars compounds which produce glucose in gluconeogenesis. 4. What is the net gain of ATP in glycolysis? 5. Give the significance of HMP pathway. 6. Give the reaction catalyzed by pyruvate dehydrogenase complex. 7. Give example of substrate level phosphorylation in glycolysis. 8. Define glycogenolysis in liver and muscles. **Mitochondrial Electron Transport chain** 1. Define oxidative phosphorylation 2. Name four complexes of ETC 3. Enlist the uncouplers of oxidative phosphorylation. 4. Enlist the inhibitors of ETC. 5. Define P/O ratio. 6. What is Q cycle? **Fatty acid metabolism** 1. Write the energetics of β-Oxidation of palmitoyl cycle. 2. Enlist the examples of ketone bodies. 3. Name the transporters used for transport of fatty acyl CoA in matrix of mitochondria. 4. Give the effect of insulin on fatty acid synthesis.

5. Give the function of carnitine shuttle in fatty acid synthesis.
6. What are the primary locations for TAG synthesis in body?
7. Give the condensation reaction of fatty acid synthesis.

Membrane lipid and lipoproteins Metabolism

1. What are the components of sphingomyelins?
2. Give the metabolic role of plasma proteins.
3. Give the reaction of formation of HMG COA.
4. What is a ceramide?
5. Outline the step of formation of phosphatidic acid.
6. Write the step formation of phosphatidyl ethanolamine from phosphatidyl serine.

2. Long Answer Questions

Carbohydrate Metabolism

1. Write the reactions of TCA cycle. Comment on its energetics.
2. Give examples of oxidative decarboxylation reactions in TCA cycle. Add a note on regulation of TCA cycle.
3. Explain the process of glycogenesis.
4. Outline the steps of HMP pathway.
5. Comment on energetics of glycolysis. Add a not on its inhibitors.
6. Explain glucose alanine cycle.

Mitochondrial Electron Transport chain

1. Explain Chemical coupling hypothesis of oxidative phosphorylation.
2. Describe Mitchell's hypothesis of oxidative phosphorylation.
3. Describe mitochondrial ETC. Give its schematic representation.
4. Comment on uncouplers and inhibitors of oxidative phosphorylation.
5. Give the structure and mechanism of F_oF_1ATP synthase.
6. Describe the complexes of ETC with their functions.

Fatty acid metabolism

1. Explain the β-Oxidation fatty acid.
2. Explain the process of ketogenesis.
3. Common upon multienzyme complex fatty acid synthase complex
4. Describe the biosynthesis of palimitic acid.
5. Explain the steps of TAG synthesis.

6. Describe the oxidation of polyunsaturated fatty acids.
7. Describe biosynthesis of unsaturated fatty acids.

Membrane lipid and lipoproteins Metabolism

1. Describe biosynthesis of Phosphoinisitol.
2. Explain biosynthesis of Lecithin.
3. Summarize the biosynthesis of cholesterol.
4. Comment on the rate limiting step of cholesterol biosynthesis.
5. Describe biosynthesis of Phosphocholine.
6. Explain the biosynthesis of sphingolipids.
7. Describe the synthesis of cerebrosides.
8. Write two strategies for the addition of head group in glycerophospholipids

Multiple choice questions:

1. The enzymes of TCA are located in _____

A) cytoplasm

B) Mitochondrial matrix

C) Nucleus

D) Ribosomes

2. HMP shunt is significant in generating …….. and …….

A) amino acids and water

B) FAD and NAD

C) pentoses and NADPH

D) FAD and water

3. The two final products in the β -oxidation of odd chain fatty acids are

A) Acetyl CoA and malonyl CoA

B) Acetyl CoA and acetyl CoA

C) Acetyl CoA and propionyl CoA

D) Acetyl CoA and succinyl CoA

4. The total number of ATP produced by the oxidation of a molecule of palmitic acid is

A) 139

B) 138

C) 129

D) 128

	5. The process of glycolysis occurs in __ A) Ribosomes B) Cell membrane C) Nucleus D) Cytoplasm 6. Cholesterol biosynthesis is controlled by the rate limiting enzyme …… A) HMG CoA synthetase B) Hydroxylase C) Phospholipase **D) HMG CoA reductase** 7. The connecting link between HMP shunt and lipid synthesis is …… A) Ribose B) NADPH C) Sedoheptulose 7-phosphate D) NADH 8. Fatty acids are activated (acyl CoA) and transported to mitochondria by …… A) Glycine B) Glutamine C) Aspartate D) Carnitine 9. The most predominant lipid component of chylomicrons …… A) TAG B) Phospholipids C) Cholesterol D) free fatty acids

103212 Theory 4 (Major) Metabolism II							
Level	**Semester**	**Course code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Maximum marks**
5.0	III	103212	Metabolism II	2	30	2 Hrs	30

Course Objectives:	• To study the metabolism of different biomolecules. • To understand the regulation of various pathways. • To know the interrelationships between different metabolites • To understand the role of enzymes in the diagnosis of diseases.
Course Outcomes	Upon successful completion of the course, students will be able …. • To outline the pathways of amino acid metabolism and the urea cycle. • To understand the pathways involved in nucleic acid and porphyrin metabolism and illustrate the interplay between catabolism and anabolism. • To study the disorders of carbohydrate and lipid metabolism, amino acid metabolism, purine & pyrimidine metabolism. • To relate the metabolic disorders and inborn errors.

Unit System	**Contents**	**Workload allotted In hours**	**Weightage of Marks Allotted**	**Pedagogy**
Unit I Amino Metabolism	a. General reactions of amino acid metabolism such as transamination, oxidative deamination and decarboxylation b. Degradation and biosynthesis of amino acids Serine, Cysteine, Methionine, Glutamic acid, Leucine, Phenylalanine and Tyrosine. c. Disposal of ammonia, Urea cycle and its regulation.	8	8	Chalk and board Power point presentation, Videos, Animation etc
Unit II Nucleotide Metabolism	a. Sources of atoms in purines and pyrimidine molecules, Salvage and de-novo pathway of biosynthesis of purines and pyrimidines. b. Catabolism of Purines and Pyrimidines. c. Regulation of purines and pyrimidine biosynthesis, Biosynthesis of de-oxyribonucleotides, ribonucleotides.	7	7	Chalk and board Power point presentation, Videos, Animation etc

Unit III Porphyrin Metabolism	a. Porphyrins: Structure, classification and functions of porphyrins in biological systems. b. Biosynthesis and degradation of porphyrins c. Porphyrias, Hemoglobinopathies and Jaundice	8	8	Chalk and board Power point presentation, Videos, Animation etc
Unit-IV Metabolic Disorders	a. Hyperglycemia, diabetes mellitus, glycogen storage diseases, and galactosemia b. Hypercholesterolemia, Taysach's disease, Gaucher's and Niemannpick's disease-causes and symptoms. c. Phenyl ketonuria, Tyrosinemia, Maple syrup urine disease, albinism and alkaptonuria- causes and symptoms. d. Hyperuricemia, gout and Lesch Nyhan Syndrome	7	7	Chalk and board Power point presentation, Videos, Animation etc
References:	1. Lehninger Principles of Biochemistry" by David L. Nelson and Michael M. Cox 2. Biochemistry" by Jeremy M. Berg, John L. Tymoczko, and Gregory J. Gatto Jr. 3. Biochemistry" by Donald Voet and Judith G. Voet 4. Biochemistry" by Reginald H. Garrett and Charles M. Grisham 5. Fundamentals of Biochemistry: Life at the Molecular Level" by Donald Voet, Judith G. Voet, and Charlotte W. Pratt 6. Marks' Basic Medical Biochemistry: A Clinical Approach" by Michael Lieberman and Alisa Peet 7. Harper's Illustrated Biochemistry" by Victor W. Rodwell, David A. Bender, Kathleen M. Botham, Peter J. Kennelly, and P. Anthony Weil 8. Textbook on Metabolism by Ravi Dabhade and Dr Pooja Rana, Nirali Publication 9. Principles of Biochemistry" by H. Robert Horton, Laurence A. Moran, Gray Scrimgeour, Marc Perry, and David Rawn 10. Biochemistry: U Satyanarayan 11. Biochemistry: Luber Stryer 12. Fundamental of Biochemistry: A.C Deb			

Model Questions	1. Short Answer Questions

Amino acid Metabolism

1. Give the energetics of urea cycle.
2. Describe transamination reaction.
3. Describe the fate of carbon skeleton of amino acids.
4. Describe oxidative deamination reaction.
5. Give the reaction of biosynthesis of serine from glycine.
6. Write a note on regulation of urea cycle.

Nucleotide Metabolism

1. Give the difference between *denovo* and salvage pathway of purine biosynthesis.
2. Enlist the amino acids that contribute to the formation of purine ring.
3. Write the products obtained on degradation of pyrimidines.
4. What is the committed step in purine biosynthesis by *denovo* pathway.
5. Give the formation of AMP from IMP.
6. Give the reaction catalyzed by carbamoyl phosphate synthetase.
7. How ribonucleotides can be converted to form deoxyribonucleotides?

Porphyrin Metabolism

1. Write an account of hemoglobinopathies.
2. What are porphyrias? Describe any one porphyria in detail.
3. Give the reaction catalysed by heme oxygenase.
4. Write the functions of porphyrins in biological systems.
5. Give the types and nomenclature of porphyrins.
6. Write the first committed step in heme synthesis.
7. Write a note on Jaundice.
8. Outline the steps of porphobilinogen biosynthesis from glycine and succinyl CoA.

Metabolic Disorders

1. What is gout? How can it be treated?
2. What is Lesch- Nyhan syndrome?
3. Name the biochemical defect in the following disorders of amino acid metabolism.

a) Phenyl ketonuria

b) Maple syrup urine disease

c) albinism

4. What are glycogen storage diseases?
5. Write a note on Hyperglycemia.

6. Give the causes of Gaucher's and Niemannpick's diseases
7. Write about galactosemia

2. Long Answer Questions

1. Describe the urea cycle in detail.
2. Explain the steps in biosynthesis of cysteine.
3. Explain the transamination and deamination reaction reactions in detail.
4. Discuss the degradation of tyrosine.
5. Describe the biosynthesis of methionine.
6. Describe biosynthesis of serine and glycine.
7. Explain the biosynthesis of phenyl alanine from chorismate.

Nucleotide metabolism

1. Write an account of salvage pathway in purine nucleotide synthesis.
2. Write an account of the biosynthesis of inosine monophosphate.
3. Describe the catabolism of purine nucleotides.
4. Describe biosynthesis of UMP.
5. Describe the formation of AMP and GMP from IMP.
6. Describe the regulation of pyrimidine biosynthesis.

Metabolic disorders

1. Discuss in detail Diabetes Mellitus.
2. Describe hypercholesterolemia.
3. Discuss the defects caused by defect in tyrosine amino acid metabolism.
4. Describe in detail disorders of gangliosides and sphingolmyelins.
5. Explain Hyperuricemia and gout in detail.
6. Discuss glycogen storage diseases

Multiple choice questions

Amino acid Metabolism

1) The synthesis of urea occurs in
A) Kidney
B) Liver
C) Muscle
D) Brain

2) The coenzyme that participates in transamination reactions is ……
A) NAD
B) Biotin
C) Coenzyme A
D) Pyridoxal Phosphate

3) In the synthesis of cysteine, the carbon skeleton is provided by …….
A) Serine
B) Methionine
C) Glutamate
D) Alanine

4) The end product of purine metabolism in humans is
A) Xanthine
B) Uric acid

C) Urea
D) Allantoin

5) The nitrogen atoms in the purine ring are obtained from
A) Glycine
B) Glutamine
C) Aspartate
D) All of them

6) The regulatory enzyme in the pyrimidine biosynthesis in animals is …….
A) Carbamoyl phosphate synthetase II
B) Aspartate transcarbamoylase
C) OMP decarboxylase
D) Dihydroorotate dehydrogenase

7). Niemann-Pick disease is due to a defect in the enzyme ……..
A) Cerebrosidase
B) **Sphingomyelinase**
C) Phospholipase
D) Cholesterol esterase

8) The metal ion in heme is ……..
A) M
B) Co
C) Fe
D) Ca

9) Name the amino acid that directly participates in the synthesis of heme
A) Methionine
B) Aspartate
C) Glycine
D) Tryptophan

10) Galactosemia is mostly due to the deficiency of the enzyme
A) SGPT
B) GLAT
C) PRPP
D) HGPRT

The distribution of marks for the continuous assessment test (CAT) shall be as follows:

Internal Assessment (Theory) for 20 marks		
MCQ Test 1 based on 25% syllabus MCQ Test 2 based on 50% syllabus MCQ Test 3 based on 75% syllabus	Consider best 2 out of 3 test (Average of best 2) (Total performance is not less 40%)	10 Marks
Assignments /Innovative activities /GD/Seminar/ Poster presentation, quiz etc. (any two activities 5 marks each)		10 Marks
Total		20 Marks

Lab-8: 103213 (Major) Practical Aspects in Metabolic Biochemistry							
Level	**Sem**	**Course Code**	**Course Name**	**Credits**	**Teaching hours**	**Exam duration**	**Maximum Marks**
5.00	III	103213	Practical Aspects in Metabolic Biochemistry	2	60	2 Hours	25 + 25
Course Objectives	• To understand the principles of biochemical estimations used in clinical diagnostics. • To learn different enzymatic and colorimetric methods for quantifying biomolecules in biological samples. • To enable students to interpret results and correlate biochemical markers with physiological and pathological conditions. • To familiarize with clinical significance of glucose, lipids, uric acid and liver enzymes. • To develop laboratory skills for handling biological fluids (blood, serum) and performing biochemical assays.						
Course Outcomes	Upon successful completion of this course, students will be able to: • Perform quantitative analysis of glucose, cholesterol, Urea, Uric acid, Inorganic phosphate, SGPT, SGOT etc • Analyze the experimental data and interpret deviations in biochemical parameters. • Apply laboratory techniques in medical and diagnostic laboratories. • Explain the biochemistry of metabolic disorders/diseases.						

Sr No.	**Content of Practical (List of Laboratory Experiments/ Activities etc.)**
1	Estimation of blood glucose by GOD/POD Method
2	Estimation of serum Cholesterol
3	Estimation of serum Uric acid
4	Estimation of serum SGPT and SGOT
5	Estimation of serum Bilirubin
6	Estimation of serum Urea
7	Estimation of inorganic phosphate in serum by Fiske-Subbarow method.
8	Detection of Ketone bodies in Urine (Rothera's test)

References	1) An Introduction to Practical Biochemistry by David T Plummer 2) Text book of Biochemistry (Intermediary metabolism) by A.B. Patil and S.M.Patil (Nabh Prakashan) 3) Devlin, T.M., (2011). Textbook of Biochemistry with Clinical Correlations 7th ed., John Wiley & Sons, Inc. (New Jersey), ISBN: 978-0-470-28173-4. 4)Practical manual in Biochemistry by Jairaman. 5)Text book of Biochemistry by Sucheta Dandekar. 6)Text book of Biochemistry by U. Sattyanarayan 7) Practical Clinical Biochemistry, Harold Varley, Interscience Publishers Inc, 2002 8) Introductory Practical Biochemistry (2001). 2nd Edition. S.K. Sawhney and Randhir Singh. Narosa Publishing House, ISBN- 8173193029 9) Biochemistry 3rd edition (1994) by Lubert Stryer WH Freeman and Co. San Francisco. 11) Clinical Chemistry by Tietz

The distribution of marks for the practical examination shall be as follows:

External Evaluation		**Internal Evaluation base on CAT**	
Performance of any two Experiments	20 marks	Attendance & student's performance	10 Marks
Viva-voce	05 marks	Practical Record book	05 Marks
		MCQ/ Spottings	10 Marks
Total	25 Marks	**Total**	25 Marks

103214 Theory (IKS Major Specific) **IKS in Biochemistry**							
Level	**Semester**	**Course code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Maximum marks**
5.0	III	103214	IKS in Biochemistry (IKS Major Specific)	2	30	2 Hrs	30

Course Objectives	• Understand the biochemical basis of traditional Indian dietary guidelines, food preservation, and medicinal plant usage. • Explore ancient agricultural practices and nutrient recycling and their relevance to modern sustainability. • Evaluate the role of the metabolites in health and disease management. • Study the pharmacological activities of medicinal plants and their therapeutic applications
Course Outcomes	After the completion of this course, the student will be able to: • Describe the nutritional and biochemical significance of ancient Indian dietary concepts. • Apply scientific principles to traditional food preservation techniques and assess their effectiveness. • Explain the biochemical mechanisms of fermentation and distillation in traditional brewing practices. • Identify and classify medicinal plants based on their primary and secondary metabolite composition.

Unit	**Contents**	**Workload allotted In hours**	**Weightage of Marks Allotted**	**Pedagogy**
Unit-I Biochemical Foundations of Early Human Nutrition and Diet Practices	a. Role of nutrition in early human survival and development. b. Ancient Indian dietary guidelines, Rasa (tastes) and their biochemical significance c. Traditional methods of food preservation and their scientific basis d. Nutritional and therapeutic role of traditional herbs and plants	8	8	Chalk and board Power point presentation, Videos, Animation etc

Unit-II Medicinal Plants and Their Biochemical Properties in Ancient Civilizations	a. Importance of medicinal plants in ancient civilizations b. Primary metabolites: Carbohydrates, proteins, and lipids c. Secondary metabolites: Alkaloids, flavonoids, tannins, saponins, terpenoids, and phenolics d. Antioxidant properties of medicinal plants: Biochemical mechanisms and health benefits. Pharmacological activities of medicinal plants Example-Antimicrobial, anti-inflammatory, and anti-cancer properties	7	7	Chalk and board Power point presentation, Videos, Animation etc
Unit-III Biochemical Knowledge in Traditional Brewing and Alcohol Production	a. Historical evolution of brewing in ancient Indian cultures b. Cultural significance of traditional alcoholic beverages (e.g., sura, soma, sake), Overview of biochemical processes in fermentation, Carbohydrate sources: Cereal grains (rice, barley, millet), fruits, and tubers, Role of natural enzymes (e.g., amylases, proteases) in raw material breakdown, Factors influencing fermentation efficiency: pH, temperature, substrate concentration, Production of by-products- Glycerol, fusel oils and organic acids. c. Principles of distillation: Simple vs. fractional distillation. Techniques to remove or reduce impurities (e.g., fusel oils).	8	8	Chalk and board Power point presentation, Videos, Animation etc
Unit-IV Biochemistry in ancient cosmetics and skin care formulation	a. Importance of cosmetics in ancient civilizations b. Plant-Based Ingredients including Sandalwood (Cooling and anti-inflammatory properties), Aloe Vera (Hydration and wound healing) and Turmeric (Antioxidant and antimicrobial activity) c. Animal-Based Ingredients**:** Milk and cream- Natural moisturizers (lactic acid as an exfoliant), Beeswax- Emollient properties. Egg whites- Tightening and smoothing effect. d. Traditional Cosmetic Preparations: Oils and Creams-Herbal oils like sesame, coconut, and almond. Role of essential fatty acids in skin repair.	7	7	Chalk and board Power point presentation, Videos, Animation etc.

References	1. "Understanding Nutrition" – Ellie Whitney & Sharon Rady Rolfes 2. "Modern Nutrition in Health and Disease" – A. Catharine Ross et al. 3. "Charaka Samhita" – Translated by P.V. Sharma (Classical Ayurvedic Text) 4. "Ashtanga Hridayam" – Vagbhata (Ancient Ayurvedic text) 5. "Ayurvedic Nutrition: Ancient Wisdom for Modern Wellbeing" – Sandhya Kandathil 6. "Food and Nutrition in India: Ancient and Modern Perspectives" – Dr. Sujata Deshpande 7. "Traditional Food Processing and Preservation" – Mohammed Wasim Siddiqui 8. "Handbook of Indigenous Foods Involving Alkaline Fermentation" – Prabodh Halde & Keshav Kumar 9. "Fermentation Microbiology and Biotechnology" – Mansi Arora & Arora Ajay 10. "Vrikshayurveda: The Science of Plant Life" – Surapala (Ancient Text, Translated by Nalini Sadhale) 11. "Organic Farming: Everything You Need to Know" – Peter Fossel 12. "Principles of Organic Farming" – Balasubramanian A & Palaniappan S.P. 13. "Sustainable Agriculture and Food Security" – Walter Leal Filho & Ademir Calegari 14. "Medicinal Plants in Folk Tradition: An Ethnobotany of Britain & Ireland" – David E. Allen & Gabrielle Hatfield 15. "Indian Medicinal Plants: An Illustrated Dictionary" – C.P. Khare 16. "Lehninger Principles of Biochemistry" – David L. Nelson & Michael M. Cox 17. "Biochemistry of Plant Secondary Metabolism" – Michael Wink 18. "Plant Secondary Metabolites: Occurrence, Structure, and Role in the Human Diet" – Alan Crozier, Mike N. Clifford, & Hiroshi Ashihara 19. "Secondary Metabolism in Microorganisms, Plants, and Animals" – Lester Packer 20. "Phytochemistry of Medicinal Plants" – John T. Arnason, Rachel Mata, & John T. Romeo 21. "The Origins and Ancient History of Wine" – Patrick E. McGovern 22. "Food and Drink in Ancient India" – Om Prakash 23. "Indian Brewing Traditions: History, Culture, and Science" – K.T. Achaya 24. "A History of Alcohol and Drugs in India" – Madhu Sinha 25. "Fermented Foods and Beverages of the World" – Jyoti Prakash Tamang 26. "Yeast Physiology and Biotechnology" – Graeme M. Walker 27. "Handbook of Brewing: Processes, Technology, Markets" – Hans Eblinger 28. "Cereal Chemistry" – Kent & Evers 29. "Principles of Fermentation Technology" – Stanbury, Whitaker & Hall 30. "The Science and Technology of Alcohol Production" – L. F. Green 31. "Purification Processes for Alcoholic Beverages" – Roy A. Chinnici

Model Questions	**Short-Answer Questions:** **1.** How did nutrition play a role in the survival and development of early humans? **2.** What are the six Rasa (tastes) in ancient Indian dietary guidelines, and what is their biochemical significance? **3.** Explain any two traditional methods of food preservation and their scientific basis. **4.** How do traditional herbs contribute to both nutrition and therapy? Give one example. **5.** What is the significance of organic farming in maintaining soil fertility and sustainability? **6.** Describe the concept of nutrient recycling in ancient Indian agriculture. **7.** How can traditional food practices be integrated into modern nutritional science for better health benefits? **Long answer type question.** 1. Discuss the role of nutrition in early human survival and development. How did dietary habits evolve with time? 2. Explain the ancient Indian dietary guidelines with reference to the six Rasa (tastes). Discuss their biochemical significance in maintaining health. 3. Describe various traditional methods of food preservation. Explain their scientific basis and relevance in modern food technology. 4. Discuss the nutritional and therapeutic roles of traditional herbs and plants. Provide examples of medicinal plants and their biochemical properties. 5. Explain the principles of organic farming and nutrient recycling in ancient Indian agriculture. How can these practices contribute to sustainable agriculture today? **Multiple Choice questions** 1. Which of the following nutrients played a crucial role in early human survival and development? A) Proteins B) Carbohydrates C) Fats D) All of the above

2. In ancient Indian dietary guidelines, how many primary Rasa (tastes) are recognized?
   A) 4
   B) 5
   C) 6
   D) 7

3. Which traditional food preservation method involves removing moisture to prevent microbial growth?

   A) Fermentation
   B) Drying
   C) Pickling
   D) Smoking

4. Which of the following medicinal plants is known for its antioxidant and anti-inflammatory properties?

   A) Tulsi (Holy Basil)
   B) Neem
   C) Amla (Indian Gooseberry)
   D) All of the above

5. What is the primary benefit of organic farming over conventional farming?
   A) Increased pesticide use
   B) **Improved soil health and sustainability**
   C) Higher crop yields through synthetic fertilizers
   D) Rapid crop growth using chemical stimulants

6. Which practice in ancient Indian agriculture helped in nutrient recycling?
   A) Use of synthetic fertilizers
   B) **Crop rotation and composting**
   C) Genetic modification of crops
   D) Excessive irrigation

7. What is the primary function of fermentation in traditional food preservation?
   A) Enhancing food flavor
   B) Killing all microorganisms
   C) Increasing food toxicity
   D) Removing nutrients from food

The distribution of marks for the continuous assessment test (CAT) shall be as follows:

<table>
<tr><th colspan="3">Internal Assessment (Theory) for 20 marks</th></tr>
<tr><td>MCQ Test 1 based on 25% syllabus</td><td rowspan="3">Consider best 2 out of 3 tests (Average of best 2)

(Total performance is not less 40%)</td><td rowspan="3">10 Marks</td></tr>
<tr><td>MCQ Test 2 based on 50% syllabus</td></tr>
<tr><td>MCQ Test 3 based on 75% syllabus</td></tr>
<tr><td colspan="2">Assignments /Innovative activities /GD/Seminar/ Poster presentation, quiz etc (any two activities 5 marks each)</td><td>10 Marks</td></tr>
<tr><td colspan="2">Total</td><td>20 Marks</td></tr>
</table>

Minor Biochemistry 103215 Theory3 (Minor) Basic Metabolism							
Level	**Semester**	**Course Code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Max Marks**
5.0	III	103215	Basic Metabolism	2	30	2 Hrs	30

Course Objectives	• To study the metabolism of different biomolecules • To Understand the regulation of various pathways • To know the interrelationships between different metabolites, • To understand the role of enzymes in the diagnosis of diseases.
Course Outcomes	Upon successful completion of this course, students will be able to: • To outline the pathways of amino acid metabolism and the urea cycle. • To understand the pathways involved in nucleic acid and porphyrin metabolism and illustrate the interplay between catabolism and anabolism • To study the disorders of carbohydrate and lipid metabolism, amino acid metabolism, purine & pyrimidine metabolism. • To relate the metabolic disorders and inborn errors.

Unit	**Contents**	**Workload allotted In hours**	**Weightage of Marks Allotted**	**Pedagogy**
Unit I Carbohydrate Metabolism	a. Glycolysis: Steps, regulation, and energetics, Gluconeogenesis, Oxidation of Pyruvate b. TCA cycle: steps and regulation and energetics, Amphibolic nature of TCA Cycle c. Mitochondrial ETC, Oxidative phosphorylation, Inhibitors and uncouplers d.Hypoglycemia, Hyperglycemia, diabetes mellitus-causes and etiology, Glucose Tolerance Test	8	8	Chalk and board Power point presentation, Videos, Animation etc
Unit II Lipid Metabolism	a. Biosynthesis of saturated and unsaturated fatty acids. b. Transport of fatty acid into mitochondria, β-Oxidation of saturated and unsaturated fatty acids, ATP yield from fatty acids, Ketogenesis c. Biosynthesis and regulation of Cholesterol metabolism. a. d. Hyperlipidemia, fatty liver and Atherosclerosis	7	7	Chalk and board Power point presentation, Videos, Animation etc

Unit III Amino acid Metabolism	a. General reactions of amino acid metabolism such as transamination, oxidation deamination and decarboxylation b. Urea cycle and its regulation. c. Degradation and biosynthesis of amino acids serine, Methionine, glutamic acid, Leucine, Phenylalanine and Tyrosine d. Phenyl ketonuria, Tyrosinemia, Maple syrup urine disease and albinism	8	8	Chalk and board Power point presentation, Videos, Animation etc
Unit-IV Nucleotide Metabolism	a. Sources of atoms in purines and pyrimidine molecules b. Biosynthesis, regulation and degradation of purine nucleotides c. Biosynthesis, regulation and degradation of pyrimidine nucleotides. d. Hyperuricemia, gout and Lesch Nyhan Syndrome	7	7	Chalk and board Power point presentation, Videos, Animation etc
References:	1. Lehninger Principles of Biochemistry" by David L. Nelson and Michael M. Cox 2. Biochemistry" by Jeremy M. Berg, John L. Tymoczko, and Gregory J. Gatto Jr. 3. Biochemistry" by Donald Voet and Judith G. Voet 4. Biochemistry" by Reginald H. Garrett and Charles M. Grisham 5. Fundamentals of Biochemistry: Life at the Molecular Level" by Donald Voet, Judith G. Voet, and Charlotte W. Pratt 6. Marks' Basic Medical Biochemistry: A Clinical Approach" by Michael Lieberman and Alisa Peet 7. Harper's Illustrated Biochemistry" by Victor W. Rodwell, David A. Bender, Kathleen M. Botham, Peter J. Kennelly, and P. Anthony Weil 8. Textbook on Metabolism by Ravi Dabhade and Dr Pooja Rana, Nirali Publication 9. Principles of Biochemistry" by H. Robert Horton, Laurence A. Moran, Gray Scrimgeour, Marc Perry, and David Rawn 10. Biochemistry: U Satyanarayan 11. Biochemistry: Luber Stryer 12. Fundamental of Biochemistry: A.C Deb			

Model Questions	**1. Short Answer Questions** **Carbohydrate Metabolism** 1. Outline the steps of glycolysis. 2. Give the amphibolic role of TCA cycle. 3. Enlist non- sugars compounds which produce glucose in gluconeogenesis. 4. Enlist the components of ETC? 5. Give the significance of HMP pathway. 6. Give the reaction catalyzed by pyruvate dehydrogenase complex. 7. Give example of substrate level phosphorylation in glycolysis. 8. Enlist the uncouplers of oxidative phosphorylation. **Lipid Metabolism** 1. Write the energetics of β-Oxidation of palmitoyl cycle. 2. Enlist the examples of ketone bodies. 3. Name the transporters used for transport of fatty acyl CoA in matrix of mitochondria. 4. Give the effect of insulin on fatty acid synthesis. 5. Give the function of carnitine shuttle in fatty acid synthesis. 6. What is fatty liver? 7. Give the condensation reaction of fatty acid synthesis **Amino acid Metabolism** 1. Give the energetics of urea cycle. 2. Describe transamination reaction. 3. Describe the fate of carbon skeleton of amino acids. 4. Describe oxidative deamination reaction. 5. Give the reaction of biosynthesis of serine from glycine. 6. Name the biochemical defect in the following disorders of amino acid metabolism. a) Phenyl ketonuria b) Maple syrup urine disease c) albinism. **Nucleotide Metabolism** 1. Give the difference between *denovo* and salvage pathway of purine biosynthesis.

2. Enlist the amino acids that contribute to the formation of purine ring.
3. Write the products obtained on degradation of pyrimidines.
4. What is the committed step in purine biosynthesis by *denovo* pathway.
5. Give the formation of AMP from IMP.
6. Give the reaction catalyzed by carbamoyl phosphate synthetase.
7. What is gout? How can it be treated?

2. Long Answer Questions

Carbohydrate Metabolism

1. Write the reactions of TCA cycle. Comment on its energetics.
2. Give examples of oxidative decarboxylation reactions in TCA cycle.
3. Explain the process of gluoneogenesis.
4. Describe the complexes of ETC with their funtions. Add a note on its inhibitors.
5. Comment on energetics of glycolysis. Add a note on its inhibitors.
6. Explain mechanism of oxidative phosphorylation.

Lipid metabolism

1. Explain the β-Oxidation fatty acid.
2. Explain the process of ketogenesis.
3. Common upon multienzyme complex fatty acid synthase complex
4. Describe the biosynthesis of palimitic acid.
5. Explain the steps of TAG synthesis.
6. Describe the biosynthesis of cholesterol.
7. Describe biosynthesis of unsaturated fatty acids.

Amino acid metabolism

1. Describe the urea cycle in detail.
2. Explain the steps in biosynthesis of Leucine.
3. Explain the transamination and deamination reaction reactions in detail.
4. Discuss the degradation of tyrosine.
5. Describe the biosynthesis of methionine.
6. Describe biosynthesis of serine and glycine.
7. Explain the biosynthesis of phenyl alanine from chorismite

Nucleotide metabolism

1. Write an account of salvage pathway in purine nucleotide synthesis.
2. Write an account of the biosynthesis of inosine monophosphate.
3. Describe the catabolism of purine nucleotides.
4. Describe biosynthesis of UMP.
5. Describe the formation of AMP and GMP from IMP.

Multiple choice questions

1. The synthesis of urea occurs in _____
A) Kidney
B) Liver
C) Muscle
D) Brain

2) The coenzyme that participates in transamination reactions is _____
A) NAD
B) Biotin
C) Coenzyme A
D) Pyridoxal Phosphate

3) In the synthesis of cysteine, the carbon skeleton is provided by _____
A) Serine
B) Methionine
C) Glutamate
D) Alanine

4) The end product of purine metabolism in humans is
A) Xanthine
B) Uric acid
C) Urea
D) Allantoin

5) The nitrogen atoms in the purine ring are obtained from
A) Glycine
B) Glutamine
C) Aspartate
D) All of them

6) The regulatory enzyme in the pyrimidine biosynthesis in animals is _____
A) Carbamoyl phosphate synthetase II
B) Aspartate transcarbamoylase
C) OMP decarboxylase
D) Dihydroorotate dehydrogenase

7) The enzymes of TCA are located in _____
A) cytoplasm
B) Mitochondrial matrix
C) Nucleus
D) Ribosomes

8) ……. ATPs are produced by the oxidation of a molecule of palmitic acid
A) 139
B) 138
C) **129**
D) 128

9) Cholesterol biosynthesis is controlled by the rate limiting enzyme _____

	A) HMG CoA synthetase B) Hydroxylase C) Phospholipase **D) HMG CoA reductase** 10) The process of glycolysis occurs in _____ A) Ribosomes B) Cell membrane C) Nucleus D) **cytoplasm**

The distribution of marks for the continuous assessment test (CAT) shall be as follows:

Internal Assessment (Theory) for 20 marks		
MCQ Test 1 based on 25% syllabus	Consider best 2 out of 3 tests (Average of best 2) (Total performance is not less 40%)	10 Marks
MCQ Test 2 based on 50% syllabus		
MCQ Test 3 based on 75% syllabus		
Assignments /Innovative activities /GD/Seminar/ Poster presentation, quiz etc (any two activities 5 marks each)		10 Marks
Total		20 Marks

103216 Minor -Lab Practical 9: Practical Applications of Metabolism							
Level	**Semester**	**Course code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Maximum marks**
5.0	III	103216	Practical Applications of Metabolism	2	60	2 Hrs	50

Course Objectives:	• To understand the principles of biochemical estimations used in clinical diagnostics. • To learn different enzymatic and colorimetric methods for quantifying biomolecules in biological samples. • To enable students to interpret results and correlate biochemical markers with physiological and pathological conditions. • To develop laboratory skills for handling biological fluids (blood, serum) and performing biochemical assays.
Course Outcomes:	Upon successful completion of this course, students will be able to: • Perform quantitative analysis of glucose, cholesterol, Urea, Uric acid, Triglycerides, SGPT and SGOT etc • Analyze the experimental data and interpret deviations in biochemical parameters. • Apply laboratory techniques in medical and diagnostic laboratories. • Explain the biochemistry of metabolic disorders/diseases.

Sr. No.	**Content of Practical (List of Laboratory Experiments/ Activities etc.)**
1	Estimation of blood glucose by GOD/POD Method
2	Oral Glucose Tolerance Test
3	Detection of Ketone bodies in Urine (Rothera's test)
4	Estimation of serum Cholesterol
5	Estimation of serum Triglycerides
6	Estimation of serum Uric acid
7	Estimation of serum SGPT, SGOT
8	Estimation of serum Urea
9	Estimation of serum creatinine
10	Estimation of inorganic phosphate in serum by Fiske-Subbarow method.

References	1) An Introduction to Practical Biochemistry by David T Plummer 2) Text book of Biochemistry (Intermediary metabolism) by A.B. Patil and S.M.Patil (Nabh Prakashan) 3) Devlin, T.M., (2011). Textbook of Biochemistry with Clinical Correlations 7th ed., John Wiley & Sons, Inc. (New Jersey), ISBN:978-0-470-28173-4. 4) Practical manual in Biochemistry by Jairaman. 5) Text book of Biochemistry by Sucheta Dandekar. 6) Text book of Biochemistry by U. Sattyanarayan 7) Practical Clinical Biochemistry, Harold Varley, Interscience Publishers Inc, 2002 8) Introductory Practical Biochemistry (2001). 2nd Edition. S.K. Sawhney and Randhir Singh. Narosa Publishing House, ISBN- 8173193029 9) Biochemistry 3rd edition (1994) by Lubert Stryer WH Freeman and Co. San Francisco. 10) Clinical Chemistry by Tietz

The distribution of marks for the practical examination shall be as follows:

External Evaluation		**Internal Evaluation based on CAT**	
Performance of any two Experiments	20 marks	Attendance & student's performance	10 Marks
Viva-voce	05 marks	Practical Record book	05 Marks
		MCQ/ Spotting	10 Marks
Total	25 Marks	**Total**	25 Marks

Sant Gadge Baba Amravati University, Amravati NEP Syllabus

UG Programme

Faculty: Science and Technology

Programme: B. Sc. (Biochemistry)

Course: B.Sc. II Semester III: Open Elective

FACULTY: **SCIENCE AND TECHNOLOGY**

Teaching and learning scheme: For the Degree of Bachelor of Science

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

B.Sc. II: SEMESTER-III

103217 Human Reproductive Health and Blood Components. (GOEC)

Level	Sem	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.0	**III**	**103217**	Human Reproductive Health and Blood Components.	**2**	**30**	**2 Hrs**	**30**

Course Objective:

- To study human circulatory system.
- To study male and female reproductive system.
- To study menstrual cycle and menopause.
- To study In-vitro fertilization and Family planning.

Course Outcomes:

Upon completion of the course, students would be able to…

- Explain structure and functions of various parts of circulatory system.
- Understand the structure of Male and Female reproductive system and process of fertilization.
- Deeply understand Menstrual cycle its disorders and can analyze PCOD and PCOS.
- Explain In- vitro fertilization and suggest family planning options.

Unit System	Contents	Workload
Unit 1 Blood	• Composition and functions of blood and plasma. • Structure, functions and life span of RBCs, WBCs and platelets. • Hematopoiesis • Blood: - Blood groups, A, B, O and Rh factor, Bombay blood group, cross matching, Compatibility- Erythroblastosis fetalis. • Hemoglobin- Anemias – Sickle Cell Anemia and Thalassemia. Blood transfusion. Health benefits of Blood donation.	8
UNIT–2 Reproductive system	● Male reproductive system: Anatomy and functions of testis. Structure of sperm, spermatogenesis. Semen. Accessory glands: seminal vesicles, prostate, bulbourethral gland. ● Female reproductive system: Ovary: anatomy and functions. Maturation of Graafian follicle and ovum. ● Hormones secreted by gonads: Functions of androgen, testosterone, estrogen and progesterone. ● Fertilization: Definition and molecular events during fertilization.	8
UNIT–3 Menstrual cycle and Menopause	• Menstrual cycle- four phases of Menstrual cycle • Menstrual disorders – Menorrhagia, Amenorrhea • Oligomenorrhea, Fibroids. • Polycystic ovary disease and Polycystic ovary syndrome – Causes, Symptoms, differences and treatment of PCOD and PCOS. • Menopause – Introduction, Causes and Symptoms.	7
UNIT– 4 In- Vitro fertilization and Family Planning	● In vitro fertilization :- Introduction, Four stages of IVF, benefits of IVF. ● Family Planning Methods:- Contraceptive pills, Injectable contraceptives, Intrauterine devices, Barrier method, Non – Invasive method, Vasectomy and Tubectoctomy.	7

References:

1. Harper's Illustrated Biochemistry" by Victor W. Rodwell, David A. Bender, Kathleen M. Botham, Peter J. Kennelly, and P. Anthony Weil
2. Lehninger Principles of Biochemistry" by David L. Nelson and Michael M. CoxBiochemistry" by Lubert Stryer, Jeremy M. Berg, and John L. Tymoczko
3. Marks' Basic Medical Biochemistry" by Alisa Peet, Allan Marks, and Michael Lieberman
5. Medical Biochemistry" by John W. Baynes and Marek H. Dominiczak Biochemistry: The Molecular Basis of Life" by Trudy McKee and James R. McKee
6. Biochemistry for Dummies" by John T. Moore and Richard H. Langley
7. Textbook of Biochemistry for Medical Students" by D. M. Vasudevan and S. Sreekumari
8. Clinical Biochemistry Made Ridiculously Simple" by Stephen Goldberg
9. Essential Biochemistry for Medicine" by Mitchell Fry and Harpal Singh Randeva

Model Questions	**Long Questions:-** **Circulatory System: -** 1. Explain the composition and function of blood and plasma. 2. Enlist blood cell types, explain their structure and functions. 3. With the help of suitable diagram describe the process of Hematopoiesis. 4. Give types of Blood groups, Explain significance of Blood grouping. 5. Comment on Erythroblastosis faetalis. 6. What is Hemoglobin? Give structure and significance of Hemoglobin. 7. Define Blood Transfusion. Give significance of Blood Donation. **Reproductive System:-** 1. With the help of suitable diagram describe Male reproductive system. 2. Draw well labelled diagram of female reproductive system and explain oogenesis. 3. What is fertilization? Describe in brief molecular events during fertilization. 4. Briefly explain functions of following gonadal hormones. a) Estrogen b) Testosterone c) Progesterone **Menstrual cycle and Menopause:-** 1. What is Menstruation? Write on four phases of Menstruation. 2. Comment on any three Menstrual disorders. 3. Give causes, symptoms, differences and treatment of PCOD. 4. Explain causes, symptoms, differences and treatment of PCOS. 5. What is Menopause? Write on Causes and symptoms of Menopause. **In-Vitro fertilization and Family Planning:-** 1. What is In-vitro fertilization? Write in brief about four stages of IVF. 2. Define Family Planning. Explain any five family planning methods. **Circulatory System:** 1. What is Hemoglobin? Describe its structure. 2. Who discovered ABO blood group system? Explain blood groups in brief. 3. Discuss Bombay blood group.

4. Explain in brief importance of blood donation.

Reproductive System: -

1. Draw and describe structure of Sperm.
2. Comment on Spermatogenesis.
3. Write in brief about structure and function of ovary.
4. Write the functions of Testosterone and Progesterone.

Menstrual cycle and Menopause: -

1. Write in brief about Menorrhagia.
2. Illustrate symptoms and causes of Amenorrhea.
3. Differentiate between PCOD and PCOS.
4. Discuss the symptoms of Menopause.

In-Vitro fertilization and Family Planning: -

1. Differentiate between In-vivo and In-vitro fertilization**.**
2. Explain the need of IVF.
3. Differentiate between Tubectomy and Vasectomy.
4. Write in brief about Family planning methods.

Multiple Choice Questions MCQs:

1) Lifespan of Red blood cell is …… days.

a) 100 b) 89 c) 65 d) 120.

2) Person having Bombay blood group has …… antigen on its erythrocytes.

a) M b) N c) Z d) H

3) Spermatogenesis takes place in ……

a) Ovaries b) Testis c) kidney d) liver.

4) Which of the following is male sex hormone.

a) Progesterone

b) Estrogen

c) Testosteron

d) Estradiol.

	5) Menstrual flow occurs due to shedding of …….. a) Endometrium. b) Myometrium. c) Mesometrium d) Perimetrium. 6) The main function of Menopause is…….. a) Hot Flashes b) Night Sweat c) Vaginal Dryness d) All the above 7) The success of the birth control programme in controlling population growth is dependent on……. a) Tubectomy b) Vasectomy c) Use of Contraceptives d) Acceptability of the above by the people 8) Test tube baby means a baby born when…… a) Developed in test tube. b) Ovum is fertilized externally and there after implanted in the uterus. c) It is developed through tissue culture method d) Developed from non-fertilized egg.

103218 (Major) VSC Lab Practical 10 Metabolic Biochemistry in Laboratory Diagnostics							
Level	**Semester**	**Course code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Maximum marks**
5.0	III	103218	Metabolic Biochemistry in Laboratory Diagnostics	2	60	2Hrs	50

Course Objectives	• To understand the biochemical basis of metabolic disorders and their laboratory diagnosis. • Develop technical skills for performing clinical diagnostic tests related to carbohydrate, lipid and protein metabolism • To interpret biochemical test results for disease diagnosis, including diabetes, renal failure, liver dysfunction, and metabolic disorders. • To apply analytical skills to case-based studies, comparing metabolic profiles in different physiological and pathological conditions.
Course Outcomes :	By the end of this module, the students will be able to: • Compare fasting vs. postprandial glucose levels for diabetes assessment. • Estimate serum triglycerides and cholesterol to assess lipid metabolism and cardiovascular risk. • Assess renal function by serum creatinine and proteinuria tests. • Evaluate liver enzyme levels to determine liver function status. • Identify inborn errors of metabolism (IEM) using urinary biochemical tests.

Sr.No.	
1.	Compare fasting vs. postprandial glucose levels for diabetes assessment in diabetic and non-diabetic individuals by GOD-POD method
2.	Case study: Oral Glucose Tolerance Test (OGTT) in Normal pregnancy *vs.* Gestational Diabetes Mellitus
3.	Compare lipid profile biomarkers total cholesterol, HDL, LDL and triglycerides in high risk *vs.* normal individuals for cardiovascular risk assessment.
4.	Qualitative and Quantitative analysis of proteinuria as an indicator of CKD
5.	Case study: Serum creatinine in normal individual *vs* renal failure patient.
6.	Estimation of serum liver enzyme SGPT and Bilirubin in liver disease patients. (Fatty liver/Hepatitis/Liver cirrhosis)
7.	Screening for inborn errors of metabolism using urinary biochemical tests- • Phenylketonuria by ferric chloride test • Maple syrup urine disease by DNPH test

References	1) An Introduction to Practical Biochemistry by David T Plummer) Text book of Biochemistry (Intermediary metabolism) by A.B. Patil and S.M.Patil (Nabh Prakashan)) Devlin, T.M., (2011). Textbook of Biochemistry with Clinical Correlations 7th ed., John Wiley & Sons, Inc. (New Jersey), ISBN: 978-0-470-28173-4. 4) Practical manual in Biochemistry by Jairaman. 5) Text book of Biochemistry by Sucheta Dandekar. 6) Text book of Biochemistry by U. Sattyanarayan 7) Practical Clinical Biochemistry, Harold Varley, Interscience Publishers Inc, 2002) Introductory Practical Biochemistry (2001). 2nd Edition. S.K. Sawhney and Randhir Singh. Narosa Publishing House, ISBN- 8173193029) Biochemistry 3rd edition (1994) by Lubert Stryer WH Freeman and Co. San Francisco. 10) Clinical Chemistry by Tietz

The distribution of marks for the practical examination shall be as follows:

Internal Evaluation for VSC	
Attendance	10 Marks
Practical performance	20 Marks
MCQ/ Spotting	10 Marks
Practical Record book	10 Marks
Total	**50 Marks**

B. Sc. II Semester III (NEP)

Course Category: Field Project (FP) / Community Engagement and Service (CES) of Major subject: Biochemistry

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.0	III	103219	(FP/ CEP in Biochemistry - I)	2	60	--	50

Course Objectives:	The intended objectives are: • To provide practical, real-world experience, in their field of study, allowing them to apply theoretical knowledge to real-world situations or address Real-World Problems. • To enhance research, interpretation and analytical skills, strengthening their critical thinking and problem-solving abilities. • To foster engagement with a specific biochemistry related issue or area of study, address specific challenges or needs within a community. • To Improve Collaboration, Communication among students and facilitate knowledge transfer from lab to land and get self inspiration for contribution to the society by applying the subject knowledge.
Course Outcomes:	Upon successful completion of this course, students will be able to: • Develop their practical, technical skills and a deeper understanding of their subject matter and how it applies to real-world situations. • Learn to identify, analysis, and interpretation of complex problems using their knowledge and develop research skills. • Gain insight into social issues and the role of various governmental schemes for the welfare of people and explore new ideas and approaches. • Learn to work effectively in teams and collaborate with others to achieve common goals and contributing to community's socio-economic improvements

As per NEP 2020, students of B Sc. II of Semester III need to perform a Field Project (FP)/ Community Engagement Service (CES) for TWO (2) credits i.e. 50 Marks. The guidelines/ SoP regarding the FP/CES are as follows:

1) The total time allocation for the student to carry out FP/CES is 60 hours.
2) Students should participate in FP/CES under the supervision of faculty.
3) Assigning the FP/CES topics to individual students or groups of students (4 to 5 students in one group) and one faculty member from the department will act as Guide for the student or group of students.
4) CES may include awareness programs, public talk/ lectures, workshops, blood testing camps, vaccination drives in collaboration, surveys etc
5) For a SURVEY based FP/CES, related questionnaire (15 or more questions) should be prepared. The departmental coordinator/guide should 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.
6) Field project may be undertaken to include survey/ laboratory work/ data analysis/ field work or in combination of these which involves practical application of knowledge and skill to address a specific

problem or issue within biochemistry related context such as health, sustainable environment, agriculture etc.

7) A project report should be written individually in the standard format (2 Copies): Index, Introduction, Materials, Methods, Result, Conclusion/output, References (Numeric citation type) etc. The report should be of minimum 6 pages (excluding Title page, Certificate, Index, Acknowledgement etc.) Submit the project report with the Guide's signature to the department.
8) Students should maintain the documentation and record properly which includes dairy, photographs, certificates, feedback of beneficiaries, news in local paper if any.
9) A CES report should be written individually in the standard format (2 Copies): Index, Introduction, details of activities, photographs, signature sheets of beneficiaries, feedback of beneficiaries, own feedback, summary /output, etc. It should be submitted with the Guide's signature to the department.
10) The oral /poster presentation for all the FP/CES should be arranged in the department. To evaluate the project, examiner should be appointed by HoD.
11) The total work for FP/CES including preparation of questionnaire to presentation should be evaluated for 2 credits (50 Marks).

References	1. https://www.ugc.gov.in/pdfnews/4187860_Revised-Final-Guidelines.pdf 2. https://en.wikipedia.org/wiki/OU_Citizen_Science_Soil_Collection_Program
Model Questions:	**NA**

Distribution of Marks and the scheme of FP/CES Evaluation as follows:

Sr. No	Evaluation type	Marks
1	Student performance	20
2	FP/CES Report	20
3	Presentation (PPT or Poster)	10
Total		50

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

Programme: B. Sc. (Biochemistry)
Course : B. Sc II Semester IV

Mode of Teaching	Vertical No.	The Vertical	Type of Course	Course Code	Course Name
Classroom Teaching/ Lab Work (Practical)/ Outdoor / Field	a.	Major Biochemistry	Theory-5	103220	Basic enzymology
			Theory-6	103221	Advanced enzymology
			Theory -7	103229	Endocrinology
			Lab/Practical-11	103222	Enzyme Technology: Methods
	b.	Minor	Theory-4	103223	General enzymology
			Lab/Practical-12	103224	Practical enzymology
	c.	Generic/ Open Elective	Theory-5	103225	Biochemistry of food Digestion
	d.	VSC	Lab/Practical-13	103226	Practicals in Applied Enzyme Technology
	e.	AEC - English	Theory		
		AEC –MIL	Theory		
	f.	FP/CES	Project	103228	(FP/ CEP in Biochemistry - II)

NEP Syllabus

UG Programme

Programme: B. Sc. (Biochemistry)

Course : **B. Sc II Semester IV**

103220 Theory 5 (Major)							
Level	**Semester**	**Course code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Maximum marks**
5.0	IV	103220	Basic enzymology	2	30	2 Hrs	30

Course Objective	• To understand the general characteristics, classification, and nomenclature of enzymes. • To explore the structure and function of holoenzymes, apoenzymes, coenzymes, cofactors, activators, inhibitors, and metalloenzymes. • To learn about enzyme activity, specificity, isoenzymes, and multienzyme complexes. • To examine the role of coenzymes (NAD, NADP, FAD, FMN, etc.) and cofactors/metal ions in enzyme catalysis and oxidation-reduction reactions. • To study enzyme catalysis mechanisms, including acid-base catalysis, covalent catalysis, and enzyme-substrate interactions. • To understand enzyme kinetics through different models like the Lock and Key hypothesis and the Induced Fit model. • To learn methods for enzyme isolation, characterization, and purification using chromatography and precipitation techniques.
Course outcomes	Upon completing this course, students will be able to: • Classify and explain enzyme nomenclature and properties based on the IUB classification system. • Differentiate between holoenzymes, apoenzymes, cofactors, coenzymes, and inhibitors and their roles in enzymatic reactions. • Describe enzyme kinetics, enzyme specificity, and factors affecting enzyme activity. • Explain the role of coenzymes and metal ions in enzyme catalysis, oxidation-reduction reactions, and metabolic pathways.

	• Analyze different catalytic mechanisms of enzymes, such as acid-base and covalent catalysis, using examples like chymotrypsin and carboxypeptidase. • Illustrate the principles of enzyme-substrate interactions using models like Lock and Key and Induced Fit hypotheses. • Apply knowledge of enzyme purification and characterization techniques, including chromatography and precipitation methods. • Design and conduct enzymatic assays for enzyme activity determination.

Unit	Content	Workload Allotted in Hours	Weightage of Marks Allotted	Pedagogy
Unit I Introduction to Enzymes	a. General characteristics, nomenclature, IUB classification of enzymes. b. Holoenzymes, apoenzymes, coenzymes, cofactors, activators, inhibitors, active site, metalloenzyme, marker enzyme, monomeric and oligomeric enzymes. c. Unit of enzyme activity, isoenzyme, multienzyme complexes, enzyme specificity.	**8**	**8**	Chalk and board Power point presentation ,Videos, Animation Etc
Unit II Coenzymes & Cofactors	a. Role of coenzymes in enzyme catalysis- NAD, NADP,FAD, FMN, Coenzyme- Q, Biotin, Cobamide, Lipoamide, TPPTHF, Pyridoxal phosphate. b. Role of cofactors/metal ions in enzyme catalysis: Metalloenzymes and metal activated enzymes, role of metal as structural element during enzyme catalysis, c. Role of metal ions in oxidation reduction reactions.	7	7	Chalk and board Power point presentation ,Videos, Animation Etc

Unit III Mechanism of enzyme Action	a. Acid-base catalysis, covalent catalysis, Mechanism of action of chymotrypsin and carboxypeptidase. b. Proximity and orientation effect, strain and distortion effect. c. Mechanism of action- Lock and Key hypothesis Induced fit model.	8	8	
Unit IV Isolation and Purification enzymes	a. Methods for isolation of crude enzyme from plant, animal and microbial sources. b. Methods of characterization of enzymes; development of enzymatic assays. c. Precipitation of enzymes by organic solvents such as acetone, ethanol etc or by neutral salt like ammonium sulfate, dialysis, purification of enzymes using chromatography techniques such as ion exchange chromatography, gel filtration chromatography, affinity chromatography etc.	7	7	Chalk and board Power point presentation ,Videos, Animation etc
References	1) Text Book of Biochemistry by Dr. O. P. Agrawal. 2) An Introduction to Practical Biochemistry by David T Plummer 3) Essentials of Biochemistry by Dr. M. C. Pant. 4) Text book of Biochemistry by West and Todd. 5) Practical manual in Biochemistry by Jairaman. 6) Essentials of Food and Nutrition, Volume I & II by Swaminathan 7) Text book of Biochemistry by Sucheta Dandekar. 8) Text book of Biochemistry by U. Sattyanarayan 9) Fundamentals of Biochemistry by J. L. Jain 10) Lehninger, A I., (1982), Principles of Biochemistry, Butterworth Publishers, New York. 11) Palmer T., (1985). Understanding Enzymes. 2nd Ed., Ellis Horwood Ltd., Chichester 12) Price, N. C, Stevens, L, (1989), Fundamentals of Enzymology, 2"d Ed.,Oxford Sci. Publ., Oxfor 13) Fundamentals of Biochemistry (1999) by Donald Voet, Judith Voet, Charlotte Pratt, John Wiley & Sons, N.Y. 145 146 14) Biochemistry 3rd edition (1994) by Lubert Stryer WH Freeman and Co. San Francisco. 15) General Enzymology by M.S. Deshpande and N.S. Kulkarni (Himalaya Publication House)			

Model questions	**Long-Answer Questions:** 1. Define enzymes and explain the IUB classification system for enzymes. 2. Differentiate between holoenzymes, apoenzymes, coenzymes, cofactors, activators, and inhibitors**.** 3. Discuss the various methods used for enzyme purification, including precipitation techniques, dialysis, and chromatography-based approaches. 4. Describe the role of metal ions in enzyme catalysis, particularly in oxidation-reduction reactions, and differentiate between metalloenzymes and metal-activated enzymes. **Short-Answer Questions:** 1. What are the general characteristics of enzymes? 2. Define the term 'active site' in the context of enzyme structure. 3. What is the role of NAD/NADP in enzyme catalysis? 4. Describe the Lock and Key hypothesis of enzyme action. 5. Differentiate between monomeric and oligomeric enzymes. 6. Explain the proximity and orientation effect in enzyme catalysis. 7. Name any two chromatography techniques used for enzyme purification and explain their principle. 8. What are isoenzymes? Give an example. **Multiple-Choice Questions (MCQs):** 1. The IUB classification system classifies enzymes based on their: a) Molecular weight b) Substrate specificity c) Type of reaction they catalyze d) Source of origin

	2. A holoenzyme consists of: a) Only an apoenzyme b) Only a coenzyme c) Both apoenzyme and coenzyme/cofactor d) Only a metal ion 3. The unit of enzyme activity is measured in: a) Moles per second b) International Units (IU) c) Grams per liter d) Kilojoules per mole 4. Which of the following is NOT a coenzyme? a) NAD b) FAD c) Mg^{2+} d) Coenzyme Q 5. The Induced Fit model of enzyme action suggests that: a) The enzyme's active site has a fixed shape b) The enzyme changes shape to fit the substrate c) The enzyme is consumed during the reaction d) Enzymes work only at high temperatures 6. Which of the following is a metalloenzyme? a) Amylase b) Carboxypeptidase c) Trypsin d) Pepsin 7. Enzyme specificity refers to: a) The rate of enzyme catalysis b) The enzyme’s ability to catalyze a particular reaction c) The number of active sites present d) The molecular weight of an enzyme 8. In enzyme purification, ammonium sulfate is used for: a) Dialysis b) Precipitation c) Gel filtration chromatography d) Electrophoresis

103221 Theory 6 (Major)							
Level	**Semester**	**Course code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Maximum marks**
5.0	IV	103221	Advanced enzymology	2	30	2 Hrs	30

Course Objectives:	• To understand the fundamental concepts of reaction rate, enzyme-substrate interaction, and product formation. • To explore enzyme kinetics, including enzyme activity, Michaelis-Menten kinetics, and factors affecting enzyme activity. • To analyze different types of enzyme inhibition and their significance in biological and drug design applications. • To examine enzyme regulation through covalent modification, allosteric regulation, and zymogen activation. • To learn about enzyme immobilization and its applications in various industries. • To study the role of enzymes in food processing, fermentation, and the medical field, including disease diagnosis and treatment.
Course Outcomes	Upon successful completion of the course, students will be able to: • Explain the kinetics of enzyme-substrate interactions and factors affecting enzyme activity. • Solve numerical problems related to enzyme kinetics, including Km and Vmax. • Describe different types of enzyme inhibition and their impact on enzyme activity. • Analyze enzyme regulation mechanisms, including covalent modification and allosteric regulation. • Discuss the applications of enzyme immobilization in various industrial and medical fields. • Explain the role of enzymes in food processing, detergent production, and leather industries. • Identify the significance of enzymes in diagnosing and treating various diseases. • Evaluate the role of enzyme inhibitors in drug design and their potential therapeutic uses.

Unit System	Contents	Workload allotted In hours	Weightage of Marks Allotted	Pedagogy
Unit I Enzyme Kinetics	a. Significance of energy of activation and free energy. Bisubsratre reaction: Sequential and ping pong mechanism with examples. Concept of reaction rate, enzyme- substrate interaction, and product formation. b. Concept of enzyme activity, ketal, International Unit (IU), Specific Activity c. Factors affecting enzyme activity (temperature, pH, enzyme and substrate concentration). Michaelis-Menten equation, Definition and significance of Km (Michaelis constant), Vmax (maximum velocity).	8	8	Chalk and board Power point presentation, Videos, Animation Etc
Unit-II Enzyme Inhibition	a. Introduction to enzyme inhibition Significance of enzyme inhibitors in controlling metabolic pathways, Inhibition in pathways such as glycolysis, citric acid cycle, and protein synthesis. Classification of enzyme inhibition. b. Reversible Inhibition: Competitive, noncompetitive, uncompetitive and mixed inhibition with examples, Effect of inhibitors on Km and Vmax, c. Irreversible inhibition: Types of irreversible inhibitors (group-specific, affinity labels, suicide inhibitors) Examples of irreversible inhibitors and their biological relevance, Applications of inhibitors in medicine and research. enzyme inhibitors in food processing, and diagnostics. Enzyme inhibitors as pesticides and herbicides	7	7	Chalk and board Power point presentation , Videos, Animation etc

Unit III Regulation of Enzyme activity	a. Covalently modulated enzymes with examples of adenylation and phosphorylation b. Zymogen form of enzyme and zymogen activation; Multienzyme complexes and their role in regulation of metabolic pathways; c. Allosteric regulation – Aspartate trascarbamoylase, Isoenzymes- Lactate dehydrogenase and creatine phosphokinase.	8	8	Chalk and board Power point presentation, Videos, Animation etc
Unit-IV Applications of enzymes	a. Enzyme immobilization and their applications. b. Application of enzyme in food industry: Enzyme in milk processing and cheese production, tenderization of meat, baking industry, Use of enzymes in detergents and leather industry, Enzymes used in Fermentation c. Medical applications of enzymes: 1. In treatment of diseases such as leukemia, skin cancer, blood clots, cyanide poisoning etc . 2. In diagnosis of diseases such as hepatic disorder, heart related disorder, bone disorder, pancreatic disorder etc.	7	7	Chalk and board Power point presentation , Videos, Animation etc

References	1) Text Book of Biochemistry by Dr. O. P. Agrawal. 2) An Introduction to Practical Biochemistry by David T Plummer 3) Essentials of Biochemistry by Dr. M. C. Pant. 4) Text book of Biochemistry by West and Todd. 5) Practical manual in Biochemistry by Jairaman. 6) Essentials of Food and Nutrition, Volume I & II by Swaminathan. 7) Text book of Biochemistry by Sucheta Dandekar. 8) Text book of Biochemistry by U. Sattyanarayan 9) Fundamentals of Biochemistry by J. L. Jain 10) Lehninger, A I., (1982), Principles of Biochemistry, Butterworth Publishers, New York. 11) Palmer T., (1985). Understanding Enzymes. 2nd Ed., Ellis Horwood Ltd., Chichester 12) Price, N. C, Stevens, L, (1989), Fundamentals of Enzymology, 2"d Ed.,Oxford Sci. Publ., Oxfor 13) Fundamentals of Biochemistry (1999) by Donald Voet, Judith Voet, Charlotte Pratt, John Wiley & Sons, N.Y. 145 146 14) Biochemistry 3rd edition (1994) by Lubert Stryer WH Freeman and Co. San Francisco. 15) General Enzymology by M.S. Deshpande and N.S. Kulkarni (Himalaya Publication House)

Model Questions	Long-Answer Questions: 1. Derive the Michaelis-Menten equation and explain the significance of Km and Vmax in enzyme kinetics. 2. Explain the different types of enzyme inhibition (competitive, non-competitive, uncompetitive, and mixed) with examples and their effects on Km and Vmax. 3. Discuss the mechanisms of bisubstrate reactions, including the sequential and ping-pong mechanisms, with suitable examples. 4. Describe the zymogen form of enzymes and their activation process. How do multienzyme complexes regulate metabolic pathways? **Short Answer Questions** 1. How do temperature and pH affect enzyme activity? 2. What is the significance of the energy of activation in enzyme catalysis? 3. Differentiate between sequential and ping-pong bisubstrate reactions. 4. What is suicide inhibition? Give an example. 5. Explain the concept of allosteric regulation with the example of Aspartate transcarbamoylase. 6. What are isoenzymes? Describe the significance of lactate dehydrogenase isoenzymes. 7. Describe the role of phosphorylation and adenylation in enzyme regulation. 8. What is enzyme immobilization, and what are its advantages? **Multiple-Choice Questions (MCQs):** 1. The Michaelis constant (Km) is defined as: a. The maximum velocity of an enzyme-catalyzed reaction b. The substrate concentration at which the reaction velocity is half of Vmax c. The total number of active sites in an enzyme d. The rate of enzyme inactivation 2. Which of the following factors does NOT affect enzyme activity? a. Temperature b. Substrate concentration c. Light intensity d. pH 3. In competitive inhibition, the inhibitor: a) Binds to the enzyme-substrate complex b) Binds to the active site of the enzyme c) Binds to an allosteric site d) Changes the enzyme structure irreversibly

	4. Which of the following is an example of an irreversible inhibitor? a) Malonate b) Penicillin c) ATP d) NADP 5. Enzymes that are synthesized as inactive precursors and activated later are called: a) Allosteric enzymes b) Zymogens c) Isoenzymes d) Metalloenzymes 6. Which enzyme is used in the milk industry for cheese production? a) Amylase b) Lipase c) Rennin d) Catalase 7. Which enzyme is commonly used in detergents for stain removal? a) Trypsin b) Amylase c) Lipase d) Lactase 8. The role of metal ions in enzyme activity includes: a) Acting as a substrate b) Stabilizing enzyme structure c) Increasing Km d) Inhibiting enzyme function

103229 Theory 7 (Major)							
Level	**Semester**	**Course code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Maximum marks**
5.0	IV	103229	Endocrinology	2	30	2 Hrs	30

Course Objectives	• To provide a comprehensive understanding of the structural classification of hormones, their biosynthetic pathways, and their mechanisms of transport in the bloodstream. • To elucidate the biochemical molecular mechanisms of hormone action, focusing on receptor ligand interactions, G-proteins, second messengers, and nuclear receptor-mediated gene regulation. • To explain the physiological and metabolic roles of peripheral endocrine hormones (thyroid, adrenal, pancreatic, and gonadal) in maintaining systemic homeostasis. • To introduce the biochemical basis of major endocrine disorders and the principles of modern diagnostic laboratory techniques used to measure hormone levels.
Course Outcomes	Upon successful completion of the course, students will be able to: • Classify and Describe: Students will be able to categorize hormones based on their chemical nature and describe their specific synthesis, storage, and transport mechanisms. • Analyze Signalling Pathways: Students will be able to map out and analyze complex intracellular signal transduction pathways triggered by both water-soluble and lipid-soluble hormones. • Explain Homeostatic Feedback: Students will be able to explain how the central nervous system integrates endocrine signals via the hypothalamus and pituitary, using feedback loops to maintain systemic balance. • Correlate Structure and Function: Students will be able to correlate the biochemical actions of metabolic hormones (like insulin, glucagon, and cortisol) with the physiological regulation of glucose, lipids, and minerals.

Unit	**Content**	**Hours**	**Weightage of Marks Alloted**	**Incorporation of Pedagogies**
Unit 1: Introduction to the Endocrine System:	**Classification of Hormones:** Classification based on chemical nature, including peptide hormones, steroid hormones, amino acid–derived hormones, and eicosanoids; biosynthesis, storage, and secretion of hormones. **Hormone Transport and Metabolism:** Role of plasma binding proteins in hormone transport, hormonal half-life, and mechanisms of metabolic clearance. **Mechanisms of Hormone Action:** **Cell Surface Receptors:** Structure and function of G-protein coupled receptors (GPCRs), receptor tyrosine kinases	8	8	•Chalk & Board. •Interactive Lectures: Use of multimedia presentations, interactive slides, and animations. •Hands-On Models:

	(RTKs), and cytokine receptors. **Second Messenger Systems:** Signaling pathways mediated by cAMP, cGMP, IP3/DAG, and Ca^{2+}. **Intracellular Receptors:** Nuclear receptor superfamily, hormone response elements (HREs), and regulation of gene expression by hormones.			Models/ Charts. •Virtual Labs: Explore virtual labs and simulationsto enhance understanding of the topic. •Flip-Class: Assign readings or video lectures, assignments homework and use class time for interactive discussions. •Concept Maps: Ask Students to create own concept maps that illustrate the relationships between different concepts. •Inquiry-Based Learning: Explore topics through questioning, investigation, and research. •Case-Based Learning: Analyze and discuss real
Unit 2: Hypothalamic-Pituitary Axis and Neuroendocrinology	**The Hypothalamic–Pituitary Unit:** Structure and functional organization of the hypothalamus and pituitary gland; anatomy of the anterior and posterior pituitary. **Anterior Pituitary Hormones:** Synthesis, regulation, secretion, and physiological functions of Growth Hormone (GH), Prolactin (PRL), Adrenocorticotropic Hormone (ACTH), Thyroid-Stimulating Hormone (TSH), and Gonadotropins (Luteinizing Hormone—LH and Follicle-Stimulating Hormone—FSH). **Posterior Pituitary Hormones:** Biosynthesis, release, and physiological roles of Oxytocin and Antidiuretic Hormone (ADH/Vasopressin). **Feedback Regulation of Hormone Secretion:** Principles of endocrine feedback control, including negative and positive feedback mechanisms.	7	7	
Unit 3: Peripheral Endocrine Glands & Metabolic Regulation	**Thyroid Gland:** Biosynthesis of thyroid hormones (T_3 and T_4) from thyroglobulin, iodine metabolism, transport, regulation, and metabolic functions of thyroid hormones. **Adrenal Gland:** Adrenal Cortex-Biosynthesis, regulation, and physiological functions of glucocorticoids (cortisol), mineralocorticoids (aldosterone), and adrenal androgens; the Renin–Angiotensin–Aldosterone System (RAAS). Adrenal Medulla- Biosynthesis, secretion, and physiological actions of catecholamines (epinephrine and norepinephrine) in the "fight-or-flight" response. **Endocrine Pancreas:** Synthesis, secretion, regulation, and metabolic actions of insulin and glucagon **Calcium and Phosphate Homeostasis:** Hormonal regulation of calcium and phosphate metabolism by Parathyroid Hormone (PTH), Calcitonin, and Vitamin D (1,25-dihydroxyvitamin D_3).	8	8	

Unit 4: Reproductive Endocrinology & Clinical Endocrinology	**Reproductive Hormones:** Biosynthesis, regulation, and physiological functions of testosterone, estrogens, and progesterone; hormonal control of the menstrual cycle, pregnancy, and lactation. **Endocrine Disruptors:** Environmental endocrine-disrupting chemicals and their effects on hormone synthesis, secretion, transport, receptor interactions, and physiological functions. **Clinical Endocrinology (Pathophysiology):** • **Thyroid Disorders:** Graves' disease, Hashimoto's thyroiditis, and goiter. • **Pancreatic Disorders:** Type 1 and Type 2 Diabetes Mellitus. • **Adrenal Disorders:** Cushing's syndrome and Addison's disease. • **Pituitary Disorders:** Gigantism, acromegaly, and diabetes insipidus.	7	7	cases to apply theoretical knowledge. .

References:

1. Berg, J. M., Tymoczko, J. L., Gatto, G. J., & Stryer, L. (2019). *Biochemistry* (9th ed.). W. H. Freeman.
2. Lodish, H., Berk, A., Kaiser, C. A., Krieger, M., Bretscher, A., Ploegh, H., Amon, A., & Martin, K. C. (2021). *Molecular cell biology* (9th ed.). W. H. Freeman.
3. Nelson, D. L., & Cox, M. M. (2021). *Leininger principles of biochemistry* (8th ed.). Macmillan Learning.
4. Hadley, M. E., & Levine, J. E. (2007). *Endocrinology* (6th ed.). Pearson Prentice Hall.
5. Holt, R. I. G., & Hanley, N. A. (2021). *Essential endocrinology and diabetes* (7th ed.). Wiley-Blackwell.
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7. Satyanarayana, U., & Chakrapani, U. (2021). Biochemistry (6th ed.). Elsevier India / Books and Allied.
8. Vasudevan, D. M., Sreekumari, S., & Vaidyanathan, K. (2023). Textbook of biochemistry for medical students (10th ed.). Jaypee Brothers Medical Publishers.

Model Questions	**Unit I: Introduction to the Endocrine System** **Short Answer Questions** 1. Define hormone and endocrine gland. 2. Classify hormones based on their chemical nature. 3. What are peptide hormones? 4. Define plasma binding proteins and mention their significance.

5. What is the half-life of a hormone?
6. What are G-protein coupled receptors (GPCRs)?
7. Name the major second messenger systems involved in hormone action.

Long Answer Questions

1. Discuss the classification of hormones based on their chemical nature with suitable examples.
2. Explain the biosynthesis, storage, and secretion mechanisms of peptide, steroid, amino acid-derived, and eicosanoid hormones.
3. Describe hormone transport in blood and discuss the significance of plasma binding proteins, half-life, and metabolic clearance.
4. Explain the mechanisms of hormone action through cell surface receptors, including GPCRs, receptor tyrosine kinases, and cytokine receptors.
5. Discuss the cAMP and cGMP second messenger pathways in hormonal signaling.
6. Explain the IP_3/DAG and Ca^{2+} signaling pathways with suitable examples.
7. Describe intracellular receptors, hormone response elements (HREs), and regulation of gene expression by steroid hormones.

Unit II: Hypothalamic-Pituitary Axis and Neuroendocrinology

Short Answer Questions

1. Describe the anatomical divisions of the pituitary gland.
2. What is the hypothalamic-pituitary axis?
3. State the functions of Growth Hormone (GH).
4. What is the role of Prolactin (PRL)?
5. Mention the physiological functions of Antidiuretic Hormone (ADH).
6. What is the role of Oxytocin?
7. Define negative feedback regulation in endocrinology.

Long Answer Questions

1. Discuss the anatomy of the pituitary gland and its vascular and neural connections with the hypothalamus.
2. Explain the synthesis, regulation, and physiological actions of Growth Hormone (GH).
3. Describe the synthesis, regulation, and biological functions of Prolactin, ACTH, and TSH.
4. Explain the synthesis, regulation, and functions of Gonadotropins (LH and FSH).
5. Discuss the synthesis and physiological roles of Oxytocin and Antidiuretic Hormone

	(ADH). 6. Explain long-loop, short-loop, and ultra-short-loop feedback mechanisms in endocrine regulation. 7. Discuss positive and negative feedback mechanisms with suitable endocrine examples.
	Unit III: Peripheral Endocrine Glands & Metabolic Regulation **Short Answer Questions** 1. Name the thyroid hormones and their precursors. 2. What is thyroglobulin? 3. Define glucocorticoids and mineralocorticoids. 4. What is the Renin-Angiotensin-Aldosterone System (RAAS)? 5. Name the hormones secreted by the adrenal medulla. 6. What are the functions of insulin and glucagon? 7. Mention the hormones involved in calcium homeostasis. **Long Answer Questions** 1. Explain the biosynthesis, transport, and physiological functions of thyroid hormones (T_3 and T_4). 2. Discuss iodine metabolism and its role in thyroid hormone synthesis. 3. Describe the synthesis and functions of cortisol, aldosterone, and adrenal androgens. 4. Explain the Renin-Angiotensin-Aldosterone System (RAAS) and its physiological significance. 5. Discuss the biosynthesis and physiological functions of catecholamines in the fight-or-flight response. 6. Explain the synthesis, secretion, and metabolic actions of insulin and glucagon and their role in blood glucose regulation. 7. Discuss the roles of Parathyroid Hormone (PTH), Calcitonin, and Vitamin D in calcium and phosphate homeostasis.
	Unit IV: Reproductive Endocrinology & Clinical Biochemistry **Short Answer Questions** 1. Name the major reproductive hormones in males and females. 2. What is the physiological role of testosterone? 3. Define endocrine disruptors. 4. What is Graves' disease?

5. Differentiate between Type 1 and Type 2 Diabetes Mellitus.
6. What is Cushing's syndrome?

Long Answer Questions

1. Discuss the biosynthesis and physiological functions of testosterone, estrogens, and progesterone.
2. Explain the hormonal regulation of the menstrual cycle.
3. Describe the endocrine changes during pregnancy and lactation.
4. Discuss endocrine disruptors and their effects on hormone action.
5. Explain the etiology, biochemical features, and clinical manifestations of Graves' disease, Hashimoto's thyroiditis, and goiter.
6. Discuss the biochemical basis, symptoms, and complications of Type 1 and 2 Diabetes Mellitus.

Multiple Choice Questions

1. Which of the following is a steroid hormone?
   A) Insulin
   B) Cortisol
   C) Glucagon
   D) Growth Hormone
2. The second messenger commonly associated with GPCR activation is:
   A) DNA
   B) RNA
   C) cAMP
   D) ATP
3. Growth Hormone is secreted by the:
   A) Thyroid gland
   B) Posterior pituitary
   C) Anterior pituitary
   D) Adrenal cortex
4. Antidiuretic Hormone (ADH) primarily regulates:
   A) Blood glucose
   B) Calcium levels
   C) Water balance
   D) Thyroid function
5. The major hormone produced by the adrenal medulla is:

A) Aldosterone

B) Cortisol

C) Epinephrine

D) Testosterone

6. Insulin is secreted by:

A) Alpha cells

B) Beta cells

C) Delta cells

D) Acinar cells

7. Which hormone increases blood calcium levels?

A) Calcitonin

B) Insulin

C) Parathyroid Hormone

D) Glucagon

8. Graves' disease is associated with:

A) Hypothyroidism

B) Hyperthyroidism

C) Diabetes Mellitus

D) Addison’s disease

9. Deficiency of ADH results in:

A) Diabetes Mellitus

B) Diabetes Insipidus

C) Acromegaly

D) Goiter

10. ELISA is commonly used for:

A) DNA sequencing

B) Hormone estimation

C) Chromosome analysis

D) Protein synthesis

The distribution of marks for the continues assessment test (CAT) shall be as follows:

<table>
<tr><th colspan="3">Internal Assessment (Theory) for 20 marks</th></tr>
<tr><td>MCQ Test 1 (10M) based on 25% syllabus</td><td rowspan="3">Average of best 2 out of 3 tests (Total performance is not less 40%)</td><td rowspan="3">10 Marks</td></tr>
<tr><td>MCQ Test 2 (10M) based on 50% syllabus</td></tr>
<tr><td>MCQ Test 3(10M) based on 75% syllabus</td></tr>
<tr><td colspan="2">Assignments /Innovative activities /GD/Seminar/ Poster presentation, quiz etc (any two activities 5 mark each)</td><td>10 Marks</td></tr>
<tr><td colspan="2">Total</td><td>20 Marks</td></tr>
</table>

103222 (Major) Lab Practical 11 Enzyme Technology: Laboratory Methods							
Level	**Semester**	**Course code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Maximum marks**
5.0	IV	103222	Enzyme Technology: Laboratory Methods	2	60	2Hrs	25+25

Course Objective	• To equip students with knowledge of how various factors such as temperature, pH, substrate concentration, inhibitors, and activators influence enzyme activity. • To train students in essential biochemical laboratory techniques, including the extraction and analysis of enzyme activity from natural sources like jack bean meal and germinating seeds. • To enable students to accurately collect, analyze, and interpret experimental data, fostering critical thinking and problem-solving skills. • To encourage students to apply theoretical concepts to practical experiments, bridging the gap between classroom learning and laboratory practice.
Course Outcomes :	Upon successful completion of this course, students will be able to: • Assess how temperature, pH, substrate concentration, inhibitors, and activators affect the activity of enzymes like salivary amylase. • Calculate key enzyme kinetics parameters, specifically Km and Vmax, through experimental data. • Conduct enzyme assays to determine critical points such as the achromic point of salivary amylase. • Successfully extract and evaluate the activity of enzymes from natural sources, including urease from jack bean meal and amylase from germinating seeds. • Demonstrate proficiency in maintaining accurate laboratory records and adhering to safety protocols.

Sr. No.	Content of Practical (List of Laboratory Experiments/ Activities etc.)
1	To determination of Amylase Activity Using Starch Hydrolysis Assay
2	To estimate Protease Activity Using Casein Digestion Assay
3	To study effect of temperature on activity of Salivary Amylase or any other suitable enzyme.
4	To study effect of pH on activity of Salivary Amylase or any other suitable enzyme.
5	To study effect of substrate concentration on salivary amylase or any other suitable enzyme
6	To determination of achromic point of salivary amylase
7	To demonstrate Urease activity from Jack Bean Meal
8	To estimate day wise amylase activity in germinating seeds

References	
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The distribution of marks for the practical examination shall be as follows:

External Evaluation		Internal Evaluation base on CAT	
Performance of any two experiments	20 marks	Attendance & student's performance	10 Marks
Viva-voce	05 marks	Practical Record book	05 Marks
		MCQ/ Spotting (Consider best 2 out of 3 tests)	10 Marks
Total	25 Marks	**Total**	25 Marks

103223 Theory 4 (Minor) General Enzymology							
Level	**Semester**	**Course code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Maximum marks**
5.0	IV	103223	General Enzymology	2	30	2 Hrs	30

Course Objective	• To understand Enzyme Structure and Function • To comprehend Enzyme Kinetics and Inhibition • To explore Coenzymes and Cofactors • To analyze Mechanisms of Enzyme Action • To develop Practical Skills in Enzymology • To appreciate Applications of Enzymes
Course Outcomes	After the completion of this course, the student will be able to: • Describe nomenclature and classification of enzymes and coenzymes. • Apply knowledge on enzyme kinetics for laboratory and research purpose. • Predict the type of enzyme inhibition from kinetic data. • Apply the knowledge on isolation and purification of enzymes for practical purpose • Describe the major applications of enzymes in industry and medicine.

Unit System	Contents	Workload allotted In hours	Weightage of Marks Allotted	Pedagogy
Unit-I Basic enzymology	a. General characteristics, nomenclature, IUB classification ofenzymes. b. Holoenzymes, apoenzymes, coenzymes, cofactors, activators, inhibitors, active site, metalloenzyme, marker enzyme, monomeric and oligomeric enzymes. c. Unit of enzyme activity, isoenzyme, multienzyme complexes, enzyme specificity.	8	8	Chalk and board Power point presentation, Videos, Animation etc
Unit-II Enzyme Kinetics and Enzyme inhibition	a. Significance of energy of activation and free energy, Derivation of Michalis Menton equation for unisubstrate reaction, Km and its significance, Line Weaver Burk plot and its limitation. b. Factors affecting enzyme activity Substrate concentration, enzyme conc., pH, temperature c. Bisubstrate reactions sequential and ping-pong mechanism with examples Reversible and irreversible inhibition, competitive, noncompetitive and uncompetitive inhibition	7	7	Chalk and board Power point presentation, Videos, Animation etc

Unit-III Coenzymes and Cofactors	a. Allosteric enzymes: Characteristics and models of allosteric enzyme regulation b. Role of coenzymes in enzyme catalysis- NAD/NADP,FAD/FMN, Coenzyme- Q, Biotin, Cobamide, Lipoamide,TPP,THF, Pyridoxal phosphate. c. Role of cofactors/metal ions in enzyme catalysis: Metalloenzymes and metal activated enzymes, role of metal as structural element during enzyme catalysis role of metal ionsin oxidation reduction reactions.	8	8	Chalk and board Power point presentation, Videos, Animation etc
Unit-IV Mechanism of enzyme action	a. Acid-base catalysis, covalent catalysis, Metal Ion Catalysis, Mechanism of action of chymotrypsin and carboxypeptidase. b. Proximity and orientation effect, strain and distortion effect. c. Mechanism of action- Lock and Key hypothesis Induced fit model.	7	7	Chalk and board Power point presentation, Videos, Animation etc

References	1) Text Book of Biochemistry by Dr. O. P. Agrawal. 2) An Introduction to Practical Biochemistry by David T Plummer 3) Essentials of Biochemistry by Dr. M. C. Pant. 4) Text book of Biochemistry by West and Todd. 5) Practical manual in Biochemistry by Jairaman. 6) Essentials of Food and Nutrition, Volume I & II by Swaminathan. 7) Text book of Biochemistry by Sucheta Dandekar. 8) Text book of Biochemistry by U. Sattyanarayan 9) Fundamentals of Biochemistry by J. L. Jain 10) Lehninger, A I., (1982), Principles of Biochemistry, Butterworth Publishers, New York. 11) Palmer T., (1985). Understanding Enzymes. 2nd Ed., Ellis Horwood Ltd., Chichester 12) Price, N. C, Stevens, L, (1989), Fundamentals of Enzymology, 2"d Ed.,Oxford Sci. Publ., Oxford 13) Fundamentals of Biochemistry (1999) by Donald Voet, Judith Voet, Charlotte Pratt, John Wiley& Sons, N.Y. 145 146 14) Biochemistry 3rd edition (1994) by Lubert Stryer WH Freeman and Co. San Francisco. 15) General Enzymology by M.S. Deshpande and N.S. Kulkarni (Himalaya Publication House)

Model Questions	Long-Answer Questions: 1. Discuss the general characteristics of enzymes, including their nomenclature and the International Union of Biochemistry (IUB) classification system. 2. Define and differentiate between holoenzymes, apoenzymes, coenzymes, cofactors, activators, inhibitors, active sites, metalloenzymes, marker enzymes, monomeric enzymes, and oligomeric enzymes. 3. Explain the derivation of the Michaelis-Menten equation for a unisubstrate reaction, define the Michaelis constant (Km), and discuss its significance. Additionally, describe the Lineweaver-Burk plot and its limitations. 4. Describe the mechanisms of acid-base catalysis and covalent catalysis in enzymes, providing specific examples of enzymes that utilize these mechanisms.

Short-Answer Questions:

1. What is the significance of the activation energy in enzymatic reactions?
2. List and briefly describe the factors that affect enzyme activity.
3. Differentiate between competitive, noncompetitive, and uncompetitive inhibition.
4. What are allosteric enzymes, and how do they regulate enzymatic activity?
5. Name two models that explain enzyme-substrate interaction and briefly describe them.
6. Define isoenzymes and provide an example.
7. What is the role of metal ions in enzyme catalysis?
8. Explain the concept of enzyme specificity.

Multiple-Choice Questions (MCQs):

1. Which of the following statements about the mechanism of allosteric control of enzyme activity is correct?

   A) Allosteric enzymes are typically single-subunit enzymes.

   B) Allosteric enzymes show greater sensitivity to changes in substrate concentration compared to classical type enzymes with hyperbolic kinetics.

   C) Allosteric enzymes show Michaelis-Menten kinetics.

   D) Allosteric enzymes are not influenced by effector molecules.

2. Which of the following statements about the nature of enzyme catalysis is correct?

   A) The rate of formation of the transition state intermediate determines the overall free energy change of the reaction.

   B) The active site of an enzyme is perfectly complementary to the substrate in its ground state.

C) The rate of formation of the transition state intermediate determines the overall reaction rate.

D) Enzymes alter the equilibrium constant of the reactions they catalyze.

3. In the Michaelis-Menten equation, what does Km represent?

A) The maximum reaction velocity.

B) The substrate concentration at half-maximal velocity.

C) The equilibrium constant for the enzyme-substrate complex.

D) The turnover number of the enzyme.

4. Which type of enzyme inhibition can be overcome by increasing substrate concentration?

A) Competitive inhibition.

B) Noncompetitive inhibition.

C) Uncompetitive inhibition.

D) Irreversible inhibition.

5. What is the effect of a noncompetitive inhibitor on Vmax and Km?

A) Decreases Vmax; Km remains unchanged.

B) Increases Vmax; Km remains unchanged.

C) Decreases Vmax; increases Km.

D) Increases Vmax; decreases Km.

6. Which of the following is an example of a coenzyme?

A) Mg^{2+}

B) NAD^{+}

C) Zn^{2+}

D) Cl^{-}

7. The 'Induced Fit' model of enzyme action suggests that:

A) The enzyme's active site is rigid and complementary to the substrate.

	B) The enzyme undergoes a conformational change upon substrate binding. C) The substrate must change its shape to fit the enzyme. D) The enzyme and substrate interact through covalent bonds. 8. Which of the following best describes acid-base catalysis in enzymes? A) Formation of a transient covalent bond between enzyme and substrate. B) Transfer of protons to stabilize charged intermediates. C) Utilization of metal ions to facilitate catalysis. D) Induced fit of the enzyme to the substrate

The distribution of marks for the continuous assessment test (CAT) shall be as follows:

Internal Assessment (Theory) for 20 marks		
MCQ Test 1 based on 25% syllabus	Consider best 2 out of 3 test (Average of best 2) (Total performance is not less 40%)	10 Marks
MCQ Test 2 based on 50% syllabus		
MCQ Test 3 based on 75% syllabus		
Assignments /Innovative activities /GD/Seminar/ Poster presentation, quiz etc (any two activities 5 mark each)		10 Marks
Total		20 Marks

103224 (Minor) Lab/ Practical-12 : Practical Enzymology							
Level	**Semester**	**Course code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Maximum marks**
5.0	IV	103224	Practical Enzymology	2	60	2 Hrs	30
Course Objectives	• To understand the principles and methods for determining enzyme activity. • To study the effect of various factors such as temperature, pH, and substrate concentration on enzyme activity. • To determine the achromic point of salivary amylase and its significance in enzymatic reactions. • To evaluate the role of activators in enhancing enzyme activity. • To demonstrate urease activity from Jack Bean Meal and understand its enzymatic function. • To study amylase activity from germinating seeds and its role in seed metabolism.						
Course Outcomes	Upon successful completion of this course, students will be able to: • Perform enzyme activity assays for different enzymes using suitable methods. • Analyze the effect of temperature, pH, and substrate concentration on enzyme-catalyzed reactions. • Determine Km and Vmax values for enzyme kinetics and interpret their biological significance. • Explain the concept of the achromic point and its application in enzymatic studies. • Evaluate the influence of activators on enzyme activity and understand their mechanism of action. • Demonstrate and analyze urease activity from Jack Bean Meal. • Investigate amylase activity in germinating seeds and its role in carbohydrate metabolism.						
Sr. No.	**Content of Practical (List of Laboratory Experiments/ Activities etc.)**						
1	To determine enzyme activity of any suitable enzyme.						
2	To study effect of temperature on Salivary Amylase or any other suitable enzyme.						
3	To study effect of pH on Salivary Amylase or any other suitable enzyme.						
4	To study effect of substrate concentration on salivary amylase or any other suitable enzyme and determination of Km and Vmax						
5	Determination of achromic point of salivary amylase						
6	To study the effect of activator on enzyme activity						
7	Demonstration of Urease activity from Jack Bean Meal						
8	Demonstration of amylase activity from germinating seeds.						

The distribution of marks for the practical examination shall be as follows

External Evaluation		**Internal Evaluation base on CAT**	
Performance of any two experiments	20 Marks	Attendance & student's performance	10 Marks
Viva-voce	05 Marks	Practical Record book	05 Marks
		MCQ/ Spotting	10 Marks
Total	25 Marks	**Total**	25 Marks

Sant Gadge Baba Amravati University, Amravati NEP Syllabus

UG Programme

Faculty: Science and Technology

Programme: B.Sc. Biochemistry

Course: B.Sc. II Semester-IV : Open Elective

FACULTY: **SCIENCE AND TECHNOLOGY**

Teaching and learning scheme: For the Degree of Bachelor of

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

B.Sc II: SEMESTER-IV

103225: Biochemistry of food digestion (GOEC)							
Level	**Semester**	**Course Code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Max Marks**
5.0	IV	103225	Biochemistry of food digestion	2	30	2 Hrs	30

Course Objectives:

- **To understand the composition and Nutritional Roles of Foods**: Analyze the types, sources, and biochemical nature of daily-consumed foods, along with their macronutrient and micronutrient content.
- **To explore digestive and Biochemical Processes**: Examine the structure and function of the digestive system, the role of enzymes and hormones in macronutrient breakdown, and the absorption mechanisms for nutrients.
- **To link nutrition to Health and Disease**: Understand the integration of nutrients into energy metabolism and the clinical implications of digestive and metabolic disorders, such as lactose intolerance and malabsorption syndromes.

Course Outcomes: Upon completion of the course, students would be able to

- Identify and classify different types of foods and understand their

biochemical composition and nutritional significance.

- Gain insights into the anatomical and biochemical mechanisms of digestion, nutrient absorption, and their integration into energy metabolism.
- Analyze the impact of nutrient metabolism on health and recognize clinical implications of digestive and metabolic disorders, enabling informed decision-making in nutrition and dietetics.

Unit System	Contents	Workload
Unit 1: Foods and their nutrients	**a. Definition of food and types of daily consumed foods:** Energy-Proving Foods, Energy-Proving Foods, Protective Foods, Plant-Based Foods, Animal-Based Foods, Processed Foods, Functional Foods, Convenience Foods, Junk Foods, Sea foods. **b. Overview of food composition**: Cereals, Pulses, oil seeds, Vegetables, Fruits, Non-veg foods, Fishes, eggs, **c. Brief biochemical nature and nutritional role of food ingredients:** carbohydrates, dietary fibers, proteins, fatty acids, lipids, vitamins and minerals.	8
Unit 2: Digestion and Biochemical Processes	**a. Overview of the Digestive System:** Structure and Anatomy of the gastrointestinal (GI) tract, Accessory organs (liver, pancreas, salivary glands). **b. Digestive Secretions:** Saliva, gastric juice, bile, pancreatic enzymes, Regulation of digestive secretions by hormones (gastrin, secretin, cholecystokinin). **c. Biochemical Principles in Digestion:** Role of enzymes in digestion, Hydrolysis reactions in macronutrient breakdown.	8

Unit 3: Carbohydrate Digestion and Absorption	a. **Biochemical Breakdown of Carbohydrates:** Role of amylase (salivary and pancreatic), Enzymatic digestion in the small intestine (maltase, lactase, sucrase). b. **Mechanism of Absorption:** Transporters for glucose and fructose (SGLT1, GLUT2, GLUT5), Role of the hepatic portal system in carbohydrate metabolism, Integration of carbohydrates in energy metabolism c. **Clinical Implications:** Lactose intolerance and other carbohydrate digestion disorders.	7
Unit 4: Protein and Lipid Digestion	a. **Protein Digestion:** Proteolytic enzymes: pepsin, trypsin, chymotrypsin, carboxypeptidase, Role of HCl in protein denaturation, Absorption of amino acids and peptides. b. **Lipid Digestion:** Emulsification by bile salts, Enzymatic action of lipases, Absorption of monoglycerides, fatty acids, and formation of chylomicrons, Integration of proteins, and lipids in energy metabolism c. **Pathophysiology:** Disorders like pancreatitis, gallstones, and malabsorption syndromes.	7
References	1. "Principles of Human Nutrition" by Martin Eastwood 2. "Understanding Nutrition" by Ellie Whitney and Sharon Rady Rolfes 3. "Advanced Nutrition and Human Metabolism" by Sareen S. Gropper, Jack L. Smith, and Timothy P. Carr 4. "Biochemistry of Foods" by N.A. Michael Eskin and Fereidoon Shahidi 5. "Textbook of Biochemistry for Medical Students" by DM Vasudevan, Sreekumari S., and Kannan Vaidyanathan 6. "Food Science" by Norman N. Potter and Joseph H. Hotchkiss 7. "Food Chemistry" by Owen R. Fennema 8. "Introduction to Human Nutrition" by Michael J. Gibney, Susan A. Lanham-New, Aedin Cassidy, and Hester H. Vorster 9. "Modern Nutrition in Health and Disease" by A. Catherine Ross, Benjamin Caballero, Robert J. Cousins, Katherine L. Tucker, and Thomas R. Ziegler	

	10. "Clinical Nutrition" by Marinos Elia, Olle Ljungqvist, Rebecca Stratton, and Neville L. Shaffer
Model Questions	**Long Question** 1. Discuss the classification of foods based on their sources and nutritional roles. 2. Explain the structure and function of the gastrointestinal (GI) tract and its accessory organs. 3. Describe the biochemical processes involved in carbohydrate digestion and absorption. 4. Elaborate on the digestion and metabolism of proteins and lipids.
	Short questions 1. Define food and classify the types of daily consumed foods. 2. What are functional foods? Provide two examples. 3. List the key biochemical components of cereals and their nutritional roles. 4. Explain the role of dietary fibers in human health. 5. Name the hormones that regulate digestive secretions and describe their functions. 6. What is the function of bile salts in lipid digestion? 7. Describe the mechanism of glucose absorption in the small intestine. 8. What are the clinical symptoms and causes of lactose intolerance?
	Multiple Choice Questions (MCQs) 1. **Which of the following is an example of a protective food?** a) Rice b) Milk c) Butter d) Potato **Answer:** b) Milk 2. **Which nutrient is primarily responsible for energy storage in the body?** a) Proteins b) Lipids c) Vitamins d) Minerals **Answer:** b) Lipids

	3. **What is the primary enzyme involved in the digestion of carbohydrates in the mouth?** a) Trypsin b) Amylase c) Pepsin d) Lipase **Answer:** b) Amylase 4. **Which organ produces bile to aid in lipid digestion?** a) Stomach b) Liver c) Pancreas d) Gallbladder **Answer:** b) Liver 5. **What is the main transporter responsible for glucose absorption in the small intestine?** a) SGLT1 b) GLUT2 c) GLUT5 d) SGLT2 **Answer:** a) SGLT1 6. **Which vitamin is essential for calcium absorption in the body?** a) Vitamin C b) Vitamin D c) Vitamin A d) Vitamin K **Answer:** b) Vitamin D 7. **What is the primary function of dietary fiber in the diet?** a) Provide energy b) Aid in digestion and prevent constipation c) Build muscle d) Enhance lipid absorption **Answer:** b) Aid in digestion and prevent constipation **8. Which disorder is associated with a deficiency of lactase enzyme?** a) Pancreatitis b) Lactose intolerance c) Gallstones d) Malabsorption syndrome **Answer:** b) Lactose intolerance

103226 (Major) VSC - Lab Practical 13 Practicals in Applied Enzyme Technology							
Level	**Semester**	**Course code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Maximum marks**
5.0	**IV**	**103226**	**Practicals in Applied Enzyme Technology**	**2**	**60**	**2Hrs**	**50**
Course Objective	• To introduce students to enzyme extraction techniques from plant sources and their industrial significance. • To develop hands-on skills in enzyme isolation, purification, and characterization. • To understand the enzymatic clarification of fruit juices and its commercial applications. • To explore the role of papain in food processing, particularly in meat tenderization. • To analyze the activity of proteolytic enzymes in digestive supplements using spectrophotometry. • To compare amylase activity from different plant sources through starch hydrolysis assays. • To evaluate the amylase inhibitory potential of various plant extracts and its relevance in diabetes management. • To provide exposure to real-world industrial practices through visits and vocational skill training.						
Course Outcomes:	After completing this course, students will be able to: 1. Extract and characterize enzymes such as pectinase, papain, and amylase from plant sources. 2. Demonstrate enzymatic applications in food processing, particularly in juice clarification and meat tenderization. 3. Quantify enzyme activity using spectrophotometric methods and interpret results scientifically. 4. Compare enzyme activities from different plant sources to understand their biochemical variations. 5. Evaluate enzyme inhibition mechanisms and their potential role in metabolic regulation, such as diabetes management. 6. Develop analytical and technical skills in enzyme assay techniques relevant to research and industry.						

Sr No.	List of Laboratory Experiments/Activities etc.
1	Salting in and salting out using any salt
2	Organic solvent precipitation of any one enzyme.
3	Extraction of enzyme pectinase from plant sources
4	Enzymatic Clarification of Fruit Juice Using Plant-Derived Pectinase
5	Isolation of papain enzyme from plant latex
6	Extraction of lipase from germinating seeds
7	To compare Amylase Activity from Starch Hydrolysis Assay in different plant sources
8	To compare the amylase inhibitory activity of different plant sources
9	Industrial visit / excursion tour for vocational skill training

References	Practical Biochemistry: Principles and Techniques – Keith Wilson & John Walker 1. Methods in Enzymology – Sidney P. Colowick& Nathan O. Kaplan 2. Biochemical Methods – S. Sadasivam & A. Manickam 3. Practical Biochemistry for Students – D.T. Plummer 4. Laboratory Manual in Biochemistry – J. Jayaraman 5. Experimental Biochemistry – Robert Switzer & Liam Garrity 6. Biochemical Techniques: Theory and Practice – John F. Robyt& Bernard J. White 7. Practical Biochemistry and Molecular Biology – A.K. Ghosh Enzymology Lab Manual – Nigam A. & Singh R.

The distribution of marks for the practical examination shall be as follows

Internal Evaluation for VSC	
Attendance	10 Marks
Practical performance	20 Marks
MCQ/ Spotting	10 Marks
Practical Record book	10 Marks
Total	**50 Marks**

B. Sc. II Semester IV (NEP)

Course Category: Field Project (FP) / Community Engagement and Service (CES) of Major subject: Biochemistry

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.0	IV	103228	(FP/ CEP in Biochemistry - II)	2	60	--	50

Course Objectives:	The intended objectives are: • To provide practical, real-world experience, in their field of study, allowing them to apply theoretical knowledge to real-world situations or address Real-World Problems. • To enhance research, interpretation and analytical skills, strengthening their critical thinking and problem-solving abilities. • To foster engagement with a specific biochemistry related issue or area of study, address specific challenges or needs within a community. • To Improve Collaboration, Communication among students and facilitate knowledge transfer from lab to land and get self inspiration for contribution to the society by applying the subject knowledge.
Course Outcomes:	Upon successful completion of this course, students will be able to: • Develop their practical, technical skills and a deeper understanding of their subject matter and how it applies to real-world situations. • Learn to identify, analysis, and interpretation of complex problems using their knowledge and develop research skills. • Gain insight into social issues and the role of various governmental schemes for the welfare of people and explore new ideas and approaches. • Learn to work effectively in teams and collaborate with others to achieve common goals and contributing to community's socio-economic improvements

As per NEP 2020, students of B Sc. II of Semester III need to perform a Field Project (FP)/ Community Engagement Service (CES) for TWO (2) credits i.e. 50 Marks. The guidelines/ SoP regarding the FP/CES are as follows:

12) The total time allocation for the student to carry out FP/CES is 60 hours.
13) Students should participate in FP/CES under the supervision of faculty.
14) Assigning the FP/CES topics to individual students or groups of students (4 to 5 students in one group) and one faculty member from the department will act as Guide for the student or group of students.
15) CES may include awareness programs, public talk/ lectures, workshops, blood testing camps, vaccination drives in collaboration, surveys etc
16) For a SURVEY based FP/CES, related questionnaire (15 or more questions) should be prepared. The departmental coordinator/guide should 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.
17) Field project may be undertaken to include survey/ laboratory work/ data analysis/ field work or in combination of these which involves practical application of knowledge and skill to address a specific problem or issue within biochemistry related context such as health, sustainable environment, agriculture etc.
18) A project report should be written individually in the standard format (2 Copies): Index,

	Introduction, Materials, Methods, Result, Conclusion/output, References (Numeric citation type) etc. The report should be of minimum 6 pages (excluding Title page, Certificate, Index, Acknowledgement etc.) Submit the project report with the Guide's signature to the department. 19) Students should maintain the documentation and record properly which includes dairy, photographs, certificates, feedback of beneficiaries, news in local paper if any. 20) A CES report should be written individually in the standard format (2 Copies): Index, Introduction, details of activities, photographs, signature sheets of beneficiaries, feedback of beneficiaries, own feedback, summary /output, etc. It should be submitted with the Guide's signature to the department. 21) The oral /poster presentation for all the FP/CES should be arranged in the department. To evaluate the project, examiner should be appointed by HoD. 22) The total work for FP/CES including preparation of questionnaire to presentation should be evaluated for 2 credits (50 Marks).
References	3. https://www.ugc.gov.in/pdfnews/4187860_Revised-Final-Guidelines.pdf 4. https://en.wikipedia.org/wiki/OU_Citizen_Science_Soil_Collection_Program
Model Questions:	**NA**

Distribution of Marks and the scheme of FP/CES Evaluation as follows:

Sr. No	Evaluation type	Marks
1	Student performance	20
2	FP/CES Report	20
3	Presentation (PPT or Poster)	10
Total		50

Sant Gadge Baba Amravati University, Amravati
Teaching and Learning Scheme for the Degree of Bachelor of Science
(Three Years Six Semesters Bachelor's Degree Programme)

Programme: B. Sc. (Biochemistry)
Course: B. Sc III Semester V

Vertical No.	The Vertical	Type of Course	Course Code	Course Name
a.	Major Biochemistry	Theory 8	103230	Inheritance Biology
		Theory 9	103231	Molecular Biology
		Theory 10	103232	Biotechnology
		Lab/Practical 15	103233	Laboratory Techniques in Genetics, Molecular Biology and Biotechnology
	Mejor (Elective)	Theory 1 (DSE 1)	103234	Fundamentals of Plant Biochemistry
		Lab/Practical 16	103235	Basic practicals in Plant Biochemistry
		Theory 1 (DSE 2)	103236	Biostatistics and Bioinformatics
		Lab/Practical 16	103237	Basic practicals in Biostatistics and Bioinformatics
b.	Minor	Theory 5	103238	Molecular Biology and Biotechnology
		Lab/Practical 17	103239	Practicals in Molecular Biology and Biotechnology
c.	Generic/OE	-	-	-
d.	VSC	Lab/Practical 18	103240	Applied Techniques in Biotechnology
	SEC	Lab/Practical 19	103241	Analytical Techniques in Molecular Biology and Genetics
e.	FP/CES	Project	103242	(FP/ CEP in Biochemistry)
	Non-Credit	Non Credit		Foundation of Artificial Intelligence
	TOTAL			

(103230) Theory 8 (Major) Inheritance Biology							
Level	**Semester**	**Course code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Maximum marks**
5.5	V	103230	Inheritance Biology	2	30	2 Hrs	30
Course Objectives	• To understand the fundamental principles of inheritance and Mendelian genetics. • To explain non-Mendelian inheritance patterns and gene interactions. • To describe cytoplasmic inheritance, mutations and chromosomal abnormalities. • To understand population genetics and the genetic basis of human disorders.						
Course Outcomes	Upon completion of this course successfully, students would be able to • Understand the Laws of Mendel, gain insight in to various types of gene interaction. • Gain knowledge on the principles of Linkage and crossing; analyze the genetic map. • Comprehend the phenomenon of extra nuclear inheritance. • Understand analyze various structural and numerical chromosomal aberrations. • To understand population genetics and common human genetic disorders.						
Unit	**Content**				**Workload Allotted in Hours**	**Weightage of Marks Allotted**	**Pedagogy**
Unit 1 **Principles of Inheritance**	➢ Basic concepts of genetics: gene, allele, multiple alleles, pseudoalleles, genome, genotype and phenotype ➢ Heredity, variation, pure lines and inbred lines ➢ Mendelian principles of inheritance: dominance, segregation and independent assortment ➢ Monohybrid and dihybrid crosses, back cross and test cross, Complementation test and its applications				8 Hrs	8 marks	Chalk and board Power point presentation, Videos, Animation Etc
Unit 2 **Non-Mendelian Inheritance and Gene Interactions**	➢ Patterns of Non-Mendelian Inheritance: Incomplete dominance and codominance. Gene interactions and epistasis ➢ Gene Expression and Inheritance: Pleiotropy, Penetrance and expressivity, Phenocopy and genomic imprinting ➢ Linkage and Sex-linked Inheritance: Linkage and crossing over. Sex determination, sex-linked, sex-limited and sex-influenced inheritance				7 Hrs	7 marks	Chalk and board Power point presentation, Videos, Animation Etc
Unit 3 Cytoplasmic Inheritance,	➢ Cytoplasmic Inheritance: Extra-chromosomal inheritance, Mitochondrial and chloroplast inheritance, Maternal inheritance and its significance				8 Hrs	8 marks	Chalk and board Power point presentation,

Mutations and Chromosomal Aberrations	➢ Mutations and Mutagenesis: Types and causes of mutations, Spontaneous and induced mutations, Loss-of-function and gain-of-function mutations, Germinal and somatic mutations, Insertional mutagenesis ➢ Chromosomal Aberrations: Numerical chromosomal aberrations: Aneuploidy and Polyploidy, Structural chromosomal aberrations: Deletion, Duplication, Inversion and Translocation, genetic implications of chromosomal abnormalities			Videos, Animation Etc
Unit 4 **Population Genetics and Human Genetic Disorders**	➢ Population Genetics: Gene and genotype frequencies, Hardy–Weinberg equilibrium: assumptions and applications. ➢ Factors affecting genetic equilibrium: mutation, migration, genetic drift and natural selection ➢ Human Genetic Disorders: Sickle Cell Anemia, Thalassemia, Hemophilia, Color Blindness, Down Syndrome, Turner Syndrome	7 Hrs	7 marks	Chalk and board Power point presentation, Videos, Animation Etc
References	1. Principles of Genetics, Snustad D.P. and Simmons M.J., John Wiley & Sons. 2. Genetics: A Conceptual Approach, W.H. Freeman & Company. 3. Concepts of Genetics, Pearson Education. 4. Introduction to Genetic Analysis, W.H. Freeman & Company. 5. Human Genetics, McGraw-Hill Education. 6. Molecular Biology of the Gene, Pearson Education. 7. Cell and Molecular Biology, Lippincott Williams & Wilkins. 8. Molecular Cell Biology, W.H. Freeman & Company. 9. Genetics, Rastogi Publications. 10. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, S. Chand & Company.			
Model Questions	**Short Answer Questions** 1. Define gene and allele. 2. What are multiple alleles? 3. Define genotype and phenotype. 4. What is pleiotropy? 5. Define penetrance and expressivity. 6. What is genetic drift? 7. What is Down syndrome? 8. What is Turner syndrome? **Long Answer Questions** 1. Explain Mendel's laws of inheritance with suitable examples. 2. Discuss incomplete dominance, codominance, and gene interactions with examples. 3. Describe linkage and crossing over and explain their significance in genetic mapping. 4. Explain cytoplasmic inheritance wrt mitochondrial and maternal inheritance. 5. Discuss the types, causes, and significance of mutations. 6. Describe numerical and structural chromosomal abnormalities. 7. Explain the Hardy–Weinberg equilibrium and factors affecting genetic equilibrium. **Multiple choice questions** 1. The alternative forms of a gene are called:			

	a) Loci **b) Alleles** c) Chromatids d) Genomes **2.** A cross between an unknown genotype and a homozygous recessive individual is called: a) Monohybrid cross b) Dihybrid cross **c) Test cross** d) Reciprocal cross 3. Human ABO blood group is an example of: a) Incomplete dominance **b) Codominance** c) Linkage d) Epistasis 4. One gene affecting multiple traits is called: a) Epistasis b) Linkage **c) Pleiotropy** d) Penetrance 5. Turner syndrome is characterized by: a) XXY b) XXX c) **XO** d) XYY

(103231) Theory 9 (Major) Molecular Biology							
Level	**Semester**	**Course code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Maximum marks**
5.5	V	103231	Molecular Biology	2	30	2 Hrs	30

Course Objectives	• To provide fundamental knowledge of molecular biology, including the structure and organization of nucleic acids and chromosomes. • To explain the principles and mechanisms of DNA replication, DNA repair, and maintenance of genome integrity in prokaryotic and eukaryotic systems. • To develop an understanding of transcription, translation, and post-transcription as well as post-translation modifications involved in gene expression
Course Outcomes	Upon successful completion of the course, students will be able …. • Describe the structure, properties, and different forms of DNA, genome organization, and chromosomal packaging. • Explain the mechanisms of DNA replication and various DNA repair pathways in prokaryotic and eukaryotic organism • Illustrate the processes of transcription, RNA processing, translation, and post-translation modifications • Analyze the role of promoters, RNA polymerases, and regulatory factors involved in gene expression. • Differentiate between positive and negative gene regulation mechanisms and explain operon models such as lac, trp, and gal operons.

Unit System	**Contents**	**Workload allotted In hours**	**Weightage of Marks Allotted**	**Pedagogy**
Unit 1 **History and architecture of nucleic Acid**	➢ Salient features of Watson and Crick model, melting Temperature (Tm) ➢ Nucleic Acid as the genetic material: Griffith's; Experiment, Avery, MacLeod, McCarty's experiment ➢ Genome and its Organization: Histone protein, Structure of nucleosome, Packaging of DNA, Strucure of Chromosome ➢ Concept of Central Dogma of Molecular Biology.	8 Hrs	8 marks	Chalk and board Power point presentation, Videos, Animation etc
Unit 2 **DNA replication and**	➢ Replication: Features of DNA replication, Enzymes and proteins involved in Prokaryotic replication	7 Hrs	7 marks	Chalk and board

DNA repair	➢ Process of replication in Prokaryotes, ➢ DNA Damage, types and causes. ➢ DNA repair - Concept of DNA repair Types of repair; Base excision, Nucleotide excision, Mismatch, Photo reactivation, SOS repair			Power point presentation, Videos, Animation etc
Unit 3 **Transcription and Translation**	➢ Transcription: Structure and Functions of promoter in RNA, Types and Function of RNA polymerase in prokaryotes, Mechanism of Transcription in prokaryotes- Initiation, elongation and termination ➢ Translation: Components of translation, Genetic Code, Wobble Hypothesis, Process of translation in prokaryotes- Initiation, elongation and termination	8 Hrs	8 marks	Chalk and board Power point presentation, Videos, Animation etc
Unit 4 **Gene Regulation**	➢ Principle of Gene Regulation; Transcriptional and post-Transcriptional gene regulation: activators, coactivators, supressor, repressor, moderators ➢ Negative and positive regulation in gene expression ➢ Concept and structure of Operon: Lac operon in E.Coli, trp operon, gal operon ➢ Exception to central dogma- reverse-transcription and DRT7	7 Hrs	7 marks	Chalk and board Power point presentation, Videos, Animation etc
References	1. Lewin's GENES XII. Jocelyn E. Krebs, Elliott S. Goldstein, Stephen T. Kilpatrick. 12th Edition, 2018 2. Molecular Biology of the Gene by James D. Watson, W. A. Benjamin (1965) New York, New York. 3. Biochemistry, Molecular Biology and Genetics. Lieberman, Michal, A., M. D. icer, Rick. Lippincot Williams publisher, Sixth Edition,2013 4. Molecular Biology Principle and Practice. Michael M. Cox, Michael O'Donnel and Jenifer Doudna. WHF Freeman Publisher. 5. Molecular Cell Biology, W.H. Freeman & Company. 6. Genetics by P. K. Gupta, Rastogi Publications. 7. Molecular Biology Of the gene and Essential Genes Benjamin Lewin. Person Publisher, 2006			
Model Questions	**1. Short Answer Questions** 1. What is Nucleotide? 2. Define Denaturation of DNA? 3. Enlist the types of DNA repair. 4. What is Semiconservative Replication 5. Define Promoter of Transcription.			

	6. What is Polyadenylation? 7. Mention the role of activators in Gene expression? 8. Draw the strucure of Lac operon? **2. Long Answer Questions** 1. Describes the structure of Watson and Crick Model of DNA. 2. Explain Griffith Experiment.Add note on Principle of Transformation. 3. Outline the process of replication in Eukaryotes in detail. 4. Discuss on types of DNA Repair. 5. Elaborate the Mechanism transcription in Eukaryotes.Add note on Post-transcriptional modification. 6. Enlist the Components of Translation 7. Explain the structure of Lac Operon **Multiple choice questions** 1. Sugar present in DNA is…. a) Trioses **b) Pentoses** c) Hexoses d) Tretoses 2. -------is the key enzyme DNA replication **a) DNA polymerase** b) Adenylate Cyclase c) RNA Polymerase d) peptidase 3. in Translation process Upcoming t-RNA binds to …..site. a) P **b) A** c) E d) None of the above 4. Which of the following is the most common post-translational modification? a) Glycosylation b) Phosphorylation c) Hydroxylation d) Methylation

(103232) Theory 10 (Major) Biotechnology							
Level	**Semester**	**Course code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Maximum marks**
5.5	V	103232	Biotechnology	2	30	2 Hrs	30

Course Objectives:	• To introduce the fundamental concepts of biotechnology. • To provide knowledge of genetic engineering and tissue culture techniques. • To acquaint students with industrial and environmental applications of biotechnology. • To introduce bioinformatics and issues related to biosafety and ethics.
Course Outcomes	Upon completing the course, students will be able to….. • Explain the fundamentals of genetic engineering and recombinant DNA technology. • Describe plant and animal biotechnology techniques and applications. • Discuss industrial and environmental biotechnology processes. .

Unit System	**Contents**	**Workload allotted In hours**	**Weightage of Marks Allotted**	**Pedagogy**
Unit 1 **Fundamentals of Genetic Engineering and Recombinant DNA Technology**	➢ Introduction to Recombinant DNA technology and applications ➢ Enzymes Used in Genetic Engineering: Restriction Endonucleases: Types, recognition sequences, sticky and blunt ends, applications (EcoRI, HindIII) DNA Ligase: Role in DNA ligation and recombinant DNA formation Reverse Transcriptase**:** cDNA synthesis and applications ➢ Cloning vectors: Characteristics of an ideal cloning vector, Plasmids, bacteriophages, cosmids ➢ Recombinant DNA Technology and Gene Cloning: Basic steps involved in gene cloning and selection of recombinant clones ➢ Principle, Types and Applications of PCR	8 Hrs	8 marks	Chalk and board Power point presentation, Videos, Animation etc
Unit 2 **Plant and Animal Biotechnology**	➢ Introduction to Plant Biotechnology: Concept, scope and applications ➢ Plant genetic engineering: Gene transfer methods in plants: Agrobacterium-mediated Transformation and direct gene transfer Methods (electroporation, biolistics/gene gun) ➢ Development and characterization of transgenic plants	7 Hrs	7 marks	Chalk and board Power point presentation, Videos, Animation etc

	➢ Applications of transgenic plants in agriculture and crop improvement **Animal Biotechnology** ➢ Animal Cell Culture: Principles, types, culture media and growth requirements ➢ Gene Transfer Techniques in Animals: Microinjection, electroporation, lipofection and viral vectors ➢ Stem Cell Technology: Concept and applications, Hybridoma Technology and Monoclonal Antibodies: Principle and applications ➢ Transgenic Animals and Animal Cloning: Production, applications and significance ➢ Applications of Animal Biotechnology in medicine, pharmaceuticals and livestock improvement			
Unit 3 **Industrial and Environmental Biotechnology**	**Industrial Biotechnology** ➢ Fermentation Technology: Principles, types (batch, fed-batch and continuous) and applications, Bioreactors: Concept, components and types ➢ Industrial Production of Microbial Product: Penicillin, Amylase, Citric acid, Vitamin B12 ➢ Single Cell Protein (SCP): Concept, production, advantages and factors affecting production ➢ Biofertilizers: Concept, types and important microorganisms used as biofertilizers ➢ Biopesticides: Types, important biopesticidal agents (Bt, Trichoderma and Neem), production and applications **Environmental Biotechnology** ➢ Biofuels: Biogas, Bioethanol and biodiesel – production and applications ➢ Bioremediation, wastewater treatment and applications in sustainable development	8 Hrs	8 marks	Chalk and board Power point presentation, Videos, Animation etc
Unit 4 **Applications of Biotechnology**	**Agricultural Biotechnology** ➢ Biofortification and crop improvement; Genetically Modified (GM) crops: Bt cotton, Golden Rice **Medical Biotechnology** ➢ Recombinant therapeutic proteins:	7 Hrs	7 marks	Chalk and board Power point presentation, Videos, Animation etc

	insulin, human growth hormone, interferons; Recombinant vaccines (Hepatitis B vaccine) and edible vaccines (Plant-based vaccines ➢ Gene therapy: Concept, types (somatic and germline) and applications in treatment of genetic disorders (ADA deficiency, cystic fibrosis). **Forensic and Diagnostic Biotechnology** ➢ DNA fingerprinting: principle and applications ➢ PCR-based diagnostics: Concept and applications ➢ Molecular markers in disease diagnosis: RFLP and RAPD			
References	**1. Singh, B.D. (2023).** *Biotechnology: Expanding Horizons* (5th Edition). Kalyani Publishers, New Delhi. **2. Das, H.K. (2017).** *Textbook of Biotechnology* (5th Edition). Wiley India Pvt. Ltd., New Delhi. **3. Brown, T.A. (2021).** *Gene Cloning and DNA Analysis: An Introduction* (9th Edition). Wiley-Blackwell, Oxford. **4. Primrose, S.B. and Twyman, R.M. (2014).** *Principles of Gene Manipulation and Genomics* (8th Edition). Wiley-Blackwell, Oxford. **5. Glick, B.R., Pasternak, J.J. and Patten, C.L. (2022).** *Molecular Biotechnology: Principles and Applications of Recombinant DNA* (6th Edition). ASM Press, Washington, D.C. **6. Dubey, R.C. (2021).** *A Textbook of Biotechnology* (6th Edition). S. Chand & Company Pvt. Ltd., New Delhi. **7. Gupta, P.K. (2022).** *Elements of Biotechnology* (3rd Edition). Rastogi Publications, Meerut. **8. Satyanarayana, U. (2021).** *Biotechnology*. Books and Allied (P) Ltd., Kolkata. **9. Watson, J.D., Caudy, A.A., Myers, R.M. and Witkowski, J.A. (2007).** *Recombinant DNA: Genes and Genomes – A Short Course* (3rd Edition). W.H. Freeman & Company, New York. **10. Smith, J.E. (2009).** *Biotechnology* (5th Edition). Cambridge University Press, Cambridge.			

The distribution of marks for the continuous assessment test (CAT) shall be as follows:

Internal Assessment (Theory) for 20 marks		
MCQ Test 1 based on 25% syllabus		

MCQ Test 2 based on 50% syllabus MCQ Test 3 based on 75% syllabus	Consider best 2 out of 3 test (Average of best 2, Total performance is not less 40%)	10 Marks
Assignments /Innovative activities /GD/Seminar/ Poster presentation, quiz etc. (any two activities 5 marks each)		10 Marks
Total		20 Marks

103233 (Major) Lab 15 Laboratory Techniques in Genetics, Molecular Biology and Biotechnology							
Level	**Sem**	**Course Code**	**Course Name**	**Credits**	**Teaching hours**	**Exam duration**	**Maximum Marks**
5.5	V	103233	Laboratory Techniques in Genetics, Molecular Biology and Biotechnology	2	60	2 Hours	25 + 25
Course Objectives		• To develop understanding of basic concepts in cell biology, genetics, molecular biology, and biotechnology. • To provide hands-on/virtual exposure to essential laboratory techniques in biotechnology. • To train students in analysis and interpretation of biological and genetic data. • To expose students to industrial and research environments in biotechnology/pharmaceutical sectors.					
Course Outcomes		Upon completing the course, students will be able… • Perform and interpret basic cytological and genetic experiments such as mitosis observation and genetic cross problems. • Carry out and analyze fundamental molecular biology techniques including DNA isolation, gel electrophoresis, and restriction digestion. • Understand and evaluate protein analysis and fermentation processes used in biotechnology. • Gain awareness of industrial applications of biotechnology through laboratory visits and report					
Sr No.		**Content of Practical (List of Laboratory Experiments/ Activities etc.)**					
1		Observation of mitosis in onion root tip squash.					
2		Monohybrid cross, dihybrid cross and test cross problems.					
3		Isolation of genomic DNA from onion/banana.					
4		Isolation of genomic DNA from animal/ human source					
5		Agarose gel electrophoresis of isolated DNA.					
6		Restriction digestion of DNA (demonstration or virtual analysis).					
7		Separation of Proteins by using SDS- PAGE					
8		Production of ethanol by yeast fermentation.					
9		Visit to a biotechnology/pharmaceutical industry or research laboratory and submission of report					
References		1. Das, H.K. (2017). Textbook of Biotechnology (5th ed.). Wiley India Pvt. Ltd., New Delhi. 2. Singh, B.D. (2023). Biotechnology: Expanding Horizons (5th ed.). Kalyani Publishers, New Delhi. 3. Gupta, P.K. (2022). Genetics (7th ed.). Rastogi Publications, Meerut.					

	4. Verma, P.S. and Agarwal, V.K. (2020). Cell Biology, Genetics, Molecular Biology, Evolution and Ecology. S. Chand & Company Pvt. Ltd., New Delhi. 5. Dubey, R.C. and Maheshwari, D.K. (2019). Practical Microbiology (1st ed.). S. Chand & Company Pvt. Ltd., New Delhi. 6. Dubey, R.C. and Maheshwari, D.K. (2022). A Textbook of Microbiology (6th ed.). S. Chand & Company Pvt. Ltd., New Delhi. 7. Sambrook, J. and Russell, D.W. (2001). Molecular Cloning: A Laboratory Manual (3rd ed.). Cold Spring Harbor Laboratory Press, New York. 8. Brown, T.A. (2021). Gene Cloning and DNA Analysis: An Introduction (9th ed.). Wiley-Blackwell, Oxford. 9. Primrose, S.B. and Twyman, R.M. (2014). Principles of Gene Manipulation and Genomics (7th ed.). Wiley-Blackwell, Oxford. 10. Powar, C.B. (2018). Cell Biology (4th ed.). Himalaya Publishing House, Mumbai. 11. Snustad, D.P. and Simmons, M.J. (2019). Principles of Genetics (8th ed.). John Wiley & Sons, New York. 12. Wilson, K. and Walker, J. (2018). Principles and Techniques of Biochemistry and Molecular Biology (8th ed.). Cambridge University Press, Cambridge.

The distribution of marks for the practical examination shall be as follows:

External Evaluation		**Internal Evaluation base on CAT**	
Performance of any two experiments	20 marks	Attendance & student's performance	10 Marks
Viva-voce	05 marks	Practical Record book	05 Marks
		MCQ/ Spottings	10 Marks
Total	25 Marks	**Total**	25 Marks

Elective Theory 1 (Major) Fundamentals of Plant Biochemistry (103234) DSE 1							
Level	**Semester**	**Course Code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Maximm Marks**
5.5	V	103234	Fundamentals of Plant Biochemistry	02	30	02 Hours	30
Course Objectives	• To understand the fundamental principles of Photosynthesis, Photorespiration and ATP generation. • To explain the basic pathways of secondary metabolite production. • To describe Mechanism of action, physiological effect and applications of phytohormones. • To learn various techniques of Plant tissue culture and applications.						
Course Outcomes	Upon completion of this course successfully, students would be able to • Understand the basic and vital life processes of plants. • Gain knowledge of structure and functions of Phytohormones. • Comprehend the phenomenon of Totipotency and Somatic embryogenesis. • Perform plant tissue culture of medicinal and endangered plants.						
Unit	**Content**			**Workload Allotted in Hours**	**Weightage of Marks Allotted**	**Pedagogy**	
Unit 1 **Photosynthesis, Photorespiration and ATP generation**	➢ Definition of photosynthesis, Ultra structure of chloroplast, Chemistry of Chlorophyll ➢ Mechanism of Photosynthesis: Photosystem I and II, Light (Hill) reaction: Cyclic and noncyclic photophosphorylation ➢ Dark reaction: C3 and C4 pathways, Kranz anatomy, Significance of photosynthesis, ➢ Photorespiration: Definition, Metabolism of Photorespiration, Significance of photorespiration, Electron transport chain			08 Hours	08 Marks	Chalk and board Power point presentation, Videos, Animation Etc	
Unit 2 **Secondary Metabolites**	➢ Introduction and biosynthetic pathways of secondary metabolites ➢ Classification, chemistry, distribution and role of Isoprenoid /terpenoids ➢ Nitrogen containing secondary plant products, Alkaloids: chemistry classification, and physiological role ➢ Chemistry and functions of Cyanogenic: Glycosides, Glucosinolates ➢ Plant phenolics: classification, Chemistry and functions of lignin, flavonoids and tannin			7 Hours	07 Marks	Chalk and board Power point presentation, Videos, Animation Etc	
Unit 3 **Phytochormones**	➢ Definition and types of phytohormones, ➢ Mechanism of action, physiological effect and applications of Auxins, Cytokinins,			08 Hours	08	Chalk and board Power	

	Gibberellins, Abscisic acid, Ethylene. ➢ Physiology and Biochemistry of Seed dormancy and seed germination, ➢ Biochemical changes during seed germination, Leaf Scenescence.			point presentation, Videos, Animation Etc
Unit 4 **Plant Tissue Culture**	➢ Introduction and History of Plant tissue culture ➢ Plant Tissue Culture laboratory, Media Preparation and composition, Totipotency ➢ Applications and Steps involved in Plant Tissue Culture; In-vitro techniques in Plant tissue culture ➢ Practical applications of Plant tissue culture	07 Hours	07	Chalk and board Power point presentation, Videos, Animation Etc
References	1. Gupta P. K. (2005), Elements of Biotechnology, Rastogi Publication Meerut. 2. Ignacimuthu S. (1997), Applied plant biotechnology, Science Publishers, U.S. 3. Ramavat K. G. (2008), Plant biotechnology, S. Chand and Co., New Delhi. 4. Gupta P. K. (2005), Molecular biology and genetic engineering, 1st edition, Rastogi Publication Meerut. 5. Verma S. K., Verma M. (1995), A Textbook of Plant Physiology, Biochemistry and Biotechnology, S. Chan and company ltd, New Delhi. 6. Satyanarayana U. (2008), Biotechnology, Books and Allied (P) Ltd, Kolkata. 7. Jain V. K. (1983), Fundamentals of Plant Physiology, 3rd edition, S. Chan and company ltd, New Delhi 8. Chawla H.S. (2009), Introduction to Plant Biotechnology, 3rd edition, CRC press. 9. Jogdand S.N. (2012), Advances in Biotechnology, Himalaya Publishing House, Mumbai.			
Model Questions	**Short Answer Questions** 1. Define Totipotency. 2. What is Leaf Scenescence. 3. Define Kranz anatomy. 4. What is Photorespiration? 5. Define Oxidative Phosphorylation? 6. What is Seed germination? 7. What is Seed Dormancy? 8. What is Redox potantial? **Long Answer Questions** 1. With the help of suitable describe Electron Transport Chain. 2. What is seed germination, describe biochemical changes during seed germination. 3. Explain C3 and C4 Pathway. 4. Explain classification, chemistry, distribution and role of isoprenoids. 5. Discuss the various types of phytochromes with their mechanism of action, site of synthesis and applications. 6. Describe Photosystem I and Photosystem II. 7. Explain in details In-vitro techniques in Plant Tissue Culture.			

The distribution of marks for the continuous assessment test (CAT) shall be as follows:

<table>
<tr><th colspan="3">Internal Assessment (Theory) for 20 marks</th></tr>
<tr><td>MCQ Test 1 based on 25% syllabus</td><td rowspan="3">Consider best 2 out of 3 tests (Average of best 2, Total performance is not less 40%)</td><td rowspan="3">10 Marks</td></tr>
<tr><td>MCQ Test 2 based on 50% syllabus</td></tr>
<tr><td>MCQ Test 3 based on 75% syllabus</td></tr>
<tr><td colspan="2">Assignments /Innovative activities /GD/Seminar/ Poster presentation, quiz etc.

(any two activities 5 marks each)</td><td>10 Marks</td></tr>
<tr><td colspan="2">Total</td><td>20 Marks</td></tr>
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Lab Practical 16 Major (Elective 1) Basic Practicals in Plant Biochemistry (103235)							
Level	**Semester**	**Course code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Maximum marks**
5.5	V	103235	Basic Practicals in Plant Biochemistry	2	60	2Hrs	25+25
Course Objectives		• To understand the fundamental principles of Plant Tissue culture. • To formulate the basic components of MS Media. • To learn the qualitative analysis of plant secondary metabolites. • To learn technique of hydrated synthetic seed preparation					
Course outcomes		Upon completion of the course, the student would be able to: • Develop skills in extraction of secondary metabolites and further purification and characterization. • Understand the phenomenon of water immbibition. • Learn how to induce callus from explant. • Qualitatively analyse plant secondary metabolites.					
Sr. No.		**Practicals**					
1.		Microscopic obervation of Chloroplast					
2		Estimation of Ascorbic acid in germinating seeds					
3		Demonstration of Imbibition of water by different types of seeds.					
4		Demonstration of extraction of secondary metabolites					
5		Qualititive analysis of plant secondary metabolites.					
6		Preparation of MS nutrient medium.					
7		To induce callus from explant.					
8		To prepare hydrated and synthetic seeds in vitro.					
9		To induce Embryo Culture					
References		1. Practical Plant Physiology (2005) – D. P.Singh, Published by Agribios and Lalyani publication. 2. Practical Pharmacognosy (2010) – C.K. Kokate, Nirali Publication. 3. Plant Tissue Culture: (1996) Theory and Practice – S.S. Bhojwani & M.K.Razdan, Studies in plant Sciences, ELSEVIER. 4. Laboratory Manual in Plant Biotechnology (2010)– P.K. Gupta, Rastogy publication. 5. Jogdand S.N. (2012), Advances in Biotechnology, Himalaya Publishing House, Mumbai					

The distribution of marks for the practical examination shall be as follows:

External Evaluation		**Internal Evaluation base on CAT**	
Performance of any two experiments	20 marks	Attendance & student's performance	10 Marks
Viva-voce	05 marks	Practical Record book	05 Marks
		MCQ/ Spottings	10 Marks
Total	25 Marks	**Total**	25 Marks

Elective Theory 1 (Major) Biostatistics and Bioinformatics (103236) DSE 2							
Level	**Semester**	**Course code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Maximum marks**
5.5	V	103236	Biostatistics and Bioinformatics	2	30	2 Hrs	30

Course Objectives	• To understand concepts of biostatistics and their applications in biological sciences. • To apply statistical methods for analysis and interpretation of biochemical data. • To gain knowledge of bioinformatics databases and computational tools used in life sciences. • To retrieve, analyze, and interpret biological information from online databases.			
Course Outcomes	Upon completing the course, students will be able to… • Explain basic statistical concepts, data types, probability, and data presentation methods used in biology. • Perform statistical analyses such as t-test, ANOVA etc for biological datasets. • Demonstrate familiarity with major biological databases including NCBI, GenBank, UniProt, PubChem, and PDB. • Apply biostatistical and bioinformatics approaches for solving problems in biochemistry, biotechnology, and life science research.			
Unit System	**Contents**	**Workload allotted In hours**	**Weightage of Marks Allotted**	**Pedagogy**
Unit 1 Basics of Biostatistics	➢ Introduction to biostatistics and its importance in biological sciences, ➢ Types of biological data and methods of data collection. ➢ Measures of central tendency (mean, median, mode) ➢ Measures of dispersion (range, variance, standard deviation, SEM); ➢ Basic concepts of probability and normal distribution; Graphical representation of biological data using tables, histograms and scatter plots	8 Hrs	8 marks	Chalk and board Power point presentation, Videos, Animation etc
Unit 2 Statistical Analysis in	➢ Concept of hypothesis testing, null and alternative hypotheses ➢ p-value and significance level; ➢ Application of Student's t-test and one-	7 Hrs	7 marks	Chalk and board Power point presentation, Videos,

Biology	way ANOVA in biological experiments. ➢ Chi-square test for categorical data analysis; ➢ Correlation analysis, Linear regression and standard curves			Animation etc
Unit 3 **Introduction to Bioinformatics**	➢ Definition, scope and applications of bioinformatics in biochemistry; ➢ Introduction to biological databases including NCBI, GenBank, PubChem, UniProt and Protein Data Bank (PDB). ➢ Retrieval, storage and management of biological information. ➢ Basic concepts of nucleotide and protein sequence analysis.	8 Hrs	8 marks	Chalk and board Power point presentation, Videos, Animation etc
Unit 4 **Bioinformatics Tools and Applications**	➢ Principles and applications of BLAST. ➢ Introduction to multiple sequence alignment and phylogenetic analysis. ➢ KEGG pathways and biological pathway databases. ➢ Molecular visualization tools and their applications. ➢ Role of bioinformatics in genomics, proteomics and drug discovery	7 Hrs	7 marks	Chalk and board Power point presentation, Videos, Animation etc
References	1. Fundamentals of Biostatistics – Bernard Rosner 2. Fundamentals of Biostatistics, Cengage Learning 3. Biostatistics: A Foundation for Analysis in the Health Sciences – Wayne W. Daniel and Chad L. Cross 4. Principles of Biostatistics – Marcello Pagano and Kimberlee Gauvreau 5. Bioinformatics: Sequence and Genome Analysis – David W. Mount 6. Essential Bioinformatics – Jin Xiong 7. Introduction to Bioinformatics – Arthur M. Lesk 8. Additional Online Resources 9. NCBI (National Center for Biotechnology Information) 10. UniProt Protein Database 11. Protein Data Bank (PDB) 12. KEGG Pathway Database			
Model Questions	**Short Answer Questions** 1. Differentiate between mean and median. 2. What is standard deviation? 3. Define p-value. 4. What is ANOVA? 5. Write a note on NCBI. 6. What is GenBank?			

	7. Define UniProt. 8. What is PDB? **Long Answer Questions** 1. Explain the scope and importance of biostatistics in biological sciences. 2. Describe measures of central tendency with suitable examples. 3. Explain hypothesis testing and discuss Student's t-test and ANOVA. 4. Explain the Chi-square test and its applications in biological research. 5. Describe NCBI, GenBank, UniProt and PDB databases. 6. Explain the principle and applications of BLAST. 7. Discuss the role of bioinformatics in genomics and proteomics. **Multiple choice questions** ➢ Standard deviation is a measure of: A) Central tendency **B) Dispersion** C) Probability D) Correlation ➢ Student's t-test is used to: **A) Compare means** B) Compare proportions C) Sequence alignment D) Database search ➢ ANOVA is used for comparing: A) Two groups only **B) Three or more groups** C) DNA sequences D) Proteins ➢ Which database stores nucleotide sequences? A) PDB B) UniProt **C) GenBank** D) KEGG ➢ UniProt is a database of: **A) Proteins** B) Genes C) Diseases D) Journals

The distribution of marks for the continuous assessment test (CAT) shall be as follows:

Internal Assessment (Theory) for 20 marks		
MCQ Test 1 based on 25% syllabus		

MCQ Test 2 based on 50% syllabus MCQ Test 3 based on 75% syllabus	Consider best 2 out of 3 test (Average of best 2, Total performance is not less 40%)	10 Marks
Assignments /Innovative activities /GD/Seminar/ Poster presentation, quiz etc. (any two activities 5 marks each)		10 Marks
Total		20 Marks

Lab Practical 16 Major (Elective 2) Biostatistics and Bioinformatics (103237)							
Level	**Semester**	**Course code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Maximum marks**
5.5	V	103237	Biostatistics and Bioinformatics	2	60	2Hrs	25+25

Course Objectives	➢ To develop skills in statistical analysis of biological data. ➢ To learn graphical presentation and interpretation of experimental results. ➢ To familiarize students with biological databases and bioinformatics resources. ➢ To apply bioinformatics tools for sequence retrieval and analysis.
Course outcomes	Upon completion of the course, the student would be able to: ➢ Calculate and analyze biological data using basic statistical tools. ➢ Construct and interpret graphs, standard curves, and statistical tests using MS Excel. ➢ Retrieve biological information from bioinformatics databases. ➢ Perform sequence analysis using bioinformatics tools such as BLAST.

Sr. No.	**Contents of Practical**
1.	Calculation of mean, median, mode, standard deviation and SEM in MS Excel.
2.	Preparation and interpretation of histograms and scatter plots in MS Excel.
3.	Application of Student's t-test for comparison of biological samples in MS Excel.
4.	Construction of a standard calibration curve.
5.	Retrieval of nucleotide and protein sequences from NCBI and UniProt.
6.	Exploration of protein structures using PDB.
7.	Sequence similarity search using BLAST.
References	➢ Fundamentals of Biostatistics – Bernard Rosner. ➢ Biostatistics: A Foundation for Analysis in the Health Sciences – Wayne W. Daniel and Chad L. Cross. ➢ Practical Statistics for Medical Research – Douglas G. Altman. ➢ Bioinformatics: Sequence and Genome Analysis – David W. Mount. ➢ Essential Bioinformatics – Jin Xiong. ➢ Introduction to Bioinformatics – Arthur M. Lesk. ➢ Bioinformatics and Functional Genomics – Jonathan Pevsner. **Online Resources for Practicals** ➢ NCBI Database Resources ➢ UniProt Knowledgebase ➢ Protein Data Bank (PDB)

	➢ BLAST Search Tool

The distribution of marks for the practical examination shall be as follows:

External Evaluation		**Internal Evaluation base on CAT**	
Performance of any two experiments	20 marks	Attendance & student's performance	10 Marks
Viva-voce	05 marks	Practical Record book	05 Marks
		MCQ/ Spottings	10 Marks
Total	25 Marks	**Total**	25 Marks

Theory 5 (Minor) Molecular Biology and Biotechnology (103238)							
Level	**Semester**	**Course code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Maximum marks**
5.5	V	103238	Molecular Biology and Biotechnology	2	30	2 Hrs	30
Course Objectives	• To provide a comprehensive understanding of the molecular basis of genetic information and gene expression. • To explain the mechanisms of DNA replication, transcription, translation, and gene regulation. • To introduce the principles and applications of modern molecular biology techniques. • To develop an understanding of recombinant DNA technology and molecular diagnostics.						
Course Outcomes	Upon completion of this course successfully, students would be able to • Explain the molecular basis of genetic information and gene expression. • Describe the mechanisms of DNA replication, transcription, translation, and gene regulation. • Interpret the role of molecular biology in understanding cellular and genetic processes. • Explain the principles and applications of PCR, blotting techniques, and DNA sequencing.						
Unit	**Content**			**Workload Allotted in Hours**	**Weightage of Marks Allotted**	**Pedagogy**	
Unit 1 Molecular Basis of Genetic Information	➢ DNA as genetic material, Structure and forms of DNA ➢ RNA: types and functions ➢ Central Dogma of Molecular Biology ➢ Genetic code and its characteristics ➢ Organization of prokaryotic and eukaryotic genomes			8 Hrs	8 marks	Chalk and board Power point presentation, Videos, Animation Etc	
Unit 2 Gene Expression and Regulation	➢ DNA replication, Transcription in prokaryotes, ➢ Translation and protein synthesis ➢ Gene regulation: Lac operon and Trp operon; ➢ Introduction to epigenetics ➢ Exception to central dogma- reverse-transcription and DRT7			7 Hrs	7 marks	Chalk and board Power point presentation, Videos, Animation Etc	
Unit 3 Recombinant DNA Technology	➢ Concept and history of genetic engineering, ➢ Restriction endonucleases and DNA modifying enzymes ➢ Cloning vectors: plasmids, bacteriophages, cosmids, BACs and YACs ➢ Gene cloning strategies; Construction of			8 Hrs	8 marks	Chalk and board Power point presentation, Videos, Animation	

	recombinant DNA molecules, Transformation, selection and screening of recombinants			Etc
Unit 4 Molecular Techniques and Applications	➢ PCR and its applications; Gel electrophoresis-Principle and application ➢ Blotting techniques (Southern, Northern, Western); ➢ DNA sequencing (Sanger and NGS); DNA fingerprinting ➢ CRISPR-Cas technology and its application; ➢ Applications of rDNA technology in: Agriculture, Medicine, Industry, Environmental biotechnology	7 Hrs	7 marks	Chalk and board Power point presentation, Videos, Animation Etc
References	1. Lewin's GENES XII. Jocelyn E. Krebs, Elliott S. Goldstein, Stephen T. Kilpatrick. 12th Edition, 2018 2. Molecular Biology of the Gene by James D. Watson, W. A. Benjamin (1965) New York, New York. 3. Biochemistry, Molecular Biology and Genetics. Lieberman, Michal, A., M. D. icer, Rick. Lippincot Williams publisher, Sixth Edition,2013 4. Brown, T.A. (2021). *Gene Cloning and DNA Analysis: An Introduction* (9th Edition). Wiley-Blackwell, Oxford. 5. Primrose, S.B. and Twyman, R.M. (2014). *Principles of Gene Manipulation and Genomics* (8th Edition). Wiley-Blackwell, Oxford. 6. Singh, B.D. (2023). *Biotechnology: Expanding Horizons* (5th Edition). Kalyani Publishers, New Delhi. 7. Das, H.K. (2017). *Textbook of Biotechnology* (5th Edition). Wiley India Pvt. Ltd., New Delhi. 8. Dubey, R.C. (2021). *A Textbook of Biotechnology* (6th Edition). S. Chand & Company Pvt. Ltd., New Delhi.			
Model Questions	**Short Answer Questions** 1. Define the Central Dogma of Molecular Biology. 2. What is meant by gene expression? 3. Differentiate between transcription and translation. 4. State any four characteristics of the genetic code. 5. What is an operon? Give one example. 6. Define gene regulation. 7. What are restriction endonucleases? 8. What is recombinant DNA (rDNA)? 9. Define cloning vector and give two examples. 10. What is transformation in genetic engineering? 11. Write the principle of PCR. 12. Name the components required for PCR. 13. Differentiate between Southern and Northern blotting. 14. What is DNA sequencing? 15. Write any four applications of recombinant DNA technology. **Short Long-Answer Questions** 1. Explain the Central Dogma of Molecular Biology. 2. Describe the process of transcription. 3. Explain translation and protein synthesis. 4. Discuss the Lac operon. 5. Explain the Trp operon.			

6. Describe gene regulation in prokaryotes.
7. Explain restriction enzymes and their role in rDNA technology.
8. Describe the construction of recombinant DNA.
9. Explain cloning vectors with examples.
10. Describe the steps involved in gene cloning.
11. Explain the principle and steps of PCR.
12. Compare Southern, Northern, and Western blotting.
13. Describe DNA sequencing by the Sanger method.
14. Explain the applications of recombinant DNA technology.
15. Discuss recent advances in molecular biology and genetic engineering.

Multiple Choice Questions

1. The Central Dogma of Molecular Biology was proposed by:
   a) Watson
   b) Crick
   c) Mendel
   d) Jacob
2. During transcription, RNA is synthesized from:
   a) Protein
   b) DNA
   c) Lipid
   d) Carbohydrate
3. The process of protein synthesis from mRNA is called:
   a) Replication
   b) Transcription
   c) Translation
   d) Mutation
4. The start codon is:
   a) UAA
   b) UAG
   c) AUG
   d) UGA
5. Which RNA carries amino acids to the ribosome?
   a) mRNA
   b) rRNA
   c) tRNA
   d) snRNA
6. The Lac operon is an example of:
   a) Repressible operon
   b) Inducible operon
   c) Structural gene
   d) Mutation
7. Restriction enzymes are also known as:
   a) Ligases
   b) Polymerases
   c) Molecular scissors
   d) Helicases
8. Which enzyme joins DNA fragments?
   a) DNA polymerase
   b) DNA ligase
   c) Reverse transcriptase
   d) Primase
9. A plasmid is commonly used as:

	a) Probe b) Vector c) Marker d) Primer 10. PCR was developed by: a) Watson b) Kary Mullis c) Crick d) Sanger 11. Which enzyme is used in PCR? a) DNA ligase b) Restriction enzyme c) Taq DNA polymerase d) Reverse transcriptase 12. Southern blotting is used for the detection of: a) Proteins b) DNA c) RNA d) Lipids

The distribution of marks for the continuous assessment test (CAT) shall be as follows:

Internal Assessment (Theory) for 20 marks		
MCQ Test 1 based on 25% syllabus MCQ Test 2 based on 50% syllabus MCQ Test 3 based on 75% syllabus	Consider best 2 out of 3 test (Average of best 2, Total performance is not less 40%)	10 Marks
Assignments /Innovative activities /GD/Seminar/ Poster presentation, quiz etc. (any two activities 5 marks each)		10 Marks
Total		20 Marks

Lab Practical 17 (Minor) Practicals in Molecular Biology and Biotechnology (103239)							
Level	**Semester**	**Course code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Maximum marks**
5.5	V	103239	Practicals in Molecular Biology and Biotechnology	2	60	2Hrs	25+25
Course Objectives	• To understand the principles and applications of molecular biology and recombinant DNA technology techniques. • To develop skills in the isolation, quantification, and quality assessment of nucleic acids. • To acquire hands-on experience in agarose gel electrophoresis. • To understand the role of molecular diagnostic techniques in the detection of genetic disorders. • To explore the applications of DNA fingerprinting in forensic science, parentage testing, and biodiversity studies.						
Course outcomes	Upon completion of the course, the student would be able to: • Isolate genomic DNA from plant samples. • Estimate DNA/RNA concentration using spectrophotometry. • Assess the quality and purity of nucleic acids. • Perform and interpret agarose gel electrophoresis. • Analyze molecular diagnostic approaches for genetic diseases. • Interpret DNA fingerprinting results and their applications.						
Sr. No.	**Practicals**						
1.	Isolation of genomic DNA from plant material.						
2	Spectrophotometric estimation DNA/RNA						
3	DNA quantification and purity assessment.						
4	Agarose gel electrophoresis.						
5	DNA fingerprinting (virtual analysis).						
6	Restriction digestion of DNA (demonstration or virtual analysis).						
7	Separation of Proteins by using SDS- PAGE						
8	Production of ethanol by yeast fermentation.						
9	Visit to a biotechnology/pharmaceutical industry or molecular biology laboratory.						
References	1. Sambrook, J. and Russell, D.W. (2001). *Molecular Cloning: A Laboratory Manual* (3rd Edition). Cold Spring Harbor Laboratory Press, New York. 2. Green, M.R. and Sambrook, J. (2012). *Molecular Cloning: A Laboratory Manual* (4th Edition). Cold Spring Harbor Laboratory Press, New York. 3. Brown, T.A. (2021). *Gene Cloning and DNA Analysis: An Introduction* (9th Edition). Wiley-Blackwell, Oxford. 4. Primrose, S.B. and Twyman, R.M. (2014). *Principles of Gene Manipulation and Genomics* (8th Edition). Wiley-Blackwell, Oxford. 5. Das, H.K. (2017). *Textbook of Biotechnology* (5th Edition). Wiley India Pvt. Ltd., New Delhi. 6. Singh, B.D. (2023). *Biotechnology: Expanding Horizons* (5th Edition). Kalyani Publishers, New Delhi. 7. Wilson, K. and Walker, J. (2018). *Principles and Techniques of Biochemistry and Molecular Biology* (8th Edition). Cambridge University Press, Cambridge. 8. Gupta, P.K. (2022). *Elements of Biotechnology* (3rd Edition). Rastogi						

	Publications, Meerut.

The distribution of marks for the practical examination shall be as follows:

External Evaluation		**Internal Evaluation base on CAT**	
Performance of any two experiments	20 marks	Attendance & student's performance	10 Marks
Viva-voce	05 marks	Practical Record book	05 Marks
		MCQ/ Spottings	10 Marks
Total	25 Marks	**Total**	25 Marks

Lab 18 VSC (Major) Applied Techniques in Biotechnology (103240)							
Level	**Semester**	**Course code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Maximum marks**
5.5	V	103240	Applied Techniques in Biotechnology	2	30	2 Hrs	30
Course Objectives		• To develop fundamental laboratory skills used in biotechnology. • To provide hands-on experience in molecular, industrial, and agricultural biotechnology techniques. • To train students in biological data analysis and interpretation. • To develop competency in laboratory documentation, quality control, and SOP preparation.					
Course Outcomes		Upon completion of the course, the student would be able to: • Perform basic biotechnology laboratory techniques and maintain aseptic practices. • Analyze and interpret biological, molecular, and protein-related experimental data. • Apply fermentation and bioprocessing techniques for the production of biotechnological products. • Demonstrate skills in biopesticide preparation, laboratory documentation, and quality management					
Sr. No.		**Practicals**					
1.		Preparation of Culture Media and Sterility Assessment					
2		Cell Counting and Viability Test Using Hemocytometer and Trypan Blue					
3		Analysis and Interpretation of DNA Sequencing Autoradiogram obtained from sequencing gel					
4		Determination of Molecular Weight of Recombinant Protein Using SDS-PAGE					
5		Optimization of pH and Temperature for Ethanol Production and Assessment of Fermentation Efficiency					
6		Production of Citric Acid by *Aspergillus niger* Fermentation					
7		Preparation and Demonstration of Neem-Based Biopesticidal Activity					
8		Preparation of Standard Operating Procedures (SOPs)					
References		1. Sambrook, J. and Russell, D.W. (2001). *Molecular Cloning: A Laboratory Manual* (3rd Edition). Cold Spring Harbor Laboratory Press, New York. 2. Green, M.R. and Sambrook, J. (2012). *Molecular Cloning: A Laboratory Manual* (4th Edition). Cold Spring Harbor Laboratory Press, New York. 3. Brown, T.A. (2021). *Gene Cloning and DNA Analysis: An Introduction* (9th					

	Edition). Wiley-Blackwell, Oxford. 4. Wilson, K. and Walker, J. (2018). *Principles and Techniques of Biochemistry and Molecular Biology* (8th Edition). Cambridge University Press, Cambridge. 5. Primrose, S.B. and Twyman, R.M. (2014). *Principles of Gene Manipulation and Genomics* (8th Edition). Wiley-Blackwell, Oxford. 6. Freshney, R.I. (2016). *Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications* (7th Edition). Wiley-Blackwell, Hoboken, New Jersey. 7. Verma, P.S. and Agarwal, V.K. (2020). *Cell Biology, Genetics, Molecular Biology, Evolution and Ecology*. S. Chand & Company Pvt. Ltd., New Delhi. 8. Gupta, P.K. (2022). *Genetics* (7th Edition). Rastogi Publications, Meerut. 9. Das, H.K. (2017). *Textbook of Biotechnology* (5th Edition). Wiley India Pvt. Ltd., New Delhi. 10. Singh, B.D. (2023). *Biotechnology: Expanding Horizons* (5th Edition). Kalyani Publishers, New Delhi.

The distribution of marks for the practical examination shall be as follows:

Internal Evaluation for VSC	
Attendance	10 Marks
Practical Performance	20 Marks
MCQ/Spotting	10 Marks
Practical record Book	10 Marks
Total	50 Marks

Lab 19 SEC (Major) Analytical Techniques in Molecular Biology and Genetics (103241)							
Level	**Semester**	**Course code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Max marks**
5.5	V	103241	Analytical Techniques in Molecular Biology and Genetics	2	30	2 Hrs	30
Course Objectives			• Develop skills in preparation and use of buffers for biomolecular studies. • To develop skills in DNA isolation, quantification, and electrophoretic analysis. • To train students in the interpretation of protein, chromosome, and cell-based analytical data. • To enhance analytical and problem-solving abilities applicable to biotechnology and life science research.				
Course Outcomes			Upon completion of the course, the student would be able to: • Perform and interpret basic molecular biology techniques for DNA analysis. • Analyze DNA and protein data obtained through spectrophotometry, agarose gel electrophoresis, and SDS-PAGE. • Identify chromosomal abnormalities and assess cell viability using standard cytogenetic and cell biology methods. • Apply analytical skills in molecular biology, genetics, and biotechnology for research and industrial applications.				
Sr. No.			**Practicals**				
1.			Preparation and applications of various buffers used in Molecular Biology				
2			Calibration and operation of pH meter.				
3			Comparative analysis of DNA isolation methods and DNA yield from different biological sources				
4			Quantitative Estimation and Purity Assessment of DNA Using UV Spectrophotometry				
5			Analysis of DNA Fragment Size Using Agarose Gel Electrophoresis				
6			Identification and Interpretation of Protein Molecular Weight Markers Used in SDS-PAGE				
7			Study of human karyotypes and identification of chromosomal abnormalities				
8			Induction of polyploidy in plants				
References			1. Sambrook, J. and Russell, D.W. (2001). Molecular Cloning: A Laboratory Manual (3rd Edition). Cold Spring Harbor Laboratory Press, New York. 2. Green, M.R. and Sambrook, J. (2012). Molecular Cloning: A Laboratory Manual (4th Edition). Cold Spring Harbor Laboratory Press, New York. 3. Brown, T.A. (2021). Gene Cloning and DNA Analysis: An Introduction				

	(9th Edition). Wiley-Blackwell, Oxford. 4. Wilson, K. and Walker, J. (2018). Principles and Techniques of Biochemistry and Molecular Biology (8th Edition). Cambridge University Press, Cambridge. 5. Primrose, S.B. and Twyman, R.M. (2014). Principles of Gene Manipulation and Genomics (8th Edition). Wiley-Blackwell, Oxford. 6. Freshney, R.I. (2016). Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications (7th Edition). Wiley-Blackwell, Hoboken, New Jersey. 7. Verma, P.S. and Agarwal, V.K. (2020). Cell Biology, Genetics, Molecular Biology, Evolution and Ecology. S. Chand & Company Pvt. Ltd., New Delhi. 8. Gupta, P.K. (2022). Genetics (7th Edition). Rastogi Publications, Meerut. 9. Das, H.K. (2017). Textbook of Biotechnology (5th Edition). Wiley India Pvt. Ltd., New Delhi. 10. Singh, B.D. (2023). Biotechnology: Expanding Horizons (5th Edition). Kalyani Publishers, New Delhi.

The distribution of marks for the practical examination shall be as follows:

Internal Evaluation for SEC	
Attendance	10 Marks
Practical Performance	20 Marks
MCQ/Spotting	10 Marks
Practical record Book	10 Marks
Total	50 Marks

B. Sc. III Semester V (NEP)

Course Category: Field Project (FP) / Community Engagement and Service (CES) of Major subject: Biochemistry

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.5	V	103242	(FP/CEP in Biochemistry)	2	60	--	50

Course Objectives:	The intended objectives are: • To provide practical, real-world experience, in their field of study, allowing them to apply theoretical knowledge to real-world situations or address Real-World Problems. • To enhance research, interpretation and analytical skills, strengthening their critical thinking and problem-solving abilities. • To foster engagement with a specific biochemistry related issue or area of study, address specific challenges or needs within a community. • To Improve Collaboration, Communication among students and facilitate knowledge transfer from lab to land and get self inspiration for contribution to the society by applying the subject knowledge.
Course Outcomes:	Upon successful completion of this course, students will be able to: • Develop their practical, technical skills and a deeper understanding of their subject matter and how it applies to real-world situations. • Learn to identify, analysis, and interpretation of complex problems using their knowledge and develop research skills. • Gain insight into social issues and the role of various governmental schemes for the welfare of people and explore new ideas and approaches. • Learn to work effectively in teams and collaborate with others to achieve common goals and contributing to community's socio-economic improvements

As per NEP 2020, students of B Sc. III of Semester V need to perform a Field Project (FP)/ Community Engagement Service (CES) for TWO (2) credits i.e. 50 Marks. The guidelines/ SoP regarding the FP/CES are as follows:

23) The total time allocation for the student to carry out FP/CES is 60 hours.

24) Students should participate in FP/CES under the supervision of faculty.

25) Assigning the FP/CES topics to individual students or groups of students (4 to 5 students in one group) and one faculty member from the department will act as Guide for the student or group of students.

26) CES may include awareness programs, public talk/ lectures, workshops, blood testing camps,

vaccination drives in collaboration, surveys etc

27) For a SURVEY based FP/CES, related questionnaire (15 or more questions) should be prepared. The departmental coordinator/guide should 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.
28) Field project may be undertaken to include survey/ laboratory work/ data analysis/ field work or in combination of these which involves practical application of knowledge and skill to address a specific problem or issue within biochemistry related context such as health, sustainable environment, agriculture etc.
29) A project report should be written individually in the standard format (2 Copies): Index, Introduction, Materials, Methods, Result, Conclusion/output, References (Numeric citation type) etc. The report should be of minimum 6 pages (excluding Title page, Certificate, Index, Acknowledgement etc.) Submit the project report with the Guide's signature to the department.
30) Students should maintain the documentation and record properly which includes dairy, photographs, certificates, feedback of beneficiaries, news in local paper if any.
31) A CES report should be written individually in the standard format (2 Copies): Index, Introduction, details of activities, photographs, signature sheets of beneficiaries, feedback of beneficiaries, own feedback, summary /output, etc. It should be submitted with the Guide's signature to the department.
32) The oral /poster presentation for all the FP/CES should be arranged in the department. To evaluate the project, examiner should be appointed by HoD.
33) The total work for FP/CES including preparation of questionnaire to presentation should be evaluated for 2 credits (50 Marks).

References	5. https://www.ugc.gov.in/pdfnews/4187860_Revised-Final-Guidelines.pdf 6. https://en.wikipedia.org/wiki/OU_Citizen_Science_Soil_Collection_Program
Model Questions:	**NA**

Distribution of Marks and the scheme of FP/CES Evaluation as follows:

Sr. No	Evaluation type	Marks
1	Student performance	20
2	FP/CES Report	20
3	Presentation (PPT or Poster)	10
Total		50

Name of Course – "Foundation of Artificial Intelligence"

Introduction:

The National Education Policy (NEP) 2020 emphasizes the integration of Artificial Intelligence (AI) across all undergraduate levels and disciplines to foster digital literacy and problem-solving skills. „It can enhance the employability of the youth and prepare professionals in cutting-edge areas.‟(pg. 46, R.D Kulkarni Report) The Foundations of Artificial Intelligence course offers an overview of the key concepts, structures, applications, and ethical aspects of AI. It helps learners understand how intelligent systems work and shape modern life. The course covers AI‟s definition, evolution, types, and practical uses, along with its basic architectures like rule-based systems, machine learning, and neural networks. Learners will explore AI‟s role in education, healthcare, and commerce while reflecting on ethical and social concerns such as privacy, bias, and automation. In line with NEP 2020, it fosters digital literacy and responsible AI awareness for all disciplines.

A) Objectives

i) Introduce all undergraduate students of all the faculties to the basic concepts, uses, and importance of AI.

ii) Enable learners to understand AI‟s principles, applications, limitations, and effectively use AI tools.

iii) Encourage students to recognize AI‟s role in enhancing life and engage with its social and ethical implications**.**

B) Outcomes

i) Understand the fundamental concepts, types, and evolution of Artificial Intelligence.

ii) Apply basic AI techniques and tools to real-world problems across different domains.

iii) Evaluate the social, ethical, and professional implications of AI in everyday life.

C) Implementation of Syllabus, Scheme of Examination and Teaching

1. Curriculum, Teaching and Examination Scheme Given in Appendix A
2. This course given in Appendix A shall be compulsory course in fifth semester of all undergraduate programs of all faculties in Sant Gadge Baba Amravati University, Amravati.
3. Medium of instruction, paper setting and writing of Answer paper shall be in English, Marathi and Hindi.
4. Question paper shall be set and valuated by the College/ Department.
5. Duration of external examination shall be of 2 hours and paper shall be of 30 marks.
6. Internal 20 marks shall be distributed, 5 to attendance, 15 marks to assignment/class test/viva voce/presentation.
7. Distribution of 30 external marks shall be based on 4 units, 15 marks to short and 15 marks to long answer type questions.

8.It shall be obligatory on part of the college/department to conduct examination on prescribed date by the university and submit the candidate wise information as follows on university portal on due date after valuation answer books.

- Grade A -- mark secured 30 to 50,
- Grade B -- 25 to 29,
- Grade C- 20 to 24,
- FAIL 19 and below

8. The final Grade shall be determined by the combined performance in internal and external assessments. A student must secure a minimum of 30% in the internal assessment, 30% in the external assessment, and at least 40% overall to pass. Failure to meet any of these criteria will result in a grade of "Fail." 9. In case of failure, student needs to appeared in backlog examination by paying prescribed fees.

10. Valuated answer book shall be kept in college custody for one academic year and random verification may be done by the University if required.

11. Result of final year of respective degree shall not be declared of an examination unless secured any of the grades out of A to C in Foundation of Artificial intelligence.

12. Grade secured by an examinee in examination of said course shall be shown on fifth and last semester marksheet.

13. The candidates shall have to pay Rs 150 /- in 5th semester to the college to meet out the expenses by the college on teaching of course, question paper setting and printing, paper valuation, providing answer sheet, and filling grade on University portal. In case of failure student need to pay Rs 20 /- for conduction of examination. There shall not have any facility of revaluation of answer book.

14.For teaching of the subject person having PG degree in any faculty with second class shall be considered eligible, provided priority shall be given to Ph.D., NET, SET, regular teacher.

15. **Format of question paper**

Distribution of 30 external marks shall be based on 4 units, 15 marks to short and 15 marks to long answer type questions with internal choice.

1a) Long or short answer questions based on unit number 1 having 8 marks

OR

1b) Long or short answer questions based on unit number 1 having 8 marks

2a) Long or short answer questions based on unit number 2 having 7 marks

OR

2b) Long or short answer questions based on unit number 2 having 7 marks

3a) Long or short answer questions based on unit number 3 having 8 marks

OR

3b) Long or short answer questions based on unit number 3 having 7 marks

4a) Long or short answer questions based on unit number 4 having 8 marks

OR

4b) Long or short answer questions based on unit number 4 having 8 marks

Program:					**Semester:**	**V**			
Course:	**Foundation of Artificial Intelligence**				**Code:**				
Teaching Scheme				**Evaluation Scheme**					
Level	**Lecture**	**Hours**	**Credit**	**Internal**	**External**	**Total**			
5.5	**2**	**2**	**2**	**20**	**30**	**50**			
Methods of Internal Assessment: 15 Marks to Class Tests, /Assignments/Viva voce/Presentation & 5 Mark to Attendance									
Course Objectives: To introduce AI concepts in a simple, real-life way with focus on understanding applications, ethics, and future opportunities**.**									
Course Outcomes: After completion of the course, the students will be able to:									
CO	**Course Outcomes**				**BT Level**				
CO-1	Explain the basic concepts, history, and types of AI with real-life examples.				L1 – Knowledge, L2 – Understanding				
CO-2	Describe AI structures and architectures using simple				L2 – Understanding, L3 – Application				
CO-3	Identify and analyze applications of AI in the area of arts, commerce, humanities, and daily life.				L3 – Application, L4 – Analysis				
CO-4	Evaluate ethical, social issues and predict future opportunities of AI in their own fields.				L4 – Analysis, L5 – Evaluation				

Unit 1: Introduction to Artificial Intelligence (8 Hours)

Definition of AI: What is Intelligence? Natural vs. Artificial, Simple definition of AI; History & Evolution of AI: From early computers to modern AI; Types of AI: Narrow AI vs. General AI vs. Super AI; AI in Everyday Life: Google Maps, E-commerce suggestions, Chatbots, Social Media feeds; Key Components: Data, Algorithms, Computing Power

Unit 2: AI Structures, Architectures & Techniques (7 Hours)

Basic Structure of an AI System; AI Architectures (Simplified): Rule Based System, Machine Learning, Neural Networks; Key Concepts: Knowledge Representation (using symbols, facts), Search & Problem Solving (maze example, finding shortest route), Natural Language Understanding (Google Translate, chatbots)

Unit 3: Applications of AI in Society (7 Hours)

AI in Different Fields: Education (Personalized learning apps, plagiarism checkers), Healthcare (Disease prediction, medical chatbots), Commerce (Fraud detection in banking, stock market predictions, customer support), Daily Life(Smart home devices, language translation, travel assistants); AI & Decision Making: Hiring, Loan Approval, Court Decisions; Advantages of AI, Limitations of AI

Unit 4: Ethical, Social & Future Aspects of AI (8 Hours)

Ethical Concerns in AI: Privacy issues (CCTV, online data), Bias & Fairness (AI preferring certain groups), Job Displacement (automation replacing humans); Responsible AI: Transparency, Accountability, Human oversight; Future Trends in AI: Self-driving cars, AI in governance, creative industries; AI and You (Career Perspective): Opportunities in Digital Marketing, Content Creation, Business Analytics, HR Tech, Creative Industries (non-programming roles)

Textbook:

1. Melanie Mitchell – Artificial Intelligence: A Guide for Thinking Humans Reference Books:
2. Boden, Margaret A., Artificial Intelligence: A Very Short Introduction
3. Elaine Rich – Artificial Intelligence (3rd Edition)
4. Godbole, Achyut, Artificial Intelligence आर्टिफिशियल इंटेलिजेंस (Bookganga Publication.)
5. Kulkarni, Dr Anand, आर्टिफिशियल इंटेलिजन्सच्या वाटेवर. Sakal Media Pvt. Ltd.
6. Stuart Russell – Human Compatible (2019)
7. Thorpe, Josh, AI for Students: Creative Hacks for Academic Success, Promplty Books

Sant Gadge Baba Amravati University, Amravati Teaching and Learning Scheme for the Degree of Bachelor of Science (Three Years Six Semesters Bachelor's Degree Programme) Programme: B. Sc. (Biochemistry) Course: B. Sc. III Semester VI					
Mode of Teaching	**Vertical No.**	**The Vertical**	**Type of Course**	**Course Code**	**Course Name**
Classroom Teaching/ Lab Work (Practical)/ Outdoor/ Field	a.	Major Biochemistry	Theory11	103243	Fundamental Immunology
			Theory12	103244	Basic Clinical Biochemistry
			Theory13	103245	Cell Biology
			Lab/Practical-20	103246	Integrated Immunology and Clinical biochemistry Laboratory
		Major Biochemistry (Elective)	Theory 2	103247	Introduction to Bacteriology and Microbial Biochemistry
			Lab/Practical-21	103248	Microbiological Techniques and Biochemical Analysis
			OR		
			Theory 2	103249	Nutritional Biochemistry
			Lab/Practical-21	103250	Biochemical Analysis and Food Chemistry Laboratory
	b.	Minor	Theory 6	103251	Immunology and Clinical Biochemistry
			Lab/Practical-22	103252	Clinical Biochemistry and Immunology laboratory
	d.	VSC	Lab/Practical-23	103253	Analysis of Food Antinutritional Factors and Toxicants
	e.	Internship / Apprenticeship/	OJT (On the Job Training)	103254	OJT (On the Job Training

NEP Syllabus

UG Programme

Programme: B. Sc. (Biochemistry)

Course: B.Sc. Part-III Semester-VI

103243 Theory 11 (Major) Lab-Fundamental Immunology							
Level	**Semester**	**Course Code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Maximum Marks**
5.5	VI	103243	Fundamental Immunology	2	30	2	30

Course Objectives:

- To understand the structural and functional basis of the immune system, including organs, cells, and molecules.
- To differentiate between innate and adaptive immunity and comprehend their cooperative mechanisms.
- To study the structure, genetics, and diversity of antibodies and the Major Histocompatibility Complex (MHC).
- To explore clinical immunology, including hypersensitivity, autoimmunity, vaccines, and diagnostic assays

Course Outcomes (COs): After completing this course, students will be able to:

- Differentiate innate and adaptive immunity, map haematopoiesis, and explain lymphoid organ functions. Structural features and properties of immunoglobulins, mechanisms of V(D)J recombination, and complement pathway activation.
- Contrast MHC class processing pathways, and deconstruct T-cell and B-cell activation mechanisms.
- Classify hypersensitivity types, identify autoimmune/immunodeficiency mechanisms, and apply diagnostic assay principles.

Unit	**Content**	**Hours**	**Weightage of Marks Allotted**	**Pedagogy**
Unit-1 Cells, organs and concept of Immune System.	➢ Cells of the Immune System: Haematopoiesis, structure and functions of myeloid cells (neutrophils, eosinophils, basophils, monocytes, macrophages, dendritic cells) and lymphoid cells (B-cells, T-cells, NK cells). ➢ Organs of the Immune System: Primary Lymphoid Organs: Bone marrow and Thymus (site of T-cell maturation and selection). ➢ Secondary Lymphoid Organs: Spleen, Lymph nodes, and Mucosal-Associated Lymphoid Tissue (MALT/GALT). ➢ Concept of immunity, types of Immunity:	08	08	Chalk and board Power point presentation, Videos, Animation etc.

	Innate immunity-mechanism of immune response (anatomic; physiological; phagocytic and inflammatory barriers), Adaptive immunity: Humoral and Cell-mediated immunity. Innate vs. adaptive immunity.			
Unit 2: Antigens, Antibodies, and the Complement System	➢ Antigens: Immunogenicity vs. antigenicity. Factors influencing immunogenicity. Epitopes, haptens, and adjuvants. ➢ Antibodies (Immunoglobulins): Structure: Fine structure of a typical IgG molecule (heavy chains, light chains, variable and constant regions, hinge region, F_{ab} and F_c fragments). Isotypes: Structure and biological properties of IgG, IgM, IgA, IgE, and IgD. ➢ The Complement System: Components and biological functions. Pathways of complement activation: Classical, Alternative, and Lectin pathways.	07	07	Chalk and board Power point presentation, Videos, Animation etc.
Unit 3: Antigen Presentation, T-Cell Activation, and Adaptive Responses	➢ Major Histocompatibility Complex (MHC): Structure and functional differences between Class I and Class II MHC molecules. ➢ Antigen Processing and Presentation: Endogenous Pathway: Processing of cytosolic antigens via proteasomes and presentation on Class I MHC. Exogenous Pathway: Processing of endocytosed antigens via endosomes and presentation on Class II MHC. ➢ Immune Responses: Humoral Immune Response: B-cell activation, clonal selection, plasma cell differentiation, and memory cell generation. ➢ Cell-Mediated Immune Response: T-cell activation, role of T_H1 and T_H2 subsets, and the cytotoxic T-lymphocyte (CTL) killing mechanism.	08	08	Chalk and board Power point presentation, Videos, Animation etc.

Unit 4 **Hypersensitivity and Diagnostic Techniques**	➢ Hypersensitivity Reactions: Gell and Coombs classification: Type I: IgE-mediated (Anaphylaxis/Allergy). Type II: Antibody-mediated cytotoxic reactions. Type III: Immune-complex-mediated reactions. Type IV: Delayed-type hypersensitivity (DTH). ➢ Antigen-Antibody Interactions in Vitro (Immunodiagnostics): Principles and clinical applications of Precipitation and Agglutination reactions, Western Blotting, Enzyme-Linked Immunosorbent Assay (ELISA), and Radio Immuno Assay (RIA).	07	07	Chalk and board Power point presentation, Videos, Animation etc.

References:

1. Murphy, K., & Weaver, C. (2022). Janeway's Immunobiology (10th ed.). Garland Science.
2. Abbas, A. K., Lichtman, A. H., & Pillai, S. (2023). Cellular and Molecular Immunology (11th ed.). Elsevier.
3. Punt, J., Stranford, S. A., Jones, P. P., & Owen, J. A. (2018). Kuby Immunology (8th ed.). W.H Freeman.
4. Delves, P. J., Martin, S. J., Burton, D. R., & Roitt, I. M. (2017). Roitt's Essential Immunology (13th ed.). Wiley-Blackwell.
5. Parham, P. (2021). The Immune System (5th ed.). Garland Science.
6. Sompayrac, L. M. (2019). How the Immune System Works (6th ed.). Wiley-Blackwell
7. Paul, W. E. (Ed.). (2013). Fundamental Immunology (7th ed.). Lippincott Williams & Wilkins.
8. Nairn, R., & Helbert, M. (2017). Immunology for Medical Students (3rd ed.). Elsevier. Indian Authors
9. Chakravarty, A. K. (2018). Introduction to Immunology and Immunotechnology. Oxford University Press India.
10. Dubey, R. C., & Maheshwari, D. K. (2022). A Textbook of Microbiology (including Immunology chapters). S. Chand Publishing.

Model questions	**Short Answer Questions**
	1. Define hematopoiesis and mention its primary site in adults. 2. List any three myeloid cells and state one function of each. 3. What is the difference between innate and adaptive immunity? 4. Name the primary lymphoid organs and state their main functions. 5. What are antigens? Differentiate between immunogenicity and antigenicity. 6. Define epitope and hapten with one example each. 7. Draw the basic structure of an IgG molecule and label its main regions (mention key parts in words if drawing is not possible). 8. Name the three pathways of complement activation and mention one key feature of each.

	9. Differentiate between MHC Class I and MHC Class II molecules. 10. What is delayed-type hypersensitivity (Type IV reaction)? Give one example. **Long Answer Questions** 1. Explain the process of hematopoiesis. Mention its importance and site in adults. 2. Describe the structure and functions of neutrophils, eosinophils, and basophils. 3. Explain innate immunity and adaptive immunity. Give any four differences between them. 4. Describe the primary lymphoid organs and their functions. 5. What is an antigen? Explain the factors that influence immunogenicity. 6. Explain the structure of an antibody (IgG) with a neat labeled diagram. 7. Describe the different classes of immunoglobulins and mention one function of each. 8. Explain the complement system and describe the three pathways of complement activation. 9. Differentiate between MHC Class I and MHC Class II molecules. 10. Explain Type IV (Delayed-Type) hypersensitivity reaction with its mechanism and one example. **Multiple Choice Questions** **1. Which of the following cells differentiates into plasma cells?** A) T-lymphocyte **B) B-lymphocyte** C) Neutrophil D) Macrophage **2. The primary site of T-cell maturation is:** A) Bone marrow **B) Thymus** C) Spleen D) Lymph node **3. The largest secondary lymphoid organ is:** A) Thymus B) Bone marrow **C) Spleen** D) Tonsil

	4. A hapten becomes immunogenic when combined with: A) Antibody **B) Carrier protein** C) Cytokine D) Complement **5. Which immunoglobulin is the first antibody produced during a primary immune response?** A) IgG **B) IgM** C) IgA D) IgE **6. The antibody responsible for allergic reactions is:** A) IgG B) IgM C) IgA **D) IgE** **7. The classical complement pathway is activated primarily by:** A) Bacterial endotoxins **B) Antigen-antibody complexes** C) Mannose residues D) Cytokines **8. Endogenous antigens are presented by:** **A) MHC Class I molecules** B) MHC Class II molecules C) Antibodies D) Complement proteins **9. Delayed-type hypersensitivity belongs to:** A) Type I B) Type II C) Type III **D) Type IV** **10. ELISA is commonly used for:** A) DNA sequencing

	B) Chromosome analysis **C) Detection of antigens and antibodies** D) Protein synthesis

The distribution of marks for the Continues Assessment Test (CAT) shall be as follows:

Internal Assessment (Theory) for 20 marks		
MCQ Test 1 based on 25%syllabus	Consider best 2 out of 3 tests	10 Marks
MCQ Test 2 based on 50%syllabus		
MCQ Test 3 based on 75%syllabus		
Assignments/Innovative activities /GD/Seminar/Poster presentation, quiz etc. (any Two activity 5 marks each)		10 Marks
Total		20 Marks

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Maximum Marks
5.5	VI	103244	Basics in Clinical Biochemistry	2	30	2	30

Course Objectives:

- To understand the role of a clinical biochemistry laboratory in disease diagnosis, monitoring, and prognosis.
- To master the principles of organ function tests (liver, kidney, gastric, and thyroid).
- To explore the biochemical basis of metabolic disorders like diabetes, atherosclerosis, and plasma protein abnormalities.
- To gain proficiency in clinical enzymology and the diagnostic value of biological fluids.

Course Outcomes (COs): After completing this course, students will be able to:

- Apply standard biosafety protocols, specimen collection techniques, and anticoagulant selection within pre-analytical workflows.
- Analyze plasma protein variations, diagnostic SPEP electropherograms, and tissue-specific isoenzymes to identify acute organ damage.
- Differentiate clinical jaundice types, evaluate hepatic synthetic function, and calculate renal clearance rates and GFR.
- Diagnose acid-base disturbances, assess gastrointestinal absorption efficiency, and interpret toxicology and therapeutic drug monitoring markers.

Unit	Content	Hours	Weightage of Marks Allotted	Pedagogy
Unit-1 Laboratory Management	➢ Introduction to Clinical Laboratory: Scope and evolution of clinical biochemistry in modern medicine. Layout, workflow design. Brief review of units and abbreviations used expressing concentration and standard solution. ➢ Requirements of setting up of clinical laboratory, Safety measures in clinical laboratory.Laboratory safety protocols: Biosafety Levels (BSLs). ➢ Chemical hazards, spill management, and biomedical waste disposal (color-	07	07	Chalk and board Power point presentation, Videos, Animation etc.

	coded segregation). ➢ Role of the laboratory technician, ethics, and patient data confidentiality (HIPAA/local regulations).			
Unit 2: Anticoagulants and blood Preservation	➢ Anticoagulants and preservatives: Mechanism of action and specific diagnostic applications of common anticoagulants: EDTA, Heparin, Sodium Citrate, and Potassium Oxalate. ➢ Role of Glycolytic Inhibitors (Sodium Fluoride) in stabilizing blood glucose levels. ➢ Preservatives used for 24-hour urine collection (Toluene, HCl, Boric acid, Thymol) and their biochemical preservation mechanisms. ➢ Collection, preservation, and processing of biological specimens (blood, urine, cerebrospinal fluid). Techniques of venipuncture, skin puncture, and arterial blood sampling Specimen preservation, transport temperatures and storage protocols.	7	7	Chalk and board Power point presentation, Videos, Animation etc.
Unit 3: Plasma Proteins & Clinical Enzymology	➢ Plasma Proteins in Health and Disease: Synthesis and functional significance of albumin, globulins, transferrin, ceruloplasmin, and C-reactive protein (CRP). ➢ Clinical Enzymology: Functional vs. Non-functional Plasma Enzymes: Mechanisms of enzyme release into blood during cell injury. ➢ Diagnostic Enzymes & Isoenzymes: Clinical significance of Aminotransferases (ALT, AST), Lactate Dehydrogenase (LDH isoenzymes), Creatine Kinase (CK-MB in myocardial infarction). Alkaline Phosphatase (ALP), Acid Phosphatase (ACP), and Amylase/Lipase (in acute pancreatitis).	08	08	Chalk and board Power point presentation, Videos, Animation etc.
Unit 4: Liver and Kidney Function Tests	➢ Liver Function Tests (LFTs): Bilirubin Metabolic & Excretory Functions: Bilirubin metabolism (production, conjugation, and excretion)	08	08	Chalk and board, Power point presentation, Videos, Animation etc.

	➢ Jaundice: Biochemical differentiation of pre-hepatic (hemolytic), hepatic (hepatocellular), and post-hepatic (obstructive) jaundice using serum and urine markers (urobilinogen, bilirubin). ➢ Synthetic and Excretory Markers: Total protein, albumin, prothrombin time, ALP, and GGT. ➢ Renal Function Tests (RFTs): Glomerular filtration rate (GFR) and renal plasma flow, Clearance Tests: Principle, execution, and calculation of Creatinine Clearance and Urea Clearance tests. ➢ Urinalysis: Routine physical, chemical (proteinuria, glycosuria, hematuria), and microscopic examination.			

References:

1. Tietz Textbook of Clinical Chemistry and Molecular Diagnostics – Rifai, Horvath, and Wittwer
2. Clinical Chemistry: Principles, Techniques, and Correlations – Bishop, Fody, and Schoeff
3. Textbook of Medical Biochemistry – MN Chatterjea and Rana Shinde
4. Clinical Biochemistry: Metabolic and Clinical Aspects – William J. Marshall
5. Textbook of Clinical Biochemistry by R. Sood. CBS Publication 219 Edition.
6. Textbook of Clinical Biochemistry by S. K. Gupta and Binita Goswami. Arya Publication, 2023 Third Edition.

Model questions	**Short Answer Questions**
	1. Define clinical biochemistry and mention its importance in modern medicine. 2. What are Biosafety Levels (BSLs)? Name the different biosafety levels. 3. Write any three laboratory safety measures followed in a clinical laboratory. 4. State the role of a laboratory technician in a clinical laboratory. 5. Name any four commonly used anticoagulants and mention one diagnostic use of each. 6. What is the role of sodium fluoride in blood sample collection? 7. Describe the procedure and precautions for venipuncture. 8. Name any four plasma proteins and state one function of each. 9. Differentiate between functional and non-functional plasma enzymes. 10. What is jaundice? Name its three major types.

Long Answer Questions

1. Explain the scope and importance of clinical biochemistry in modern medicine.
2. Describe the safety measures and biosafety levels used in a clinical laboratory.
3. Explain the role and responsibilities of a laboratory technician.
4. Describe the mechanism of action and uses of common anticoagulants used in clinical laboratories.
5. Explain the collection, preservation, and processing of blood, urine, and cerebrospinal fluid samples.
6. Describe the synthesis, functions, and clinical significance of plasma proteins.
7. Explain the clinical significance of important diagnostic enzymes and isoenzymes.
8. Describe bilirubin metabolism and the biochemical basis of different types of jaundice.
9. Explain the liver function tests and their clinical importance.
10. Describe the renal function tests and routine urinalysis used in clinical diagnosis.

Multiple Choice Questions

1. Which anticoagulant is commonly used for hematological investigations?
   - A) Heparin
   - B) Sodium Citrate
   - **C) EDTA**
   - D) Potassium Oxalate
2. Sodium fluoride is primarily used to:
   - A) Prevent coagulation
   - **B) Preserve blood glucose**
   - C) Increase pH
   - D) Preserve proteins
3. The most abundant plasma protein is:
   - A) Globulin
   - **B) Albumin**
   - C) Fibrinogen
   - D) Ceruloplasmin
4. An M-spike in serum protein electrophoresis is characteristic of:
   - A) Hepatitis
   - B) Cirrhosis
   - **C) Multiple Myeloma**
   - D) Nephritis

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Internal Assessment (Theory) for20 marks		
MCQ Test 1 based on 25%syllabus	Consider best 2 out of 3 test	10 Marks
MCQ Test 2 based on 50%syllabus		
MCQ Test 3 based on 75%syllabus		
Assignments/Innovative activities /GD/Seminar/Poster presentation, quiz etc. (any Two activity 5 marks each)		10 Marks
Total		20 Marks

103245 Theory 13(Major): Cell Biology							
Level	**Semester**	**Course Code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Maximum Marks**
5.5	VI	103245	Cell Biology	2	30	2	30

Course Objectives:

- To understand the structural organization and functional complexity of prokaryotic and eukaryotic cells.
- To explore the structure, composition, and transport dynamics of cellular membranes.
- To study the functions of various cell organelles and the molecular mechanisms of energy generation.
- To analyze the cell cycle, its regulatory checkpoints, and the fundamentals of cellular communication and programmed cell death.

Course Outcomes (COs): After completing this course, students will be able to:

- Distinguish structural variations between prokaryotes, eukaryotes, viruses, and prions based on evolutionary and morphological features.:
- Analyze the fluid mosaic model, lipid raft composition, and structural roles of membrane proteins and carbohydrates.
- Differentiate passive, primary/secondary active, and vesicular transport mechanisms across the plasma membrane.
- Explain the role of the endoplasmic reticulum and Golgi apparatus in protein synthesis, modification, and targeting.
- Appraise lysosomal and peroxisomal metabolic pathways and correlate their dysfunctions with specific cellular diseases.
- Deconstruct the signal hypothesis and pathways governing co-translational and post-translational protein trafficking.
- Formulate the chemiosmotic hypothesis of mitochondrial ATP synthesis and evaluate the endosymbiotic theory using mitochondrial DNA.
- Diagram the nuclear pore complex and compare the structural dynamics of microtubules, microfilaments, and intermediate filaments.CO-9:
- Evaluate the molecular regulation of cell cycle phases, checkpoints, and cyclins/CDKs in relation to cancer development.
- Classify cell junctions and compare the underlying biochemical pathways of programmed apoptosis versus necrosis.

Unit	Content	Hours	Weightage of Marks Allotted	Pedagogy
Unit-I: Cellular Architecture & The Plasma Membrane	➢ Structural differences between prokaryotic and eukaryotic cells ➢ The Plasma Membrane: Structure and Models: Evolution of membrane models, culminating in the Fluid Mosaic Model (Singer and Nicolson). chemical Composition of plasma Membrane ➢ Membrane Transport Dynamics: Passive Transport: Simple diffusion, facilitated diffusion via ion channels and permeases, and osmosis. ➢ Active Transport: Primary active transport (the Na^+/K^+ ATPase pump, Ca^{2+} pump) and secondary active transport (Na^+/glucose cotransporter).	08	08	Chalk and board Power point presentation, Videos, Animation etc.
Unit 2: The Endomembrane System & Protein Sorting	➢ Endoplasmic Reticulum (ER): Structural distinction between Rough ER (RER) and Smooth ER (SER). Functions of SER (lipid synthesis, detoxification) and RER (protein synthesis). ➢ The Golgi Apparatus: Structural polarity (Cis, Medial, and Trans faces). Role in post-translational modifications (O-linked and N-linked glycosylation, sulfation) and secretory protein targeting. ➢ Structure and Biochemical function of lysosomes and peroxisomes. ➢ Protein Trafficking (Sorting): The signal hypothesis; signal peptides, co-translational and post-translational import of proteins into	07	07	Chalk and board Power point presentation, Videos, Animation etc.

	the ER, mitochondria, and nucleus (Nuclear Localization Signals).			
Unit 3: Mitochondria, Nucleus & Cytoskeleton	➢ Mitochondria: Structure and function. ➢ The Nucleus: Nuclear envelope structure, nuclear pore complex (NPC), Organization of chromatin (heterochromatin vs. euchromatin) and the structure of the nucleolus. Functions of nucleus, ➢ The Cytoskeleton: Structure, assembly, and dynamic instability of Microtubules: Tubulin dimers, role in mitotic spindle formation and intracellular transport ➢ Microfilaments: Actin and myosin filaments, role in amoeboid movement and cytokinesis.	08	08	Chalk and board Power point presentation, Videos, Animation etc.
Unit 4: Cell Cycle, Signalling, & Cell Death	➢ The Cell Cycle: Phases of the cell cycle (G1, S, G2, and M phases). Mechanics of Mitosis and Meiosis. ➢ Regulation of the Cell Cycle ➢ Cell Signalling Foundations: Basic principles of cell signalling; classification of extracellular signalling molecules, receptor types, and an introduction to programmed cell death (Apoptosis) vs. accidental cell death (Necrosis)	07	07	Chalk and board Power point presentation, Videos, Animation etc.
References:	1. Alberts, B., Johnson, A., Lewis, J., Morgan, D., Raff, M., Roberts, K., & Walter, P. (2022). Molecular Biology of the Cell (7th ed.). Garland Science. 2. Lodish, H., Berk, A., Kaiser, C. A., Krieger, M., Bretscher, A., Ploegh, H., Amon, A., & Martin, K. C. (2021). Molecular Cell Biology (9th ed.). W.H. Freeman. 3. Nelson, D. L., & Cox, M. M. (2021). Lehninger Principles of Biochemistry (8th ed.). W.H. Freeman. 4. Berg, J. M., Tymoczko, J. L., Gatto, G. J., & Stryer, L. (2019). Biochemistry (9th ed.). W.H. Freeman. Indian Authors 5. Gupta, P. K. (2020). Cell and Molecular Biology (6th ed.). Rastogi Publications.			

	6. Verma, P. S., & Agarwal, V. K. (2021). Cell Biology, Genetics, Molecular Biology, Evolution and Ecology. S. Chand Publishing. 7. Rastogi, S. C. (2019). Cell Biology. New Age International Publishers. 8. Singh, B. D. (2022). Cell Biology, Genetics and Molecular Biology. Kalyani Publishers. 9. Arora, M. P., & Kaur, H. (2019). Cell Biology. Himalaya Publishing House. 10. Dubey, R. C. (2022). A Textbook of Biotechnology. S. Chand Publishing.

Model questions	**Short Answer Questions** 1. Differentiate between prokaryotic and eukaryotic cells. 2. Explain the Fluid Mosaic Model of the plasma membrane. 3. What are the major chemical components of the plasma membrane? 4. Differentiate between passive transport and active transport. 5. State the functions of Rough Endoplasmic Reticulum (RER) and Smooth Endoplasmic Reticulum (SER). 6. What are the functions of the Golgi apparatus? 7. Differentiate between lysosomes and peroxisomes. 8. Describe the structure and functions of mitochondria. 9. Differentiate between heterochromatin and euchromatin. 10. Differentiate between apoptosis and necrosis. **Long Answer Questions** 1. Describe the structure, composition, and Fluid Mosaic Model of the plasma membrane. 2. Explain the different mechanisms of membrane transport with suitable examples. 3. Describe the structure and functions of Rough Endoplasmic Reticulum and Smooth Endoplasmic Reticulum. 4. Explain the structure and functions of the Golgi apparatus. 5. Describe the structure and biochemical functions of lysosomes and peroxisomes. 6. Explain the structure and functions of mitochondria and the nucleus. 7. Describe the structure and functions of microtubules and microfilaments in the cytoskeleton. Explain the phases of the cell cycle and the process of mitosis and meiosis. 8. Describe the basic principles of cell signalling and differentiate between apoptosis and necrosis. **Multiple Choice Questions**

	1. Which of the following is a characteristic feature of prokaryotic cells? A) Membrane-bound nucleus **B) Absence of membrane-bound organelles** C) Mitochondria present D) Linear chromosomes **2. The Fluid Mosaic Model of plasma membrane was proposed by:** A) Watson and Crick B) Schleiden and Schwann **C) Singer and Nicolson** D) Robert Hooke **3. Movement of water across a semipermeable membrane is called:** A) Diffusion B) Active transport **C) Osmosis** D) Endocytosis **4. The Na^+/K^+ ATPase pump is an example of:** A) Facilitated diffusion B) Osmosis **C) Primary active transport** D) Secondary active transport **5. Protein synthesis mainly occurs on:** A) Smooth ER **B) Rough ER** C) Golgi apparatus D) Lysosomes **6. Glycosylation and packaging of proteins occur in the:** A) Nucleus B) Ribosome **C) Golgi apparatus** D) Peroxisome **7. The powerhouse of the cell is:** A) Lysosome B) Golgi body

	C) Nucleus **D) Mitochondrion** **8. Microfilaments are primarily composed of:** A) Tubulin **B) Actin** C) Keratin D) Elastin **9. DNA replication occurs during which phase of the cell cycle?** A) G1 phase **B) S phase** C) G2 phase D) M phase **10. Programmed cell death is known as:** A) Necrosis B) Autolysis **C) Apoptosis** D) Senescence

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Internal Assessment (Theory) for20 marks		
MCQ Test 1 based on 25%syllabus	Consider best 2 out of 3 test	10 Marks
MCQ Test 2 based on 50%syllabus		
MCQ Test 3 based on 75%syllabus		
Assignments/Innovative activities /GD/Seminar/Poster presentation, quiz etc. (any Two activity 5 marks each)		10 Marks
Total		20 Marks

103246 Lab 20: Integrated Immunology and Clinical biochemistry Laboratory							
Level	**Semester**	**Course Code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Maximum Marks**
5.5	VI	103246	Integrated Immunology and Clinical biochemistry Laboratory	2	30	2	30

Course Objectives:

- To provide comprehensive, practical knowledge of antigen-antibody interactions used in routine clinical diagnostics.
- To develop core technical competencies in sample preparation, dilution, and troubleshooting within biological and clinical laboratory settings.

Course Outcomes (CO): Upon successful completion of this laboratory course, students will be able to:

- Perform and interpret diagnostic blood typing assays based on agglutination patterns.
- Execute serological and rapid slide agglutination tests to screen for bacterial infections, pregnancy biomarkers, and systemic inflammation. Quantify total protein concentrations in clinical samples using standard colorimetric assays (Biuret or Lowry) and construct standard calibration curves.
- Evaluate renal performance and metabolic waste excretion by accurately measuring serum creatinine and uric acid levels.
- Analyze dynamic carbohydrate and lipid metabolism through glucose tolerance profiling and serum triglyceride quantification.

Sr. No.	List of Practical's
1	Blood Typing and Rh Factor Determination by Slide Agglutination Method
2	Qualitative Detection of Human Chorionic Gonadotropin (hCG) using Rapid Lateral Flow Immunoassay
3	Serological Diagnosis of Typhoid Fever using Widal Slide and Tube Agglutination Tests
4	Qualitative and Semi-Quantitative Determination of Rheumatoid Factor (RF) by Latex Agglutination
5	Estimation of serum Creatinine
6	Glucose Tolerance test
7	Estimation of Serum Triglyceride
8	Estimation of serum uric acid
9	Qualitative analysis of urine sample for abnormal constituent

References:

1) Bishop, M. L., Fody, E. P., & Schoeff, L. E. (2018). Clinical Chemistry: Principles, Techniques, and Correlations (8th ed.). Wolters Kluwer.
2) Burtis, C. A., Bruns, D. E., & Baird, G. S. (2022). Tietz Fundamentals of Clinical Chemistry and Molecular Diagnostics (9th ed.). Elsevier.
3) McPherson, R. A., & Pincus, M. R. (2021). Henry's Clinical Diagnosis and Management by Laboratory Methods (24th ed.). Elsevier.
4) Turgeon, M. L. (2022). Clinical Laboratory Science: Concepts, Procedures, and Clinical Applications (9th ed.). Elsevier.
5) Mukherjee, K. L., & Nema, M. (2019). Medical Laboratory Technology: Procedure Manual for Routine Diagnostic Tests (Vol. I–III). Tata McGraw-Hill Education.
6) Ramnik Sood. (2022). Medical Laboratory Technology: Methods and Interpretations (7th ed.). Jaypee Brothers Medical Publishers.
7) Chatterjea, M. N., & Shinde, R. (2021). Textbook of Medical Biochemistry (10th ed.). Jaypee Brothers Medical Publishers.
8) Satyanarayana, U., & Chakrapani, U. (2023). Biochemistry (7th ed.). Elsevier India.

The distribution of marks for the practical examination shall be as follows:

External Evaluation		**Internal Evaluation based on CAT**	
Performance of any two Experiments	20 marks	Attendance and Students performance	10 Marks
Viva-voce	05 marks	Practical/Record Book	05 Marks
		MCQ/ Spotting	10 Marks
Total	25 Marks	**Total**	25 Marks

103247Theory 2(Major elective): Introduction to Bacteriology and Microbial Biochemistry							
Level	**Semester**	**Course Code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Maximum Marks**
5.5	VI	103247	Introduction to Bacteriology and Microbial Biochemistry	2	30	2	30

Course Objectives:

- Understand the structure, organization, and functions of bacterial cells, including specialized structures such as capsules, flagella, pili, and endospores.
- Develop knowledge of microbiological techniques used for the cultivation, identification, control, and characterization of bacteria, including staining methods, culture media, and pure culture techniques.
- Explain the principles and mechanisms of microbial control, including sterilization, disinfection, and the action of physical and chemical antimicrobial agents.
- Analyse microbial physiological processes, including metabolism, fermentation, anaerobic respiration, growth kinetics, sporulation, and microbial cell-to-cell communication.

Course Outcomes: Upon successful completion of this course, students will be able to:

- Describe and differentiate bacterial cell structures and explain their roles in bacterial growth, survival, and adaptation.
- Apply microbiological laboratory techniques such as Gram staining, endospore staining, preparation of culture media, and pure culture isolation methods for bacterial identification and cultivation.
- Evaluate and select appropriate microbial control methods based on the principles of sterilization, disinfection, and the properties of physical and chemical antimicrobial agents.
- Interpret microbial physiological processes including metabolic pathways, fermentation, anaerobic respiration, growth kinetics, sporulation, and quorum sensing, and relate them to microbial behavior and industrial or clinical applications.

Unit	Content	Hours	Weightage of Marks Allotted	Pedagogy
Unit-1 Basic Microbiology	➢ Typical structure of bacterial cell. Structure and function of bacteria – Cell wall, Plasma membrane (cytoplasmic membrane), Ribosome, Capsule, Flagella, Pili, Endospore: Structure and stages in Sporulation ➢ Staining techniques: Definition and types of stains, Mechanism, procedure and application of Gram staining, Endospore staining, acid fast staining ➢ Culture media: Components of media, types of media - Selective media, differential media, enriched and enrichment media. ➢ Methods of preparation of pure culture- Streak plate method pour plate method and spread plate method.	08	08	Chalk and board Power point presentation , Videos, Animation etc.
Unit-II Microbial Control	➢ Definitions- Sterilization and Disinfection, Antiseptic, Germicide, Microbiostatic, Microbicidal. ➢ Physical agents- i) Temperature - dry heat, moist heat, incineration. ii) Radiations: Ionizing and Non-ionizing. ➢ Chemical agents- i) phenol and phenolic compounds. ii) Alcohols iii) Halogens. iv) Heavy metals and their compounds v) aldehydes vi) gaseous agents vii) Quaternary ammonium compounds. ➢ Characteristics of an Ideal disinfectant, Phenol Coefficient Experiment.			
Unit III Microbial Energetics & Metabolic Diversity	➢ Bacterial Fermentations: Carbohydrate Breakdown: overview of Glycolysis (EMP pathway), Entner-Doudoroff (ED) pathway, and the Pentose Phosphate Pathway (PPP). ➢ Fermentation End-Products: Biochemical pathways for homolactic and heterolactic fermentation, mixed acid fermentation, 2,3-butanediol fermentation, and butyric acid fermentation. ➢ Anaerobic Respiration: Electron transport chains using alternative terminal electron acceptors instead of oxygen (Nitrate reduction/Denitrification, Sulfate reduction, and Methanogenesis). bacteria. The biochemical mechanism of reverse electron flow for generating reducing power (NADH).	07	07	Chalk and board Power point presentation , Videos, Animation etc.

Unit IV: Microbial Growth, Regulation, and Stress Responses	➢ Microbial Growth Kinetics: Mathematical expression of growth, generation time, and specific growth rate. Phases of the batch culture growth curve (lag, exponential/log, stationary, and death phases). Continuous culture systems (chemostat and turbidostat). ➢ Endospore Formation: Biochemical and structural changes during bacterial sporulation in Bacillus species; the role of dipicolinic acid and small acid-soluble proteins (SASPs) in heat resistance. ➢ Microbial Signalling: Quorum Sensing: Molecular mechanisms of cell-to-cell communication using Acyl-homoserine lactones (AHLs) in Gram-negative bacteria and peptide autoinducers in Gram-positive bacteria.	08	08	Chalk and board Power point presentation , Videos, Animation etc.

References :

1. Madigan, M. T., Bender, K. S., Buckley, D. H., Sattley, W. M., & Stahl, D. A. (2024). *Brock Biology of Microorganisms* (17th ed.). Pearson Education.
2. Willey, J. M., Sherwood, L. M., & Woolverton, C. J. (2022). *Prescott's Microbiology* (12th ed.). McGraw-Hill Education.
3. Moat, A. G., Foster, J. W., & Spector, M. P. (2002). *Microbial Physiology* (4th ed.). Wiley-Liss.
4. Gottschalk, G. (2012). *Bacterial Metabolism* (2nd ed.). Springer-Verlag.
5. Pelczar, M. J., Chan, E. C. S., Krieg, N. R., (Indian Edition). (2019). *Microbiology*. Tata McGraw-Hill Education.
6. Dubey, R. C., & Maheshwari, D. K. (2022). *A Textbook of Microbiology* (5th ed.). S. Chand Publishing.
7. Aneja, K. R. (2023). *Experiments in Microbiology, Plant Pathology and Biotechnology* (5th ed.). New Age International Publishers.
8. Purohit, S. S. (2021). *Microbiology: Fundamentals and Applications* (8th ed.). Agrobios (India).
9. Sharma, P. D. (2022). *Microbiology* (3rd ed.). Rastogi Publications.
10. Singh, R. P. (2021). *General Microbiology*. Kalyani Publishers.

Model questions	**Short Answer Questions**
	1. Draw and explain the typical structure of a bacterial cell. 2. State the functions of the bacterial cell wall. 3. What are capsules and what are their functions? 4. Differentiate between flagella and pili. 5. What are endospores? Mention their significance. 6. List the stages involved in bacterial sporulation.

	7. Define staining and classify different types of stains. 8. Explain the principle of Gram staining. 9. Write the applications of Gram staining. 10. What is endospore staining? State its importance. **Long Answer Questions** 1. Describe the structure of a typical bacterial cell and explain the functions of its major components. 2. Explain the structure and functions of bacterial cell wall, plasma membrane, capsule, flagella, pili, and endospores. 3. Describe the principle, procedure, and applications of Gram staining and endospore staining. 4. Explain the different types of culture media and their uses in microbiology. 5. Describe the methods used for obtaining pure culture, including streak plate, spread plate, and pour plate methods. 6. Define sterilization and disinfection. Explain physical methods of sterilization in detail. 7. Explain the chemical agents used for disinfection and their mechanisms of action. 8. Describe bacterial fermentation pathways including glycolysis, Entner-Doudoroff pathway, and pentose phosphate pathway. 9. Explain bacterial growth curve and describe microbial growth kinetics and continuous culture systems. 10. Explain anaerobic respiration, endospore formation, and quorum sensing in bacteria. **Multiple choice questions** **1. Which component of a bacterial cell wall is responsible for its rigidity?** A) Lipopolysaccharide **B) Peptidoglycan** C) Cellulose D) Chitin **2. The primary function of bacterial ribosomes is:** A) Energy production B) DNA replication **C) Protein synthesis** D) Cell division

3. In Gram staining, Gram-positive bacteria appear purple because they:

A) Have a thick peptidoglycan layer that retains crystal violet stain
B) Contain lipopolysaccharides
C) Lack a cell wall
D) Possess endospores

4. Which staining technique is commonly used to visualize bacterial endospores?

A) Negative staining
B) Acid-fast staining
C) Schaeffer-Fulton staining
D) Capsule staining

5. MacConkey agar is an example of:

A) Enriched medium only
B) Selective and differential medium
C) Enrichment medium only
D) Minimal medium

6. Which method is most commonly used to obtain isolated bacterial colonies on a solid medium?

A) Filtration
B) Streak plate method
C) Centrifugation
D) Sedimentation

7. Which physical method of sterilization uses steam under pressure?

A) Hot-air oven
B) Incineration
C) Autoclaving
D) Pasteurization

8. During glycolysis (EMP pathway), one molecule of glucose is converted into:

A) One pyruvate molecule
B) Two pyruvate molecules
C) Three pyruvate molecules
D) Four pyruvate molecules

	9. In a typical bacterial growth curve, the phase with maximum cell division rate is: A) Lag phase B) Stationary phase C) Death phase **D) Log (Exponential) phase** **10. Quorum sensing in Gram-negative bacteria commonly involves:** A) Peptide autoinducers **B) Acyl-homoserine lactones (AHLs)** C) Dipicolinic acid D) Lipoteichoic acid

Internal Assessment (Theory) for 20 marks		
MCQ Test 1 based on 25%syllabus	Consider best 2 out of 3 tests	10 Marks
MCQ Test 2 based on 50%syllabus		
MCQ Test 3 based on 75%syllabus		
Assignments/Innovative activities /GD/Seminar/Poster presentation, quiz etc. (any Two activity 5 marks each)		10 Marks
Total		20 Marks

103248 Practical: Microbiological Techniques and Biochemical Analysis							
Level	**Semester**	**Course Code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Maximum Marks**
5.5	VI	103248	Microbiological Techniques and Biochemical Analysis	2	30	2	50 (25 +25)

Course Objectives:

- To master basic aseptic techniques, media preparation, and physical sterilization methods required for working safely in a microbiology lab.:
- To develop competency in brightfield microscopy and differential bacterial staining techniques for cellular identification.
- To learn pure culture isolation strategies and screening techniques used to identify industrially important, enzyme-producing microbes.
- To apply quantitative biochemical assays to measure microbial growth, protein yield, and enzyme kinetics.

Course Outcomes (Cos): Upon successful completion of this laboratory course, students will be able to:

- Formulate, prepare, and sterilize synthetic and complex solid or liquid culture media tailored for cultivating target bacteria and fungi.
- Operate and maintain compound light microscopes to visually identify microbial structures using simple, negative, differential (Gram), and structural (endospore) staining protocols.
- Isolate, purify, and maintain clonal microbial populations from mixed samples using standard streak, spread, and pour plate techniques.
- Screen environmental samples for functional amylolytic bacteria and quantitatively analyze extracellular amylase production via enzyme assays.
- Characterize enzyme kinetics by evaluating the direct effects of physical parameters (pH and temperature) on microbial enzyme activity.
- Quantify total bacterial protein yield in cell lysates using colorimetric spectrophotometric assays.

Sr. No.	List of Practicals
1	To perform sterilization of glassware by dry heat & Moist heat.
2	To prepare basic solid & liquid media (broth) for routine cultivation of bacteria & fungi.
3	To study the principle, working and applications of light microscope.
4	To perform simple staining, negative staining, Gram staining & endospore of bacteria.

5	To obtain pure culture of microbes by streak, spread, pour plate methods.
6	Isolation and Screening of Amylolytic Bacteria
7	Assay of microbial Amylase Production
8	Effect of temperature and pH on Microbial Enzyme Activity
References	1, Aneja, K. R. (2007). *Experiments in microbiology, plant pathology and biotechnology* (4th ed.). New Age International Publishers. 2. Cappuccino, J. G., & Welsh, C. T. (2020). *Microbiology: A laboratory manual* (12th ed.). Pearson Education. 3. Crueger, W., & Crueger, A. (1990). *Biotechnology: A textbook of industrial microbiology* (2nd ed.). Sinauer Associates. 4. Kannan, N. (1996). *Laboratory manual in general microbiology*. Palani Paramount Publications. 5. Plummer, D. T. (1987). *An introduction to practical biochemistry* (3rd ed.). McGraw-Hill Book Company.

The distribution of marks for the practical examination shall be as follows:

External Evaluation		**Internal Evaluation based on CAT**	
Performance of any two Experiments	20 marks	Attendance and Students performance	10 Marks
Viva-voce	05 marks	Practical/Record Book	05 Marks
		MCQ/ Spotting	10 Marks
Total	25 Marks	**Total**	25 Marks

103249 Theory 2 (Major elective): Nutritional Biochemistry							
Level	**Semester**	**Course Code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Maximum Marks**
5.5	VI	103249	Nutritional Biochemistry	2	30	2	30

Course Objectives:

- To enable students to understand the basic principles of a balanced diet, determine the calorific value of foods via proximate analysis, and calculate human energy requirements based on Basal Metabolic Rate (BMR) and physical activity.
- To impart deep knowledge of the physiological roles of carbohydrates, lipids, and dietary fibers, and to train students in the mathematical and experimental methods used to evaluate dietary protein quality.
- To familiarize students with the structural chemistry, dietary sources, and daily allowances of vitamins and minerals, while correlating their physiological deficiencies with specific clinical disorders.
- To explain the dynamic inter-organ metabolic cross-talk during the fed-fast cycle, the chronological biochemistry of starvation, and the molecular pathways linking obesity to chronic inflammation and insulin resistance.

Course Outcomes: After completing this course, students will be able to:

- Analyse the principles of a balanced diet, proximate food analysis, and the physiological determinants of Basal Metabolic Rate (BMR) and Recommended Dietary Allowances (RDA) across different life stages.
- Evaluate the nutritional significance of carbohydrates and lipids—including glycemic kinetics, dietary fiber, and fatty acid profiles—and mathematically assess protein quality using nitrogen balance and bio efficiency indices.
- Correlate the chemical structure, dietary sources, biochemical functions, and clinical deficiency disorders of essential fat-soluble vitamins, water-soluble vitamins, macro minerals, and micro minerals.
- Deconstruct the inter-organ metabolic cross-talk during the fed-fast cycle and prolonged starvation, and appraise the molecular mechanisms linking endocrine adipose dysfunction in obesity to chronic inflammation and insulin resistance.

Unit	Content	Hours	Weightage of Marks Allotted	Pedagogy
Unit-1 **Basic concepts of Nutrition**	➢ Introduction, Basic principles of a balanced diet to provide energy and nutrients. ➢ Composition of foods and proximate analysis of foods. Calorific value of foods and Basal metabolism. ➢ Basal Metabolic Rate (BMR), Factors affecting BMR, Energy requirements for different physical activities, Specific dynamic action of food, ➢ Nutritive value of proteins. Energy requirements and recommended dietary allowance (RDA) for infants, children, and pregnant women.	08	08	Chalk and board Power point presentation, Videos, Animation etc.
Unit 2: Macromolecular Nutrition & Protein Quality Evaluation	➢ Nutritional Significance of Carbohydrates and Lipids: Carbohydrates: Glycemic Index (GI) and Glycemic Load (GL) of foods. Role of dietary fiber (soluble and insoluble) in metabolic health. ➢ Lipids: Essential fatty acids (-3 and -6 families) and their roles in eicosanoid synthesis. Health implications of trans-fatty acids, saturated vs. polyunsaturated fatty acids (PUFA). ➢ Nutritional Significance & Quality of Proteins: Nitrogen balance concept: Positive, negative, and equilibrium states. Essential, non-essential, and conditionally essential amino acids. ➢ Methods of Evaluating Protein Quality: Principles, experimental execution, and mathematical formulas for: Biological Value, Digestibility Coefficient. Protein Efficiency Ratio. Net Protein Utilization	07	07	Chalk and board Power point presentation, Videos, Animation etc.
Unit 3: Micronutrients Vitamins and Minerals	➢ Vitamins: Chemistry, sources, daily allowances function & deficiencies of water soluble & fat-soluble vitamins. ➢ Sources and biochemical functions of Macro and microminerals.	08	08	Chalk and board Power point presentation, Videos, Animation etc.
Unit 4: Metabolic Integration, Starvation, and obesity	➢ Inter-organ Regulation of Metabolism: Cross-talk between liver, skeletal muscle, adipose tissue, and brain during the fed-fast cycle. ➢ Biochemistry of Starvation: Chronological metabolic shifts during short-term and	07	07	Chalk and board Power point presentati

	prolonged fasting: Depletion of hepatic glycogen stores. Transition to muscle proteolysis and hepatic gluconeogenesis. Adipose lipolysis and the rise of hepatic ketogenesis to preserve brain function. Nutritional Disorders & Modern Conditions: ➢ Obesity: Adipose tissue as an endocrine organ (Leptin and Adiponectin signaling). Molecular link between obesity, chronic low-grade inflammation, and insulin resistance.			on, Videos, Animation etc.
References:	1. Advanced Nutrition and Human Metabolism – Gropper, Smith, and Carr 2. Human Nutrition and Dietetics – Garrow, James, and Ralph 3. Textbook of Human Nutrition – M.S. Bamji, N. Prahlad Rao, and V. Reddy 4. Nutritional Biochemistry – Tom Brody			

Model Questions	**Short Answer Questions** 1. What is a balanced diet? State its basic principles. 2. Define calorific value of food. 3. What is Basal Metabolic Rate (BMR)? 4. Mention any four factors affecting BMR. 5. What is Specific Dynamic Action (SDA) of food? 6. Define Glycemic Index (GI) and Glycemic Load (GL). 7. What are essential fatty acids? Give examples. 8. Define nitrogen balance and mention its types. 9. Name water-soluble and fat-soluble vitamins with one example each. 10. What is obesity? Mention one biochemical reason for it. **Long Answer Questions** 1. Explain the basic principles of a balanced diet and its importance in human health. 2. Describe the composition of foods and explain proximate analysis of foods. 3. Explain Basal Metabolic Rate (BMR) and discuss the factors affecting it. 4. Describe the energy requirements for different physical activities and explain Specific Dynamic Action (SDA) of food. 5. Explain the nutritive value of proteins and describe RDA for infants, children, and pregnant women.

	6. Describe Glycemic Index (GI), Glycemic Load (GL), and the role of dietary fiber in metabolic health. 7. Explain essential fatty acids and discuss the health effects of saturated, unsaturated, and trans fats. 8. Describe the concept of nitrogen balance and explain protein quality evaluation methods. 9. Explain the chemistry, sources, functions, and deficiency diseases of vitamins. 10. Describe the biochemical changes during starvation and explain the metabolic role of liver, muscle, and adipose tissue. **Multiple Choice Questions** **1. A balanced diet should provide:** A) Only carbohydrates B) Only proteins **C) Adequate energy and all essential nutrients** D) Only vitamins **2. The amount of energy required by the body at complete rest is called:** A) Specific Dynamic Action **B) Basal Metabolic Rate (BMR)** C) Energy Expenditure D) Respiratory Quotient **3. Which nutrient provides approximately 9 kcal per gram?** A) Protein B) Carbohydrate **C) Fat** D) Vitamin **4. Glycemic Index (GI) is used to measure:** A) Protein quality **B) Blood glucose response to carbohydrate-containing foods** C) Fat digestion D) Mineral absorption **5. Which of the following is an essential fatty acid?** A) Palmitic acid B) Stearic acid

	C) Linoleic acid D) Oleic acid **6. Positive nitrogen balance is commonly observed during:** A) Starvation B) Severe illness **C) Growth and pregnancy** D) Protein deficiency **7. Protein Efficiency Ratio (PER) is used to evaluate:** A) Fat quality B) Vitamin content **C) Protein quality** D) Mineral utilization **8. Which vitamin deficiency causes scurvy?** A) Vitamin A B) Vitamin D **C) Vitamin C** D) Vitamin K **9. Iron is classified as a:** A) Macronutrient B) Fat-soluble vitamin **C) Micromineral (trace element)** D) Carbohydrate **10. Ketone bodies are produced mainly during:** A) Fed state B) High carbohydrate intake **C) Prolonged fasting and starvation** D) Excess vitamin intake

Internal Assessment (Theory) for 20 marks		
MCQ Test 1 based on 25%syllabus	Consider best 2 out of 3 tests	10 Marks
MCQ Test 2 based on 50%syllabus		
MCQ Test 3 based on 75%syllabus		
Assignments/Innovative activities /GD/Seminar/Poster presentation, quiz etc. (any Two activity 5 marks each)		10 Marks
Total		20 Marks

103250 Lab/Practical 20: Biochemical Analysis and Food Chemistry Laboratory							
Level	**Semester**	**Course Code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Maximum Marks**
5.5	VI	103250	Biochemical Analysis and Food Chemistry Laboratory	2	30	2	50 (25 +25)

Course Objectives;

- Identify and differentiate biomolecules such as carbohydrates, proteins, lipids, vitamins, and minerals using standard laboratory methods.
- Perform analytical techniques for the estimation of nutrients and bioactive compounds in food and biological samples.
- Develop practical laboratory skills in handling reagents, instruments, calculations, and interpretation of experimental data.
- Evaluate the chemical properties and nutritional quality of foods and biological materials through biochemical assays.
- Apply safety procedures and good laboratory practices during biochemical experiments.

Course Outcomes: After successful completion of the course, students will be able to:

- Identify and differentiate carbohydrates, proteins, and glycerol using standard qualitative biochemical tests.
- Determine physicochemical properties of fats and oils through acid value and saponification value analysis.
- Perform quantitative estimation of biochemical constituents such as phosphorus, iron, polyphenols, and vitamins in food and biological samples.
- Evaluate nutritional quality and vitamin stability in foods using appropriate biochemical techniques.
- Interpret experimental results, perform laboratory calculations, and prepare scientific laboratory reports accurately.

Sr. No.	List of Practicals
1.	Identification of Monosaccharide, Oligosaccharide and polysaccharide
2.	Identification of Proteins (albumin, gelatin, peptone)
3.	Identification of glycerol.

4.	Estimation of Ash content
5.	Estimation of Serum inorganic phosphorus (Fiske and Subba Row method).
6.	Estimation of polyphenols in foods.
7.	Estimation of moisture content of food items
8	Estimation of iron
9	Estimation of Vitamin A/E
10	Estimation of Calcium in milk
References	1. Biochemical Methods — S. Sadasivam & A. Manickam 2. Laboratory Manual in Biochemistry — J. Jayaraman 3. An Introduction to Practical Biochemistry — D. T. Plummer 4. A Manual of Laboratory Techniques — N. Raghuramulu, K. Madhavan Nair & S. Kalyanasundaram 5. Hawk's Physiological Chemistry — Bernard L. Oser 6.Food Analysis Laboratory Manual — Suzanne S. Nielsen 7. Handbook of Analysis and Quality Control for Fruit and Vegetable Products — S. Ranganna

The distribution of marks for the practical examination shall be as follows:

External Evaluation		**Internal Evaluation based on CAT**	
Performance of any two Experiments	20 marks	Attendance and Students performance	10 Marks
Viva-voce	05 marks	Practical/Record Book	05 Marks
		MCQ/ Spotting	10 Marks
Total	25 Marks	**Total**	25 Marks

103251 Theory 4 (Minor): Immunology and Clinical Biochemistry							
Level	**Semester**	**Course Code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Maximum Marks**
5.5	VI	103251	Immunology and Clinical Biochemistry	2	30	2	30

Course Objectives:

- To understand the role of a clinical biochemistry laboratory in disease diagnosis, monitoring, and prognosis.
- To master the principles of organ function tests (liver, kidney, gastric, and thyroid).
- To explore the biochemical basis of metabolic disorders like diabetes, atherosclerosis, and plasma protein abnormalities.
- To gain proficiency in clinical enzymology and the diagnostic value of biological fluids.

Course Outcomes: After completing this course, the student will be able to:

- Understand the fundamentals of immunity, including innate and adaptive immune responses and their roles in body defense.
- Describe the structure and functions of immune system components, such as antigens, antibodies, and MHC molecules.
- Explain antigen processing, presentation, and immune response mechanisms, including clonal selection and activation of lymphocytes.
- Classify and compare immunological reactions and techniques, including precipitation, agglutination, complement fixation, ELISA, and RIA.
- Understand the principles and clinical applications of immunological diagnostic techniques used in disease detection and monitoring.
- Gain knowledge of clinical biochemistry, including its scope, importance, laboratory setup, safety measures, quality control, and automation systems.
- Demonstrate proper collection, preservation, handling, and processing of biological samples such as blood, urine, serum, plasma, and CSF.
- Interpret biochemical parameters and enzyme patterns in health and disease, and apply clinical biochemistry and immunology principles in laboratory diagnostics and patient care.

Unit	Content	Hours	Weightage of Marks	Pedagogy

			Allotted	
Unit-1 Basic Immunology	➢ Immunology: Concept of immunity, types of Immunity: Innate immunity-mechanism of immune response (anatomic; physiological; phagocytic and inflammatory barriers) ➢ Adaptive immunity: Humoral and Cell-mediated immunity; ➢ Mechanism of immune response antigen processing and presentation; ➢ types and structures of Major Histocompatibility Complex molecules (MHC) and their role in antigen presentation; clonal selection of lymphocytes. ➢ Antigen: Definition, factors determining antigenicity, complete antigen, types of antigens. ➢ Antibodies (Immunoglobulins): Definition, structure, classification, properties and differences	08	08	Chalk and board Power point presentation , Videos, Animation etc.
Unit-2 Antigen-Antibody reactions	➢ Precipitation: Definition, Mechanism; Marrack's Hypothesis, zonal phenomenon, Application; ring test, flocculation test. immunodiffusions, and immunoelectrophoresis ➢ Agglutination: Definition, mechanism, Types; direct and indirect agglutination, Application: slide agglutination test, tube agglutination test, Coombs' test, Latex agglutination test. ➢ Complement Fixation Test and toxin – antitoxin neutralization reaction, ELISA, RIA	07	07	Chalk and board Power point presentation , Videos, Animation etc.
Unit-3 Basic Clinical Biochemistry	➢ Basic concepts of clinical biochemistry. Definition and scope of clinical biochemistry in diagnosis. Brief review of units and abbreviations used expressing concentration and standard solution, ➢ Requirements of setting up of clinical laboratory, Safety measures in clinical laboratory, Quality Control in clinical laboratory ➢ Types of Automation, Analyzer- Semi and auto analyzer, Manual versus automation in clinical laboratory.	08	08	Chalk and board Power point presentation , Videos, Animation etc.
Unit-4 Analytical clinical	➢ Collection and preservation of biological fluids (Blood, serum, plasma, urine and CSF).	07	07	Chalk and board Power point

biochemistry	➢ Chemical analysis of blood, urine and CSF. Normal values of important constituents (in SI units) in blood (Plasma/serum) CSF and urine ➢ Functional and non-functional plasma enzymes. Isozymes and diagnostic applications of isozymes. Enzyme pattern in health and diseases with special reference to plasma lipase, amylase, choline esterase, alkaline and acid phosphatase, SGOT and SGPT, LDH and CPK			presentation , Videos, Animation etc.
References:	1. Kuby Immunology – Punt, Stranford, Jones, and Owen 2. Janeway's Immunobiology – Murphy and Weaver 3. Roitt's Essential Immunology – Delves, Martin, Burton, and Roitt 4. Immunology – Khan 5. Tietz Textbook of Clinical Chemistry and Molecular Diagnostics – Rifai, Horvath, and Wittwer 6. Clinical Chemistry: Principles, Techniques, and Correlations – Bishop, Fody, and Schoeff 7. Textbook of Medical Biochemistry – MN Chatterjea and Rana Shinde 8. Clinical Biochemistry: Metabolic and Clinical Aspects – William J. Marshall			

Modal Question	**Short Answer Questions** 1. Define immunity and mention its types. 2. What is innate immunity? Name its main barriers. 3. Differentiate between humoral and cell-mediated immunity. 4. What is antigen processing and presentation? 5. Define MHC and mention its types. 6. What is an antigen? Mention any four factors affecting antigenicity. 7. Define antibodies and mention their basic structure. 8. What is agglutination? Mention any two types. 9. Name any four diagnostic immunological tests used in clinical practice. 10. What is ELISA? State its principle in brief. **Long Answer Questions** 1. Explain the concept of immunity and describe the types of immunity with examples. 2. Describe innate immunity and explain its different barriers in detail. 3. Explain humoral and cell-mediated immunity and differentiate between them. 4. Describe antigen processing and presentation and explain the role of MHC molecules. 5. Explain the structure and classification of antibodies (immunoglobulins) in detail. 6. Describe the principle, mechanism, and applications of precipitation reactions. 7. Explain agglutination reactions and describe different types with applications. 8. Describe ELISA, RIA, and complement fixation test with their principles and applications. 9. Explain the basic concepts of clinical biochemistry and its role in disease diagnosis. 10. Describe collection and preservation of biological samples and explain normal values of important blood, urine, and CSF constituents.

Multiple Choice Questions

1. The first line of defense against infection is:

A) Antibodies

B) Innate immunity

C) Memory cells

D) Plasma cells

2. Antibody-mediated immunity is known as:

A) Innate immunity

B) Humoral immunity

C) Cell-mediated immunity

D) Passive immunity

3. MHC Class II molecules are mainly present on:

A) Red blood cells

B) Antigen-presenting cells

C) Platelets

D) Muscle cells

4. A substance capable of inducing an immune response is called:

A) Antibody

B) Antigen

C) Complement

D) Cytokine

5. The most abundant immunoglobulin in serum is:

A) IgA

B) IgM

C) IgG

D) IgE

6. Visible clumping of antigen and antibody is called:

A) Precipitation

B) Agglutination

C) Neutralization

D) Opsonization

	7. ELISA is primarily used for: A) DNA sequencing **B) Detection of antigens or antibodies** C) Protein synthesis D) Cell culture **8. Which biological fluid surrounds the brain and spinal cord?** A) Plasma B) Serum **C) Cerebrospinal fluid (CSF)** D) Lymph **9. Creatine phosphokinase (CPK) is clinically important in:** A) Liver disorders **B) Myocardial and muscle disorders** C) Renal disorders D) Thyroid disorders **10. Serum amylase levels are elevated in:** A) Hepatitis B) Anemia **C) Acute pancreatitis** D) Hypertension

Internal Assessment (Theory) for 20 marks		
MCQ Test 1 based on 25%syllabus	Consider best 2 out of 3 tests	10 Marks
MCQ Test 2 based on 50%syllabus		
MCQ Test 3 based on 75%syllabus		
Assignments/Innovative activities /GD/Seminar/Poster presentation, quiz etc. (any Two activity 5 marks each)		10 Marks
Total		20 Marks

103252 Lab 22: Clinical Biochemistry and Immunology laboratory							
Level	**Semester**	**Course Code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Maximum Marks**

5.5	VI	103252	Clinical Biochemistry and Immunology laboratory	2	30	2	30

Course Objectives;

- Identify and differentiate biomolecules such as carbohydrates, proteins, lipids, vitamins, and minerals using standard laboratory methods.
- Perform analytical techniques for the estimation of nutrients and bioactive compounds in food and biological samples.
- Develop practical laboratory skills in handling reagents, instruments, calculations, and interpretation of experimental data.
- Evaluate the chemical properties and nutritional quality of foods and biological materials through biochemical assays.
- Apply safety procedures and good laboratory practices during biochemical experiments.

Course Outcomes: After successful completion of the course, students will be able to:

- Identify and differentiate carbohydrates, proteins, and glycerol using standard qualitative biochemical tests.
- Determine physicochemical properties of fats and oils through acid value and saponification value analysis.
- Perform quantitative estimation of biochemical constituents such as phosphorus, iron, polyphenols, and vitamins in food and biological samples.
- Evaluate nutritional quality and vitamin stability in foods using appropriate biochemical techniques.
- Interpret experimental results, perform laboratory calculations, and prepare scientific laboratory reports accurately.

Sr. No.	**List of Practical/Laboratory Experiments.**
A) Clinical Biochemistry :	
1.	Separation of Serum and plasma from whole blood.
2.	Glucose tolerance test
3.	Liver function tests (SGPT/SGOT)
4.	Cardiac function tests (Serum Cholesterol, Triglycerides,)
5.	Kidney function tests (Blood urea, Serum creatinine)
B) Serological tests :	
1.	Blood Grouping

2.	HBsAg (Hepatitis/B/C)
3.	Pregnancy test
References	1. Medical Laboratory Technology: Methods and Interpretations — Ramnik Sood 2. Practical Clinical Biochemistry: Methods and Interpretations — Ranjna Chawla 3. Textbook of Medical Laboratory Technology — Praful B. Godkar & Darshan P. Godkar 4. A Manual of Laboratory Techniques — N. Raghuramulu, K. Madhavan Nair & S. Kalyanasundaram 5. Practical Biochemistry — D. M. Vasudevan & Sreekumari S. 6. Laboratory Manual in Biochemistry — J. Jayaraman 7. Practical Clinical Biochemistry — Harold Varley, Alan H. Gowenlock & Maurice Bell 8. Tietz Fundamentals of Clinical Chemistry and Molecular Diagnostics — Nader Rifai, Andrea Rita Horvath & Carl T. Wittwer

The distribution of marks for the practical examination shall be as follows:

External Evaluation		**Internal Evaluation based on CAT**	
Performance of any two Experiments	20 marks	Attendance and Students performance	10 Marks
Viva-voce	05 marks	Practical/Record Book	05 Marks
		MCQ/ Spotting	10 Marks
Total	25 Marks	**Total**	25 Marks

103253-VSC-Lab practical 23: Analysis of Food Antinutritional Factors and Toxicants							
Level	**Semester**	**Course code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Maximum marks**
5.5	VI	103253	**Analysis of Food Antinutritional**	2	60	2Hrs	50

	Factors and Toxicants
Course Objective	➢ To understand major antinutritional factors and natural toxicants present in foods. ➢ To develop practical skills in food analysis and toxicological assessment. ➢ To learn standard laboratory techniques for qualitative and quantitative determination of food constituents. ➢ To evaluate the nutritional and safety implications of food contaminants and antinutritional compounds. ➢ To interpret analytical results and apply them to food quality and safety management.
Course Outcomes:	After completing this course, students will be able to: ➢ Estimate and quantify antinutritional factors such as phytic acid, tannins, and saponins in food samples using standard analytical methods. ➢ Detect naturally occurring toxicants and enzyme inhibitors in foods and evaluate their implications for nutrition and food safety. ➢ Identify and assess lectins, food toxicants, contaminants, and heavy metals using appropriate laboratory screening and analytical techniques. ➢ Analyze and interpret results related to antinutritional factors, toxicants, and contaminants in relation to food quality, nutritional value, and safety standards. ➢ Apply laboratory techniques for sample preparation, extraction, qualitative and quantitative analysis, data recording, and result interpretation. ➢ Evaluate the effectiveness of food processing methods in reducing antinutritional factors and toxic compounds in food materials. ➢ Develop technical competencies in food safety, contaminant analysis, and quality assessment relevant to food testing laboratories and the food industry. ➢ Demonstrate professional skills in food toxicology, quality control, and research practices applicable to industrial, regulatory, and research settings.

Sr. No.	**List of Laboratory Experiments/Activities etc.**
01.	Estimation of Phytic Acid in Food Samples
02.	Determination of Tannins in Plant Foods
03.	Detection of Cyanogenic Glycosides in Cassava
04.	Detection of Trypsin Inhibitor Activity in Soybean
05.	Detection of Amylase Inhibitor activity in pulses
06.	Estimation of Saponins in Legumes
07.	Detection of Lectins in Pulses
08.	Detection of Aflatoxins in Groundnut Samples
09.	Determination of Solanine in Potato

References

1. Nielsen, S. S. *Food Analysis*. Springer.
2. AOAC International. Official Methods of Analysis of AOAC International.
3. Shibamoto, T. and Bjeldanes, L. F. Introduction to Food Toxicology.
4. Fennema, O. R. Fennema's Food Chemistry.
5. Wilson, K. and Walker, J. Principles and Techniques of Practical Biochemistry.
6. Legumes: Chemistry, Technology and Human Nutrition.
7. Handbook of Food Toxicology.
8. Food Contaminants and Residue Analysis.
9. Practical book on : Standard Methods of Biochemical Analysis by S. K. Thimmaiah

The distribution of marks for the practical examination shall be as follows:

Internal Evaluation for VSC	
Attendance	10 Marks
Practical performance	20 Marks
MCQ/ Spotting	10 Marks
Practical Record book	10 Marks
Total	**50 Marks**

Course Category: Internship/Apprenticeship/ OJT
103254 Internship / Apprenticeship/ OJT (On Job Training)

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.5	**VI**	**103254**	**Internship / Apprenticeship/ OJT (On Job Training)**	**4**	**80**	**--**	**100**

Course Objectives:	➢ To provide direct, experiential training in biochemistry-related industries, diagnostic pathways, clinical pathology laboratories, or dedicated research institutions. ➢ To expose students to standard industrial workflows, advanced analytical instrumentation, quality assurance (QA/QC) metrics, and strict biological/chemical safety protocols. ➢ To develop core problem-solving capabilities, workplace team dynamics, technical communication, and data interpretation skills within a professional setting. ➢ To cultivate foundational awareness regarding commercial biotechnology avenues, intellectual property, and diverse employment or startup opportunities within the biochemical and healthcare sectors. ➢ To bridge the gap between classroom pedagogy and field execution by allowing students to see the real-world operational scale of metabolic, enzymatic, and molecular principles.
Course Outcomes:	➢ Apply theoretical biochemistry and molecular biology concepts directly to practical industrial, clinical diagnostic, and research environments. Instrumental Competence ➢ Operate, calibrate, and troubleshoot standard analytical instruments and laboratory techniques used in chemical and biochemical assays. Safety & Ethics ➢ Demonstrate rigorous laboratory safety (including Biosafety Levels), chemical hazard management, professional work ethics, and efficient teamwork. Data Analysis & Logic ➢ Analyze biochemical profiles, clinical data, experimental observations, and metabolic trends accurately and effectively. Technical Communication

	➢ Compile comprehensive technical internship reports, project dossiers, and communicate scientific or diagnostic findings professionally.

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-Internship-Guidelines.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: 80 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 asset of skills and attributes developed through a range of experiences at workshops, workplaces and industry.

ii. Internship for developing the research aptitude and practical exposure: Research internship aims at providing hands-on training to work on research tools, techniques, methodologies, handling lab 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 shall 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 are:

a. Laboratory and Analytical Training (Diagnostic & Environmental

1. Clinical biochemistry and automated diagnostic laboratory exposure (blood, urine, and cerebrospinal fluid profiles).

2. Pathological assay training (lipid profiles, liver/kidney function tests, diabetic monitoring).

3. Advanced chromatography and spectroscopy training (HPLC, GC, UV-Vis spectrophotometry).

4. Water, soil, and agricultural chemical analysis (macro and micronutrient mapping).

5. Forensic biochemistry training (toxicology, DNA profiling, and biomaterial testing).

6. Food, dairy, and beverage adulteration testing.

7, Clinical trial data monitoring and biostatistics training.

b. Biochemistry Industry-Based OJT

1. Finished pharmaceutical and active pharmaceutical ingredient (API) manufacturing units.

2. Enzyme production and industrial fermentation facilities (cellulases, amylases, proteases).

3. Cosmetic and personal care formulations (serums, bioactive creams, and specialized soap matrices).

4. Nutraceutical and dietary supplement manufacturing (vitamins, amino acid formulations, protein powders).

5. Distilleries, bio-ethanol, and brewing industry analytical process lines.

6. Biopesticide and bio-stimulant characterization and production units.

c. Research and Academic Exposure

1. Project-based research internships at University labs or premier national institutes (e.g., CSIR, ICMR, IISERs, IITs).

2. Molecular biology technique training (PCR, gel electrophoresis, DNA/RNA extraction, and gene cloning basics).

3. Protein purification and characterization workflows (column chromatography, SDS-PAGE).

4. Nanomaterial synthesis, green biochemistry, and structural characterization exposure.

5. Scientific documentation, research proposal drafting, and laboratory management protocols.

d. Entrepreneurship and Skill-Based OJT

1. Small-scale diagnostic kit assembly or extraction setups (e.g., basic blood grouping kits, biochemical reagents).

2. Organic extraction ventures: Essential oils, plant pigments (chlorophyll, anthocyanins), and bioactive herbal compounds.

3.Culinary preservation and nutritional labeling training for local MSMEs.

4. Entrepreneurship blueprints in industrial enzyme marketing or clinical lab franchising.

5. Biochemical product packaging, labelling stability testing, and regulatory documentation training.

References	**1.https://www.ugc.gov.in/pdfnews/2051511_Internship-Research-Internship-Guidelines.pdf** **2.https://www.sgbau.ac.in/pdf/1092Internship%20Policy.pdf**
Model Questions	**NA**