TUMKUR UNIVERSITY

Syllabus for

B. Sc. (Basic / Hons.) Programme in Biochemistry

Under

NATIONAL EDUCATION POLICY -2020
NEP-2020

Submitted to
Tumkur University

by

Board of Studies in Biochemistry (UG)
Tumkur University
2022

Preamble

Biochemistry, today is considered as an application oriented integrated basic science. It's an interdisciplinary science that has emerged by the confluence of principles of chemistry, physics and maths to biology. Advances in biochemistry have immense positive implications on the understanding of biochemical interactions, cellular communications, hormonal mechanism and the cross talks between them. The research in biochemistry has been translational and there is a shift from hypothesis driven research to data dependent research, that promises translational, product oriented research. Much of the advancement in biochemistry is in the advancement of biotechnology, ss a basic science discipline biochemistry lead to biotechnological advancement. Considering its pivotal role in biological sciences, it is imperative to strengthen the fundamental concepts of biochemistry. The current pattern is designed to provide a focused learning outcome-based syllabus at the Honors level providing structured teaching-learning experiences catering to the needs of the students. The honors courses will prepare the students both academically and in terms of employability. The programme also inculcates various attributes at the Honors level. These attributes encompass values related to emotional stability, social justice, creative and critical thinking, well-being and various skills required for employability, thus preparing students for continuous learning and sustainability. The new curriculum based on learning outcomes of BSc (Honours) Chemistry offers knowledge of areas including organic, inorganic, physical, analytical, spectroscopy and pharmaceutical chemistry. The courses define clearly the objectives and the learning outcomes, enabling students to choose the elective subjects broadening their skills in the field of chemistry. The course also offers skills to pursue research in the field of Chemistry and thus would produce best minds to meet the demands of society.

Curriculum

Name of the Degree Programme : B.Sc (Basic/Hons.)
Discipline Core : Biochemistry
Total Credits for the Programme :184
Starting year of implementation: 2021-22

The learning outcomes are designed to help learners understand the objectives of studying B.Sc. (Honors) Biochemistry that is, to analyze, appreciate, understand the basic concepts of biomolecular processes and chemical reactions occurring in the living system. This course is fundamental to tackle many of the health - related challenges facing society. Considering the rapid and far-reaching advances in biological sciences in 21st century, it is imperative to have curriculum incorporating these updated emerging concepts of biochemistry. The current pattern is designed to impart concept-based learning with emphasis on hands-on training, skill development and research. Aimed at multi-faceted development of a student, the curriculum includes courses encompassing core courses, intra and inters discipline specific courses, skill and ability enhancement courses to impart in-depth knowledge in biochemistry complemented with varied subjects and skills. The course seeks to discover and nurture typical attributes of a competent science graduate such as; spirit of inquiry, critical thinking, problem solving, analytical reasoning, aptitude to research/industry and entrepreneurial instincts.

Programme Learning Outcome: The learning outcome-based curriculum is specific in terms of changes in cognitive and psychomotor behavior of students. Biochemistry Honors course is intended to provide a broad framework enabling students to acquire a skill set that helps them understand and appreciate the field of

biochemistry. The structure or design of this framework shall ensure a high standard of the Honors degree in Biochemistry at national level. The programme specification are intended as a reference point for prospective students, current students, academic in delivering the programme and realizing its objectives. Keeping in pace with the developmental trends in Biochemistry and allied areas, it is expected that the students undertaking Biochemistry (Honours) course become conversant with the essence of Biochemistry and exhibit certain levels of learning outcomes as proposed below;

PROGRAMME OUTCOME (PO)

PO1	To create interest in Biochemistry and appreciation for chemical basis of biological processes.
PO2	To inculcate the spirit of inquiry and value of systematic study of a discipline. Provide a general understanding of the related disciplines with a holistic knowledge generation in biological sciences.
PO3	To provide an in-depth understanding of chemical reaction mechanisms in biological processes.
PO4	To provide a flavor of historical developments of enzymes and their applications in research, diagnostics and various industries.
PO5	Gain proficiency in basic laboratory techniques and be able to apply the scientific method to the processes of experimentation, hypothesis testing, data interpretation and logical conclusions.
PO6	Develop problem solving and analytical skills through case studies, research papers and hands-on-experience
PO7	To appreciate biochemical mechanistic basis of physiological processes, metabolism under normal and pathological conditions importance and levels of metabolic regulations.
PO8	To apply and effectively communicate scientific reasoning and data analysis in both written and oral forms. They will be able to communicate effectively with well-designed posters and slides in talks aimed at scientific audiences as well as the general public.
PO9	To bridge the knowledge and skill gap between academic out and industry requirements.
PO10	To give students experience in conducting independent, hypothesis-driven, biological research, project planning and management
PO11	To provide skills to publish research findings, and awareness of IP rights, and scientific publication ethics and problems of plagiarism.
PO12	To prepare competent human resource with better knowledge, hands-on-experience and scientific attitude, at national and global levels for careers in research and development, academia and Pharma-, biotech- and agro-, and food processing industries.

GRADUATE ATTRIBUTES B.Sc. BIOCHEMISTRY (Honours):

Graduates with strong academic knowledge, discipline-specific and generic skills complemented with social responsibility are greatest asset of the country. The curriculum frame work under NEP for Biochemistry graduates aims to build the following attributes;

Disciplinary Knowledge:

a) Ability to comprehend fundamental concepts of biology, chemistry and apply basic principles of chemistry to biological systems.
b) Ability to relate various interrelated physiological and metabolic events.
c) Ability to critically evaluate a problem and resolve to challenge blindly accepted concepts
d) Ability to think laterally and in an integrating manner and develop interdisciplinary
e) Good experimental and quantitative skills and awareness of laboratory safety
f) A general awareness of current developments at the forefront in biochemistry and allied subjects.
g) Awareness of resources, and their conservation.

Communication Skills:

a) Ability to speak and write clearly in English and local language
b) Ability to listen to and follow scientific viewpoints and engage with them.
c) Ability to understand and articulate with clarity and critical thinking one's position.

Critical Thinking:

a) Ability to conceptualize critical readings of scientific texts in order to comprehend.
b) Ability to place scientific statements and themes in contexts and also evaluate them in terms of generic conventions.

Problem Solving:

a) Ability make careful observation of the situation, and apply lateral thinking and analytical skills.

Analytical Reasoning:

a) Ability to evaluate the strengths and weaknesses in scholarly texts spotting flaws in their arguments. b. Ability to use scientific evidences and experimental approach to substantiate one's argument in one's reading of scientific texts.

Research Skills:

a) Ability to formulate hypothesis and research questions, and to identify and consult relevant sources to find answers.
b) Ability to plan and write a research paper.

Teamwork and Time Management:

a) Willingness to participate constructively in class room discussions and contribute to group work.
b) Ability to meet a deadline.

Scientific Reasoning:

a) Ability to analyze theories and beliefs, evaluate ideas and scientific strategies.
b) Ability to formulate logical and convincing arguments.

Reflective Thinking:

a) Ability to locate oneself and see the influence of location—regional, national, global— on critical thinking.

Self-Directing Learning:

a) Ability to work independently in terms of organizing laboratory, and critically analyzing scientific literature.
b) Ability to postulate hypothesis, questions and search for answers.

Digital Literacy:

a) Ability to use digital resources, and apply various platforms to convey and explain concepts of biochemistry.

Multicultural Competence:

a) Ability to engage with and understand cultures of various nations and respect and transcend differences.

Moral and Ethical Values:

a) Ability to interrogate one's own ethical values, and to be aware of ethical and environmental issues.
b) Ability to read values inherited in society and criticism vis-a-vis, the environment, religion, spirituality, and structures of power.

Leadership qualities:

a) Ability to lead group discussions, to formulate questions related to scientific and social issues.

Life-long Learning:

a) Ability to retain and build on critical thinking skills, and use them to update scientific knowledge and apply them in day to day business.

Exit Options and credit requirement

Progressive Certificate in Science, Diploma in Science, Bachelor of Science Degree or Bachelor of Science Degree with Honors in Biochemistry is awarded at the completion of every progressive year.

A student will be allowed to enter/re-enter only at the ODD semester and can only exit after EVEN semester. Re-entry at various as lateral entrants in academic programmes based on the above mentioned earned credits and proficiency test records.

Exit with	Credit requirements
CERTIFICATE IN SCIENCE at the successful completion of First year (Two Semesters) of the Four Years Multidisciplinary Undergraduate Degree Programme.	50
DIPLOMA IN SCIENCE at the successful completion of Second year (Four Semesters) of the Four Years Multidisciplinary Undergraduate Degree Programme.	100
BACHELOR OF SCIENCE DEGREE at the successful completion of Three year (Six Semesters) of the Four Years Multidisciplinary Undergraduate Degree Programme.	142
BACHELOR OF SCIENCE DEGREE WITH HONOURS IN BIOCHEMISTRY at the successful completion of Four year (Eight Semesters) of the Four Years Multidisciplinary Undergraduate Degree Programme.	184

TUMKUR UNIVERSITY

Course outline for Bachelor of Science (B. Sc., Basic/ Honors) in Biochemistry SEMESTER-III

Sl. No.	Course	Paper	Title of the Paper	No. of credits	Total contact hours	Duration of the Exam (Hr)	Marks		
							Formative/ Continuous assessment	End semester Examination	Total
1	Theory: Discipline Specific Core	BICDSC03	BIOORGANIC CHEMISTRY-3	4	56	2	40	60	100
2	Practical: Discipline Specific Core	BICDSC03P	BIOORGANIC CHEMISTRY- Practical-3	2	56	3	25	25	50

Course outline for Bachelor of Science (B. Sc., Basic/ Honors) in Biochemistry SEMESTER-IV

Sl. No.	Course	Paper	Title of the Paper	No. of credits	Total contact hours	Duration of the Exam (Hr)	Marks		
							Formative/ Continuous assessment	End semester Examination	Total
1	Theory: Discipline Specific Core	BICDSC04	ANALYTICAL BIOCHEMISTRY -4	4	56	2	40	60	100
2	Practical: Discipline Specific Core	BICDSC04P	ANALYTICAL BIOCHEMISTRY – Practical-4	2	56	3	25	25	50

Course outline of Open Elective courses for Bachelor of Science (B. Sc., Basic/ Honors) in Biochemistry II Year

Sl. No.	Course	Paper	Title of the Paper	No. of credits	Total contact hours	Duration of the Exam (Hr)	Marks		
							Formative/ Continuous assessment	End semester Examination	Total
1	Theory: Open Elective	BICOEC03	BIOCHEMICAL TECHNIQUES	3	42	2	40	60	100
2	Theory: Open Elective	BICOEC04	HORMONES-BIOCHEMISTRY & FUNCTIONS	3	42	2	40	60	100
3	Theory: Open Elective	BICOEC05	BIOCHEMICAL TOXICOLOGY	3	42	2	40	60	100
4	Theory: Open Elective	BICOEC06	PLANT BIOCHEMISTRY	3	42	2	40	60	100

Syllabus Theory and Practical
B.Sc., (Basic/ Honors) Semester-III

Course outline for Bachelor of Science (B. Sc., Basic/ Honors) in Biochemistry
SEMESTER-III

Sl. No.	Course	Paper	Title of the Paper	No. of credits	Total contact hours	Duration of the Exam (Hr)	Marks		
							Formative/ Continuous assessment	End semester Examination	Total
1	Theory: Discipline Specific Core	BICDSC03	BIOORGANIC CHEMISTRY-3	4	56	2	40	60	100
2	Practical: Discipline Specific Core	BICDSC03P	BIOORGANIC CHEMISTRY- Practical-3	2	56	3	25	25	50

Course code: BICDSC03;
Course Title: BIOORGANIC CHEMISTRY -3 (Theory)

COURSE TITLE	BIOORGANIC CHEMISTRY
Couse code	BICDSC03
Course credits	04
Total contact hours	56
Duration of EXAM (Hour)	02
Formative assessment marks	40
Summative assessment marks	60

Course Outcome:

The course in Bioorganic chemistry emphasize on the understanding of mechanisms, process and kinetics of different types of chemical reactions like, addition, substitution, elimination on aliphatic and aromatic compounds. Thorough understandings of the organic reaction mechanisms help understand the biochemical reaction mechanisms using enzymes as catalysts. This course serves as foundation for understanding the mechanisms of enzyme catalyzed reactions.

Course outcomes /Program outcomes	1	2	3	4	5	6	7	8	9	10	11	12
Aptitude	X	X	X	X								
Critical thinking		X										
Subject clarity	X	X				X	X	X		X		X
Analytical skill	X				X	X	X	X	X			X

Content of Theory course- Bioorganic Chemistry-3 Total credits = 4	**56 Hr**
Unit 1: Reaction mechanisms and aliphatic hydrocarbons	14 Hr
Introduction, meaning of the term- kinetic and non-kinetic, homo and heterolytic cleavage. Reactive intermediates of the following– free radicals, carbocations and carbanions, carbenes, nucleophiles and electrophiles (Formation and Stability). Concept of inductive effect, mesomeric effect, resonance, and hyper conjugation. Classification of organic	

reactions (substitution, addition, elimination, & re-arrangement) with two examples for each. **Hydrocarbons**: Alkenes - Mechanism of addition of HCl to propene, Markownikoff's rule, Peroxide effect, oxidation, ozonolysis. Alkynes – formation of acetylides and their importance. **Dienes**– types with examples. Conjugate dienes, 1, 3-butadiene – stability, mechanism of addition of HBr. Conformational analysis of ethane and n–butane.	
Unit 2 : Mechanism of substitution, elimination, and addition reactions	14 Hr
S_N1 and S_N2 reactions - mechanism, energy profile diagrams, Stereochemistry, factors affecting S_N2 and S_N1 reactions **Elimination reactions** –Zaitsev (Saytzef) rule. E1 & E2 mechanism. Stereochemistry of E1 & E2 reactions, E2 & E1 elimination from cyclic compound **Addition reactions** - aldehydes and ketones - nucleophilic addition (acetals & ketals formation): addition of ammonia, primary amines, and other ammonium derivatives. Conjugate addition - conjugation addition in alpha and beta unsaturated aldehydes and ketones (1, 2 and 1, 4 addition).	
Unit 3: Mechanism of electrophilic aromatic substitution reactions	14 Hr
Aromatic compounds - aromaticity, criteria for aromaticity, anti-aromatic, and non-aromatic compounds with examples. Mechanism of electrophilic aromatic substitution reactions - halogenation, nitration, sulfonation, Friedel crafts alkylation and acylation. Relative reactivity of substituted benzenes, polycyclic benzenoid and hydrocarbons. **Coenzymes:** Definition, thiamine pyrophosphate-structure and its role in decarboxylation of α - keto acids. Biotin- structure and its role in carboxylation reactions of carbohydrate and lipid metabolism. Vit B_{12} its role in rearrangement reactions. Vit B_2 coenzymes its role in redox reactions with suitable examples.	
Unit 4: Bio-organic compounds	14 Hr
Alcohols: classification with examples, monohydric alcohols: general and distinguishing reactions (primary, secondary and tertiary). Dihydric alcohols: glycols, Tri hydric alcohols: glycerol – synthesis from propene, properties and uses. Phenols: classification with examples, electronic interpretation of acidity of phenols, mechanism of Kolbe, Reimer –Tiemann and bromination reactions. **Hydroxy acids:** structure and properties: Lactic acid, Citric acid and Isocitric acid. Dicarboxylic acids: Maleic and Fumaric acid. Ketoacids: Pyruvic, α-Ketoglutaric, Oxaloacetic acid. **Carbonyl compounds:** General properties, Keto-enol tautomerism. Mechanisms: addition of HCN to acetaldehyde, claisen and aldol condensations. Quinones: o and p-benzoquinones structure. **Amines:** Classification, properties – Basicity of amines, acylation; reaction with HNO2 & Schiff's base formation. Distinguishing reactions of primary, secondary and tertiary amines. **Heterocyclic compounds:** Definition, classification with examples, structure and biological importance of furan, pyrrole, thiophene, pyridine, pyran, thiazole, pyrimidine, purine, indole, imidazole, quinoline and isoquinoline. Basicity of pyrrole and pyridine. **Terpenes:** Definition, Isoprene rule, classification, structure and biological importance of menthol, camphor, farnesol, phytol, lanosterol, lycopene and dolichols. Steroids: Basic ring structure; Structure and biological importance of cholesterol, phytosterols, ergosterol, cortisol, β-estradiol, testosterone, and aldosterone. Bile acids	

mono, di & tri cholic acids).

Alkaloids: Definition, classification based on their structure and biological functions. Isolation of alkaloids, structure and physiological action of morphine, nicotine and atropine.

References:

1. Textbook of Organic Chemistry 22nd Edition S. Chand Publishers 2019.
2. Organic Chemistry. Vol. I Fundamental Principles. I. L. Finar. 6th Edn. ELBS, 2002
3. Organic Mechanisms, Peter Sykes, Longman, 1977
4. Organic Chemistry. R.T. Morrison and R.N. Boyd. 6th Edn. Prentice Hall, India, 2018
5. Lehninger- Principles of Biochemistry; DL Nelson and MM Cox [Eds), 6th Edn. Macmillan Publications 2012
6. Chemistry- An Introduction to General, Organic and Biological Chemistry, 7th Edn. Karen C. Timberlake, Benjamin Cummings, 1999
7. Reaction Mechanisms at a Glance, ed. M. Moloney, Blackwell Science 2000.

Pedagogy: MOOC/desk work/book chapter/problem solving /assignment

Formative Assessment			
Activity	C1	C2	Total
Session tests / Continuous evaluation	10	10	20
Seminar/ presentation/ activity/class work	5	5	10
Assignment/ Case study/ Field work/ Project	5	5	10
Total	20	20	40

Course code: BICDSC03P
Course Title: BIOORGANIC CHEMISTRY PRACTICAL-3

COURSE TITLE	BIOORGANIC CHEMISTRY –(PRACTICAL-3)
Couse code	BICDSC03P
Course credits	02
Total contact hours	56 (4 h/ week)
Duration of EXAM (Hour)	3
Formative assessment marks	25
Summative assessment marks	25

Course outcome:

This course aims to familiarize students with the principles of organic chemistry and basic qualitative analysis of organic compounds. Course objective is to provide experimental practice of preparation of organic compounds and extraction of biologically important compounds.

Content of Practical course- Bioorganic Chemistry Practical-3	
Total Teaching Hours = 56; Total Credits = 2	**56 Hr**
List of experiments to be conducted	

I. Systematic qualitative analysis of organic compounds (6 practicals)

1. Urea	2. Glucose	3. Aniline
4. Benzoic Acid	5. Salicylic acid	6. Benzaldehyde
7. Acetophenone	8. Chlorobenzene	9. Nitrobenzene

II. Preparation of following organic compounds (2 practicals)

1. Acetylation: Preparation of acetyl salicylic acid from salicylic acid.
2. Oxidation: Preparation of benzoic acid from benzaldehyde.
3. Nitration: Preparation of m-dinitrobenzene from nitrobenzene.
4. Hydrolysis: Preparation of benzoic acid from ethyl benzoate.

III. Extractions

1. Extraction of caffeine from tea leaves
2. Extraction of starch from potatoes
3. Extraction of casein from milk

References

1. Practical Organic Chemistry: Qualitative Analysis by S.P. Bhutani, A. Chhikara 2009
2. Textbook of Practical Organic Chemistry Including Qualitative Organic Analysis by Arthur Israel Vogel 2003
3. Comprehensive practical organic chemistry- preparation and quantitative analysis. V. K. Ahluwalia and Renu Aggarwal 2004
4. Practical Hand Book of Systematic Organic Qualitative Analysis. Md. Rageeb Md. Usman, S. S. Patil 2017
5. Laboratory Manual of Inorganic & Organic Chemistry (Qualitative Analysis) Kalpa Mandal, Sonia Ratnani 2020

Pedagogy: MOOC/desk work/book chapter/problem solving /assignment

Formative Assessment	
Assessment occasion	Weightage in marks
Lab test (Two Lab tests)/ Continuous evaluation	15
Practical record and Viva voce	10
Total	25

Syllabus Theory and Practical
B.Sc., (Basic/ Honors) Semester-IV

Course outline for Bachelor of Science (B. Sc., Basic/ Honors) in Biochemistry
SEMESTER-IV

Sl. No.	Course	Paper	Title of the Paper	No. of credits	Total contact hours	Duration of the Exam (Hr)	Marks		
							Formative/ Continuous assessment	End semester Examination	Total
1	Theory: Discipline Specific Core	BICDSC04	ANALYTICAL BIOCHEMISTRY	4	56	2	40	60	100
2	Practical: Discipline Specific Core	BICDSC04P	ANALYTICAL BIOCHEMISTRY-Practical	2	56	3	25	25	50

Course code: BCIDSC04;
Course Title: ANALYTICAL BIOCHEMISTRY **(Theory)**

COURSE TITLE	ANALYTICAL BIOCHEMISTRY
Couse code	BICDSC04
Course credits	04
Total contact hours	56
Duration of Exam (Hour)	03
Formative assessment marks	40
Summative assessment marks	60

Course **Outcome:** These topics will enable students to understand the

- concept of biological sample preparation
- Appreciate chemistry and application of analytical instruments.
- Get acquainted with care and maintenance of equipment and chemicals.
- Understand clinically relevant biochemical analysis of all biochemical components i.e., proteins, electrolytes, hormones etc.,
- Have basic knowledge of clinical and forensic analytical methods and their principles.

Course outcomes /Program Outcomes	1	2	3	4	5	6	7	8	9	10	11	12
Aptitude	X	X	X	X								
Critical thinking		X				X						
Subject clarity	X	X						X				X
Analytical skill				X	X	X	X	X	X	X	X	X

Content of Theory course- Analytical Biochemistry- Total credits = 4	56 Hr
Unit 1: Biological sample preparation and fractionation:	14 Hr
Introduction and objectives of sample preparation from tissues and cells. Sample preparation types: living, postmortem. extraction of macromolecules: liquid-liquid, liquid-solid and precipitation methods. Centrifugation- Introduction, principle. sedimentation. sedimentation coefficient, angular velocity, centrifugal field. relative centrifugal field. Types – Preparative, analytical. differential. density gradient and ultra-centrifugation. Basic instrumentation: types of rotors and their design. Laboratory centrifuge: operational instruction and applications. Analytical Centrifuges-optics: application in sub-cellular fractionation. Care and maintenance of instrument.	
Unit 2: Chromatography:	14 Hr
General principles of chromatography – adsorption. partition. classification based on 1. Nature of stationary and mobile phase are brought together- Planar and column chromatography, 2. Based on types of mobile and/or liquid phase adsorption and partition- Gas chromatography and liquid chromatography. Based on stationary phase-thin layer chromatography, Paper chromatography; ascending, descending, circular, 2-D chromatography, Rf values. Principles and applications of ion-exchange, gel-filtration and affinity-chromatography. Advanced chromatography- HPLC and FPLC, UPLC and GLC.	
Unit 3: Electrophoretic and radioisotopic methods:	14 Hr
Electrophoresis: General principle, work of Tiselius, Supporting media - paper. agarose, polyacrylamide. Chemistry of polymerization of acrylamide gels, methodology and applications of native PAGE and SDS- PAGE, 2-D electrophoresis, Identification of proteins - dyes and biological activities. Principle and application of agarose gel and Pulse field electrophoresis, capillary electrophoresis and isoelectric focusing, Cellulose acetate electrophoresis and immune- electrophoresis. **Radioisotopic methods:** Radioactivity–Types of radioactive decay, Properties of α, β, γ radiations. Group displacement law. Decay law - decay constant, half-life period and average life of a radioactive element. Detection of radioactivity – GM counter and scintillation counters (only principle and working) Applications of radioisotopes – ^{3}H, ^{14}C, ^{131}I, ^{60}Co and ^{32}P. Biological effects of radiations. Radiolabeling, safety measures in handling radio isotopes.	
Unit 4: Spectroscopic methods of bio-analysis:	14 Hr
Spectroscopic methods: Duel nature of light, electromagnetic spectrum, transition in spectroscopy. Principle, design and application of UV-Vis spectrophotometer. Beer-lambert law and its limitations, determination of molar absorption coefficient of molecules. Working principle and application of a colorimeter, flame photometer and fluorimeter. Principle and application of IR, and Raman, ESR and NMR spectroscopy.	
References 1. Analytical techniques in Biochemistry and Molecular Biology; Katoch, Rajan. Springer 2011 2. Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology 8th Edn. Andreas Hoffman and Samuel Clockie, Ed., Cambridge University Press, 2018. 3. Biochemistry and Molecular Biology; 5th Edn. D. Papachristodoulou, A. Snape, W.H. Elliott, and D. C. Elliott, Oxford University Press 2014	

Pedagogy: **MOOC/desk work/book chapter/problem solving /assignment**

Formative Assessment			
Activity	C1	C2	Total
Session tests / Continuous evaluation	10	10	20
Seminar/ presentation/ activity/class work	5	5	10
Assignment/ Case study/ Field work/ Project	5	5	10
Total	20	20	40

Course code: BICDSC04P;
Course Title: ANALYTICAL BIOCHEMISTRY (Practical)

COURSE TITLE	**Analytical Biochemistry-Practical**
Couse code	BICDSC04P
Course credits	02
Total contact hours	56 (4 h/ week)
Duration of Exam(Hour)	3
Formative assessment marks	25
Summative assessment marks	25

Course outcome: This course aims to provide experimental practice of analytical techniques in Biochemistry. Upon successful completion, students should develop skills in handling instruments and understand its application in research work.

- Sourcing and handling biological samples. Develop skill and proficiency in basic techniques
- Centrifugation
- Chromatography
- Electrophoresis and
- Spectroscopy

Content of Practical course- Analytical Biochemistry	
Total Teaching Hours = 56; Total Credits = 2	**56 Hr**
List of experiments to be conducted	
1. Preparation of human lymphocytes using clinical centrifuge 2. Determination of packed cell volume/ hematocrit 3. Resolution of basic, acidic and aromatic amino acids by descending and circular paper chromatography. 4. Separation of plant pigments by gel-permeation chromatography 5. Identification and resolution of pigments by thin layer chromatography. 6. Determination of void volume of a gel-filtration column 7. Recording the absorption spectrum of riboflavin 8. Colorimetric estimation of glucose by DNS method 9. Estimation of DNA by diphenylamine method	

10. Electrophoretic separation of plasma proteins
11. Estimation of protein by Biuret / Lowry's method

References

1. Analytical techniques in Biochemistry and Molecular Biology: Katoch, Rajan. Springer. 2011
2. Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology 8th Edn. Andreas Hoffman and Samuel Clockie. Ed.. Cambridge University Press, 2018.
3. Biochemistry and Molecular Biology: 5th Edn. D. Papachristodoulou, A. Snape, W.H. Elliott. and D. C. Elliott, Oxford University Press. 2014

Pedagogy: MOOC/desk work/book chapter/problem solving /assignment

Formative Assessment	
Assessment occasion	Weightage in marks
Class test (Two class tests)/ Continuous evaluation	15
Practical record and Viva voce	10
Total	25

Open Elective Course Syllabus for
B.Sc., (Basic/ Honors) Biochemistry II Year
Under NEP-2020

Course outline of Open Elective Courses for Bachelor of Science (B. Sc., Basic/ Honors) in Biochemistry II Year

Sl. No.	Course	Paper	Title of the Paper	No. of credits	Total contact hours	Duration of the Exam (Hr)	Marks		
							Formative/ Continuous assessment	End semester Examination	Total
1	Theory: Open Elective	BICOEC03	Biochemical Techniques	3	42	2	40	60	100
2	Theory: Open Elective	BICOEC04	Hormomes-Biochemistry & function	3	42	2	40	60	100
3	Theory: Open Elective	BICOEC05	Biochemical Toxicology	3	42	2	40	60	100
4	Theory: Open Elective	BICOEC06	Plant Biochemistry	3	42	2	40	60	100

Open Elective Course Code: BICOEC03
Course Title: BIOCHEMICAL TECHNIQUES (Theory)

COURSE TITLE	BIOCHEMICAL TECHNIQUES
Couse code	BICOEC03
Course credits	03
Total contact hours	42
Duration of EXAM (Hour)	02
Formative assessment marks	40
Summative assessment marks	60

Course outcome:

These topics will enable students to develop competence in handling various chromatographic, electrophoretic and isotopic techniques and apply them in isolating and characterizing different biological molecules.

Content of Theory course- BIOCHEMICAL TECHNIQUES (Theory) Total credits =3	42Hr
UNIT -1	14Hr
Microscopy: Different types of microscopes – electron microscopes – TEM, SEM. Fluorescence and confocal microscopes used in fine structure studies. **Centrifugation:** Introduction, basic principles, and applications. Types of centrifuges and their use - table top centrifuges, large capacity refrigerated centrifuges, high speed refrigerated centrifuges, continuous flow centrifuges, Preparative ultra - centrifuges, analytical ultracentrifuges, and density gradient centrifugation.	
UNIT -2	14Hr
Chromatography: Introduction, classification of chromatographic techniques. Principle and applications of paper chromatography, thin layer chromatography column chromatography - adsorption chromatography, gel permeation, ion exchange chromatography, affinity chromatography, gas chromatography, FPLC, high performance (pressure) liquid chromatography. **Electrophoresis:** Principles and application of paper electrophoresis, starch gel electrophoresis, polyacrylamide gel electrophoresis, agarose gel electrophoresis, isoelectric focusing, isotachophoresis, pulse field electrophoresis, two-dimensional electrophoresis, capillary electrophoresis, preparative.	
UNIT 3:	14Hr
Radio isotopes: Introduction to isotopes; nature of radioactive decay, rate of radioactive decay, units of radioactivity, measurement of radioactivity - proportional counters, scintillation counter, autoradiography,. Applications of radioisotopes in the biological systems. **Spectroscopy:** Introduction, nature of electromagnetic radiations; Principles and applications of the Visible and Ultraviolet spectroscopy, Fluorescence spectroscopy, Infrared spectroscopy, Atomic Absorption spectroscopy, Nuclear Magnetic resonance (NMR) and Mass spectroscopy.	
REFERENCES: 1. Modern Experimental Biochemistry: Rodney Boyer, 3rd Edn. Benjamin Cummings, 2000 2. Practical Skills in Biomolecular Sciences: R Reed, D. Holmes, J. Weyers, and A. Jones 1998 3. Physical Biochemistry: David Frifielder 2nd Edition, 1983 4. Biophysical Chemistry Upadya and Upadya, 2016 5. Introductory Practical Biochemistry: SK Sawhney and Randhir Singh, 2001	

Pedagogy: MOOC/desk work/book chapter/problem solving /assignment

Formative Assessment			
Activity	C1	C2	Total
Session tests / Continuous evaluation	10	10	20
Seminar/ presentation/ activity/class work	5	5	10
Assignment/ Case study/ Field work/ Project	5	5	10
Total	20	20	40

Open Elective Course Code: BICOEC04
Course Title: HORMONES – BIOCHEMISTRY AND FUNCTION (Theory)

COURSE TITLE	HORMONES – BIOCHEMISTRY AND FUNCTION
Couse code	BICOEC04
Course credits	03
Total contact hours	42
Duration of EXAM (Hour)	02
Formative assessment marks	40
Summative assessment marks	60

Course outcome: These topics will enable the students to:

The OE course 'Hormone- Biochemistry and Function' being offered to the students belonging to different streams will provide information about the significance of hormones and its regulation on cell signaling, bodily functions, physiology and disorders. The course provides knowledge about endocrine glands and different hormones and their influence on growth, puberty, immunity, general metabolism, metabolic disorders and endocrine disorders.

Content of Theory course: HORMONES -BIOCHEMISTRY AND FUNCTION **Total credits =3**	**42 Hr**
Unit 1:	**14 Hr**
Introduction to Cell signaling, intercellular communication, chemical signaling- endocrine, paracrine, autocrine, and neuroendocrine signaling. Mechanisms of hormone action: synergism, antagonism, permissive effects; regulation of synthesis and secretion of hormones. Classification of hormones by its origin, chemical structure, location and mechanism of action. Physiological role and disorders of Pituitary, Pineal, Thyroid and Parathyroid hormones. Hypothalamus: Introduction, as a true master gland. Neurohypophysis and its secretions – ADH and Oxytocin.	
Unit 2:	**14 Hr**
Hormones of pancreas, adrenal gland, and placenta: their physiological role and disorders. Mechanism of action, target tissues, and the physiological effects of gastrointestinal hormones. Structure and functions of sex hormones; Hormones during ovarian and uterine phases of menstrual cycle. Role of placental hormones during parturition and lactation. Introduction to gastrointestinal hormones and neurotransmitters (Acetyl choline, GABA, Serotonin). Hormone receptors: receptors in the cell membrane and in the cell. Secondary and tertiary messengers (cAMP and Ca+2). Overview on signal transduction pathways for steroidal and non-steroidal hormones (One example each).	
Unit 3:	**14 Hr**
Clinical endocrinology - Blood volume, composition and functions of plasma and serum. Separation and storage of body fluids (blood, CSF and lymph). Methods of hormone estimation: principles, normal range of hormones in tissues and clinical conditions with interpretations. Thyroid function test- Determination of T_3, T_4, and TSH. Infertility profile: Determination of LH, FSH, TSH, Estrogen, Progesterone, Total Testosterone, Free testosterone. Major manifestations of disease of the endocrine - pancreas, thyroid, hypothalamus and pituitary disease.	

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1. Norman AW, Litwack G (1997), Hormones, 2nd Edition, Elsevier Publications.
2. Bolander F (2004), Molecular Endocrinology, 3rd Edition, Elsevier Publications.
3. Rifai N (2007), Teitz Fundamentals of Clinical Chemistry, 6th Edition, Elsevier Publications.
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5. Vasudevan DM (2011), Text book of Medical Biochemistry, 6th Edition, Jaypee Publishers.
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Pedagogy: MOOC/desk work/book chapter/problem solving /assignment

Formative Assessment			
Activity	C1	C2	Total
Session tests / Continuous evaluation	10	10	20
Seminar/ presentation/ activity/class work	5	5	10
Assignment/ Case study/ Field work/ Project	5	5	10
Total	20	20	40

Open Elective Course Code: BICOEC05
Course Title: BIOCHEMICAL TOXICOLOGY

COURSE TITLE	**BIOCHEMICAL TOXICOLOGY**
Course code	BICOEC05
Course credits	03
Total contact hours	42
Duration of Exam (Hour)	02
Internal assessment marks	40
External Examination marks	60

Course outcome: This open elective course offered to various streams gives basic idea about biochemical basis of various effects of toxins/ pharmaceuticals and an outline of process involved in toxicity testing and drug dosing.
Categorize the classes of toxicants/drugs and know specific examples
State the routes of exposure to toxins/drugs;
Explain the processes of absorption, metabolism and elimination of toxins/drugs; and
Explain environmental and physiological factors that affect toxicant metabolism

Content of Theory course- Analytical Biochemistry-4 **Total credits = 4**	**42 Hr**
UNIT 1: Fundamentals of toxicology and dose response	**14 Hr**
Scope, definition – drug, toxins and xenobiotics; Grading toxicity, Animal model for toxicity studies, *in vitro* toxicity, organ toxicity (liver and kidney). Biomarkers as indicators of toxicity/drug effects. Concentration and site of action, dose response, effect of route of administration, ED_{50}, LD_{50}/TD_{50}. Hazard and risk assessment, acceptable daily intake (ADI) and tolerable daily intake (TDI).	
Unit 2: Factors affecting toxic responses	**14 Hr**
Disposition - outline of toxin/drug uptake, entry to cells and systemic circulation. Effect of size, shape, solubility, and charge. Major sites of absorption - liver, intestine, skin. Role of transporters - plasma proteins in distribution, plasma levels of toxins/drugs, plasma half-life. Excretion- disposition by kidney, biliary excretion. Metabolism - types of metabolic changes of foreign compounds, biotransformation/detoxification reactions, phase-1 and, phase -2 reactions, nature of phase-1 and phase 2 enzymes.	
Unit 3: Targets of toxic damages and biochemical mechanism of toxicity	**14 Hr**
Toxins/drugs causing liver, kidney, gall bladder, and lung damage; Methods of identifying the damages. Examples of biochemical toxicity mechanisms; chemical carcinogens - Benzo[a]pyrene, Tamoxifen. Liver necrosis- carbon tetrachloride, Valproic Acid, and Iproniazid, Kidney damage- Chloroform. Antibiotics- gentamycin, Lung damage- 4-Ipomeanol, Neurotoxicity- Isoniazid, parquet, primaquine, cyclophosphamide.	

References

1. Biopharmaceuticals Biochemistry and Biotechnology 2nd Edn. Gary Walsh. John Wiley & Sons, Ltd, England, 2003.
2. Fundamentals of Experimental Pharmacology. Ghosh, M.N. 2nd Edition, Scientific Book Agency, Kolkatta, 1984.
3. Introduction to Biochemical Toxicology. 3rd Edn.. Ernest Hodgson , Robert C. Smart: Wiley-Interscience; , 2001
4. Principles of Biochemical Toxicology. John A. Timbrell. 4th Edn. 2009. Taylor & Francis Remington Pharmaceutical Sciences. Lippincott. Williams and Wilkins, 2000

Pedagogy: MOOC/desk work/book chapter/problem solving /assignment

Formative Assessment			
Activity	C1	C2	Total
Session tests / Continuous evaluation	10	10	20
Seminar/ presentation/ activity/class work	5	5	10
Assignment/ Case study/ Field work/ Project	5	5	10
Total	20	20	40

Open Elective Course Code: BICOEC06
Course Title: PLANT BIOCHEMISTRY

COURSE TITLE	PLANT BIOCHEMISTRY
Course code	BICOEC06
Course credits	03
Total contact hours	42
Duration of Exam (Hour)	02
Internal assessment marks	40
External Examination marks	60

Course outcome:

This open elective course in 'Plant Biochemistry' offered to the students of various streams

- Understand the plant cell, photosynthesis, transporters, and important primary metabolites.
- Illustrate plant growth regulators, plant's responses to various biotic and abiotic stresses.
- Explain about plant secondary metabolites and their functional importance.

Content of Theory course- Plant Biochemistry Total credits = 4	42 Hr
UNIT 1:	14 Hr
Plant cell- structure and molecular components: Introduction - structure of plant cell, cell division and cell cycle. Cytoskeleton- an overview. Outlines of energy production in plant cells. Carbon assimilation and nitrogen assimilation. **An overview of photosynthesis:** Introduction, C3, C4 plants and crussulacean acid metabolism (CAM); photorespiration; Phytochromes, cryptochromes and phototropins. Non-protein thiols and sulfur cycle. **Plant cell membranes and membrane transport:** Introduction to plant cell membranes and membrane constituents. Organization of transport systems across plant membranes; Different types of pumps operate at plant cell and organelle membranes; classification and importance of H^+-ATPases. Ion channels-properties and significance; Aquaporins and water transport. **Important Primary metabolites of plants:** Cellulose, starch, sucrose, oligosaccharides; fructans, gums, mucilages, poly unsaturated fatty acids, lignin, suberin, surface waxes, sulfides and sweet proteins.	
Unit 2:	14 Hr
Plant growth regulators: Auxins, cytokinins, gibberellins, abscisic acid, ethylene, brassinosteroids, polyamines, jasmonic acid, salicylic acid. **Plant responses to biotic and abiotic stresses:** Introduction; Plant pathogens and diseases: plant defense systems - hypersensitive response; systemic acquired resistance; induced systemic resistance; Plant biotic stress response to pathogens and insects. **Plant abiotic stress responses**: Salt stress, drought, and heavy metal stress responses; osmotic adjustment and significance of osmotic agents such as proline, sugar alcohols and quaternary ammonium compounds; An overview of oxidative stress and oxidative damage. Antioxidant enzymes and stress tolerance.	

Unit 3:	14 Hr
Plant secondary metabolites (Natural products): Introduction; secondary metabolites (natural productions) definition; classification of plant secondary metabolites (natural products). An overview of primary metabolism contribution to secondary metabolites biosynthesis. **Alkaloids:** Classification; Contribution of amino acids for alkaloid biosynthesis: Isolation, purification and characterization of alkaloids. (S)-Seticuline-the chemical chameleon. **Phenolics:** Classification: Classification of flavonoids; Classification of anthocyanins; Isolation, purification and characterization of phenolics. **Terpenoids:** Classification of terpenoids, biogenic isoprene rule; volatile compounds; plant growth regulator terpenoids – gibberellin, abscisic acid; brassinosteroids and saponins Isolation, purification, and characterization of terpenoids **Biological properties of secondary metabolites**: Role of secondary metabolites - in plants' defense; in insects' signalling, morphogenesis, and defense. Physiologically active secondary metabolites in modern medicine and therapeutic compounds for human ailments	

References

1. Lehninger's Principles of Biochemistry - Nelson & Cox. CBS Publishers & Distributors. 2013
2. Principles of Biochemistry - Moran, Horton, Scrimgeour, Perry. Pearson. 5th Edition . 2011
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11. Misaka T. Molecular mechanisms of the action of miraculin, a taste-modifying protein. Seminars Cell Develop Biol. 24:222-225, 2013.
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Pedagogy: MOOC/desk work/book chapter/problem solving /assignment

Formative Assessment			
Activity	C1	C2	Total
Session tests / Continuous evaluation	10	10	20
Seminar/ presentation/ activity/class work	5	5	10
Assignment/ Case study/ Field work/ Project	5	5	10
Total	20	20	40

B.Sc. (Basic/ Hons.) Semester III / IV Examination

Model question paper Discipline Specific Course (DSC, Theory)

Biochemistry

Time: 2 h Max. Marks:

NOTE: All sections are compulsory

SECTION – A

1. Answer any ***five*** of the following 5 x 2 = 10

a)
b)
c)
d)
e)
f)
g)

SECTION – B

Answer any ***four*** of the following 4 x 5 = 20

2.
3.
4.
5.
6.
7.

SECTION – C

Answer any ***three*** of the following 3 x 10 = 30

08.

09.

10.

11.

12

Note: Section C may include sub questions a, b

B.Sc. (Basic/ Hons.) Semester III / IV Examination

Model question paper Open Elective (OE, Theory)

Biochemistry

Time: 2 h Max. Marks: 60

NOTE: All sections are compulsory

SECTION – A

1. Answer any ***five*** of the following 5 x 2 = 10

a)
b)
c)
d)
e)
f)
g)

SECTION – B

Answer any ***four*** of the following 4 x 5 = 30

2.
3.
4.
5.
6.
7.

SECTION – C

Answer any ***three*** of the following 3 x 10 = 30

08.

09.

10.

11.

12

Note: Section C may include sub questions a, b

B.Sc. (Basic/ Hons.) Semester III / IV Examination
Model question paper (Practicals)
Biochemistry

Time: 3 h Max. Marks:25

1.	Write the principle and procedure of _____ experiment/spotters	05 marks
2.	Major experiment (Conduct the experiment and report the results) (Experiment- 15 marks or Experiment + spotters=15 marks)	15 Marks
3.	Viva voce	05 Marks

Tumkur University
Board of Studies in Biochemistry (UG)

Sl. No.	Name	Affiliation	Signature
1	DR. Manohar Shinde	Chairman, BOS Professor Dept. of Studies & Research in Biochemistry. Tumkur University	
2	Dr. Rajesh J.	External Member, BOS Professor, Dept. of Biochemistry Yuvaraja's College, University of Mysore Mysuru	Sd/-
4	Dr. Savitha K R	Member, BOS Assistant Professor, Dept. of Biochemistry UCS, Tumkur University	
5	Dr. M. Bhagyalakshmi	Member, BOS Assistant Professor, Dept. of Biochemistry UCS, Tumkur University	

TUMKUR UNIVERSITY

Department of Biochemistry, University College of Science

Proceedings of BOS meeting in Biochemistry [UG] held on Nov. 23, 2022

Agenda:

1. BOS approval of B.Sc. [Basic/ Hons.]Programme in Biochemistry III and IV semester under NEP-2020.
2. BOS approval of Open Elective theory (OET) courses of B. Sc. [Basic/ Hons.]Programme in Biochemistry II Year under NEP-2020 to be offered to the students of other streams.
3. BOS Approval of scheme outline for B.Sc. [Basic/ Hons.]Programme in Biochemistry III and IV semester under NEP-2020.
4. Approvsal of Panel of Examiners for B.Sc. [Basic/ Hons.]Programme in Biochemistry if Tumkur University.

Following Members were present in the meeting:

Dr. Manohar Shinde	Professor DOSR in Biochemistry TU	Chairman BOS
Dr. Rajesh J.	Professor, Dept. of Biochemistry, Yuvaraja's College, University of Mysore, Mysuru	Member BOS (External)
Dr. Savitha K. R	Assistant Professor, Dept. of Biochemistry UCS, TU	Member BOS
Dr. Bhagyalakshmi M.	Assistant Professor, Dept. of Biochemistry UCS, TU	Member BOS

The BOS meeting in Biochemistry (UG) began at 11 AM on Nov. 23, 2022 in the Department of Studies and Research in Biochemistry of Tumkur University, Tumakuru. At the outset, the Chairman, Prof. Manohar Shinde welcomes the Members of the BOS and briefs the agenda of the said meeting.

The curricula and the programme outline were provided to the BOS members in advance by E-mail and the hard copy of the proposed syllabus was provided in the meeting. Dr. Rajesh, Member BOS, suggested some of the changes in the syllabus including Open Elective courses and helped formulating Panel of Examiners.

The members of the BOS went through the proposed syllabus of B.Sc. [Basic/ Hons.]Programme in Biochemistry III and IV semester and had detailed discussions.

After due deliberations and detailed discussions on the proposed curricula, the BOS members unanimously resolved to approve the following:

1) III and IV semester course curriculua,
2) Programme outcomes
3) Scheme outline of B.Sc. [Basic/ Hons.]Programme in Biochemistry and
4) Panel of examiners for B.Sc. [Basic/ Hons.]Programme in Biochemistry of Tumkur University.

The BOS approved curriculum, programme outcome, scheme outline and Panel of Examiners for B.Sc. [Basic/ Hons.]Programme in Biochemistry is attached herewith.

The Chairman of BOS in Biochemistry (UG) thanks the members and concludes the meeting.

Sl. No.	Name	Signature
1	Dr. Manohar Shinde Chairman BOS in Biochemistry (UG)	23/11/2022
2	Dr. Rajesh J. Member [External] BOS in Biochemistry (UG)	23/11/22
3	Dr. Savitha K. R. Member BOS in Biochemistry (UG)	22/11/22
4	Dr. Bhagyalakshmi M. Member BOS in Biochemistry (UG)	23/11/22

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