K. C. E. Society's
Moolji Jaitha College
An 'Autonomous College' Affiliated to
K.B.C. North Maharashtra University, Jalgaon.
NAAC Reaccredited Grade - A (CGPA : 3.15 - 3rd Cycle)
UGC honoured "College of Excellence" (2014-2019)
DST(FIST) Assisted College

KNOWLEDGE IS POWER
ESTD. 1945

के. सी. ई. सोसायटीचे
मूळजी जेठा महाविद्यालय
क.ब.चौ. उत्तर महाराष्ट्र विद्यापीठ, जळगाव संलग्नित
'स्वायत्त महाविद्यालय'
नॅकद्वारा पुनर्मानांकित श्रेणी – 'ए' (सी.जी.पी.ए. : ३.१५ – तिसरी फेरी)
विद्यापीठ अनुदान आयोगाद्वारा घोषित 'कॉलेज ऑफ एक्सलन्स' (२०१४-२०१९)
डी.एस.टी. (फीस्ट) अंतर्गत अर्थसहाय्य प्राप्त

Date :- 25/04/2025

NOTIFICATION

Sub :- CBCS Syllabi of B. Sc. in Biochemistry (Sem. V & VI)

Ref. :- Decision of the Academic Council at its meeting held on 22/04/2025.

The Syllabi of B. Sc. in Biochemistry (Fifth and Sixth Semesters) as per **NATIONAL EDUCATION POLICY – 2020 (2023 Pattern)** and approved by the Academic Council as referred above are hereby notified for implementation with effect from the academic year 2025-26.

Copy of the Syllabi Shall be downloaded from the College Website (www.kcesmjcollege.in)

Sd/-
Chairman,
Board of Studies

To :

1) The Head of the Dept., M. J. College, Jalgaon.
2) The office of the COE, M. J. College, Jalgaon.
3) The office of the Registrar, M. J. College, Jalgaon.

Near Samarth Colony, Jalgaon - 425 002. (Maharashtra, India) | Ph. : +91 257 - 2237363, 2234281 | e-mail : mjcollege@kces.in | Website : mjcollege.kces.in
समर्थ कॉलनी जवळ, जळगांव – ४२५ ००२. (महाराष्ट्र, भारत) । दूरध्वनी क्र. : +९१ २५७–२२३७३६३, २२३४२८१ । ई–मेल: mjcollege@kces.in । वेबसाईट: mjcollege.kces.in

Khandesh College Education Society's

Moolji Jaitha College, Jalgaon

An "Autonomous College"

Affiliated to

Kavayitri Bahinabai Chaudhari

North Maharashtra University, Jalgaon-425001

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STRUCTURE AND SYLLABUS

B.Sc. Honours/Honours with Research (T.Y.B.Sc.Biochemistry)

UnderChoiceBasedCreditSystem(CBCS)

and

as per NEP-2020 Guidelines

[w.e.f.AcademicYear:2025-26]

Preface

The cumulative demand for trained and skilled manpower in the area of Biochemistry requires in depthfunctional knowledge of modern biology through hands-on training to the students.The Moolji Jaitha College (Autonomous) has adopted a department-specific model as per the guidelines of UGC, NEP-2020 and the Government of Maharashtra. The Board of Studies in Biochemistry of the college has prepared the syllabus for the Third-year undergraduate of Biochemistry.

The syllabus has been prepared anticipating the requirements of B.Sc. Biochemistry students underCBCS Program. The contents have been drawn to accommodate the widening horizons of theBiochemistry discipline and reflect the changing needs of the students. The detailed syllabus for eachpaper is appended with a list of suggested readings.

The degree of Bachelor of Science in Biochemistry (Choice Based Credit System) aims to introducevarious aspects of Biochemistry and interdisciplinary subjects to the students. The program inBiochemistry as one of the core subject is designed to cultivate a scientific attitude and interest towardsthe modern areas of Biochemistry in particular and life science in general. This will help the studentsto become critical and curious in their outlook. The courses are designed to impart the essential basicsin Biochemistry, Chemistry, Botany, Microbiology, Zoology and Biotechnology at the initial level ofgraduation. The basic courses are infused with application in modern life sciences, and awareness onBiochemistry and its influence in human life. The integration of various courses in the program is aimedto 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. Besidethis, the students will be equipped with knowledge in the newer areas of Biochemistry and itsapplication in medical science, agriculture, industry, proteomics, genomics, metabolomics,bioinformatics, nano-biotechnology etc. This will create awareness about Biochemistry andcontribution of Biochemistry among the society. At the end of the course, the students are expected tohave good working knowledge in the field of Biochemistry and in addition knowledge gained fromcourses of interdisciplinary in nature. Students will surely have an urge to continue higher studies inBiochemistry and contribute significantly in the development.

The present syllabus is restructured anticipating the future needs of Biochemistry with more emphasis onimparting hands-on skills. The main thrust is laid on making syllabus compatible with developments inEducation, Research and Industrial sectors. The Theory and Practical course in new restructured coursewill lead to impart skill-set essentials to further Biochemistry.

Hence, Board of Studies in Biochemistry in its meeting held on 22nd March 2025 resolved to accept therevised syllabus for T. Y. B. Sc. (Biochemistry) based on Choice Based Credit System (CBCS) ofUGC, NEP-2020 and the Government of Maharashtra guidelines.

Program Outcomes (PO) for B.Sc. Program:

Program outcomes associated with a B.Sc. degree are as follows:

PO No.	PO
1	Graduates should have a comprehensive knowledge and understanding of the fundamental principles, theories, and concepts in their chosen field of study.
2	Graduates should possess the necessary technical skills and competencies related to their discipline, including laboratory techniques and data analysis.
3	Graduates should be able to identify, analyze, and solve complex problems using logical and critical thinking skills. They should be able to apply scientific methods and principles to investigate and find solutions.
4	Graduates should be proficient in effectively communicating scientific information, both orally and in writing.
5	Graduates should have a basic foundation in research methods and be capable of designing and conducting scientific investigations.
6	Graduates should be able to work effectively as part of a team, demonstrating the ability to collaborate with others, respect diverse perspectives, and contribute to group projects.
7	Graduates should recognize the importance of ongoing learning and professional development. They should be equipped with the skills and motivation to engage in continuous learning, adapt to new technologies and advancements in their field, and stay updated with current research.

Programme Specific Outcome (PSO) for B.Sc. BiochemistryHonours/Honours with Research:

After completion of this program, students are expected to learn/understand the:

PSO No.	PSO
1	Structure, properties, pathways and applications of biomolecules in various fields.
2	Isolation, purification, biochemical mechanisms, regulation and applications of enzymes in various sectors.
3	Isolation, identification and characterization of various microbes from diverse habitats.
4	Principle and applications of various bio-analytical tools and techniques.
5	Physiological Biochemistry and correlate it with clinical applications.
6	Applications of Biochemistry in various industrial sectors such as agriculture, medical, pharmaceuticals, food, cosmetic etc.

Multiple Entry and Multiple Exit options:

The multiple entry and exit options with the award of UG certificate/ UG diploma/ or three-year degree depending upon the number of credits secured;

Levels	Qualification Title	Credit Requirements		Semester	Year
		Minimum	Maximum		
4.5	UG Certificate	40	44	2	1
5.0	UG Diploma	80	88	4	2
5.5	Three Year Bachelor's Degree	120	132	6	3
6.0	Bachelor's Degree- Honours **Or** Bachelor's Degree- Honours with Research	160	176	8	4

Credit distribution structure for Three/ Four year Honors/ Honors with Research Degree Programme with Multiple Entry and Exit

F.Y. B.Sc.

Year (Level)	Sem	Subject-I (M-1)	Subject-II (M-2)	Subject-III (M-3)	Open Elective (OE)	VSC, SEC (VSEC)	AEC, VEC, IKS	CC, FP, CEP, OJT, RP	Cumulative Credits/Sem	Degree/ Cumulative Credit
I (4.5)	I	DSC-1(2T) DSC-2(2P)	DSC-1(2T) DSC-2(2P)	DSC-1(2T) DSC-2(2P)	OE-1(2T)	---	AEC-1(2T) (Eng) VEC-1(2T) (ES) IKS(2T)	CC-1(2T)	22	**UG Certificate**
	II	DSC-3(2T) DSC-4(2P)	DSC-3(2T) DSC-4(2P)	DSC-3(2T) DSC-4(2P)	OE-2(2T) OE-3(2P)	---	AEC-2(2T) (Eng) VEC-2(2T) (CI)	CC-2(2T)	22	
	Cum. Cr.	**8**	**8**	**8**	**6**	**---**	**10**	**4**	**44**	
Exit option: Award of UG Certificate with 44 credits and an additional 4 credits core NSQF course/ Internship OR Continue with Major and Minor.										

S.Y. B.Sc.

Year (Level)	Sem	Subject-I (M-1) Major*		Subject-II (M-2) Minor #	Subject-III (M-3)	Open Elective (OE)	VSC, SEC (VSEC)	AEC, VEC, IKS	CC, FP, CEP, OJT/Int/RP	Cumulative Credits/Sem	Degree/ Cumulative Credit
		Mandatory (DSC)	**Elective (DSE)**	**(MIN)**							
2 (5.0)	III	DSC-5(2T) DSC-6(2T) DSC-7(2P)	---	MIN-1(2T) MIN-2(2T) MIN-3(2P)	---	OE-4(2T)	SEC-1(2T)	AEC-3(2T) (MIL)	CC-3(2T) CEP(2)	22	**UG Diploma**
	IV	DSC-8(2T) DSC-9(2T) DSC-10(2P)	---	MIN-4(2T) MIN-5(2P)	---	OE-5(2T)	SEC-2(2T) SEC-3(2P)	AEC-4(2T) (MIL)	CC-4(2T) ۞FP(2)	22	
	Cum. Cr.	**12**	**---**	**10**	**---**	**4**	**6**	**4**	**8**	**44**	
	Exit option: Award of UG Diploma in Major and Minor with 88 credits and an additional 4 credits core NSQF course/ Internship OR Continue with Major & Minor.										

***** Student must choose one subject as a Major subject out of M-1, M-2 and M-3 that he/she has chosen at First year
#Student must choose one subject as a Minor subject out of M-1, M-2 and M-3 that he/she has chosen at First year (Minor must be other than Major)
۞ OJT/Internship/CEP should be completed in the summer vacation after 4th semester

T.Y. B.Sc.

Year (Level)	Sem	Subject-I (M-1) Major		Subject-II (M-2) Minor	Subject-III (M-3)	Open Elective (OE)	VSC, SEC (VSEC)	AEC, VEC, IKS	CC, FP, CEP, OJT/Int/RP	Cumulative Credits/Sem	Degree/ Cumulative Credit
		Mandatory (DSC)	**Elective (DSE)**	**(MIN)**							
3 (5.5)	V	DSC-11(2T) DSC-12(2T) DSC-13(2T) DSC-14(2P) DSC-15(2P)	DSE-1A/B (2T) DSE-2A/B (2P)	---	---	---	VSC-1(2T) VSC-2(2P)	---	OJT/Int (4)	22	**UG Degree**
	VI	DSC-16(2T) DSC-17(2T) DSC-18(2T) DSC-19(2T) DSC-20(2T) IKS DSC-21(2P) DSC-22(2P)	DSE-3A/B (2T) DSE-4A/B (2P)	---	---	---	VSC-3(2T) VSC-4(2P)	---	---	22	
	Cum. Cr.	**24**	**8**	**---**	**---**	**---**	**8**	**---**	**4**	**44**	
	Exit option: Award of UG Degree in Major with 132 credits OR Continue with Major and Minor										

Fourth Year B.Sc. (Honours)

Year (Level)	Sem	Major Core Subjects		Research Methodology (RM)	VSC, SEC (VSEC)	OE	AEC, VEC, IKS	CC, FP, CEP, OJT/Int/RP	Cumulative Credits/Sem	Degree/ Cumulative Credit
IV (6.0)	VII	DSC-23(4T) DSC-24(4T) DSC-25(4T) DSC-26(2P)	DSE-5A/B (2T) DSE-6A/B (2P)	RM(4T)	---	---	---	---	22	**UG Honours Degree**
	VIII	DSC-27(4T) DSC-28(4T) DSC-29(4T) DSC-30(2P)	DSE-7A/B (2T) DSE-8A/B (2P)	---	---	---	---	OJT/Int (4)	22	
	Cum. Cr.	**28**	**8**	**4**	**---**	**---**	**---**	**4**	**44**	
Four Year UG Honors Degree in Major and Minor with 176 credits										

Fourth Year B.Sc. (Honours with Research)

Year (Level)	Sem	Major Core Subjects		Research Methodology (RM)	VSC, SEC (VSEC)	OE	AEC, VEC, IKS	CC, FP, CEP, OJT/Int/RP	Cumulative Credits/Sem	Degree/ Cumulative Credit
IV (6.0)	VII	DSC-23(4T) DSC-24(4T) DSC-26(2P)	DSE-5A/B (2T) DSE-6A/B (2P)	RM(4T)	---	---	---	RP(4)	22	UG Honours with Research Degree
	VIII	DSC-27(4T) DSC-28(4T) DSC-30(2P)	DSE-7A/B (2T) DSE-8A/B (2P)	---	---	---	---	RP(8)	22	
	Cum. Cr.	**20**	**8**	**4**	**---**	**---**	**---**	**12**	**44**	
Four Year UG Honours with Research Degree in Major and Minor with 176 credits										

Sem- Semester, **DSC**- Department Specific Course, **DSE**- Department Specific Elective, **OE/GE**- Open/Generic elective, **VSC**- Vocational Skill Course, **SEC**- Skill Enhancement Course, **VSEC**- Vocation and Skill Enhancement Course, **AEC**- Ability Enhancement Course, **IKS**- Indian Knowledge System, **VEC**- Value Education Course, **T**- Theory, **P**- Practical,**CC**-Co-curricular **RM**- Research Methodology, **OJT**- On Job Training, **FP**- Field Project, **Int**- Internship, **RP**- Research Project, **CEP**- Community Extension Programme, **ENG**- English, **CI**- Constitution of India, **MIL**- Modern Indian Laguage

- Number in bracket indicate credit
- The courses which do not have practical 'P' will be treated as theory 'T'
- If student select subject other than faculty in the subjects M-1, M-2 and M-3, then that subject will be treated as Minor subject, and cannot be selected as Major at second year.

Details of T.Y. B.Sc. (Biochemistry)

Course	Course Type	Course Code	Course Title	Credits	Teaching Hours/ Week			Marks			
					T	P	Total	Internal		External	
								T	P	T	P
Semester V, Level – 5.5											
DSC-11	DSC	BIC-DSC-351	Genetics	2	2	---	2	20	---	30	---
DSC-12	DSC	BIC-DSC-352	Basic Immunology	2	2	---	2	20	---	30	---
DSC-13	DSC	BIC-DSC-353	Plant Biochemistry	2	2	---	2	20	---	30	---
DSC-14	DSC	BIC-DSC-354	Practical on Genetics andImmunology	2	---	4	4	---	20	---	30
DSC-15	DSC	BIC-DSC-355	Practical on Plant Biochemistry	2	---	4	4	---	20	---	30
DSE-1A	DSE	BIC-DSE-351A	Enzymology	2	2	---	2	20	---	30	---
DSE-1B	DSE	BIC-DSE-351B	Molecular Biology	2	2	---	2	20	---	30	---
DSE-2A	DSE	BIC-DSE-352A	Practical on Enzmology	2	---	4	4	---	20	---	30
DSE-2B	DSE	BIC-DSE-352B	Practical on Molecular Biology	2	---	4	4	---	20	---	30
VSC-1	VSC	BIC-VSC-351	Fermentation Technology	2	2	---	2	20	---	30	---
VSC-2	VSC	BIC-VSC-352	Practical on Fermentation Technology	2	---	4	4	---	20	---	30
OJT/Int	OJT	BIC-OJT-351	On Job Training/Internship	4	---	8	8	---	40	---	60
Semester VI, Level – 5.5											
DSC-16	DSC	BIC-DSC-361	Fundamentals of Toxicology	2	2	---	2	20	---	30	---
DSC-17	DSC	BIC-DSC-362	Animal and Plant tissue culture	2	2	---	2	20	---	30	---
DSC-18	DSC	BIC-DSC-363	Metabolism	2	2	---	2	20	---	30	---
DSC-19	DSC	BIC-DSC-364	Clinical Biochemistry	2	2	---	2	20	---	30	---
DSC-20	DSC/IKS	BIC-DSC-365	Ayurved: Ancient Indian Medicinal System	2	2	---	2	20	---	30	---
DSC-21	DSC	BIC-DSC-366	Practical on Toxicology	2	---	4	4	---	20	---	30
DSC-22	DSC	BIC-DSC-367	Practical on Clinical Biochemistry	2	---	4	4	---	20	---	30
DSE-3A	DSE	BIC-DSE-361A	Genetic Engineering	2	2	---	2	20	---	30	---
DSE-3B	DSE	BIC-DSE-361B	Enzyme Science and Technology	2	2	---	2	20	---	30	---
DSE-4A	DSE	BIC-DSE-362A	Practical on Genetics and Tissue Culture Techniques	2	---	4	4	---	20	---	30
DSE-4B	DSE	BIC-DSE-362B	Practical on Enzyme Science and Technology	2	---	4	4	---	20	---	30
VSC-3	VSC	BIC-VSC-361	Analytical Techniques	2	2	---	2	20	---	30	---
VSC-4	VSC	BIC-VSC-362	Practical on Analytical Techniques	2	---	4	4	---	20	---	30

Examination Pattern

Theory Question Paper Pattern:

- 30 (External) +20 (Internal) for 2 credits
    - External examination will be of 1½ hours duration
    - There shall be 3 questions: Q1 carrying 6 marks and Q2, Q3 carrying 12 marks each. The tentative pattern of question papers shall be as follows;
    - Q1 Attempt any 2 out of 3 sub-questions; each 3 marks
    - Q 2 and Q3 Attempt any 3 out of 4 sub-question; each 4 marks.

Rules of Continuous Internal Evaluation:

The Continuous Internal Evaluation for theory papers shall consist of two methods:

1. Continuous & Comprehensive Evaluation (CCE): CCE will carry a maximum of 30% weightage (30/15 marks) of the total marks for a course. Before the start of the academic session in each semester, the subject teacher should choose any three assessment methods from the following list, with each method carrying 10/5 marks:

i. Individual Assignments
ii. Seminars/Classroom Presentations/Quizzes
iii. Group Discussions/Class Discussion/Group Assignments
iv. Case studies/Case lets
v. Participatory & Industry-Integrated Learning/Field visits
vi. Practical activities/Problem Solving Exercises
vii. Participation in Seminars/Academic Events/Symposia, etc.
viii. Mini Projects/Capstone Projects
ix. Book review/Article review/Article preparation
x. Any other academic activity
xi. Each chosen CCE method shall be based on a particular unit of the syllabus, ensuring that three units of the syllabus are mapped to the CCEs.

2. Internal Assessment Tests (IAT): IAT will carry a maximum of 10% weightage (10/5 marks) of the total marks for a course. IAT shall be conducted at the end of the semester and will assess the remaining unit of the syllabus that was not covered by the CCEs. The subject teacher is at liberty to decide which units are to be assessed using CCEs and which unit is to be assessed on the basis of IAT.The overall weightage of Continuous Internal Evaluation (CCE + IAT) shall be 40% of the total marks for the course. The remaining 60% of the marks shall be allocated to the semester-end examinations.The subject teachers are required to communicate the chosen CCE methods and the corresponding syllabus units to the students at the beginning of the semester to ensure clarity and proper preparation.

Practical Examination Credit 2: Pattern (30+20)

External Practical Examination (30 marks):

- Practical examination shall be conducted by the respective department at the end of the semester.
- Practical examination will be of 3 hours duration and shall be conducted as per schedule.
- Practical examination shall be conducted for 2 consecutive days for 2 hr/ day where incubation conditionis required.
- There shall be 05 marks for journal and viva-voce. Certified journal is compulsory to appear for practical examination.

Internal Practical Examination (20 marks):

- Internal practical examination of 10 marks will be conducted by department as per schedule given.
- For internal practical examination student must produce the laboratory journal of practicals completed along with the completion certificate signed by the concerned teacher and the Head of the department.
- There shall be continuous assessment of 30 marks based on student performance throughout the semester. This assessment can include quizzes, group discussions, presentations and other activities assigned by the faculty during regular practicals. For details refer internal theory examination guidelines.
- Finally 40 (10+30) marks performance of student will be converted into 20 marks.

SEMESTER-V

T.Y. B.Sc. Biochemistry (Major)
Semester-V
BIC-DSC-351: Genetics

Total Hours: 30 **Credits: 2**

Course Objectives	• To accustom students with basic concepts of Genetics. • To attune students with organization of DNA. • To study central dogma of genetics.	
Course Outcomes	After successful completion of this course, students are expected to: • Understand and discuss the importance of Mendel's work. • Understand and discuss structure of chromosome and DNA organization. • Understand and discuss replication, transcription, translation processes. • Understand and discuss fine structure of gene, gene regulation and mutations.	
Unit	**Contents**	**Hours**

Unit I	**Basic Genetics**
	• Mendel's law
	  o Law of dominance
	  o Law of segregation
	  o Law of independent assortment
	• Incomplete dominance
	• Test cross, back cross
	• Concept of multiple alleles
	  o Characters, symbolism e.g. ABO types
	• Lethal gene
		07

Unit II	**Chromosomes & organization of prokaryotic & eukaryotic DNA** • Morphology, structure and types of chromosome • Chromosome number and variation in chromosome number • Structural organization of prokaryotic & eukaryotic DNA • Central dogma	**08**

Unit III	**DNA replication and transcription in bacteria**
	• DNA replication in *E. coli*
	  o Replication origin, unwinding of the strand, Template DNA, RNA primer, polymerization, replication fork, leading strand, lagging strand, Okazaki fragment
	• Transcription components
	  o Template, activated precursors, divalent metal ions, RNA polymerase, sigma factor
	  o Transcription process-initiation, elongation, termination
	• Fine structure of gene
	  o Cistron, muton, recon, intron, promotor, repressor, exon, regulator, operator etc
	• Gene regulation
	  o Operon concept, *lac* operon
		08

Unit IV	**Prokaryotic Translation and Mutations** • Activation and transfer of amino acids to tRNA • Translation-initiation, elongation, termination • Post translational modification in eukaryotes • Mutations- definition • Gene mutations o Base pair substitutions- transition, transversion and inversion	**07**

	○ Frameshift mutations- deletion and insertion ○ Missense mutation, nonsense mutations ○ Mutations in termination codons ○ Silent mutations • Mutagens: definition ○ Chemical-base analogues, agents modifying purines and pyrimidines ○ Physical radiation	
Study Resources	• Berg J. M., Tymoczko J. L., Gatto Jr. G. J., Stryer L. (2015), Biochemistry, 8th edition, W. H. Freeman and Company, New York. • Krebs J. E., Goldstein E. S., Kilpatrick S. T. (2018), Lewin's Genes XII, Jones and Barlett Learning. • Gardner M., Simmons J., Snustad D. P. (2006), Principle of Genetics, 8th edition, John Willey and Sons. • Strickberger M.W. (2015), Genetics, 3rd edition, Pearson, India. • Gupta P.K. (2009), Genetics, Rastogi publication, Meerut. • Satyanarayana U. (2008), Biotechnology, Books and Allied (P) Ltd, Kolkata. • Agarwal G. R., Agarwal K., Agarwal O. P. (2014), Textbook of Biochemistry, Goel Publishing House, Meerut • Powar C.B. (2010), Cell Biology, Himalaya Publishing House, Mumbai • Powar C.B. (2007), Genetics Vol. I, Himalaya Publishing House, Mumbai • Powar C.B. (2009), Genetics Vol. II, Himalaya Publishing House, Mumbai	

T.Y. B.Sc. Biochemistry (Major)
Semester-V
BIC-DSC-352: Basic Immunology

Total Hours: 30 **Credits: 2**

Course Objectives	• To accustom students with basics of immunology. • To aware students about importance and role of immune system. • To comprehend students with various immunochemical tests.	
Course Outcomes	After successful completion of this course, students are expected to: • Explore cells and organs of immune system. • Understand immunity and immune response. • Discuss concept of antigen and antibody. • Understand the importance of immunochemistry in diagnosis.	
Unit	**Contents**	**Hours**
Unit I	**Cells and organs of immune system** • Hematopoiesis • Cells of immune system o Lymphoid cells- T-cells, B-cells, Natural killer cells, dendritic cells o Granulocytes- Neutrophils, Eosinophils, Basophils, Monocytes, Macrophages, Mast cells • Organs of immune system o Primary lymphoid organs ▪ Thymus ▪ Bone marrow ▪ Lymphatic system o Secondary lymphoid organs ▪ Lymph nodes ▪ Spleen ▪ MALT and GALT	**07**
Unit II	**Immunity and Immune response** • Immunity- definition and types • Innate immunity o Factors influencing innate immunity o Mechanism of innate immunity o Cellular factor in innate immunity • Adaptive/ acquired immunity o Active and passive immunity • Immune response o Humoral immune response ▪ Primary and secondary immune response ▪ Antibody production ▪ Factors affecting antibody production • Cell mediated immune response	**08**
Unit III	**Antigen and Antibody** • Antigen- o Definition o Basic terms- hapten, adjuvants, epitopes o Antigenicity and immunogenicity o Determinants of an antigenicity	**08**

	• Basic structure of antibody
	  o Classes of antibodies:
	  ▪ IgG, IgA, IgM, IgD, IgE- structure and functions
	  o Antigenic determinants on immunoglobulins
	  ▪ Isotype, Allotype and Idiotype	

Unit IV	**Immunochemistry**
	• General features of antigen-antibody reactions
	  o Precipitation reaction- mechanism and applications
	  o Flocculation reaction
	  o Single diffusion
	  o Double diffusion
	  o Radial immunodiffusion
	  o Immunoelectrophoresis
	  o Crossover immunoelectrophoresis
	  o Rocket immunoelectrophoresis
	• Agglutination reaction
	  o Slide and tube agglutination
	  o Coombs test and passive agglutination
	• Immunofluorescence
	• Radioimmunoassay
	• ELISA- types
		07

Study Resources	• Shastri N.V. (2005), Principles of Immunology, Himalaya Publishing House, Mumbai • Kindt T. J., Goldsby R. A., Osborne B. A. (2006), Kuby Immunology, 6th edition, W.H. Freeman and Company, New York • Kanungo R. (2017), Ananthanarayan and Panikar's Textbook of Microbiology, 10th edition, The Orient Blackswan. • Delves P. J., Martin S. J., Burton D. R. (2011), Roitt's Essential Immunology, 12th edition, Willey-Blackwell. • Tizard I. (2005), Immunology: An Introduction, Cengage Learning (RS).	

T.Y. B.Sc. Biochemistry (Major)
Semester-V
BIC-DSC-353: Plant Biochemistry

Total Hours: 30 **Credits: 2**

Course Objectives	• To accustom students with basics of Plant Biochemistry. • To study the life processes of plants. • To generate awareness about importance of plant nutrition requirements.	
Course Outcomes	After successful completion of this course, students are expected to: • Discuss life processes like photosynthesis, photorespiration and energy generation. • Acquire knowledge about various phytohormones, secondary metabolites and their mechanism. • Understand importance of plant nutrition.	
Unit	**Contents**	**Hours**
Unit I	**Photosynthesis, Photorespiration and ATP generation** • Definition of photosynthesis, Ultra structure of chloroplast • Chemistry of Chlorophyll • Mechanism of Photosynthesis o Photosystem I and II o Light (Hill) reaction: Cyclic and non-cyclic photophosphorylation o Dark reaction: C3 and C4 pathways o Kranz anatomy o Significance of photosynthesis o Factors affecting photosynthesis-external and internal • Photorespiration: o Definition o Metabolism of Photorespiration o Significance of photorespiration • Electron transport chain: o Components of ETC o Oxidative phosphorylation o Redox potential and sites of ATP synthesis	**08**
Unit II	**Phytohormones** • Definition and types of phytohormones • Mechanism of action, physiological effect and applications of o Auxins o Cytokinins o Gibberellins o Abscisic acid o Ethylene o Seed dormancy and seed germination	**07**
Unit III	**Secondary Metabolites** • Introduction and overview of biosynthetic pathway of secondary metabolites • Classification of Isoprenoid /terpenoids: classification, chemistry, distribution and role of isoprenoids • Nitrogen containing secondary plant products: Classification o Alkaloids: chemistry distribution classification and physiological role	**07**

	○ Cyanogenic glycosides and Glucosinolates: chemistry and functions ○ Non-protein amino acids: chemistry and functions • Plant phenolics: chemistry, biological functions, classification • Chemistry and functions of lignin, flavonoids and tannins	
Unit IV	**Plant nutrition** • Essential and non-essential elements ○ Macronutrients- definition and examples ○ Micronutrients- definition and examples • Source, functions and deficiency symptoms of macronutirents (C, H, O, N, S, P, K, Mg, Ca and Fe) • Source, functions and deficiency symptoms of micronutirents (B, Mn, Zn, Cu, Mo and Cl) • Biofertilizers ○ Symbiotic nitrogen fixer ○ Asymbiotic nitrogen fixer ○ Phosphate solubilising bacteria ○ Organic fertilizers ○ Benefits and limitations of biofertilizers • Composting –mixed culture composting, vermicomposting	
Study Resources	• Gupta N. K., Gupta S. (2005), Plant physiology, Oxford and IBH publishing Co. Pvt. Ltd., New Delhi. • Devlin R. M., Witham F. H. (1983), Plant Physiology, 4th edition, CBS Pub. New Delhi. • Salisbary and Ross (2006), Plant physiology, 3rd edition, CBS Pub. New Delhi. • Verma S. K., Verma M. (1995), A Textbook of Plant Physiology, Biochemistry and Biotechnology, S. Chan and company ltd, New Delhi. • Satyanarayana U. (2008), Biotechnology, Books and Allied (P) Ltd, Kolkata. • Jain V. K. (1983), Fundamentals of Plant Physiology, 3rd edition, S. Chan and company ltd, New Delhi • Chawla H.S. (2009), Introduction to Plant Biotechnology, 3rd edition, CRC press.	

T.Y. B.Sc. Biochemistry (Major)
Semester-V
BIC-DSC-354: Practical on Genetics andImmunology

Total Hours: 60 **Credits: 2**

Course Objectives	• To accustom students with techniques in Molecular Biology. • To make students aware about Mendelian Genetics. • To accustom students with immunological methods.	
Course Outcomes	After successful completion of this course, students are expected to: • Isolate DNA and estimate DNA and RNA • Cross match donor's and recipient's blood and conclude about blood trasfusion. • Perform various immunological Ag-Ab tests.	
Sr. No.	**Contents**	**Hours**
1	Isolation of genomic DNA from suitable bacterial sample	**4**
2	Isolation of genomic DNA from human blood sample	**4**
3	Isolation of genomic DNA from suitable plant sample	**4**
4	Quality check of isolated DNA by Agarose gel electrophoresis.	**4**
5	Determination of concentration of isolated DNA by spectrophotometeric method.	**4**
6	Purification of isolated DNA by phenol: chloroform: Isoamyl alcohol method	**4**
7	Estimation of DNA by DPA method	**4**
8	Estimation of RNA by orcinol method	**4**
9	DeterminationofTmand GC content of DNA	**4**
10	Solve problems based on Mendelian genetics	**4**
11	Blood group detection and cross matching	**4**
12	Ag-Ab reaction by Ouchterlony double diffusion method	**4**
13	Radial immunodiffusion.	**4**
14	Widal agglutination test (slide test method).	**4**
15	VDRL test.	**4**
Study Resources	• Sadasivam S., Manikam A. (2018), Biochemical Methods, 3rd edition, New Age International Pvt. Ltd. • Aneja K. R. (2003), Experiments in Microbiology, Plant Pathology and Biotechnology, New Age International Pvt. Ltd. • Sawhney S.K., Singh R. (2001), Introductory Practical Biochemistry, Narosa Publishing House, New Delhi • Plummer D. (2017), An Introduction to Practical Biochemistry, Indian Edition, McGraw Hill Education. • Jayaraman J. (1996), Laboratory manual in Biochemistry, Wiley Eastern Ltd. • Maheshwari N. (2008), Clinical Biochemistry, Jaypee Brothers, Medical Publishers. • Godkar P. B., Godkar D. P., Textbook of medical laboratory technology, 2nd edition, Bhalani Publishing House, Mumbai • Rao B. S., Deshpande V. (2005), Experimental Biochemistry A student companion, I.K. International Pvt. Ltd., Mumbai.	

***Mandatory to perform any 12 practical from above.**

T.Y. B.Sc. Biochemistry (Major)
Semester-V
BIC-DSC-355: Practical on Plant Biochemistry

Total Hours: 60 **Credits: 2**

Course Objectives	• To study the process of photosynthesis in practical manner. • To develop skill full hand on estimation, separation and isolation of plant metabolites. • To accustom students with isolation of micro-organisms.	
Course Outcomes	After successful completion of this course, students are expected to: • Explain effect of CO_2, light intensity/quality on photosynthesis. • Estimate, separate and isolate plant metabolites like chlorophyll, chloroplast, plant hormones and secondary metabolites • Isolate microorganisms acting as biofertilizers.	
Sr. No.	**Contents**	**Hours**
1	Estimation of chlorophyll pigments by spectrophotometric method.	**4**
2	Separation of plant pigments by chromatography.	**4**
3	Isolation chloroplast from suitable leaf sample.	**4**
4	Spectrophotometric assay of the Hill reaction.	**4**
5	Effect of light intensity /quality of light on rate of photosynthesis	**4**
6	Effect of CO_2 on rate of photosynthesis.	**4**
7	Estimation of auxin from suitable plant source by spectrophotometeric method.	**4**
8	Estimation of gibberellin from suitable plant source by spectrophotometeric method.	**4**
9	Estimation of tannin by Folin-Dennis method.	**4**
10	Qualitative tests for detection of alkaloids	**4**
11	Qualitative tests for detection of phenolic compounds	**4**
12	Isolation of Phosphate solubilizing microorganisms.	**4**
13	Isolation of nitrogen fixing bacteria from root nodules.	**4**
14	Isolation of nitrogen fixing bacteria from soil sample.	**4**
15	Preparation of manure by vermicomposting process.	**4**
Study Resources	• Sadasivam S., Manikam A. (2018), Biochemical Methods, 3rd edition, New Age International Pvt. Ltd. • Aneja K. R. (2003), Experiments in Microbiology, Plant Pathology and Biotechnology, New Age International Pvt. Ltd. • Sawhney S.K., Singh R. (2001), Introductory Practical Biochemistry, Narosa Publishing House, New Delhi • Plummer D. (2017), An Introduction to Practical Biochemistry, Indian Edition, McGraw Hill Education. • Jayaraman J. (1996), Laboratory manual in Biochemistry, Wiley Eastern Ltd. • Aneja K. R. (2003), Experiments in Microbiology, Plant Pathology and Biotechnology, New Age International Pvt. Ltd.	

***Mandatory to perform any 12 practical from above.**

T.Y. B.Sc. Biochemistry (Elective)
Semester-V
BIC-DSE-351A: Enzymology

Total Hours: 30 **Credits: 2**

Course Objectives	• To accustom students with basics of enzymology. • To attune students with mechanism of enzyme action. • To understand applications enzyme in various fields.	
Course Outcomes	After successful completion of this course, students are expected to: • Understand classification and specificity of enzymes. • Discuss mechanism of enzyme action and enzyme kinetics. • Explain activation and deactivation of regulatory enzymes. • Explore various industrial applications of enzymes	
Unit	**Contents**	**Hours**
Unit I	**Basic concepts in Enzymology** • Definition and historical background of enzyme • Terminologies - intracellular enzymes, extracellular enzymes, holoenzymes, apoenzymes, prosthetic group, cofactor, coenzymes, isoenzymes, katal, international unit, turnover number and active site. • Nomenclature and classification (IUB) of enzymes • Factors affecting enzyme activity - effect of substrate concentration, enzyme concentration, product concentration, pH, temperature, activators, time, light and radiation. • Specificity of enzyme action - absolute specificity, group specificity, optical specificity and geometrical specificity. • Active site - definition and salient features of active site. • Industrial applications of enzymes	**07**
Unit II	**Enzyme Kinetics and Inhibition** • Mechanism of enzyme action – lowering of activation energy, lock and key model, induced fit model. • MichaelisMenten Equation: derivation, Km Vmax • Transformation of Michaelis –Menten equation: Lineweaver-Burk plot, Eadie-Hofstee plot • Inhibition: Irreversible and reversible inhibition • Reversible inhibition- competitive, non-competitive and uncompetitive inhibition with examples. • Factors contributing to the catalytic efficiency of enzymes: proximity and orientation of the substrate, covalent catalysis, acid-base catalysis, factor of strain in enzyme catalysis	**08**
Unit III	**Regulatory enzymes** • Allosteric enzymes: definition, feedback inhibition, positive and negative modulator, heterotropic and homotropic control, mechanism of regulatory activity of allosteric enzymes- sequential and symmetry model, kinetics of allosteric enzymes, aspartate transcarbamoylase-kinetics and inhibition • Covalently modulated enzymes: definition, explanation with example of glycogen phosphorylase enzyme • Covalent activation of zymogen: pepsinogen, trypsinogen, chymotrypsinogen • Classes of proteolytic enzymes: serine, aspartate, cysteine and metalloproteases	**07**

Unit IV	**Applications of enzymes**
	• Enzyme Immobilization: methods
	• Applications of immobilized enzymes and cells
	  o Manufacture of commercial products
	  o Analytical applications
	  o Therapeutic applications
	• Enzyme based biosensors and their applications
		08

Study Resources	• Nelson D. L., Cox M. M. (2013), Lehninger Principles of Biochemistry, 6th edition, W. H. Freeman and Company, New York. • Berg J. M., Tymoczko J. L., Gatto Jr. G. J., Stryer L.(2015), Biochemistry, 8th edition, W. H. Freeman and Company, New York. • Satynarayana U., Chakrapani U. (2017), Textbook of Biochemistry, 5th edition, Elsevier, India. • Talwar G. P. (2002), Textbook of Human Biochemistry, 3rd edition, Prentice Hall India Learning Pvt. Ltd. • Agarwal G. R., Agarwal K., Agarwal O. P. (2014), Textbook of Biochemistry, Goel Publishing House, Meerut • Powar C. B. (2010), Cell Biology, Himalaya Publishing House, Mumbai • Powar C. B., Chatwal G. R. (2011), Biochemistry, Himalaya Publishing House, Mumbai	

T.Y. B.Sc. Biochemistry (Elective)
Semester-V
BIC-DSE-351B: Molecular Biology
(NPTEL course code: noc25-bt35)

Total Hours: 30 **Credits: 2**

Course Objectives	• To accustom students with basic concepts of Molecular Biology. • To study central dogma of Molecular Biology. • To attune students with Molecular Techniques and applications.	
Course Outcomes	After successful completion of this course, students are expected to: • Understand and discuss cellular structure and basic biomolecules. • Explain replication, transcription, translation processes. • Understand and discuss molecular techniques like blotting, PCR, genome editing etc. • Explore applications of molecular biology in various fields.	
Unit	**Contents**	**Hours**
Unit I	• **Basics of Biological System (Part 1)** o Cellular structure (Part I) o Cellular structure (Part II) o Cellular structure (Part III) • **Basics of Biological System (Part 2)** o Cellular Metabolism o Cell Cycle and control o Program Cell Death • **Basics of Biomolecules** o DNA o RNA o Protein	**07**
Unit II	• **Central Dogma of Molecular Biology** o Genetic Material (Part 1) o Genetic Material (Part 2) o Central Dogma of Molecular Biology • **Replication** o Replication (Part 1) o Replication (Part 2) o Mutagenesis and repair mechanism • **Transcription** o Transcription in Prokaryotes o Transcription in Eukaryotes o Post-transcriptional Modifications	**08**
Unit III	• **Translation** o Translation in Prokaryotes o Translation in Eukaryotes o Post-translational Modifications o Gene control mechanisms • **Molecular Techniques (Part 1)** o SouthernBlotting o Northern Blotting o Western Blotting • **Molecular Techniques (Part 2)** o Polymerase chain reaction (Part 1)	**07**

	○ Polymerase chain reaction (Part 2) ○ Real-Time PCR	
Unit IV	• **Molecular Cloning** ○ Cloning of gene ○ DNA delivery ○ Screening of cloned DNA • **Genome Editing** ○ Genome Editing (Part 1) ○ Genome Editing (Part 2) ○ Genome Editing (Part 3) • **Application of Molecular Biology** ○ Application of Molecular Biology (Part 1) ○ Application of Molecular Biology (Part 1) ○ Summary and Conclusions	**08**
Study Resources	• https://nptel.ac.in/courses/102103341 • Berg J. M., Tymoczko J. L., Gatto Jr. G. J., Stryer L. (2015), Biochemistry, 8th edition, W. H. Freeman and Company, New York. • Krebs J. E., Goldstein E. S., Kilpatrick S. T. (2018), Lewin's Genes XII, Jones and Barlett Learning. • Gardner M., Simmons J., Snustad D. P. (2006), Principle of Genetics, 8th edition, John Willey and Sons. • Strickberger M.W. (2015), Genetics, 3rd edition, Pearson, India. • Gupta P.K. (2009), Genetics, Rastogi publication, Meerut. • Satyanarayana U. (2008), Biotechnology, Books and Allied (P) Ltd, Kolkata. • Agarwal G. R., Agarwal K., Agarwal O. P. (2014), Textbook of Biochemistry, Goel Publishing House, Meerut • Powar C.B. (2010), Cell Biology, Himalaya Publishing House, Mumbai • Powar C.B. (2007), Genetics Vol. I, Himalaya Publishing House, Mumbai • Powar C.B. (2009), Genetics Vol. II, Himalaya Publishing House, Mumbai	

T.Y. B.Sc. Biochemistry (Elective)
Semester-V
BIC-DSE-352A: Practical on Enzymology

Total Hours: 60 **Credits: 2**

Course Objectives	• To study enzyme kinetics practically. • To understand importance and applications of immobilization techniques. • To isolate enzyme by various methods.	
Course Outcomes	After successful completion of this course, students are expected to: • Understand effect of various factors on enzyme activity. • Calculate K_m and V_{max} • Immobilize enzymes/cells and explore its applications. • Isolate enzymes by methods like salt/solvent precipitation.	
Sr. No.	**Contents**	**Hours**
1	Estimation of maltose by DNSA method.	**4**
2	Determination of amylase activity	**4**
3	Determination of specific activity of amylase enzyme	**4**
4	To determine the effect of amylase concentration on the rate of reaction.	**4**
5	To determine the effect of substrate concentration on the activity of amylase.	**4**
6	To determine K_m and V_{max} of the reaction catalysed by amylase using M-M plot.	**4**
7	To determine K_m and V_{max} of the reaction catalysed by amylase by using L-B plot	**4**
8	To determine effect of suitable inhibitor on α-amylase activity.	**4**
9	To determine the effect of pH on activity of amylase.	**4**
10	To determine the effect of temperature on activity of amylase.	**4**
11	Immobilization of suitable enzyme / yeast cells.	**4**
12	Isolation of amylase by salt precipitation method	**4**
13	Isolation of enzyme by solvent precipitation method	**4**
14	Partial purification of salt precipitated amylase by dialysis	**4**
15	Qualitative determination amylase activity in precipitated sample.	**4**
Study Resources	• Sadasivam S., Manikam A. (2018), Biochemical Methods, 3rd edition, New Age International Pvt. Ltd. • Aneja K. R. (2003), Experiments in Microbiology, Plant Pathology and Biotechnology, New Age International Pvt. Ltd. • Sawhney S.K., Singh R. (2001), Introductory Practical Biochemistry, Narosa Publishing House, New Delhi • Plummer D. (2017), An Introduction to Practical Biochemistry, Indian Edition, McGraw Hill Education. • Jayaraman J. (1996), Laboratory manual in Biochemistry, Wiley Eastern Ltd. • Aneja K. R. (2003), Experiments in Microbiology, Plant Pathology and Biotechnology, New Age International Pvt. Ltd.	

***Mandatory to perform any 12 practical from above.**

T.Y. B.Sc. Biochemistry (Elective)
Semester-V
BIC-DSE-352B: Practical on Molecular Biology

Total Hours: 60 **Credits: 2**

Course Objectives	• To accustom students with DNA isolation and estimation of DNA and RNA • To familiarize students practically with restriction digestion and PCR • To develop skill full hand on agarose gel electrophoresis	
Course Outcomes	After successful completion of this course, students are expected to: • Isolate DNA and estimate DNA and RNA • Amplify DNA using PCR and fragment DNA using restriction digestion technique • Separate DNA using agarose gel electrophoresis	
Sr. No.	**Contents**	**Hours**
1	Restriction digestion of DNA using molecular scissors	**4**
2	Separation of DNA fragments by agarose gel electrophoresis	**4**
3	Amplification of DNA fragment using PCR	**4**
4	Separation of fragments produced by PCR by agarose gel electrophoresis	**4**
5	Isolation of genomic DNA from suitable bacterial sample	**4**
6	Isolation of genomic DNA from human blood sample	**4**
7	Isolation of genomic DNA from suitable plant sample	**4**
8	Quality check of isolated DNA by Agarose gel electrophoresis.	**4**
9	Purity check of isolated DNA by spectrophotometeric method.	**4**
10	Purity check of RNA by spectrophotometeric method.	**4**
11	Purification of isolated DNA by suitable method	**4**
12	Estimation of DNA by DPA method	**4**
13	Estimation of RNA by orcinol method	**4**
14	Determination of T_m and GC content of DNA	**4**
15	Solve problems based on Mendelian genetics	**4**
Study Resources	• Sadasivam S., Manikam A. (2018), Biochemical Methods, 3rd edition, New Age International Pvt. Ltd. • Aneja K. R. (2003), Experiments in Microbiology, Plant Pathology and Biotechnology, New Age International Pvt. Ltd. • Sawhney S.K., Singh R. (2001), Introductory Practical Biochemistry, Narosa Publishing House, New Delhi • Plummer D. (2017), An Introduction to Practical Biochemistry, Indian Edition, McGraw Hill Education. • Jayaraman J. (1996), Laboratory manual in Biochemistry, Wiley Eastern Ltd. • Sharma S., Sharma R. (2016), Practical manual of Biochemistry, Scientific International Publisher and Distributor, New Delhi. • Maheshwari N. (2008), Clinical Biochemistry, Jaypee Brothers, Medical Publishers. • Godkar P. B., Godkar D. P., Textbook of medical laboratory technology, 2nd edition, Bhalani Publishing House, Mumbai	

***Mandatory to perform any 12 practical from above.**

T.Y. B.Sc. Biochemistry (Vocational)
Semester-V
BIC-VSC-351: Fermentation Technology

Total Hours: 30 **Credits: 2**

Course Objectives	• To accustom students with basics of Fermentation Technology • To attune students with bioreactors and downstream processing • To explore industrial applications of fermentation	
Course Outcomes	After successful completion of this course, students are expected to: • Screen and preserve microbes and develop inoculum • Understand instrumentation, types and working of bioreactors • Explain the basics of downstream processing	
Unit	**Contents**	**Hours**

Unit I	**Basics of Fermentation Technology**
	• Fermentation: definition and concept
	• Characteristic of industrial strain
	• Screening of industrially important microbes: Primary & Secondary
	• Fermentation media: Composition, Raw materials, screening of media, antifoam, buffer.
	• Industrial sterilization process –
	  o Concept and need of sterilization
	  o Types of sterilization:
	  ▪ Batch
	  ▪ Continuous
	  ▪ Filtration
	• Inoculum –stock, working culture
	• Inoculum development
	• Preservation methods for industrially important microbes
		08

Unit II	**Bioreactors**
	• History of Bioreactors
	• Parts of Bioreactors and their functions
	  o Materials of construction
	  o Valves
	  o Agitators and its types
	  o Sparger
	  o Port feeders
	  o Baffles
	• Controlling system
	• Types of bioreactors
	  o Primary bioreactor
	  o Tower
	  o Air lift
	  o Deep jet
	• Conventional Bioreactor-common features
	• Operation of conventional bioreactor
		07

Unit III	**Types of fermentation and Downstream processing**
	• Types of fermentation
	  o Submerged
	  o Solid state
	  o Batch fermentation
	  o Continuous fermentation:
		08

	▪ Chemostat ▪ Turbidostat • Synchronous culture and its applications. • Introduction to downstream processing o Solid-liquid separation o Release of intracellular products by cell disruption o Concentration o Purification by chromatography o Formulation o Drying	
Unit IV	**Industrial Biotechnology** • Industrial production of – o Enzymes- amylase o Acid- citric acid o Alcohol- ethanol o Antibiotic- penicillin • Microbial biomass production o Introduction o Yeast o Economic aspect and Applications	**07**
Study Resources	• Patel A. H. (1984), Industrial Microbiology, MacMillan India Ltd, New Delhi • Verma S. K., Verma M. (1995), A Textbook of Plant Physiology, Biochemistry and Biotechnology, S. Chan and company ltd, New Delhi. • Satyanarayana U. (2008), Biotechnology, Books and Allied (P) Ltd, Kolkata. • Gupta P.K. (2005), Elements of Biotechnology, Rastogi Publication Meerut. • Chawla H.S. (2009), Introduction to Plant Biotechnology, 3rd edition, CRC press. • Jogdand S.N. (2012), Advances in Biotechnology, Himalaya Publishing House, Mumbai. • Gupta P.K. (2008), Biotechnology and Genomics, Rastogi publication, Meerut. • Casida L. E. (1968), Industrial microbiology, 1st edition, New age international publishers.	

T.Y. B.Sc. Biochemistry (Vocational)
Semester-V
BIC-VSC-352: Practical on Fermentation Technology

Total Hours: 60 **Credits: 2**

Course Objectives	• To accustom students with preservation methods of microorganisms • To develop inoculum and produce various products by fermentation technique • To recover and estimate product produced by fermentation technique	
Course Outcomes	After successful completion of this course, students are expected to: • Preserve important microorganisms required for fermentation • Develop imoculum and carry out fermentation successfully • Recover and estimate product produced by fermentation technique	
Sr. No.	**Contents**	**Hours**
1	Study of various parts of Bioreactor	**4**
2	Preservation of industrially important microorganisms	**4**
3	Inoculum development for ethanol production	**4**
4	Production of ethanol by submerged/batch fermentation method	**4**
5	Recovery of ethanol by distillation method	**4**
6	Estimation of ethanol by dichromate method	**4**
7	Estimation of ethanol by specific gravity	**4**
8	Inoculum development for amylase production	**4**
9	Production of amylase by submerged/batch fermentation method	**4**
10	Determination of amylase activity by DNSA method	**4**
11	Inoculum development for citric acid production	**4**
12	Production of Citric acid by solid state fermentation	**4**
13	Production of citric acid by submerged/batch fermentation method	**4**
14	Recovery of citric acid	**4**
15	Estimation of citric acid by volumetric method	**4**
Study Resources	• Sadasivam S., Manikam A. (2018), Biochemical Methods, 3rd edition, New Age International Pvt. Ltd. • Aneja K. R. (2003), Experiments in Microbiology, Plant Pathology and Biotechnology, New Age International Pvt. Ltd. • Sawhney S.K., Singh R. (2001), Introductory Practical Biochemistry, Narosa Publishing House, New Delhi • Plummer D. (2017), An Introduction to Practical Biochemistry, Indian Edition, McGraw Hill Education. • Jayaraman J. (1996), Laboratory manual in Biochemistry, Wiley Eastern Ltd. • Aneja K. R. (2003), Experiments in Microbiology, Plant Pathology and Biotechnology, New Age International Pvt. Ltd.	

***Mandatory to perform any 12 practical from above.**

T.Y. B.Sc. Biochemistry (On Job Training)
Semester-V
BIC-OJT-351: On Job Training/Internship

Total Hours: 120 **Credits:4**

Course objectives	• To provide the students with actual work experience • To make aware prescribe standards and guidelines at work • To develop the employability of participating student • To avail an opportunities to eventually acquire job experiences
Course outcomes	After successful completion of this course, students are expected to: • Get actual work experience with office and virtual exposure to various management styles, technical, industrial, and proceduralsystems • Acquaintthe knowledge related to working hours, work protocols and guidelines • Understand the roles and responsibilities of employee as well as team work • Justify job experiences that match theirpotentials, skills, and competencies

Internship

An internship is a professional learning experience that offers meaningful, practical work related to a student's field of study or career interest. An internship gives a student the opportunity for career exploration and development, and to learn new skills.

On the job training

On the job training is a form of training provided at the workplace. During the training, employees are familiarized with the working environment they will become part of. Employees also get a hands-on experience using machinery, equipment, tools, materials, etc.

Internship / OJT Process:

1. **Pre-Approval**: Students should seek approval from the college before starting the Internship / OJT. This ensures that the Internship / OJT aligns with the curriculum and meets the necessary criteria.
2. **Mentor and Supervisor**: Each student should have an assigned mentor at the organization/industry where they are interning. Additionally, anInternship / OJT supervisor from the college will be appointed to guide and monitor the progress.
3. **Regular Reporting:** Students should maintain regular communication with their supervisor and mentor, providing progress reports and seeking feedback.
4. **Professional Conduct**: Students must adhere to professional conduct throughout the Internship / OJT, including punctuality, respect for colleagues, and adherence to the organization's/industry's policies and guidelines.
5. **Student Diary**: Students should maintain a diary to document their experiences, challenges faced, and lessons learned during the Internship / OJT.
6. **Final Report**: At the end of the Internship / OJT, students should submit a comprehensive final report, summarizing their accomplishments, contributions, and key takeaways.
7. **Evaluation**: The Internship / OJT is worth 4 credits (equivalent to 100 marks), and the evaluation will be divided into two categories: one by the mentor and the other by the Internship / OJT supervisor. The mentor's evaluation (internal examination) will carry 40 marks, and it will be based on the student's performance during the Internship / OJT. External examination will be conducted by mentor and supervisor which will be based on the student's diary, the final report prepared by the student, and their performance in the final viva voce, and will carry60 marks. The total marks obtained by the students in both evaluations will be added together for the purpose of final evaluation. The evaluation of the students will be conducted by the mentor using the evaluation sheet provided by the college.

Internal Evaluation Criteria for Students by the Mentor:

1. **Quality of Work** (10 marks): How well did the student perform their assigned tasks during the Internship / OJT? Evaluate the accuracy, thoroughness, and attention to detail in their work.
2. **Initiative and Proactiveness**(10 marks): Did the student show initiative in taking on additional responsibilities or tasks beyond their assigned role? Did they demonstrate a proactive attitude towards problem-solving?
3. **Communication Skills** (10 marks): Assess the student's ability to communicate effectively with colleagues, superiors, and clients (if applicable). Consider both written and verbal communication.
4. **Problem-Solving SkillsandTime Management** (10 marks): Evaluate the student's ability to analyze problems, propose solutions, and implement effective strategies to overcome challenges.How well did the student manage their time during the Internship / OJT? Were they able to meet project deadlines and handle multiple tasks efficiently?

External Evaluation Criteria for Students by the Supervisor and Mentor:

1. **Student Diary** (15 marks): Review the student's diary to understand their reflections, insights gained, and self-assessment of their performance during the Internship / OJT.
2. **Final Report** (15 marks): Evaluate the quality and comprehensiveness of the student's final report, including the clarity of their achievements and contributions.
3. **Presentation of Student in Viva Voce** (30 marks): Evaluate the responses given by the student to the questions asked by the faculty in the Viva Voce.

Evaluation Criteria for Final Viva Voce:

1. Presentation Skills
2. Knowledge of the Internship / OJT Project
3. Practical Application and Work Experience
4. Problem-Solving and Critical Thinking
5. Communication and Professionalism

SEMESTER-VI

T.Y. B.Sc. Biochemistry (Major)
Semester-VI
BIC-DSC-361: Fundamentals of Toxicology

Total Hours: 30 **Credits: 2**

Course Objectives	• To accustom students with basic concepts of toxicology • To make students understand mechanism of action and metabolism of toxicants • To study biotransformation of toxicants	
Course Outcomes	After successful completion of this course, students are expected to: • Understand basic concepts of toxicants, toxicity and dose-response relationship • Comprehend metabolism and mode of action of toxicants • Understand biotransformation and bioaccumulation of toxicants	
Unit	**Contents**	**Hours**
Unit I	**Basic Concepts of Toxicology** • Toxicology: Definition, history, scope, basic divisions and goals of toxicology • Toxicants and toxicity: o Definition and concept o Factors that influence toxicity o Toxicity of chemical mixtures • Dose: o Definition o Selection of dose o Effect and response of dose • Dose-response relationship: ▪ Graded/quantitative response ▪ Quantal/quantum response • Statistical concept of toxicity: o Concentration-response relationship/ Threshold limits o Criteria for effects and LD_{50}	**07**
Unit II	**Absorption, Translocation and Excretion of Xenobiotics** • Membrane permeability and mechanism of chemical transfer • Absorption of Xenobiotics: o Gastro-intestinal tract o Skin, Lungs o Parenteral administration • Translocation of Xenobiotics: o Membrane Barriers o Binding of xenobiotics to plasma proteins o Storage depots: Body fats, brain tissue, erythrocytes and other storage depots • Excretion of Xenobiotics: o Renal excretion o Biliary excretion o Gastro-intestinal tract o Expired air o Sweat, Saliva o Milk, Vaginal secretion	**08**
Unit III	**Mode of Action of Toxicants** • Effect of toxicants on structural proteins, enzymes, carriers, coenzymes, nucleic acids and lipids	**08**

	• Receptor Concept:
	  o Definition, location and chemical nature
	  o Categories of receptors
	  o Mechanism of action of receptors
	  o Factors affecting functions of receptors
	  o Concept of agonism and antagonism
	  o Role of receptors in toxicology
	• Mechanism of action of commonly used toxicants:
	  o Metals
	  o Pesticides
	  o Environmental carcinogens
	  o Teratogens
	  o Ionizing and non-ionizing radiations	

Unit IV	**Biotransformation of Toxicants**
	• Biotransformation: Definition, sites, principle, objectives
	• Mechanism of biotransformation
	• Phase I reactions:
	  o Oxidation
	  o Reduction
	  o Hydrolysis
	• Phase II reactions: conjugation reactions
	• Factors affecting biotransformation
	• Biotransformation of DDT
	• Bioactivation
	• Antidotes/antagonists:
	  o Definition and classification
	  o Mechanism of antidotal therapy
	  o Antidotal procedures
		07

Study Resources	• Klaassen C. D. (2008), Casarett and Doull's Toxicology- The Basic Science of Poisons, 7th edition, The McGraw Hill Companies Inc. • Hayes A. W. and Kruger C. L. (2014) Hayes' Principles and Methods of Toxicology, 6th edition, CRC Press. • Harbison R. D. (1998) Hamilton and Hardy's Industrial Toxicology, 5th edition, Mosby. • Ung-Mu Lee, Sam Kacew, HyungSik Kim (2017) Lu's Basic Toxicology: Fundamentals, Target Organs, and Risk Assessment, 7th edition, CRC Press. • Lipmann M. (2009), Environmental toxicants – Human Exposure and Their Health Effects, 3rd edition, Wiley Interscience. • Duffus J. H. and Worth H. (1996) Fundamental Toxicology for Chemists, Royal Society of Chemistry. • Pandey K., Shukla J. P., Trivedi S. P. (2005) Fundamentals of Toxicology, New Central Book Agency, Kolkata • Subramanian M. A. (2010), Toxicology, Principles and Methods, 2nd revised edition, MJP Publisher, Chennai. • Sharma P. D. (2003), Toxicology, 2nd edition, Rastogi Publication, Meerut.	

T.Y. B.Sc. Biochemistry (Major)
Semester-VI
BIC-DSC-362: Animal and Plant Tissue Culture

Total Hours: 30 **Credits: 2**

Course Objectives	• To accustom students with animal tissue culture technique • To accustom students with plant tissue culture technique • To make student competent in plant and animal tissue culture sector	
Course Outcomes	After successful completion of this course, students are expected to: • Culture animal and plant cells • Understand the construction of ATC and PTC lab and maintainance of cell lines • Explore applications of ATC and PTC	
Unit	**Contents**	**Hours**
Unit I	**Introduction to animal tissue culture** • Introduction and historical background • Terminologies in cell culture o Organ culture, cell culture, histotypic culture, organotypic culture, primary culture and cell line • Laboratory design and required facilities • Sterlization methods- Dry heat, moist heat, filters, sterile filteration • Advantages and limitations of animal tissue culture • Applications of animal cell culture • Types of culture media for animal cells; o Natural media and artificial media o Physiochemical properties- CO_2 and bicarbonates; Buffering; Oxygen; Osmolarity; Temperature	**07**
Unit II	**Primary cell culture and cell lines** • Primary cell culture o Techniques for primary culture, Mechanical disaggregation, Enzymatic disaggregation (Trypsin and collagenase), Primary explants. • Separation of viable and non viable cells. • Cell lines o Finite cell lines, Continuous cell lines, Nomenclature of cell lines, Selection of cell lines, Maintenance of cell lines • Subculture o Monolayer and suspension culture	**08**
Unit III	**Introduction to plant tissue culture** • Introduction to Plant Tissue Culture o Defination, History, Scope, Terms used in Plant tissue culture • Organization of Tissue culture laboratory o Facilities, Equipments and Basic Techinques. • Culture media: o Synthetic and Natural, Murashige and Skoog, Gamborg's B5, White's Medium,Nitsch and NitschMedium o Basic constituents of PTC medium • Types of cultures o Callus culture, Organ culture, Suspension culture, Protoplast culture. • Applications of Plant tissue culture	**07**

Unit IV	**Micropropagation and Agrobacterium mediated gene transfer**
	• Micropropagation:
	  o Definition and Technique, Multiplication by axillary buds and apical shoots- meristem, shoot tip cultures and bud cultures
	• Organogenesis-direct and indirect
	• Somatic embryogenesis-direct and indirect, Artificial seeds
	• Embryo culture and Embryo rescue
	• Agrobacterium mediated gene transfer
	  o Organisation of Ti plasmid, T-DNA transfer and integration, Ti plasmid derived vector systems, Plant transformation techniques using Agrobacterium, Advantages and limitation of Agrobacterium mediated gene transfer
		08

Study Resources	• Culture of Animal Cells(2005) 5th Edition, FreshneyWiley-Liss, • Animal Cell Culture - Practical Approach (2000), 3rd Edition, Ed. John R.W. Masters Oxford University Press Animal Cell Culture Techniques. (1998). Ed. Martin ClynesSpringer • Gupta P. K. (2005), Elements of Biotechnology, Rastogi Publication Meerut. • Ignacimuthu S. (1997), Applied plant biotechnology, Science Publishers, U.S. • Ramavat K. G. (2008), Plant biotechnology, S. Chand and Co., New Delhi. • Satyanarayana U. (2008), Biotechnology, Books and Allied (P) Ltd, Kolkata. • Chawla H.S. (2009), Introduction to Plant Biotechnology, 3rd edition, CRC press. • Jogdand S.N. (2012), Advances in Biotechnology, Himalaya Publishing House, Mumbai.	

T.Y. B.Sc. Biochemistry (Major)
Semester-VI
BIC-DSC-363: Metabolism

Total Hours: 30 **Credits: 2**

Course Objectives	• To accustom students with basics of metabolism • To comprehend catabolism and anabolism of various metabolites • To aware students about regulation of metabolic reactions	
Course Outcomes	After successful completion of this course, students are expected to: • Acquire the knowledge of various catabolic and anabolic reactions related to carbohydrate and amino acids • Comprehendlipid and nucleotide metabolic reactions • Understand importance of metabolism in living things	
Unit	**Contents**	**Hours**
Unit I	**Carbohydrate metabolism** • Glycolysis: steps; balance sheet; bioenergetics; fate of pyruvate • Tricarboxylic acid cycle: oxidation of pyruvate to acetyl Co-A; steps of TCA cycle; balance sheet; bioenergetics • Glyoxylate cycle • HMP pathway: functions of HMP pathway; steps • Glycogenolysis: steps of conversion of glycogen to glucose under the influence of epinephrine and glucagon • Gluconeogenesis: from pyruvate and amino acids • Glycogen biosynthesis	**08**
Unit II	**Amino acids metabolism** • Proteolysis: digestion of proteins; enzymes involved in digestion of protein • Transamination: Transamination of L-aspartate, L-alanine, L-leucine, and L-tyrosine; mechanism of the reaction • Oxidative deamination: general reaction; oxidative deamination of glutamate • Transmethylation: mechanism of transmethylation involving methionine as methyl group donor • Decarboxylation: general reaction; decarboxylation of histidine, tryptophan and arginine • Nitrogen excretory products: o Synthetic pathway o Glutamine pathway o Direction excretion o Creatine and Creatinine o Urea cycle	**07**
Unit III	**Lipid metabolism** • Activation of fatty acids and transportation into mitochondria • β-oxidation of saturated even carbon fatty acids: steps, balance sheet, bioenergetics • β-oxidation of saturated odd carbon fatty acids: steps, fate of propionyl Co-A • β-oxidation of unsaturated fatty acids: fatty acids having one and two double bonds • Biosynthesis of fatty acids: formation of malonyl Co-A; enzymes and	**07**

	functions of fatty acid synthetase complex; steps of fatty acid biosynthesis • Elongation of saturated fatty acid and desaturation of fatty acids	
Unit IV	**Nucleotides metabolism** • Biosynthesis of purine ribonucleotides: steps of AMP and GMP biosynthesis • Regulation of purine nucleotide biosynthesis • Biosynthesis of pyrimidine ribonucleotide: steps of UMP and CMP biosynthesis • Regulation of pyrimidine biosynthesis • Biosynthesis of Deoxyribonucleotides: conversion of ribose sugar to 2'deoxyribose sugar • Formation of deoxythymidylic acid: steps • Regulation of deoxyribonucleotide biosynthesis • Degradation of purines • Salvage of purines • Purine nucleotide cycle • Pyrimidine degradation	**08**
Study Resources	• Nelson D. L., Cox M. M. (2013), Lehninger Principles of Biochemistry, 6th edition, W. H. Freeman and Company, New York. • Berg J. M., Tymoczko J. L., Gatto Jr. G. J., Stryer L.(2015), Biochemistry, 8th edition, W. H. Freeman and Company, New York. • Satynarayan U., Chakrapani U. (2017), Textbook of Biochemistry, 5thedition, Elsevier, India. • Talwar G. P. (2002), Textbook of Human Biochemistry, 3rd edition, Prentice Hall India Learning Pvt. Ltd. • Agarwal G. R., Agarwal K., Agarwal O. P. (2014), Textbook of Biochemistry, Goel Publishing House, Meerut • Powar C. B. (2010), Cell Biology, Himalaya Publishing House, Mumbai • Powar C. B., Chatwal G. R. (2011), Biochemistry, Himalaya Publishing House, Mumbai	

T.Y. B.Sc. Biochemistry (Major)
Semester-V
BIC-DSC-364: Clinical Biochemistry

Total Hours: 30 **Credits: 2**

Course Objectives	• To accustom students with Biochemistry of various diseases • To attune students with inborn errors of metabolism • To generate awareness about clinical significance of marker enzymes	
Course Outcomes	After successful completion of this course, students are expected to: • Learn various disorders related to carbohydrate metabolism • Study different hemoglobinopathies • Understand clinical importance of various enzymes and isoenzymes • Learn concept of inborn errors of metabolism	
Unit	**Contents**	**Hours**
Unit I	**Disorders related to Carbohydrate metabolism** • Regulation of blood glucose level o Supply of glucose to the blood and removal glucose from blood o Post absorptive state o Postprandial state o Fundamental regulatory mechanism o Hormonal influence on carbohydrate metabolism • Blood sugar level and its clinical significance o Normal values of blood glucose level o Causes of hyperglycemia and hypoglycaemia • Glycosuria: mechanism, types-hyperglycemic glycosuria and renal glycosuria and their subtypes • Diabetes Mellitus: Definition, stages of diabetes mellitus, clinical types and causes, metabolic changes and complications, effect of insulin on carbohydrate, lipid and protein metabolism	**08**
Unit II	**Hemoglobinopathies** • Structure and functions of hemoglobin • Abnormal hemoglobins: types based on mutation in structural gene and mutation in regulator gene o Sickle cell anaemia o Methemoglobinemia-Hb-M, Hb-Sabine o High O_2-affinity hemoglobins-Hb-Chesapeake, Hb-Rainier o Hemoglobin interfere in mRNA formation-Hb-Constant spring o Thalassemia	**07**
Unit III	**Enzymes and isoenzymes of clinical importance** • General consideration • Serum enzymes in heart diseases • Serum enzymes in liver diseases • Serum enzymes in GI tract diseases • Serum enzymes in muscle diseases • Serum enzymes in bone diseases • Isoenzymes: definition, clinical significance of LDH and CPK isoenzymes	**07**
Unit IV	**Inborn Errors of Metabolism** • Carbohydrate metabolism disorders o Lactose intolerance o Glycogen storage disease	**08**

	○ Galactosemia • Protein metabolism disorders ○ Phenylketonuria ○ Alkaptonuria ○ Albinism ○ Maple syrup urine disease • Lipids metabolism disorders ○ Gaucher's disease ○ Nieman Pick's disease ○ Tay Sachs disease • Nucleic acid metabolism disorders ○ Lesch Nyhan syndrome ○ Gout	
Study Resources	• Chatterjee M. N., Shinde R. (2012) Textbook of Medical Biochemistry, 8th edition, Jaypee Brothers Medical Publishers (P) Ltd, New Delhi • Dua A., Mahajan R. (2018) Clinical Biochemistry, JnandaPrakashan, Delhi • Satynarayana U., Chakrapani U. (2017) Textbook of Biochemistry, 5thedition, Elsevier, India. • Hall J. E. (2019), Guyton and Hall Textbook of Medical Physiology, 2nd South Asia edition, Elsevier, India. • Sanyal S., Bhattacharyya A. (2012), Clinical Pathology-A Practical Manual, 3rd edition, Elsevier, India. • Murray R., Bender D., Botham K. (2012), Harper's Illustrated Biochemistry, 29th edition, McGraw Hill Education. • Talwar G. P. (2002), Textbook of Human Biochemistry, 3rd edition, Prentice Hall India Learning Pvt. Ltd. • Chatterjee C. C. (2018), Human Physiology Vol I and II, 12th edition, CBS.	

Semester-VI
BIC-DSC-365:Ayruved: Ancient Indian Medicinal System

Total Hours: 30 **Credits: 2**

Course Objectives	• To indtroduce students to great Ancient Indian Medicinal System : Ayruved • To make students aware about ayurvedic diagnosis of some common diseases • To make students aware about ayurvedic treatment of some common diseases	
Course Outcomes	After successful completion of this course, students are expected to: • Recognize the importance of Ayurved in medical field • Understand base of Ayurvedic treatment • Explore home remedies for common diseases	
Unit	**Contents**	**Hours**

Unit I	**Ayurveda- Traditional medicinal system**
	• Ayurveda: Definition, Scope, History and origin
	• Father of Indian ancient medicine
	  o Charaka: Biography and contribution.
	• Father of Indian ancient surgery:
	  o Sushruta: Biography and contribution.
	• PanchaMahabhutas : Akasha, Vayu, Agni, Ap (Jal), Prithvi
	• Saptadhatu: Rasa, Rakta, Mansa, Meda, Asthi, Majja, Shukra
	• Tridosha:Vata, Kapha, and Pitta and their subtypes
	• Rasayana: Definition, types (KamyaRasayanas and NaimittikaRasayanas), formulations.
		08

Unit II	**Ajirna(Indigestion) and Amlapita(Hyperacidity)**
	Ajirna (Indigestion)
	• Definition, clinical description
	• History and epidemiology
	• Etiology
	• Pathogenesis and pathology
	• Clinical diagnosis
	• Classification of indigestion
	• Clinical course and prognosis
	• Management: Ayurvedic therapy and management, clinical experiences
	• Life style changes
	Amlapita (Hyperacidity)
	• Definition, clinical description
	• History and epidemiology
	• Etiology
	• Pathogenesis and pathology
	• Clinical diagnosis
	• Classification
	• Clinical features of GERD
	• Therapy
	  o Lifestyle changes
	  o Home remedies for hyperacidity
		07

Unit III	**Medoroga (Obesity) and Madhumeha (Diabetes Mellitus)** **Medoroga (Obesity)**	**08**

	• Definition, Agni and srotas, Adipose tissue • Measurement of obesity • Features of obseisty • Symptoms and signs • Obesity and affect disorders • Body mass index • Prevention of obesity • Management of obesity **Madhumeha (Diabetes Mellitus)** • Introduction • Clinical description • Pathogenesis • Clinical course and prognosis • Clinical examination and diagnosis • Therapy	
Unit IV	**Shvasa (Bronchial Asthma) and Kaphaja Disease (Allergry)** **Shvasa (Bronchial Asthma)** • Definition • Etiology • Pathology and Pathogenesis • Clinical Features • Clinical Course and Prognosis • Management • Ayurvedic Approach o Precautions o Diet o Lifestyle o Breathing o Meditation **Kaphaja Disease (Allergry)** • Definition and clinical description • Etiology • Pathogenesis • Diagnosis and prognosis • Therapy	**07**
Study Resources	▪ Scientific Basis for Ayurvedic Therapies, CRC PRESS ▪ Indication of vedic plants available in the present era, International Journal of Ayurveda and Pharma Research ▪ Sherwin, R.S., Diabetes mellitus, in Cecil Textbook of Medicine, Goldman, L. and Bennett, J.C.,Eds., W.B. Saunders, New York, 2000. ▪ Swoboda, R.E. (translator), Prakriti: Your Ayurvedic Constitution, 1st ed., MotilalBanarasidas, New Delhi, 1994. ▪ deShazo, R.D., Allergic rhinitis, in Cecil Text Book of Medicine, Goldman, L. and Bennett, J.C., Eds., W.B. Saunders, Philadelphia, 2000.	

Semester-VI
BIC-DSC-366: Practical on Toxicology

Total Hours: 60 **Credits: 2**

Course Objectives	• To acquaintstudents with various toxicological methods • To make students understand effect of various factors on toxicity • To make students able to determine various toxins	
Course Outcomes	After successful completion of this course, students are expected to: • Determine LC_{50} value of pollutants • Determinethe effect of temperature and pH on toxicity of pollutant • Determine various insecticides	
Sr. No.	**Contents**	**Hours**
1	Determination of LC_{50} value of a pollutant by using suitable test animal	**4**
2	Determination of the effect of temperature on the toxicity of a pollutant	**4**
3	Determination of the effect of pH on the toxicity of a pollutant	**4**
4	Qualitative evaluation of pesticide residues in vegetable samples	**4**
5	Qualitative evaluation of pesticide residues in fruit samples	**4**
6	Qualitative evaluation of pesticide residues in food samples	**4**
7	Determination of combined toxicity of pollutants on suitable organism	**4**
8	Biodegradation of dyes	**4**
9	Evaluation of toxicity of Biodegraded dyes	**4**
10	Determination of Organophosphates insecticeds by using iodine fumigated paperstrips	**4**
11	Determination of Organophosphates insecticeds by using silver nitrate and sodium hydroxide treated paper strips	**4**
12	Determination of Organophosphates insecticeds by methyl red treated paper strip	**4**
13	Determination of Organophosphates insecticeds by sodium carbonate and methonalic ferric chloride treated paper strip	**4**
14	Determination of dimetholate by using silver nitrate and sodium hydroxide treated paper strips	**4**
15	Determination of phosphamidon and quinolphos by using silver nitrate and sodium hydroxide treated paper strips	**4**
Study Resources	• Subramanian M. A. (2010), Toxicology, Principles and Methods, 2nd revised edition, MJP Publisher, Chennai. • S Easwari and R Jayakumar, Detection of pesticide residues in vegetables by using rapid test KIT. International Journal of Chemical Studies 2017; 5(5): 2274-2277. • Gilden RC, Huffling K, Sattler B. Pesticides and Health Risks. J. Obstet. Gynecol. Neonatal. Nurs. 2010; 39:103- 110. • Katrolia SP, Methotra RK, Ramanujam S. Thin layer chromatography of pesticides and their residues. Def. Sci. J., 1973; 24:113-119.	

***Mandatory to perform any 12 practical from above.**

T.Y. B.Sc. Biochemistry (Major)

Semester-VI
BIC-DSC-367:Practical on Clinical Biochemistry

Total Hours: 60 **Credits: 2**

Course Objectives	• To accustom students with various pathological tests • To generate awareness about clinical significance of the tests • To develop skill full hand on pathological tests	
Course Outcomes	After successful completion of this course, students are expected to: • Estimate various clinically important components and understand their clinical significance • Estimate various clinically important enzymes and understand their clinical significance • Correlate results obtained clinically	
Sr. No.	**Contents**	**Hours**
1	Estimation of blood glucose by suitable method	**4**
2	Estimation of reducing sugar in urine	**4**
3	Estimation of haemoglobin by using haematometer and its significance	**4**
4	Estimation of serum bilirubin.	**4**
5	Estimation of SGOT by 2, 4 DNPH method	**4**
6	Estimation of SGPT by 2, 4 DNPH method	**4**
7	Estimation of serum alkaline phosphatase by colorimetric method	**4**
8	Estimationof serum acid phosphatase by colorimetric method	**4**
9	Estimation of serum cholesterol by colorimetric method	**4**
10	Estimation of serum uric acid from the given sample	**4**
11	Estimation of serum urea from the given sample	**4**
12	Estimation of serum creatinine from the given sample	**4**
13	Detection of abnormal constituents of urine: Sugar, protein, ketone bodies and bile pigments	**4**
14	Estimation of proteins by Biuret method	**4**
15	Estimation of serum calcium from given sample	**4**
Study Resources	• Sharma S., Sharma R. (2016), Practical manual of Biochemistry, Scientific International Publisher and Distributor, New Delhi. • Maheshwari N. (2008), Clinical Biochemistry, Jaypee Brothers, Medical Publishers. • Godkar P. B., Godkar D. P., Textbook of medical laboratory technology, 2nd edition, Bhalani Publishing House, Mumbai • Sadasivam S., Manickam A. (2018), Biochemical Methods, 3rd edition, New Age International Pvt. Ltd. • Sawhney S. K., Singh R. (2001), Introductory Practical Biochemistry, Narosa Publishing House, New Delhi	

***Mandatory to perform any 12 practical from above.**

Semester-VI
BIC-DSE-361A: Genetic Engineering

Total Hours: 30 **Credits: 2**

Course Objectives	• To introduce students to the genetic engineering field • To make students aware about various genetic engineering techniques • To appraise students about applications of genetic engineering.	
Course Outcomes	After successful completion of this course, students are expected to: • Learn role of enzymes and vectors involved in gene transfer. • Explain various gene transfer methods. • Understand gene library preparation. • Understand the basic principles of DNA sequencing and PCR.	
Unit	**Contents**	**Hours**
Unit I	**Introduction to Genetic Engineering** • Concepts of Genetic engineering • Enzymes involved in genetic engineering- restriction endonucleases, DNA ligases, Alkaline phosphatases, DNA modifying enzymes • Prokaryotic and eukaryotic cells as hosts	**07**
Unit II	**Vectors and methods of gene transfer** • Vectors- Plasmids, Bacteriophages, Cosmids, Artificial chromosome vectors, Shuttle vectors • Construction of rDNA- palindromes and staggered cleavage adding poly dA and poly dT tails, blunt end ligation • Methods of gene transfer- transformation, conjugation, Electroporation, Liposome mediated gene transfer, transduction, direct transfer of DNA, particle bombardment, microinjection, polyethylene glycol mediated gene transfer	**08**
Unit III	**Gene Libraries** • Concept of gene libraries • Creation of human gene library, Use of long chain PCR for gene library construction • cDNA libraries- cDNA synthesis, construction of cDNA libraries, RT-PCR for cDNA libraries • Screening Strategies- screening by DNA hybridization, DNA probes, colony hybridization, PCR, immunological assay, protein function	**07**

Unit IV	**Techniques in Genetic Engineering**
	• DNA Sequencing: Technique, applications, limitations of
	  o Maxam Gilbert technique
	  o Sanger's Dideoxynucleotide method
	  o Pyrosequencing
	• DNA chip
	• Polymerase Chain Reaction: principle, technique, applications of PCR in various fields
	• Blotting Techniques: Southern, Northern and Western blotting.
	• Introduction to genome editing
	• Regulatory framework for GE in India
		08

Study Resources	• Berg J. M., Tymoczko J. L., Gatto Jr. G. J., Stryer L. (2015), Biochemistry, 8th edition, W. H. Freeman and Company, New York. • Krebs J. E., Goldstein E. S., Kilpatrick S. T. (2018), Lewin's Genes XII, Jones and Barlett Learning. • Gardner M., Simmons J., Snustad D. P. (2006), Principle of Genetics, 8th edition, John Willey and Sons. • Strickberger M.W. (2015), Genetics, 3rd edition, Pearson, India. • Gupta P.K. (2009), Genetics, Rastogi publication, Meerut. • Satyanarayana U. (2008), Biotechnology, Books and Allied (P) Ltd, Kolkata. • Agarwal G. R., Agarwal K., Agarwal O. P. (2014), Textbook of Biochemistry, Goel Publishing House, Meerut • Powar C.B. (2010), Cell Biology, Himalaya Publishing House, Mumbai • Powar C.B. (2007), Genetics Vol. I, Himalaya Publishing House, Mumbai • Powar C.B. (2009), Genetics Vol. II, Himalaya Publishing House, Mumbai	

T.Y. B.Sc. Biochemistry (Elective)
Semester-VI
BIC-DSE-361B: Enzyme Sciences and Technology
(NPTEL course code: noc25-bt19)

Total Hours: 30 **Credits: 2**

Course Objectives	• To accustom students with basics of enzymology • To attune students with mechanism of enzyme action • To understand applications enzyme in various fields	
Course Outcomes	After successful completion of this course, students are expected to: • Understand classification and specificity of enzymes • Discuss mechanism of enzyme action and enzyme kinetics • Explain activation and deactivation of regulatory enzymes • Explore various industrial applications of enzymes	
Unit	**Contents**	**Hours**
Unit I	• **Introduction to Enzymes** o Introduction to Enzymes o Basics of Enzyme o Enzyme Classification (Part-I) o Enzyme Classification (Part-II) o Enzyme Nomenclature • **Structure of enzyme** o Enzyme Structure (Part 1) o Enzyme Structure (Part 2) o Enzyme Structure (Part 3) • **Enzyme Production (Part 1)** o Cloning of Enzyme (Part 1) o Cloning of Enzyme (Part 2) o Over-expression in Host	**08**
Unit II	• **Enzyme Production (Part 2)** o Extraction of enzyme o Purification Strategies (Part 1) o Purification Strategies (Part 2) • **Enzyme Production (Part 3)** o Purification Strategies (Part 3) o Purification Strategies (Part 4) o Enzyme Characterization Approaches • **Enzyme catalyzed Biochemical reactions** o Enzyme Catalyzed reactions (Part 1: Carbohydrate Metabolism) o Enzyme Catalyzed reactions (Part 2: Lipid and Protein Metabolism) o Enzyme Catalyzed reactions (Part 3: Detoxification)	**08**
Unit III	• **Enzyme-Substrate interaction** o Enzyme-Substrate interaction (Part 1: Spectroscopic approaches) o Enzyme-Substrate interaction (Part 2: Isothermal Calorimetry) o Enzyme-Substrate interaction (Part 3: Surface plasma resonance • **Enzyme assay system and Kinetics** o Enzyme assay system o Enzyme Kinetics (Part 1) o Enzyme Kinetics (Part 2) • **Enzyme Inhibitor Designing** o Inhibitor designing (Part 1: Traditional approach)	**07**

	○ Inhibitor designing (Part 2: Modern approach) ○ Inhibitor designing (Part 3: Computational approaches)	
Unit IV	• **Enzyme Inhibition kinetics** ○ Enzyme Inhibition kinetics (Part 1) ○ Enzyme Inhibition kinetics (Part 2) ○ Enzyme Inhibition kinetics (Part 3) • **Enzyme Applications (Part 1)** ○ Enzymes in Industrial setup (Part 1) ○ Enzymes in Industrial setup (Part 2) ○ Enzymes in catalyzing chemical reactions • **Enzyme Applications (Part 2)** ○ Enzymes in medical field ○ Enzymes in environment field ○ Enzymes in drug discovery	**07**
Study Resources	• https://nptel.ac.in/courses/102103097 • Nelson D. L., Cox M. M. (2013), Lehninger Principles of Biochemistry, 6th edition, W. H. Freeman and Company, New York. • Berg J. M., Tymoczko J. L., Gatto Jr. G. J., Stryer L.(2015), Biochemistry, 8th edition, W. H. Freeman and Company, New York. • Satynarayana U., Chakrapani U. (2017), Textbook of Biochemistry, 5th edition, Elsevier, India. • Talwar G. P. (2002), Textbook of Human Biochemistry, 3rd edition, Prentice Hall India Learning Pvt. Ltd. • Agarwal G. R., Agarwal K., Agarwal O. P. (2014), Textbook of Biochemistry, Goel Publishing House, Meerut • Powar C. B. (2010), Cell Biology, Himalaya Publishing House, Mumbai • Powar C. B., Chatwal G. R. (2011), Biochemistry, Himalaya Publishing House, Mumbai	

T.Y. B.Sc. Biochemistry (Elective)
Semester-VI
BIC-DSE-362A:Practical on Genetics and Tissue Culture Techniques

Total Hours: 60 **Credits: 2**

Course Objectives	• To accustom students with Techniques in Genetic engineering • To make students competent in PTC techniques • To introduce students to the animal cell culturing	
Course Outcomes	After successful completion of this course, students are expected to: • Perform skillfully various plant tissue culture techniques • Separate DNA fragments by agarose gel electrophoresis • Perform restriction digestion and PCR • Culture animal cells successfully	
Sr. No.	**Contents**	**Hours**
1	DNA digestion using restriction endonucleases	**4**
2	Amplification of DNA fragment using PCR	**4**
3	Separation of fragments produced by PCR and restriction digestion by agarose gel electrophoresis	**4**
4	Transfer of plasmid by bacterial conjugation	**4**
5	Isolation of cells from suiatable animal tissue	**4**
6	Primary culturing of suitable animal cells	**4**
7	Quantification of cell viability and cell counting	**4**
8	Preparation of MS media for PTC	**4**
9	Development of seedling by aseptic germination of available seed	**4**
10	Initiation of shoots by shoot tip culture method	**4**
11	Multiplication of shoots by shoot tips	**4**
12	Elongation and rooting of multiplied shoots	**4**
13	Development of callus from suitable tissue	**4**
14	Development of somatic embryo from suitable tissue	**4**
15	Isolation of protoplast	**4**
Study Resources	• Sadasivam S., Manickam A. (2018), Biochemical Methods, 3rd edition, New Age International Pvt. Ltd. • Aneja K. R. (2003), Experiments in Microbiology, Plant Pathology and Biotechnology, New Age International Pvt. Ltd. • Sawhney S. K., Singh R. (2001), Introductory Practical Biochemistry, Narosa Publishing House, New Delhi • Rao B. S., Deshpande V. (2005), Experimental Biochemistry A student companion, I.K. International Pvt. Ltd., Mumbai • Jayaraman J. (1996), Laboratory manual in Biochemistry, Wiley Eastern Ltd.	

***Mandatory to perform any 12 practical from above.**

T.Y. B.Sc. Biochemistry (Elective)
Semester-VI
BIC-DSC-362B: Practical on Enzyme Science and Technology

Total Hours: 60 **Credits: 2**

Course Objectives	• To study enzyme kinetics practically • To understand importance and applications of immobilization techniques • To isolate enzyme by various methods	
Course Outcomes	After successful completion of this course, students are expected to: • Understand effect of various factors on enzyme activity • Calculate K_m and V_{max} • Immobilize enzymes/cells and explore its applications • Isolate enzymes by methods like salt/solvent precipitation	
Sr. No.	**Contents**	**Hours**
1	Estimation of maltose by DNSA method	**4**
2	Determination of amylase activity	**4**
3	Estimation specific activity of amylase	**4**
4	Determination of the effect of amylase concentration on the rate of reaction	**4**
5	Determination of the effect of substrate concentration on the activity of amylase	**4**
6	Determination of K_m and V_{max} of the reaction catalysed by amylase using M-M plot	**4**
7	Determinationof K_m and V_{max} of the reaction catalysed by amylase by using L-B plot	**4**
8	Determination ofeffect of suitable inhibitor on α-amylase activity	**4**
9	Determination ofeffect of pH on activity of amylase	**4**
10	Determination ofeffect of temperature on activity of amylase	**4**
11	Immobilization of suitable enzyme / yeast cells	**4**
12	Isolation of amylase by salt precipitation method	**4**
13	Isolation of enzyme by solvent precipitation method	**4**
14	Partial purification of salt precipitated amylase by dialysis	**4**
15	Qualitative determination amylase activity in precipitated sample	**4**
Study Resources	• Sadasivam S., Manikam A. (2018), Biochemical Methods, 3rd edition, New Age International Pvt. Ltd. • Aneja K. R. (2003), Experiments in Microbiology, Plant Pathology and Biotechnology, New Age International Pvt. Ltd. • Sawhney S.K., Singh R. (2001), Introductory Practical Biochemistry, Narosa Publishing House, New Delhi • Plummer D. (2017), An Introduction to Practical Biochemistry, Indian Edition, McGraw Hill Education. • Jayaraman J. (1996), Laboratory manual in Biochemistry, Wiley Eastern Ltd. • Aneja K. R. (2003), Experiments in Microbiology, Plant Pathology and Biotechnology, New Age International Pvt. Ltd.	

***Mandatory to perform any 12 practical from above.**

T.Y. B.Sc. Biochemistry (Vocational)
Semester-VI
BIC-VSC-361: Analytical Techniques

Total Hours: 30 **Credits: 2**

Course Objectives	• To accustom students with basics of various analytical techniques • To familiarize students with working principles of various analytical instruments • To explore applications of analytical techniques	
Course Outcomes	After successful completion of this course, students are expected to: • Understand concept, principle, and applications of various spectrophotometry • Understand principles and applications of various chromatography and electrophoretic techniques • Understand concept of centrifugation and radioactivity and its applications	
Unit	**Contents**	**Hours**
Unit I	**Spectrophotometry** • Concept of electromagnetic radiations, electromagnetic spectrum • Laws of absorption- Lambert and Beer Law • Chromophore concept-auxochrome, various chromic shifts • Instrumentation for UV-Visible and infra-red spectrophotometry o Applications of UV-Vis spectrophotometry o Theory and applications of infra-red spectroscopy • Spectrofluorimetry o Fluorescence and phosphorescence o Theory and instrumentation of fluorimetry o Advantages, disadvantages and applications • Flame spectrophotometry-concept o Instrumentation for emission flame photometry and atomic absorption spectrophotometry o Applications of both	**07**
Unit II	**Chromatography** • Concept of distribution coefficient • Modes of chromatography • Classification of chromatography • Principle and applications of- o Paper chromatography o Thin layer chromatography o Gel filtration chromatography o Ion exchange chromatography o Affinity chromatography o Gas liquid chromatography o Liquid-liquid chromatography	**08**
Unit III	**Electrophoresis** • Principle of electrophoresis • Migration of an ion in an electric field • Factors affecting electrophoretic mobility • Principle and applications of- o Paper electrophoresis o Agarose gel electrophoresis o Polyacrylamide gel electrophoresis o SDS-Polyacrylamide gel electrophoresis o Isoelectric focussing	**08**

	○ Capillary electrophoresis ○ Immunoelectrophoresis	
Unit IV	**Centrifugation and Radioactivity** • Basic principles of centrifugation • Instrumentation for centrifugation: low speed, high speed and ultra centrifuges • Applications of centrifugation: preparative techniques, analytical measurements • Radioactivity: introduction, isotopes in Biochemistry, units of radioactivity • Detection and measurement of radioactivity: Liquid Scintillation Counting, Geiger Muller Counting • Applications of radioisotopes • Radioisotopes and safety	**07**
Study Resources	• Frifielder D. (1983), Physical biochemistry, W. H. Freeman and Co. New York. • Holmes D. J., Peck H. (1983), Analytical biochemistry, academic press, New York. • Upadhyay A., Upadhyay K., Nath N. (2016), Biophysical chemistry: Principle and technique, Himalaya Pub. Nagpur. • Wilson K,. Walker J. (2010), Principles and techniques of Biochemistry and Molecular Biology, 7th edition, Cambridge University press, UK • Satyanarayana U. (2008), Biotechnology, Books and Allied (P) Ltd, Kolkata. • Powar C.B., Chatwal G.R. (2011), Biochemistry, Himalaya Publishing House, Mumbai • Boyer R. (2002), Modern Experimental Biochemistry, 3rd edition, Pearson Education, Inc. • Roy R.N. (2001), A Textbook of Biophysics, New Central Book agency (P) Ltd.	

T.Y. B.Sc. Biochemistry (Vocational)
Semester-VI
BIC-VSC-362: Practical on Analytical Techniques

Total Hours: 60 **Credits: 2**

Course Objectives	• To accustom students with various analytical techniques • To study principle and working of analytical instruments • To make students competent in separation techniques	
Course Outcomes	After successful completion of this course, students are expected to: • Understand and explain working and principle of UV-visible spectroscopy and centrifuge • Understand and explain working and principle of chromatography and electrophoresis • Separate components using centrifugation, chromatography and electrophoretic techniques	
Sr. No.	**Contents**	**Hours**
1	Principle and working of UV-Visible spectrophotometer	**4**
2	Verification of Beers-Lamberts law	**4**
3	Estmation of λmax of a given chromophore	**4**
4	Determination of crude protein by Micro-Kjeldahl's method	**4**
5	Principle and working of centrifuge	**4**
6	Separation of serum/plasma from whole blood sample using centrifugation	**4**
7	Separation of plant pigments by gel filteration	**4**
8	Separation of amino acids using Paper chromatography	**4**
9	Separation of amino acids using Thin layer chromatography	**4**
10	Separation of amino acids using paper electrophoresis	**4**
11	Separation of proteins by SDS-PAGE	**4**
12	Separation of proteins by Native PAGE	**4**
13	Demonstration of HPLC	**4**
14	Demonstartion of GC	**4**
15	Demonstration of AAS	**4**
Study Resources	• Sadasivam S., Manikam A. (2018), Biochemical Methods, 3rd edition, New Age International Pvt. Ltd. • Sawhney S. K., Singh R. (2001), Introductory Practical Biochemistry, Narosa Publishing House, New Delhi • Rao B. S., Deshpande V. (2005), Experimental Biochemistry A student companion, I.K. International Pvt. Ltd., Mumbai • Plummer D. (2017), An Introduction to Practical Biochemistry, Indian Edition, McGraw Hill Education.	

***Mandatory to perform any 12 practical from above.**

Skills acquired and Job prospects for the Biochemistry students

Biochemistry is the molecular basis of life. Degree program in Biochemistry teaches students the way several 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 opportunities 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:

- Laboratory safety practices as well as aseptic techniques
- Accurate weighing and reagent preparation
- Skillful handling of basic and advanced instruments
- Calibration of basic instruments like pH meter, micropipettes etc
    - Advanced techniques like; Chromatography, Electrophoresis
    - Spectrometry, Polymerase Chain Reaction (PCR)
    - Plant Tissue Culture, Animal Tissue Culture
- Collection, organization and presentation of data
- Analysis, Logical thinking and, interpretation of results

Transferable Skills:
During the course student will develop skills other than laboratory skills that are transferable across the number of career areas which include;

- Analytical skill, Observational skill
- Planning and Time management
- Mathematical and IT skills
- Creative thinking, Problem solving
- Report writing skill, Presentation 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 (Government) 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.

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

Opportunities in higher studies
After successful completion of B.Sc. in Biochemistry, student may continue further studies like M.Sc. in Biotechnology / Biochemistry and pursue higher studies. Even students can pursue other courses where graduation is essential.

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