KURUKSHETRA UNIVERSITY KURUKSHETRA

Scheme of Examination and Syllabus for Under-Graduate Programmes – Multidisciplinary

Scheme - A

(Subject: Biochemistry)

Under Multiple Entry-Exit, Internship and CBCS-LOCF in accordance to NEP-2020w.e.f. 2023-24 (in phased manner)

DEPARTMENT OF BIOCHEMISTRY, KURUKSHETRA UNIVERSITY, KURUKSHETRA

Scheme of Examination and Syllabus for Under-Graduate Programmes – Multidisciplinary (Scheme – A)

Under Multiple Entry-Exit, Internship and CBCS-LOCF in accordance to NEP-2020 w.e.f. 2023-24 (in phased manner), Subject: Biochemistry

FIRST YEAR: SEMESTER-1

Semester	Course	Paper(s)	Nomenclature of Paper	Credits	Hours/ Week	Internal marks	External Marks	Total Marks	Exam Duration
I	CC-1/ MCC-1 4 credits	B23-BCH-101	Biomolecules	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	4 hrs.
	CC-M1 2 credits	B23-BCH-103	Molecules of Life-I	1	1				3 hrs.
			Practical	1	2	5	15	20	4 hrs.
	MDC-1 3 credits	B23-BCH-104	Biochemical Insights into the Human Body	2	2	15	35	50	3 hrs.
			Practical	1	2	5	20	25	4 hrs.
	AEC-1 2 credits	From Available AEC-1 of two credits as per NEP							
	SEC-1 3 credits	From Available SEC-1 of three credits as per NEP							
	VAC-1 2 credits	From Available VAC-1 of two credits as per NEP							

FIRST YEAR: SEMESTER-2

Semester	Course	Paper(s)	Nomenclature of Paper	Credits	Hours/ Week	Internal marks	External Marks	Total Marks	Exam Duration
II	CC-2/ MCC-3 4 credits	B23-BCH-201	Enzymology	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	4 hrs.
	CC-M2 2 credits	B23-BCH-203	Molecules of Life-II	1	1	10	20	30	3 hrs.
			Practical	1	2	5	15	20	4 hrs.
	MDC-2 3 credits	B23-BCH-204	Biochemistry& Health	2	2	15	35	50	3 hrs.
			Practical	1	2	5	20	25	4 hrs.
	AEC-2 2 credits	From Available AEC-2 of two credits as per NEP							
	SEC-2 3 credits	From Available SEC-2 of three credits as per NEP							
	VAC-2 2 credits	From Available VAC-2 of two credits as per NEP							

Internship of 4 credits of 4-6 weeks duration after 2nd Semester

DEPARTMENT OF BIOCHEMISTRY, KURUKSHETRA UNIVERSITY, KURUKSHETRA

SECOND YEAR: SEMESTER-3									
Semester	**Course**	**Paper(s)**	**Nomenclature of Paper**	**Credits**	**Hours/ Week**	**Internal marks**	**External Marks**	**Total Marks**	**Exam Duration**
III	**CC-3/ MCC-4 4 credits**	B23-BCH-301	Carbohydrate and Lipid Metabolism	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	4 hrs.
	MDC-3 3 credits	B23-BCH-303	Biochemistry of Lifestyle Diseases	2	2	15	35	50	3 hrs.
			Practical	1	2	5	20	25	4 hrs.
	CC-M3 4 credits	From Available CC-M3 of 4 credits as per NEP							
	AEC-3 2 credits	From Available AEC-3 of two credits as per NEP							
	SEC-3 3 credits	From Available SEC-3 of three credits as per NEP							

SECOND YEAR: SEMESTER-4									
Semester	**Course**	**Paper(s)**	**Nomenclature of Paper**	**Credits**	**Hours/ Week**	**Internal marks**	**External Marks**	**Total Marks**	**Exam Duration**
IV	**CC-4/ MCC-6 4 credits**	B23-BCH-401	Amino acid and Nucleotide Metabolism	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	4 hrs.
	CC-M4(V) 4 credits	From Available CC-M4(V) of 4 credits as per NEP							
	AEC-4 2 credits	From Available AEC-3 of two credits as per NEP							
	VAC-3 2 credit	From Available VAC-3 of two credits as per NEP							
Internship of 4 credits of 4-6 weeks duration after 4th Semester (if not done after second semester)									

DEPARTMENT OF BIOCHEMISTRY, KURUKSHETRA UNIVERSITY, KURUKSHETRA

THIRD YEAR: SEMESTER-5									
Semester	**Course**	**Paper(s)**	**Nomenclature of Paper**	**Credits**	**Hours/ Week**	**Internal marks**	**External Marks**	**Total Marks**	**Exam Duration**
V	**CC-5/ MCC-9 4 credits**	B23-BCH-501	Molecular Biology	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	4 hrs.
	CC-M5(V) 4 credits	From Available CC-M5(V) of 4 credits as per NEP							
	Internship 4 credits	Internship#4 credit after 4th semester							
THIRD YEAR: SEMESTER-6									
Semester	**Course**	**Paper(s)**	**Nomenclature of Paper**	**Credits**	**Hours/ Week**	**Internal marks**	**External Marks**	**Total Marks**	**Exam Duration**
VI	**CC-6/ MCC-11 4 credits**	B23-BCH-601	Immunology	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	4 hrs.
	CC-M6 4 credits	From Available CC-M6 of 4 credits as per NEP							
	CC-M7(V) 4 credits	From Available CC-M7(V) of 4 credits as per NEP							

PROGRAM LEARNING OUTCOMES (PLO)

1. Inculcate comprehensive knowledge and acquire skills in the field's biology
2. Develop experimenting skills in laboratory that enhances critical thinking skills, logical application these skills in problem solving
3. To equip students with necessary theoretical and practical skills to enable them to pursue multidisciplinary courses at Post Graduate level
4. Demonstrate the abilities to work in collaborative activities and inculcate leadership qualities
5. Identify and follow the ethical issues related to Biology, biosafety, and perform unbiased and truthful actions
6. Capability for raising relevant questions relating to basic understanding and applications biology and planning, executing and reporting the results of an experiment or investigation

KURUKSHETRA UNIVERSITY KURUKSHETRA

Scheme of Examination and Syllabus for Under-Graduate Programmes

Scheme-B

(When student opts to continue with single Major subject in second year)

(Subject: Biochemistry)

Under Multiple Entry-Exit, Internship and CBCS-LOCF in accordance to NEP-2020 w.e.f. 2023-24 (in phased manner)

DEPARTMENT OF BIOCHEMISTRY, KURUKSHETRA UNIVERSITY, KURUKSHETRA

Scheme of Examination and Syllabus for Under-Graduate Programmes – (**Scheme-B)**

(When student opts to continue with single Major subject in second year)

Under Multiple Entry-Exit, Internship and CBCS-LOCF in accordance to NEP-2020 w.e.f. 2023-24 (in phased manner), Subject: Biochemistry

FIRST YEAR: SEMESTER-1									
Semester	**Course**	**Paper(s)**	**Nomenclature of Paper**	**Credits**	**Hours/ Week**	**Internal marks**	**External Marks**	**Total Marks**	**Exam Duration**
I	**CC-1/ MCC-1 4 credits**	B23-BCH-101	Biomolecules	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	4 hrs.
	CC-M1 2 credits	B23-BCH-103	Molecules of Life-I	1	1	10	20	30	3 hrs.
			Practical	1	2	5	15	20	4 hrs.
	MDC-1 3 credits	B23-BCH-104	Biochemical Insights into the Human Body	2	2	15	35	50	3 hrs.
			Practical	1	2	5	20	25	4 hrs.
	AEC-1 2 credits	From Available AEC-1 of two credits as per NEP							
	SEC-1 3 credits	From Available SEC-1 of three credits as per NEP							
	VAC-1 2 credits	From Available VAC-1 of two credits as per NEP							
FIRST YEAR: SEMESTER-2									
Semester	**Course**	**Paper(s)**	**Nomenclature of Paper**	**Credits**	**Hours/ Week**	**Internal marks**	**External Marks**	**Total Marks**	**Exam Duration**
II	**CC-2/ MCC-3 4 credits**	B23-BCH-201	Enzymology	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	4 hrs.
	CC-M2 2 credits	B23-BCH-203	Molecules of Life-II	1	1	10	20	30	3 hrs.
			Practical	1	2	5	15	20	4 hrs.
	MDC-2 3 credits	B23-BCH-204	Biochemistry& Health	2	2	15	35	50	3 hrs.
			Practical	1	2	5	20	25	4 hrs.
	AEC-2 2 credits	From Available AEC-2 of two credits as per NEP							
	SEC-2 3 credits	From Available SEC-2 of three credits as per NEP							
	VAC-2 2 creditss	From Available VAC-2 of two credits as per NEP							
Internship of 4 credits of 4-6 weeks duration after 2nd Semester									

DEPARTMENT OF BIOCHEMISTRY, KURUKSHETRA UNIVERSITY, KURUKSHETRA

SECOND YEAR: SEMESTER-3

Semester	Course	Paper(s)	Nomenclature of Paper	Credits	Hours/ Week	Internal marks	External Marks	Total Marks	Exam Duration
III	**MCC-2 4 credits**	B23-BCH-102	Cell Biochemistry	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	4 hrs.
	CC-3/ MCC-4 4 credits	B23-BCH-301	Carbohydrate and Lipid Metabolism	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	4 hrs.
	MCC-5 4 credits	B23-BCH-302	Hormones	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	4 hrs.
	MDC-3 3 credits	B23-BCH-303	Biochemistry of Lifestyle Diseases	2	2	15	35	50	3 hrs.
			Practical	1	2	5	20	25	4 hrs.
	CC-M3 (V) 4 credits	From Available CC-M3(V) of 4 credits as per NEP							
	AEC-3 2 credits	From Available AEC-3 of two credits as per NEP							
	SEC-3 3 credits	From Available SEC-3 of three credits as per NEP							

SECOND YEAR: SEMESTER-4

Semester	Course	Paper(s)	Nomenclature of Paper	Credits	Hours/ Week	Internal marks	External Marks	Total Marks	Exam Duration
IV	**CC-4/ MCC-6 4 credits**	B23-BCH-401	Amino acid and Nucleotide Metabolism	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	4 hrs.
	MCC-7 4 credits	B23-BCH-402	Basics of Genetic Information	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	4 hrs.
	MCC-8 4 credits	B23-BCH-403	Elementary Microbial Biochemistry	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	4 hrs.
	DSE-1 4 credits Select one option	B23-BCH-404	Animal Biochemistry	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	4 hrs.
		B23-BCH-405	Plant Biochemistry	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	4 hrs.
	CC-M4(V) 4 credits	From Available CC-M4(V) of 4 credits as per NEP							
	AEC-4 2 credits	From Available AEC-3 of two credits as per NEP							
	VAC-3 2 credits	From Available VAC-3 of two credits as per NEP							

Internship of 4 credits of 4-6 weeks duration after 4th Semester (if not done after second semester)

DEPARTMENT OF BIOCHEMISTRY, KURUKSHETRA UNIVERSITY, KURUKSHETRA

THIRD YEAR: SEMESTER-5									
Semester	**Course**	**Paper(s)**	**Nomenclature of Paper**	**Credits**	**Hours/ Week**	**Internal marks**	**External Marks**	**Total Marks**	**Exam Duration**
V	**CC-5/ MCC-9 4 credits**	B23-BCH-501	Molecular Biology	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	4 hrs.
	MCC-10 4 credits	B23-BCH-502	Biochemical Techniques	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	4 hrs.
	DSE-2 4 credits Select one Option	B23-BCH-503	Clinical Biochemistry	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	4 hrs.
		B23-BCH-504	Nutritional Biochemistry	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	4 hrs.
	DSE-3 4 credits Select one Option	B23-BCH-505	Molecular Basis of Infectious Diseases	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	4 hrs.
		B23-BCH-506	Food Biochemistry	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	4 hrs.
	Internship 4 credits	Internship#4 credit after 4th semester							

THIRD YEAR: SEMESTER-6									
Semester	**Course**	**Paper(s)**	**Nomenclature of Paper**	**Credits**	**Hours/ Week**	**Internal marks**	**External Marks**	**Total Marks**	**Exam Duration**
VI	**CC-6/ MCC-11 4 credits**	B23-BCH-601	Immunology	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	4 hrs.
	MCC-12 4 credits	B23-BCH-602	Recombinant DNA Technology	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	4 hrs.
	DSE-4 4 credits Select one Option	B23-BCH-603	Molecular Basis of non-infectious Diseases	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	4 hrs.
		B23-BCH-604	Industrial Biochemistry	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	4 hrs.
	DSE-5 4 credits Select one Option	B23-BCH-605	Plant Physiology	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	4 hrs.
		B23-BCH-606	Biopharmaceuticals	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	4 hrs.
	CC-M5(V) 4 credits	From Available CC-M5(V) of 4 credits as per NEP							

DEPARTMENT OF BIOCHEMISTRY, KURUKSHETRA UNIVERSITY, KURUKSHETRA

FOURTH YEAR: SEMESTER-7 (FOR HONOURS/HONOURS WITH RESEARCH IN BIOCHEMISTRY)									
Semester	**Course**	**Paper(s)**	**Nomenclature of Paper**	**Credits**	**Hours/ Week**	**Internal marks**	**External Marks**	**Total Marks**	**Exam Duration**
VII	**CC-H1 4 credits**	B23-BCH-701	Gene Regulation	4	4	30	70	100	3 hrs.
	CC-H2 4 credits	B23-BCH-702	Animal Cell Culture	4	4	30	70	100	3 hrs.
	CC-H3 4 credits	B23-BCH-703	Protein Purification	4	4	30	70	100	3 hrs.
	DSE-H1 4 credits Select one Option	B23-BCH-704	Clinical trials & Management	4	4	30	70	100	3 hrs.
		B23-BCH-705	Bioinformatics	4	4	30	70	100	3 hrs.
	PC-H1 4 credits	B23-BCH-706	Practical Based on B23-BCH-701 TO 704/705	4	8	30	70	100	6 hrs.
	CC-HM1 4 credits	From Available Minor of 4 credits as per NEP							
SEMESTER-8 (FOR HONOURS IN BIOCHEMISTRY)									
Semester	**Course**	**Paper(s)**	**Nomenclature of Paper**	**Credits**	**Hours/ Week**	**Internal marks**	**External Marks**	**Total Marks**	**Exam Duration**
VIII	**CC-H4 4 credits**	B23-BCH-801	Research Methods & Documentation	4	4	30	70	100	3 hrs.
	CC-H5 4 credits	B23-BCH-802	Biosafety and Intellectual Property Rights	4	4	30	70	100	3 hrs.
	CC-H6 4 credits	B23-BCH-803	Stem Cell Biology	4	4	30	70	100	3 hrs.
	DSE-H2 4 credits Select one option	B23-BCH-804	Biostatistics	4	4	30	70	100	3 hrs.
		B23-BCH-805	Agriculture Waste Management	4	4	30	70	100	3 hrs.
	PC-H2 4 credits	B23-BCH-806	Practical Based on B23-BCH-801 TO 804/805	4	8	30	70	100	6 hrs.
	CC-HM2 4 credits	From Available Minor of 4 credits as per NEP							
ORSEMESTER-8 (FOR HONOURS WITH RESEARCH IN BIOCHEMISTRY)									
Semester	**Course**	**Paper(s)**	**Nomenclature of Paper**	**Credits**	**Hours/ Week**	**Internal marks**	**External Marks**	**Total Marks**	**Exam Duration**
VIII	**CC-H4 4 credits**	B23-BCH-801	Research Methods& Documentation	4	4	30	70	100	3 hrs.
	CC-H5 4 credits	B23-BCH-802	Biosafety and Intellectual Property Rights	4	4	30	70	100	3 hrs.
	Project/Dissertation 12 credits	B23-BCH-807	Project/Dissertation	8+4	-	-	-	-	-
	CC-HM2 4 credits	From Available Minor of 4 credits as per NEP							

PROGRAM LEARNING OUTCOMES (PLO)

1. Inculcate comprehensive knowledge and acquire skills in the field's biology
2. Develop experimenting skills in laboratory that enhances critical thinking skills, logical application these skills in problem solving
3. To equip students with necessary theoretical and practical skills to enable them to pursue multidisciplinary courses at Post Graduate level
4. Demonstrate the abilities to work in collaborative activities and inculcate leadership qualities
5. Identify and follow the ethical issues related to Biology, biosafety, and perform unbiased and truthful actions
6. Capability for raising relevant questions relating to basic understanding and applications biology and planning, executing and reporting the results of an experiment or investigation

KURUKSHETRA UNIVERSITY KURUKSHETRA

Scheme of Examination and Syllabus for Under-Graduate Programmes - Single Major

(Scheme –C)

(A student will take admission in UG Programme with Single Major Subject in the first year)

(Subject: Biochemistry)

Under Multiple Entry-Exit, Internship and CBCS-LOCF in accordance to NEP-2020 w.e.f. 2023-24 (in phased manner)

DEPARTMENT OF BIOCHEMISTRY, KURUKSHETRA UNIVERSITY, KURUKSHETRA

Scheme of Examination for Under-Graduate Programme – Scheme C

(A student will take admission in UG Programme with Single Major Subject in the first year)

Under Multiple Entry-Exit, Internship and CBCS-LOCF in accordance to NEP-2020 w.e.f. 2023-24 (in phased manner), Subject: Biochemistry

FIRST YEAR: SEMESTER-1

Semester	Course	Paper(s)	Nomenclature of Paper	Credits	Hours/ Week	Internal marks	External Marks	Total Marks	Exam Duration
I	CC-1/ MCC-1 4 credits	B23-BCH-101	Biomolecules	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	4 hrs.
	MCC-2 4 credits	B23-BCH-102	Cell Biochemistry	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	4 hrs.
	MDC-1 3 credits	B23-BCH-104	Biochemical Insights into the Human Body	2	2	15	35	50	3 hrs.
			Practical	1	2	5	20	25	4 hrs.
	CC-M1 4 credits	From Available CC-M1 of 4 credits as per NEP							
	AEC-1 2 credits	From Available AEC-1 of two credits as per NEP							
	SEC-1 3 credits	From Available SEC-1 of three credits as per NEP							
	VAC-1 2 credits	From Available VAC-1 of two credits as per NEP							

FIRST YEAR: SEMESTER-2

Semester	Course	Paper(s)	Nomenclature of Paper	Credits	Hours/ Week	Internal marks	External Marks	Total Marks	Exam Duration
II	CC-2/ MCC-3 4 credits	B23-BCH-201	Enzymology	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	4 hrs.
	DSEC-2 4 credits	B23-BCH-202	Bioanalytical Techniques	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	4 hrs.
	MDC-2 3 credits	B23-BCH-204	Biochemistry& Health	2	2	15	35	50	3 hrs.
			Practical	1	2	5	20	25	4 hrs.
	CC-M2 4 credits	From Available CC-M2 of 4 credits as per NEP							
	AEC-2 2 credits	From Available AEC-2 of two credits as per NEP							
	SEC-2 3 credits	From Available SEC-2 of three credits as per NEP							
	VAC-2 2 credits	From Available VAC-2 of two credits as per NEP							

Internship of 4 credits of 4-6 weeks duration after 2nd Semester

DEPARTMENT OF BIOCHEMISTRY, KURUKSHETRA UNIVERSITY, KURUKSHETRA

SECOND YEAR: SEMESTER-3									
Semester	**Course**	**Paper(s)**	**Nomenclature of Paper**	**Credits**	**Hours/ Week**	**Internal marks**	**External Marks**	**Total Marks**	**Exam Duration**
III	**CC-3/ MCC-4 4 credits**	B23-BCH-301	Carbohydrate and Lipid Metabolism	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	4 hrs.
	MCC-5 4 credits	B23-BCH-302	Hormones	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	4 hrs.
	MDC-3 3 credits	B23-BCH-303	Biochemistry of Lifestyle Diseases	2	2	15	35	50	3 hrs.
			Practical	1	2	5	20	25	4 hrs.
	CC-M3 4 credits	From Available CC-M3 of 4 credits as per NEP							
	AEC-3 2 credits	From Available AEC-3 of two credits as per NEP							
	SEC-3 3 credits	From Available SEC-3 of three credits as per NEP							
	VAC-3 2 credits	From Available VAC-3 of two credits as per NEP							

SECOND YEAR: SEMESTER-4									
Semester	**Course**	**Paper(s)**	**Nomenclature of Paper**	**Credits**	**Hours/ Week**	**Internal marks**	**External Marks**	**Total Marks**	**Exam Duration**
IV	**CC-4/ MCC-6 4 credits**	B23-BCH-401	Amino acid and Nucleotide Metabolism	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	4 hrs.
	MCC-7 4 credits	B23-BCH-402	Basics of Genetic Information	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	4 hrs.
	MCC-8 4 credits	B23-BCH-403	Elementary Microbial Biochemistry	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	4 hrs.
	DSE-1 4 credits Select one option	B23-BCH-404	Animal Biochemistry	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	4 hrs.
		B23-BCH-405	Plant Biochemistry	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	4 hrs.
	CC-M4(V) 4 credits	From Available CC-M4(V) of 4 credits as per NEP							
	AEC-4 2 credits	From Available AEC-3 of two credits as per NEP							
	VAC-4 2 credits	From Available VAC-4 of two credits as per NEP							
Internship of 4 credits of 4-6 weeks duration after 4th Semester (if not done after second semester)									

DEPARTMENT OF BIOCHEMISTRY, KURUKSHETRA UNIVERSITY, KURUKSHETRA

THIRD YEAR: SEMESTER-5									
Semester	**Course**	**Paper(s)**	**Nomenclature of Paper**	**Credits**	**Hours/ Week**	**Internal marks**	**External Marks**	**Total Marks**	**Exam Duration**
V	**CC-5/ MCC-9 4 credits**	B23-BCH-501	Molecular Biology	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	4 hrs.
	MCC-10 4 credits	B23-BCH-502	Biochemical Techniques	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	4 hrs.
	DSE-2 4 credits Select one Option	B23-BCH-503	Clinical Biochemistry	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	4 hrs.
		B23-BCH-504	Nutritional Biochemistry	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	4 hrs.
	DSE-3 4 credits Select one Option	B23-BCH-505	Molecular Basis of Infectious Diseases	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	4 hrs.
		B23-BCH-506	Food Biochemistry	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	4 hrs.
	CC-M5(V) 4 credits	From Available CC-M5(V) of 4 credits as per NEP							
	Internship 4 credits	Internship#4 credit after 4th semester							

THIRD YEAR: SEMESTER-6									
Semester	**Course**	**Paper(s)**	**Nomenclature of Paper**	**Credits**	**Hours/ Week**	**Internal marks**	**External Marks**	**Total Marks**	**Exam Duration**
VI	**CC-6 MCC-11 4 credits**	B23-BCH-601	Immunology	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	4 hrs.
	MCC-12 4 credits	B23-BCH-602	Recombinant DNA Technology	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	4 hrs.
	DSE-4 4 credits Select one Option	B23-BCH-603	Molecular Basis of non-infectious Diseases	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	4 hrs.
		B23-BCH-604	Industrial Biochemistry	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	4 hrs.
	DSE-5 4 credits Select one Option	B23-BCH-605	Plant Physiology	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	4 hrs.
		B23-BCH-606	Biopharmaceuticals	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	4 hrs.
	CC-M6(V) 4 credits	From Available CC-M6(V) of 4 credits as per NEP							
	SEC-4 2 credits	From Available SEC-4 of two credits as per NEP							

DEPARTMENT OF BIOCHEMISTRY, KURUKSHETRA UNIVERSITY, KURUKSHETRA

FOURTH YEAR: SEMESTER-7 (FOR HONOURS/HONOURS WITH RESEARCH IN BIOCHEMISTRY)									
Semester	**Course**	**Paper(s)**	**Nomenclature of Paper**	**Credits**	**Hours/ Week**	**Internal marks**	**External Marks**	**Total Marks**	**Exam Duration**
VII	**CC-H1 4 credits**	B23-BCH-701	Gene Regulation	4	4	30	70	100	3 hrs.
	CC-H2 4 credits	B23-BCH-702	Animal Cell Culture	4	4	30	70	100	3 hrs.
	CC-H3 4 credits	B23-BCH-703	Protein Purification	4	4	30	70	100	3 hrs.
	DSE-H1 4 credits Select one Option	B23-BCH-704	Clinical trials & Management	4	4	30	70	100	3 hrs.
		B23-BCH-705	Bioinformatics	4	4	30	70	100	3 hrs.
	PC-H1 4 credits	B23-BCH-706	Practical Based on B23-BCH-701 TO 704/705	4	8	30	70	100	6 hrs.
	CC-HM1 4 credits	From Available Minor of 4 credits as per NEP							
SEMESTER-8 (FOR HONOURS IN BIOCHEMISTRY)									
Semester	**Course**	**Paper(s)**	**Nomenclature of Paper**	**Credits**	**Hours/ Week**	**Internal marks**	**External Marks**	**Total Marks**	**Exam Duration**
VIII	**CC-H4 4 credits**	B23-BCH-801	Research Methods & Documentation	4	4	30	70	100	3 hrs.
	CC-H5 4 credits	B23-BCH-802	Biosafety and Intellectual Property Rights	4	4	30	70	100	3 hrs.
	CC-H6 4 credits	B23-BCH-803	Stem Cell Biology	4	4	30	70	100	3 hrs.
	DSE-H2 4 credits Select one option	B23-BCH-804	Biostatistics	4	4	30	70	100	3 hrs.
		B23-BCH-805	Agriculture Waste Management	4	4	30	70	100	3 hrs.
	PC-H2 4 credits	B23-BCH-806	Practical Based on B23-BCH-801 TO 804/805	4	8	30	70	100	6 hrs.
	CC-HM2 4 credits	From Available Minor of 4 credits as per NEP							
ORSEMESTER-8 (FOR HONOURS WITH RESEARCH IN BIOCHEMISTRY)									
Semester	**Course**	**Paper(s)**	**Nomenclature of Paper**	**Credits**	**Hours/ Week**	**Internal marks**	**External Marks**	**Total Marks**	**Exam Duration**
VIII	**CC-H4 4 credits**	B23-BCH-801	Research Methods & Documentation	4	4	30	70	100	3 hrs.
	CC-H5 4 credits	B23-BCH-802	Biosafety and Intellectual Property Rights	4	4	30	70	100	3 hrs.
	Project/Dissertation 12 credits	B23-BCH-807	Project/Dissertation	8+4	-	-	-	-	-
	CC-HM2 4 credits	From Available Minor of 4 credits as per NEP							

PROGRAM LEARNING OUTCOMES (PLO)

1. Inculcate comprehensive knowledge and acquire skills in the field's biology
2. Develop experimenting skills in laboratory that enhances critical thinking skills, logical application these skills in problem solving
3. To equip students with necessary theoretical and practical skills to enable them to pursue multidisciplinary courses at Post Graduate level
4. Demonstrate the abilities to work in collaborative activities and inculcate leadership qualities
5. Identify and follow the ethical issues related to Biology, biosafety, and perform unbiased and truthful actions
6. Capability for raising relevant questions relating to basic understanding and applications biology and planning, executing and reporting the results of an experiment or investigation

KURUKSHETRA UNIVERSITY KURUKSHETRA

Scheme of Examination and Syllabus for Vocational Courses- (Voc) under UG Programmes

Under Multiple Entry-Exit, Internship and CBCS-LOCF in accordance to NEP-2020 w.e.f. 2023-24 (in phased manner)

DEPARTMENT OF BIOCHEMISTRY, KURUKSHETRA UNIVERSITY, KURUKSHETRA

Scheme of Examination and Syllabus for Vocational Courses (Voc) under UG Programmes

Under Multiple Entry-Exit, Internship and CBCS-LOCF in accordance to NEP-2020 w.e.f. 2023-24 (in phased manner), Subject: Biochemistry

Course	Paper(s)	Nomenclature of Paper	Credits	Hours/ Week	Internal marks	External Marks	Total Marks	Exam Duration
CC-M3 (VOC) 4 credits								
	B23-VOC-124	Biomedical Waste Management	2	2	15	35	50	3 hrs.
		Practical	2	4	15	35	50	4 hrs.

KURUKSHETRA UNIVERSITY KURUKSHETRA

Scheme of Examination and Syllabus for Skill Enhancement Courses (SEC) For under UG Programmes

Under Multiple Entry-Exit, Internship and CBCS-LOCF in accordance to NEP-2020w.e.f. 2023-24 (in phased manner)

DEPARTMENT OF BIOCHEMISTRY, KURUKSHETRA UNIVERSITY, KURUKSHETRA

Scheme of Examination and Syllabus for Skill Enhancement Courses (SEC) For under UG Programmes

Under Multiple Entry-Exit, Internship and CBCS-LOCF in accordance to NEP-2020 w.e.f. 2023-24 (in phased manner), Subject: Biochemistry

Semester	Course	Paper(s)	Nomenclature of Paper	Credits	Hours/ Week	Internal marks	External Marks	Total Marks	Exam Duration
2									
	SEC-2 3 credits	B23-SEC-222	Bioanalytical Techniques	2	2	15	35	50	3 hrs.
			Practical	1	2	5	20	25	4 hrs.
3									
	SEC-3 3 credits	B23-SEC-322	Immunological Techniques	2	2	15	35	50	3 hrs.
			Practical	1	2	5	20	25	4 hrs.
	SEC-3 3 credits	B23-SEC-323							
			Genetic Engineering	2	2	15	35	50	3 hrs.
			Practical	1	2	5	20	25	4 hrs.

Session: 2023-24			
Part A – Introduction			
Subject	Biochemistry		
Semester	1		
Name of the Course	Biomolecules		
Course Code	B23-BCH-101		
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	CC/MCC		
Level of the course (As per Annexure-I	100-199		
Pre-requisite for the course (if any)	Senior secondary (10+2) or Equivalent in any stream		
Course Learning Outcomes (CLO):	After completing this course, the learner will be able to: 1. Exhibit the knowledge to classify, define and explain various properties of carbohydrates and correlate them to their functions. 2. Learn to classify, define, draw structures and explain functions of various types of lipids: Illustrate various parameters of characterization of lipids. 3. Gain knowledge to classify, draw structures of standard amino acids, explain chemical and physical properties of amino acids; Describe different classes of proteins and explain different levels of structural organization in protein architecture. 4. Understand the characteristics and draw structures of various types of nucleic acids.		
	5* Learn to prepare various types of solutions used in qualitative and quantitative biochemical estimations; analyze the unknown samples qualitatively for the presence of various biomolecules.		
Credits	Theory	Practical	Total

	3	1	4
Contact Hours	45	15	60
Max. Marks: 100 **Internal Assessment Marks: 30 (20T+10P)** **End Term Exam Marks: 70 (50T+20P)**		**Time: T-3hrs.** **P-4hrs.**	

Part B- Contents of the Course

Instructions for Paper- Setter: The question paper will consist of NINE questions out of which the candidate would be required to attempt FIVE questions. The first question will be compulsory and will have 5 short answer questions uniformly spread over entire syllabus. The remaining EIGHT questions will be set taking TWO questions from each of the four units. Each question will carry 10 marks. The candidate would be required to attempt ONE question from each unit in addition to compulsory question.

Unit	Topics	Contact Hours
I	Carbohydrates: **Definition and classification. Monosaccharides: Structure, occurrence and biological importance of monosaccharides; Stereoisomerism of sugars; Mutarotation; Reactions: oxidation, reduction, formation of glycosides and esters. Important derivatives of monosaccharides: deoxy sugars and amino sugars. Structure, occurrence and functions of important disaccharides. Polysaccharides: Structure, occurrence and biological importance of starch, glycogen, cellulose, chitin.**	11
II	Lipids: **Definition and classification. Fatty acids: introduction, classification, nomenclature, structure and properties of saturated and unsaturated fatty acids. Essential fatty acids. Waxes, Triacylglycerols: physical and chemical properties. Saponification values, iodine value, rancidity of fats. Biological significance of fats. Structure & biological functions of glycerophospholipids (lecithin, cephalin, phosphatidylserine, phosphatidylinositol) and sphingolipids. Structure & biological functions of cholesterol.**	12
III	Proteins: **Amino acids: common structural features, stereoisomerism and RS system of designating optical isomers, classification and structures of standard amino acids as Zwitter ion in aqueous solutions, titration of amino acids, essential amino acids and non-protein amino acids. Protein classification based on solubility, shape and functions. Protein structure: levels of structure in protein architecture (Primary, secondary, tertiary and quaternary structures of proteins) and forces stabilizing these structures.**	11

IV	**Nucleic acids:** Structures of purines and pyrimidines, nucleosides and nucleotides in RNA and DNA, features of DNA double helix and forces stabilizing DNA double helix. A, B and Z-DNAs. Chargaff's rules. Denaturation (T_m and buoyant density and their relationship with G-C content in DNA) and annealing of DNA. Structure and roles of different types of RNA.	11
V*	1. To study biochemistry laboratory safety rules and guidelines. 2. Preparation of normal, molar, percent solutions, buffer solutions and determination of their pH. 3. Qualitative tests for Carbohydrates. 4. Qualitative tests for lipids. 5. Qualitative tests for amino acids and Proteins.	15

Suggested Evaluation Methods

Internal Assessment: ➢ **Theory** • Class Participation: • Seminar/presentation/assignment/quiz/class test etc.: • Mid-Term Exam: ➢ **Practicum** • Class Participation: • Seminar/Demonstration/Viva-voce/Lab records etc.: • Mid-Term Exam:	**End Term Examination:** Written theory examination will be conducted as per scheme. Evaluation of the practical skill will be done by an external examiner.

Part C-Learning Resources

1. Lehninger: Principles of Biochemistry, 7th edition, by David L. Nelson and M.M. Cox. (2017). Maxmillan/ Worth publishers.
2. Fundamentals of Biochemistry: Life at the Molecular Level, 5th Edition, by Donald Voet, Judith G Voet, Charlotte W. Pratt. (2016). John Wiley & Sons, NY
3. Biochemistry, 4th edition, by R.H. Garrett and C.M. Grisham (2010). Saunders College Publishing, NY.
4. Biochemistry, 8th edition, by J.M. Berg, John L. Tymoczko, L. Stryer. (2015). W.H. Freeman & Co., NY.
5. Harpers Illustrated Biochemistry, 31st edition, Peter J. Kennelly, P. Anthony Weil, Victor W Rodwell, David A. Bender, Kathleen M. Botham. (2018). McGraw Hill Educations Publishers.
6. Fundamental of Biochemistry by J.L. Jain, Sanjay Jain, Nitin Jain, S. Chand & Co. Publication.
7. An introduction to Practical Biochemistry, 3rd Edition, by David Plummer. (2017). Tata Mc-Graw Hill.
8. Introductory Practical Biochemistry by S.K. Sawhney & R. Singh. (2014). Narosa Publishers.
9. Biochemical Methods, 3rd edition, by Sadasivam & Manickam. (2018). New Age International (P) Ltd.

*Applicable for courses having practical component.

Session: 2023-24	
Part A – Introduction	
Subject	Biochemistry
Semester	1
Name of the Course	Cell Biochemistry
Course Code	B23-BCH-102
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	CC/MCC
Level of the course (As per Annexure-I	100-199
Pre-requisite for the course (if any)	Senior secondary (10+2) or Equivalent in any stream
Course Learning Outcomes (CLO):	After completing this course, the learner will be able to: 1. Exhibit the knowledge of the structural organization of prokaryotic and eukaryotic cell, the chemical composition and functions of plasma membrane. 2. Understand the mechanism of membrane transport, passive and active transport; know the maintenance of cytoskeleton structure and cell motility. 3. Know the structure and functions of cell organelles; understand the role of endoplasmic reticulum & Golgi apparatus in protein segregation & secretion. 4. Learn the structural organization of nucleus and nucleolus; know the events in cell division; enumerate the phases of cell cycle; understand the process of apoptosis.
	5*. Impart practical knowledge to conduct the morphomatric analysis of cell and demonstrate cell division; able to identify variations in human chromosomes.

Credits	Theory	Practical	Total
	3	1	4
Contact Hours	45	15	60

Max. Marks: 100 **Internal Assessment Marks: 30 (20T+10P)** **End Term Exam Marks: 70 (50T+20P)**	**Time: T-3hrs.** **P-4hrs.**

Part B- Contents of the Course

Instructions for Paper- Setter: The question paper will consist of NINE questions out of which the candidate would be required to attempt FIVE questions. The first question will be compulsory and will have 5 short answer questions uniformly spread over entire syllabus. The remaining EIGHT questions will be set taking TWO questions from each of the four units. Each question will carry 10 marks. The candidate would be required to attempt ONE question from each unit in addition to compulsory question.

Unit	Topics	Contact Hours
I	**Cell Type:** Discovery of cells, Basic properties of cells, Two fundamentally different classes of cells: structure of Prokaryotic and Eukaryotic cell, Differences between Prokaryotic and Eukaryotic cell, Model organisms. **Plasma Membrane:** Studies on plasma membrane (brief history), Structure (Lamellar-models, micellar models and fluid mosaic model) and chemical composition of plasma membrane (lipids, proteins and carbohydrates), Functions of plasma membrane.	12
II	**Membrane Transport:** Passive and facilitated diffusion, carrier proteins (uni, sym and anti-porters), channel proteins (voltage and ligand gated), Active transport (primary and secondary). **Cytoskeleton:** Structure and functions of microfilaments, microtubules (cilia and flagella) and intermediary filaments.	11
III	Structure and functions of cell organelles: Mitochondria- **the power house**, Chloroplast- **the site of photosynthesis,** Ribosomes- **the site of protein synthesis,** Lysosomes and Peroxisomes- **the organelles of hydrolytic reactions** **Endoplasmic reticulum:** Structure and function including role in protein segregation Golgi Apparatus: **Structure and function including role in protein secretion.**	11

IV	**Nucleus:** Structure of nuclear envelope, nuclear pore complex, nucleolus. **Cell Division:** Mitosis (cell cycle stages, cytokinesis), Meiosis (reproductive cycle stages, synaptonemal complex, recombination nodules). Comparison between mitosis and meiosis. **Apoptosis** (Programmed cell death).	11
V*	6. Visualization of animal and plant cell by methylene blue. 7. Sub-cellular fractionation. 8. Visualization of nuclear fraction by acetocarmine stain. 9. Isolation of genetic material from onion peel.	15

Suggested Evaluation Methods

Internal Assessment: ➢ **Theory** • Class Participation: • Seminar/presentation/assignment/quiz/class test etc.: • Mid-Term Exam: ➢ **Practicum** • Class Participation: • Seminar/Demonstration/Viva-voce/Lab records etc.: • Mid-Term Exam:	**End Term Examination:** Written theory examination will be conducted as per scheme. Evaluation of the practical skill will be done by an external examiner.

Part C-Learning Resources

10. The Cell: A Molecular Approach, 5th ed., Cooper, G.M. and Hausman, R.E. (2009). ASM Press & Sunderland (Washington DC), Sinauer Associates, MA.
11. Cell and molecular biology: concepts and experiments. Karp, G. (2009). John Wiley & Sons, NY.
12. Molecular Cell Biology. Lodish, H., Berk, A., Zipursky, S.L., Matsudaria, P., Baltimoe, D. and Darnell, J. (2008). W.H. Freeman and Co., New York., USA.
13. Genetics. Russel, P.J. 1998. The Benjamin/Cummings Publishing Co. Inc., USA.
14. Principles of Genetics. 5th ed., Snustad, D.P. and Simmons, M.J. 2015. John Wiley and Sons, Inc. USA.
15. Molecular Biology of the Cell (2008) 5th ed., Alberts, B., Johnson, A., Lewis, J., and Enlarge, M., Garland Science (Princeton).

*Applicable for courses having practical component.

Session: 2023-24			
Part A - Introduction			
Subject	Biochemistry		
Semester	1		
Name of the Course	Molecules of Life-1		
Course Code	B23-BCH-103		
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	CC-M		
Level of the course (As per Annexure-I	100-199		
Pre-requisite for the course (if any)	Senior secondary (10+2) or Equivalent in any stream		
Course Learning Outcomes (CLO):	After completing this course, the learner will be able to: 1. Learn to classify, define and explain various properties of monosaccharides and correlate them to their functions. 2. Understand structure, occurrence and biological functions of disaccharides and polysaccharides. 3. Impart knowledge to classify, define fatty acids; illustrate various parameters of characterization of lipids. **4.** Learn to draw structures and explain functions of various types of lipids.		
	5* Learn to prepare various types of solutions used in qualitative and quantitative biochemical estimations; analyze the unknown samples qualitatively for the presence of various **biomolecules.**		
Credits	Theory	Practical	Total

	1	1	1
Contact Hours	15	15	30

Max. Marks: 50 **Internal Assessment Marks: 15 (10T+5P)** **End Term Exam Marks: 35 (20T+15P)**	**Time: T-3hrs.** **P-4hrs.**

Part B- Contents of the Course

Instructions for Paper- Setter: The question paper will consist of NINE questions out of which the candidate would be required to attempt FIVE questions. The first question will be compulsory and will have 5 short answer questions uniformly spread over entire syllabus. The remaining EIGHT questions will be set taking TWO questions from each of the four units. Each question will carry 10 marks. The candidate would be required to attempt ONE question from each unit in addition to compulsory question.

Unit	Topics	Contact Hours
I	Carbohydrates: Definition and classification. Monosaccharides: Structure and biological importance of monosaccharides; Stereoisomerism of sugars; Mutarotation; Important derivatives of monosaccharides: deoxy sugars and amino sugars.	4
II	Structure and functions of important disaccharides. Polysaccharides: Structure, occurrence and biological importance of starch, glycogen, cellulose, chitin.	4
III	Lipids: Definition and classification. Fatty acids: introduction, classification, nomenclature, structure and properties of saturated and unsaturated fatty acids. Essential fatty acids. Waxes, Triacylglycerols: physical and chemical properties.	4
IV	Biological functions of glycerophospholipids (lecithin, cephalin, phosphatidylserine, phosphatidylinositol) and sphingolipids. Structure & biological functions of cholesterol.	3
V*	10. Safety measures in laboratories. 11. Preparation of normal and molar solutions. 12. Qualitative tests for Carbohydrates. 13. Qualitative tests for lipids.	15

Suggested Evaluation Methods

Internal Assessment: ➢ **Theory** • Class Participation: • Seminar/presentation/assignment/quiz/class test etc.: • Mid-Term Exam: ➢ **Practicum** • Class Participation: • Seminar/Demonstration/Viva-voce/Lab records etc.: • Mid-Term Exam:	**End Term Examination:** Written theory examination will be conducted as per scheme. Evaluation of the practical skill will be done by an external examiner.

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Lehninger: Principles of Biochemistry, 7th edition, by David L. Nelson and M.M. Cox (2017) Maxmillan/ Worth publishers.
2. Fundamentals of Biochemistry: Life at the Molecular Level, 5th Edition, by Donald Voet, Judith G Voet, Charlotte W. Pratt (2016). John Wiley & Sons, NY
3. Biochemistry, 4th edition, by R.H. Garrett and C.M. Grisham (2010). Saunders College Publishing, NY.
4. Biochemistry, 8th edition, by J.M. Berg, John L. Tymoczko, L. Stryer (2015). W.H. Freeman & Co.,NY.
5. Harpers Illustrated Biochemistry, 31st edition, by Peter J. Kennelly, P. Anthony Weil, Victor W Rodwell, David A. Bender, Kathleen M. Botham (2018). McGraw Hill Educations Publishers.
6. Fundamental of Biochemistry by J.L. Jain, Sanjay Jain, Nitin Jain, S. Chand & Co. Publication.
7. Introductory Practical Biochemistry by S.K. Sawhney & R. Singh (2014). Narosa Publishers.
8. Biochemical Methods, 3rd edition, by Sadasivam & Manickam (2018). New Age International (P) Ltd.

*Applicable for courses having practical component.

Session: 2023-24			
Part A - Introduction			
Subject	Biochemistry		
Semester	1		
Name of the Course	Biochemical Insights into the Human Body		
Course Code	B23-BCH-104		
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	MDC		
Level of the course (As per Annexure-I	100-199		
Pre-requisite for the course (if any)	Senior secondary (10+2) or Equivalent in any stream		
Course Learning Outcomes (CLO):	After completing this course, the learner will be able to: 1. Learn and correlate the biochemistry and human biology; illustrate role of biomolecules in body. 2. Understand the biochemical nature and functions of hormones. 3. Learn to correlate the cellular metabolism and energy production. 4. Know the various applications of biochemistry in industrial & medical sector.		
	5*. Acquire knowledge and hands-on training of analytical tools of biochemistry & understanding of good laboratory practices; learn qualitative aspects of various biomolecules.		
Credits	Theory	Practical	Total

	2	1	3
Contact Hours	30	15	45

Max. Marks: 75 **Internal Assessment Marks: 20 (15T+5P)** **End Term Exam Marks: 55 (35T+20P)**	**Time: T-3hrs.** **P-4hrs.**

Part B- Contents of the Course

Instructions for Paper- Setter: The question paper will consist of NINE questions out of which the candidate would be required to attempt FIVE questions. The first question will be compulsory and will have 5 short answer questions uniformly spread over entire syllabus. The remaining EIGHT questions will be set taking TWO questions from each of the four units. Each question will carry 10 marks. The candidate would be required to attempt ONE question from each unit in addition to compulsory question.

Unit	Topics	Contact Hours
I	Introduction to Biochemical Architecture: Overview of biochemistry and its relevance to human biology. Biomolecules and their role in body composition: Carbohydrate, Lipids, Proteins, Nucleic acids and Enzymes.	7
II	Metabolism and Energy Production: Introduction to energy balance; Role of diet, exercise and life style in management of energy balance.	8
III	Hormones- role in growth, in reproductive system, in the diseases like hypothyroidism, hyperthyroidism, diabetes, blood pressure, Parkinson and schizophrenia.	7
IV	Integration and Applications of Biochemical Knowledge in the field of food, health, industry (food processing; leather; detergent) and medicine.	8
V*	1. Safety measures to be taken while handling Biochemicals. 2. To detect the presence of carbohydrates in food (glucose/sucrose/starch). 3. To detect the presence of proteins in food. 4. To detect the presence of fats (lipid) in different plants and animal materials.	15

Suggested Evaluation Methods	
Internal Assessment: ➢ **Theory** • Class Participation: • Seminar/presentation/assignment/quiz/class test etc.: • Mid-Term Exam: ➢ **Practicum** • Class Participation: • Seminar/Demonstration/Viva-voce/Lab records etc.: • Mid-Term Exam:	**End Term Examination:** Written theory examination will be conducted as per scheme. Evaluation of the practical skill will be done by an external examiner.

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Lehninger: Principles of Biochemistry, 7th edition, by David L. Nelson and M.M. Cox (2017). Maxmillan/ Worth publishers.
2. Fundamentals of Biochemistry: Life at the Molecular Level, 5th Edition, by Donald Voet, Judith G Voet, Charlotte W. Pratt (2016). John Wiley & Sons, NY
3. Biochemistry, 8th edition, by J.M. Berg, John L. Tymoczko, L. Stryer (2015). W.H. Freeman &Co., NY.
4. Harpers Illustrated Biochemistry, 31st edition, Peter J. Kennelly, P. Anthony Weil, Victor W Rodwell, David A. Bender, Kathleen M. Botham (2018). McGraw Hill Educations Publishers.
5. Essentials of Biochemistry, 5th edition by Satyanarayana and Chakrapani. (2019). Elsevier, India.
6. Introductory Practical Biochemistry by S.K. Sawhney & R. Singh (2014). Narosa Publishers.
7. Practical Biochemistry by David Plummer (2001). Tata Mc-Graw Hill
8. Biochemical Methods, 3rd edition, by Sadasivam & Manickam (2018) New Age International (P) Ltd.

*Applicable for courses having practical component.

Session: 2023-24	
Part A - Introduction	
Subject	Biochemistry
Semester	2
Name of the Course	Enzymology
Course Code	B23-BCH-201
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	CC/MCC
Level of the course (As per Annexure-I	100-199
Pre-requisite for the course (if any)	Students appeared in B.Sc. 1st semester
Course Learning Outcomes (CLO):	After completing this course, the learner will be able to: 1. Learn various characteristics of enzymes, classify them and elaborate the role of cofactors in enzyme catalysis 2. Correlate the structure of enzymes to their functions, mechanism of enzyme catalysis. 3. Exhibit the knowledge of enzyme kinetics of unisubstrate reactions, various kinetics parameters (Km, Vmax etc.) and describe different types of enzyme inhibitions. 4. Correlate different ways of enzyme regulation to cellular metabolism: discuss and analyze the importance of immobilized enzymes and the techniques to prepare them.

	5*. Knowledge to extract and quantitatively estimate the enzyme activity and protein content of the samples; exhibit skills in studying various characteristics of enzymes like temperature optima, Km, Vmax.		
Credits	Theory	Practical	Total
	3	1	4
Contact Hours	45	15	60
Max. Marks: 100 **Internal Assessment Marks: 30 (20T+10P)** **End Term Exam Marks: 70 (50T+20P)**		**Time: T-3hrs.** **P-4hrs.**	

Part B- Contents of the Course

Instructions for Paper- Setter: The question paper will consist of NINE questions out of which the candidate would be required to attempt FIVE questions. The first question will be compulsory and will have 5 short answer questions uniformly spread over entire syllabus. The remaining EIGHT questions will be set taking TWO questions from each of the four units. Each question will carry 10 marks. The candidate would be required to attempt ONE question from each unit in addition to compulsory question.

Unit	Topics	Contact Hours
I	**Enzymes:** General characteristics, nomenclature & classification, significance of numbering system, holoenzyme, apoenzyme, coenzymes, cofactors, activators, inhibitors, active site, metallo-enzymes, isoenzymes, monomeric enzymes, oligomeric enzymes, multifunctional enzyme and multi-enzyme complexes. Enzyme specificity (absolute and group specificity), Three-point attachment theory of enzyme specificity, Measurement and expression of enzyme activity: Enzyme assay, enzyme units, enzyme turn over number and specific activity.	11
II	**Role of cofactors in enzyme catalysis:** NAD/NADP, FMN/FAD, CoA, TPP, PLP, tetrahydrofolate and metal ions. **Enzyme catalysis:** Reaction co-ordinate diagram, transition state, acid-base catalysis, covalent catalysis, proximity and orientation effects, strain and distortion theory. Mechanism of action of chymotrypsin and ribonuclease.	11

III	**Enzyme Kinetics:** Factors affecting enzyme activity- enzyme concentration, substrate concentration, pH and temperature. Derivation of Michaelis-Menten equation for uni-substrate reactions. K_m and its significance. Lineweaver-Burk plot. Importance of K_{cat}/K_m. Reversible (competitive, non-competitive and uncompetitive inhibitions) and irreversible inhibition. Impact of inhibitors on K_m & V_{max} value of enzyme. Bi-substrate reactions- brief introduction of sequential and ping-pong mechanisms with examples.	12
IV	**Enzyme regulation:** Feedback inhibition, Allosteric enzymes. Covalently modulated enzymes. Zymogen activation. **Immobilized enzymes:** Advantages, methods of immobilization - Adsorption, ionic binding, covalent coupling, cross-linking, entrapment, microencapsulation. Applications of immobilized enzymes (A brief account).	11
V*	1. Estimation of protein by Biuret/Lowry method 2. Assay of acid phosphatase activity from germinating mungbean seeds and calculation of specific activity of acid phosphatase. 3. Effect of enzyme concentration on enzyme activity. 4. Effect of substrate concentration on acid phosphatase activity and determination of its Km value. 5. Effect of Temperature on Enzyme activity and determination of optimum temperature.	15
Suggested Evaluation Methods		
Internal Assessment: ➢ **Theory** • Class Participation: • Seminar/presentation/assignment/quiz/class test etc.: • Mid-Term Exam: ➢ **Practicum** • Class Participation: • Seminar/Demonstration/Viva-voce/Lab records etc.: • Mid-Term Exam:		**End Term Examination:** Written theory examination will be conducted as per scheme. Evaluation of the practical skill will be done by an external examiner.
Part C-Learning Resources		

1. Structure and mechanism in Protein Science, by Alan Fersht (2017). World Scientific.
2. Fundamentals of Enzymology, 3rd edition, by Nicholas C. Price and Lewis Stevens (2009) Oxford U.
3. Enzymes: Biochemistry, Biotechnology and Clinical Chemistry by Trevor Palmer, Philip Bonner (2008). East West Publishing.
4. The Chemical Kinetics of Enzyme action by K.J. Laidler and P.S. Bunting, Oxford University Press London.
5. An introduction to Practical Biochemistry, 3rd Edition, by David Plummer (2017). Tata Mc-Graw Hill
6. Introductory Practical Biochemistry by S.K. Sawhney& R. Singh (2014). Narosa Publishers
7. Modern Experimental Biochemistry, 3rd edition, by R. Boyer (2002). Addison-Wesley Longman.
8. Biochemical Methods, 3rd edition, by Sadasivam & Manickam (2018). New Age International (P) Ltd.
9. An introduction to Practical Biochemistry, 3rd Edition, by David Plummer (2017). Tata Mc-Graw Hill.

*Applicable for courses having practical component.

Session: 2023-24			
Part A - Introduction			
Subject	Biochemistry		
Semester	2		
Name of the Course	Bioanalytical Techniques		
Course Code	B23-BCH-202		
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	DSEC		
Level of the course (As per Annexure-I	100-199		
Pre-requisite for the course (if any)	Students appeared in B.Sc. 1st semester		
Course Learning Outcomes (CLO):	After completing this course, the learner will be able to: 1. Understand the basic chemistry and properties of water; physiological buffers. 2. Demonstrate the knowledge of the general principles, components and applications of centrifuges. 3. Learn the principles and applications of chromatographic techniques in isolation, quantification and characterization of biomolecules. 4. Know the general principles, components and applications of spectrophotometer.		
	5*. Develop the skills to verify and apply the basic principles of spectroscopy; separation of amino acids by thin layer/ paper chromatography. .		
Credits	Theory	Practical	Total
	3	1	4

Contact Hours	45	15	60

Max. Marks: 100 **Internal Assessment Marks: 30 (20T+10P)** **End Term Exam Marks: 70 (50T+20P)**	**Time: T-3hrs.** **P-4hrs.**

Part B- Contents of the Course

Instructions for Paper- Setter: The question paper will consist of NINE questions out of which the candidate would be required to attempt FIVE questions. The first question will be compulsory and will have 5 short answer questions uniformly spread over entire syllabus. The remaining EIGHT questions will be set taking TWO questions from each of the four units. Each question will carry 10 marks. The candidate would be required to attempt ONE question from each unit in addition to compulsory question.

Unit	Topics	Contact Hours
I	Water and Buffers: **Structure, hydrogen bonding, solvent properties, and ionization, Weak acids and bases, ionization of weak acids, titration of weak acid by a strong base, pH, buffers, Henderson-Hasselbalch equation and physiological buffers.** **Measurement of pH:** Principles and composition of reference electrodes, glass electrode and combined electrode.	12
II	**Centrifugation**: Basic principle of centrifugation techniques, sedimentation rate, Svedberg unit / sedimentation coefficient. Preparative ultracentrifuge, Differential centrifugation, density gradient centrifugation, rate zonal, isopycnic, equilibrium centrifugation. Analytical ultracentrifuge method.	11
III	**Chromatographic techniques**- General principles and applications of adsorption, ion-exchange, molecular-sieve, thin layer & paper chromatography.	11
IV	**UV-Visible Spectroscopic techniques:** Beer-Lambert law, light absorption and its transmittance, extinction coefficient, a brief account of instrumentation and applications of UV-visible spectroscopic techniques (structure elucidation excluded).	11
V*	1. Determination of pKa of acetic acid and glycine. 2. Verification of Beer- Lambert's Law.	15

	3. Estimation of Amino acid by Ninhydrin method. 4. Estimation of Protein by Biuret method. 5. Separation of amino acids/ sugars by thin layer chromatography/paper chromatography.	

Suggested Evaluation Methods

Internal Assessment: ➢ **Theory** • Class Participation: • Seminar/presentation/assignment/quiz/class test etc.: • Mid-Term Exam: ➢ **Practicum** • Class Participation: • Seminar/Demonstration/Viva-voce/Lab records etc.: • Mid-Term Exam:	**End Term Examination:** Written theory examination will be conducted as per scheme. Evaluation of the practical skill will be done by an external examiner.

Part C-Learning Resources

10. Principles & Techniques of Biochemistry & Molecular Biology, 7th edition, by Keith Wilson and John Walker (2018).
11. Biophysical Chemistry: Principles and Techniques, by A. Upadhyay, K. Upadhyay and N. Nath. (2016). Himalaya Publishing House, Delhi.
12. Introductory Practical Biochemistry by S.K. Sawhney and Randhir Singh (2014). Narosa Publishing House, New Delhi.
13. An introduction to Practical Biochemistry, 3rd Edition, by David Plummer (2017). Tata Mc-Graw Hill
14. Modern Experimental Biochemistry, 3rd edition, by R. Boyer (2002) Addison-Wesley Longman.
15. Biochemical Methods, 3rd edition, by Sadasivam & Manickam (2018) New Age International (P) Ltd.
16. A Lab. Manual in Biochemistry by J. Jayaraman (1996) New Age International (P) Ltd.

*Applicable for courses having practical component.

Session: 2023-24			
Part A - Introduction			
Subject	Biochemistry		
Semester	2		
Name of the Course	Molecules of Life-II		
Course Code	B23-BCH-203		
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	CC-M		
Level of the course (As per Annexure-I	100-199		
Pre-requisite for the course (if any)	Students appeared in B.Sc. 1st semester		
Course Learning Outcomes (CLO):	After completing this course, the learner will be able to: 5. Exhibit the knowledge to classify, draw structures of standard amino acids, explain chemical and physical properties of amino acids. 6. Understand different classes of proteins and explain different levels of structural organization in protein architecture. 7. Know structure, biological functions and importance of nucleotides. 8. Learn the characteristics and draw structures of various types of nucleic acids.		
	5* Learn preparation of buffer and qualitatively & quantitatively estimation of amino acids, proteins and nucleic acids in the unknown samples.		
Credits	Theory	Practical	Total

	1	1	2
Contact Hours	15	15	30
Max. Marks: 50 **Internal Assessment Marks: 15 (10T+5P)** **End Term Exam Marks: 35 (20T+15P)**		**Time: T-3hrs.** **P-4hrs.**	

Part B- Contents of the Course

Instructions for Paper- Setter: The question paper will consist of NINE questions out of which the candidate would be required to attempt FIVE questions. The first question will be compulsory and will have 5 short answer questions uniformly spread over entire syllabus. The remaining EIGHT questions will be set taking TWO questions from each of the four units. Each question will carry 10 marks. The candidate would be required to attempt ONE question from each unit in addition to compulsory question.

Unit	Topics	Contact Hours
I	**Amino acids**: Common structural features, stereoisomerism and RS system of designating optical isomers, classification and structures of standard amino acids as Zwitter ion in aqueous solutions, physical and chemical properties, essential amino acids and non-protein amino acids.	4
II	**Proteins:** Protein classification based on solubility, shape and functions. Protein structure: levels of structure in protein architecture (Primary, secondary, tertiary and quaternary structures of proteins), and forces stabilizing these structures.	4
III	**Nucleotides:** Structures and function of purines and pyrimidines; Nucleosides & Nucleotides, biologically important nucleotides.	3
IV	**Nucleic acids**: Generalized structural plan of nucleic acids, nomenclature used in writing structure of nucleic acids, features of DNA double helix and forces stabilizing DNA double helix. A, B and Z-DNAs. Chargaff's rules.	4
V*	14. Preparation of buffers, phosphate and acetate buffers and determination of their pH. 15. Qualitative tests for amino acids and Proteins. 16. Quantitative estimation of proteins by Lowry's method. 17. Estimation of DNA by diphenylamine method.	15

Suggested Evaluation Methods

Internal Assessment: ➢ **Theory** • Class Participation: • Seminar/presentation/assignment/quiz/class test etc.: • Mid-Term Exam: ➢ **Practicum** • Class Participation: • Seminar/Demonstration/Viva-voce/Lab records etc.: • Mid-Term Exam:	**End Term Examination:** Written theory examination will be conducted as per scheme. Evaluation of the practical skill will be done by an external examiner.

Part C-Learning Resources

Recommended Books/e-resources/LMS:

9. Lehninger: Principles of Biochemistry, 7th edition, by David L. Nelson and M.M. Cox (2017) Maxmillan/ Worth publishers.
10. Fundamentals of Biochemistry: Life at the Molecular Level, 5th Edition, by Donald Voet, Judith G Voet, Charlotte W. Pratt (2016). John Wiley & Sons, NY
11. Biochemistry, 4th edition, by R.H. Garrett and C.M. Grisham (2010). Saunders College Publishing, NY.
12. Biochemistry, 8th edition, by J.M. Berg, John L. Tymoczko, L. Stryer (2015). W.H. Freeman & Co.,NY.
13. Harpers Illustrated Biochemistry, 31st edition, Peter J. Kennelly, P. Anthony Weil, Victor W Rodwell, David A. Bender, Kathleen M. Botham (2018) McGraw Hill Educations Publishers.
14. Fundamental of Biochemistry by J.L. Jain, Sanjay Jain, Nitin Jain, S. Chand & Co. Publication.
15. An introduction to Practical Biochemistry, 3rd Edition, by David Plummer (2017). Tata Mc-Graw Hill
16. Introductory Practical Biochemistry by S.K.Sawhney & R. Singh (2014). Narosa Publishers.

*Applicable for courses having practical component.

Session: 2023-24			
Part A - Introduction			
Subject	Biochemistry		
Semester	2		
Name of the Course	Biochemistry and Health		
Course Code	B23-BCH-204		
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	MDC		
Level of the course (As per Annexure-I	100-199		
Pre-requisite for the course (if any)	Students appeared in B.Sc. 1st semester		
Course Learning Outcomes (CLO):	After completing this course, the learner will be able to: 1. Exhibit the knowledge of the importance of biochemistry with reference to health. 2. Learn the biochemical functions and role of major and minor nutrients. 3. Know the relationship between biochemistry, exercise and energy metabolism. 4. Understand the Biochemistry of Aging and effect of environmental toxins and pollutants on human health.		
	5*. An understanding of quantitatively analyze the sample for vitamin, minerals and lactose.		
Credits	Theory	Practical	Total
	2	1	3

Contact Hours	30	15	45

Max. Marks: 75 **Internal Assessment Marks: 20 (15T+5P)** **End Term Exam Marks: 55 (35T+20P)**	**Time: T-3hrs.** **P-4hrs.**

Part B- Contents of the Course

Instructions for Paper- Setter: The question paper will consist of NINE questions out of which the candidate would be required to attempt FIVE questions. The first question will be compulsory and will have 5 short answer questions uniformly spread over entire syllabus. The remaining EIGHT questions will be set taking TWO questions from each of the four units. Each question will carry 10 marks. The candidate would be required to attempt ONE question from each unit in addition to compulsory question.

Unit	Topics	Contact Hours
I	**Overview of Health:** Components of health (physical, mental and emotional), importance of air, water and food in health and relevance of studying Biochemistry in maintaining good health.	7
II	**Nutritional Biochemistry and Health:** Macronutrients and micronutrients: roles and biochemical functions of macronutrients and micronutrients in human health.	8
III	**Biochemistry and Exercise Physiology:** Energy metabolism during exercise; Biochemical adaptations to physical activity; and complications related to sedentary life style, Sports nutrition and performance-enhancing substances.	7
IV	**Biochemistry of Aging:** Biochemical changes associated with aging; impact on hormones, muscle and nervous system. Impact of environmental toxins and pollutants on human health.	8
V*	1. Estimation of carbohydrate in milk. 2. Estimation of protein in milk. 3. Estimation of fats in milk. 4. Estimation of sugar in blood – before and after exercise	15

Suggested Evaluation Methods	
Internal Assessment: ➢ **Theory** • Class Participation: • Seminar/presentation/assignment/quiz/class test etc.: • Mid-Term Exam: ➢ **Practicum** • Class Participation: • Seminar/Demonstration/Viva-voce/Lab records etc.: • Mid-Term Exam:	**End Term Examination:** Written theory examination will be conducted as per scheme. Evaluation of the practical skill will be done by an external examiner.

Part C-Learning Resources

Recommended Books/e-resources/LMS:

9. Textbook of Biochemistry with Clinical Correlations (2011) Devlin, T.M. John Wiley & Sons, Inc. (New York).
10. Nutrition for health, fitness and sport (2013); Williams. M.H, Anderson, D.E, Rawson, E.S. McGraw Hill international edition.
11. Krause's Food and Nutrition Care process. (2012); Mahan, L.K Strings, S.E, Raymond, J. Elsevier's Publications.
12. Principles of Nutritional Assessment (2005) Rosalind Gibson. Oxford University Press.
13. Essentials of Biochemistry, 5th edition by Satyanarayana and Chakrapani. (2019) Elsevier, India.
14. Introductory Practical Biochemistry by S.K. Sawhney & R. Singh (2014). Narosa Publishers
15. Practical Biochemistry by David Plummer (2001). Tata Mc-Graw Hill
16. Biochemical Methods, 3rd edition, by Sadasivam & Manickam (2018) New Age International (P) Ltd.

*Applicable for courses having practical component.

Session: 2023-24	
Part A - Introduction	
Subject	Biochemistry
Semester	3
Name of the Course	Carbohydrate and Lipid Metabolism
Course Code	B23-BCH-301
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	CC/MCC
Level of the course (As per Annexure-I	200-299
Pre-requisite for the course (if any)	Students appeared in B.Sc. 2nd semester
Course Learning Outcomes (CLO):	After completing this course, the learner will be able to: 1. Apply the knowledge of biological redox reactions, coupled reactions, energy rich compounds and the energy transactions in studying metabolism. 2. Describe the metabolic pathways *i.e.* glycolysis (catabolism), gluconeogenesis (anabolism), and TCA cycle and their regulations. **3.** Discuss the reactions, regulation and importance of pentose phosphate pathway, glycogen metabolism and glyoxylate cycle. **4.** To understand ETC and apply the concept of oxidative phosphorylation to calculate energy production by oxidation of carbohydrates.
	5*. Determine biomolecules in the samples quantitatively; isolate and characterize carbohydrates, lipids and proteins from the natural sources.

Credits	Theory	Practical	Total
	3	1	4
Contact Hours	45	15	60

Max. Marks: 100 **Internal Assessment Marks: 30 (20T+10P)** **End Term Exam Marks: 70 (50T+20P)**	**Time: T-3hrs.** **P-4hrs.**

Part B- Contents of the Course

Instructions for Paper- Setter: The question paper will consist of NINE questions out of which the candidate would be required to attempt FIVE questions. The first question will be compulsory and will have 5 short answer questions uniformly spread over entire syllabus. The remaining EIGHT questions will be set taking TWO questions from each of the four units. Each question will carry 10 marks. The candidate would be required to attempt ONE question from each unit in addition to compulsory question.

Unit	Topics	Contact Hours
I	**Bioenergetics:** Concept of free energy, standard free energy, relation between equilibrium constant and standard free energy change and coupled reactions. Biological oxidation-reduction. High-energy compounds: phosphate group transfer potential, free energy of hydrolysis of ATP, PEP and other sugar phosphates along with reasons for high ΔG^0.	11
II	**Carbohydrate Metabolism:** Reactions and energetics of glycolysis. Alcoholic and lactic acid fermentations. Feeder pathways, Entry of fructose, galactose, mannose etc. into glycolysis. Reactions of TCA cycle. Regulation of glycolysis and TCA cycle.	11
III	**Carbohydrate-related other metabolic pathways:** Gluconeogenesis, Glycogenesis and glycogenolysis. Regulation of glycogen metabolism. Reactions and physiological significance of pentose phosphate pathway. Glyoxylate cycle**.**	11
IV	**Electron Transport Chain and Oxidative Phosphorylation:** Structure of mitochondria, organization and sequence of electron carriers, sites of ATP production, inhibitors of electron transport chain. Oxidative phosphorylation: chemiosmotic theory, structure of ATP synthase, binding change mechanism	12

	for proton driven ATP synthesis, Inhibitors and uncouplers of oxidative phosphorylation. Transport of reducing equivalents from cytosol into mitochondria.	
V*	1. Estimation of nitrogen by micro-Kjeldahl method /nesslers reagent. 2. Estimation of blood glucose by colorimetrically. 3. Estimation of ascorbic acid by titrimetric method. 4. Preparation of starch from potato and determination of achromatic point by salivary amylase 5. Determination of total lipids by Folch's method.	15

Suggested Evaluation Methods

Internal Assessment: ➢ **Theory** • Class Participation: • Seminar/presentation/assignment/quiz/class test etc.: • Mid-Term Exam: ➢ **Practicum** • Class Participation: • Seminar/Demonstration/Viva-voce/Lab records etc.: • Mid-Term Exam:	**End Term Examination:** Written theory examination will be conducted as per scheme. Evaluation of the practical skill will be done by an external examiner.

Part C-Learning Resources

1. Lehninger: Principles of Biochemistry, 7th edition, by David L. Nelson and M.M. Cox (2017). Maxmillan/ Worth publishers.
2. Fundamentals of Biochemistry: Life at the Molecular Level, 5th Edition, by Donald Voet, Judith G Voet, Charlotte W. Pratt (2016). John Wiley & Sons, NY
3. Biochemistry, 4th edition, by R.H. Garrett and C.M. Grisham (2010). Saunders College Publishing, NY.
4. Biochemistry, 5th edition, by Laurence A. Moran, H. R. Horton, K.G. Scrimgeour, Marc D. Perry (2011). Pearson Publishers.
5. An introduction to Practical Biochemistry, 3rd Edition, by David Plummer (2017). Tata Mc-Graw Hill
6. Introductory Practical Biochemistry by S.K. Sawhney & R. Singh (2014). Narosa Publishers
7. Modern Experimental Biochemistry, 3rd edition, by R. Boyer (2002). Addison-Wesley Longman.
8. Biochemical Methods, 3rd edition, by Sadasivam & Manickam (2018). New Age International (P) Ltd.

*Applicable for courses having practical component.

Session: 2023-24			
Part A – Introduction			
Subject	Biochemistry		
Semester	3		
Name of the Course	Hormones		
Course Code	B23-BCH-302		
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	MCC		
Level of the course (As per Annexure-I	200-299		
Pre-requisite for the course (if any)	Students appeared in B.Sc. 2nd semester		
Course Learning Outcomes (CLO):	After completing this course, the learner will be able to: 1. Gain knowledge on functions, classification and regulation of hormones. 2. Understand the role of secondary messengers, effector systems and protein kinases, tyrosine kinases in hormonal action. 3. Acquire detailed knowledge of the biochemical action and physiological role of peptide hormones. **4.** Learn the biochemical and physiological role of steroid hormones & amino acid derivatives.		
	5*. Get more acquainted with the determination of macronutrients & electrolytes in the serum sample quantitatively; quantitative analysis of hormones in serum sample.		
Credits	Theory	Practical	Total
	3	1	4
Contact Hours	45	15	60

Max. Marks: 100 **Internal Assessment Marks: 30 (20T+10P)** **End Term Exam Marks: 70 (50T+20P)**	**Time: T-3hrs.** **P-4hrs.**

Part B- Contents of the Course

Instructions for Paper- Setter: The question paper will consist of NINE questions out of which the candidate would be required to attempt FIVE questions. The first question will be compulsory and will have 5 short answer questions uniformly spread over entire syllabus. The remaining EIGHT questions will be set taking TWO questions from each of the four units. Each question will carry 10 marks. The candidate would be required to attempt ONE question from each unit in addition to compulsory question.

Unit	Topics	Contact Hours
I	**Introduction to endocrinology**: Characteristic and general functions of hormones. Classification of hormones- Based on chemical nature and mechanism of action, Chemical signaling of hormones- endocrine, paracrine, autocrine, Regulation of hormones (Feedback mechanism), Factors regulating hormone action.	11
II	**Mechanism of hormone action:** Hormones that bind to intracellular receptors and hormones that bind to cell surface receptors. Role of secondary messengers, signaling involving cyclic AMP, cyclic GMP, phosphoinositide, calcium, diacylglycerol and nitric oxide, kinase-phosphatase system.	12
III	**Biochemical and physiological role of peptide Hormones:** Pancreatic hormones, Hypophyseal hormones, Para-thyroidal hormones, Gastro-intestinal tract hormones.	11
IV	**Biochemical and physiological role of steroid Hormones:** Ovarian hormones, Testicular hormones, Adrenal cortical hormones and Corpus luteal hormone. **Biochemical and physiological role of Amino Acid derivatives:** Thyroidal hormones and Adrenal medullary hormones	11

V*	1. Glucose tolerance test. 2. Estimation of serum Ca^{2+}. 3. Estimation of serum T_4. 4. Estimation of serum electrolytes.	15

Suggested Evaluation Methods

Internal Assessment: ➢ **Theory** • Class Participation: • Seminar/presentation/assignment/quiz/class test etc.: • Mid-Term Exam: ➢ **Practicum** • Class Participation: • Seminar/Demonstration/Viva-voce/Lab records etc.: • Mid-Term Exam:	**End Term Examination:** Written theory examination will be conducted as per scheme. Evaluation of the practical skill will be done by an external examiner.

Part C-Learning Resources

1. Textbook of Biochemistry and Human Biology (3rd Edition). Talwar G.P, Srivastava L.M. and Moudgil K.D. (2002). Prentice-Hall of India Private Limited, New Delhi, India.
2. Lehninger: Principles of Biochemistry (7th edition). Nelson D.L. and Cox, M.M. (2017). Worth Publishers, New York, USA.
3. Essentials of Medical Physiology (5th Edition). Sembuligam K. and Sembulingam P (2010). Jaypee Brothers Medical Publishers, New Delhi, India.
4. Endocrinology (6th Edition). Hadley M.C. and Levine. (2007). J.E. Pearson Education, New Delhi.
5. The Cell: A Molecular Approach (5th Edition). Cooper G.M. and Hausman R.E (2009). ASM Press & Sunderland, Washington DC.
6. Introductory Practical Biochemistry by S.K. Sawhney & R. Singh (2017). Narosa Publishers.
7. Biochemical Methods, 3rd edition, by Sadasivam & Manickam (2018). New Age International (P) Ltd.
8. Modern Experimental Biochemistry, 3rd edition, by R. Boyer (2002) Addison-Wesley Longman.

*Applicable for courses having practical component.

Session: 2023-24			
Part A - Introduction			
Subject	Biochemistry		
Semester	3		
Name of the Course	Biochemistry of Lifestyle Diseases		
Course Code	B23-BCH-303		
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	MDC		
Level of the course (As per Annexure-I	200-299		
Pre-requisite for the course (if any)	Students appeared in B.Sc. 2nd semester		
Course Learning Outcomes (CLO):	After completing this course, the learner will be able to: 5. Demonstrate the knowledge of various types of lifestyle diseases; correlation among lifestyle and metabolic disorders. 6. Give an insight on Diabetes and cancer (lifestyle factors, exercise and management). 7. Know about the Diet and lifestyle interventions in management of heart diseases. 8. Understand and analyze the relationship of Sedentary Lifestyle and metabolism and significance of physical exercise in maintaining good health.		
	5*. An understanding of qualitative analysis of normal and abnormal constituents of urine; quantitative analysis of constituents of blood.		
Credits	Theory	Practical	Total

	2	1	3
Contact Hours	30	15	45

Max. Marks: 75 **Internal Assessment Marks: 20 (15T+5P)** **End Term Exam Marks: 55 (35T+20P)**	**Time: T-3hrs.** **P-4hrs**

Part B- Contents of the Course

Instructions for Paper- Setter: The question paper will consist of NINE questions out of which the candidate would be required to attempt FIVE questions. The first question will be compulsory and will have 5 short answer questions uniformly spread over entire syllabus. The remaining EIGHT questions will be set taking TWO questions from each of the four units. Each question will carry 10 marks. The candidate would be required to attempt ONE question from each unit in addition to compulsory question.

Unit	Topics	Contact Hours
I	**Overview of lifestyle diseases:** Impact of lifestyle diseases on public health, economy and society. **Obesity and metabolic syndrome:** Molecular mechanisms linking lifestyle factors (diet, physical activity) to metabolic disorders.	7
II	**Diabetes:** Role of diet, exercise, and other lifestyle factors in diabetes management. **Cancer:** Lifestyle factors influencing cancer development; Diet and lifestyle interventions in management of cancer.	8
III	**Heart diseases and atherosclerosis development:** Diet and lifestyle interventions in management of these diseases.	7
IV	**Modern Lifestyle and Exercise:** Impact of physical inactivity on metabolism and health; Biochemical changes induced by exercise and physical activity; Exercise prescription and its role in preventing lifestyle diseases.	8
V*	5. Qualitative analysis of sugar in urine. 6. Monitoring blood pressure (systolic and diastolic) using sphygmomanometer. 7. Estimation of hemoglobin. 8. Monitoring oxygen level and heart rate during and after exercise.	15

Suggested Evaluation Methods

Internal Assessment: ➢ **Theory** • Class Participation: • Seminar/presentation/assignment/quiz/class test etc.: • Mid-Term Exam: ➢ **Practicum** • Class Participation: • Seminar/Demonstration/Viva-voce/Lab records etc.: • Mid-Term Exam:	**End Term Examination:** Written theory examination will be conducted as per scheme. Evaluation of the practical skill will be done by an external examiner.

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Teitz text book of clinical chemistry, 6th edition, Carl A. Burtis and Edward R. Ashwood, W. B. (2017). Saunders Company.
2. Harper's Biochemistry by R.K. Murray, P.A. Hayes, D.K. Granner, P.A. Mayes and V.W. Rodwell (2003). Prentice Hall International.
3. Textbook of Biochemistry with Clinical Correlations, 5th edition, by T.M. Devlin (2002). Wiley-liss.
4. Biochemistry 4th edition, by U. Satyanarayana (2013). Books and allied (P) Ltd.
5. Textbook of Biochemistry and Human Biology, 3rd edition, Talwar G.P, Srivastava L.M. and Moudgil K.D. (2002). Prentice-Hall of India Private Limited, New Delhi, India.
6. Introductory Practical Biochemistry by S.K. Sawhney & R. Singh (2014). Narosa Publishers.
7. Biochemical Methods, 3rd edition, by Sadasivam & Manickam (2018). New Age International (P) Ltd.
8. Modern Experimental Biochemistry, 3rd edition, by R. Boyer (2002) Addison-Wesley Longman.

*Applicable for courses having practical component.

Session: 2023-24			
Part A – Introduction			
Subject	Biochemistry		
Semester	4		
Name of the Course	Amino acid and Nucleotide Metabolism		
Course Code	B23-BCH-401		
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	CC/MCC		
Level of the course (As per Annexure-I	200-299		
Pre-requisite for the course (if any)	Students appeared in B.Sc. 3rd semester		
Course Learning Outcomes (CLO):	After completing this course, the learner will be able to: 1. Know the reactions and regulation of lipid biosynthesis and catabolism by beta oxidative pathways: ketone bodies metabolism and integration to the metabolism of other biomolecules. 2. Understand how amino acid catabolism leads to formation of diverse type molecules including ketone bodies, glucose, urea. 3. Learn the catabolism and anabolism of nucleic acids. **4.** Acquire detailed knowledge of porphyrin Metabolism.		
	5*. Develop the skills of performing analysis of transaminases profile of serum; quantitatively analyze the serum sample for metabolized product.		
Credits	Theory	Practical	Total

	3	1	4
Contact Hours	45	15	60
Max. Marks: 100 **Internal Assessment Marks: 30 (20T+10P)** **End Term Exam Marks: 70 (50T+20P)**		**Time: T-3hrs.** **P-4hrs.**	

Part B- Contents of the Course

Instructions for Paper- Setter: The question paper will consist of NINE questions out of which the candidate would be required to attempt FIVE questions. The first question will be compulsory and will have 5 short answer questions uniformly spread over entire syllabus. The remaining EIGHT questions will be set taking TWO questions from each of the four units. Each question will carry 10 marks. The candidate would be required to attempt ONE question from each unit in addition to compulsory question.

Unit	Topics	Contact Hours
I	**Lipid Metabolism:** Introduction, hydrolysis of triacylglycerols, activation of fatty acids, transport of fatty acyl CoA into mitochondria, beta-oxidation of saturated, unsaturated and odd chain fatty acids. ATP yield from fatty acid oxidation. Biosynthesis of saturated fatty acids. Biosynthesis of triglycerides. Metabolism of ketone bodies.	12
II	**Amino acid Metabolism:** General reactions of amino acid metabolism: transamination, oxidative and non-oxidative deamination and decarboxylation. Urea cycle. Glycogenic and ketogenic amino acids. Biosynthesis of aromatic amino acids. Glucose-Alanine cycle.	11
III	**Nucleotide Metabolism:** Sources of the atoms in the purine and pyrimidine molecules, *denovo* biosynthesis and degradation of purine and pyrimidine nucleotides, Regulation of purine and pyrimidine biosynthesis. Salvage pathways of purines and pyrimidines.	11
IV	**Porphyrin Metabolism:** Structure of porphyrins, Biosynthesis and degradation of heme. Disorders of porphyrin metabolism and their treatment (Chronic hepatic, acute hepatic and erythroietic); jaundice (Hemolytic and obstructive jaundice).	11

V*	1. Assay of serum transaminases – SGOT. 2. Assay of serum transaminases –SGPT. 3. Estimation of serum urea. 4. Estimation of serum uric acid. 5. Estimation of serum creatinine.	15

Suggested Evaluation Methods

Internal Assessment: ➢ **Theory** • Class Participation: • Seminar/presentation/assignment/quiz/class test etc.: • Mid-Term Exam: ➢ **Practicum** • Class Participation: • Seminar/Demonstration/Viva-voce/Lab records etc.: • Mid-Term Exam:	**End Term Examination:** Written theory examination will be conducted as per scheme. Evaluation of the practical skill will be done by an external examiner.

Part C-Learning Resources

9. Lehninger: Principles of Biochemistry, 7th edition, by David L. Nelson and M.M. Cox (2017). Maxmillan/ Worth publishers.
10. Fundamentals of Biochemistry: Life at the Molecular Level, 5th Edition, by Donald Voet, Judith G Voet, Charlotte W. Pratt. (2016). John Wiley & Sons, NY
11. Biochemistry, 4th edition, by R.H. Garrett and C.M. Grisham. (2010). Saunders College Publishing, NY.
12. Biochemistry, 5th edition, by Laurence A. Moran, H. R. Horton, K.G. Scrimgeour, Marc D. Perry. (2011), Pearson Publishers.
13. Introductory Practical Biochemistry by S.K. Sawhney & R. Singh (2014). Narosa Publishers
14. Modern Experimental Biochemistry, 3rd edition, by R. Boyer (2002) Addison-Wesley Longman.
15. An introduction to Practical Biochemistry, 3rd Edition, by David Plummer (2017). Tata Mc-Graw Hill.
16. Biochemical Methods, 3rd edition, by Sadasivam & Manickam (2018). New Age International (P) Ltd.

*Applicable for courses having practical component.

Session: 2023-24			
Part A – Introduction			
Subject	Biochemistry		
Semester	4		
Name of the Course	Basics of Genetic Information		
Course Code	B23-BCH-402		
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	MCC		
Level of the course (As per Annexure-I	200-299		
Pre-requisite for the course (if any)	Students appeared in B.Sc. 3rd semester		
Course Learning Outcomes (CLO):	After completing this course, the learner will be able to: 1. Understand the basic Concepts of Genetic Information and genomic organization. 2. Explain the concepts of genes and their role in genetic inheritance and evolution; know the chromatin & chromosomal organization. 3. Understand the organization and function of chromosomes and their impact on cellular functioning and development; also know the overview of chromosomal anomalies. 4. Know the details about the transposable elements and elaborate the DNA supercoiling; nucleases and various approaches of sequencing of DNA.		
	5*. Develop proficiency in laboratory techniques for chromosome and genomic analysis and isolation of genetic material from biological samples.		
Credits	Theory	Practical	Total
	3	1	4

Contact Hours	45	15	60

Max. Marks: 100 **Internal Assessment Marks: 30 (20T+10P)** **End Term Exam Marks: 70 (50T+20P)**	**Time: T-3hrs.** **P-4hrs.**

Part B- Contents of the Course

Instructions for Paper- Setter: The question paper will consist of NINE questions out of which the candidate would be required to attempt FIVE questions. The first question will be compulsory and will have 5 short answer questions uniformly spread over entire syllabus. The remaining EIGHT questions will be set taking TWO questions from each of the four units. Each question will carry 10 marks. The candidate would be required to attempt ONE question from each unit in addition to compulsory question.

Unit	Topics	Contact Hours
1	**Basic Concepts of Genetic Information:** Nucleic acids as genetic information carriers: experimental evidences e.g. bacterial genetic transformation, Hershey-Chase experiment, TMV reconstitution experiment. Central dogma of molecular genetics: current version. **Genome organization:** Viruses and prokaryotes, Eukaryotes-Organization of nuclear and organellar genomes, C-value paradox, Repetitive DNA - satellite DNAs and interspersed repeat DNAs.	12
II	**Concept of gene**: Conventional and modern views, fine structure of gene, split genes, pseudogenes, non-coding genes, overlapping genes and multi-gene families. **Eukaryotic chromatin and chromosome:** Histones: structure and functions, Nucleosome morphology and higher-level organization, Functional states of chromatin and alterations in chromatin organization.	11
III	**Chromosome organization:** Metaphase chromosomes: centromere and kinetochore, telomere and its maintenance, Holocentric chromosomes, Heterochromatin and euchromatin, Chromosomal domains (matrix, loop domains) and their functional significance, Chromatin remodeling. **Chromosomal anomalies:** Overview of numerical and structural alterations, and their impact on cellular functioning and development, induced chromosomal aberrations in somatic cells.	11
IV	**Transposable elements**: Barbara McClintock's experiment of maize, Autonomous and non-autonomous transposons, clonal	11

	selection, retrotransposons, LINES, SINES, Alu family, Application of transposons in mutagenesis, genome mapping and evolution. **DNA Supercoiling:** A brief account of DNA supercoiling and topoisomerases. DNA Sequencing: Sequencing of DNA by chemical cleavage and dideoxy methods. Nucleases: Important DNases and RNases including restriction endonucleases.	
V*	1. Laboratory orientation and demonstration of basic equipments to be used in chromosome/gene analysis. 2. Chromosome Analysis: karyotyping. 3. Metaphase chromosome preparation with G banding and C banding from any biological sample. 4. Isolation of genomic DNA from any biological sample. 5. Isolation of metagenome from soil/water samples.	15

Suggested Evaluation Methods

Internal Assessment: ➢ **Theory** • Class Participation: • Seminar/presentation/assignment/quiz/class test etc.: • Mid-Term Exam: ➢ **Practicum** • Class Participation: • Seminar/Demonstration/Viva-voce/Lab records etc.: • Mid-Term Exam:	**End Term Examination:** Written theory examination will be conducted as per scheme. Evaluation of the practical skill will be done by an external examiner.

Part C-Learning Resources

17. Lehninger: Principles of Biochemistry, 7th edition, by David L. Nelson and M.M. Cox (2017). Maxmillan/ Worth publishers.
18. Fundamentals of Biochemistry: Life at the Molecular Level, 5th edition, by Donald Voet, Judith G Voet, Charlotte W. Pratt (2016). John Wiley & Sons, NY.
19. Biochemistry, 4th edition, by R.H. Garrett and C.M. Grisham (2010). Saunders College Publishing, NY.
20. Biochemistry, 5th edition, by Laurence A. Moran, H. R. Horton, K.G. Scrimgeour, Marc D. Perry (2011), Pearson Publishers.
21. Biochemistry, 8th edition, by J.M. Berg, John L. Tymoczko, L. Stryer (2015). W.H. Freeman & Co.,NY.
22. Molecular Cell Biology, 8th edition, by Harvey Lodish et al. (2016), Macmillian learning.
23. Molecular Biology of the Gene, 7th edition, by J.D. Watson (2017), Pearson Publisher.
24. Genes XII by B. Lewin (2017), Jones and Bartlett Publishers.

*Applicable for courses having practical component.

Session: 2023-24	
Part A - Introduction	
Subject	Biochemistry
Semester	4
Name of the Course	Elementary Microbial Biochemistry
Course Code	B23-BCH-403
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	MCC
Level of the course (As per Annexure-I	200-299
Pre-requisite for the course (if any)	Students appeared in B.Sc. 3rd semester
Course Learning Outcomes (CLO):	After completing this course, the learner will be able to: 1. Know various types of microbes, understand the classification strategy, microbial diversity and morphology of major groups of microorganisms. 2. Demonstrate the cultivation and maintenance of microorganisms including the factors affecting the microbial growth; learn the various methods of control of microorganisms. 3. Exhibit the knowledge of microbial metabolism and types of reproduction in bacteria. 4. Able to understand the various aspects of water and food microbiology.
	5*. Exhibit skills in preparation of media and staining; isolate, identify and characterize bacteria from

	different sources.		
Credits	Theory	Practical	Total
	3	1	4
Contact Hours	45	15	60
Max. Marks: 100 **Internal Assessment Marks: 30 (20T+10P)** **End Term Exam Marks: 70 (50T+20P)**		**Time: T-3hrs.** **P-4hrs.**	

Part B- Contents of the Course

Instructions for Paper- Setter: The question paper will consist of NINE questions out of which the candidate would be required to attempt FIVE questions. The first question will be compulsory and will have 5 short answer questions uniformly spread over entire syllabus. The remaining EIGHT questions will be set taking TWO questions from each of the four units. Each question will carry 10 marks. The candidate would be required to attempt ONE question from each unit in addition to compulsory question.

Unit	Topics	Contact Hours
I	**Introduction to Microbiology:** Some important events in the development of Microbiology, The species concept in Microbiology, Classical taxonomy, Microbial phylogeny and current classification of bacteria, Microbial Diversity: Distribution and characterization of Prokaryotic and Eukaryotic cells, Morphology and cell structure of major groups of microorganisms e.g. Bacteria, Algae, Fungi, Protozoa and Unique features of viruses.	12
II	**Cultivation and Maintenance of microorganisms**: Nutritional categories of micro-organisms, Culture Media, Isolation of pure cultures, Microbial growth: Growth curve, Generation time, Continuous culture, factors affecting growth of bacteria: temperature, pH, osmolarity and oxygen. 1 **Control of Microorganisms:** Physical and chemical methods.	11
III	**An overview of metabolism**: Energy conservation, Fermentation: Some common microbial fermentations, Aerobic and anaerobic respiration, Chemolithotrophy and Phototrophy.	11

	Bacterial Genetics: Transformation, Transduction and Conjugation.	
IV	**Water Microbiology:** Public health and water quality, Coliform test, Drinking water purification, Waterborne microbial diseases: Cholera and Typhoid fever **Food Microbiology**: Food spoilage, major food born infections and intoxications, Basic approaches to food preservation, Fermented foods.	11
V*	1. Isolation of bacteria & their biochemical characterization. 2. Preparation of media & Sterilization of microbial media by autoclave. 3. Isolation of pure cultures: (i) Streak plate method. (ii) Serial dilution method. 4. Gram Staining Techniques.	15

Suggested Evaluation Methods

Internal Assessment: ➢ **Theory** • Class Participation: • Seminar/presentation/assignment/quiz/class test etc.: • Mid-Term Exam: ➢ **Practicum** • Class Participation: • Seminar/Demonstration/Viva-voce/Lab records etc.: • Mid-Term Exam:	**End Term Examination:** Written theory examination will be conducted as per scheme. Evaluation of the practical skill will be done by an external examiner.

Part C-Learning Resources

1. Microbiology. Prescott, Harley, Klein. (2008). McGraw-Hill Higher Education, Boston.
2. Microbiology. Pelczar M.J, Chan E.C.S, Krieg N.R. (1998). McGraw-Hill, New York.
3. A textbook of Microbiology. Dubey R.C. and Maheshwari D.K. (2008). S. Chand and Company Ltd, New Delhi.
4. Text book of Microbiology, 8th edition, Ananthanarayan R and Paniker CKJ. (2009). University Press.
5. Biology of Microorganisms. Madigan M., Martinko., Parker J. Brock's. (2007). Pearson Prentice Hall.
6. An introduction to Practical Biochemistry, 3rd Edition, by David Plummer. (2017). Tata Mc-Graw Hill.
7. Introductory Practical Biochemistry by S.K. Sawhney & R. Singh (2014). Narosa Publishers.
8. Principles & Techniques of Biochemistry & Molecular Biology, 7th edition, by Keith

Wilson and John Walker. (2018).

*Applicable for courses having practical component.

Session: 2023-24			
Part A - Introduction			
Subject	Biochemistry		
Semester	4		
Name of the Course	Animal Biochemistry		
Course Code	B23-BCH-404		
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	DSE		
Level of the course (As per Annexure-I	200-299		
Pre-requisite for the course (if any)	Students appeared in B.Sc. 3rd semester		
Course Learning Outcomes (CLO):	After completing this course, the learner will be able to: 1. Understand the concept of homeostasis and its importance in maintaining a stable internal environment. 2. Understand the anticoagulant and fibrinolytic systems and their regulation of blood and will also be able to analyze the urine composition. 3. Understand the concepts of water and acid-base balance in the human body and the specific role of the kidneys in regulating acid-base balance. 4. Understand the composition and structure of specialized tissues of the body.		
	5*. Knowledge of experiments of hematology like RBC, WBC, differential leucocyte count; quantitative analysis of constituents of blood and their estimation using standard methods.		
Credits	Theory	Practical	Total
	3	1	4

Contact Hours	45	15	60

Max. Marks: 100 **Internal Assessment Marks: 30 (20T+10P)** **End Term Exam Marks: 70 (50T+20P)**	**Time: T-3hrs.** **P-4hrs.**

Part B- Contents of the Course

Instructions for Paper- Setter: The question paper will consist of NINE questions out of which the candidate would be required to attempt FIVE questions. The first question will be compulsory and will have 5 short answer questions uniformly spread over entire syllabus. The remaining EIGHT questions will be set taking TWO questions from each of the four units. Each question will carry 10 marks. The candidate would be required to attempt ONE question from each unit in addition to compulsory question.

Unit	Topics	Contact Hours
I	**Homeostasis and the organization of body fluid compartments:** Blood composition and biochemical functions of erythrocytes, leucocytes and platelets. Important plasma proteins and their functions. Homeostasis: Intracellular, extracellular and interstitial fluid.	12
II	**Blood Clotting:** Molecular mechanism of blood coagulation, role of vitamin K in coagulation, anticoagulant and fibrinolytic systems. Urine composition and analysis.	11
III	**Electrolyte and acid base balance:** Disorders of electrolytes (hypernatremia, hyponatremia, hypokalemia, hyperkalemia, hyperchloremia, hypochloremia); water and acid base balance (metabolic and respiratory acidosis, metabolic and respiratory alkalosis); Role of blood buffers; respiratory and renal mechanism in the maintenance of blood pH. Role of kidneys in acid base balance.	11
IV	**Composition and metabolism of specialized tissues:** Muscle, connective tissue, skin, nervous tissue and adipose tissue.	11
V*	1. RBC and WBC counting 2. Differential leucocyte count. 3. Identify and differentiate erythrocytes, leukocytes, and platelets. 4. Separation of serum and plasma from blood. 5. Observe clotting time of the blood	15

Suggested Evaluation Methods

Internal Assessment:	End Term Examination:
➢ **Theory** • Class Participation: • Seminar/presentation/assignment/quiz/class test etc.: • Mid-Term Exam: ➢ **Practicum** • Class Participation: • Seminar/Demonstration/Viva-voce/Lab records etc.: • Mid-Term Exam:	Written theory examination will be conducted as per scheme. Evaluation of the practical skill will be done by an external examiner.

Part C-Learning Resources

9. Lehninger: Principles of Biochemistry, 7th ed., by David L. Nelson and M.M. Cox (2017.) Maxmillan/ Worth publishers.
10. Vander's Human Physiology, 11th ed., Widmaier, E.P., Raff, H. and Strang, K.T. (2008) McGraw Hill International Publications (New York).
11. Harper's Biochemistry, 29th ed., Murray, R.K., Granner, D.K., Mayes and P.A., Rodwell, V.W. (2012) Lange Medical Books/McGraw Hill.
12. Textbook of Medical Physiology, 10th ed., Guyton, A.C. and Hall, J.E. (2011). Reed Elseviers India Pvt. Ltd. (New Delhi).
13. Fundamental of Anatomy and Physiology, 8th ed., Martini, F.H. and Nath, J.L. (2009) Pearson Publications (San Francisco).
14. Biochemistry by Satyanarayana, U. (2013). Elsevier Health Sciences.
15. Immunology, 7th ed., Janis Kuby. (2019). W. H. Freeman and Co.
16. Modern Experimental Biochemistry, 3rd edition, by R. Boyer (2002) Addison-Wesley Longman.

*Applicable for courses having practical component.

Session: 2023-24			
Part A – Introduction			
Subject	Biochemistry		
Semester	4		
Name of the Course	Plant Biochemistry		
Course Code	B23-BCH-405		
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	DSE		
Level of the course (As per Annexure-I	200-299		
Pre-requisite for the course (if any)	Students appeared in B.Sc. 3rd semester		
Course Learning Outcomes (CLO):	After completing this course, the learner will be able to: 1. Exhibit the knowledge of structure and energy generation by the photosynthetic apparatus; CO_2 assimilation by different pathways. 2. Understand CO_2 assimilation by different pathways and photorespiration. 3. Gain knowledge about structural organization and functioning of ETC in chloroplast and mitochondria. 4. Learn in detail about nitrogen metabolism pathway in plants with structure and regulation of enzymes: nitrate reductase and nitrite reductase; exhibit the knowledge of nitrogen fixation with illustrate the mechanism of action of the enzyme nitrogenase.		
	5*. Learn appropriate how to extract and determine quantitatively the contents and the spectral patterns of photosynthetic pigments; determine content of phenols and tannins in plant samples and explore antioxidant property of plant extracts.		
Credits	Theory	Practical	Total

	3	1	4
Contact Hours	45	15	60
Max. Marks: 100 **Internal Assessment Marks: 30 (20T+10P)** **End Term Exam Marks: 70 (50T+20P)**		**Time: T-3hrs.** **P-4hrs.**	

Part B- Contents of the Course

Instructions for Paper- Setter: The question paper will consist of NINE questions out of which the candidate would be required to attempt FIVE questions. The first question will be compulsory and will have 5 short answer questions uniformly spread over entire syllabus. The remaining EIGHT questions will be set taking TWO questions from each of the four units. Each question will carry 10 marks. The candidate would be required to attempt ONE question from each unit in addition to compulsory question.

Unit	Topics	Contact Hours
I	Photosynthesis**: Photosynthetic apparatus, pigments of photosynthesis, role of carotenoids, photosystems I and II, their location; Hill reaction, photosynthetic electron transport and generation of NADPH & ATP, cyclic and non-cyclic photophosphorylation, complexes associated with thylakoid membranes; light harvesting complexes.**	12
II	**Photosynthetic CO_2 Assimilation**: Pathways, reactions and regulation of CO_2 assimilation in C3 plants (wheat, rice), C4 (sugarcane, corn) & CAM (pineapple, moringa) plants. Photorespiration**: Organelles involved in photorespiration, reactions of C2 cycle and co-ordination among the organelles involved, correlation of photosynthesis and photorespiration, importance of photorespiration for plants (correlation to yield).**	11
III	Electron transport system in plants**: Oxidative phosphorylation, mitochondrial respiratory complexes, order and organization of electron carriers, electrochemical gradient, chemiosmotic theory, ATP synthase and mechanism of ATP synthesis. Comparison of plants and animal electron transport chain.**	11
IV	**Nitrogen metabolism**: Nitrate uptake, factors affecting nitrate uptake, structural features of nitrate reductase and nitrite reductase, incorporation of ammonia into organic	11

	compounds, regulation of nitrate reductase, nitrite reductase and nitrate assimilation. **Biological N_2-fixation**: Biological nitrogen fixation by free living organisms. Symbiotic association; structure, function and mechanism of action of the enzyme nitrogenase, strategies for protection of nitrogenase from inhibition by oxygen; structure of nodule, role of leghaemoglobin.	
V*	1. Extraction and estimation of chlorophylls from grass/spinach leaves 2. Extraction and estimation of carotenoids from grass/spinach leaves 3. Extraction and estimation of total phenols in plant samples 4. Estimation of tannins in fruits and vegetables 5. Determination of radical scavenging activity of plant extracts.	15
Suggested Evaluation Methods		
Internal Assessment: ➢ **Theory** • Class Participation: • Seminar/presentation/assignment/quiz/class test etc.: • Mid-Term Exam: ➢ **Practicum** • Class Participation: • Seminar/Demonstration/Viva-voce/Lab records etc.: • Mid-Term Exam:		**End Term Examination:** Written theory examination will be conducted as per scheme. Evaluation of the practical skill will be done by an external examiner.
Part C-Learning Resources		
17. Biochemistry and Molecular Biology of Plants, 2nd edition by Bob, B. Buchanan (2015). 18. Plant Biochemistry & Molecular Biology, 4th edition, by Hans –Walter Heldt (2010), Academic Press. 19. Plant Biochemistry and Molecular Biology, 2nd edition, by Peter J. Lea and Richard C. Leegood (1999). John Wiley and Sons. 20. Plant physiology, 4th edition, by L. Taiz and E-Zeigler (2006). 21. An introduction to Practical Biochemistry, 3rd edition, by David Plummer (2017). Tata Mc-Graw Hill. 22. Introductory Practical Biochemistry by S.K. Sawhney& R. Singh (2014). Narosa Publishers. 23. Modern Experimental Biochemistry, 3rd edition, by R. Boyer (2002). Addison-Wesley Longman.		

*Applicable for courses having practical component.

Session: 2023-24			
Part A - Introduction			
Subject	Biochemistry		
Semester	3		
Name of the Course	Biomedical Waste Management		
Course Code	B23-VOC-124		
CourseType: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	VOC		
Level of the course (As per Annexure-I	200-299		
Pre-requisite for the course (if any)	Students appeared in B.Sc. 2nd semester		
Course Learning Outcomes (CLO):	After completing this course, the learner will be able to: 1. Exhibit the definition and classification of biomedical waste. 2. Demonstrate the ability to segregate biomedical waste according to its category and color-coding. 3. Analyze the environmental impact of biomedical waste treatment and disposal methods. 4. Demonstrate knowledge of occupational health and safety practices for waste handlers.		
	5* Understand the practical aspect of waste management, specifically on the proper segregation and handling of biomedical waste .		
Credits	Theory	Practical	Total

	2	2	4
Contact Hours	30	30	60

Max. Marks: 100 **Internal Assessment Marks: 30 (15T+15P)** **End Term Exam Marks: 70 (35T+35P)**	**Time: T-3hrs.** **P-4hrs.**

Part B-Contents of the Course

Instructions for Paper- Setter: The question paper will consist of NINE questions out of which the candidate would be required to attempt FIVE questions. The first question will be compulsory and will have 5 short answer questions uniformly spread over entire syllabus. The remaining EIGHT questions will be set taking TWO questions from each of the four units. Each question will carry 10 marks. The candidate would be required to attempt ONE question from each unit in addition to compulsory question.

Unit	Topics	Contact Hours
I	**Introduction to Biomedical Waste Management:** Definition and classification of biomedical waste; Significance of proper biomedical waste management; Health and environmental risks associated with biomedical waste; National and international regulations and guidelines; Role of regulatory bodies and compliance requirements.	8
II	**Biomedical Waste Segregation and Collection:** Segregation techniques and color-coding of waste categories; Safe handling procedures and personal protective equipment (PPE); Collection methods, containers, and labeling requirements; Transportation considerations and logistics; Documentation and record-keeping for waste collection.	7
III	**Biomedical Waste Treatment and Disposal:** Overview of treatment technologies (e.g., autoclaving, incineration, chemical treatment); Environmental impact assessment and considerations; Disposal methods, including landfilling, recycling, and waste-to-energy; Emerging trends in waste treatment and disposal; Effective waste treatment and disposal practices.	8
IV	**Infection Control and Safety Practices:** Infection control measures to prevent the spread of diseases; Occupational health and safety practices for waste handlers; Training	7

	programs and education for healthcare professionals; Auditing, monitoring, and quality assurance; Public awareness campaigns and community engagement.	
V*	1. Visits to healthcare facilities/waste treatment plants/ or waste management companies (to provide students with first hand exposure to biomedical waste management practices). 2. Safety and infection control demonstrations (include proper hand hygiene techniques, waste handling procedures etc). 3. Field survey – survey of 10 hospitals of the area and prepare project report (highlighting real-world challenges and solutions in biomedical waste management) on the management in these organizations. 4. Group projects that involve developing waste management plans for hypothetical healthcare facilities or designing public awareness campaigns.	30

Suggested Evaluation Methods

InternalAssessment: ➢ **Theory** • Class Participation: • Seminar/presentation/assignment/quiz/class test etc.: • Mid-Term Exam: ➢ **Practicum** • Class Participation: • Seminar/Demonstration/Viva-voce/Lab records etc.: • Mid-Term Exam:	**End Term Examination:** Written theory examination will be conducted as per scheme. Evaluation of the practical skill will be done by an external examiner.

Part C-Learning Resources

- Hospital Waste Management: A Guide for Self-Assessment and Review " by Shishir Basarkar (2021).
- Biomedical Waste Management in Hospitals: Dr. G. Latha & Dr. M. Rajasekhar (2021).
- Waste Management and Resource Recycling in the Developing World by André C. S. Batalhão, Arif Ahamad, Pardeep Singh, Pramit Verma, Rishikesh Singh (2022).
- Biomedical Waste Management by Srividya Kartik (2019).

*Applicable for courses having practical component.

Session: 2023-24			
Part A - Introduction			
Subject	Biochemistry		
Semester	2		
Name of the Course	Bioanalytical Techniques		
Course Code	B23-SEC-222		
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	SEC		
Level of the course (As per Annexure-I	100-199		
Pre-requisite for the course (if any)	Students appeared in B.Sc. 1st semester		
Course Learning Outcomes (CLO):	After completing this course, the learner will be able to: 5. Understand the basic chemistry and properties of water; physiological buffers. 6. Demonstrate the knowledge of the general principles, components and applications of centrifuges. 7. Learn the principles and applications of chromatographic techniques in isolation, quantification and characterization of biomolecules. 8. Know the general principles, components and applications of spectrophotometer.		
	5*. Develop the skills to verify and apply the basic principles of spectroscopy; separation of amino acids by thin layer/ paper chromatography. .		
Credits	Theory	Practical	Total
	2	1	3

Contact Hours	30	15	45

Max. Marks: 75 **Internal Assessment Marks: 20 (15T+5P)** **End Term Exam Marks: 55 (35T+20P)**	**Time: T-3hrs.** **P-4hrs.**

Part B- Contents of the Course

Instructions for Paper- Setter: The question paper will consist of NINE questions out of which the candidate would be required to attempt FIVE questions. The first question will be compulsory and will have 5 short answer questions uniformly spread over entire syllabus. The remaining EIGHT questions will be set taking TWO questions from each of the four units. Each question will carry 10 marks. The candidate would be required to attempt ONE question from each unit in addition to compulsory question.

Unit	Topics	Contact Hours
I	Water and Buffers: **Structure, hydrogen bonding, solvent properties, and ionization, Weak acids and bases, ionization of weak acids, titration of weak acid by a strong base, pH, buffers, Henderson-Hasselbalch equation and physiological buffers.** **Measurement of pH:** Principles and composition of reference electrodes, glass electrode and combined electrode.	8
II	**Centrifugation**: Basic principle of centrifugation techniques, sedimentation rate, Svedberg unit / sedimentation coefficient. Preparative ultracentrifuge, Differential centrifugation, density gradient centrifugation, rate zonal, isopycnic, equilibrium centrifugation. Analytical ultracentrifuge method.	7
III	**Chromatographic techniques**- General principles and applications of adsorption, ion-exchange, molecular-sieve, thin layer & paper chromatography.	7
IV	**UV-Visible Spectroscopic techniques:** Beer-Lambert law, light absorption and its transmittance, extinction coefficient, a brief account of instrumentation and applications of visible and UV spectroscopic techniques (structure elucidation excluded).	8
V*	1. Determination of pKa of acetic acid and glycine. 2. Verification of Beer- Lambert's Law.	15

	3. Estimation of Amino acid by Ninhydrin method. 4. Estimation of Protein by Biuret method. 5. Separation of amino acids/ sugars by thin layer chromatography/paper chromatography.	
Suggested Evaluation Methods		
Internal Assessment: ➢ **Theory** • Class Participation: • Seminar/presentation/assignment/quiz/class test etc.: • Mid-Term Exam: ➢ **Practicum** • Class Participation: • Seminar/Demonstration/Viva-voce/Lab records etc.: • Mid-Term Exam:		**End Term Examination**
Part C-Learning Resources		

17. Principles & Techniques of Biochemistry & Molecular Biology, 7th edition, by Keith Wilson and John Walker (2018).
18. Biophysical Chemistry: Principles and Techniques, by A. Upadhyay, K. Upadhyay and N. Nath. (2016). Himalaya Publishing House, Delhi.
19. Introductory Practical Biochemistry by S.K. Sawhney and Randhir Singh (2014). Narosa Publishing House, New Delhi.
20. An introduction to Practical Biochemistry, 3rd Edition, by David Plummer (2017). Tata Mc-Graw Hill
21. Modern Experimental Biochemistry, 3rd edition, by R. Boyer (2002) Addison-Wesley Longman.
22. Biochemical Methods, 3rd edition, by Sadasivam & Manickam (2018) New Age International (P) Ltd.

*Applicable for courses having practical component.

Session: 2023-24			
Part A – Introduction			
Subject	Biochemistry		
Semester	3		
Name of the Course	**Immunological Techniques**		
Course Code	B23-SEC-322		
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	SEC		
Level of the course (As per Annexure-I	200-299		
Pre-requisite for the course (if any)	Students appeared in B.Sc. 2nd semester		
Course Learning Outcomes (CLO):	After completing this course, the learner will be able to: 9. Gain the knowledge about the components and production of the immune system including antibodies and antigens 10. Understand about electrophoresis and Immunoprecipitation techniques. 11. Demonstrate principles and applications of agglutination reactions and immunoassays. 12. Demonstrate the knowledge of advance techniques in immunology.		
	5*. Exhibit skills to isolate lymphocytes from blood/spleen and to perform various immunoassays such as Ouchterlony double immunodiffusion (DID); perform techniques to purify immunoglobulins and the blood typing. .		
Credits	Theory	Practical	Total

	2	1	3
Contact Hours	30	15	45
Max. Marks: 75 **Internal Assessment Marks: 20 (15T+5P)** **End Term Exam Marks: 55 (35T+20P)**		**Time: T-3hrs.** **P-4hrs.**	

Part B- Contents of the Course

Instructions for Paper- Setter: The question paper will consist of NINE questions out of which the candidate would be required to attempt FIVE questions. The first question will be compulsory and will have 5 short answer questions uniformly spread over entire syllabus. The remaining EIGHT questions will be set taking TWO questions from each of the four units. Each question will carry 10 marks. The candidate would be required to attempt ONE question from each unit in addition to compulsory question.

Unit	Topics	Contact Hours
I	**Introduction to Immunology and basic technique:** Overview of the immune system and its components; Antigens (Types, properties, and preparation); Antibodies: Structure, types, and functions, Introduction to monoclonal and polyclonal antibodies.	7
II1	**Electrophoresis and Immunoprecipitation Techniques:** Basic principles of electrophoresis; Native and SDS-PAGE (Polyacrylamide Gel Electrophoresis); Agarose gel electrophoresis; Immunoprecipitation techniques in solution; Immunoprecipitation reactions in gel: Radial immune-diffusion (Mancini method) and Ouchterlony double immuno-diffusion.	8
III	**Agglutination reactions and Immunoassays:** Agglutination reactions, immunoassays (principle and methodology); Radioimmunoassay (RIA: Principle and applications); Enzyme-Linked Immunosorbent Assay (ELISA): Direct, indirect, and sandwich; Immuno electrophoresis (principle and methodology): Rocket immunoelectrophoresis: Identification and quantification of antigens;.	8
IV	**Advanced Techniques in Immunology:** Western blotting (immunoblotting- Principle, methodology, and applications); Immunofluorescence techniques: Direct and indirect methods; Principle and applications of immunohistochemistry,	7

	immunocytochemistry and Flow cytometry.	
V*	6. Demonstration of immunodiffusion 7. Purification of immunoglobulins 8. Demonstration of Immunoelectrophoresis 9. Demonstration of Western Blotting 10. Assays based on agglutination reactions – Blood grouping.	15

Suggested Evaluation Methods

Internal Assessment: ➢ **Theory** • Class Participation: • Seminar/presentation/assignment/quiz/class test etc.: • Mid-Term Exam: ➢ **Practicum** • Class Participation: • Seminar/Demonstration/Viva-voce/Lab records etc.: • Mid-Term Exam:	**End Term Examination**

Part C-Learning Resources

23. Immunology – Janis Kuby – W. H. Freeman and Co. 7th edition (2019)
24. Janeway's Immunobiology 2012 8th ed., Murphy, K., Mowat, A., and Weaver, C.T., Garland Science (London & New York), ISBN:978-0-8153-4243-4
25. Immunology, 13th ed. by Roitt et al., Mosby Publications.
26. Immunology" 8th edn. David Male Jonathan Brostoff David Roth Ivan Roitt, 2012.
27. Cellular and Molecular Immunology, 9thed. by Abbas and Litchman, Saunders Publication.
28. Immunology: an introduction, 4th Edition by Ian R Tizard, Saunders College Publishing.

*Applicable for courses having practical component.

Session: 2023-24			
Part A - Introduction			
Subject	Biochemistry		
Semester	3		
Name of the Course	Genetic Engineering		
Course Code	B23-SEC-323		
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	SEC		
Level of the course (As per Annexure-I	200-299		
Pre-requisite for the course (if any)	Students appeared in B.Sc. 2nd semester		
Course Learning Outcomes (CLO):	After completing this course, the learner will be able to: 13. Understand about different terminology related to genetic engineering and tools used for it. 14. Understand about isolation, sequencing and synthesis of genes. 15. Know the techniques for transfer and expression of cloned gene 16. Apply the knowledge of genetic engineering in biological research.		
	5*. Develop the skills to isolate DNA from plants and bacteria, plasmid DNA; Demonstrate the making and transforming competent cells.		
Credits	Theory	Practical	Total
	2	1	3
Contact Hours	30	15	45

Max. Marks: 75 **Internal Assessment Marks: 20 (15T+5P)** **End Term Exam Marks: 55 (35T+20P)**	**Time: T-3hrs.** **P-4hrs.**

Part B- Contents of the Course

Instructions for Paper- Setter: The question paper will consist of NINE questions out of which the candidate would be required to attempt FIVE questions. The first question will be compulsory and will have 5 short answer questions uniformly spread over entire syllabus. The remaining EIGHT questions will be set taking TWO questions from each of the four units. Each question will carry 10 marks. The candidate would be required to attempt ONE question from each unit in addition to compulsory question.

Unit	Topics	Contact Hours
I	**Cloning and amplification of DNA:** Introduction, choice of the organism, use of restriction endonucleases for the production of DNA fragments. Vehicles for cloning - plasmids, phage vectors and cosmids. RNA isolation, preparation and use of cDNAs. Application of recombinant DNA technology.	8
II	**Isolation, sequencing and synthesis of genes:** Isolation of genes, sequencing of genes, synthesis of genes, Cloning of specific eukaryotic genes and their expression in bacteria. Genes involved in regulation, regulatory gene, promoter gene, operator gene and structural genes.	7
III	**Gene transfer methods:** Gene transfer methods for plants- Agrobacterium mediated gene transfer, physical and chemical methods. Gene transfer methods for animals- Biochemical, physical and virus-mediated gene transfer methods.	7
IV	**Applications of Genetic Engineering:** Genetic engineering in animals: Production and applications of transgenic mice, role of ES cells in gene targeting in mice, Therapeutic products produced by genetic engineering.	8
V*	1. Isolation of chromosomal DNA from plant/animal cells 2. Qualitative and quantitative analysis of DNA using spectrophotometer. 3. Plasmid DNA isolation 4. Restriction digestion of DNA 5. Making competent cells 6. Transformation of competent cells.	15

Suggested Evaluation Methods

Internal Assessment: ➢ **Theory** • Class Participation: • Seminar/presentation/assignment/quiz/class test etc.: • Mid-Term Exam: ➢ **Practicum** • Class Participation: • Seminar/Demonstration/Viva-voce/Lab records etc.: • Mid-Term Exam:	**End Term Examination**

Part C-Learning Resources

29. Gene Cloning and DNA Analysis - An Introduction, 7 th edition, by T. A. Brown (2016), Blackwell Publishing.
30. Molecular Biotechnology - Principles & applications of Recombinant DNA, 5th ed., Bernard R. Glick, Cheryl L. Patten (2017), ASM Press.
31. Principles of Gene Manipulation, 7th ed., Sandy B. Primrose, Richard Twyman (2006), Blackwell Scientific Publication.
32. Analysis of Genes and Genomes, 2004 by Richard J Reece, John Wiley & Sons, Ltd.
33. Beier F.K, Crespi R.S and Straus T. Biotechnology and Patent protection, Oxford and IBH Publishing Co. New Delhi.
34. Rajmohan Joshi (Ed.) 2006. Biosafety and Bioethics, Isha Books, Delhi.

*Applicable for courses having practical component.