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UNIVERSITY OF MYSORE

Estd. 1916

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Crawford Hall, Mysuru- 570 005

No.AC2(S)/151/2020-21

Dated: 01.09.2023

Notification

Sub:- Syllabus and Scheme of Examinations of Molecular Biology (UG) (V & VI Semester) with effect from the Academic year 2023-24.

Ref:- 1. This office letter No: AC6/303/2022-23 dated: 28-07-2023.

2. Decision of BOS in Molecular Biology (UG) meeting held on 07-08-2023.

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The Board of Studies in Molecular Biology (UG) which met on 07-08-2023 has resolved to recommended and approved the syllabus and scheme of Examinations of Molecular Biology programme (V & VI Semester) with effect from the Academic year 2023-24.

Pending approval of the Faculty of Science & Technology and Academic Council meetings the above said syllabus and scheme of examinations are hereby notified.

The syllabus and scheme of Examinations contents may be downloaded from the University website i.e., www.uni-mysore.ac.in.

Registrar
University of Mysore
Mysore

Registrar

To:-

1. All the Principal of affiliated Colleges of University of Mysore, Mysore.
2. The Registrar (Evaluation), University of Mysore, Mysuru.
3. The Chairman, BOS/DOS, in Molecular Biology, Manasagangothri, Mysore.
4. The Director, Distance Education Programme, Moulya Bhavan, Manasagangotri, Mysuru.
5. The Director, PMEB, Manasagangothri, Mysore.
6. Director, College Development Council , Manasagangothri, Mysore.
7. The Deputy Registrar/Assistant Registrar/Superintendent, Administrative Branch and Examination Branch, University of Mysore, Mysuru.
8. The PA to Vice-Chancellor/ Registrar/ Registrar (Evaluation), University of Mysore, Mysuru.
9. Office Copy.

University of Mysore

DEPARTMENT OF MOLECULAR BIOLOGY

Syllabus for

V and VI semesters

Integrated M.Sc. in Molecular Biology

(Integrated UG/PG in Molecular Biology)

Model: Integrated UG/PG-C4

Approved during the Board of studies meeting held on 07.08.2023

Integrated UG/PG-C4. Curriculum and Credit Framework for Undergraduate/Postgraduate Programme in a multidisciplinary or interdisciplinary subject Molecular Biology

Sem.	Discipline Specific – Core (DSC), Elective (DSE) Courses (Credits) (L+T+P)	Minor/ Multidisciplinary/ Open Elective (OE) Courses (Credits) (L+T+P)	Ability Enhancement Courses (AEC)(Credits) (L+T+P) (Languages)	Skills Enhancement Courses (SEC) (Credits) (L+T+P)/ Value Added Courses (Credits) (L+T+P) (common for all UG Programs)/ Summer Internship.		Total Credits
I	DSC-C1 (4+0+2); DSC-C2 (4+0+2)	OE-1 (3)	L1-1(3), L2-1(3) (4 hrs each)	**SEC-1**: Digital Fluency (2) (1+0+2)/ Env. Studies (3)	Health, Wellness & Yoga (2) (1+0+2)	25/26
II	DSC-C3 (4+0+2); DSC-C4 (4+0+2)	OE-2 (3)	L1-2(3), L2-2(3) (4 hrs each)	Env. Studies (3)/ SEC-1: Digital Fluency (2) (1+0+2)	Sports/NCC/NSS/R&R(S&G)/ Cultural (2) (0+0+4)/ SEC (2)	26/25
III	DSC-C5 (4+0+2); DSC-C6 (4+0+2)	OE-3 (3)/ India and Indian Constitution (3)	L1-3(3), L2-3(3) (4 hrs. each)	**SEC-2**:AI/Cyber Security/Financial Edu. & Inv. Aw. (2) (1+0+2)	Sports/NCC/NSS/R&R(S&G)/ Cultural (2) (0+0+4)/ SEC (2)	25
IV	DSC-C7(4+0+2); DSC-C8 (4+0+2)	India and Indian Constitution (3)/ OE-3(3)	L1-4(3), L2-4(3) (4 hrs. each)	**SEC-3**: Financial Edu. &Inv. Aw. /AI /Cyber Security (2) (1+0+2)	Sports/NCC/NSS/R&R(S&G)/ Cultural (2) (0+0+4)/ SEC (2)	25
Students exiting the programme after 2-years will be awarded UG Diploma in a Multidisciplinary or Interdisciplinary subject, upon securing 92 credits provided they secure additional 4 credits in skill based vocational courses offered during the first- or second-year summer term.						
V	DSC-C9(4+0+2); DSC-C10 (4+0+2)	DSE-E1(3), E2(3)	Vocational-1(3)	**SEC-4**: Job Skills (3) (2+0+2)		24
VI	DSC-C11(4+0+2); DSC-C12 (4+0+2)	DSE-E3(3), E4(3).	Vocational-2(3).	Internship (2)		23
Students who want to exit after 3-years /undertake 3-year UG programme will be awarded B. Sc. Degree in a Multidisciplinary or Interdisciplinary subject, upon securing 136 credits and satisfying the minimum credit requirements under each category of courses prescribed.						
B.Sc. (Honours) in Disciplines/Inter-disciplines			B.Sc. (Honours with Research) in Disciplines/Inter-disciplines			
VII	DSC-C13(4+0+2); DSC-C14 (4+0+2); Res. Methodology (4)	DSE-E5(3), Vocational-3(3)	DSC-C12(4+0+2); DSC-C13 (4+0+2); Res. Methodology (4)	DSE-E5(3), Vocational-3(3) Res. Proposal formulation (2*)		22
VIII	DSC-C15(4+0+2), DSC-C16 (4+0+2); Internship/Entrepreneurship (4)	DSE-E6(3), Vocational-4(3)	DSC-C14(4)	DSE-E6(3), Vocational-4(3) Research Project (10+2*)		22
Students exiting the programme after 4-years will be awarded B.Sc. (Honours) or B.Sc. (Honours with Research) degree in a Multidisciplinary or Interdisciplinary subject, upon securing 176 credits and satisfying the minimum credit requirements under each category of courses prescribed.						
IX	DSC-C17(4+0+2), DSC-C18 (4+0+2); C19(4), Res. Proposal formulation (2*)	DSE-E7(3), Vocational-5(3).	DSC-C30(2), C31(4), C32(2), C33(4); C34(2), C35(4),	DSE-E7(3), Vocational-5(3),		22/24
X	Research Internship (4), Research Project (16+2*)		DSE-E8(3), E9(3), Research Internship (4), Research Project (10)			22/20
Students successfully completing the programme will be awarded B.Sc./B.Sc. (Hons.)/B.Sc. (Hons. with Res.) & M.Sc. Degrees in a Multidisciplinary or Interdisciplinary subject, upon securing 216 credits and satisfying the minimum credit requirements under each category of courses prescribed						

Note: Only those students who secure 75% marks or CGPA of 7.5 and above in the first six semesters may choose to undertake research in the fourth year. Honours students not undertaking research must do 3 to 4 Additional Courses/Entrepreneurship Courses and Internship/Apprenticeship for 12 credits.

The above is based on the Integrated UG/PG-C4 as given by KHEC, Banagalore which is given below:

Integrated UG/PG-C4. Curriculum and Credit Framework for for Undergraduate/Postgraduate Programme in a multidisciplinary or interdisciplinary subject such as Biological Sciences, Life Sciences, Molecular Biology, Computer Applications, Data Analytics, etc.

Sem.	Discipline Specific – Core (DSC), Elective (DSE) Courses (Credits) (L+T+P)	Minor/ Multidisciplinary/ Open Elective (OE) Courses (Credits) (L+T+P)	Ability Enhancement Courses (AEC)(Credits) (L+T+P) (Languages)	Skills Enhancement Courses (SEC) (Credits) (L+T+P)/ Value Added Courses (Credits) (L+T+P) (common for all UG Programs)/ Summer Internship.		Total Credits
I	DSC-C1(4), C2(2), C3(4), C4(2).	OE-1 (3)	L1-1(3), L2-1(3) (4 hrs each)	**SEC-1**: Digital Fluency (2) (1+0+2)/ Env. Studies (3)	Health, Wellness & Yoga (2) (1+0+2)	25/26
II	DSC-C5(4), C6(2), C7(4), C8(2).	OE-2 (3)	L1-2(3), L2-2(3) (4 hrs each)	Env. Studies (3)/ SEC-1: Digital Fluency (2) (1+0+2)	Sports/NCC/NSS/R&R(S&G)/ Cultural (2) (0+0+4)/ SEC (2)	26/25
III	DSC-C9(4), C10(2), C11(4), C12(2).	OE-3 (3)/ India and Indian Constitution (3)	L1-3(3), L2-3(3) (4 hrs. each)	**SEC-2**:AI/Cyber Security/Financial Edu. & Inv. Aw. (2) (1+0+2)	Sports/NCC/NSS/R&R(S&G)/ Cultural (2) (0+0+4)/ SEC (2)	25
IV	DSC-C13(4), C14(2), C15(4), C16(2).	India and Indian Constitution (3)/ OE-3(3)	L1-4(3), L2-4(3) (4 hrs. each)	**SEC-3**: Financial Edu. &Inv. Aw. /AI /Cyber Security (2) (1+0+2)	Sports/NCC/NSS/R&R(S&G)/ Cultural (2) (0+0+4)/ SEC (2)	25
Students exiting the programme after 2-years will be awarded UG Diploma in a Multidisciplinary or Interdisciplinary subject, upon securing 92 credits provided they secure additional 4 credits in skill based vocational courses offered during the first- or second-year summer term.						
V	DSC-C17(4), C18(2), C19(4), C20(2),	DSE-E1(3), E2(3)	Vocational-1(3)	**SEC-4**: Job Skills (3) (2+0+2)		24
VI	DSC-C21(4), C22(2), C23(4), C24(2),	DSE-E3(3), E4(3).	Vocational-2(3).	Internship (2)		23
Students who want to exit after 3-years /undertake 3-year UG programme will be awarded B. Sc. Degree in a Multidisciplinary or Interdisciplinary subject, upon securing 136 credits and satisfying the minimum credit requirements under each category of courses prescribed.						
	B.Sc. (Honours) in Disciplines/Inter-disciplines		B.Sc. (Honours with Research) in Disciplines/Inter-disciplines			
VII	DSC-C25(4), C26(2), C27(4), C28(2); Res. Methodology (4)	DSE-E5(3), Vocational-3(3)	DSC-C25(4), C26(2), C27(4), C28(2); Res. Methodology (4)	DSE-E5(3), Vocational-3(3) Res. Proposal formulation (2*)		22
VIII	DSC-C29(4), C30(2), C31(4), C32(2); Internship/Entrepreneurship (4)	DSE-E6(3), Vocational-4(3)	DSC-C29(4).	DSE-E6(3), Vocational-4(3) Research Project (10+2*)		22
Students exiting the programme after 4-years will be awarded B.Sc. (Honours) or B.Sc. (Honours with Research) degree in a Multidisciplinary or Interdisciplinary subject, upon securing 176 credits and satisfying the minimum credit requirements under each category of courses prescribed.						
IX	DSC-C33(4), C34(2), C35(4), C36(2); C37(4), Res. Proposal formulation (2*)	DSE-E7(3), Vocational-5(3).	DSC-C30(2), C31(4), C32(2), C33(4); C34(2), C35(4),	DSE-E7(3), Vocational-5(3),		22/24
X	Research Internship (4), Research Project (16+2*)		DSE-E8(3), E9(3), Research Internship (4), Research Project (10)			22/20
Students successfully completing the programme will be awarded B.Sc./B.Sc. (Hons.)/B.Sc. (Hons. with Res.) & M.Sc. Degrees in a Multidisciplinary or Interdisciplinary subject, upon securing 216 credits and satisfying the minimum credit requirements under each category of courses prescribed						

Note: Only those students who secure 75% marks or CGPA of 7.5 and above in the first six semesters may choose to undertake research in the fourth year. Honours students not undertaking research must do 3 to 4 Additional Courses/Entrepreneurship Courses and Internship/Apprenticeship for 12 credits.

Prof. B. Thimme Gowda, Former Vice Chairman, KSHEC and Former VC, Bangalore & KSRDPR Universities.

University of Mysore

Listing of Courses from I to VI Semesters for Integrated UG/PG (Integrated Master of Science) - C4. Curriculum and Credit Framework for Undergraduate/Postgraduate Programme in Molecular Biology

Sem. No.	Course Category	Course Code	Course Title	Credits Assigned	Instructional hours per week		Duration of Exam (Hrs.)	Exam/ Evaluation Pattern (Marks)		
					Theory	Practical		IA	Exam	Total
I	DSC	DSC-C1	General Botany	4	4	-	2	40	60	100
			General Botany Practical	2	-	4	3	25	25	50
		DSC-C2	General Zoology	4	4	-	2	40	60	100
			General Zoology Practical	2	-	4	3	25	25	50
II	DSC	DSC-C3	Cell Biology and Plant Physiology I	3	3		2	40	60	100
			Cell Biology and Plant Physiology I Practical	2	-	4	3	25	25	50
		DSC-C4	Inorganic and Physical Chemistry	3	3	-	2	40	60	100
			Inorganic and Physical Chemistry Practical	2	-	4	3	25	25	50
III	DSC	DSC-C5	Microbiology	3	3	-	2	40	60	100
			Microbiology Practical	2	-	4	3	25	25	50
		DSC-C6	Biochemistry	3	3	-	2	40	60	100
			Biochemistry Practical	2	-	4	3	25	25	50
IV	DSC	DSC-C7	Reproductive and Developmental Biology	3	3	-	2	40	60	100
			Reproductive and Developmental Biology Practical	2	-	4	3	25	25	50
		DSC-C8	Plant Physiology II and Animal Physiology	3	3	-	2	40	60	100
			Plant Physiology II and Animal Physiology Practical	2	-	4	3	25	25	50
V	DSC	DSC-C9	Metabolism I	4	4	-	2	40	60	100
			Metabolism I Practical	2	-	4	3	25	25	50
		DSC-C10	Enzymology	4	4	-	2	40	60	100
			Enzymology Practical	2	-	4	3	25	25	50
	DSE	DSE-E1 (any one)	Principles of Genetics Forensic Biology	3	3	-	2	40	60	100
	DSE	DSE-E2 (any one)	Biophysics Nannoscience	3	3	-	2	40	60	100
	Vocational	VOC-1	Biochemical Techniques	3	2	2	2	50	50	100
	SEC	SEC-1	Bioinformatics	3	2	2	2	50	50	100
VI	DSC	DSC-C11	Metabolism II	4	4	-	2	40	60	100

			Metabolism II Practical	2	-	4	3	25	25	50
		DSC-C12	Molecular Genetics	4	4	-	2	40	60	100
			Molecular Genetics Practical	2	-	4	3	25	25	50
	DSE	DSE-E3 (Anyone to be chosen)	Genetic Engineering Clinical Biochemistry	3	3	-	2	40	60	100
	DSE	DSE-E4 (Anyone to be chosen)	Molecular Cell Biology Molecular Endocrinology	3	3	-	2	40	60	100
	Vocational	VOC-2	Cell and Tissue culture Technology	3	3	-	2	40	60	100
	Internship	INT-1	Internship	2	-	-	-	-	-	-

Note: If any Elective or Vocational course involves theory-cum-practical, then IA to Exam. Marks will be in the ratio of 50:50. The practical part is to be evaluated as part of IA. Semester end examination is only in theory component and questions from practical part, if any. -

Prof. B. Thimme Gowda, KSHEC.

Syllabus for V and VI semester

Integrated UG/PG (Master of Science -Integrated) - C4. Curriculum and Credit Framework for Undergraduate/Postgraduate Programme in Molecular Biology

Sem.	**Discipline Specific – Core(DSC), Elective (DSE) Courses (Credits) (L+T+P)**	**Minor/ Multidisciplinary /Open Elective (OE) Courses (Credits) (L+T+P)**	**Ability Enhancement Courses (AEC)(Credits)(L+T+P) (Languages)**	**Skills Enhancement Courses (SEC) (Credits) (L+T+P)/ Value Added Courses (Credits) (L+T+P) (common for all UG Programs)/ Summer Internship.**	**Total Credits**
V	DSC-C9(4+0+2); DSC-C10 (4+0+2)	DSE-E1(3), E2(3)	Vocational-1(3) (2+0+2)	**SEC-4**: Job Skills (3) (2+0+2)	24
VI	DSC-C11(4+0+2); DSC-C12 (4+0+2)	DSE-E3(3), E4(3).	Vocational-2(3).	Internship (2)	23

Note: If any Elective or Vocational course involves theory-cum-practical, then IA to Exam. Marks will be in the ratio of 50:50. The practical part is to be evaluated as part of IA. Semester end examination is only in theory component and questions from practical part, if any.

Listing of Courses for V and VI Semesters for Integrated UG/PG (Integrated Master of Science) - C4. Curriculum and Credit Framework for Undergraduate/Postgraduate Programme in Molecular Biology

Sem. No.	Course Category	Course Code	Course Title	Credits Assigned	Instructional hours per week		Duration of Exam (Hrs.)	Exam/ Evaluation Pattern (Marks)		
					Theory	Practical		IA	Exam	Total
V	DSC	DSC-C9	Metabolism I	4	4		2	40	60	100
			Metabolism I Practical	2		4	3	25	25	50
		DSC-C10	Enzymology	4	4		2	40	60	100
			Enzymology Practical	2		4	3	25	25	50
	DSE DSE	DSE-E1 (any one)	Principles of Genetics Forensic Biology	3	3	-	2	40	60	100
		DSE-E2 (any one)	Biophysics Nannoscience	3	3	-	2	40	60	100
	Vocational	VOC-1	Biochemical Techniques	3	2	2	2	50	50	100
	SEC	SEC-1	Bioinformatics	3	2	2	2	50	50	100
VI	DSC	DSC-C11	Metabolism II	4	4		2	40	60	100
			Metabolism II Practical	2		4	3	25	25	50
		DSC-C12	Molecular Genetics	4	4		2	40	60	100
			Molecular Genetics Practical	2		4	3	25	25	50
	DSE	DSE-E3 (Anyone to be chosen)	Genetic Engineering Clinical Biochemistry	3	3	-	2	40	60	100
	DSE	DSE-E4 (Anyone to be chosen)	Molecular Cell Biology Molecular Endocrinology	3	3	-	2	40	60	100
	Vocational	VOC-2	Cell and Tissue culture Technology	3	3	-	2	40	60	100
	Internship	INT-1	Internship	2	-	-	-	-	-	-

Syllabus for V semester

Sem. No.	Course Category	Course Code	Course Title	Credits Assigned	Hours of teaching /week
V	DSC	DSC-C9	Metabolism I	4	4
		DSC-C9P	Metabolism I Practical	2	4
		DSC-C10	Enzymology	4	4
		DSC-C10P	Enzymology Practical	2	4
	DSE	DSE-E1 (Any one)	Principles of Genetics Forensic Biology	3	3
		DSE-E2 (Any one)	Biophysics Nannoscience	3	3
	Vocational	VOC-1	Biochemical Techniques	2	2
			Biochemical Techniques	1	2
	SEC	SEC-1	Bioinformatics	2	2
			Bioinformatics Practical	1	2

Course Code : DSC-C9 Metabolism I Credits: 4 4 hrs/week

Course objectives:

- To understand the basic aspects of metabolic pathways and regulation of biomolecules.
- To study and understand the structural and functional aspects of mitochondrial electron transport chain in detail.
- To gain deeper insights on photosynthesis and its associated process.
- To impart practical skills in concepts of Metabolism.

Course outcome:

- Students will acquire the concept of anabolism, catabolism, anapleurotic reactions, redox balance etc. and the role of high energy compounds in the cell.
- They will acquire knowledge related to regulation of various pathways.
- The role of lipids as storage molecules and structural component of bio membranes will be understood in detail.
- Students will learn about importance of high energy compounds, electron transport chain, synthesis of ATP under aerobic and anaerobic conditions will be understood.
- Students will gain knowledge about the fundament aspects of photosynthesis and its associated processes in depth.

UNIT I **15 hrs**

Introduction: Metabolism - catabolic, anabolic and amphibolic pathways.

Carbohydrates – Glycolysis- energetics regulation. Pathways of utilization of pyruvate-lactate, ethanol. Gluconeogenesis- regulation. Cori cycle, Citric acid cycle regulation, energetics, anapleurosis, Glyoxylate cycle. HMP shunt pathway, Entry of other carbohydrates (fructose, galactose, Maltose, Lactose) to glycolytic pathway. Biosynthesis of: sucrose, starch and glycogen. Inborn errors of carbohydrate metabolism (Glycogen storage disease, Galactosemia).

Mitochondrial Electron transport: Entry of reducing equivalents for oxidation: Malate - Aspartate shuttle, Glycerol phosphate shuttle. Organization of respiratory chain complexes, structure and function of the components - Fe-S proteins, cytochromes, Q cycle, proton transfer, P/O ratio, respiratory control, oxidative phosphorylation, uncouplers and inhibitors, sequence of electron carriers based on redox potentials. ATP synthesis- ATP synthase complex, Binding change mechanism, Proton motive force, Mitchell's hypothesis.

UNIT II **15 hrs**

Lipids: Degradation of triacylglycerols and phospholipids -lipase, hormone sensitive lipase, phospholipases. Fatty acid degradation -b oxidation- Knoop's experiment; Oxidation of Saturated and unsaturated fatty acids. α and ω oxidation, Energetics of palmitic acid oxidation, Biosynthesis of fatty acids – Fatty acid synthetase complex, chain elongation and desaturation. Pathways in plants and animals - conversion of linoleate to arachidonante (scheme only).

Biosynthesis of: Prostaglandins, thromboxanes, leukotrienes, COX-1 v/s COX-2

UNIT III **15 hrs**

Phospholipid: Biosynthesis-de novo pathway and interconversion; biosynthesis of sphingolipids, ether lipids and glycolipids. Degradation and biosynthesis of gangliosides and cerebrosides. Inborn errors: Taysach's disease, Niemann-Pick disease, Fabry's disease.

Cholesterol: biosynthesis and degradation-regulation. Mechanism of Statin Action. Metabolism of circulating lipids - chylomicrons, HDL, LDL and VLDL. Reverse cholesterol transport by HDL. Oxidized lipids and their metabolism, Bile acids.

Integration of: carbohydrate and lipid metabolism, metabolomics glucose paradox

UNIT IV **15 hrs**

Photosynthesis: Overview of photosynthesis and photosynthetic apparatus of higher plants Light harvesting antennae complex, role of pigments in trapping light energy, Electron flow – cyclic & non-cyclic photo phosphorylation; oxygen evolution; Calvin cycle, C3 & C4 cycle, primary photochemical reaction – Hill reaction, regulation of photosynthesis, photo inhibition, photorespiration, bacterial photosynthesis, structure and function of RUBISCO.

Plant hormones: Biosynthesis of hormones - IAA from Tryptophan biosynthetic pathway; Ethylene from Methionine (Yang Cycle); Cytokinins, Gibberellins, Brassinosteroids and Abscisic acid from Isoprenoid pathway; Jasmonic acid from octadeconoid pathway.
Secondary metabolites: Biosynthesis of - Terpenes from Mevalonic acid pathway, Methylerythritol phosphate (MEP) pathways; phenolic compounds from shikimic acid and Melonic acid pathways; Jasmonic acid from octadecanoid pathway; Biosynthesis of alkaloids and cyanogenic glycosides.

Course Code : DSC-C9P Metabolism I - Practical Credits: 2 4hrs/week

1. Estimation of Cholesterol- in serum by Zak's Method.
2. Estimation of blood sugar by Folin-Wu's Method/glucose oxidase test
3. Estimation of calcium in serum by titrimetric method.
4. Estimation of phosphorous by ascorbic Molybdate method
5. Antioxidant assay using DPPH
6. Estimation of blood urea by DAMO method
7. Estimation of SOD Activity
8. Estimation of Glutathione Activity
9. Demonstration of Hill's reaction.

10. Mohl's Half-leaf experiment
11. Detection of plant pigments using TLC.
12. Quantitative estimation of chlorophyll a, chlorophyll b, and total chlorophyll in plant tissues
13. & 14. Preparation of charts related to metabolic pathways

References:

1. Principles of Biochemistry, D.L. Nelson and M.M. Cox (2008), 5th ed., W.H. Freeman & Co.
2. Biochemistry, D. Voet and J.G. Voet (2004), 3rd ed.. John Wiley and Sons Inc.
3. Biochemistry, J.M. Berg, J.L. Tymoczko and L. Stryer (2007), 7th ed., W.H. Freeman & Co.
4. Essentials of Glycobiology, E. Etzler et.al. (2009), Cold Spring Harbor Laboratory Press.
5. Plant Physiology, L. Taiz and E. Zeiger (2006), 4th ed., Sinauer Associates Inc.

Course Code : DSC-C10 Enzymology Credits: 4 4hrs/week

Course objectives:

- To study general aspects of enzymes and its classification.
- To study the molecular mechanisms of enzyme reactions using inhibitors and activators.
- To learn about kinetics and regulation of enzymes to drug delivery and discovery which helps to establish a strong background for future endeavors.
- To impart practical skills in concepts of Enzymology.

Course outcome:

- Students will be able to understand the general aspect of enzymes, their activity measurements and kinetic reactions.
- They will be able to learn about enzyme reactions using inhibitors and activators.
- Enabling to understand the nature of catalysis, action and type of inhibition.
- Students will understand the regulation of enzymes in metabolic reactions.
- Students will get a deeper level knowledge about the mechanism of action of specific enzymes, important for biological function.

UNIT I **15 hrs**

General Aspects -Nature of enzymes, localization, isolation, purification and characterization of enzymes. Criteria of purity of enzymes. Units of enzyme activity, specificity and specific activity. Nomenclature and IUB classification of enzymes. Assay methods -coupled enzyme assays, continuous, end point and kinetic assay.

Enzyme Kinetics -Rate of a reaction, order and molecularity. Michaelis Menten equation, initial velocity approach, steady state approach. Vmax Km and their significance. Linear transformation of Michaelis Menten equation -Lineweaver Burk plot, Eadie Hofstee, Haynes - Wolf and Comish-Bowden. Turnover number.

UNIT II **15 hrs**

I**nhibitio**n - Competitive, non-competitive, uncompetitive and product inhibition. Irreversible inhibition- suicide inhibition. Determination of Ki.

Bisubstrate Reaction - Cleland's notation with examples of ordered, pingpong, and random.General rate equation. Primary and secondary plots.

Mechnisms of Enzyme Catalysis - Active site structure. Methods of determining active site structure - isolation of ES complex, affinity labeling, chemical modification studies. Active site structure investigation.

UNIT III **15 hrs**

Nature of Enzyme catalysis - Transition state theory proximity and orientation, oribital steering, acid base catalysis, covalent catalysis, metal ion catalysis, nueleophilic and electrophilic catalysis, intramolecular catalyses, entropy effects. Effect of temperature and pH on enzyme catalysed reaction.

Cooperativity - Binding of ligands to macromolecules - Scatchard plot, cooperativitiy, positive and negetive cooperativity. Oxygen binding to hemoglobin. Hill equation homotropic and heterotropic effectors, aspartyl transcarbamylase as an allosteric enzyme.

UNIT IV **15 hrs**

Mechanisms of Action of Specific Enzyme - Chymotrypsin zymogen activation, acid – base catalysis, charge relay network. Lysozyme, Alcohol dehydrogenase, Ribonuclease, Carboxypeptidase A, RNA as enzyme, Coenzymic action of NAD+ FAD, TPP, PLP, Biotin, CoA, Folic acid, Lipoic acid.

Enzymes in Plants: Overview of enzymes related to defense and fruit ripening.

Multimolecular Forms - Isozyzme, eg. LDH, Multifunctional enzyme (DNA polymerase) multi enzyme complex (PDC)

Metabolic regulation of Enzyme Activity - Feedback regulation, fine control of enzyme activity

Fast reactions - Stopped flow, temperature jump method with examples of enzymes

Course Code : DSC-C10P Enzymology-Practical Credits: 2 4hrs/week

1-7 Salivary amylase assay – Specific activity, pH, Temperature, Time Kinetics, Km & Vmax.
8,9. Effect of Activators and Inhibitors on Salivary amylase activity.
10. Acid phosphatase (Fiske Subbarow's Method).
11. Alkaline phosphatase.
12. Invertase assay from Calotropis gigantea
13-14 Assay of Pectinases.

References:

1. Dixon, M Webb E C 1979 Enzymes, 3rd Ed Academic Press, New York
2. Alan F. Enzyme structure and mechanism. 2nd ed. 1985. Cornish-Bowden, Athel.
3. Lehninger AL., Nelson JR., and Cox MM., 1993.Principles of Biochemistry. CBS Publishers, New Delhi.
4. Smith et al., Principles of Biochemistry General Aspects 1983 . McGraw Hill.
5. Voet D, Voet JG. Biochemistry, 2a Ed.. New York: John Wiley & Sons.
6. Stryer L 1996. Biochemistry**.** WH Freeman &Company.
4. T. M. Devlin.Devlin T.M. 1986. Text Book of Biochemistry with clinical correlations (4th edition). John Wiley & Sons, New York.
5. West & Todd. Text of Biochemistry. 1908. MacMillian.
6. Zuby G.L., 1988. Biochemistry. (second ed.). MacMillan, New York.
7. Palmer T. 1985. Understanding Enzymes. John Wiley.

11. Price N. C., Stevens L. 1999.Fundamentals of Enzymology: The cell and molecular biology of catalytic proteins, 3rd edition. Oxford University Press.
12.Matzler D. E. Biochemistry chemical reactions of living cells. 2001.Vol.I Harcourt/ Academic Press. San Diego.
13 Mathews, C. K., van Holde, K. E. and Ahern, K. G. 1999. Biochemistry (3rd edn.), Addison Wesley Longman, San Francisco (Benjamin and cumming).
14.Palmer.Bonner T. L. and Bonner P. L. 2007. Enzymes; biochemistry, biotechnology and clinical chemistry, 2d ed. Horwood Publishing.

One of the following Discipline Specific Electives has to be opted under DSE-E1:

Course Code: DSE-E1 Principles of Genetics Credits: 3 3 hrs/week
Course Code: DSE-E1 Forensic Biology Credits: 3 3 hrs/week

Course Code : DSE-E1 Principles of Genetics Credits: 3 3hrs/week

Course objectives:

- To understand the basic principles of genetics, Mendelism, extension of Mendelism.
- To learn about chromosome, Chromosomal aberrations and population genetics.;
- To impart practical skills in concepts in Principles of Genetics.

Course outcome:

- Students study about the history, experiments of Mendel`s laws along with statistical testing of hybrid crosses.
- Extension of Mendelism is studied which includes concepts of dominance, alleles, interaction of genes, polygenic inheritance, and pleotropism.
- Students will understand chromosomal aberrations and extra chromosomal inheritance which in turn help to understand various disease mechanisms associated with aberrations.
- Enabling students to learn about lethal mutations and mutation detection tests like Ames test, CIB technique.
- Students are exposed to concepts of population genetics and darwinism and mutation studies.

UNIT I **15 hrs**

Mendelism: History and Mendel's experiments, Laws of inheritance-dominance and recessive concept, law of segregation, law of independent assortment, back cross and test cross, sex-linked inheritance, sex linked genes, sex limited genes and sex influenced genes,
Statistical testing of hybrid crosses: Mean, Mode, median, Standard deviation and standard error, probability rules, calculation of genetic ratios, ratios for two or more segregating gene pairs, level of significance, degrees of freedom, chi square.
Extension of Mendelism: incomplete dominance, codominance, multiple alleles, Pseudo alleles, Lethal alleles, Penetrance and expressivity, Interaction of genes- epistasis- dominance, recessive (atavism), complementary genes, supplementary genes, interaction of genes in comb pattern of fowls, polygenic inheritance, pleotropism

UNIT II **15 hrs**

Chromosomal aberrations: Structural - Deletion, Duplication, Inversion, Translocation, Centric fusion and fission; Numerical variations – Aneuploidy, Euploidy,& Polyploidy; Chromosome syndromes- Causes & consequences of chromosomal aberrations; Karyotyping and chromosome banding.
Chromosomes: Types of chromosomes, Chromosome theory of inheritance, Special chromosomes – B chromosome, Polytene & Lamp brush.
Extra Chromosomal inheritance: Maternal effect – Pigmentation in *Ephistia*, inheritance of shell coiling in *Limnaea*, Infectious heredity of Paramecium, Cytoplasmic inheritance – Male sterility in maize and plastid inheritance in *Mirabilisjalapa*

Unit III **15 hrs**

Population genetics: populations, gene pool, gene frequency, Law of Hardy- Weinberg equilibrium, assumptions of Hardy- Weinberg equilibrium, causes of changes in gene frequency (migration, selection, random genetic drift, inbreeding and mutations). Darwinism- concepts of variation, adaptation, struggle, survival of fittest and natural selection.

Mutations: **S**pontaneous, Induced mutation, Conditional lethal mutations – point mutation, Base substitution mutation, Mutation rates. Chemical mutagens, radiation induced mutation, reverse mutations and suppressor mutations - intergenic and intragenic suppression,, Missense, Nonsense and Silent mutations; and Detection of mutations induced by chemicals (Ames test), radiations (ClB technique)

References:

1. Hartl D L Freifelder D Snyder L A 1988 Basic Genetics 1. Ed. Boston Portola Valley: Jones and Bartlett
2. Atherly A G, Girton, J R and Mc Donald J F, 1999. The Science of Genetics, Saunders College Publishing, Harcourt Brace College Publishers.
3. Brooker R.J. 1999. Genetics. Analysis and Principles. Ed. Benjamin Cummings. California
4. Gardner E J, Simmons M J, Snustad D P 1991. Principles of Genetics. John Wiley & Sons, Inc.
5. Griffith A J F, Miller J H, Suzuki D T, Lewontin R C, Gelbert W M.1996. An introduction to Genetic Analysis. W.H. Freeman and Co. New York
6. Strickberger, Monroe W. 1976. Genetics. Macmillan New York:
7. Watson, J. D., T. A. Baker, S. P. Bell, A. Gann, M. Levine, R. Losick. 2004. Molecular Biology of the Gene. 5th Edition. Pearson Education Pte. Ltd., New Delhi, India.
8. Klug, W S, and M R Cummings. 1998. Essentials of Genetics, 3rd ed. Prentice Hall, Upper Saddle River, NJ.
9. Hartl, D L & Jones E W 2006. Essential genetics: a genomics perspective (4th Ed), Jones and Bartlett Publishers, Boston.
10. Robert H. Tamarin. 2002. Principles of Genetics Tata-McGraw Hill, Seventh Edition.
11. Lewin B., Gene IV, V, VI. Oxford University press, Oxford.
12. Gilham, N. W. 1994. Organelle genes and genomes. Oxford University Press, Oxford and New York
13. Goodenough, U. 1984. Genetics, Saunders College Publishing
14. Gardner, E.J. et al., 1996. Principles of Genetics, VII Edn. Jjohn Wiley land Sons, Inc., New York.
15. Winter, P.C. et al., 2000. Instant notes in Genetics. Viva Books Pvt. Ltd. New Delhi
    Sambamurthy A V S, 1999 Genetics. Narosa Publishing House, New Delhi.

Course Code : DSE-E1 Forensic Biology Credits: 3 3hrs/week

Course Objectives

- To understand significance of biological and serological evidence.
- To know the forensic importance of hair evidence.
- To gain the knowledge on the importance of biological fluids in crime investigations.
- To understand how wildlife forensics aid in conserving natural resources.
- To know the role of forensic entomology in death investigations.

Course Outcome

- Students will appreciate the significance of biological and serological evidence.
- Will know the forensic importance of hair evidence.
- Will gain the knowledge on the importance of biological fluids in crime investigations.
- Will understand how wildlife forensics aid in conserving natural resources.

- Will get insights on the role of forensic entomology in death investigations.

UNIT-I **15 hrs**

Introduction: Scope,various forms of biological evidences like wood, timber varieties, seeds and leaves - Their identification and matching.

Forensic Botany:Toxic principles of plants and their forensic significance, identification of poisonous plants and mushrooms of India; Diatoms: Types, morphology,methods of isolation from tissues and bones, forensic significance in drowning cases; Study and identification of pollen grains, identification of starch grains, powder, stains of spices, paper pulp identification; Isolation and identification of microorganisms

UNIT II **15 hrs**

Nature and importance of biological evidence.

Hair Examination: Introduction, structure of hair, growth and chemistry of hair, identification and comparison of hair by microscopic, chemical, biochemical and instrumental methods, identification of animal hair. Assessment of age, sex, race and site of hair, analysis of drugs and elements in hair, hair diseases, hair transfer, persistence and recovery, DNA typing of hair.

Fibre Examination: Introduction, classification of fibres, identification and comparison of fibres by Physical, chemical, microscopic, spectroscopic, chromatographic methods, persistence and recovery of fibres, forensic significance.

Forensic Entomology: Introduction, analyzing crime scene for entomological evidence, collection of climatological data and specimen before body removal, common arthropod found on the dead body, determination of time of death, entomological succession in case of buried, drowned and buried bodies

UNIT III **15 hrs**

Wild Life Forensics: Introduction, importance of wild life, wild life Protection Act, endangered Species, CITES, Census of wildlife population, wild life crime, methods of smuggling and poaching of wild life artifacts, crime scene search, criminal investigation, determination of time of death, sex determination from bones, identification of teeth, claws, ivory, horns, antlers, furs, skin, bite marks, pug
marks, Identification of blood, excreta and bones by biochemical and immunological methods,

References :

1. L. Stryer, Biochemistry, 3rd Edition, W.H. Freeman and Company, New York (1988).
2. R.K. Murray, D.K. Granner, P.A. Mayes and V.W. Rodwell, Harper's Biochemistry, APPLETON & Lange, Norwalk (1993).
3. S. Chowdhuri, Forensic Biology, BPRD, New Delhi (1971).
4. R. Saferstein, Forensic Science Handbook, Vol. III, Prentice Hall, New Jersey (1993).
5. G.T. Duncan and M.I. Tracey, Serology and DNA typing in, Introduction to Forensic Sciences, 2nd Edition, W.G. Eckert (Ed.), CRC Press, Boca Raton (1997).

One of the following Discipline Specific Electives has to be opted under DSE-E2:

Course Code: DSE-E2 Biophysics **Credits: 3** **3 hrs/week**
Course Code: DSE-E2 Nannoscience **Credits: 3** **3 hrs/week**

Course Code : DSE-E2 Biophysics Credits: 3 3hrs/week

Course outcome:

- To understand the scope and role of biophysics in natural science.

- To understand the various techniques like microscopy, SPR etc associated with it.
- To impart practical skills in concepts of Biophysics.

Course outcome:

- Students will understand the principle and applications of spectroscopy and X-ray diffraction techniques.
- Will get advanced knowledge in the field of radiation biophysics and various advanced microscopy including surface plasma resonance.
- Important biological phenomenon like Neurobiophyscis

UNIT I **15 hrs**

Introduction to Biophysics: Role of Biophysics in natural science, Scope and methods of Biophysics.
Spectroscopy: Spectral analysis of structure of simple organic compounds & Biomolecules from: Vibration spectra – IR and Raman – Principles and applications, UV difference spectra. Plane and circularly polarized light, Principles and applications of Optical Rotatory dispersion (ORD), Circular Dichroism (CD). Beer-Lambert's law and its limitation, Principle, instrumentation and applications of colorimetry, UV-Visible Spectrophotometry, spectrofluorimetry, atomic spectroscopy-absorption, emission and fluorescence, flame photometry, luminometry, turbidometry.

UNIT II **15 hrs**

Biomolecular studies by X-ray diffraction and NMR techniques: X-ray diffraction, Bragg's law, Unit cell, Miller's indices, phase problem, Isomorphous replacement, fiber pattern of DNA, Wet crystals, Crystallization of biomolecules, 3D structure determination of proteins, NMR spectroscopy, chemical shift, spin-spin coupling, coupling constant, 1D and 2D NMR, applications, MRI, ESR - Principles and applications.

Mass spectrometric techniques: Introduction, mass spectrometer, Ionization techniques- Electron impact ionization (EI), Electrospray Ionization (ESI), Chemical ionization (CI), Field ionization (FI), Ion disruption methods, Ion desorption and evaporation methods, MALDI, Analyzers- Magnetic sector, time-of-flight, quadropole, ion trap, Detectors- electron multipliers, Tandem mass spectrometry, applications.

UNIT III **15 hrs**

Radiation Biophysics: Ionization radiation, Interaction of radiation with matter, Cerenkov radiation, Radiation dosimetry, Biological effects of ionizing radiation, Nature of radioactivity, half life, Specific activity, detection and measurement of radioactivity, GM counter, scintillation counting, autoradiography, applications of radioisotopes in biology

Neurobiophysics: Blood brain barrier, Physicochemical basis of membrane potential, Resting and action potential, Propagation of action potential, Voltage clamp and patch-clamp techniques, Neuronal networks, Processing of information
Advanced Microscopy: Principle, working and applications of fluorescence microscopy, Concepts of optical sectioning, 3-D reconstruction in confocal microscopy**,** Applications of Atomic Force Microscopy & Scanning Tunneling Microscopy in biology. Brief introduction to advanced microscopy techniques: Cryoelectron microscopy, X-ray, Laser and infrared microscopy, Multiphoton microscopy, CLEM (Correlative Light – Electron Microscopy); SPIM (Selective Plane Illumination Microscopy), FIB (Focussed Ion Beam) – Electron Microscopy; TIRF (Total Internal Reflection Fluorescence) Microscope; Super resolution microscopy: STED (Stimulated Emission Depletion) Microscopy.

Reference Books:

1. Bergethon P. R, 1998.The Physical Basis of Biochemistry, Springer- Verlag Publishers, New York.
2. Creighton T, 1987.Protein Structure: A Practical Approach**,** Oxford University Press.
3. Wilson K. Walker J., 2005. Biophysical Chemistry, Cambridge University Press Cambridge, New York.

4. Upadhyay A. and Upadhyay K., 2002.Biophysical Chemistry: Principle and techniques**,** Himalaya Publishing House, Bangalore.
5. Lehninger A. L., Nelson J. R. and Cox M. M., 1993.Principles of Biochemistry**,**CBS Publishers, New Delhi.

Course Code : DSE-E2 Nannoscience Credits: 3 3hrs/week

Course objectives

- To understand the fundamentals of nanoscale materials, synthesis and characterization of different nanomaterials.
- To understand the Basic structure of Nanoparticles and bionanocomposites.
- To understand the sustainable Nanobiotechnology.

Course outcome

- Will be able to understand the different formats of nanomaterials, Cellular nanostructureand Bio-inspired Nanostructures.
- Will be able to understand the Synthesis and characterization of nanomaterials.
- Will be able to understand the Applications of nanobiotechnology in Plant and animal cellcultures.
- Be able to understand the toxicity testing and Mechanism of nano-size particletoxicity

UNIT I **15 hrs**

Introduction and Fundamentals of nanobiotechnology : Concepts, historical perspective; Nanoscale materials: Definition and properties; Different formats of nanomaterial and applications; Cellular nanostructure; nanopores; Biomolecular motors; Bio-inspired Nanostructures, Quantum dots.

Synthesis and characterization of different nanomaterials: Synthesis of nanomaterials from plant, microbial and animal cell sources. Characterization of nanomaterials using Optical Microscopy, Scanning Electron Microscopy, Transmission Electron Microscopy, Atomic Force Microscopy, Scanning Tunneling Microscopy, Optical Absorption and Emission Spectroscopy, Thermogravimetric Analysis, Differential Scanning Calorimetry, Thermomechanical Analysis, X-Ray, neutron diffraction.

Applications of nanobiotechnology in Plant and animal cell cultures, stem cell culture and artificial organ synthesis.

Unit II **15 hrs**

Nano-particles: Concepts of Nanoparticles: Basic structure of Nanoparticles- Kinetics in nano-structured Materials- Zero dimensional, size and shape of nanoparticles; one-dimensional and two- dimensional nanostructures; clusters of metals and semiconductors, bionano-particles.

Bionancomposites: Nano-particles and Microorganisms; Microbial Synthesis of Nano-materials; Biological methods for synthesis of nano-emulsions using bacteria, fungi and Actinomycetes; Plant-based nanoparticle synthesis; Nano-composite biomaterials – Fibres, devices and structures, Nano Bio-systems.

Unit III **15 hrs**

Applications of Nanobiotechnology: Applications of Nanomedicine: Nanotechnology in diagnostic applications, materials used in Diagnostics and Therapeutics. Nanomaterials for catalysis, development and characterization of nanobiocatalysts, application of nano-scaffolds in synthesis, applications of nano-biocatalysis in the production of drugs and drug intermediates.

Nano-films: Thin films; Colloidal nanostructures; Self-assembly, Nanovesicles; Nanospheres; nanocapsules and their characterization.

Nanoparticles for drug delivery: Strategies for cellular internalization and long circulation, strategies for enhanced permeation through various anatomical barriers.
Nanoparticles for diagnostics and imaging: Concepts of smart stimuli responsive nanoparticles, implications in cancer therapy, nanodevices for biosensor development.
Applications in Agriculture: Biogenic nanomaterials and their role in soil, water quality and plant protection; Smart nanoscale systems for targeted delivery of fertilizers, pesticides (nanocides); Nanoremediation.

References:

1. Salati, G., 2016. Principles and Practices of Nanobiotechnology, Syrawood Publishing House, New York.
2. Saudagar, P. and Divakar, K. 2016. Recent Trends in Nanobiotechnology, food and Biomedical Applications. Central West Publishing, New South Wales, Australia.
3. Bhushan, I., Singh, V.K. and Tripathi, D. K., 2020. Nanomaterials and Environmental Biotechnology, Springer, New York.
4. Parak, W. and Feliu, N., 2020. Colloids for Nanobiotechnology, Elsevier Science, Amsterdam.
5. Xie, Y., 2017. Nanobiotechnology Hand Book. CRC Press, Florida.

Course Code : VOC-1 Biochemical Techniques Credits: (2+0+1)
Biochemical Techniques (Theory) Credits: 2 2hrs/week

Course objectives:

- To give theoretical background regarding biomolecular preparative and analytical methods.
- To Impart practical skills regarding the above.

Course outcome:

- This course explores the basic principles of biochemical methods and develops the student's appreciation and understanding of biological process.
- Course will teach the students the various instrumentations that are used in the analytical laboratories.
- Course covers both fundamental and applications of the instruments that are routinely used for the characterization of biomolecules.
- At the end of the course, the student has the basic knowledge on the theory, operation and function of analytical instruments.
- After the completion of this course students will gain a fundamental knowledge of biochemical concepts and techniques which is necessary for future scientific endeavors.

UNIT I **15 hrs**

Fractionation Techniques: Cell disruption techniques, Isolation of Proteins, salting in, Salting out, Dialysis, Ultra filtration.
Centrifugation: Basic principles of sedimentation, Svedberg's constant, Types of centrifuges and their uses, Preparative centrifugation- differential and density gradient separation, Analytical ultracentrifuges- construction and working, sedimentation velocity and sedimentation equilibrium applications.

Chromatographic Techniques: Concept of stationary and mobile phases, Principles and Applications of Paper, TLC, Column chromatography, adsorption, Ion exchange, Gel Filtration, Affinity, GLC, Chromato focusing, HPLC, RPHPLC of proteins, peptides and organic compounds, FPLC, LC-MS.

UNIT II **15 hrs**

Electrophoretic Techniques: Basic principles**,** low voltage and high voltage electrophoresis, separation of proteins and nucleic acids, Polyacrylamide gel electrophoresis, SDS-PAGE, estimation of molecular weight of proteins, native PAGE, Agarose gel Electrophoresis, Visualizing separated components - staining, glycoprotein staining, Fluorescent techniques, isoelectric focusing, pulsed field electrophoresis, Capillary Electrophoresis, Isotachophoresis. Blotting techniques: Southern, Northern and Western blotting, applications.

Course Code : VOC-1 Biochemical Techniques Credits: (2+0+1)
Biochemical Techniques (Practical) Credits: 1 2hrs/week

1. Extraction and salting out of proteins (ammonium sulphate saturations).
2,3 Polyacrylamide gel electrophoresis (PAGE) of proteins.
4. Thin Layer chromatography of lipids.
5,6. Electrophoresis of Glycoproteins and PAS staining.
7. Circular paper chromatography.
8. Determination of Isoelectric point of Amino acid.
9. Ascending paper chromatography.
10,11. Column chromatography- Gel permeation and Affinity Chromatography.
12,13. Agarose gel electrophoresis of DNA.
14.Visit to Institutes and/Industry having instrument facilities

Reference Books:

1. Wilson, K. and Walker, J. 2010. Principles and Techniques of Biochemistry and Molecular Biology. Cambridge University Press, Cambridge.
2. Sambrook, J.. 2001. Molecular cloning : a laboratory manual. Cold Spring Harbor, N.Y. :Cold Spring Harbor Laboratory Press.
3. Boyer, R. 2000. Modern Experimental Biochemistry. Pearson Eucation, Inc., New Delhi.

Course Code : SEC-4 Bioinformatics Credits: (2+0+1)
Bioinformatics (Theory) Credits: 2 2hrs/week

UNIT I **15 hrs**

Introduction to Bioinformatics: Bioinformatics- an overview, Definition and History, Applications of Bioinformatics. Introduction to Genomics, Transcriptomics and Proteomics.
Introduction to Bioinformatics Databases: Importance of databases (b) Nucleic acid Sequence databases- NCBI, EBI, DDBJ (c) Protein Sequence Databases- UNIPROT, SWISS-PROT, PIR (d) Structure Databases- PDB (e) Bibliography Databases- PUBMED (f) Secondary Databases- CATH, SCOP, PRODOM, PROSITE (g) Introduction to sequence submission softwares- webin, seqin, sakura (h) Genome databases (i) Proteomic databases (j) Metabolomic databases.

UNIT II **15 hrs**

Introduction to sequence submission softwares- webin, seqin, sakura (h) Genome databases (i) Proteomic databases (j) Metabolomic databases.
Predictive methods using DNA sequences: Introduction to Bioinformatics softwares, Gene prediction strategies, Gene prediction programs, BLAST (its variants), Multiple sequence alignments, ORF Mapping, CpG Plot, Primers, Primer Designing, Restriction Enzyme digestion.

Course Code : SEC-4 Bioinformatics Credits: (2+0+1)
Bioinformatics (Practical) Credits: 1 2hrs/week

1, 2. Downloading DNA sequence from NCBI database and interpretation.

3,4. Downloading data from uniprot

5,6. Analyzing the DNA sequence Fasta, Blast, Clustal W.

7,8. Analysing dna data for exon identification

9,10. Analyzing the DNA sequence in EMBOSS

11,12.Downloading data from PDB database

13,14.Visualising in RASMOL

References:

1. Hartwell L. H., 2004. Genetics, McGraw HILL higher education.
2. David W mount, 2002. Bioinformatics: Sequence and genome analysis, Cold Spring Harbor Laboratory Press.
3. Higgins and Taylor, 2000. Bioinformatics Sequence, Structure and databanks, Oxford University Press.
4. Starkey M. P. Edit. 2001Genomics protocols, Methods of Molecular Biology, VOL. 175, Humana Press.
5. Lesk A. 2007. Introduction to Genomics, Oxford University Press, USA; 1 edition.
6. Campbell A. M., Heyer L. J., 2006. Discovering Genomics, Proteomics and Bioinformatics, Benjamin Cummings; 2 edition.
7. Gibson G., Muse S. V., 2004. A Primer of Genome Science, Sinauer Associates, 2nd Edition
8. Cristianini N., Hahn M. W., 2007. Introduction to Computational Genomics: A Case Studies Approach, Cambridge University Press.

QUESTION PAPER:THEORY EXAMINATION

(Applicable to DSC courses of V and VI semesters Papers)

5-Year Integrated M.Sc. Course in Molecular Biology

_____ Semester

Title of the Paper:_____

Time: 2 ½ hours **Max. Marks: 60**

Instructions: Draw neat and labelled diagrams wherever necessary

PART-A

1. Define/Explain any five of the following:

(2 questions from each unit) **2x5=10**

a.
b.
c.
d.
e.
f.
g.
h.

PART-B

Answer any four of the following (Internal Choice)

(Internal choice should be from the same unit) **5x4=20**

2.
3.
4.
5.

PART-C

Answer any three of the following:

(One question from each unit) **10X3=30**

6.
7.
8.
9.

QUESTION PAPER:THEORY EXAMINATION

(Applicable to VOC/SEC courses with practical component of V and VI semesters Papers)

5-Year Integrated M.Sc. Course in Molecular Biology

_____ Semester

Title of the Paper:_____

Time: 2 hours **Max. Marks: 50**

Instructions: Draw neat and labelled diagrams wherever necessary

PART-A

1. Define/Explain any five of the following:

(4 questions from each unit) **2x5=10**

a.
b.
c.
d.
e.
f.
g.
h.

PART-B

Answer any four of the following (Internal Choice: four questions from each unit)

(Internal choice should be from the same unit) **5x4=20**

2.
3.
4.
5.

PART-C

Answer any three of the following:
(One question from each unit) 10X2=20

6. Unit I
7. Unit II
8. Unit 1 and II (equal weightage with two sub questions)

Scheme of Discipline Core (DSC) Practical evaluation
5-Year Integrated M.Sc. Course in Molecular Biology

Max. Marks: 50marks
(Practical test/Viva/MCQ/written test based on Practical concepts: 20 marks + Record :05 marks + Practical examination : 25 marks)

Scheme of Practical Examination
V Semester – Metabolism I/Enzymology

1. Write the principle and procedure for the experiment mentioned 05M
   (principle:2marks, procedure:5 marks, Tabular colum:2marks, Result:1mark)
2. Conduct the major experiment 10M
   (Principle: 1marks, Procedure: 2 marks, Standardization: 1 marks, Tabular colum:1 mark, graph: 2 marks, Results: 3 marks)
3. Conduct the minor experiment 06 M
   (Principle:1marks: Procedure and conducting: 3 marks, reporting:2marks)
4. Identify and comment on A, B 2x2=4 M
   a.
   b.

(**Note:** Duly certified practical record shall be submitted at the practical examination (No evaluation of record).

Syllabus for VI semester

Sem. No.	Course Category	Course Code	Course Title	Credits Assigned	Hours of teaching /week
VI	DSC	DSC-C11	Metabolism II	4	4
			Metabolism II Practical	2	4
		DSC-C12	Molecular Genetics	4	4
			Molecular Genetics Practical	2	4
	DSE DSE	DSE-E3 (Anyone to be chosen)	Genetic Engineering Clinical Biochemistry	3	3
		DSE-E4 (Anyone to be chosen)	Molecular Cell Biology Molecular Endocrinology	3	3
	Vocational	VOC-2	Cell and Tissue culture Technology	2	2
	Internship	INT-1	Internship	1	2

Course Code : DSC-C11 Metabolism II Credits: 4 4 hrs/week

Course objectives:

- To study about the importance of, nitrogen containing compounds, porphyrins, and steroid hormones.
- To study and appreciate the integrated approach of interrelated pathways of catabolism and anabolism.
- To emphasizes on metabolic disorders at molecular level.
- To learn the regulatory aspects of metabolism for better understanding of physiology and therapeutic applications.
- To impart practical skills in concepts of Metabolism.

Course outcome:

- Students will learn about the importance of nitrogen and nitrogen containing compounds in biological system.
- Students will learn to explain/describe the synthesis, degradation and functional aspects of amino acids, nucleic acids, steroid hormones and vitamins in detail.
- Students will learn about the regulatory aspects of metabolic pathways at various phases like transcriptional, translational, and post-translational levels.

UNIT I **15 hrs**

General Mechanisms of Amino Acid metabolisms: Degradation of proteins, specificity of action of digestive enzymes, absorption of amino acids. Deamination, role of PLP in the following transamination, decarboxylation desulphuration; Degradation and biosynthesis of individual amino acids. Differences in the pathways in microorganisms, plants and animals. Ketogenic and glucogenic amino acids.

Regulation of amino acid biosynthesis: Transglutaminase cycle, Urea cycle; Inborn errors of amino acid metabolism - Phenylketonuria, Alkaptonuria, Maple syrup urine

UNIT II **15 hrs**

Protein Metabolism: General mechanisms of degradation in cells, Degradation and biosynthesis of glycoproteins, proteoglycans and lipoproteins, errors in protein metabolism.

Metabolism of Vitamins and Minerals: absorption and utilization in health and disease with any two examples each. Biosynthesis of NAD^+, FAD and coenzyme A.

UNIT III **15 hrs**

Nucleotide metabolism: Pathways of degradation of nucleotides in cells, Catabolism of purines and pyrimidines; Uric acid formation & its inhibition. Salvage pathways, De novo biosynthetic pathways, Regulation of biosynthesis of nucleotides, conversion of ribonucleotides to deoxynuclotides. Mechanism of action of methotrexate, 5 fluorouracil, Azathymidine.

Importance of nitrogen in biological systems: Nitrogen cycle, Nitrogen fixation- symbiotic and non-symbiotic, nitrogenase complex, energetic and regulation. Assimilation of ammonia. Nitrogen deficiency in plants.

UNIT IV **15 hrs**

Steroid hormone metabolism: Introduction, biological importance, physiological action of cholesterol. Structural formulae of estradiol, progesterone and testosterone and their importance. Phytosterols, fungal sterols.

Metabolism of porphyrins and Peptides: Heme, porphyrins, Biosynthesis ofcreatine, polyamines glutathione and gramicidine.

Course Code : DSC-C11P Metabolism II Credits: 2 4 hrs/week

1. Estimation of protein by Estimation of proteins by Bicinchoninic acid method
2,3.Estimation of Creatine and Creatinine in serum.
4. Estimation of Urea in serum.
5. Estimation of Uric acid in serum.
6. Estimation of Iron in Blood by Wong's method.
7. Estimation of Ketoacid by DNPH Method.
8. Estimation of Protein by Bradford's Method.
9, 10. Collection and study of Root and stem nodule forming plants along (along with nodules)
11. Study of nitrogen fixing cyanobacteria
12. Comparison of the protein content leguminous roots with nodules and Non-leguminous roots without nodules
13. Estimation of leghaemoglobin in root nodules by pyredine method
14. Visit to a diagnostic laboratory to familiarize the techniques used in relation to metabolic disorders

References:

1. Voet D., Voet J. G. Biochemistry. 2nd Ed. John Wiley & Sons. New York.
2. David J Rawn. Biochemistry, 1983. Harper and Row. New York.
3. Zuby G. L. 1988. Biochemistry 2nd Edn. McMillan. New York.
4. Lehninger AL., Nelson JR., and Cox MM., 1993.Principles of Biochemistry. CBS Publishers, New Delhi.
5. Stryer L 1996. Biochemistry**.** WH Freeman &Company.
6. Buchanan R. B. Gruissem W. Jones R. Biochemistry and Molecular Biology of Plants. American Society of Plant Physiology, Maryland.
7. Goodwin and Mercer, Introduction to plant Biochemistry. IInd Ed. CBS Publication and distributors, New Delhi.
8. Dey, P.M., Harborne J.B, Plant Biochemistry Academic Press, New York.

Course Code : DSC-C12 Molecular Genetics Credits: 4 4 hrs/week

Course objectives:

- To describe the central dogma of molecular biology.
- To understand crossing over, linkage mapping inboth prokaryotes and eukaryotes.
- To study sex determination.
- To impart practical skills in concepts of Molecular Genetics.

Course outcome:

- Enable students to know about the historical perspective and experiments that led to the discovery of central dogma of molecular biology.
- To briefly understand DNA, replication, transcription, translation processes .
- Students will understand the concept of gene and sex determination and dosage compensation of genes in fruit fly and man.
- Crossing over, linkage and mapping studies in both prokaryotes and eukaryotes are discussed along with problems are studied by students for better understanding and to enable construction of gene maps.

UNIT I **15 hrs**

Central dogma of molecular biology, historical perspectives- Hammerling (Nuclear control), Griffith (DNA, the genetic material), Avery *et al. (*DNA as the genetic material*),* Hershe & Chase (DNA as the genetic material in bacteriophage), Frankel Conrat (RNA as the genetic material in TMV) and Meselson and Stahl's experiment (DNA replication by Semi conservative mechanism), nearest base frequency (anti parallel nature) analysis.

DNA replication- semi conservative method - role of helicases, topoisomerases, formation of replication fork, DNA polymerases, DNA ligases.

UNIT II **15 hrs**

Transcription- Colinearity of genes and proteins, eukaryotic and prokaryotic gene structure, transcription in prokaryotes- initiation, elongation, rho dependant and rho independent termination, capping, tailing and splicing (spliceosome mediated) in eukaryotic RNA.

Translation- genetic code, experiments of Khorana and Nirenberg, feature of genetic code- triplet codon, degeneracy, wobble hypothesis, variation in codon usage, structure of ribosome(review), A, P, E sites of ribosomes, translation in prokaryotes- activation of amino acids, initiation: shine dalgarno complex, initiation factors, elongation: elongation factors, peptide bond formation, termination: release factors.

UNIT III **15 hrs**

Concept of gene: Fine structure of gene, Beadle and Tatum's One gene one enzyme concept, One gene one polypeptide concept, Complementation test, Intragenic complementation, Cistron, Recon and Muton, Split gene, Jumping gene, Overlapping gene & multiple genes.

Sex Determination: Sex chromosomes, Chromosomal basis of sex determination- Lyon hypothesis, genic balance in *C.elegans*, *Drosophila*, Man and Plant Example: *Lychnis(Melandrium)*. Molecular basis of sex determination in *C.elegans*, *Drosophila* and Man.

Dosage compensation: Gene dose, Molecular basis of dosage compensation in *Drosophila* and man.

UNIT IV **15 hrs**

Crossing over,Linkage and mapping in eukaryotes: Crossing over**;** Mitotic recombination (somatic crossing over), meiotic recombination (Holliday model, gene conversion e.g., *Neurospora),* Concept of linkage- Bateson and Punett's Experiment, Incomplete linkage in *Drosophila* and *Maize,* genetic distance, two point cross, three point cross, gene order and construction of genetic maps in *Drosophila* and maize, Interference and coincidence, haploid mapping(tetrad analysis), Problems related to linkage and mapping.

Linkage and mapping in prokaryotes: sexual processes in bacteria and virusestransformation, transformation mapping, conjugation, F+ plasmids, Hfr cells, mapping of genes by interrupted mating, transduction and mapping with transduction.

Course Code: DSC-C12P Molecular Genetics Practical Credits: 4 4 hrs/week

1. Study of morphology and handling of *Drosophila melanogaster*.
2. Study of mutants of *Drosophila melanogaster*
3. Preparation of Salivary gland chromosomes of *Drosophila melanogaster*.
4. Demonstration of Mendel Monohybrid ratio.
5. Demonstration of Mendel Dihybrid ratio.
6. Demonstration of Sex linked inheritance.
7. Study of Karyotyping (normal and syndrome)
8. Study of inversion in *Drosophila*
9. Induction of puff in salivary glands chromosomes of *Drosophila Melanogaster*
10. Study of linkage analysis in Drosophila
11. Study of bar body in Buccal smear
12. Study of imaginal disc in Drosophila
13. Demonstration of multiple alleles

14 Photographs and charts related to molecular genetics

References :

1. Hartl D L Freifelder D Snyder L A 1988 Basic Genetics 1. Ed. Boston Portola Valley: Jones and Bartlett
2. Atherly A G, Girton, J R and Mc Donald J F, 1999. The Science of Genetics, Saunders College Publishing, Harcourt Brace College Publishers.
3. Brooker R.J. 1999. Genetics. Analysis and Principles. Ed. Benjamin Cummings. California
4. Gardner E J, Simmons M J, Snustad D P 1991. Principles of Genetics. John Wiley & Sons, Inc.
5. Griffith A J F, Miller J H, Suzuki D T, Lewontin R C, Gelbert W M.1996. An introduction to Genetic Analysis. W.H. Freeman and Co. New York
6. Strickberger, Monroe W. 1976. Genetics. Macmillan New York:
7. Watson, J. D., T. A. Baker, S. P. Bell, A. Gann, M. Levine, R. Losick. 2004. Molecular Biology of the Gene. 5th Edition. Pearson Education Pte. Ltd., New Delhi, India.
8. Klug, W S, and M R Cummings. 1998. Essentials of Genetics, 3rd ed. Prentice Hall, Upper Saddle River, NJ.
9. Hartl, D L & Jones E W 2006. Essential genetics: a genomics perspective (4th Ed), Jones and Bartlett Publishers, Boston.
10. Robert H. Tamarin. 2002. Principles of Genetics Tata-McGraw Hill, Seventh Edition.
11. Lewin B., Gene IV, V, VI. Oxford University press, Oxford.
12. Gilham, N. W. 1994. Organelle genes and genomes. Oxford University Press, Oxford and New York
13. Goodenough, U. 1984. Genetics, Saunders College Publishing
14. Gardner, E.J. et al., 1996. Principles of Genetics, VII Edn. Jjohn Wiley land Sons, Inc., New York.
15. Winter, P.C. et al., 2000. Instant notes in Genetics. Viva Books Pvt. Ltd. New Delhi
16. Sambamurthy A V S, 1999 Genetics. Narosa Publishing House, New Delhi

One of the following Discipline Specific Electives has to be opted under DSE-E3:

Course Code: DSE-E3 Genetic Engineering I Credits: 3 3 hrs/week
Course Code: DSE-E3 Clinical Biochemistry Credits: 3 3 hrs/week

Course Code: DSE-E3 Genetic Engineering I Credits: 3 3 hrs/week

Course objectives:

- To understand the different tools of genetic engineering such as enzymes, vectors, labelling methods and PCR.
- To impart knowledge on the use of different tools in genetic engineering.

Course outcome:

- Students will become familiar with the tools and techniques of genetic engineering.
- Students will be able to perform basic genetic engineering experiments at the end of course.
- Students will acquire knowledge of advances in biotechnology through recombinant DNA technology.
- Students will be able to describe the importance of DNA and protein sequence alignments, methods of alignment.
- Students will learn various biological databases and tools in bioinformatics.

UNIT I **15 hrs**

Enzyme as tools in Genetic Engineering:

a) Nucleases: DNases, RNases, exonucleases, endonucleases, restriction endonucleases, isoschizomers.
b) DNA polymerase, klenow fragment, reverse transriptase, ligases, S1 nuclease.
c) DNA modifying enzymes: polynucleotide kinase, terminal transferase, phosphorylase & phosphatase.Glycosylases,ribonuclease inhibitors, topoisomerases.

Extraction: Isolation and purification of DNA, RNA and plasmid from various Sources (review)

Vectors: Types - cloning, transcripts and expression vectors and construction, plasmid, phages, cosmid, phagemid, shuttle vectors, YAC, BAC, PAC and their significance. Hosts: bacteria, yeast, drosophila, xenopus oocyte, plant cell, mammalian cell.

UNIT II **15 hrs**

Recombinant DNA technology: linkers, adapters, homopolymer tailing cloning, ligation (blunt and staggered), gene transfer methods. Transformation, transfection(stable and transient), lipsome mediated transfer, microinjection, calcium phosphate method, DEAE- dextran method, electroporation, polybrene, laser transfection, biolistic methods (gene gun, microparticle bombardment.

Library construction and screening methods: genomic library, cDNA library, probe hybridization, plaque hybridization, colony hybridization, PCR screening. Direct screening**:** blue white screening, alpha-complementation, insertional inactivation, plaque phenotype. Indirect screening: hybrid arrest and hybrid select translation.

UNIT III **15 hrs**

Labelling methods: end labelling, oligonucleotide labelling by nick translation,fluorescent labelling and other methods like streptavidin and biotin

PCR concepts, methodology, types and applications: PCR basics, inverse PCR, multiplex PCR, nested PCR, colony PCR, real time PCR, tail PCR, reverse transcriptase PCR, PCR primers and primer designing.

Genetic engineering in plants: Vector mediated (*Agrobacterium* mediated transformation: *rhizogenes* and *tumefaciens*,) Physical methods (Microprojectile, microinjection, Liposome fusion)

References:

1. Sambrook J, Frisch E and Maniatis T Molecular Cloning: A Laboratory manual. 2000. Old Spring Harbor Laboratory Press New York,
2. Glover D M and Hames BD.DNA Cloning: a Practical Approach, IRL Press
3. Kaufman P B, Kim W.Wu.D and Cseke L J. Molecular and Cellular methods in Biology and Medicine, CRC Press, Boca Raton Florida.
4. Berger S L and Kimmel A P. Methods in Enzymology Vol. 152, Guide to Molecular Cloning Techniques.1998. Academic Press, Inc San Diego,
5. Methods in Enzymology Vol. 185, Gene Expression Technology, D V Goeddel,
6. Academic Press, Inc. San Diego, 1990
7. Mickloss D A and Freyer G A. DNA Science: A first Course in Recombinant Technology. 1990. Cold Spring Harbor Laboratory Press, New York
8. Primrose S B. Molecular Biotechnology. 2nd Edn. 1994. Blackwell Scientific Pub. Oxford.
9. Davies J A and Reznikoff W S. Milestones in Biotechnology: Classic papers on Genetic Engineering. 1992. Butterworth-Heinemann, Boston,
10. Walker M R and Rapley R. Route Maps in Gene Technology. 1997. Blackwell Science Ltd, Oxford.
11. Bernard R. Glick, Jack J. Pasternak Molecular Biotechnology: Principles and Applications of Recombinant DNA (3rd edition). 2003. Amer Society for Microbiology
12. Balasubramanian Et Al. Concepts in Biotechnology. 1996. Orient Longman Publisher.
13. Primrose S B Richard M. Principles of Gene Manipulation Blackwell Publishing.
14. Brown T.A. Gene Cloning and DNA Analysis. (4^{th} ed.). 2001. Blackwell Publishing.

Course Code: DSE-E3 Clinical Biochemistry Credits: 3 3 hrs/week

Course objectives:

- To understand the concept of health & diseases, communicable, non-communicable diseases. Metabolic diseases & deficiency.
- To give knowledge on various bio-molecules and their use in diagnosis and treatment of diseases.
- To create awareness of different lifestyle diseases including its management.
- To give insights to the recent developments in clinical diagnosis.

Course outcome:

- It illustrates the mechanism of metabolic disorders at molecular level.
- Students will learn about the normal constituents of urine, blood and their significance in maintaining good health.
- Students will get the knowledge of marker enzymes useful in diagnosis of various diseases.
- It is directed towards the employability in diagnostic centers.

UNIT I **15 hrs**

Concept of health & diseases. Communicable, non-communicable diseases. Metabolic diseases & deficiency

Enzymes in clinical diagnosis

Diabetes - Etiology, classification, diagnosis, treatment strategies. Complications, Role of diet, life style in development and control of diabetes, Role of exercise, obesity and role of fat.

UNIT II **15 hrs**

Cardiovascular diseases: Types, etiology, risk factors, causative mechanism,diagnosis, lipid profile, cholesterol, atherosclerosis. Management, obesity, diet

Inflammation : Mechanism, mediators, anti-inflammatory drugs, Diabetes, Arthritis, CVD and Cancer as inflammatory diseases**.**

Unit III **15 hrs**

Obesity: Problems, Causes & Consequences BMI, treatment and strategies.

Jaundice: Types, Prehepatic, hepatic and post hepatic gaundice. Laboratory diagnosis, liver function tests

Disease management: Inborn errors: Carbohydrate, Protein and Lipid; molecular diseases; possible course of treatment and management.

References:

1. Murphy, M. and Srivatsava, R. 2018. Clinical Biochemistry, Elsevier Publishing Services, Chennai.
2. Rodwell,V.W., Bender, D., Botham, K., Kennelly, P.J. and Weil, P.A. 2018. Harper's Illustrated Biochemistry. 31st Edition, McGraw Hill, India.
3.Conn E.E. and Stumf P.K. 1992. Outlines of Biochemistry. Wiley Eastern Pvt. Ltd.

One of the following Discipline Specific Electives has to be opted under DSE-E4:

Course Code: DSE-E4 Molecular Cell Biology Credits: 3 3 hrs/week
Course Code: DSE-E4 Molecular Endocrinology Credits: 3 3 hrs/week

Course Code: DSE-E4 Molecular Cell Biology Credits: 3 3 hrs/week

Course objectives:

- To give deeper knowledge on cellular processes that drive biological systems.
- To build the fundamental concepts of cellular structural organization and functional understanding of sub-cellular components.
- To impart practical skills in concepts of Molecular Cell Biology

Course outcome:

- Students will obtain understanding of the molecular aspects of biology.
- It also helps in understanding the concepts of cellular function.
- Students obtain fundamental knowledge required for understanding the cancer/apoptosis at molecular level.
- The course addresses molecular mechanisms underlying several central themes in cellular biology like cell division and replication, the transport of proteins and other macromolecules within cells.
- Students of this course will obtain an elementary introduction to the study of molecular biology.

UNIT I **15 hrs**

Plasma membrane: Membrane biogenesis-lipids and proteins, membrane flow hypothesis, regulation of plasma membrane composition, membrane lipid and protein turnover, polarized cells Mechanism of protein sorting and targeting (ER, golgi, plasma membrane, mitochondria), signal peptide.

Special features of other organelles: Golgi & ER – processing of glycoproteins, peroxisomes – lipid degradation and oxidative stress, vacuoles and their functions.

Membrane dynamics: Lateral diffusion, FRAP, FRET, single particle tracking, transbilayer movement of lipids (flip-flop) (flippase, floppase, scramblase), microdomains caveolae, rafts. Membrane fusion eg: neurotransmitters release.

UNIT II **15 hrs**

Membrane Transport: Law of diffusion overview, glucose transporter, Na^+ K^+ ATPase, receptor mediated endocytosis, Ion channels (ligand gated and voltage gated), aquaporin channel, ionophores, and patch clamp technique.

Structural frame work of eukaryotic cell: cytoskeleton, microfilaments, microtubules, and intermediate filaments. Composition, assembly and function.

Cell dynamics – Flagella and cilia, structure and assembly, cell movement, diapedisis, and moment of vesicles (vesicular trafficking).

UNIT III **15 hrs**

Cell cycle regulation: cell cycle overview, cell cycle check points, cell cycle regulatory genes, cyclins (D, E, A, and B), cdk's role, phase transition regulation (G1- S, S-G2, G2-M), S phase replication initiation regulation by S-cdk's & MCM proteins, role of microtubule & kinesin, dynein in anaphase, anaphase promoting complex, and cytokinesis.

Protein degradation: lysosomes (primary & secondary), lysosomal targeting of protein and degradation, non-lysosomal protein degradation- proteasome complex, ubiquitin mediated protein degradation.

Cell death: Apoptosis & necrosis role and mechanism, caspases and cathepsins. Cell death signals, survival factors, cell death genes. Cell death pathways, pro & anti apoptotic molecules.

References:

1. Cooper Geoffrey M. 2000. The Cell - a molecular approach. 2nd Edn. ASM Press.Washington.
2. Sharma A K & Sharma A. 1980. Chromosome techniques: Theory & Practice. Batterworth.
3. Bray A. D., Lewis J., Raff M., Roberts K. and Watson J.D. Moleucular Biology of the Cell. B. Garland Publishing, New York and London.
4. De Robertis E.D.P., De Robertis E.M.F. 2001. Cell and Molecular biology. Lippincott Williams & Wilkins. Bombay.
5. Freifelder D. 1990. Molecular biology. Narosa Publishing House, New Delhi
6. Gardner E J & D P Snustad 1996. Principles of genetics. John Willey, New York.

Course Code: DSE-E4 Molecular Endocrinology Credits: 3 3 hrs/week

Course objectives:

- To understand the molecular structure and function of Endocrine, Paracrine and autocrine secretions, Local hormones, Neuroendocrine secretions and Neurotransmitters
- To understand the genetic control of hormone synthesis

Course outcome:

- understand the basics of endocrine system
- able to discuss the mechanism of hormone action
- get a better understanding of Hypothalamo-Hypophyseal system
- able to explain the Morphology and physiological actions of melatonin
- able to explain the Bio-chemistry of synthesis, secretion and metabolism of thyroid hormones and Parathormone

UNIT I **15 hrs**

Hormones: History, ii).Endocrine, Paracrine and autocrine secretions, Local hormones, Neuroendocrine secretions and Neurotransmitters iii) An over view of Mammalian endocrine system, iv) An overview of general classes of chemical messengers-Peptide, Amino acid derivatives and Steroid hormones; v) Neurotransmitters-Neuropeptides, vi). Growth stimulating factors, Chalones, Eicosanoids and Pheromones.

Hormones and Homeostatsis : Glucose, Calcium and Sodium Homeostasis, ii).Neuro-endocrine integration: milk ejection reflex and water balance.

UNIT II **15 hrs**

Hypothalamo-Hypophyseal system

Endocrine Hypothalamus : Structure, Chemical nature and control of secretion of hypothalamic hormones-TRH, GHRH, GnRH, CRH, Somatostatin and dopamine, Control of release of these hormones and their action on target cells, Pituitary: Location, Development, structure and functional cell types, Hypothalomo-hypophysial portal system, Pituitary hormone and their physiological actions with emphasis on molecular mechanisms-GH and Prolactin, FSH, LH and FSH (Glycoprotein Hormones), Pro- opiomelanocortin and Neurohypophysial Hormones, Control of Hypophysial Hormones: secretion and feed back regulation, Pituitary patho-physiology: Hyperprolactinaemia, Pituitary dwarfish, Gigantism and Acromegaly.

Pineal gland : Morphology and physiological actions of melatonin

Endocrine Pancreas : i). Structure and cell types of Islets of Langerhans, ii). Secretion and metabolism of Insulin, Glucagon and other pancreatic hormones, iii). Cellular and molecular actions of Insulin and Glucagon, iv). Insulin and Non Insulin Dependent Diabetes Mellitus, v). Islet cell tumor

UNIT III **15 hrs**

Thyroid and Parathyroid Glands:i). Position and Morphology, ii). Bio-chemistry of synthesis, secretion and metabolism of thyroid hormones and Parathormone, iii). Actions with emphasis on molecular mechanisms, iv). Patho-physiology-Goiter, Grave's disease and Cretinism.

Adrenal Gland: i). Anatomy, embryology and histology, ii). Control of synthesis, secretion and physiological roles of cortical hormones with emphasis on molecular actions, iii). Adrenal chromaffin tissue: Synthesis, and actions of catecholamines, iv). Addison's disease and Cushing's syndrome.

Gastro-Intestinal Hormones :Endocrine cells, Gastrin, CCK and Secretin

References

1.Norman, A.W. and Henry, H.L., 2014. Hormones. 3rd Edition., Elsevier, Amsterdam.

2.Hall, J.E. and Hall, M.E. 2020. Guyton and Hall Text Book of Medical Physiology. 14th Edition. Elsevier, Amsterdam.

3. Melmed, S., Larsen, P.R., Polonsky, K.S. and Kroneberg, H. M. 2015. Williams Textbook of Endocrinology. Elsevier, Amsterdam.

4. Wass, J., Arlt, W. and Semple, R. 2022. Oxford Book of Endocrinology. Oxford University Press, London.

Course Code: VOC-2 Cell and Tissue Culture Technology Credits: 3 3 hrs/week

Course objectives:

- To develop basic aseptic skills for cell culture and their applications.
- To understand media constituents and media formulation strategies for cell and tissue culture.
- To provide complete exposure as how plant and animal cells are isolated, cultured and genetically manipulated in laboratory.

Course outcome:

- Students will get knowledge of cell and tissue culture which is required for biological science research.
- Based on the knowledge gained after studying this course, students will able to conduct *in-vitro* experiments using different cell lines and tissues during their research work.
- It can create job opportunities in pharmaceutical companies or they can have their own startups.

UNIT I 15 hrs

Plant Cell and tissue culture Technology:

History : Developments in Plant Cell culture and different areas of Applications in Plant tissue culture.

Laboratory organization and culture techniques: general requirements, aseptic conditions, media preperation, culture media Role of hormones in growth and development of plants, tissue-specific hormones, sterlization, pre-treatment of ex-plants. Problems and solutions associated with tissue culture.

Principles of Tissue culture: callus culture- definition of callus, initiation, maintenance, subculture and organogenesis.

Organ culture: culture protocols and importance of root, meristem, ovary and ovule culture, factors affecting organogenesis. Cytodifferentiation, dedifferentiation and factors affecting them.

Micropropagation: methods, micropropagation from pre-existing meristem, shoot apical meristem, shoot and node culture, micropropagation stages and applications, somaclonal variation for disease resistance and desired agronomic traits.

Somatic embryogenesis: Embryoid and embryogenesis Induction and development, synthetic seeds. Applications of somatic embryogenesis.

UNIT II 15 hrs

Haploid Production in Plants: Techniques and methods of haploid culture, Factors affecting anther and microspore cultures, factors affecting androgenesis, applications and limitations

Protoplast Technology: Isolation, purification and culture of protoplasts, protoplast fusion and somatic hybridization, regeneration of plants. Applications of somatic hybrids/cybrids.

Secondary metabolite production in Plant Cell culture : Induction of secondary metabolites by plant cell culture, technology of plant cell culture for production of chemicals, biotransformation using plant cell culture. Bioreactor systems and models for mass cultivation of plant cells.

Animal Cell and tissue culture Technology:

Tissue culture laboratory: Advantages and limitations of tissue culture, types of tissue culture, equipment, aseptic and sterile handling, general safety, choice of culture vessel, media, preparation and

sterilization of media, facilities required, serum free media.

Primary culture: Isolation of mouse and chick embryos, human biopsies, methods for primary culture, nomenclature of cell lines, sub culture and propagation, immortalization of cell lines, cell line designation, selection of cell line and routine maintenance cell lines, cloning and selection, contamination management, cryopreservation, quantitation of cells, cytotoxicity assays.

Specialized Cells: different cell types used, development of cell lines,selective culture, specific tumor types.

Cloning and Selection: Cloning protocol, stimulation of plating efficiency, suspension cloning, isolation of clones, isolation of genetic variants, interaction with substrate, selective inhibitors.

UNIT III **15 hrs**

Cell separation and characterization: Density based, antibody based, magnetic and fluorescence based cell sorting. Characterization of cells based in morphology, chromosome analysis, DNA content, RNA and protein, enzyme activity, antigenic markers, cytotoxicity assays, cell quantitation, cell culture

Contamination: monitoring and eradication, cryopreservation.

Culturing of specialized cells: Epithelial, mesenchymal, neuro ectodermal, hematopoietic gonad and tumor cells, Lympocyte preparation, culture of amniocytes, fish cells, confocal microscopy. Stem cell culture and its applications

Organ and embryo culture: Choice of models, organ culture, histotypic culture, filter-well inserts, neuronal aggregates whole embryo culture eggs, chick and mammalian embryos.

Cell and Tissue engineering: Growth factors for in situ tissue regeneration, biomaterials in tissue engineering, approaches for tissue engineering of skin, bone grafts, nerve grafts. Haemoglobin-based blood substitutes, bio artificial or biohybrid organs. Limitations and possibilities of tissue engineering.

References:

Plant Cell and Tissue culture Technology

1. Murthy, B.R.C. and Sai, V. S. T., 2017. Plant Tissue Culture and its Biotechnological Applications. Venkateswara Publications, Guntur
2. Pullaiah. T. and Subba Rao, M.V., 2009. Plant Tissue culture. Scientific Publishers, New Delhi.
3. Bhojwani, S.S. and Razdan, M.K., 1990. Plant Tissue Culture: Theory and Practice. Elsevier Science Amsterdam. he Netherlands.
4. Glick, B.R. and Pasternak, J.J., 2003. Molecular Biotechnology- Principles and Applications of recombinant DNA.,ASM Press, Washington.
5. Bhojwani, S.S. and Bhatnagar, S.P. 2011. The Embryology of Angiosperms. 5th Edition. Vikas PublicationHouse Pvt. Ltd., New Delhi.
6. Stewart, C.N. Jr., 2008. Plant Biotechnology & Genetics: Principles, Techniques and Applications. John Wiley & Sons Inc. U.S.A.

Animal Cell and Tissue culture Technology

1. Freshney, R. I., 2010. Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications. 6th Edition, Wiley-Blackwell,.
2. Davis, J. M., 2008. Basic Cell Culture. Oxford University Press. New Delhi.
3. Davis, J. M., 2011. Animal Cell Culture. John Willy and Sons Ltd. USA.
4. Freshney, R. I., 2005. Culture of Animal Cells. John Willy and Sons Ltd. USA.
5. Butler, M., 2004. Animal Cell Culture and Technology. Taylor and Francis. New York, USA.
6. Verma, A. S. and Singh, A.,2014. Animal Biotechnology. Academic Press, Elsevier, USA.
7. Cartwright, E. J., 2009. Transgenesis Techniques. Humana Press. London, UK.
8. McArthur, R. A. and Borsini, F., 2008. Animal and Translational Models for CNS Drug Discovery. Elsevier, London.

QUESTION PAPER:THEORY EXAMINATION
(Applicable to DSC courses of V and VI semesters Papers)
5-Year Integrated M.Sc. Course in Molecular Biology
_____ Semester
Title of the Paper:_____

Time: 2 ½ hours **Max. Marks: 60**

Instructions: Draw neat and labelled diagrams wherever necessary

PART-A

1. Define/Explain any five of the following:
(2 questions from each unit) **2x5=10**

a.
b.
c.
d.
e.
f.
g.
h.

PART-B

Answer any four of the following (Internal Choice)
(Internal choice should be from the same unit) **5x4=20**

2.
3.
4.
5.

PART-C

Answer any three of the following:
(One question from each unit) **10X3=30**

6.
7.
8.
9.

Scheme of Discipline Core (DSC) Practical evaluation
5-Year Integrated M.Sc. Course in Molecular Biology

Max. Marks: 50marks
(Practical test/Viva/MCQ/written test based on Practical concepts: 20 marks + Record :05 marks + Practical examination : 25 marks)

Scheme of Practical Examination
V Semester – Metabolism II/Enzymology

1. Write the principle and procedure for the experiment mentioned 05M
   (principle:2marks, procedure:5 marks, Tabular colum:2marks, Result:1mark)
2. Conduct the major experiment 10M
   (Principle: 1marks, Procedure: 2 marks, Standardization: 1 marks, Tabular colum:1 mark, graph: 2 marks, Results: 3 marks)
3. Conduct the minor experiment 06 M
   (Principle:1marks: Procedure and conducting: 3 marks, reporting:2marks)
4. Identify and comment on A, B 2x2=4 M
   a.
   b.

(**Note:** Duly certified practical record shall be submitted at the practical examination (No evaluation of record).

Scheme of Practical Examination
V Semester – Molecular Genetics

1. Conduct the major experiment 08 M
   (Distribution of the marks can be depending on the experiment given)
2. Conduct the minor experiment 06 M
   (Distribution of the marks can be based on the experiment given)
3. Identify and comment on A, B 2x2=6 M
   a.
   b.
   c.

(**Note:** Duly certified practical record shall be submitted at the practical examination (No evaluation of record).

Integrated M.Sc. Program outcomes	
PO1	**Disciplinary Knowledge:** Integrated M.Sc. (Five Years) degree in Molecular biology is the culmination no fin-depth knowledge of various facets of Biology giving an in depth understanding at biochemical and molecular level. To give various facets of biology, computational biology is also taught. The interdisciplinary nature of the course gives a holistic understanding of biology with a physical science background.
PO2	**Communication Skills**: Ability to communicate various biological concepts at biochemical, molecular and computational levels effectively.Theskillsandknowledgegainedinthisprogramwillleadtotheanalyticalreasoningwhichcanbeusedfor solving of the problems faced by humanity such as vaccine development, drug development, ecofriendly way of disease management.
PO3	**Critical thinking:** The students undergoing this programme will acquire ability of critical thinking and will show passion for the chosen area which will help them to perform better in their chosen profession.
PO4	**Problem Solving** : The knowledge on the various facets of Molecular Biology gained by the students through this programme develop an ability to analyze the given biological problems, identify and define appropriate requirements including computational approach for its solutions. This programme enhances overall development of the students with problem solving skills.
PO5	**Research related skills:** The completing this programme develop the capability of asking questions which are inquisitive. The capability to ask good questions enables them to find out the ways to solve the same which is very much needed by a good researcher. Apart from this, students would have learnt many hands on techniques needed to undertake research in molecular biology area.
PO6	**Information/digital Literacy**: The completion of this programme will enable the learner to use appropriate softwares to undertake biological science research with significant outcome. This approach will reduce the time required for solving a given problem. This is very much applicable in the area of drug development.
PO7	**Self–directed learning**: The student completing this program will Develop an ability of working independently and to make an in-depth study of various branches of Molecular biology.
PO8	**Moral and ethical awareness/reasoning:** The student completing this program will develop an ability to identify the original research and will be responsible to follow the research ethics which is ultimately required for the development of biological science and ultimately for the progress of science.
PO9	**Lifelong learning**: This programme provides self-directed learning and lifelong learning skills. This programme helps the learner to thinking dependently and will be able to evolve for solving Real word problems.
PO10	**Research capability:** Ability to peruse advanced studies and research in basic and applied aspects related to biological sciences using molecular tools .

Program Articulation Matrix for V and VI semesters

Program articulation of the courses which include courses such as theory, laboratory, project, internships etc. is given below:

Semester	Course	PO addressed	Pedagogy	Assessment pattern
V	Metabolism I Theory	PO-1,PO-3,PO-4	The course is taught using traditional chalk and talk method using through examples and exercises. Power point presentations, audiovisual method 2. Students are encouraged to use resources available on open sources	The assessment is done using continuous assessment through written test, seminars, and peer discussions and /viva/ attendance
	Metabolism I Practical	PO-1,PO- 3, PO-4, PO- 5	The course is taught using related experiments using relevant instruments like colorimeter, spectrophotometer, centrifuge, lab visits and use of Chalk and talk, digital presentations and will be taken to diagnostic laboratory/Institute of Excellence, UOM to expose the techniques in field.	Practical test/Viva/MCQ/written test based on Practical concepts: 20 marks + Record and Attendance :05 marks
	Enzymology Theory	PO-1,PO-3,PO-4, PO-9, PO-10	The course is taught using traditional chalk and talk method using through examples and exercises. Power point presentations, audiovisual method 2. Students are encouraged to use resources available on open sources	The assessment is done using continuous assessment through written test, seminars, and peer discussions and /viva/ attendance
	Enzymology Practical	PO-1,PO- 3, PO-4, PO- 5	The course is taught using related experiments using relevant instruments like colorimeter, spectrophotometer, centrifuge, use of Chalk and talk, digital presentations.	Practical test/Viva/MCQ/written test based on Practical concepts: 20 marks + Record and Attendance :05 marks
	Principles of Genetics Theory	PO-1,PO- 3, PO-4, PO- 5, PO-6	The course is taught using traditional chalk and talk method using through examples and exercises, group discussions. Power point presentations, audiovisual method 2. Students are encouraged to use resources available on open sources	The assessment is done using continuous assessment through written test, seminars, and peer discussions and /viva/ attendance
	Forensic Biology Theory	PO-1,PO- 3, PO-4, PO- 5, PO-6	The course is taught using traditional chalk and talk method using through examples and exercises, group discussions. Alumni of the Department who are working as Scientific officers will be invited to give exposure to Forensic Biology technques. Power point presentations, audiovisual method 2. Students are encouraged to use resources available on open sources	The assessment is done using continuous assessment through written test, seminars, and peer discussions and /viva/ attendance
	Biophysics Theory	PO-1,PO- 3, PO-4, PO- 5, PO-6	The course is taught using traditional chalk and talk method using through examples and exercises, group discussions. Power point presentations, audiovisual method 2. Students are encouraged to use resources available on open sources	The assessment is done using continuous assessment through written test, seminars, and peer discussions and /viva/ attendance

	Nannoscience Theory	PO-1,PO-2 PO-3,PO-4, PO-5	The course is taught using traditional chalk and talk method using through examples and exercises, group discussions. Power point presentations, audiovisual method 2. Students are encouraged to use resources available on open sources	The assessment is done using continuous assessment through written test, seminars, and peer discussions and /viva/ attendance
	Biochemical Techniques theory	PO-1,PO-2 PO-3,PO-4, PO-5, PO-6	The course is taught using traditional chalk and talk method using through examples and exercises, group discussions, power point presentations, audiovisual method, students are encouraged to use resources available on open sources	The assessment is done using continuous assessment through written test, seminars, and peer discussions and /viva/ attendance
	Biochemical Techniques Practical	PO-1,PO-3,PO-4	1.The course is taught using traditional chalk and talk method using through examples and exercises. 2. power point presentations, audiovisual method 2. Students are encouraged to use resources available on open sources	The assessment is done using continuous
	Bioinformatics Theory and practical	PO-1,PO-3,PO-4, PO-9	The course is taught using open resources, group discussions, power point presentations, audiovisual method, students are encouraged to use resources available on open sources	The assessment is done using continuous assessment through written test, seminars, and peer discussions and /viva/ attendance
VI Sem	Metabolism II Theory	PO-1,PO-3,PO-4	The course is taught using traditional chalk and talk method using through examples and exercises, group discussions, power point presentations, audiovisual method, students are encouraged to use resources available on open sources	The assessment is done using continuous assessment through written test, seminars, and peer discussions and /viva/ attendance
	Metabolism II Practical	PO-1,PO-3,PO-4	The course is taught using related experiments using relevant instruments like colorimeter, spectrophotometer, centrifuge, use of Chalk and talk, digital presentations	Practical test/Viva/MCQ/written test based on Practical concepts: 20 marks + Record and Attendance :05 marks
	Molecular Genetics Theory	PO-1,PO-3,PO-4	The course is taught using traditional chalk and talk method using through examples and exercises, group discussions, power point presentations, audiovisual method, students are encouraged to use resources available on open sources, Invited lectures will be arranged	The assessment is done using continuous assessment through written test, seminars, and peer discussions and /viva/ attendance
	Molecular Genetics Practical	PO-1,PO-3,PO-4,PO-5	The course is taught using related experiments using relevant instruments like colorimeter, spectrophotometer, centrifuge, lab visits and use of Microscopes and slides, Chalk and talk, digital presentations and will be taken to diagnostic laboratory to expose the techniques in field.	Practical test/Viva/MCQ/written test based on Practical concepts: 20 marks + Record and Attendance :05 marks
	Genetic Engineering Theory	PO-1,PO-3,PO-4	The course is taught using traditional chalk and talk method using through examples and exercises, group discussions, power point presentations, audiovisual method, students are encouraged to use resources available on open sources, invited lectures will be arranged	The assessment is done using continuous assessment through written test, seminars, and peer discussions and /viva/ attendance
	Clinical Biochemistry Theory	PO-1,PO-3,PO-4	The course is taught using traditional chalk and talk method using through examples and exercises, group discussions, power point presentations,	The assessment is done using continuous assessment through written test, seminars,

			audiovisual method, students are encouraged to use resources available on open sources, Invited lectures will be arranged	and peer discussions and /viva/ attendance
	Molecular Cell Biology Theory	PO-1,PO-3,PO-4	The course is taught using traditional chalk and talk method using through examples and exercises, group discussions, power point presentations, audiovisual method, students are encouraged to use resources available on open sources, Invited lectures will be arranged	The assessment is done using continuous assessment through written test, seminars, and peer discussions and /viva/ attendance
	Molecular Endocrinology Theory	PO-1,PO-3,PO-4,PO-5	The course is taught using related specimens, and use of Microscopes, centrifuges, Haemocytometer, microtome machine and slides, Chalk and talk, digital presentations	Assessment Through practical experiments and lab records and /viva
	Cell and Tissue Culture Technology Theory	PO-1,PO-3,PO-4	The course is taught using traditional chalk and talk method using through examples and exercises, group discussions, power point presentations, audiovisual method, students are encouraged to use resources available on open sources, Invited lectures will be arranged.	The assessment is done using continuous assessment through written test, seminars, and peer discussions and /viva/ attendance
	Internship	PO-1, PO-2, PO- 3,PO-4, PO-5,PO-9, PO-10	This training is done in a reputed research laboratory of our country or abroad where all hands on skills and critical thinking on a given research area will be gained. Students will be encouraged ask good questions. This approach will be a life long training for these students	Assessment is based on the attendance and practical skill development and problem-solving skills will be tested.

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