Telephone No. 2419677/2419361
Fax: 0821-2419363/2419301

e-mail : registrar@uni-mysore.ac.in
www.uni-mysore.ac.in

UNIVERSITY OF MYSORE

Estd. 1916

VishwavidyanilayaKaryasoudha
Crawford Hall, Mysuru- 570 005

No.AC2(S)/55/2024-25 Dated: 20.07.2024

Notification

Sub:-Syllabus and Scheme of Examinations of Molecular biology (PG) Programme (IV & V year) with effect from the Academic year 2024-25.

Ref:-1. Decision of Board of Studies in Molecular biology (CB) meeting held on 10-06-2024.
2. Decision of the Faculty of Science & Technology meeting held on 19-06-2024.
3. Decision of the Academic Council meeting held on 28-06-2024.

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The Board of Studies in Molecular biology (CB) which met on 10-06-2024 has resolved to recommend & approved the Syllabus and Scheme of examinations of Molecular biology (PG) programme (IV & V year) with effect from the Academic year 2024-25.

The Faculty of Science & Technology and Academic Council at their meetings held on 19-06-2024 and 28-06-2024 respectively has also approved the above said Syllabus and Scheme of examinations hence it is hereby notified.

The Syllabus and Scheme of Examinations content may be downloaded from the University Website i.e., www.uni-mysore.ac.in.

Registrar

Registrar
University of Mysore
Mysore

To;

1. The Registrar (Evaluation), University of Mysore, Mysuru.
2. The Chairman, BOS/DOS in Molecular biology, Manasagangothri, Mysore.
3. The Dean, Faculty of Science & Technology, DOS in Mathematics, MGM.
4. The Director, Distance Education Programme, Moulya Bhavan, Manasagangothri, Mysore.
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

Integrated Five years UG/PG in Molecular Biology

Integrated Five Years

B.Sc./B.Sc.(Hons)/ and M.Sc in Molecular Biology

Effective from 2021-2022 onwards

Model: Integrated Five years UG/PG Programme

VII to X semesters (PG syllabus)

Approved in the meeting of BOS in Molecular Biology
10.06.2024

Integrated Five years UG/PG-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
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/Finan-cial 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
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.

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
		DSC-C2	General Botany Practical	2	-	4	3	25	25	50
		DSC-C3	General Zoology	4	4	-	2	40	60	100
		DSC-C4	General Zoology Practical	2	-	4	3	25	25	50
II	DSC	DSC-C5	Cell Biology and Plant Physiology I	3	3		2	40	60	100
		DSC-C6	Cell Biology and Plant Physiology I Practical	2	-	4	3	25	25	50
		DSC-C7	Inorganic and Physical Chemistry	3	3	-	2	40	60	100
		DSC-C8	Inorganic and Physical Chemistry Practical	2	-	4	3	25	25	50
III	DSC	DSC-C9	Microbiology	3	3	-	2	40	60	100
		DSC-C10	Microbiology Practical	2	-	4	3	25	25	50
		DSC-C11	Biochemistry	3	3	-	2	40	60	100
		DSC-C12	Biochemistry Practical	2	-	4	3	25	25	50
IV	DSC	DSC-C13	Reproductive and Developmental Biology	3	3	-	2	40	60	100
		DSC-C14	Reproductive and Developmental Biology Practical	2	-	4	3	25	25	50
		DSC-C15	Plant Physiology II and Animal Physiology	3	3	-	2	40	60	100
		DSC-C16	Plant Physiology II and Animal Physiology Practical	2	-	4	3	25	25	50
V	DSC	DSC-C17	Metabolism I	4	4	-	2	40	60	100
		DSC-C18	Metabolism I Practical	2	-	4	3	25	25	50
		DSC-C19	Enzymology	4	4	-	2	40	60	100
		DSC-C20	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-C21	Metabolism II	4	4	-	2	40	60	100
		DSC-C22	Metabolism II Practical	2	-	4	3	25	25	50
		DSC-C23	Molecular Genetics	4	4	-	2	40	60	100
		DSC-C24	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	-	-	-	-	-	-

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
VII	DSC	DSC-C25	Immunology	4	4	-	2.5	40	60	100
		DSC-C26	Immunology Practicals	2	-	4	3	25	25	50
		DSC-C27	Genetic Engineering II	4	4	-	2.5	40	60	100
		DSC-C28	Genetic Engineering Practicals	2	-	4	3	25	25	50
		DSC-RM5	Research Methodology and Biostatistics	4	3	2	2.5	50	50	100
		DSE-E5	Cell signalling	3	3	-	2.5	40	60	100

		DSE-E5	Toxicology (Any one to be taken)							
		VOC-4	Molecular Diagnostics	3	2	2	2	50	50	100
VIII	DSC	DSC-C29	Molecular Pathology	4	4	-	2.5	40	60	100
		DSC-C30	Molecular Pathology Practicals	2	-	4	3	25	25	50
		DSC-C31	Genomics and Proteomics	4	4	-	2.5	40	60	100
		DSC-C32	Genomics and Proteomics Practicals	2	-	4	3	25	25	50
		INT/ENT	Internship/Entrepreneurships	4	-	-	-	50	50	100
		DSE-E6 DSE-E6	Molecular Basis of Development and differentiation Molecular Ecology (Any one to be taken)	3	3	-	2.5	40	60	100
		VOC-5	Bioenterpruneurship	3	2	2	2.5	50	50	100
IX	DSC	DSC-C33	Gene Expression and Regulation	4	4	-	2.5	40	60	100
		DSC-C34	Gene Expression and Regulation Practicals	2	-	4	3	25	25	100
		DSC-C35	Systems biology	4	-	4	2.5	40	60	100
		DSC-C36	Systems biology Practicals	2	-	4				
		DSC-C37	Biology of life style disorders	4						
		DSE-E7 DSE-E7	Molecular Evolution and Behavior Artificial intelligence in Biology (Any one to be taken)	3						
		VOC-5	Drug discovery and design	3	2	2	2	50	50	100
X		RIT	Research Internship	4	4	-	-	50	50	100
		RPF*	Research Proposal Formulation	2	2	-	-	50	50	100
		RPJ	Research Project	16		32	-	50	50	100

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. –

Detailed Syllabus of 5 Year Integrated M.Sc. Molecular Biology
Course Content of Semester–VII

Sem. No.	Course Category	Course Code	Course Title	Credits Assigned	Hours of teaching/week
VII	DSC	DSC-C25	Immunology	4	4
		DSC-C26P	Immunology Practical	2	4
		DSC-C27	Genetic Engineering II	4	4
		DSC-C28P	Genetic Engineering II Practical	2	4
		DSC-RM5	Research Methodology and Biostatistics	4	3 hrs theory +2 hours of practicals
	DSE	DSE-E5	Cell signaling	3	3
		DSE-E5	Toxicology	3	3
	Vocational	VOC-4	Molecular Diagnostics	2	2
				1	2

DSC -C25 IMMUNOLOGY – THEORY - 4 CREDITS 60 hrs

Course objectives:

- To gain knowledge of the development of the various cells and tissues of the human immune system.
- To model the physiological and pathological functions of the immune system at a molecular level.
- To demonstrate some of the major modern techniques influenced by immunology and to understand types of immune responses seen in the body in normal and pathological conditions.
- To acquire knowledge about research and development of novel vaccines and immunotherapeutics.

Course outcome:

- Students will have knowledge of different types of immunity, protection barriers, different cells which are participating in the immune responses. Applications of monoclonal antibodies. Immunology of cancer and other disorder.
- Students will understand the importance of ongoing research like production of vaccines for emerging pathogens, also in immunotherapy, autoimmune diseases.
- This will helps the students in advancing understanding of basic immunology which is essential for clinical and commercial application and will facilitate the discovery of new diagnostics and treatments to manage a wide array of diseases.
- Students will understand the role of immune responses in numerous disciplines of medicine, particularly in the field of organ transplantation, oncology etc.

UNIT I

1. **Introduction:** Historical development and milestones in immunology – Contributions of Edward Jenner, Louis Pasteur, Emilvon Behring &Kitasato, Metchinkoff, Cells of Immune system, Primary and secondary lymphoid organs – Lymphatic system, Reticulo-endothelial system, Types of immunity, Innate & Acquired.

2. **Non-specific defenses in man:** Barriers to infection – skin, mucous membrane,Inflammation, phagocytosis.

3. **Complement system:** Classical, alternate and lectin binding pathway, Generation ofmembrane attach complex. Anaphylotoxins&Opsonins.

– hematopoiesis;soluble molecules and membraneassociated receptors; Toll-like receptors; cell types of innate immunity (neutrophils and macrophages); signal transduction pathways. **3 hrs UNIT II**

4. **Antigens and Antibodies:** Chemical nature & properties, Epitopes, Antigenecity, Immunogenecity, Valency of antigens, Haptens. Immunoglobulins - Structure, Classes and subclasses, Paratopes, Immunoglobulin variants – Isotypes, Allotypes&Idiotypes, Valency of antibody, Genetic basis of antibody diversity.

5. **Immune responses:** Primary and secondary, class switching, Immune responses toInfectious diseases caused by Bacteria, virus and fungi.

6. **MHC:** Structure & functions-MHC antigens in man Antigen processing & presentation

UNIT III

7. Vaccines: Vaccines and their preparations (traditional and recombinant vaccines)BCG, Polio, DPT, HBV, Adjuvants.

8. **Cellular basis of immunity:** Hematopoiesis, Biology of T-cells and B-Cells, Generation and activation. T-cell subsets. T-cell and B-Cell receptors. Antigen presenting cells and accessory cells (macrophages & dendritic cells), T-cell and BCell co-operation, NK cells-ADCC, Clonal selection, Cytokines – role in immunity.

9. **Transplantation:** Tissue typing- Autograft, Isograft, Allograft &Xenograft. Graftversus host reactions (GVHI). Immunosuppression.

10. **Hypersensitivity:** Types of Hypersensitivity reactions. Types – I, II, III & IV Anaphylaxis.

Complement system - components, activation and biological functions.

UNIT IV

11. **Disorders of immune system:** Immunological tolerance, Organ-specific and Systemic Autoimmune disorders, Immunodeficiency disorders, SCID, AIDS, Erythroblastosisfoetalis.

12. **Tumor immunology:** Tumor associated antigens & Tumor specific antigens.Immune surveillance, TNF !& ", immunotherapy.

13. **Monoclonal antibodies**: Preparations, stabilization and applications.

14. **Immunological techniques:** Preparations, agglutinations, Complement fixation, WIDAL Test, Coomb's Test, Immunoferritin technique, Immunodiffusion, Immuno-electrophoresis and variants, Immunofluroscence, RIA & ELISA, Western blotting.

References:

1. Roitt I M, Brostoff J and Male D K. Immunology. 3rd edn. 1993. Mosby – Yearbook Europe Ltd., London.
2. Roitt I M Delves P J. Essential Immunology 10th ed 2001 Blackwell Scientific Publications
3. Boyd W C Fundamentals of Immunology 1964 Toppan Co. Ltd., Tokyo.
4. Kimball J W Introduction To Immunology. 1983. Macmillan Publishing Co., Inc.New. York.
5. Otto S. View and others. Fundamentals of Immunology.
6. Wier D M. Experimental Immunology 1978 Blackwell Scientific Publications Oxford.
7. Kubay J. Immunology. 2001. Second Edition. W H Frecman & Company NewYork.
8. Abbas A K Lichtman A H Cellular and molecular immunology 3rd edition 2007 Oxford University Press, Oxford.

DSC -C26P IMMUNOLOGY – PRACTICALS- 2 CREDITS 2 HOURS/WEEK 30 hrs

1. Observation of Immune System Cells under Microscope
2. Ouchterlony's Double diffusion.
3. Single Radial Immuno diffusion (SRID).
4. Immunoelectrophoresis.
5. ELISA (Enzyme-Linked Immunosorbent Assay)
6. Slide agglutination- Antigen-Antibody Reaction
7. Isolation of IgG form human serum.
8. Purification of IgG by affinity chromatography.
9. Complement assay.
10. Hemagglutination Inhibition Test
11. Vaccine Preparation (Simple Model)
12. WIDAL Test for Typhoid (kit method)
13. Western Blotting (demonstration/charts)

Protocol and charts for

1. Lymphocyte Isolation and Culture (charts)
2. Mixed Lymphocyte Reaction (MLR) (charts)
3. Coomb's Test (Direct and Indirect)
4. Phagocytosis Assay (charts)

DSC -C27 GENETIC ENGINEERING II CREDITS 4 HOURS/WEEK 60 hrs

Course objective:

- To understand the prokaryotic and eukaryotic expression systems.
- To impart knowledge on plant and animal cell culture.
- To give deeper knowledge on the mechanism of RNA interference and antisense RNA.
- To introduce fundamental aspects of intellectual property rights to students who are going to play a major role in development and management of innovative projects in industries.

Course outcome:

- Students will be able to get knowledge on selection of suitable expression system for a specific metabolic product.
- Students will learn the application of plant and animal cell culture.
- It enables the students to acquire knowledge on biomarkers and their application in molecular biology during molecular breeding.
- Students will become aware of genetic engineering and its applications in various fields like medicine, vaccine production, disease diagnosis, agriculture and environment.
- Students will acquire knowledge on bio safety, handling, testing & evaluation of GMO's, and animal ethical issues.
- Students will learn the disposal methodologies and safety concerns related to GMO's by understanding the role of different committees such as IBSC, RCGM, GEAC.
- The students once they complete this course shall get an adequate knowledge on patent and copyright for their innovative research works during their research career.
- Knowledge gained after completing this course, will make the students to get jobs in R&D. They can also become entrepreneurs.

UNIT I

I. GENETIC ENGINEERING OF LIVING ORGANISMS-

Prokaryotic expression systems: Expression and purification of recombinant proteins in *E.coli*,

Eukaryotic expression systems - expression vectors in yeast (*S. cerevisiae*– YES, and P. pastoris– pPICZ); gene expression in animal cells - pcDNA3.1/His and pSecTag2/Hygro; viral vectors – adenoviral and retroviral (pLenti expression system).
Insect expression system - baculovirus system

Mammalian Expression system: knock-out mice by targeted disruption by homologous recombination in ES cells; conditional knock-out by site specific recombination (Cre/loxP system); advanced transgenic technology – inducible expression system – tet on/off system
Transgenic plants:

II Cell Culture:

Plant Cell Culture: Micropropagation callus culture, haploid production, somatic embryogenesis, somatic hybridization and cybridization, somaclonal variation.

Animal Cell Culture: Culture techniques, media, preparation of primary culture, chick embryo, HUVEC, cell lines, characterization of cultures ploidy, cell doubling time. Amplified cultures continuous cultures, applications.

UNIT II

III. Techniques: Sequencing techniques (**Maxam and Gilbert, Sanger and Coulson,** shot gun, nanopore) methods (NGS), cyclic reversible termination (CRT), singlenucleotide addition (SNA) and real-time sequencing, Sequencing by ligation (SBL), pyrosequencing. DNA finger printing, DNA foot printing, nuclease protection assay (EMSA), band shift assay, genome walking, RACE

VI. RNA interference and Antisense RNA: RNA induced gene silencing (miRNA, siRNA, shRNA) Molecular mechanism of antisense molecules, inhibition of splicing, polyadenylation and translation.

VII. Ribozymes: Ribozyme biochemistry, hammerhead, hairpin and other ribozymes, strategies for designing ribozymes, application of antisense and ribozyme technologies.

UNIT III

VIII. Biomarkers - Morphological, biochemical and molecular markers; Importance of molecular markers; Molecular and protein polymorphism; Naturally occurring polymorphism in DNA sequences – Base pair deletion, substitution, additions or patterns; Application – germplasm characterization, genetic diagnosis, characterization of transformants, study of genome organization and phylogenetic analysis. Molecular markers for genome analysis: kinds of molecular markers - (RFLP, RAPD, STS, SSR, AFLP, SNPs) protein markers – merits and demerits and their applications in different fields of molecular biology; isozyme marker – merits and demerits, their application in molecular biology.

Molecular breeding: Marker-Assisted-Selection (MAS). Marker-Assisted Backcrossing (MABC). Case studies of MAS and MABC in rice.

Applications of recombinant DNA technology- Vaccine production, disease diagnosis, for disease prevention & treatment and production of transgenic plants and animals, Humanised antibody.

UNIT IV

Gene Therapy: Gene therapy, types of gene therapy (somatic cell gene therapy, germ line gene therapy,

Human Genetic Enhancement (Human genetic engineering), The New Eugenics: Genetic Engineering, applications in agriculture medicine, industry

GM bio safety: GM foods, terminator gene technology and its negative impact. Laboratory methodologies, Handling of GMO's, Testing, Evaluation, Toxicity, Allergenic & Animal ethical issues, Disposal methodologies, role of IBSC, RCGM, GEAC

IPR Issues: Forms of IPR, IPR legislation in India, implication of IPR legislation on India and other developing countries, WIPO, WTO, GATT, TRIPS Agreement, Introduction to patenting and patenting process. Biodiversity board.

Biotechnology Start-ups : Regulations and Schemes and financial assistance from Government of India.

References:

1. Sateesh M. K. 2008. Bioethics and Biosafety. I. K. International, Bangalore.
2. Sambrook J., Ffrisch E., Maniatis T., 2000. Molecular Cloning: A Laboratory manual, Old Spring Harbor Laboratory Press New York,
3. Glover D.M., Hames B. D., DNA Cloning : a Practical Approach, IRL Press.
4. Kaufman P.B., Kim W.W.D., Cseke L.J., Molecular and Cellular methods in Biology and Medicine. CRC Press..
5. Berger S.L., Kimmel A.P. 1998. Methods in Enzymology Vol. 152, Guide to Molecular Cloning Techniques, Academic Press, Inc San Diego.
6. Goeddel D.V., 1990. Methods in Enzymology Vol. 185, Gene Expression Technology, Academic Press, Inc. San Diego,
7. Mickloss D.A. and Freyer G.A., DNA Science. 1990. A first Course in Recombinant Technology, Cold Spring Harbor Laboratory Press, New York
8. Primrose S.B., 1994. Molecular Biotechnology (2nd Edn) Blackwell Scietific Pub. Oxford,

9. Davies J.A., Reznikoff W.S., 1992. Milestones in Biotechnology. Classic papers on Genetic Engineering. Butterworth-Heinemann, Boston.
10. Walker M.R., Rapley R. 1997. Route Maps in Gene Technology, Blackwell Science Ltd, Oxford.
11. Glick B. R., Jack J. Pasternak 2003.Molecular Biotechnology: Principles and Applications of Recombinant DNA (3rd edition). American Society for Microbiology.
12. Balasubramanian Et Al. 1996. Concepts in Biotechnology. Orient Longman Publisher.
13. Primrose S B Richard M. Principles of Gene Manipulation. Blackwell Publishing.
14. Draper J., Scott R., Armitage P., Walden R. 1988. Plant Genetic Transformation and Gene expression: A Laboratory Manual. Scientific Publication Oxford, London, Edinburgh

DSC -C27P GENETIC ENGINEERING II CREDITS 4 HOURS/WEEK 60 hrs

1. Recovery of DNA from agarose gel
2. Southern blotting.
3. PCR amplification of DNA.
4. Isolation of RNA from various sources.
5. Electrophoretic separation of RNA on denaturing gel.
6. Bacterial and yeast transformation.
7. Cloning of amplified gene into expression vector
8. Expression and Purification of Recombinant Proteins in *E.coli*
9. Purification of His-tagged protein by Ni-Affinity chromatography.
10. Detection of Genetically engineered plants.
11. Plant tissue culture Media preparation.
12. Callus culture.
13. Somatic embryogenesis and synthetic seeds.
14. Suspension culture.
15. Meristem culture.
16. Isolation of *Agrobacterium* and *Agrobacterium* mediated plant transformation.
17. Hairy root culture

    Protocols have to be written and Charts have to be prepared for the experiments if facilities are limited.

DSC -RM5 RESEARCH METHODOLOGY AND BIOSTATISTICS

3 HOURS/WEEK 45 hrs

Course objectives:

- To introduce students to the various research methodologies in a systematic approach for data analysis.
- To encourge the students to take up research challenge in proper direction and validation of research data.
- To train the students to review a given research paper, prepare research project proposal to funding agencies.
- To impart practical skills in concepts in Biostatistics.

Course outcome:

- Biostatistics helps the students to understand numerous modern biological theories. Geneticstudies and to understand observed experimental results.
- Students will unmderstand the statistical advances with the development of methods and tools for many genetic data analysis like NGS.
- Overall biostatistics provides tools and techniques for collecting data and then summarizing, analyzing, and interpreting biological data accurately in the field of life science research to the students of molecular biology.
- Research methodology helps the students to follow certain methods, prediction and accuracy of observations.
- It helps to produce new knowledge and deepens understanding of a research task through proper research design.

UNIT I **15 HOURS**

Introduction: Scope and significance of research methodology, Good laboratory practices, Quality control.

Review of literature, identifying the gaps and formulating the hypothesis.

Research material: Use of taxonomic keys, Samples: Collection, transport, handling and preservation of microorganisms, planktons, insects, animals from natural and lab bred population. Water and air samples. Relevance of sample size. Culture and maintenance of samples. Safe disposal of used and rejected samples and materials.

Types of research studies: Collection of data – sources; methods –questionnaires, records, archives; scaling – Likert and Guteman scaling.

Design of experiments: Cohort studies, Double blind, placebo control, crossover. Eg., UKPDS, CUPS, Farmington), Clinical studies, toxicity studies.

Selection methods: Reviewing, standardization of the methods, modification and experimental design collection, analysis, statistical inference, presentation of the data.

UNIT II **15 HOURS**

Review of research articles (To be done by students. Each student can select one paper review and present it).

Demonstration of writing a research proposal

Research proposal: The student will identify a topic for research and prepare a document with the following information – Back ground of research problems, Objectives, strategies for experimental work, Expected results, preparation of rough draft and bibliography. The student will also present and defend the research proposal, Evaluation of research proposal

UNIT III

BIOSTATSTICS

Introduction: Why Statistics? Types of data: nominal, ordinal, discrete, continuous, Collection, classification and tabulation of data. Exploratory data analysis- histogram, stem and leaf diagram, frequency curves,

Descriptive analysis of statistical data. Measures of central tendency (mean, median and mode and quartiles), Measures of dispersion (Range and standard deviation, coefficient of variation, quartile deviation)

Basic models of probability. Definitions and properties. Random variables-discrete and continuous. Concepts of mathematical expectation and variance, Binomial, Poisson, Normal distributions (Definition and applications)

Regression and correlation:

Parametric Statistical inference: Estimators, confidence intervals, t-test, z-test, chi-square test. ANOVA-(One way and two way), DMRT.

Non parametric tests: Sign test, Median test

DSC -RM5P RESEARCH METHODOLOGY AND BIOSTATISTICS 1 credit

2 HOURS/WEEK 30 hours

Practicals – 1 Credit

Section B: Biostatistics

1, 2 Exploratory data analysis
3. Measures of central tendency
4. Measures of dispersion
5. Measures of skewness
6. Correlation and regression
7,8. Simple problems on probability and probability distributions
9,10. z and t-test
11. Chi-square test
12,13. ANOVA and DMRT
14. Non parametric test
15. Analysis using Minitab and excel- (two practicals)

References:

1. Michael R.Chernick, Robert H.Friis (2003) – Introductory Biostatistics for the Health Sciences, Wiley – Interscience.
2. Bhattacharya, G.K. and Johnson, R.A. (1977) – Statistical Concepts and Methods, John Wiley.
3. Freedman, D., Pisani, R., Purves, R., Adhikari, A. (1991) Statistics, W.W.Norton and Company.
4. Agarwal, B.L. (2001) – Basic Statistics, New Age International Publishers.
5. Chap T.Lee (2003) – Introductory Biostatistics, John Wiley.
6. Heejung Bang, Xi Kathy Zhou, Heather L. van Epps, Madhu Mazumdar - Statistical Methods in Molecular Biology, Publisher: Humana Press

DSE -E5 CELL SIGNALLING 3 HOURS/WEEK 45 hrs

Course objectives:

- To understand the basic concepts of signal transduction and its impact on physiology and pathology.
- To understand the role of secondary messengers and their mechanism of action in up regulations and down regulations of various signalling pathways.

Course outcome:

- It will help to understand the basic principles of signal transduction mechanisms, in particular the concepts of sensory transduction pathways, signal amplitude and signal integration.
- Students will understand the role of hormones in signal transduction.
- Students will acquire the knowledge of signal transduction in bacteria, yeast, plant and animal models. Also to study the signaling processes in healthy and diseased conditions.

UNIT I **15 hrs**

I. Introduction to cell signaling - Definition ligands and receptors. Endocrine, paracrine, merocrine, juxtacrine and autocrine signaling.

II. Receptors and signaling pathways: cell signaling, cell surface receptors. G Protein coupled receptors-structure, mechanism of signal transmission, regulatory GTPases, heterotrimeric G proteins and effector molecules of G Proteins. Signaling molecules cAMP, cGMP, metabolic pathways for the formation of inositol triphosphate from phosphatidyl inositol diphosphate, Ca2+, DAG and NO as signaling molecules, ryanodine and other Ca2+ receptors, phosphoregulation of inositol and the calcium channel activation. Ser/Thr-specific protein kinases and phosphatases. Receptor tyrosine kinases, Role of phospho tyrosine in SH2 domain binding. Signal transmission via Ras proteins and MAP kinase pathways. Receptor guanylyl cyclases, Gated ion channels

UNIT II **15 hrs**

Signaling by nuclear receptors: ligands, structure and functions of nuclear receptors, nuclear functions for hormones/metabolites - orphan receptors; cytoplasmic functions and crosstalk with signaling molecules, signaling pathway of the steroid hormone receptors.

Cytokine receptors- structure and activation of cytokine receptors, Jak-Stat path way, Janus kinases, Stat proteins.

Regulation-c AMP discovery, function and regulation by Cholera toxin and Pertusis toxin and calcium signaling. Lipid second messengers - DAG and ceramide. SH and PH motifs, PI3K, PLC, and SMase. Receptor upregulation, down regulation, desensitization, signal cross talk MAPK pathway, stress pathway, Transcription factors - NF KB-regulation. Other transcription factors. cytoplasmic receptors, signaling cross talk, Glucocorticoid and estrogen receptors and their mechanism of action, antihormones (Eg. RU 486) and hormone replacement therapy.

UNIT III: **15 hrs**

Signaling in Bacteria, yeast and plants:

Signaling in Bacteria - Quorum sensing in Bacteria, mechanism of chemokine signaling. Molecules and mechanisms.

Signaling in yeast- pheromone signaling and nutrient signaling

Signaling in plant – Light perception and signaling, Auxin, Gibberellin, Cytokinin, Abscisic acid and ethylene signaling, NO Signaling, Jasmonate signaling pathway.

DSE -E5 TOXICOLOGY 3 HOURS/WEEK 45 hrs

UNIT-I

General account of toxicology, Definition and types of toxicants, History, scope and various branches of toxicology, Types of toxic responses. Different types of toxicities (acute, subacute, chronic, sub-chronic toxicity). A brief outline of methods of toxicity assessment, Animal use in toxicology and animal welfare.Toxicity in action Dose-response relationship, ED50, LD50, EC50, LC50. Regulatory requirement of toxicity testing.

UNIT-II

Journey of a toxicant in our body Different routes of exposure to toxicants. Toxicokinetics. Absorption, distribution, and storage of toxic chemicals. Sites of metabolism of a toxicant. Biotransformation and detoxification reactions; Phase l and Phase II reactions (various types of Hydrolysis, Oxidation, Reduction and Conjugation reactions with appropriate examples) Distribution, storage and elimination of toxicants.

UNIT-III

Mechanisms of action of toxicants, Effects of toxicants on target molecules, toxicant- induced cellular dysfunction, molecular and cellular repair, Chemical interactions (additive effect, potentiation, synergism and antagonism) and their consequences. Factors affecting toxicity and metabolism of toxicants. A brief introduction to systemic toxicity.

Reference Books:

1. Casarett &Doull's Toxicology: The Basic Science of Poisons, 9th Edition. (2018). Greece: McGraw-Hill Education.

2. Burcham, P. C. (2013). An Introduction to Toxicology. United Kingdom: Springer London.

VOC -4 MOLECULAR DIAGNOSTICS 2 credits ; 2 HOURS/WEEK Theory :30 hrs

MOLECULAR DIAGNOSTICS 1 credit; 2 HOURS/WEEK Practicals :30 hrs

UNIT I

Introduction to diagnostics: **15 hours**

Why diagnostics? Brief historical overview. Sample-body fluids- blood, urine, saliva, amniotic fluid, tissue- biopsies, post operative samples. Diagnostic tests, Markers, reference values, sensitivity and specificity of the diagnostic tests, false positive and false negative response, Turnaround time.

Molecular diagnostics: Methods used in diagnosis: Classical- Biochemistry, histology, instruments-X ray, MRI, CT; Sample used- macromolecules- proteins, Nucleic acids, Metabolites, chromosomes, cells, sample processing.

UNIT II **15 hours**

Analytical Methods in Molecular Diagnostics: ELISA, FACS, Mass spectroscopy, NGS, Principles and applications. Prediction of response to therapy, monitoring response to therapy. Advantages and drawbacks of Molecular diagnostics

Molecular diagnostics with specific examples:

Diagnosis of risk of breast cancer by BRACA1 and 2

Diagnosis of mental retardation by amniocentesis

Diagnosis of cysteic fibrosis by NGS

Liquid biopsy and early diagnosis of cancer by NGS

RFLP in diagnosis of Huntington's disease

Metabolic profiling in Heart diseases (Mass spectroscopy)

Chromosome abnormalities by FISH

T-cells in HIV infection by FACS

Diagnosis of SARS-Cov2 by RNA amplification

DNA finger print analysis in paternity testing

Concept of personalized medicine.

Practicals 15x2=30 hours

- 1.Hemoglobin Electrophoresis – identification of Thalassemia
- 2, 3,4 Urine analysis- Uric acid, creatinine, micro albuminuria
- 5,6, 7,8, Blood analysis- HDL, LDL, PON1, Calculation of CVD risk from given parameters
- 9.Prostatic acid phosphatase
- 10.ELISA
- 11.Buccal cavity sampling of cells and staining for chromosome analysis
- 12.Primer design for a specific disease detection
- 13.Antibiotic sensitivity test
- 14.Testing for malarial parasite
- 15.WBC count in leukemia
- Visit to a Diagnostic laboratory

Detailed Syllabus of 5 Year Integrated M.Sc. Molecular Biology
Course Content of Semester–VIII

Sem. No.	Course Category	Course Code	Course Title	Credits Assigned	Hours of teaching/week
VII	DSC	DSC-C29	Molecular Pathology	4	4
		DSC-C30P	Molecular Pathology Practicals	2	4
		DSC-C31	Genomics and Proteomics	4	4
		DSC-C32P	Genomics and Proteomics Practicals	2	4
		INT/ENT*		4	
	DSE	DSE-E6	Molecular Basis of Development and differentiation	3	3

		DSE-E6	Molecular Ecology	3	3
	Vocational	VOC-4	Bioenterpruneurship	2 1	2 hrs theory +2 hours of practicals

*Visit to a minimum of four Translational Research centres and Biotech industries (Total of four): Students have to be taken on Educational tour to obtain first hand information and prepare a report and submit for evaluation

DSC-C29 MOLECULAR PATHOLOGY 4 HOURS/WEEK 60 HRS

MBH110- MOLECULAR PATHOLOGY – THEORY - 3 CREDITS

Tutorials-1 Credit (32 hours)

Course objectives:

- Study of etiology, symptoms, predisposing factors and recurrence of plant ~~and~~ animal and human infectious and other diseases.
- To understand molecular mechanism of infectious human diseases and predisposing genetic factors in common diseases.

Course outcome:

- Study of this course enables the students to know how pathogens cause disease, including analysis of the molecular signaling among plant, pathogens and genes. The scope and responsibilities is to prevent and control plant diseases of economic importance and thereby maximize crop yield.
- Understanding genetics of resistance, host pathogen interaction and key proteins which are involved in plant defense.
- Understanding the molecular and genetic basis of common human disorders.
- Students will know challenges faced by humans during a pandemic, especially emerging viral diseases.

UNIT I

Pathology of Prokaryotes- Examples of Diseases of viruses, bacteria, fungi in plants, animals. Mechanism of pathogen entry, virulence, spreading and mechanism of diseases (in brief). Endo and exo toxins, animal toxins e.g.venoms.

Plant pathology- Some diseases of economically important plants: Downy mildew of bazra, Fruit rot of areca, powdery mildew of mulberry, rust of coffee, Helminthosporium blight and blast diseseses of rice, Fusarium wilt disease, Bacterial blight of paddy, Sandal spike, bunchy top of Banana

UNIT II

Physiological and Molecular Plant Pathology- Altered metabolism of plants under biotic and abiotic stresses. Molecular mechanisms of pathogenesis: recognition phenomenon, penetration, invasion. Enzymes and toxins in relation to plant disease. Mechanisms of resistance: Genetics of Resistance, Host Pathogen interaction, Phytoalexins. PR proteins, HR, SAR, and active oxygen radicals. Role of Jasmonic

acid and Salicylic acid in plant defense. , Management of Plant diseases: Disease diagnosis, Treatment: Biological control, through satellite, antisense - RNA. Ribozymes, coat protein, hypovirulence cross protection/useful genes. Tissue culture-meristem culture

UNIT III

Infectious Diseases of human- mechanism of pathogen entry, virulence, spreading and mechanism of diseases**.**

a) Mycobacterial Diseases: Tuberculosis and Leprosy

b) Bacterial diseases: Pyogenic, Typhoid, Diphtheria, Gram negative infection, Bacillary dysentery, Syphilis.

c) Viral: Polio, Rabies, Measles; emerging viral diseases

d) Fungal diseases: Candidiasis

e) Parasitic Diseases: Filaria, Amoebiasis

f) AIDS: Aetiology, modes of transmission, diagnostic procedures and handling of infected material and health education.

UNIT IV

Molecular mechanism of human diseases: Nutritional deficiency diseases –vitamin, mineral and protein-calorie. Symptoms, diagnosis and treatment. Classes of gene mutations in humans, Human mitochondrial diseases, loss of function and gain of functional mutations in humans, Agammaglobinemia, Diseases of collagens.

Genetic factor in common diseases- Genetic susceptibility to common diseases. Types and mechanisms of susceptibility. Genetic approaches to common diseases. Diabetes mellitus, Hypertension, Coronary artery diseases, Schizophrenia, Alzheimer's disease, congenital abnormalities.

References:

1. Agrios. G. N. 1997. Plant Pathology. Academic press, London.
2. Manners, J.G.1982. Principles of Plant Pathology. Cambridge University Press.
3. Marshall, H. 1999. Diseases of Plants. Anmol Publications Pvt. Ltd. New Delhi.
4. Mehrotra, R.S.2000. Plant Pathology, Tata McGraw Hill Publishing Co. New Delhi.
5. Mundkur, 1982. Textbook of Plant Diseases. Macmillan India, New Delhi.
6. Rangaswamy, G. 1992. Diseases of Crop Plants in India. Prentice Hall of India, New Delhi.
7. Singh, R.S. 1991. Plant Diseases. Oxford IBH, New Delhi.
8. Vashishta, P.C. and Gill, P.C. 1998. Plant Pathology. Pradeep Publications, Jalandhar.
9. Wheeler, B.E. 1972. An Introduction to Plant Diseases. John Wiley.
10. Voet D, Voet JG. Biochemistry, 2a Ed.. New York: John Wiley & Sons.
11. Lehninger AL., Nelson JR., and Cox MM., 1993.Principles of Biochemistry. CBS Publishers, New Delhi.
12. Medical Biochemsitry. M.N.Chatarjea & Rana Shinde.
13. R.K.Murray et al., Harper's review of biochemistry. 25th edition Appleton and Lange.
14. Barch MJ, Knutsen T, Spurbeck JL, Ed.s. The ACT Cytogenetics Laboratory Manual, 3rd Ed. New York: Raven Press, 1997.
15. Burtis CA, Ashwood EA, Bruns DE. Tietz Textbook of Clinical Chemistry and Molecular Diagnostics, 4th Ed. St. Louis, MO: Saunders, 2006.
16. Coleman, WB, Tsongalis GJ. Molecular Diagnostics for the Clinical Laboratorian, 2nd Ed. Totowa, NJ: Humana Press, 2002.
17. Gardner RJM, Sutherland GR. Chromosome Abnormalities and Genetic Counseling, 2nd Ed. New York: Oxford University Press, 1996.
18. Geren S, Keagle M. The Principles of Clinical Cytogenetics. Totowa, NJ: Humana Press, 1998.

19. Heim S, Mitelman F. Cancer Cytogenetics, 2nd Ed. New York: Wiley-Liss, 1995.
20. Killeen AA. Principles of Molecular Pathology. Totowa, NJ:, Humana Press, 2004.
21. Leonard DGB. Diagnostic Molecular Pathology. Philadelphia: WB Saunders, 2003.
22. Persing DH, Tenover FC, Versalovic J, Tang Y-W, Unger ER, Relman DA, White TJ, Eds. Molecular Microbiology: Diagnostic Principles and Practice. Washington: ASM Press, 2003.
23. Rooney DE, Czepulkowski BH, Eds. Human Cytogenetics – A Practical Approach, Vols. II and 2nd Ed. Oxford, I: IRL Press, 1992.
24. Scriver CR, Sly WS, Childs B, Beaudet AL, Valle D, Kinzler KW, Vogelstein B. The Metabolic and Molecular Bases of Inherited Disease, 8th Ed. New York: McGraw-Hill, 2000.
25. Sen F, Vega F, Medeiros LJ. Molecular genetic methods in the diagnosis of hematologic neoplasms. Semin Diagn Pathol 2002;19:72–93.
26. Shaffer LG, Tommerup N, Eds. ISCN 2005: An International System for Human Cytogenetic Nomenclature. Basel, Switzerland: S Karger, 2005.
27. Strachan T, Read AP. Human Molecular Genetics, 3rd Ed. London: Garland Press, 2004.
28. Therman E, Susman M. Human Chromosomes, 4th Ed. New York: Springer-Verlag, 2001.

Thompson MW, Mc Innes RR, Willard HF, Eds. Thompson & Thompson: Genetics in Medicine, 5th Ed. Philadelphia: WB Saunders, 2002

DSC-C30 P MOLECULAR PATHOLOGY 4 HOURS/WEEK 60 HRS

Course objectives:

- Students will understand the fundamental knowledge in animal and plant diseases at molecular level
- Students will learn to isolate pathogens from diseased plants.
- Students will get to know role enzymes in diseases .

Course outcome:

- Students will be able to do disease diagnosis which will connect to them to diagnostic laboratories
- Students will have strong practical knowledge in molecular pathology

Practicals

1. Determination SGOT and SGPT assay.
2. LDH assay by Wrobleski-Ladue's method.
3. Determination of A/G ratio in serum.
4. Observation of cancer cells by H & E staining.
5. Study of Plant diseases: Symptoms, Causal agents– fungal - Downy mildew of bazra, Fruit rot of areca, rust of coffee,
6. Study of Plant diseases: tikka disease of groundnut, fusarium wilt of tobacco.
7. Study of plant diseases – bacterial –Bacterial blight of paddy, mycoplasmal – sandal spike; viral – bunchy top of banana.
8. Isolation of any one fungal and one bacterial pathogens and pure culturing them
9. Control of Plant Pathogens : Biocontrol (*Fusarium oxysporum versus Trichoderma harzianum/T. Viride*), Demonstrations of some biocontrol formulations
10. Comparison of phenylalanine ammonia lyase in healthy and diseased plants.
11. Pectic enzyme assay in plant pathogens by viscometry and disc diffusion method.
12. Comparision of peroxidase in healthy and diseased plants.

13. Comparision of superoxide dismutase in healthy and diseased plants.
14. Genetic variation of fungal pathogens using Molecular markers.
15. Studies of charts displaying transmission cycle of malaria, kala azar, tuberculosis, leprosy, Influenza.

DSC-C31 GENOMICS AND PROTEOMICS 4 HOURS/WEEK 60 HRS

Course objective:

- To teach genomics, using model organisms representing plants and animals.
- To giveunderstanding of the diversity and complexity of genomes.
- To give insights to the recent developments in the genomics field, and to give exposure on different tools used for biological data and its annotations.
- To equip the students to develop skills in preliminary data analysis and experimental design.

Course outcome:

- Students will understand the basics of genetic analysis of the gene, genome.
- Enables them to understand the basic organization of prokaryotic and eukaryotic genomes.
- This course introduces the students to conceptualize the principles of different tools in bioinformatics.
- The student will be able to apply basic principles of biology, computer science and mathematics to address complex biological problems.
- This course provides the knowledge and practical skills of functional genomics.
- The course also teaches the techniques used in functional genomics such as microarrays, NGS, mRNA expression and miRNA expression.

Unit I

Concepts of genomics :History of genomics; Prokaryotic and Eukaryotic Genome: structure and organization. Genome annotation, Human genome structure. Genomic elements, SNPs and genome-wide association studies. Human genome project – aims, goals and achievements, Completed genome projects of model organisms .

Overview of metagenomics: Principles, applications and limitations of metagenomics, differences between metagenomics and single-cell genomics. Definition and principle of population genomics, difference between metagenomics and population genomics, applications of population genomics.

Genome sequencing technology: Principles and output from Sanger's dideoxy method versus NGS; shotgun sequencing method and library preparations, comparative study of standard NGS methods. Basics of Next Generation Sequence data analysis, fragment assembly, genome assembly, General Principles of Gene therapy.

Unit II

Gene Expression Profiling: Aligning Whole genome alignment (WGA), Prediction of Coding regions – genes structure- conserved motifs, Comparative genomics, methods of gene discovery- prediction of gene function – methods – annotation, coding and non-coding genes and RNA. Expression profiling - Northern, qPCR, DDRT-PCR, EST Library, cDNA AFLP and SAGE

Transcriptome: General Account; DNA microarray: understanding of microarray data and correlation of gene expression data to biological processes. Gene regulatory networks and models

Overview of Bioinformatics databases

Sequence Analysis: Basic concepts, Alignment of pairs of sequence:- Homologous, Analogue, Orthologous, paralogous, Xenologous (Need for sequence alignment, Local and Global alignment, Scoring matrices- PAM and BLOSUM matrices, Pairwise sequence alignments

Collecting and storing sequences: Various file formats for bio-molecular sequences: Genbank, FASTA, GCG, MSF, NBRF-PIR etc.

Phylogenetic analysis:Phylogenetics data analysis, Tree building methods, Rooted tree, un rooted tree, Distance method, UPGMA, NJ, Fitch-Margoliash, Minimum Evolution, Character based methods - Maximum Likelihood and Maximum Parsimony. Advantages and disadvantages of various sequence analysis methods.

Unit III

Principles of Protein Structure and Classification: Properties of amino acids and peptide bonds, Ramachandran plot, Secondary structures, motifs and folds. Protein Structure Visualization; tools and analysis of protein structures. Concepts of B-factor and R-factor. Protein Structural Alignment and Superposition. Protein Fold Classification, CATH, SCOP and FSSP Databases.

Proteomics: Need, Scope and challenge of proteomics, how proteomics is applied in real life scientific research, protein structures. Protein expression profiling, Protein secondary structure analysis.

Proteome profiling methods: 2-D electrophoresis image comparisons; yeast two-hybrid system, protein arrays, mass spectrometry data processing and analysis; pathway analysis and identifying protein-protein interactions with mass scale expression data.

UNIT IV

Biopolymer modeling: Building, editing and visualizing biopolymer structures and their complexes. Rendering, mutations, calculation of geometric parameters (bond distance, bond angle, dihedral angle). Overview of Protein databases- UniProt, Protein Data Bank (PDB) and NDB databases. Identifying inter-molecular interactions from crystal structures; protein…protein, protein…nucleic acids, protein…ligand/water, nucleic acids… ligand/water, protein… carbohydrate interactions.

Protein structure/fold prediction: Concepts and algorithms related to homology modeling, loop modeling, sequence-structure alignment (1D-3D), protein threading, Protein 3D structure prediction using Threading approach, secondary structure prediction, predicting cellular localization; structure refinement methods like energy minimization, MD simulation; structure validation methods such as RMSD and intra/inter-molecular interaction. Simulation study of protein, Force field concepts.

Practicals – 1 Credits 32 hours

Genomics

1. Downloading DNA sequence from NCBI database and interpretation.
2. Analyzing the DNA sequence in EMBOSS/ GENE TOOL/ DSGENE,
3. Analyzing the DNA sequence Fasta, Blast, Clustal W.
4. Analyzing the sequence against EST and genome database
5. Use of Mega
6. Use of other related softwares (Specify during the practicals)
7. Phylogenetics construction

Proteomics

8. Protein sequence from Uniprot database.
9. Analyzing the protein sequence in EMBOSS
10. Analyzing the protein sequence Fasta, Blast
11. Analyzing the protein sequence Clustal W
12. Analysing the sequence against Prosite and Prodom database
13. Use of Expasy, SWISS-model
14. Use of Rasmol, DS wewer
15. Autodock, Online Docking software

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.
9. Pagel M., Pomiankowski A., 2007. Evolutionary Genomics and Proteomics, Sinauer Associates Inc.,U.S.; 1 edition
10. Pevsner J., 2003. Bioinformatics and Functional Genomics, Wiley-Liss; 1 edition
11. Felsenstein J., 2003. Inferring Phylogenies, Sinauer Associates; 2 edition
12. Hall B. G., 2007. Phylogenetic Trees Made Easy: A How-to Manual, inauer Associates, Inc.; 3 edition
13. Nei M., 2000. Molecular Evolution and Phylogenetics, Oxford University Press, USA; 1 edition
14. Graur D., 2000. Fundamentals of Molecular Evolution, Sinauer Associates; 2 Sub edition.
15. Salemi M., 2003. The Phylogenetic Handbook: A Practical Approach to DNA and Protein Phylogeny, Cambridge University Press; 1 edition.

INT/ENT INTERNSHIP/ENTERPRENEURSHIPS 4 CREDITS

Visit to a minimum of four Translational Research centers and Biotech industries (Total of four from both): Students have to be taken on educational tour to a maximum of seven days to obtain first-hand information and prepare a report and submit for evaluation

DSE-6 MOLECULAR BASIS OF DEVELOPMENT AND DIFFERENTIATION 3 CREDITS

3 HOURS/WEEK 45 HRS

Course objective:

- To understand the molecular basis and genes involved in the development and regulation of various model organisms and ,plants and differentiation of neurons, muscles, bone, heart,pancreas .
- To study development in plants from embryogenesis to seed development.

Course outcome:

- Students will learn briefly about gametogenesis and fertilization to better understand the development and differentiation that happens later.
- To aid deeper understanding of Molecular basis of development and differentiation in various model organisms like *C. elegans*, Drosophila, Mammals and plants.
- Students will learn the later developmental process like myogenesis, osteogenesis, and angiogenesis.
- They will study about reproductive biotechnology and parthenogenesis which helps in understanding the industrial commercial importance.
- Development in plants from embryogenesis, vegetative development to flowering and seed are extensively discussed to help students to understand its importance in agriculture especially in floriculture.

UNIT I **15 hours**

An overview of gametogenesis and fertilization.Molecular basis of early development and differentiation: ***Caenorhabditis elegans***: Anterior- posterior axis formation, formation of the dorsal – ventral and right-left axes, control of blastomere identity. Differentiation of pharynx.
Drosophila: Primary axis formation during oogenesis. Generating dorsal – ventral pattern in embryo. Segmentation and the anterior – posterior body plan, segmentation genes, homeotic selector genes.

UNIT II **15 hours**

Mammals: Anterior–posterior axis formation, the dorsal–ventral and right–left axes in mice.
Molecular basis of later development:
Differentiation of neural tubes and neurons. Myogenesis, osteogenesis, heart and angiogenesis. Differentiation of pancreas.

Reproductive biotechnology: Collection and cryopreservation of gametes – human and animals, superovulation and collection of eggs, *in vitro*- fertilisation (test tube baby), surrogate mothers.

UNIT III **15 hours**

Development in plants:

Embryogenesis: Pattern formation, establishment of symmetry, Cell lineages

Vegetative development: Organization of shoot apical meristem (SAM); Molecular analysis of SAM; Leaf development and differentiation, Development of dorsal and ventral symmetry in leaves; Organization of root apical meristem (RAM); Root hair and trichome development.

Transition to flowering: Vegetative meristems to inflorescence and floral meristems. Photoperiodism and vernalization (in brief)

Floral development: Genetic regulation of floral development. The ABC model for floral organ specification in *Arabidopsis thaliana*, ABCDE model

Fruit development

References:

1. Gilbert S. F. 2006. Developmental biology 8th edn., Sinaeur Associates, Massachusetts.
2. Bhojwani S.S. and Soh W.Y. (2001). Current Trends in Embryology of Angiosperms, Kluwer Academic Publishers.
3. Srivastava, L. M. 2003. Plant growth and development. Oxford University Press.
4. Lyndon R.F. (1990) Plant Development The Cellular Basis. Unwin Hyman
5. Raghavan V. (2000) Developmental Biology of Flowering Plants.Springer Verlag.
6. Buchanan B. B., Gruissem W. and Jones R. L. (2000) Biochemistry and Molecular Biology of Plants. Americal Society of Plant Physiology, Maryland.
7. Weiss P., Willier B. H., Hamburger V. 1955. Analysis of Development. Saunders, Philadelphia.

DSE-6 MOLECULAR ECOLOGY 3 CREDITS 3 HOURS/WEEK 45 HRS

UNIT I

Introduction to Molecular Ecology: Emergence of Molecular Ecology, Protein alloenzymes, Allozymes as genetic markers, Mutations and Recombinations as data source for Molecular Ecology, Adaptive nature of organisms-through variations

Ecologically important traits: Ecogenomics- Definition, Applications of Microarray: Variation within individuals, Variation between species, Sequence differences, Differences in gene expression, Microarrays and community ecology of microorganisms

QTL analysis and reverse genetics, Connecting genotype to phenotype, QTL mapping of ecologically important traits

UNIT II

Phylogeography: Definition, Molecular markers in phylogeography, Organelle versus nuclear markers, Repetitive versus non-repetitive markers , Neutral versus adaptive markers

Molecular Clocks, Bifurcating trees, Nested Clade Phylogeographic analysis and statistical phylogeography, The distributions of genetic lineages: Subdivided populations; Comparative phylogeography: Regional concordance, Continental concordance, Dispersal and invasive species; Allele sharing between species: Lineage sorting, Hybrid zones

UNIT III

Behavioural Ecology: Mating systems: Parentage analysis,; Extra-pair fertilizations; Mate choice , Social breeding, Social insects; Manipulating sex ratios: Sex ratio conflicts; Sex-biased dispersal : Nuclear and mitochondrial markers, Relatedness, FST values, Assignment tests, Spatial autocorrelation, Concordant results; Predators and prey : Predation and conservation

Conservation Genetics: Taxonomy: Species concepts, DNA barcoding, Subspecies, Conservation units, Hybrids; Population size, Genetic diversity and inbreeding: Inbreeding depression, Heterozygosity fitness correlations, Self-fertilization, Inbreeding avoidance, Outbreeding depression; Translocations: Genetic rescue, Source populations, Restoration genetics; Captive breeding: Maximizing genetic diversity, Captive inbreeding and outbreeding; Genetic diversity banks

DSE-6 BIOENTERPRESEURSHIP 3 CREDITS 3 HOURS/WEEK 45 HRS

The objectives of this course are:

- To understand the Innovation and entrepreneurship in bio-business, bio-markets.
- To understand the financing and accounting in bio-business.
- To understand the Management of technology transfer.

Course outcome

Upon Course completion, the student will:

- Be able to understand the types of bio-industries and competitive dynamics between the sub-industries of the bio-sector.
- Be able to understand the Pricing strategy, Challenges in marketing in bio business.
- Be able to understand the Business feasibility study, financial management and Collaborations & partnership.
- Be able to understand the knowledge centers and Technology transfer agencies, Understanding of regulatory compliances and procedures.

Unit I 15 hours

Innovation and entrepreneurship in bio-business: Introduction and scope in Bio-entrepreneurship, Types of bio-industries and competitive dynamics between the sub-industries of the bio-sector (e.g. pharmaceuticals vs. Industrial biotech), Strategy and operations of bio-sector firms: Factors shaping opportunities for innovation and entrepreneurship in bio-sectors, and the business implications of those opportunities, Alternatives faced by emerging bio-firms and the relevant tools for strategic decision, Entrepreneurship development programs of public and private agencies (MSME,

DBT, BIRAC, Make In India), strategic dimensions of patenting & commercialization strategies.

Unit II 15 hours

Bio markets - business strategy and marketing: Negotiating the road from lab to the market (strategies and processes of negotiation with financiers, government and regulatory authorities), Pricing strategy, Challenges in marketing in bio business (market conditions & segments; developing distribution channels, the nature, analysis and management of customer needs), Basic contract principles, different types of agreement and contract terms typically found in joint venture and development agreements, Dispute resolution skills.

Unit III

Finance and accounting: Business plan preparation including statutory and legal requirements, Business feasibility study, financial management issues of procurement of capital and management of costs, Collaborations & partnership, Information technology.

Technology management: Technology – assessment, development & upgradation, Managing technology transfer, Quality control & transfer of foreign technologies, Knowledge centers and Technology transfer agencies, Understanding of regulatory compliances and procedures (CDSCO, NBA, GCP, GLA, GMP).

Detailed Syllabus of 5 Year Integrated M.Sc. Molecular Biology
Course Content of Semester–IX

Sem. No.	Course Category	Course Code	Course Title	Credits Assigned	Hours of teaching/week
VII	DSC	DSC-C33	Gene Expression and Regulation	4	4
		DSC-C34P	Gene Expression and Regulation Practicals	2	4
		DSC-C35	Systems biology	4	4
		DSC-C36P	Systems biology Practicals	2	4
		DSC-C37	Biology of life style disorders	4	3 hrs theory +2 hours of practicals
	DSE	DSE-E7	Molecular Evolution and Behavior	3	3
		DSE-E7	Artificial intelligence in Biology	3	3
	Vocational	VOC-5	Drug discovery and design	2	2
				1	2

DSC-C33 GENE EXPRESSION AND REGULATION - 4 CREDITS 4 HOURS/WEEK 60 HRS

Course objectives:

- Learning structural and functional levels of nucleic acids through operon models.
- To give the overview of DNA packaging; synthesis and processing of RNA and proteins; regulation of gene expression.
- To provide an understanding of the regulation of transcription and translation in both prokaryotic and eukaryotic organisms.

Course outcome:

- Students will be able to understand the regulation of gene expression in prokaryotes and Eukaryotes.
- It helps the students to understand how transcriptional control is achieved through alterations in chromatin structure.
- Students will learn the mechanism of RNA processing and export.

UNIT 1 **15 hours**

Gene Expression: Fine structure of the prokaryotic and eukaryotic gene overview
Overview of DNA replication, transcription and translation, DNA replication: Replication of mitochondrial DNA, replication in viruse-phiX174, M13 single stranded DNA, rolling circle model; Transcription: Post transcriptional modifications- capping, tailing, and splicing (spliceosome mediated, non spliceosomal mediated), self-splicing RNA, RNA editing. Nuclear mRNA export. Reverse transcriptase (RNA mediated RNA synthesis), RNA replicase in QB virus. Transcriptional inhibitors; Tranaslation: Viral translation (IRES), translational inhibitors.

UNIT II **15 hours**

Regulation of Gene Expression in Prokaryotic: Operon model- Lac operon, structure and regulation (operator 1, 2, 3, and CAP protein). Galactose Operon –Role of two promoters, Arabinose operon –Positive –control, tryptophan operon –attenuation control.

Regulation of gene expression at the level of DNA structure: Super coiling, DNA methylation, role of nucleosome structure of eukaryotic DNA in gene expression –e.g. Glucocorticoid gene, DNA kinking, bending and gene regulation.

UNIT III

Regulation at the Level of Transcription: Transcription factors, TF II, NFkB, Regulation of NFkB and its activation. Formation of initiation complex, role of cis acting regulatory sequence- enhancer, mediators, activators & silencers in regulation. Regulation at chromatin level (acetylation & phosphorylation), **Histone code hypothesis,** SWI/SNF. Role of HAT and HDAC, regulation of transcription by non-coding RNA (gene silencing).

DNA Binding Protein Motifs: Zinc finger, Leucine Zipper, Helix-Turn- Helix and helix- loop- helix and other motifs.

UNIT IV

Regulation at the level of RNA processing and export: RNA export arid RNA stability. Regulation at level of processing (splicing). Factors affecting RNA stability and RNA degradation.

Regulation at the Level of Translation: Secondary structure in the 5' and 3' untranslated region – e.g. Regulation of Feretin and Transferin mRNA. Role of upstream AUG codons. (Eg. GCN 4 gene regulation), transplicing and translational introns (inteins), protein splicing.

8 hrs

Role of aminoacyl tRNA synthetase in the regulation of accuracy of translation –proof reading mechanism. Ribosomal optimization of translation. Regulation at the level of ribosome assembly.

6hrs

DSC-C34P GENE EXPRESSION AND REGULATION Practical - 2 CREDITS 4 HOURS/WEEK 60 HRS

- 1-3 DNA isolation from plant, animal and microbial sources and quantification and compare.
- 4-6 RNA isolation from plant, animal and microbial sources and quantification and compare.
- 7-15: Charts and experimental protocols

References

1. Kornberg A., Tania A B. DNA replication. University Science books.
2. Harvy F. Lodish (Editor) Arnold Berk, Paul Matsudaira, Chris A. Kaiser, Monty Krieger, Matthew P. Scott, S. Lawrence Zipursky, James Darnell: Authors. Molecular Cell Biology. W. H. Freeman and Co., Publishers
3. Alberts, B., Bray, D., Lewis, J., Raff, M, Roberts, K, and Watson, J. D. 1983. Molecular biology of cell. Garland Publishing Inc., New York.
4. Freifelder D. Molecular Biology. A Comprehensive Introduction to Prokaryotes and Eukaryotes. Jones and Bartlett, USA.
5. Watson J.D., Tooze J., Kurtz D.T. Recombinant DNA: A Short Course. Scientific American Book, W.A.Preemon.
6. Maniatis, Fritsch E.F., Sambrook J. 1982. Molecular cloning: Laboratory Manual. Cold Spring Harber Laboratory, New York.

7. Ayala A.J., Castra. W. 1984. Modern Genetics. 2nd Edition, Geom Helns, London.
8. Walker J., Ed., Castra W. 1992.Techniques in Molecular Biology. Geom Helns, London.
9. Schecleif R.F., Wensik. P.C. 1991. Practical Methods in Molecular Biology
Springer Verlag.
10. Lewin B. 1994. Genes V. Oxford University Press.
11. 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.
12. Voet D, Voet JG. Biochemistry. Ed. John Wiley & Sons. New York.

DSC-C35 SYSTEMS BIOLOGY - 4 CREDITS; 4 HOURS/WEEK 60 HRS

This syllabus provides a comprehensive overview of key topics in systems biology, covering foundational concepts, biological networks, data integration and analysis, and computational modeling. Each unit incorporates theoretical concepts, practical applications, and case studies to provide students with a well-rounded understanding of systems biology principles and techniques.

UNIT I

Introduction to Systems Biology: Overview of Systems Biology: Definition, scope, and interdisciplinary nature, Historical Perspective: Milestones and key concepts in systems biology, Systems Thinking: Principles and concepts of systems theory, Emergence and Complexity: Understanding emergent properties and complexity in biological systems, Systems Biology Approaches: Experimental and computational techniques in systems biology

UNIT II

Biological Networks: Introduction to Biological Networks: Types and characteristics of biological networks, Network Representation: Graph theory fundamentals and network visualization, Molecular Interaction Networks: Protein-protein interaction networks, gene regulatory networks, and metabolic networks, Network Analysis: Basic network properties, centrality measures, and network motifs, Dynamic Modeling: Introduction to dynamic modeling of biological networks using ordinary differential equations (ODEs) and Boolean networks

UNIT III

Data Integration and Analysis: Omics Technologies: Introduction to genomics, transcriptomics, proteomics, and metabolomics, Data Sources and Databases: Publicly available data resources and databases in systems biology, Data Preprocessing: Data normalization, quality control, and preprocessing techniques, Statistical Analysis: Basic statistical methods for analyzing omics data, Integration of Multi-Omics Data: Approaches for integrating data from different omics layers

UNIT IV

Computational Modeling and Simulation: Modeling Paradigms: Introduction to different modeling approaches, including deterministic, stochastic, and agent-based modeling, Model Building: Principles of model construction and parameterization, Model Simulation: Numerical methods for simulating biological models, Model Analysis: Sensitivity analysis, parameter estimation, and model validation techniques, Case Studies: Application of computational modeling to study specific biological systems and processes

References:

Unit 1: Introduction to Systems Biology

1. "Systems Biology: A Very Short Introduction" by Eberhard O. Voit
2. "Systems Biology: Properties of Reconstructed Networks" by Bernhard Ø. Palsson
3. "Introduction to Systems Biology" by Sangdun Choi

Unit 2: Biological Networks

4. "Networks: An Introduction" by Mark Newman
5. "Biological Network Analysis: Methods and Applications" edited by Anastasios A. Tsonis
6. "Systems Biology: Simulation of Dynamic Network States" by Bernhard Ø. Palsson

Unit 3: Data Integration and Analysis

7. "Biological Data Mining" by Jake Y. Chen and Stefano Lonardi
8. "Introduction to Bioinformatics" by Arthur M. Lesk
9. "Bioinformatics: Sequence and Genome Analysis" by David W. Mount

Unit 4: Computational Modeling and Simulation

10. "A First Course in Systems Biology" by Eberhard O. Voit
11. "Systems Biology: Constraint-Based Reconstruction and Analysis" by Bernhard Ø. Palsson
12. "Introduction to Computational Biology: Maps, Sequences, and Genomes" by Michael S. Waterman

DSC-C36P SYSTEMS BIOLOGY Practicals - 2 CREDITS; 4 HOURS/WEEK 60 HRS

Practicals:

1. **Introduction to Systems Biology**

- Overview of systems biology concepts and approaches
- Introduction to computational tools and databases in systems biology
- Hands-on exercise: Accessing and navigating systems biology databases. BioModels Database/ STRING Database/ KEGG/ Reactome database/ Wikipathways/Human Protein Atlas.

2. **Network Biology**

- Introduction to biological networks (e.g., gene regulatory networks, protein-protein interaction networks)
- Network visualization and analysis using one or any of these, Cytoscape/Gephi/VisANT (Visual Analysis of Networks)
- Hands-on exercise: Constructing and analyzing biological networks using STRING Database for exploring protein-protein interaction networks and Cytoscape for Network analysis.

3. **Mathematical Modeling in Systems Biology**

- Basics of mathematical modeling in biology
- Introduction to ordinary differential equations (ODEs) and their application in systems biology
- Hands-on exercise: Building and simulating ODE-based models using software (e.g., MATLAB, Python)

4. **Metabolic Pathway Analysis**

- Overview of metabolic pathways and their regulation
- Introduction to metabolic pathway databases (e.g., KEGG, Reactome)
- Hands-on exercise: Analyzing metabolic pathways and pathway enrichment analysis

5. **Gene Expression Analysis**

- Basics of gene expression profiling techniques (e.g., microarrays, RNA-Seq)
- Data preprocessing and quality control
- Hands-on exercise: Analyzing gene expression data using R/Bioconductor packages

6. **Protein Structure Prediction**

- Introduction to protein structure prediction methods (e.g., homology modeling, ab initio modeling)
- Hands-on exercise: Predicting protein structures using online tools (e.g., SWISS-MODEL, Phyre2)

7. **Systems Biology of Signaling Pathways**

- Overview of cell signaling pathways and signal transduction networks
- Hands-on exercise: Analyzing signaling pathways using pathway visualization tools (e.g., PathVisio)

8. **Genome-scale Metabolic Modeling**

- Introduction to genome-scale metabolic modeling (GSMM)
- Constraint-based modeling approaches (e.g., Flux Balance Analysis)
- Hands-on exercise: Building and simulating GSMMs using software (e.g., COBRA Toolbox in MATLAB)

9. **Systems Pharmacology**

- Integration of systems biology and pharmacology for drug discovery and development
- Introduction to drug-target interaction databases (e.g., DrugBank)
- Hands-on exercise: Analyzing drug-target interactions and drug pathways

10. **Single-cell Omics Analysis**

- Introduction to single-cell omics technologies (e.g., scRNA-Seq, scATAC-Seq)
- Data preprocessing and analysis workflows for single-cell data
- Hands-on exercise: Analyzing single-cell omics data using bioinformatics tools (e.g., Seurat, Scanpy)

11. **Systems Immunology**

- Overview of systems biology approaches in immunology research
- Introduction to immune cell signaling networks and immune response modeling
- Hands-on exercise: Analyzing immune cell populations and signaling pathways (e.g., ImmunoGlobe, GSEA, Enrichr)

12. **Systems Biology of Disease**

- Application of systems biology in understanding disease mechanisms and biomarker discovery
- Case studies of systems biology approaches in disease research
- Hands-on exercise: Identifying disease-associated pathways and biomarkers from omics data.(e.g., DAVID, Metascape, Enrichr, GSEA, STRING)

13. **Data Integration and Multi-omics Analysis**

- Integration of multi-omics data (e.g., genomics, transcriptomics, proteomics)
- Methods for data integration and multi-omics analysis

- Hands-on exercise: Integrating and analyzing multi-omics datasets.(e.g., **Jupyter Notebooks with Python/R** , Integrative Genomics Viewer (IGV), Multi-Omics Factor Analysis (MOFA), Omics Integrator, MixOmics, MetaOmics.
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14. **Project Work and Presentations**

- Students work on a systems biology project of their choice
- Data analysis, interpretation, and presentation of project findings
- Peer review and feedback on project presentations

DSC-C37P BIOLOGY OF LIFE STYLE DISORDERS; 4 credits 4 HOURS/WEEK 60 HRS

Course objectives

- Obtain knowledge and understanding of health, nutri_on and other lifestyle and
- associated diseases.
- Develop own thinking, opinions and a_tudes to global health issues.
-

Course outcome

Students will develop

- general awareness of health and well being.
- basic awareness of modern lifestyle and the diseases associated with it.
- awareness on the diseases affecting the organs like kidney, liver
- and heart.

UNIT I **15 hours**

General awareness Basic biochemistry (Biomolecules- carbohydrates, lipids, proteins, nucleic acids, vitamins, minerals – brief outline), Life style, food habits, healthy habits, exercise and unhealthy habits

Atherosclerosis: Characteristics, causes (confirmed & indirect risk factors – brief description only), ischemia, myocardial infarction -definiton, Diagnosis (electrocardiography , Exercise ECG – Stress test, Echocardiography , Coronary angiography, Intravascular ultrasound, Magnetic resonance imaging – brief description only), Prevention (lifestyle, diet, drugs), management (drugs, angioplasty, stent, bypass surgery

UNIT II **15 hours**

Hypertension: Characteristics, Causes, Diagnosis, Prevention and Management), Stroke, Characteristics (ischemic and hemorrhagic), Causes,

Diagnosis (neurological examination, scanning) Management – (drugs,Mechanical thrombectomy, Angioplasty and stenting).

Diabetes mellitus: Classification – type 1, type 2, gestational, Type 2

diabetes: Glucose level, GTT, Glycated haemoglobin, Characteristics (polyuria, polydypsia, polyphagia), Causes, Diagnosis, Management (diet, exercise, drugs). Obesity- classifica on according to BMI , symptoms, causes, diagnosis, treatment and management.

UNIT III **15 hours**

Cancer: Introduction, Types-(benign, malignant), Metastasis (definition), Mechanism, Causes, Diagnosis, (screening. blood tests, X-rays, CT scans & endoscopy, Prevention- (Dietary, Medication, Vaccination, Screening-Outline only) Management- (Surgery, Chemotherapy, Radiation, Palliative care).

UNIT IV **15 hours**

Nephritis, Function of kidney (brief outline), Nephritis (mention subtypes), Causes, Symptoms, Diagnosis (Kidney function test) Treatment, management (dialysis- peritoneal and hemodialysis). Liver disease Function of liver (brief outline), Liver disease symptoms, causes, diagnosis (Liver function test), treatment and management.

References:

1. Biochemistry – U. Satyanarayana, U. Chakrapani , third edi_on, ISBN 81-87134-80-1
2. Textbook of Medical Physiology, by Arthur C Guyton, John E Hall Prism Saunders 9th Edition ISBN: 81-7286-034-X.
3. Cell and Molecular Biology by Gerald Karp, John Wiley & Son, Inc. New York ISBN 978 0470-16961-2, 5th Edition.

DSE-E7 MOLECULAR EVOLUTION AND BEHAVIOUR 3 credits 3 HOURS/WEEK 45 HRS

Course objectives:

- To provide a course on evolutionary biology that introduces students to the major principles of evolutionary theory.
- To show how natural selection ultimately underpins all biological processes and how evolution has generated biological diversity.
- To understand the molecular aspects of evolution and animal behaviour.

Course outcome:

- Students will have a greatly enhanced knowledge and appreciation of evolutionary biology and behaviour.
- Student will appreciate the contributions of evolutionary biologist and their thought processes. This will help the students to think better.
- Students will acquire knowledge on evolutionary time scale.
- Student will get a complete perspective on animal behaviour.

- The study on biological clock will enable the students to connect this to behavioural pattern of organisms.

UNIT I **15 hours**

Emergence of evolutionary thoughts:

Lamarck; Darwin–concepts of variation, adaptation, struggle, fitness and natural selection; Spontaneity of mutations; The evolutionary synthesis.

Origin of cells and unicellular evolution:

Origin of basic biological molecules; Abiotic synthesis of organic monomers and polymers; Concept of Oparin and Haldane; Experiement of Miller (1953); The first cell;Evolution of prokaryotes; Origin of eukaryotic cells; Evolution of unicellular eukaryotes; Anaerobic metabolism, photosynthesis and aerobic metabolism.

UNIT II **15 hours**

Paleontology and Evolutionary History:

The evolutionary time scale; Eras, periods and epoch; Major events in the evolutionary time scale; Origins of unicellular and multi cellular organisms; Major groups of plants and animals; Stages in primate evolution including *Homo sapiens*

Molecular Evolution:

Concepts of neutral evolution, molecular divergence and molecular clocks; Molecular tools in phylogeny, classification and identification; Protein and nucleotide sequence analysis; origin of new genes and proteins; Gene duplication and divergence.

UNIT III **15 hours**

Brain, Behavior and Evolution:

Approaches and methods in study of behavior; Proximate and ultimate causation; Altruism and evolution- Group selection, Kin selection, Reciprocal altruism; Neural basis of learning, memory, cognition, sleep and arousal; Biological clocks; Development of behavior; Social communication; Social dominance; Use of space and territoriality; Mating systems, Parental investment and Reproductive success; Parental care; Aggressive behavior; Habitat selection and optimality in foraging; Migration, orientation and navigation; Domestication and behavioral changes.

DSE-E7 ARTIFICIAL INTELLIGENCE IN BIOLOGY 3 credits 3 HOURS/WEEK 45 HRS

VOC-5 DRUG DISCOVERY AND DESIGN 3 credits 3 HOURS/WEEK 45 HRS

Detailed Syllabus of 5 Year Integrated M.Sc. Molecular Biology
Course Content of Semester–X

Course Code	Course Title	Credits Assigned	Hours of teaching/week
RIT	Research Internship	4	4
RPF	Research Proposal Formulation	2	4
RPJ	Research Project	4	4

Students have to work under a guide, who can be outside the college from a reputed Institute or Industry with the prior permission from the head of the department/Principal of the College for a period of 4 months which can be extended for two more months if required with permission. Students have to visit all the sections of the institute/industry and prepare a report which forms the internship report, during the project period, the research proposal formulation done by the student shall be evaluated by the guide. Research project also shall be evaluated by the guide for internal assessment of C1 and C2