SARDAR PATEL UNIVERSITY,
VALLABH VIDYA NAGAR
(Reaccredited with 'A' Grade by NAAC (CGPA3.11)
Syllabus with effect from the Academic Year 2024-25

PROGRAMME STRUCTURE
Master of Science in Biomedical Science
MSc (Biomedical Science) Semester: IV

Programme outcome (PO) -for MSc Biomedical Science programme	Master of Science program provides extended theoretical and practical knowledge of different science subjects. Master of science at Sardar Patel University is designed keeping the overall back ground preparation in mind for the student to either seek a job or to become a entrepreneur. The students, after completion of bachelor of science can select the masters programme in the subject they have had at the final year or in related discipline (depending upon eligibility criteria prescribed by the university). **Programme outcomes: At the end of the program, the students will be able to** 1. Have a deep understanding of both the theoretical and practical concepts in the respective subject. 2. Understand laboratory processes and use scientific equipment's and work independently. 3. Develop research temperament as a consequence of their theory and practical learning. 4. Communicate scientific information in oral and written form. 5. Understand the issues related to nature and environmental contexts and think rationally for sustainable development. 6. The students are able to handle unexpected situation by critically analyzing the problems
Program Specific Outcome (PSO) – For MSc Biomedical Science Semester-I	After completion of the program students can apply their expertise in laboratory work, as experts and consultant in research, education and management of health care industry, laboratories that deal with diagnosis, prevention and control of infectious and communication diseases, food testing laboratories, appear for CSIR-UGC NET (JRF& Lectureship) and industries based on pharmaceutical and biotechnology.

Choice- I: Four Theory+ Project Work

Course Type	Course Code	Course Title	Theory/ Practical	Credit	Contact Hrs./ Weeks	Exam duration in Hrs.	Component of Marks		
							Internal	External	Total
							Total/ Passing	Total/ Passing	Total/ Passing
Core Course	PT04CBMC51	Molecular Diagnostic Techniques	Theory	4	4	3	30/12	70/28	100/40
	PT04CBMC52	Medical Imaging Techniques	Theory	4	4	3	30/12	70/28	100/40
	PT04CBMC53	Animal Cell Culture and Gene Therapy	Theory	4	4	3	30/12	70/28	100/40
	PT04CBMC54	Project Work	---	8	--	12	60/24	140/56	200/80
	PT04CBMC55	Comprehensive Viva	--	1	2	--		50/20	50/20
Elective Course	PT04EBMC51	Developmental Biology	Theory	4	4	3	30/12	70/28	100/40
	PT04EBMC52	Omics and Computational Biology	Theory	4	4	3	30/12	70/28	100/40
	PT04EBMC53	Biodynamics	Theory	4	4	3	30/12	70/28	100/40

Credits (per semester*)

Theory + Seminar	16
Practical	08
Comprehensive Viva	01
Total	25

Choice- II: Two Theory+ One Practical Course +Project Work

Course Type	Course Code	Course Title	Theory/ Practical	Credit	Contact Hrs./ Weeks	Exam duration in Hrs.	Component of Marks		
							Internal	External	Total
							Total/ Passing	Total/ Passing	Total/ Passing
Core Course	PT04CBMC51	Molecular Diagnostic Techniques	Theory	4	4	3	30/12	70/28	100/40
	PT04CBMC52	Medical Imaging Techniques	Theory	4	4	3	30/12	70/28	100/40
	PT04CBMC56	Practical based on PT01CBMC51 and PT01CBMC52	Practical	4	8	3.5	30/12	70/28	100/40
	PT04CBMC57	Project Work	--	12	12	--	90/36	210/84	300/120
	PT04CBMC58	Comprehensive Viva	--	1	2	--	--	50/20	50/20

Credits (per semester*)
Theory + Seminar 08
Practical 04
Project Work 12
Comprehensive Viva 01
Total 25

Choice- III: Project Work (06 months)

Course Type	Course Code	Course Title	Theory/ Practical	Credit	Contact Hrs./ Weeks	Exam duration in Hrs.	Component of Marks		
							Internal	External	Total
							Total/ Passing	Total/ Passing	Total/ Passing
Core Course	PT04CBMC59	Project Work	--	24	--	--	--	600	600/240
	PT04CBMC60	Comprehensive Viva	--	1	--	--	--	70/28	50/20

Credits (per semester*)

Project Work	24
Comprehensive Viva	01
Total	

Masters Degree in Biomedical Science
M.Sc. (Biomedical Science) Semester IV

Course Code	PT04CBMC51	Title of the Course	Molecular Diagnostic Techniques
Total Credits of the Course	4	Hours per Week	4

Course Objectives:	The objective of the paper is to 1. Make students familiar with the evolution of molecular diagnostic techniques. 2. Know about infectious diseases, clinical specimens, and samples collected. 3. Understand various techniques used in molecular diagnostic labs 4. Provide information about various human infectious diseases, Genetic disorders, an inborn error, and their diagnoses

Course Content		
Unit	Description	Weightage* (%)
1.	Introduction and History of diagnostics, Diseases- infectious, physiological, and metabolic errors, the genetic basis of diseases, inherited diseases. Infection – mode of transmission in infections, factors predisposing to microbial pathogenicity, types of infectious diseases: bacterial, viral, fungal, protozoans, and other parasites. Philosophy and general approach to clinical specimens, Sample collection- method of collection, transport and processing of samples, interpretation of results, Normal microbial flora of the human body, Host-Parasite relationships.	25
2.	Molecular Diagnosis: Nucleic acid amplification methods and types of PCR: Reverse Transcriptase-PCR, Real-Time PCR, Inverse PCR, Multiplex PCR, Nested PCR, Alu-PCR, Hot-start, In situ PCR, Long-PCR, PCR-ELISA, Arbitrarily primed PCR, Ligase Chain Reaction. Proteins and Amino acids, Qualitative and quantitative techniques: Protein stability, denaturation; amino acid sequence analysis. RNAi Interference study, CRISPR Cas9 gene biology, and itsapplications.	25

3.	Hybridization techniques and DNA sequencing methods in molecular diagnosis: Southern, Northern, *In-situ* (including FISH), microarrays – types and applications; Protein extraction and analysis (including PAGE and its variations); Western Blot Automated DNA sequencing- Principles, Methods, and Instrumentation- Advances in DNA sequencing- Next-Generation sequencing Methods, Pyrosequencing, · Microarrays- Personalised Medicine- Pharmacogenomics(ADMET)	25
4.	Infectious diseases Diagnosis: Bacterial-Tuberculosis; Viral-AIDS, Human Papilloma Virus, Herpes, Hepatitis-C; parasitic diseases- Neiseriagonorrhoeae, malaria. Genetic disorders and inborn errors of metabolism: Monogenetic disorder – e.g. Cystic fibrosis, etc. Epigenetic disorder – e.g. Cancer, etc. Polygenetic disorder – e.g. Diabetes, Triple repeat, Obesity, etc. Inborn error of metabolism: Lipidosis-, Lysomal storages disorders-, glycogen storage disorders- Gaucher and Pompe; mucopolysaccharides- Hunter andHurler.	25

Teaching-Learning Methodology	• Regular class room teaching will be done with following tools: a. Conventional black board and chalk. b. ICT tools such as projectors, smart boards, etc will also be used for better explanation of scientific components. • Appropriate reference materials will also provided to the students as and when required from departmental library resources

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written Examination (As per CBCS R.6.8.3)	15%
2.	Internal Continuous Assessment in the form of Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3)	15%
3.	University Examination	70%

Course Outcomes: Having completed this course, the learnerwill be able to

1.	Know about the evolution of molecular diagnostic techniques
2.	Acquire knowledge about infectious diseases and methods for the collection of clinical specimens and samples.
3.	Recognize various techniques used in molecular diagnostic labs
4.	Know various human infectious diseases, Genetic disorders, an inborn error, and their diagnoses

Suggested References:	
Sr. No.	References
1.	Buckingham L and Flaws, ML MOLECULAR DIAGNOSTICS: Fundamentals, Methods, & ClinicalApplications.
2.	Nyhan William L, Barshop Bruce A, Ozand Pinar T. Atlas of Metabolic Diseases 2nd edition.
3.	MousumiDebnath, Godavarthi B.K.S. Prasad, Prakash S. Bisen Molecular Diagnostics: Promises andPossibilities
4.	Medical Microbiology, Edited by Greenwood, D, Slack, R and Peutherer, J, ELST Publishers.Henry's Clinical Diagnosis and Management By Laboratory Methods Mcpherson
5.	Molecular Diagnostics: Fundamentals, Methods & Clinical applications. Lele Buckingham and Maribeth L.Flaws

On-line resources to be used if available as reference material
Online Resources https://nptel.ac.in/courses/102/103/102103013/ https://nptel.ac.in/courses/102/104/102104056/# https://nptel.ac.in/content/storage2/courses/102101040/downloads/Handouts/Lec-34.pdf

https://www.tandfonline.com/doi/full/10.1080/10408398.2015.1126701

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Masters Degree in Biomedical Science
M.Sc. (Biomedical Science) Semester IV

Course Code	PT04CBMC52	Title of the Course	Medical Imaging Techniques
Total Credits of the Course	4	Hours per Week	4

Course Objectives:	The objective of the paper is to 1. Understand principles of various imaging modalities thathave clinical application. 2. Acquire knowledge of medical imaging which is safe and protective from radiation interaction to human tissue. 3. Studynew evolving techniques of medical imaging using which normal and abnormal living tissue and organs can be studied

Course Content		
Unit	Description	Weightage* (%)
1.	Medical imaging techniques: Photography and film image: Principle of photography and radiographic film image, film sensitometry, the information content of an image, image quality factors (resolution, contrast, noise). Radiation Detectors: flat panel detector (FPD) assembly, ionization chamber, proportional counter, Geiger-Muller counter, scintillation detectors, semiconductor radiation detector, efficiency and sensitivity of detectors. Image intensifier, automatic brightness control system, image distortion, and artifacts. Conventional X-ray Radiography, Fluoroscopy, and angiography: Overview of Fluoroscopic imaging system, principle, specific system design. Digital fluoroscopy-c-arm system. Digital subtraction angiography (DSA), digital subtraction programming	25
2.	Basic Computed Tomography (CT) - Basic principles of CT, generations of CT, CT instrumentation, image formation in CT, CT image reconstruction, Hounsfield unit, CT image quality, CT image display Imaging techniques and protocols for various parts of the body, CT contrast-enhanced protocols – CT angiography Aortogram, selective angiogram head, neck, and peripheral. Radioisotope imaging / Nuclear medicine: Radionuclides for imaging, radionuclide production: cyclotron production, reactor production, generator production. Rectilinear scanners, Linear scanners, SPECT, PET, Gamma Camera, Comparison of other tomographic techniques.	25
3.	Ultrasonography: Basic Acoustics, Ultrasound terminologies: acoustic pressure, power, intensity, impedance, speed, frequency, dB notation: relative acoustic pressure and relative acoustic intensity. US machine controls, US focusing. Production of ultrasound: Piezoelectricity,	25

	Medical ultrasound transducers: Principle, construction and working, characteristics of US beam. Ultrasound display modes: A, B, M, Real-time ultrasound: Line density and frame rate, Real-time ultrasound transducers: mechanical and electronic arrays, ultrasound artifacts, ultrasound recording devices, and Distance, area & volume measurements. Applications of diagnostic ultrasound Doppler Ultrasound, Doppler artifacts, vascularsonography.	
4.	Magnetic Resonance Imaging: Principles of MRI, Image reconstruction techniques, Advantages and biological effect of MR imaging system. MR Instrumentation: Types of magnets – RF transmitter – RF receiver – Gradient coils – shim coils – RF shielding – computers. Image formation: 2D Fourier transformation method – K-space representation – 3D Fourier imaging – MIP. MR contrast media – MR angiography – TOF & PCA – MR Spectroscopy – functionalMRI.	25

Teaching-Learning Methodology	• Regular class room teaching will be done with following tools: a. Conventional black board and chalk. b. ICT tools such as projectors, smart boards, etc will also be used for better explanation of scientific components. • Appropriate reference materials will also provided to the students as and when required from departmental library resources

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written Examination (As per CBCS R.6.8.3)	15%
2.	Internal Continuous Assessment in the form of Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3)	15%
3.	University Examination	70%

Course Outcomes: Having completed this course, the learnerwill be able to	
1.	Understand the working principles of various imaging modalities used in clinical application
2.	Acquire knowledge of medical imaging for safe and protective radiation interaction with human tissue
3.	Identify evolving modern techniques of medical imaging for normal and abnormal living tissue and organ.

4.	Know the selection of specific & suitable medical imaging modalities for the successful clinical procedure.

Suggested References:	
Sr. No.	References
1.	Principles of Medical imaging, K. Kirk Shung, Michael B. Smith, Benjami n M. W. Tsui, Pub: Academic Press.
2.	Handbook of Biomedical Instrumentation, R.S.Khandpur.
3.	Introduction to biomedical imaging, Andrew Webb. Pub: IEEE press series: Wiley Interscience
4.	Medical Microbiology, Edited by Greenwood, D, Slack, R and Peutherer, J, ELST Publishers. Henry's Clinical Diagnosis and Management By Laboratory Methods Mc pherson
5.	Fundamentals of medical imaging: Paulsuetens. Pub: Cambridge university press.

On-line resources to be used if available as reference material
Online Resources: https://nptel.ac.in/courses/108/105/108105091/ https://ocw.mit.edu/courses/health-sciences-and-technology/hst-582j-biomedical-signal-and-image-processing-spring-2007/lecture-notes/

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Masters Degree in Biomedical Science
M.Sc. (Biomedical Science) Semester IV

Course Code	PT04CBMC53	Title of the Course	Animal Cell Culture and Gene Therapy
Total Credits of the Course	4	Hours per Week	4

Course Objectives:	The objective of the paper is to 1. Understand the importance of animal biotechnology 2. Study techniques of animal cell culture and its various applications 3. Understand somatic and germline gene therapy, Gene replacement, and gene addition. 4. Understand the concept of gene therapy and its applications.

Course Content		
Unit	Description	Weightage* (%)
1.	Animal Cell Culture: Historical Background, Importance and progress in Animal Cell Culture Technology and its applications in biomedical sciences, Laboratory setup and equipment, aseptic technique, different cell culture mediaand supplements, Importance of Serum and SerumFreeMedia,preparationandsterilizationofcellculturemediaandsupplements	
2.	Cell culture techniques: Disaggregation of tissue and primary culture, Types of primaryculture; Chick embryo fibroblast culture; Chick liver and kidney culture; Secondary culture; Trypsinisation; Cell separation; Continuous cell lines; Passage number; Anchorage and Anchorage-independent cells and cultures; Suspension culture; Organotypic and Histotypic cultures: tissue-specific stem cells; embryonic hematopoietic and neural stem cells, classification and sources,uses.	
3.	Introduction: Somatic and germline gene therapy, Gene replacement, and gene addition. In vivo, ex vivo, and In vitro gene therapy, Transgenic animal models, Vehicles for gene transfer-Viral vectors like the retrovirus, Adenovirus, Adeno-associated virus. Lentivirus, Recombinant SV40 virus, Nonviral vectors, DNA vaccines, Liposomes and lipoplexes, Naked DNA, transposon. Gene Transfection methods – (RNAi) – siRNA, shRNAmiRNA, etc.	

4.	Cancer gene therapy, Gene therapies for Crigler-Najjar syndrome I, Cystic fibrosis, Duchnne muscular dystrophy, Bleeding disorders, Tyrosinemia, Severe combined immunodeficiency syndrome (SCID), Gene therapy of non-heritable disorders, Cancer gene therapy. Recent advancement in Gene Therapy.	

Teaching-Learning Methodology	• Regular class room teaching will be done with following tools: a. Conventional black board and chalk. b. ICT tools such as projectors, smart boards, etc will also be used for better explanation of scientific components. • Appropriate reference materials will also provided to the students as and when required from departmental library resources

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written Examination (As per CBCS R.6.8.3)	15%
2.	Internal Continuous Assessment in the form of Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3)	15%
3.	University Examination	70%

Course Outcomes: Having completed this course, the learner will be able to	
1.	Understand the scope of animal biotechnology
2.	Basic techniques of animal cell culture, applications of animal tissue culture, and techniques for producing transgenic animals.
3.	Know somatic and germline gene therapy, Gene replacement, and gene addition
4.	Understand how gene therapy can be used to cure heritable and non-heritable disorders in humans.

Suggested References:

Sr. No.	References
1.	Culture of animal cells: A manual of basic technique- R. Ian Freshney, Wiley Publication.
2.	Animal cell culture & technology-M.Butler
3.	Animal cell culture techniques- M. Clynes,Springer
4.	Animal Biotechnology- M. M. Ranga. Agrobios(India).
5.	Animal Biotechnology-Young, Murray, Moo. Pergamon Press,Oxford.

On-line resources to be used if available as reference material
On-line Resources: https://nptel.ac.in/courses/102/104/102104059/ https://nptel.ac.in/content/storage2/courses/102103012/pdf/mod6.pdf https://nptel.ac.in/courses/102/103/102103041/ https://nptel.ac.in/content/storage2/courses/102103041/pdf/mod2.pdf https://www.ncbi.nlm.nih.gov/books/NBK21859/ https://www.researchgate.net/publication/309624598_Basics_of_animal_cell_culture_Foundation_for_modern_science

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Master Degree in Biomedical Science
M.Sc. (Biomedical Science) Semester (IV)

Course Code	PT04CBMC54/ PT04CBMC57/ PT04CBMC59	Title of the Course	Project Work
Total Credits of the Course	8/12/24	Hours per Week	12/12/40

Course Objectives:	• Identify and define the research problem • Generate research questions and hypothesis • Students will be able to collect data and will learn to interpret their results and also able to discuss and present their findings.

Course Content		
Unit	Description	Weightage* (%)
		100

Teaching-Learning Methodology	Students with be assigned a research problem on which they will work. They will be conducted project work in a suitably equipped laboratory.

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Project report Examination (As per CBCS R.6.8.3)	30%
2.	University Examination	70%

Course Outcomes: Having completed this course, the learner will be able to	
1.	Identify and define the research problem

2.	Generate research questions and hypothesis
3.	Students will be able to collect data and will learn to interpret their results and also able to discuss and present their findings.

Suggested References:	
Sr. No.	References

On-line resources to be used if available as reference material
Online Resources:-

Master Degree in Biomedical Science
M.Sc. (Biomedical Science) Semester (IV)

Course Code	PT04CBMC55/58/60	Title of the Course	Comprehensive Viva
Total Credits of the Course	1	Hours per Week	2

Course Objectives:	The objective of the paper is to 1. Provide knowledge about Practical based on theory papers 2. Get familiar with basic instrumental techniques. 3. Evaluate the knowledge gained by dissertation students after conducing research independently

Course Content		
Unit	Description	Weightage* (%)
	Evaluation of knowledge gained from core, elective and practical papers by conducting comprehensive viva	200/300/600

Teaching-Learning Methodology	

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	University Examination	100%

Course Outcomes: Having completed this course, the learner will be able to	
1.	Defend the questions related to core and elective papers studied during semester-III

Suggested References:	
Sr. No.	References

On-line resources to be used if available as reference material
On-line Resources:--

Master Degree in Biomedical Science
M.Sc. (Biomedical Science) Semester IV

Course Code	PT04CBMC56	Title of the Course	Practical based on PT04CBMC51 and PT04CBMC52
Total Credits of the Course	4	Hours per Week	8

Course Objectives:	The objective of the paper is to 1. Provide knowledge about Practical based on PT04CBMC21 and PT04CBMC22 2. Get familiar with basic instrumental techniques.

Course Content		
Unit	Description	Weightage* (%)
	1. PCR based diagnosis – of Tuberculosis andHPV 2. Kit based diagnosis of HIV/ Hepatitis /Tuberculosis 3. cDNASynthesis 4. Basic lab layout of Animal cell culturelab 5. Sterilization Techniques 6. Preparation ofMedia 7. Preparation ofSera 8. Primary CellCulture 9. Preparation of established Celllines 10. Cell Counting andViability 11. Staining ofCells 12. Preservation ofCells 13. Running NCBI-BLAST for protein, DNA, and RNAsequences. 14. Visit radiology lab in nearby medical hospital or imagingcenter. 15. To study X-ray imaging with Diagnosticmethods. 16. To study Computed Tomography with imagecharacteristics. 17. To study Ultrasonography with differentModes. 18. To study magnetic properties usingan electromagnet. 19. DeadtimedeterminationofaGeiger-MullerCounter. 20. CountingstatisticsofBetarayabsorptioncoefficient. 21. Inverse-square law verification by Gamma-ray detection using GMcounter.	100

Teaching-Learning Methodology	Practical sessions will be conducted in a suitably equipped laboratory either individually or in groups depending on the nature of exercise as well as the availability of infrastructure

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Practical Examination (As per CBCS R.6.8.3)	30%
2.	University Examination	70%

Course Outcomes: Having completed this course, the learner will be able to	
1.	Perform PCR based diagnosis of various human diseases
2.	Know the techniques used in animal tissue culture labs.
3.	Perform cell count, staining, and preservation of cells.
4.	Use of various bioinformatics tools

Suggested References:	
Sr. No.	References
1.	Biochemical methods: S. Sadasivam & A. Manickam
2.	Molecular Cloning: A Laboratory Manual: Joe Sambrook

On-line resources to be used if available as reference material
Online Resources:-- https://vlab.amrita.edu/index.php?sub=3&brch=273 https://nptel.ac.in/courses/102/106/102106065/ https://nptel.ac.in/courses/102/103/102103083/

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Masters Degree in Biomedical Science
M.Sc. (Biomedical Science) Semester IV

Course Code	PT04EBMC51	Title of the Course	Developmental Biology
Total Credits of the Course	4	Hours per Week	4

Course Objectives:	The objective of the paper is to 1. Comprehend embryogenesis and organogenesis 2. Understand the mechanism of differential gene expression during various development stages. 3. Understand the role of hormones in the development and control of growth.

Course Content		
Unit	Description	Weightage* (%)
1.	Introduction to animal development: Fertilization: Structure of gametes, Egg sperm recognition, fertilization in sea urchins, Differential gene expression and cell-cell communication in development: Differential gene transcription, RNA processing, Control of gene expression at translation, Cell adhesion and cell signaling	
2.	Early development in invertebrates and vertebrates: Cleavage and pattern of embryonic cleavage; Comparative account of gastrulation; Early development in the Sea urchin, C. Elegans; Drosophila; Amphibia; Birds; Mammals. Later embryonic development: Development of ectoderm, Neurulation, and Central nervous system, Neural crest cell; Development of mesoderm: Paraxial mesoderm, Intermediate mesoderm, Lateral plate mesoderm. Development of endoderm.	
3.	Body Axes: Establishment of body axes in C.Elegans. Birds and Mammals, tetrapod limb development: Tetrapod limb development: Proximo –distal, Anterior-posterior, Dorsal-ventral; Cell death pathwayDrosophila axis specification: Dorso- Ventral pattern, Segmentation and Anterior-Posterior body plan, Maternal gradient, Segmentation genes	

4.	Hormones as mediators of development: Amphibian metamorphosis: Morphological and biochemical changes, Hormonal control. Insect metamorphosis: Imaginal discs. Hormonal control, and Molecular mechanism of action of ecdysone. Birth defects, Endocrine disruptors, and cancer. Environmental as a normal agent in producing phenotype: Polyphenisms and Plasticity, Temperature and sex, Environmental induct. Medical Implications of Developmental biology – Teratogenesis, genetic errors. Environmental influences ondevelopment.	

Teaching-Learning Methodology	• Regular class room teaching will be done with following tools: a. Conventional black board and chalk. b. ICT tools such as projectors, smart boards, etc will also be used for better explanation of scientific components. • Appropriate reference materials will also provided to the students as and when required from departmental library resources

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written Examination (As per CBCS R.6.8.3)	15%
2.	Internal Continuous Assessment in the form of Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3)	15%
3.	University Examination	70%

Course Outcomes: Having completed this course, the learner will be able to	
1.	Understand embryogenesis and organogenesis
2.	Gain knowledge on differential gene expression during development
3.	Relate to medical implications of developmental biology
4.	Know the role of hormones in the development and control of growth.

Suggested References:	
Sr. No.	References
1.	S.F. Gilbert, Developmental Biology, Sinauer Associates Inc. Massachusetts
2.	Ethan Bier, 'The Cold Spring' Cold Spring Harbor Laboratory Press New York
3.	Karp G, and Berrill N. J., Development

On-line resources to be used if available as reference material
Online Resources: https://nptel.ac.in/courses/102/106/102106084/ https://ocw.mit.edu/courses/biology/7-22-developmental-biology-fall-2005/study-materials/

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Masters Degree in Biomedical Science
M.Sc. (Biomedical Science) Semester IV

Course Code	PT04EBMC52	Title of the Course	Omics and Computational Biology
Total Credits of the Course	4	Hours per Week	4

Course Objectives:	The objective of the paper is to 1. Become proficient in understanding methods used in the study of genomics. 2. Learn about protein structure, function, and protein-protein interactions. 3. Know about the various genome projects and hi throughput sequencing. 4. Understand computational biology basics and diverse biological databases.

Course Content		
Unit	Description	Weightage* (%)
1.	Genomics and methods in genomics: Introduction to the proteome and the genome, codon bias, gene expression, Genome size-C value paradox, DNA sequencing: Maxam- Gilbert, Sanger, Pyrosequencing, automated DNA sequencing. Other features of nucleic acid sequencing. Analysis andAnnotation-ORF. Exon-intron boundaries, DNA Microarray technology: The generation of cDNA expression libraries, their robotic arraying, Complex hybridization on DNA chips. Transcriptomics: Comparative transcriptomics, Differential gene expression; Genotyping/SNP detection; Detection technology; Computational analysis of microarraydata.	
2.	Proteomics and methods in proteomics: Relationship between protein structure and function, Identification and analysis of proteins by 2D analysis; Spot visualization and picking; Tryptic digestion of protein and peptide fingerprinting; Common ionization methods for peptide/protein analysis; Introduction to Mass spectrometers; MALDI-TOF and LCMSanalyses	

	Protein-protein interactions: Solid-phase ELISA, pull-down assay (using GST-tagged protein), far western analysis, surface plasmon resonance technique, Yeast two-hybrid system, Phage display; Protein interactionmaps. Protein arrays-definition, applications- diagnostics, expression profiling. Uses of automated technologies to generate protein arrays and chips.	
3.	Introduction to computational biology basics and biological databases: Computers in biology, Overview of biological databases, nucleic acid & protein databases, primary, secondary, functional, composite, structural classification database, Sequence formats & storage Pairwise and multiple sequence alignments: Local alignment, Global alignment, Scoring matrices - PAM, BLOSUM, Gaps and penalties, Dot plots. Dynamic programming approach: Needleman and Wunsch Algorithm, Smith and Waterman Algorithm, Hidden Markov Model: Viterbi Algorithm. Heuristic approach: BLAST, FASTA. Building Profiles, Profile-based functionalidentification	
4.	Genome analysis: Polymorphisms in the DNA sequence, Introduction to Next Generation Sequencing technologies, Whole Genome Assembly and challenges, Sequencing and analysis of large genomes, Gene prediction, Functional annotation, Comparative genomics, Probabilistic functional gene networks. Human genome project. Structure visualization: Retrieving and drawing structures, Macromolecule viewing platforms, Structure validation and correction, Structure optimization, Analysis of ligand-protein interactions; Tools such as PyMol or VMD. Gene expression study basics: Gene Ontology, metabolic pathways, and gene set enrichment analysis (NGSEA, MGI, GOAnnotations)	

Teaching-Learning Methodology	• Regular class room teaching will be done with following tools: a. Conventional black board and chalk. b. ICT tools such as projectors, smart boards, etc will also be used for better explanation of scientific components. • Appropriate reference materials will also provided to the students as and when required from departmental library resources

Evaluation Pattern

Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	15%
2.	Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3)	15%
3.	University Examination	70%

Course Outcomes: Having completed this course, the learner will be able to	
1.	Understand the genome and methods used in the study of genomics
2.	Acquire knowledge about protein structure, function, and protein-protein interactions
3.	Know about the human genome project, large scale sequencing methods, some model organisms, and their genome projects
4.	Understand computational biology basics and biological databases

Suggested References:	
Sr. No.	References
1.	Discovering Genomics, Proteomics and Bioinformatics, A,M,Campbell, C. S.H. Press,(2003)
2.	Essential of Genomics and Bioinformatics C,W, Sensen, Wiley(2003).
3.	Handbook of Comparative Genomics: Principle and Methodology by Cecilia Saccone,
4.	Graziano Pesole, Wiley-LISS publication(2003).
5.	Proteomics: From protein, sequencing to function by S. R. Pennington & M.J. Dunn, Pvt Ltd(2001)

On-line resources to be used if available as reference material
Online Resources: https://nptel.ac.in/courses/102/101/102101076/ https://nptel.ac.in/courses/102/106/102106068/ https://nptel.ac.in/content/storage2/courses/102103044/pdf/mod6.pdf https://www.britannica.com/science/computational-biology

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Masters Degree in Biomedical Science
M.Sc. (Biomedical Science) Semester IV

Course Code	PT04EBMC53	Title of the Course	Biodynamics
Total Credits of the Course	4	Hours per Week	4

Course Objectives:	The objective of the paper is to 1. Understand the fluid mechanics and fluid dynamics of hard and soft tissues 2. Know about the biomechanics of joints and Body fluids and their motions

Course Content		
Unit	Description	Weightage* (%)
1.	Introduction to fluid mechanics: Fluid properties, basic laws governing the conservation of mass momentum and energy; Laminar flow, Couette flow and Hagen-Poiseuille equation, turbulent flow. Bernoulli's equation and its clinical significance, Make up of blood vessels, Angiology, Compliance, and Elastance, Wind Kessel Model, Flow dynamical study of the circulatory system, heart and blood vessels, anatomy and physiological considerations; Components and functions of arterial and venous systems; Lymphatic system	
2.	Fluid dynamics of hard and soft tissues: Hard tissues: Bone structure and composition mechanical properties of bone, cortical and cancellous bones, viscoelastic properties, Maxwell and Voight models – anisotropy, Electrical properties of bone, fracture mechanism and crack propagation in bones, fracture fixators, repairing of bones, mechanical properties of collagen-rich tissues, teeth, and its properties. Soft tissues: Structure and functions of cartilages, tendons, ligaments, stress-strain relationship, soft tissue mechanics, mechanical testing of soft tissues standard sample preparation, cross-section measurement, clamping of the specimen, strain measurement, environmental control), time-dependent properties of testing.	
3.	Biomechanics of joints: Skeletal joints, skeletal muscles, basic considerations, basic assumptions and limitations, forces and stresses in	

	human joints, mechanics of the elbow, mechanics of the shoulder, mechanics of spinal column, mechanics of hip, mechanics of knee, mechanics of ankle. Locomotion: Human locomotion, gait analysis, and goniometry, Ergonomics, Foot Pressure measurements – Pedobarograph, Force platform, mechanics of the foot. Total Hip Prosthesis: requirements, different types of components, Stress analysis and instrumentation, Knee Prosthesis.	
4.	Body fluids and their motions: Flow of Newtonian and non-Newtonian fluids in rigid tubes, flexible tubes, and collapsible tubes; Blood flow through arteries and veins; Holt and Conrad's experimental investigations. Kinetic energy, flow, pressure-flow relations in vascular beds; Cardiac cycle; Cardiac valve dysfunctions; Blood pressure, regulation and controlling factors; Coronary circulation, heart failure. Left ventricle pressure-volume (P-V) relationship and P- V relationship in different valve diseases	

Teaching-Learning Methodology	• Regular class room teaching will be done with following tools: a. Conventional black board and chalk. b. ICT tools such as projectors, smart boards, etc will also be used for better explanation of scientific components. • Appropriate reference materials will also provided to the students as and when required from departmental library resources

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written Examination (As per CBCS R.6.8.3)	15%
2.	Internal Continuous Assessment in the form of Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3)	15%
3.	University Examination	70%

Course Outcomes: Having completed this course, the learner will be able to	
1.	Know about the fluid mechanics, Fluid dynamics of hard and soft tissues

2.	Biomechanics of joints and Body fluids and their motions

Suggested References:	
Sr. No.	References
1.	Fung, Y.C. Biomechanics: Circulation, Springer Verlag Publications NewYork
2.	WaiteL. ,Biofluid mechanicsin the cardiovascular system, McGrawhill Publications
3.	Hall S. J., Basic Biomechanics 3rd Edition, WCB/McGraw Hill Publications.

On-line resources to be used if available as reference material
Online Resources: - https://nptel.ac.in/courses/112/104/112104118/ https://nptel.ac.in/courses/103/103/103103133/ https://www.khanacademy.org/test-prep/mcat/physical-sciences-practice/physical-sciences-practice-tut/e/the-effects-of-ultrasound-on-different-tissue-types

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