

MEDICAL & HEALTH SCIENCES

Programme Code: HLTH04

Programme Outcome:

- To train candidates in regards to all aspects in relation to conducting scientific research.
- To make students understand basics of cancer biology.
- To understand various aspects of research methodologies; use of ethical practices in conduct of research; application of statistics in research; & how to critically read and analyze scientific literature.
- To introduce aspects of clinical and translational research in relation to oncology during the program.
- To develop analytical thinking in students and help in developing ability to raise appropriate / relevant questions for doing research.

DETAILED COURSE STRUCTURE

Core Course				
Course Code	Course Name	Hours		Credit
		Lecture	Practical	
09HLTH04001-C	Cell Biology & Cancer Biology	14	5	1
09HLTH04002-C	Cell Proliferation and Cell death	14	5	1
09HLTH04003-C	Oncogenes and Tumor Suppressors	14	5	1
09HLTH04004-C	Metastasis and Angiogenesis	14	5	1
09HLTH04005-C	Cancer Epigenetics and Genetics	14	5	1
09HLTH04006-C	Carcinogenesis	14	5	1
09HLTH04007-C	Tumor Immunology	14	5	1
09HLTH04008-C	Structural Biology and Biophysics	14	5	1
09HLTH04009-C	Research Methodology	45	--	3
09HLTH04010-C	Research & Publication Ethics			
09HLTH04011-C	Clinical research study designs – to remove from Electives	14	5	1
09HLTH04012-C	Structural Bioinformatics, Biophysics	14	5	1
09HLTH04013-C	Clinical Research 01-Phase of Trials, Bioethics and Regulations governing Clinical Trials in India	14	5	1
09HLTH04014-C	Cancer Therapeutics: Biology and Treatment of malignancies– to move to electives	14	5	1
09HLTH04015-C	Biomarkers in Clinical Research	14	5	1

Elective Course				
Course Code	Course Name	Hours		Credit
		Lecture	Practical	
09HLTH04001-E	Biostatistics	14	5	1
09HLTH04002-E	Animal Models in Cancer Research	14	5	1
09HLTH04003-E	Cancer Therapeutics	14	5	1
09HLTH04004-E	Carcinogenesis, Chemoprevention and DNA Repair	14	5	1
09HLTH04005-E	Deregulation of Cell Growth in Cancer	14	5	1
09HLTH04006-E	Structural Bioinformatics, Biophysics & Structural Biology	14	5	1
09HLTH04007-E	Tumor Immunology	14	5	1
09HLTH04008-E	Metastasis	14	5	1
09HLTH04009-E	Bioinformatics	14	5	1
09HLTH04010-E	Epidemiology & Preventive Oncology	14	5	1
09HLTH04011-E	Medical Physics	14	5	1
09HLTH04012-E	Nutrition	14	5	1
09HLTH04013-E	Basic, Clinical and Applied Neurosciences	14	5	1
09HLTH04014-E	Computational Biology, Medical Informatics & Artificial Intelligence	14	5	1
09HLTH04015-E	Theory+ Observation in clinics	14	5	1
09HLTH04016-E	Advanced Cancer Cytogenetics in Haematolymphoid Malignancies	14	5	1
09HLTH04017-E	Applied psychology	14	5	1
09HLTH04018-E	Implementation Research	14	5	1
09HLTH04019-E	Quality of Life research in Clinical Trials	14	5	1
09HLTH04020-E	Advanced microscopy and Imaging	14	5	1

09HLTH04021-E	Advanced Scientific writing and communication	14	5	1
09HLTH04022-E	Organoid & 3D culture Models in Oncology	14	5	1
09HLTH04023-E	Cancer Virology and Oncogenesis	14	5	1
09HLTH04024-E	Cancer Pharmacogenomics	14	5	1
09HLTH04025-E	Molecular Endocrinology of Cancer	14	5	1
09HLTH04026-E	GMP Manufacturing – to move to electives	14	5	1

Special Lecture				
Course Code	Course Name	Hours	Practical	Credit
09-HLTH04001-S	Epidemiology & Bioinformatics	14	5	1
09-HLTH04002-S	Intellectual Property Rights	14	5	1

CORE COURSES

09HLTH04-001-C: Cell Biology & Cancer Biology (14 Lecture + 5 Practical)

Course Outcomes:

- Overview on what is cancer and its causes, differences between normal and cancer cells, detailed understanding of cell organelles, intracellular protein transport.
- Understanding of normal stem cells and cancer stem cells, biomarkers to identify cancer stem cells.
- Reprogramming and pluri-potency. Demonstrations and lectures on advanced microscopy and in vivo - cell imaging using luminescence and microPET-CT

09HLTH04-002-C: Cell Proliferation & Cell death (14 Lecture + 5 Practical)

Course Outcomes:

- A detailed analysis of the pathways underlying cell cycle progression and cell death. Study on animal models for understanding phenotype of cyclin and cyclin dependent kinases.
- Understanding the mechanisms of cell death and methods to detect apoptosis.
- Understanding differences between apoptosis, necrosis and autophagy. How cancer metabolism is distinct from normal cells and how this can be exploited therapeutically.

09HLTH04-003-C: Oncogenes & Tumor Suppressors (14 Lecture + 5 Practical)

Course Outcomes:

- Understanding the mechanism of action of oncogenes and tumor suppressor genes and their function.
- Understand the difference between mouse and human telomeres and how this affects tumor progression in both species.

09HLTH04-004-C: Metastasis & Angiogenesis (14 Lecture + 5 Practical)

Course Outcomes:

- Mechanisms underlying cell adhesion and migration and how these are altered in tumors.
- Mechanisms underlying metastatic progression. Understanding how a tumor deals with nutrient and oxygen deprivation.
- Understanding how hypoxia contributes to angiogenesis and vasculogenesis. Various models to study angiogenesis.

09HLTH04-005-C: Cancer Epigenetics & Genetics (14 Lecture + 5 Practical)

Course Outcomes:

- Epigenetic mechanisms that affect tumor growth.
- Cancer as an inherited genetic disease. Understanding chromatin structure, histone-variants and their modifications in cancer.
- Understanding DNA methylation and gene-regulation.
- Detailed methodology to study chromatin-biology.
- Advanced knowledge on application of proteomics, Next Generation Sequencing and Genomics

09HLTH04-006-C: Carcinogenesis (14 Lecture + 5 Practical)

Course Outcomes:

- Understanding Mechanisms of carcinogenesis. DNA repair and its role in inhibiting tumor progression.
- Understanding carcinogen metabolism and activation of cellular oncogenes and their contribution to carcinogenesis.
- Understanding role of tumor viruses and micro-organisms contributing to carcinogenesis.

09HLTH04-007-C: Tumor Immunology (14 Lecture + 5 Practical)

Course Outcomes:

- Basics of tumor immunology. Differences between adaptive and innate immunity.
- Cell types contributing to tumor immunity and their role in cancer immuno therapy. Applications of monoclonal antibodies, vaccines in cancer diagnosis and therapy.
- Advanced technologies to study immune biomarkers on cells, immuno deficient mouse models to study tumor development and immune responses.

09HLTH04-008-C: Structural Biology & Biophysics (14 Lecture + 5 Practical)

Course Outcomes:

- Basics of spectroscopy. Principles of protein-protein interactions and protein folding.
- Understanding mechanism of action of enzymes and assays to study their function.

09HLTH04-009-C: Research Methodology (15 Lecture + 5 Practical)

Course Outcomes:

- Develop understanding on various kinds of research, objectives of doing research, research process, research designs and sampling.
- Have basic knowledge on qualitative research techniques
- Have adequate knowledge on measurement & scaling techniques as well as the quantitative data analysis
- Have basic awareness of data analysis-and hypothesis testing procedures
- To develop an understanding of the ethical dimensions of conducting applied research.

09HLTH04-010-C: Research and Publication Ethics (30 Lecture + 5 Practical)

Course Outcomes:

- Understand and fundamentals of ethical research, Understand the regulatory requirements for research studies
- Understand national and / or international guidelines on research
- Understand fundamentals and tools to be used for plagiarism check.
- Understand how to find and store literature, Manuscript writing, how to make presentation

09HLTH04-011-C: Clinical research study designs (14 Lecture + 5 Practical)

Course Outcomes:

- Understand various types of observational and interventional clinical research study designs
- Learn appropriateness of different study designs including cross-sectional, casecontrol and cohort studies, for various research questions
- Understand various types of randomized trials including parallel-group, crossover, factorial, non-inferiority, cluster randomization, stepped-wedge, principles and practice of randomization including blinding, sequence generation and allocation concealment
- Learn regulatory aspects of clinical research on human subjects including ethics principles, regulatory approvals

Protocol development

Course Outcomes:

- Understand the core components of clinical trial protocols
- Understand the component of protocols based on the design
- Developing clinical trial protocols for observational and interventional studies

Clinical trial designs

Course Outcomes:

- Observational study designs, Phases of clinical trials, novel clinical trial designs

Data management tools

Course Outcomes:

- Understand the various types of data management tools and designing the case record forms

Quality assurance and quality control in clinical research

Course Outcomes:

- Understanding how to build and monitor quality in clinical research

Health economics

Course Outcomes:

- Understanding how to design research for cost-effectiveness studies, basics of health economics and how to incorporate health technology assessment in clinical trials.

Drug and device development process

Course Outcomes:

- Understanding the process, steps and regulations in drug and device development.

ELECTIVE COURSES

09HLTH04-001-E: Biostatistics (14 Lecture + 5 Practical)

Course Outcomes:

- Probability distribution (normal, Poisson, t, F, Chi-square)
- Sample size determination and justification of power estimates in a research protocol - observational studies, clinical trials (superiority, noninferiority / equivalence), animal studies
- Hypothesis testing: analysis of categorical or continuous data
- Biostatistics pertaining to survival analysis

09HLTH04-002-E: Animal Models in Cancer Research (14 Lecture + 5 Practical)

Course Outcomes:

- Anatomy and biology of small animals used in cancer research.
- Transgenic and knockout technology to generate animal models
- Animal models for carcinogenesis, chemoprevention and drug screening and testing.
- Using imaging to study tumor progression in animal models.

09HLTH04-003-E: Cancer Therapeutics (14 Lecture + 5 Practical)

Course Outcomes:

- Modules of cancer therapy – chemo, radio and targeted therapy.
- Mechanisms of resistance to chemo and radio therapeutics.
- Drug design, development and screening
- Immunotherapy and gene therapy including RNAi

09HLTH04-004-E: Carcinogenesis, Chemoprevention and DNA Repair (14 Lecture + 5 Practical)

Course Outcomes:

- Determination of carcinogen exposure and dosage
- Short term and long term assays for carcinogenesis
- The role of DNA damage, viruses and epigenetics in carcinogenesis
- Basics of chemoprevention.

09HLTH04-005-E: Deregulation of Cell Growth in Cancer (14 Lecture + 5 Practical)

Course Outcomes:

- Detailed analysis of the molecular mechanisms underlying Rb and p53 function.
- Mechanisms underlying tumor progression upon activation of Ras, PI3K, Myc and wnt-signaling.
- Checkpoint pathways and cancer
- Senescence and cancer.

09HLTH04-006-E: Structural Bioinformatics, Biophysics & Structural Biology (14 Lecture + 5 Practical)

Course Outcomes:

- Spectroscopic Techniques: Absorption Spectroscopy and Fluorescence Spectroscopy
Spectropolarimetry: Circular Dichroism.
- Biophysical methods: Protein conformation, interactions and oligomeric properties.
- X-ray Crystallography (lecture and hands-on)
- NMR Spectroscopy
- Structural Bioinformatics: Molecular Modeling (homology, threading, ab initio); small molecule/peptide design; MDS: Different tools available for these in silico studies
- Molecular Docking (protein-protein, protein-ligand/small molecules).
- Drug Designing-challenges, in-silico design-advantages, steps and tools (QSAR, 3D-QSAR etc.).
Application: How drug design leads to clinical trials with example.
- Hands-on training in Bioinformatics

09HLTH04-007-E: Tumor Immunology (14 Lecture + 5 Practical)

Course Outcomes:

- Basic concepts of innate and adaptive immunity and their role in tumor immunity
- Immunodiagnostics and immunotherapy of Cancer. Role of monoclonal antibodies, vaccines and cell-based therapies
- Understanding of the tumor microenvironment, cells soluble factors contributing to immunosuppressive networks
- Animal models that have immune defects used to transplant human tumors and study their application for drug development and immunotherapies
- Understanding how Flow Cytometer works. Principle and applications followed by demonstration

09HLTH04-008-E: Metastasis (14 Lecture + 5 Practical)

Course Outcomes:

- Molecular basis underlying detachment, intravasation and invasion in tumor cells.
- Survival in the bloodstream, invasion and metastatic colonization.
- Pathways contributing to the spread of metastatic disease including EMT Hippo, Notch Wnt and CSC pathways.
- Targeted therapy and immunotherapy in metastasis and models and imaging in metastasis.

09HLTH04-009-E: Bioinformatics (14 Lecture + 5 Practical)

Course Outcomes:

- To get introduced to the basic concepts of Bioinformatics and its significance in Biological data analysis.
- Be capable of using critical thinking and research methods in Bioinformatics to understand computational and experimental data.
- Conduct scholarly activities in a professional and ethical manner.
- Develop the ability to communicate clearly the meaning, potential impacts and risks associated with one's research activities to a nontechnical audience in ways that confer a sense for its value to society.

09HLTH04-010-E: Epidemiology & Preventive Oncology (14 Lecture + 5 Practical)

Course Outcomes:

- Describe population patterns of health-related risk factors & health related outcomes in terms of person, place, &time.
- Compare the relative strengths and weaknesses of common epidemiologic study designs (e.g., cross-sectional, cohort, casecontrol, randomized experiments).
- Elucidate risk and prognostic factors for common and high-mortality cancers, with a focus on lifestyle, environmental and molecular exposures.
- Discover and implement prevention strategies, incorporating environmental, ‘omic’, and imaging approaches.
- Develop and operationalize novel bio-statistical and analytic methods for big data and personalized prevention.

09HLTH04-011-E: Medical Physics (14 Lecture + 5 Practical)

Course Outcomes:

- Student will learn how different ionizing radiation effects influence biological systems.
- Student will acquire special competence within one or more academic fields. This may be radiation physics, modern radiation technology, radiobiology, radiation therapy for cancer, radio immunotherapy
- While working on their assignments, students will, in cooperation with the academic staff, learn to develop quantitative measurement methods, plan, execute and analyse relevant experiments and model central physical, biochemical or biological processes and systems within the subject area.
- Student will train in critical thinking, ethics and accountability, problem solving, project management and in addition be able to express themselves in a precise manner, both in writing and orally.

09HLTH04-012-E: Nutrition (14 Lecture + 5 Practical)

Course Outcomes:

- Comprehensive understanding of core nutrition knowledge.
- Identify and conduct original research and scholarship in the field of nutrition.
- Effectively communicate in their field of study.
- Think critically, creatively and solve problems in their field of study. Skills in research methodologies demonstrated by conducting original scholarly research.
- Conduct research in an ethical and responsible manner.
- Demonstrate attributes of professional development consistent with the expectation within their field of study. Effective dissemination of research findings via peer-reviewed publications, seminars and practical applications such as teaching.

Basic, Clinical and Applied Neurosciences (14 Lecture + 5 Practical)

Course Outcomes:

- Neuroanatomy
 - Understanding the normal brain structures with practical orientation.

- Neuroradiology
 - Orientation in various imaging modalities used in brain & spinal cord structure
 - Understanding these imaging techniques to diagnose various central nervous system (CNS) tumors and the changes after different treatments.

- Neuropsychology and Neurocognition
 - Understanding the biology of neuroinflammation and neurocognition.
 - Orientation on various psychological tests to assess brain functions and their interpretation.
 - Development of animal models for studying neurocognitive behavior.

- Basic & clinical Neurophysiology
 - Understanding the basic physiology of brain functions.
 - Intra-operative brain neurophysiology in clinical applications.

- Neuroanaesthesia
 - Understanding the pharmacological and physiological basis of drugs used during neurosurgical procedures

- Neuropathology
 - Understanding various brain tumor pathologies with practical understanding of the use of immunohistochemistry in diagnosing and classifying the brain tumors.

Computational Biology, Medical Informatics & Artificial Intelligence (14 Lecture + 5 Practical)

Course Outcomes:

- Integrate principles of medical informatics to manage, interpret, and visualize clinical and biomedical data for enhanced decision-making and personalized medicine applications.
- Develop and implement AI/ML models for pattern recognition, predictive analytics, and automation in biological and healthcare datasets, with emphasis on model validation and interpretability.
- Demonstrate ethical and responsible use of AI in biomedical research, addressing concerns related to data privacy, algorithmic bias, and clinical applicability.
- Laboratory notebooks, backup and integrity
- Programming tools in Biology & Medicine

Theory Observation clinics (14 Lecture + 5 Practical)

Course Outcomes:

- Correlate theoretical knowledge of disease mechanisms and pathophysiology with clinical presentations through direct observation and interaction in clinical settings.
- Critically analyze patient care approaches by observing diagnostic strategies, therapeutic interventions, and multidisciplinary decision making processes.
- Integrate clinical insights into research planning by identifying unmet clinical needs, gaps in existing therapies, and opportunities for translational research. Reflect on the role of research in clinical practice through documented observations, case based discussions, and feedback from clinical mentors.
- Attend teaching sessions, lectures, clinicopathology meetings, etc pertaining to the field of research

Advanced Cancer Cytogenetics in Hematolymphoid Malignancies (14 Lecture + 5 Practical)

Course Outcomes:

- Demonstrate advanced understanding of chromosomal structure, function, and behavior, with an emphasis on mechanisms of structural and numerical chromosomal abnormalities in human diseases, including cancer and developmental disorders.
- Interpret complex cytogenetic data and integrate it with molecular findings to identify clinically relevant genomic aberrations and their implications in Disease pathogenesis, prognosis, and therapeutic decision-making.
- Design and execute cytogenetic experiments for research applications, including chromosome preparation, banding techniques, hybridization protocols, and digital karyotyping, While adhering to quality assurance and biosafety standards.
- Analyze and communicate cytogenetic research findings through scientific writing, presentations, and peer- reviewed publications, demonstrating critical thinking and awareness of current trends and ethical issues in cytogenomics.

Advanced hematopathology & biology (14 Lecture + 5 Practical)

Course Outcomes:

- Demonstrate a comprehensive understanding of normal and abnormal hematopoiesis, including stem cell biology, lineage commitment, and the molecular basis of hematologic development and differentiation.
- Demonstrate in-depth knowledge of hematologic malignancies and non- neoplastic hematologic disorders, including their morphological, immunophenotypic, cytogenetic, and molecular characteristics
- Interpret and integrate hematopathological findings (morphology, histology, immunohistochemistry, and flow cytometry) with clinical, cytogenetic, And molecular data for accurate disease classification.
- Design and implement experimental strategies to investigate hematologic disease mechanisms using advanced laboratory technique since biology, molecular genetics, and pathology.
- Molecular hematopathology fundamentals of cytogenetics
- Flow cytometry,
- Next generation sequencing
- Immunohistochemistry,
- FISH
- WSI and digital pathology
- Attend clinics and / or bedside ward rounds

Advanced medical sciences (14 Lecture + 5 Practical)

Course Outcomes:

- Demonstrate multidisciplinary knowledge across advanced domains of medical sciences including molecular biology, pathophysiology, pharmacology, and clinical diagnostics to formulate research hypotheses and design translational studies.
- Critically evaluate contemporary scientific literature in medical sciences and identify knowledge gaps to develop innovative approaches for addressing complex biomedical challenges.
- Apply advanced laboratory techniques and computational tools in molecular medicine, genomics, and cellular research to investigate mechanisms underlying human diseases.
- Demonstrate competence in scientific communication by effectively presenting research findings through scholarly publications, presentations, and grant writing.
- CT, PET/CT, SPECT
- Bacteriology, Serology, Mycobacteriology
- Phlebotomy, Biochemistry and Immunoassay
- HLA genotyping

Advanced molecular biology & diagnostics of solid tumors

Course Outcomes:

- Molecular pathology & diagnostics
- Next-generation sequencing

Advanced Neurobiology & physiology

Course Outcomes:

- Fundamentals of Neurophysiology

SPECIAL LECTURE

09HLTH04-001-S: Epidemiology & Bioinformatics (14 Lecture + 5 Practical)

Course Outcomes:

- Discuss the strengths and weaknesses of study designs (e.g., cross-sectional, cohort, casecontrol, randomized experiments) and the appropriate measure of association for a given study design
- Communicate clinical or translational research findings to a medical audience
- Analyze research data and interpret these results from a population health or clinical-translational perspective
- Demonstrate knowledge of regulatory requirements for clinical research
- To get introduced to the basic concepts of Bioinformatics and its significance in Biological data analysis.
- Be capable of using critical thinking and research methods in Bioinformatics to understand computational data and apply it to epidemiological data.

09HLTH04-002-S: Intellectual Property Rights (14 Lecture + 5 Practical)

Course Outcomes:

- The students once they complete their academic projects, will get awareness of acquiring the patent and copyright for their innovative works
- They also get the knowledge of plagiarism in their innovations which can be questioned legally
- Students should be able to apply intellectual property law principles (including copyright, patents, designs and trademarks) to real problems and analyze the social impact of intellectual property law and policy