

Short-Term Offline Internship on Cancer Biology & Cancer Informatics

For Undergraduate Students in Life Sciences

This **4-week internship** is designed to provide undergraduate life science students with **hands-on training and computational analysis in cancer biology**. The program covers **cancer cell biology, molecular mechanisms, cancer diagnostics, bioinformatics tools, and research methodologies**, integrating wet lab experiments with computational data analysis.

Internship Structure & Study Design

Week 1: Fundamentals of Cancer Biology & Experimental Techniques

✦ **Objective:** Understanding the molecular basis of cancer and essential lab techniques.

- Introduction to cancer biology: types, hallmarks, and progression.
- Molecular and cellular mechanisms: oncogenes, tumor suppressors, apoptosis, angiogenesis.
- Cancer cell culture techniques: maintenance, passaging, and drug treatment.
- Fluorescence microscopy and staining techniques for cancer cell morphology.
- DNA damage and repair mechanisms in cancer.
- Ethics in cancer research and preclinical studies.

🔗 **Lab Work:**

- ✓ Cell culture techniques for cancer cells.
 - ✓ Trypan blue exclusion assay for cell viability.
 - ✓ Detection of apoptosis using Annexin V staining.
 - ✓ Gene expression analysis using RT-PCR.
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Week 2: Cancer Biomarkers & Molecular Diagnostics

✦ **Objective:** Exploring cancer biomarkers and diagnostic techniques.

- Role of biomarkers in cancer detection and therapy.
- Molecular diagnostics: PCR, ELISA, Western blot, and immunohistochemistry.
- Cancer epigenetics and role of DNA methylation in gene regulation.
- Tumor microenvironment and immune evasion strategies.
- CRISPR-Cas9 and gene-editing applications in cancer research.

🔗 **Lab Work:**

- ✓ Extraction and quantification of cancer cell RNA.

- ✓ Real-time PCR (qPCR) for gene expression profiling.
 - ✓ Western blot for detecting oncogenic protein markers.
 - ✓ Immunocytochemistry for tumor marker detection.
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Week 3: Cancer Informatics & Bioinformatics Tools

✦ **Objective:** Application of computational tools in cancer research.

- Introduction to cancer genomics and Next-Generation Sequencing (NGS).
- Public cancer databases: TCGA, OncoKB, COSMIC, cBioPortal.
- RNA-Seq and differential gene expression analysis in cancer.
- Mutation analysis and drug target identification.
- Artificial intelligence (AI) and machine learning in cancer diagnostics.

 **Computational Work:**

- ✓ Retrieval and interpretation of cancer genomic data from TCGA.
 - ✓ Analysis of somatic mutations using bioinformatics tools.
 - ✓ Identification of differentially expressed genes in cancer datasets.
 - ✓ Drug-target interaction analysis using molecular docking.
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Week 4: Translational Cancer Research & Project Work

✦ **Objective:** Application of knowledge in real-world cancer research.

- Personalized medicine and precision oncology.
- Immunotherapy, targeted therapy, and novel drug discovery.
- Role of liquid biopsy and circulating tumor DNA in early detection.
- Industrial and clinical applications of cancer informatics.

 **Research Project Options:**

- ✓ Identifying novel cancer biomarkers using RNA-Seq data.
- ✓ Drug resistance analysis in specific cancer types.
- ✓ Mutation mapping in oncogenes and tumor suppressor genes.
- ✓ Computational drug screening for cancer therapy.

 **Final Presentation & Certification:**

- Students present their findings in a scientific seminar.
 - Evaluation by experts from academia/industry.
 - Certification of completion provided.
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Expected Outcomes of the Internship

🔬 Technical & Laboratory Skills:

- ✓ Cell culture, drug treatment, and apoptosis detection.
- ✓ Molecular techniques (PCR, qPCR, Western blot, immunostaining).
- ✓ Analysis of gene expression and epigenetic regulation.
- ✓ Bioinformatics tools for genomic and transcriptomic data analysis.

🔬 Research & Analytical Skills:

- ✓ Ability to design experiments and analyze cancer-related data.
- ✓ Handling and interpreting large-scale genomic datasets.
- ✓ Application of AI and machine learning in cancer diagnostics.
- ✓ Understanding of personalized medicine approaches.

🔬 Industry Readiness & Career Advancement:

- ✓ Exposure to cancer informatics in pharma and biotech industries.
- ✓ Training in cutting-edge computational biology techniques.
- ✓ Networking opportunities with researchers and industry professionals.
- ✓ Certification for career enhancement in cancer research.

Short-Term Online Internship on Cancer Bioinformatics

For Undergraduate Students in Life Sciences

This **4-week online internship** is designed to introduce undergraduate students to the field of **cancer bioinformatics**, focusing on computational analysis of cancer-related genomic and transcriptomic data. The program will cover **mutation profiling, gene expression analysis, drug target identification, and machine learning applications in cancer research**, preparing students for research and industry roles in cancer informatics.

Internship Structure & Study Design

Week 1: Introduction to Cancer Bioinformatics

✦ **Objective:** Understanding the basics of cancer biology and bioinformatics tools.

- **Introduction to Cancer Biology:** Hallmarks of cancer, tumor progression, and metastasis.
- **Molecular Basis of Cancer:** Role of oncogenes, tumor suppressor genes, and signaling pathways.
- **Introduction to Cancer Bioinformatics:** Importance of computational tools in cancer research.

- **Public Cancer Databases:** Overview of The Cancer Genome Atlas (TCGA), cBioPortal, COSMIC, and OncoKB.
- **Introduction to Linux & R/Python for Bioinformatics Analysis.**

Online Activities & Assignments:

- ✓ Guided tutorials on accessing and retrieving data from TCGA & cBioPortal.
 - ✓ Hands-on exercise: Exploring somatic mutations in a selected cancer type.
 - ✓ Assignment: Literature review on a specific cancer bioinformatics study.
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Week 2: Genomic & Transcriptomic Data Analysis in Cancer

★ **Objective:** Learning computational techniques for analyzing cancer omics data.

- **Introduction to Next-Generation Sequencing (NGS) & RNA-Seq Analysis.**
- **Mutation Profiling & Variant Analysis in Cancer.**
- **Gene Expression Analysis & Differential Expression in Tumor vs. Normal Tissues.**
- **Functional Enrichment Analysis (GO & KEGG Pathway Analysis).**
- **Survival Analysis Using Bioinformatics Tools (Kaplan-Meier Plot, Cox Regression Analysis).**

Hands-on Computational Work:

- ✓ Differential gene expression analysis using TCGA RNA-Seq data.
 - ✓ Visualization of mutation frequencies in different cancer types.
 - ✓ Performing KEGG pathway enrichment analysis in R/Python.
 - ✓ Assignment: Identify key oncogenic pathways using real datasets.
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Week 3: Cancer Drug Discovery & Target Identification Using Bioinformatics

★ **Objective:** Applying computational tools to identify druggable cancer targets.

- **Overview of Cancer Drug Discovery & Precision Medicine.**
- **Structural Bioinformatics & Molecular Docking for Cancer Therapy.**
- **Machine Learning & AI in Cancer Research.**
- **Drug Repurposing for Cancer Treatment Using Bioinformatics.**
- **Network Biology Approach in Cancer Target Identification.**

Hands-on Computational Work:

- ✓ Predicting drug-target interactions using molecular docking (AutoDock/Vina).
 - ✓ Analysis of drug response data from GDSC/CCL6 databases.
 - ✓ Machine learning model for cancer classification using genomic data.
 - ✓ Assignment: Propose a computational drug repurposing strategy.
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Week 4: Research Project & Presentation

✦ **Objective:** Applying knowledge to real-world cancer bioinformatics research.

🔗 **Choose One Research Project:**

- ✓ Identification of novel cancer biomarkers using differential gene expression analysis.
- ✓ Drug-target interaction prediction for a specific cancer therapy.
- ✓ Analysis of mutation hotspots in a selected cancer dataset.
- ✓ Application of machine learning for classifying cancer subtypes.

📄 **Final Presentation & Certification:**

- Students present their research findings in a **virtual seminar**.
 - Expert evaluation from academia/industry professionals.
 - **Certificate of Completion** provided.
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Expected Outcomes of the Internship

🎓 **Theoretical & Computational Skills:**

- ✓ Understanding of cancer genomics, transcriptomics, and drug discovery approaches.
- ✓ Proficiency in analyzing large-scale cancer datasets using bioinformatics tools.
- ✓ Hands-on experience in computational drug screening and biomarker discovery.
- ✓ Ability to perform machine learning-based cancer data analysis.

🔍 **Research & Analytical Skills:**

- ✓ Literature review and interpretation of cancer-related bioinformatics studies.
- ✓ Data mining and visualization of genomic and transcriptomic datasets.
- ✓ Functional analysis of cancer-related mutations and gene expression changes.
- ✓ Presentation of computational research findings in a scientific format.

🏢 **Industry Readiness & Career Advancement:**

- ✓ Training in cutting-edge bioinformatics tools used in pharma and biotech industries.
 - ✓ Exposure to AI/ML applications in precision oncology and drug discovery.
 - ✓ Certification for career enhancement in cancer research and computational biology.
 - ✓ Networking opportunities with researchers and industry professionals.
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