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AI unlocks cancer's secrets for personalised therapy

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To read the molecular "mind" of cancer and predict its behaviour

A new study has introduced an artificial intelligence (AI) framework that could change how we understand and treat cancer. The framework gives us a new lens to look at cancer, not by its size or spread alone, but by its molecular personality.

Cancer is not just a disease of growing tumors—it is powered by a set of hidden biological programs called the hallmarks of cancer. These hallmarks explain how healthy cells turn malignant: how they spread, evade the immune system, and resist treatment. For decades, doctors have relied on staging systems like TNM, which describe the size and spread of tumours. But such systems often miss the deeper molecular story—why two patients with the "same" cancer stage can have very different outcomes.

Scientists of S N Bose National Centre for Basic Sciences, an autonomous institute of the Department of Science and Technology (DST) working with Ashoka University have introduced the first AI framework that can read the molecular "mind" of cancer and predict its behaviour.

The team led the framework titled OncoMark to analyse 3.1 million single cells across 14 cancer types, creating synthetic "pseudo-biopsies" that represent hallmark-driven tumor states. This huge dataset allowed the AI to learn how hallmarks like metastasis, immune evasion, and genomic instability work together to fuel tumor growth and therapy resistance.

OncoMark achieved over 99% accuracy in internal testing and remained above 96% across five independent cohorts. It was validated on 20,000 real-world patient samples from eight major datasets, showing broad applicability. For the first time, scientists could actually visualize how hallmark activity rises with advancing cancer stage.

The new framework can reveal which hallmarks are active in a patient's tumor, pointing doctors toward drugs that directly

target those processes. It can also help identify aggressive cancers that might look less harmful under standard staging, supporting earlier intervention.