SEPTEMBER 24, 2025

Moonshots and Groundshots:
How research is changing the future of cancer

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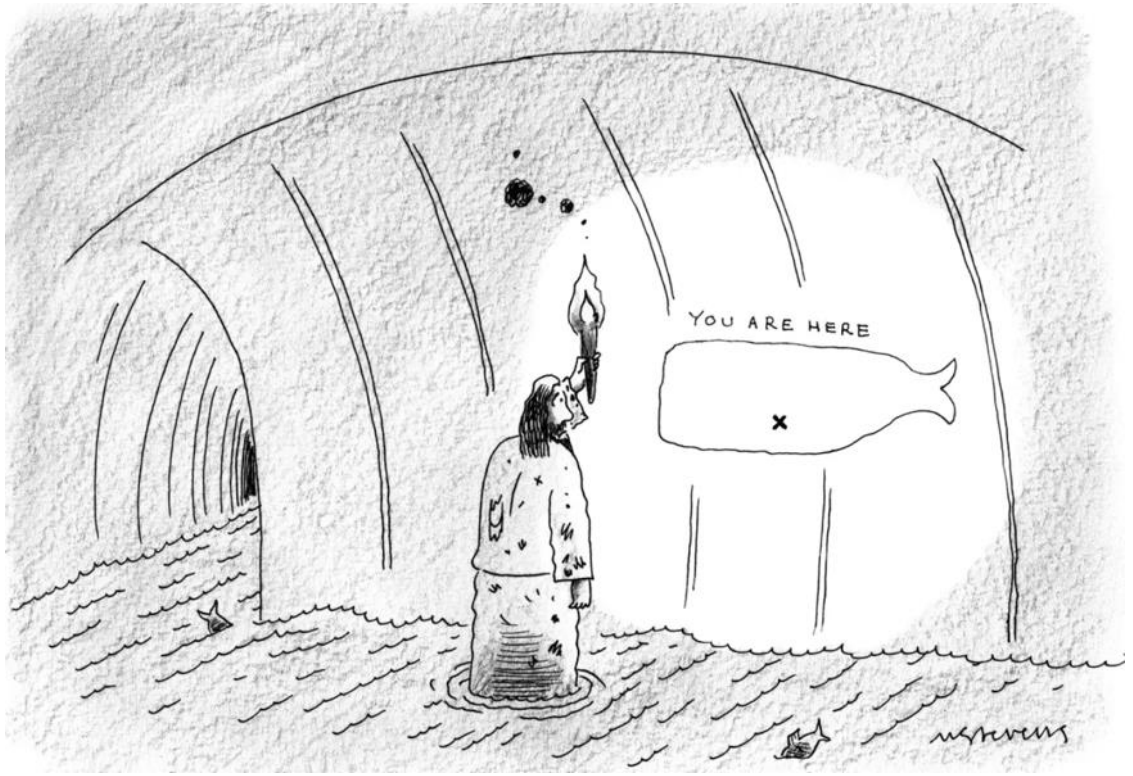
Executive Director, ACCESS

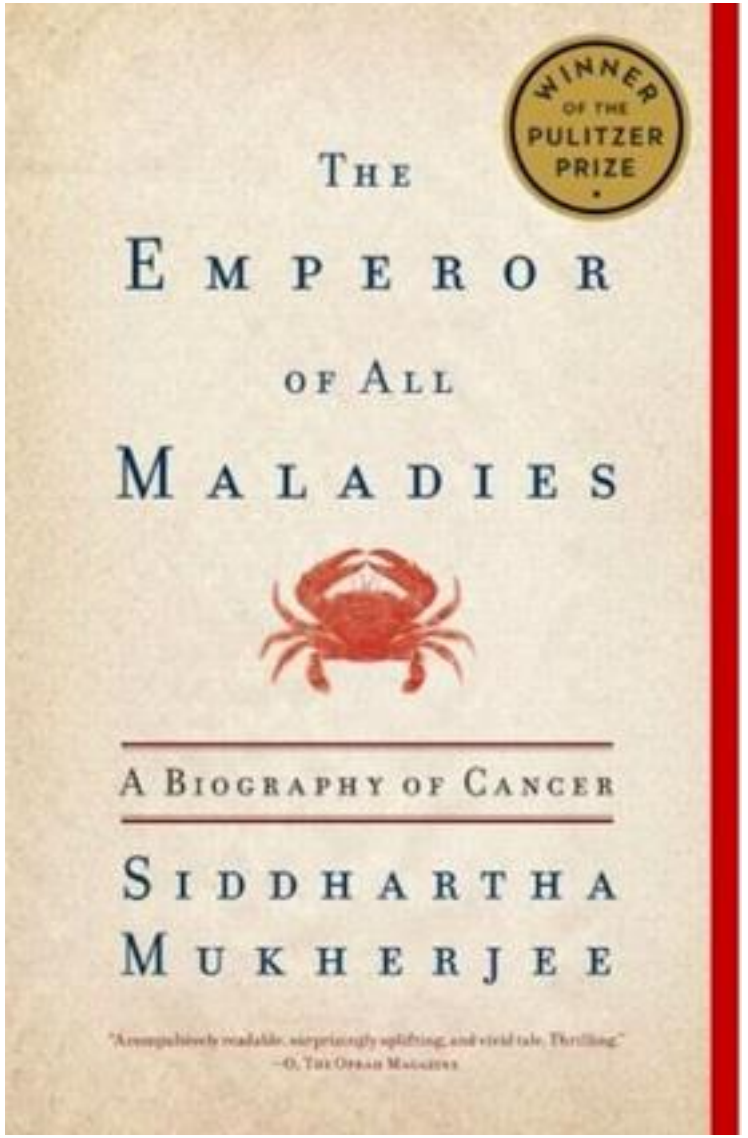
OICR
Ontario Institute
for Cancer Research

Orientation

1. Introduction to cancer
2. Cancer research in Canada
3. Research Moonshots
4. Research Groundshots
5. Future of cancer

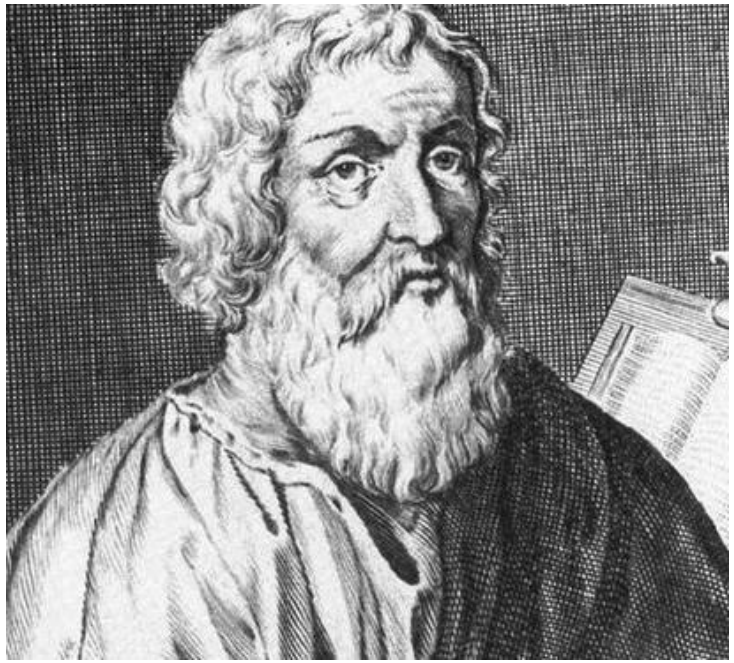


“a biography of cancer”



Cancer is as old as recorded human history

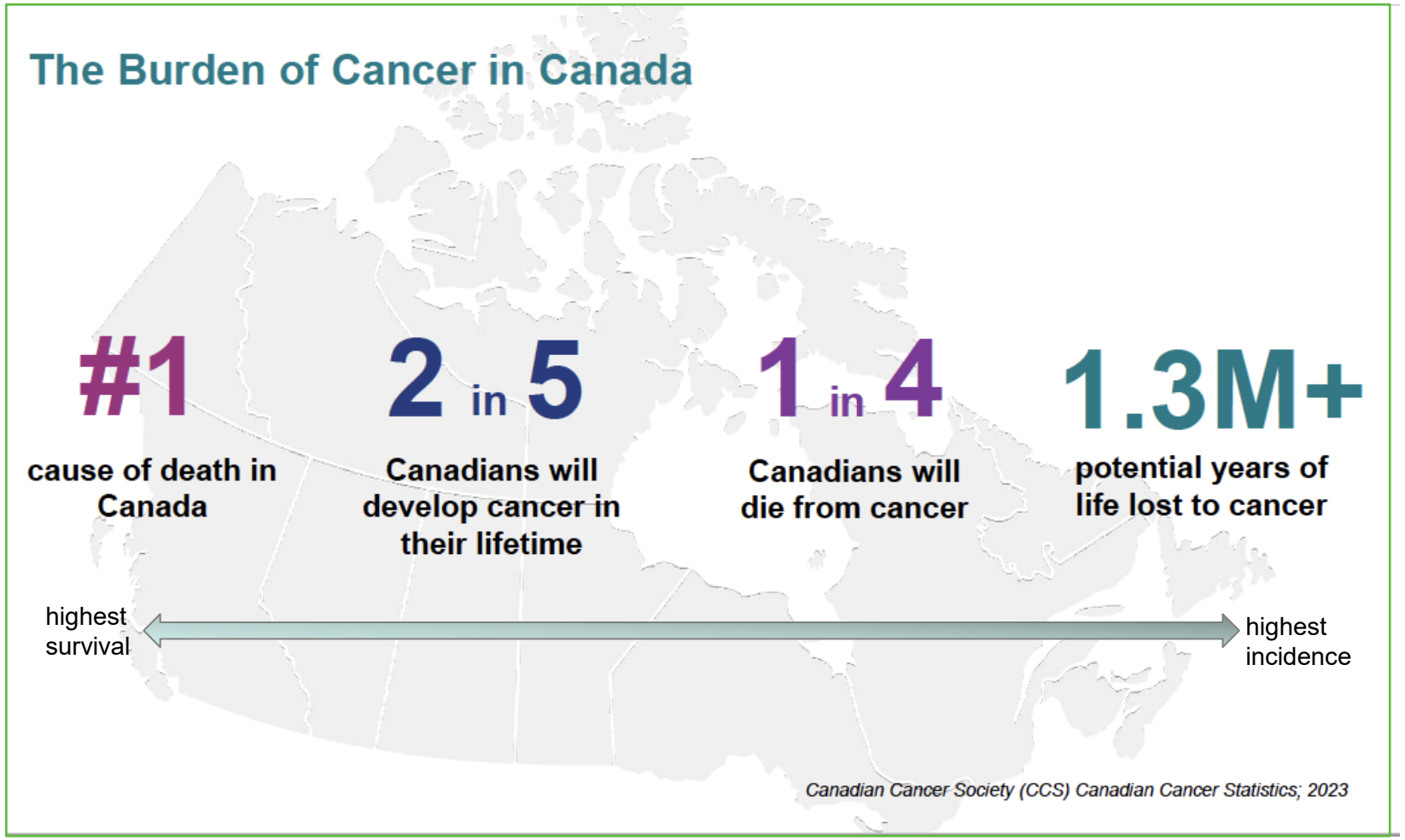
Imhotep case study scrolls, ~2600BCE



Hippocrates “karkinos”, ~400BCE

Galen “oncos”, ~200AD

Cancer affects all of us



↑ 40%

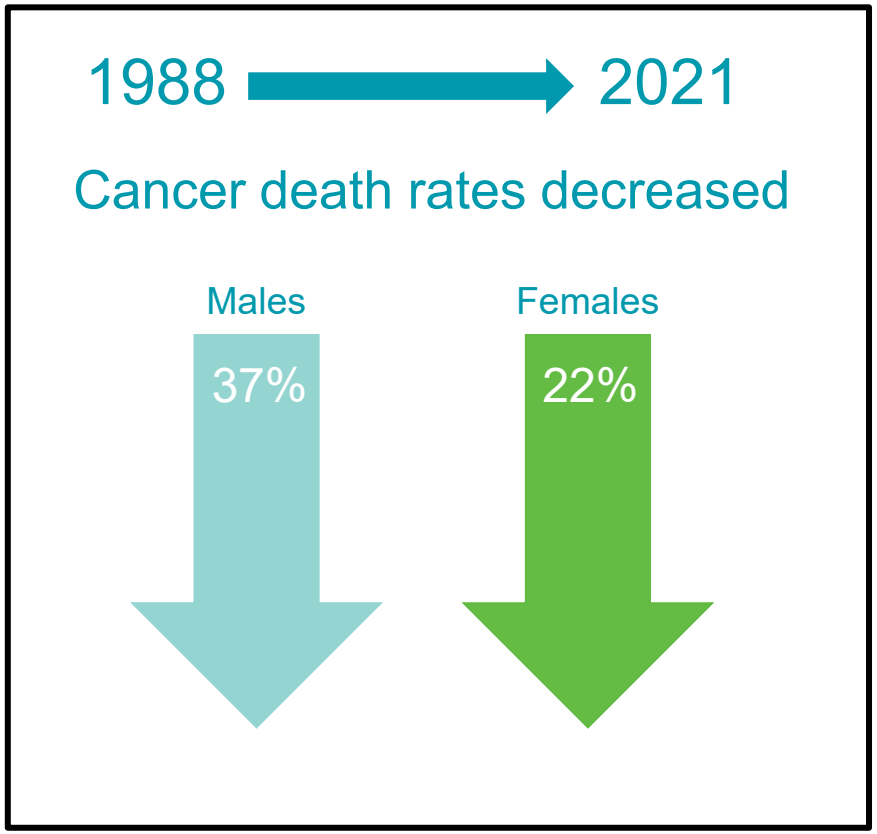
increase in cancer cases expected from 2015 to 2030

Fewer Canadians are dying from cancer

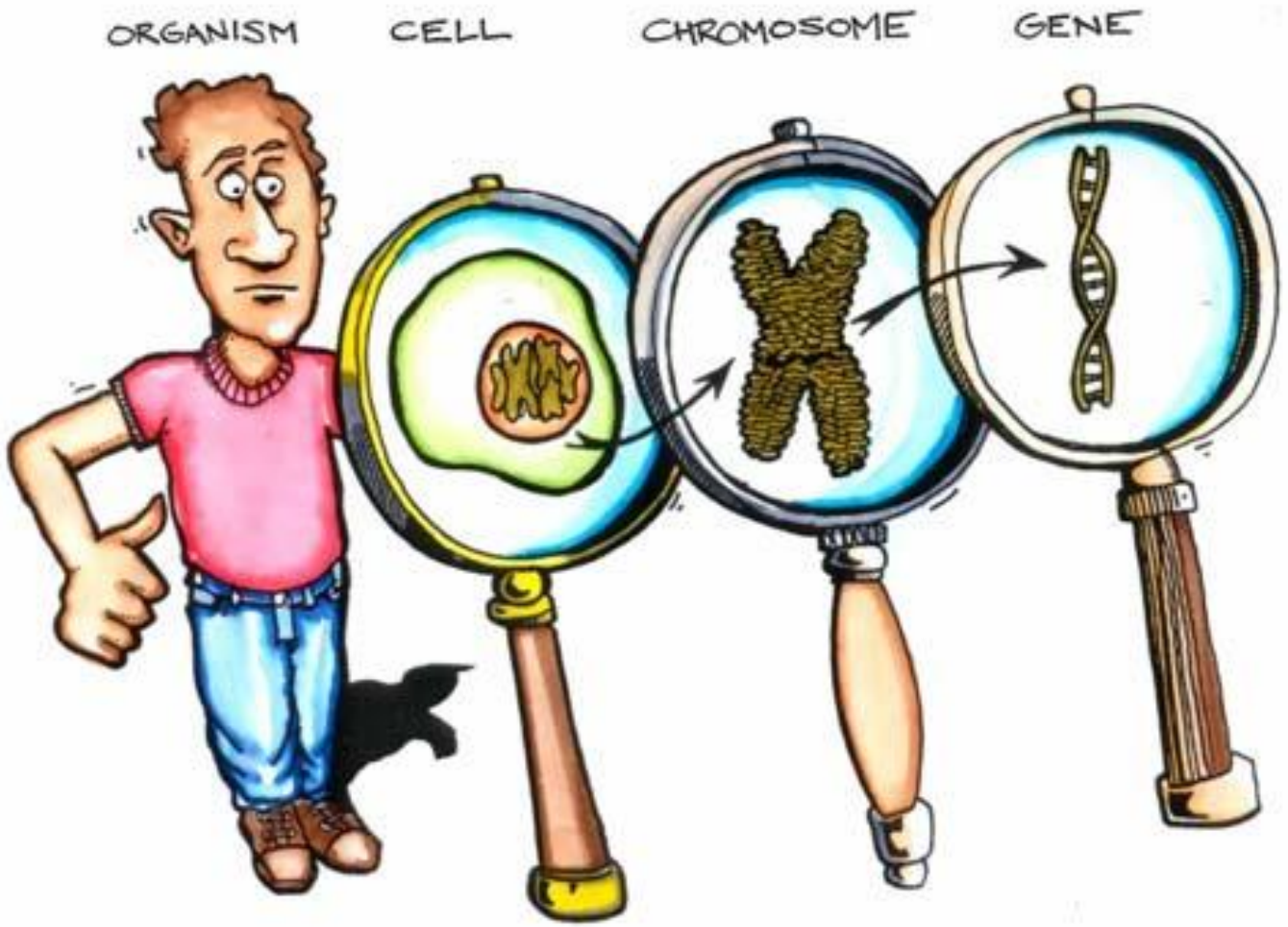
64% of Canadians diagnosed with cancer are expected to survive for

5 years or more

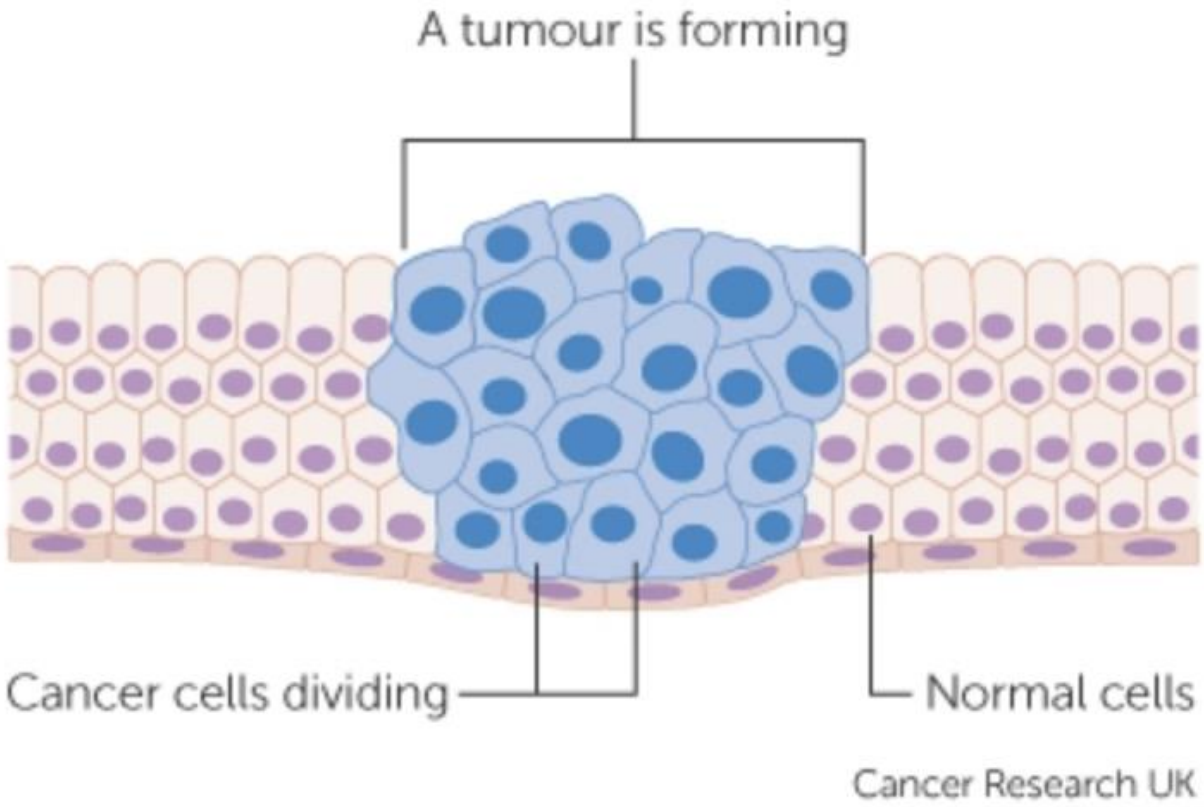
after a cancer diagnosis.

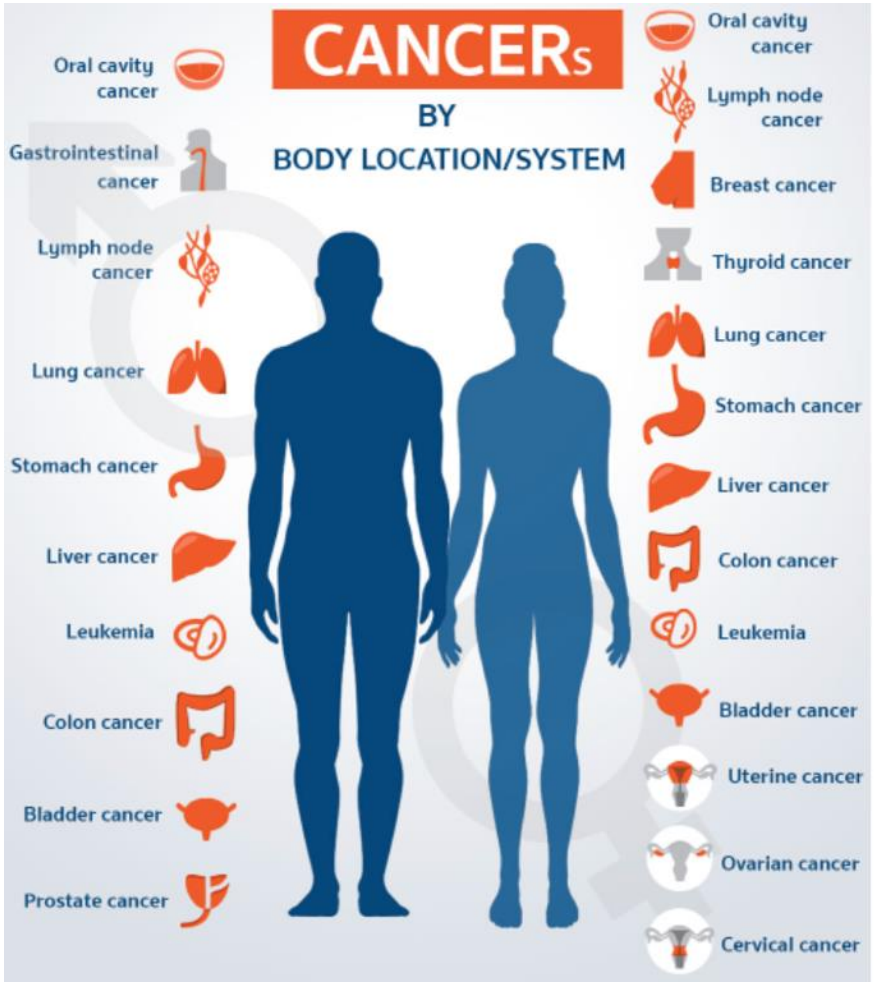


What is cancer? The cellular context



What is cancer?





Uncontrolled growth of cells

What causes cancer?

Changes to DNA can be…

1. inherited from your parents
2. caused by certain exposures
3. the result of errors that occur as cells divide

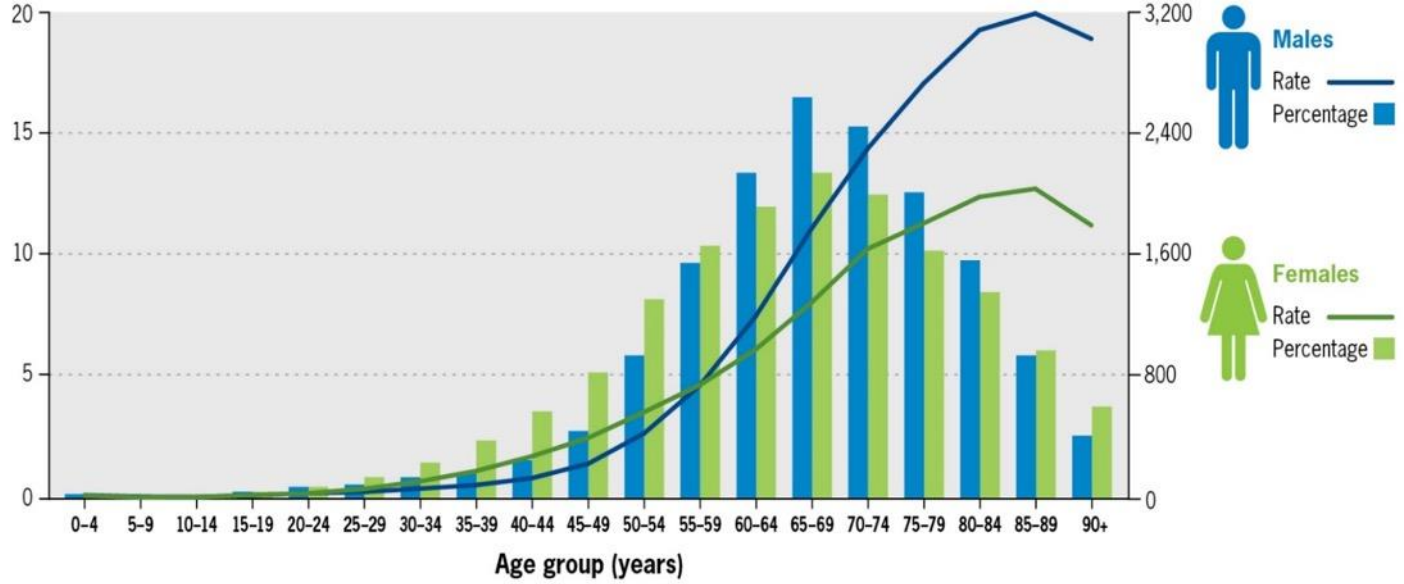
Changes to DNA

(usually in genes that control growth)

Cancer risk increases with age

Average age of a cancer diagnosis in Canada is 66.9

FIGURE 1.3 Percentage of new cases and age-specific incidence rates for all cancers, by age group and sex, Canada (excluding Quebec*), 2015–2017



* Quebec is excluded because cases diagnosed in Quebec from 2011 onward had not been submitted to the Canadian Cancer Registry.
Analysis by: Centre for Surveillance and Applied Research, Public Health Agency of Canada
Data source: Canadian Cancer Registry database at Statistics Canada

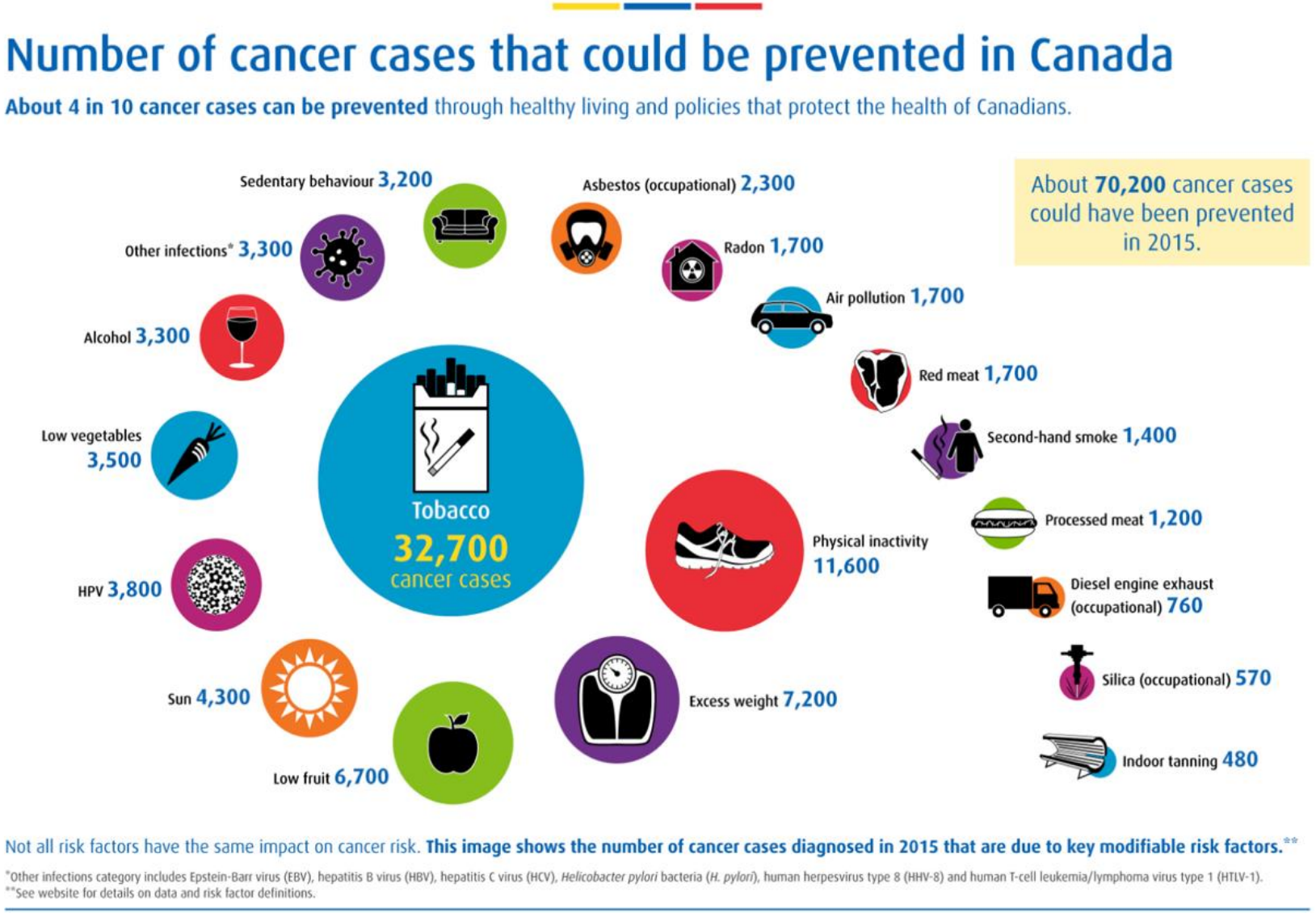
Canadian Cancer Statistics 2021

Can cancer be prevented?

Some of it, yes!

“modifiable risk factors”

What are the main preventable causes of cancer?

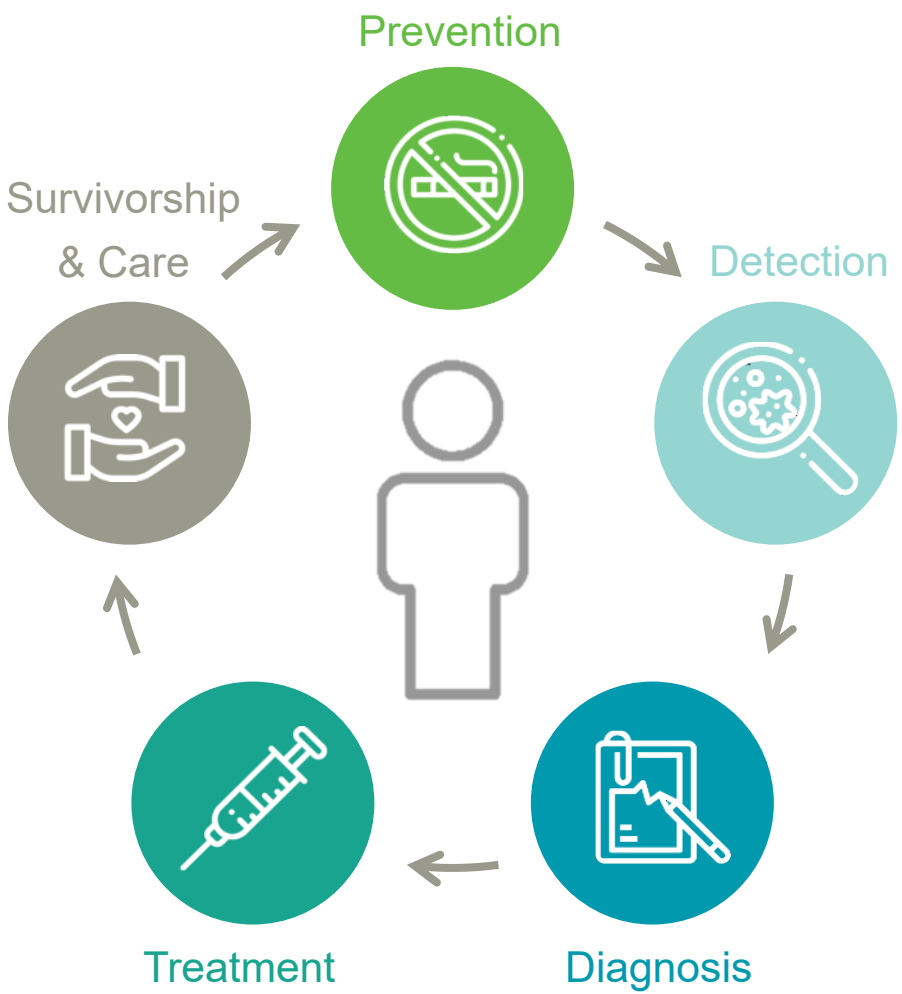


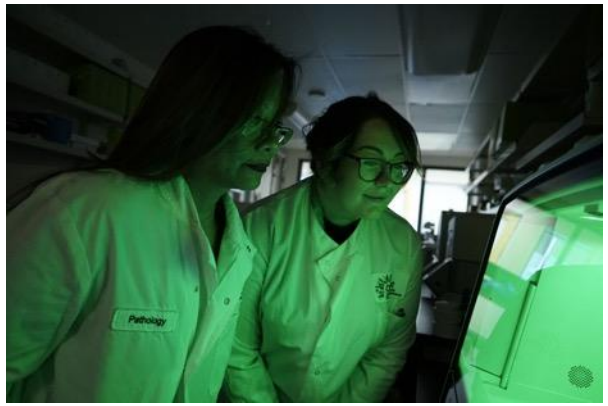
ComPare Study
https://prevent.cancer.ca/

Cancer is a uniquely complex foe

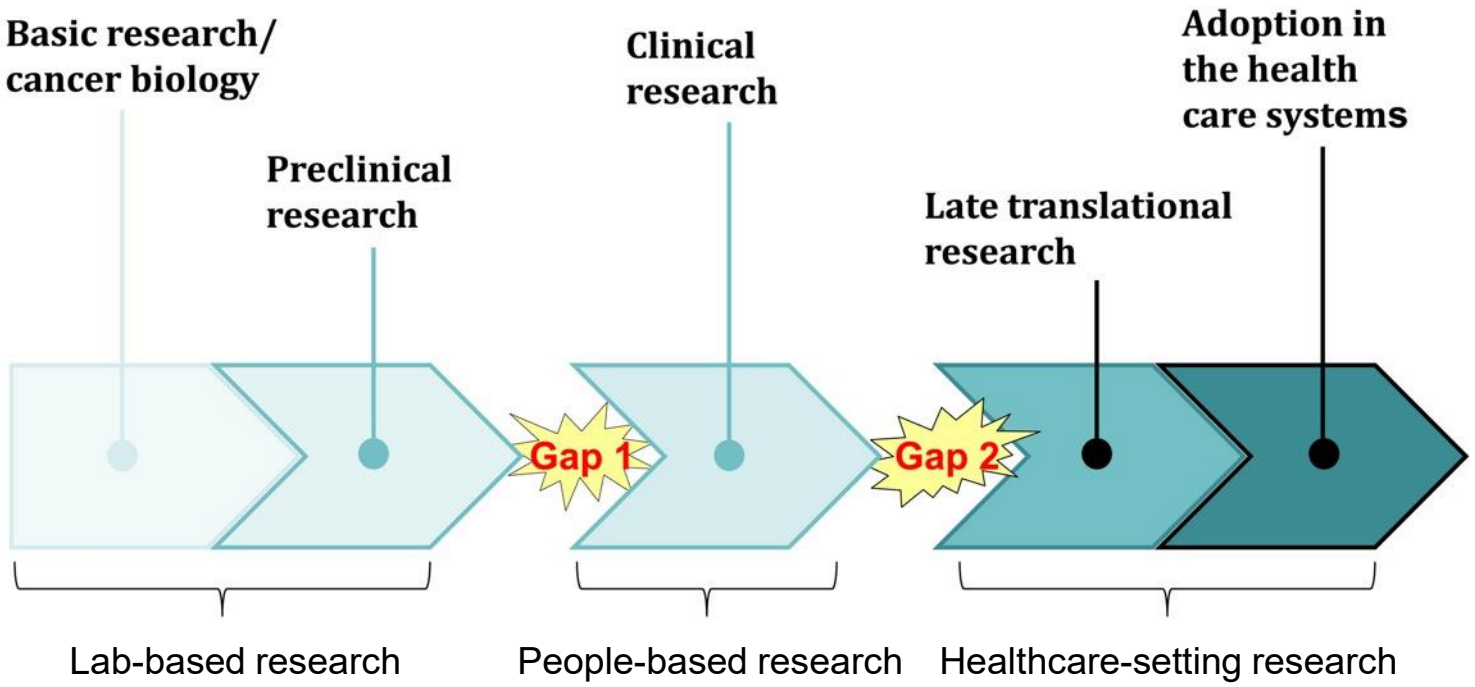
- More than **200** different diseases
- **Evolves** and becomes **resistan**t to treatment
- Lays **dormant**
- **Evades** the immune system
- **Environmental and genetic** causes; complex interplay, hard to control
- **Every person's cancer is unique** and individualized diagnosis and treatment is needed
- **Fear**

Cancer research spans the patient journey





Research relies on a pipeline of ideas and collaborations



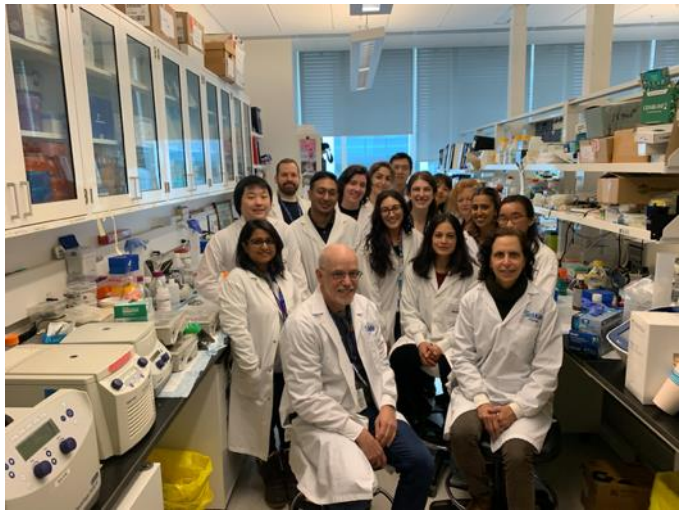
- It can take up to 17 years for a basic cancer discovery to impact clinical care.
- Of 100 findings important for human health, 5 will be translated for human use

Science requires partnerships between institutions and funders

INFRASTRUCTURE, LAB SPACE, RESEARCH CENTRES

Hospitals, universities and research institutes

Dr David Malkin, Sick Kids



Government

Charities

Private philanthropy

Private sector/industry

PEOPLE, PROJECTS, EQUIPMENT

Researchers wear a lot of hats!

Lecturer

Clinician

Reviewer

Teacher

Media spokesperson

Author

Fundraiser

Mentor

Camp doctor!

Canada invests a lot of money in cancer research…

- Collective government and charitable investment in cancer research (n=47 orgs) in 2021:

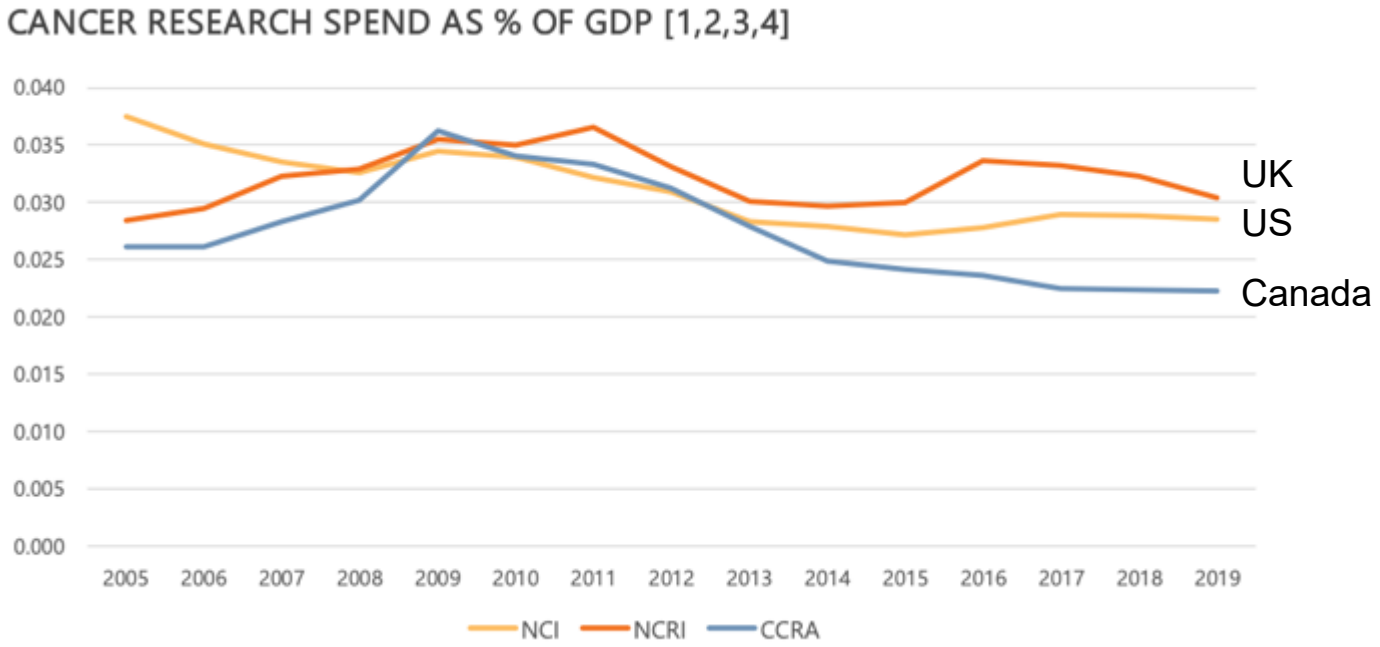
$519 M

- The top 10 funders make up 72% of this total

Canadian Institutes for Health Research	$177.8M
Ontario Institute for Cancer Research	$49.5M
Canadian Cancer Society	$32.6M
Canada Foundation for Innovation	$27.4M
Canada Research Chairs	$21.7M
Fonds de recherche du Quebec Santé	$17.4M
NSERC	$16.5M
Terry Fox Foundation	$15.6M
Ontario Ministry of Colleges/Univ	$14.3M
Genome Canada	$9.8M

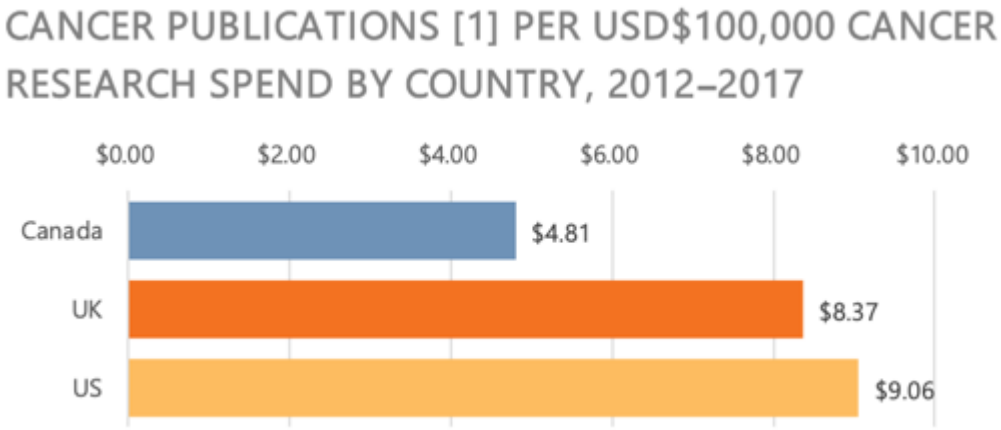
CCRA ACRC Canadian Cancer Research Alliance / Alliance canadienne pour la recherche sur le cancer

…or do we?



R&D spend overall is 1.5% of Canada's GDP
Healthcare spend is ~11% of Canada's GDP

"bang for our Canadian buck"



The future of cancer research: Moonshots

”We choose to go to the moon in this decade and do the other things, not because they are easy, but because they are hard…” –President Kennedy, 1961

CANCER MOONSHOT
PRESIDENT JOE BIDEN

“If we work together, we can cut the death rate from cancer by at least 50% over the next 25 years…” – President Biden, 2022

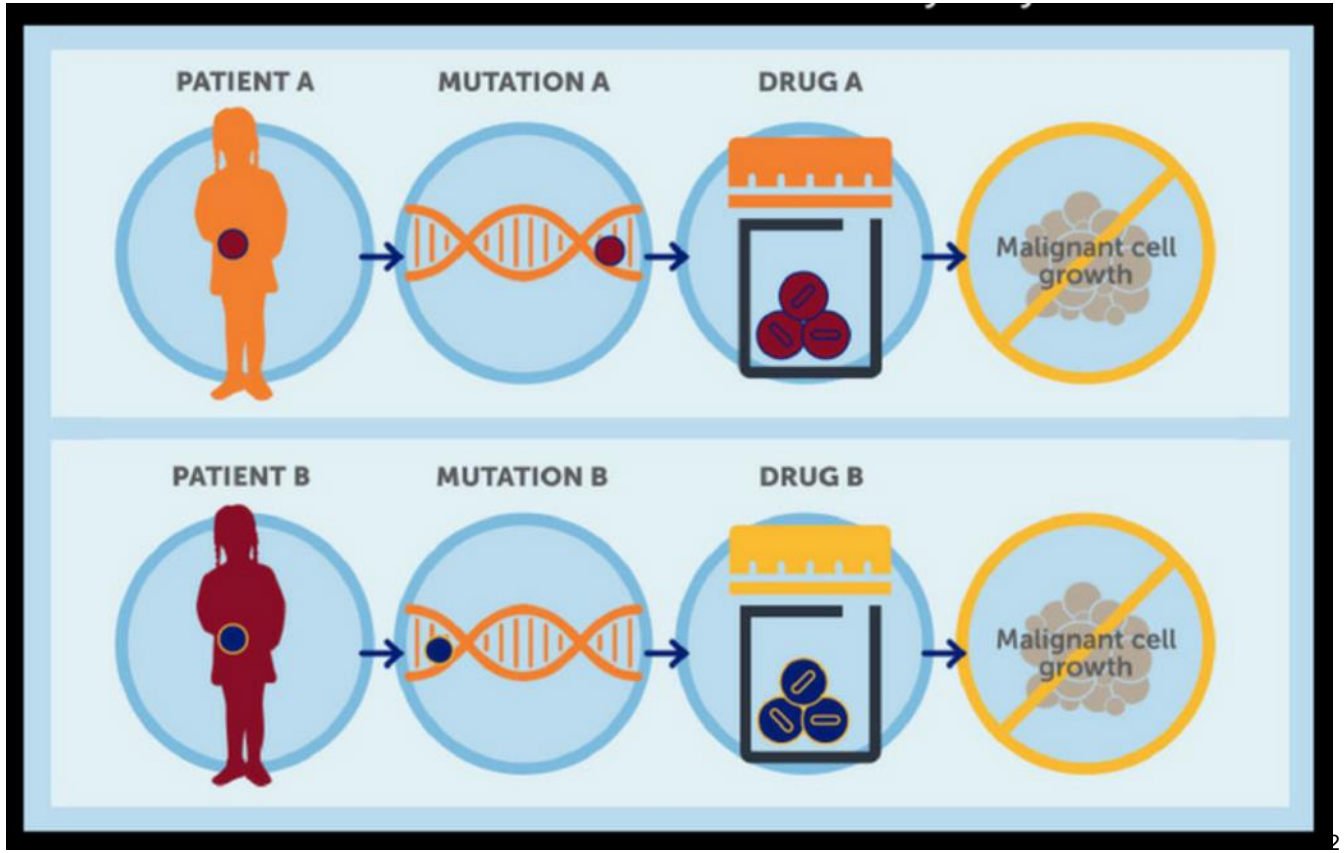
$1.8B/7 years for “high tech science”

1. Precision Medicine in cancer

No two patients are the same and no two cancers are the same
Detailed genetic and molecular profile of an individual's tumour
Tailored diagnosis and therapy ("driver" mutations)

"Right treatment to the right patient at the right time"

(with fewest side effects)

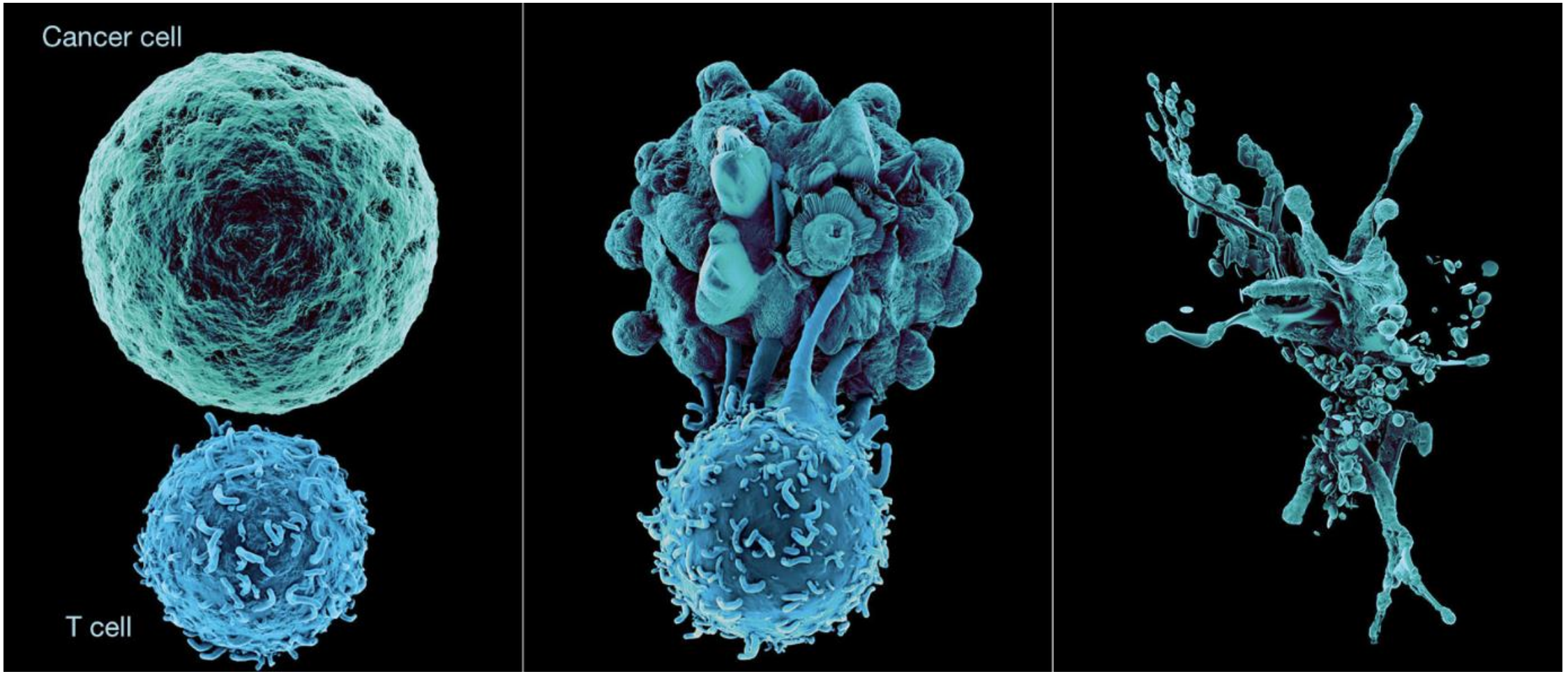


Precision medicine is changing clinical trials

Understanding a patient's genes ("-omics") provides clues for how to more precisely treat their disease.

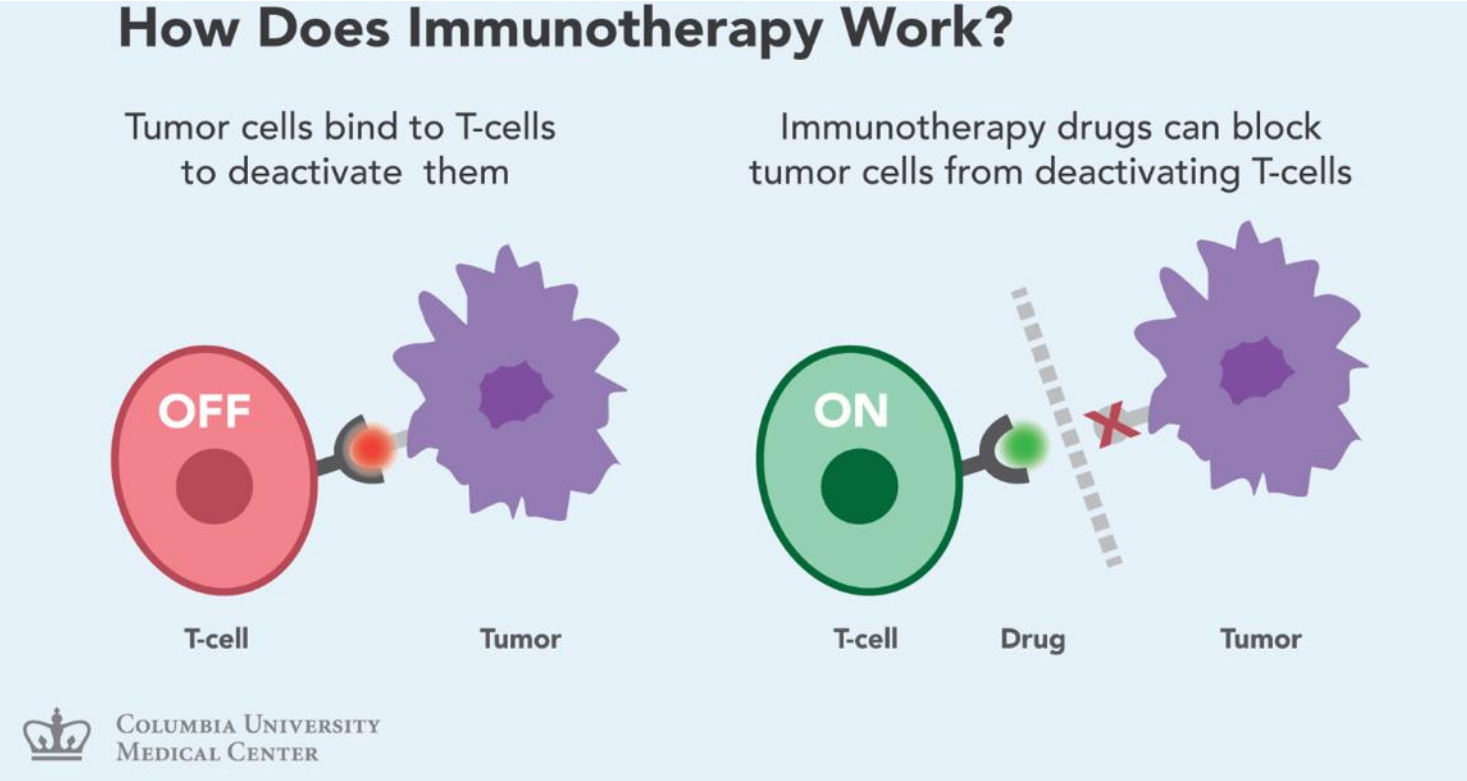
2. Immunotherapy

Your immune system can recognize and kill tumour cells



Clue: immunosuppression…high cancer rates (ie Kaposi's sarcoma in HIV patients)

Cancer cells can ‘turn off’ immune surveillance



- Immunomodulating agents block the deactivating signal (double negative = positive!).
- Some cancer types are more immunogenic than others.
- Particularly effective in melanoma.
- Often used in combination with other drugs.

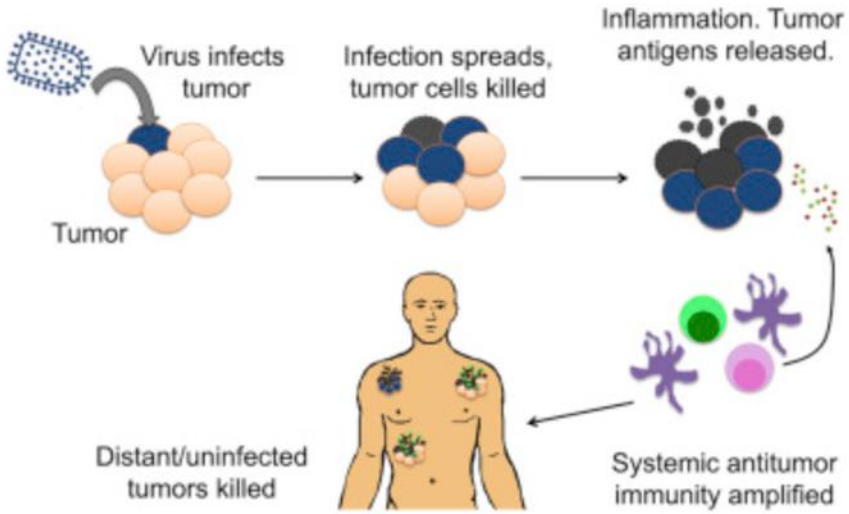
Other types of immune therapy

- **Adoptive cell therapy:** Remove, engineer and reintroduce a person's immune cells to seek out and destroy cancer cells. Ie, CAR-T cell therapy

- **Cancer vaccines:** The human papillomavirus (HPV) vaccine protects against cervical, anal, throat and penile cancers. The Hepatitis B vaccines prevents liver cancer.

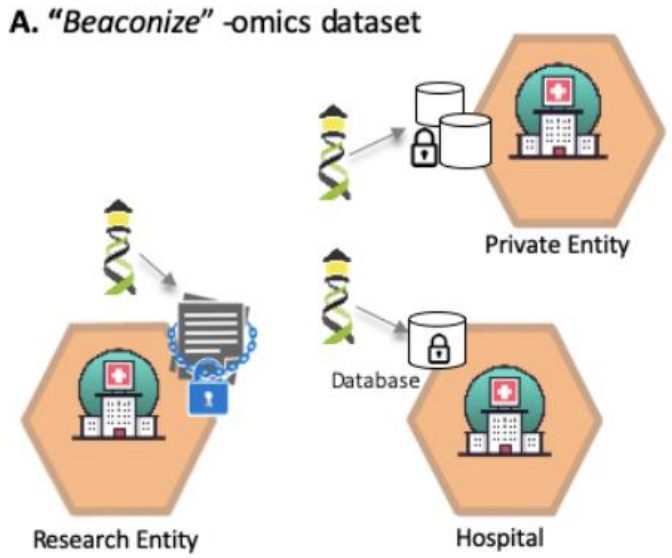
- **Monoclonal antibodies:** These lab-made proteins attack specific parts of a cancer cell. Monoclonal antibodies can also deliver drugs, toxins or radioactive material directly to tumors.

- **Oncolytic virus therapy:** virus engineered to cause bursting (lysis) of tumour cells and stimulate a systemic immune response.

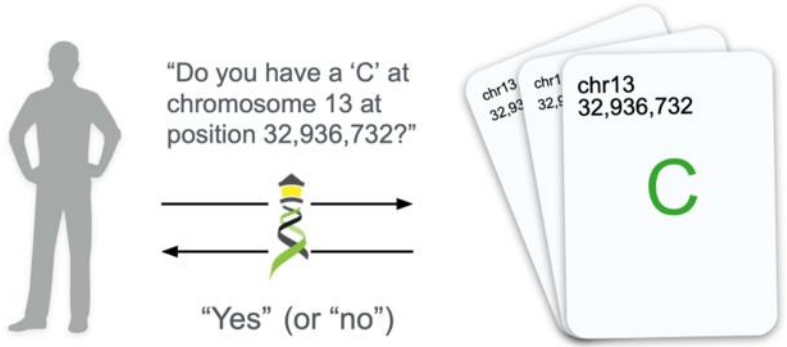


3. Big data, data sharing and AI

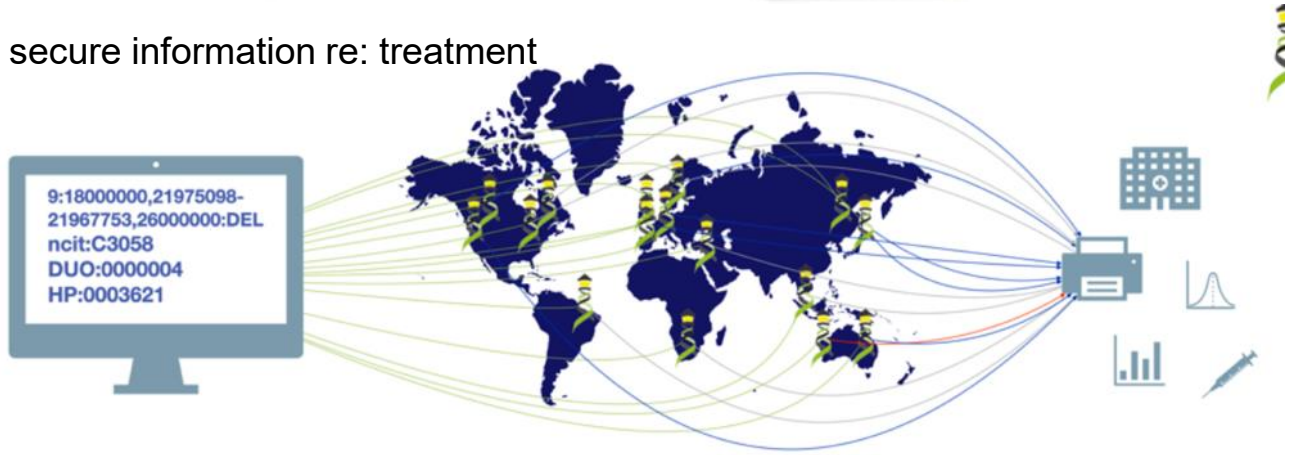
Irony: precision medicine requires huge numbers of patients and data points to make it effective.
Solution: enable safe, ethical, secure international data sharing of health information.
Example: Beacon Project (Global Alliance for Genomics and Health)



B. "Go Fish" query

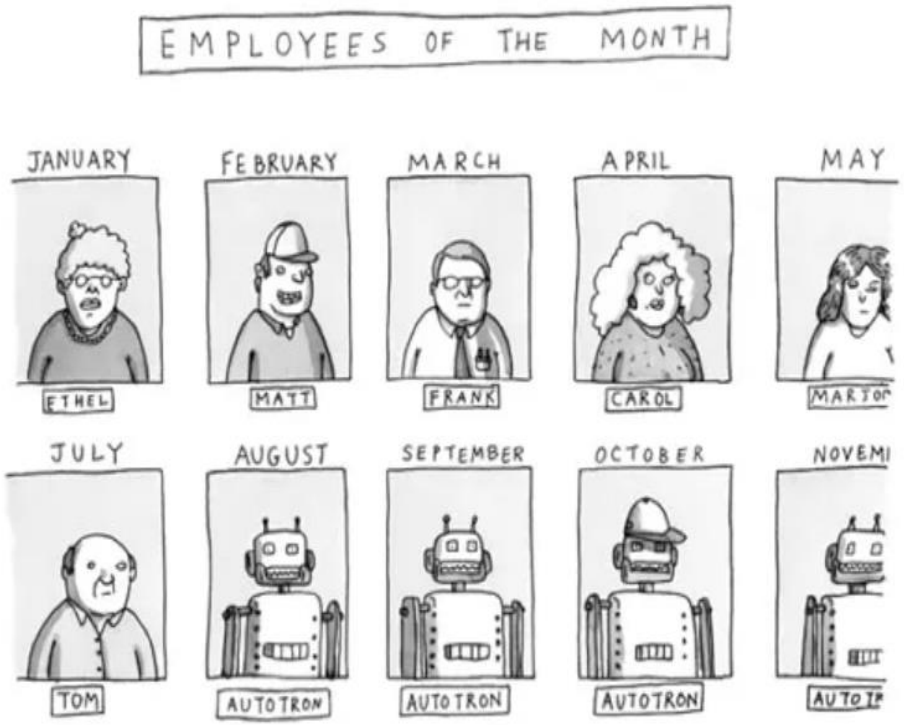


C. Deeper, secure information re: treatment



In the future, AI will…

- **Predict patient outcomes** before they happen and signal the need for an urgent clinical response
- Provide clinician **decision support** with evidence-informed diagnoses and treatment options
- Passively **analyze huge data sets** and look for pattern associations not previously seen (ie, mutation X + patient profile Y + condition Z = consistent outcome)
- Read routine **radiology** scans and **pathology** slides
- Help **triage symptoms** and need/type of clinical response via chatbots
- **Automate** test ordering, test reporting, prescriptions and other routine care outcomes
- Assist in **robotic surgery**
- Use deep learning on huge datasets to **identify people at risk of disease** to enable earlier intervention (precision prevention; population cohorts)
- Write grant proposals! ☺



4. Early detection of cancer

Select 5-year cancer survival rates (2021)

Pediatric (overall):	92%	
Prostate:	91%	Screen (PSA)
Breast:	89%	Screen (mammog/US)
Cervix:	74%	Screen (Pap/HPV)
Colorectal:	67%	Screen (colonosc/FIT)
Ovarian:	44%	
Lung:	22%	Screen*
Pancreas:	10%	

*high risk only

The biggest impact on patient outcomes is **detecting cancer early** before it has spread.

Research will result in new early detection methods

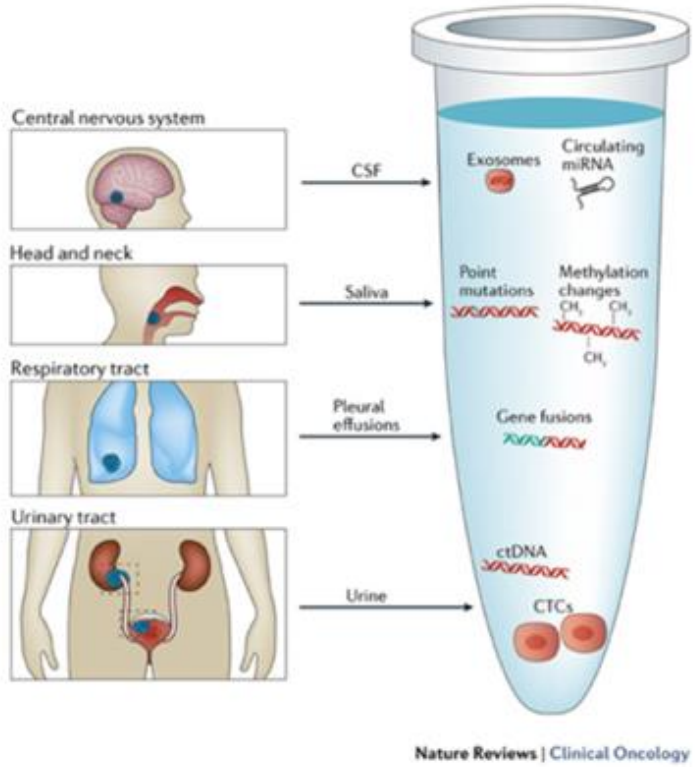
Identify **new biomarkers**: biological “tags” that distinguish cancer cells from normal cells to enable focused treatment.

Develop new minimally invasive detection methods that are **sensitive and specific**.

- multimodal imaging technology (high contrast agents; nanoparticles)
- liquid biopsies (blood, urine, saliva)
- circulating tumour cells and cell-free DNA

Understand who is most at risk for developing specific cancers and develop organized screening programs to detect more cancer earlier.

Learn from COVID and empower **more self-screening tests**.



“Liquid biopsy”

In addition to Moonshots, we need to consider Groundshots

Drs. Chris Booth and Bishal Gyawali, Queen's University

Its not just about new innovations…we need to apply what we know. There are actionable, high-value ideas applicable to Canada from all over the world.

Patients should be central to all we do in research

Cancer treatments should benefit patients: a common-sense revolution in oncology

Many newly approved cancer therapeutics offer limited clinical benefits yet are still prescribed to patients. A common-sense revolution in oncology would prioritize treatments that meaningfully improve survival and quality of life.

Bishal Gyawali and Christopher M. Booth

Oncology needs a common-sense revolution. Although there has been important progress in some elements of cancer care, the cancer field is losing sight of what matters to patients. Hype has overshadowed hope, and biological plausibility precedes efficacy. The cancer community celebrates so-called 'game-changing' treatments on the basis of single-arm studies, observational data and even animal models. Even when randomized controlled trials (RCTs) provide evidence in support of treatment efficacy, there are many problems with such studies, including the promotion of statistical significance over clinical significance, the use of substandard control arms and subgroup analyses to claim treatment benefits, the use of non-inferiority design instead of superiority design, and the promotion of efficacy on the basis of surrogate or secondary endpoints[1]. These problems call for a common-sense revolution that will require paradigm shifts in education, research design and the delivery of cancer care (Table 1).

Medical education

Many problems in oncology could be mitigated by the education of trainees, patients, the media and journal editors. Problems with oncology education, and potential solutions, are presented in Table 1.

The main challenge in education is the hype that surrounds new cancer therapies. The ability to critically evaluate the literature is one of the most important skills in clinical care; this should be emphasized in training programs and continuing education.

There is a prevailing narrative that all new treatments have a major clinical impact, which influences how physicians, lay people, policy-makers and politicians perceive these treatments. Health journalists have a role in this, as news stories of supposed treatment breakthroughs drive unrealistic patient expectations and pressure policy-makers to approve marginal treatments[2]. The reality is very different, as most advances in oncology are small and incremental.

Credit: mathisworks / DigitalVision Vectors / Getty

Trainees need to be taught how to engage in difficult discussions about stopping anti-cancer therapy, rather than following the easier route of prescribing a marginal or ineffective drug. Journalists should be equipped with basic skills in critical appraisal that would allow them to ask tough questions and view press releases with skepticism and clarity. Oncology researchers should also recognize that in most cases, the main source of hype is their own community. The opening press conferences at annual meetings are often rife with hype surrounding 'major advances', but these advances are often modest.

Patients should be better informed and should be given unbiased educational materials that clearly explain magnitude of benefit, toxicity and cost. Social media is a major platform for oncology education of patients and others, but the content is not subject to critical review and is prone to spin

NATURE MEDICINE | VOL 28 | APRIL 2022 | 614–629 | www.nature.com/naturemedicine

Too many cancer drugs are unaffordable and don't extend the patient's life.

Success = patient value (overall survival, quality of life), **not** tumour size.

Repurpose drugs and test efficacy of affordable medicines.

Ensure what we know works is uniformly used and accessible to all (equity and 'postal code medicine').

Disinvest in expensive interventions and drugs that don't work.

Invest in prevention and screening programs and healthy communities.

Expand access to palliative care and pain medication.

Plan early for the implementation of scientific innovations and collect real world evidence of effectiveness.

Put another way….

Research ALONE can't cure cancer.

We also need…

- Clinicians to use it
- Patients to want it
- Health systems/hospitals/caregivers that can deliver it
- Industries that can produce it
- Governments who will pay for it
- …and we need to know it *really works*

We need a Learning Health System

- Research, care and preventive/community health are **linked**
- Data is shareable
- Link of clinical experience, research and real-world data over time
- **Patients are at the centre**

Research is part of patient care.

We learn from every patient;
every patient benefits from learnings.

The future of cancer

People will continue to get cancer AND we will live longer, healthier lives. There will be less fear.

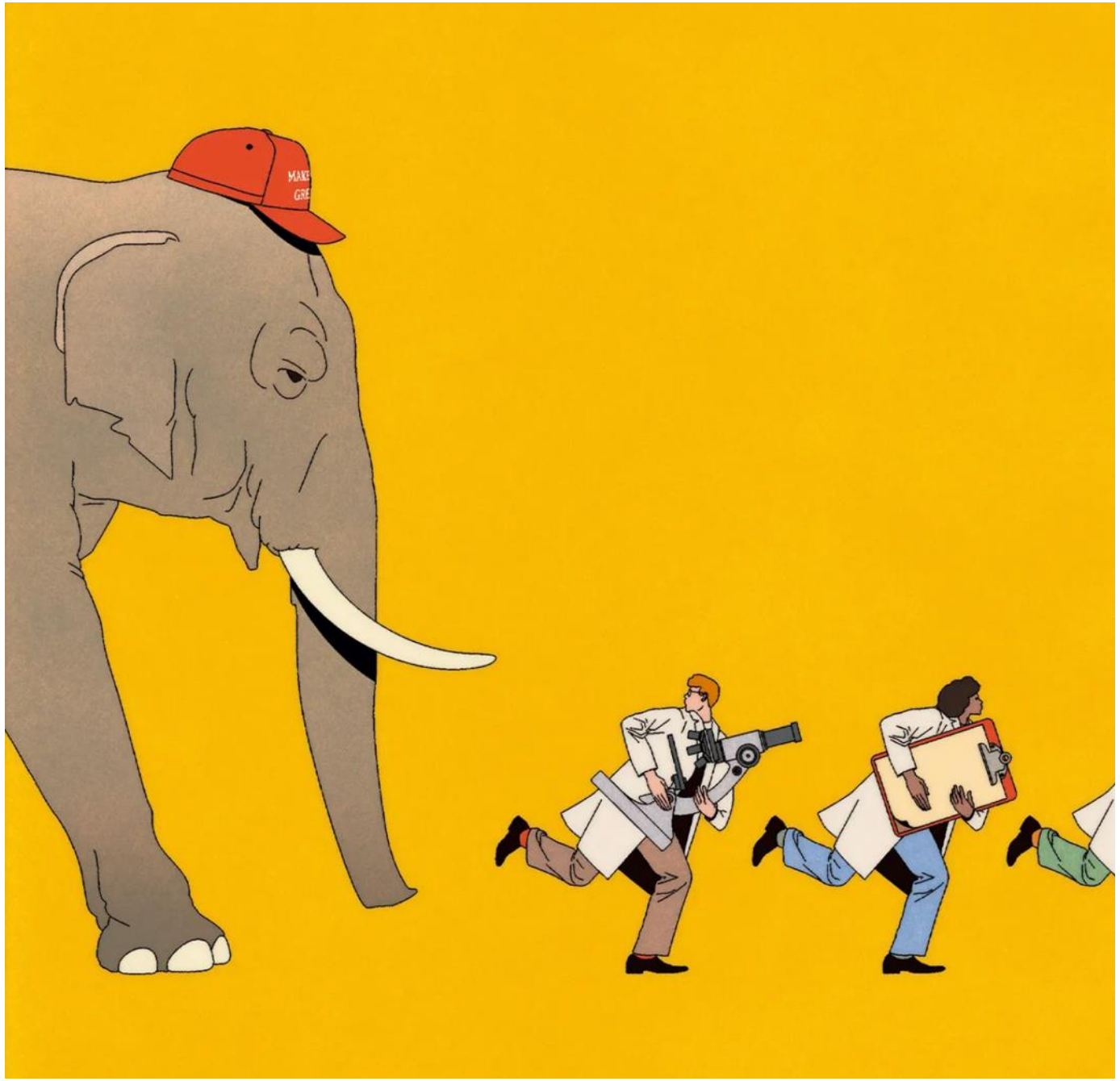
Rates of cancer will decrease (prevention) and survival and quality of life will both improve (precision medicine).

Cancer will be detected earlier when it is more treatable with fewer side effects and better outcomes.

Patients will be empowered and part of the research team.

Care will become more equitable.

More prevention, screening and care will occur outside of hospital settings (wearable technology; remote access; proactive management).



“American science is under attack”

-NYT Feb 14, 2025

“This assault includes nominating leaders hostile to science and unqualified for their roles; issuing a barrage of executive
meetings, pu
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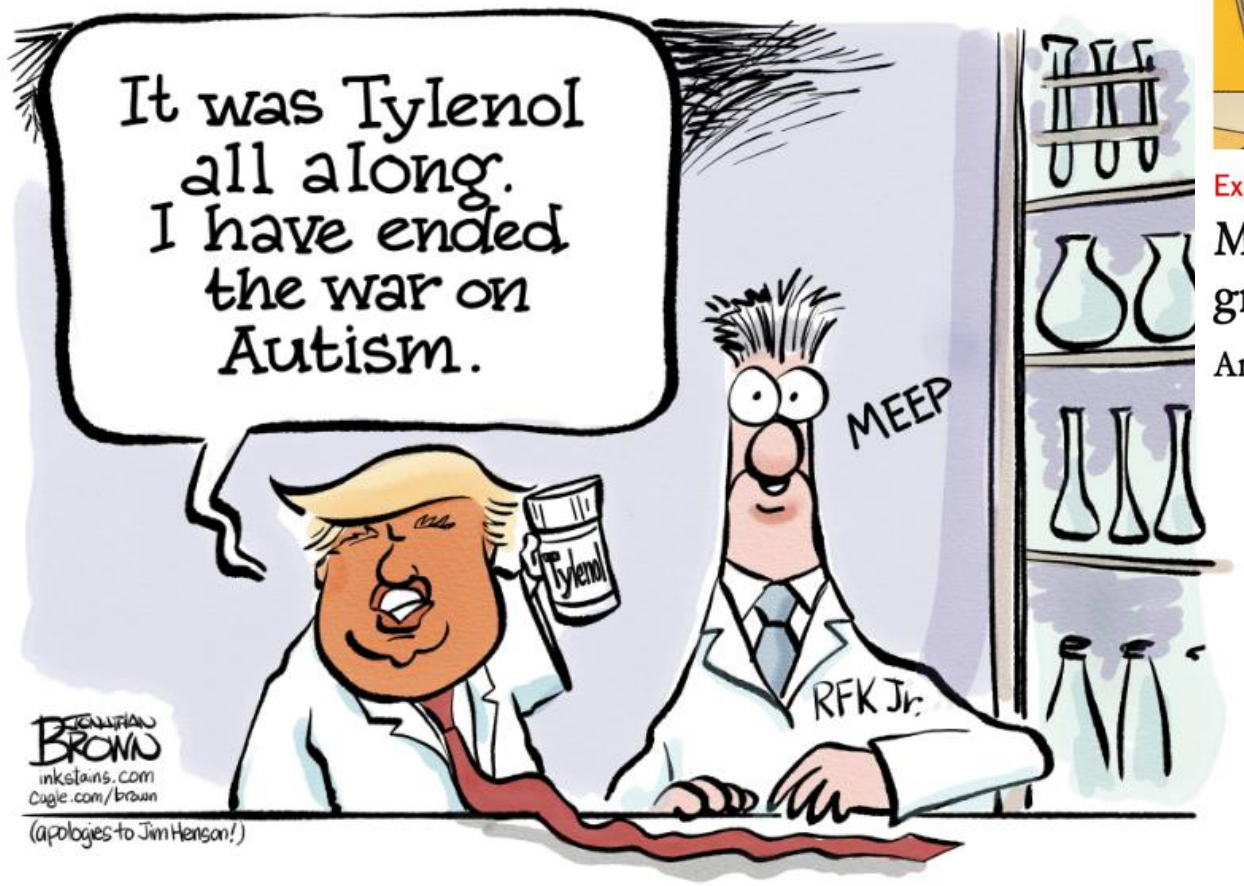
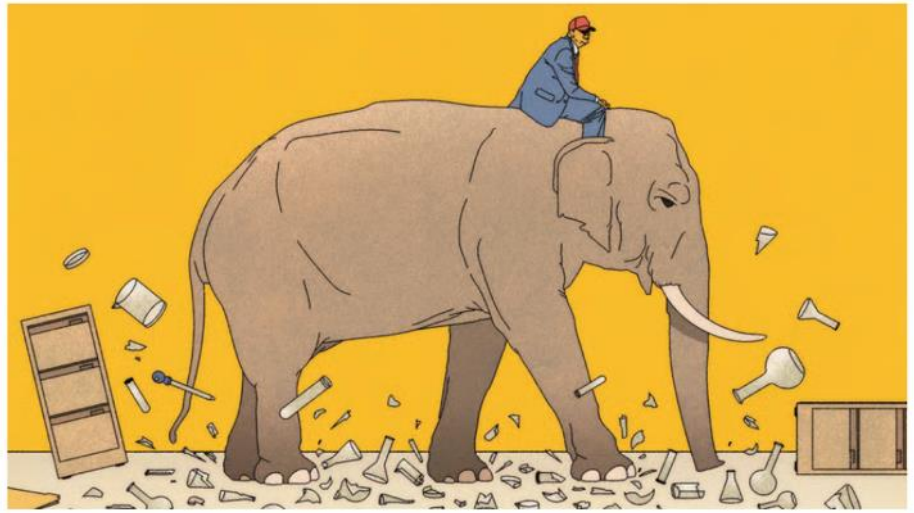


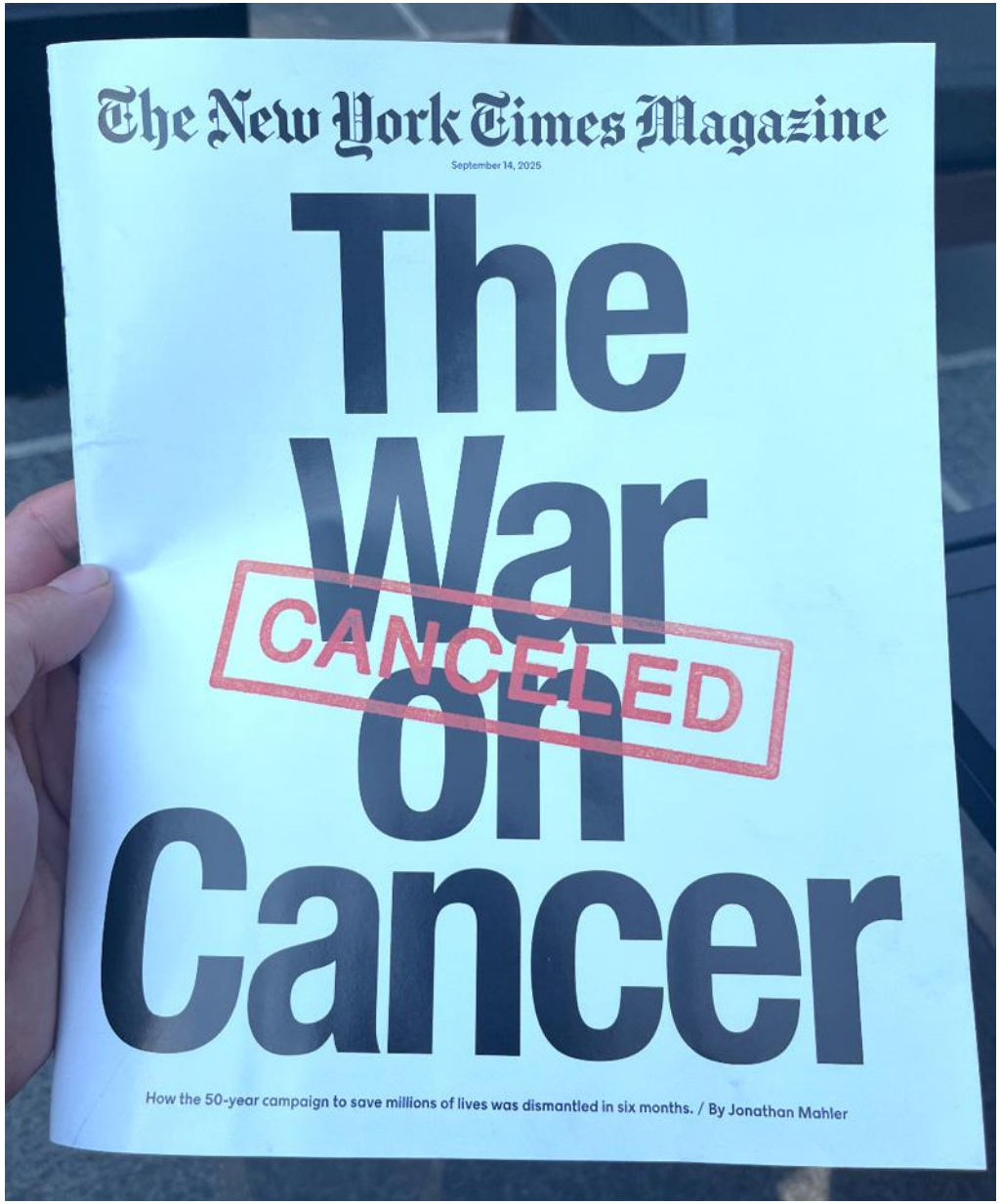


Exit, pursued by an elephant

MAGA’s assault on science is an act of grievous self-harm

America will pay the price most of all

-The Economist, May 2025



Sept 14, 2025, NYT Magazine

US federal support for science is primarily through the National Institutes of Health (NIH) which has seen a 40% budget cut ($10B) under RFK Jr.

"The Trump administration is actively dismantling the cancer research system.

New presidential administrations have usually gone out of their way to make transitions at the NIH as seamless as possible so as not to disrupt ongoing research. The Trump administration, in sharp contrast, has canceled hundreds of millions of dollars' worth of cancer-related grants and contracts and suspended or delayed payments for hundreds of millions more – largely for political reasons.

It is also seeking to cut the National Cancer Institute's budget by more than a third, and to sharply lower the percentage of overhead expenses that the government will cover for federally funded research labs."

What is the impact on Canada?

Clinical trials for childhood cancer closed to new Canadian patients in wake of U.S. funding cuts

KELLY GRANT > HEALTH REPORTER
PUBLISHED SEPTEMBER 11, 2025
UPDATED 11 HOURS AGO

Threat

Opportunity

Toronto's University Health Network launches scientist recruitment campaign amid U.S. health cuts, layoffs

Aim is to attract best from around the world, including discontented U.S. researchers, officials say

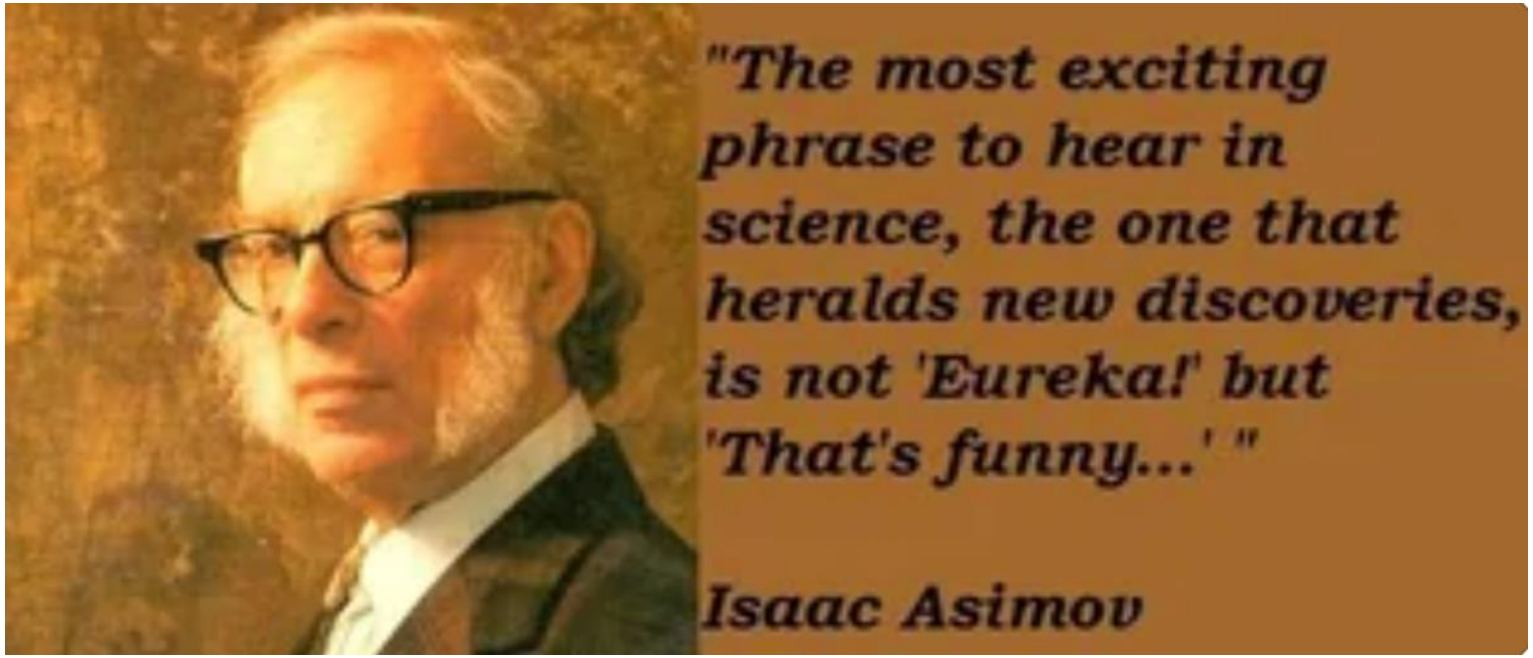
Ethan Lang · CBC News · Posted: Apr 07, 2025 2:27 PM EDT | Last Updated: April 8

Canada has been too reliant on the US government and the US scientific community for support; Canada must invest in its own R&D.

…And Canadian scientists need to do a **better job of communicating** the link between a robust life sciences ecosystem and economic prosperity.

There are very few ‘breakthroughs’.

Progress is incremental and science is a team sport requiring creativity, serendipity and humility.



Thank you! Merci!

Strategic Priorities

Research excellence

- Talent Development.
- Collaborative Research Resources.
- Artificial Intelligence.
- Emerging Opportunities.

Better health

- Early Detection and Precise Intervention.
- Interdisciplinary Networks Focused on Unmet Patient Needs.
- Improving Patient Access to Clinical Trials.
- Closing the Gap between Cancer Discovery and Patient Care.

Stronger economy

- Turn Research into Innovation.
- Anchor and Scale Early-stage Companies in Ontario.
- Streamline Access to Commercialization Support and Investment.