

# Exploring Cancer: An Integrated Approach to Discovering Cures

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## Introduction and Background

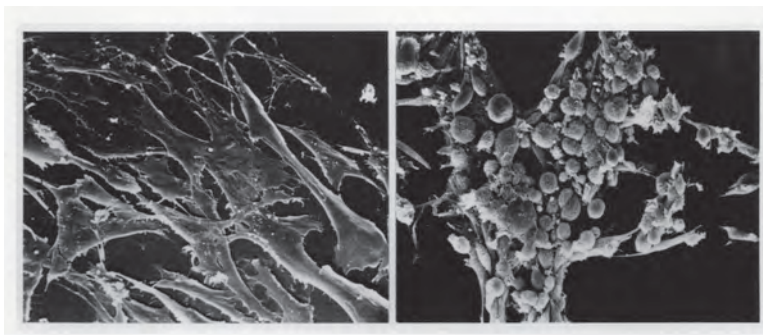
During our lifetimes, we will know someone, either a family member, neighbour, co-worker, or friend, who has been afflicted with cancer. Some battle resiliently and survive, while others unfortunately succumb to this cruel condition. Scientists around the world have endeavoured honourably to find a cure for cancer. Over the past 40 years, scientists have collected much needed information regarding cancer; however, a single cure for the condition remains elusive. Several pieces are still missing in the cancer puzzle. Each year millions of dollars are allocated toward cancer research and related health care initiatives. We all hope that someday we will elucidate the mechanisms, regulation, and causes for the assessment, prevention, and effective treatment of the diverse forms of cancer.

Cancer cells display several characteristics that distinguish them from normal cells. Normal cells possess complex shapes that are relatively flat, and they connect with adjacent cells and to surrounding substrates. Cancer cells appear strikingly different in comparison with normal cells. Cancer cells display round or ball-like conformations and are often weakly connected to one another. Cancer cells do not require anchorage to their surrounding substrates.

In normal cells, **cell cycle checkpoints** ensure that DNA replication (which occurs during the synthesis phase [S phase] of interphase) and mitosis occur when conditions are favourable and the related processes are functioning properly. Cell cycle checkpoints regulate the proper sequence of events and control the synchrony of different processes. In cancer cells, these cell cycle checkpoints are disrupted. Consequently, cancer cells divide rapidly in an uncontrolled manner and form masses of accumulated cells, which

### LEARNING OBJECTIVES

1. To analyze and interpret cancer from several integrated holistic levels, including molecular biology, cellular biology, genetics, evolutionary biology, population ecology, and conservation biology
2. To assess how cancers are linked to uncontrolled cell division and the failure of cell cycle checkpoints
3. To apply knowledge to formulate research topics that should be investigated in order to find the cures for cancer

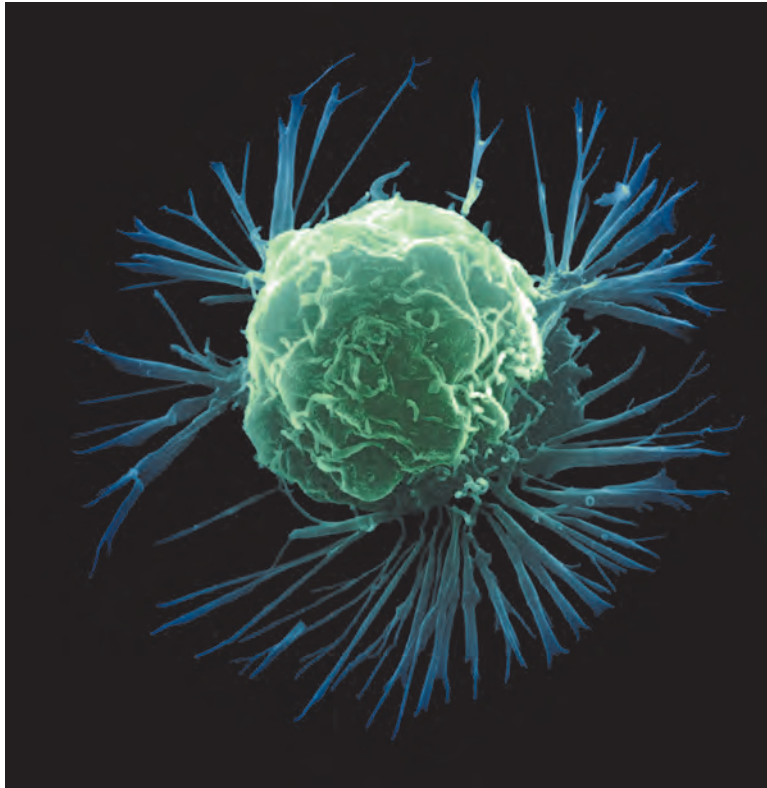


**PHOTO A.** Scanning electron microscope photos of normal cells and cancer cells.

Source: Photographs by G. Steven Martin.

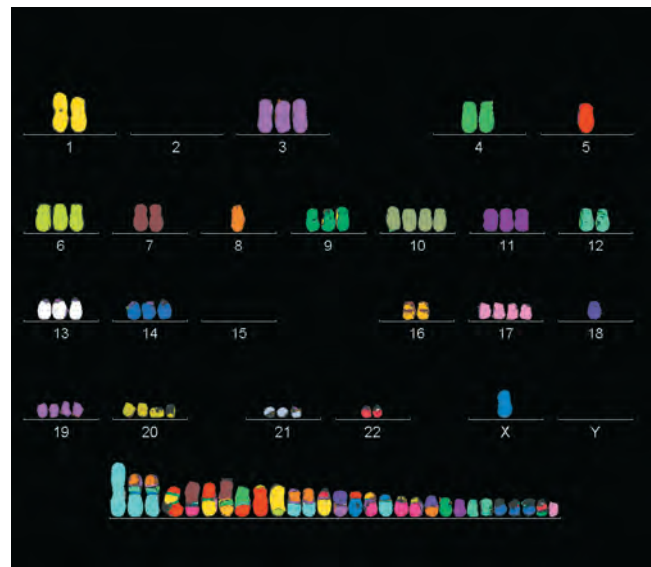
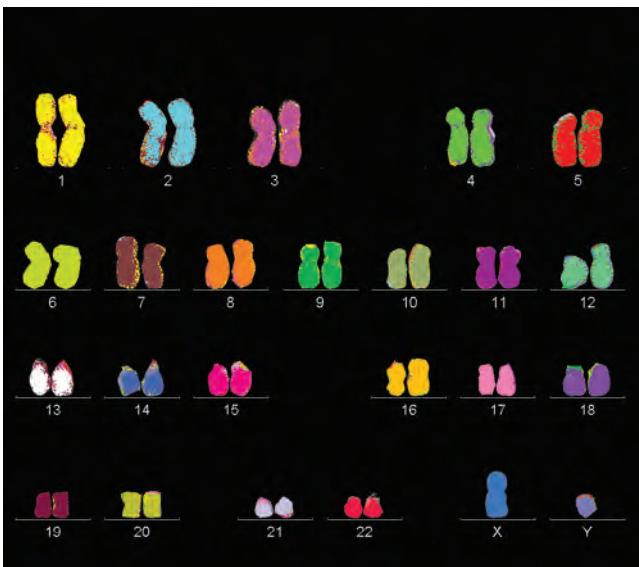
**PHOTO B. Breast cancer cell.**

Source: Science Source/Photo Researchers/First Light.



are called **tumours**. Early detection of tumours is crucial for the survival of cancer patients, as tumours may quickly spread or **metastasize** to other locations of the body.

A **karyotype** is an orderly display of chromosomes. A normal human karyotype shows 46 chromosomes composed of 22 pairs of autosomes (non-sex chromosomes) and 1 pair of sex chromosomes: XX for a female and XY for a male. Cancer cells display an **aneuploid** condition in which there are abnormal numbers of specific chromosomes. Karyotypes of cancer cells display numerous aberrations in chromosomal structure.

**PHOTO C. Karyotypes of a normal human cell and a breast cancer tumour cell.**

Source: Courtesy of Peter H. Duesberg, University of California, Berkeley.

## Investigation: Working to Cure Cancer

Imagine that you are a member of a Canadian cancer research team focused on the goal of curing cancer. In this case study, you will expand on your understanding of cancer-related concepts. You are encouraged to apply your research skills to obtain knowledge in order to design, evaluate, analyze, apply, interpret, and identify promising areas for cancer-related research. Suggested areas of research include the following: tumour suppressors, proteins (molecular biology); cell cycle checkpoints (cellular biology); karyotypes (cellular biology); xeroderma pigmentosum (genetics); discodermolide (evolutionary biology); and such anticancer extracts as vincristine (rosy periwinkle) and Taxol (Pacific yew tree) (population ecology and conservation biology). Other topics of study include thalidomide, liposomal nanomedicines, radiation therapy, dysfunctional DNA repair mechanisms, environmental factors (i.e., social, stress, exercise, nutrition) and their linkages with cancer, and stem cell research. By conducting this investigation, you will gain a greater understanding of cancer research and an appreciation of the complex, holistic nature of its integrated components.

### Critical Thinking Questions

As a suggested research plan, you should assess and explore the following three questions:

1. Why should we study cancer?
2. Is it possible to find a single cure for all cancers?
3. What areas of biology should be investigated to discover how to cure cancer?

### Individual Student Activity

Consider the following scenario. Consult additional sources (e.g., journal articles, textbooks, and websites) to perform the actions requested.

You are in charge of a Canadian research team that is working to discover how to cure cancer and how to improve the current strategies for treating cancers. Use your vast knowledge of biology and cancer to propose specific areas that should be investigated for future experiments. Carefully explain the reasoning behind your proposed research topics, assessing and justifying the areas of research you want to pursue for your large research team and the international researchers with whom you will be collaborating. Evaluate the research topics that will also effectively meet your personal goals. Formulate the areas and topics that you will consider, and describe how you will prioritize those areas and topics for your research team.

### Student Group Activity

Consider the following scenario. Consult additional sources (e.g., journal articles, textbooks, and websites) to perform the actions requested.

Your group is part of a Canadian research initiative that is working to discover how to cure cancer and how to improve the current strategies for treating cancers. Use your group's vast knowledge of biology and cancer to propose specific areas that should be investigated in current and future research initiatives. Explain the reasoning behind your proposed topics. Given that you are working as a team, you will have to debate among yourselves as to which research path is the most practical and beneficial to follow. Formulate a summary of your discussions, and record it as a typed report.

## References and Further Reading

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## Some Useful Websites

3D Medical Animation—What Is Cancer? (on YouTube): <http://www.youtube.com/watch?v=LEpTTtolebqo>

This video is an excellent three-dimensional medical animation of the processes related to cancer.

American Cancer Society: <http://www.cancer.org/>

The American Cancer Society is a national organization that provides cancer-related information for patients, families, friends, survivors, caregivers, health information seekers, professionals, donors, and volunteers.

The Angels of Hope: <http://www.angelssofhope.net/index.html>

This website contains information related to various types of cancer for patients and caregivers.

Canadian Cancer Society: <http://www.cancer.ca/>

The Canadian Cancer Society is a nationwide, community-based organization of volunteers whose mission is the eradication of cancer and the enhancement of the quality of life of people living with cancer.

Cancer Cells vs. Healthy Cells (on YouTube): <http://www.youtube.com/watch?v=tjNxBH1qsRM&feature=related>

This interesting animation highlights the differences between abnormal cancer cells and healthy normal cells.

CancerCare: <http://www.cancercare.org/>

The information about cancer treatments and care on this website is for patients and caregivers.

The Cell Cycle: [http://www.cellsalive.com/cell\\_cycle.htm](http://www.cellsalive.com/cell_cycle.htm)

Cell cycle checkpoints are described in this interactive website.

Chronic Myeloid (Myelogenous) Leukemia (on YouTube): <http://www.youtube.com/watch?v=NdRMAhZZTmE>

This video describes the condition of chronic myelogenous leukemia.

Cold Spring Harbor Laboratory: <http://www.cshl.org/public/overviews/cancer.html>

This site provides a comprehensive summary of cancer-related research.

Drug Discovery for Anti-Cancer Compounds: <http://www.fau.edu/hboi/MarineDrugDiscovery/MDDanticancer.php>

This website describes anticancer drugs.

Human Chromosomes Karyotyping and Karyotyping Analysis (on YouTube): <http://www.youtube.com/watch?v=F7trv8c3Vlo>

This video displays the use of karyotype analyses for genetic testing.

Juravinski Cancer Institute: <http://jcc.hhsc.ca/>

This excellent website is connected to the cancer institute in Hamilton, Ontario.

Metastasis (on YouTube): [http://www.youtube.com/watch?v=rrMq8uA\\_6iA&feature=related](http://www.youtube.com/watch?v=rrMq8uA_6iA&feature=related)

This movie describes the spread of cancer from its original site to other locations in the body via the process of metastasis.

National Cancer Institute (NCI): <http://www.nci.nih.gov/>

This site compiles several cancer-related resources, including cancer topics, clinical trials, cancer statistics, research, and news.

Nature (Cancer): <http://www.nature.com/cancer/index.html>

This website provides access to peer-reviewed journal articles covering the fields of cancer-related research.

Nature Reviews Cancer: <http://www.nature.com/nrc/index.html>

This website provides access to reviews (i.e., compilations of several studies) related to cancer.

Retinoblastoma International: <http://www.retinoblastoma.net>

This site provides information related to retinoblastoma, which is the growth of tumours in the retina of the eye.

You are especially encouraged to use e-portals, such as the one listed below, to access primary scientific literature:

MEDLINE PubMed <http://www.ncbi.nlm.nih.gov/pubmed/>

PubMed provides access to journal articles related to cancer-research topics.