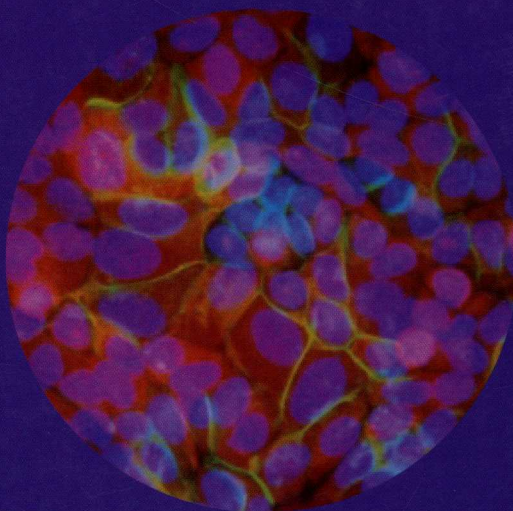
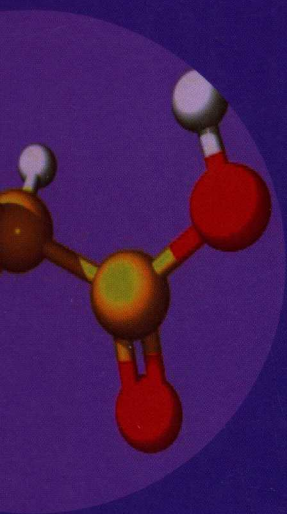


Craig A. Almeida and Sheila A. Barry

# cancer

basic science and clinical aspects



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# **Cancer: Basic Science and Clinical Aspects**

**Craig A. Almeida and Sheila A. Barry**

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Massachusetts, USA



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## Cancer

I am indebted to Kevin, my parents, brothers, and sisters for their unconditional love, support, and understanding, especially through the process of writing this book.

Craig A. Almeida

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Sheila A. Barry

This book is accompanied by a companion website:  
[www.wiley.com/go/almeida/cancer](http://www.wiley.com/go/almeida/cancer)



# Preface

We have authored a textbook on cancer that is unique in its coverage in a number of respects. This book stands out from others because it is written for both nonscience and science majors. The coverage spans the spectrum from the molecular, cellular, and genetic through to the applied aspects of the disease. The book has been structured so that it will be an appropriate text for use by an instructor regardless of the depth to which he/she desires to cover any of the material. The amount of material is manageable within a single semester, and individual chapters can be excerpted for study on each of the major cancers.

We believe this book is appropriate for cancer courses offered to either science or nonscience majors at any level. A target audience with such a variant science background is accommodated by a series of introductory chapters that provide the molecular, cellular, and genetic information needed to comprehend the material of the subsequent chapters. A reader without a science background could study the chapter on breast cancer and learn the risk factors, symptoms, diagnostic testing, and treatment methods without being overwhelmed. If after reading about the risks associated with the *BRCA1* and 2 genes, a student wants a better understanding of what a gene is, he or she could then refer back to the appropriate section of one of the introductory chapters. This cross-referencing ability is what we feel is the basis for the success of the text from the perspectives of both student and instructor. The introductory chapters can be used by lower or upper class science majors to review foundational information.

The chapters of the book are grouped into two sections. The first seven chapters contain introductory information that will be most helpful to the nonscientist while serving as a review for the scientist in training. The second section contains nine chapters, each focusing on a specific form of cancer in areas such as risk factors, diagnostic and treatment methods, and relevant current research. Each of the chapters includes review questions as marginal insertions at points through the text, key words/terms in bold in the text, boxed articles highlighting stories of an individual's experience, and complex questions in the section "Expand your knowledge" for the student to answer with some additional reading.

We have taught an undergraduate biology of cancer course open to all majors since the fall of 2005. The organization of the book reflects the format that we have used successfully when teaching the course. Since this text is intended for use in either a nonscience or science course, it addresses a wide range of issues associated with cancer. Depending on each course design, it could be either an elective or satisfy a requirement within a general education program or a natural science or allied health major. One of the major strengths of the book is that it can be used in any level undergraduate course. There are no specific prerequisites assumed; the information in the introductory chapters is sufficient to bring the non-scientist to the level needed to read and understand the later chapters. The ultimate intent of the book is to have appeal to students who are either at the beginning or intermediate stages of scientific inquiry into the study of cancer.

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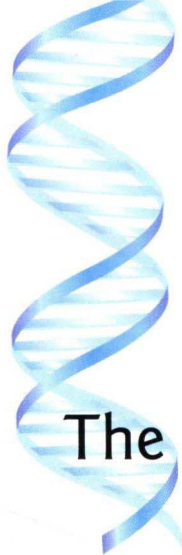
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# The basics of cancer

If the three worst words are, 'You have cancer', then the four worst are 'Your cancer is back'.

Katie Couric, American newscaster and journalist

## CHAPTER CONTENTS

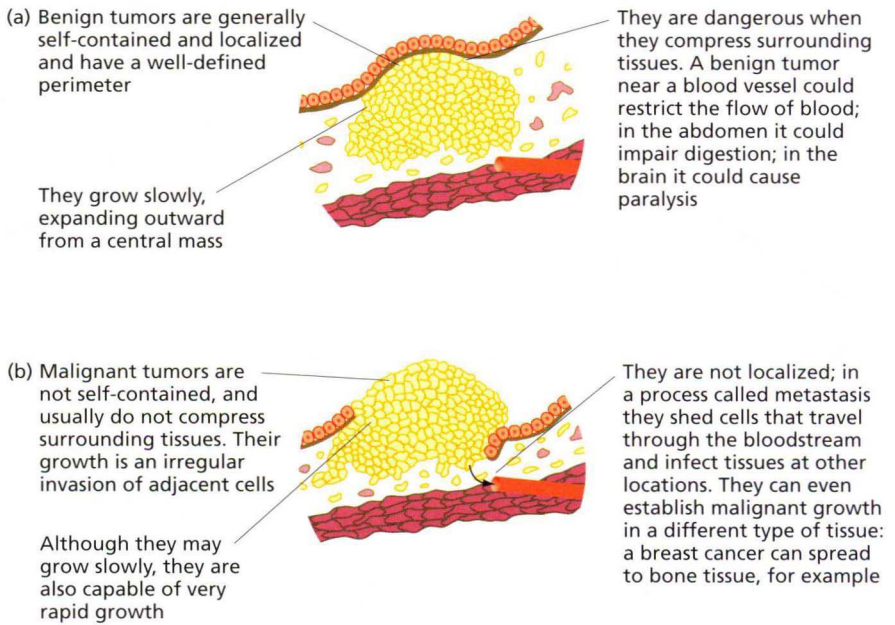
- Cancer is a complex entity
- Cancer through the ages
- Modern day cancer research and treatment
- Prevalence and mortality varies with each cancer
- Risk factors have been identified
- Will cancer be conquered within our lifetime?
- Expand your knowledge
- Additional readings

Very little strikes more fear into peoples' hearts than being told they have cancer. Such a diagnosis can turn a person's world upside down and conjure up thoughts of what lies ahead: pain, disfigurement, disability, nausea, hair loss, or even death. Recent years, however, have seen extraordinary advances in basic cancer research and in the development of more effective methods for the detection, diagnosis, and treatment of cancer. Consequently, while the phrase "You have cancer," may be life-altering, it is not necessarily the devastating, life-threatening diagnosis of generations past.

## CANCER IS A COMPLEX ENTITY

In the most basic sense, cancer is the abnormal, uncontrolled growth of previously normal cells. The transformation of a cell results from alterations to its DNA that accumulate over time. The change in the genetic information causes a cell to no longer carry out its functions properly. A





**Figure 1.1** Benign vs. malignant cancers. (a) A benign tumor is a mass of cells that remains within the tissue in which it originally developed. (b) The invasion of cancer cells into surrounding tissues is the hallmark of a malignant tumor. Malignant cells may break free from the tumor and travel to other locations in the body through the process of metastasis. Source: <http://health.stateuniversity.com/pages/1580/Tumor-Removal.html>

primary characteristic of cancer cells is their ability to rapidly divide, and the resulting accumulation of cancer cells is termed a **tumor**. As the tumor grows and if it does not invade the surrounding tissues, it is referred to as being **benign** (Figure 1.1a). If, however, the tumor has spread to nearby or distant tissues then it is classified as **malignant** (Figure 1.1b).

**Metastasis** is the breaking free of cancer cells from the original primary tumor and their migration to either local or distant locations in the body where they will divide and form secondary tumors.

**Do benign or malignant cells form metastatic tumors?**

### There are many types of cancer

Cancer is not a single disease; there are over 100 identified types, all with different causes and symptoms. To distinguish one form from another the cancers are named according to the part of the body in which they originate. Some tumors are identified to reflect the type of tissues they arise from, with the suffix *-oma*, meaning tumor, added on. For example, *myelos-* is a Greek term for marrow. Thus, myeloma is a tumor of the bone

marrow, whereas hepatoma is liver cancer (*hepato-* = liver), and melanoma is a cancer of melanocytes, cells found primarily in the skin that produce the pigment melanin. (Table 1.1)

### There are four predominant types of cancer

The four major types of cancer are carcinomas, sarcomas, leukemias, and lymphomas. Approximately 90% of human cancers are **carcinomas**, which arise in the skin or epithelium (outer lining of cells) of the internal organs, glands, and body cavities. Tissues that commonly give rise to carcinomas are breast, colorectal, lung, prostate, and skin. **Sarcomas** are less common than carcinomas and involve the transformation of cells in connective tissue such as cartilage, bone, muscle, or fat. There are a variety of sarcoma subtypes and they can develop in any part of the body, but most often arise in the arms or legs. Liposarcoma is a malignant tumor of fat tissue (*lipo-* = fat) whereas a sarcoma that originates in the bone is called osteosarcoma (*oste-* = bone).

**What is the difference between the terms hepatoma and hepatocarcinoma?**

Certain forms of cancer do not form solid tumors. For example, **leukemias** are cancers of the bone marrow, which leads to the overproduction and early release of immature leukocytes (white blood cells). **Lymphomas** are cancers of the lymphatic system. This system, which is a component of the body's immune defense, consisting of lymph, lymph vessels, and lymph nodes, serves as a filtering system for the blood and tissues.

### Each cancer is unique

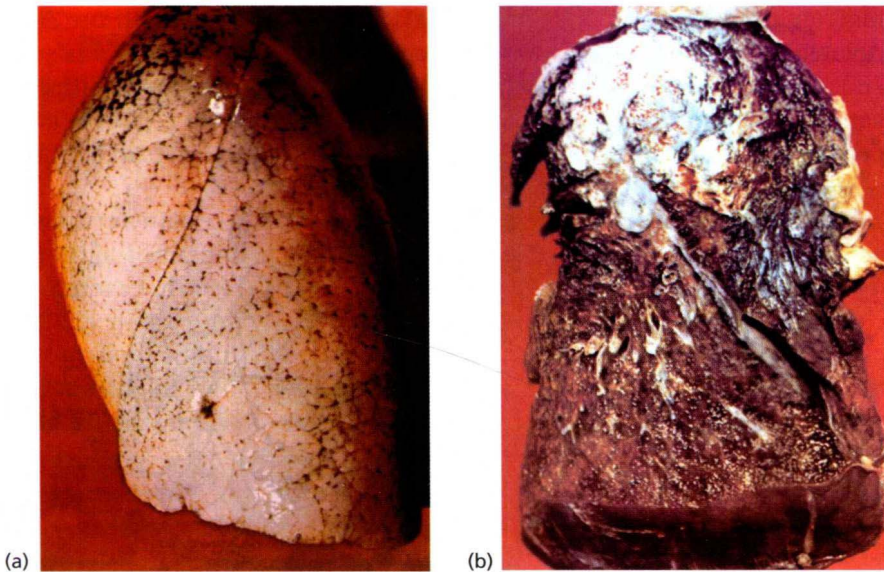
While there are certain commonalities shared by cancers of a particular type, each may be unique to a single individual. This is because of different cellular mutations that are possible, and can depend on whether the disease is detected at an early or advanced stage. As a result, two women diagnosed with breast cancer may or may not receive the same treatment. The impact of the disease on the individual, as well as the final outcome of the disease, is unique in every case. Still, several types of cancers can have a similar set of symptoms, which may be shared with several other conditions, making screening, detection, and diagnosis a complex problem.

A tumor can impact the function of the tissue in which it resides or those in the surrounding areas. Tumors provide no useful function themselves and may be considered "parasites," with every step of their advance being at the expense of healthy tissue (Figure 1.2). While most types of cancers form tumors, many do not form discrete masses. As previously stated, leukemia is a cancer of the blood that does not produce a tumor, but rather rapidly produces abnormal blood cells in the bone marrow at the expense of normal blood cells.



Table 1.1 Tumor terminology

Prefix	Cell type	Benign tumor	Malignant tumor	Tissue affected
<i>Tumors of epithelial cells:</i>				
Adeno-	Gland	Adenoma	Adenocarcinoma	Breast, colon/rectum, lung, ovary, pancreas, prostate
Basal cell	Basal cell	Basal cell adenoma	Basal cell carcinoma	Skin
Squamous cell	Squamous cell	Keratoacanthoma	Squamous cell carcinoma	Esophagus, larynx, lung, oral cavity, pharynx, skin, cervix
Melano-	Pigmented cell	Mole	Melanoma	Skin
<i>Tumors of supporting tissue origin:</i>				
Hemangio-	Blood vessels	Hemangioma	Hemangiosarcoma	Blood vessels
Lipo-	Fat	Lipoma	Liposarcoma	Fat cells
Meningio-	Meninges	Meningioma	Meningiosarcoma	Brain
Myo-	Muscle	Myoma	Myosarcoma	Muscle
Osteo-	Bone	Osteoma	Osteosarcoma	Bone
<i>Cancers of blood and lymphatic origin:</i>				
Lympho-	Lymphocyte		Lymphoma Lymphocytic leukemia	Lymphocytes
Myelo-	Bone marrow		Myeloma, Myelogenous leukemia	Granulocytes



**Figure 1.2** (a) Healthy lung and (b) cancerous lung. Reprinted with permission © American Lung Association. For more information about the American Lung Association or to support the work it does, call 1-800-LUNG-USA (1-800-586-4872 or log on to [www.lungusa.org](http://www.lungusa.org))

## The development of tumors

All tumors begin with mutations (changes) that accumulate in the DNA (genetic information) of a single cell causing it and its offspring to function abnormally. DNA alterations can be sporadic or inherited. **Sporadic mutations** occur spontaneously during the lifespan of a cell for a number of reasons: a consequence of a mistake made when a cell copies its DNA prior to dividing, the incorrect repair of a damaged DNA molecule, or chemical modification of the DNA, each of which interferes with expression of the genetic information. **Inherited mutations** are present in the DNA contributed by the sperm and/or egg at the moment of conception. To date, 90–95% of diagnosed cancers appear to be sporadic in nature and thus have no heredity basis. Whether the mutations that result in a cancer are sporadic or inherited, certain genes are altered that negatively affect the function of the cells.

## Genetic influence on tumors

A link between a particular genetic mutation and one or more types of cancers is made by analyzing and comparing the DNA of malignant tissue samples obtained from patients and members of families with a high incidence of a particular cancer and comparing it to the DNA from healthy