Cancer: Basic Science and Clinical Aspects

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Department of Biology, Stonehill College, Easton, Massachusetts, USA

WILEY-BLACKWELL

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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

This book could not have been made possible without the continuing love and support of my husband Richard and children Janine and Craig, all of whom were eternally patient and encouraging of this effort.

Sheila A. Barry

This book is accompanied by a companion website:
www.wiley.com/go/almeida/cancer

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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 nonscientist 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.

Acknowledgments

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A special appreciation goes to all of the students who have taken our biology of cancer course, for their subtle and unknowing influences can be found in the organization, content and pedagogy of this book.

1 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

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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

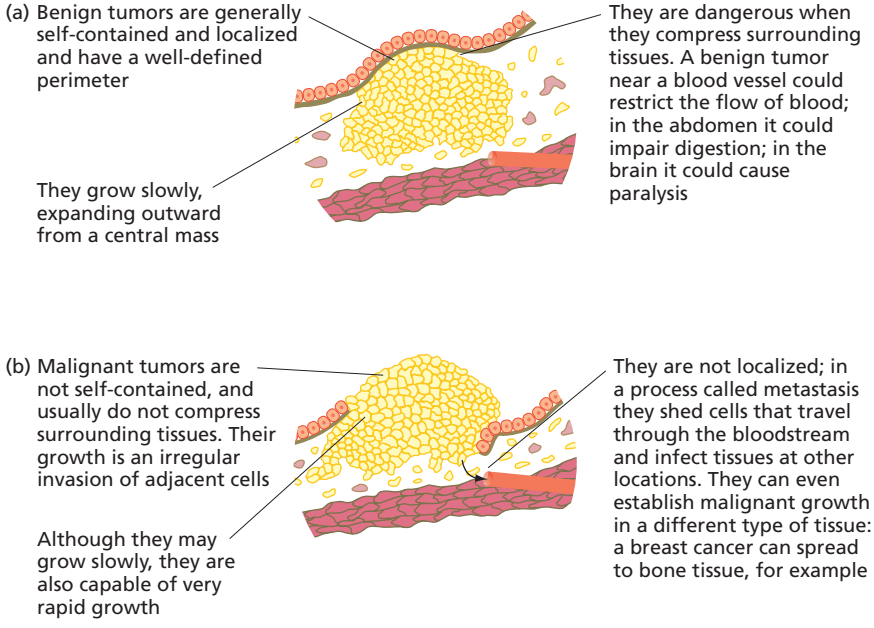

Figure 1.1 Benign vs. malignant cancers. (a) A benign tumor is a mass of cells that remains within the tissue in which it originally developed. (b) The invasion of cancer cells into surrounding tissues is the hallmark of a malignant tumor. Malignant cells may break free from the tumor and travel to other 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 (osteo- = 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
Tumors of epithelial cells:				
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
Tumors of supporting tissue origin:				
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 Ewing's sarcoma	Bone
Cancers of blood and lymphatic origin:				
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)

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

individuals. For example, a study could be conducted in which the DNA isolated from tumor cells obtained from liver cancer patients is analyzed and determined to possess certain versions of genes whereas different versions of those same genes are present in the DNA of liver cells of healthy persons. An association could then be drawn between the "bad" versions of those genes and liver cancer.

This type of analysis has been crucial in identifying certain versions of genes associated with a predisposition for the development of particular forms of cancer. For example, studies have demonstrated that there is an elevated risk of breast or ovarian cancer associated with certain versions of the BRCA1 and/or BRCA2 genes (Chapter 8). Another example is retinoblastoma, a rare tumor of the eye typically found in infants and young children, which is associated with alterations within the Rb gene (Chapter 4).

CANCER THROUGH THE AGES

Although not specifically identified as such, cancer has been known for many centuries. In fact, there is evidence of tumors in the bones of five thousand year old mummies from Egypt and Peru. The disease itself was not very common, nor explored or understood, because in ancient times fatal infectious diseases resulted in shorter lifespans. Given that the vast majority of cancers are sporadic, there was less opportunity for the accumulation of the mutations necessary to transform normal cells into cancerous ones.

The word "cancer" was first introduced by Hippocrates (460–370 BC), the Greek physician and "father of medicine" (Figure 1.3). He coined the term carcinoma, from the Greek word *karcinos*, meaning "crab," when describing tumors. This is because tumors often have a central cell mass with extensions radiating outward that mimic the shape of the shellfish (Figure 1.4).

Hippocrates believed that the body contained four "humors" or body fluids, and that each fluid was associated with a specific personality or temperament characteristic. "Blood" persons had a sanguine or optimistic personality with a passionate, joyous disposition. Someone with a dull or sluggish temperament would have "Phlegm." Possessing "Yellow Bile" meant that one was quick to anger, while having "Black Bile" indicated a person was melancholic or depressed. In medieval times, it was believed that disease was a result of an imbalance of any of the four humors and physicians could restore health or harmony by purging, starving, vomiting, or bloodletting. In particular, an excess of black bile was thought to be the primary cause of cancer. This theory was accepted and taught for over 1300 years through the Middle Ages and championed by Claudius Galen (131–201 AD), a Greek physician and writer who described many diseases using this hypothesis (Figure 1.5). Both Hippocrates and Galen defined disease as a natural process, a theory that remained for centuries.

Figure 1.3 Hippocrates is history's most famous physician.

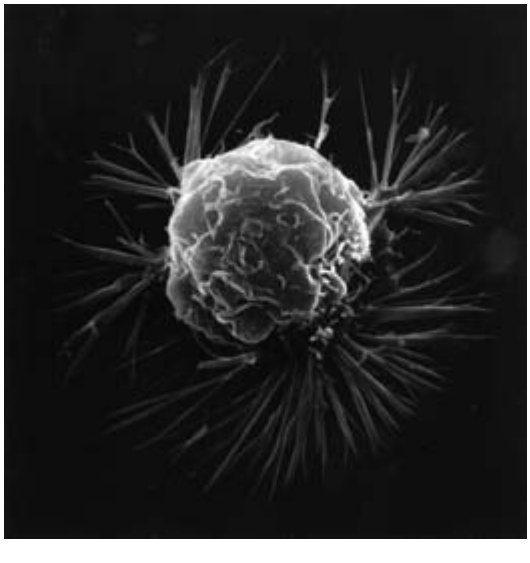

Figure 1.4 A cancer cell that has extensions extending out from the central body of the cell. Source: National Cancer Institute Visuals Online; http://visualsonline.cancer.gov/

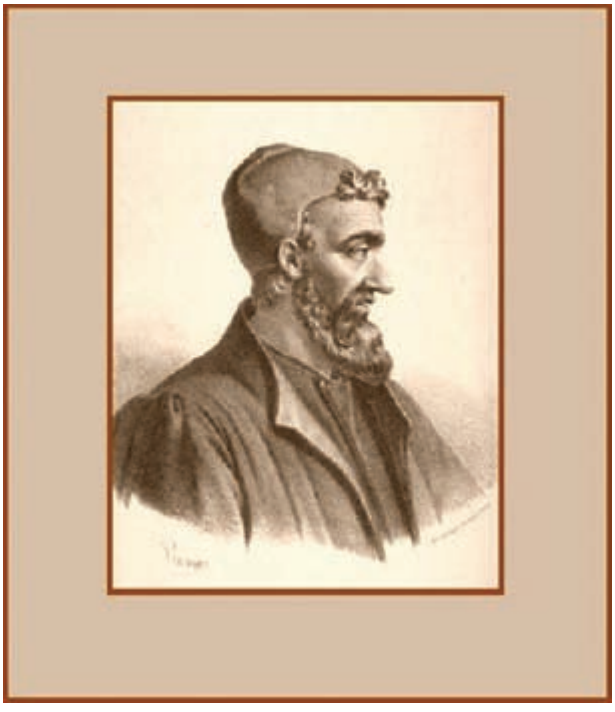

Figure 1.5 Claudius Galen is considered by some to be the second most important contributor to medicine, after Hippocrates, in ancient times.

Box 1.1

Bloodletting as a medical practice

Interestingly, bloodletting is a method used in modern medical practice. The FDA formally approved the use of leeches as medical devices in June 2004. The invertebrate bloodsuckers are most often used following reconstructive surgery for the reattachment of fingers and toes to remove the excess blood that accumulates from severely damaged blood vessels. Since pooled blood often inhibits the healing of wounded tissues, the leeches' ability to extract it is beneficial and efficient. Hirudin is an effective anti-blood clotting agent present in the saliva of the leech that keeps the blood flowing, giving time for the vessels and tissues to heal. Although it seems as if leech therapy would be painful, it is not thanks to a mild anesthetic the leeches produce.

The use of autopsies is very significant to medical discoveries

Unfortunately, during the Middle Ages the dissection of cadavers was largely prohibited for religious reasons, or yielded little data when conducted at all, due to its primitive nature. The failure to recognize the benefits of studying cadavers, or the understandable ignorance of the times, arguably delayed the progress of medical science. As a result, one of medicine's most informative research tools, dissection of cadavers, was largely ignored.

The English physician William Harvey (1578–1657) is credited with conducting the first examples of postmortem (after death) analysis (Figure 1.6). Although rare and certainly unscientific by modern standards, his "public dissections" are now known as autopsies. Giovanni Morgagni (1682–1771), an Italian physician, is considered the founder of pathological anatomy (Figure 1.7). In 1761, at the age of 79, he published a book describing nearly 700 autopsies that he had performed associating a patient's cause of death to the pathological findings made postmortem. His work was a far cry from the theory of "humors" that had previously existed and laid the foundation for the serious study of cancer as a cause of morbidity (disease) and mortality (death).

Figure 1.6 William Harvey was the first, as a result of performing many autopsies, to demonstrate that the heart pumped the blood around the body through arteries and veins.

Figure 1.7 Giovanni Morgagni performed hundreds of autopsies in the 1700s, leading to verification of cancer as a cause of death.

Early discovery of carcinogens

Also published in 1761 was a paper by John Hill, an English physician. In it he made the first causal link between substances in the environment and cancer when he described a relationship between tobacco snuff and nasal cancer. This brought about the awareness of **carcinogens** (chemical agents that have been demonstrated to cause cancer). In 1775, the English surgeon Sir Percivall Pott observed and noted a high rate of scrotal cancer among chimney sweepers. He postulated that it was caused by long-term exposure to the chemicals in the soot-soaked ropes worn as harnesses. His research led to studies that associated particular occupations with an increased risk of developing specific forms of cancer – the forerunner to the field of **public health** and cancer.

The use of microscopes demonstrated changes at a cellular level

The development of improved microscopes in the late nineteenth century allowed for more thorough examinations of cells and their activities than was previously possible. It was realized that cancer cells were different

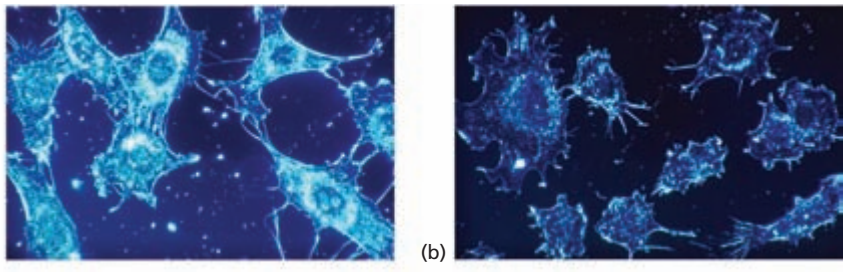

Figure 1.8 (a) Note the abundance of the thin, sheet-like extensions from the cell bodies of the healthy cells. (b) Note the rounded appearance of the cancer cells. Source: National Cancer Institute Visuals Online; http://visualsonline.cancer.gov/

in both appearance and behavior from normal cells within the same tissue or organ (Figure 1.8). Early twentieth century accomplishments in the development of cell culture (an *in vitro* technique for studying the activity of cells in an **organism** under simulated physiological conditions[1.1]), new and improved diagnostic techniques, the discovery of chemical carcinogens, and the use of **chemotherapy** (powerful anticancer drugs) all had significant impacts upon the understanding and treatment of cancer.

[1.1] The term *in vitro* is Latin for "in glass" meaning that an experiment is being conducted in an artificial environment, such as a glass test tube. The complementary Latin term *in vivo* means "in life," implying that something is occurring in a living organism.

MODERN DAY CANCER RESEARCH AND TREATMENT

The radioactive element radium, isolated by Marie and Pierre Curie in 1898, was found to be effective in the treatment of tumors in 1903. While both healthy and cancerous cells are susceptible to the damage caused by X-rays, cancer cells are inherently less able to repair the damage and recover. Once safe dosage levels were determined, **radiation therapy** became a standard form of treatment for many cancers.

Public awareness of cancer

As the access to scientific knowledge increased, so too did the public's fear and misconceptions. In the early 1900s the word "cancer" was rarely spoken in public and it was omitted from obituaries, similar to how the use of the word AIDS was avoided in the 1980s and 1990s. Surprisingly, the first widely published discussion of cancer was a 1913 *Ladies Home Journal* magazine article that asked "What Can We Do About Cancer?" and listed the disease's principal warning signs. With its large circulation,

the magazine brought the word "cancer" to the forefront of public awareness and discussion. That same year in New York City, a group of ten physicians and five laypeople established the American Society for the Control of Cancer (ASCC). The group raised $10,000 that year, and published a pamphlet titled *The Facts About Cancer*. In 1945 the ASCC changed its name and to this day is known as the American Cancer Society (ACS). The following year, volunteer Mary Lasker and her colleagues raised over $4 million, an extraordinary amount at that time and even today, for the Society. Of that sum, $1 million was allocated to establish the Society's cancer research program. In 1947 the ACS initiated its public education campaign concentrating on "The seven signs and symptoms of cancer," utilizing the word "Caution" as a way to remember the first letter of each symptom:

- Change in bowel or bladder habits.
- A sore that does not heal.
- Unusual bleeding or discharge.
- Thickening or a lump in the breast or other parts of the body.
- Indigestion that is chronic or difficulty in swallowing.
- Obvious changes in a wart or mole.
- Nagging cough or hoarseness.

Although currently outdated due to its lack of specificity and discontinued in the 1980s, the campaign served to provide enormous awareness among people who, for the first time, were encouraged to be aware of and on the lookout for possible signs and symptoms of cancer.

Unexpected discoveries result in some cures

The first clinical use of a dramatic new form of cancer treatment – **chemotherapy** – occurred in the 1940s. Soldiers in World War I who were exposed to the chemical warfare agent known as mustard gas would develop painful blisters on their skin and eyes. If the gas was inhaled, their ability to breathe was severely compromised because the gas would destroy the mucous linings of their lungs. It was noted that those who survived an attack developed low white blood cell counts. This led researchers to question whether mustard gas or a derivative of it could be used to treat certain cancers that affect white blood cells.

Shortly after World War II, a clinical study determined that the injection (rather than inhalation) of the principal component of mustard gas caused the temporary remission of lymphoma, a type of white blood cell cancer.[1.2] As is commonly done when a molecule demonstrates potential

[1.2] The use of chemicals as weapons was considered so horrific and inhumane that it was outlawed by an international chemical weapons convention treaty in 1997. What is significant is that the evil use of chemical warfare against people gave rise to the beneficial practice of chemotherapy in the war against cancer.

clinical effectiveness, a large number of chemical variants were synthesized in an attempt to lessen the highly reactive nature of the original mustard gas compound while retaining, and eventually improving upon, its desired function.

The synthesis and testing of literally hundreds of molecules in animal and human trials have led to several of them becoming conventional cancer treatment regimens. Serendipitous findings similar to those associated with mustard gas tend to occur often in scientific discoveries and are examples of some good coming from an unfortunate event.

Another milestone came in 1947 when Dr Sidney Farber of the Harvard Medical School treated children with acute leukemia, another form of white blood cell cancer, with the drug aminopterin. The drug blocked the synthesis of nucleotides, the building blocks of DNA. This effectively inhibited the division of the cancer cells because they were unable to replicate their DNA and the children entered into a cancer-free state of remission. Even though the remission period was only temporary, Dr Farber is credited with the first successful use of chemotherapy.

Government funding was/is necessary

The National Cancer Institute Act was passed by the US Congress in 1937, creating the National Cancer Institute (NCI), with the goal of conducting

Box 1.2

The Legacy of Henrietta Lacks

Henrietta Lacks died of cervical cancer in 1951 at the age of 31 at Johns Hopkins University Hospital in Baltimore, Maryland. She might have long been forgotten by all except her family and friends. Instead, she lives on in the form of highly malignant cells taken from the quarter-sized tumor that was removed from her cervix and that eventually invaded almost every organ of her body. Laboratories and research centers worldwide have been using these cells for many years. Given the code name HeLa, for the first two letters of her first and last names, these were the first human cells known to thrive and multiply outside of the body. Still alive and rapidly dividing to this day, HeLa cells have been used in the development of the polio vaccine, the search for causes of cancer and a cure for leukemia, the study of the growth of viruses, the mechanisms that control the expression of our genetic information, and the effects of drugs and radiation on cellular functions. Henrietta's cells grow aggressively, producing an entirely new generation of cells every 24 hours. Unfortunately, at the time of her death and for years after, there was no system of "**informed consent**" in medical research, so it took many years for her family to discover the impact that she has had on science.

and promoting cancer research. In 1971, President Richard M. Nixon signed the National Cancer Act, legislation that provided federal funds for cancer research to fight the disease. This Act infused money and authority into the NCI in order to more effectively carry out the national effort to understand and fight cancer. Thus the phrase "War on Cancer" was born. After more than three decades the war remains ongoing, although great strides occur almost daily.

The field of oncology was born

One primary outcome of the research and focus on cancer has been the establishment of the field of **oncology**, the medical subspecialty dealing with the study and treatment of cancer. Previously, primarily family physicians treated people diagnosed with cancer and followed their care throughout their illnesses. If a woman developed the disease she might have been treated by her gynecologist, a doctor who specializes in female medical issues and who did not have extensive cancer training. The body of knowledge physicians had to work with was limited, to say the least. Only 51 physicians attended the first meeting of the American Society of Clinical Oncology in 1964. Today the organization comprises more than 25,000 members representing the principal oncology disciplines (medical, radiological, and surgical) as well as several subspecialties (geriatric oncology, pediatric oncology, gastrointestinal oncology, etc.). Government funding and private research spurred by charitable giving and the tireless support of groups such as the American Cancer Society, St Jude Children's Research Hospital, and the Boston-based Jimmy Fund have helped to raise cancer awareness. Unfortunately, as aging baby boomers become increasingly cancer-prone, medical schools cannot train enough new oncologists to satisfy the need for them. A 2007 report by the Association of American Medical Colleges estimates that by 2020, visits to oncologists will increase by 48% while the projected number of oncologists is estimated to grow by only 14% over the same time period. It is hoped that medical schools will acknowledge this shortage and address the issue by taking an active role in recruiting a greater number of future oncologists.

Currently, there are a wide variety of methods to diagnose and treat cancer. The ones used are dependent upon the type of cancer and its current stage and location within the body. Genetic links to the disease are being discovered at a rapid pace, enabling physicians to identify those patients who have a predisposition for the development of specific cancers or will respond best to certain forms of treatment. It is hoped that this knowledge will encourage people to be more diligent in maintaining healthy lifestyles and be more consistent in following recommendations for regular screening tests. Some treatments will be personalized based on one's genetic make-up and/or the specific genetic make-up of the tumor.

While not all treatment options offer a "cure," they enable a large number of individuals to manage their disease and live fairly normal and full lives.

The field of oncology is evolving and expanding, with research articles being published almost weekly announcing links between certain versions of genes and the risk for the development of a particular form of cancer, methods to either reduce certain cancer risks or detect the disease at an earlier stage, and treatment options that are more effective and increase the chance for survival. Media reports are often based on a single study, and they are designed so as to have a "wow!" factor that will garner maximum public attention. As a result, one must be able to differentiate between a reputable study and a report that is not scientifically valid, and learn to distinguish hype from reality. All too frequently, today's established protocols are challenged by tomorrow's newest discoveries. For this reason, the integrity and accuracy of new research findings must withstand the test of time and be constantly questioned and reviewed.

PREVALENCE AND MORTALITY VARIES WITH EACH CANCER

Unfortunately, most of us know or will know someone who has been diagnosed with cancer. In 2008 an estimated 1.4 million Americans were newly diagnosed with cancer and approximately 565,000 died from the disease (Table 1.2). This ACS estimate does not include two forms of cancer. The first are those classified as carcinoma ***in situ*** (in the original site), which are more commonly known as benign tumors. They are confined and have not invaded surrounding tissues. An exception to this rule is carcinoma *in situ* of the urinary bladder which is reported because of its tendency to aggressively grow and progress to a malignant state. The second form consists of **nonmelanomas** or **basal** and **squamous cell skin cancers**, which are the most common forms of skin cancer with over one million new cases per year. Because these skin cancers rarely spread and are not life threatening, they are routinely removed and treated on an outpatient basis in nonhospital settings and, as such, are rarely reported to cancer registries.

Cancer rates are different for men and women

For men, the five most prevalent cancers, in decreasing order, are prostate, lung and bronchus, colorectal, urinary bladder, and skin melanoma. The most commonly diagnosed cancers in women are breast, lung and bronchus, colorectal, non-Hodgkin's lymphoma, and skin melanoma. Lung and bronchus, colorectal, and pancreatic cancers are among the top five most fatal forms of the disease in both men and women. Ironically, the number one cancer killer for both men and women, lung and bronchus,

Table 1.2 Estimated new cancer cases and deaths by sex, USA, 2008*

	Estimated new cases			Estimated deaths		
	Both sexes	Male	Female	Both sexes	Male	Female
All sites	1,437,180	745,180	692,000	565,650	294,120	271,530
Oral cavity and pharynx	35,310	25,310	10,000	7,590	5,210	2,380
Tongue	10,140	7,280	2,860	1,880	1,210	670
Mouth	10,820	6,590	4,230	1,840	1,120	720
Pharynx	12,410	10,060	2,350	2,200	1,620	580
Other oral cavity	1,940	1,380	560	1,670	1,260	410
Digestive system	271,290	148,560	122,730	135,130	74,850	60,280
Esophagus	16,470	12,970	3,500	14,280	11,250	3,030
Stomach	21,500	13,190	8,310	10,880	6,450	4,430
Small intestine	6,110	3,200	2,910	1,110	580	530
Colon†	108,070	53,760	54,310	49,960	24,260	25,700
Rectum	40,740	23,490	17,250			
Anus, anal canal, and anorectum	5,070	2,020	3,050	680	250	430
Liver and intrahepatic bile duct	21,370	15,190	6,180	18,410	12,570	5,840
Gallbladder and other biliary	9,520	4,500	5,020	3,340	1,250	2,090
Pancreas	37,680	18,770	18,910	34,290	17,500	16,790
Other digestive organs	4,760	1,470	3,290	2,180	740	1,440
Respiratory system	232,270	127,880	104,390	166,280	94,210	72,070
Larynx	12,250	9,680	2,570	3,670	2,910	760
Lung and bronchus	215,020	114,690	100,330	161,840	90,810	71,030
Other respiratory organs	5,000	3,510	1,490	770	490	280
Bones and joints	2,380	1,270	1,110	1,470	820	650
Soft tissue (including heart)	10,390	5,720	4,670	3,680	1,880	1,800
Skin (excluding basal and squamous)	67,720	38,150	29,570	11,200	7,360	3,840
Melanoma	62,480	34,950	27,530	8,420	5,400	3,020
Other non-epithelial skin	5,240	3,200	2,040	2,780	1,960	820
Breast	184,450	1,990	182,460	40,930	450	40,480
Genital system	274,150	195,660	78,490	57,820	29,330	28,490
Uterine cervix	11,070		11,070	3,870		3,870