Human Diseases

Sixth Edition

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Cengage

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***Human Diseases,* Sixth Edition**
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To my husband, Larry Butler, who is now with the Lord, and my son Jeremy Neighbors, his wife Misty, and my grandson Kieran. I love you all very much. Marianne

To my husband, Jim, the quiet, solid, love of my life for over 48 years, and to the other man in my life, my brother Bob Tannehill, who has always loved and supported me, "his younger, little sister." Ruth

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Preface

Allied health professionals are required to be knowledgeable about the common diseases and disorders health care providers see and treat. As the medical field continues to grow and change and new diseases emerge, the need for these careers will continue to expand. This book includes the most current research and reflects the latest practices from actual practice.

Conceptual Approach

Many pathophysiology books have been written to address the informational needs of the medical community, but learners in allied health professional programs require an essential pathophysiology text geared specifically for these programs. *Human Diseases, Sixth Edition* is designed and specifically written for learners in health care programs pursuing careers as allied health professionals, including but not limited to medical assistants, medical coders, surgical technologists, respiratory therapist assistants, physical therapist assistants, radiologic technologists, medical transcriptionists, emergency medical technicians, nursing assistants. The book is intended to meet the needs of learners enrolled in an allied health career program as well as serve as a valuable resource for health care professionals on the job. It is also ideal as a resource on basic diseases by anyone within the medical arena or individuals interested in human diseases. Current information for this book was based on the authors' own experiences and research sought from current literature, books, Internet resources, and physician consultations.

Students will understand this text best if a basic medical terminology or anatomy and physiology course has been completed before this course of study. However, this book is designed to make difficult pathophysiology concepts easier to understand by using a consistent organization, and including pronunciations, boxed features, and full-color illustrations and photos of diseases and disorders. Organized into three units, the book begins with basic concepts of human diseases, introduces common diseases and disorders of the body systems, followed by genetic and developmental, childhood, and mental health diseases and disorders. Chapters progress through a basic review of anatomy and physiology before introducing the most common diseases related to each system and specialty area. Common diseases and disorders for each body system are presented consistently through a description of the disease or disorder, the etiology, symptoms, diagnosis, treatment, and prevention.

Simulated real-world activities provide learners with hands-on experience applying key concepts learned in the chapters into practice.

Several dilemmas immediately emerge when one considers writing a textbook for such a large and diverse audience as the health care field. Questions arise as to how much content to include, what to exclude, how detailed the content should be, and how to organize the content in the most understandable manner. Another common concern is the question of the appropriate reading level.

In an attempt to resolve these dilemmas, it was decided to organize the book in such a way that blocks of material or even entire chapters could be omitted or covered in detail, depending on the format of the course and needs of the learner. At the same time, information on each disease is written in such a way that it can stand alone or be viewed as all inclusive. This concept allows the instructor, learner, or individual to select and study only those specific diseases or individual disease of interest. Not all health conditions are covered in the text, so the conditions chosen to be included are those that are most common, along with the new and emerging diseases. A few rare conditions are also included. Of the conditions chosen for the text, only general information is covered. The text is designed to be a basic overview of common diseases and disorders, not an in-depth study. Thus, the diseases presented are not described on a cellular physiological level, which would be too complex for the intended audience. The intention also was to keep the reading level of the text at an easy-to-read basic level to promote understanding. We did not want to write beneath the level of the learner but, at the same time, felt that a difficult reading level would only increase the complexity of the material and thus fail to promote understanding of the subject matter.

The boxed features within the chapters either add interesting information about staying healthy, present

new research on the chapter topics, or present information about alternative treatments. The pharmacology boxed features list some of the possible medications for diseases or disorders in the chapter. These drugs are listed with generic names only since there are many trade names for the same generic medication. It is not intended to be an exhaustive list of possible medications, but just to give the reader some information about common medications that might be prescribed for certain diseases or disorders reviewed in the chapter. The "Consider This" feature presents interesting facts to engage learners in the material.

Organization of The Text

Human Diseases, Sixth Edition, consists of 21 chapters, two appendices, glossary, index, and bibliography. To gain the most benefit from your use of this text, take advantage of the review questions and case studies that are included at the end of each chapter.

Unit I Chapters

Chapters 1 through 4 lay the foundation for some basic disease concepts, including mechanisms of disease, neoplasms, inflammation, and infection.

Unit II and Unit III Chapters

Unit II includes chapters 5-18 which are organized by body systems and begin with a basic anatomy and physiology review of each system before discussing that system's common diseases and disorders. Included with this discussion, where appropriate, are common signs and symptoms, diagnostic tests, trauma, and rare diseases. In addition, a unique section toward the end of each chapter discusses the effects of aging on each system to help learners understand the natural aging process of the human body.

Unit III includes chapters 19 through 21 on specialty areas covering genetics, childhood diseases, and mental health disorders.

Each disease in Units II and III is broken down (where applicable) into the following sections: Description, Etiology, Symptoms, Diagnosis, Treatment, and Prevention. Although this may appear to be very title-heavy when there is only a sentence or two in each section, this breakdown will assist the learner to clearly identify these components of each disease. It also maintains consistency throughout the textbook.

Appendices and Glossary

Appendix A presents common laboratory values. Appendix B includes metric conversion tables. The glossary includes key terms and their definitions.

New to This Edition

Changes to the sixth edition include:

Changes in All Chapters

Cengage is committed to providing quality and inclusive learning materials. As we adapt our learning materials to the continually evolving areas of inclusion and diversity, the below strategies were adopted for this edition.

- Use age and gender-appropriate terms with the following exceptions:
  - Use the terms male and female when discussing anatomical structures and physiology based on biological sex assignment to ensure alignment of terminology learners see in other scientific courses.
  - Use the terms male(s) and female(s) when referring to different age groups based on biological sex assignment rather than using terms based on various age groups (for example, a disease affects female adolescents, women, and older adult).
- Use terms that appear in ICD-10 coding as diagnosis codes to ensure consistency of the medical language learners are exposed to in the text and will see in actual practice.
- In an effort to keep the text as current as possible, the Glimpse of the Future boxes were eliminated because this content quickly becomes outdated.

Chapter-Specific Changes

Chapter 1

- Added the term healthcare-associated infection (HAI)
- Added material to clarify the difference between an epidemic and a pandemic

Chapter 2

- Updated the list of deaths caused by trauma
- Updated the BMI scale

- Updated Consumer Responsibility in Disease Prevention Healthy Highlight to include COVID-19.
- Added material on comorbidity

Chapter 3

- Updated cancer statistics
- Updated personal risk behaviors for cancer
- Updated material on smoking and tobacco product use
- Updated cancer prevention with the latest recommendations from the American Cancer Society
- Updated the section on diagnosis of cancer
- Added a new Complementary and Alternative Therapy: Kombucha Beverage for Some Forms of Cancer

Chapter 4

- Added a new Healthy Highlight: Emerging Infectious Diseases: How to Stay Healthy

Chapter 5

- Updated the section on common signs and symptoms
- Added a new Healthy Highlight: The Importance of Sleep to the Immune System
- Updated the Pharmacology Highlight with the biologics category
- Added a new Healthy Highlight: There's a Difference Between Food Allergy and Food Intolerance
- Added a new Complementary and Alternative Therapy: How to Boost the Immune System
- Updated the section on Acquired Immunodeficiency Syndrome (AIDS)

Chapter 6

- Added information on arthroscopy.
- Added a new Complementary and Alternative Therapy: Stem Cell Therapy for Knee Osteoarthritis
- Added a new Complementary and Alternative Therapy: Honey for Bone Health?

Chapter 7

- Updated the Pharmacology Highlight with the anticoagulants and plasminogen activators category
- Added a new Healthy Highlight: Increasing Iron in the Diet
- Updated the treatment section for aplastic anemia
- Updated the treatment section for Hodgkin's lymphoma, Non-Hodgkin's lymphoma, and multiple myeloma
- Added a new Complementary and Alternative Therapy: Hematologic Disorders Treated with Stem Cell Transplants

Chapter 8

- Updated the Pharmacology Highlight
- Added a new Complementary and Alternative Therapy: Quercetin for Cardiovascular Disease
- Updated the Healthy Highlight: Prevent High Blood Pressure
- Updated the treatment section for coronary artery disease
- Added a new Complementary and Alternative Therapy: Low Fat Diets: Are They Necessary?
- Added a new Complementary and Alternative Therapy: Salidroside Use in Heart Disease

Chapter 9

- Updated the Healthy Highlight: Why Do I Sneeze?
- Updated the Diagnostic Tests section
- Updated the Pharmacology Highlight with the anticholinergics and mucolytics categories, added examples of decongestants, and information on drugs used to treat COVID-19
- Added a new Complementary and Alternative Therapy: Echinacea for Colds and Influenza Prevention
- Added a new Complementary and Alternative Therapy: Nutritional Supplements as a Treatment for COVID-19?
- Added a Healthy Highlight: Coronavirus 2019 (COVID-19)
- Updated the pulmonary tuberculosis section
- Updated the Healthy Highlight: The Harmful Effects of Smoking
- Added a Healthy Highlight: Are Electronic Cigarettes Safe?
- Updated the Healthy Highlight: Abdominal Thrust

Chapter 10

- Updated the Pharmacology Highlight with the immunotherapy category and added examples of medications
- Added a new Complementary and Alternative Therapy: Acupuncture for Lymphedema Treatment

Chapter 11

- Updated the Diagnostic Tests section
- Updated the Pharmacology Highlight with the promotility agent category and updated the examples of medications
- Updated the Healthy Highlight: What Does the Tongue Tell You?
- Added a new Complementary and Alternative Therapy: Essential Oils for Relief of Nausea and Vomiting
- Updated the Healthy Highlight: How to Tell Heartburn from a Heart Attack
- Added a new Complementary and Alternative Therapy: Curcumin
- Added a new Complementary and Alternative Therapy: Natural Therapies for Irritable Bowel Syndrome
- Updated the Healthy Highlight: Screening Tests for Colon Cancer

Chapter 12

- Updated the Diagnostic Tests section
- Updated the Pharmacology Highlight with the alcohol abuse treatment, kinase inhibitor, and immune system booster categories, and updated the examples of medications
- Updated the Complementary and Alternative Therapy: Dietary Supplements for Hepatitis C
- Added a new Complementary and Alternative Therapy: Liver Cancer Treatment

Chapter 13

- Updated the Diagnostic Tests section
- Updated the Pharmacology Highlight with the immunotherapy category and updated the examples of medications
- Added a new Complementary and Alternative Therapy: New Ways to Treat Lower Urinary Tract Problems
- Updated the renal calculi section
- Updated the renal failure section
- Added a new Complementary and Alternative Therapy: Herbal Medicine for Incontinence
- Updated the urinary incontinence section

Chapter 14

- Updated the Diagnostic Tests section
- Updated the Pharmacology Highlight with the alpha-glucosidase inhibitors, thioglitazones, hormone agonists, hormone antagonists, and anticancer agents categories, and updated the examples of medications
- Added a new Complementary and Alternative Therapy: Berberine for Hyperglycemia
- Updated the Healthy Highlight: What You Need to Know About Type 2 Diabetes and Taking Dietary Supplements
- Added a new Complementary and Alternative Therapy: Luteolin to Maintain Blood Glucose Levels
- Added a new Complementary and Alternative Therapy: Acupuncture for Diabetic Neuropathy

Chapter 15

- Updated the Diagnostic Tests section
- Updated the Pharmacology Highlight with the dopamine agonists category and added and updated the examples of medications
- Updated the treatment section for shingles
- Updated the diagnosis section and added a new image for cerebrovascular accident
- Added a new Complementary and Alternative Therapy: Using Acupuncture for Dysphagia
- Added a new Complementary and Alternative Therapy: Meditation for Dementia
- Updated the Healthy Highlight: Hand Tremors
- Updated the Healthy Highlight: Brain Foods (New title: The MIND Diet for Brain Health)
- Added a new Complementary and Alternative Therapy: Aromatherapy for Better Sleep

Chapter 16

- Updated the Diagnostic Tests of the Eye section
- Updated the example medications in the Pharmacology Highlight for eye disorders

- Updated the Diagnostic Tests of the Ear section
- Updated the example medications in the Pharmacology Highlight for ear disorders
- Added a new Healthy Highlight: UV Light Exposure and Your Eyes
- Updated the Healthy Highlight: What is a Blepharospasm?
- Added a new Complementary and Alternative Therapy: Nutrition for Eye Health
- Updated the Healthy Highlight: Foods to Help Dry Eyes
- Added a new Healthy Highlight: Some Drugs Can Cause Ear Problems
- Updated the Healthy Highlight: Preserving and Improving Your Hearing
- Added a new Healthy Highlight: Natural Treatments for Ear Problems

Chapter 17

- Updated the Diagnostic Tests section
- Updated the Pharmacology Highlight for Female Reproductive Disorders with the Fertility drugs category and updated the examples of medications
- Updated the Pharmacology Highlight for Male Reproductive Disorders with the Phosphodiesterase inhibitors category and example medications
- Added a new Complementary and Alternative Therapy: The Chaste Tree Berry Benefits
- Updated the section on breast cancer
- Added a new Complementary and Alternative Therapy: Art and Music Therapy to Improve Quality of Life for Breast Cancer Patients
- Updated the Complementary and Alternative Therapy: Supplements for Men's Health
- Added a new Complementary and Alternative Therapy: Apitherapy for Benign Prostatic Hyperplasia (BPH)
- Updated the statistics in the genital herpes section
- Updated the Healthy Highlight: Preventing Sexually Transmitted Infections: Practice Safe Sex
- Updated the Healthy Highlight: Some Facts about Human Papillomavirus (HPV)
- Added a new Complementary and Alternative Therapy: Alternative Ways to Boost Testosterone Levels

Chapter 18

- Updated the Healthy Highlight: Collagen for Healthy Skin
- Updated the Diagnostic Tests section
- Updated the Pharmacology Highlight with the antivirals, enzyme inhibitors, and immunosuppressants categories, and updated the examples of medications
- Added a new Complementary and Alternative Therapy: Therapies for Skin Conditions
- Updated the Complementary and Alternative Therapy: Chamomile for Skin Conditions
- Updated the Complementary and Alternative Therapy: Therapy for Scars
- Added a new Complementary and Alternative Therapy: The Lone Star Tick and Red Meat Food Allergies

Chapter 19

- Added a new Healthy Highlight: Gene Mutations
- Updated the Complementary and Alternative Therapy: Using Meditation to Improve Health
- Updated the Diagnostic Tests section
- Updated the examples of medications in the Pharmacology Highlight
- Updated the Microcephaly section
- Updated the Huntington's Disease section
- Added a new Healthy Highlight: Genetic Testing
- Added a new Complementary and Alternative Therapy: Herbs for Treatment of Phenylketonuria (PKU)
- Updated the Autism Spectrum Disorder section

Chapter 20

- Updated the Acquired Immunodeficiency Syndrome section
- Updated statistics in the Diphtheria section
- Updated the Healthy Highlight: Epinephrine for Allergic Reactions
- Added a new Complementary and Alternative Therapy: Managing Food Allergies
- Added a new Complementary and Alternative Therapy: Herbs for Children
- Updated statistics in the Suicide section

- Updated the Healthy Highlight: Immunization Schedule for Children

Chapter 21

- Updated the Diagnostic Tests section
- Added a new Healthy Highlight: Staying Positive to Improve Life
- Updated the examples of medications in the Pharmacology Highlight
- Updated the Intellectual Disability section
- Added a new Healthy Highlight: The National Helpline for Mental Health and/or Substance Use Disorders
- Updated the Caffeine and Nicotine Abuse section
- Added a new Healthy Highlight: Naloxone for Overdoses
- Added a new Healthy Highlight: Preventing Opioid Overdoses
- Updated the Complementary and Alternative Therapy: Aromatherapy for Mood Elevation
- Updated the Complementary and Alternative Therapy: Exercise for Relief from Depression
- Added a section on Gender Dysphoria

Instructor and Student Resources

Additional instructor and student resources for this product are available online. Instructor assets include an Instructor's Manual, Educator's Guide, PowerPoint® slides, Solution and Answer Guide, and a test bank powered by Cognero®. Student assets include PowerPoint® slides. Sign up or sign in at www.cengage.com to search for and access this product and its online resources.

- The Instructor's Manual includes a sample course syllabus and outline as a guide for setting up a course. Additional materials for each chapter include detailed content outlines, learning objectives, expanded chapter summaries, discussion topics and learning activities, and discussion questions.
- The Solution and Answer Guide includes answers to the text chapter review questions and case studies. The PowerPoint® slides include chapter objectives, content and activity slides, and a self-assessment.
- The Cognero® Test Bank includes 60 questions per chapter, including multiple-choice and scenario multiple-choice questions and feedback; true/false questions were deleted.

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About the Authors

Dr. Marianne Neighbors has been in nursing practice and nursing education for more than 40 years. She received her bachelor's degree in nursing at Mankato State, a master's degree in health education at the University of Arkansas, a master's degree in nursing at the University of Oklahoma, and a doctoral degree in education with a focus on health science at the University of Arkansas. Dr. Neighbors has taught in associate degree nursing education for 18 years, focusing on medical/surgical nursing, and in baccalaureate nursing education for 23 years, focusing on health promotion and community health. She also taught advanced health promotion and nurse educator classes at the master's level. She has coauthored many research articles; four medical/surgical nursing texts, along with two medical/surgical handbooks; a health assessment handbook; and a home health handbook, in addition to the six editions of Human Diseases. Dr. Neighbors has also written chapters for other nursing authors' books. She is currently an Emeritus professor in the Eleanor Mann School of Nursing at the University of Arkansas, Fayetteville, Arkansas.

Ruth Tannehill-Jones worked as a registered nurse for more than 30 years. She began her nursing education at the University of Arkansas, Fayetteville, with completion of an associate degree in nursing.

Ms. Tannehill-Jones was not a newcomer to this campus; some years previously, she had completed a bachelor's degree in home economics. On receiving her RN license, she worked at St. Mary-Rogers Memorial Hospital in Rogers, Arkansas, in the capacities of staff nurse, head nurse, and nursing supervisor. Her other nursing experience includes assisting orthopedic surgeons while employed by Ozark Orthopedic and Sports Medicine Clinic located in the Northwest Arkansas area. Ms. Tannehill-Jones gained experience in education by working as an instructor of surgical technology while serving as the Divisional Chair of Nursing and Allied Health Programs at Northwest Technical Institute in Springdale, Arkansas. She obtained her bachelor's degree in nursing from Missouri Southern State College in Joplin and her master's degree in health service administration at Southwest Baptist University in Bolivar, Missouri. She worked for St. Mary's—Mercy Health System for more than 20 years in a variety of nursing positions, with her last position being Vice President of Patient Care Services, Chief Nurse Executive. Ms. Tannehill-Jones retired from Regency Hospital of Northwest Arkansas in 2011.

Acknowledgments

A special thanks goes out to all our colleagues, friends, and family members who have supported us throughout this project.

Feedback From The User(S)

The authors would like to hear from instructors, learners, or anyone using the textbook about its strengths and/or suggestions for revisions. They are truly interested in making the textbook user-friendly and comprehensive but not too detailed or too in-depth for the reader. The authors want to know how the text is being used and what features are most helpful. Please feel free to forward comments to the authors through Cengage Learning or directly by e-mail to Dr. Neighbors at neighbo@uark.edu and Ms. Tannehill-Jones at rjonesnwark@hotmail.com.

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Reviewers

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Unit I

Concepts of Human Disease

1 Introduction to Human Diseases

Key Terms

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Auscultation (p. 8)
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Diagnosis (p. 7)
Disease (p. 4)
Disorder (p. 4)
Epidemic (p. 8)
Etiology (p. 5)
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Predisposing factors (p. 6)
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Symptoms (p. 8)
Syndrome (p. 4)

Learning Objectives

Upon completion of the chapter, the learner should be able to:

1. Define basic terminology used in the study of human diseases.
2. Discuss the pathogenesis of a disease.
3. Describe the standard precaution guidelines for disease prevention.
4. Identify the predisposing factors to human diseases.
5. Explain the difference between the diagnosis and the prognosis of a disease.
6. Describe some common tests used to diagnose disease states.

Overview

The study of human diseases is important for understanding a variety of other topics in the health care field. Diseases that affect humans can range from mild to severe and can be acute (short term) or chronic (long term). Some diseases affect only one part of the body or a particular body system, whereas others affect several parts of the body or body systems at the same time. Many factors influence the body's ability to stay healthy or predispose the body to a disease process. Some of these factors are controllable, but some are strictly related to heredity. Diseases can be diagnosed by professional health care providers using a variety of techniques and tests. ■

Disease, Disorder, and Syndrome

In the study of human disease, several terms may be similar and often used interchangeably but might not have identical definitions.

Disease

Disease may be defined in several ways. It may be called a change in structure or function that is considered to be abnormal within the body, or it may be defined as any change from normal. It usually refers to a condition in which symptoms occur and a pathologic state is present, such as in pneumonia or leukemia. Both definitions have one underlying concept: the alteration of **homeostasis** (ho-mee-oh-STAY-sis).

Homeostasis is the state of sameness or normalcy the body strives to maintain. The body is remarkable in its ability to maintain homeostasis, but when this homeostasis is no longer maintained, the body is diseased or "not at ease."

Disorder

Disorder is defined as a derangement or abnormality of function. The term *disorder* can also refer to a pathologic condition of the body or mind but more commonly is used to refer to a problem such as a vitamin deficiency (nutritional disorder). It is also used to refer to structural problems such as a malformation of a joint (bone disorder) or a condition in which the term *disease* does not seem to apply, such as dysphagia (swallowing disorder). Because *disease* and *disorder* are so closely related, they are often used synonymously.

Syndrome

Syndrome (SIN-drome) refers to a group of symptoms, which might be caused by a specific disease but might also be caused by several interrelated problems. Examples include Tourette's syndrome, Down syndrome, and acquired immunodeficiency syndrome (AIDS), which are discussed later in the text.

Pathology

Pathology (pah-THOL-oh-jee) can be broadly defined as the study of disease (*patho* = disease, *ology* = study). A **pathologist** (pah-THOL-oh-jist) is one who studies disease. Using this strict definition of the word, even a student studying diseases might be considered a pathologist.

TABLE 1–1 Types of Pathologists

Pathologist	Role or Subject
Experimental	Research
Academic	Teaching
Anatomic	Clinical examinations
Autopsy	Postmortem
Surgical	Biopsies
Clinical	Laboratory examinations
Hematology	Blood
Immunology	Antigen/antibodies
Microbiology	Microorganisms

There are many types of pathologists because there are numerous ways to study disease. One of the more commonly known pathologists is the surgical pathologist, who inspects surgical tissue or biopsies for evidence of disease. The medical examiner or coroner can be a pathologist who studies human tissue to determine the cause of death and provide evidence of criminal involvement in a death. Other types of pathologists are outlined in Table 1–1.

The prefix *patho-* can be used in a variety of ways to describe disease processes or the disease itself. Microorganisms or agents that cause disease are called **pathogens** (PATH-oh-jens). These include some types of bacteria, viruses, fungi, protozoans, and helminths (worms). All pathogens have the ability to cause a disease or disorder. Fractures that are caused by a disease process that weakens the bone, such as osteoporosis, would be called **pathologic** (path-oh-LODGE-ick) fractures.

Pathogenesis

The **pathogenesis** (PATH-oh-JEN-ah-sis; *patho* = disease, *genesis* = arising) is a description of how a particular disease progresses. Many of us are familiar with the pathogenesis of the common cold.

A cold begins with an inoculation of the cold virus. This can occur following a simple handshake with someone who has a cold. Afterward, the target person might rub their eyes or nose, allowing entry of the virus into the body. After the inoculation period comes the incubation time. During this period, the virus multiplies, and the target person begins to have symptoms such as a runny nose and itchy eyes. The pathogenesis of the cold

TABLE 1–2 Examples of Acute and Chronic Diseases/Disorders

Acute	Chronic
Upper respiratory infections	Arthritis
Lacerations	Hypertension
Middle ear infections	Diabetes mellitus
Gastroenteritis	Low back pain
Pneumonia	Heart disease
Fractures	Asthma

then moves into full-blown illness, usually followed by recovery and return to the previous state of health.

The pathogenesis of a disease can be explained in terms of time. An **acute** (a-CUTE) disease is short term and usually has a sudden onset. If the disease lasts for an extended period or the healing process is progressing slowly, it is classified as a **chronic** (KRON-ick) condition. See Table 1–2 for examples of acute and chronic diseases !.

Etiology

The **etiology** (EE-tee-OL-oh-jee) of a disease means the study of cause. The term *etiology* is commonly used to mean simply "the cause." One might say that the cause is unknown or "of unknown etiology." The cause or etiology of pneumonia can be a virus or a bacterium. The etiology of athlete's foot is a fungus named tinea pedis.

Another term used to mean "the cause is unknown" is **idiopathic** (ID-ee-oh-PATH-ick). If an individual is diagnosed as having idiopathic gastric pain, it means the cause of the pain in the stomach is unknown.

Other terms related to cause of disease are **iatrogenic** (EYE-at-roh-JEN-ick) and **nosocomial** (NOS-oh-KOH-me-al). Iatrogenic (*iatro* = medicine, physician, *genic* = arising from) means that the problem arose from a prescribed treatment. An example of an iatrogenic problem is the development of anemia

Healthy Highlight

How Should You Wash Your Hands

Keeping your hands clean through improved hand hygiene is one of the most important steps we can take to avoid getting sick and spreading germs to others. Many diseases and conditions are spread by not washing hands with soap and clean water.

To wash your hands,

- wet your hands with clean, running water (warm or cold), turn off the tap, and apply soap.
- lather your hands by rubbing them together with the soap. Be sure to lather the backs of your hands, between your fingers, and under your nails.
- scrub your hands for at least 20 seconds. Need a timer? Hum the "Happy Birthday" song from beginning to end twice.
- rinse your hands well under clean, running water.
- dry your hands using a clean towel or air-dry them.

It is important to wash

- before eating or preparing food.
- before touching your face.
- after using the restroom.
- after blowing your nose, coughing, or sneezing.
- after handling a face mask.
- after changing a diaper.
- after caring for someone who is ill.
- after touching animals.

Source: Centers for Disease Control and Prevention (2020).

Healthy Highlight

Standard Precautions

Using standard precautions is recommended by the Centers for Disease Control and Prevention for the care of all patients or when administering first aid to anyone. These standards also include respiratory hygiene and cough etiquette, safe injection techniques, and wearing masks for spinal insertions.

- **Handwashing** Wash your hands after touching blood, body fluids, or both, even if gloves are worn; use an antimicrobial soap.
- **Respiratory etiquette** Cover your mouth, nose, or both with a tissue when coughing and dispose of used tissue immediately. Wear a mask if possible. Maintain distance from others, ideally greater than 3 feet. Wash hands after contact with secretions.
- **Gloves** Wear gloves when touching blood, body fluids, and contaminated items; change gloves after patient contact or contact with contaminated items; wash your hands before and after.
- **Eyewear, mask, and face shield** Wear protection for your eyes, mouth, and face when performing procedures in which a risk of splashing or spraying of blood or body secretions exists. This includes inserting catheters or injecting material into spinal or epidural spaces. A mask should also be worn if the caregiver has a respiratory infection but cannot avoid direct patient contact.
- **Gown** Wear a waterproof gown to protect the clothing from splashing or spraying blood or body fluids.
- **Equipment** Wear gloves when handling equipment contaminated with blood or body fluids; clean equipment appropriately after use; discard disposable equipment in proper containers.
- **Environment control** Follow proper procedures for cleaning and disinfecting the patient's environment after completion of a procedure.
- **Linen** Use the proper procedure for disposing of linen contaminated with blood or body fluids.
- **Blood-borne pathogens** Do not recap needles; dispose of used needles and other sharp instruments in proper containers; use a mouthpiece for resuscitation; keep a mouthpiece available in areas where there is a likelihood of need.

in a patient undergoing chemotherapy treatments for cancer.

Nosocomial is a closely related term; it implies that the disease was acquired from a hospital environment. A more comprehensive descriptor of a disease acquired in the hospital or in any health care facility is health care–associated infection (HAI). An example of a nosocomial or HAI would be a postoperative patient developing an incisional staphylococcal infection. The best way to prevent these infections is through the practice of good handwashing. A good handwashing technique is described in the Healthy Highlight box.

Predisposing Factors

Predisposing factors, also known as risk factors, make a person more susceptible to disease. Predisposing factors are not the cause of the disease, and people with predisposing factors do not always develop the disease. These factors include age, sex, environment, lifestyle, and heredity. Some risk factors, such as lifestyle behaviors, are controllable, whereas others such as age are not.

Age

From the beginning of life until death, our risk of disease follows our age. Newborns are at risk of disease because their immune systems are not fully developed. On the other hand, older persons are at risk because their immune systems are degenerating or wearing out. Girls in their early teens and women over the age of 30 are at high risk for a difficult or problem pregnancy. The older we

become, the higher the risk for diseases such as cancer, heart disease, stroke, senile dementia, and Alzheimer's disease.

Sex

Some diseases are more **prevalent** (occurring more often) in one gender or the other. Men are more at risk for diseases such as lung cancer, gout, and parkinsonism. Other disorders or diseases, including osteoporosis, rheumatoid arthritis, and breast cancer, occur more often in women.

Environment

Air and water pollution can lead to respiratory and gastrointestinal disease. Poor sanitation, excessive noise, and stress are also environmental risk factors. Occupational diseases such as lung disease are high among miners and persons working in areas with increased amounts of dust or other particles in the air.

Farmers are considered to be at higher risk for diseases because of their increased exposure to dust, pesticides, and other pollutants. Farmers are also at higher risk for trauma injuries due to safety problems around farm machinery. People living in remote, rural areas do not have health care availability comparable to that enjoyed by people living in urban areas. This increases their risk for chronic illnesses.

Lifestyle

Lifestyle factors fall into a category over which the individual has some control. Choosing to improve health behaviors in these areas could lead to a reduction in risk and thus a possibility of avoiding the occurrence of the disease. Such factors include smoking, drinking alcohol, poor nutrition (excessive fat, salt, and sugar and not enough fruits, vegetables, fiber), a lack of exercise, and stress.

Practicing health behaviors to prevent contamination, and thus disease, is also an important lifestyle behavior. The Centers for Disease Control and Prevention recommends the use of standard precautions when caring for any individual when there is a chance of being contaminated with blood or body fluids (see the Healthy Highlight box "Standard Precautions"). This is an important measure to prevent transmission of any disease that can be passed between humans in blood or body fluids, such as hepatitis, *Escherichia coli* infections, and AIDS.

Consider This...

About 90% of diseases are partially caused or affected by stress.

Heredity

Although one cannot change genetic makeup, being aware of hereditary risk factors might encourage the individual to change lifestyle behaviors to reduce the risk of disease. For example, coronary heart disease has been shown to have a high familial tendency. Persons with this family inheritance are compounding their chances if they smoke, have poor nutritional intake, and do not exercise routinely.

Breast cancer and cervical cancer also have familial tendencies. Women with family members who have been diagnosed with breast cancer or cervical cancer are at a higher risk of developing these diseases. These women should be screened routinely for evidence of cancer and should complete monthly breast self-exams. With this knowledge about hereditary factors, individuals can choose to decrease their overall risk by improving their lifestyle health behaviors.

Diagnosis

Diagnosis (die-ag-NO-sis) is the identification or naming of a disease or condition. When an individual seeks medical attention, it is the duty of the physician to determine a diagnosis of the problem. A diagnosis is made after a methodical study by the physician, using data collected from a medical history, physical examination, and diagnostic tests (Figure 1–1).

Figure 1–1 Physician checking a patient.

A medical history is a systems review that might include such information as previous illnesses, family illness, predisposing factors, medication allergies, current illnesses, and current **symptoms** (SIMP-tums; what patients report as their problem or problems). Examples of symptoms might include stomach pain, headache, and nausea.

The physician proceeds with a head-to-toe physical examination of the patient, looking for signs of the disease. **Signs** differ from symptoms in that signs are observable or measurable. Signs are what the physician sees or measures. Examples of signs could include vomiting, elevated blood pressure, and elevated temperature.

In some cases, a patient's concern might be considered as both a symptom and a sign. Some references call this an objective or observable symptom, whereas others state that it is also a sign. An example would be a patient complaining of a runny nose. The runny nose is the patient's symptom, and because it is observable to the physician, it is also a sign.

During the physical examination, the physician might use other skills such as **auscultation** (awskul-TAY-shun; using a stethoscope to listen to body cavities), **palpation** (pal-PAY-shun; feeling lightly or pressing firmly on internal organs or structures), and **percussion** (per-KUSH-un; tapping over various body areas to produce a vibrating sound). All the results are compared to a normal standard to identify problems.

Diagnostic tests and procedures to assist in determining a diagnosis are numerous. The routine or most common include urinalysis, complete blood count, chest X-ray, and electrocardiography (EKG or ECG). See Table 1–3 for examples of common diagnostic tests and procedures.

If an unusually large number of people in a region are diagnosed with the same disease around the same time, the disease is called an **epidemic**. During the late fall, winter, and early spring, influenza (flu) often reaches epidemic numbers in various regions. If an epidemic affects an exceptionally large area, even as far as worldwide, it is called a **pandemic**. Pandemics are rare. The most recent being Coronavirus Disease 2019 (COVID-19).

Prognosis

Prognosis (prawg-KNOW-sis) is the predicted or expected outcome of the disease. For example, the prognosis of the common cold would be that the individual should feel better in 7 to 10 days.

Acute Disease

The duration of the disease can be described as acute in nature. An acute disease is one that usually has a sudden onset and lasts a short amount of time (days or weeks). Most acute diseases are related to the respiratory system. Again, the common cold would be a good example.

Chronic Disease

If the disease persists for a long time, it is considered chronic. Chronic diseases might begin insidiously (slowly and without symptoms) and last for the individual's entire life. As one ages, the occurrence of chronic disease increases. One of the most common chronic diseases is hypertension, or high blood pressure.

Chronic diseases often go through periods of **remission** and **exacerbation** (eg-ZAS-er-BAY-shun).

TABLE 1–3 Examples of Common Diagnostic Tests and Procedures

Test	Description
Complete blood count (CBC)	An examination of blood for cell counts and abnormalities
Urinalysis (UA)	An examination of urine for abnormalities
Chest X-ray (CXR)	X-ray examination of the chest cavity
Electrocardiography (ECG or EKG)	A procedure for recording the electrical activity of the heart
Blood glucose	A test of the blood to determine its glucose or sugar levels
Computerized axial tomography (CT or CAT)	A special X-ray examination showing detailed images of body structures and organs
Serum electrolytes	An examination of blood serum to determine the levels of the common electrolytes (sodium, potassium, chloride, and carbon dioxide)

Remission refers to a time when symptoms are diminished or temporarily resolved. *Exacerbation* refers to a time when symptoms flare up or become worse. Leukemia is a disease that progresses through periods of remission and exacerbation. Both acute and chronic diseases can range from mild to life-threatening.

Complication

The prognosis might be altered or changed at times if the individual develops a **complication**. A complication is the onset of a second disease or disorder in an individual who is already affected with a disease. An individual with a fractured arm might have a prognosis of the arm healing in 6 to 8 weeks. If the individual suffers the complication of bone infection, the prognosis might change drastically.

Mortality Rate

Mortality is defined as the quality of being mortal, that is, destined to die. Diseases commonly leading to the death of an individual have a high **mortality rate**. The mortality rate of a disease (also called death rate) is related to the number of people who die with the disease in a certain amount of time. Other terms the medical community uses to refer to a deadly disease include **fatal** and **lethal**.

Consider This...

The ashes of the average cremated human weigh approximately 9 pounds.

Survival Rate

A physician's prognosis can also consider the survival rate. The survival rate is the percentage of people with a particular disease who live for a set time. For example, the 2-year survival rate of individuals with lung cancer would be the percentage of people alive 2 years after diagnosis.

Treatment

After the diagnosis is established, the physician will work with the individual to explain or outline a plan of care. The physician might offer treatment options to the individual with expected outcomes or prognoses. The individual's entire being should be taken into consideration. The concept of considering the whole person rather than just the physical being is called **holistic medicine**.

From a holistic viewpoint, there is an interaction among the spiritual, cognitive, social, physical, and emotional being. These areas do not work independently but have a dynamic interaction (Figure 1–2).

Treatment interventions might include (a) medications, (b) surgery, (c) exercise, (d) nutritional modifications, (e) physical therapy, and (f) education. Individuals and family members should be educated and involved in the treatment plan. Failing to involve the individual and family can decrease compliance and lead to the plan failing.

After the treatment plan is implemented, the physician will follow up with the individual to determine the plan's effectiveness. The individual and physician should work together to modify the plan if it is found to be ineffective. Implementation of the plan usually requires an entire health care team. The team can include nurses, a physical therapist, a social worker, clergy, and other health care professionals as needed.

The best treatment option is a **preventive** plan. In preventive treatment, care is given to prevent disease. Examples of preventive care are breast mammograms

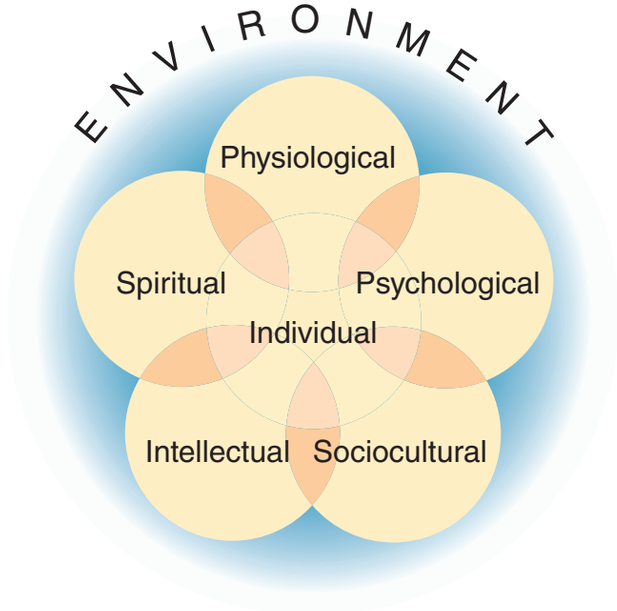


Figure 1–2 Holistic medicine.

to screen for breast cancer, blood pressure screening for hypertension, routine dental care to prevent dental caries, and a fecal occult blood test to screen for colon cancer.

Other treatment plans might include **palliative** (PAL-ee-ay-tiv) treatment. Palliative treatment is aimed at preventing pain and discomfort but does not seek to cure the disease. Treatment for end-term cancer and other serious chronic conditions can be palliative.

Decisions concerning treatment plans can be very difficult for the patient, the patient's family, and the health care team. This is especially true when those decisions involve palliative treatment and end-of-life issues. During these times, professionals often seek assistance in decision-making by using their knowledge of medical ethics.

Medical Ethics

Webster's Dictionary defines *ethics* as "the study of standards of conduct and moral judgment." More simply put, ethics deals with the "rightness and wrongness" or "goodness and badness" of human actions. Ethics covers many areas of conduct and judgment in our society.

Bioethics is a branch of ethics concerned with what is right or wrong in bio (life) decisions. Because bioethics is a study of life ethics, it covers or becomes entwined with medical ethics. Medical ethics includes the values and decisions in medical practice, including relationships to patients, patients' families, peer physicians, and society.

Part of the ethical challenge in this age of rapidly advancing technologies is actually determining what is right or wrong, good or bad. New scientific discoveries are challenging familiar or usual human behaviors, leading to reconsideration of actions, thoughts, and emotions. Ethical dilemmas, once rare, are now common and often happen so quickly that society is unable to understand completely the impact these decisions will have on the future.

Bioethical decisions are often very difficult because they touch the core of humanity in dealing with issues of birth, death, sickness, health, and dignity. This generation and generations to come will be faced with ethical decisions formerly unknown to humans. Many of these decisions will have a great impact on medical ethics and will actually shape the future of humankind.

When challenges concerning medical ethics arise in a health care facility, an ethics committee might be called on to make a decision. This committee might involve one or more persons at each of these levels: physician, nurse, ethicist, social worker, case manager, chaplain, legal representative, and administrator, or director.

Groups or committees involved in decision-making might need to consider previous works of philosophy, history, law, and religion to assist them in reaching a conclusion. Participation in ethical decision-making requires members to follow some basic rules, which can include

- keeping the discussion focused and civil.
- listening with an open mind to all opinions.
- entertaining diverse ideas.
- weighing out the pros and cons of each idea.
- considering the impact of the decision on all persons involved.

Every individual at some time or another will encounter or be called on to make a decision that is bioethical in nature. Examples of these can include one's willingness to

- use a surrogate mother or father to have a biological child.
- control the sex of children through chromosome selection.
- use fetal stem cells to grow new organs and tissues.
- use prescription stimulants in children.
- legalize abortion.
- use mood-altering drugs for older persons.
- clone humans.
- treat disease by replacing damaged or abnormal genes with normal genes.
- use animal organs or tissues (xenotransplants) in humans.
- support euthanasia.
- allow physician-assisted suicide.

Each of the preceding issues can be overwhelming. Even so, yet another concern must be addressed, involving the economics of these choices.

Consider, for example, the economics of human cloning. How will research, technology, and

intervention be funded? If costs are funded by individuals, only wealthy individuals would be able to afford clones. Is that fair or right? If costs are funded by the government, what criteria will be used for selection? Will selection be based on intelligence, physical ability, or artistic skills? Who decides?

Medical ethics includes some very complicated life issues. Bioethical decision-making, or determining the rightness or wrongness of such issues, will continue to be a challenge for society well into the future.

Consider This...

A study in the Netherlands determined that smokers and obese persons benefit a socialized health care system due to earlier deaths. Health care costs for a lifetime for a healthy person will average $417,000, whereas the obese person will cost $371,000 and the smoker will cost $326,000.

Summary

The study of human diseases is important to any health care or allied health professional. Disease can affect any body system or organ and can range from mild to severe, depending on many factors. Several risk factors for disease can be controlled to some extent by one's lifestyle. Other diseases might not be preventable or controlled but need medical intervention for treatment or cure. Diagnosing and treating a disease are usually accomplished by a team of health care professionals led by the physician. Ethical decision-making has become a challenge in health care today, and as technology continues to grow and develop, medical ethics will become more challenging than ever.

Review Questions

Short Answer

1. Identify why it is important to study human diseases.

2. Describe the types of pathologists and their roles in the study of disease.

3. List the five predisposing factors for disease and one disease related to each factor.

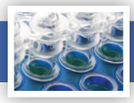
Matching

4. Match the terms in the left column with the correct definition in the right column.

_____ Pathogenesis	a. The cause of a disease
_____ Etiology	b. Interventions to cure or control a disease
_____ Diagnosis	c. The development of a disease
_____ Prognosis	d. The identification or naming of a disease
_____ Treatment	e. The predicted or expected outcome of a disease

Fill in the Blank

5. A common test used in determining a disease diagnosis that involves recording the electrical activity of the heart is a/an _____.



Case Studies

■ Stan Cotton was accidentally tripped by another player while running down the field at a soccer game you were coaching. He is able to walk to the sideline with assistance but has obvious bleeding on his legs and one arm. You grab the first-aid box and go to his side. What do you do next? What equipment might you use to give aid to Stan? What standard precautions should apply to this case?

■ Jane Swenson has been suffering from a cold for about a week and has missed 3 days of work. She decides to return to work at the local community center for older adults. She is still coughing at intervals and has a runny nose but has improved since last week. Should she still use some precautions to prevent spreading her illness? If so, what should she do?

2 Mechanisms of Disease

Key Terms

AIDS (p. 19)
Allergen (p. 18)
Allergy (p. 18)
Anoxia (p. 20)
Antibodies (p. 18)
Antigens (p. 18)
Atrophy (p. 20)
Autoimmunity (p. 18)
Bariatrics (p. 18)
Benign (p. 16)
Body mass index (BMI) (p. 18)
Cachexia (p. 17)
Cancer (p. 16)
Comorbidity (p. 23)
Congenital (p. 14)
Degenerative (p. 19)
Dysplasia (p. 20)
Encapsulated (p. 16)
Enteral (p. 17)
Gangrene (p. 22)
Hyperplasias (p. 15)
Hypertrophy (p. 20)
Hypoxia (p. 20)
Immunodeficiency (p. 19)
Infarct (p. 22)
Infection (p. 15)
Inflammation (p. 15)
Ischemia (p. 22)
Malignant (p. 16)
Metaplasia (p. 20)
Metastasize (p. 16)
Metastatic (p. 16)
Morbidity (p. 23)
Motor vehicle accidents (MVAs) (p. 14)
Necrosis (p. 22)
Neoplasia (p. 20)
Neoplasms (p. 15)
Oncology (p. 15)
Organ rejection (p. 19)
Parenteral (p. 17)
Total parenteral nutrition (TPN) (p. 17)
Trauma (p. 14)
Triage (p. 15)
Tumors (p. 15)

Learning Objectives

Upon completion of the chapter, the learner should be able to:

1. Identify important terminology related to the mechanisms of human disease.
2. Describe the causes of disease.
3. Identify disorders in each category of the causes of disease.
4. Describe behaviors important to a healthy lifestyle.
5. Compare the various types of impaired immunity.
6. Identify the basic changes in the body occurring in the aging process.
7. Describe the process of cell and tissue injury, adaptation, and death.

Overview

The human body is a complex machine that normally runs in an efficient, balanced manner, but when changes occur in the body due to lifestyle behaviors, abnormal growths, nutritional problems, bacterial invasion, or any other factor that upsets the balance, the result might be a disease process. Human disease

can be very minor or life-threatening. Diseases are caused by a variety of factors; some are controllable, and some are not. Even normal changes, such as aging, can put the individual at higher risk for developing disease. Many changes or alterations in cell and tissue structure can occur. Some of these changes are reversible, but some might cause cellular, tissue, organ, or system death. ■

Causes of Disease

To gain a better understanding of the different causes of diseases, it is usually helpful to classify or divide them into smaller groups. This classification can be approached in several different yet logical ways. One commonly used approach is to divide the causes of disease into the following six categories:

1. Heredity
2. Trauma
3. Inflammation and infection
4. Hyperplasias and neoplasms
5. Nutritional imbalance
6. Impaired immunity

Heredity

Hereditary diseases are caused by an abnormality in the individual's genetic or chromosomal makeup. These diseases might or might not be apparent at birth. Hereditary diseases present at birth, even if not apparent, are called **congenital** (kon-JEN-ih-tahl) disorders. However, not all congenital disorders are inherited. Some other causes of congenital disorders include disease during pregnancy (e.g., fetal alcohol syndrome) or difficulty with delivery (e.g., cerebral palsy), to name only a couple.

Hereditary diseases are classified in three basic ways: (1) a single-gene abnormality, (2) an abnormality of several genes (polygenic), or (3) an abnormality of a chromosome (either entire absence of a chromosome or the presence of an additional chromosome). See Table 2–1 for the classification of hereditary diseases and examples.

Chromosomal and genetic abnormalities might or might not be compatible with life. Some abnormalities might be present but cause no effect on the individual, whereas others might lead to the death and spontaneous abortion of the unborn child.

More information related to hereditary diseases can be found in Chapter 19, "Genetic and Developmental, Childhood, and Mental Health Diseases and Disorders."

Trauma

Traumatic diseases are caused by a physical injury from an external force. Trauma is the leading cause of death in children and young adults. The type of **trauma** (TRAW-mah) or traumatic disease most commonly affecting individuals varies with age, race, and residence. For example, accidents, especially falls, are a common cause of traumatic disorders in older adults, whereas **motor vehicle accidents (MVAs)** are the most frequent cause of injury and death in young adults.

The National Safety Council lists deaths caused by trauma, in order of prevalence (or occurrence), as follows:

- Poisoning
- Falls
- MVA
- Choking
- Drowning

Emergency management of trauma is often necessary to prevent the complications of shock, hemorrhage,

TABLE 2–1 Classification of Hereditary Disease with Examples

Single Gene	Polygenic	Chromosomal
Cystic fibrosis	Gout	Klinefelter's syndrome
Phenylketonuria	Hypertension	Turner's syndrome
Sickle cell anemia	Congenital heart anomalies	Down syndrome

and infection. On arrival at an emergency department, patients are assessed according to signs and symptoms, age, and medical history. Needs are then prioritized, and care is given in order of severity of injury. This prioritizing of care is called **triage** (tree-AZH) and incorporates an ABC prioritizing method, with A for airway, B for breathing, and C for cardiac function. After these areas are assessed, other areas of trauma such as bleeding and fractures are addressed. An example of triage, in general, would be giving priority care to a patient who is not breathing before assisting a patient who has a bleeding leg wound.

Types of trauma commonly occurring in each body system are discussed in the specific system chapters.

Inflammation and Infection

Inflammation (in-flah-MAY-shun) is a protective immune response that is triggered by any type of injury or irritant. Even the slightest trauma can initiate the inflammatory response. Signs of inflammation are redness, heat, swelling, pain, and loss of motion. An example of inflammation is sunburn. The tissue is red, warm to the touch, swollen, painful, and uncomfortable when moving. Although this area is inflamed, it is usually not infected.

Infection (in-FEK-shun) refers to the invasion of microorganisms into tissue that causes cell or tissue injury. *Inflammation* and *infection* are often used synonymously even though they are quite different. A tissue can be inflamed but not infected, as in sunburn, but usually, infected tissue will also be inflamed.

For tissue to be infected or for an infection to occur, there has to be an invasion of microorganisms. Usually, inflammation and infection go hand in hand. For example, when the skin is cut, the tissue around the cut will undergo a mild inflammation. As skin bacteria invade the cut tissue, the area becomes infected and usually becomes even more inflamed due to the irritation to the tissue caused by the bacteria (Figure 2–1).

Diseases that are related to inflammation are identified with the suffix *-itis*. Examples include appendicitis (inflammation of the appendix), gastritis (inflammation of the stomach), colitis (inflammation of the colon), and encephalitis (inflammation of the brain). In many cases, the inflammation will progress to an infection due to the presence of bacteria in the region. For example, appendicitis can be caused by an obstruction of the appendix. Because the bacteria *Escherichia coli* (*E. coli*) are commonly found in the colon, the appendix becomes infected.

Figure 2–1 Inflammation of a finger.

Hyperplasias and Neoplasms

Hyperplasias (high-per-PLAY-zee-ahs; *hyper* = excessive, *plasia* = growth) and **neoplasms** (NEE-oh-plazms; *neo* = new, *plasm* = growth) are similar because, in both, an increase in cell number leads to an increase in tissue size.

Hyperplasias

Hyperplasias differ from neoplasms in terms of cause and growth limits. Hyperplasias are overgrowths in response to some type of stimulus. An example of a hyperplasia would be enlargement of the thyroid gland (goiter) in response to a hormone deficiency.

Neoplasms

Neoplasms (new growths) are commonly called **tumors**. The Latin word *tumor* means "swelling" and originally was used in the description of the swelling related to inflammation. The Greek term for swelling is *onkos*, which has been used to construct the word **oncology** (ong-KOL-oh-jee; *onco* = tumor, *logy* = study of, or the study of cancer). Although all tumors are not neoplasms, as described in more detail in Chapter 3, "Neoplasms," the words are often used synonymously.

Diseases with tumor involvement usually end with the suffix *-oma*. Examples include lipoma, carcinoma, melanoma, and sarcoma (Table 2–2). An exception to this is the word *hematoma*, which is a clot of blood in an area. A hematoma on the head due to a blunt blow would be an example.

TABLE 2–2 Examples of Neoplasms or Tumors

Neoplasm/Tumor	Description
Adenoma	Usually benign tumor arising from glandular epithelial tissue
Carcinoma	Malignant tumor of epithelial tissue
Fibroma	Benign encapsulated tumor of connective tissue
Glioma	Malignant tumor of neurologic cells
Lipoma	Benign fatty tumor
Melanoma	Malignant tumor of the skin
Sarcoma	Malignant tumor arising from connective tissue such as muscle or bone

Neoplasms or tumors (-omas) may be classified as **benign** (beh-NINE) or **malignant** (mah-LIG-nant). Generally, benign tumors have limited growth, are **encapsulated** (enclosed in a capsule) and thus easily removed, and are not deadly. Malignant tumors are just the opposite. These tumors grow uncontrollably; have fingerlike projections into surrounding tissue, making removal very difficult; and are usually deadly. *Malignant* means deadly or progressing to death. With these definitions, it is understandable why the terms *tumor*, *malignancy*, and *cancer* bring fear to an individual. Some -omas, or tumor diseases, are commonly called cancer. **Cancer** is defined as any malignant tumor.

The fingerlike or crab-like projections that characterize malignant tumors give cancer its name, from the Greek *karkinos*, meaning "crab." This characteristic makes surgical removal of cancer quite difficult (Figure 2–2). Another characteristic of malignant neoplasms is that they **metastasize** (meh-TAS-tah-sighz), or spread. **Metastatic** (MET-ah-STAT-ic) cancers spread from a site of origin to a secondary site in the body. For example, lung cancer commonly metastasizes to the bone. Chapter 3 discusses more detailed information about hyperplasias and neoplasms.

Courtesy of Mark L. Kuss

Figure 2–2 Crab-like appearance of cancer in a kidney.

Nutritional Imbalance

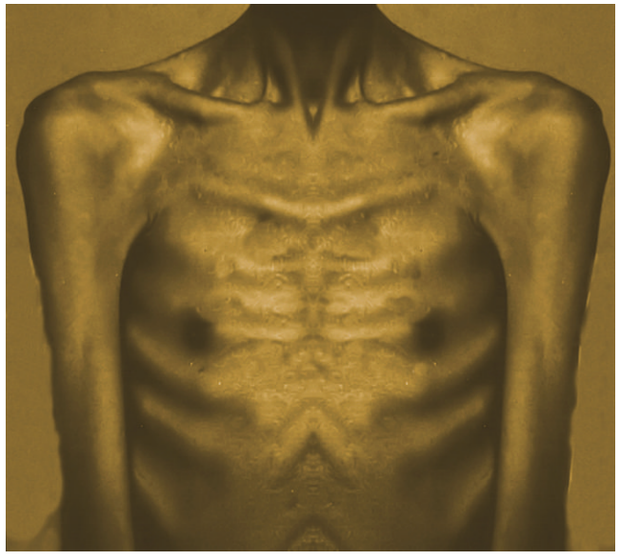
Good nutrition is important in maintaining good health and reducing the chance of disease. Nutritional disorders can cause problems with physical growth, mental and intellectual changes, and even death in extreme cases. Most nutritional diseases are related to overconsumption or under-consumption of nutrients. Specific problems are malnutrition, obesity, and excessive or deficient vitamins, minerals, or both.

Consider This...

Lack of water is the number one trigger of daytime fatigue.

Malnutrition

Malnutrition can be due to inadequate nutrient intake or to intake of an adequate amount with poor nutritive value. Diseases that cause a problem with the absorption of



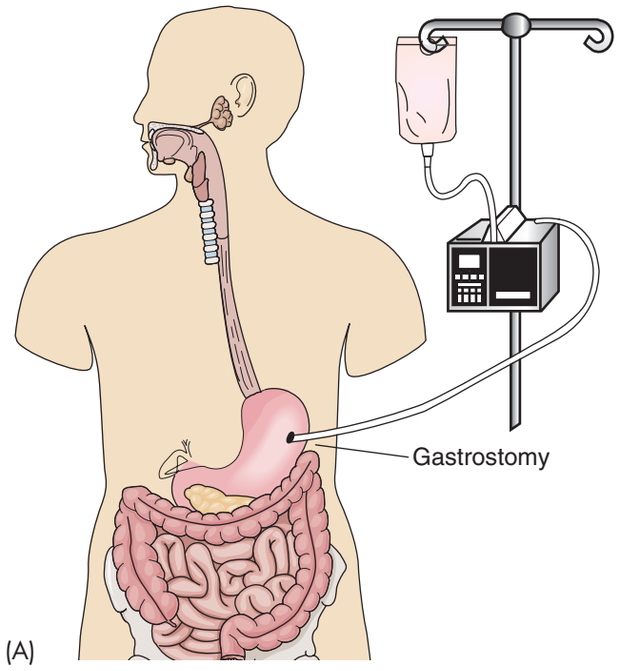
Courtesy of Mark L. Kuss

Figure 2–3 Cachexia.

nutrients can also lead to malnutrition. Children and older persons are the age groups most affected by malnutrition. Persons suffering with cancer often experience problems with malnutrition and develop cachexia. **Cachexia** (ca-KECK-see-ah) is a term that describes any individual who has an ill, thin, wasted appearance (Figure 2–3).

Persons who are unable to eat enough to maintain their body weight can receive nutritional supplements in a liquid drink. Another way to supplement or provide for total nutritional intake is not through the alimentary canal or digestive system but through a **parenteral** (pah-REN-ter-al; to administer by injection) route. Parenteral routes can include subcutaneous (*sub* = under, *cutaneous* = skin), intramuscular (*intra* = within, *muscular* = muscle), or intravenous (*intra* = within, *venous* = vein) administration. The intravenous route is the most commonly used parenteral route. Providing the total nutrition needed by giving nutritive liquid through a venous (vein) route is called **total parenteral nutrition (TPN)**.

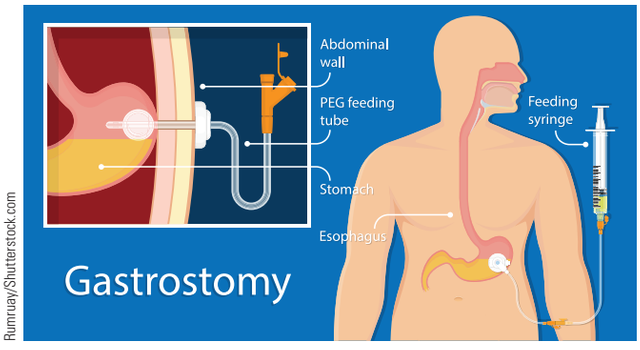
Nutrition can also be provided through an **enteral** (small intestine) route. A nasogastric (*naso* = nose, *gastric* = stomach) tube or a tube running through the nose and into the stomach can be used for feedings if the supplement is planned short term. For longer-term enteral feeding, a gastrostomy (*gastro* = stomach, *ostomy* = opening; opening into the stomach) procedure is performed to place a tube through the abdominal and stomach wall (Figure 2–4A). Enteral feeding, commonly called "tube feeding," is accomplished by this method (Figure 2–4B).



(A)

Courtesy of Mark L. Kuss

(B)



Rumruay/Shutterstock.com

(C)

Figure 2–4 Gastrostomy. (A) Feeding. (B) Insertion site. (C) internal location.

Obesity

Although many individuals in the United States have a nutritional deficiency, the most common problem is obesity, which is primarily due to overconsumption of nutrients and lack of exercise. According to the American Heart Association, obesity is a national health concern, with nearly one in three (31.7%) U.S. children ages 2 to 19 being obese and more than one third (33.7%) of adults being obese. Obesity shortens the life span of the individual by increasing the chance for arteriosclerosis, leading to cardiovascular diseases. It also affects the individual's risk for developing bone or joint problems due to the increased pressure on the skeletal system.

Obesity is simply defined as too much body fat. It is medically determined when an individual has a **body mass index (BMI)** of greater than 29.9. BMI is obtained by dividing the individual's weight in pounds by the square of their height, multiplied by 703. For example, a person weighing 250 pounds who is 5 feet 6 inches tall (66 inches) has a BMI of 40.3. This is calculated as 250 divided by (66 × 66) × 703. This person is considered extremely obese.

A simple BMI scale uses these figures to determine levels of obesity:

BMI
<18.5 underweight
18.5–<25 normal
25–<30 overweight
30–<40 obese
>40 or higher extremely obese

Bariatrics (bear-ee-AT-tricks) is a branch of medicine that deals with the prevention and treatment of obesity. First-line treatment for obesity often includes diet, exercise, anti-obesity medication, and behavior modification. These treatments in the severely obese population often have poor long-term success. In these cases, bariatric or weight loss surgery may be recommended. Gastric banding and gastric bypass are two of the most common types of surgery.

Obesity is one of the most preventable causes of death. Worldwide, it is viewed as one of the most serious public health problems of the twenty-first century.

Vitamin or Mineral Excess or Deficiency

Vitamin and mineral excesses and deficiencies are usually related to diet, metabolic disorders, and some medications. Hypervitaminosis can occur in individuals who consume large amounts of vitamins for an extended time.

Nutritional guidelines for a healthy lifestyle are difficult to determine because they must cover a variety of ages and nutritional needs. Children, teens, and pregnant women have very specific nutritional needs. See the Healthy Highlight box "General Guidelines for a Healthy Lifestyle" for more information.

Impaired Immunity

The immune system of the body is a specialized group of cells, tissues, and organs designed to defend the body against pathogenic attacks. The body's first line of defense against pathogens is its normal structure and function, including intact skin, mucous membranes, tears, and secretions. The immune system protects the body in two additional ways, through

1. the inflammatory response, in which leukocytes play a vital part in killing foreign invaders.
2. the specific antigen–antibody reaction, in which the body responds to **antigens** (AN-tih-jens) by producing antibodies. Antigens are substances that cause the body some type of harm, thus setting off this specific reaction. **Antibodies**, also called immune bodies, are proteins that the body produces to react to the antigen and render it harmless.

Impaired immunity occurs when some part of this system malfunctions. Following are some common ways the system malfunctions.

Allergy

The immune response is too intense or hypersensitive to an environmental substance. The **allergen** (environmental substance that causes a reaction) in an **allergy** might be such things as house dust, grass, pets, perfumes, or insect bites, to name a few. These allergens do not usually cause this type of reaction in most persons but do cause an allergic reaction in persons sensitive to them.

Autoimmunity

The immune response attacks itself. In **autoimmunity** (*auto* = self), the body's lymphocytes (white blood cells that produce antibodies) cannot identify the body's own self-antigens, which are harmless. In response, the lymphocytes form antibodies that then attack the body's own cells. Examples of autoimmune diseases include rheumatoid arthritis and rheumatic fever.

Healthy Highlight

General Guidelines for a Healthy Lifestyle

General guidelines for a healthy lifestyle include the following tips:

- Maintain proper body weight.
- Eat a variety of foods.
- Avoid excessive fat, salt, and sugar.
- Eat adequate amounts of fiber.
- Consume alcohol in moderation, no more than two drinks per day for men and one for women.
- Get enough rest and sleep, at least seven or more hours per day.
- Always eat breakfast.
- Maintain a moderate exercise schedule.

Immunodeficiency

The immune response is unable to defend the body due to a decrease or absence of leukocytes, primarily lymphocytes. Persons with **immunodeficiency** are usually asymptomatic (without symptoms) except for recurrent infections. It is these recurrent infections that often lead to death. An example of an immunodeficiency disease is acquired immunodeficiency syndrome **(AIDS)**. Immunodeficiency also can be caused by medications, chemotherapy, or radiation. Organ recipients are intentionally immunosuppressed or immunodeficient to save their transplanted organ. Without immunosuppressant medications, the body's immune system would recognize the organ as foreign and attack it, leading to organ death. This process is called **organ rejection**. Cancer patients often undergo chemotherapy and radiation treatments that can cause immunodeficiency. Some medications also affect the system by depressing its ability to function properly. Chapter 5, "Immune System Diseases and Disorders," discusses the immune system and related diseases in more detail.

Aging

There is no definite age in years when an individual becomes aged. However, some statisticians consider the retirement age of 65 as aged. An individual's body actually begins to age at physical maturity, around age 18, in a complicated process that is not completely understood but is progressive and irreversible. Diseases related to aging are often called **degenerative** diseases. Tissue degeneration is a change in functional activity to a lower or lesser level. Examples of degenerative diseases are degenerative joint disease and degenerative disk disease.

The mechanisms of aging are complex and thought to include such factors as heredity, lifestyle, stress, diet, and environment. One might slow the process of aging to some degree by living a healthy lifestyle and controlling stress and environmental factors.

Hereditary factors can include an increased life span related to an inherited ability to resist disease. Just as families have a history of disease patterns, they also appear to have a pattern of longevity. Thus, individuals who have relatives who live to be in their nineties might themselves live to that age. Individuals with a family history of members who have died of heart disease in their early years might also suffer from the same problem. Although hereditary patterns cannot be controlled, longevity can be increased and disease decreased by controlling lifestyle behaviors that increase the risk of chronic disease.

The body replaces and repairs itself throughout its lifetime, but with aging, this process slows. As early as age 40, there are changes in skin, endocrine function, vision, and muscle strength. Other changes in the aging process might include bone loss leading to osteoporosis, decreased melanin pigment production leading to graying of the hair, decreased immunity leading to an increase in infections and possible development of

Healthy Highlight

Consumer Responsibility in Disease Prevention

Today's consumer should be more health conscious than in the past. Individuals are now expected to take charge of their health care needs and be more informed about health choices. However, this may not be the case with many people. It is recommended that the consumer become more knowledgeable about diseases, medications, and prevention. Unfortunately, many diseases are on the rise in the United States due to a variety of causes. The public needs to be informed about these and to be active in prevention. Diseases on the rise include pertussis, *Shigella* (especially in day-care centers), salmonellosis, *E. coli*, meningococcal infection, tuberculosis, influenza, and streptococcal infections, as well as new viral diseases, such as COVID-19. Epidemics have been common in the past, but most people are not as familiar with pandemics. In these circumstances, the public needs to be kept informed about lifestyle changes that might be needed. Health care providers should help their patients find the most accurate information about these diseases and help them incorporate prevention strategies into their lifestyles.

cancer, a loss of brain and nerve cells that might lead to senile dementia, and a decrease in intestinal motility leading to constipation and possible diverticulosis.

Consider This...

After age 30, the brain loses 50,000 neurons per day, causing a brain shrinkage of approximately one-fourth of a percent (0.25%) each year.

Death

Humans are mortal, so eventually, everyone will die. Even though we are unable to understand the aging process fully, cellular, tissue, and organ deaths can be reviewed in an effort to understand the death of the organism as a whole.

Cellular Injury

Cellular injury and death can be due to some type of trauma, **hypoxia** (high-POCK-see-ah; not enough oxygen), **anoxia** (ah-NOCK-see-ah; no oxygen), drug or bacterial toxins, or viruses. Cells can undergo near-death experiences and actually recuperate in what is considered reversible cell injury.

The ability of the cell to survive depends on several factors, including the amount of time the cell suffers and the type of cell injury that occurred. If the cause of the injury is short term, the cell has a greater chance of survival.

The type of cell also plays a part in its ability to recuperate. The heart, brain, and nerve cells are easily injured and often suffer death. This is particularly important because these cells do not replace themselves. Even short-term injury might readily lead to death in these cells. Other cells are not as easily damaged. Connective and epithelial cells often recuperate and even readily replace themselves by mitosis (cell division).

Cellular Adaptation

Cells that are exposed to adverse conditions often go through a process of adaptation. When the condition is changed, these cells might be able to change back to their normal structure and function. However, some adaptations are permanent, so even if the condition improves, the cells are not able to return to normal. Types of adaptation include **atrophy** (AT-tro-fee), **hypertrophy** (high-PER-tro-fee), hyperplasia, **dysplasia** (dis-PLAY-zee-ah), **metaplasia** (met-ah-PLAY-zee-ah), and **neoplasia** (nee-oh-PLAY-zee-ah).

Atrophy

Atrophy (*a* = without, *trophy* = growth) is a decrease in cell size, which leads to a decrease in the size of the tissue and organ (Figure 2–5). Atrophy is often due to

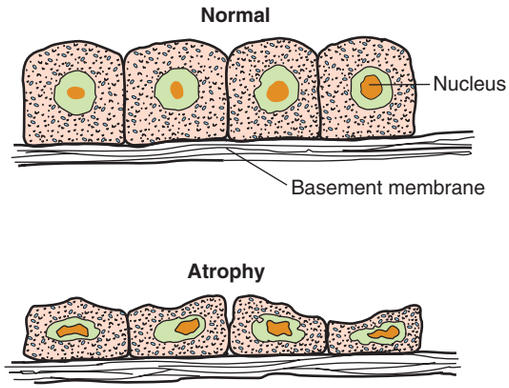


Figure 2–5 Normal cell versus atrophied cell.

the aging process itself or to disease. An example of atrophy related to aging would be the smaller size of the muscles and bones of older people. As the female ages, the breasts and female reproductive organs atrophy, especially after menopause. Examples of disease or pathologic atrophy are usually related to decreased use of the organ, especially muscles. Spinal cord injuries lead to an inability to move muscles. Without use, muscle cells decrease in size, and the muscles atrophy.

Hypertrophy

Hypertrophy (*hyper* = excessive, *trophy* = growth) is an increase in the size of the cell leading to an increase in tissue and organ size (Figure 2–6). Skeletal muscle and heart muscle cells do not increase in number by mitosis. Literally, what an individual has at birth is what the individual has throughout life. This helps explain why some athletes bulk up with exercise while others do not. The inherited number of muscle cells

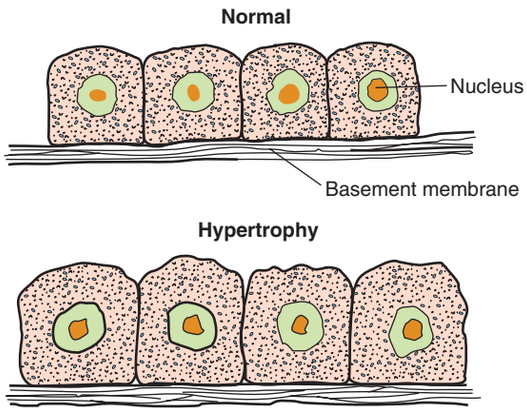


Figure 2–6 Normal cell versus hypertrophied cell.

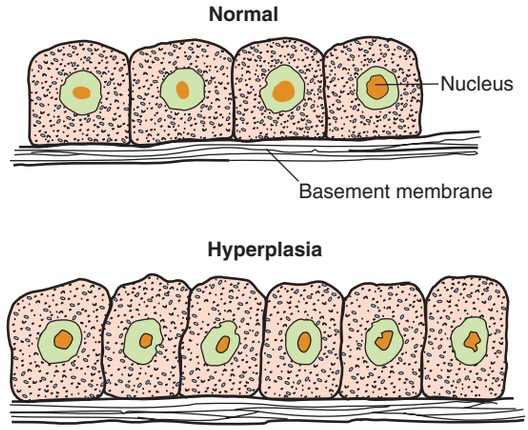


Figure 2–7 Normal tissue versus hyperplasia.

does not change with exercise; only the size of each cell changes. To adapt to an increased workload, muscle cells increase in size. Increased workload on the skeletal muscles causes cellular hypertrophy and an increase in muscle size. Heart muscle hypertrophy is usually seen in the left ventricle of the heart (left ventricular hypertrophy) when the left ventricle must work harder to pump blood through diseased valves and arteries. To adapt to this need, the cells increase in size and the left side of the heart enlarges.

Hyperplasia

Hyperplasia (*hyper* = increased, *plasia* = growth) is an increase in cell number that is commonly due to hormonal stimulation (Figure 2–7). Hyperplasia is discussed in more detail in Chapter 3.

Dysplasia

Dysplasia (*dys* = bad or difficult, *plasia* = growth) usually follows hyperplasia. It is an alteration in size, shape, and organization of cells (Figure 2–8). Dysplastic cells might change back to the normal cell structure if the irritant or stimulus is removed, but usually, these cells progress to neoplasia.

Metaplasia

Metaplasia (*meta* = changed, *plasia* = growth) is a cellular adaptation in which the cell changes to another type of cell (Figure 2–9). An example is the columnar epithelial cells of the respiratory tree, which often change to stratified squamous epithelial cells when exposed to the irritants of cigarette smoking. This protective adaptation might be reversible if the individual quits smoking.

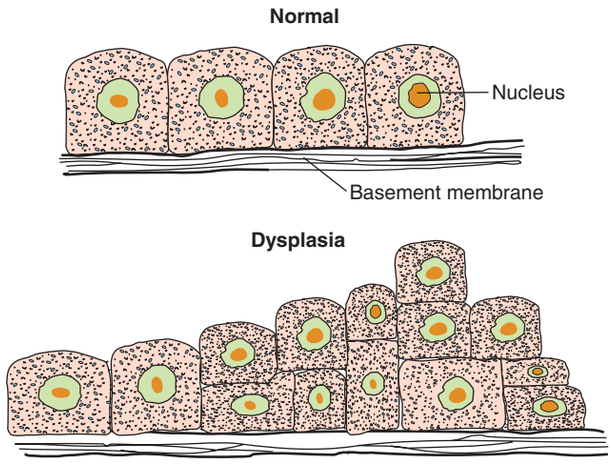


Figure 2–8 Normal tissue versus dysplasia.

Neoplasia

Neoplasia (*neo* = new, *plasia* = growth) is the development of a new type of cell with an uncontrolled growth pattern (Figure 2–10). Neoplasia is discussed in more detail in Chapter 3.

Cell and Tissue Death

Cell death, as previously mentioned, can be caused by trauma, hypoxia, anoxia, drug or bacterial toxins, or viruses. The most common causes of cell death are hypoxia and anoxia.

Cell hypoxia caused by decreased blood flow is called **ischemia** (iss-KEE-me-ah; *isch* = hold back, *emia* = blood). A cell without oxygen cannot produce needed energy and eventually dies.

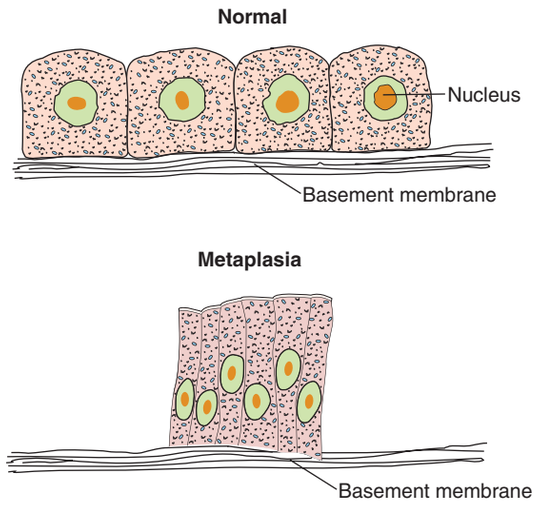


Figure 2–9 Normal tissue versus metaplasia.

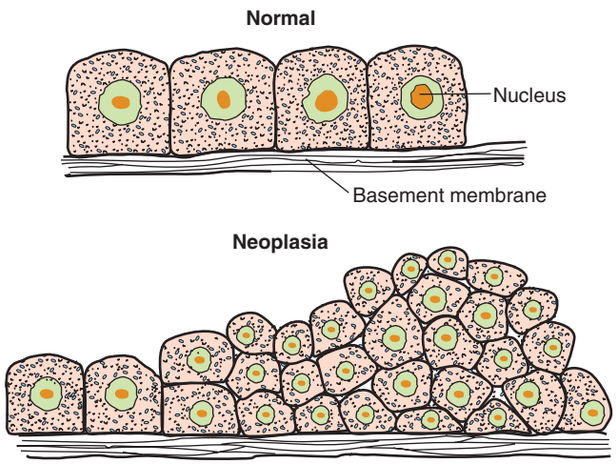


Figure 2–10 Normal tissue versus neoplasia.

Cellular death, called **necrosis** (neh-CROW-sis), can involve a group of cells and, thus, tissue. When referring to dead cells or tissue, one would describe the area as necrotic. When necrosis occurs due to ischemia, the area of dead cells (ischemic necrosis) is called an **infarct** (IN-farkt). Infarcts are commonly due to obstruction of arteries. The most common infarct affects tissues of the heart, leading to a myocardial infarction, or heart attack.

Cells that are injured and not able to recover eventually die. The cause of cell death can be determined by a pathologist because the gross (visible with the eye) and microscopic appearance of the tissue differs with the type of death. There are several types of necrosis, primarily named by the microscopic appearance of the dead cells.

The most common type of necrosis is called coagulation necrosis and is due to cellular anoxia. Coagulation necrosis is the type of cell death experienced with myocardial infarction.

A common alteration in necrosis occurs when saprophytic (dead tissue–loving) bacteria become involved in the necrotic tissue. With this occurrence, the necrotic tissue is now described as gangrenous or having **gangrene** (GANG-green). The type of gangrene can be wet, dry, or gas, depending on the appearance of the necrotic tissue.

Wet gangrene usually occurs when the necrosis has been caused by the sudden stoppage of blood flow, as in the trauma of burning, freezing, or embolism.

Dry gangrene occurs when blood flow has been slowed for a long period of time before necrosis occurred, as in the case of arteriosclerosis and advanced diabetes. In dry gangrene, the tissue is black, shriveled, or mummified. This type of gangrene occurs on the extremities only, primarily on the feet and toes.

Gas gangrene occurs with dirty, infected wounds. The tissue becomes infected with anaerobic (growing without oxygen) bacteria that produce a toxic gas. This is an acute, painful, and often fatal type of gangrene.

Organism Death

Human death can be related to any of the aforementioned causes of disease. The aging process leads to death due to a change in the normal structure of the individual's organs or a decrease in the ability to fight disease. Diseases that would not be lethal in our younger years, such as respiratory infections, can be the cause of death in an older individual.

According to the CDC, the most common cause of death in the United States is heart disease, followed by cancer and strokes (cerebrovascular accident). Although heart disease is the leading cause of death, stroke is the leading cause of serious, long-term disability in the United States. (See Chapter 8, "Cardiovascular System Diseases and Disorders," for more information.)

Many times, the human organism—like the cell—does not die but becomes disabled. Disability is called **morbidity** (state of being diseased). Often, morbidity is so extreme that the individual's quality of life is severely limited. This is often seen in cases of severe brain injury or even in some congenital disorders.

It is very common for individuals to have more than one disease or condition at the same time. When two or more conditions occur at the same time, this is called **comorbidity** and often complicates the individual's ability to heal or overcome the first or primary condition.

Prior to death, major organs such as the heart, lungs, and brain stop functioning. When the brain ceases to function, the individual is considered brain dead. Although death is difficult to define and difficult to determine in some cases, one guideline used is that of brain death. The criteria for determining brain death include

- a lack of response to stimuli.
- a loss of all reflexes.
- an absence of respiration or breathing effort.
- a lack of brain activity as shown by an electroencephalogram.

This issue of defining death and when an individual is actually dead is still controversial in the medical profession.

Summary

Human diseases are caused by heredity; trauma; inflammation, infection, or both; hyperplasias, neoplasms, or both; nutritional imbalances; impaired immunity; or some or all of these. Lifestyle behaviors can also be contributing factors to disease development, as can the aging process. Eventually, all organisms die, and the process of death can occur at the cellular, tissue, or whole-organism level.

Review Questions

Matching

1. Match the cause of diseases in the left column with the example of a disease for that category in the right column.

_____ Heredity	a. Pneumonia
_____ Trauma	b. Motor vehicle accident
_____ Inflammation/infection	c. Cancer
_____ Hyperplasias/neoplasms	d. Obesity
_____ Nutritional imbalance	e. Allergies
_____ Impaired immunity	f. Cystic fibrosis

True or False

2. T F In autoimmunity, the body's immune system attacks itself.

3. T F Some medications used to prevent or cure some diseases can cause immunodeficiency.

4. T F Diseases related to the aging process are called regenerative disorders.

5. T F All congenital disorders are easily recognized at birth.

6. T F Heart and brain cells are easily injured by hypoxia.

7. T F Heredity does not affect the aging process.

8. T F Cellular death occurs only in the event of hypoxia (lack of oxygen).

Short Answer

9. List the factors that affect a cell's ability to survive after injury.

10. How do cells adapt when exposed to adverse conditions?

11. What are the definitions of the following terms?

a. Inflammation _____

b. Infection _____

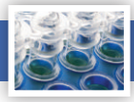
c. Neoplasm _____

d. Immunity _____

12. What are two important habits for a healthy lifestyle?

a. _____

b. _____



Case Studies

■ Cann Ragland, age 29, was seriously injured in a motorcycle accident. He is comatose and on life support equipment to maintain his breathing. He has not improved in 2 weeks with aggressive medical treatment. The family is questioning whether he is alive or dead at this time. What criteria can be used to determine this? What are the issues surrounding this determination? How could you help the family through this difficult time? What resources are available to help people make decisions about end-of-life care?

■ Jessie Leher, age 69, is concerned about her aging status and loss of short-term memory at times. Her sister told her to take *Ginkgo biloba* and CoQ10, over-the-counter herbal products. Jessie has high blood pressure and some circulatory problems. She takes several prescription medications for these disorders and for a couple of other problems, such as arthritis. Should she be cautioned about also taking the herbal remedies? How much should she actually know about her medications? Should health care providers provide more education for patients? Are consumers more interested in knowing about their health care treatments in today's world than in the past? Is that a good change?

3 Neoplasms

Key Terms

Anaplastic (p. 32)
Angiogenesis (p. 29)
Benign (p. 26)
Biopsy (p. 32)
Cachexia (p. 29)
Carcinogen (p. 30)
Carcinogenesis (p. 32)
Carcinoma (p. 27)
Carcinoma in situ (p. 31)
Chemotherapy (p. 39)
Curative (p. 39)
Cytology (p. 38)
Differentiation (p. 28)
Dysplasia (p. 31)
Frozen section (p. 38)
Grading (p. 32)
Hematoma (p. 26)
Hyperplasia(s) (p. 29)
Invasion (p. 26)
Leukemia (p. 26)
Lymphomas (p. 27)
Malignant (p. 26)
Metaplasia (p. 32)
Metastasis (p. 26)
Neoplasm(s) (p. 26)
Palliative (p. 39)
Pap test (p. 37)
Preventive (p. 35)
Radiation (p. 30)
Sarcoma (p. 27)
Staging (p. 32)
Tumor (p. 26)

Learning Objectives

Upon completion of the chapter, the learner should be able to:

1. Define basic terminology used in the study of neoplasms.
2. Explain the system used to classify neoplasms.
3. Compare hyperplasias to neoplasms.
4. Identify the progression of cancer development.
5. State the signs and symptoms of cancer.
6. Identify some common carcinogenic substances.
7. Identify high-risk behaviors for cancer development.
8. State the frequency of cancer development in the population.
9. Describe the curative, palliative, and preventive methods used in cancer treatment.

Overview

Thousands of individuals are diagnosed with neoplasms each year. The diagnostic statement "You have a tumor" often causes instant fear, dread, and tears for the individuals and families involved; few statements in our society carry the emotional impact this one does. To most people, this diagnosis is equivalent to a pronouncement of death. But not all tumors are malignant, and not all are deadly. However, more than 1.8 million individuals are diagnosed with malignant neoplasms each year. This includes all types of cancers. Approximately 1,640 die each day, with

over a half-million deaths per year in the United States. However, the death rate of cancer dropped 26% in the past 20 years. Lung cancer is the leading cause of cancer death. After lung cancer, prostate cancer is the most commonly diagnosed cancer among men, whereas breast cancer is the most commonly diagnosed type in women (Centers for Disease Control and Prevention [CDC], 2020). Cancer can be diagnosed using a variety of diagnostic tests, and treating cancer is most successful when the cancer has been diagnosed early. Individuals can reduce their risk of developing some types of cancer by following preventive measures recommended by the American Cancer Society. ■

Terminology Related to Neoplasms and Tumors

The term **neoplasm** (NEE-oh-plazm; *neo* = new, *plasm* = growth) means "a new growth." The term **tumor** may be defined simply as "a swelling" or as "a neoplasm." *Tumor* is used as a sign of inflammation and, in this instance, describes swelling. The term *tumor* as related to neoplasm means "a new growth." Even though the terms *tumor* and *neoplasm* are used synonymously, not all neoplasms form tumors (Table 3–1). For instance, **leukemia** (loo-KEE-me-ah; *leuk* = white, *emia* = blood) is a malignant disease of the bone marrow that causes an increase in white blood cell production and might not form distinctive tumors. Likewise, not all tumors are neoplasms—a **hematoma** (HEM-ah-TOH-mah; *hemat* = blood, *oma* = tumor) is a large tumor or swelling filled with blood, commonly called a bruise or contusion (Figure 3–1).

Classification of Neoplasms

Neoplasms may be classified in a variety of ways. Two of the most common ways are according to the (1) appearance and growth pattern and (2) tissue of origin, or type of body tissue from which they grow.

Appearance and Growth Pattern

Classification by appearance and growth pattern identifies neoplasms (tumors) as **benign** (beh-NINE) or **malignant** (mah-LIG-nant).

TABLE 3–1 Neoplasm vs. Nonneoplasm

Neoplasm—new growth	Swelling: Can be called tumor
	No swelling: No tumor, but is a neoplasm—e.g., leukemia
Non-neoplasm	Swelling: Hematoma, inflammation

Courtesy of Mark L. Kuss

Figure 3–1 Hematoma.

Benign Neoplasm

Neoplasms that are confined to a local area and do not spread are called benign. Benign neoplasms are more commonly called tumors. They are generally harmless unless they are growing in a confined space such as the brain.

Malignant Neoplasm

Malignant (deadly) neoplasms are so named because they exhibit characteristics of invasion and metastasis. **Invasion** refers to the spreading of the neoplasm into the local or surrounding tissue. **Metastasis** (meh-TAS-tah-sis) is the spread of the neoplasm to distant sites. The general term for any malignant neoplasm is *cancer*.

Tissue of Origin

Neoplasms are classified or named according to the tissue from which they grow along with the suffix *-oma* for tumor. A benign tumor will have the suffix *-oma* added after the name of the tissue. An example would be lipoma, a benign tumor of fatty tissue. A malignant neoplasm will have the term **carcinoma** (KAR-sih-NO-mah) or **sarcoma** (sar-KOH-mah) added to the name of the tissue type.

Epithelial Tissue (Skin or Gland)

A benign tumor of epithelial tissue such as a gland would be adenoma; if it is a malignant neoplasm, the name becomes adenocarcinoma. *Carcinoma* denotes the largest group of malignant neoplasms and indicates a tumor of epithelial tissue found on external or internal body surfaces.

Connective Tissue (Bone, Muscle, or Fat)

A benign tumor of connective tissue such as bone would be an osteoma; if it is a malignant neoplasm, the name is osteosarcoma—*sarcoma* is the term used if the neoplasm is from connective tissue such as muscle, fat, and bone. Sarcomas are less common than carcinomas but spread more rapidly and are highly malignant.

Lymphatic or Blood-Forming Tissue

Lymphomas (lim-FOH-mas) and leukemias are malignant neoplasms of lymphatic and blood-forming organs and lymphatic tissues, respectively. These malignant neoplasms do not have benign counterparts. All leukemias and lymphomas are malignant, although their prognoses can vary considerably (Figure 3–2).

Other Tissues

Some tumors, of course, do not follow this pattern. For example, malignant melanoma, a malignant neoplasm of melanocytes (skin cells), is not a benign tumor, as its name would suggest. *Glioma* refers to all tumors of the glial cells of the brain, but gliomas do not fit truly the terms of this classification system. They are benign in appearance and do not metastasize, but they are malignant (deadly) because most are fatal. Examples of benign and malignant neoplasms are listed in Table 3–2.

Growth of Benign and Malignant Neoplasms

Normal cells grow and function for a purpose and are regulated by several factors. First, the built-in genetic program of each cell regulates its growth pattern. Second, normal cellular growth is limited by contact with other cells. When two normal cells come in contact with one another, they tend to stick together and transmit a signal, called contact inhibition, to each other to stop growing (Figure 3–3).

Finally, normal cellular growth is regulated by growth-promoting or growth-inhibiting substances. When the normal cells stop growing, they begin performing their specialized function. For example,

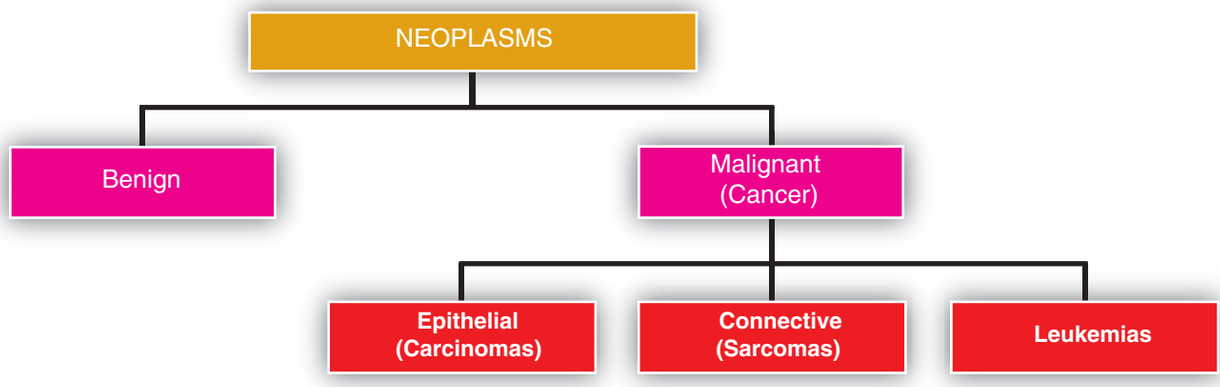


Figure 3–2 Classification of neoplasms.

TABLE 3–2 Origins and Names for Benign and Malignant Neoplasms

Cell or Tissue of Origin	Name of Benign Neoplasm	Name of Malignant Neoplasm
Glandular epithelium	Adenoma	Adenocarcinoma
Squamous epithelium	Epithelioma	Squamous cell carcinoma
Adipose (fat)	Lipoma	Liposarcoma
Cartilage	Chondroma	Chondrosarcoma
Bone	Osteoma	Osteosarcoma
Glial cell		Glioma
Blood		Leukemia

epithelial cells begin functioning to cover and protect the organism, whereas bone cells function to provide structure and support. This process of individual specialization is called **differentiation** (Figure 3–4).

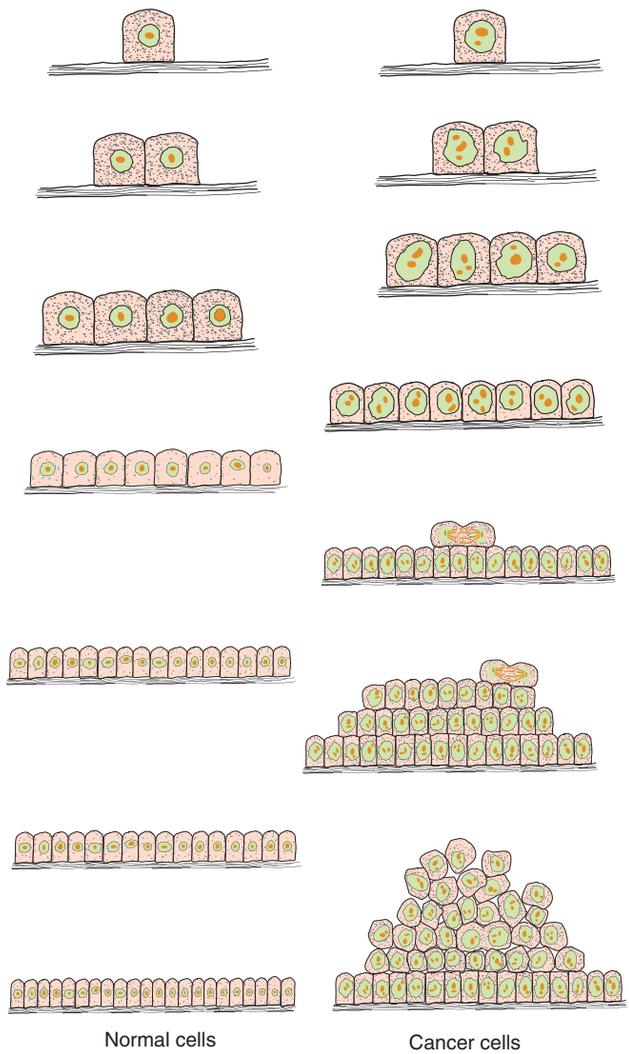


Figure 3–3 Cellular growth patterns.

Benign Neoplasm Growth

Benign neoplasm or tumors might retain some normal structure and function. These cells often resemble cells of their origin, and even though they have an abnormal appearance, their appearance is uniform. Benign neoplasms also can function to some degree like normal cells. They are encapsulated, or covered with a capsule-like material, that makes removal or excision easier. These tumor cells have a limited growth potential and are slower growing than metastatic neoplasms.

Benign neoplasms are expansive (grow and enlarge in the area) but are not invasive or metastatic. This does not mean that benign tumors are harmless. The presence and growth of any tumor can obstruct passageways such as those in the digestive and respiratory systems, leading to difficulty with eating or breathing.

Tumors also can exert pressure on nerves, causing pain and loss of sensation or movement. Benign tumors affecting a gland might cause an over- or under-secretion of hormones, with resulting disorders. A benign tumor growing in an enclosed area such as the brain can place pressure on normal tissue, leading to the death of the tissue and, potentially, the death of the individual.

Malignant Neoplasm Growth

Malignant neoplasms are cells whose growth pattern has no purpose and is uncontrollable. Neoplastic cells grow autonomously or independently of growth factors. These cells grow excessively, without regard to normal regulatory factors, such as contact inhibition.

Malignant neoplastic cells do not have the structure or function of the cells of their origin. Unlike benign tumor cells, neoplastic cells do not look alike. Their structure is not uniform but rather is haphazard and

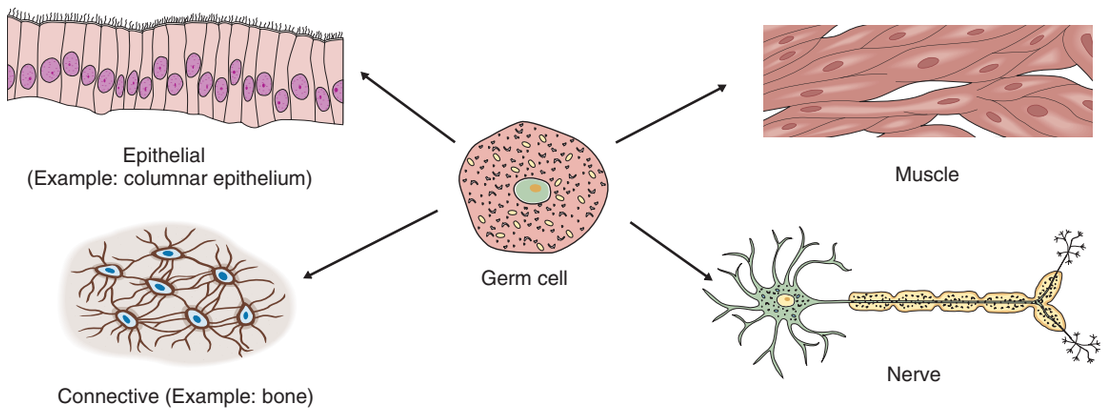


Figure 3–4 The process of cell differentiation.

inconsistent. They are not differentiated and do not perform specialized functions. The surface area of the malignant neoplasm is not encapsulated. Rather, it is more crab-like in appearance, with multiple claw-like extensions that invade surrounding tissue. A malignant neoplasm (cancer) also metastasizes to distant areas or organs. A comparison of benign and malignant neoplasms is listed in Table 3–3.

Cancer (malignant neoplasm) cells are fast growing. The entire metabolism of the cancerous cell is aimed at rapid reproduction and growth, far outpacing the growth of the normal cell, and leads to an increase in the need for nutrients and oxygen. To meet this need, **angiogenesis** (AN-jee-oh-JEN-eh-sis; *angio* = vessel, *genesis* = growth or new growth of blood vessels) occurs to increase blood flow, providing increased nutrients to the neoplasm and allowing it to continue this rapid, uncontrolled growth. During this time, normal cells are deprived of needed nutrients, and the individual begins to lose weight and appear thin, frail, and weak, a condition called **cachexia**.

Consider This...

Fight cancer with bright-colored fruits and vegetables—the brighter the color, the higher the antioxidant content. Blueberries, other bright-colored berries, red cabbage, and eggplant, to name a few, are good sources of antioxidants. These bright-colored foods are thought to not only stop tumor growth but also kill tumor cells.

Hyperplasias and Neoplasms

It is important to note that there is another type of cellular growth that closely resembles a neoplasm. **Hyperplasia** (HIGH-per-PLAY-zee-ah; *hyper* = too much, *plasia* = growth) and neoplasia (*neo* = new, *plasia* = growth) are both overgrowths of cells that cause an increase in the size of the tissue.

TABLE 3–3 Comparison of Benign and Malignant Neoplasms

Feature	Benign	Malignant
Growth	Slow, expansive	Fast, invasive, metastatic
Appearance	Symmetrical	Crab-like
Capsule	Yes	No
Tissue type	Resembles tissue of origin	Does not resemble tissue of origin
Cells	Differentiated	Undifferentiated
Surface	Smooth	Irregular, may ulcerate and hemorrhage

Both commonly produce masses that, once discovered, must be identified as either hyperplasia or neoplasm because the treatment of each is drastically different. Hyperplasias and neoplasms differ in the cause and extent of their growth.

Hyperplasias

Hyperplasia usually occurs in response to a stimulus, and the growth stops when the stimulus stops. Hyperplasias can be caused by a variety of stimuli. An example of a hyperplasia caused by tissue irritation is a skin callus on the foot; the stimulus is the irritation or rubbing of a shoe on that particular area. When the shoe size is corrected, the stimulus ends, the hyperplasia stops, and the callus eventually disappears.

Hyperplasias can develop due to hormone excess or deficiency, such as the hormone-deficiency hyperplasia causing enlargement of the thyroid gland, called goiter. Chronic inflammation can also lead to hyperplasia, as in lymph node hyperplasia or adenoid hyperplasia. Finally, hyperplasia can be caused by an unknown stimulus, as in the case of prostatic hyperplasia in older men.

Hyperplasias are an increase of cells that look like cells of their origin. To simplify this concept, one might consider the cells as daughter cells that still look like their mother (Figure 3–5).

Neoplasms

Hyperplasias and neoplasms both represent an increase in cell number, but neoplasms grow independently, excessively, and usually unceasingly.

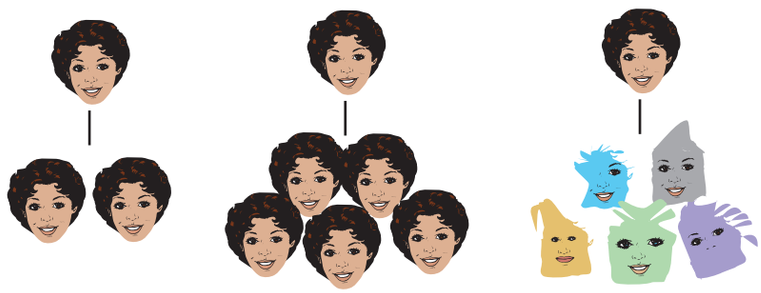
Neoplasms are not only an increase in cell number but new (*neo* = new) or different in their appearance from their cell of origin, or mother, unlike hyperplasia. This difference in appearance is important to the clinical pathologist who determines or diagnoses the mass as hyperplasia or neoplasm.

Development of Malignant Neoplasms (Cancer)

Genetic alteration is the basis for the development of malignant neoplasm, or cancer. Cells throughout the body can undergo genetic alteration or mutation, but amazingly, few develop into cancer. A cell must undergo a change or series of changes in its DNA structure to acquire the altered growth pattern of cancer. Genetic mutation or change is brought about by a virus, chemicals, **radiation** (the process of using light, short waves such as ultraviolet or X-ray), or other biologic agent called a **carcinogen** (kar-SIN-oh-jen; *carcino* = cancer, *gen* = arising), or cancer-causing agent or substance.

Continued exposure to a carcinogen or to several carcinogens can increase or promote the abnormality of the cell. Abnormal cells might revert to normal cells, appear as benign tumors, or digress to a malignant neoplasm. The body's immune system might prevent or reverse the development of cancer. Just removing or stopping the carcinogen can also reverse cancer development.

If development is not halted, abnormal cells begin to establish themselves in an effort to become cancerous and must now grow rapidly enough to establish a site. They must fight for space and nutrition, so the body and the abnormal cells are at odds with each other at



	Normal	Hyperplastic	Neoplastic
Cell Number	Normal	Increased	Increased
Cell Appearance	Normal like tissue of origin	Normal like tissue of origin	Abnormal not like tissue of origin

Figure 3–5 Comparison of hyperplasia and neoplasm.

this point. If the body wins, the abnormal cells might die out and disappear. If the abnormal cells attain the upper hand, they can become established and thrive.

As long as the abnormal cells are not firmly established, they are considered pre-neoplastic or precancerous. If these cells are discovered at this point, surgical removal can occur before cancer actually develops. Unfortunately, very few potential cancers are discovered at this stage. Squamous epithelial tissue often progresses through a slow series of changes, including hyperplasia, abnormal hyperplasia called **dysplasia** (DIS-PLAY-zee-ah), and, finally, a stage called **carcinoma in situ**.

In carcinoma in situ, the atypical cells are "just sitting" in the epithelial layer of the tissue and have not broken through the basement membrane and invaded the surrounding tissue. Carcinoma in situ commonly occurs in the uterine cervix, larynx, and mouth. Cancer can be avoided at this stage by surgical removal of the dysplasia, or in situ tumor.

The final stage in cancer development is the invasion by the precancerous cells into the surrounding tissue, signifying a change from precancerous to malignant neoplasm. In epithelial tissue, this is the point at which neoplastic cells (carcinomas) break through the basement membrane that separates the epithelium from the connective tissue below (Figure 3–6). When this break occurs, the neoplastic cells can spread quickly, not only with local tissue invasion but also via the lymphatic system (lymph fluid) and circulatory system (blood).

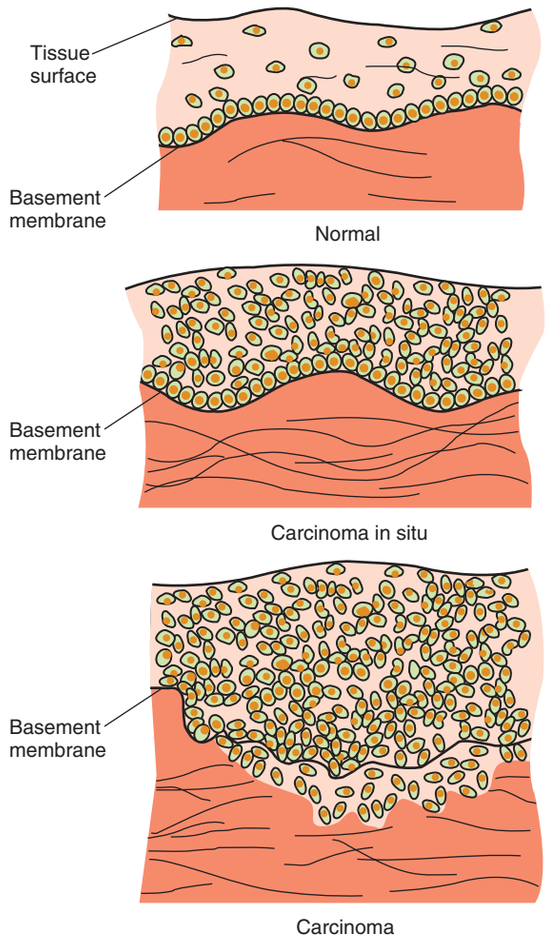


Figure 3–6 Normal, carcinoma in situ, and carcinoma tissue.

Invasion by and Metastasis of Cancer

Local invasion by cancer is similar to the way plants sink their roots into the soil. The fingerlike projections of the neoplasms force themselves along the lines of least resistance. Pressure from the growing tumor occludes blood supply, leading to local tissue necrosis, weakening the tissue, which eases further spread of the neoplasm.

The spread of cancer from this primary location or site to secondary sites in the body is called metastasis. Cancer cells are carried, or metastasized, through the lymphatic system or through the blood. In some cases, metastasis occurs by seeding or spreading within a cavity.

Lymphatic System Metastasis

Carcinomas—epithelial tissue neoplasms—commonly spread through the lymphatics or lymphatic system. Because lymph nodes can catch or filter cancer cells, lymph nodes are commonly removed surgically and examined for the presence of cancerous cells. Lymph nodes near the tumor are generally the first to filter cancerous cells. As more and more neoplastic cells spread into the lymphatic system, the filters fill with neoplastic cells and, eventually, the nodes become full and unable to filter more cells. When this occurs, the neoplastic cells can spill over into the bloodstream.

The absence of lymph node involvement with cancer is a favorable sign and can mean that surgical cure is possible. Usually, the higher the number of lymph nodes involved, the poorer the chance of survival.

Bloodstream Metastasis

Sarcomas do not use the lymphatic system as readily as carcinomas (Table 3–4). These tumors shed neoplastic

TABLE 3–4 Comparison of Carcinomas and Sarcomas

Feature	Carcinoma	Sarcoma
Tissue	Epithelial	Connective
Occurrence	Very common	Less common
Growth	Slow	Rapid
Metastasis	Primarily through lymph	Primarily through blood

cells directly into the blood, by which they can be widely distributed throughout the body. Common sites of bloodstream metastasis are the liver, lungs, and brain. Frequently, and unfortunately, it is the secondary cancer site that is discovered first.

Cavity Metastasis

Metastasis can also occur by invasion and implantation within a serous (watery or fluid-filled) cavity. When neoplastic cells reach a serous cavity such as the pleural or peritoneal cavity, they can seed and implant freely within that cavity.

Grading and Staging of Cancer

Grading and **staging** of malignant tumors are used to plan treatment and predict the possibility of a cure. Grading determines the degree of abnormality of the neoplasm. Determining the degree of spread is called staging.

Grading

Grading is the microscopic examination of the tumor to determine the degree of differentiation. The more differentiated the tumor, the more it looks like the tissue of its origin. The more abnormal the tissue appears in comparison to its normal tissue, the more undifferentiated or **anaplastic** (AN-ah-PLAST-ic) it is. The higher the degree of differentiation, the better the prognosis.

Tumors that are undifferentiated or anaplastic do not resemble the tissue of origin, are highly malignant and offer a poor prognosis. Tumors are typically placed into grades from I to IV. Grade I tumors are the less aggressive and serious, whereas grade IV tumors are the most aggressive and serious in nature.

Staging

Determining the extent of the spread of the neoplasm is called staging. Clinical examination, X-rays, **biopsy** (BYE-op-see; removing a small piece of tissue for microscopic examination), and surgical exploration can be used to evaluate the degree of spread. Tumors can be placed in stages according to a numerical system (I–IV), much like the system described for grading.

A second, more detailed staging is the TNM system. In this system, tumors are staged according to the size and extent of the primary tumor, the number of lymph nodes involved, and metastasis to other sites.

Grading and staging are two predictors of prognosis. Of the two predictors, staging is the better indicator.

Causes of Cancer

Unfortunately, the actual cause of most cancer is unknown. Cancer appears to occur due to a variety of circumstances, which suggests that more than one factor is involved in its development. One thing remains constant in the development of cancer: the genetic alteration that allows the cell to grow independently and uncontrollably. It is thought that cellular mutations actually occur frequently in humans. It is further theorized that the human immune system catches and destroys these abnormal cells as soon as they occur. So, in some respects, cancer might represent some failure of the immune system in the individual. The prevention and cure of cancer will depend on finding the initiating agents that cause the genetic alteration in the cell or the event that causes an altered cell to become malignant. Currently, hundreds of carcinogenic compounds have been identified.

The process of **carcinogenesis** (KAR-sin-oh-JEN-eh-sis; cancer development) in an individual might take many years to develop, might stop and start, or might even be reversed, but usually there will be a continual progression of cellular changes from hyperplasia to dysplasia to **metaplasia** (MET-ah-PLAY-zee-ah) to neoplasia (Figure 3–7).

Chemical Carcinogens

Chemical carcinogenesis is quite complex. The frequency of exposure and the strength or potency of the chemical are important factors in the development of cancer. Chemicals that do not cause a problem by themselves might enhance cancer development when used in combination with other chemicals.

Chemical carcinogens abound in our environment, and exposure to certain chemicals used in industry can lead to cancer among workers. For instance, naphthylamine, found in certain types of dye, has been found to cause bladder cancer; asbestos, previously used in roofing and insulating materials, has been identified as a

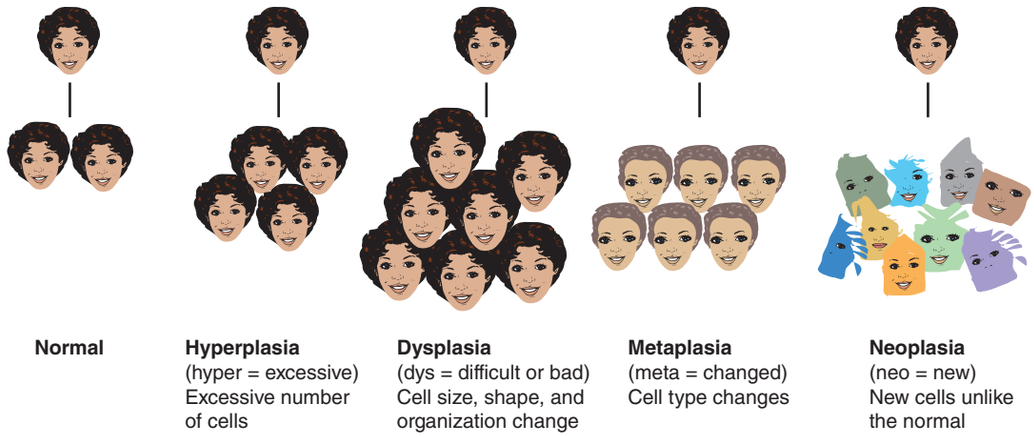


Figure 3–7 Cellular changes progressing to neoplasm.

carcinogen leading to lung cancer. Miners of nickel ore have a high rate of nasal cancer, and farmers using arsenic as an insecticide often suffer from skin and lung cancers.

Currently, chemicals used as food additives, cosmetics, and certain plastics are the focus of intensive research investigating the possible relationship of these chemicals to cancer.

Hormones

Hormones can increase the incidence of cancer, yet, at times, hormones can be used as a form of cancer treatment. The action of hormones as related to cancer is not clearly understood. For example, a benign mole normally does not become malignant until sex hormones increase at puberty, but the administration of diethylstilbestrol, a synthetic estrogen compound, to pregnant women during the 1940s and 1950s led to an increase in a rare vaginal adenocarcinoma in their female children and to testicular abnormalities in their male children.

Excessive production of estrogen in the female can lead to cancer of the breast and uterus. Estrogen medication used to treat menopausal symptoms in women has been shown to lead to an increase in endometrial cancer. The ovaries are sometimes removed after a female has breast cancer in an effort to decrease the stimulation of other possible tumors.

Although much research has been done to correlate cancer with birth control pills, the findings are inconclusive. The most widely used combination pill, combining estrogen and progestin, a synthetic form of progesterone, might actually decrease the risk of ovarian and endometrial cancer.

Cancer of the prostate is stimulated by the male hormone testosterone but is slowed or inhibited by estrogen treatment. Males who suffer with prostatic cancer can undergo treatment with estrogen medication to counteract the effects of testosterone. Treatment to decrease testosterone production might also include an orchiectomy—removal of the testes—in an effort to decrease or slow the growth of the prostatic tumor or decrease stimulation of other possible tumors.

Radiation

Ultraviolet (UV) radiation, X-radiation, and radioactive materials are all known carcinogens. More than 5 million cases of skin cancer are diagnosed each year (National Cancer Institute, 2014). Sunbathers, farmers, fishermen, construction workers, mariners, and anyone else with extended exposure to the UV rays of the sun or tanning lights have an increased risk of developing basal or squamous cell carcinomas. Although basal and squamous cell carcinomas tend to occur from cumulative exposure to the sun, melanoma occurs more frequently due to extreme, blistering burns at a young age. Fair-skinned people are at the greatest risk for skin cancer because they lack the protective effects of melanin. UV-related skin cancer is uncommon among the black population.

X-rays have been used extensively as a diagnostic tool since their discovery by Wilhelm Roentgen in 1895. Radiologists commonly developed cancers before the correlation of radiation and cancer—Roentgen himself developed skin cancer. In the late 1800s, radiation dosage was determined by taking repeated X-rays