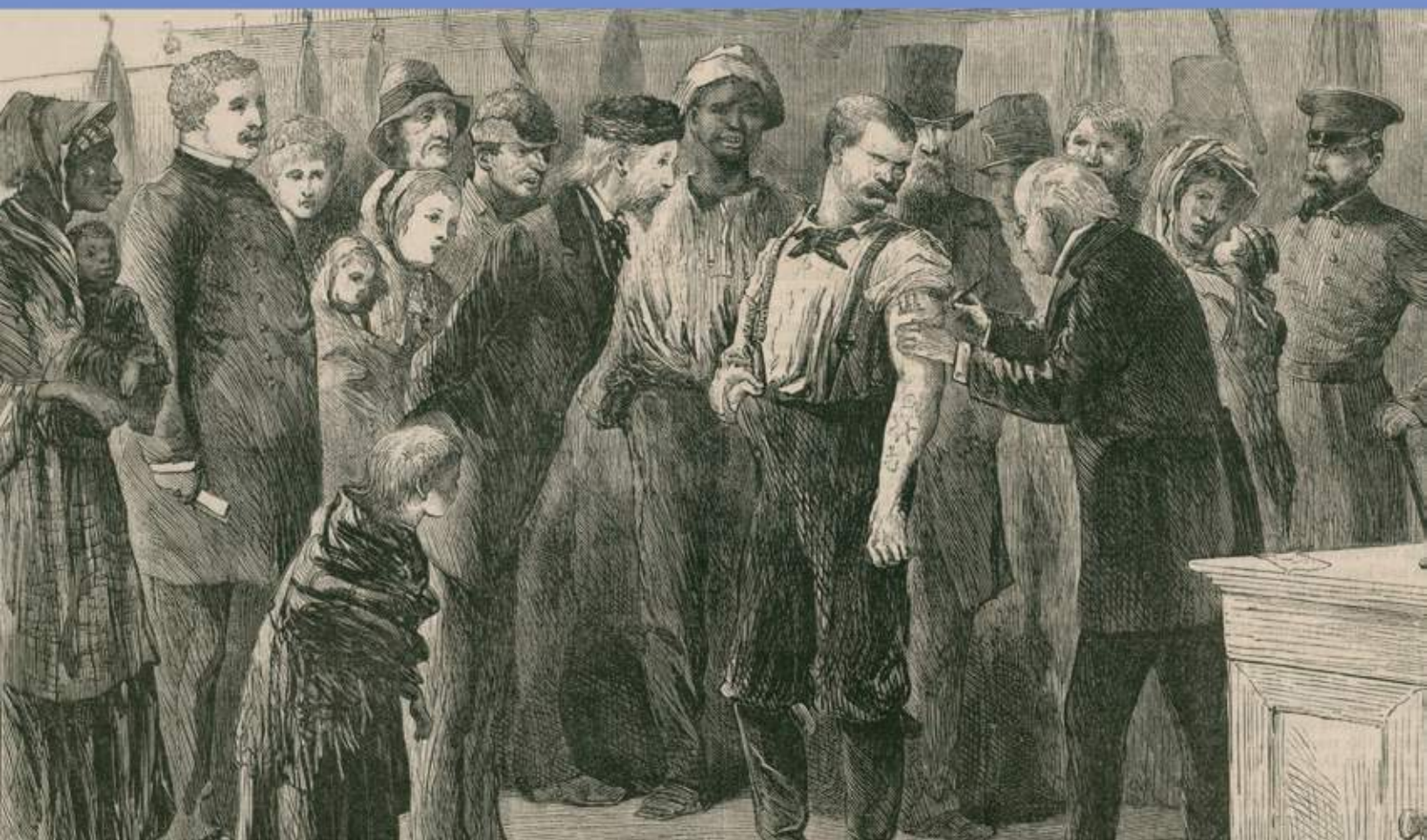
INTRODUCTION TO HUMAN DISEASE

Pathophysiology for Health Professionals

SEVENTH EDITION

AGNES G. LOEFFLER | MICHAEL N. HART



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SEVENTH EDITION

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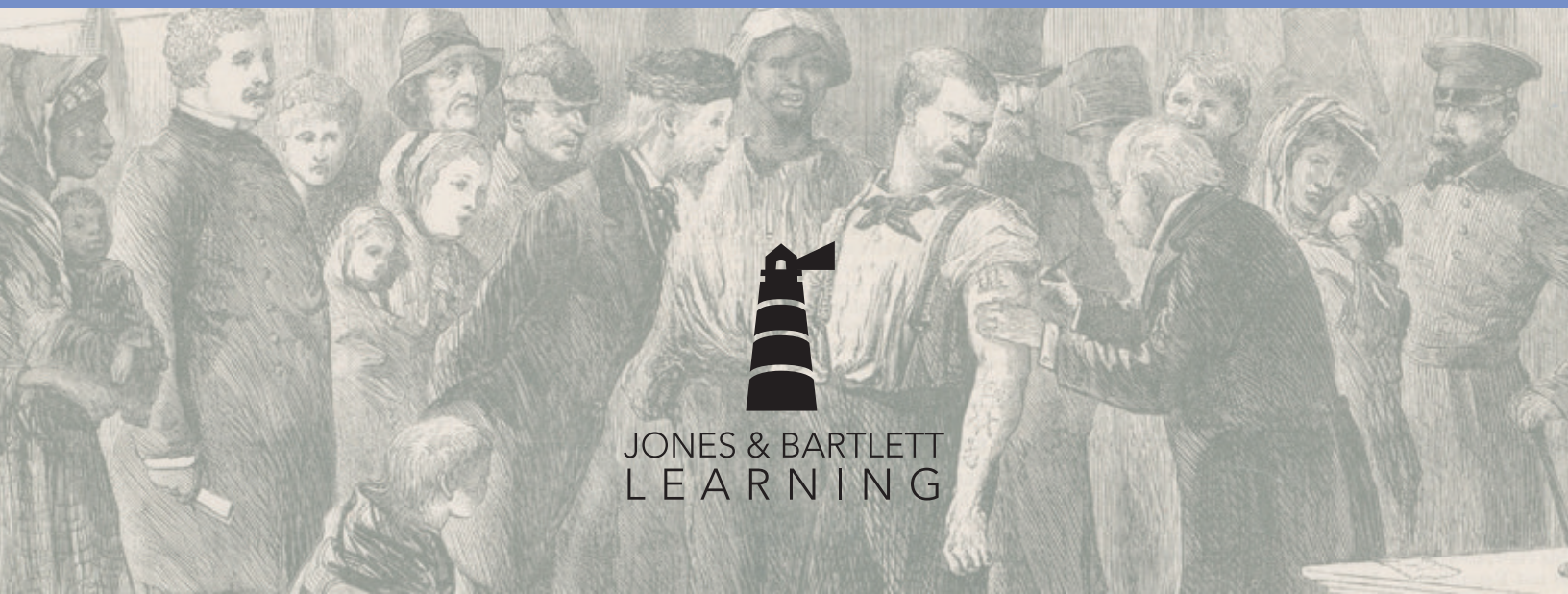

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This book is dedicated to students beginning their careers in the allied health sciences.

Brief Contents

Contents

Preface

The scope and purpose of this text have not changed since it was first published in 1979, and the intentions expressed in the preface to the first edition are just as applicable to the Seventh Edition. *Introduction to Human Disease: Pathophysiology for Health Professionals* introduces the basic principles of disease to allied health professions students. Our intent is to provide comprehensive information on all aspects of human disease with minimal requirements for prerequisite knowledge. Over the course of the previous six editions, we have noticed that lay people and medical students—overwhelmed by the volumes of detailed and technical information delivered to them in print and, increasingly, on the Internet—turn to this text for a basic outline of how the health profession approaches particular diseases or where a specific disease fits into the medical nosological scheme. While we are happy they derive benefit from the discussions of diseases laid forth in this text, the intended readership is students wishing to pursue a career in nursing, pharmacy, dentistry, physical or occupational therapy, nutrition, or other allied health professions fields who require a broad understanding of disease epidemiology, cause, diagnosis and treatment, and a basic grounding in the specialized medical lexicon.

We have been pleased by the continued use of previous editions by instructors who teach pathology courses to a variety of allied health professions students. We believe all health professions students have a need for a common vocabulary and a broad-based understanding of human disease. Thus, we define terms as clearly and specifically as possible and attempt to describe the most common and important diseases of humans, including mental illnesses. In fact, a special effort is made in this text's format to make the reader aware of the most frequent and significant diseases in each organ category.

The basic format of this text, which has made it so popular over the course of editions, has been retained, including the comprehensive list of learning objectives at the beginning of each chapter and a set of practice questions at the end of each chapter. Each chapter has been critiqued by pathophysiology instructors for content, accuracy, and presentation. Based on reviewers' and readers' suggestions for each successive edition, we have added more clinical information, including general and specific treatments for diseases. Consequently, although *Introduction to Human Disease* remains primarily a pathology text, the clinical information provides a more comprehensive foundation for the reader.

New to the Seventh Edition

In this Seventh Edition, new illustrations have been added, and the content has been updated to reflect the current state of medical knowledge and practice. Specifically,

- Previous edition Chapter 5, Hyperplasias and Neoplasm, and Chapter 6, Cancer, are now combined into one chapter—Chapter 5, Neoplasia.
- Chapter 16, Kidney, Lower Urinary Tract, and Male Genital Organs, has now been split into two new chapters—Chapter 15, Kidney and Lower Urinary Tract, and Chapter 16, Male Genital Organs.

How This Text Is Organized

This text is divided into four sections:

- **Section I** provides fundamental vocabulary and concepts, a broad analysis of the most common and significant diseases, and a discussion of the tools and processes of diagnosis.
- **Section II** provides a framework for the basic types of human disease: reactions to injury, neoplasia, genetically determined disease, and intrauterine injury.
- In **Section III** each chapter discusses the diseases of a specific organ system. We review the anatomy and physiology of that organ, provide an overview of the most frequent and important diseases encountered, discuss diagnostic techniques (symptoms, signs, laboratory tests, and radiological and clinical procedures), profile the diseases, and discuss the consequences of failure of the organ to function.

- **Section IV** presents diseases that tend to affect multiple organs and share causative mechanisms within each group. Included topics are infections, immune reactions, external injury by physical and chemical agents, and disorders caused by nutritional deprivations and excesses. We believe these chapters are easier to learn after diseases of the organs have been studied; however, they can be inserted earlier in a course without any prerequisites other than Sections I and II.

We hope that this Seventh Edition continues to be of use to students embarking on a career in the allied health professions. The sheer volume of medical knowledge can appear overwhelming, and the technical vocabulary used can seem like a foreign language to students at the beginning of their studies. By reading and studying the content in *Introduction to Human Disease*, students should be well on their way to gaining the basic foundation they need for a rewarding and exciting career in medicine.

How to Use This Text

Pedagogy

Introduction to Human Disease: Pathophysiology for Health Professionals, Seventh Edition, incorporates a number of engaging pedagogical features to aid in the student's understanding and retention of the material.

CHAPTER 16

Male Genital Organs

OUTLINE

Review of Structure and Function
Most Frequent and Serious Problems
Symptoms, Signs, and Tests
Specific Diseases
Genetic/Developmental Diseases
Inflammatory/Degenerative Diseases
Hyperplastic/Neoplastic Diseases
Benign Prostatic Hypertrophy
Adenocarcinoma of the Prostate
Cancers of the Testis
Penile Cancer
Organ Failure
Practice Questions
References

OBJECTIVES

1. Review the structure and function of the male genital tract.
2. Recognize some of the most common medical diseases and cancers of the male genital tract.
3. Describe some of the surgical interventions that can be performed on the male genital tract.
4. Describe the roles of radiography, physical examination, biopsy, and the serum PSA in the diagnosis of diseases of the male genital tract.
5. List and describe the most common congenital conditions of the male genital tract.
6. Name the most common infectious diseases affecting the male genital tract, and describe how they come to clinical attention and how they are managed.
7. Name the three most common sexually transmitted diseases in men, and describe their incidence, symptoms, and systemic manifestations.
8. Describe testicular torsion: how does it happen, and who is at risk for developing it?
9. Compare prostatic hyperplasia and prostatic carcinoma in terms of causes, lesions, manifestations, treatment, and possible complications.
10. Compare and contrast carcinomas of the prostate, testis, and penis in terms of incidence, age at diagnosis, stage at diagnosis, 5-year survival, treatment, methods of detection, and risk factors.
11. Define Gleason score and describe its importance in estimating prognosis in prostate cancer.
12. Define "male factor infertility," and describe its importance in the workup of the infertile couple.
13. Define "sexual dysfunction," and list its possible causes.
14. Define and use in proper context all words and terms in headings and in bold print in this chapter.

KEY TERMS

bacterial prostatitis
benign prostatic hypertrophy
chlamydia
corpus spongiosum
corpora cavernosa
cryptorchidism
digital rectal examination
epididymis
glans penis
Gleason score
gonorrhea
hydrocele
hypospadias
inguinal hernia
Leydig cells
male factor infertility
mumps orchitis
orchiectomy
penis
prepuce
prostate cancer
prostate gland
prostate specific antigen
seminal vesicles
seminiferous fluid
seminiferous tubules
seminoma
syphilis
testicular torsion
testis
transrectal ultrasound
varicocele
vas deferens

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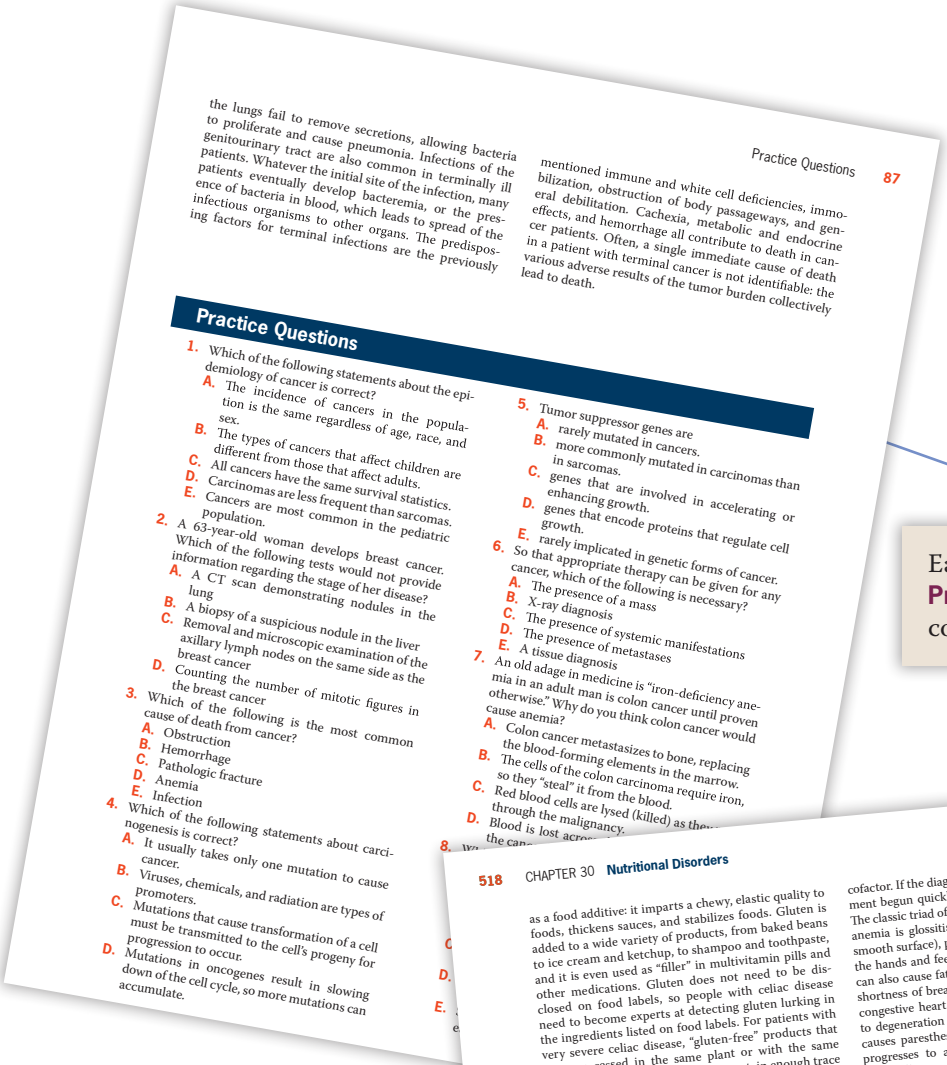
Each chapter begins with a framework for learning the most important topics covered, utilizing an **Outline** of material to be discussed, a list of learning **Objectives**, and an inventory of the **Key Terms** defined in the content.



the lungs fail to remove secretions, allowing bacteria to proliferate and cause pneumonia. Infections of the genitourinary tract are also common in terminally ill patients. Whatever the initial site of the infection, many patients eventually develop bacteremia, or the presence of bacteria in blood, which leads to spread of the infectious organisms to other organs. The predisposing factors for terminal infections are the previously mentioned immune and white cell deficiencies, immobilization, obstruction of body passageways, and general debilitation. Cachexia, metabolic and endocrine effects, and hemorrhage all contribute to death in cancer patients. Often, a single immediate cause of death in a patient with terminal cancer is not identifiable: the various adverse results of the tumor burden collectively lead to death.

Practice Questions 87

Practice Questions

1. Which of the following statements about the epidemiology of cancer is correct?
   A. The incidence of cancers in the population is the same regardless of age, race, and sex.
   B. The types of cancers that affect children are different from those that affect adults.
   C. All cancers have the same survival statistics.
   D. Carcinomas are less frequent than sarcomas.
   E. Cancers are most common in the pediatric population.
2. A 63-year-old woman develops breast cancer. Which of the following tests would not provide information regarding the stage of her disease?
   A. A CT scan demonstrating nodules in the lung
   B. A biopsy of a suspicious nodule in the liver
   C. Removal and microscopic examination of the axillary lymph nodes on the same side as the breast cancer
   D. Counting the number of mitotic figures in the breast cancer
3. Which of the following is the most common cause of death from cancer?
   A. Obstruction
   B. Hemorrhage
   C. Pathologic fracture
   D. Anemia
   E. Infection
4. Which of the following statements about carcinogenesis is correct?
   A. It usually takes only one mutation to cause cancer.
   B. Viruses, chemicals, and radiation are types of promoters.
   C. Mutations that cause transformation of a cell must be transmitted to the cell's progeny for progression to occur.
   D. Mutations in oncogenes result in slowing down of the cell cycle, so more mutations can accumulate.
5. Tumor suppressor genes are
   A. rarely mutated in cancers.
   B. more commonly mutated in carcinomas than in sarcomas.
   C. genes that are involved in accelerating or enhancing growth.
   D. genes that encode proteins that regulate cell growth.
   E. rarely implicated in genetic forms of cancer.
6. So that appropriate therapy can be given for any cancer, which of the following is necessary?
   A. The presence of a mass
   B. X-ray diagnosis
   C. The presence of systemic manifestations
   D. The presence of metastases
   E. A tissue diagnosis
7. An old adage in medicine is "iron-deficiency anemia in an adult man is colon cancer until proven otherwise." Why do you think colon cancer would cause anemia?
   A. Colon cancer metastasizes to bone, replacing the blood-forming elements in the marrow.
   B. The cells of the colon carcinoma require iron, so they "steal" it from the blood.
   C. Red blood cells are lysed (killed) as they through the malignancy.
   D. Blood is lost across

518 CHAPTER 30 Nutritional Disorders

as a food additive: it imparts a chewy, elastic quality to foods, thickens sauces, and stabilizes foods. Gluten is added to a wide variety of products, from baked beans to ice cream and ketchup, to shampoo and toothpaste, and it is even used as "filler" in multivitamin pills and other medications. Gluten does not need to be disclosed on food labels, so people with celiac disease need to become experts at detecting gluten lurking in the ingredients listed on food labels. For patients with very severe celiac disease, "gluten-free" products that were processed in the same plant or with the same machinery as wheat products can contain enough trace gluten to cause disease symptoms. Even toasting gluten-free and wheat bread in the same toaster can cause problems.

BOX 30–4 Celiac Disease

Causes
Immunologically mediated reaction to ingested gluten

Lesions
Short intestinal villi causing malabsorption
Some patients may develop skin manifestation (dermatitis herpetiformis)

Manifestations
Bloating
Diarrhea
Abdominal pain
Irritability, weakness
Failure to thrive

Another autoimmune disease linked to digestion and absorption is **pernicious anemia**. Epithelial cells in the stomach produce a protein called intrinsic factor, which binds to vitamin B_{12} in the duodenum and facilitates its absorption in the ileum. Without intrinsic factor, vitamin B_{12} is absorbed very poorly. In pernicious anemia, an autoimmune reaction destroys the epithelial cells in the stomach, so the production of intrinsic factor declines. Once the body uses up its stores of vitamin B_{12}, the patient begins to develop symptoms of vitamin B_{12} deficiency. Pernicious anemia is most common in the elderly population (the median age of diagnosis is 60 years), and it can develop in conjunction with other conditions in which the epithelial cells of the stomach are damaged (e.g., achlorhydria, chronic inflammation) or surgically removed (e.g., for **bariatric surgery**).

Pernicious anemia develops insidiously and, if untreated, progresses relentlessly to cause irreversible neurologic damage and death. Before overt symptoms develop, routine laboratory testing may detect megaloblastic anemia. The diagnosis is confirmed with additional laboratory findings: leukopenia, low serum vitamin B_{12}, and increased levels of metabolites usually processed by the enzyme of which vitamin B_{12} is the cofactor. If the diagnosis is made early enough and treatment begun quickly, the symptoms may never develop. The classic triad of symptoms associated with pernicious anemia is glossitis (large, sore, and red tongue with a smooth surface), paresthesias (numbness and tingling of the hands and feet), and weakness. This type of anemia can also cause fatigue, rapid heart rate, heart murmurs, shortness of breath, and, if severe and prolonged, frank congestive heart failure. The neurologic damage is due to degeneration of axons in the spinal tract. It initially causes paresthesias in the hands and feet, which then progresses to absent reflexes, difficulty walking, and eventually paraplegia.

There is no cure for pernicious anemia: the epithelial cells of the stomach, once irreparably damaged, cannot be stimulated to produce intrinsic factor again. Also, because oral vitamin B_{12} is absorbed very poorly in the absence of intrinsic factor, oral administration of this nutrient alone is insufficient to bring the body stores of vitamin B_{12} back up to safe levels. Patients with vitamin B_{12} deficiency are initially treated with daily, intramuscular injection of high doses of vitamin B_{12}. Once the serum levels of vitamin B_{12} are sufficiently high, the patient can be maintained on monthly injections. If caught early enough, pernicious anemia is reversible, and signs of anemia and neurological damage do not develop.

BOX 30–5 Pernicious Anemia

Causes
Autoimmune destruction of cells in the stomach that produce intrinsic factor
Decreased absorption of vitamin B_{12}

Lesions
Autoimmune gastritis
Leukopenia
Low serum vitamin B_{12}

Manifestations
Glossitis
Paresthesias, progressing to paraplegia
Weakness
Cardiac abnormalities (rapid heart rate, murmurs)

Enzyme Deficiencies

Digestion and absorption of nutrients require the action of numerous enzymes, as well as lubrication by secretions produced by various glands in the upper digestive tract and participation of the indigenous intestinal flora. **Amylase**, an enzyme that digests starch, is produced by the salivary glands and begins to digest food while it is being masticated in the mouth. Destruction of the salivary glands—for example, by an autoimmune disorder—can lead to problems with nutrition, both because of

Each chapter concludes with **Practice Questions** to assess comprehension of concepts.

Throughout the text, key points are illustrated and important information is highlighted in **Boxes** to ensure comprehension and to aid the study of critical materials. **Key Terms** also are bolded throughout the chapters for ease of discovery.

A colorful and engaging layout enables easy reading and supports the retention of important concepts. Additionally, more than 400 full-color, medically accurate **photographs, illustrations, and tables** provide valuable insight into disease epidemiology and diagnosis.

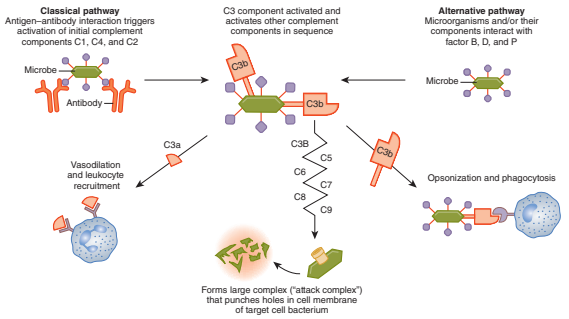


FIGURE 4–19 Complement system.

foreign material, and some can induce fever. Their exact effect depends on the cell that produces them and the context in which they are produced. For example, one type of leukotriene, produced by endothelial cells, maintains vascular smooth muscle at a steady state of constriction at all times. During an acute inflammatory event, a different leukotriene, produced by leukocytes, counteracts this effect and causes the vessel to dilate. Arachidonic acid metabolites are very potent mediators of inflammation, and some of the most potent anti-inflammatory pharmaceutical drugs we have interfere with arachidonic acid metabolism. *Non-steroidal anti-inflammatory drugs* such

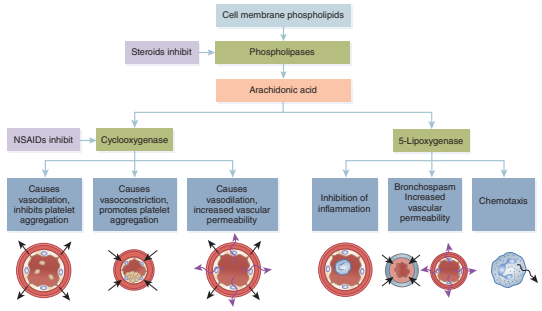


FIGURE 4–20 Arachidonic acid system.

TABLE 4–3 Cytokines

Pro-inflammatory (↑ Regulators)	IL-1 IL-6 TNF IL-8 IFN-γ	a) Systemic effects ↑ Slow-wave sleep Neutrophilia ↓ Appetite Fever
Attenuating	TGF-β IL-10	b) Endothelial effects ↑ Leucocyte adhesion ↑ Procoagulant activity ↑ PGI_2 synthesis
		c) Fibroblast effects ↑ Proliferation ↑ Collagen synthesis

as aspirin and ibuprofen prevent the production of prostacyclins, and steroids inhibit the first step in arachidonic acid metabolism, so that neither leukotrienes nor prostaglandins can be produced in sufficient quantity to sustain an inflammatory response.

In addition to the plasma-derived and cell-derived mediators of inflammation, a variety of polypeptide cytokines and chemokines regulate inflammation (Table 4–3). Tumor necrosis factor (TNF), interleukin-1 (IL-1), IL-8, and IL-6 are cytokines produced by leukocytes and endothelial cells; they enhance the acute inflammatory process locally by increasing leukocyte adhesion to endothelium, increasing blood coagulation properties, and stimulating the further production of prostaglandins. Systemically, these cytokines elicit fever and neutrophilia, increase sleep, and decrease appetite. Other cytokines, such as IL-10 and transforming growth factor (TGF), have a down-regulating effect and consequently aid in the **resolution** of acute inflammation.

We have already mentioned, in passing, some important variations in the inflammatory process. Reactions with lots of neutrophils cause tissue destruction but are important in containing pyogenic bacteria. Macrophages are prominent when there is dead tissue to remove or foreign substances to contain. Edema predominates when lots of histamine is released, as in atopic allergy and immune complex reactions. Fibrin is a prominent part of the inflammatory process if a protective barrier is needed on injured surfaces. Chronicity, or prolonged duration, of inflammation introduces even more variations.

Chronic Inflammation

Chronic means persistent for a long time. Chronic inflammation may result from acute inflammation that persists because the cause is not completely eliminated, or it may be associated with a cause that never was acute but present at a low level for a long time.

The term *chronic inflammation* is also used as a label for the histologic picture typically associated with prolonged inflammation. As will be discussed later, some

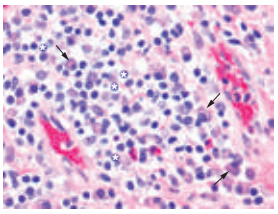


FIGURE 4–21 Chronic inflammation is characterized by an infiltrate composed of lymphocytes (white *), plasma cells (black arrows), and macrophages. Eosinophils are also present in this focus of chronic inflammation. Notice also the vascular congestion (bright red areas represent red blood cells in capillaries).

chronic inflammations have a more specific appearance (e.g., granulomatous inflammation) and some clinically acute inflammations mimic chronic inflammation histologically. Let us first describe the typical appearance of chronic inflammation and then deal with the variations and their pathogenesis.

Because the injury in chronic inflammation is usually low grade, edema and hyperemia are less pronounced than in acute inflammation and few or no neutrophils are present. The area is infiltrated predominantly by lymphocytes, plasma cells, and, less conspicuously, macrophages (**Figure 4–21**). Plasma cells are often prominent and easily recognized. They are derived from B-lymphocytes in the tissue, and their primary function is to produce antibodies. These attach to foreign material in the area as opsonins, priming neutrophils and macrophages to phagocytose this material. Lymphocytes, which morphologically consist mostly of a nucleus with a small rim of cytoplasm, play a much larger role than their innocuous appearance suggests. Different types of lymphocytes can perform various functions. They can recognize foreign material, kill host cells in the area of foreign antigens to isolate the foreign substance, transform into plasma cells to produce antibodies, and direct the traffic of other inflammatory cells, especially macrophages. However, in routine histologic sections, it is not possible to tell which lymphocytes are doing what and why. Macrophages may play the same role as they do in acute inflammation (phagocytosis and digestion of debris), but they may also become directly cytotoxic to host cells under certain conditions. Lymphocytes produce cytokines and chemokines that attract macrophages to the area of inflammation, and macrophages in turn secrete cytokines and chemokines that attract and activate lymphocytes.

Another hallmark of chronic inflammation, regardless of type, is the creation of fibrous tissue, or **fibrosis**

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Acknowledgments

Foremost, we want to acknowledge the contributions of Thomas Kent, MD, who was the senior author of *Introduction to Human Disease* through the first four editions. Dr. Kent was a leading medical educator for many years and was cofounder of the Group for Research in Pathology Education (GRIPE), a consortium that shares pathology education materials amongst more than 75 medical schools. In 1975, Dr. Kent had students at the University of Iowa's College of Medicine take tests on the computer, a further example of his prescience in education. Dr. Kent is now retired from pathology teaching, but the success of the first four editions of this text is in no small measure the result of his vision in creating the style and format of the text, plus his insistence that the content be directed to an understanding of the most common and important diseases. We strive to carry forward his vision into the Seventh Edition.

In June 2008, we received a letter from Jones & Bartlett Learning. The publisher had received a note from a person who "was extremely sad" to see *Introduction to Human Disease* "leave the shelves" after the fourth edition, and we were asked if we would consider revising the book. Thus began our relationship with Jones & Bartlett Learning; and we have been extremely pleased with the help we have received along the way, most recently from Cathy Esperti, Rachael Souza, Nora Menzi, Rob Boder, Troy Liston, and other members of the editorial, marketing, and production teams.

SECTION I

An Overview

The purpose of this section is to give you (1) the general vocabulary used to discuss and classify diseases, (2) a feeling for the general frequency and significance of particular diseases, and (3) an overview of the resources commonly used in diagnosis that bridge the gap between pathophysiology and the care of patients.

CHAPTER 1

Introduction to Pathology

OUTLINE

OBJECTIVES

1. Define disease and state the philosophic tenet of disease causation that forms the basis of allopathic medicine.
2. Define pathology and describe what pathologists do.
3. Define manifestation as used in the context of the workup of an ill patient, and describe the general categories of manifestations that healthcare practitioners use to identify diseases.
4. Compare and contrast functional and organic (structural) disease.
5. List, define, and give examples of the three major forms of organic disease.
6. Identify the three basic categories of exogenous causes of diseases.
7. Identify the three basic categories of endogenous causes of diseases.
8. Describe the steps involved in the workup, diagnosis, and treatment of a patient.
9. Describe some of the social, scientific, and economic obstacles to patient care.
10. Define and use in proper context all words and terms in this chapter that are in headings and in bold print.

KEY TERMS

allopathic medicine
anatomic pathologist
cellular basis of disease
clinical pathologist
clinicopathologic observations
complications
cytopathology
developmental disease
diagnosis
differential diagnosis
disease
endogenous
etiology
evidence-based medicine
exogenous
experimental pathologist
external agents of injury
follow-up
functional disease
genetic disease
history
homeostasis
hyperplasia
iatrogenic
idiopathic
immunologic disease
infection
inflammation
internal mechanism of injury
laboratory finding
lesion
metabolic disease
neoplasia
nosocomial
organic disease
pathogenesis
pathology
pathophysiology
physical examination
prognosis
repair
sign
surgical pathology
symptom
syndrome
trauma
vascular disease
workup

Disease

Disease is a structural or functional change in the body that is harmful to the organism. Some changes in the body are perfectly normal, such as puberty, pregnancy, or increasing muscle mass in an athlete undergoing training. Also, the cells and tissues in the body can adapt to minor fluctuations in their environment, thereby maintaining a state of **homeostasis**. Disease

occurs when the cellular environment changes to such a degree that tissues are no longer able to perform their function optimally. For example, with cataracts, the crystalline lens of the eye undergoes degenerative changes over the course of a person's lifetime and becomes cloudy, obstructing the passage of light and causing decreased visual acuity. In diabetes, the extracellular tissue of blood vessel walls undergoes changes that lead to narrowing of the blood vessels, which in turn leads to decreased blood flow, decreased oxygen delivery, and eventually irreversible damage to tissues such as the retina, skin, heart, and kidney. In cancer, mutations accumulating in the nucleic acids of cells result in distorted structure and function of proteins, which in turn affect the way the cells interact with or react to other cells, growth factors, hormones, and the extracellular matrix in their environment. In multiple sclerosis, destruction of the protective myelin sheath around axons in the brain results in decreased electrical conduction, which manifests in neurologic signs and symptoms such as weakness, double vision, and incoordination. In each of these conditions, the ability of cells or tissues to optimally perform their function is compromised, with deleterious consequences to the organism.

Every society identifies conditions that are abnormal and has devised means of treating illness, but there is great variation between cultures and even within subcultures in what constitutes "normal," "abnormal," "disease," or "feelings of ill health." Over time and over place, the explanations that have been given for ill health have varied from spirit possession, witchcraft, sorcery, the anger of ancestors, balance or imbalance of energy, elements or "humors," nutrition, and the will of God, to the bad influence of the climate, weather, or environment. Treatments have accordingly been as various as exorcism, prayer, shamanic rites, rituals that bring the ill person back into the social and universal order, herbs and foods that restore the balance of internal elements, physical manipulations that restore the flow of energy in the body, the "laying on of hands," and arming the ill person with amulets that provide protection against potentially harmful forces. Obviously, the diseases identified or named by all these various systems are not comparable to one another. Imagine the perplexity of a Western medical doctor if s/he were confronted with a patient who claimed to have been possessed by an ancestor's spirit, to be suffering a blockage in the flow of *chi* (the energy at the root of Chinese medicine, including acupuncture), or to be suffering an attack of "nerves" (Latin America: *susto*) brought on by witnessing the traumatic death of a close family member.

Although these conceptualizations of ill health are at variance with the definition of disease set forth in this textbook, it is necessary to recognize that they are millennia old, are based on a vast amount of experiential evidence, and are as real to the sufferers and the people who take care of them as are notions of cancer and infection to Western health practitioners. Though we may not understand them, and may argue that they have no basis in science, we have no right to dismiss them or belittle them as "superstitious" or "uneducated" because this does no service to the patient who is suffering. Instead, we need to attempt to translate the patient's distress into something that does make sense in terms of our own notions of disease causation.

With the Enlightenment, people began to look at the workings of the body in a scientific manner—in other words, through repeated observations made under controlled circumstances. As knowledge about the way the body works accrued, scientifically oriented doctors began to formulate the idea that disease is not some external force that takes possession of the body, but rather arises from organs and tissues and leaves visible traces there. Physicians gained these insights by closely observing the course of disease on a patient's body, often over weeks or months, and then correlating the clinical findings with the appearance of the organs after death, as seen at autopsy. On the basis of these **clinicopathologic observations**, a philosophy called the **cellular basis of disease** developed. This states that diseases can be traced to deranged structures or functions of organs, tissues, and cells. Nowadays, we have expanded the definition to include changes at the molecular level, including proteins and, ultimately, genes. The medical tradition that has evolved from this philosophy is variously called **allopathic medicine**, biomedicine, or Western medicine.

Pathology

The term **pathology** has several meanings. In the broadest sense, pathology is the study of disease. All people working in a health-related field are lifelong students of pathology because, in one way or another, all are interested in altering the course of disease through scientific understanding of its nature. A course in pathology, such as the one you are taking, provides a concentrated study of the nature of disease and lays the foundation for its further study within specific disciplines. Pathology includes the study of basic structural and functional changes associated with a disease, as well as the sequence of events that leads from structural and functional abnormalities to clinical manifestations. This sequence is referred to as the **pathogenesis** of disease; its study is called **pathophysiology**. The term **etiology** means the study of causes, but it is also commonly used simply to connote the cause of disease.

Pathology is also the name of one of the specialties of medicine, one that deals with analysis of body fluids and tissues for diagnostic purposes and with teaching and research relating to fundamental aspects of disease (**Table 1–1**). Pathologists usually practice laboratory medicine or study basic aspects of disease within a department of pathology associated with a hospital and/or medical school. The field of pathology is itself subspecialized. There are experimental pathologists,

TABLE 1–1 Roles of a Pathologist

Role	Subject
Experimental pathology	**Research**
Academic pathology	**Teaching, research, anatomic, and/or clinical pathology**
Anatomic pathology	**Teaching, research and/or clinical practice**
Autopsy pathology	Postmortem examination of organs in the body
Surgical pathology	Gross and microscopic examination of tissues (biopsies and those removed during surgery)
Cytopathology	Microscopic examination of cells removed by scraping (e.g., cervical cells: Pap smear) or washing (e.g., bronchial cells).
Clinical pathology	**Laboratory tests**
Chemistry	Chemical analysis of urine, blood serum and secretions
Microbiology	Detection and identification of micro-organisms from sites of infection
Hematology	Examination of blood cells and bone marrow, bone clotting
Blood banking	Blood transfusion services
Immunopathology	Antigen and antibody detection
Molecular diagnosis	Nucleic acid (DNA and RNA) analysis

anatomic pathologists, and clinical pathologists. **Experimental pathologists** are basic scientists who spend the majority of their time in research, investigating the causes and mechanisms of disease. **Anatomic pathologists** perform autopsies, examine all tissues removed from live patients (**surgical pathology**), and examine cell preparations to look for cancer cells (**cytopathology**). **Clinical pathologists** analyze various specimens removed from patients, such as blood, urine, feces, spinal fluid, or sputum, for chemical substances, microorganisms, antigens and antibodies, nucleic acids, atypical blood cells, and coagulation factors. Anatomic and clinical pathologists are primarily concerned with diagnosing diseases, but, especially at hospitals associated with medical schools, they may also be engaged in research and teaching.

Manifestations of Disease

We use the term *manifestation* to refer to all the data gathered about a disease as it occurs in a patient. The manifestations that are of interest to the allopathic doctor are symptoms, signs, and laboratory abnormalities (**Table 1–2**). **Symptoms** are evidence of disease perceived by the patient, such as pain, a lump, or diarrhea. Health practitioners carefully elicit these during an interview with the patient, and record them in the patient's chart as the **history**. **Signs** are physical observations made by the person who examines the patient. Examples include tenderness, a mass, or abnormal heart sounds. Signs are elicited and observed during the **physical examination**, the results of which are also recorded in the patient's chart. **Laboratory findings** are observations made by the application of tests or special procedures, such as X-rays, blood counts, or biopsies. **Diagnosis** is the process of assimilating the information from the history, physical examination, and laboratory findings to identify the condition causing the disease. Diagnosis also refers to the name given to that disease, such as "multiple sclerosis" or "diabetes." This name is a shorthand way of communicating and thinking. It sums up all the essential information from the history, physical examination, and laboratory findings so that a prognosis can be rendered and appropriate therapy can be initiated. Underlying diagnosis and treatment is the assumption that diseases of the same name run a predictable course that can be altered, to lesser or greater degree, by medical or surgical intervention.

TABLE 1–2 Manifestations of Disease

Type of Manifestation	Nature of Data	Name for Collection of Results
Symptoms	Patient's perceptions	History
Signs	Examiner's observations	Physical examination
Laboratory abnormalities	Results of tests and special procedures	Laboratory findings
Radiographic abnormality	Radiographic studies (X-Ray, CT, MRI, ultrasound)	Radiographic findings

Sometimes, a diagnosis cannot immediately be made. For example, Alzheimer disease cannot definitively be diagnosed until a patient's brain is examined after his or her death. Obviously, it is too late to do anything about it then, so, while the patient is alive, the patient is given a provisional diagnosis of "Alzheimer-type dementia." Other diseases, such as rheumatologic, neurologic, or gastrointestinal ones, may also be vaguely identified (for example, "paralysis of unknown cause") and treated symptomatically until the disease "declares itself," or develops some features that allow its unique identification. In such cases, the clinical problem—paralysis, dementia—is used as the focus of symptomatic treatment until the patient's disease can definitively be identified.

Clusters of findings commonly encountered with more than one disease are called **syndromes**. For example, leakage of protein into the urine, low serum protein, and edema are a common set of findings in the "nephrotic syndrome," which can be caused by a number of different diseases that affect renal tissue. The syndrome is a description of a constellation of symptoms, signs and/or laboratory tests, and though treatments can be initiated to alleviate these, specific treatment of the disease causing the syndrome is still necessary.

Structural Diseases

Structural diseases, or **organic diseases**, are characterized by structural changes within the body. Structural changes are called **lesions**. Until recently, lesions were visually identified, either by changes visible to the naked eye or changes visible through the light or electron microscope. With the advent of molecular medicine, health professionals also recognize lesions that occur at the level of proteins and genes. Three broad categories suffice to classify most structural diseases (Table 1–3). As with all classification schemes, there are always some items that do not fall easily into just one category, and some items simply don't fit the classification scheme. Nevertheless, the scheme does capture most structural diseases, so it is useful to start sorting the vast numbers of diseases you will learn about.

Genetic diseases are caused by abnormalities in the genetic makeup of the individual, either at the level of chromosomes, such as increased chromosome numbers or translocations, or at the genetic level, such as mutations. **Developmental diseases** are ones that originated during embryonic and fetal development. The range of genetic and developmental abnormalities is very broad, extending from deformities present at birth, to biochemical changes caused by genes but influenced by the environment so that they appear later in life, such as hemochromatosis. You will learn about genetic and developmental diseases in Chapter 6.

TABLE 1–3 Major Categories of Structural Diseases

- Genetic and developmental diseases
- Degenerative and inflammatory diseases and trauma
- Hyperplasias and neoplasms

Degenerative and inflammatory diseases are caused by forces or agents that destroy cells or intercellular substances, deposit abnormal substances in cells and tissues, or cause injury by means of the inflammatory process. **External agents of injury** include physical and chemical substances and microbes. The major **internal mechanisms of injury** are vascular insufficiency, immunologic reactions, and metabolic disturbances. There are two general reactions to injury: inflammation and repair. **Inflammation** is a vascular and cellular reaction that attempts to localize the injury, destroy the offending agent, and remove damaged cells and other materials. **Repair** is the replacement of damaged tissue by new tissue of the same type and/or fibrous connective tissue. Typically, repair follows inflammation. How severe the associated tissue damage is depends on the nature of the insult. Whether the tissue will repair by regeneration or scar formation depends on characteristics of the tissue type itself. You will learn about the processes of inflammation and repair in Chapter 4.

Neoplastic diseases are characterized by an increase in cell populations. **Hyperplasia** is a proliferative reaction to a prolonged external stimulus and usually regresses when the stimulus is removed. **Neoplasia** results from genetic changes that favor the growth of a single population of cells. Neoplasms are divided into two groups, benign and malignant, based on whether the cells remain localized or develop the ability to grow into surrounding tissue or even migrate to other tissues. *Cancer* is the colloquial term for malignant neoplasm. You will learn about neoplasia in Chapter 5.

Functional Diseases

Functional diseases are those in which there are no visible lesions, at least at the onset of the disease. The basic change is a physiologic one. Two of the most common functional disorders are tension headache and irritable bowel syndrome, disorders that may be the result of unconscious stimulation of the autonomic nervous system.

Other examples of common functional disorders are diabetes and hypertension. These diseases are diagnosed by laboratory evidence of increased circulating glucose in the blood and increased blood pressure readings, respectively. Only over time do structural changes become evident, first in blood vessels and then in the form of end-organ damage. By this time, the disease has progressed to such a degree that complications (stroke, heart disease, blindness, and kidney disease, among others) are inevitable. Many mental illnesses are considered functional disorders; however, there is increasing

evidence that they may, indeed, have an organic basis. The same is true for many other functional disorders. In fact, most diseases have a genetic basis. Even how people respond to external stimuli such as infectious agents, alcohol, or environmental toxins is genetically based. The classification of such diseases as "functional" may therefore be an oversimplification, but it is of value in understanding how diseases come to clinical attention.

Causes of Disease

Diseases are initiated by injury, which may be either external or internal in origin. Agents acting from outside are termed **exogenous**; those acting from within are referred to as **endogenous**.

Exogenous causes of disease are divided into physical, chemical, and microbiologic (Table 1–4). Direct physical injury is called **trauma**. Physical agents causing disease include extremes of heat and cold, electricity, atmospheric pressure changes, and radiation (electromagnetic and particulate). Chemical injuries are generally subdivided by the manner of injury into poisoning (accidental, homicidal, or suicidal) and drug reactions (toxic effects of prescription or proprietary drugs taken to treat disease). Increasingly, the role of environmental toxins in causing disease is being recognized. Toxins can be encountered due to occupational exposure (e.g., asbestos, benzene or silica dust), in the environment (e.g., cockroach feces are a known trigger of asthma in children; smog and second-hand smoke are linked to some forms of cancer), or due to "recreational" use (e.g., cigarette smoke and alcohol). Microbiologic injuries are usually classified by the type of offending organism (bacteria, fungi, rickettsiae, viruses, protozoa, and helminths) and are called **infections**.

Endogenous causes of disease fall into three large categories (Table 1–5). **Vascular diseases** include obstruction of blood supply to an organ or tissue (e.g., myocardial ischemia secondary to atherosclerosis), hemorrhage (e.g., a ruptured abdominal aortic aneurysm), or altered blood flow (e.g., microvascular changes in diabetes or hypertension). **Immunologic diseases** are those caused by aberrations of the immune system. Failure of the immune system to work when it is needed results in immunodeficiency. Overreaction of the immune system causes allergic, or hypersensitivity, diseases. Abnormal reaction of the immune system to endogenous substances causes autoimmune diseases. The category of **metabolic diseases** encompasses a wide variety of biochemical disorders that may be genetically determined, or the secondary effects of acquired disease. Metabolic diseases are most commonly categorized by the type of molecule or substance involved, such as lipids, carbohydrates, proteins, minerals or vitamins.

Some diseases cannot be classified according to internal or external causes because the cause is not known. Diseases of unknown cause are termed **idiopathic**. Adverse reactions resulting from treatment by a health specialist produce **iatrogenic** disease. **Nosocomial** diseases are those acquired from a hospital environment.

TABLE 1–4 Exogenous Causes of Disease

Physical injury • Trauma • Extremes of temperature (heat or cold) • Electricity • Atmospheric pressure • Ionizing radiation
Chemical injury • Poisoning • Drug reactions • Environmental toxins
Microbiologic injury • Bacteria • Fungi • Rickettsiae • Viruses • Protozoa • Helminths

TABLE 1–5 Endogenous Causes of Disease

Vascular • Obstruction • Bleeding • Deranged flow
Immunologic • Immune deficiency • Allergy • Autoimmunity
Metabolic: Abnormal metabolism or deficiency of • Lipids • Carbohydrates • Proteins • Minerals • Vitamins

The Care of Patients

The typical approach to disease in allopathic medicine is to wait for the patient to seek help because of worrisome symptoms. The health practitioner, presented with a sick patient, proceeds in a systematic fashion to determine the organic cause of the patient's symptoms (Table 1–6). The **workup** of a patient encompasses three major steps: (1) taking the history, which involves listening to the patient or to the patient's relatives to ascertain the patient's symptoms, and reviewing any other past or present medical problems that might relate to them; (2) performing a physical examination, or systematically

TABLE 1–6 Steps in the Care of a Patient's Illness

1. Gather facts:
   - History
   - Physical examination
   - Laboratory and radiology tests
2. Interpret the facts and render a diagnosis.
3. Treat the patient, if feasible.
4. Follow up on results of treatment.

looking, feeling, listening, and sometimes even smelling accessible parts of the body for signs of illness; and (3) when needed, ordering laboratory tests, radiologic imaging tests, and specialized clinical procedures to detect chemical, physiologic and structural abnormalities. After acquiring the history, performing the physical examination, and reviewing initial ancillary tests, the health practitioner makes a list of possible diagnoses. This is called a **differential diagnosis**. Additional tests are ordered to exclude specific diagnoses on the list so that in the end one diagnosis is made that is the best interpretation of the symptoms, signs, and laboratory data.

A diagnosis is simultaneously a summing up of a patient's problem, a prediction about the course the disease will take, or **prognosis**, and a guide for treatment. Therapy is undertaken in an attempt to alter the natural course of the patient's disease. The goal of therapy depends on the disease. The goal of treating a middle ear infection in a child is to eradicate the infection. The goal of treating diabetes is to prevent complications. The goal of surgery after a patient has been in a motor vehicle accident and has a major internal hemorrhage is to stop the hemorrhage and thereby avert the patient's death. The goal of treatment of widely metastatic cancer is to alleviate pain in the last days or weeks of a patient's life. Whatever the goal of treatment, **follow-up** of the patient is essential to monitor progress toward the goal; determine whether **complications**, or secondary problems that emerge as a consequence of treatment, have developed; and alter therapeutic efforts accordingly.

Diagnosis of specific diseases is useful not only for determining treatment and prognosis in any specific instance of disease, but also to gather data that can help guide diagnosis and therapy for future patients. It is through collection of data by disease category that knowledge of prognosis, effectiveness of treatment, and frequency of complications is derived. Sometimes these data also further the health profession's understanding of the cause of a disease. This is particularly true when the distribution of the disease gives clues as to possible causative factors. For example, our knowledge about how the human immunodeficiency virus (HIV), the cause of AIDS, is spread began with the insight that the first patients to come down with this disease in the United States were (homosexual) men practicing unprotected sex with multiple sexual partners. Our understanding of the etiology of lung cancer began when physicians repeatedly and independently of each other observed that by far the majority of patients with this disease were cigarette smokers.

Obstacles to Patient Care

The process of patient care described here is limited by availability of resources, the nature of particular diseases, and clinicians' ability to understand disease processes. The greatest improvements in health, world-wide, have come from preventive measures, including sanitation, nutrition, immunization, control of infectious diseases, and avoidance of toxic substances. Whereas infections were once the major cause of death in Western nations, reducing life expectancy to the 40- to 50-year range, we now have the means to prevent, control, and eradicate these diseases. However, as the recent example of AIDS has shown, the initiative, time, and money that it takes to spread knowledge about diseases and convince people to adopt protective measures is exorbitant. This paints a very stark line between societies that have such resources and those that do not. In the United States we might claim that AIDS is more or less under control, the incidence of this disease having declined steadily since the late 1990s. However, while the incidence has decreased among whites, it is increasing among Hispanic and African American men. From 2005 to 2014, African American gay and bisexual men between the ages of 13 and 24 experienced an 87% increase in diagnosis.[1,2] Worldwide, AIDS is one of the major killers: an estimated 1.1 million people died of AIDS in 2015, and almost three-quarters of these deaths occurred in poverty-stricken nations of sub-Saharan Africa.[3] There, as in Asia, the people most vulnerable to contracting the disease are poor women, and, by extension, their children. The reasons for this are multifactorial, but they can be summarized as lack of resources: poverty driving women to trade sex for food, no health education to learn how to prevent contracting the disease, and no access to therapies that slow progression of the disease.

Moreover, the application of new knowledge about a disease process or therapeutic intervention lags far behind discoveries. Smoking is an illustrative example. As early as the 1920s, autopsy series documented the strong link between smoking and lung cancer. By 1964, a special commission set up by President John F. Kennedy was able to review more than 7000 scholarly articles, many of them meticulously researched and prepared by the American Cancer Society, on the effect of smoking cigarettes on health. The resultant Surgeon General's report stunned the nation by detailing the magnitude of the effect of smoking on health, attributing 70% increased mortality and a 9- to 10-fold increase in the incidence of lung cancer in smokers as compared to nonsmokers. Despite the incontrovertible scientific evidence

that smoking is harmful to health, cigarette consumption actually increased over the next decades. It was not until 1987 that the first anti-smoking law, banning smoking on airlines, was passed in the United States. It took another several years for cities and states to begin banning smoking in public places, such as the workplace, restaurants, and bars. Of course, there is a lot more to smoking, beginning to smoke, and quitting smoking than personal will and judgment based on scientific evidence: peer pressure, social expectations and values, and addiction are major influences, if not determinants, of smoking behaviors. But similar lag times are well known for other scientific insights, as well. It is estimated that it takes 15 to 20 years for a scientific discovery to be translated into a standard of practice.

Standards of allopathic practice, though based on scientific evidence, are not universally adhered to. It has been well documented now for several decades that hypertension is a major risk factor for stroke and heart disease, yet the percentage of Americans who are adequately treated for hypertension is only about 30–40%. It is senseless and possibly harmful and counterproductive to take antibiotics, which inhibit the growth of bacteria, for conditions not caused by bacteria, yet many doctors continue to prescribe antibiotics for diseases that are caused by a virus (for example, upper respiratory tract infections and middle ear infections in children). Variability in patient assessment and care is such a matter of fact that patients often visit more than one doctor—and may even be encouraged to do so by their first doctor—in order to hear a "second opinion" about their diagnosis and treatment options. While in some cases the second opinion is the same as the first, it may not always be so. This leads to frustration on the part of the patient, who is expecting a single "answer" based on scientific data. It also leads to frustration on the part of doctors who believe that, for the maximal benefit of patients, medicine should be practiced strictly along guidelines formulated on the basis of a thorough review of the scientific literature. These practice guidelines, issued by expert panels, form the core of **evidence-based medicine**.

Although evidence-based practice guidelines ensure that physicians know what the standard of care should be, there is still a great amount of variation in how patients are treated. Economic factors, including the resources available at a particular clinic or hospital, the patient's insurance status, the age of the patient, other illnesses the patient has, religious beliefs, personal experiences of the physician in treating similar patients, and personal wishes of the patient all influence the treatment plan.

Moreover, the focus of treatment varies widely by clinic type and demographic factors. In large hospitals affiliated with universities, so-called academic hospitals, patients are treated at the forefront of scientific advances: organ transplantations, experimental cancer treatments, and treatment of rare and complicated diseases are the main focus at such centers. Conversely, in inner-city clinics, the main focus is on preventive care, such as maternal and child health, and on management of diseases that are most common in that population, such as diabetes and heart disease.

Scientific and technical knowledge and progress are not the only factors affecting health and health care. The United States is one of the world leaders in scientific and technical advances in the healthcare field, and it spends more money than any other nation on health care, yet it ranks low in general measures of health, such as infant mortality and life expectancy. There is no doubt that the largest challenge faced by healthcare workers in the United States is inequitable distribution of resources. Health practitioners have the knowledge to prevent many diseases and delay, if not entirely avoid, complications of others, but a large percentage of the population is denied access to this knowledge, either because of lack of the ability to pay for it, lack of health education, or lack of clinics and healthcare workers willing to serve an underprivileged community. In addition, U.S. society must confront the issue of cost containment in terminally ill patients, for whom procedures are often performed with costs that are out of proportion to the benefit received. This will mean engaging in economic studies, ethical debates, and legal reforms that will hold the healthcare industry accountable for the money it consumes. Such debates need to be informed by a solid understanding of the pathophysiology of diseases. This text will provide you with background knowledge that will allow you to become an informed participant in the healthcare debate.

The Structure of This Text

This text presents a basic classification scheme for diseases and an introductory discussion of their causes. The first part of the text discusses disease processes that are applicable to all tissues in the body, such as genetics, inflammation, and neoplasia. The second part of the text discusses diseases by organ system. The third part presents diseases that affect many different organs simultaneously, such as infections and immunologic diseases.

Each chapter begins with a short review of the structure and function of the organ system under discussion. It should be stressed that this is a review: it is advisable for you to have had a course in physiology to better understand pathophysiology.

After the review of structure and function, we list the diseases of that organ system that are most common. This means there is a certain degree of redundancy in the text because we might explain some aspect of pathophysiology in this section and reiterate this or explain it in greater detail later in the chapter. This is intentional. Getting a sense of how common a disease is and what impact it has on a population enhances learning about the disease, and repetition is one of the key factors in retention of information.