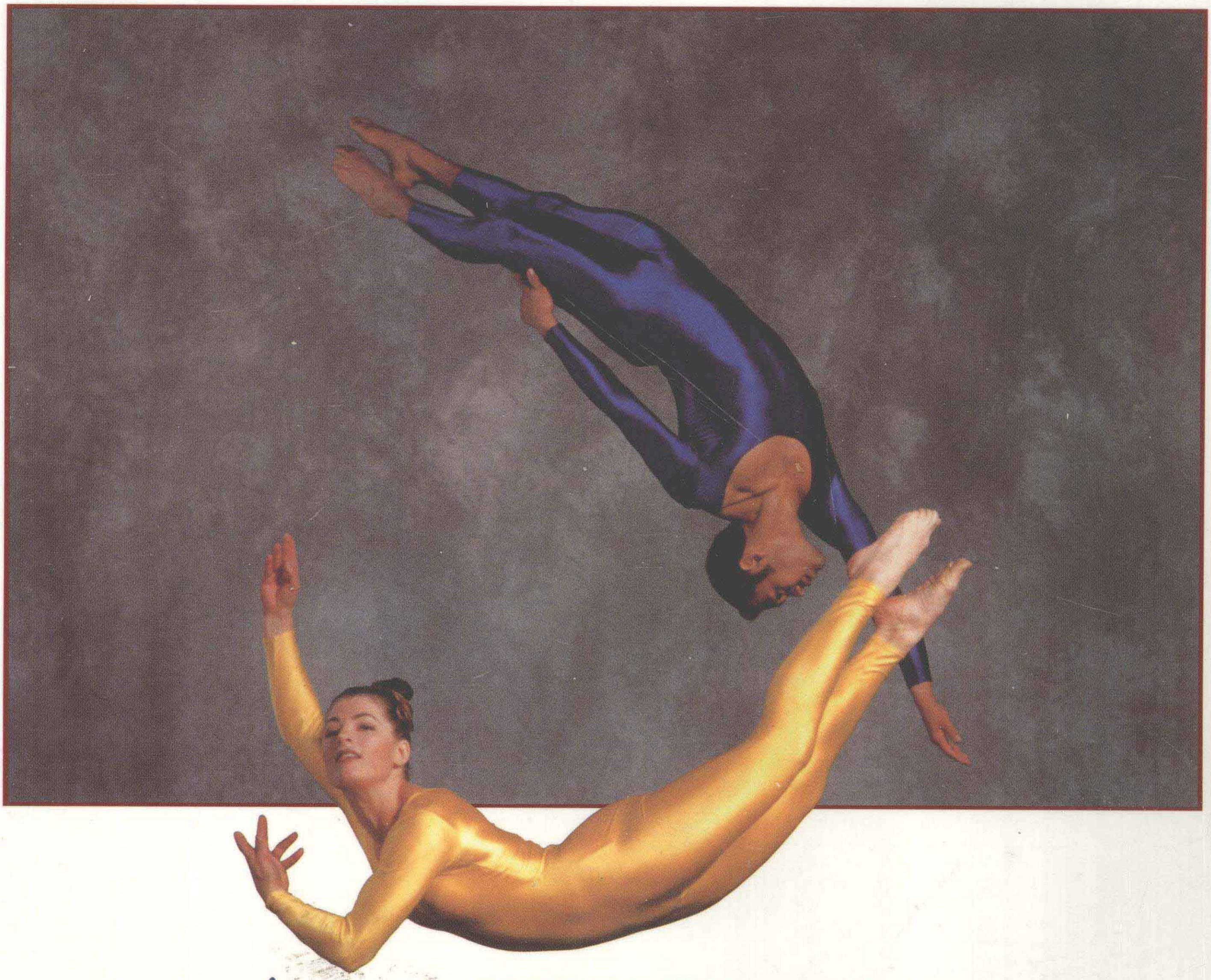
Applications Manual

Frederic H. Martini, Ph.D. • Kathleen Welch, M.D.



FUNDAMENTALS OF

Anatomy & Physiology

FOURTH EDITION

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Fundamentals of Anatomy and Physiology

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Frederic H. Martini, Ph.D.

Kathleen Welch, M.D.

with

William C. Ober, M.D.
Art coordinator and illustrator

Claire W. Garrison, R.N.
Illustrator

Ralph T. Hutchings
Biomedical photographer

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Preface

This *Applications Manual*, which accompanies the fourth edition of *Fundamentals of Anatomy and Physiology* (FAP), has one goal: to help students apply the concepts introduced in the main text to their personal lives. Together with the boxed essays and Clinical Discussions in the text, the discussions in the *Applications Manual* complete an introduction to the major pathological conditions and diagnostic procedures you may encounter in the "real world." Because most of the detailed clinical and applied topics are located in the *Applications Manual*, the applied information can be complete enough to provide a valuable reference without interrupting the text narrative that deals with normal anatomy and physiology. In *Fundamentals*, you will find the icon AM, followed by the discussion title, wherever a topic in the *Applications Manual* is linked to the main text.

The *Applications Manual* has been reorganized to enhance its value as a separate but integrated reference. This edition also contains several features not found in previous editions. For example, it contains optional background material and supplemental material that instructors can use to increase their depth of coverage on specific topics. These discussions are referenced in *Fundamentals* by the title "AM A Closer Look." Such topics include enzyme regulation and control mechanisms, pathogens, cancer, pain pathways, autonomic pharmacology, and AIDS. This edition also has a new section, called "Origins and Insertions," that will help students visualize and appreciate the anatomical relationships between the skeletal and muscular systems. In addition, the "Surface Anatomy and Cadaver Atlas" contains many new dissection photographs.

The pedagogical framework of this edition of the *Applications Manual* complements that of the main text. *Fundamentals* uses a three-level review system in which Level 3 consists of problem-solving questions and clinical or situational exercises. The *Applications Manual* in turn has three types of problem-solving questions; pages containing these questions are marked by a black band along the margin. The first type, "Critical-Thinking Questions," deals with disorders or situations that involve only one system. Those questions are therefore comparable to the Level 3 questions in *Fundamentals*. The second type, "Clinical Problems," requires students to integrate and interpret information about two or three systems. The third type, "Case Studies," offers multisystem problems that students must approach in a specific sequence. Each Case Study is based on a real patient's history. By completing the Case Study exercises, students can practice working through complex problems by using a logical, stepwise approach.

Few instructors are likely to cover all the material in the *Applications Manual*. Indeed, some instructors may choose not to cover all the boxed material in the text. Because courses differ in their emphases and students differ in their interests and backgrounds, the goal in designing the *Applications Manual* has been to provide maximum flexibility of use. The diversity of applied topics in the text discussions and boxes, the *Applications Manual*, and *The New York Times* articles provides instructors with a wide variety of ways in which to integrate the treatment of normal function, pathology, and other clinical or health-related topics. Boxed material and topics in the *Applications Manual* that are not covered in class can be assigned, recommended, used for reference, or left to the individual student. Experience indicates that each student will read those selections that deal with disorders that affect friends or family members, address topics of current interest and concern, or include information relevant to a chosen career path.

TO THE STUDENT

This *Applications Manual* is organized in units that deal with a wide variety of applied topics:

- **An Introduction to Diagnostics** discusses the basic principles involved in the clinical diagnosis of disease states.

- **Applied Research Topics** considers principles of chemistry and cellular biology that are important to understanding, diagnosing, or treating homeostatic disorders.
- **The Body Systems: Clinical and Applied Topics** is organized to parallel the text chapter by chapter and system by system. This section includes more detailed discussions of many clinical topics introduced in the main text, along with discussions of diseases and diagnostic techniques not covered in the text. Each discussion is cross-referenced to the text by page number; relevant chapter numbers in *Fundamentals* are indicated by black thumb tabs that appear in the margins of right-hand pages.
- The **Critical-Thinking Questions** at the end of each system help you sharpen your ability to think analytically.
- The **Clinical Problems,** located after each group of related systems, assist you in integrating information about several body systems and give you a chance to practice making reasonable inferences in realistic situations.
- The **Case Studies,** which follow The Body Systems section, provide further opportunities for you to develop your powers of analysis, integration, and problem solving. The studies presented, based on actual case histories, draw on material from the entire text (as they would in real life). The questions, keyed to crucial points in the presentation, help you identify the relevant facts and form plausible hypotheses. You can use the case studies as the basis for discussion with other students or tackle them yourself to hone your reasoning skills.
- The **Origins and Insertions** section consists of images of the bones of the skeleton that show the locations of the origins and insertions of the major muscles and muscle groups that are discussed in Chapter 11 of *Fundamentals*. This section will help you understand the relationship between muscle placement and muscle action and will help you remember the names and functions of the bone surface markings introduced in Chapters 6–8 of the text.
- A **Scanning Atlas** of photographs produced by various modern imaging techniques lets you view the interior of the human body section by section. These images will help you develop an understanding of three-dimensional relationships within the body. The Scanning Atlas includes a number of unlabeled images. By labeling them yourself, you can test your knowledge of anatomical structure while you develop your powers of visualization in three dimensions.
- A full-color **Surface Anatomy and Cadaver Atlas** of live-model and cadaver-dissection photographs allows you to visualize the superficial and internal structures of all major body regions and organs.

You can use the material in the *Applications Manual* in several ways. For example:

- You can read the *Applications Manual* simultaneously with *Fundamentals of Anatomy and Physiology*, referring to topics as each is referenced in the main text.
- You can read the *Applications Manual* separately, referring to *Fundamentals* for relevant background information as needed.
- You can use the *Applications Manual* as a reference, reading only those discussions that are of personal interest to you, that are relevant to your intended career, or that you need to research for some special purpose. You can locate information about specific topics, such as diagnostic procedures or drugs, by referring to the icons that appear next to each heading that is cross-referenced to *Fundamentals*. The following icons are used:

= Reference material, including discussions preceded by *A Closer Look* (as in “A Closer Look: The Nature of Pathogens,” p. 21)

= Discussions relating to the diagnosis of disease (as in “Blood Tests and RBCs,” p. 116)

= Information about specific diseases and their treatment (as in “Heart Failure,” p. 128)

= Discussions about topics in pharmacology and treatment methods (as in “Pharmacology and the Autonomic Nervous System,” p. 89)

= Exercise and sports-related topics (as in “Sports Injuries,” p. 67)

This manual was written to help you see the relevance of the text material and to give you information that you can use in your daily life. When a family member becomes ill or a medical crisis develops on a prime-time TV show, we hope that this manual will help you make sense of the situation. The organization and coverage of the *Applications Manual* have been greatly influenced by student feedback. If you have suggestions or comments about this edition, please do not hesitate to contact us at the Prentice Hall A & P web site or at the address on page ix.

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Frederic Martini, Ph.D.
Kathleen Welch, M.D.

e-mail address:
martini@maui.net

A & P Web site address:
www.prenhall.com/martini/fap

mailing address:
c/o Prentice Hall, Inc.
1208 East Broadway Road
Tempe, AZ 85282

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Kathleen Welch, M.D.
SA 20

Contents

An Introduction to Diagnostics

A **diagnosis** is a conclusion or decision based on a careful examination of relevant information. Each of us has made simple diagnoses in our everyday experiences. When the car won't start, the kitchen faucet leaks, or the checkbook doesn't balance, most of us will try to determine the nature of the problem. Sometimes the diagnosis is simple: The car battery is dead, the faucet is not completely turned off, or the amount of a check was recorded incorrectly. Once we make the diagnosis, we can take steps to remedy the situation.

Most of us use similar observational skills to diagnose simple medical conditions. For example, imagine that you awaken with a headache, feeling weak and miserable. Your face is flushed, your forehead is hot to the touch, and swallowing is painful. You know that these are the general symptoms of the flu, and you know also that your lab partner missed Tuesday's class because of the flu. You diagnose yourself as sick with the flu, and you open the medicine cabinet in search of appropriate medication.

The steps you took in arriving at the conclusion "I probably have the flu" were quite straightforward: (1) You made observations about your condition; (2) you compared your observations with available data; and (3) you determined the probable nature of the problem. **Clinical diagnosis**, or the identification of a disease, can be much more complicated, but these same steps are always required. In this section, we will examine the basic principles of diagnosis. The goal is not to train you to be a clinician but rather to demonstrate how these basic steps can be followed in a clinical setting.

Any diagnosis—of a disease or of a leaky kitchen faucet—requires an analysis that proceeds in a series of logical steps. Logical analysis, a process often called *critical thinking*, does not come naturally; it is too easy to become distracted or misled and then make a hasty or incorrect decision. Critical thinking is a learned skill that follows rules designed to minimize the chances of error. Nowhere is critical thinking more important today than in the sciences, especially the medical sciences. In applying critical thinking to scientific investigation, we follow what has been called the *scientific method*.

The Scientific Method

FAP *p. 3*

Your course in anatomy and physiology should do more than simply teach you the names and functions of different body parts. It should provide you with a frame of reference that will enable you to understand new information, draw logical conclusions, and make intelligent decisions. A great deal of confusion and misinformation exists about just how medical science "works," and people make unwise and even dangerous decisions as a result. Nowhere is this more apparent than when a discussion drifts to health, nutrition, and cancer. If you are going to be working in a health-related profession or are just trying to make sound decisions about your own life, you must learn how to organize information, evaluate evidence, and draw logical conclusions.

FORMING A HYPOTHESIS

There is a lot more to science than just the collection of information. You could spend the rest of your life carefully observing the world around you, but such a task won't reveal very much unless you can see some kind of pattern and come up with an idea, or *hypothesis*, that explains your observations.

Hypotheses are ideas that may be correct or incorrect. To evaluate one, you must have relevant data and a reliable method of data analysis. For example, you could propose the hypothesis that radiation emitted by planet X confers immortality. Could anyone prove you wrong? Not very likely, particularly if you didn't specify the location of the planet or the type of radiation. Would anyone believe you? If you were a "leading authority" on something (anything), a few probably would.

That's not as ridiculous as it might seem. For almost 1500 years "everyone knew" that inhaled air was transported from the lungs through blood vessels to the heart. They knew this because the famous Roman physician Galen had said so. Because he was right in several other respects, all his statements were accepted as true, and contrary opinions were held in low esteem. To avoid making this kind of error, you must always remember to evaluate the hypothesis, not the individual who proposed it!

In the evaluation process, we must examine the hypothesis to see if it makes correct predictions about the real world. The steps in this process are diagrammed in Figure A-1. A valid hypothesis will have three characteristics: It will be (1) testable, (2) unbiased, (3) and repeatable.

A testable hypothesis is one that can be studied by experimentation or data collection. Your assertion concerning planet X qualifies as a hypothesis, but it cannot be tested unless we find the planet and detect the radiation. An example of a testable hypothesis would be "left-handed airplane pilots have fewer crashes than do right-handed pilots." That is testable because it makes a prediction about the world that can be checked—in this case by collecting and analyzing data.

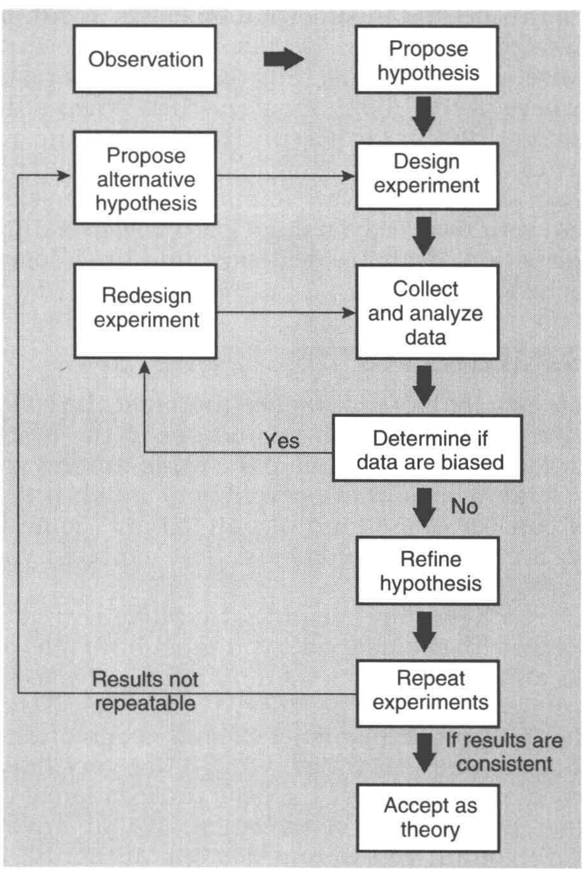

Figure A-1 The Scientific Method.
The basic sequence of steps involved in the development and acceptance of a scientific theory.

AVOIDING BIAS

Suppose, then, that you collected information about all the plane crashes in the world and discovered that 80 percent of all crashed airplanes were flown by right-handed pilots. "Aha!" you might shout, "The hypothesis is correct!" The implications are obvious: Ban all right-handed airline pilots, eliminate four-fifths of all crashes, and sit back and wait for your prize from the Air Traffic Safety Association.

Unfortunately, you would be acting prematurely, for your data collection was biased. To test your hypothesis adequately, you need to know not only how many crashes involved right-handed or left-handed pilots but how many right-handed and left-handed pilots were flying. If 90 percent of the pilots were right-handed, but they accounted for only 80 percent of the crashes, then left-handed pilots are the ones to watch out for! Eliminating bias in this case is relatively easy, but health studies may have all kinds of complicating factors. Because 25 percent of us will probably develop cancer at some point in our lives, we will use cancer studies to exemplify the problems encountered.

The first example of bias in action concerns cancer statistics, which indicate that there are definite regional variations in cancer rates in the United States and abroad. For example, although the estimated yearly cancer death rate in the United States was 173 per 100,000 population in 1997, the rate in Utah was only 126 per 100,000, whereas the rate in the District of Columbia was 221 per 100,000. It would be very easy to assume that this difference is the direct result of rural versus urban living. But these data alone should not convince you that moving from the District of Columbia to Utah will lower your risk of developing cancer. To draw that conclusion, you would have to be sure that the observed rates were the direct result of just a single factor, the difference in physical location. As you will find in later chapters, many different factors can promote cancer development. To exclude all possibilities other than geography, you would have to be certain that the populations were alike in all other respects. Here are a few possible sources of variation that could affect that conclusion:

- *Different population profiles.* Cancer rates vary between males and females, among racial groups, and among age groups. Therefore, we need to know how the populations of Utah and the District of Columbia differ in each respect.
- *Different occupations.* Because chemicals used in the workplace are implicated in many cancers, we need to know how the populations of each region are employed and what occupational hazards they face.
- *Different mobilities.* Because the region in which a person dies may not be the region in which he

or she lived and developed cancer, we need to know whether people with cancer in Utah stay in the state or go elsewhere for critical care and whether people with cancer travel to the District of Columbia to seek treatment at special clinics.

- *Different health care.* Because cancer death rates reflect differences in patterns of health care, we need to know whether residents of Utah pay more attention to preventive health care and have more regular checkups, whether their medical facilities are better, and whether they devote a larger proportion of their annual income to health services than do residents in the District of Columbia.

You can probably think of additional factors, but the point is that avoiding experimental bias can be quite difficult!

A second example of the problem of bias comes from the collection of "miracle cures" that continue to appear and disappear at regular intervals. Pyramid power, pendulum power, crystals, magnetic energy fields, and psychic healers come and go in the news. Wonder drugs are equally common, whether they are "secret formulas" or South American plant extracts discovered by colonists from other planets. The proponents of each new procedure or drug report glowing successes with patients who would otherwise have surely succumbed to the disease. And all these remedies are said to have been suppressed or willfully ignored by the "medical establishment."

Even accepting that the claims aren't exaggerated, does the fact that 1, or 100, or even 1000 patients have been cured prove anything? No, it doesn't, for a list of successes doesn't mean very much. To understand why, consider the questions you might pose to an instructor who announced on the first day of class that he or she had given 20 A's last semester. You would want to know how many students were in the class: only 20, or several hundred? You would also want to find out how the rest of the class performed—20 A's and 200 D's might be rather discouraging. You could also check on how the students were selected. If only students with A averages in other courses were allowed to enroll, your opinion should change accordingly. Finally, you might check with the students and compare their grades with those given by other instructors who teach the same course.

With just a couple of modifications, the same questions could be asked about a potential cancer cure:

- How many patients were treated, how many were cured, and how many died?
- How were the patients selected? If selection depended on wealth, degree of illness, or previous exposure to other therapeutic techniques, then the experimental procedure was biased from the start.
- How many might have recovered regardless of the treatment? Even "terminal" cancers sometimes simply disappear for no apparent reason. Such occurrences are rare, but they do happen. Thus, any treatment, however bizarre, will in some cases appear to work. If the frequency of recovery is lower than that among other patient groups, the treatment may actually be harmful despite the reported "cures."
- How do the foregoing statistics compare with those of more traditional therapies when subjected to the same unbiased tests?

THE NEED FOR REPEATABILITY

Finally, let's examine the criterion of repeatability. It's not enough to develop a reasonable, testable hypothesis and collect unbiased data. Consider the hypothesis that every time a coin is tossed, it will come up heads. You could build a coin-tossing machine, turn it on, and find that in the first experiment of 10 tosses, the coin came up heads every time. Does this result prove the hypothesis?

No, it doesn't, despite the fact that it was an honest experiment and the data supported the hypothesis. The problem here is one of statistics, sample size, and luck. The odds that a coin will come up heads on any given toss are 50 percent, or 1 in 2—the same as the odds that it will come up tails. The odds that it will come up heads 10 times in a row are about 1 in 2000—small but certainly not inconceivable. If that coin is tossed 50 times, however, the chance of getting 50 heads drops to 1 in 4,500,000,000,000,000, a figure that most people would accept as vanishingly small. Proving that the hypothesis "a tossed coin always lands heads up" is false requires that the coin come up tails only once. So the truth could be revealed by running the experiment with more coin tosses or by letting other people set up identical experiments and toss their own coins.

The point is that if a hypothesis is correct, anyone and everyone will get the same results when the experiment is performed. If it isn't repeatable, you have to doubt the conclusions even when you have complete confidence in the abilities and integrity of the original investigator.

If a hypothesis satisfies all these criteria—that is, it is testable, unbiased, and repeatable—it can be accepted as a scientific *theory*. The scientific use of this term differs from its use in general conversation. When people discuss "wild-eyed theories," they are usually referring to untested hypotheses. Hypotheses may be true or false, but by definition theories describe real phenomena and make accurate predictions about the world. Examples of scientific theories include the theory of gravity and the theory of evolution. The "fact" of gravity is not in question, and the theory of gravity accounts for the available data. But this does not mean that theories cannot change over time. Newton's original theory of gravity, though used successfully for more than two centuries, was profoundly modified and extended by Albert Einstein. Similarly, the theory of evolution has been greatly elaborated since it was first proposed by Charles Darwin in the middle of the nineteenth century. No one theory can tell the whole story, and all theories are continuously being modified and improved as we learn more about our universe.

HOMEOSTASIS AND DISEASE

FAP *p. 16*

The ability to maintain homeostasis depends on two interacting factors: (1) the status of the physiological systems involved and (2) the nature of the stress imposed. Homeostasis is a balancing act, and each of us is like a tightrope walker. Homeostatic systems must adapt to sudden or gradual changes in our environment, the arrival of pathogens, accidental injuries, and many other factors, just as a tightrope walker must make allowances for gusts of wind, frayed segments of the rope, and thrown popcorn.

The ability to maintain homeostatic balance varies with age, general health, and genetic makeup. The geriatric patient or young infant with the flu is in much greater danger than an otherwise healthy young adult with the same viral infection. If homeostatic mechanisms cannot cope with a particular stress, physiological values will drift outside the normal range. This change can ultimately affect all other systems, with potentially fatal results. After all, a person unable to maintain balance will eventually fall off the tightrope.

Consider a specific example. A young adult exercising heavily may have a heart rate of 180 bpm for several minutes. Such a heart rate can be disastrous for an older person with cardiovascular and respiratory problems. If the heart rate cannot be reduced, due to problems with the pacemaking or conducting systems of the heart, the cardiac muscle tissue will be damaged, leading to decreased pumping efficiency and a drop in blood pressure.

These changes represent a serious threat to homeostasis. Other systems soon become involved, and the situation worsens. For example, the kidneys stop working when the blood pressure falls too far, so waste products begin accumulating in the blood. The reduced blood flow in other tissues soon leads to a generalized *hypoxia*, or low tissue oxygen level. Cells throughout the body then begin to suffer from oxygen starvation. The person is now in serious trouble. Unless steps are taken to correct the situation, survival is threatened.

Disease is the failure to maintain homeostatic conditions. The disease process may initially affect a tissue, an organ, or a system, but it will ultimately lead to changes in the function or structure of cells throughout the body. A disease can often be overcome through appropriate, automatic adjustments in physiological systems. In a case of the flu, the disease develops because the immune system cannot defeat the flu virus before that virus has infected cells of the respiratory passageways. For most people, the physiological adjustments made in response to the presence of this disease will lead to the elimination of the virus and the restoration of homeostasis. Some diseases cannot easily be overcome. In the case of the person with acute cardiovascular problems, some outside intervention must be provided to restore homeostasis and prevent fatal complications.

Diseases may result from the following:

- *Pathogens or parasites that invade the body.* Examples include the viruses that cause flu, mumps, or measles; the bacteria responsible for dysentery or tetanus; and pinworms, flukes, and tapeworms. The invasion process is called **infection**. Some parasites do not enter the body but instead attach themselves to the body surface. This process is called **infestation**.
- *Inherited genetic conditions that disrupt normal physiological mechanisms.* These conditions make normal homeostatic control difficult or impossible. Examples (discussed in later sections) include the *lysosomal storage diseases*, *cystic fibrosis*, and *sickle cell anemia*.
- *The loss of normal regulatory control mechanisms.* For example, cancer involves the rapid, unregulated multiplication of abnormal cells. Many cancers have been linked to abnormalities in genes responsible for controlling the rates of cell division. A variety of other diseases, called *autoimmune disorders*, result when regulatory mechanisms of the immune system fail and normal tissues are attacked.
- *Degenerative changes in vital physiological systems.* Many systems become less adaptable and less efficient as part of the aging process. For example, we experience significant reductions in bone mass, respiratory capacity, cardiac efficiency, and kidney filtration as we age. If the elderly are exposed to stresses that their weakened systems cannot tolerate, disease results.
- *Trauma, toxins, or other environmental hazards.* Accidents may damage internal organs, impairing their function. Toxins consumed in the diet or absorbed through the skin may disrupt normal metabolic activities.
- *Nutritional factors.* Diseases may result from diets inadequate in proteins, essential amino acids, essential fatty acids, vitamins, minerals, or water. Kwashiorkor, a protein deficiency disease, and scurvy, a disease caused by vitamin C deficiency, are two examples. Excessive consumption of high-calorie foods, fats, or fat-soluble vitamins can also cause disease.

Pathology is the study of disease, and *pathophysiology* is the study of functional changes caused by disease. Different diseases may result in the same alteration of function and produce the same symptoms. For instance, a patient who has paler-than-normal skin and complains of a lack of energy and breathlessness may have (1) respiratory problems that prevent normal oxygen transfer to the blood, as in *emphysema*, or (2) cardiovascular problems that interfere with normal oxygen transport (*anemia*) or circulation (heart failure). Clinicians must ask questions and collect appropriate information to make a proper diagnosis. This process often involves eliminating possible causes until a specific diagnosis is reached.

For example, if tests indicate that anemia is responsible for the symptoms, the specific type of anemia must then be determined before treatment can begin. After all, the treatment for anemia due to a dietary iron deficiency is very different from the treatment for anemia due to internal bleeding. Of course, you could not hope to identify the probable cause of the anemia unless you were already familiar with the physical and biochemical structure of red blood cells and with their role in the transport of oxygen. This realization brings us to a key concept: *All diagnostic procedures assume an understanding of normal anatomy and physiology.*

SYMPTOMS AND SIGNS

When disease processes affect normal functions, the alterations are the *symptoms* or *signs* of the disease. An accurate diagnosis, or identification of the disease, is accomplished through the observation and evaluation of signs and symptoms.

A **symptom** is the *patient's perception* of a change in normal body function. Examples of symptoms include nausea, malaise, and pain. Symptoms are difficult to measure, and a clinician must ask appropriate questions. The following are typical questions:

"When did you first notice this symptom?"

"What does it feel like?"

"Does it come and go, or does it always feel the same?"

"Are there things you can do to make it feel better or worse?"

The answers provide information about the duration, sensations, recurrence, and potential triggering mechanisms of the symptoms important to the patient.

Pain, an important symptom of many illnesses, is often an indication of tissue injury. The flow chart in Figure A-2 demonstrates the types of pain and introduces important related terminology. Pain sensations and pathways are detailed in Chapter 17 of the text, and we shall consider the control of pain in related sections of the *Applications Manual* (p. 91).

A **sign** is a physical manifestation of the disease. Unlike symptoms, signs can be measured and observed through sight, hearing, or touch. The yellow color of the skin caused by liver dysfunction or a detectable breast lump are signs of disease. An observable change due to a disturbance in the structure of tissue or cells is called a **lesion**. We shall consider lesions of the skin in detail in a later section dealing with the integumentary system (p. 37).

Steps in Diagnosis

A person experiencing serious symptoms usually seeks professional help and thereby becomes a patient. The clinician, whether a nurse, physician, or emergency medical technician, must determine the need for medical care on the basis of observation and assessment of the patient's symptoms and signs. This is the process of diagnosis: the identification of a pathological process by its characteristic symptoms and signs.

Diagnosis is a lot like assembling a jigsaw puzzle. The more pieces (clues) available, the more complete the picture will be. The process of diagnosis is one of deduction and follows an orderly sequence of steps:

1. *Obtain the patient's medical history.* The medical history is a concise summary of past medical disorders, general factors that may affect the function of body systems, and the health of the patient's family. This information provides a framework for considering the individual's current problem. The examiner gains information about the person's concerns by asking specific questions and using good listening skills. Physical assessment begins here, and this is the time for unspoken questions such as, "Is this person moving, speaking, and thinking normally?" The answers will later be integrated with the results of more-precise observations. Other components of the medical history may include the following:
   - *Chief complaint.* The person, now a patient, is asked to specify the primary problem that requires attention. This is recorded as the *chief complaint.* An example would be the entry "Patient complains of pain in the right lower quadrant."
   - *History of current illness.* Which areas of the body are affected? What kind of functional problems have developed? When did the patient first notice the symptoms? The duration of the disease process is an important

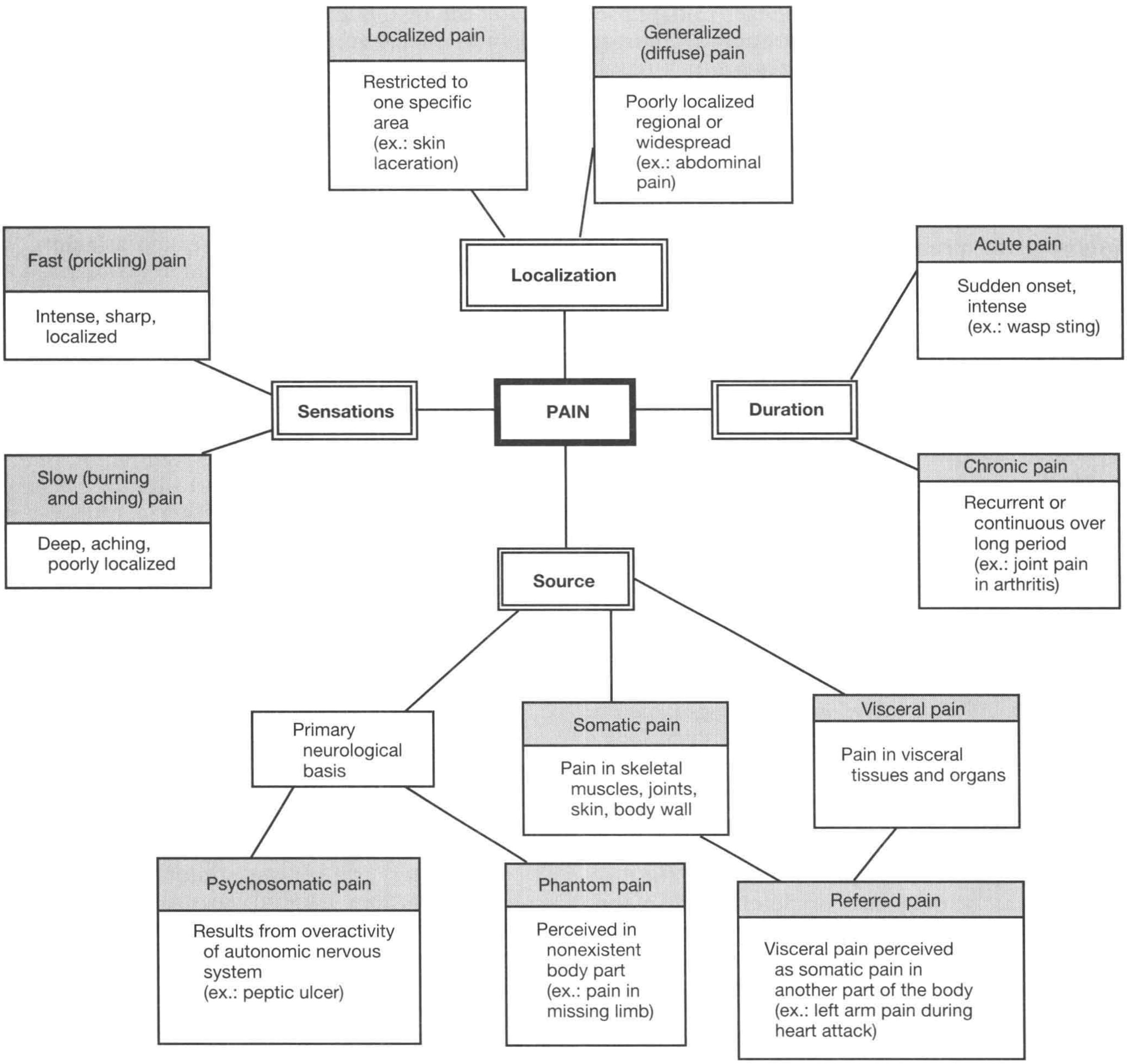

Figure A-2 Methods of Classifying and Describing Pain

factor. For example, an infection may have been present for months, only gradually increasing in severity. This would be called a *chronic infection*. A disease process may have been underway for some time before the person recognizes that a problem exists. Over the initial period, the individual experiences mild *subclinical symptoms* that are usually ignored. Chronic infections have different causes and treatments from *acute infections*, which produce sudden, intense symptoms.

- *Review of systems*. The patient is asked questions that focus on the general status of each body system. This process may detect related problems or causative factors. For example, a chief complaint of headache pain may be *related* to visual problems (stars, spots, blurs, or blanks seen in the field of vision) or *caused* by visual problems (eyeglasses poorly fitted or the wrong prescription).

2. *Perform a physical examination*. The physical examination is a basic but vital part of the diagnostic process. The common techniques used in physical examination include *inspection* (vision), *palpation* (touch), *percussion* (tapping and listening), and *auscultation* (listening):

   - **Inspection** is careful observation. A general inspection involves examining body pro-