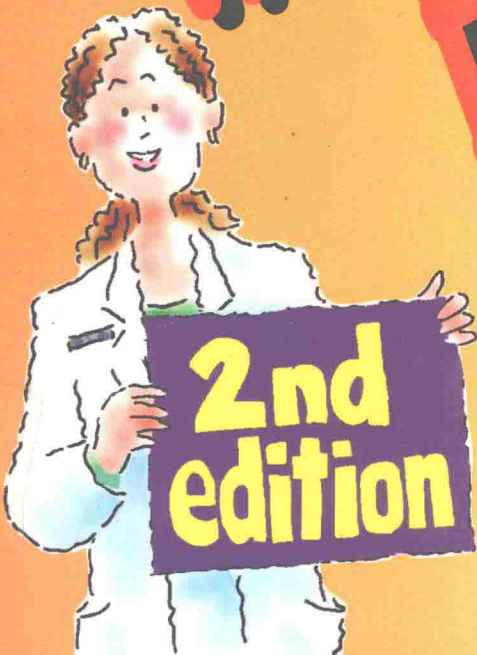


Pathophysiology

made

**Incredibly
Easy!**



**2nd
edition**



SPRINGHOUSE

LIPPINCOTT WILLIAMS & WILKINS

Pathophysiology

made
**Incredibly
Easy!**



LIPPINCOTT WILLIAMS & WILKINS

A Wolters Kluwer Company

Philadelphia • Baltimore • New York • London
Buenos Aires • Hong Kong • Sydney • Tokyo

Staff

Publisher

Judith A. Schilling McCann, RN, MSN

Editorial Director

David Moreau

Clinical Director

Joan M. Robinson, RN, MSN, CCRN

Clinical Editors

Collette Bishop Hendler, RN, CCRN (clinical project manager); Wanda H. Jones, RN, BSN, MJ

Editors

Julie Munden (senior editor), Ty Eggenberger,
Kevin Haworth, Kirk Robinson, Liz Schaeffer

Copy Editors

Peggy Williams (supervisor), Kimberly Bilotta,
Dona Hightower, Marsha Ryan, Pamela Wingrod

Designers

Arlene Putterman (senior art director),
Mary Ludwicki (art director), Lynn Foulk

Illustrators

Scott Thorn Barrows, Barbara Cousins,
John Cymerman, Mark Lefkowitz, Judy Newhouse,
Bot Roda, Mary Stangl, Nina Wallace, Larry Ward

Electronic Production Services

Diane Paluba (manager), Joyce Rossi Biletz

Manufacturing

Patricia Dorshaw (senior manager), Beth Janae Orr

Editorial Assistants

Danielle J. Barsky, Beverly Lane, Linda Ruhf

Indexer

Ellen Brennan

The clinical treatments described and recommended in this publication are based on research and consultation with nursing, medical, and legal authorities. To the best of our knowledge, these procedures reflect currently accepted practice. Nevertheless, they can't be considered absolute and universal recommendations. For individual applications, all recommendations must be considered in light of the patient's clinical condition and, before administration of new or infrequently used drugs, in light of the latest package-insert information. The authors and publisher disclaim responsibility for any adverse effects resulting from the suggested procedures, from any undetected errors, or from the reader's misunderstanding of the text.

© 2002 by Lippincott Williams & Wilkins. All rights reserved. No part of this publication may be used or reproduced in any manner whatsoever without written permission, except for brief quotations embodied in critical articles and reviews. For information, write Lippincott Williams & Wilkins, 1111 Bethlehem Pike, P.O. Box 908, Springhouse, PA 19477-0908. Authorization to photocopy items for internal or personal use, or for the internal or personal use of specific clients, is granted by Lippincott Williams & Wilkins for users registered with the Copyright Clearance Center (CCC) Transactional Reporting Service, provided that the fee of \$.75 per page is paid directly to CCC, 222 Rosewood Dr., Danvers, MA 01923. For those organizations that have been granted a photocopy license by CCC, a separate system of payment has been arranged. The fee code for users of the Transactional Reporting Service is 1582551685/02 \$00.00 + .75.

Printed in the United States of America.

IEP2-D N O S A J

04 03 10 9 8 7 6 5 4 3

Library of Congress Cataloging-in-Publication Data

Pathophysiology made incredibly easy. — 2nd ed.

p. ; cm.

Includes index.

1. Physiology, Pathological. 2. Nursing.

I. Lippincott Williams & Wilkins.

RB113 .P3636 2002

616 .07—dc21

ISBN 1-58255-168-5 (alk. paper)

2001050732

Pathophysiology

made
**Incredibly
Easy!**



**2nd
edition**

Contributors and consultants

Donelle M. Bussom, RN, MSN

Senior Manager, Medical Affairs
ICON Clinical Research
North Wales, Pa.

Nancy Cirone, RN, C, MSN, CDE

Director Staff Development
Warminster Hospital
Warminster, Pa.

Arlene M. Clarke-Coughlin, RN, MSN

Nursing Faculty
Holy Name Hospital School of Nursing
Teaneck, N.J.

Christian C. Evans, PT, PhD

Assistant Professor
Department of Physical Therapy
Midwestern University
Downers Grove, Ill.

William Galvin, MEd, CPFT, CRT, RRT

Assistant Professor, Program Director
Gwynedd Mercy College
Gwynedd Valley, Pa.

Nancy Hutton Haynes, RN, MN, CCRN, TNCCP

Assistant Professor of Nursing
Saint Luke's College
Kansas City, Mo.

Joyce Lyne Heise, RN, MSN, EdD

Professor of Nursing
Kent State University
East Liverpool, Ohio

Patricia A. Lange-Otsuka, RN, EdD, APRN, BC

Associate Professor of Nursing
Graduate Nursing Program Coordinator
Hawaii Pacific University
Kaneohe

Dawna Martich, RN, MSN

Clinical Trainer
American Healthways
Pittsburgh

Janet Louise Parker, RN, CS, MSN, CCP

Perfusionist
Deborah Heart and Lung Center
Browns Mills, N.J.

Cynthia A. Prows, RN, MSN

Clinical Nurse Specialist, Genetics
Cincinnati Children's Hospital Medical Center

Hema Santhanam, RN, MSN, ACRN, CFNP

Nursing Director
Yonkers (N.Y.) General Hospital

We extend special thanks to the following people, who contributed to the previous edition:

Deborah Becker, RN, MSN, CCRN

Susan J. Brown-Wagner, RN, MSN, AOCN, CRNP

Jacqueline Crocetti, RN, MSN, CRNP

Susan B. Dickey, RN, C, PhD

DuWayne C. Englert, PhD

Marilyn A. Folcik, RN, MPH, ONC

Ellie Z. Franges, RN, MSN, CCRN, CNRN

Linda B. Haas, RN, PhD, CDE

Nancy A. Hauko, RN, BAN, CIC

Christine A. Kogel, RN

Kay L. Luft, MN, CCRN, TNCC

Judith E. Meissner, RN, MSN

Teresa Murphy, RN, BSN, CCRN

Barbara Barnes Rogers, RN, MN, AOCN, CRNP

Michael L. Silverman, MD

Maryann Summers, RN, MS

Foreword

I always get excited when a new edition of a nursing book comes out. To begin with, it shows that the book has value and appeal to its audience. Perhaps what's most exciting, it reflects the changes and improvements in the field. The contributors and consultants who helped bring out this second edition of *Pathophysiology Made Incredibly Easy* should be commended for their efforts to provide nurses and nursing students the means to quickly stay up-to-date on the complex processes of patient care. Nursing is difficult work—this book can help make it a little easier.

Pathophysiology is one of those “hard science” subjects, and our knowledge keeps changing as more information is gained through research. This book and series help the reader stay current while presenting the material in an easy-to-understand format—with a little humor added in. The diagrams and illustrations help you visualize and conceptualize the information. It certainly makes better reading than some of those two-inch-thick, 10-pound textbooks with microscopic print.

I can't count how many times I have sat at my desk with three to five pathophysiology textbooks in front of me and tried to break down the information into manageable pieces. *Pathophysiology Made Incredibly Easy*, Second Edition, is now my first stop. Although it can't tell you everything in two pounds or less, it's always a great start. It also leaves you room on your desk for that essential computer!

I find this book invaluable when trying to explain health concepts to patients and their families. The illustrations are clear and accurate without the clutter that can get in the way of learning. A picture really can speak a thousand words and, more importantly, cross borders when the words aren't in a common language. I have also found the illustrations large enough to place a transparency sheet over them, allowing me to draw on them for patients and students. This book will challenge you to find new ways to use your copy.

Chapter 1 begins with an introduction to the basics of pathophysiology. Chapter 2 discusses cancer with a review of pathophysiology, tests, and treatments for common types of cancer. Chapters 3, 4, and 5 present the latest information on infection, immune disorders, and genetics. Each chapter explains complex concepts in clear-cut language with relevant clinical information about the pathophysiology of common disorders.

The remaining eight chapters focus on body systems and review a wide range of common disorders from acquired immunodeficiency syndrome to viral hepatitis. Each chapter starts with the basics and transforms complex topics into manageable pieces.

The value-added components and new features are what really make this book easy to understand and enjoyable to read. Within each chapter, you'll find many helpful features to enhance your learning. They include:

- overviews of common disorders using a systems approach
- associated signs and symptoms
- relevant diagnostic tests and findings
- quick quizzes at the end of every chapter



- a comprehensive glossary of terms.

You'll also find special logos throughout the book that alert you to important points:



Battling illness highlights current treatments.



Now I get it! alerts you to complex ideas with illustrated explanations.

This second edition has been enhanced with these new logos:



Under investigation highlights current research in the pathophysiology of a specific disorder.



Cheat sheets summarize key points and provide a quick review.



Practice makes perfect presents case study questions and answers at the end of the book to reinforce and test your learning. It might even help students prepare for their next test!

Finally, you won't want to miss the *Incredibly Easy miniguides* on pages 183 to 186 and 219 to 222. A favorite feature of many, these guides provide elaborate, four-color illustrations of heart and lung pathophysiology. You've never seen it clearer!

Understanding the complex workings of our bodies during illness and promoting the restoration and maintenance of health are key elements of nursing practice. Being a professional requires life-long learning—and learning is made easier with this book.

I hope you're as pleased as I am with this edition and join me in looking forward to future editions.

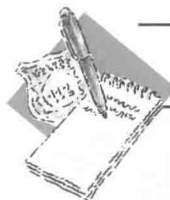
Patricia A. Lange-Otsuka, RN, EdD, APRN, BC

Associate Professor of Nursing
Graduate Nursing Program Coordinator
Hawaii Pacific University
Kaneohe

Contents

<i>Contributors and consultants</i>	<i>vii</i>
<i>Foreword</i>	<i>ix</i>
1	Pathophysiology basics 1
2	Cancer 15
3	Infection 43
4	Immune system 67
5	Genetics 93
6	Endocrine system 123
7	Respiratory system 157
	Incredibly Easy miniguide 183
8	Cardiovascular system 201
	Incredibly Easy miniguide 219
9	Neurologic system 249
10	Blood 289
11	Digestive system 309
12	Renal system 347
13	Musculoskeletal system 379
<i>Appendices and index</i>	
	<i>Practice makes perfect 404</i>
	<i>Less common disorders 418</i>
	<i>Glossary 427</i>
	<i>Index 432</i>

Pathophysiology basics



Just the facts

This chapter presents basic information about cells and diseases. In this chapter, you'll learn:

- ◆ the structure of cells and how cells reproduce, age, and die
- ◆ what homeostasis is and how it affects the body
- ◆ what causes disease
- ◆ how diseases develop.

Understanding cells

The cell is the body's basic building block. It's the smallest living component of an organism. Many organisms are made up of one independent, microscopically tiny cell. Others, such as humans, consist of millions of cells grouped into highly specialized units that function together throughout the organism's life.

Large groups of individual cells form tissues, such as muscle, blood, and bone. Tissues, in turn, form the organs, such as the brain, heart, and liver, which are integrated into body systems—such as the central nervous system (CNS), cardiovascular system, and digestive system.

Understanding pathophysiology begins with understanding the body's basic building block, the cell.

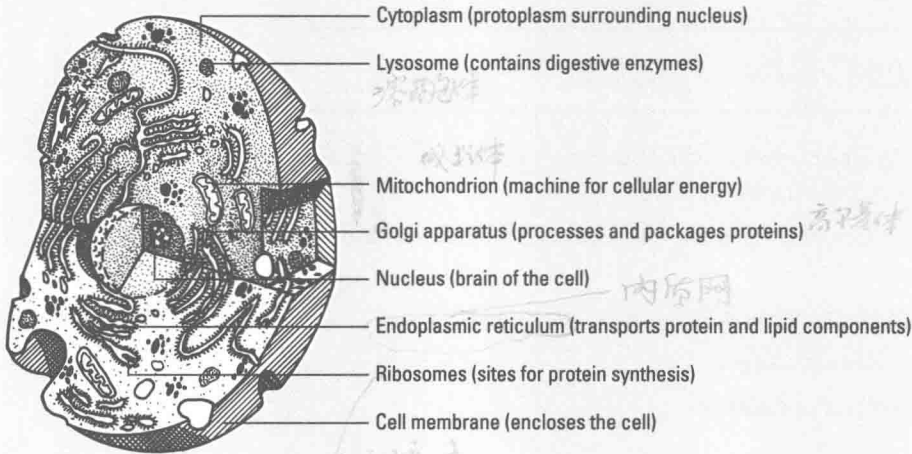
Cell components

Cells are composed of various structures, or organelles, each with specific functions. (See *Just your average cell*, page 2.) The organelles are contained in the cytoplasm—an aqueous mass—that is surrounded by the cell membrane. The largest organelle, the nucleus, stores deoxyribonucleic acid (DNA), which carries genetic material and is responsible for cellular reproduction or division.



Just your average cell

The illustration below shows cell components and structures. Each part has a function in maintaining the cell's life and homeostasis.



More components

The typical animal cell is characterized by several additional elements:

- Adenosine triphosphate, the energy that fuels cellular activity, is made by the mitochondria.
- Ribosomes and the endoplasmic reticulum synthesize proteins and metabolize fat within the cell.
- The Golgi apparatus holds enzyme systems that assist in completing the cell's metabolic functions.
- Lysosomes contain enzymes that allow cytoplasmic digestion to be completed.

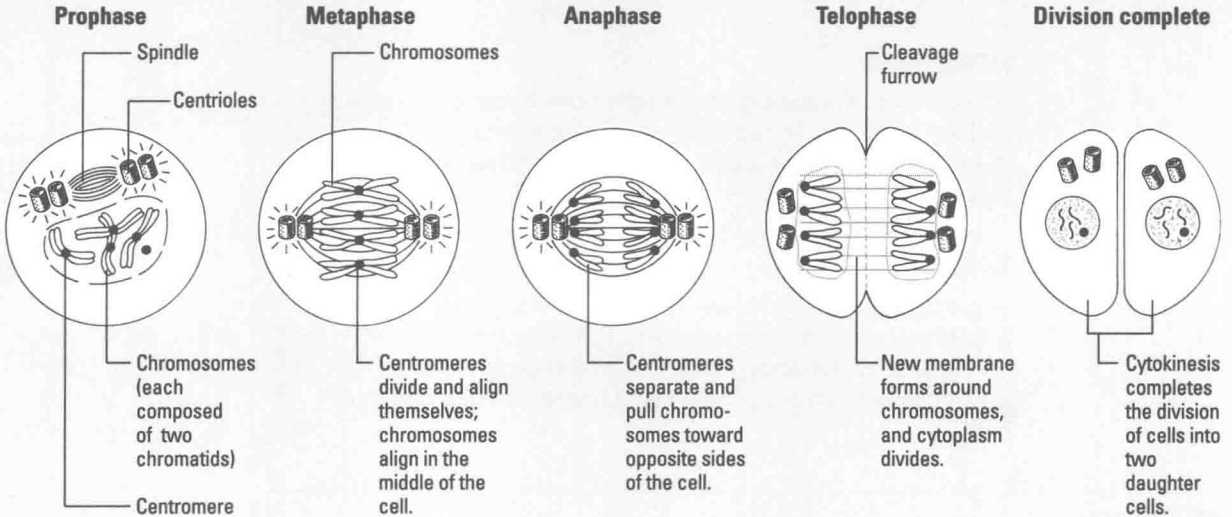
Cell division and reproduction

Individual cells don't live as long as the individual they're a part of. They're subject to wear and tear and must reproduce and be replaced. Most cells reproduce as quickly as they die.

Cell reproduction occurs in two stages. In the first stage, called mitosis, the nucleus and genetic material divide. In the second stage, called cytokinesis, the cytoplasm divides, beginning during late anaphase or telophase. At the end of cytokinesis the cell produces two daughter cells. (See *Replicate and divide.*)

Replicate and divide

The illustrations below show the different phases of mitosis, or cell reproduction.



The great divide

Before division, a cell must double its mass and content. This occurs during the growth phase, called interphase. Chromatin, the small, slender rods of the nucleus that give it its granular appearance, begins to form.

Replication and duplication of DNA occur during the four phases of mitosis:

-  prophase
-  metaphase
-  anaphase
-  telophase.

Prophase

During prophase, the chromosomes coil and shorten, and the nuclear membrane dissolves. Each chromosome is made up of a pair of strands called chromatids, which are connected by a spindle of fibers called a centromere.

Metaphase

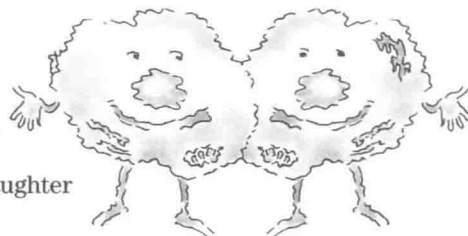
During metaphase, the centromeres divide, pulling the chromosomes apart. The centromeres then align themselves in the middle of the spindle.

Anaphase

At the onset of anaphase, the centromeres begin to separate and pull the newly replicated chromosomes toward opposite sides of the cell. By the end of anaphase, 46 chromosomes are present on each side of the cell.

Telophase

In the final phase of mitosis — telophase — a new membrane forms around each set of 46 chromosomes. The spindle fibers disappear, cytokinesis occurs, and the cytoplasm divides, producing two identical new daughter cells.



Cell injury

A person's state of wellness and disease is reflected in the cells. Injury to any of the cell's components can lead to illness.

One of the first indications of cell injury is a biochemical lesion that forms on the cell at the point of injury. This lesion changes the chemistry of metabolic reactions within the cell.

Consider, for example, a patient with chronic alcoholism. The cells of the immune system may be altered, making the patient susceptible to infection. Other cells, such as those of the pancreas and liver, are also affected. These cells can't be reproduced, which prevents a return to normal functioning.



Draw on your reserves, adapt, or die

When cell integrity is threatened — for example, by toxins, infection, physical injury, or deficit injury — the cell reacts in one of two ways:

- by drawing on its reserves to keep functioning
- by adapting through changes or cellular dysfunction.

If enough cellular reserve is available and the body doesn't detect abnormalities, the cell adapts. If there isn't enough cellular reserve, cell death (necrosis) occurs. Necrosis is usually localized and easily identifiable.



Toxic injuries may result from factors inside or outside the body.

Toxic injury

Toxic injuries may be caused by factors inside the body (called endogenous factors) or outside the body (called exogenous factors). Common endogenous factors include genetically determined metabolic errors, gross malformations, and hypersensitivity reactions. Exogenous factors include alcohol, lead, carbon monoxide, and drugs that alter cellular function. Examples of such drugs are chemotherapeutic agents used for cancer treatment and immunosuppressant drugs that prevent rejection in organ transplant recipients.

Infectious injury

Viral, fungal, protozoan, and bacterial agents can cause cell injury or death. These organisms affect cell integrity, usually by interfering with cell synthesis, which produces nonviable, mutant cells. For example, human immunodeficiency virus alters the cell when the virus is replicated in the cell's ribonucleic acid.

Physical injury

Physical injury results from a disruption in the cell or in the relationships of the intracellular organelles. Two major types of physical injury are thermal (electrical or radiation) and mechanical (trauma or surgery). Causes of thermal injury include radiation therapy for cancer, X-rays, and ultraviolet radiation. Causes of mechanical injury include motor vehicle crashes, frostbite, and ischemia.

Deficit injury

When a deficit of water, oxygen, or nutrients occurs, or if constant temperature and adequate waste disposal aren't maintained, cellular synthesis can't take place. A lack of just one of these basic requirements can cause cell disruption or death.



Memory jogger

To remember the four causes of cell injury, think of how the injury tipped (or *TIPD*) the scale of homeostasis:

Toxin or other lethal (cytotoxic) substance

Infection

Physical insult or injury

Deficit, or lack of water, oxygen, or nutrients.



Cell degeneration

A type of nonlethal cell damage known as degeneration generally occurs in the cytoplasm of the cell, while the nucleus remains unaffected. It usually affects organs with metabolically active cells, such as the liver, heart, and kidneys, and is caused by the following problems:

- increased water in the cell or cellular swelling
- fatty infiltrates
- atrophy

- autophagocytosis, during which the cell absorbs some of its own parts
- pigmentation changes
- calcification
- hyaline infiltration
- hypertrophy
- dysplasia (related to chronic irritation)
- hyperplasia.

Degeneration occurs in the cytoplasm of the cell; the nucleus remains unaffected.

Talkin' 'bout degeneration

When changes within cells are identified, degeneration may be slowed or cell death prevented through prompt health care. An electron microscope makes the identification of changes within cells easier. When a disease is diagnosed before the patient complains of any symptoms, it's termed *subclinical identification*. Unfortunately, many cell changes remain unidentifiable even under a microscope, making early detection impossible.



Cell aging

During the normal process of cell aging, cells lose structure and function. Lost cell structure may cause a decrease in size or wasting away, a process called atrophy. Two characteristics of lost cell function are:

- hypertrophy, an abnormal thickening or increase in bulk
- hyperplasia, an increase in the number of cells.

Cell aging may slow down or speed up, depending on the number and extent of injuries and the amount of wear and tear on the cell.

Down with cell aging!

Warning: This cell will self-destruct

Signs of aging occur in all body systems. Examples include decreases in elasticity of blood vessels, bowel motility, muscle mass, and subcutaneous fat. The cell aging process limits the human life span. One theory says that cell aging is an inherent self-destructive mechanism that increases with a person's age.

Cell death may be caused by internal (intrinsic) factors that limit the cells' life span or external (extrinsic) factors that contribute to cell damage and aging. (See *In's and out's of cell aging*.)



In's and out's of cell aging

Factors that affect cell aging may be intrinsic or extrinsic, as outlined below.

Intrinsic factors

- Psychogenic
- Inherited
- Congenital
- Metabolic
- Degenerative
- Neoplastic
- Immunologic
- Nutritional

Extrinsic factors

Physical agents

- Force
- Temperature
- Humidity
- Radiation
- Electricity
- Chemicals

Infectious agents

- Viruses
- Bacteria
- Fungi
- Protozoa
- Insects
- Worms

The cell aging process is what actually limits the human life span.



Homeostasis

The body is constantly striving to maintain a dynamic, steady state of internal balance called homeostasis. Every cell in the body is involved in maintaining homeostasis, both on the cellular level and as part of an organism.

Any change or damage at the cellular level can affect the entire body. When an external stressor disrupts homeostasis, illness may occur. A few examples of external stressors include injury, lack of nutrients, and invasion by parasites or other organisms. Throughout the course of a person's lifetime, many external stressors affect the body's internal equilibrium.

Maintaining the balance

Three structures in the brain are responsible for maintaining homeostasis:



the medulla oblongata, the part of the brain stem that's associated with vital functions, such as respiration and circulation



the pituitary gland, which regulates the function of other glands and thereby a person's growth, maturation, and reproduction



the reticular formation, a group of nerve cells or nuclei that form a large network of connected tissues that help control vital reflexes, such as cardiovascular function and respiration.

Feedback mechanisms

Homeostasis is maintained by self-regulating feedback mechanisms. These mechanisms have three components:



a sensor mechanism that senses disruptions in homeostasis



a control center that regulates the body's response to disruptions in homeostasis



an effector mechanism that acts to restore homeostasis.

An endocrine (hormone-secreting) gland usually controls the sensor mechanism. A signal is sent to the control center in the CNS, which initiates the effector mechanism.

There are two types of feedback mechanisms:



a negative feedback mechanism, which works to restore homeostasis by correcting a deficit within the system



a positive feedback mechanism, which occurs when hormone secretion triggers additional hormone secretion. This indicates a trend away from homeostasis.

Negative feedback in fact cancels out the original response.

Accentuate the negative

For negative feedback mechanisms to be effective, they must sense a change in the body — such as a high blood glucose level — and attempt to return body functions to normal. In the case of a high blood glucose level, the effector mechanism triggers increased insulin production by the pancreas, returning blood glucose levels to normal and restoring homeostasis. (See *Negative feedback, positive result.*)

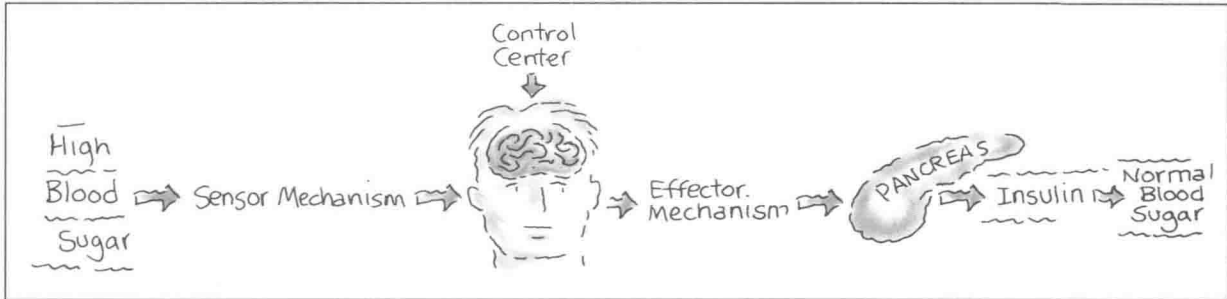
Accentuate the positive

The positive feedback mechanism is far from positive. It takes the original response and exaggerates it. It's said to be positive because the change that occurs proceeds in the same direction as the initial disturbance, causing a further deviation from homeostasis. A positive feedback mechanism is responsible for intensifying labor contractions during childbirth.



Negative feedback, positive result

This flow chart shows how a negative feedback mechanism works to restore homeostasis in a patient with a high blood glucose level.



Disease and illness

Although disease and illness aren't synonymous, they're commonly used interchangeably. Disease occurs when homeostasis isn't maintained. Illness occurs when a person is no longer in a state of normal health.

For example, a person may have coronary artery disease, diabetes, or asthma but not be ill all the time because his body has adapted to the disease. In this situation, a person can perform necessary activities of daily living.

Genetic factors, plus unhealthy behaviors, plus personality type, plus attitude, plus perception may add up to disease.

Genetic factors plus

Genetic factors (such as a tendency toward obesity), unhealthy behaviors (such as smoking), stress, and even the patient's perception of the disease (such as acceptance or denial) influence the course and outcome of a disease. Diseases are dynamic and may manifest in a variety of ways, depending on the patient and his environment.



Cause

One aspect of disease is its cause (the fancy term is *etiology*). The cause of disease may be intrinsic or extrinsic. Inherited traits, the person's age and sex, exposure to infectious agents, and personal behaviors (such as inactivity, smoking, or using drugs) can all cause disease. Diseases with no known cause are called idiopathic.