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# Human Physiology: An Integrated Approach, Global Edition

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Theme 3: Information Flow Coordinates Body Functions

Theme 4: Homeostasis Maintains Internal Stability

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# RUNNING PROBLEMChromium Supplements

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Electrons Have Four Important Biological Roles

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Membrane Proteins May Be Loosely or Tightly Bound to the Membrane



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The Cytoplasm Includes Cytosol, Inclusions, Fibers, and Organelles

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Emerging ConceptsSingle Cilia Are Sensors

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CLINICAL FOCUSLDL: The Lethal Lipoprotein

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BIOTECHNOLOGYCalcium Signals Glow in the Dark

CLINICAL FOCUSFrom Dynamite to Medicine

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CLINICAL FOCUSDiabetes: The Discovery of Insulin

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**CLINICAL FOCUSMutant Channels** 

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BIOTECHNOLOGYThe Body's Wiring

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Neurotransmitters Are Highly Varied

CLINICAL FOCUSMyasthenia Gravis

BIOTECHNOLOGYOf Snakes, Snails, Spiders, and Sushi

Neurotransmitters Are Released from Vesicles

Stronger Stimuli Release More Neurotransmitter



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CLINICAL FOCUSDiabetes: Hypoglycemia and the Brain

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**CLINICAL FOCUSNatural Painkillers** 

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**Emerging ConceptsMelanopsin** 



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Myosin Crossbridges Move Actin Filaments

Calcium Signals Initiate Contraction

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Acetylcholine Initiates ExcitationContraction Coupling

**BIOTECHNOLOGYWatching Myosin Work** 

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Fatigue Has Multiple Causes

Skeletal Muscle Is Classified by Speed and Fatigue Resistance



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RUNNING PROBLEMMyocardial Infarction



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The Cardiovascular System Consists of the Heart, Blood Vessels, and Blood

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CLINICAL FOCUSGallops, Clicks, and Murmurs

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# RUNNING PROBLEMEssential Hypertension

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CLINICAL FOCUSSHOCK

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CLINICAL FOCUSDiabetes and Cardiovascular Disease

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Focus on . . . Bone Marrow

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CLINICAL FOCUSDiabetes: Hemoglobin and Hyperglycemia

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# RUNNING PROBLEMEmphysema

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CLINICAL FOCUSCongestive Heart Failure

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**RUNNING PROBLEMGout** 

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# RUNNING PROBLEMHyponatremia

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CLINICAL FOCUSDiabetes: Osmotic Diuresis

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CLINICAL FOCUSDiabetes: Delayed Gastric Emptying

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Chemical and Mechanical Digestion Begins in the Mouth

Saliva Is an Exocrine Secretion

Swallowing Moves Food from Mouth to Stomach

Integrated Function: The Gastric Phase



The Stomach Stores Food

Gastric Secretions Protect and Digest

The Stomach Balances Digestion and Defense

# Integrated Function: The Intestinal Phase

Intestinal Secretions Promote Digestion

The Pancreas Secretes Enzymes and Bicarbonate

The Liver Secretes Bile

Most Digestion Occurs in the Small Intestine

Focus on . . . The Liver

Bile Salts Facilitate Fat Digestion

Carbohydrates Are Absorbed as Monosaccharides

Proteins Are Digested into Small Peptides and Amino Acids

Some Larger Peptides Can Be Absorbed Intact

Nucleic Acids Are Digested into Bases and Monosaccharides

The Intestine Absorbs Vitamins and Minerals

The Intestine Absorbs Ions and Water

Regulation of the Intestinal Phase

The Large Intestine Concentrates Waste

Diarrhea Can Cause Dehydration

EMERGING CONCEPTSThe Human Microbiome Project

## Immune Functions of the GI Tract

M Cells Sample Gut Contents

Vomiting Is a Protective Reflex

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# Chapter 22: Metabolism and Energy Balance

Appetite and Satiety

# **RUNNING PROBLEMEating Disorders**

BIOTECHNOLOGYDiscovering Peptides: Research in Reverse

# **Energy Balance**

**Energy Input Equals Energy Output** 

Oxygen Consumption Reflects Energy Use

CLINICAL FOCUSEstimating Fat-The Body Mass Index

Many Factors Influence Metabolic Rate

Energy Is Stored in Fat and Glycogen

#### Metabolism

Ingested Energy May Be Used or Stored

Enzymes Control the Direction of Metabolism

## FedState Metabolism

Carbohydrates Make ATP

Amino Acids Make Proteins



Fats Store Energy

CLINICAL FOCUSAntioxidants Protect the Body

Plasma Cholesterol Predicts Heart Disease

#### FastedState Metabolism

Glycogen Converts to Glucose

Proteins Can Be Used to Make ATP

Lipids Store More Energy than Glucose or Protein

# Homeostatic Control of Metabolism

The Pancreas Secretes Insulin and Glucagon

The InsulintoGlucagon Ratio Regulates Metabolism

Insulin Is the Dominant Hormone of the Fed State

Insulin Promotes Anabolism

Glucagon Is Dominant in the Fasted State

Diabetes Mellitus Is a Family of Diseases

Type 1 Diabetics Are Prone to Ketoacidosis

Type 2 Diabetics Often Have Elevated Insulin Levels

Metabolic Syndrome Links Diabetes and Cardiovascular Disease

Multiple Hormones Influence Metabolism

# Regulation of Body Temperature

Body Temperature Balances Heat Production, Gain, and Loss

Body Temperature Is Homeostatically Regulated

Movement and Metabolism Produce Heat

The Bodys Thermostat Can Be Reset

## CHAPTER SUMMARY

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# Chapter 23: Endocrine Control of Growth and Metabolism

# Review of Endocrine Principles

RUNNING PROBLEMHyperparathyroidism

## Adrenal Glucocorticoids

The Adrenal Cortex Secretes Steroid Hormones

Cortisol Secretion Is Controlled by ACTH

Cortisol Is Essential for Life

Cortisol Is a Useful Therapeutic Drug

Cortisol Pathologies Result from Too Much or Too Little Hormone

CRH and ACTH Have Additional Physiological Functions

#### Thyroid Hormones

Thyroid Hormones Contain Iodine

TSH Controls the Thyroid Gland

Thyroid Pathologies Affect Quality of Life

**Growth Hormone** 



Growth Hormone Is Anabolic

Growth Hormone Is Essential for Normal Growth

Genetically Engineered hGH Raises Ethical Questions

## Tissue and Bone Growth

Tissue Growth Requires Hormones and Paracrine Factors

Bone Growth Requires Adequate Dietary Calcium

**CLINICAL FOCUSNew Growth Charts** 

#### Calcium Balance

Plasma Calcium Is Closely Regulated

Three Hormones Control Calcium Balance

Multiple Factors Control Bone Remodeling

Calcium and Phosphate Homeostasis Are Linked

Osteoporosis Is a Disease of Bone Loss

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# Chapter 24: The Immune System

#### Overview

RUNNING PROBLEMHPV: To Vaccinate or Not?

## Anatomy of the Immune System

Lymphoid Tissues Are Everywhere

Leukocytes Are the Immune Cells

# Development of Immune Cells

Focus on . . . The Thymus Gland

Lymphocytes Mediate the Adaptive Immune Response

The Immune System Must Recognize Self

Early Pathogen Exposure Strengthens Immunity

## Molecules of the Innate Immune Response

Many Molecules of the Innate Immune Response Are Always Present

# Antigen Presentation and Recognition Molecules

Major Histocompatibility Complexes, MHC

AntigenRecognition Molecules

B Lymphocytes Produce Antibodies

# Pathogens of the Human Body

Bacteria and Viruses Require Different Defense Mechanisms

Viruses Can Only Replicate inside Host Cells

## The Immune Response

Barriers Are the Bodys First Line of Defense

Innate Immunity Provides Nonspecific Responses

AntigenPresenting Cells Bridge Innate and Adaptive Responses

Adaptive Immunity Creates AntigenSpecific Responses



**Antibody Functions** 

# Integrated Immune Responses

**Bacterial Invasion Causes Inflammation** 

Viral Infections Require Intracellular Defense

Specific Antigens Trigger Allergic Responses

MHC Proteins Allow Recognition of Foreign Tissue

# Immune System Pathologies

Autoimmune Disease Results from Antibodies against SelfAntigen

Immune Surveillance Removes Abnormal Cells

## NeuroEndocrineImmune Interactions

Stress Alters Immune System Function

Modern Medicine Includes MindBody Therapeutics

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# Chapter 25: Integrative Physiology III: Exercise

# RUNNING PROBLEMMalignant Hyperthermia

## Metabolism and Exercise

Hormones Regulate Metabolism during Exercise

Oxygen Consumption Is Related to Exercise Intensity

Several Factors Limit Exercise

# Ventilatory Responses to Exercise

# Cardiovascular Responses to Exercise

Cardiac Output Increases during Exercise

Muscle Blood Flow Increases during Exercise

Blood Pressure Rises Slightly during Exercise

The Baroreceptor Reflex Adjusts to Exercise

## Feedforward Responses to Exercise

# Temperature Regulation During Exercise

#### Exercise and Health

Exercise Lowers the Risk of Cardiovascular Disease

Type 2 Diabetes Mellitus May Improve with Exercise

Stress and the Immune System May Be Influenced by Exercise

#### CHAPTER SUMMARY

**REVIEW QUESTIONS** 

# Chapter 26: Reproduction and Development

# **RUNNING PROBLEMInfertility**

#### Sex Determination

Sex Chromosomes Determine Genetic Sex

Sexual Differentiation Occurs Early in Development



**CLINICAL FOCUSXLinked Inherited Disorders** 

## Basic Patterns of Reproduction

CLINICAL FOCUSDetermining Sex

Gametogenesis Begins in Utero

The Brain Directs Reproduction

Environmental Factors Influence Reproduction

## Male Reproduction

Testes Produce Sperm and Hormones

Spermatogenesis Requires Gonadotropins and Testosterone

Male Accessory Glands Contribute Secretions to Semen

Androgens Influence Secondary Sex Characteristics

# Female Reproduction

The Ovary Produces Eggs and Hormones

A Menstrual Cycle Lasts about One Month

Hormonal Control of the Menstrual Cycle Is Complex

Hormones Influence Female Secondary Sex Characteristics

#### Procreation

The Human Sexual Response Has Four Phases

The Male Sex Act Includes Erection and Ejaculation

Sexual Dysfunction Affects Males and Females

Contraceptives Are Designed to Prevent Pregnancy

Infertility Is the Inability to Conceive

# Pregnancy and Parturition

Fertilization Requires Capacitation

The Developing Embryo Implants in the Endometrium

The Placenta Secretes Hormones During Pregnancy

Pregnancy Ends with Labor and Delivery

The Mammary Glands Secrete Milk During Lactation

## Growth and Aging

Puberty Marks the Beginning of the Reproductive Years

Menopause and Andropause Are a Consequence of Aging

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Appendix B Physics and Math

Appendix C Genetics

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