ANATOMY & PHYSIOLOGY COLORING WORKBOOK

A Complete Study Guide

NINTH EDITION

Elaine N. Marieb, R.N., Ph.D.

Holyoke Community College

San Francisco Boston New York
Cape Town Hong Kong London Madrid Mexico City
Montreal Munich Paris Singapore Sydney Tokyo Toronto

Senior Acquisitions Editor: Deirdre Espinoza

Project Editor: Sabrina Larson

Managing Editor: Wendy Earl

Production Editor: David Novak

Composition: The Left Coast Group, Inc.

Copy Editor: Michelle Gossage

Text and Cover Designer: Yvo Riezebos

Senior Manufacturing Buyer: Stacey Weinberger

Marketing Manager: Gordon Lee

Cover and Text Printer: Courier Stoughton Inc.

ISBN 0-8053-7756-X

1 2 3 4 5 6 7 8 9 10—CRS—12 11 10 09 08

www.pbeweb.com

THE BENJAMIN CUMMINGS SERIES IN HUMAN ANATOMY & PHYSIOLOGY

Two-Semester Human Anatomy & Physiology

Elaine N. Marieb and Katja Hoehn
Human Anatomy & Physiology
Seventh Edition
ISBN: 0-8053-5091-5

Elaine N. Marieb and Katja Hoehn
Anatomy & Physiology
Third Edition
ISBN: 0-8053-4773-0

One-Semester Human Anatomy & Physiology

Elaine N. Marieb
Essentials of Human Anatomy & Physiology Ninth Edition
ISBN: 0-321-51312-8

Supplements for Human Anatomy & Physiology

Lori Garrett
Get Ready for A&P
ISBN: 0-321-49326-5

Gloria Bastian
Anatomy Flash Cards
ISBN: 0-8053-6837-3

Mark Taffetty and Samuel Panella
A.D.A.M.® Interactive Anatomy Student Lab Guide, Third Edition
ISBN: 0-8053-5911-7

Mark Taffetty and Samuel Panella
A.D.A.M.® Interactive Anatomy Student Package, Third Edition
With Windows DVD
ISBN: 0-8053-7232-6
With Windows CD-ROM
ISBN: 0-8053-9574-1

Elaine N. Marieb and Susan Mitchell
Human Anatomy & Physiology Laboratory Manual, Main Version
Eighth Edition Update
ISBN: 0-321-55595-2

Elaine N. Marieb and Susan Mitchell
Human Anatomy & Physiology Laboratory Manual, Cat Version
Ninth Edition Update
ISBN: 0-321-55597-9

Elaine N. Marieb and Susan Mitchell
Human Anatomy & Physiology Laboratory Manual, Fetal Pig Version
Ninth Edition Update
ISBN: 0-321-55596-0

Elaine N. Marieb
Essentials of Human Anatomy & Physiology Laboratory Manual
Fourth Edition
ISBN: 0-321-52399-7

Human Anatomy

Elaine N. Marieb, Lori Mallatt, and Patricia Brady Wilhelm
Human Anatomy Fifth Edition
ISBN: 0-8053-4786-7

Supplements for Human Anatomy

Robert A. Chase
The Benseit Atlas of Human Anatomy
ISBN: 0-8053-0118-6

Victor Dresdenkio
Laboratory Manual for Human Anatomy with Cadavers
Second Edition
ISBN: 0-673-99558-5

Wynn Kapit and Larry Elson
The Anatomy Coloring Book.
Third Edition
ISBN: 0-8053-5096-1

Elaine N. Marieb
Human Anatomy Laboratory Manual with Cat Dissections.
Fifth Edition
ISBN: 0-8053-3856-X

Human Physiology

Cindy L. Stanfield and William Germann
Principles of Human Physiology,
Third Edition
ISBN: 0-8053-8280-0

Dee Silverthorn
Human Physiology: An Integrated Approach, Fourth Edition
ISBN: 0-8053-6851-5

Supplements for Human Physiology

Dee Silverthorn, Bruce Johnson, and Alice Mills
Laboratory Manual for Physiology
ISBN: 0-8053-0828-0

Gerald Kharp and David Woodman
Experiments in Physiology,
Ninth Edition
ISBN: 0-8053-4007-6

Wynn Kapit, Robert I. Macey, and Esmail Meisami
The Physiology Coloring Book,
Second Edition
ISBN: 0-321-05663-8

Electronic Supplements

A.D.A.M.®—Benjamin Cummings
InterActive Physiology® 9 System Suite
www.interactivephysiology.com
- Muscular System
- Nervous System I
- Nervous System II
- Cardiovascular System
- Respiratory System
- Urinary System
- Fluid, Electrolyte, and Acid/Base Balance
- Endocrine System
- Digestive System

ISBN: 0-8053-0075-9

Practice Anatomy Lab (PAL™)
ISBN: 0-8053-9432-X

Peter Zoo, Timothy Stabler, Lori Smith, Greta Peterson, and Andrew Tokuta
PhysioEx 8.0 for A&P
ISBN: 0-321-54856-6

Timothy Stabler, Lori Smith, Greta Peterson, and Andrew Tokuta
PhysioEx 8.0 for Human Physiology
ISBN: 0-321-54857-4

PREFACE

Although never a simple task, the study of the human body is always fascinating. Over the years, thousands of students have benefited in their studies and enjoyed the process of working through this book. The ninth edition of the *Anatomy & Physiology Coloring Workbook* continues to serve as a review and reinforcement tool to help health professional and life science students master the basic concepts of human anatomy and physiology. Whether you are taking a 1- or 2-semester course, you will find this book invaluable to the study of anatomy and physiology.

Scope

Although this book reviews the human body from microscopic to macroscopic levels (that is, topics range from simple chemistry and cells to body organ systems), it is not intended to be encyclopedic. In fact, to facilitate learning, this workbook covers only the most important and useful aspects of human anatomy and physiology. Pathophysiology is briefly introduced with each system so that students can apply their learning. Where relevant, clinical aspects (for example, muscles used for injection sites, the role of ciliated cells in protection of the respiratory tract, and reasons for skin ulcer formation) are covered. To encourage a view of the human body as a dynamic and continually changing organism, developmental aspects of youth, adulthood, and old age are included.

Learning Aids

As in previous editions, multiple pedagogical devices are used throughout the book to test comprehension of key concepts. The integration of a traditional study guide approach with visualization and coloring exercises is unique. The variety of exercises demands learning on several levels, avoids rote memorization, and helps maintain a high level of interest.

The exercises include completion from a selection of key choices, matching terms or descriptions, and labeling diagrams. Elimination questions require the student to discover the similarities or dissimilarities among a number of structures or objects and to select the one that is not appropriate. Connectable true/false questions add a new dimension to the more traditional form of this exercise. Also, students are asked to provide important definitions. In the completion sections, the answer lines are long enough so that the student can write in either the key letter or the appropriate term. Both responses are provided in the answer section.

Coloring exercises are a proven motivating, effective approach to learning. Each illustration has been carefully prepared to show sufficient detail for learning, without students becoming bored with coloring. There are more than 700 coloring exercises distributed throughout the text that should prove valuable to all students. The ninth edition features many new coloring exercises to ensure that

students gain practice with a wide range of structures. Students who are visually oriented will find these exercises particularly beneficial. When completed, the color diagrams provide an ideal reference and review tool.

Visualization exercises are a truly unique feature of this book. With the exception of the introductory chapter on terminology, each chapter contains an "Incredible Journey." Students are asked to imagine themselves in miniature, traveling within the body through various organs and systems. These visualization exercises are optional, but they often summarize chapter content, allowing students to assimilate what they have learned in unusual and amusing ways.

Thought-provoking "At the Clinic" questions challenge students to apply their newly acquired knowledge to clinical situations. Additionally, the ninth edition features a brand-new finale to each chapter with challenging multiple-choice questions.

Acknowledgments

To those educators, colleagues, and students who have provided feedback and suggestions during the preparation of all nine editions of this workbook, I am sincerely grateful. In particular, I want to thank the reviewers of the ninth edition for their valuable comments and suggestions: Lt. Anne Clark, Lansing Community College; Catherine Elliott, Mount San Jacinto College; Judy Garrett, University of Arkansas Community College; Judy Megaw, Indian River Community College; Ila Nauman, Clatsop Community College; Lynn Rivers, Henry Ford Community College; Tina Ross, North Hennepin Community College; and Mary Wess, Collin County Community College District—Spring Creek Campus.

The staff at Benjamin Cummings has continuously supported my efforts to turn out a study tool that will be well received and beneficial to both educator and student audiences. For this edition, Deirdre Espinoza, Senior Acquisitions Editor, and Sabrina Lanson, Project Editor, deserve special mention. I also wish to thank the entire team at Wendy Ford Productions and particularly David Novak for his diligent work as production editor on this edition.

INSTRUCTIONS FOR THE STUDENT—HOW TO USE THIS BOOK

Dear Student

The *Anatomy & Physiology Coloring Workbook* has been created particularly for you. It is the outcome of years of personal attempts to find and create exercises helpful to my own students when they study and review for a lecture test or laboratory quiz.

I never cease to be amazed at how remarkable the human body is, but I would never try to convince you that studying it is easy. The study of human anatomy and physiology has its own special terminology. It requires that you become familiar with the basic concepts of chemistry to understand physiology, and often (sadly) it requires rote memorization of facts. It is my hope that this workbook will help simplify your task. To make the most of the exercises, read these instructions carefully before starting work.

Labeling and Coloring. Some of these questions ask you only to label a diagram, but most also ask that you do some coloring of the figure. You can usually choose whichever colors you prefer. Soft colored pencils are recommended so that the underlying diagram shows through. Most figures have several parts to color, so you will need a variety of colors—18 should be sufficient. In the coloring exercises, you are asked to choose a particular color for each structure to be colored. That color is then used to fill in both a color-coding circle found next to the name of the structure or organ, and the structure or organ on the figure. This allows you to identify the colored structures quickly and by name in cases where the diagram is not labeled. In a few cases you are given specific coloring instructions to follow.

Matching. Here you are asked to match a key term denoting a structure or physiologic process with a descriptive phrase or sentence. Because you must write the chosen term in the appropriate answer blank, the learning is more enduring.

Completion. You select the correct term to answer a specific question, or you fill in blanks to complete a sentence. In many exercises, some terms are used more than once and others are not used at all.

Definitions. You are asked to provide a brief definition of a particular structure or process.

True or False. One word or phrase is underlined in a sentence. You decide if the sentence is true as it is written. If not, you correct the underlined word or phrase.

Elimination. Here you are asked to find the term that does not "belong" in a particular grouping of related terms. In this type of exercise, you must analyze how the various terms are similar to or different from the others.

Visualization. The "Incredible Journey" is a special type of completion exercise, found in every chapter except the first one. For this exercise, you are asked to imagine that you have been miniaturized and injected into the body of a human being (your host). Anatomical landmarks and physiological events are described from your miniaturized viewpoint, and you are then asked to identify your observations. Although this exercise is optional, my students have found them fun to complete and I hope you will, too.

At the Clinic. "At the Clinic" sections ask you to apply your newly acquired knowledge to clinical situations.

The Finale: Multiple Choice. The multiple choice questions test you from several vantage points and 1, 2, 3, or all of the answers may be correct—an approach that really tests your understanding of what you have studied.

Each exercise has complete instructions, which you should read carefully before beginning the exercise. When there are multiple instructions, complete them in the order given.

At times it may appear that information is duplicated in the different types of exercises. Although there is some overlap, the understandings being tested are different in the different exercises. Remember, when you understand a concept from several different perspectives, you have mastered that concept.

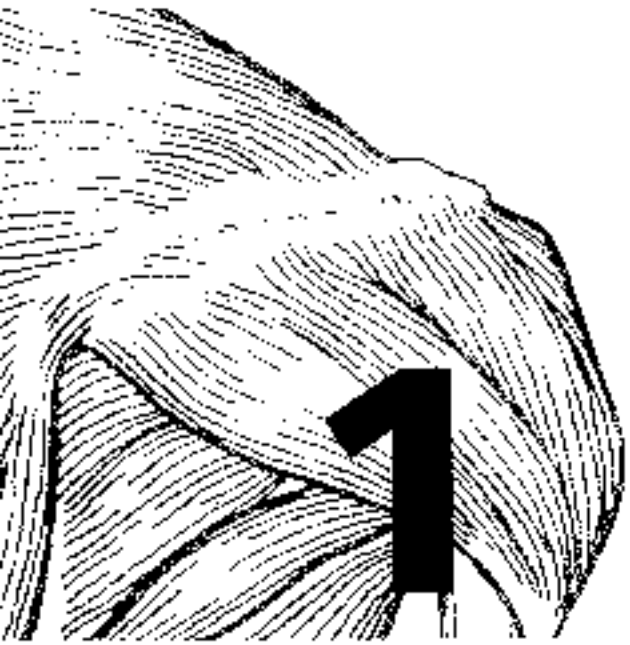
I sincerely hope that the *Anatomy & Physiology Coloring Workbook* challenges you to increase your knowledge, comprehension, retention, and appreciation of the structure and function of the human body.

Good luck!

Elaine Marieb

Elaine Marieb
Benjamin Cummings Publishing
1301 Sansome Street
San Francisco, CA 94111

CONTENTS



1 THE HUMAN BODY: AN ORIENTATION

Most of us have a natural curiosity about our bodies, and a study of anatomy and physiology elaborates on this interest. Anatomists have developed a universally acceptable set of reference terms that allows body structures to be located and identified with a high degree of clarity. Initially, students might have difficulties with the language used to describe anatomy and physiology, but without such a special vocabulary, confusion is bound to occur.

The topics in this chapter enable students to test their mastery of terminology commonly used to describe the body and its various parts, and concepts concerning functions vital for life and homeostasis. Body organization from simple to complex levels and an introduction to the organ systems forming the body as a whole are also covered.

AN OVERVIEW OF ANATOMY AND PHYSIOLOGY

1. Match the terms in Column B to the appropriate descriptions provided in Column A. Enter the correct letter or its corresponding term in the answer blanks.

	Column A	Column B
_____	1. The branch of biological science that studies and describes how body parts work or function	A. Anatomy
_____	2. The study of the shape and structure of body parts	B. Homeostasis
_____	3. The tendency of the body's systems to maintain a relatively constant or balanced internal environment	C. Metabolism
_____	4. The term that indicates *all* chemical reactions occurring in the body	D. Physiology

2. Circle all the terms or phrases that correctly relate to the study of *physiology*. Use a highlighter to identify those terms or phrases that pertain to the study of *anatomy*.

A. Measuring an organ's size, shape, and weight
B. Can be studied in dead specimens
C. Often studied in living subjects
D. Chemistry principles
E. Measuring the acid content of the stomach
F. Principles of physics
G. Observing a heart in action
H. Dynamic
I. Dissection
J. Experimentation
K. Observation
L. Directional terms
M. Static

LEVELS OF STRUCTURAL ORGANIZATION

3. The structures of the body are organized into successively larger and more complex structures. Fill in the answer blanks with the correct terms for these increasingly larger structures.

Chemicals → ____ ____ ____ → _____ →

____ _____ → ____ ____ → Organism

4. Circle the term that does not belong in each of the following groupings.

1. Electron Cell Tissue Atom Organ
2. Brain Stomach Heart Liver Epithelium
3. Epithelium Heart Muscle tissue Nervous tissue Connective tissue
4. Human Digestive system Horse Pine tree Amoeba

5. Using the key choices, identify the organ systems to which the following organs or functions belong. Insert the correct letter or term in the answer blanks.

Key Choices

A. Cardiovascular
B. Digestive
C. Endocrine
D. Integumentary
E. Lymphatic/Immune
F. Muscular
G. Nervous
H. Reproductive
I. Respiratory
J. Skeletal
K. Urinary

_____ 1. Rids the body of nitrogen-containing wastes

_____ 2. Is affected by the removal of the thyroid gland

_____ 3. Provides support and levers on which the muscular system can act

_____ 4. Includes the heart

_____ 5. Protects underlying organs from drying out and mechanical damage

_____ 6. Protects the body; destroys bacteria and tumor cells

_____ 7. Breaks down foodstuffs into small particles that can be absorbed

_____ 8. Removes carbon dioxide from the blood

_____ 9. Delivers oxygen and nutrients to the body tissues

_____ 10. Moves the limbs, allows facial expression

_____ 11. Conserves body water or eliminates excesses

_____ 12. Provides for conception and childbearing

_____ 13. Controls the body with chemicals called hormones

_____ 14. Is damaged when you cut your finger or get a severe sunburn

6. Using the key choices from Exercise 5, choose the organ system to which each of the following sets of organs belongs. Enter the correct letter or term in the answer blanks.

_____ 1. Blood vessels, heart

_____ 2. Pancreas, pituitary, adrenal glands

_____ 3. Kidneys, bladder, ureters

_____ 4. Testis, vas deferens, urethra

_____ 5. Esophagus, large intestine, rectum

_____ 6. Breastbone, vertebral column, skull

_____ 7. Brain, nerves, sensory receptors

7. Figures 1–1 to 1–5, on pages 4–6, represent the various body organ systems. First identify and name each organ system by labeling the organ system under each illustration. Then select a different color for each organ and use it to color the coding circles and corresponding structures in the illustrations.

- ◯ Blood vessels
- ◯ Heart

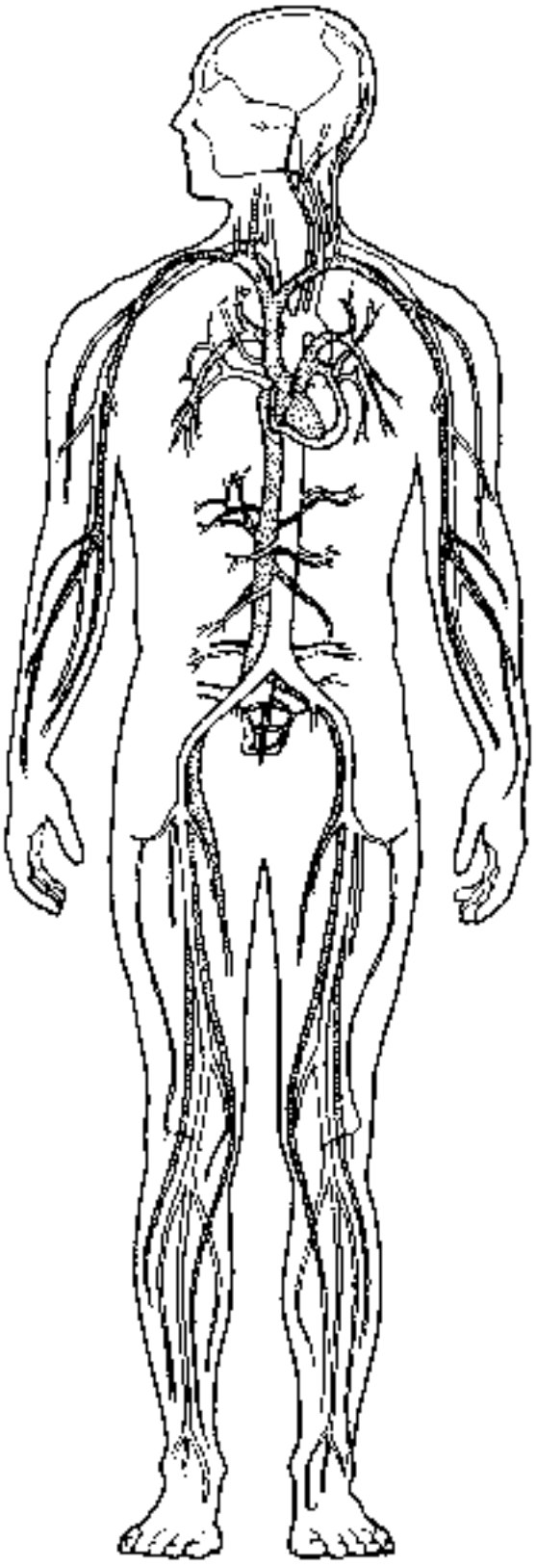


Figure 1–1

- ◯ Nasal cavity
- ◯ Lungs
- ◯ Trachea

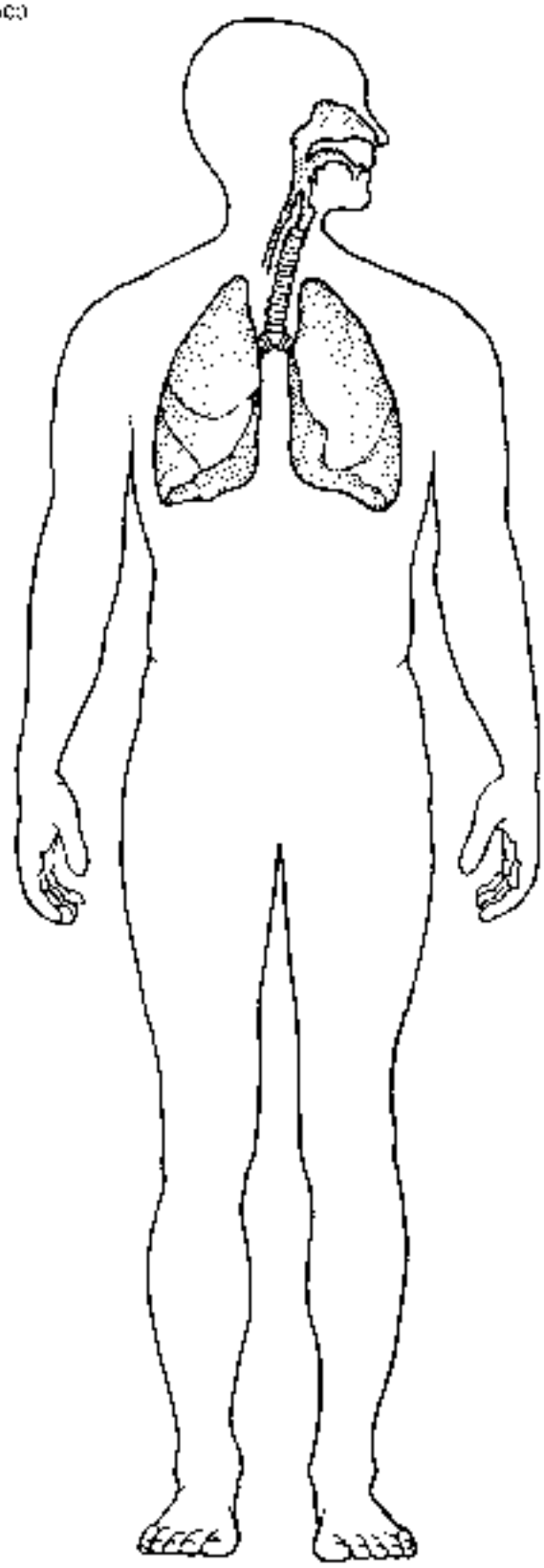


Figure 1–2

○ Brain
○ Spinal cord
○ Nerves
○ Kidneys
○ Ureters
○ Bladder

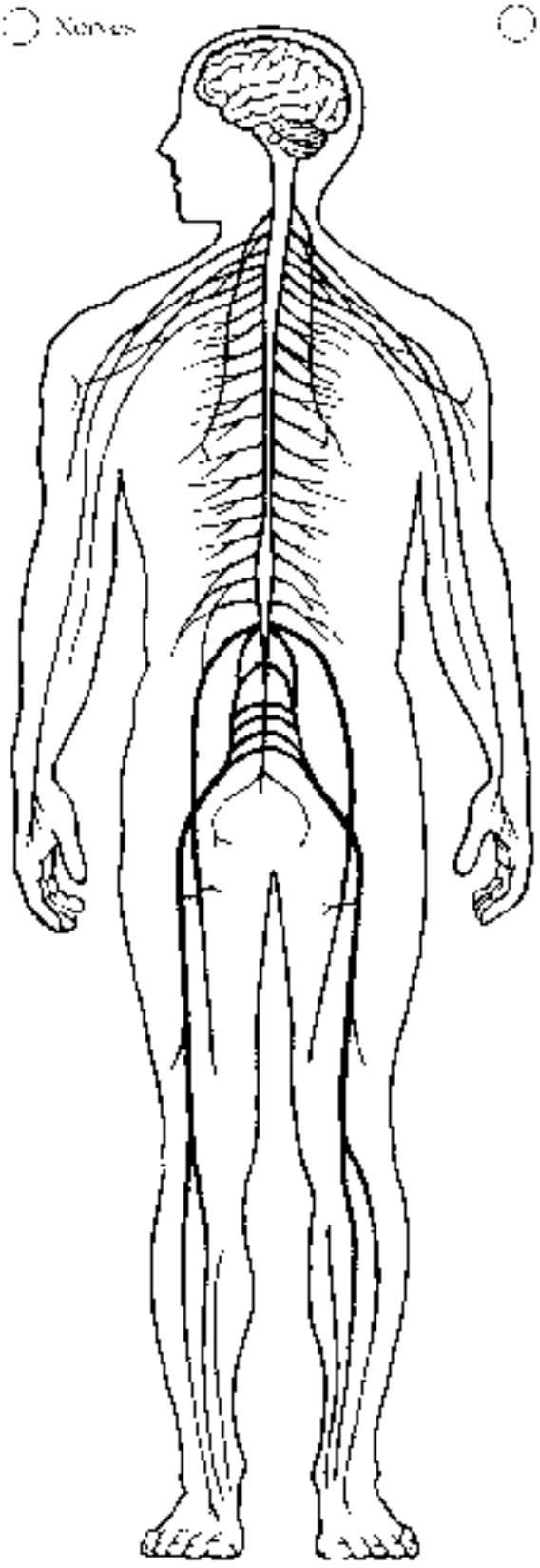


Figure 1–3

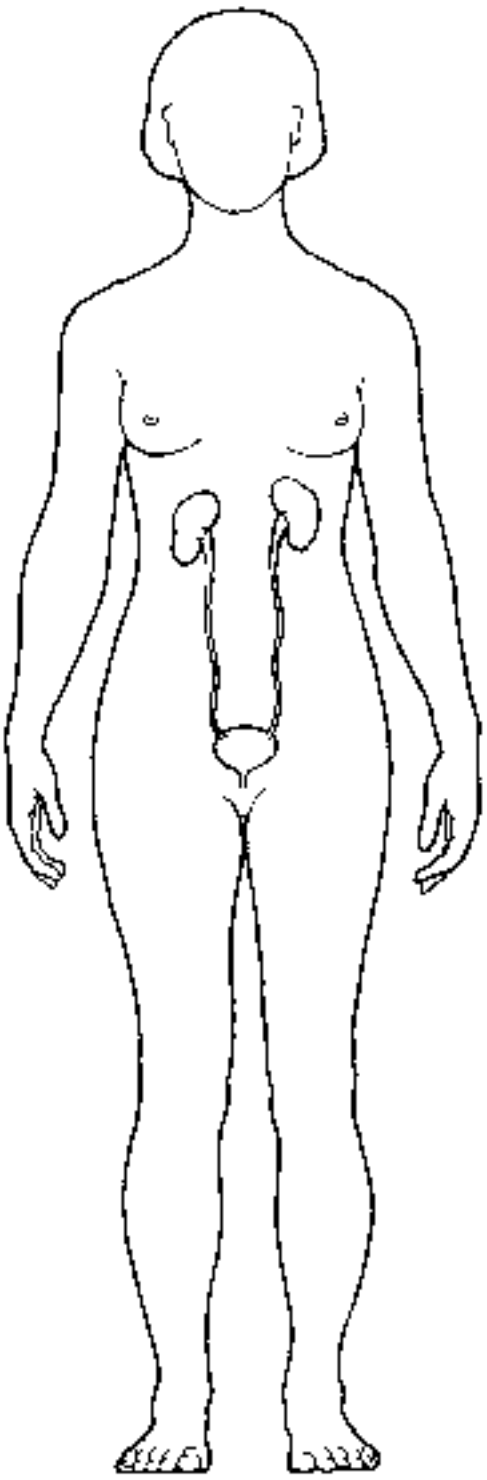


Figure 1–4

◯ Stomach ◯ Esophagus ◯ Ovaries

◯ Intestines ◯ Oral cavity ◯ Uterus

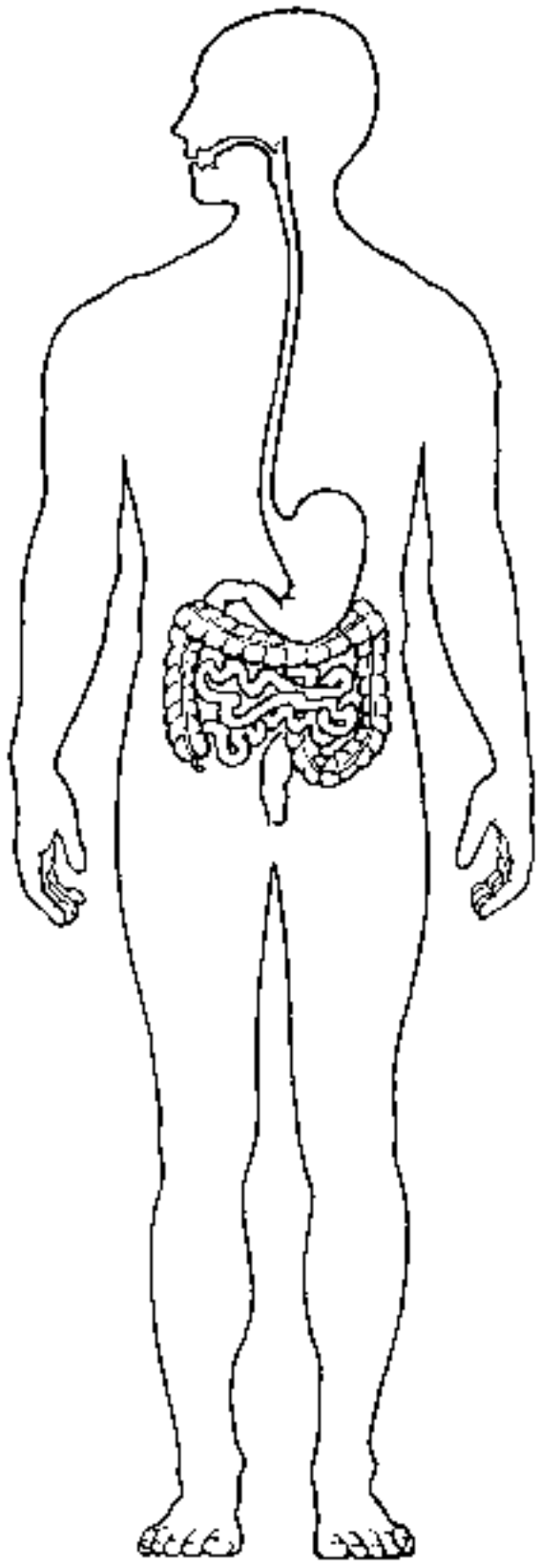


Figure 1–5

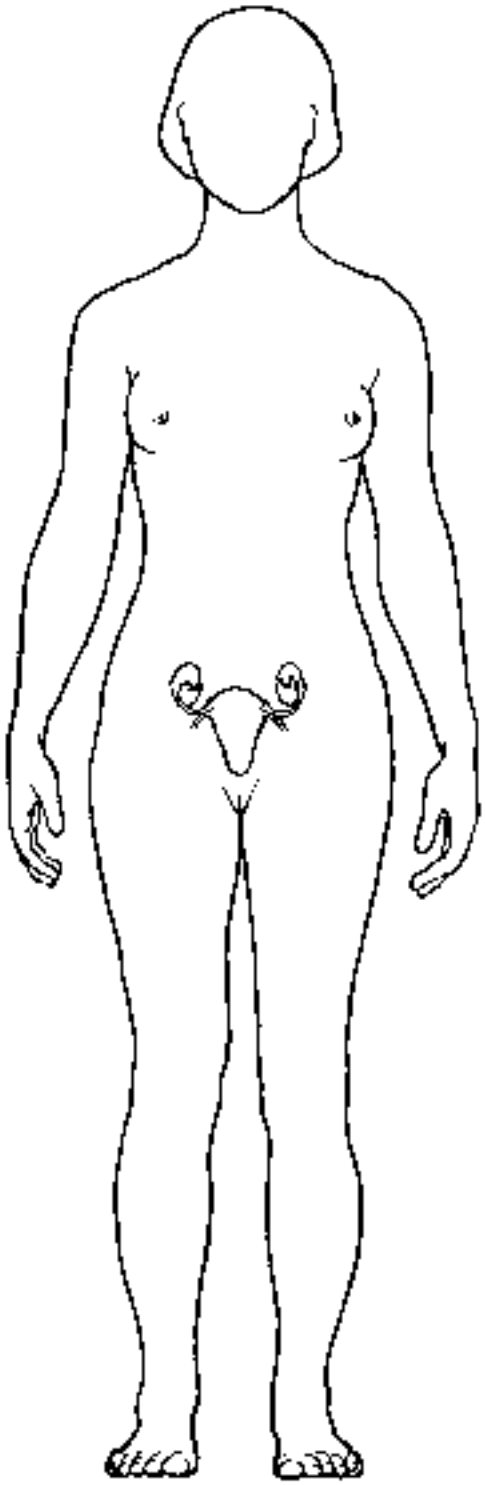


Figure 1–6

MAINTAINING LIFE

8. Match the terms pertaining to functional characteristics of organisms in Column B with the appropriate descriptions in Column A. Fill in the answer blanks with the appropriate letter or term.

Column A		Column B
____ ____	1. Keeps the body's internal environment distinct from the external environment	A. Digestion
____ .	2. Provides new cells for growth and repair	B. Excretion
___ ____.	3. Occurs when constructive activities occur at a faster rate than destructive activities	C. Growth
____ ____	4. The tuna sandwich you have just eaten is broken down to its chemical building blocks	D. Maintenance of boundaries
____. ___	5. Elimination of carbon dioxide by the lungs and elimination of nitrogenous wastes by the kidneys	E. Metabolism
____	6. Ability to react to stimuli; a major role of the nervous system	F. Movement
____	7. Walking, throwing a ball, riding a bicycle	G. Responsiveness
____	8. All chemical reactions occurring in the body	H. Reproduction
____	9. At the cellular level, membranes; for the whole organism, the skin	

9. Using the key choices, correctly identify the survival needs that correspond to the following descriptions. Insert the correct letter or term in the answer blanks.

Key Choices

A. Appropriate body temperature	C. Nutrients	E. Water
B. Atmospheric pressure	D. Oxygen	

____ 1. Includes carbohydrates, proteins, fats, and minerals

.. ____. 2. Essential for normal operation of the respiratory system and breathing

___ ____ 3. Single substance accounting for more than 60% of body weight

____ ____ 4. Required for the release of energy from foodstuffs

____ ____ 5. Provides the basis for body fluids of all types

____ 6. When too high or too low, physiological activities cease, primarily because molecules are destroyed or become nonfunctional

HOMEOSTASIS

10. The following statements refer to homeostatic control systems. Complete each statement by inserting your answers in the answer blanks.

_____ 1.
_____ 2.
_____ 3.
_____ 4.
_____ 5.
_____ 6.
_____ 7.
_____ 8.
_____ 9.

There are three essential components of all homeostatic control mechanisms: control center, receptor and effector. The (1) senses changes in the environment and responds by sending information (input) to the (2) along the (3) pathway. The (4) analyzes the input, determines the appropriate response, and activates the (5) by sending information along the (6) pathway. When the response causes the initial stimulus to decline, the homeostatic mechanism is referred to as a (7) feedback mechanism. When the response enhances the initial stimulus, the mechanism is called a (8) feedback mechanism. (9) feedback mechanisms are much more common in the body.

THE LANGUAGE OF ANATOMY

11. Complete the following statements by filling in the answer blanks with the correct term.

_____ 1.
_____ 2.
_____ 3.

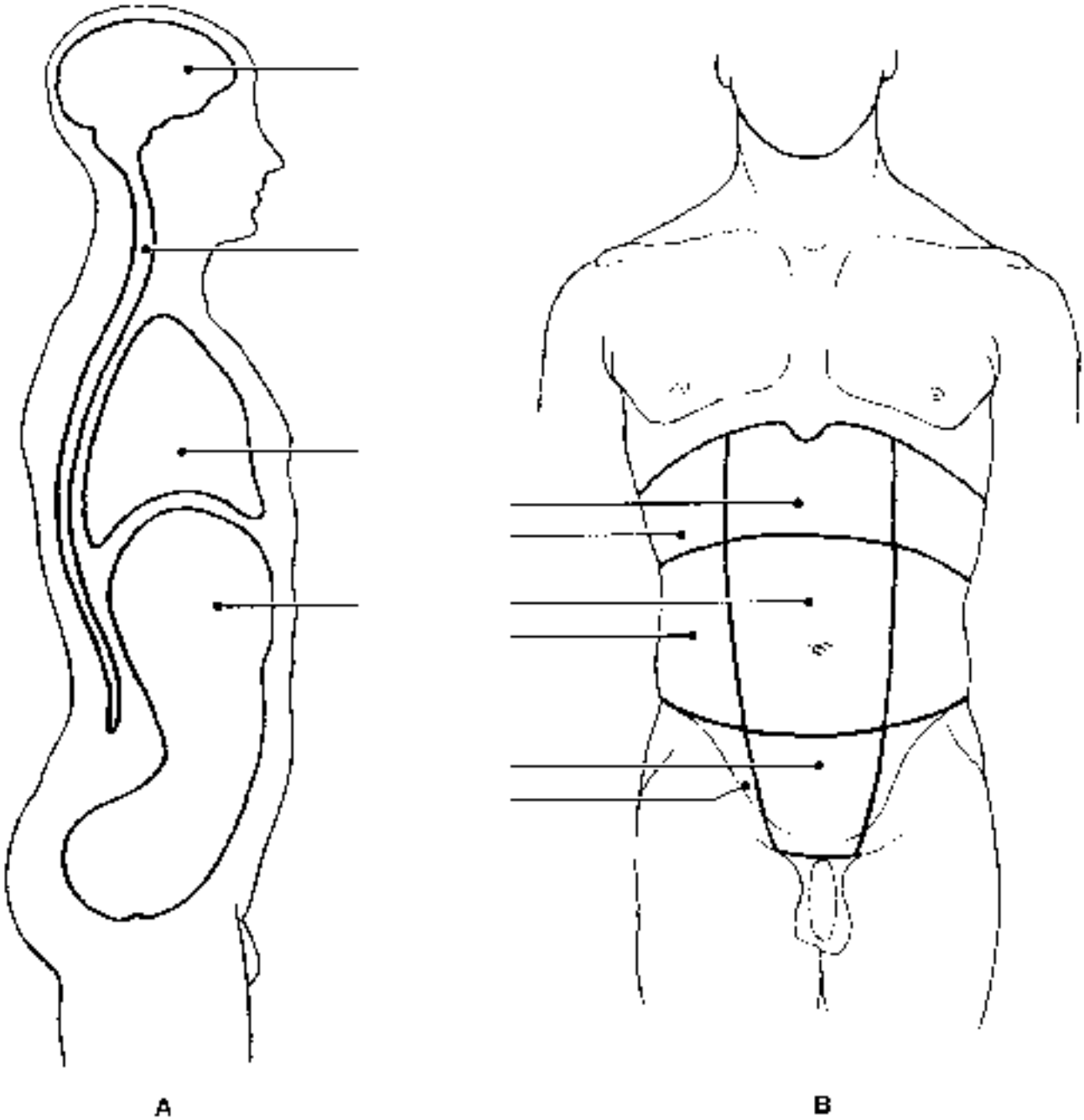
The abdominopelvic and thoracic cavities are subdivisions of the (1) body cavity; the cranial and spinal cavities are parts of the (2) body cavity. The (3) body cavity is totally surrounded by bone and provides very good protection to the structures it contains.

12. Circle the term or phrase that does not belong in each of the following groupings.

1. Transverse Distal Frontal Sagittal
2. Lumbar Thoracic Antecubital Abdominal
3. Calf Brachial Femoral Popliteal
4. Epigastric Hypogastric Right iliac Left upper quadrant
5. Orbital cavity Nasal cavity Ventral cavity Oral cavity

13. Select different colors for the *dorsal* and *ventral* body cavities. Color the coding circles below and the corresponding cavities in part A of Figure 1–7. Complete the figure by labeling those body cavity subdivisions that have a leader line. Complete part B by labeling each of the abdominal regions indicated by a leader line.

◯ Dorsal body cavity ◯ Ventral body cavity



A B

Figure 1–7

14. Select the key choices that identify the following body parts or areas. Enter the appropriate letter or corresponding term in the answer blanks.

Key Choices

A. Abdominal	E. Buccal	I. Inguinal	M. Pubic
B. Antecubital	F. Cervical	J. Lumbar	N. Scapular
C. Axillary	G. Femoral	K. Occipital	O. Sural
D. Brachial	H. Gluteal	L. Popliteal	P. Umbilical

_____ 1. Armpit

_____ 2. Thigh region

_____ 3. Buttock area

_____ 4. Neck region

_____ 5. "Belly button" area

_____ 6. Genital area

_____ 7. Anterior aspect of elbow

_____ 8. Posterior aspect of head

_____ 9. Area where trunk meets thigh

_____ 10. Back area from ribs to hips

_____ 11. Pertaining to the cheek

15. Using the key terms from Exercise 14, correctly label all body areas indicated with leader lines on Figure 1–8.

In addition, identify the sections labeled A and B in the figure.

Section A: _____

Section B: _____

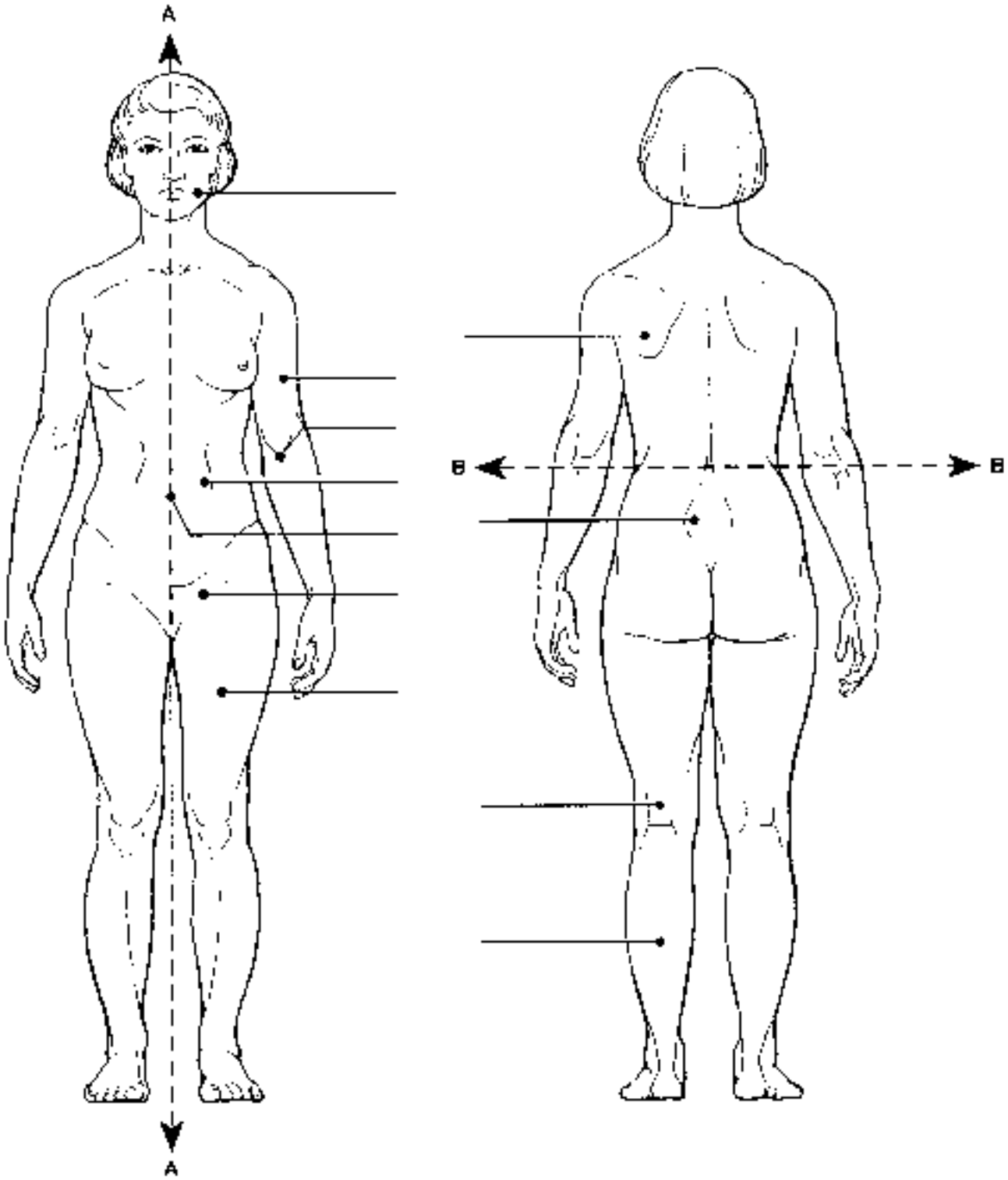


Figure 1-8

16. From the key choices, select the body cavities where the following surgical procedures would occur. Insert the correct letter or term in the answer blanks. Be precise. Also select the name of the cavity subdivision if appropriate.

Key Choices

A. Abdominal	C. Dorsal	E. Spinal	G. Ventral
B. Cranial	D. Pelvic	F. Thoracic	

_____ 1. Removal of the uterus, or womb

_____ 2. Coronary bypass surgery (heart surgery)

_____ 3. Removal of a serious brain tumor

_____ 4. Removal of a "bad" appendix

_____ 5. A stomach ulcer operation

17. Complete the following statements by choosing an anatomical term from the key choices. Enter the appropriate letter or term in the answer blanks.

Key Choices

A. Anterior	D. Inferior	G. Posterior	J. Superior
B. Distal	E. Lateral	H. Proximal	K. Transverse
C. Frontal	F. Medial	I. Sagittal	

_____ 1.

_____ 2.

_____ 3.

_____ 4.

_____ 5.

_____ 6.

_____ 7.

_____ 8.

_____ 9.

_____ 10.

_____ 11.

In the anatomical position, the face and palms are on the __(1)__ body surface, the buttocks and shoulder blades are on the __(2)__ body surface, and the top of the head is the most __(3)__ part of the body. The ears are __(4)__ to the shoulders and __(5)__ to the nose. The heart is __(6)__ to the spine and __(7)__ to the lungs. The elbow is __(8)__ to the fingers but __(9)__ to the shoulder. In humans, the dorsal surface can also be called the __(10)__ surface, however, in four-legged animals, the dorsal surface is the __(11)__ surface.

_____ 12.
_____ 13.
_____ 14.
_____ 15.

If an incision cuts the heart into right and left parts, the section is a __(12)__ section, but if the heart is cut so that anterior and posterior parts result, the section is a __(13)__ section. You are told to cut an animal along two planes so that the paired kidneys are observable in both sections. The two sections that meet this requirement are the __(14)__ and __(15)__ sections.

18. Using the key choices, identify the body cavities where the following body organs are located. Enter the appropriate letter or term in the answer blanks.

Key Choices

A. Abdominopelvic B. Cranial C. Spinal D. Thoracic

_____ 1. Stomach _____ 7. Bladder

_____ 2. Small intestine _____ 8. Trachea

_____ 3. Large intestine _____ 9. Lungs

_____ 4. Spleen _____ 10. Pituitary gland

_____ 5. Liver _____ 11. Rectum

_____ 6. Spinal cord _____ 12. Ovaries

19. Number the following structures, from darkest (black) to lightest (white), as they would appear on an X ray. Number the darkest one 1, the next darkest 2, etc.

____ A. Soft tissue

_____ B. Femur (bone of the thigh)

_____ C. Air in lungs

_____ D. Gold (metal) filling in a tooth

AT THE CLINIC

20. A jogger has stepped in a pothole and sprained his ankle. What systems have suffered damage?

21. A newborn baby is unable to hold down any milk. Examination reveals a developmental disorder in which the esophagus fails to connect to the stomach. What survival needs are most immediately threatened?

22. The Chan family was traveling in their car and had a minor accident. The children in the backseat were wearing lap belts, but they still sustained bruises around the abdomen and had some internal organ injuries. Why is this area more vulnerable to damage than others?

23. John, a patient at Jones Gate Hospital, is in tough shape. He has a hernia in his inguinal region, pain from an infected kidney in his lumbar region, and severe bruises and swelling in his pubic region. Explain where each of these regions is located.

24. The hormone thyroxine is released in response to a pituitary hormone called TSH. As thyroxine levels increase in the blood, they exert negative feedback on the release of TSH by the pituitary gland. What effect will this have on the release of TSH?

25. In congestive heart failure, the weakened heart is unable to pump with sufficient strength to empty its own chambers. As a result, blood backs up in the veins, blood pressure rises, and circulation is impaired. Describe what will happen as this situation worsens owing to positive feedback. Then, predict how a heart-strengthening medication will reverse the positive feedback.

26. The following advanced imaging techniques are discussed in the text: CT, DSA, PET, ultrasound, and MRI. Which of these techniques uses X rays? Which uses radio waves and magnetic fields? Which uses radioisotopes? Which displays body regions in sections? (You may have more than one answer for each question.)

27. A patient reports stabbing pains in the right hypochondriac region. The medical staff suspects gallstones. What region of the body will be examined?

THE FINALE: MULTIPLE CHOICE

28. Select the best answer or answers from the choices given.

1. Which of the following activities would not represent an anatomical study?
   A. Making a section through the heart to observe its interior
   B. Drawing blood from recently fed laboratory animals at timed intervals to determine their blood sugar levels
   C. Examining the surface of a bone
   D. Viewing muscle tissue through a microscope

2. Which of the following is (are) involved in maintaining homeostasis?
   A. Effector
   B. Control center
   C. Receptor
   D. Feedback
   E. Lack of change

3. When a capillary is damaged, a platelet plug is formed. The process involves platelets sticking to each other. The more platelets that stick together, the more the plug attracts additional platelets. This is an example of:
   A. negative feedback
   B. positive feedback

4. A coronal plane through the head
   A. could pass through both the nose and the occiput
   B. could pass through both ears
   C. must pass through the mouth
   D. could lie in a horizontal plane

5. Which of the following statements is correct?
   A. The brachium is proximal to the antebrachium.
   B. The femoral region is superior to the tarsal region.
   C. The orbital region is inferior to the buccal region.
   D. The axillary region is lateral to the sternal region.
   E. The crural region is posterior to the sural region.

6. Which of the following body regions is (are) found on the torso?
   A. Gluteal
   B. Inguinal
   C. Popliteal
   D. Acromial
   E. Olecranal

7. A neurosurgeon orders a spinal tap for a patient. Into what body cavity will the needle be inserted?
   A. Ventral
   B. Thoracic
   C. Dorsal
   D. Cranial
   E. Pelvic

8. An accident victim has a collapsed lung. Which cavity has been entered?
   A. Mediastinal
   B. Pericardial
   C. Pleural
   D. Vertebral
   E. Ventral

9. Which body system would be affected by degenerative cartilage?
   A. Muscular
   B. Nervous
   C. Cardiovascular
   D. Skeletal
   E. Lymphatic

10. The position of the heart relative to the structures around it would be described accurately as:
    A. deep to the sternum (breastbone)
    B. lateral to the lungs
    C. superior to the diaphragm
    D. inferior to the ribs
    E. anterior to the vertebral column

11. What term(s) could be used to describe the position of the nose?
    A. Intermediate to the eyes
    B. Inferior to the brain
    C. Superior to the mouth
    D. Medial to the ears
    E. Anterior to the ears

12. The radiographic technique used to provide information about blood flow is:
    A. DSA
    B. CT
    C. PET
    D. ultrasonography
    E. any X-ray technique

13. A patient complains of pain in the lower right quadrant. Which system is most likely to be involved?
    A. Respiratory
    B. Digestive
    C. Urinary
    D. Skeletal
    E. Muscular

2 BASIC CHEMISTRY

Everything in the universe is composed of one or more elements, the unique building blocks of all matter. Although over 100 elemental substances exist, only four of these (carbon, hydrogen, oxygen, and nitrogen) make up more than 96% of all living material.

The student activities in this chapter consider basic concepts of both inorganic and organic chemistry. Chemistry is the science that studies the composition of matter. Inorganic chemistry studies the chemical composition of nonliving substances that (generally) do not contain carbon. Organic chemistry studies the carbon-based chemistry (or biochemistry) of living organisms, whether they are maple trees, fish, or humans.

Understanding of atomic structure, bonding behavior of elements, and the structure and activities of the most abundant biologic molecules (proteins, fats, carbohydrates, and nucleic acids) is tested in various ways. Mastering these concepts is necessary to understand how the body functions.

CONCEPTS OF MATTER AND ENERGY

1. Select *all* phrases that apply to each of the following statements and insert the letters in the answer blanks.

_____ 1. The energy located in the bonds of food molecules:
- A. is called thermal energy
- B. is a form of potential energy
- C. causes molecular movement
- D. can be transformed to the bonds of ATP

2. Heat is:
- A. thermal energy
- B. infrared radiation
- C. kinetic energy
- D. molecular movement

_____ 3. Whenever energy is transformed:
- A. the amount of useful energy decreases
- B. some energy is lost as heat
- C. some energy is created
- D. some energy is destroyed

2. Use choices from the key to identify the energy *form* in use in each of the following examples.

Key Choices

A. Chemical B. Electrical C. Mechanical D. Radiant

_____ 1. Chewing food

_____ 2. Vision (two types, please—think!)

_____ 3. Bending your fingers to make a fist

_____ 4. Breaking the bonds of ATP molecules to energize your muscle cells to make that fist

_____ 5. Lying under a sunlamp

COMPOSITION OF MATTER

3. Complete the following table by inserting the missing words.

Particle	Location	Electrical charge	Mass
		+1	
Neutron			
	Orbitals		

4. Insert the *chemical symbol* (the chemist's shorthand) in the answer blank for each of the following elements.

_____ 1. Oxygen _____ 4. Iodine _____ 7. Calcium _____ 10. Magnesium

_____ 2. Carbon _____ 5. Hydrogen _____ 8. Sodium _____ 11. Chlorine

_____ 3. Potassium _____ 6. Nitrogen _____ 9. Phosphorus _____ 12. Iron

5. Using the key choices, select the correct responses to the following descriptive statements. Insert the appropriate answers in the answer blanks.

Key Choices

A. Atom C. Element E. Ion G. Molecule I. Protons

B. Electrons D. Energy F. Matter H. Neutrons J. Valence

_____ 1. An electrically charged atom or group of atoms

_____ 2. Anything that takes up space and has mass (weight)

_____ 3. A unique substance composed of atoms having the same atomic number

_____ 4. Negatively charged particles, forming part of an atom

_____ 5. Subatomic particles that determine an atom's chemical behavior or bonding ability

_____ 6. The ability to do work

_____ 7. The smallest particle of an element that retains the properties of the element

_____ 8. The smallest particle of a compound, formed when atoms combine chemically

_____ 9. Positively charged particles forming part of an atom

_____ 10. Name given to the electron shell that contains the most reactive electrons

_____ 11. _____ 12. Subatomic particles responsible for most of an atom's mass

6. For each of the following statements that is true, insert *T* in the answer blank. If any of the statements are false, correct the underlined term by inserting your correction in the answer blank.

_____ 1. Na^+ and K^+ are needed for nerve cells to conduct electrical impulses.

_____ 2. The atomic number of oxygen is 8. Therefore, oxygen atoms always contain 8 neutrons

_____ 3. The greater the distance of an electron from the nucleus, the less energy it has

_____ 4. Electrons are located in more or less designated areas of space around the nucleus called orbitals

_____ 5. An unstable atom that decomposes and emits energy is called retroactive

_____ 6. Iron is necessary for oxygen transport in red blood cells.

_____ 7. The most abundant negative ion in extracellular fluid is calcium

_____ 8. The element essential for the production of thyroid hormones is magnesium.

_____ 9. Calcium is found as a salt in bones and teeth.

MOLECULES, CHEMICAL BONDS, AND CHEMICAL REACTIONS

7. Match the terms in Column B to the chemical equations listed in Column A. Enter the correct letter or term in the answer blanks.

	Column A	Column B
_____	_____ 1. $A + B \longrightarrow AB$	A. Decomposition
	_____ 2. $AB + CD \longrightarrow AD + CB$	B. Exchange
	_____ 3. $XY \longrightarrow X + Y$	C. Synthesis

8. Figure 2–1 is a diagram of an atom. Select two different colors and use them to color the coding circles and corresponding structures on the figure. Complete this exercise by responding to the questions that follow, referring to the atom in this figure. Insert your answers in the answer blanks provided.

◯ Nucleus

◯ Electrons

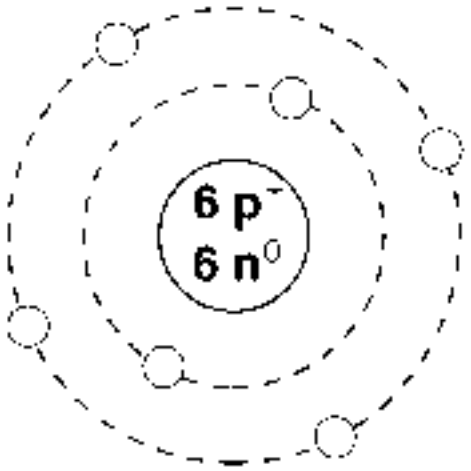


Figure 2–1

1. What is the atomic number of this atom? _____
2. What is its atomic mass? _____ _____
3. What atom is this? _____ _____
4. If this atom had one additional neutron but the other subatomic particles remained the same as shown, this slightly different atom (of the same element) would be called a(n) _____
5. Is this atom chemically active or inert? _____
6. How many electrons would be needed to fill its outer (valence) shell? _____

7. Would this atom most likely take part in forming ionic or covalent bonds? _____ Why? _____

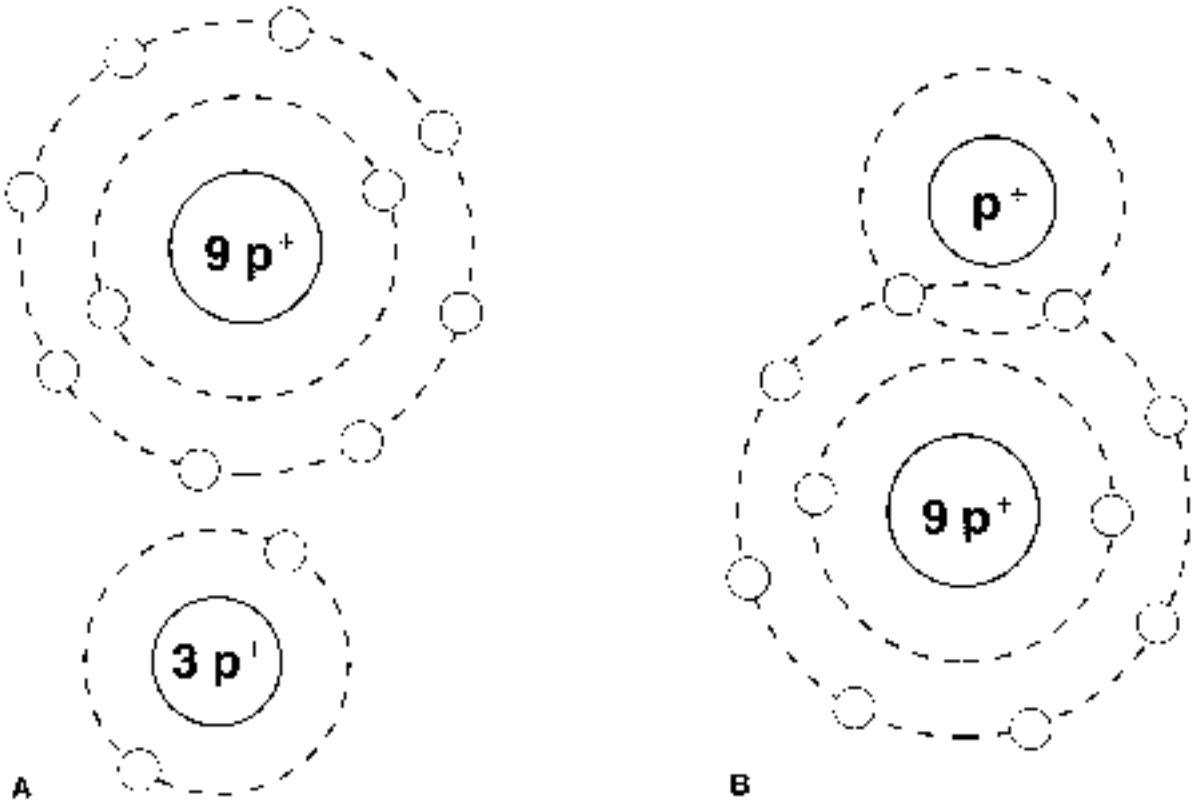
_____ _____

9. Both H_2O_2 and $2OH^-$ are chemical species with two hydrogen atoms and two oxygen atoms. Briefly explain how these species are different.

_____ _____ _____

_____ _____ _____

10. Two types of chemical bonding are shown in Figure 2–2. In the figure, identify each type as an) *ionic* or *covalent* bond. In the case of the ionic bond, indicate which atom has lost an electron by adding a colored arrow to show the direction of electron transfer. For the covalent bond, indicate the shared electrons.



Type of bond: _____ **Type of bond:** _____

Figure 2–2

11. Figure 2–3 illustrates five water molecules held together by hydrogen bonds. First, correctly identify the oxygen and hydrogen atoms both by color and by inserting their atomic symbols on the appropriate circles (atoms). Then label the following structures in the figure.

- ◯ Oxygen
- ◯ Hydrogen
- ◯ Positive pole (end)
- ◯ Negative pole (end)
- ◯ Hydrogen bonds

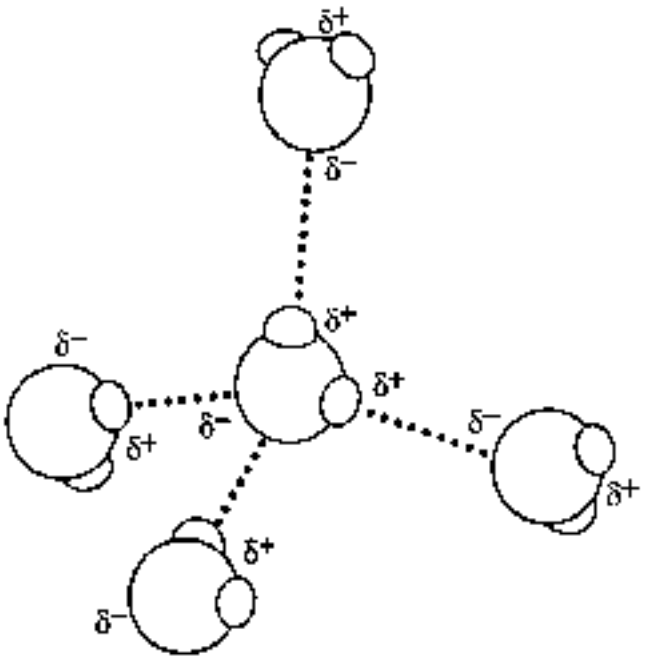
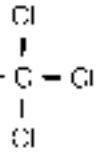


Figure 2–3

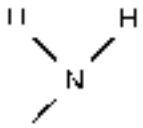
12. Circle each structural formula that is *likely* to be a polar covalent compound.

A



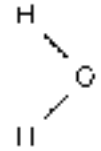
B H — Cl

C



D Cl — C

E



13. Respond to the instructions following the equation:

$$H_2CO_3 \longrightarrow H^+ + HCO_3^-$$

1. In the space provided, list the chemical formula(s) of compounds. _____
2. In the space provided, list the chemical formula(s) of ions. _____
3. Circle the product(s) of the reaction.
4. Modify the equation by adding a colored arrow in the proper place to indicate that the reaction is reversible

BIOCHEMISTRY: THE COMPOSITION OF LIVING MATTER

14. Use the key choices to identify the substances described in the following statements. Insert the appropriate letter(s) or corresponding formula(s) in the answer blanks.

Key Choices

A. Acid(s) B. Base(s) C. Buffer D. Salt(s)

_____ 1. _____ 2. _____ 3. Substances that ionize in water; good electrolytes

_____ 4. Proton (H^+) acceptor

_____ 5. Ionize in water to release hydrogen ions and a negative ion other than hydroxide (OH^-)

_____ 6. Ionize in water to release ions other than H^+ and OH^-

_____ 7. Formed when an acid and a base are combined

_____ 8. Substances such as lemon juice and vinegar

_____ 9. Prevents rapid/large swings in pH

15. Complete the following statements concerning the properties and biological importance of water.

_____ 1.
_____ 2.
_____ 3.
_____ 4.
_____ 5.
_____ 6.
_____ 7.
_____ 8.

The ability of water to maintain a relatively constant temperature and thus prevent sudden changes is because of its high (1) _____. Biochemical reactions in the body must occur in (2) _____. About (3) _____% of the volume of a living cell is water. Water molecules are bonded to other water molecules because of the presence of (4) _____ bonds. Water, as H^+ and OH^- ions, is essential in biochemical reactions such as (5) _____ and (6) _____ reactions. Because of its (7) _____, water is an excellent solvent and forms the basis of mucus and other body (8) _____.

16. Use an *X* to designate which of the following are organic compounds.

_____ Carbon dioxide _____ Fats _____ Proteins _____ H_2O

_____ Oxygen _____ KCl _____ Glucose _____ DNA

17. Using the key choices, fully characterize weak and strong acids.

Key Choices

A. Ionize completely in water

B. Ionize incompletely in water

C. Act as part of a buffer system

D. When placed in water, always act to change the pH

E. Ionize at high pH

F. Ionize at low pH

G. Ionize at pH 7

Weak acid: _____ Strong acid: _____

18. Match the terms in Column B to the descriptions provided in Column A. Enter the correct letter(s) or term(s) in the answer blanks.

Column A	Column B
_____ 1. Building blocks of carbohydrates	A. Amino acids
_____ 2. Building blocks of fat	B. Carbohydrates
_____ 3. Building blocks of protein	C. Lipids (fats)
_____ 4. Building blocks of nucleic acids	D. Fatty acids
_____ 5. Cellular cytoplasm is primarily composed of this substance	E. Glycerol
_____ 6. The single most important fuel source for body cells	F. Nucleotides
_____ 7. Not soluble in water	G. Monosaccharides
_____ 8. Contain C, H, and O in the ratio CH_2O	H. Proteins
_____ 9. Contain C, H, and O, but have relatively small amounts of oxygen	
_____ 10. _____ 11. These building blocks contain N in addition to C, H, and O	
_____ 12. Contain P in addition to C, H, O, and N	
_____ 13. Used to insulate the body and found in all cell membranes	
_____ 14. Primary components of meat and cheese	
_____ 15. Primary components of bread and lollipops	
_____ 16. Primary components of egg yolk and peanut oil	
_____ 17. Include collagen and hemoglobin	
_____ 18. Class that usually includes cholesterol	

19. Using the key choices, correctly select *all* terms that correspond to the following descriptions. Insert the correct letter(s) or their corresponding term(s) in the answer blanks.

Key Choices

A. Cholesterol	D. Enzyme	G. Hormones	J. Maltose
B. Collagen	E. Glycogen	H. Keratin	K. RNA
C. DNA	F. Hemoglobin	I. Lactose	L. Starch

_____ _____ 1. Example(s) of fibrous (structural) proteins

_____ _____ 2. Example(s) of globular (functional) proteins

_____ _____ 3. Biologic catalyst

_____ _____ 4. Plant storage carbohydrate

_____ _____ 5. Animal storage carbohydrate

_____ 6. The "stuff" of the genes

_____ 7. A steroid

_____ 8. Double sugars, or disaccharides

20. Five simplified diagrams of biological molecules are depicted in Figure 2–4. First, identify the molecules and insert the correct names in the answer blanks on the figure. Then select a different color for each molecule listed below and use them to color the coding circles and the corresponding molecules on the illustration.

◯ Fat ◯ Nucleotide ◯ Monosaccharide

◯ Functional protein ◯ Polysaccharide

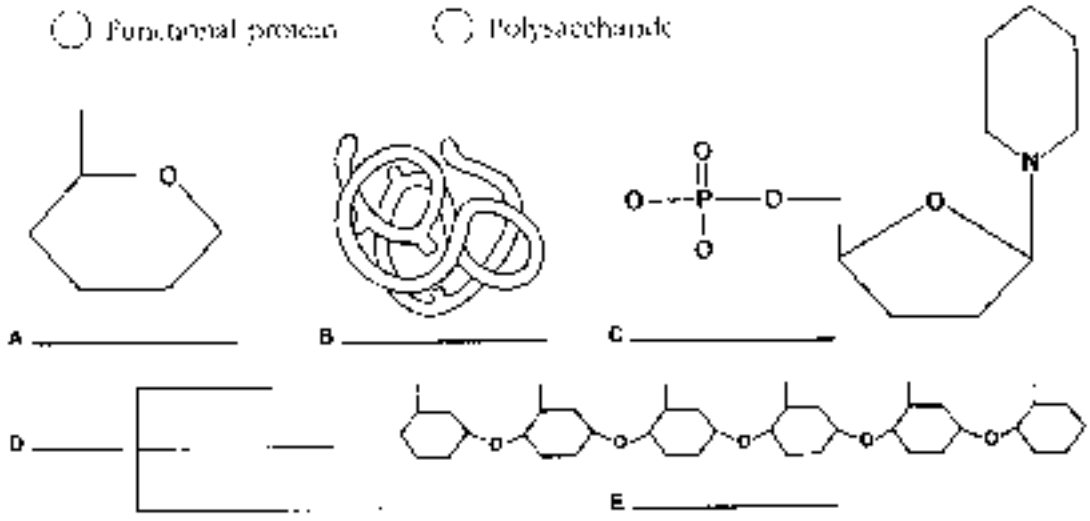


Figure 2–4

21. Circle the term that does not belong in each of the following groupings

1. Adenine Guanine Glucose Thymine
2. DNA Ribose Phosphate Deoxyribose
3. Galactose Glycogen Fructose Glucose
4. Amino acid Polypeptide Glycerol Protein
5. Glucose Sucrose Lactose Maltose

22. For each true statement, insert *T* in the answer blank. If any are false, correct the underlined term and insert your correction in the answer blank.

_____ 1. Phospholipids are polarized molecules.

_____ 2. Steroids are the major form in which body fat is stored

_____ _____ 3. Water is the most abundant compound in the body

_____ _____ 4. Nonpolar molecules are generally soluble in water.

_____ _____ 5. The bases of RNA are A, G, C, and U

_____ _____ 6. The universal energy currency of living cells is RNA.

_____ 7. RNA is single stranded

_____ 8. The four elements that make up more than 90% of living matter are C, H, N, and Na

23. Figure 2–5 shows the molecular structure of DNA, a nucleic acid.

A. First, identify the two unnamed nitrogen (N) bases and insert their correct names and symbols in the two blanks beside the color coding circles.

B. Complete the identification of the bases on the diagram by inserting the correct symbols in the appropriate sources on the right side of the diagram.

C. Select different colors and color the coding circles and the corresponding parts of the diagram.

D. Label one deoxyribose (d-R) sugar unit and one phosphate (P) unit of the "backbones" of the DNA structure by inserting leader lines and labels on the diagram.

E. Circle the associated nucleotide.

◯ Deoxyribose sugar (d-R) ◯ Adenine (A) ◯ _____ _____ ( )

◯ Phosphate (P) ◯ Cytosine (C) ◯ _____ _____ ( )

Then answer the questions following Figure 2–5 by writing your answers in the answer blanks

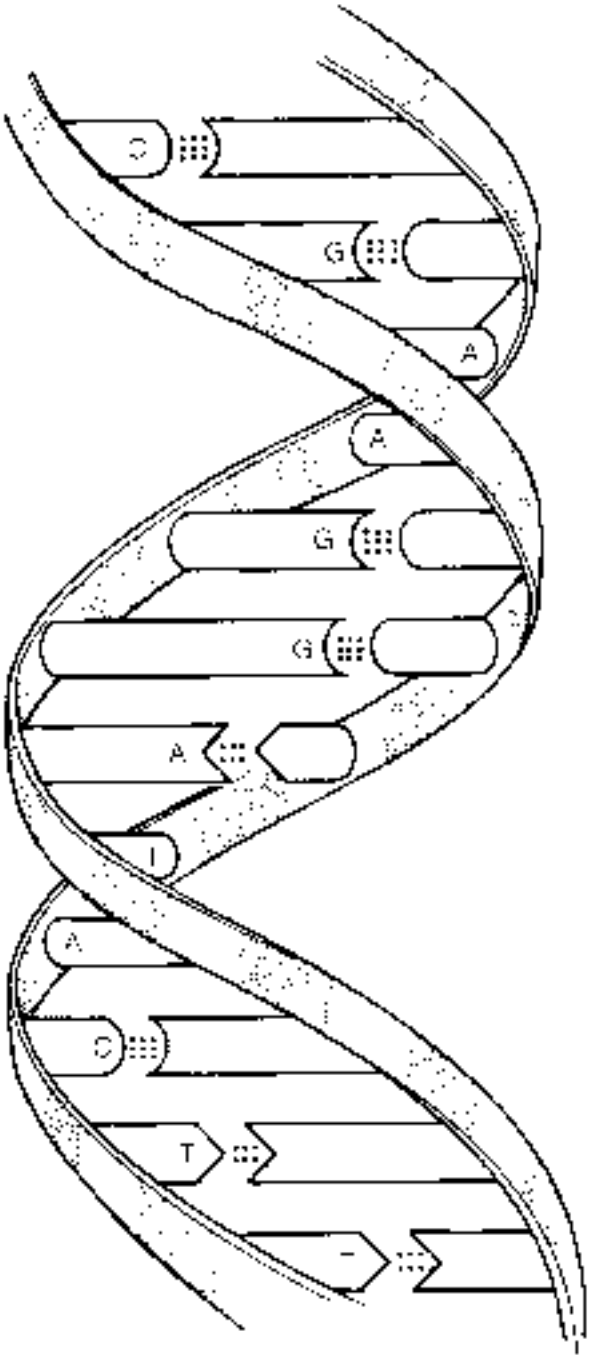


Figure 2–5

1. Name the bonds that help to hold the two DNA strands together _____ _____
2. Name the three-dimensional shape of the DNA molecule. _ _____ _____
3. How many base pairs are present in this segment of a DNA model? _____ _____
4. What is the term that means 'base pairing'? _____. _____. _____

24. The biochemical reaction shown in Figure 2–6 represents the complete digestion of a polymer (a large molecule as consumed in food) down to its constituent monomers, or building blocks. Select two colors and color the coding circles and the structures. Then, select the one correct answer for each statement below and insert your answer in the answer blank.

◯ Monomer ◯ Polymer

Figure 2–6

_____ _____. _____ 1. If starch is the polymer, the monomer is:

A. glycogen B. amino acid C. glucose D. maltose

_____. 2. During polymer digestion, water as H^+ and OH^- ions would:

A. be a product of the reaction.

B. act as a catalyst.

C. enter between monomers, bond to them, and keep them separated.

D. not be involved in this reaction.

___ ____ ___ 3. Another name for the chemical digestion of polymers is:

A. dehydration B. hydrolysis C. synthesis D. displacement

_____ _____ ___ 4. If the monomers are amino acids, they may differ from each other by their:

A. R group B. amino group C. acid group D. peptide bond

INCREDIBLE JOURNEY

A Visualization Exercise for Biochemistry

. . . you are suddenly upended and are carried along in a sea of water molecules at almost unbelievable speed.

25. Complete the narrative by inserting the missing words in the answer blanks.

For this journey, you are miniaturized to the size of a very small molecule by colleagues who will remain in contact with you by radio. Your instructions are to play the role of a water molecule and to record any reactions that involve water molecules. Considering water molecules are polar

molecules, you are outfitted with an insulated rubber wet suit with one (11) charge at your helmet and two (12) charges, one at the end of each leg.

As soon as you are injected into your host's bloodstream, you feel as though you are being pulled apart. Some large, attractive forces are pulling at your legs from different directions! You look about but can see only water molecules. After a moment's thought, you remember the polar nature of your wet suit. You record that these forces must be the (13) that are easily formed and easily broken in water.

After this initial surprise, you are suddenly upended and carried along in a sea of water molecules at almost unbelievable speed. You have just begun to observe some huge, red, disk-shaped structures (probably (14)) taking up O_2 molecules when you are swept into a very turbulent environment. Your colleagues radio that you are in the small intestine. With difficulty, because of numerous collisions with other molecules, you begin to record the various types of molecules you see.

In particular, you notice a very long helical molecule made of units with distinctive R groups. You identify and record this type of molecule as a (15) , made of units called (16) , that are joined together by (17) bonds. As you move too close to the helix during your observations, you are nearly pulled apart to form two ions, (18) , but you breathe a sigh of relief as two ions of another water molecule take your place. You watch as these two ions move between two units of the long helical molecule. There, in a fraction of a second, the bond between the two units is broken. As you record the occurrence of this chemical reaction, called (19) , you are jolted into another direction by an enormous globular protein, the very same (20) that controls and speeds up this chemical reaction.

Once again you find yourself in the bloodstream, heading into an organ identified by your colleagues as the liver. Inside a liver cell, you observe many small monomers made up only of C, H, and O atoms. You identify these units as (21) molecules because the liver cells are bonding them together to form very long, branched polymers called (22) . You record that this type of chemical reaction is called (23) , and you happily note that this reaction also produces (24) molecules like you!

After another speedy journey through the bloodstream, you reach the skin. You move deeply into the skin and finally gain access to a sweat gland. In the sweat gland, you collide with millions of water molecules and some ionized salt molecules that are continually attracted to your positive and negative charges. Suddenly, the internal temperature rises, and molecular collisions (25) at an alarming rate, propelling you through the pore of the sweat gland onto the surface of the skin. So that you will be saved from the fate of evaporating into thin air, you contact your colleagues and are speedily rescued.

AT THE CLINIC

26. It is determined that a patient is in acidosis. What does this mean, and would you treat the condition with a chemical that would *raise* or *lower* the pH?

27. A newborn is diagnosed with sickle cell anemia, a genetic disease in which substitution of one amino acid results in abnormal hemoglobin. Explain to the parents how the substitution can have such a drastic effect on the structure of the protein.

28. Johnny's body temperature is spiking upward. When it reaches 104°F, his mother puts in a call to the pediatrician. She is advised to give Johnny children's acetaminophen or ibuprofen and sponge his body with cool to tepid water to prevent a further rise in temperature. How might a fever (excessively high body temperature) be detrimental to Johnny's welfare?

29. Mrs. Gallo's physician suspects that she is showing the initial signs of multiple sclerosis, a disease characterized by the formation of hardened plaques in the insulating sheaths surrounding nerve fibers. What medical imaging technique will the physician probably order to determine if such plaques are present?

30. Stanley has indigestion and is doubled over with pain. How could an antacid reduce his stomach discomfort?

31. Explain why the formation of **ATP** from ADP and P_i requires more energy than the amount released for cellular use when ATP is broken down.

THE FINALE: MULTIPLE CHOICE

32. Select the best answer or answers from the choices given.

1. Which of the following is (are) true concerning the atomic nucleus?
   A. Contains the mass of the atom
   B. The negatively charged particles are here
   C. Particles can be ejected
   D. Contains protons that determine atomic number
   E. Contains particles that interact with other atoms

2. Organic compounds include:
   A. water
   B. carbon dioxide
   C. oxygen
   D. carbonic acid
   E. glycerol

3. Important functions of water include:
   A. cushioning
   B. transport medium
   C. participation in chemical reactions
   D. solvent for sugars, salts, and other solutes
   E. reducing temperature fluctuations

4. Which of the elements listed is the most abundant extracellular anion?
   A. Phosphorus
   B. Sulfur
   C. Potassium
   D. Chloride
   E. Calcium

5. The element essential for normal thyroid function is:
   A. iodine
   B. iron
   C. copper
   D. selenium
   E. zinc

6. Alkaline substances include:
   A. gastric juice
   B. water
   C. blood
   D. orange juice
   E. ammonia

7. Which of the following is (are) not a monosaccharide?
   A. Glucose
   B. Fructose
   C. Sucrose
   D. Glycogen
   E. Deoxyribose

8. Which is a building block of neutral fats?
   A. Ribose
   B. Guanine
   C. Glycerol
   D. Glycine
   E. Glucose

9. Which of the following is primarily responsible for the helical structure of a polypeptide chain?
   A. Hydrogen bonding
   B. Tertiary folding
   C. Peptide bonding
   D. Quaternary associations
   E. Complementary base pairing

10. Which of the following is (are) not true of RNA?
    A. Double-stranded
    B. Contains cytosine
    C. Directs protein synthesis
    D. Found primarily in the nucleus
    E. Can act as an enzyme

11. DNA
    A. contains uracil
    B. is a helix
    C. is the "genes"
    D. contains ribose

12 Glucose is to starch as

A a steroid is to a lipid

B a nucleotide is to nucleic acid

C. an amino acid is to a protein

D. a polypeptide is to an amino acid

13. Energy contained in molecular bonds is:

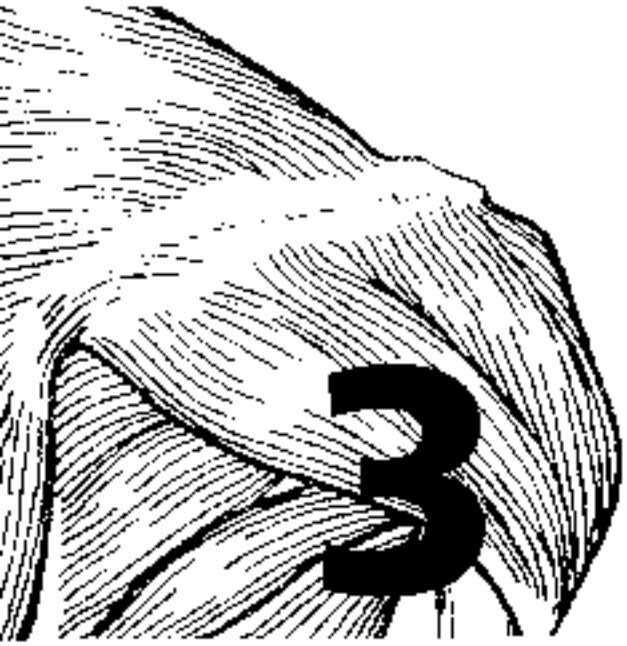
A. electrical

B mechanical

C. chemical

D. radiant

E. kinetic



3 CELLS AND TISSUES

The basic unit of structure and function in the human body is the cell. Each of a cell's parts, or organelles, as well as the entire cell, is organized to perform a specific function. Cells have the ability to metabolize, grow and reproduce, move, and respond to stimuli. The cells of the body differ in shape, size, and in specific roles in the body. Cells that are similar in structure and function form tissues, which, in turn, construct the various body organs.

Student activities in this chapter include questions relating to the structure and function of the generalized animal cell and to the general arrangement of tissues and their contribution to the activities of the various body organs.

CELLS

Overview

1. Answer the following questions by inserting your responses in the answer blanks.

_____ 1.
_____ 2.
_____ 3.
_____ 4.
_____ 5.
_____ 6.
_____ 7.
_____ 8.
_____ 9.
_____ 10.

1–4 Name the four elements that make up the bulk of living matter.

5 Name the single most abundant material or substance in living matter.

6. Name the trace element most important for making bones hard.

7 Name the element, found in small amounts in the body, that is needed to make hemoglobin for oxygen transport.

8–12. Although there are many specific "jobs" that certain cells are able to do, name five functions common to all cells.

_____ 11.
_____ 12. →

_____ 13.

_____ 14.

_____ 15.

_____ 16.

_____ 17.

13. 15. List three different cell shapes.

16. Name the fluid, similar to seawater, that surrounds and bathes all body cells.

17. Name the flattened cells, important in protection, that fit together like tiles. (This is just one example of the generalization that a cell's structure is very closely related to its function in the body.)

Anatomy of a Generalized Cell

2. Using the list of terms on the following page, correctly label all cell parts indicated by leader lines in Figure 3-1. Then select different colors for each structure and use them to color the coding circles and the corresponding structures in the illustration.

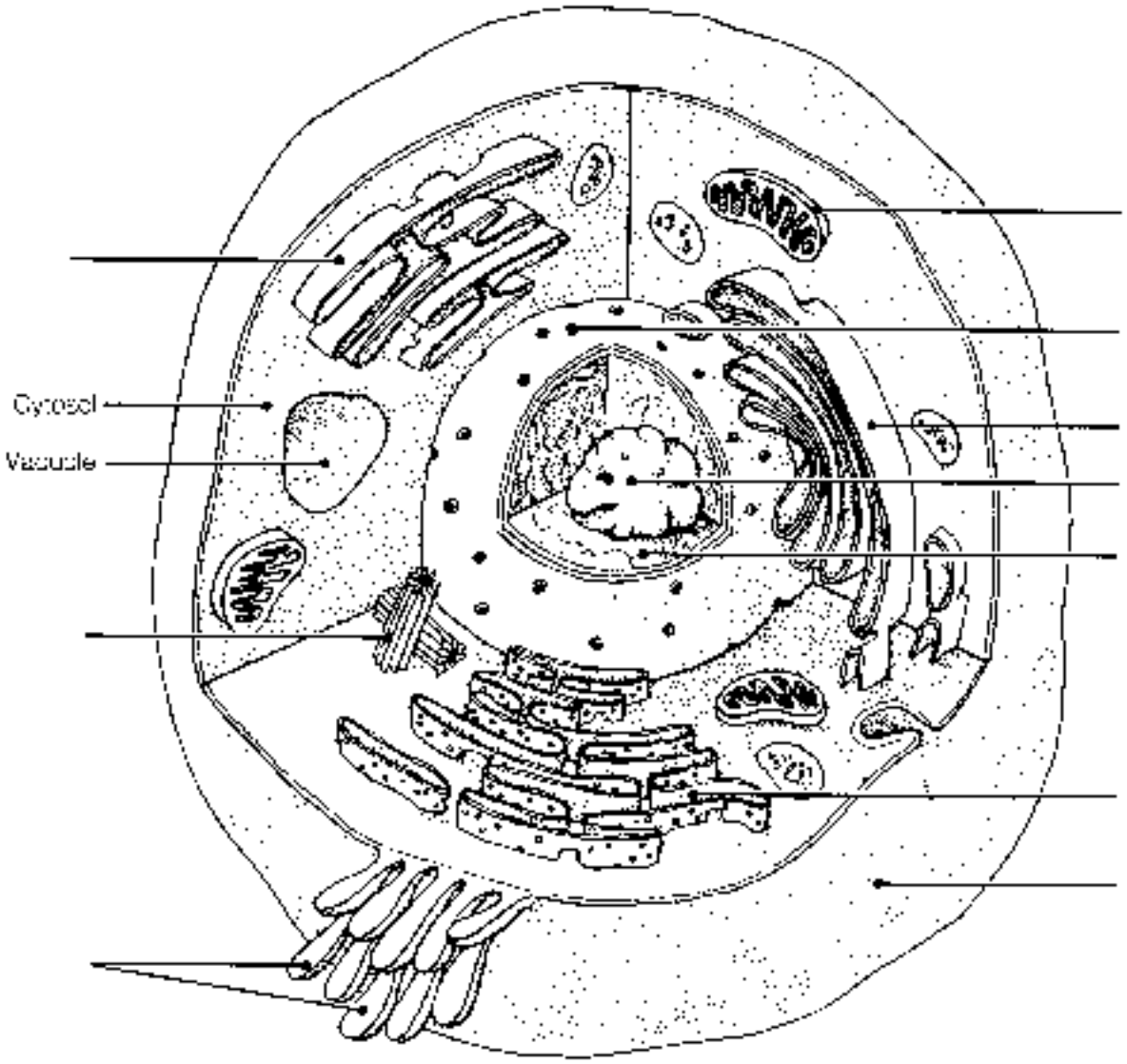


Figure 3–1

- ◯ Plasma membrane
- ◯ Centriole(s)
- ◯ Cytoskeletal filament(s)
- ◯ Golgi apparatus
- ◯ Microvilli
- ◯ Mitochondrion
- ◯ Nuclear membrane
- ◯ Nucleolus
- ◯ Rough endoplasmic reticulum (ER)
- ◯ Smooth endoplasmic reticulum (ER)

3. Figure 3–2 is a diagram of a portion of a plasma membrane. Select three different colors and color the coding circles and the corresponding structures in the diagram. Then respond to the questions that follow, referring to Figure 3–2 and insert your answers in the answer blanks.

◯ Phospholipid molecules ◯ Carbohydrate molecules ◯ Protein molecules

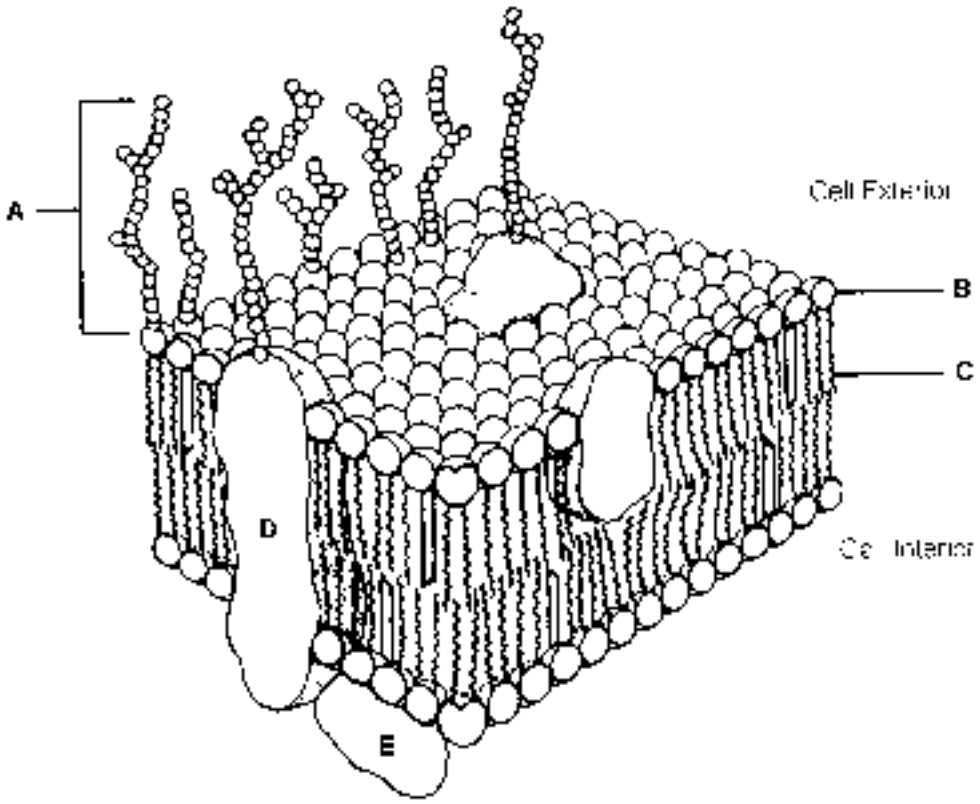


Figure 3–2

a. Name the carbohydrate-rich area at the cell surface (indicated by bracket A) _____

b. Which label, B or C, indicates the nonpolar region of a phospholipid molecule? _____

c. Does nonpolar mean hydrophilic or hydrophobic? _____

d. What are two roles of the membrane proteins? _____

and _____

4. Label the specializations of the plasma membrane, shown in Figure 3-3, and color the diagram as you wish. Then, answer the questions provided below that refer to this figure.

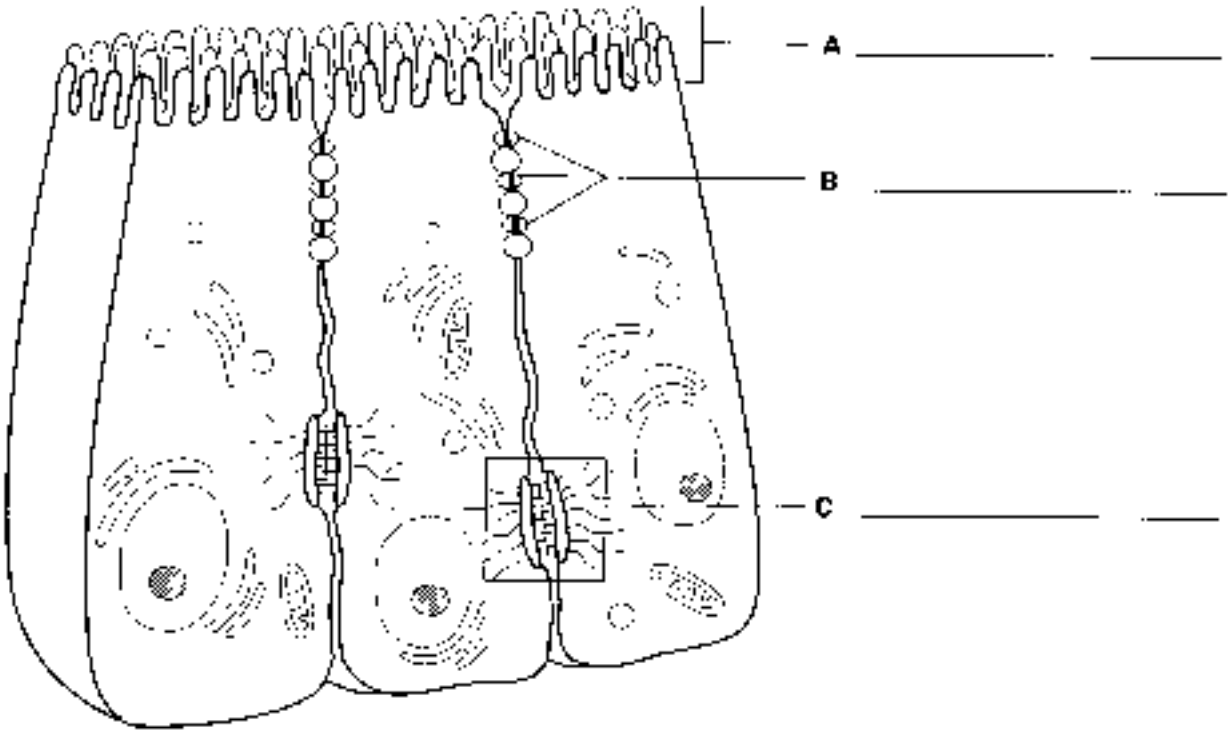


Figure 3-3

1. What type of cell function(s) does the presence of microvilli typically indicate? _____

2. Which cell junction forms an impermeable barrier? _____

3. Which cell junction is an anchoring junction? _____

4. Which junction has linker proteins spanning the intercellular space? _____

5. Which cell junction is not illustrated, and what is its function? _____

5. Relative to cellular organelles, circle the term or phrase that does not belong in each of the following groupings.

1. Peroxisomes Enzymatic breakdown Centrioles Lysosomes
2. Microtubules Intermediate filaments Cytoskeleton Cilia
3. Ribosomes Smooth ER Rough ER Protein synthesis
4. Mitochondrion Cristae ATP production Vitamin A storage
5. Centrioles Mitochondria Cilia Flagella
6. ER Nuclear pores Ribosomes Transport vesicles Golgi apparatus
7. Nucleus DNA Lysosomes Chromatin Nucleoli

6. Name the cytoskeletal element (microtubules, microfilaments, or intermediate filaments) described by each of the following phrases.

_____ ___ __ 1. Give the cell its shape

_____ __ _ 2. Resist tension placed on a cell

_____ __ _ 3. Radiate from the cell center

_____ ___ _ 4. Involved in moving intracellular structures

_ _ _ _____ 5. Are the most stable

_ _ _ ____ 6. Have the thickest diameter

7. Different organelles are abundant in different cell types. Match the cell types with their abundant organelles by selecting a letter from the key choices.

Key Choices

A. Mitochondria C. Rough ER E. Microfilaments G. Intermediate filaments

B. Smooth ER D. Peroxisomes F. Lysosomes H. Golgi apparatus

1. Cell lining the small intestine (assembles fats)
2. White blood cell, a phagocyte
3. Liver cell that detoxifies carcinogens
4. Muscle cell (contractile cell)
5. Mucus-secreting cell (secretes a protein product)
6. Cell at external skin surface (withstands friction and tension)
7. Kidney tubule cell (reabsorbs and uses large amounts of ATP)

Cell Physiology

Membrane Transport

8. Figure 3–4 shows a semipermeable sac, containing 4% NaCl, 9% glucose, and 10% albumin, suspended in a solution with the following composition: 10% NaCl, 10% glucose, and 40% albumin. Assume the sac is permeable to all substances *except* albumin. Using the key choices, insert the letter indicating the correct event in the answer blanks.

Key Choices

A. Moves into the sac B. Moves out of the sac C. Does not move

_____ _____ 1. Glucose _____ _____ 3. Albumin

_____ _____ 2. Water _____ _____ 4. NaCl

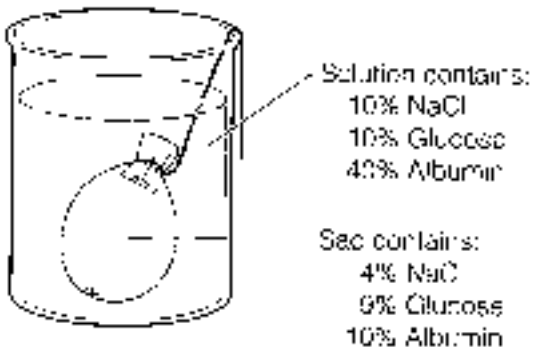


Figure 3–4

9. Figure 3–5 shows three microscopic fields (A–C) containing red blood cells. Arrows indicate the direction of net osmosis. Respond to the following questions, referring to Figure 3–5, by inserting your responses in the spaces provided.

1. Which microscopic field contains a *hypertonic* solution? _____

   The cells in this field are said to be _____

2. Which microscopic field contains an isotonic bathing solution? _____

   What does *isotonic* mean? _____

3. Which microscopic field contains a *hypotonic* solution? _____

   What is happening to the cells in this field and why? _____

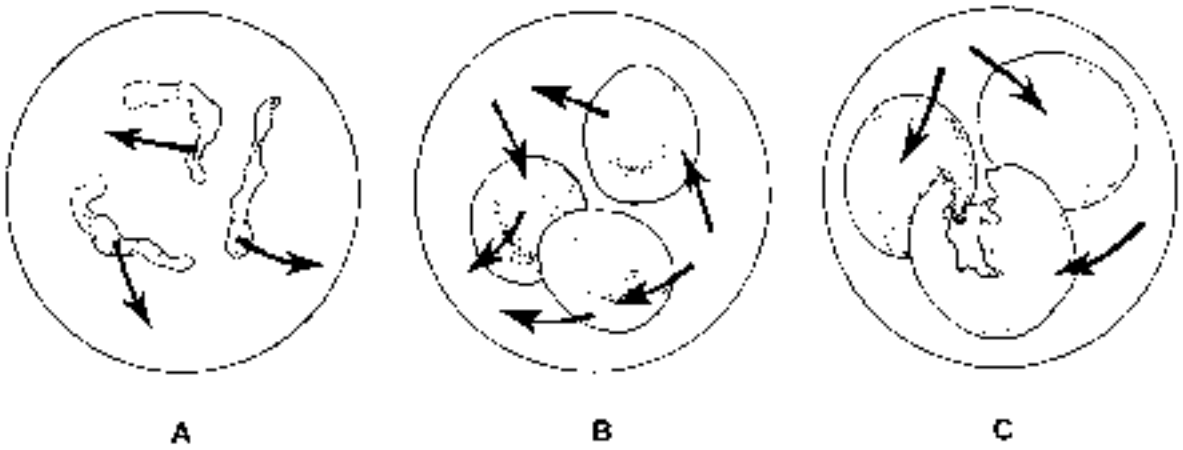


Figure 3–5

10. Figure 3–6 is a simplified diagram of the plasma membrane. Structure A represents channel proteins constructing a pore, structure B represents an ATP-energized solute pump, and structure C is a transport protein that does not depend on energy from ATP. Identify these structures and the membrane phospholipids by color before continuing.

◯ Channel ◯ Solute pump ◯ Passive transport protein carrier ◯ Phospholipids

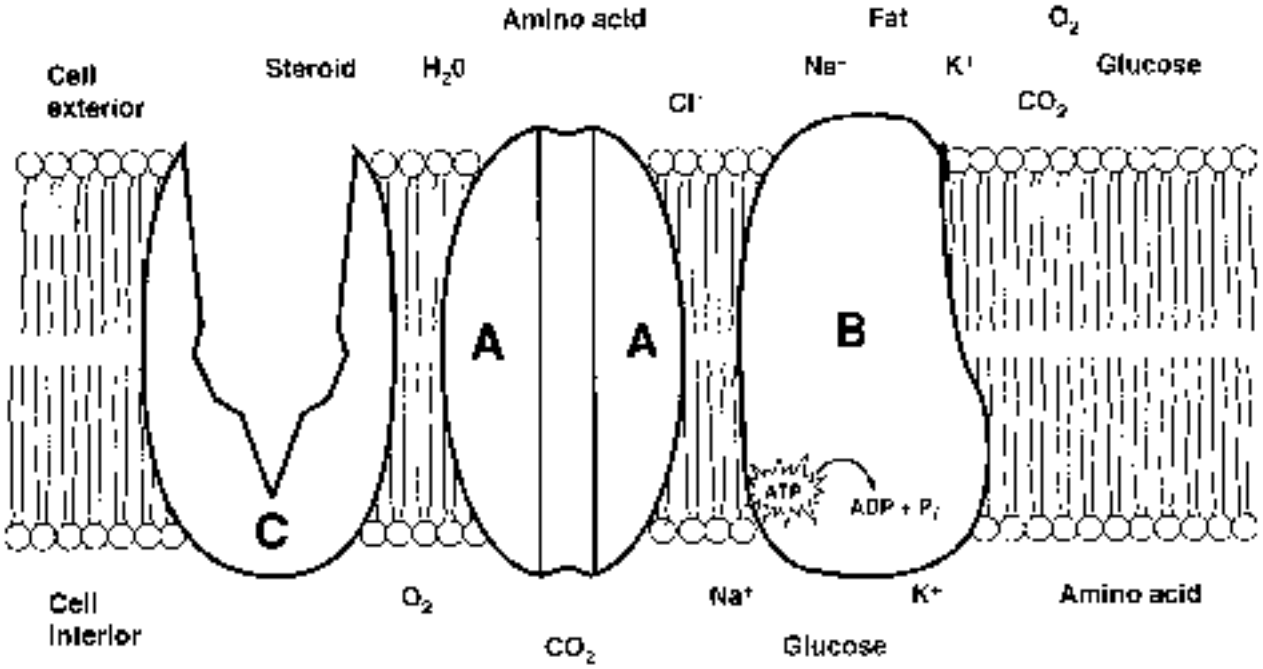


Figure 3–6

Now add arrows to Figure 3–6 as instructed next. For each substance that moves through the plasma membrane, draw an arrow indicating its (most likely) direction of movement into or out of the cell. If it is moved actively, use a red arrow; if it is moved passively, use a blue arrow.

→

Finally, answer the following questions referring to Figure 3-6:

1. Which of the substances shown moves passively *through the lipid* part of the membrane? _____.
2. Which of the substances shown enters the cell by attachment to a passive transport protein carrier? _____.
3. Which of the substances shown moves passively through the membrane by moving through its pores? _____ _____
4. Which of the substances shown would have to use a solute pump to be transported through the membrane? _____ _____

11. Select the key choices that characterize each of the following statements. Insert the appropriate answers in the answer blanks.

Key Choices

A. Active transport	D. Exocytosis	G. Phagocytosis
B. Diffusion, simple	E. Facilitated diffusion	H. Pinocytosis
C. Diffusion, osmosis	F. Filtration	I. Receptor-mediated endocytosis

_____ _____ 1. Engulfment processes that require ATP

_____ 2. Driven by molecular energy

_____ 3. Driven by hydrostatic (fluid) pressure (typically blood pressure in the body)

_____ 4. Moves down a concentration gradient

_____ 5. Moves up (against) a concentration gradient; requires a carrier

_____ 6. Moves small or lipid-soluble solutes through the membrane

_____ 7. Transports amino acids and Na^+ through the plasma membrane

_____ 8. Examples of vesicular transport

_____ _____ 9. A means of bringing fairly large particles into the cell

_____ _____ 10. Used to eject wastes and to secrete cell products

_____ 11. Membrane transport using channels or carrier proteins that does not require ATP

Cell Division

12. The following statements provide an overview of the structure of DNA (genetic material) and its role in the body. Choose responses from the key choices that complete the statements. Insert the appropriate answers in the answer blanks.

Key Choices

A. Adenine	G. Enzymes	M. Nucleotides	S. Ribosome
B. Amino acids	H. Genes	N. Old	T. Sugar (deoxyribose)
C. Bases	I. Growth	O. Phosphate	U. Template, or model
D. Codons	J. Guanine	P. Proteins	V. Thymine
E. Complementary	K. Helix	Q. Replication	W. Transcription
F. Cytosine	L. New	R. Repair	X. Uracil

1. DNA molecules contain information for building specific (11). In a three-dimensional view, a DNA molecule looks like a spiral staircase; this is correctly called a (2). The constant pairs of DNA molecules are the (13) and (14) molecules, forming the DNA-ladder uprights, or backbones. The information of DNA is actually coded in the sequence of nitrogen-containing (15), which are bound together to form the "rungs" of the DNA ladder. When the four DNA bases are combined in different three-base sequences, called triplets, different (6) of the protein are called for. It is said that the N-containing bases of DNA are (7), which means that only certain bases can fit or interact together; specifically, this means that (8) can bind with guanine, and adenine binds with (19).

9. The production of proteins involves the cooperation of DNA and RNA. RNA is another type of nucleic acid that serves as a "molecular slave" to DNA. That is, it leaves the nucleus and carries out the instructions of the DNA for the building of a protein on a cytoplasmic structure called a (16). When a cell is preparing to divide in order for its daughter cells to have all its information, it must oversee the (11) of its DNA so that a "double dose" of genes is present for a brief period. For DNA synthesis to occur, the DNA must unzip, and the bonds between the N bases must be broken. Then the two single strands of (12) each act as a (18) for the building of a whole DNA molecule. When completed, each DNA molecule formed is half (14) and half (15). The fact that DNA replicates before a cell divides ensures that each daughter cell has a complete set of (10). Cell division, which then follows, provides new cells so that (17) and (18) can occur.

13. Identify the phases of mitosis depicted in Figure 3–7 by inserting the correct name in the blank under the appropriate diagram. Then select different colors to represent the structures listed below and use them to color in the coding circles and the corresponding structures in the illustration.

◯ Nuclear membrane(s), if present

◯ Nucleoli, if present

◯ Chromosomes

◯ Centrioles

◯ Spindle fibers

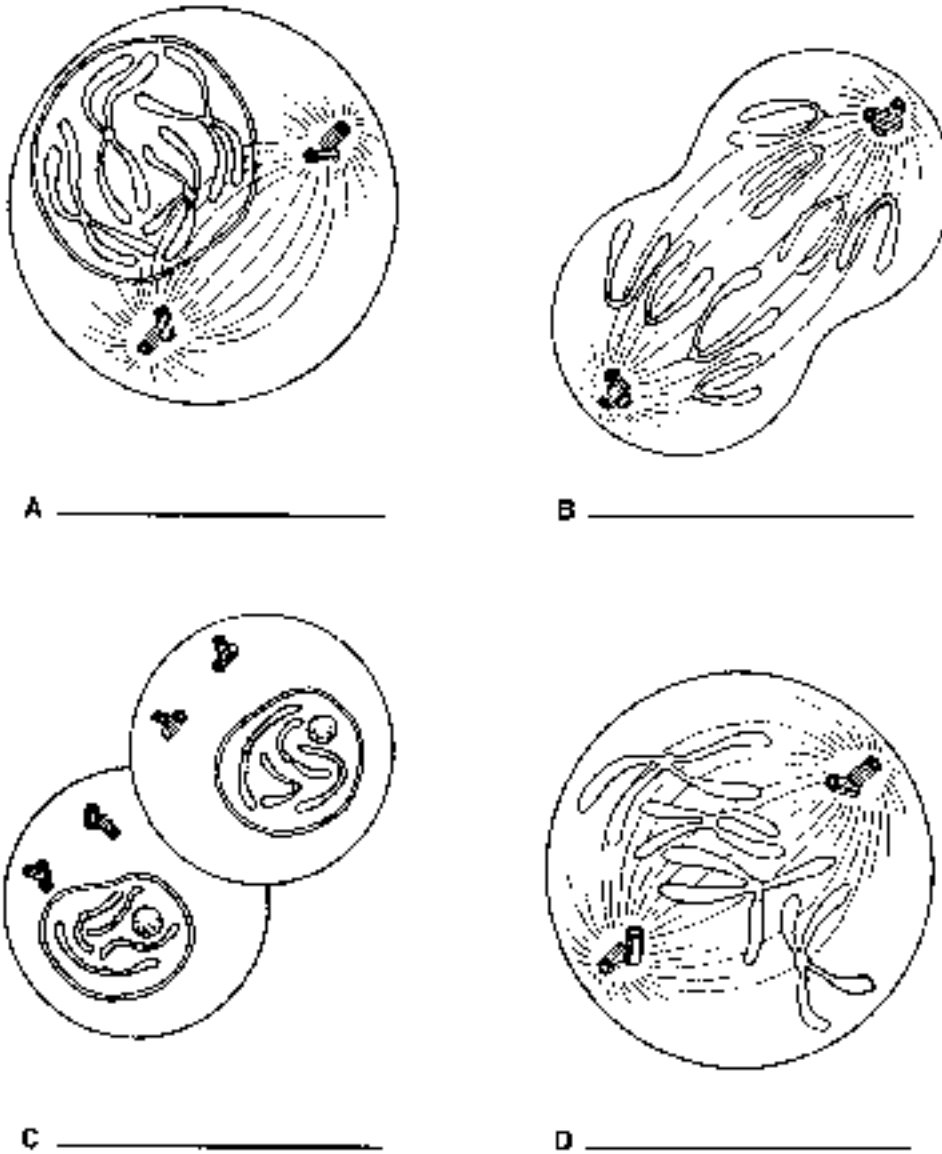


Figure 3-7

14. The following statements describe events that occur during the different phases of mitosis. Identify the phase by choosing the correct response(s) from the key choices and inserting the letter(s) or term(s) in the answer blanks.

Key Choices

A. Anaphase C. Prophase E. None of these

B. Metaphase D. Telophase

___ ___ 1. Chromatin coils and condenses to form deeply staining bodies

_____ 2. Centromeres break, and chromosomes begin migration toward opposite poles of the cell.

_____ __ 3. The nuclear membrane and nucleoli reappear

_____ . 4. When chromosomes cease their poleward movement, this phase begins

_____. 5. Chromosomes align on the equator of the spindle

_____.. 6. The nucleoli and nuclear membrane disappear

_____... 7. The spindle forms through the migration of the centrioles

_____ 8. Chromosomal material replicates

_____ 9. Chromosomes first appear to be duplex structures.

_____ 10. Chromosomes attach to the spindle fibers.

_____ 11. A cleavage furrow forms during this phase.

_____ 12. The nuclear membrane is absent during the entire phase

____ ____ 13. A cell carries out its *usual* metabolic activities.

15. Complete the following statements. Insert your answers in the answer blanks.

_ _____ 1. Division of the (1) is referred to as mitosis. Cytokinesis is the division of the (2) . The major structural difference
____ __ 2. between euchromatin and chromosomes is that the latter are (3) . Chromosomes attach to the spindle fibers by undivided
_ _____ 3. structures called (4) . If a cell undergoes nuclear division but not cytoplasmic division, the product is a (5) . The structural
_____ _____ 4. network that acts as a scaffolding for chromosomal attachment and movement is called the (6) . (7) is the period of cell life
____ . ___ 5. when the cell is not involved in division

_____. _____ 6.

_____... __ 7.

Protein Synthesis

16. Figure 3-8 is a diagram illustrating protein synthesis. Select four different colors, and use them to color the coding circles and the corresponding structures in the diagram. Next, using the letters of the genetic code, label the nitrogen bases on strand 2 of the DNA double helix, on the mRNA strands, and on the tRNA molecules. Then, answer the questions that follow referring to Figure 3-8, inserting your answers in the answer blanks.

◯ Backbones of the DNA double helix

◯ Backbone of the mRNA strands

◯ tRNA molecules

◯ Amino acid molecules

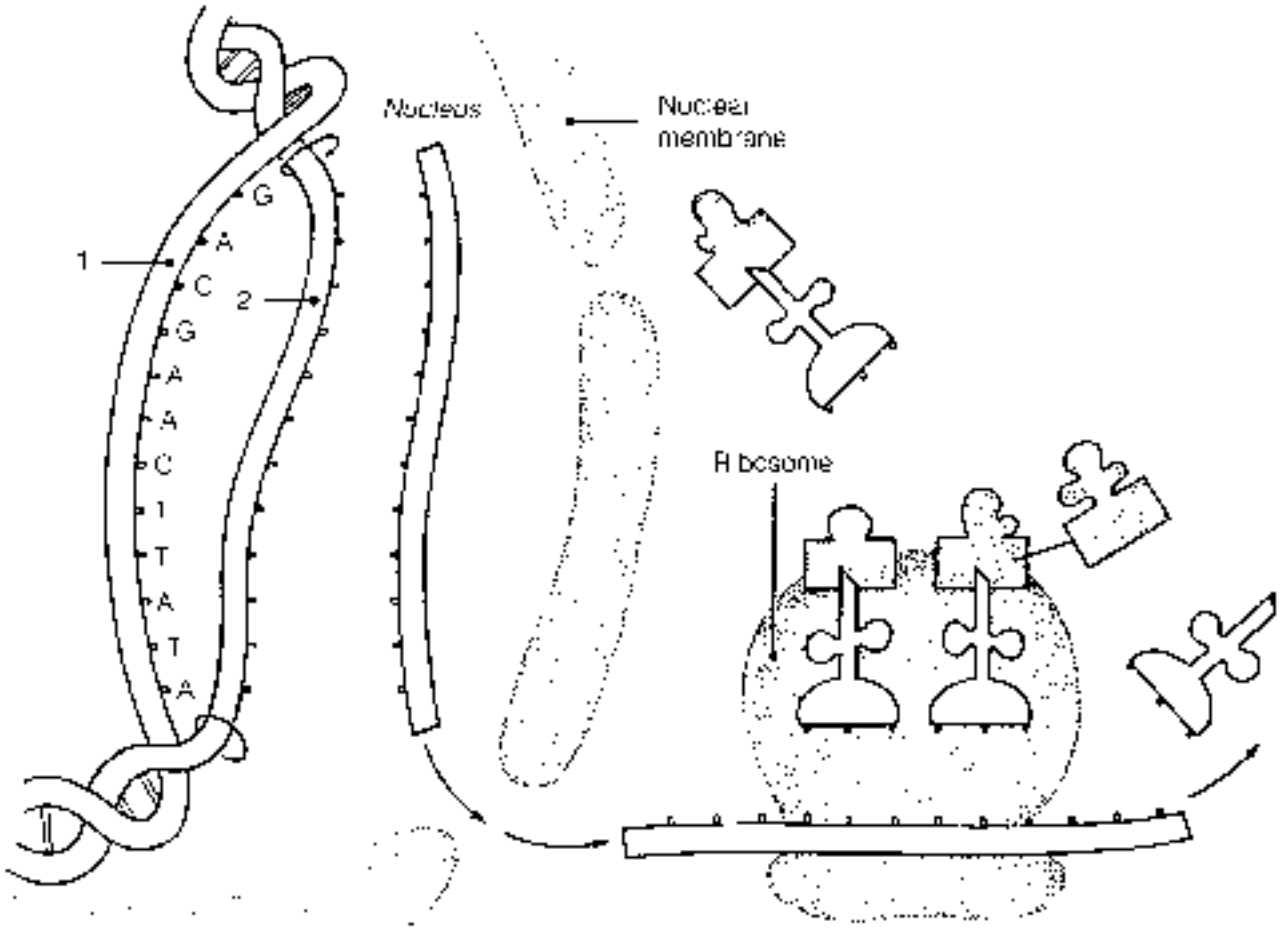


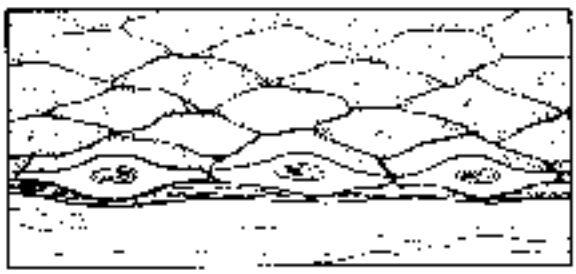
Figure 3-8

1. Transfer of the genetic message from DNA to mRNA is called _____.
2. Assembly of amino acids according to the genetic information carried by mRNA is called _____.
3. The set of three nitrogen bases on tRNA that is complementary to an mRNA codon is called a _____. The complementary three-base sequence on DNA is called a _____.

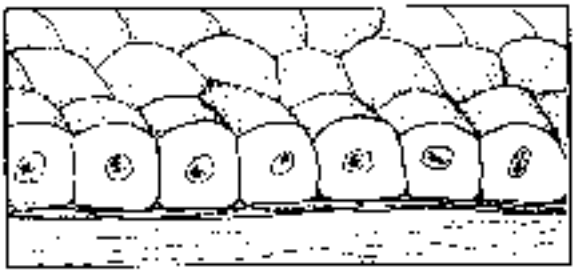
BODY TISSUES

17. Twelve tissue types are diagrammed in Figure 3–9. Identify each tissue type by inserting the correct name in the blank before it on the diagram. Select different colors for the following structures and use them to color the coding circles and corresponding structures in the diagrams.

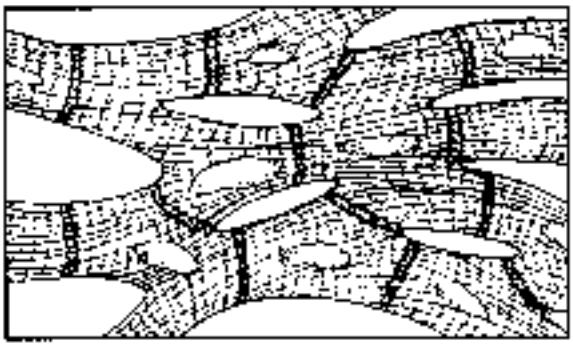
( ) Epithelial cells
( ) Muscle cells
( ) Nerve cells
( ) Matrix (Where a small matrix should be covered differently from the living cells of each tissue type. Be careful; this may not be as easy as it seems!)



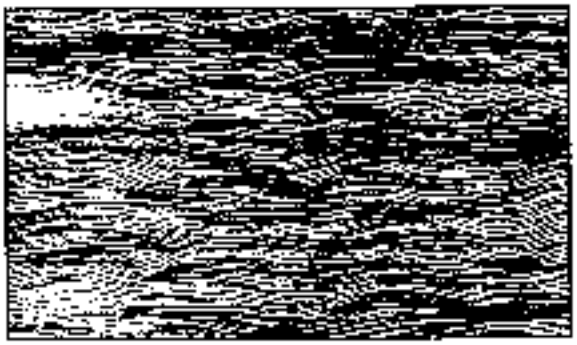
A _____



B _____

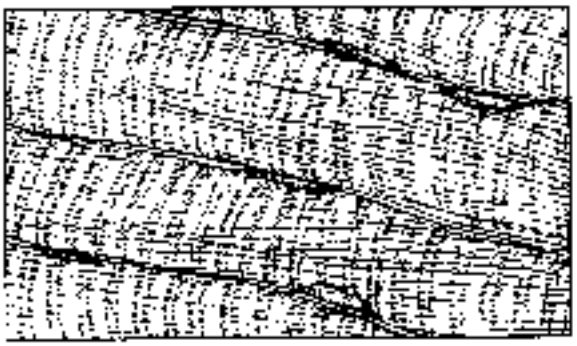


C _____



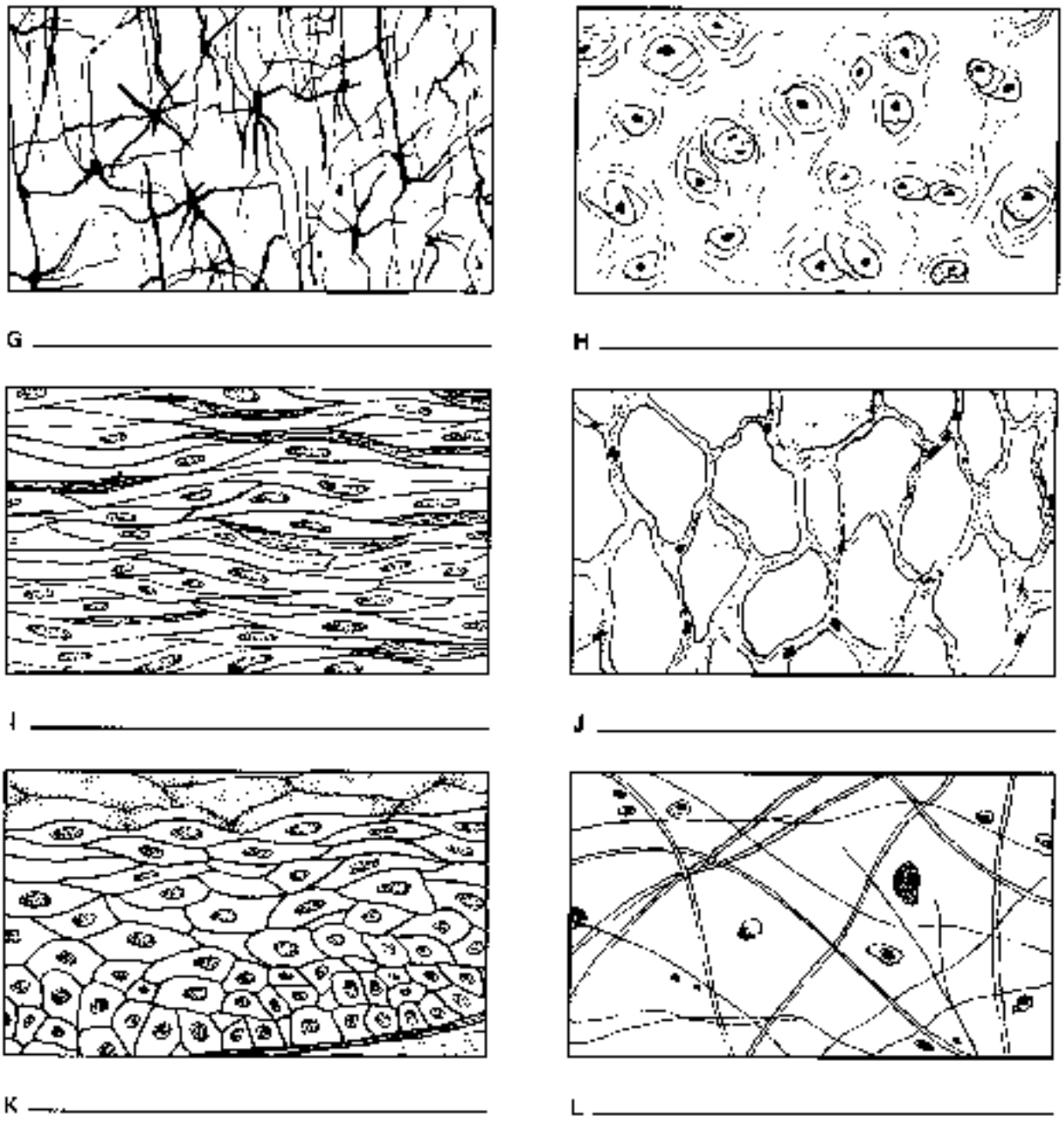
D _____

E _____



F _____

Figure 3–9, A–F



G _____ H _____

I _____ J _____

K _____ L _____

Figure 3–9, G–L

18. Describe briefly how the particular structure of a neuron relates to its function in the body. _____

19. Using the key choices, correctly identify the *major* tissue types described. Enter the appropriate letter or tissue type term in the answer blanks.

Key Choices

A. Connective B. Epithelium C. Muscle D. Nervous

_____ 1. Forms mucous, serous, and epidermal membranes

_____ 2. Allows for organ movements within the body

_____ 3. Transmits electrochemical impulses

_____ 4. Supports body organs

_____ 5. Cells of this tissue may absorb and/or secrete substances

_____ 6. Basis of the major controlling system of the body

_____ 7. The cells of this tissue shorten to exert force

_____ 8. Forms hormones

_____ 9. Packages and protects body organs

_____ 10. Characterized by having large amounts of nonliving matrix

_____ 11. Allows you to smile, grasp, swim, ski, and shoot an arrow

_____ 12. Most widely distributed tissue type in the body

_____ 13. Forms the brain and spinal cord

20. Using the key choices, identify the following specific type(s) of epithelial tissue. Enter the appropriate letter or classification term in the answer blanks.

Key Choices

A. Pseudostratified columnar (ciliated) C. Simple cuboidal E. Stratified squamous

B. Simple columnar D. Simple squamous F. Transitional

_____ 1. Lines the esophagus and forms the skin epidermis

_____ 2. Forms the lining of the stomach and small intestine

_____ 3. Best suited for areas subjected to friction

_____ 4. Lines much of the respiratory tract

_____ 5. Propels substances (e.g., mucus) across its surface

_____ 6. Found in the bladder lining; peculiar cells that slide over one another

_____ 7. Forms that serous membranes; a single layer of flattened cells

21. The three types of muscle tissue exhibit certain similarities and differences. Check (✓) the appropriate spaces in the following table to indicate which muscle types exhibit each characteristic.

Characteristic	Skeletal	Cardiac	Smooth
1. Voluntarily controlled			
2. Involuntarily controlled			
3. Banded appearance			
4. Single nucleus in each cell			
5. Multinucleate			
6. Found attached to bones			
7. Allows you to direct your eyeballs			
8. Found in the walls of stomach, uterus, and arteries			
9. Contains spindle shaped cells			
10. Contains cylindrical cells with branching ends			
11. Contains long, nonbranching cylindrical cells			
12. Displays intercalated discs			
13. Concerned with locomotion of the body as a whole			
14. Changes the internal volume of an organ as it contracts			
15. Tissue of the circulatory pump			

22. Circle the term that does not belong in each of the following groupings.

1. Collagen	Cell	Matrix	Cell product
2. Cilia	Flagellum	Microvilli	Elastic fibers
3. Glands	Bones	Epidermis	Mucosae
4. Adipose	Hyaline	Osseous	Nervous
5. Blood	Smooth	Cardiac	Skeletal

23. Using the key choices, identify the following connective tissue types. Insert the appropriate letter or corresponding term in the answer blanks.

Key Choices

A. Adipose connective tissue	C. Dense fibrous connective tissue	F. Reticular connective tissue
B. Areolar connective tissue	D. Osseous tissue	F. Hyaline cartilage

_____ 1. provides great strength through parallel bundles of collagenic fibers, found in tendons

_____ 2. Acts as a storage depot for fat

_____ 3. Composes the dermis of the skin

_____ 4. Forms the bony skeleton

_____ 5. Composes the basement membrane and packages organs; includes a gel-like matrix with all categories of fibers and many cell types

_____ 6. Forms the embryonic skeleton and the surfaces of bones at the joints; reinforces the trachea

_____ 7. Provides insulation for the body

_____ 8. Structurally amorphous matrix, heavily invaded with fibers; appears glassy and smooth

_____ 9. Contains cells arranged concentrically around a nutrient canal; matrix is hard due to calcium salts

_____ 10. Forms the stroma or internal "skeleton" of lymph nodes, the spleen, and other lymphoid organs

Tissue Repair

24. For each of the following statements about tissue repair that is true, enter *T* in the answer blank. For each false statement, correct the underlined words by writing the correct words in the answer blank.

_____ 1. The nonspecific response of the body to injury is called regeneration.

_____ 2. Intact capillaries near an injury dilate, leaking plasma, blood cells, and antibodies, which cause the blood to clot. The clot at the surface dries to form a scab.

_____ 3. During the first phase of tissue repair, capillary buds invade the clot, forming a delicate pink tissue called endodermal tissue.

_____ 4. When damage is not too severe, the surface epithelium migrates beneath the dry scab and across the surface of the granulation tissue. This repair process is called proliferation.

→

5. If tissue damage is very severe, tissue repair is more likely to occur by fibrosis, or scarring.

____ 6. During fibrosis, fibroblasts in the granulation tissue lay down keratin fibers, which form a strong, compact, but inflexible mass.

_____ 7. The repair of cardiac muscle and nervous tissue occurs only by fibrosis.

DEVELOPMENTAL ASPECTS OF CELLS AND TISSUES

25. Correctly complete each statement by inserting your responses in the answer blanks.

_____ 1. During embryonic development, cells specialize to form __(1)__. Mitotic cell division is very important for overall body __(2)__.

2. All tissues except __(3)__ tissue continue to undergo cell division until the end of adolescence. After this time, __(4)__ tissue also becomes amitotic. When amitotic tissues are damaged, they are replaced by __(5)__ tissue, which does not function in the same way as the original tissue. This is a serious problem when heart cells are damaged.

3.

____ 4

_____ 5

_____ 6. Aging begins almost as soon as we are born. Three explanations of the aging process have been offered. One states that __(6)__ insults, such as the presence of toxic substances in the blood, are important. Another theory states that external __(7)__ factors, such as X rays, help to cause aging. A third theory suggests that aging is programmed in our __(8)__. Three examples of aging processes seen in all people are __(9)__, __(10)__, and __(11)__.

_____ 7.

8.

_____ 9.

_____ 10.

_____ 11. Neoplasms occur when cells "go wild" and the normal controls of cell __(12)__ are lost. The two types of neoplasms are __(13)__ and __(14)__. The __(15)__ type tends to stay localized and have a capsule. The __(16)__ type is likely to invade other body tissues and spread to other (distant) parts of the body. To correctly diagnose the type of neoplasm, a microscopic examination of the tissue called a __(17)__ is usually done. Whenever possible, __(18)__ is the treatment of choice for neoplasms.

12.

13.

____ 14.

_____ 15.

_____ 16. An overgrowth of tissue that is not considered to be a neoplasm is referred to as __(19)__. Conversely, a decrease in the size of an organ or tissue, resulting from loss of normal stimulation, is called __(20)__.

_____ 17.

_____ 18.

_____ 19.

_____ 20.

INCREDIBLE JOURNEY

A Visualization Exercise for the Cell

A long, meandering membrane with dark globules clinging to its outer surface now comes into sight.

26. Where necessary, complete statements by inserting the missing words in the answer blanks.

_____ 1. For your second journey, you will be miniaturized to the size of a small protein molecule and will travel in a microsubmarine, specially designed to enable you to pass easily through living membranes. You are injected into the intercellular space between two epithelial cells, and you are instructed to observe one of these cells firsthand and to identify as many of its structures as possible.

_____ 2.

_____ 3.

_____ 4.

_____ 5. You struggle briefly with the controls and then maneuver your microsub into one of these cells. Once inside the cell, you find yourself in a kind of "sea." This salty fluid that surrounds you is the __(1)__ of the cell.

_____ 6.

_____ 7.

_____ 8. Far below looms a large, dark, oval structure, much larger than anything else you can see. You conclude that it is the __(2)__. As you move downward, you pass a cigar-shaped structure with strange-looking folds on its inner surface. Although you have a pretty good idea that it must be a __(3)__, you decide to investigate more thoroughly. After passing through the external membrane of the structure, you are confronted with yet another membrane. Once past this membrane, you are inside the strange-looking structure. You activate the dot on your microsub for a readout indicating which molecules are in your immediate vicinity. As suspected, there is an abundance of energy-rich __(4)__ molecules. Having satisfied your curiosity, you leave this structure to continue the investigation.

_____ 9.

_____ 10.

A long, meandering membrane with dark globules clinging to its outer surface now comes into sight. You maneuver closer and sit back to watch the activity. As you watch, amino acids are joined together, and a long, threadlike protein molecule is built. The globules must be __(5)__, and the membrane, therefore, is the __(6)__. Once again, you head toward the large dark structure seen and tentatively identified earlier. On approach, you observe that this huge structure has very large openings in its outer wall; these openings must be the __(7)__. Passing through one of these openings, you discover that from the inside, the color of this structure is a result of dark, coiled, intertwined masses of __(8)__, which your analyzer confirms contain genetic material, or __(9)__ molecules. Making your way through this tangled mass, you pass two round, dense structures that appear to be full of the same type of globules you saw outside. These two round structures are __(10)__. All this information confirms your earlier identification of this cellular structure, so now you move to its exterior to continue observations.

→

_____ 11. Just ahead, you see what appears to be a mountain of flattened sacs with bunches of small sacklike vesicles at its
_____ 12 edges. The vesicles seem to be migrating away from this area and heading toward the outer edges of the cell. The mountain of sacs must be the _(11)_. Eventually you come upon a rather simple looking membrane bound sac. Although it doesn't look too exciting and has few distinguishing marks, it does not resemble anything else you have seen so far. Deciding to obtain a chemical analysis before entering this sac, you activate the analyzer and on the screen you see "Enzymes — Enzymes — Hydrolases — Hydrolases — Danger — Danger." There is little doubt that this innocent-appearing structure is actually a _(12)_

Completing your journey, you count the number of organelles identified so far. Satisfied that you have observed most of them, you request retrieval from the intercellular space.

AT THE CLINIC

27. Johnny lacerated his arm and rushed home to Mom so she could "fix it." His mother poured hydrogen peroxide over the area, and it bubbled vigorously where it came in contact with the wound. Because you can expect that cells were ruptured in the injured area, what do you *think* was happening here?

28. The epidermis (epithelium of the cutaneous membrane or skin) is a keratinized stratified squamous epithelium. Explain why that epithelium is much better suited for protecting the body's external surface than a mucosa consisting of a simple columnar epithelium would be.

29. Streptomycin (an antibiotic) binds to the small ribosomal subunit of bacteria (but not to the ribosomes of the host cells infected by bacteria). The result is the misreading of bacteria mRNA and the breakup of polysomes. What process is being affected, and how does this kill the bacterial cells?

30. Systemic lupus erythematosus (often simply called lupus) is a condition that sometimes affects young women. It is a chronic (persistent) inflammation that affects all or most of the connective tissue proper in the body. Suzy is told by her doctor that she has lupus, and she asks if it will have widespread or merely localized effects within the body. What would the physician answer?

31. Mrs. Linsey sees her gynecologist because she is unable to become pregnant. The doctor discovers granulation tissue in her vaginal canal and explains that sperm are susceptible to some of the same chemicals as bacteria. What is inhibiting the sperm?

32. Sarah, a trainee of the electron microscopist at the local hospital, is reviewing some micrographs of muscle cells and macrophages (phagocytic cells). She notices that the muscle cells are loaded with mitochondria while the macrophages have abundant lysosomes. Why is this so?

33. Bradley tripped and tore one of the tendons surrounding his ankle. In anguish with pain, he asked his doctor how quickly he could expect it to heal. What do you think the doctor's response was and why?

34. In normally circulating blood, the plasma proteins cannot leave the bloodstream easily and, thus, tend to remain in the blood. But if stasis (blood flow stoppage) occurs, the proteins will begin to leak out into the interstitial fluid. Explain why this leads to edema (water buildup in the tissues).

THE FINALE: MULTIPLE CHOICE

35. Select the best answer or answers from the choices given.

1. A cell's plasma membrane would not contain:
   A. phospholipid
   B. nucleic acid
   C. protein
   D. cholesterol
   E. glycolipid

2. Which of the following would you expect to find in or on cells whose main function is absorption?
   A. Microvilli
   B. Cilia
   C. Desmosomes
   D. Gap junctions
   E. Secretory vesicles

3. Which cytoskeletal element interacts with myosin to produce contractile force in muscle cells?
   A. Microtubules
   B. Microfilaments
   C. Intermediate filaments
   D. None of the above

4. If a 10% sucrose solution within a semipermeable sac causes the fluid volume in the sac to increase a given amount when the sac is immersed in water, what would be the effect of replacing the sac solution with a 20% sucrose solution?
   A. The sac would lose fluid.
   B. The sac would gain the same amount of fluid.
   C. The sac would gain more fluid.
   D. There would be no effect.

5. Which of the following are possible functions of the glycocalyx?
   A. Determination of blood groups
   B. Binding sites for toxins
   C. Aiding the binding of sperm to egg
   D. Guiding embryonic development
   E. Increasing the efficiency of absorption

6. A cell stimulated to increase steroid production will have:
   A. abundant ribosomes
   B. a rough ER
   C. a smooth ER
   D. a Golgi apparatus
   E. abundant secretory vesicles

7. A cell's ability to replenish its ATP stores has been diminished by a metabolic poison. What organelle is most likely to be affected?
   A. Nucleus
   B. Plasma membrane
   C. Centriole
   D. Microtubule
   E. Mitochondrion

8. The fundamental structure of the plasma membrane is determined almost exclusively by:
   A. phospholipid molecules
   B. peripheral proteins
   C. cholesterol molecules
   D. integral proteins

9.–11. Consider the following information for Questions 9–11:

A DNA segment has this nucleotide sequence:

A A G C T C T T A C G A A T A T T C

9. Which mRNA is complementary?
   A. A A G C T C T T A C G A A T A T T C
   B. T T C G A G A A T G C T T A T A A G
   C. A A G C U C U U A C G A A U A U U C
   D. U U C G A G A A U G C U U A U A A G

10. How many amino acids are coded in this segment?

A. 18 C. 6

B. 9 D. 3

11. What is the tRNA anticodon sequence for the fourth codon from the left?

A. G C. GCU

B. GC D. CGA

12. The organelle that consists of a stack of 3–10 membranous discs associated with vesicles is

A. mitochondrion

B. smooth ER

C. Golgi apparatus

D. lysosome

13. An epithelium "built" to stretch is

A. simple squamous

B. stratified squamous

C. simple cuboidal

D. pseudostratified

E. transitional

14. Which of the following fibrous elements give a connective tissue high tensile strength?

A. Reticular fibers

B. Elastic fibers

C. Collagen fibers

D. Myofilaments

15. Viewed through the microscope, most cells in this type of tissue have only a rim of cytoplasm.

A. Reticular connective

B. Adipose connective

C. Areolar connective

D. Osseous tissue

E. Hyaline cartilage

16. Which type of cartilage is most abundant throughout life?

A. Elastic cartilage

B. Fibrocartilage

C. Hyaline cartilage

17. Which of the following terms describe skeletal muscle?

A. Striated

B. Intercalated discs

C. Medium cleaved

D. Voluntary

E. Branching

18. Events of tissue repair include

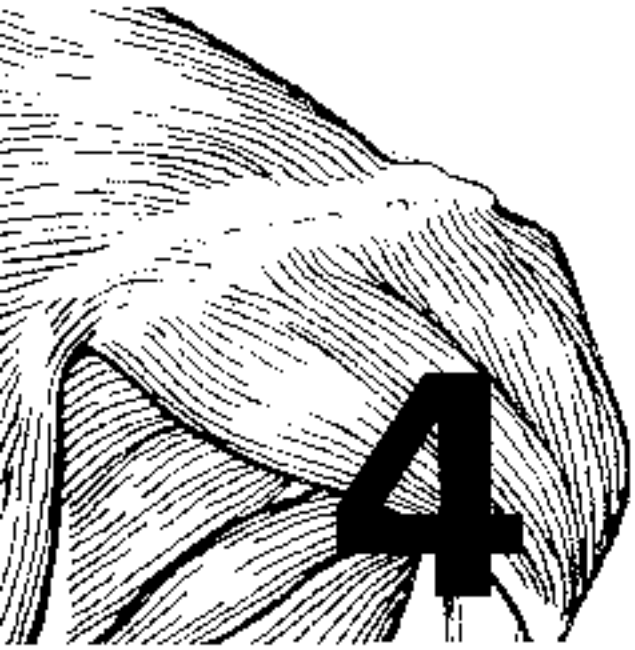
A. regeneration

B. organization

C. granulation

D. fibrosis

E. inflammation



4 SKIN AND BODY MEMBRANES

Body membranes, which cover body surfaces, line its cavities, and form protective sheets around organs, fall into two major categories. These are epithelial membranes (skin epidermis, mucosae, and serosae) and the connective tissue synovial membranes.

Topics for review in this chapter include a comparison of structure and function of various membranes, anatomical characteristics of the skin (composed of the connective tissue dermis and the epidermis) and its derivatives, and the manner in which the skin responds to both internal and external stimuli to protect the body.

CLASSIFICATION OF BODY MEMBRANES

1. Complete the following table relating to body membranes. Enter your responses in the areas left blank.

Membrane	Tissue type (epithelial/connective)	Common locations	Functions
Mucous			
Serous			
Cutaneous			
Synovial			

2. Four simplified diagrams are shown in Figure 4–1. Select different colors for the membranes listed below and use them to color the coding circles and the corresponding structures.

◯ Cutaneous membrane ◯ Parietal pleura (serosa) ◯ Synovial membrane

◯ Mucosa ◯ Visceral pericardium (serosa)

◯ Visceral pleura (serosa) ◯ Parietal pericardium (serosa)

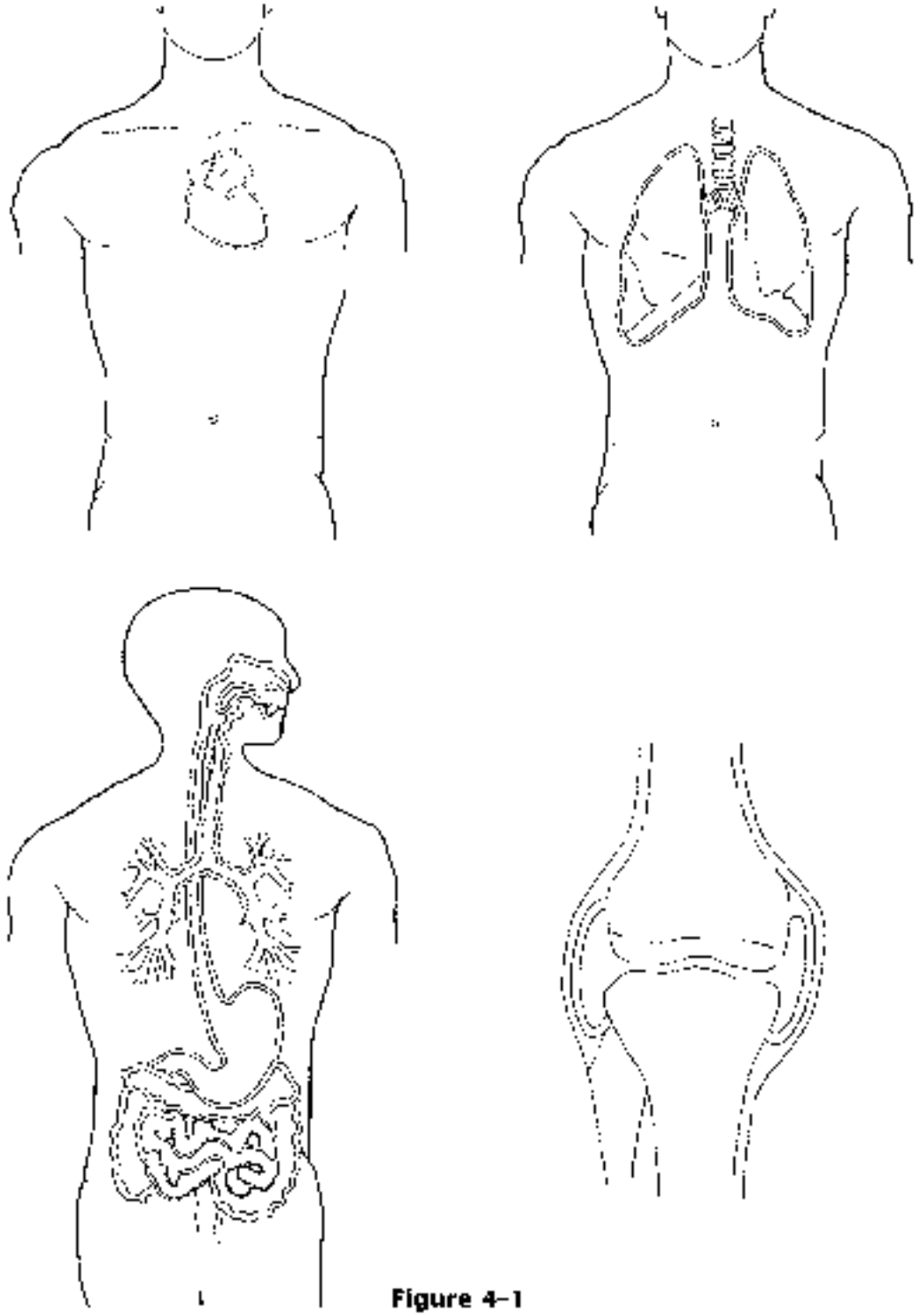


Figure 4–1

INTEGUMENTARY SYSTEM (SKIN)

Basic Functions of the Skin

3. The skin protects the body by providing three types of barriers. Classify each of the protective factors listed below as an example of a chemical barrier (C), a biological barrier (B), or a mechanical (physical) barrier (M).

_____ 1. Langerhans cells and macrophages

_____ 2. Intact epidermis

_____ 3. Bactericidal secretions

_____ 4. Keratin

_____ 5. Melanin

_____ 6. Acid mantle

4. In what way does a sunburn impair the body's ability to defend itself?

(Assume the sunburn is mild.) _____. _____ _____

_____ _____ _____. _____

5. Explain the role of sweat glands in maintaining body temperature homeostasis.

In your explanation, indicate how their activity is regulated _____. ___

___ _____ _____. ___

___ _____ _____. _____

_____. _____ ___. ___. ___

6. Complete the following statements. Insert your responses in the answer blanks.

_____ 1. The cutaneous sensory receptors that reside in the skin are normally part of the __(1)__ system. Four types of stimuli that can be detected by certain of the cutaneous receptors are __(2)__, __(3)__, __(4)__, and __(5)__.

_____ 2.

_____ 3.

___. ___. ___. 4. Vitamin D is synthesized when modified __(6)__ molecules in the skin are irradiated by __(7)__ light. Vitamin D is important in the absorption and metabolism of __(8)__ ions.

___. ___. ___ 5.

___. ___. _ 6.

_____. ___ 7.

_____ 8.

Basic Structure of the Skin

7. Figure 4–2 depicts a longitudinal section of the skin. Label the skin structures and areas indicated by leader lines and brackets on the figure. Select different colors for the structures below and color the coding circles and the corresponding structures on the figure.

- ◯ Arrector pili muscle
- ◯ Adipose tissue
- ◯ Hair follicle
- ◯ Nerve fibers
- ◯ Sweat (sudoriferous) gland
- ◯ Sebaceous gland

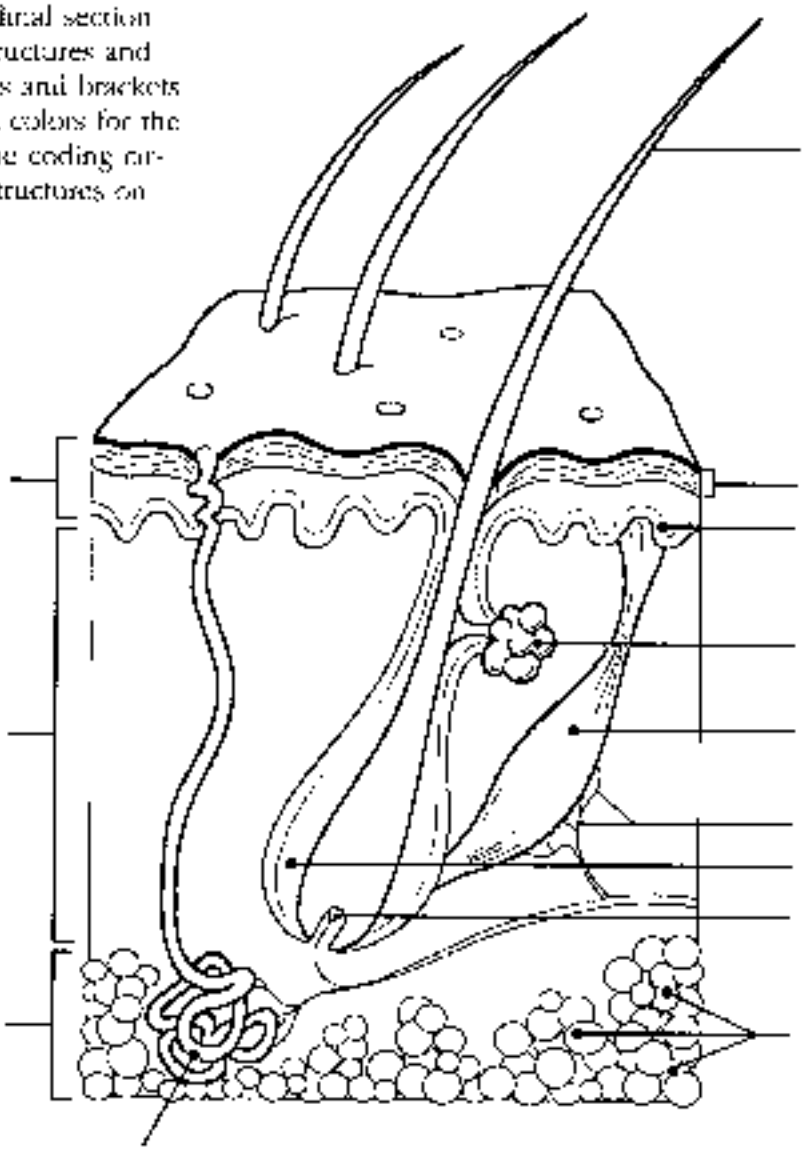


Figure 4–2

8. The more superficial cells of the epidermis become less viable and ultimately die. What two factors account for this natural demise of the epidermal cells?

1. _____ _____ _____ _____

2. _____ _____ _____

_____ _____ _____

9. Using the key choices, choose all responses that apply to the following descriptions. Enter the appropriate letter(s) or term(s) in the answer blanks.

Key Choices

A. Stratum basale	D. Stratum lucidum	G. Reticular layer
B. Stratum corneum	E. Stratum spinosum	H. Epidermis as a whole
C. Stratum granulosum	F. Papillary layer	I. Dermis as a whole

_____ 1. Translucent cells, containing keratin

_____ 2. Strata containing all or mostly dead cells

_____ 3. Dermis layer responsible for fingerprints

_____ 4. Vascular region

_____ _____ 5. Epidermal region involved in rapid cell division; most internal epidermal layer

_____ _____ 6. Scalelike cells full of keratin that constantly flake off

_____ _____ 7. Site of elastic and collagen fibers

_____ _____ 8. Site of melanin formation

_____ _____ 9. Major skin area from which the derivatives (hair, nails) arise

_____ _____ 10. Epidermal layer containing the oldest cells

_____ _____ 11. When tanned becomes leather

10. Circle the term that does not belong in each of the following groupings.

1. Reticular layer — Keratin — Dermal papillae — Meissner's corpuscles
2. Melanin — Freckle — Wart — Malignant melanoma
3. Prickle cells — Stratum basale — Stratum spinosum — Cell shrinkage
4. Langerhans' cells — Epidermal dendritic cells — Keratinocytes — Immune cells
5. Meissner's corpuscles — Pacinian corpuscles — Merkel cells — Arrector pili
6. Waterproof substance — Elastin — Lamellated granules — Produced by keratinocytes
7. Intermediate filaments — Keratin fibrils — Keratohyaline — Lamellated granules

11. This exercise examines the relative importance of three pigments in determining skin color. Indicate which pigment is identified by the following descriptions by inserting the appropriate answer from the key choices in the answer blanks.

Key Choices

A. Carotene B. Hemoglobin C. Melanin

_____ 1. Most responsible for the skin color of dark-skinned people

_____ 2. Provides an orange cast to the skin

_____ 3. Provides a natural sunscreen

_____ 4. Most responsible for the skin color of Caucasians

_____ 5. Phagocytized by keratinocytes

_____ 6. Found predominantly in the stratum corneum

_____ 7. Found within red blood cells in the blood vessels

12. Complete the following statements in the blanks provided.

1. Radiation from the skin surface and evaporation of sweat are two ways in which the skin helps to get rid of body (2).

2. Fat in the (2) tissue layer beneath the dermis helps to insulate the body.

3. A vitamin that is manufactured in the skin is (3).

4. Wrinkling of the skin is caused by loss of the (4) of the skin.

5. A dermibius ulcer results when skin cells are deprived of (5).

6. (6) is a bluish cast of the skin resulting from inadequate oxygenation of the blood.

Appendages of the Skin

13. On each true statement, write *T*; for each false statement, correct the underlined word(s) and insert your correction in the answer blank.

_____ 1. A saltwater solution is secreted by sebaceous glands.

_____ 2. The most abundant protein in dead epidermal structures such as hair and nails is melanin.

_____ 3. Sebum is an oily mixture of lipids, cholesterol, and cell fragments.

_____ 4. The externally observable part of a hair is called the root.

_____ 5. The epidermis provides mechanical strength to the skin.

14. Figure 4–3 is a diagram of a cross-sectional view of a hair in its follicle. Complete this figure by following the directions in steps 1–3.

1. Identify the two portions of the follicle wall by placing the correct name of the sheath at the end of the appropriate leader line.
2. Use different colors to color these regions.
3. Label, color-code, and color the three following regions of the hair.

◯ Cortex ◯ Cuticle ◯ Medulla

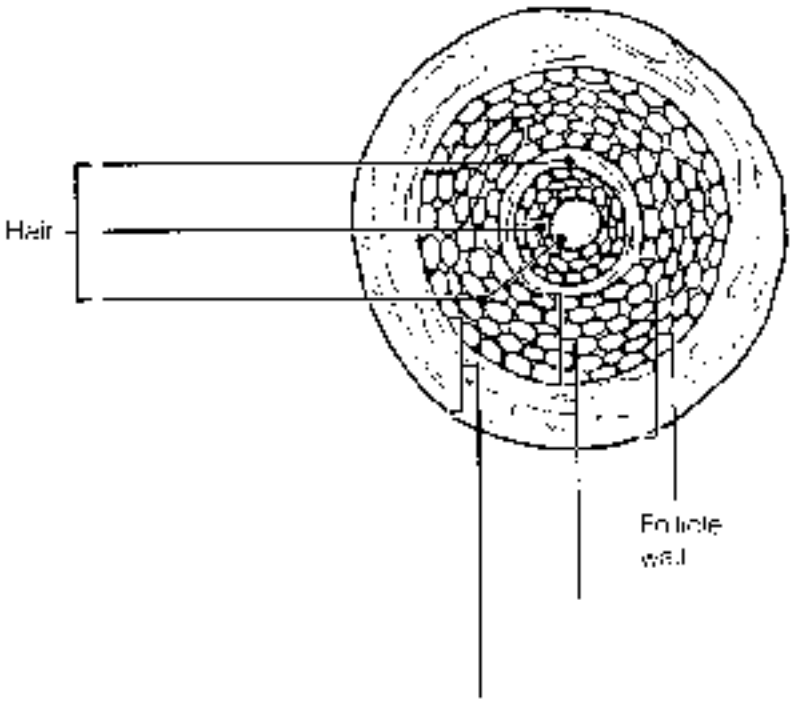


Figure 4–3

15. Circle the term that does not belong in each of the following groupings.

1. Luxuriant hair growth Testosterone Poor circulation Good blood supply
2. Vitamin D Cholesterol UV radiation Keratin
3. Stratum corneum Nail matrix Hair bulb Stratum basale
4. Scent glands Eccrine glands Apocrine glands Axilla
5. Terminal hair Vellus hair Dark, coarse hair Eyebrow hair

16. What is the scientific term for bedsores? _____ _____

17. Using the Key choices, complete the following statements. Insert the appropriate letter(s) or term(s) in the answer blanks.

Key Choices

A. Arrector pili C. Hair E. Sebaceous glands G. Sweat gland (eccrine)

B. Cutaneous receptors D. Hair follicle(s) F. Sweat gland (apocrine)

_____ 1. A blackhead is an accumulation of oily material produced by (1).

_____ 2. Tiny muscles attached to hair follicles that pull the hair upright during fright or cold are called (2).

_____ 3. The most numerous variety of perspiration gland is the (3).

_____ 4. A sheath formed of both epithelial and connective tissues is the (4).

_____ 5. A less numerous variety of perspiration gland is the (5). Its secretion (often milky in appearance) contains proteins and other substances that favor bacterial growth.

_____ 6. (6) is found everywhere on the body except the palms of the hands, soles of the feet, and lips, and it primarily consists of dead keratinized cells.

_____ 7. (7) are specialized nerve endings that respond to temperature and touch, for example.

_____ 8. (8) become more active at puberty.

_____ 9. Part of the heat-liberating apparatus of the body is the (9).

_____ 10. Secretin contains bacteria-killing substances.

18. Circle the term that does not belong in each of the following groupings.

1. Sebaceous gland Hair Arrector pili Epidermis
2. Radiation Absorption Conduction Evaporation
3. Stratum corneum Nails Hair Stratum basale
4. Scent glands Eccrine glands Apocrine glands Axilla
5. Cyanosis Erythema Wrinkles Pallor

Homeostatic Imbalances of the Skin

19. Overwhelming infection is one of the most important causes of death in burn patients. What is the other major problem they face, and what are its possible consequences?

_____ _____ _____ _____

_____ _____ _____ _____

20. This section reviews the severity of burns. Using the key choices, select the correct burn type for each of the following descriptions. Enter the correct answers in the answer blanks.

Key Choices

A. First degree burn B. Second-degree burn C. Third degree burn

_____ 1. Full-thickness burn; epidermal and dermal layers destroyed, skin is blanched

_____ 2. Blisters form

_____ 3. Epidermal damage, redness, and some pain (usually brief)

_____ 4. Epidermal and some dermal damage, pain, regeneration is possible

_____ 5. Regeneration impossible; requires grafting

_____ 6. Pain is absent because nerve endings in the area are destroyed

21. What is the importance of the "rule of nines" in treatment of burn patients?

_____ _____

22. Fill in the type of skin cancer that matches each of the following descriptions:

_____ 1. Epithelial cells, not in contact with the basement membrane, develop lesions; metastasize

_____ 2. Cells of the lowest level of the epidermis invade the dermis and hypodermis; exposed areas develop ulcer, slow to metastasize

_____ 3. Rare but often deadly cancer of pigment-producing cells

23. What does ABCD mean in reference to examination of pigmented areas? _____

_____ _____ _____

_____ _____ _____

DEVELOPMENTAL ASPECTS OF THE SKIN AND BODY MEMBRANES

24. Match the choices (letters or terms) in Column B with the appropriate descriptions in Column A.

	Column A	Column B
_____	1. Skin inflammations that increase in frequency with age	A. Acne
_____	2. Cause of graying hair	B. Cold intolerance
_____	3. Small white bumps on the skin of newborn babies, resulting from accumulations of sebaceous gland material	C. Dermatitis
_____	4. Reflects the loss of insulating subcutaneous tissue with age	D. Delayed-action gene
_____ __	5. A common consequence of accelerated sebaceous gland activity during adolescence	E. Lanugo
____ _____	6. Oily substance produced by the fetus's sebaceous glands	F. Milia
_____	7. The hairy "cloak" of the fetus	G. Vernix caseosa

INCREDIBLE JOURNEY

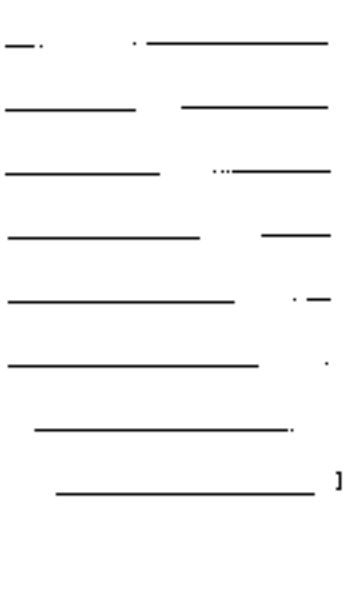
A Visualization Exercise for the Skin

Your immediate surroundings resemble huge grotesquely twisted vines . . . you begin to climb upward.

25. Where necessary, complete statements by inserting the missing words in the answer blanks.

____ _____ 1. For this trip you are *encapsulated* for injection into your host's skin. Your journey begins when you are deposited in a soft gel-like substance. Your immediate surroundings resemble huge grotesquely twisted vines. But when you peer carefully at the closest "vine," you realize you are actually seeing connective tissue fibers. Although tangled together, most of the fibers are fairly straight and look like strong cables. You identify these as the __(1)__ fibers. Here and there are fibers that resemble coiled springs. These must be the __(2)__ fibers that help give skin its springiness. At this point,

_____ __ 2.



there is little question that you are in the ___ region of the skin, particularly considering that you can also see blood vessels and nerve fibers around you.

Carefully, using the fibers as steps, you begin to climb upward. After climbing for some time and finding that you still haven't reached the upper regions of the skin, you stop for a rest. As you sit, a strange looking cell approaches, moving slowly with parts alternately flowing forward and then receding. Suddenly you realize that this must be a ___ that is about to dispose of an intruder (you) unless you move in a hurry! You scramble to your feet and resume your upward climb. On your right is a large fibrous structure that looks like a tree trunk anchored in place by muscle fibers. By scurrying up this ___ stream, you are able to escape from the cell. Once safely out of harm's way, you again scan your surroundings. Directly overhead are tall cubelike cells, forming a continuous sheet. In your rush to escape you have reached the ___ layer of the skin. As you watch the activity of the cells in this layer, you notice that many of the cells are pinching in two, and the daughter cells are being forced upward. Obviously this is the layer that continually replaces cells that rub off the skin surface, and these cells are the ___ cells.

Looking through the transparent cell membrane of one of the basal cells, you see a dark mass hanging over its nucleus. You wonder if this cell could have a tumor, but then, looking through the membranes of the neighboring cells, you find that they also have dark umbrella-like masses hanging over their nuclei. As you consider this matter, a black cell with long tentacles begins to pick its way carefully between the other cells. As you watch with interest, one of the transparent cells engulfs the tip of one of the black cell's tentacles. Within seconds a black substance appears above the transparent cell's nucleus. Suddenly, you remember that one of the skin's functions is to protect the deeper layers from sun damage; the black substance must be the protective pigment. ___

Once again you begin your upward climb and notice that the cells are becoming shorter and harder and are full of a waxy-looking substance. This substance has to be ___, which would account for the increasing hardness of the cells. Climbing still higher, the cells become flattened like huge shingles. The only material apparent in the cells is the waxy substance—there is no nucleus, and there appears to be no activity in these cells. Considering the clues—shingle-like cells, no nuclei, full of the waxy substance, no activity—these cells are obviously ___ and therefore very close to the skin surface.

Suddenly, you feel a strong agitation in your immediate area. The pressure is tremendous. Looking upward through the transparent cell layers, you see your host's fingertips vigorously scratching the area directly overhead. You wonder if you are causing his skin to sting or tickle. Then, within seconds, the cells around you begin to separate and fall apart, and you are catapulted out into the sunlight. Since the scratching fingers might descend once again, you quickly advise your host of your whereabouts.

AT THE CLINIC

26. Mrs. Ibanez volunteered to help at a hospital for children with cancer. When she first entered the cancer ward, she was upset by the fact that most of the children had no hair. What is the explanation for their baldness?

27. A new mother brings her infant to the clinic, worried about a yellowish, scummy deposit that has built up on the baby's scalp. What is this condition called, and is it serious?

28. Patients in hospital beds are rotated every 2 hours to prevent bedsores. Exactly why is this effective?

29. Eric and his wife are of northern European descent. Eric is a proud new father who was in the delivery room during his daughter's birth. He tells you that when she was born, her skin was purple and covered with a cream-cheese-like substance. Shortly after birth, her skin turned pink. Can you explain his observations?

30. Would you expect to find the highest rate of skin cancer among the Blacks of tropical Africa, research scientists in the Arctic, Norwegians in the Southern United States, or Blacks in the United States? Explain your choice.

31. After studying the skin in anatomy class Toby grabbed the large "love handles" at his waist and said, "I have too thick a hypodermis, but that's okay because this layer performs some valuable functions!" What are the functions of the hypodermis?

32. A man got his finger caught in a machine at the factory. The damage was less serious than expected but nonetheless, the entire nail was torn from his right index finger. The parts lost were the body, root, bed, matrix, and cuticle of the nail. First, define each of these parts. Then, tell if the nail is likely to grow back.

33. In cases of a ruptured appendix, what serous membrane is likely to become infected? Why can this be life threatening?

34. Mrs. Gaudier received second-degree burns on her abdomen when she dropped a kettle of boiling water. She asked the clinic physician (worriedly) if she would have to have a skin graft. What do you think he told her?

35. What two factors in the treatment of critical third-degree burn patients are absolutely essential?

THE FINALE: MULTIPLE CHOICE

36. Select the best answer or answers from the choices given.

1. Which is *not* part of the skin?
   A. Epidermis C. Dermis
   B. Hypodermis D. Superficial fascia

2. Which of the following is *not* a tissue type found in the skin?
   A. Stratified squamous epithelium
   B. Loose connective tissue
   C. Dense irregular connective tissue
   D. Ciliated columnar epithelium
   E. Vascular tissue

3. Epidermal cells that aid in the immune response include
   A. Merkel cells C. melanocytes
   B. Langerhans' cells D. spinosum cells

4. Which epidermal layer has the highest concentration of Langerhans' cells and has numerous desmosomes and thick bundles of keratin filaments?
   A. Stratum corneum
   B. Stratum lucidum
   C. Stratum granulosum
   D. Stratum spinosum

5. Fingerprints are caused by
   A. the genetically determined arrangement of dermal papillae
   B. the conspicuous epidermal ridges
   C. the sweat pores
   D. all of these

6. Some infants are born with a fuzzy skin this is due to:
   A. vellus hairs C. lanugo
   B. terminal hairs D. hirsutism

7. What is the major factor accounting for the waterproof nature of the skin?
   A. Desmosomes in stratum corneum
   B. Glycolipid between stratum corneum cells
   C. The thick insulating fat of the hypodermis
   D. The leathery nature of the dermis

8. Which of the following is *true* concerning oil production in the skin?
   A. Oil is produced by sudoriferous glands
   B. Secretion of oil is the job of the apocrine glands
   C. The secretion is called sebum
   D. Oil is usually secreted into hair follicles.

9. Contraction of the arrector pili would be "sensed" by
   A. Merkel discs
   B. Meissner's corpuscles
   C. hair follicle receptors
   D. Pacinian corpuscles

10. A dermatologist examines a patient with lesions on the face. Some of the lesions appear as shiny, raised spots; others are ulcerated with beaded edges. What is the diagnosis?
    A. Melanoma
    B. Squamous cell carcinoma
    C. Basal cell carcinoma
    D. Either squamous or basal cell carcinoma

11. A burn patient reports that the burns on her hands and face are not painful, but she has blisters on her neck and forearms and the skin on her arms is very red. This burn would be classified as:

    A. first-degree only

    B. second-degree only

    C. third-degree only

    D. critical

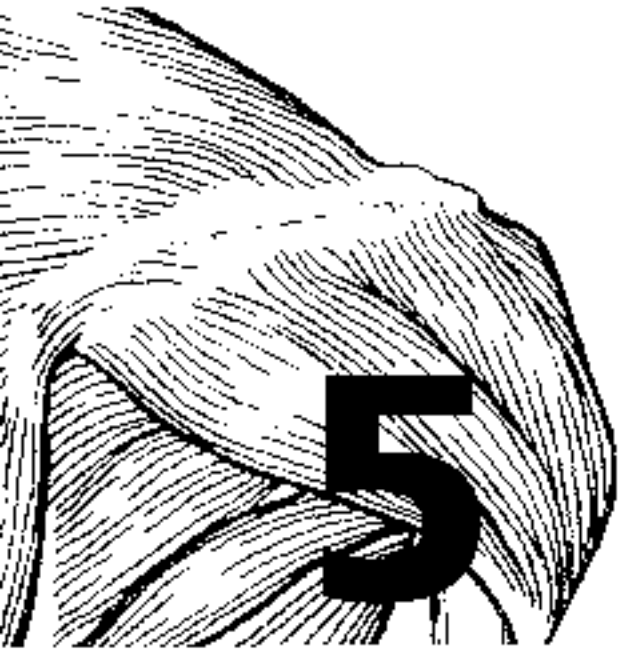
12. The reticular layer of the dermis is most important in providing:

    A. strength and elasticity to the skin

    B. toughness to the skin

    C. insulation to prevent heat loss

    D. the dermal papilla, which produces fingerprints



5 THE SKELETAL SYSTEM

The skeleton is constructed of two of the most supportive tissues found in the human body—cartilage and bone. Besides supporting and protecting the body as an internal framework, the skeleton provides a system of levers that the skeletal muscles use to move the body. In addition, the bones provide a storage depot for substances such as lipids and calcium, and blood cell formation goes on within their red marrow cavities.

The skeleton consists of bones connected at joints, or articulations, and is subdivided into two divisions. The axial skeleton includes those bones that lie around the body's center of gravity. The appendicular skeleton includes the bones of the limbs.

Topics for student review include structure and function of long bones, location and naming of specific bones in the skeleton, fracture types, and a classification of joint types in the body.

BONES—AN OVERVIEW

1. Classify each of the following terms as a projection (*P*) or a depression or opening (*D*). Enter the appropriate letter in the answer blanks.

____ 1. Condyle	4. Foramen	____ 7. Ramus
____ 2. Crest	5. Head	____ 8. Spine
____ 3. Fissure	6. Meatus	____ 9. Tuberosity

2. Group each of the following bones into one of the four major bone categories. Use *L* for long bone, *S* for short bone, *F* for flat bone, and *I* for irregular bone. Enter the appropriate letter in the space provided.

____ 1. Calcaneus	____ 4. Humerus	____ 7. Radius
____ 2. Frontal	____ 5. Mandible	____ 8. Sternum
____ 3. Femur	____ 6. Metacarpal	____ 9. Vertebra

3. Using the key choices, characterize the following statements relating to long bones. Enter the appropriate term(s) or letter(s) in the answer blanks.

Key Choices

A. Diaphysis C. Epiphysis E. Yellow marrow cavity

B. Epiphyseal plate D. Red marrow

_____ 1. Site of spongy bone in the adult

_____ 2. Site of compact bone in the adult

_____ 3. Site of hematopoiesis in the adult

_____ 4. Scientific name for bone shaft

_____ 5. Site of fat storage in the adult

_____ 6. Site of longitudinal growth in a child

4. Complete the following statements concerning bone formation and destruction, using the terms provided in the key. Insert the key letter or corresponding term in the answer blanks.

Key Choices

A. Atrophy C. Gravity E. Osteoclasts G. Parathyroid hormone

B. Calcitonin D. Osteoblasts F. Osteocytes H. Stress and/or tension

__(1)__ 1. When blood calcium levels begin to drop below homeostatic levels, __(1)__ is released, causing calcium to be released from bones.

__(2)__ 2. Mature bone cells, called __(2)__, maintain bone in a viable state.

__(3)__ 3. Disuse such as that caused by paralysis or severe lack of exercise results in muscle and bone __(3)__.

__(4)__ 4. Large tubercles and/or increased deposit of bony matrix occur at sites of __(4)__.

__(5)__ 5. Immature, or matrix-depositing, bone cells are referred to as __(5)__.

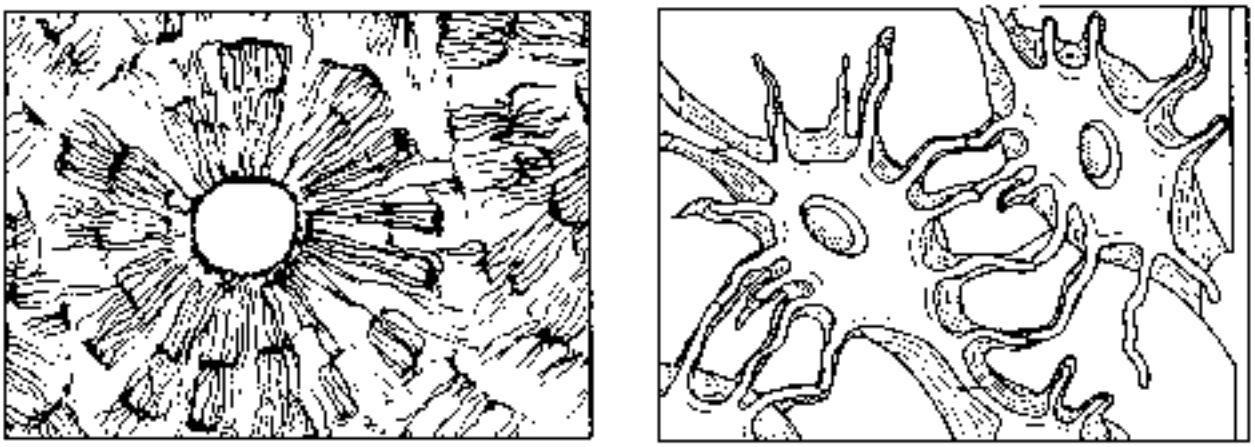
__(6)__ 6. __(6)__ causes blood calcium to be deposited in bones as calcium salts.

__(7)__ 7. Bone cells that liquefy bone matrix and release calcium to the blood are called __(7)__.

__(8)__ 8. Our astronauts must do isometric exercises when in space because bones atrophy under conditions of weightlessness or lack of __(8)__.

5. Five descriptions of bone structure are provided in Column A. First identify the structure by choosing the appropriate term from Column B and placing the corresponding answer in the answer blank. Then consider Figure 5–1A a diagrammatic view of a cross section of bone, and Figure 5–1B, a higher magnification view of compact bone tissue. Select different colors for the structures and bone areas in Column B, and use them to color the coding circles and corresponding structures on the figure diagrams. Because the concentric lamellae would be difficult to color without confusing other elements, identify one lamella by using a bracket and label.

	Column A	Column B
_____	1. Layers of calcified matrix	A. Central (Haversian) canal ◯
_____	2. "Residences" of osteocytes	B. Concentric lamellae
_____	3. Longitudinal canal carrying blood vessels and nerves	C. Lacunae ◯
		D. Canaliculi ◯
_____	4. Nonliving structural part of bone	E. Bone marrow ◯
_____	5. Tiny canals connecting lacunae	F. Osteocyte ◯



A B

Figure 5–1

6. Circle the term that does not belong in each of the following groupings.

1. Hematopoiesis Red marrow Yellow marrow Spongy bone
2. Lamellae Canaliculi Circulation Osteoblasts
3. Osteon Marrow cavity Central canal Canaliculi
4. Epiphyseal surface Articular cartilage Periosteum Hyaline cartilage

7. Figure 5–2A is a midlevel, cross-sectional view of the diaphysis of the femur. Label the membrane that lines the cavity and the membrane that covers the outside surface.

Figure 5–2B is a drawing of a longitudinal section of the femur. Color the bone tissue gold. Do *not* color the articular cartilage; leave it white. Select different colors for the bone regions listed at the coding circles below. Color the coding circles and the corresponding regions on the drawing. Complete Figure 5–2B by labeling compact bone and spongy bone.

◯ Diaphysis ◯ Area where red marrow is found

◯ Epiphyseal plate ◯ Area where yellow marrow is found

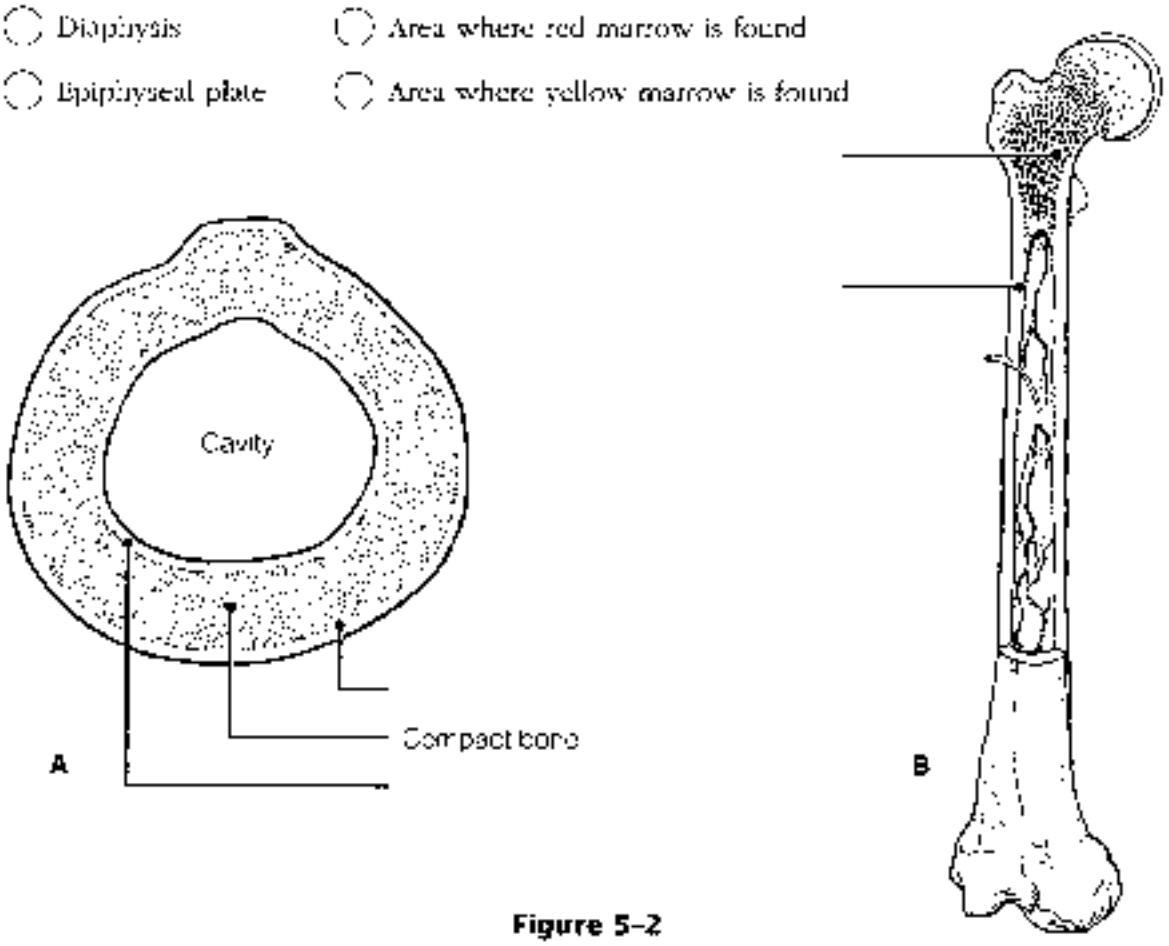


Figure 5–2

8. The following events apply to the endochondral ossification process as it occurs in the primary ossification center. Put these events in their proper order by assigning each a number (1–6).

_____ 1. Cavity formation occurs within the hyaline cartilage.

_____ 2. Collar of bone is laid down around the hyaline cartilage model just beneath the periosteum.

_____ 3. Periosteal bud invades the marrow cavity.

_____ 4. Perichondrium becomes vascularized to a greater degree and becomes a periosteum.

_____ 5. Osteoblasts lay down bone around the cartilage spicules in the bone's interior.

_____ 6. Osteoclasts remove the cancellous bone from the shaft interior, leaving a marrow cavity that then houses fat.

AXIAL SKELETON

Skull

9. Using the key choices, identify the bones indicated by the following descriptions. Enter the appropriate term or letter in the answer blanks.

_____ 1. Forehead bone

_____ 2. Cheekbone

_____ 3. Lower jaw

_____ 4. Bridge of nose

_____ 5. Posterior part of hard palate

_____ 6. Much of the lateral and superior cranium

_____ 7. Most posterior part of cranium

_____ 8. Single, irregular, bat-shaped bone, forming part of the cranial floor

_____ 9. Tiny bones, bearing tear ducts

_____ 10. Anterior part of hard palate

_____ 11. Superior and middle nasal conchae formed from its projections

_____ 12. Site of mastoid process

_____ 13. Site of sella turcica

_____ 14. Site of cribriform plate

_____ 15. Site of mental foramen

_____ 16. Site of styloid process

_____ 17. _____ 18. Four bones, containing paranasal sinuses

_____ 19. _____ 20.

_____ 21. Its condyles articulate with the atlas

_____ 22. Foramen magnum contained here

_____ 23. Middle ear bones here

_____ 24. Nasal septum

_____ 25. Bears an upward projection, the "cock's comb," or crista galli

_____ 26. Site of external acoustic means

Key Choices

A. Ethmoid

B. Frontal

C. Hyoid

D. Lacrimals

E. Mandible

F. Maxillae

G. Nasals

H. Occipital

I. Palatines

J. Parietals

K. Sphenoid

L. Temporals

M. Vomer

N. Zygomatic

10. For each statement that is true, insert *T* in the answer blank. For false statements, correct the underlined words by inserting the correct words in the answer blanks.

_____ 1. When a bone forms from a fibrous membrane, the process is called endochondral ossification.

_____ 2. When trapped in lacunae, osteoblasts change into osteocytes.

_____ 3. Large numbers of osteocytes are found in the inner periosteum layer.

_____ 4. Primary ossification centers appear in the epiphyses of a long bone.

_____ 5. Epiphyseal plates are made of spongy bone.

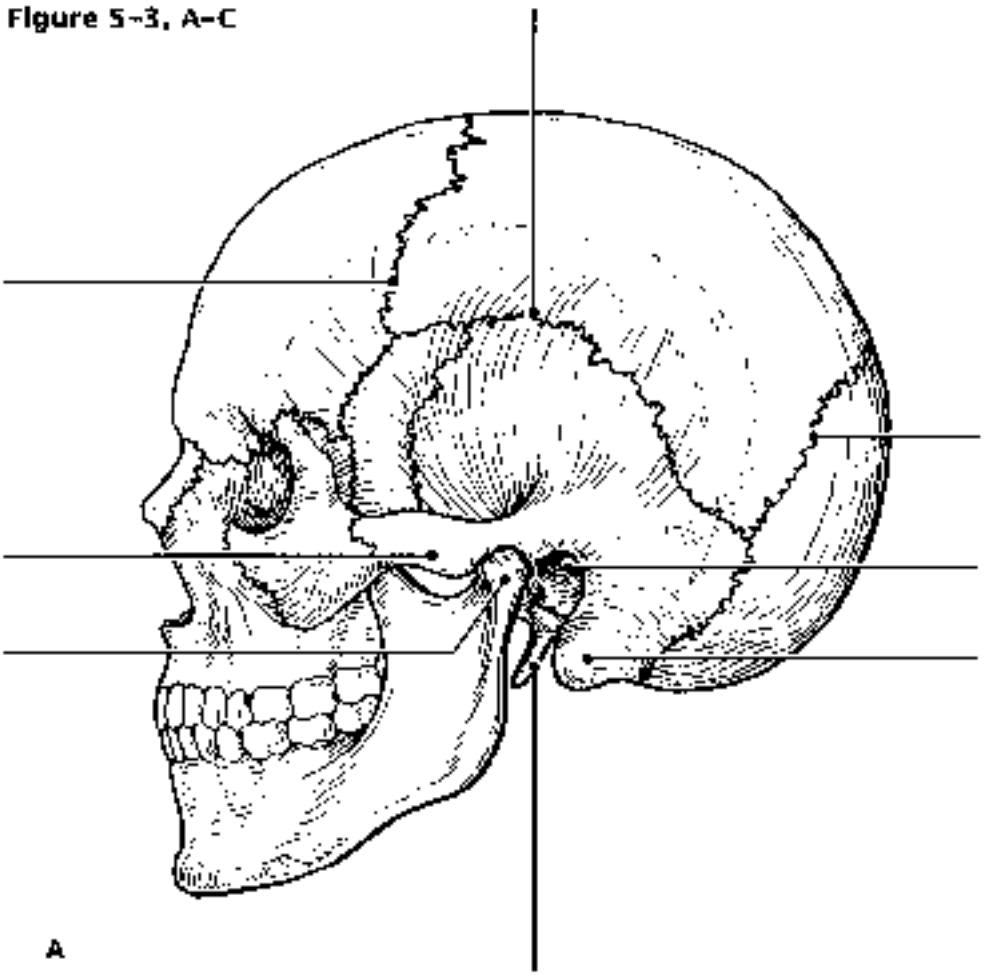
_____ 6. In appositional growth, bone reabsorption occurs on the periosteal surface.

_____ 7. "Maturation" of newly formed (mineralized) bone matrix takes about 10 days.

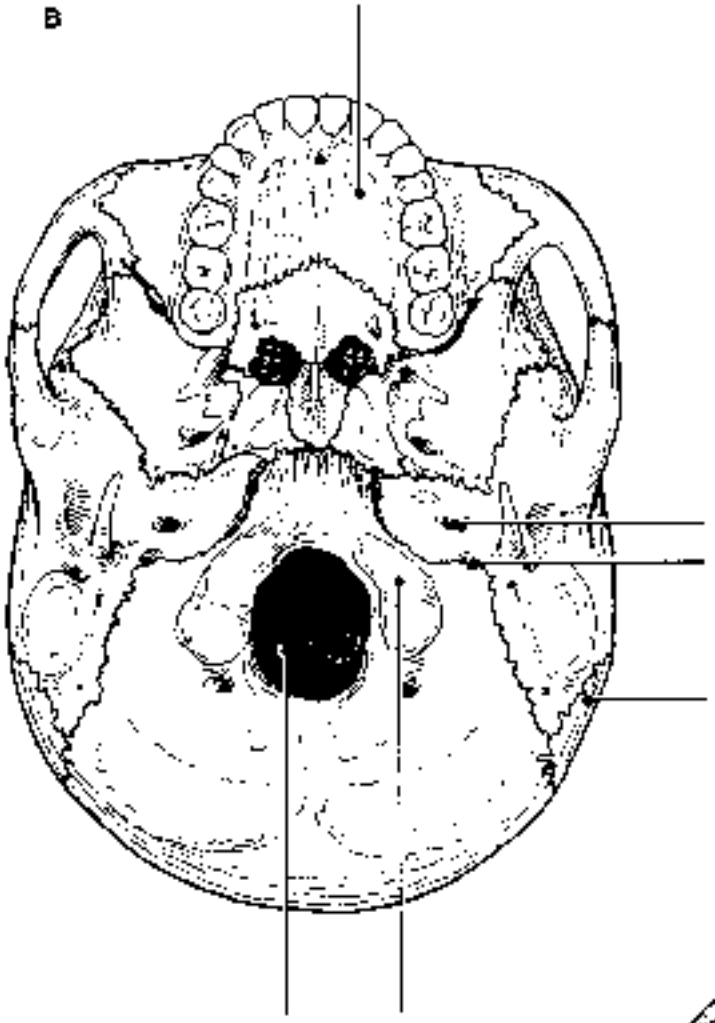
11. Figure 5–3, A–C shows lateral, anterior, and inferior views of the skull. Select different colors for the bones listed below and color the coding circles and corresponding bones in the figure. Complete the figure by labeling the bone markings indicated by leader lines.

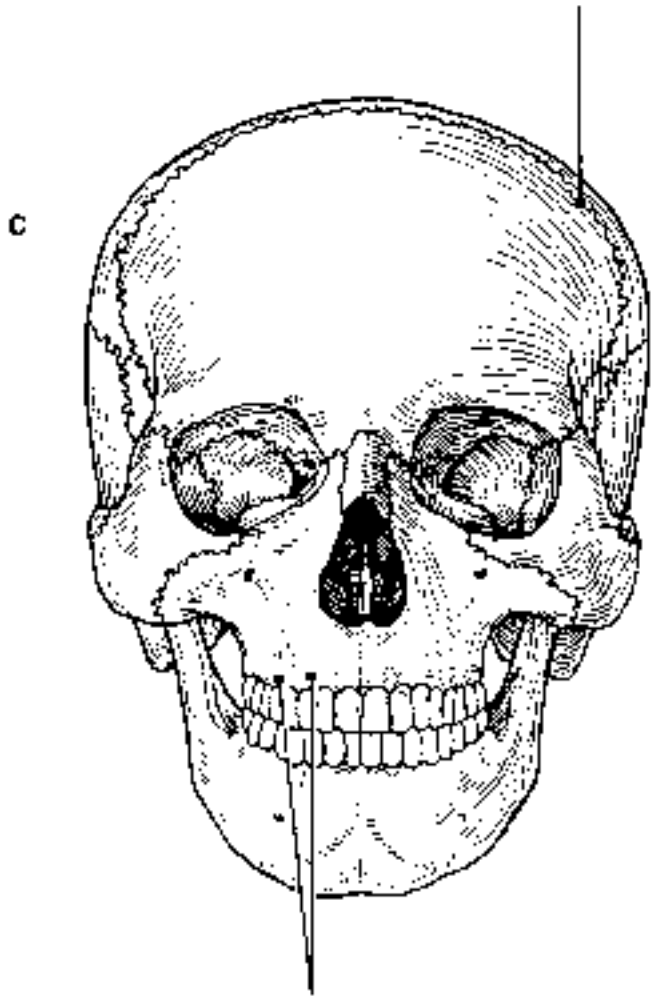
- ◯ Frontal
- ◯ Parietal
- ◯ Mandible
- ◯ Maxilla
- ◯ Sphenoid
- ◯ Ethmoid
- ◯ Temporal
- ◯ Zygomatic
- ◯ Palatine
- ◯ Occipital
- ◯ Nasal
- ◯ Lacrimal
- ◯ Vomer

Figure 5–3, A–C



A


B


C

12. An anterior view of the skull, showing the positions of the sinuses, is provided in Figure 5-4. First select different colors for each of the sinuses and use them to color the coding circles and the corresponding structures on the figure. Then briefly answer the following questions concerning the sinuses.

◯ Sphenoid sinus ◯ Ethmoid sinuses

◯ Frontal sinus ◯ Maxillary sinus

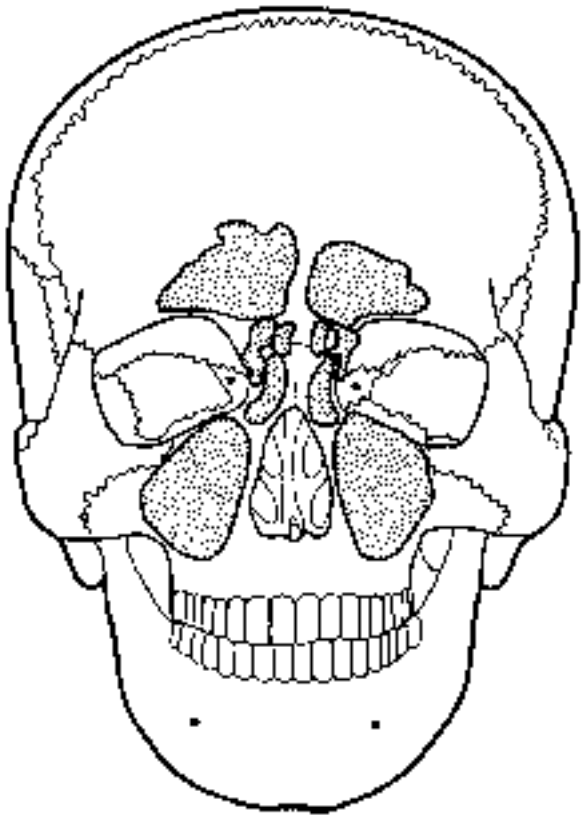


Figure 5-4

1. What *are* sinuses? _____

2. What purpose do they serve in the skull? _____

_____

_____

3. Why are they so susceptible to infection? _____

_____

_____

Vertebral Column

13. Using the key choices, correctly identify the vertebral parts/areas described as follows. Enter the appropriate term(s) or letter(s) in the spaces provided.

Key Choices

A. Body
B. Intervertebral foramina
C. Spinous process
D. Superior articular process
E. Transverse process
F. Vertebral arch

_____ 1. Structure that encloses the nerve cord

_____ 2. Weight-bearing part of the vertebra

_____ 3. Provide(s) levers for the muscles to pull against

_____ 4. Provide(s) an articulation point for the ribs

_____ 5. Openings allowing spinal nerves to pass

14. The following statements provide distinguishing characteristics of the vertebrae composing the vertebral column. Using the key choices, identify each described structure or region by inserting the appropriate term(s) or letter(s) in the spaces provided.

Key Choices

A. Atlas
B. Axis
C. Cervical vertebra—typical
D. Coccyx
E. Lumbar vertebra
F. Sacrum
G. Thoracic vertebra

_____ 1. Type of vertebra(e) containing foramina in the transverse processes, through which the vertebral arteries ascend to reach the brain

_____ 2. Its dens provides a pivot for rotation of the first cervical vertebra

_____ 3. Transverse processes have facets for articulation with ribs; spinous process points sharply downward

_____ 4. Composite bone; articulates with the hip bone laterally

_____ 5. Massive vertebrae; weight-sustaining

_____ 6. Tailbone; vestigial fused vertebrae

_____ 7. Supports the head; allows the rocking motion of the occipital condyles

_____ 8. Seven components, unfused

_____ 9. Twelve components, unfused

15. Complete the following statements by inserting your answers in the answer blanks.

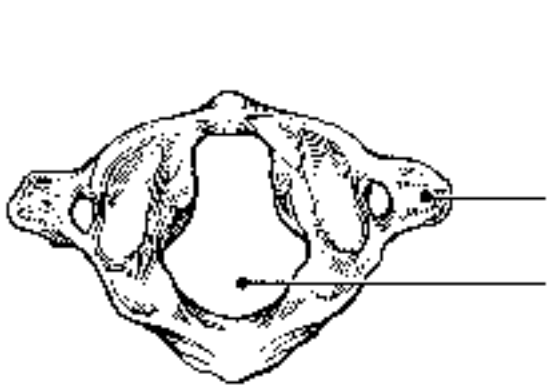
_____ 1 In describing abnormal curvatures, it could be said that __(1)__ is an exaggerated thoracic curvature and in __(2)__ the vertebral column is displaced laterally.

_____ 2

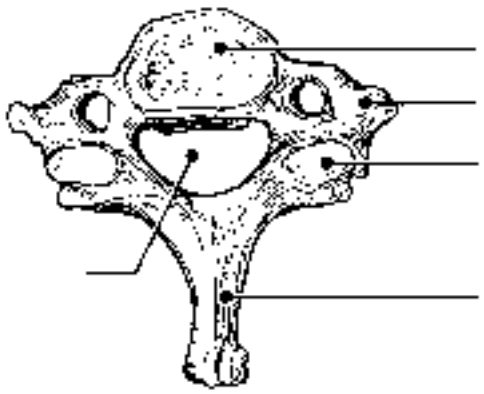
_____ 3 Invertebral discs are made of __(3)__ tissue. The discs provide __(4)__ to the spinal column.

4.

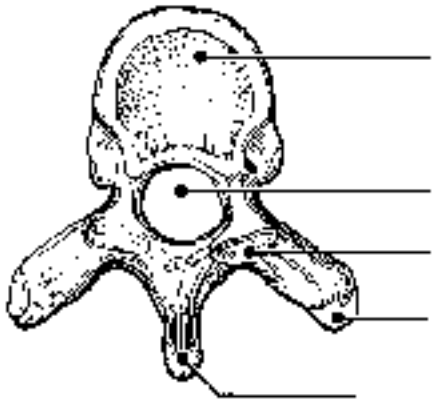
16. Figure 5–5, A–D shows superior views of four types of vertebrae. In the spaces provided below each vertebra, indicate in which region of the spinal column it would be found. In addition, specifically identify Figure 5–5A. Where indicated by leader lines, identify the vertebral body, spinous and transverse processes, superior articular processes, and vertebral foramen.



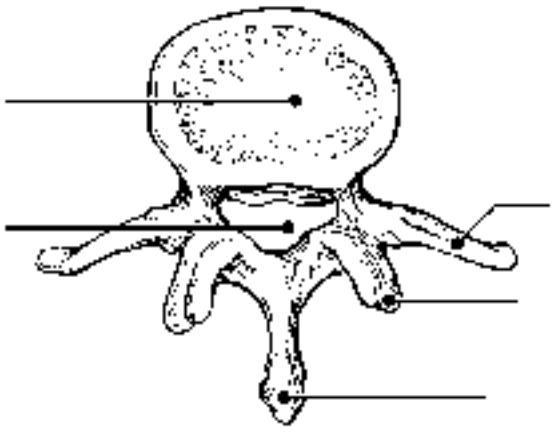
A _____



B _____



C _____



D _____

Figure 5–5

17. Figure 5–6 is a lateral view of the vertebral column. Identify each anatomical region of the column by listing in the numbered answer blanks the region name first and then the specific vertebrae involved (for example: sacral region, S1 to S5). Also identify the modified vertebrae indicated by numbers 6 and 7 in Figure 5–6. Select different colors for each vertebral region and use them to color the coding circles and the corresponding regions.

1. _____ ( )
2. _____ ( )
3. _____ ( )
4. _____ ( )
5. ( )
6. _____ ( )
7. _____ ( )

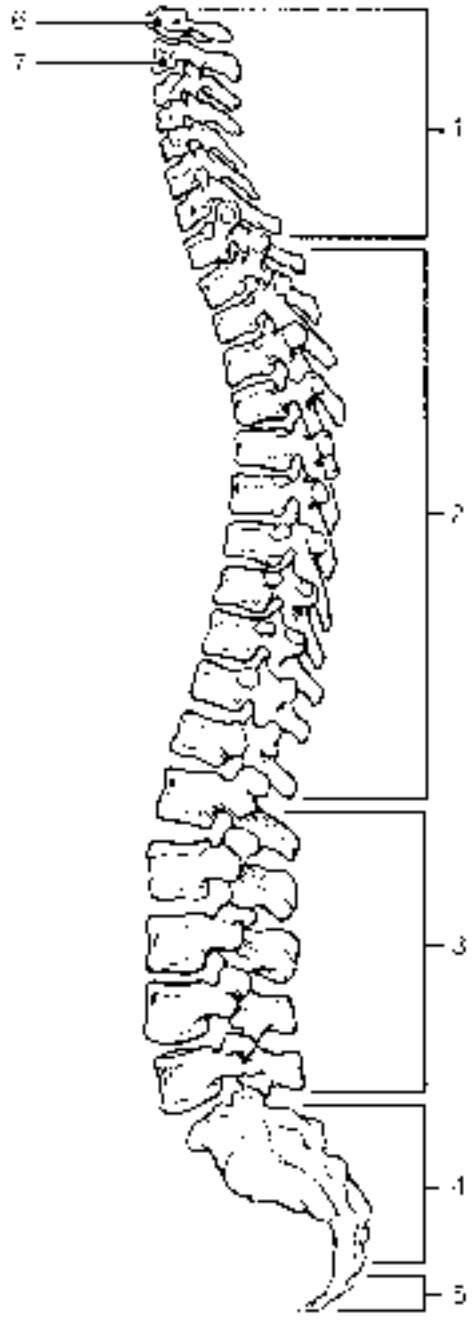


Figure 5–6

Thoracic Cage

18. Complete the following statements referring to the thoracic cage by inserting your responses in the answer blanks.

_____ 1.
_____ 2
_____ 3
_____ 4
_____ 5
_____ 6
_____ 7
_____ 8.

The organs protected by the thoracic cage include the __(1)__ and the __(2)__. Ribs 1 through 7 are called __(3)__ ribs whereas ribs 8 through 12 are called __(4)__ ribs. Ribs 11 and 12 are also called __(5)__ ribs. All ribs articulate posteriorly with the __(6)__, and most connect anteriorly to the __(7)__, either directly or indirectly.

The general shape of the thoracic cage is __(8)__.

19. Figure 5–7 is an anterior view of the thoracic cage. Select different colors to identify the structures below and color the coding circles and corresponding structures. Then label the subdivisions of the sternum indicated by leader lines.

◯ All true ribs
◯ All false ribs
◯ Costal cartilages
◯ Sternum

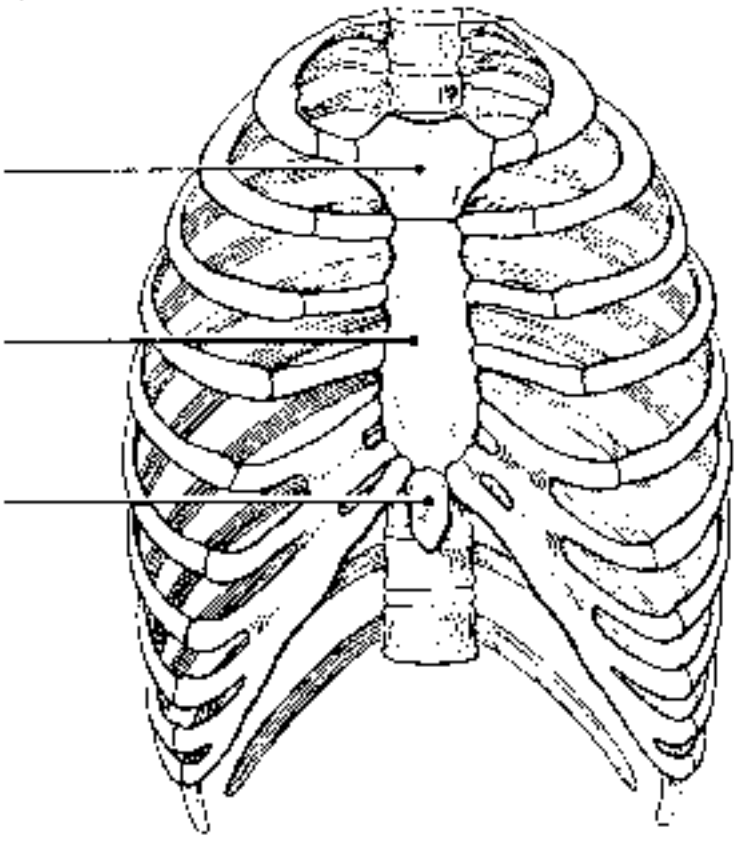


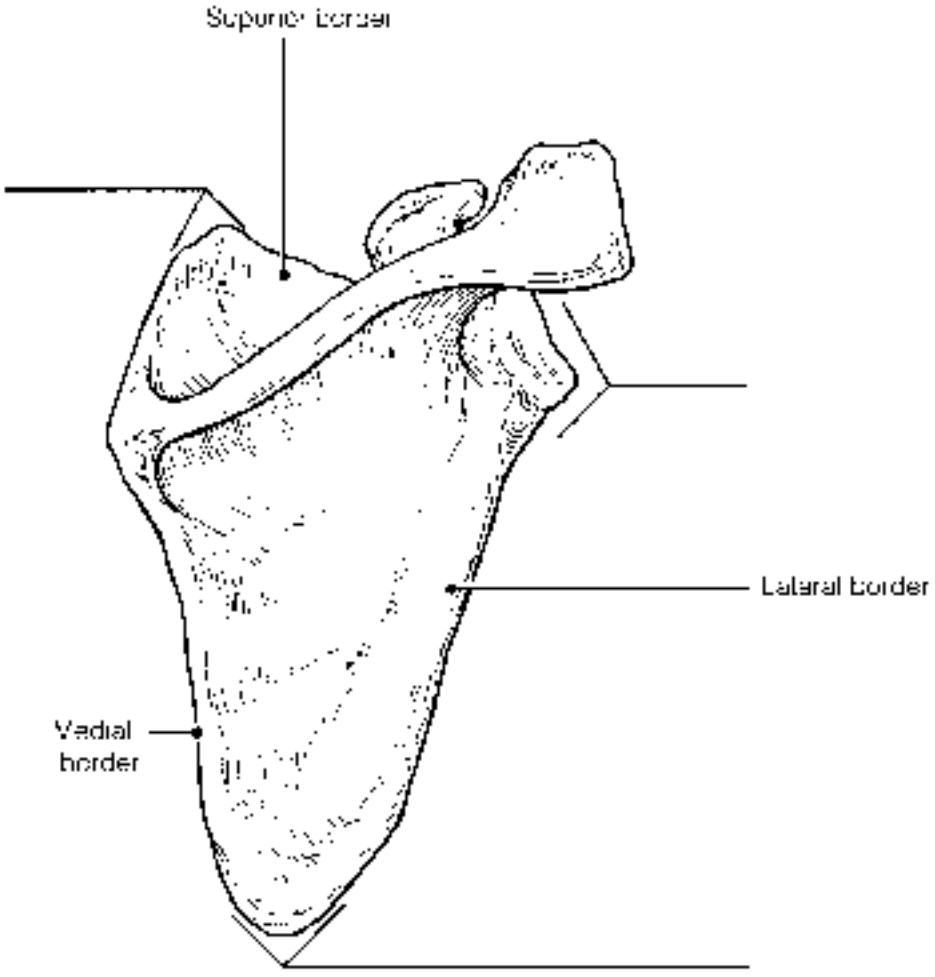
Figure 5–7

APPENDICULAR SKELETON

Several bones forming part of the upper limb and/or shoulder girdle are shown in Figures 5–8 to 5–11. Follow the specific directions for each figure.

20. Identify the bone in Figure 5–8. Insert your answer in the blank below the illustration. Select different colors for each structure listed below and use them to color the coding circles and the corresponding structures in the diagram. Then, label the angles indicated by leader lines.

◯ Spine ◯ Glenoid cavity ◯ Coracoid process ◯ Acromion



_____

Figure 5–8

21. Identify the bones in Figure 5–9 by labeling the leader lines identified as A, B, and C. Color the bones different colors. Using the following terms, complete the illustrations by labeling all bone markings provided with leader lines.

Trochlear notch	Capitulum	Coronoid process
Trochlea	Deltoid tuberosity	Olecranon process
Radial tuberosity	Head (three)	Greater tubercle
	Styloid process	Lesser tubercle

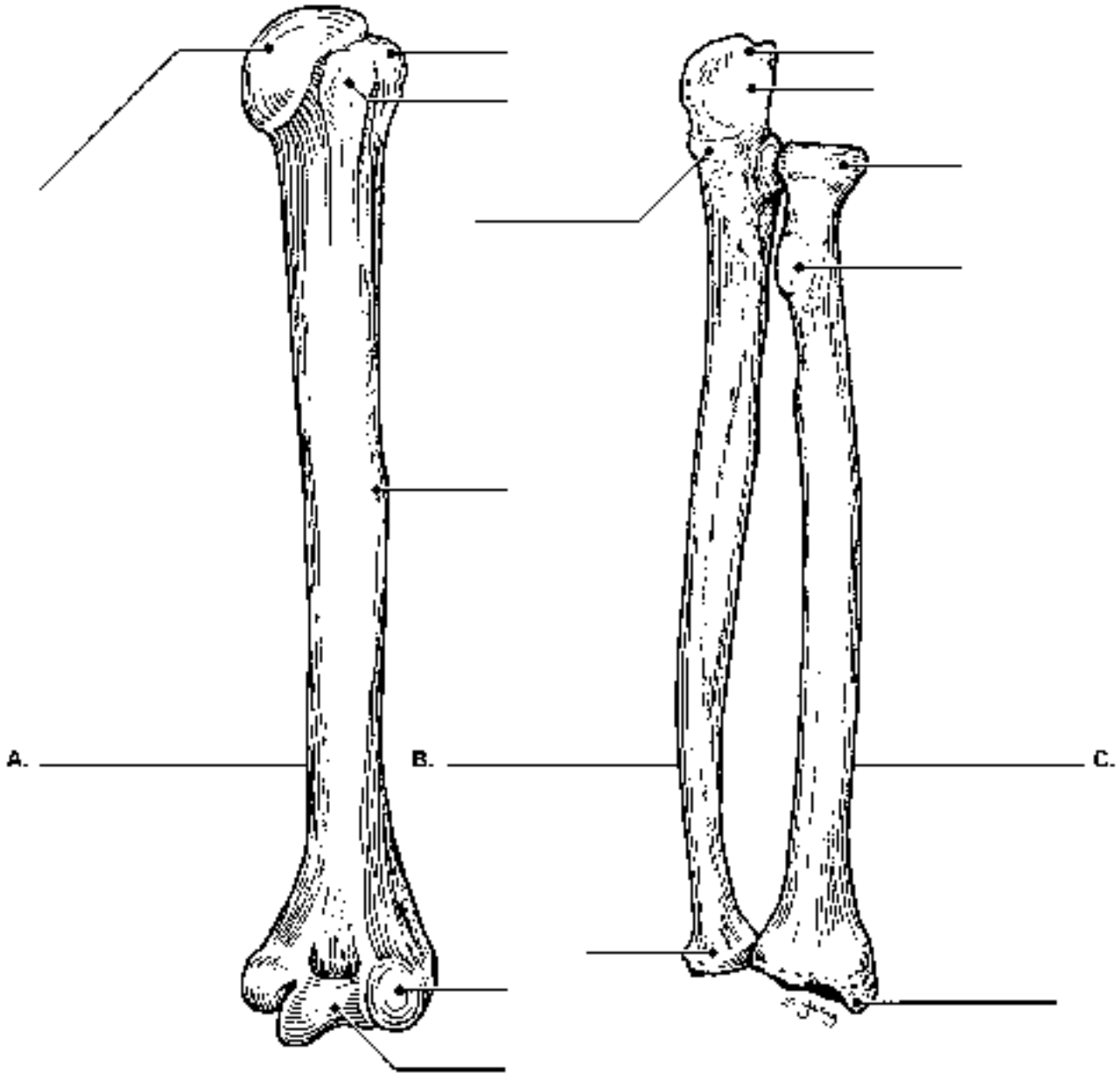


Figure 5–9

22. Figure 5–10 is a diagram of the hand. Select different colors for the following structures, and use them to color the coding circles and the corresponding structures in the diagram.

◯ Carpals ◯ Metacarpals ◯ Phalanges

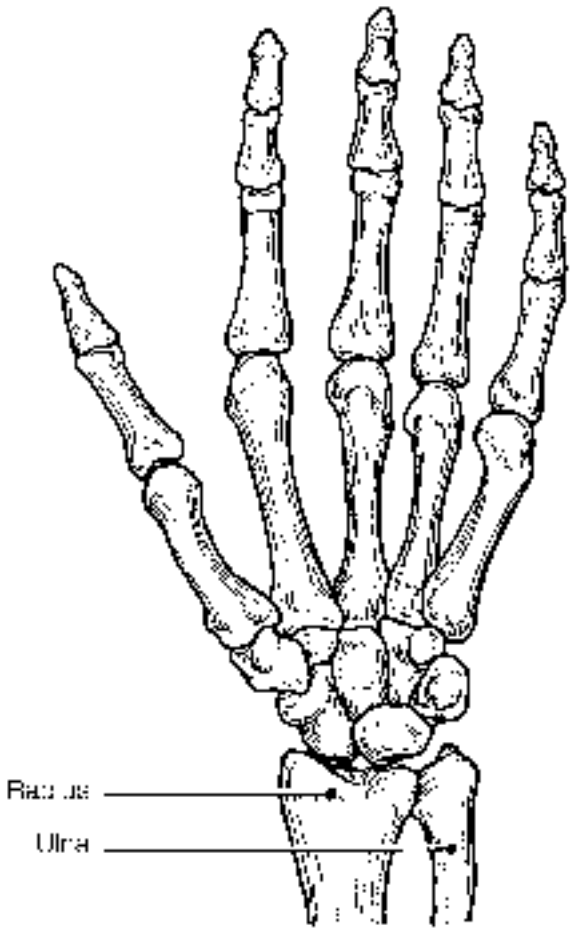


Figure 5–10

23. Compare the pectoral and pelvic girdles by choosing descriptive terms from the key choices. Insert the appropriate key letters in the answer blanks.

Key Choices

A. Flexibility D. Shallow socket for limb attachment

B. Massive E. Deep, secure socket for limb attachment

C. Lightweight F. Weight-bearing

Pectoral _____, _____, _____ Pelvic _____

24. Using the key choices, identify the bone names or markings according to the descriptions that follow. Insert the appropriate term or letter in the answer blanks.

Key Choices

A. Acromion	F. Coronoid fossa	K. Olecranon fossa	P. Scapula
B. Capitulum	G. Deltoid tuberosity	L. Olecranon process	Q. Sternum
C. Carpals	H. Glenoid cavity	M. Phalanges	R. Styloid process
D. Clavicle	I. Humerus	N. Radial tuberosity	S. Trochlea
E. Coracoid process	J. Metacarpals	O. Radius	T. Ulna

_____ 1. Raised area on lateral surface of humerus to which deltoid muscle attaches

_____ 2. Arm bone

_____ 3. _____ 4. Bones composing the shoulder girdle

_____ 5. _____ 6. Forearm bones

_____ 7. Point where scapula and clavicle connect

_____ 8. Shoulder girdle bone that has no attachment to the axial skeleton

_____ 9. Shoulder girdle bone that articulates anteriorly with the sternum

_____ 10. Socket in the scapula for the arm bone

_____ 11. Process above the glenoid cavity that permits muscle attachment

_____ 12. Commonly called the collarbone

_____ 13. Distal medial process of the humerus; joins the ulna

_____ 14. Medial bone of the forearm in anatomical position

_____ 15. Rounded knob on the humerus that articulates with the radius

_____ 16. Anterior depression superior to the trochlea; receives part of the ulna when the forearm is flexed

_____ 17. Forearm bone involved in formation of elbow joint

_____ 18. _____ 19. Bones that articulate with the clavicle

_____ 20. Bones of the wrist

_____ 21. Bones of the fingers

_____ 22. Heads of these bones form the knuckles

25. Figure 5–11 is a diagram of the articulated pelvis. Identify the bones and bone markings indicated by leader lines on the figure. Select different colors for the structures listed below and use them to color the coding circles and the corresponding structures in the figure. Also, label the dashed line showing the dimensions of the true pelvis and that showing the diameter of the false pelvis. Complete the illustration by labeling the following bone markings: obturator foramen, iliac crest, anterior superior iliac spine, ischial spine, pubic ramus, and pelvic brim. Last, list three ways in which the female pelvis differs from the male pelvis and insert your answers in the answer blanks.

◯ Coxal bone ◯ Pubic symphysis

◯ Sacrum ◯ Acetabulum

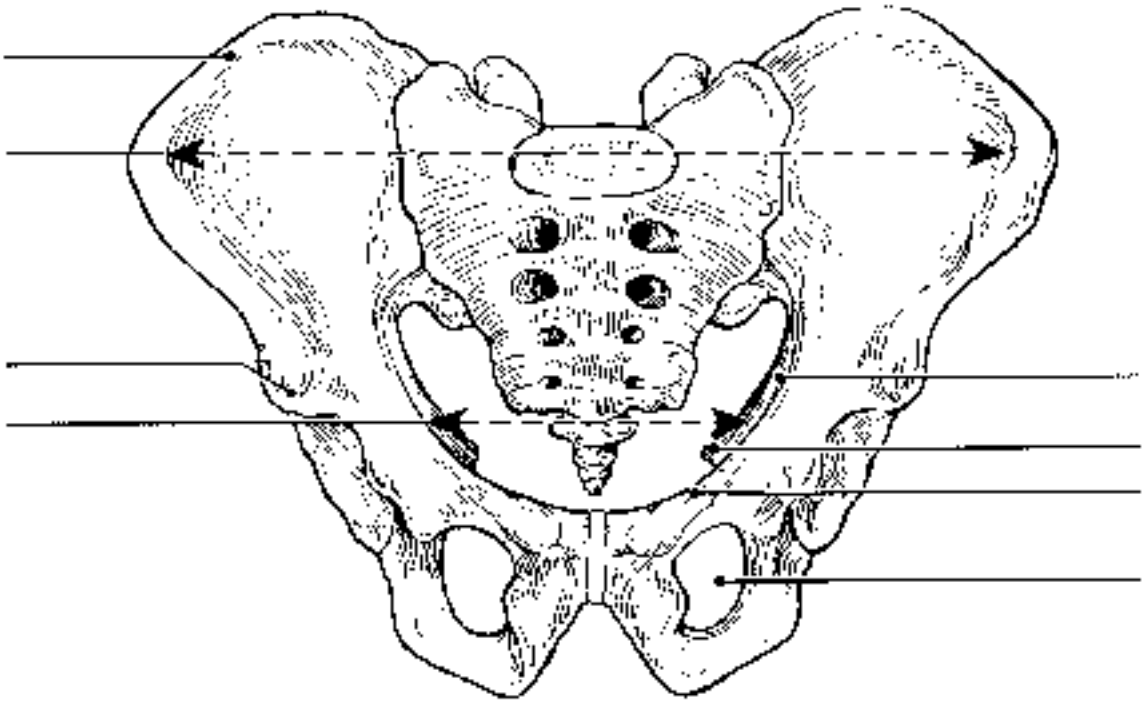


Figure 5–11

1. _____ _____

2. _____ _____

3. _____ _____ _____

26. Circle the term that does not belong in each of the following groupings.

1. Tibia Ulna Fibula Femur
2. Skull Rib cage Vertebral column Pelvis
3. Ischium Scapula Ilium Pubis
4. Mandible Frontal bone Temporal bone Occipital bone
5. Calcaneus Tarsals Carpals Talus

27. Using the key choices, identify the bone names and markings, according to the descriptions that follow. Insert the appropriate key term(s) or letter(s) in the answer blanks.

Key Choices

A. Acetabulum	I. Ilium	Q. Patella
B. Calcaneus	J. Ischial tuberosity	R. Pubic symphysis
C. Femur	K. Ischium	S. Pubis
D. Fibula	L. Lateral malleolus	T. Sacroiliac joint
E. Gluteal tuberosity	M. Lesser sciatic notch	U. Talus
F. Greater sciatic notch	N. Medial malleolus	V. Tarsals
G. Greater and lesser trochanters	O. Metatarsals	W. Tibia
H. Iliac crest	P. Obturator foramen	X. Tibial tuberosity

_____ 1. Fuse to form the coxal bone (hip bone)

_____ 2. Receives the weight of the body when sitting

_____ 3. Point where the coxal bones join anteriorly

_____ _____ 4. Upper margin of iliac bones

_____ _____ 5. Deep socket in the hip bone that receives the head of the thigh bone

_____ 6. Point where the axial skeleton attaches to the pelvic girdle

_____ 7. Longest bone in body; articulates with the coxal bone

_____ 8. Lateral bone of the leg

_____ _____ 9. Medial bone of the leg

_____ 10. Bones forming the knee joint

_____ 11. Point where the patellar ligament attaches

_____ 12. Kneecap

_____ _____ 13. Shinbone

_____ 14. Distal process on medial tibial surface

_____ 15. Process forming the outer ankle

_____ 16. Heel bone

_____ 17. Bones of the ankle

_____ 18. Bones forming the instep of the foot

_____ 19. Opening in a coxal bone, formed by the pubic and ischial rami

_____ 20. Sites of muscle attachment on the proximal end of the femur

_____ 21. Tarsal bone that articulates with the tibia

28. For each of the following statements that is true, insert *T* in the answer blank. If any of the statements are false, correct the underlined term by inserting the correct term in the answer blank.

_____ 1. The pectoral girdle is formed by the articulation of the hip bones and the sternum.

_____ 2. Bones present in both the hand and the foot are carpals.

_____ 3. The tough, fibrous connective tissue covering of a bone is the periosteum.

_____ 4. The point of fusion of the three bones forming a coxal bone is the glenoid cavity.

_____ 5. The large nerve that must be avoided when giving injections into the buttock muscles is the femoral nerve.

_____ 6. The long bones of arms are constructed of hyaline cartilage

_____ 7. Bones that provide the most protection to the abdominal viscera are the ribs.

_____ 8. The largest foramen in the skull is the foramen magnum.

_____ 9. The intercondylar fossa, greater trochanter, and tibial tuberosity are all bone markings of the humerus.

_____ 10. The first major event of fracture healing is hematoma formation

29. The bones of the thigh and the leg are shown in Figure 5-12. Identify each and put your answers in the blanks labeled A, B, and C. Select different colors for the lower limb bones listed below and use them to color in the coding circles and corresponding bones on the diagram. Complete the illustration by inserting the terms indicating bone markings at the ends of the appropriate leader lines in the figure.

◯ Femur	◯ Tibia	◯ Fibula
Head of femur	Anterior border of tibia	Head of fibula
Intercondylar eminence	Lesser trochanter	Medial malleolus
Tibial tuberosity	Greater trochanter	Lateral malleolus

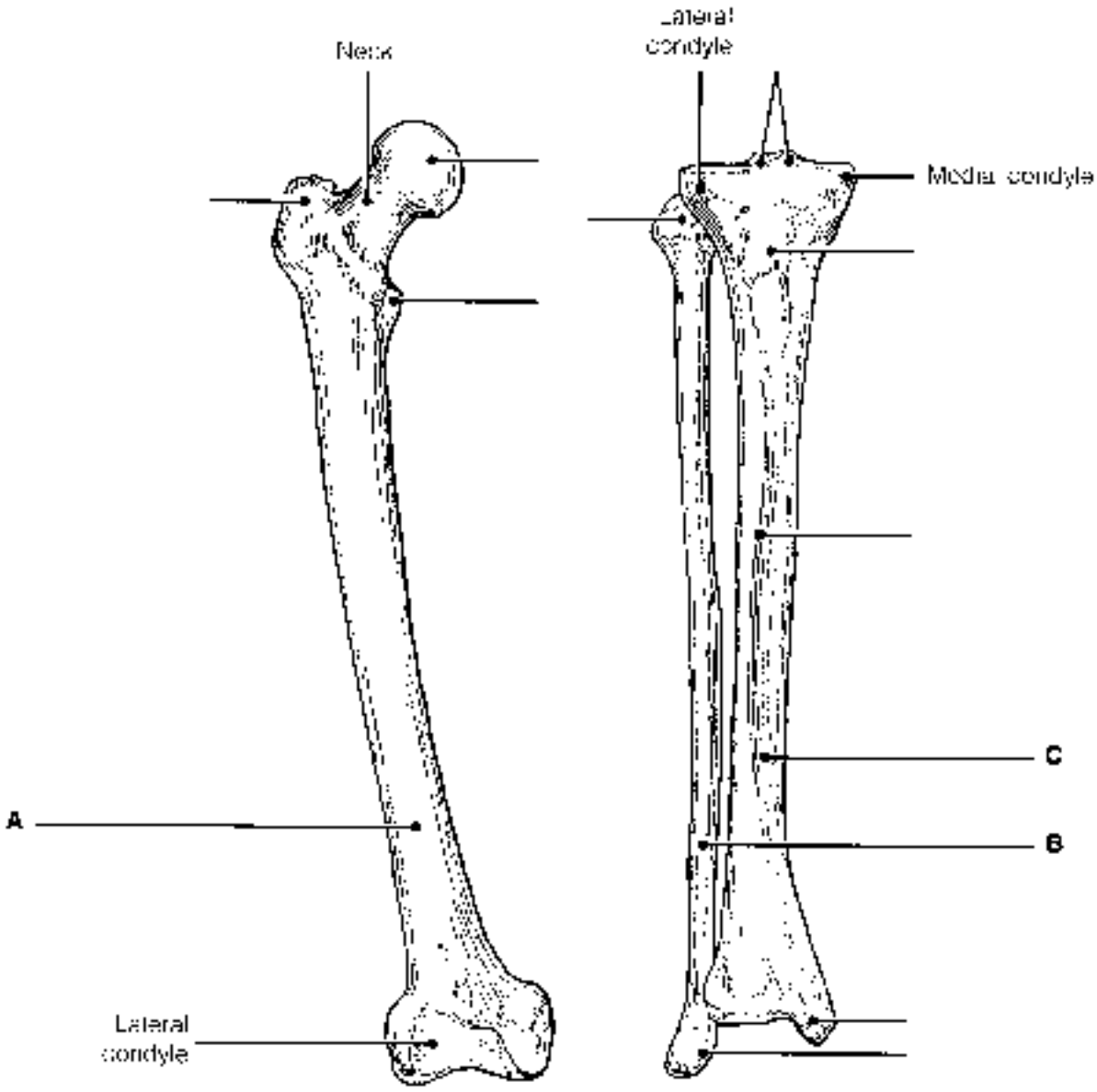


Figure 5-12

30. Figure 5–13 is a diagram of the articulated skeleton. Identify all bones or groups of bones by writing the correct labels at the end of the leader lines. Then, select two different colors for the bones of the axial and appendicular skeletons and use them to color in the coding circles and corresponding structures in the diagram.

◯ Axial skeleton ◯ Appendicular skeleton

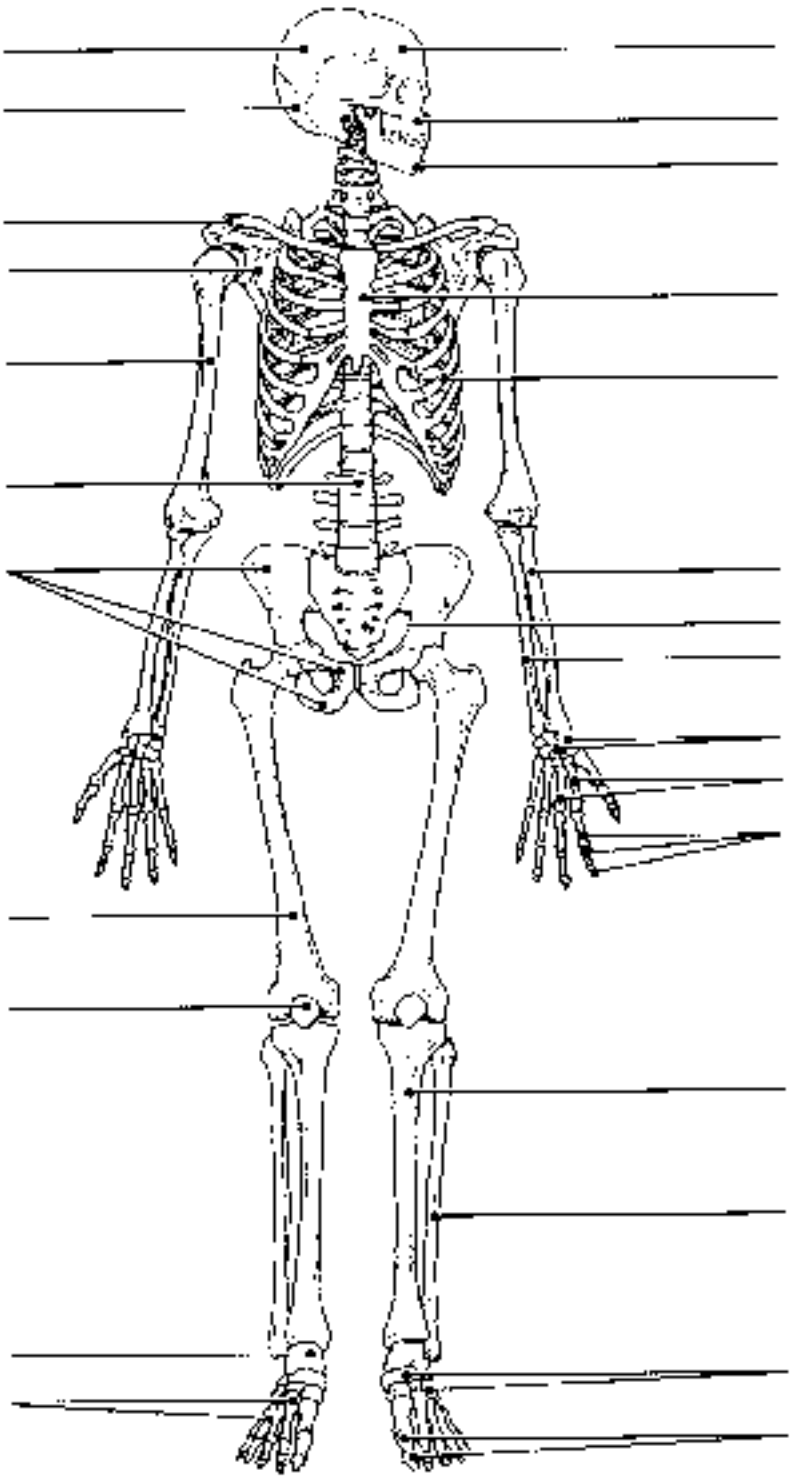


Figure 5–13

BONE FRACTURES

31. Using the key choices, identify the fracture (fx) types shown in Figure 5–14 and the fracture types and treatments described below. Enter the appropriate key letter or term in each answer blank.

Key Choices

A. Closed reduction	D. Depressed fracture	G. Simple fracture
B. Compression fracture	E. Greenstick fracture	H. Spiral fracture
C. Compound fracture	F. Open reduction	

_____ 1. Bone is broken cleanly, the ends do not penetrate the skin

_____ ___ 2. Nonsurgical realignment of broken bone ends and splinting of bone

_____ _____ 3. A break common in children. Bone splinters, but break is incomplete

_____ 4. A fracture in which the bone is crushed; common in the vertebral column

_____ 5. A fracture in which the bone ends penetrate through the skin surface

_____ ___ ___ 6. Surgical realignment of broken bone ends

_____ ___ 7. A result of twisting forces

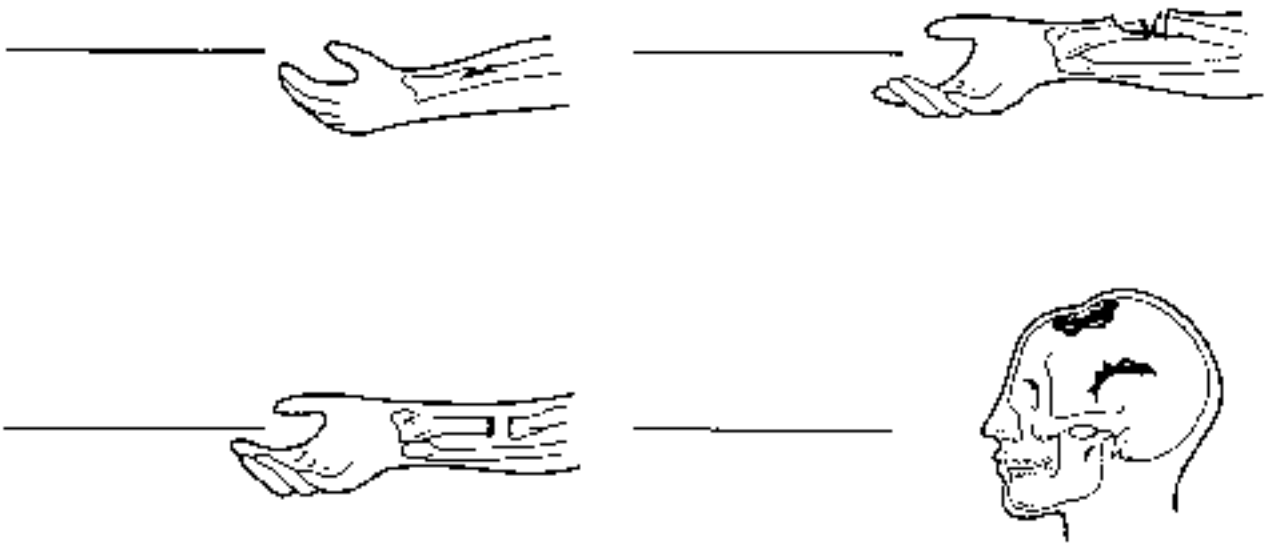


Figure 5–14

52. For each of the following statements that is true about bone breakage and the repair process, insert T in the answer blank. For false statements, correct the underlined terms by inserting the correct term on the answer blank.

_____ 1. A hematoma usually forms at a fracture site.

_____ 2. Deprived of nutrition, osteocytes at the fracture site die.

_____ 3. Nonbony debris at the fracture site is removed by osteoclasts.

_____ 4. Growth of a new capillary supply into the region produces granulation tissue.

_____ 5. Osteoblasts from the medullary cavity migrate to the fracture site.

_____ 6. The fibrocartilage callus is the first repair mass to splint the broken bone.

_____ 7. The bony callus is initially composed of compact bone.

JOINTS

53. Figure 5–15 shows the structure of a typical diarthrosis joint. Select different colors to identify each of the following areas and use them to color the coding circles and the corresponding structures on the figure. Then complete the statements below the figure.

( ) Articular cartilage of bone ends

( ) Fibrous capsule

( ) Synovial membrane

( ) Joint cavity

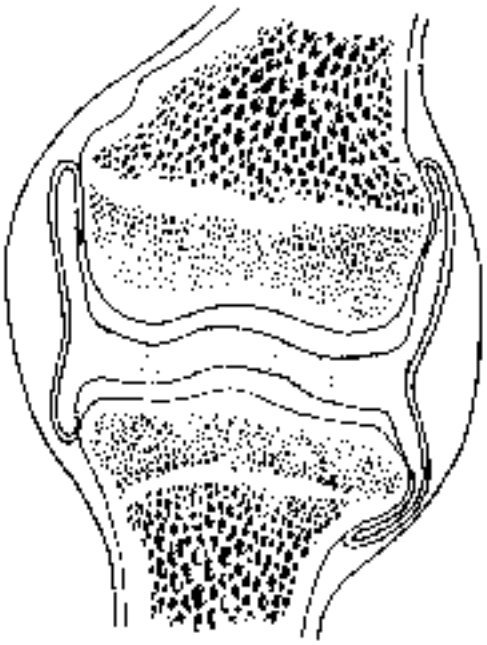


Figure 5–15

1. _____ The lubricant that minimizes friction and abrasion of joint surfaces is _____.

2. _____ The resilient substance that keeps bone ends from crushing when compressed is _____.

3. _____ _____, which reinforce the fibrous capsule, help to prevent dislocation of the joint.

34. For each joint described below, select an answer from Key A. Then, if the Key A selection *is other than C* (a synovial joint), see if you can classify the joint further by making a choice from Key B.

Key Choices

Key A:	A. Cartilaginous	Key B:	1. Epiphyseal disk
	B. Fibrous		2. Suture
	C. Synovial		3. Symphysis

_____ _____ 1. Has amphiarthrotic and synarthrotic examples

_____ _____ 2. All have a fibrous capsule lined with synovial membrane surrounding a joint cavity

_____ _____ 3. Bone regions united by fibrous connective tissue

_____ 4. Joints between skull bones

_____ 5. Joint between the atlas and axis

_____ 6. Hip, elbow, and knee

_____ 7. All examples are diarthroses

_____ _____ 8. Pubic symphysis

_____ _____ 9. All are reinforced by ligaments

_____ _____ 10. Joint providing the most protection to underlying structures

_____ _____ 11. Often contains a fluid-filled cushion

_____ _____ 12. Child's long-bone growth plate made of hyaline cartilage

_____ 13. Most joints of the limbs

_____ _____ _____ 14. Often associated with bursae

_____ 15. Have the greatest mobility

35. Which structural joint type is *not* commonly found in the axial skeleton and why not?

_____ _____ _____ _____

_____ _____ _____ _____

_____ _____ _____ _____

Homeostatic Imbalances of Bones and Joints

36. For each of the following statements that is true, enter T in the answer blank. For each false statement, correct the underlined words by writing the correct words in the answer blank.

___ ___ 1. In a sprain, the ligaments reinforcing a joint are excessively stretched or torn.

_____ 2. Age-related erosion of articular cartilages and formation of painful bony spurs are characteristic of gouty arthritis.

_____ 3. Chronic arthritis usually results from bacterial invasion.

_____ 4. Healing of a partially torn ligament is slow because its hundreds of fibrous strands are poorly aligned.

__ _____ 5. Rheumatoid arthritis is an autoimmune disease.

__ _____ 6. High levels of uric acid in the blood may lead to rheumatoid arthritis.

____ _____ 7. A "soft" bone condition in children, usually caused by a lack of calcium or vitamin D in the diet, is called osteomyelitis.

_____ ____ 8. Atrophy and thinning of bone owing to hormonal changes or inactivity (generally in the elderly) is called osteoporosis.

DEVELOPMENTAL ASPECTS OF THE SKELETON

37. Using the key choices, identify the body systems that relate to bone tissue viability. Enter the appropriate key terms or letters in the answer blanks.

Key Choices

A. Endocrine C. Muscular F. Reproductive

B. Integumentary D. Nervous E. Urinary

_____ 1. Conveys the sense of pain in bone and joints

_____ 2. Activates vitamin D for proper calcium usage

_____ 3. Regulates uptake and release of calcium by bones

_____ 4. Increases bone strength and viability by pulling on bone

_____ 5. Influences skeletal proportions and adolescent growth of long bones

_____ 6. Provides vitamin D for proper calcium absorption

38. Complete the following statements concerning fetal and infant skeletal development. Insert the missing words in the answer blanks.

"Soft spots" or membranous joints called (1) in the fetal skull, allow the skull to be (2) slightly during birth passage. They also allow for continued brain (3) during the later months of fetal development and early infancy. Eventually these soft spots are replaced by immovable joints called (4).

The two spinal curvatures well developed at birth are the (5) and (6) curvatures. Because they are present at birth, they are called (7) curvatures. The secondary curvatures develop as the baby matures. The (8) curvature develops as the baby begins to lift his or her head. The (9) curvature matures when the baby begins to walk or assume the upright posture.

INCREDIBLE JOURNEY

A Visualization Exercise for the Skeletal System

. . . stalagmite- and stalactite-like structures that surround you . . .
Since the texture is so full of holes . . .

39. Where necessary, complete statements by inserting the missing words in the answer blanks.

For this journey you are miniaturized and injected into the interior of the largest bone of your host's body, the (1). Once inside this bone, you look around and find yourself examining the stalagmite- and stalactite-like structures that surround you. Although you feel as if you are in an underground cavern, you know that it has to be bone. Since the texture is so full of holes, it obviously is (2) bone. Although the arrangement of these bony spurs seems to be haphazard, as if someone randomly dropped straws, they are precisely arranged to resist points of (3). All about you is hectic, hurried activity. Cells are dividing rapidly, nuclei are being ejected, and disklike cells are appearing. You decide that these disklike cells are (4) and that this is the (5) cavity. As you explore further, strolling along the edge of the cavity, you spot many tunnels leading into the solid bony area on which you are walking. Walking into one of these drainpipe-like openings, you notice that it contains a glistening white rodlike structure (a (6), no doubt) and blood vessels running the length of the tube. You eventually come to a point in the channel where the

_____ 7. horizontal passageway joins with a vertical passage that runs
with the longitudinal axis of the bone. This is obviously a
_____ 8. (7) canal. Because you would like to see how nutrients are
brought into (8) bone, you decide to follow the channel
_____ _____ 9. Reasoning that there is no way you can possibly scale the
slick walls of the channel, you lean and grab onto a white
_____ 10. cord, hanging down its length. Because it is easier to slide
down than to try to climb up the cord, you begin to lower
_____ 11. yourself, hand over hand. During your descent, you notice
small openings in the wall which are barely large enough for
_____ 12. you to wriggle through. You conclude that these are the
(9) that connect all the (10) to the nutrient supply in the
central canal. You decide to investigate one of these tiny
openings and begin to swing on your cord, trying to get a foothold on one of the openings. After
managing to anchor yourself and squeezing into an opening, you use a flashlight to illuminate the
passageway in front of you. You are startled by a giant cell with many dark nuclei. It appears to be
plastered around the entire tunnel directly ahead of you. As you watch this cell, the bony material
beneath it, the (11), begins to liquefy. The cell apparently is a bone-dissolving cell, or (12), and
bone so you are unsure whether or not its enzymes can also liquefy you, you slither backwards
hurriedly and begin your rock back to your retrieval site.

AT THE CLINIC

40. Antonio is hit in the face with a football during practice. An X ray reveals multiple fractures of the bones around an orbit. Name the bones that form margins of the orbit.

41. Mrs. Brasso, a woman in her 80s, is brought to the clinic with a fractured hip. X rays reveal compression fractures in her lower vertebral column and extremely low bone density in her vertebrae, hip bones, and femurs. What are the condition, cause, and treatment?

42. Jack, a young man, is treated at the clinic for an accident in which he hit his forehead. When he returns for a checkup, he complains that he can't smell anything. A hurried X ray of his head reveals a fracture. What part of which bone was fractured to cause his loss of smell?

43. A middle-aged woman comes to the clinic complaining of stiff, painful joints and increasing immobility of her finger joints. A glance at her hands reveals knobby, deformed knuckles. For what condition will she be tested?

44. At his 60th birthday party, James was complimented on how good he looked and was asked about his health. He replied, "I feel good most of the time but some of my joints ache and are stiff, especially my knees, hips, and lower back, and especially in the morning when I wake up." A series of X rays and an MRI scan taken a few weeks earlier had revealed that the articular cartilages of these joints were rough and flaking off, and bone spurs (overgrowths) were present at the ends of some of James's bones. What is James's probable condition?

45. Janet, a 10-year-old girl, is brought to the clinic after falling out of a tree. An X ray shows she has small fractures of the transverse processes of T_2 to T_5 on the right side. Janet will be watched for what abnormal spinal curvature over the next several years?

46. The serving arm of many tennis players is often significantly larger (thicker) than the other arm. Explain this phenomenon.

47. Jerry is giving cardiopulmonary resuscitation to Mr. Jackson, an elderly woman who has just been rescued from the waters of Cape Cod Bay. What bone is he compressing?

THE FINALE: MULTIPLE CHOICE

48. Select the best answer or answers from the choices given.

1. Important bone functions include:
   A. support of the pelvic organs
   B. protection of the brain
   C. providing levers for movement of the limbs
   D. protection of the skin and limb musculature
   E. storage of water

2. A passageway connecting neighboring osteocytes in an osteon is a:
   A. central canal
   B. lamella
   C. lacuna
   D. canaliculus
   E. perforating canal

3. What is the earliest event of those listed in endochondral ossification?
   A. Ossification of proximal epiphysis
   B. Appearance of the epiphyseal plate
   C. Invasion of the shaft by the periosteal bud
   D. Cavitation of the cartilage shaft
   E. Formation of secondary ossification centers

4. The growth spurt of puberty is triggered by
   A. high levels of sex hormones
   B. the initial, low levels of sex hormones
   C. growth hormone
   D. parathyroid hormone
   E. calcitonin

5. Deficiency of which of the following hormones will cause dwarfism?
   A. Growth hormone
   B. Sex hormones
   C. Thyroid hormones
   D. Calcitonin
   E. Parathyroid hormone

6. Women suffering from osteoporosis are frequent victims of _____ fractures of the vertebrae.
   A. compound
   B. spiral
   C. comminuted
   D. compression
   E. depression

7. Which of the following bones are part of the axial skeleton?
   A. Vomer
   B. Clavicle
   C. Sternum
   D. Parietal
   E. Coxal bone

8. A blow to the cheek is most likely to break what superficial bone or bone part?
   A. Superciliary arches
   B. Zygomatic process
   C. Mandibular ramus
   D. Styloid process

9. Which of the following are part of the sphenoid?
   A. Crista galli
   B. Sella turcica
   C. Petrous portion
   D. Pterygoid process
   E. Lesser wings

10. Structural characteristics of *all* cervical vertebrae are:
    A. small body
    B. bifid spinous process
    C. transverse foramina
    D. small vertebral foramen
    E. costal facets

11. Which of the following bones exhibit a styloid process?
    A. Hyoid
    B. Temporal
    C. Humerus
    D. Radius
    E. Ulna

12. Hip bone markings include:
    A. ala
    B. sacral hiatus
    C. gluteal surface
    D. pubic ramus
    E. fovea capitis

13. Cartilaginous joints include:
    A. syndesmoses
    B. symphyses
    C. synostoses
    D. synchondroses

14. Considered to be part of a synovial joint are:
    A. fossae
    B. articular cartilage
    C. tendon sheath
    D. capsular ligaments

15. Abduction is:
    A. moving the right arm out to the right
    B. spreading out the fingers
    C. wiggling the toes
    D. moving the sole of the foot laterally

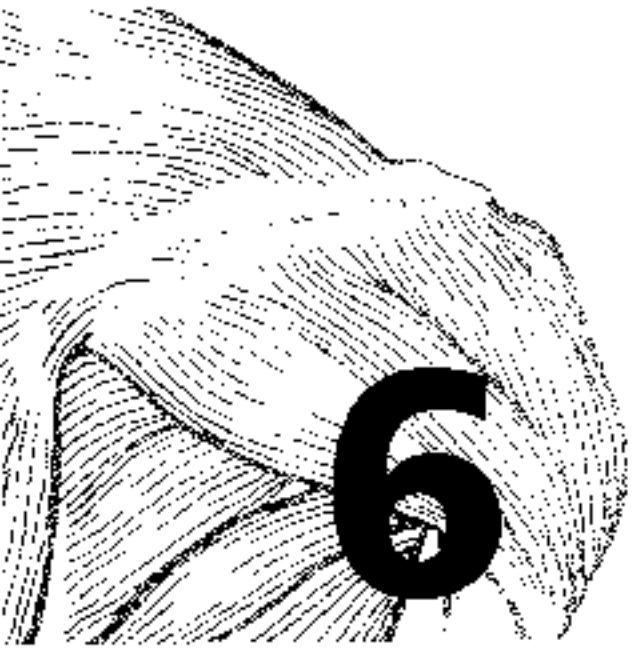
16. In comparing two joints of the same type, what characteristic(s) would you use to determine strength and flexibility?
    A. Depth of the depression of the concave bone of the joint
    B. Snugness of fit of the bones
    C. Size of bone projections for muscle attachments
    D. Presence of menisci

17. Which of the following joints has the greatest freedom of movement?
    A. Interphalangeal
    B. Saddle joint of thumb
    C. Distal tibiofibular
    D. Costal

18. Which specific joint does the following description identify? "Articular surfaces are deep and secure; multiaxial; capsule heavily reinforced by ligaments; labrum helps prevent dislocation; the first joint to be built artificially; very stable."
    A. Elbow
    B. Hip
    C. Knee
    D. Shoulder

19. An autoimmune disease resulting in inflammation and eventual fusion of diarthrotic joints is:
    A. gout
    B. rheumatoid arthritis
    C. degenerative joint disease
    D. pannus

20. Plane joints allow:
    A. pronation
    B. flexion
    C. rotation
    D. gliding



6 THE MUSCULAR SYSTEM

Muscles, the specialized tissues that facilitate body movement, make up about 40% of body weight. Most body muscle is the voluntary type, called skeletal muscle because it is attached to the bony skeleton. Skeletal muscle contributes to body contours and shape, and it composes the organ system called the muscular system. These muscles allow you to grin, frown, run, sweat, shake hands, swing a hammer, and to otherwise manipulate your environment. The balance of body muscle is smooth and cardiac muscles, which form the bulk of the walls of hollow organs and the heart. Smooth and cardiac muscles are involved in the transport of materials within the body.

Study activities in this chapter deal with microscopic and gross structure of muscle, identification of voluntary muscles, body movements, and important understandings of muscle physiology.

OVERVIEW OF MUSCLE TISSUES

1. Nine characteristics of muscle tissue are listed below and on page 104. Identify the muscle tissue type described by choosing the correct response(s) from the key choices. Enter the appropriate term(s) or letter(s) of the key choice in the answer blank.

   Key Choices

   A. Cardiac B. Smooth C. Skeletal

   _____ 1. Involuntary

   _____ 2. Banded appearance

   _____ 3. Longitudinally and circularly arranged layers

   _____ 4. Dense connective tissue packagings

   _____ 5. Figure 8 packaging of the cells

   _____ 6. Coordinated activity to act as a pump

→

_____ _____ 7. Moves bones and the facial skin

_____ _____ 8. Referred to as the muscular system

_____ _____ 9. Voluntary

2. Identify the type of muscle in each of the illustrations in figure 6–1. Color the diagrams as you wish.

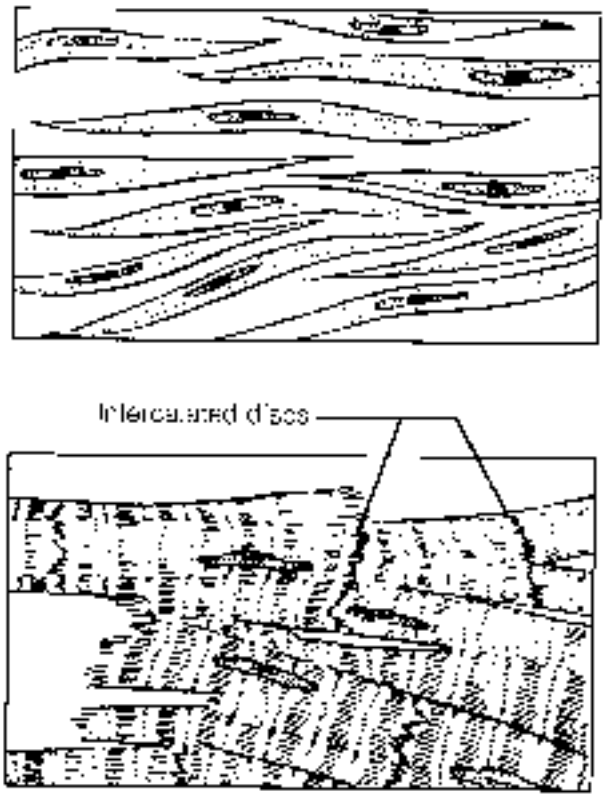


Figure 6–1

3. Regarding the functions of muscle tissues, circle the term in each of the groupings that does not belong with the other terms.

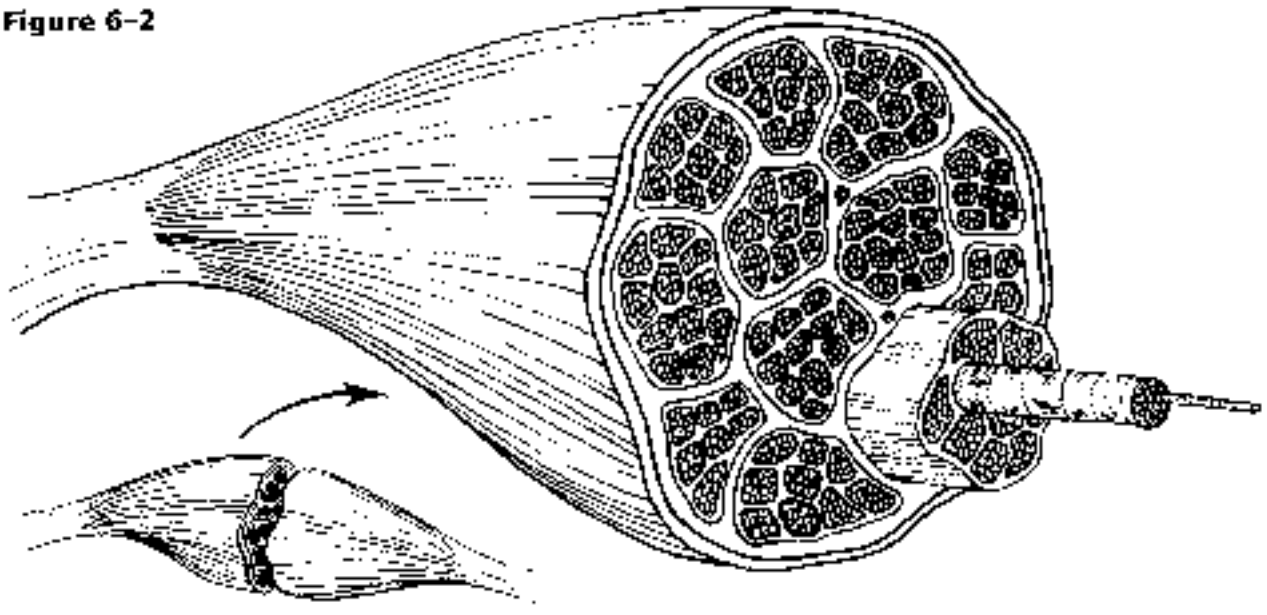
1. Urine Foodstuffs Bones Smooth muscle
2. Heart Cardiac muscle Blood pump Promotes labor during birth
3. Excitability Response to a stimulus Contractility Action potential
4. Ability to shorten Contractility Pulls on bones Stretchability
5. Maintains posture Movement Promotes growth Generates heat

MICROSCOPIC ANATOMY OF SKELETAL MUSCLE

4. First, identify the structures in Column B by matching them with the descriptions in Column A. Enter the correct letters (or terms if desired) in the answer blanks. Then, select a different color for each of the terms in Column B that has a color coding circle and color in the structures on Figure 6–2.

Column A	Column B
_____ _____ 1. Connective tissue surrounding a fascicle	A. endomysium ◯
_____ _____ 2. Connective tissue enshearthing the entire muscle	B. Epimysium ◯
_____ _____ 3. Contractile unit of muscle	C. Fascicle
_____ _____ 4. A muscle cell	D. Fiber ◯
_____ _____ 5. Fibrous connective tissue investing each muscle cell	E. Myofilament
_____ 6. Plasma membrane of the muscle cell	F. Myofibril ◯
_____ 7. A long, filamentous organelle found within muscle cells that has a banded appearance	G. Perimysium ◯
_____ 8. Actin- or myosin-containing structure	H. Sarcolemma
_____ 9. Cordlike extension of connective tissue beyond the muscle, serving to attach it to the bone	I. Sarcomere
_____ 10. A discrete bundle of muscle cells	J. Sarcoplasm
	K. Tendon ◯

Figure 6–2



5. Figure 6–3 is a diagrammatic representation of a small portion of a relaxed muscle cell (bracket indicates the portion enlarged). First, select different colors for the structures listed below. Use them to color the coding circles and corresponding structures on Figure 6–3. Then bracket and label an A band, an I band, and a sarcomere. When you have finished, draw a contracted sarcomere in the space beneath the figure and label the same structures, as well as the light and dark bands.

◯ Myosin ◯ Actin filaments ◯ Z disc

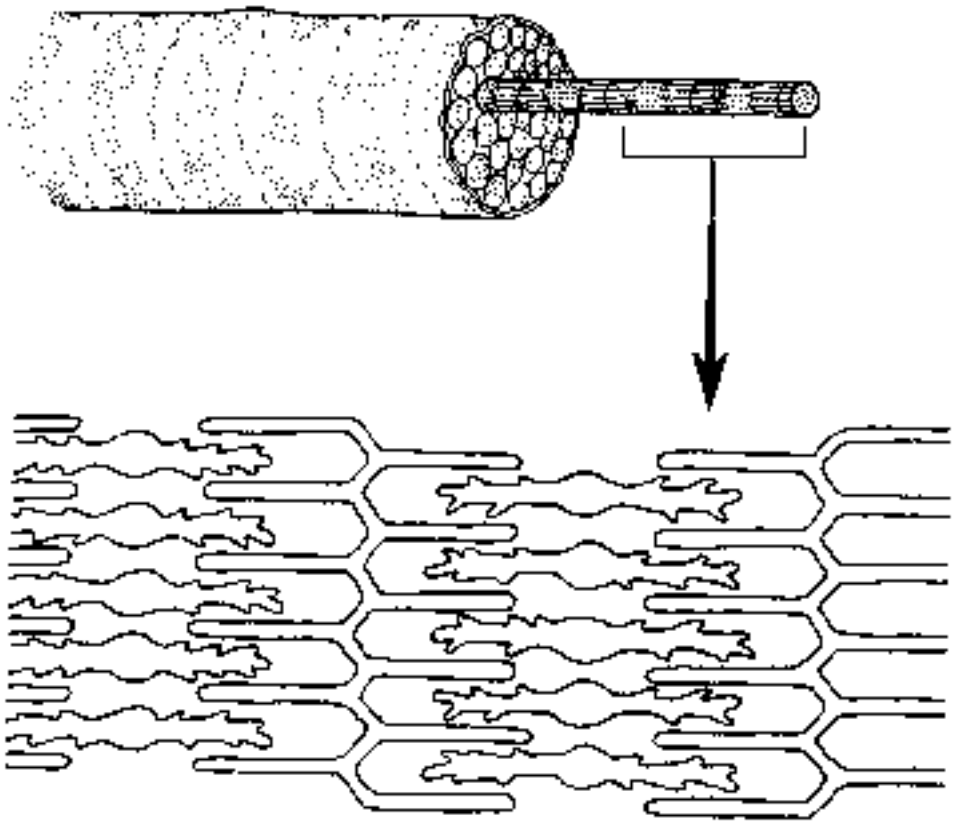


Figure 6–3

_____ _____ 1. Looking at your diagram of a contracted sarcomere from a slightly different angle, which region of the sarcomere shortens during contraction—the dark band, the light band, or both?

SKELETAL MUSCLE ACTIVITY

6. Complete the following statements relating to the neuromuscular junction. Insert the correct answers in the numbered answer blanks.

1. A motor neuron and all of the skeletal muscle cells it stimulates is called a ___1___.
2. The axon of each motor neuron has numerous endings called ___2___. The actual gap between an axonal ending and the muscle cell is called a ___3___.
3. Within the axonal endings are many small vesicles containing a neurotransmitter substance called ___4___.
4. When the ___5___ reaches the ends of the axon, the neurotransmitter is released and it diffuses to the muscle cell membrane to combine with receptors there. Binding of the neurotransmitter with muscle membrane receptors causes the membrane to become permeable to sodium, resulting in the influx of sodium ions and ___6___ of the membrane. Then contraction of the muscle cell occurs.

7. Figure 6–4 shows the components of a neuromuscular junction. Identify the parts by coloring the coding circles and the corresponding structures in the diagram. Add small arrows to indicate the location of the ACh receptors and label appropriately.

- ◯ Mitochondrion
- ◯ T tubule
- ◯ Sarcomere
- ◯ Synaptic vesicles
- ◯ Synaptic cleft

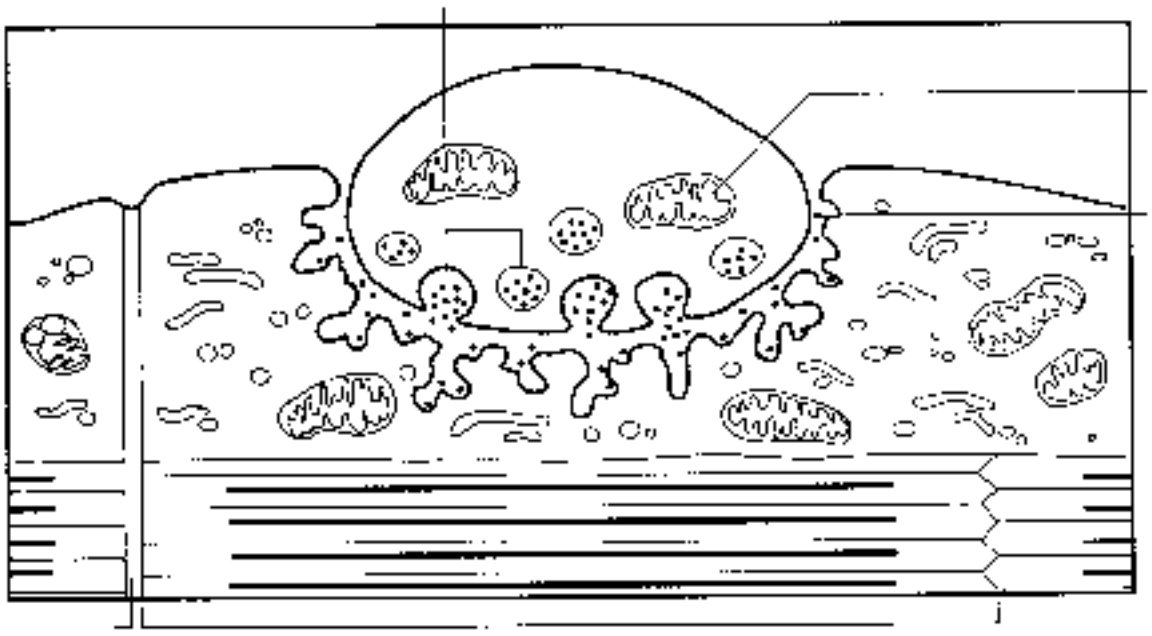


Figure 6–4

8. Number the following statements in their proper sequence to describe the contraction mechanism in a skeletal muscle cell. The first step has already been identified as number 1.

__1__ 1. Acetylcholine is released into the neuromuscular junction by the axonal terminal.

_____ 2. The action potential, carried deep into the cell, causes the sarcoplasmic reticulum to release calcium ions.

_____ 3. The muscle cell relaxes and lengthens.

_____ 4. Acetylcholine diffuses across the neuromuscular junction and binds to receptors on the sarcolemma.

_____ 5. The calcium ion concentration at the myofilaments increases; the myofilaments slide past one another, and the cell shortens.

_____ 6. Depolarization occurs, and the action potential is generated.

_____ 7. As calcium is actively reabsorbed into the sarcoplasmic reticulum, its concentration at the myofilaments decreases.

9. The following incomplete statements refer to a muscle cell in the resting, or polarized, state just before stimulation. Complete each statement by choosing the correct response from the key choices and entering the appropriate letter in the answer blanks.

Key Choices

A. Na^+ diffuses out of the cell

B. K^+ diffuses out of the cell

C. Na^+ diffuses into the cell

D. K^+ diffuses into the cell

E. Inside the cell

F. Outside the cell

G. Relative ionic concentrations on the two sides of the membrane during rest

H. Electrical conditions

I. Activation of the sodium-potassium pump, which moves K^+ into the cell and Na^+ out of the cell

J. Activation of the sodium-potassium pump, which moves Na^+ into the cell and K^+ out of the cell

_____ 1.

_____ ___ 2.

_____. 3.

_____. _____ 4.

_____. _____ 5

. _____ 6 __ . _____ 7.

There is a greater concentration of Na^+ __(1)__, and there is a greater concentration of K^+ __(2)__. When the stimulus is delivered, the permeability of the membrane is changed, and __(3)__, initiating the depolarization of the membrane. Almost as soon as the depolarization wave begins, a repolarization wave follows it across the membrane. This occurs as __(4)__. Repolarization restores the __(5)__ of the resting cell membrane. The __(6)__ is (are) reestablished by __(7)__.

10. Complete the following statements by choosing the correct response from the key choices and entering the appropriate letter or term in the answer blanks.

Key Choices

A. Fatigue	E. Isometric contraction	I. Many motor units
B. Isotonic contraction	F. Whole muscle	J. Repolarization
C. Muscle cell	G. Tetanus	K. Depolarization
D. Muscle tone	H. Few motor units	

_____ 1. _____ is a continuous contraction that shows no evidence of relaxation.

_____ _____ 2. A(n) _____ is a contraction in which the muscle shortens and work is done.

_____ _____ 3. To accomplish a strong contraction, _____ are stimulated at a rapid rate.

_____ _____ 4. When a weak but smooth muscle contraction is desired, _____ are stimulated at a rapid rate.

_____ _____ 5. When a muscle is being stimulated but is not able to respond because of oxygen debt, the condition is called _____.

_____ _____ 6. A(n) _____ is a contraction in which the muscle does not shorten, but tension in the muscle keeps increasing.

11. The terms in the key refer to the three ways that muscle cells replenish their ATP supplies. Select the letter(s) that best apply to the conditions described and insert the correct key letter(s) in the answer blanks.

Key Choices

A. Coupled reaction of creatine phosphate (CP) and ADP

B. Anaerobic glycolysis C. Aerobic respiration

_____ 1. Accompanied by lactic acid formation

_____ 2. Supplies the highest ATP yield per glucose molecule

_____ 3. Involves the simple transfer of a phosphate group

_____ 4. Requires no oxygen

_____ 5. The slowest ATP regeneration process

_____ 6. Produces carbon dioxide and water

_____ 7. The energy mechanism used in the second hour of running in a marathon

_____ 8. Used when the oxygen supply is inadequate over time

_____ 9. Good for a sprint

12. Briefly describe how you can tell when you are repaying the oxygen debt.

_____ _____ _____ _____

_____ _____ _____ _____

13. Which of the following occur within a muscle cell during oxygen debt? Place a check (✓) by the correct choices.

___	1. Decreased ATP	_____	5. Increased oxygen
___	2. Increased ATP	_____	6. Decreased carbon dioxide
___	3. Increased lactic acid	_____	7. Increased carbon dioxide
___	4. Decreased oxygen	_____	8. Increased glucose

MUSCLE MOVEMENTS, TYPES, AND NAMES

14. Relative to general terminology concerning muscle activity, first label the following structures on Figure 6–5: insertion, origin, tendon, resting muscle, and contracting muscle. Next, rightly the two structures named below by choosing different colors for the coding circles and the corresponding structures in the figure.

◯ Movable bone

◯ Immovable bone

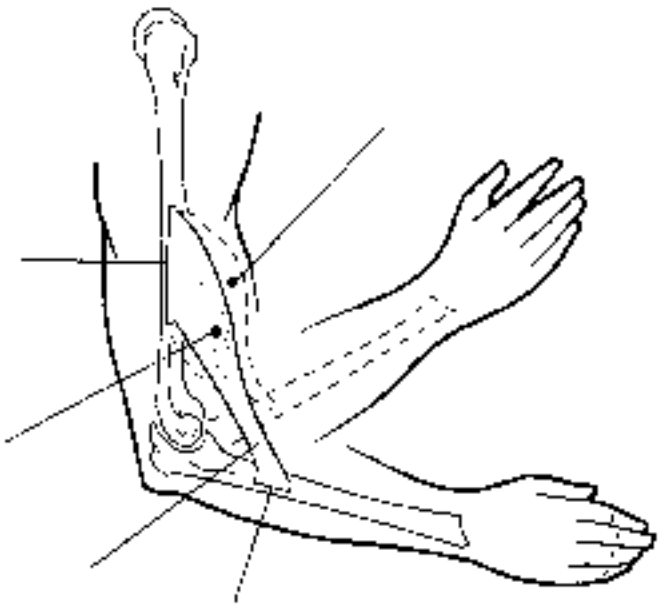


Figure 6–5

15. Complete the following statements. Insert your answers in the answer blanks.

1. Standing on your toes as in ballet is _____ of the foot. Walking on your heels is _____.
2. _____
3. Bending up for a pitch (as in baseball) can properly be called _____. To keep your seat when riding a horse, the tendency is to _____ your thighs.
4. _____
5. In running, the extension at the hip joint is _____ in reference to the leg moving forward and _____ in reference to the leg in the posterior position. When kicking a football, the action at the knee is _____. In archery, stable, the hip and knee of the forward leg are both _____. You have just touched your chin to your chest. This is _____ of the neck.
6. _____
7. _____
8. Using a screwdriver with a straight arm requires _____ of the arm. Consider all the movements of which the arm is capable. One action used for strengthening all the upper arm and shoulder muscles is _____.
9. _____
10. _____
11. Moving the head to signify "no" is _____. Action that moves the distal end of the radius across the chest is _____. Raising the arms laterally away from the body is called _____ of the arms.
12. _____
13. _____
14. _____

16. The terms provided in the key are often used to describe the manner in which muscles interact with other muscles. Select the key terms that apply to the following definitions and insert the correct letter or term in the answer blanks.

Key Choices

A. Antagonist B. Fixator C. Prime mover D. Synergist

1. _____ Agonist
2. _____ Postural muscles for the most part
3. _____ Stabilizes a joint so that the prime mover can act at more distal joints
4. _____ Performs the same movement as the prime mover
5. _____ Reverses action or opposes the action of a prime mover
6. _____ Immobilizes the origin of a prime mover

17. Several criteria are applied to the naming of muscles. These are provided in Column B. Identify which criteria pertain to the muscles listed in Column A and enter the correct letter(s) in the answer blank.

	Column A	Column B
	1. Gluteus maximus	A. Action of the muscle
	2. Adductor magnus	B. Shape of the muscle
_____	3. Biceps femoris	C. Location of the muscle's origin and/or insertion
_____	4. Transversus abdominis	D. Number of origins
_____	5. Extensor carpi ulnaris	E. Location of muscle relative to a bone or body region
_____	6. Trapezius	F. Direction in which the muscle fibers run relative to some imaginary line
_____	7. Rectus femoris	G. Relative size of the muscle
_____	8. External oblique	

GROSS ANATOMY OF THE SKELETAL MUSCLES

Muscles of the Head

18. Identify the major muscles described in Column A by choosing a response from Column B. Enter the correct letter in the answer blank. Select a different color for each muscle described and color in the coding circle and corresponding muscle on Figure 6–6.

	Column A	Column B
◯ _____	1. Used in smiling	A. Buccinator
◯ _____	2. Used to suck in your cheeks	B. Frontalis
◯ _____	3. Used in winking	C. Masseter
◯ _____	4. Used to form the horizontal frown crease on the forehead	D. Orbicularis oculi
◯ _____	5. The "kissing" muscle	E. Orbicularis oris
◯ _____	6. Prime mover of jaw closure	F. Sternocleidomastoid
◯ _____	7. Synergist muscle for jaw closure	G. Temporalis
◯ _____	8. Prime mover of head flexion; a two-headed muscle	H. Trapezius
		I. Zygomaticus

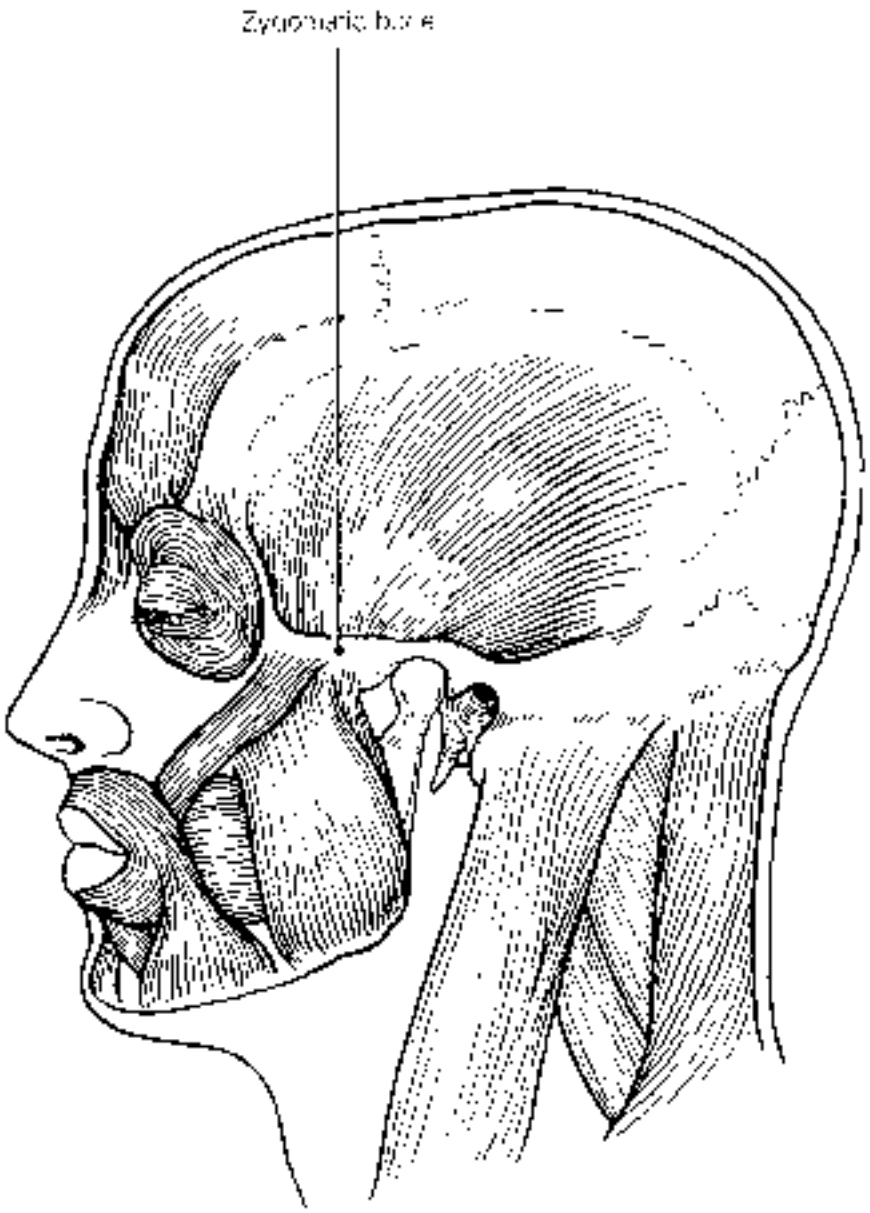


Figure 6–6

Muscles of the Trunk

19. Identify the anterior trunk muscles described in Column A by choosing a response from Column B. Enter the correct letter in the answer blank. Then, for each muscle description that has a color-coding circle, select a different color to color the coding circle and corresponding muscle on Figure 6–7.

	Column A	Column B
◯ ____	1. The name means "straight muscle of the abdomen."	A. Deltoid
◯ ____	2. Prime mover for shoulder flexion and adduction	B. Diaphragm
◯ ____	3. Prime mover for shoulder abduction	C. External intercostal
◯ ____	4. Part of the abdominal girdle; forms the external lateral walls of the abdomen	D. External oblique
◯ ____	5. Acting alone, each muscle of this pair turns the head toward the opposite shoulder	E. Internal intercostal
		F. Internal oblique
____	6. and 7. Besides the two abdominal muscles (pairs) named above, two muscle pairs that help form the natural abdominal girdle	G. Latissimus dorsi
		H. Pectoralis major
		I. Rectus abdominis
	8. Deep muscles of the thorax that promote the inspiratory phase of breathing	J. Sternocleidomastoid
		K. Transversus abdominis
	9. An unpaired muscle that acts with the muscles named immediately above to accomplish inspiration	

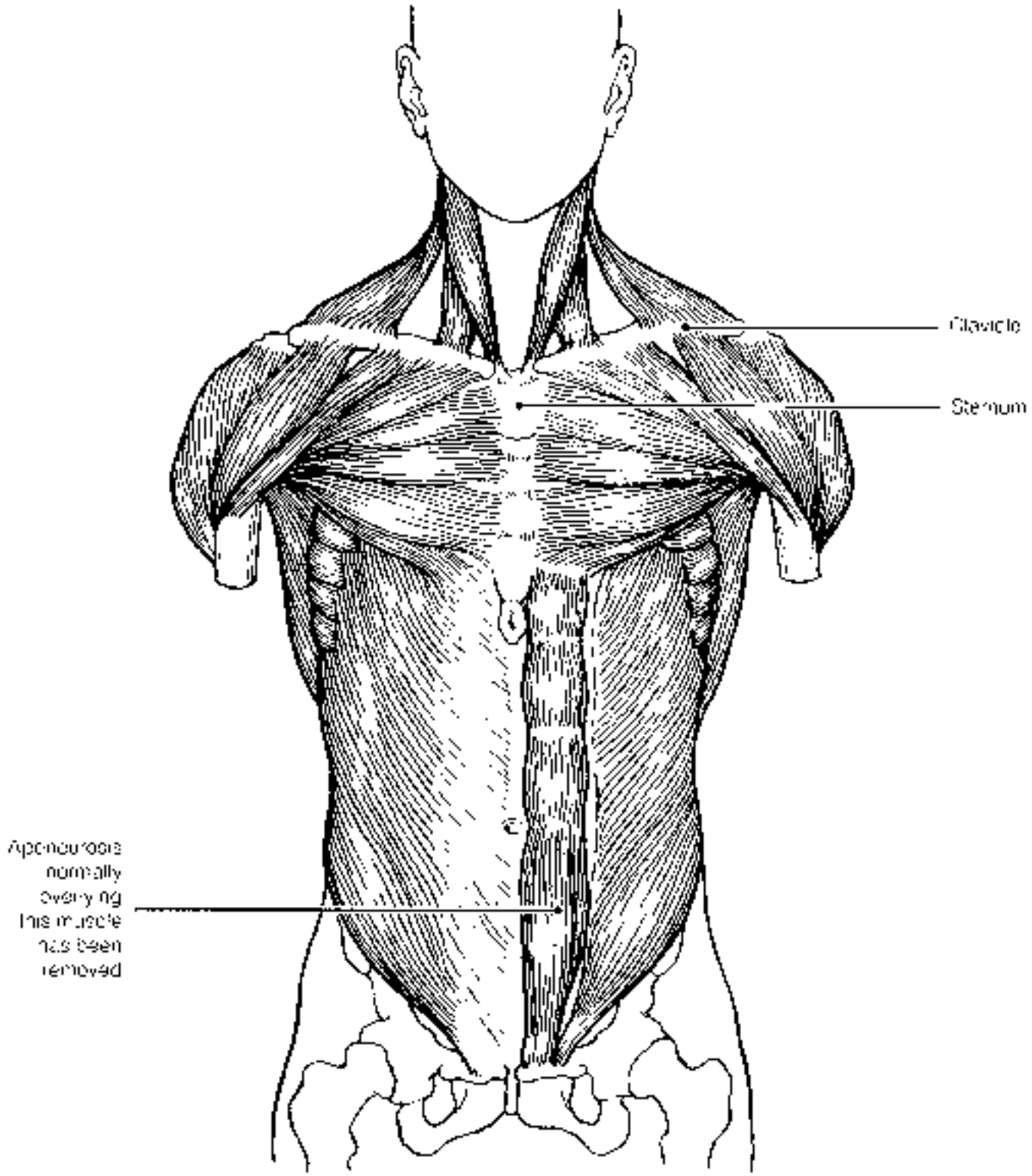

Clavicle
Sternum
Aponeurosis normally overlying this muscle has been removed

Figure 6-7

20. Identify the posterior trunk muscles described in Column A by choosing a response from Column B. Enter the correct letter in the answer blank. Select a different color for each muscle description with a coding circle and color the coding circles and corresponding muscles on Figure 6–8.

	Column A	Column B
◯ ____	1. Muscle that allows you to shrug your shoulders or extend your head	A. Deltoid
◯ ____	2. Muscle that adducts the shoulder and causes extension of the shoulder joint	B. Erector spinae
◯ ____	3. Shoulder muscle that is the antagonist of the muscle just described	C. External oblique
____	4. Prime mover of back extension; a deep composite muscle consisting of three columns	D. Gluteus maximus
____	5. Large paired superficial muscle of the lower back	E. Latissimus dorsi
◯ ____	6. Fleshy muscle forming part of the posterior abdominal wall that helps maintain upright posture	F. Quadratus lumborum
		G. Trapezius

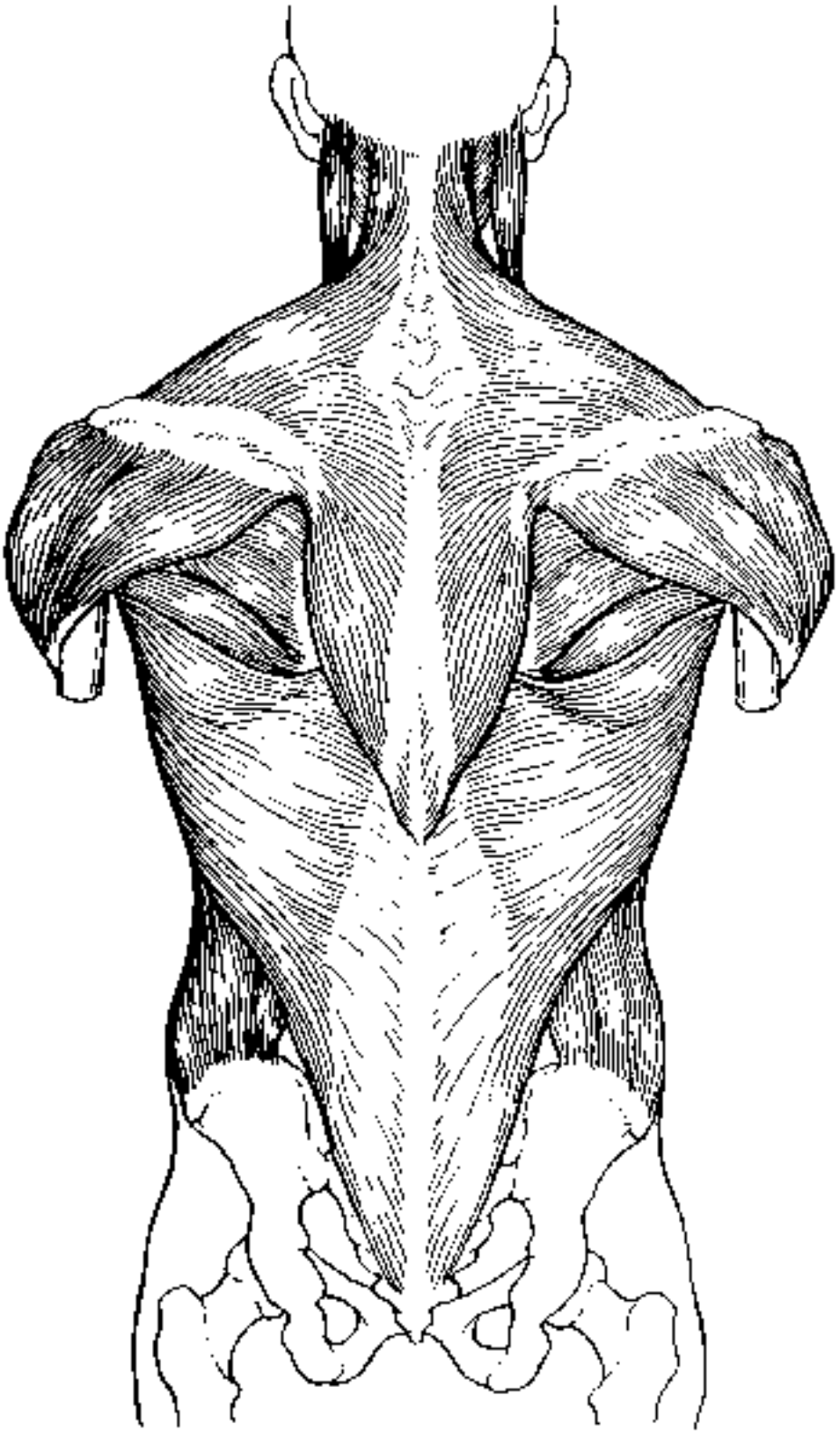


Figure 6-8

Muscles of the Hip, Thigh, and Leg

21. Identify the muscles described in Column A by choosing a response from Column B. Enter the correct letter in the answer blank. Select a different color for each muscle description provided with a color-coding circle, and use it to color the coding circles and corresponding muscles on Figure 6–9. Complete the illustration by labeling those muscles provided with leader lines.

Column A

_____ 1. Hip flexor deep in pelvis, a composite of two muscles

◯ _____ 2. Used to extend the hip when climbing stairs

◯ 3. "Toe dancer's" muscle, a two-bellied muscle of the calf

◯ 4. Inverts and dorsiflexes the foot

◯ 5. Muscle group that allows you to draw your legs to the midline of your body, as when standing at attention

◯ _____ 6. Muscle group that extends the knee

◯ _____ 7. Muscle group that extends the thigh and flexes the knee

◯ _____ 8. Smaller hip muscle commonly used as an injection site

◯ _____ 9. Muscle group of the lateral leg, plantar flex and evert the foot

◯ 10. Straplike muscle that is a weak thigh flexor, the "tailor's muscle"

◯ 11. Like the two-bellied muscle that lies over it, this muscle is a plantar flexor

Column B

A. Adductors

B. Biceps femoris

C. Fibularis muscles

D. Gastrocnemius

E. Gluteus maximus

F. Gluteus medius

G. Hamstrings

H. Iliopsoas

I. Quadriceps

J. Rectus femoris

K. Sartorius

L. Semimembranosus

M. Semitendinosus

N. Soleus

O. Tibialis anterior

P. Vastus intermedius

Q. Vastus lateralis

R. Vastus medialis

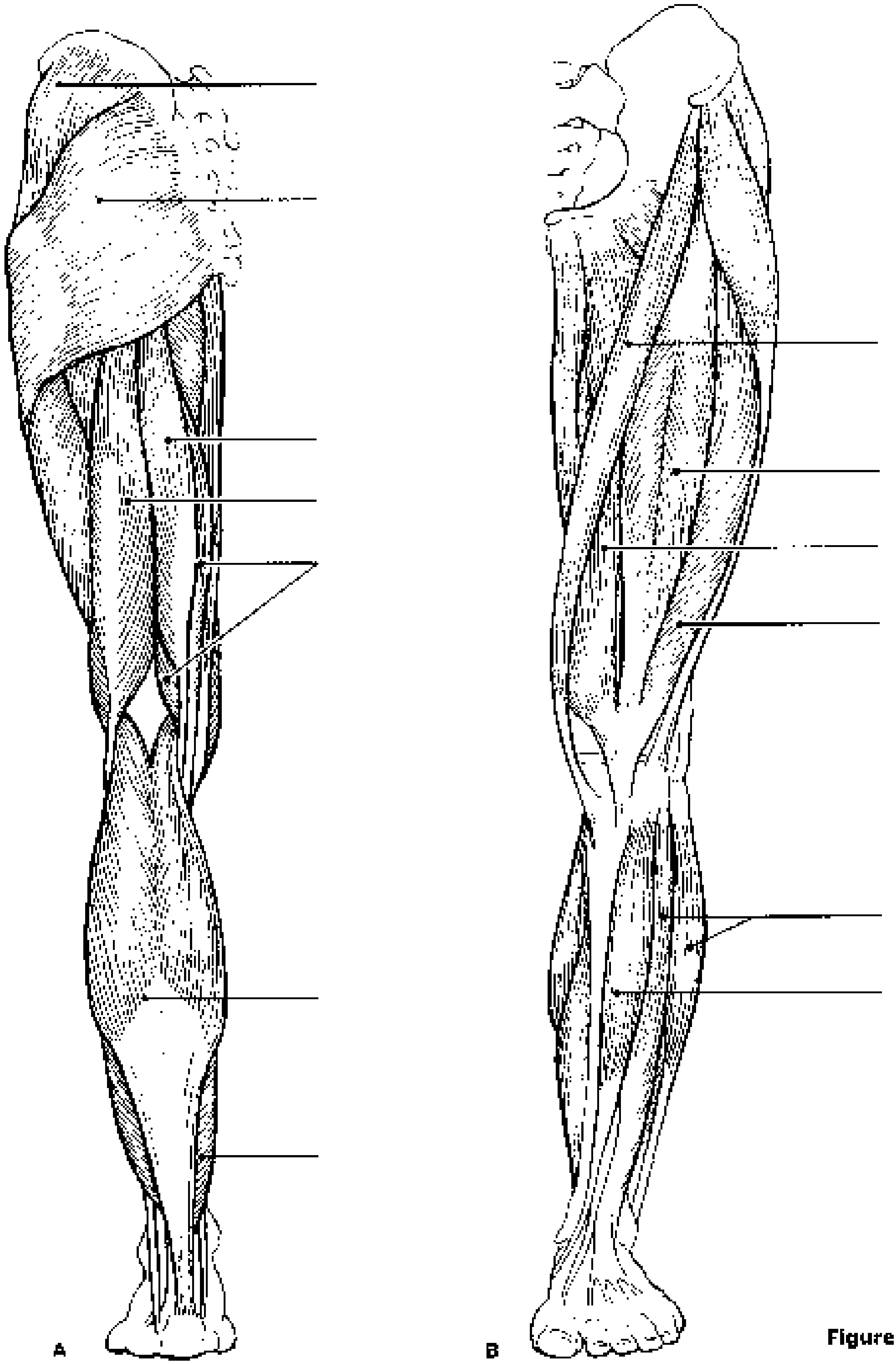


Figure 6–9

Muscles of the Arm and Forearm

22. Identify the muscles described in Column A by choosing a response from Column B. Enter the correct letter in the answer blank. Then select different colors for each muscle description provided with a color-coding circle and use them to color in the coding circles and corresponding muscles on Figure 6–10.

Column A

1. Wrist flexor that follows the ulna
2. Muscle that extends the fingers
3. Muscle that flexes the fingers
4. Muscle that allows you to bend (flex) the elbow
5. Muscle that extends the elbow
6. Powerful shoulder abductor, used to raise the arm overhead

Column B

A. Biceps brachii

B. Deltoid

C. Extensor carpi radialis

D. Extensor digitorum

E. Flexor carpi ulnaris

F. Flexor digitorum superficialis

G. Triceps brachii

Figure 6–10

General Body Muscle Review

23. Complete the following statements describing muscles. Insert the correct answers in the answer blanks.

_____ 1. Three muscles __(1)__, __(2)__, and __(3)__ are commonly used for intramuscular injections in adults.

_____ 2.

_____ 3. The insertion tendon of the __(4)__ group contains a large sesamoid bone, the patella.

_____ 4. The triceps surae insert in common into the __(5)__ tendon.

_____ 5. The bulk of the tissue of a muscle tends to lie __(6)__ to the part of the body it causes to move.

_____ 6.

_____ 7. The extrinsic muscles of the hand originate on the __(7)__.

_____ 8. Most flexor muscles are located on the __(8)__ aspect of the body; most extensors are located __(9)__. An exception to this generalization is the extensor–flexor musculature of the __(10)__.

_____ 9

_____ 10. The pectoralis major and deltoid muscles act synergistically to __(11)__ the arm.

_____ 11

24. Circle the term that does not belong in each of the following groupings.

1. Vastus lateralis Vastus medialis Knee extension Biceps femoris
2. Latissimus dorsi Pectoralis major Shoulder adduction Antagonists
3. Buccinator Frontalis Masseter Mastication Temporalis
4. Vastus medialis Rectus femoris Ilium Origin on axial bone

25. Identify the numbered muscles in Figure 6–11 by placing the numbers in the blanks next to the following muscle names. Then select a different color for each muscle provided with a color-coding circle and color the coding circle and corresponding muscle in Figure 6–11.

◯ _____ 1. Orbicularis oris

◯ _____ 2. Pectoralis major

◯ _____ 3. External oblique

◯ _____ 4. Sternocleidomastoid

◯ _____ 5. Biceps brachii

◯ _____ 6. Deltoid

◯ _____ 7. Vastus lateralis

◯ _____ 8. Frontalis

◯ _____ 9. Rectus femoris

◯ _____ 10. Sartorius

◯ _____ 11. Gracilis

◯ _____ 12. Adductor group

◯ _____ 13. Fibularis longus

◯ _____ 14. Temporalis

◯ 15. Orbicularis oculi

◯ 16. Zygomaticus

◯ _____ 17. Masseter

◯ _____ 18. Vastus medialis

◯ _____ 19. Tibialis anterior

◯ _____ 20. Transversus abdominis

◯ _____ 21. Rectus abdominis

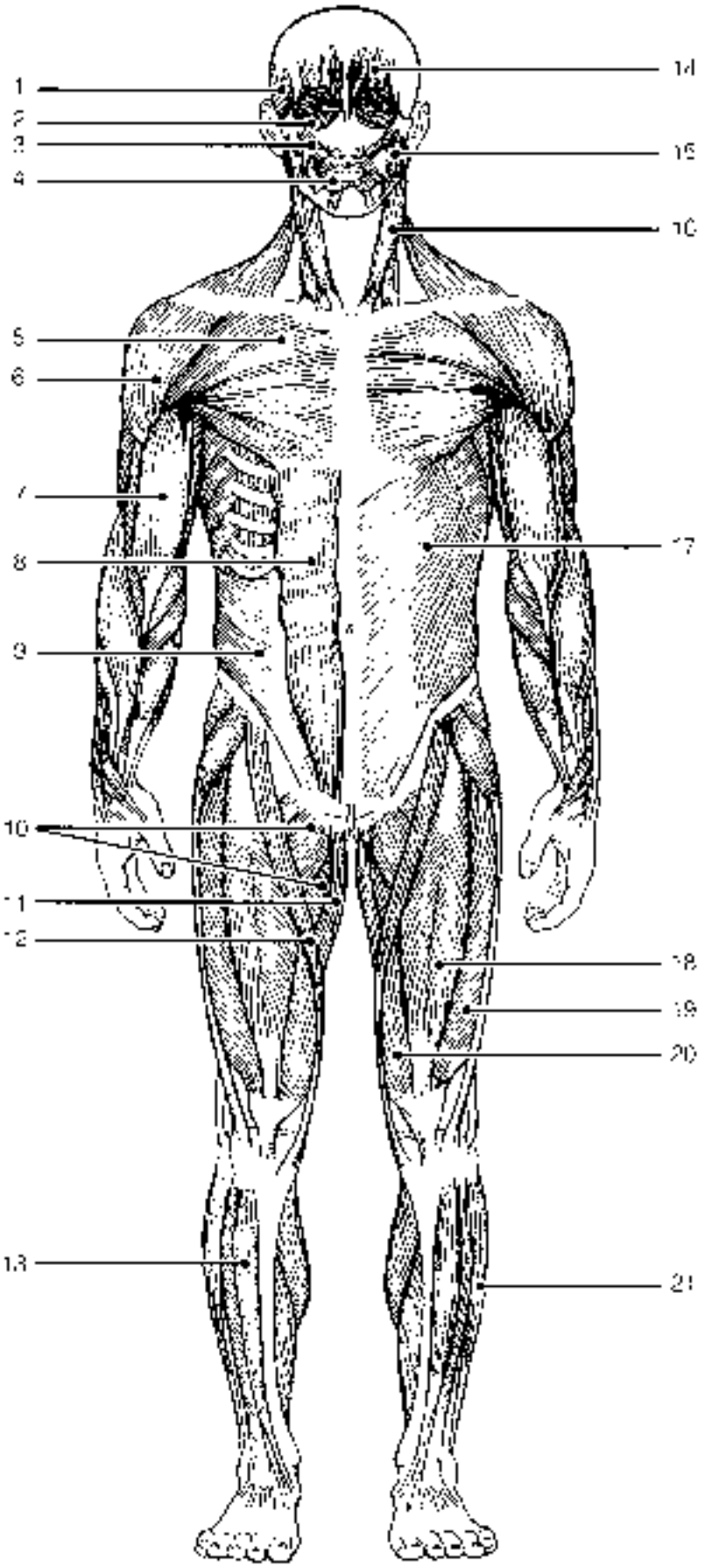


Figure 6-11

26. Identify each of the numbered muscles in Figure 6–12 by placing the numbers in the blanks next to the following muscle names. Then select different colors for each muscle and color the coding circles and corresponding muscles on Figure 6–12.

◯ ____ 1. Adductor muscle

◯ ____ 2. Gluteus maximus

◯ ____ 3. Gastrocnemius

◯ ____ 4. Latissimus dorsi

◯ ____ 5. Deltoid

◯ ____ 6. Semitendinosus

◯ ____ 7. Soleus

◯ ____ 8. Biceps femoris

◯ ____ 9. Triceps brachii

◯ ____ 10. External oblique

◯ ____ 11. Gluteus medius

◯ ____ 12. Trapezius

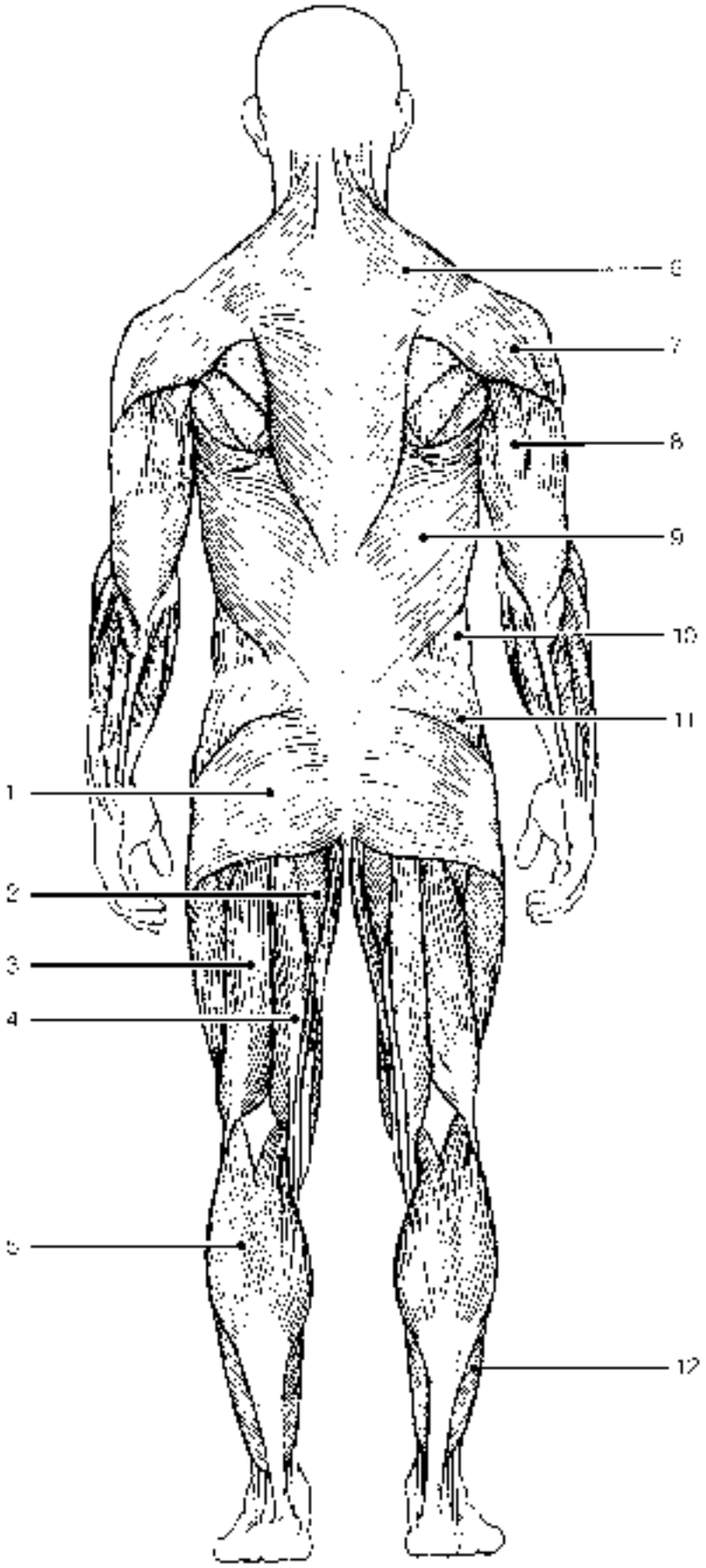


Figure 6–12

DEVELOPMENTAL ASPECTS OF THE MUSCULAR SYSTEM

27. Complete the following statements concerning the embryonic development of muscles and their functioning throughout life. Insert your answers in the answer blanks.

1. The first movement of the baby detected by the mother-to-be is called the (1).
2.
3. An important congenital muscular disease that results in the degeneration of the skeletal muscles by young adulthood is called (2).
4.
5. A baby's control over muscles progresses in a (3) direction as well as a (4) direction. In addition, (5) muscular control (that is, waving of the arms) occurs before (6) control (pincer grasp) does.
6.
7. Muscles will ordinarily stay healthy if they are (7) regularly without normal stimulation they (8)
8.
9. (9) is a disease of the muscles, which results from some problem with the stimulation of muscles by acetylcholine. The muscles become progressively weaker in this disease.
10.
11. With age, our skeletal muscles decrease in mass; this leads to a decrease in body (10) and in muscle (11). Muscle tissue that is lost is replaced by noncontractile (12) tissue.
12.

INCREDIBLE JOURNEY

A Visualization Exercise for the Muscular System

As you straddle this structure, you wonder what is happening.

28. Where necessary, complete statements by inserting the missing words in the numbered spaces.

1. On this incredible journey, you will be miniaturized and enter a skeletal muscle cell to observe the events that occur during muscle contraction. You prepare yourself by donning a wet suit and charging your ion detector. Then you climb into a syringe to prepare for injection. Your journey will begin when you see the gleaming connective tissue covering the (1) of a single muscle cell. Once injected, you monitor your descent through the endomysium and subcutaneous tissue. When you reach the muscle cell surface, you see that it is punctuated with pits at relatively

regular intervals. Looking into the darkness and off in the distance, you can see a branch of fibers ending close to a number of muscle cells. Considering that all of these fibers must be from the same motor neuron, this functional unit is obviously a (3) . You approach the fiber ending on your muscle cell and synaptize the (4) junction there. As you examine the junction, you see fluid droplets leave the nerve ending and attach to doughnut-shaped receptors on the muscle cell membrane. This substance released by the nerve ending must be (5) . Then, as a glow falls over the landscape, your ion detector indicates ions are disappearing from the muscle cell exterior and entering the muscle pits. The needle drops from high to low as the (6) ions enter the pits from the watery fluid outside. You should have expected this, because these ions must enter to depolarize the muscle cells and start the (7) .

Next, you begin to explore one of the surface pits. As the muscle jerks into action, you topple deep into the pit. Sparkling electricity lights up the wall on all sides. You grasp for a handhold, finally successful, you pull yourself laterally into the interior of the muscle cell and walk carefully along what seems to be a log. There, once again, you notice an eerie glow as your ion detector reports that (8) ions are entering the cytoplasm rapidly. The "log" you are walking on "comes to life" and begins to slide briskly in one direction. Unable to keep your balance, you fall. As you straddle this structure you wonder what is happening. On all sides, cylindrical structures—such as the one you are astride—are moving past other similar but larger structures. Suddenly you remember, these are the (9) myofilaments that slide past the (10) myofilaments during muscle contraction.

Seconds later, the forward movement ends, and you begin to journey smoothly in the opposite direction. The ion detector now indicates low (11) ion levels. Because you cannot ascend the smooth walls of one of the entry pits, you climb from one myofilament to another to reach the underside of the sarcolemma. Then you travel laterally to enter a pit close to the surface and climb out onto the cell surface. Your journey is completed, and you prepare to leave your host once again.

AT THE CLINIC

29. Pete, who has been moving furniture all day, arrives at the clinic complaining of painful spasms in his back. He reports having picked up a heavy table by stooping over. What muscle group has Pete probably strained, and why are these muscles at risk when one lifts objects improperly?

30. During an overambitious workout, a high school athlete pulled some muscles by forcing his knee into extension when his hip is already fully flexed. What muscles did he pull?

31. An emergency appendectomy is performed on Mr. Geiger. The incision was made at the lateral edge of the right iliac abdominopelvic region. Was his rectus abdominis cut?

32. Susan, a massage therapist, was giving Mr. Graves a back rub. What two broad superficial muscles of the back were receiving the "bulk" of her attention?

33. Mrs. Sanchez says that her 6-year-old son seems to be unusually clumsy and tires easily. The doctor notices that his calf muscles appear to be normal in size. If anything, they seem a bit enlarged rather than wasted. For what condition must the boy be checked? What is the prognosis?

34. People with chronic back pain occasionally get relief from a tummy tuck. How does this help?

35. Gregor, who works at a pesticide factory, comes to the clinic complaining of muscle spasms that interfere with his movement and breathing. A blood test shows that he has been contaminated with organophosphate pesticide, which is an acetylcholinesterase inhibitor. How would you explain to Gregor what this means?

THE FINALE: MULTIPLE CHOICE

36. Select the best answer or answers from the choices given.

1. Select the type(s) of muscle tissue that fit the following description: self-excitable, pacemaker cells, gap junctions, limited sarcoplasmic reticulum
   A. Skeletal muscle C. Smooth muscle
   B. Cardiac muscle D. Involuntary muscle

2. Skeletal muscle is not involved in:
   A. movement of skin
   B. propulsion of a substance through a body tube
   C. heat production
   D. inhibition of body movement

3. Which of the following are part of a thin myofilament?
   A. ATP-binding site C. Globular actin
   B. Regulatory proteins D. Calcium

4. Detachment of the cross bridges is directly triggered by:
   A. hydrolysis of ATP
   B. repolarization of the T tubules
   C. the power stroke
   D. attachment of ATP to myosin heads

5. Transmission of the stimulus at the neuromuscular junction involves:
   A. synaptic vesicles C. ACh
   B. sarcolemma D. axon terminal

6. Your ability to lift that heavy couch would be increased by which type of exercise?
   A. Aerobic C. Resistance
   B. Endurance D. Swimming

7. Which of the following activities depends most on anaerobic metabolism?
   A. Jogging
   B. Swimming a race
   C. Sprinting
   D. Running a marathon

8. The first energy source used to regenerate ATP when muscles are extremely active is:
   A. fatty acids C. creatine phosphate
   B. glucose D. pyruvic acid

9. Head muscles that insert on a bone include the:
   A. zygomaticus C. buccinator
   B. masseter D. temporalis

10. Lateral flexion of the torso involves:
   A. erector spinae
   B. rectus abdominis
   C. quadratus lumborum
   D. external oblique

11. Muscles attached to the vertebral column include:
   A. quadratus lumborum
   B. external oblique
   C. diaphragm
   D. latissimus dorsi

12. Muscles that help stabilize the scapula and shoulder joint include:
   A. triceps brachii C. trapezius
   B. biceps brachii D. rhomboids

13. Which of these thigh muscles causes movement at the hip joint?

A. Rectus femoris C. Vastus lateralis

B. Biceps femoris D. Semitendinosus

14. Leg muscles that can cause movement at the knee joint include

A. tibialis anterior C. gastrocnemius

B. fibularis longus D. soleus

15. The main muscles used when doing chin-ups are:

A. triceps brachii and pectoralis major

B. infraspinatus and biceps brachii

C. serratus anterior and external oblique

D. latissimus dorsi and brachialis

16. The major muscles used in doing push-ups are:

A. biceps brachii and brachialis

B. supraspinatus and subscapularis

C. coracobrachialis and latissimus dorsi

D. triceps brachii and pectoralis major

17. Arm and leg muscles are arranged in antagonistic pairs. How does this affect their functioning?

A. It provides a backup if one of the muscles is injured.

B. One muscle of the pair pushes while the other pulls.

C. A single neuron controls both of them.

D. It allows the muscles to produce opposing movements.

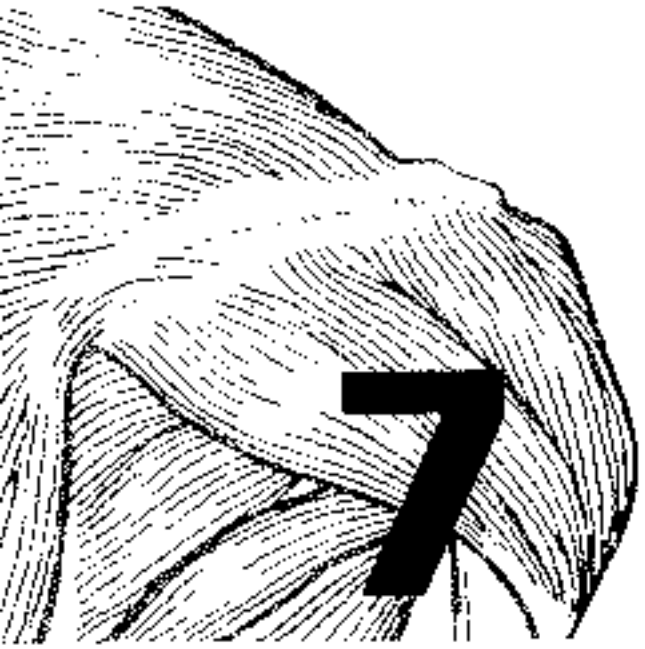
18. Muscle A and muscle B are the same size, but muscle A is capable of much finer control than muscle B. Which of the following is likely to be true of muscle A?

A. It is controlled by more neurons than muscle B.

B. It contains fewer motor units than muscle B.

C. It is controlled by fewer neurons than muscle B.

D. Each of its motor units consists of more cells than the motor units of muscle B.



7 THE NERVOUS SYSTEM

The nervous system is the master coordinating system of the body. Every thought, action, and sensation reflects its activity. The structures of the nervous system are described in terms of two principal divisions—the central nervous system (CNS) and the peripheral nervous system (PNS). The CNS (brain and spinal cord) interprets incoming sensory information and issues instructions based on past experience. The PNS (cranial and spinal nerves and ganglia) provides the communication lines between the CNS and the body's muscles, glands, and sensory receptors. The nervous system is also divided functionally in terms of motor activities into the somatic and autonomic divisions. It is important, however, to recognize that these classifications are made for the sake of convenience, and that the nervous system acts in an integrated manner both structurally and functionally.

Student activities provided in this chapter review neuron anatomy and physiology, identify the various structures of the central and peripheral nervous system, consider reflex and sensory physiology, and summarize autonomic nervous system anatomy and physiology. Because every body system is controlled, at least in part, by the nervous system, these understandings are extremely important to understanding how the body functions as a whole.

1. List the three major functions of the nervous system.

1. _____
2. _____
3. _____

ORGANIZATION OF THE NERVOUS SYSTEM

2. Choose the key responses that best correspond to the descriptions provided in the following statements. Insert the appropriate letter or term in the answer blanks.

Key Choices

A. Autonomic nervous system
B. Central nervous system (CNS)
C. Peripheral nervous system (PNS)
D. Somatic nervous system

_____ _____ 1. Nervous system subdivision that is composed of the brain and spinal cord

_____ 2. Subdivision of the PNS that controls voluntary activities such as the activation of skeletal muscles

_____ 3. Nervous system subdivision that is composed of the cranial and spinal nerves and ganglia

_____ 4. Subdivision of the PNS that regulates the activity of the heart and smooth muscle, and of glands; it is also called the involuntary nervous system

_____ _____ 5. A major subdivision of the nervous system that interprets incoming information and issues orders

_____ _____ 6. A major subdivision of the nervous system that serves as communication lines, linking all parts of the body to the CNS

NERVOUS TISSUE—STRUCTURE AND FUNCTION

3. This exercise emphasizes the difference between neurons and neuroglia. Indicate which cell type is identified by the following descriptions. Insert the appropriate letter or term in the answer blanks.

Key Choices

A. Neurons
B. Neuroglia

_____ _____ 1. Support, insulate, and protect cells

_____ _____ 2. Demonstrate irritability and conductivity, and thus transmit electrical messages from one area of the body to another area

_____ _____ 3. Release neurotransmitters

_____ _____ 4. Are amitotic

_____ _____ 5. Able to divide, therefore are responsible for most brain neoplasms

4. Relative to neuron anatomy, match the anatomical terms given in Column B with the appropriate descriptions of functions provided in Column A. Place the correct term or letter response in the answer blanks.

	Column A	Column B
_____	1. Releases neurotransmitters	A. Axon
_____	2. Conducts electrical currents toward the cell body	B. Axon terminal
_____	3. Increases the speed of impulse transmission	C. Dendrite
_____	4. Location of the nucleus	D. Myelin sheath
_____	5. Generally conducts impulses away from the cell body	E. Cell body

5. Certain activities or sensations are listed below. Using the key choices, select the specific receptor type that would be activated by the activity or sensation described. Insert the correct term(s) or letter response(s) in the answer blanks. Note that more than one receptor type may be activated in some cases.

Key Choices

A. Bare nerve endings (pain)
B. Golgi tendon organ
C. Meissner's corpuscle
D. Muscle spindle
E. Pacinian corpuscle

Activity or Sensation	Receptor Type
Walking on hot pavement	1. (Identify two) _____ and _____
Feeling a pinch	2. (Identify two) _____ and _____
Leaning on a shovel	3. _____
Muscle sensations when rowing a boat	4. (Identify two) _____ and _____
Feeling a caress	5. _____

6. Using the key choices, select the terms identified in the following descriptions by inserting the appropriate letter or term in the spaces provided.

Key Choices

A. Afferent neuron	F. Neuroglia	K. Proprioceptors
B. Association neuron (or interneuron)	G. Neurotransmitters	L. Schwann cells
C. Cutaneous sense organs	H. Nerve	M. Synapse
D. Efferent neuron	I. Nodes of Ranvier	N. Stimuli
E. Ganglion	J. Nuclei	O. Tract

____ 1. Sensory receptors found in the skin, which are specialized to detect temperature, pressure changes, and pain

_____ 2. Specialized cells that myelinate the fibers of neurons found in the PNS

_____ 3. Junction or point of close contact between neurons

_____ 4. Bundle of nerve processes inside the CNS

_____ 5. Neuron, serving as part of the conduction pathway between sensory and motor neurons

_____ 6. Gaps in a myelin sheath

_____ _____ 7. Collection of nerve cell bodies found outside the CNS

_____ _____ 8. Neuron that conducts impulses away from the CNS to muscles and glands

_____ _____ 9. Sensory receptors found in muscle and tendons that detect their degree of stretch

_____ 10. Changes, occurring within or outside the body, that affect nervous system functioning

_____ _____ _____ 11. Neuron that conducts impulses toward the CNS from the body periphery

_____ 12. Chemicals released by neurons that stimulate other neurons, muscles, or glands

7. Figure 7–1 is a diagram of a neuron. First, label the parts indicated on the illustration by leader lines. Then choose different colors for each of the structures listed below and use them to color in the coding circles and corresponding structures in the illustration. Next, circle the term in the list of three terms to the left of the diagram that best describes this neuron's structural class. Finally, draw arrows on the figure to indicate the direction of impulse transmission along the neuron's membrane.

- ◯ Axon
- ◯ Dendrites
- ◯ Cell body
- ◯ Myelin sheath

Unipolar

Bipolar

Multipolar

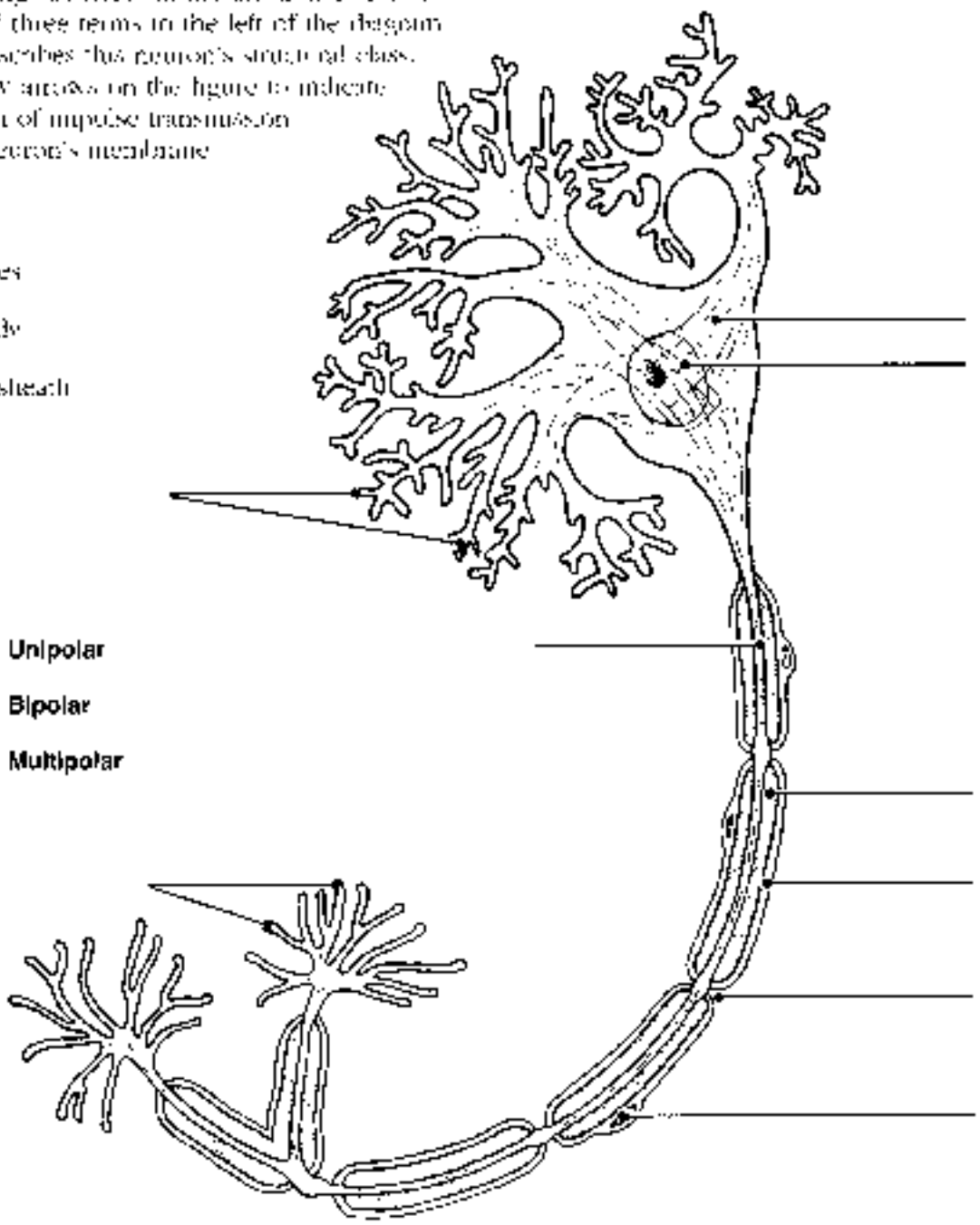


Figure 7–1

8. List in order the *minimum* elements in a reflex arc from the stimulus to the activity of the effector. Place your responses in the answer blanks.

1. Stimulus
2. _____
3. _____
4. _____
5. Effector organ

9. Using the key choices, identify the terms defined in the following statements. Place the correct term or letter response in the answer blanks.

Key Choices

A. Action potential	D. Potassium ions	G. Sodium ions
B. Depolarization	E. Refractory period	H. Sodium-potassium pump
C. Polarized	F. Repolarization	

_____ 1. Period of repolarization of the neuron during which it cannot respond to a second stimulus

_____ 2. State in which the resting potential is reversed as sodium ions rush into the neuron

_____ 3. Electrical condition of the plasma membrane of a resting neuron

_____ 4. Period during which potassium ions diffuse out of the neuron

_____ 5. Transmission of the depolarization wave along the neuron's membrane

6. The chief positive intracellular ion in a resting neuron

_____ 7. Process by which ATP is used to move sodium ions out of the cell and potassium ions back into the cell; completely restores the resting conditions of the neuron

10. Using the key choices, identify the types of reflexes involved in each of the following situations.

Key Choices

A. Somatic reflex(es) B. Autonomic reflex(es)

_____ 1. Patellar (knee-jerk) reflex

_____ 2. Pupillary light reflex

_____ 3. Effectors are skeletal muscles

_____ 4. Effectors are smooth muscle and glands

_____ 5. Flexor reflex

_____ 6. Regulation of blood pressure

_____ 7. Salivary reflex

11. Refer to Figure 7–2, showing a reflex arc, as you complete this exercise. First, briefly answer the following questions by inserting your responses in the spaces provided:

1. What is the stimulus? _____

2. What tissue is the effector? _____

3. How many synapses occur in this reflex arc? _____

Next, select different colors for each of the following structures and use them to color in the coding circles and corresponding structures in the diagram. Finally, draw arrows on the figure indicating the direction of impulse transmission through this reflex pathway.

- ◯ Receptor region
- ◯ Interneuron
- ◯ Afferent neuron
- ◯ Efferent neuron
- ◯ Effector

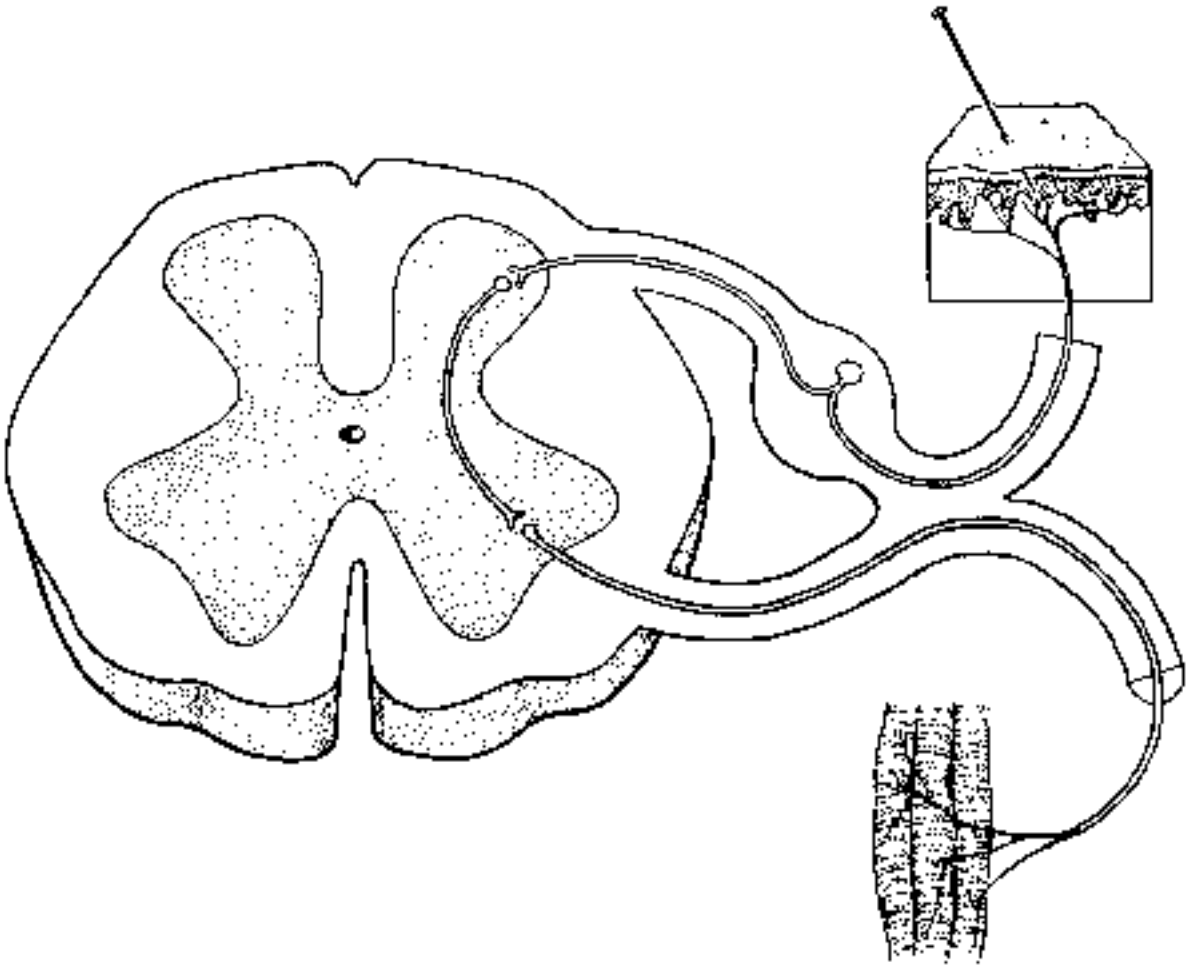


Figure 7–2

12. Circle the term that does not belong in each of the following groupings.

1. Astrocytes Neurons Oligodendrocytes Microglia
2. K^+ enters the cell K^+ leaves the cell Repolarization Refractory period
3. Nodes of Ranvier Myelin sheath Unmyelinated Saltatory conduction
4. Predictable response Voluntary act Involuntary act Reflex
5. Oligodendrocytes Schwann cells Myelin Microglia
6. Cutaneous receptors Free dendritic endings Stretch Pain and touch
7. Cell interior High Na^+ Low Na^+ High K^+

CENTRAL NERVOUS SYSTEM

Brain

13. Complete the following statements by inserting your answers in the answer blanks.

1. The largest part of the human brain is the (paired) (1) . The other major subdivisions of the brain are the (2) and the (3) . The cavities found in the brain are called (4) . They contain (5)

14. Circle the terms indicating structures that are *not* part of the brain stem.

Cerebral hemispheres Midbrain Medulla

Pons Cerebellum Diencephalon

15. Complete the following statements by inserting your answers in the answer blanks.

1. A (1) is an elevated ridge of cerebral cortex tissue. The convolutions seen in the cerebrum are important because they increase the (2) . Gray matter is composed of (3) . White matter is composed of (4) , which provide for communication between different parts of the brain as well as with lower CNS centers. The lentiform nucleus, the caudate, and other nuclei are collectively called the (5)

16. Figure 7–3 is a diagram of the right lateral view of the human brain. First, match the letters on the diagram with the following list of terms and insert the appropriate letters in the answer blanks. Then, select different colors for each of the areas of the brain provided with a color-coding circle and use them to color in the coding circles and corresponding structures in the diagram. If an identified area is part of a lobe, use the color you selected for the lobe but use *stripes* for that area.

_____ 1. ◯ Frontal lobe

_____ 2. ◯ Parietal lobe

_____ 3. ◯ Temporal lobe

_____ 4. ◯ Precentral gyrus

_____ 5. Parieto-occipital fissure

_____ 6. ◯ Postcentral gyrus

_____ 7. Lateral sulcus

_____ 8. Central sulcus

_____ 9. ◯ Cerebellum

_____ 10. ◯ Medulla

_____ 11. ◯ Occipital lobe

_____ 12. ◯ Pons

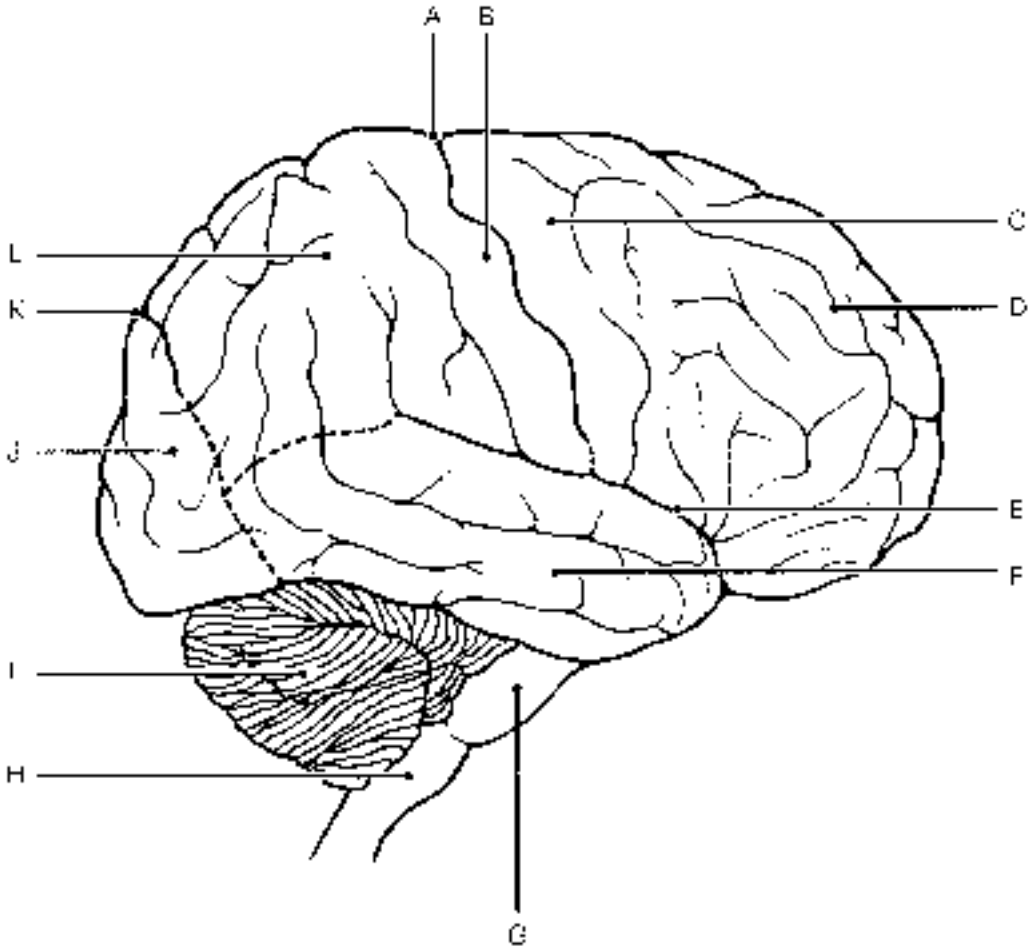


Figure 7–3

17. Figure 7–4 is a diagram of the sagittal view of the human brain. First, match the letters on the diagram with the following list of terms and insert the appropriate letter in each answer blank. Then, color the brain-stem areas blue and the areas where cerebrospinal fluid is found yellow.

_____ 1. Cerebellum

_____ 2. Cerebral aqueduct

_____ 3. Cerebral hemisphere

_____ 4. Cerebral peduncle

_____ 5. Choroid plexus

_____ 6. Corpora quadrigemina

_____ 7. Corpus callosum

8. Fourth ventricle

_____ 9. Mammillary body

_____ 10. Medulla oblongata

_____ 11. Optic chiasma

_____ 12. Pineal body

_____ 13. Pituitary gland

_____ 14. Pons

_____ 15. Thalamus

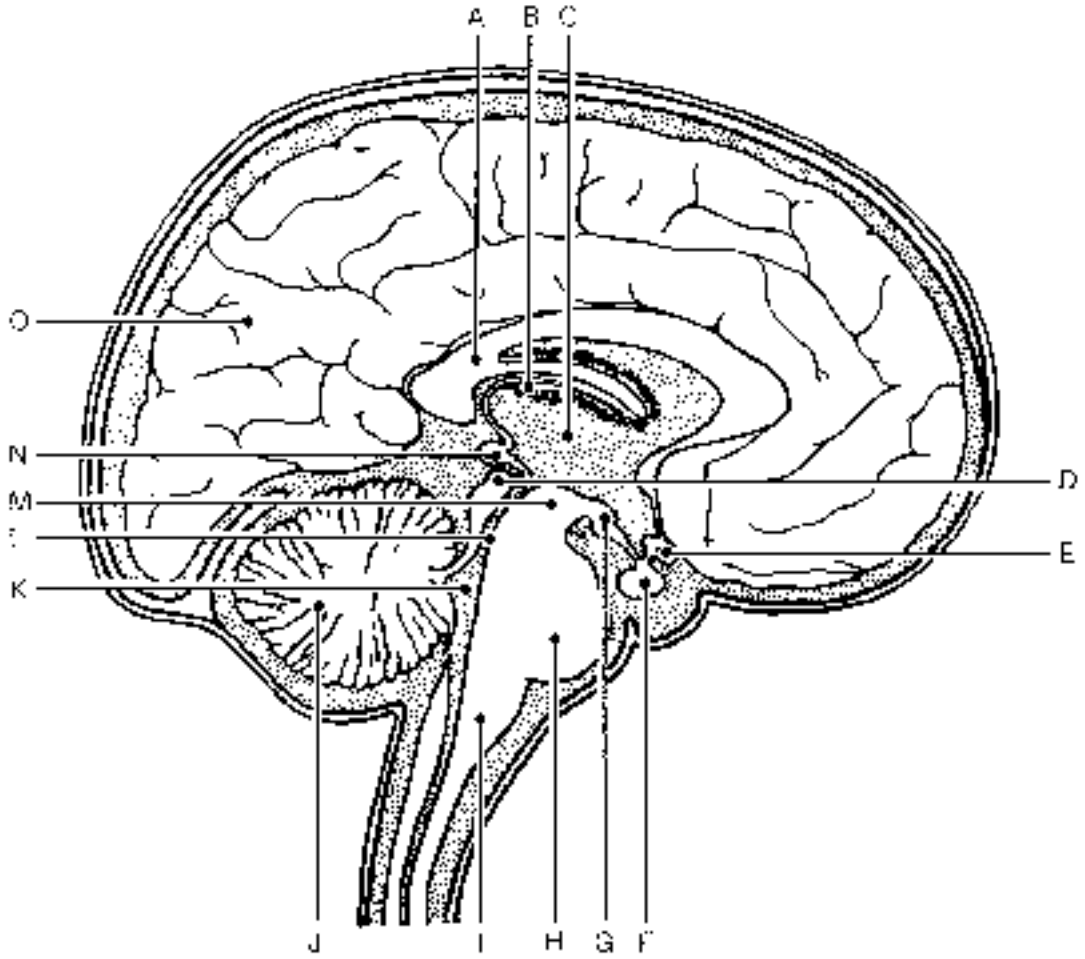


Figure 7–4

18. Referring to the brain areas listed in Exercise 17, match the appropriate brain structures with the following descriptions. Insert the correct terms in the answer blanks.

_____ 1. Site of regulation of water balance and body temperature

_____ 2. Contains reflex centers involved in regulating respiratory rhythm in conjunction with lower brain stem centers

_____ 3. Responsible for the regulation of posture and coordination of skeletal muscle movements

_____ 4. Important relay station for afferent fibers traveling to the sensory cortex for interpretation

_____ 5. Contains autonomic centers, which regulate blood pressure and respiratory rhythm, as well as coughing and sneezing centers

_____ 6. Large fiber tract connecting the cerebral hemispheres

_____ 7. Connects the third and fourth ventricles

_____ 8. Encloses the third ventricle

_____ 9. Forms the cerebrospinal fluid

_____ 10. Midbrain area that is largely fiber tracts, bulges anteriorly

_____ 11. Part of the limbic system, contains centers for many drives (rage, pleasure, hunger, sex, etc.)

19. Some of the following brain structures consist of gray matter, others are white matter. Write G (for gray) or W (for white) as appropriate.

_____ 1. Cortex of cerebellum

_____ 2. Basal nuclei

_____ 3. Anterior commissure

_____ 4. Corpus callosum

_____ 5. Pyramids

_____ 6. Thalamic nuclei

_____ 7. Cerebellar peduncle

20. Figure 7–5 illustrates a "see-through" brain showing the positioning of the ventricles and connecting canals or apertures. Correctly identify all structures having leader lines by using the key choices provided below. One of the lateral ventricles has already been identified. Color the spaces filled with cerebrospinal fluid blue.

Key Choices

A. Anterior horn	D. Fourth ventricle	G. Lateral aperture
B. Central canal	E. Inferior horn	H. Third ventricle
C. Cerebral aqueduct	F. Interventricular foramen	

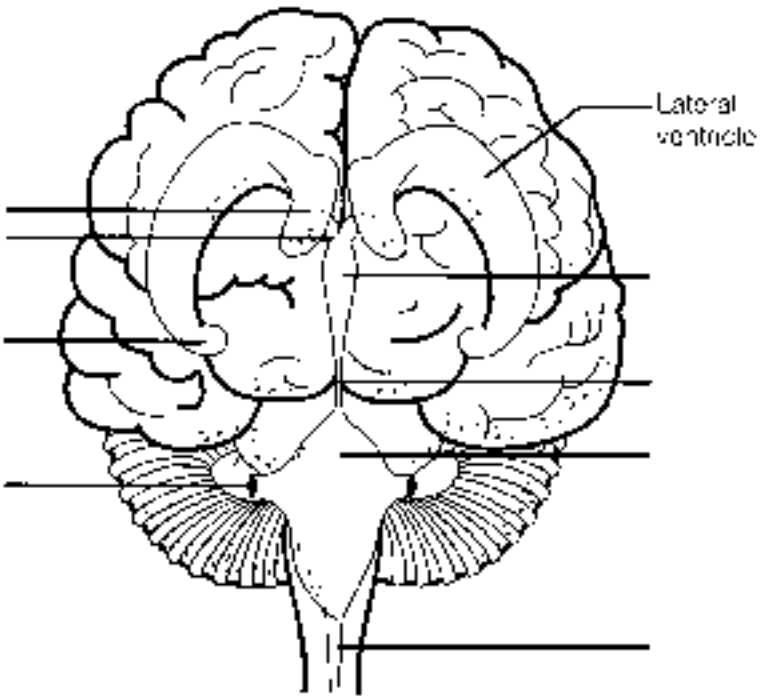


Figure 7–5

21. If a statement is true, write the letter *T* in the answer blank. If a statement is false, correct the underlined word(s) and write the correct word(s) in the answer blank.

_____ 1. The primary somatosensory area of the cerebral hemisphere(s) is found in the precentral gyrus.

_____ 2. Cortical areas involved in audition are found in the occipital lobe.

_____ 3. The primary motor area in the temporal lobe is involved in the initiation of voluntary movements.

_____ 4. The specialized motor speech area is located at the base of the precentral gyrus in an area called Wernicke's area.

_____ 5. The right cerebral hemisphere receives sensory input from the right side of the body.

_____ 6. The pyramidal tract is the major descending voluntary motor tract.

_____ 7. The primary motor cortex is located in the postcentral gyrus.

_____ 8. Centers for control of repetitious or stereotyped motor skills are found in the primary motor cortex.

_____ 9. The largest parts of the motor homunculi are the lips, tongue, and toes.

_____ 10. Sensations such as touch and pain are integrated in the primary sensory cortex.

_____ 11. The primary visual cortex is in the frontal lobe of each cerebral hemisphere.

_____ 12. In most humans, the area that controls the comprehension of language is located in the left cerebral hemisphere.

_____ 13. A flat EEG is evidence of clinical death.

_____ 14. Beta waves are recorded when an individual is awake and relaxed.

Protection of the CNS

22. Identify the meningeal (or associated) structures described here.

_____ 1. Outermost covering of the brain, composed of tough fibrous connective tissue

_____ 2. Innermost covering of the brain; delicate and vascular

_____ 3. Structures that return cerebrospinal fluid to the venous blood in the dural sinuses

_____ 4. Middle meningeal layer; like a cobweb in structure

_____ 5. Its outer layer forms the periosteum of the skull.

23. Figure 7-6 shows a frontal view of the meninges of the brain at the level of the superior sagittal (dural) sinus. First, label the *arachnoid villi* on the figure. Then, select different colors for each of the following structures and use them to color the coding circles and corresponding structures in the diagram.

◯ Dura mater

◯ Pia mater

◯ Arachnoid mater

◯ Subarachnoid space

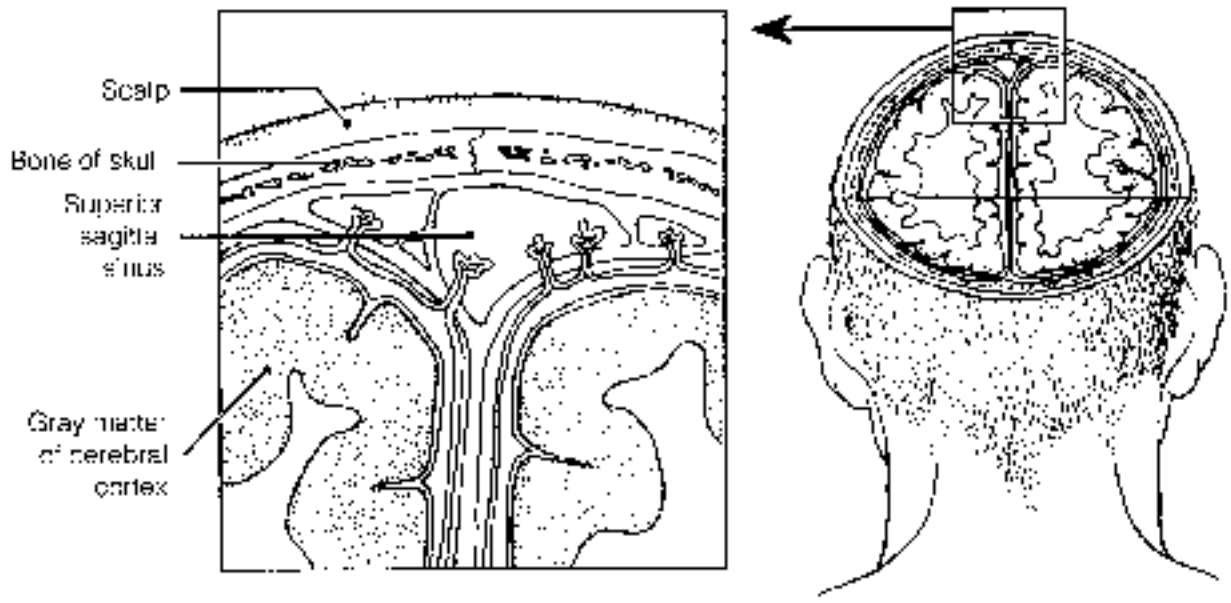


Figure 7-6

24. Complete the following statements by inserting your answers in the answer blanks.

_____ 1. Cerebrospinal fluid is formed by capillary knots called __(1)__, which hang into the __(2)__ of the brain. Ordinarily, cerebro-
_____ 2. spinal fluid flows from the lateral ventricles to the third ventricle and then through the __(3)__ to the fourth ventricle.
_____ 3. Some of the fluid continues down the __(4)__ of the spinal cord, but most of it circulates into the __(5)__ by passing
_____ 4. through three tiny openings in the walls of the __(6)__. As a rule, cerebrospinal fluid is formed and drained back into the
_____ 5. venous blood at the same rate. If its drainage is blocked, a condition called __(7)__ occurs, which results in increased
_____ 6 pressure on the brain.

_____ 7

Brain Dysfunctions

25. Match the brain disorders listed in Column B with the conditions described in Column A. Place the correct answers in the answer blanks.

	Column A	Column B
_____	1. Slight and transient brain injury	A. Alzheimer's disease
_____	2. Traumatic injury that destroys brain tissue	B. Cerebral edema
_____	3. Total nonresponsiveness to stimulation	C. Cerebrovascular accident (CVA)
	4. May cause medulla oblongata to be wedged into foramen magnum by pressure of blood	D. Coma
_____	5. After head injury, retention of water by brain	E. Concussion
_____	6. Results when a brain region is deprived of blood or exposed to prolonged ischemia	F. Contusion
_____	7. Progressive degeneration of the brain with abnormal protein deposits	G. Intracranial hemorrhage
_____	8. Autoimmune disorder with extensive demyelination	H. Multiple sclerosis
_____	9. A mini-stroke; fleeting symptoms of a CVA	I. Transient ischemic attack (TIA)

Spinal Cord

26. Complete the following statements by inserting your responses in the answer blanks.

The spinal cord extends from the _(1)_ of the skull to the (2) region of the vertebral column. The meninges, which cover the spinal cord, extend more inferiorly to form a sac from which cerebrospinal fluid can be withdrawn without damage to the spinal cord. This procedure is called a (3) . (4) pairs of spinal nerves arise from the cord. Of these, (5) pairs are cervical nerves, (6) pairs are thoracic nerves, (7) pairs are lumbar nerves, and (8) pairs are sacral nerves. The tail-like collection of spinal nerves at the inferior end of the spinal cord is called the (9)

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____

27. Using the key choices, select the appropriate terms to respond to the following descriptions referring to spinal cord anatomy. Place the correct term or letter in the answer blanks.

Key Choices

A. Afferent
B. Efferent
C. Both afferent and efferent
D. Association neurons (interneurons)

_____ 1. Neuron type found in the dorsal horn

_____ 2. Neuron type found in the ventral horn

_____ 3. Neuron type in a dorsal root ganglion

_____ 4. Fiber type in the ventral root

_____ 5. Fiber type in the dorsal root

_____ 6. Fiber type in a spinal nerve

_____ 7. Fiber type in the anterior rami

_____ 8. Damage to this fiber type would lead to a loss of sensory function

_____ 9. Damage to this fiber type results in a loss of motor function

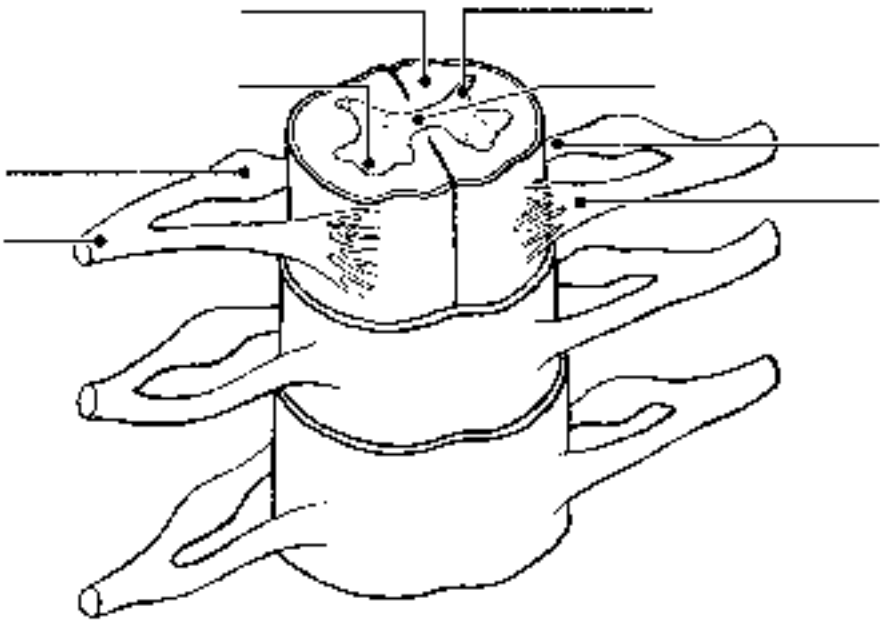
28. Figure 7–7 is a cross-sectional view of the spinal cord. First identify the items listed in the key choices by inserting the correct letters next to the appropriate leader lines on parts A and B of the figure. Then, color the bones of the vertebral column in part B gold.

Key Choices

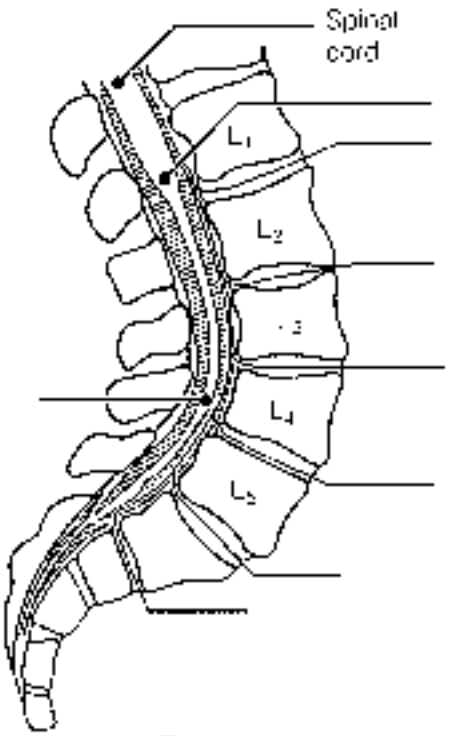
A Central canal	E Dorsal root	I Ventral horn
B Columns of white matter	F Dorsal root ganglion	J Ventral root
C Conus medullaris	G Filum terminale	
D Dorsal horn	H Spinal nerve	

On part A, color the butterfly-shaped gray matter gray, and color the spinal nerves and roots yellow. Finally, select different colors to identify the following structures and use them to color the figure.

◯ Pia mater ◯ Dura mater ◯ Arachnoid mater



A



B

Figure 7–7

PERIPHERAL NERVOUS SYSTEM

Structure of a Nerve

29. Figure 7–8 is a diagrammatic view of a nerve wrapped in its connective tissue coverings. Select different colors to identify the following structures and use them to color the coding circles and corresponding structures in the figure. Then, label each of the sheaths indicated by leader lines on the figure.

( ) Endoneurium ( ) Perineurium ( ) Epineurium

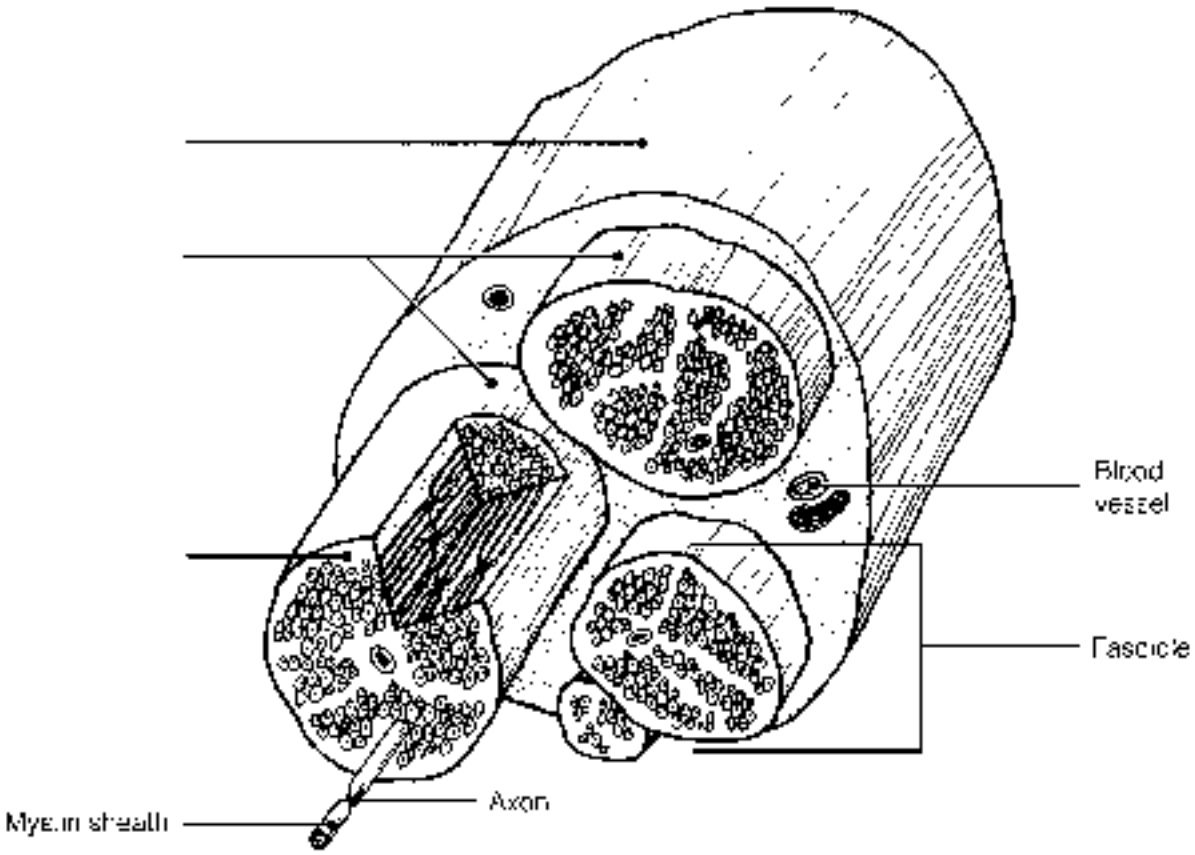


Figure 7–8

30. Complete the following statements by inserting your responses in the answer blanks.

_____ 1.
_____ 2.
_____ 3.

Another name for a bundle of nerve fibers is __(1)__. Nerves carrying both sensory and motor fibers are called __(2)__ nerves, whereas those carrying just sensory fibers are referred to as sensory, or __(3)__, nerves.

Cranial Nerves

31. The 12 pairs of cranial nerves are indicated by leader lines in Figure 7–9. First, label each by name and Roman numeral on the figure and then color each nerve with a different color.

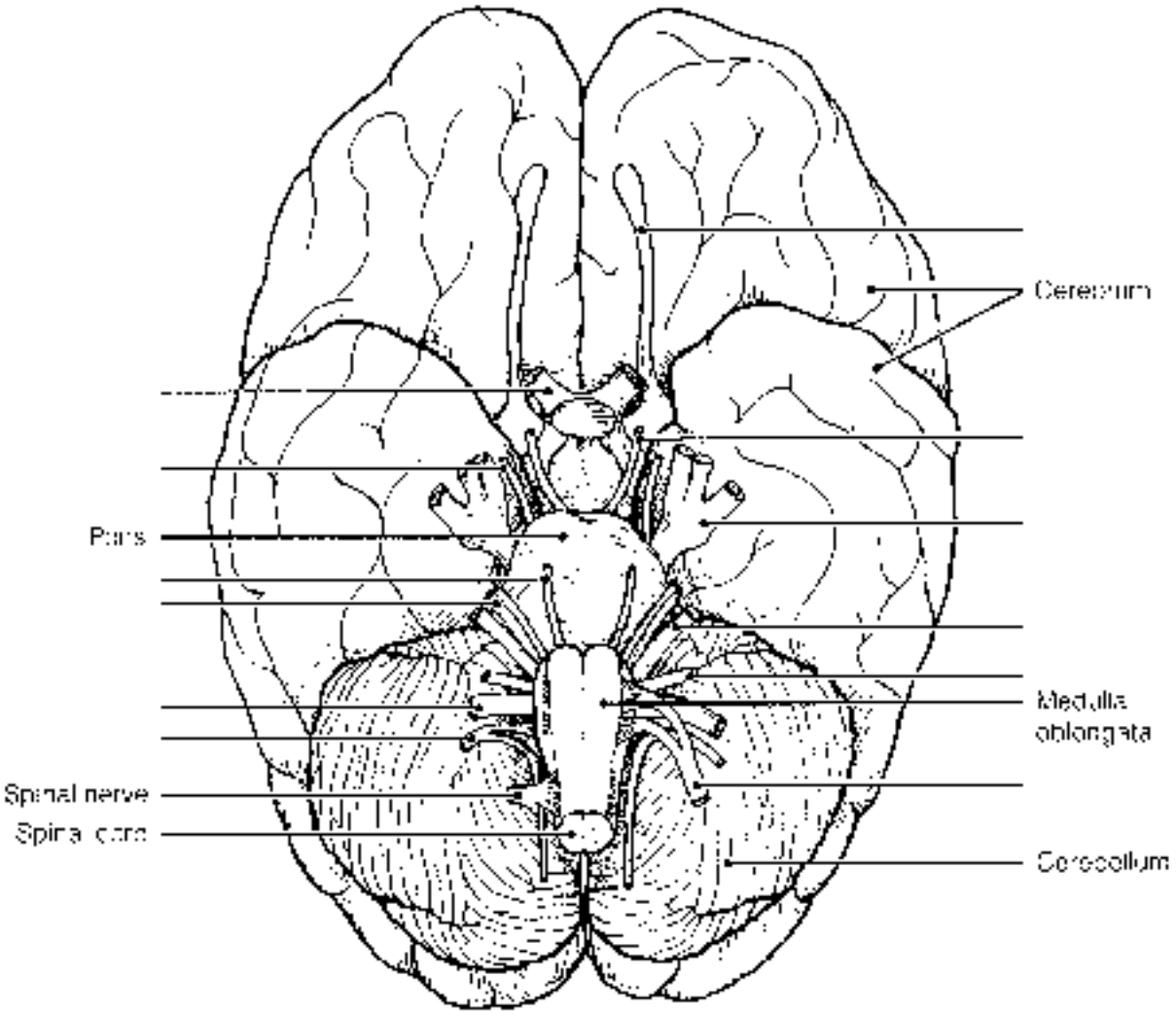


Figure 7–9

32. Provide the name and number of the cranial nerves involved in each of the following activities, sensations, or disorders. Insert your response in the answer blanks.

_____ 1. Shrugging the shoulders

2. Smelling a flower

3. Raising the eyelids and focusing the lens of the eye for accommodation, constriction of the eye pupils

_____ 4. Slows the heart; increases the motility of the digestive tract

_____ 5. Involved in smiling

_____ 6. Involved in chewing gum

7. Listening to music; seasickness

_____ 8. Sensation of salty taste during well-seasoned food

_____ 9. Involved in "rolling" the eyes (three nerves—provide numbers only)

_____ 10. Feeling a toothache

_____ 11. Reading *Teens* magazine or this study guide

_____ 12. Purely sensory (three nerves—provide numbers only)

Spinal Nerves and Nerve Plexuses

33. Complete the following statements by inserting your responses in the answer blanks.

_____ 1. The ventral rami of spinal nerves C_1 through T_1 and L_1 through S_4 take part in forming (1), which serve the (2) of the

_____ 2. body. The ventral rami of T_1 through T_{12} run between the ribs to serve the (3). The posterior rami of the spinal nerves

_____ 3. serve the (4).

_____ 4.

34. Figure 7–10 is an anterior view of the principal nerves arising from the brachial plexus. Select five different colors and color the coding circles and the nerves listed below. Also, label each nerve by inserting its name at the appropriate leader line.

- ◯ Axillary nerve
- ◯ Musculocutaneous nerve
- ◯ Median nerve
- ◯ Radial nerve
- ◯ Ulnar nerve

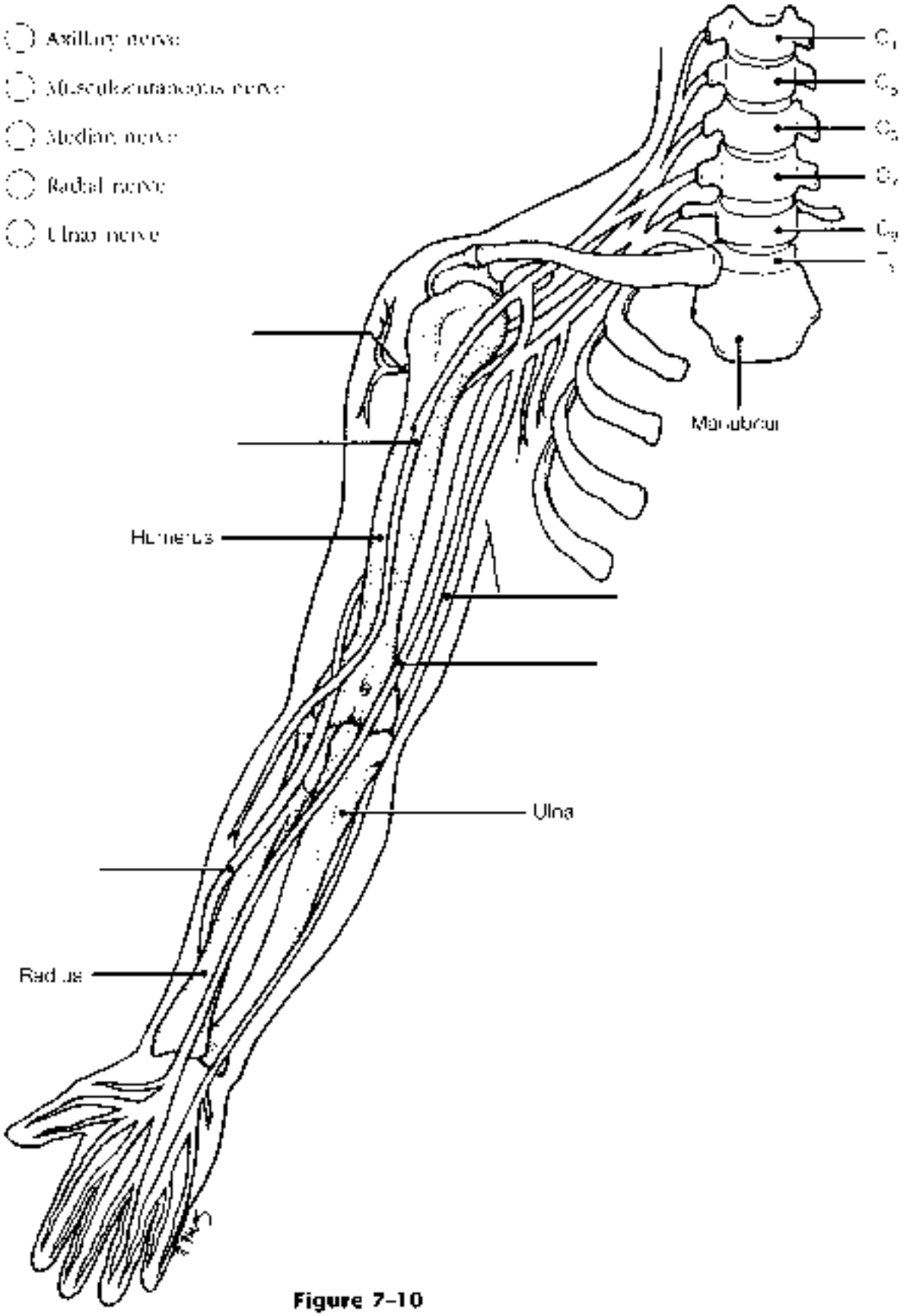


Figure 7–10

35. Name the major nerves that serve the following body areas. Insert your responses in the answer blanks.

_____ 1. Neck and shoulders (plexus only)

2. Abdominal wall (plexus only)

_____ 3. Anterior thigh

_____ 4. Diaphragm

_____ 5. Posterior thigh

_____ _____ 6. Leg and foot (2)

Autonomic Nervous System (ANS)

36. Identify, by color coding and coloring, the following structures in Figure 7–11, which depicts the major anatomical differences between the somatic and autonomic motor divisions of the PNS. Also identify by labeling all structures provided with leader lines.

- ◯ Somatic motor neuron
- ◯ ANS preganglionic neuron
- ◯ ANS ganglionic neuron
- ◯ Autonomic ganglion
- ◯ Gray matter of spinal cord (CNS)
- ◯ Effector of the somatic motor neuron
- ◯ Effector of the autonomic motor neuron
- ◯ Myelin sheath
- ◯ White matter of spinal cord (CNS)

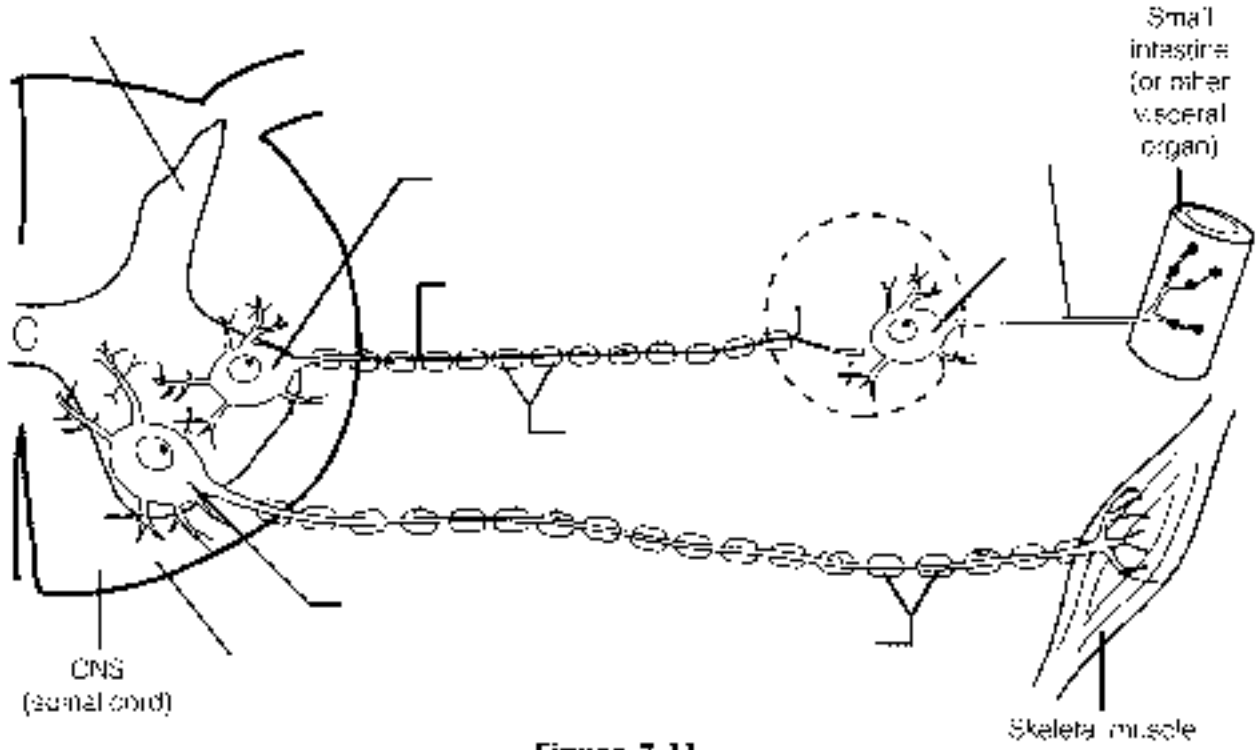


Figure 7–11

37. The following table indicates a number of conditions. Use a check (✓) to show which division of the autonomic nervous system is involved in each condition. Then, respond to the true-to-life situation below the chart.

Condition	Sympathetic	Parasympathetic
1. Postganglionic axons secrete norepinephrine; adrenergic fibers		
2. Postganglionic axons secrete acetylcholine; cholinergic fibers		
3. Long preganglionic axon, short postganglionic axon		
4. Short preganglionic axon, long postganglionic axon		
5. Arises from cranial and sacral nerves		
6. Arises from spinal nerves T_1 to L_3		
7. Normally in control		
8. Fight or flight system		
9. Has more specific control		
10. Causes a dry mouth, dilates bronchioles		
11. Constricts eye pupils, decreases heart rate		

You are alone in your home late in the evening, and you hear an unfamiliar sound in your backyard. In the spaces provided, list four physiologic events promoted by the sympathetic nervous system that would help you to cope with this rather frightening situation.

1. _____
2. _____
3. _____
4. _____

DEVELOPMENTAL ASPECTS OF THE NERVOUS SYSTEM

38. Complete the following statements by inserting your responses in the answer blanks.

1. Body temperature regulation is a problem in premature infants because the (1) is not yet fully functional. Cerebral palsy involves crippling neuromuscular problems. It usually is a result of a lack of (2) to the infant's brain during delivery. Normal maturation of the nervous system occurs in a (3) direction, and fine control occurs much later than (4) muscle control. The sympathetic nervous system becomes less efficient as aging occurs, resulting in an inability to prevent sudden changes in (5) when abrupt changes in position are made. The usual cause of decreasing efficiency of the nervous system as a whole is (6). A change in intellect caused by a gradual decrease in oxygen delivery to brain cells is called (7). Death of brain neurons, which results from a sudden cessation of oxygen delivery, is called a (8).

INCREDIBLE JOURNEY

A Visualization Exercise for the Nervous System

You climb on the first cranial nerve you see . . .

39. Where necessary, complete statements by inserting the missing words in the answer blanks.

1. Nervous tissue is quite densely packed, and it is difficult to envision strolling through its various regions. Imagine instead that each of the various functional regions of the brain has a computerized room where you can observe what occurs in that particular area. Your assignment is to determine where you are at any given time during your journey through the nervous system.

You begin your journey after being miniaturized and injected into the waste pipe of cerebrospinal fluid in your host's fourth ventricle. As you begin your stroll through the nervous tissue, you notice a huge area of branching white matter overhead. As you enter the first computer room you hear an announcement through the loudspeaker. "The pelvis is tipping too far posteriorly. Please correct. We are beginning to fall backward and will soon lose our balance." The computer responds immediately, decreasing impulses to the posterior hip muscles and increasing impulses to the anterior thigh muscles. "How is that, proprioceptor 1?" From this information, you determine that your first stop is the (1).

_____ 2.

_____ 3

_____ 4

_____ 5.

_____ 6

_____ 7

_____ 8

_____ 9

_____ 10

_____ 11

_____ 12

At the next computer room, you hear, "Blood pressure to heart is falling, increase sympathetic nervous system stimulation of the blood vessels." Then, as it becomes apparent that your host has not only stood up but is going to run, you hear, "Increase rate of impulses to the brain and respiratory muscles. We are going to need more oxygen and a faster blood flow to the skeletal muscles of the legs." You recognize that this second stop must be the _123_

Computer room 3 presents a problem. There is no loudspeaker here. Instead, incoming messages keep flashing across the wall, giving only fragmentary pieces of information. "Four hours since last meal: stimulate appetite center. Slight decrease in body temperature indicates skin vasoconstriction. Mouth dry: stimulate thirst center. Oh, a stroke on the arm: stimulate pleasure center." Looking at what has been recorded here—appetite, temperature, thirst, and pleasure—you conclude that this has to be the _132_

Continuing your journey upward toward the higher brain centers, finally you are certain that you have reached the cerebral cortex. The first center you visit is quiet, like a library with millions of "encyclopedias" of facts and recordings of past input. You conclude that this must be the area where _111_ are stored and that you are in the _151_ lobe. The next stop is close-by. As you enter the computer center you once again hear a loudspeaker: "Let's have the motor instructions to say 'rationalization.' Hurry, we don't want them to think we're tongue-tied." This area is obviously _161_. Your final stop in the cerebral cortex is a very hectic center. Electrical impulses are traveling back and forth between giant neurons, sometimes to different directions and sometimes back and forth between a small number of neurons. Watching intently, you try to make some sense out of these interactions and suddenly realize that this is what is happening here. The neurons are trying to make some sense out of something, and this helps you decide that this must be the brain area where _171_ occurs in the _181_ lobe.

You hurry out of this center and retrace your steps back to the cerebrospinal fluid, deciding en route to observe a cranial nerve. You decide to pick one randomly and follow it to the organ it serves. You climb on to the first cranial nerve you see and slide down past the throat. Picking up speed, you quickly pass the heart and lungs and see the stomach and small intestine coming up fast. A moment later you land on the stomach and now you know that this wandering nerve has to be the _191_. As you look upward, you see that the nerve is traveling almost straight up and that you'll have to find an alternative route back to the cerebrospinal fluid. You begin to walk posterior only until you find a spinal nerve, which you follow until you reach the vertebral column. You squeeze between two adjacent vertebrae to follow the nerve to the spinal cord. With your pocket knife you cut away the tough connective tissue covering the cord. Thinking that the _200_ covering deserves its name, you finally manage to cut an opening large enough to get through, and you return to the warm bath of cerebrospinal fluid that it encloses. At this point you are in the _119_, and from here you swam upward until you get to the lower brain stem. Once there, it should be an easy task to find the holes leading into the _120_ ventricle, where your journey began.

AT THE CLINIC

40. After surgery, patients are often temporarily unable to urinate, and bowel sounds are absent. Identify the division of the autonomic nervous system that is affected by anesthesia.

41. A brain tumor is found in a CT scan of Mr. Childs's head. The physician is assuming that it is not a secondary tumor (i.e., it did not spread from another part of the body) because an exhaustive workup has revealed no signs of cancer elsewhere in Mr. Childs's body. Is the brain tumor more likely to have developed from nerve tissue or from neuroglia? Why?

42. Amy, a high-strung teenager, was suddenly startled by a loud bang that sounded like a gunshot. Her heartbeat accelerated rapidly. When she realized that the noise was only a car backfiring, she felt greatly relieved but her heart kept beating heavily for several minutes more. Why does it take a long time to calm down after we are scared?

43. You have been told that the superior and medial part of the right precentral gyrus of your patient's brain has been destroyed by a stroke. What part of the body is the patient unable to move? On which side, right or left?

44. *Application of knowledge* You have been given all of the information needed to identify the brain regions involved in the following situations. See how well your nervous system has integrated this information, and name the brain region (or condition) most likely to be involved in each situation. Place your responses in the answer blanks.

1. Following a brain accident, a man with an obvious head injury was observed stumbling about the scene. An inability to walk properly and a loss of balance were quite obvious. What brain region was injured?

2. An elderly woman is admitted to the hospital to have a gallbladder operation. While she is being cared for, the nurse notices that she has trouble initiating movement and has a strange "pill-rolling" tremor of her hands. What cerebral area is most likely involved?

3. A child is brought to the hospital with a high temperature. The doctor states that the child's meninges are inflamed. What name is given to this condition?

4. A young woman is brought into the emergency room with extremely dilated pupils. Her friends state that she has overdosed on cocaine. What cranial nerve is stimulated by the drug?

5. A young man has just received serious burns, resulting from standing with his back too close to a bonfire. He is muttering that he never felt the pain. Otherwise, he would have smothered the flames by rolling on the ground. What part of his CNS might be malfunctioning?

6. An elderly gentleman has just suffered a stroke. He is able to understand verbal and written language, but when he tries to respond, his words are garbled. What cortical region has been damaged by the stroke?

7. A 12-year-old boy suddenly falls to the ground, having an epileptic seizure. He is rushed to the emergency room of the local hospital for medication. His follow-up care includes a recording of his brain waves to try to determine the area of the lesion. What is this procedure called?

45. Marie Nolin exhibits slow, tentative movements and a very unstable gait. Examination reveals she cannot touch her finger to her nose with eyes closed. What is the name of this condition and what part of her brain is damaged?

46. Which would be the more likely result of injury to the posterior side of the spinal cord only—paralysis or paresthesia (loss of sensory input)? Explain your answer.

47. While jogging to Riverside Park, Susan was confronted by an angry dog. What division of her ANS was activated as she turned tail and ran from the dog?

48. During action potential transmission, many ions cross the neuronal membrane at right angles to the membrane. What is it that travels *along* the membrane and acts as the signal?

THE FINALE: MULTIPLE CHOICE

49. Select the best answer or answers from the choices given.

1. Bipolar neurons
   A. are found in the head
   B. are always part of an afferent pathway
   C. have two dendrites
   D. have two axons

2. Which of the following skin cells would form a junction with a motor neuron?
   A. Keratinocyte
   B. Sudoriferous glandular epithelial cell
   C. Arrector pili muscle cell
   D. Fibroblast

3. A synapse between an axon terminal and a neuron cell body is called:
   A. axodendritic
   B. axosomatic
   C. axoaxonic
   D. axoneuronic

4. Which is an incorrect association of brain region and ventricle?
   A. Mesencephalon—third ventricle
   B. Cerebral hemispheres—lateral ventricles
   C. Pons—fourth ventricle
   D. Medulla—fourth ventricle

5. The pineal gland is located in the:
   A. hypophysis cerebri
   B. mesencephalon
   C. epithalamus
   D. corpus callosum

6. Which of the following is not part of the brain stem?
   A. Medulla
   B. Cerebellum
   C. Pons
   D. Midbrain

7. When neurons in Wernicke's area send impulses to neurons in Broca's area, the white matter tracts utilized are:
   A. commissural fibers
   B. projection fibers
   C. association fibers
   D. arterial funiculus

8. Functions that are at least partially overseen by the medulla are
   A. regulation of the heart
   B. maintaining equilibrium
   C. regulation of respiration
   D. visceral motor function

9. Which structures are directly involved with formation, circulation, and drainage of CSF?
   A. Ependymal cilia
   B. Ventricular choroid plexuses
   C. Arachnoid villi
   D. Serous layers of the dura mater

10. In an earthquake, which type of sensory receptor is most likely to sound the *first* alarm?
    A. Exteroceptor
    B. Visceroceptor
    C. Mechanoreceptor
    D. Proprioceptor

11. Cranial nerves that have some function in vision include the:

    A. trochlear C. abducens
    B. trigeminal D. facial

12. Eating difficulties would result from damage to the:

    A. mandibular division of trigeminal nerve
    B. facial nerve
    C. glossopharyngeal nerve
    D. vagus nerve

13. If the right trapezius and sternocleidomastoid muscles were atrophied, you would suspect damage to the:

    A. vagus nerve
    B. motor branches of the cervical plexus
    C. facial nerve
    D. accessory nerve

14. Which nerve structures muscles that flex the forearm?

    A. Ulnar C. Radial
    B. Musculocutaneous D. Median

15. Motor functions of arm, forearm, and fingers would be affected by damage to which one of these nerves?

    A. Radial C. Ulnar
    B. Axillary D. Median

16. An inability to extend the leg would result from a loss of function of the:

    A. lateral femoral cutaneous nerve
    B. ilioinguinal nerve
    C. saphenous branch of femoral nerve
    D. femoral nerve

Use the following choices to respond to questions 17–28:

A. sympathetic division
B. parasympathetic division
C. both sympathetic and parasympathetic
D. neither sympathetic nor parasympathetic

___ 17. Typically has long preganglionic and short postganglionic fibers

__ 18. Some fibers utilize gray rami communicantes

__ 19. Courses through spinal nerves

__ 20. Has splanchnic nerves

___ 21. Courses through cranial nerves

_____ 22. Originates in cranial nerves

_____ 23. Effects enhanced by direct stimulation of a hormonal mechanism

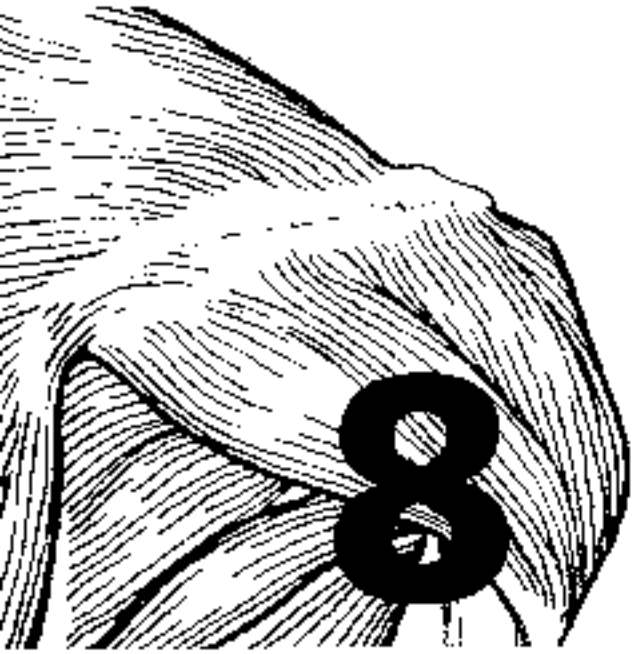
_____ 24. Includes otic ganglion

_____ 25. Includes celiac ganglion

_____ 26. Hypoactivity of this division would lead to decrease in metabolic rate

_____ 27. Has widespread, long-lasting effects

28. Sets the tone for the heart



8 SPECIAL SENSES

The body's sensory receptors react to stimuli or changes occurring both within the body and in the external environment. When triggered, these receptors send nerve impulses along afferent pathways to the brain for interpretation, thus allowing the body to assess and adjust to changing conditions so that homeostasis may be maintained.

The minute receptors of general sensation that react to touch—pressure, pain, temperature changes, and muscle tension—are widely distributed in the body. These are considered in Chapter 7. In contrast, receptors of the special senses—sight, hearing, equilibrium, smell, and taste—tend to be localized and in many cases are quite complex. The structure and function of the special sense organs are the subjects of the student activities in this chapter.

THE EYE AND VISION

1. Complete the following statements by inserting your responses in the answer blanks.

_____ _____ 1. Attached to the eyes are the __(1)__ muscles that allow us to direct our eyes toward a moving object. The anterior aspect
_____ _____ 2. of each eye is protected by the __(2)__, which have eyelashes projecting from their edges. Closely associated with the lashes
_____ _____ 3. are oil-secreting glands called __(3)__ that help to lubricate the eyes. Inflammation of the mucous lining the eyelids and cov-
_____ _____ 4. ering the anterior part of the eyeball is called __(4)__.

2. Trace the pathway that the secretion of the lacrimal glands takes from the surface of the eye by assigning a number to each structure. (Note that #1 will be closest to the lacrimal gland.)

_____ 1. Lacrimal sac
_____ 2. Nasal cavity
_____ 3. Nasolacrimal duct
_____ 4. Lacrimal canals

3. Identify each of the eye muscles indicated by leader lines in Figure 8–1. Color code and color each muscle a different color. Then, in the blanks below, indicate the eye movement caused by each muscle.

◯ 1. Superior rectus _____ ◯ 4. Lateral rectus _____

◯ 2. Inferior rectus _____ ◯ 5. Medial rectus _____

◯ 3. Superior oblique _____ ◯ 6. Inferior oblique _____

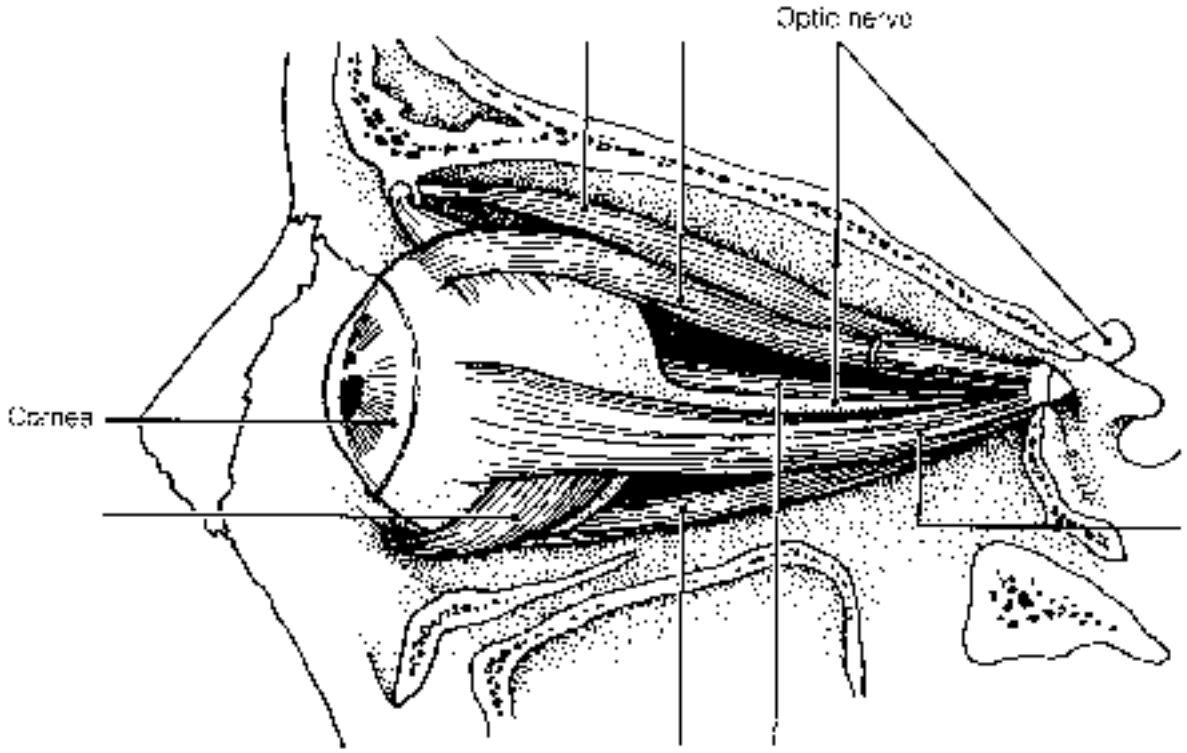


Figure 8–1

4. Three main accessory eye structures contribute to the formation of tears and/or aid in lubricating the eyeball. In the table, name each structure and then name its major secretory product. Indicate which of the secretions has antibacterial properties by circling that response.

Accessory eye structures	Secretory product
1.	
2.	
3.	

5. Match the terms provided in Column B with the appropriate descriptions in Column A. Insert the correct letter response or corresponding term in the answer blanks.

	Column A	Column B
_____	1. Light bending	A. Accommodation
_____	2. Ability to focus for close vision (under 20 feet)	B. Accommodation pupillary reflex
_____	3. Normal vision	C. Astigmatism
_____	4. Inability to focus well on close objects; farsightedness	D. Cataract
_____	5. Reflex constriction of pupils when they are exposed to bright light	E. Convergence
_____	6. Clouding of the lens, resulting in loss of sight	F. Emmetropia
_____	7. Nearsightedness	G. Glaucoma
_____	8. Blurred vision, resulting from unequal curvatures of the lens or cornea	H. Hyperopia
_____	9. Condition of increasing pressure inside the eye, resulting from blocked drainage of aqueous humor	I. Myopia
_____	10. Medial movement of the eyes during focusing on close objects	J. Night blindness
_____	11. Reflex constriction of the pupils when viewing close objects	K. Photopupillary reflex
_____	12. Inability to see well in the dark; often a result of vitamin A deficiency	L. Refraction

6. The intrinsic eye muscles are under the control of which division of the nervous system? Circle the correct response.

1. Autonomic nervous system 2. Somatic nervous system

7. Complete the following statements by inserting your responses in the answer blanks.

1. _____
2. _____
3. _____
4. _____
5. _____

A __(1)__ lens, like that of the eye, produces an image that is upside down and reversed from left to right. Such an image is called a __(2)__ image. In farsightedness, the light is focused __(3)__ the retina. The lens used to treat farsightedness is a __(4)__ lens. In nearsightedness, the light is focused __(5)__ the retina. It is corrected with a __(6)__ lens.

6. _____

8. Using the key choices, identify the parts of the eye described in the following statements. Insert the correct term or letter response in the answer blanks.

Key Choices

A. ◯ Aqueous humor	F. ◯ Cornea	K. ◯ Retina
B. Canal of Schlemm	G. ◯ Fovea centralis	L. ◯ Sclera
C. ◯ Choroid	H. ◯ Iris	M ◯ Vitreous humor
D. ◯ Ciliary body	I ◯ Lens	
E. ◯ Ciliary zonule	J. ◯ Optic disk	

_____ _____ 1. Attaches the lens to the ciliary body

_____ _____ 2. Fluid in the anterior segment that provides nutrients to the lens and cornea

_____ _____ 3. The "white" of the eye

_____ _____ 4. Area of retina that lacks photoreceptors

_____ _____ 5. Contains muscle that controls the shape of the lens

_____ _____ 6. Nutritive (vascular) layer of the eye

_____ _____ 7. Drains the aqueous humor of the eye

_____ _____ 8. Layer containing the rods and cones

_____ _____ 9. Gel-like substance that helps to reinforce the eyeball

_____ _____ 10. Heavily pigmented layer that prevents light scattering within the eye

_____ _____ 11. _____ 12. Smooth muscle structures (intrinsic eye muscles)

_____ _____ 13. Area of acute or discriminatory vision

_____ _____ 14. _____ _____ 15. Refractory media of the eye (#14–17)

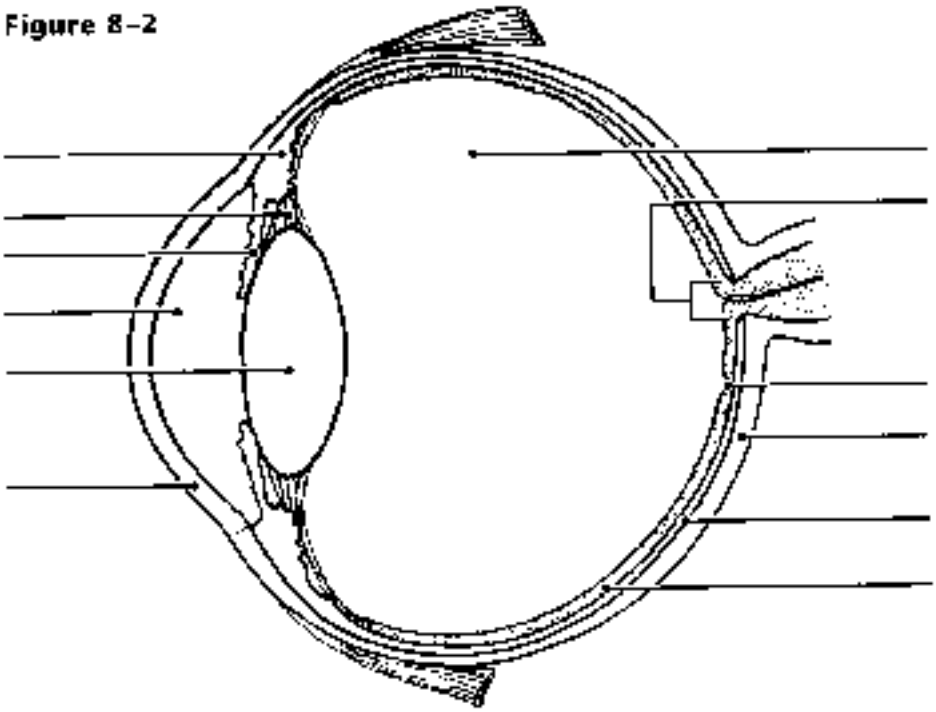
_____ _____ 16. _____ _____ 17.

_____ _____ 18. Most anterior part of the sclera —your "window on the world"

_____ _____ 19. Pigmented "diaphragm" of the eye

9. Using the key choice terms given in Exercise 8, identify the structures indicated by leader lines on the diagram of the eye in Figure 8–2. Select different colors for all structures provided with a color-coding circle in Exercise 8, and then use them to color the coding circles and corresponding structures in the figure.

Figure 8–2



10. In the following table, circle the correct word under the vertical headings that describes events occurring within the eye during close and distant vision.

Vision	Ciliary muscle		Lens convexity		Degree of light refraction	
1. Distant	Relaxed	Contracted	Increased	Decreased	Increased	Decreased
2. Close	Relaxed	Contracted	Increased	Decreased	Increased	Decreased

11. Name in sequence the neural elements of the visual pathway, beginning with the retina and ending with the optic cortex.

Retina → _____ → _____ → _____ → _____

Synapse in thalamus → _____ → Optic cortex

12. Complete the following statements by inserting your responses in the answer blanks.

There are (3) varieties of cones. One type responds most vigorously to (2) light, another to (3) light, and still another to (1) light. The ability to see intermediate colors such as purple results from the fact that more than one cone type is being stimulated (5). Lack of all color receptors results in (6). Because this condition is sex linked, it occurs more commonly in (7). Black and white, or dim light, vision is a function of the (8).

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____

13. Circle the term that does not belong in each of the following groupings.

1. Choroid Sclera Vitreous humor Retina
2. Ciliary body Iris Superior rectus Choroid
3. Pupil constriction Far vision Accommodation Bright light
4. Proprioceptors Rods Cones Photoreceptors
5. Ciliary body Iris Suspensory ligaments Lens
6. Inferior oblique Iris Superior rectus Inferior rectus
7. Retina Pigmented layer Photoreceptors Neural layer

14. Complete the statements concerning rod photopigment and physiology by writing your responses in the answer blanks.

_____ 1. The bent or kinked form of retinal is combined with a protein called _(1)_ to form the visual pigment called _(2)_. When

_____ _____ 2. light strikes the visual pigment, it straightens out and breaks down into its two components. This event is called _(3)_

_____ 3. because the purple color of the visual pigment changes to

_____ 4. _(4)_ and finally becomes _(5)_ as retinal is converted all the way back to vitamin _(6)_

_____ _____ 5. _____ _____ 6

THE EAR: HEARING AND BALANCE

15. Using the key choices, select the terms that apply to the following descriptions. Place the correct letter in the answer blanks.

Key Choices

A. Aural (incus)	E. External acoustic meatus	I. Pinna	M. Tympanic membrane
B. Pharyngotympanic tube	F. Hammer (malleus)	J. Round window	N. Vestibule
C. Cochlea	G. Oval window	K. Semicircular canals	
D. Endolymph	H. Perilymph	L. Stirrup (stapes)	

_____ 1. _____ 2. _____ 3. Structures composing the outer ear

_____ 4. _____ 5. _____ 6. Structures composing the bony or osseous labyrinth

_____ 7. _____ 8. _____ 9. Collectively called the ossicles

_____ 10. _____ 11. Ear structures not involved with hearing

____ 12. Allows pressure in the middle ear to be equalized with the atmospheric pressure

____ 13. Vibrates as sound waves hit it; transmits the vibrations to the ossicles

____ 14. Contains the organ of Corti

__ 15. Connects the nasopharynx and the middle ear

16 _ _ 17. Contain receptors for the sense of equilibrium

_ _ 18. Transmits the vibrations from the stirrup to the fluid in the inner ear

____ 19. Fluid that bathes the sensory receptors of the inner ear

__ 20. Fluid contained within the osseous labyrinth, which bathes the membranous labyrinth

16. Figure 8–3 is a diagram of the ear. Use anatomical terms (as needed) from the key choices in Exercise 15 to correctly identify all structures in the figure provided with leader lines. Color all external ear structures yellow, color the ossicles red, color the equilibrium areas of the inner ear green, and color the internal ear structures involved with hearing blue.

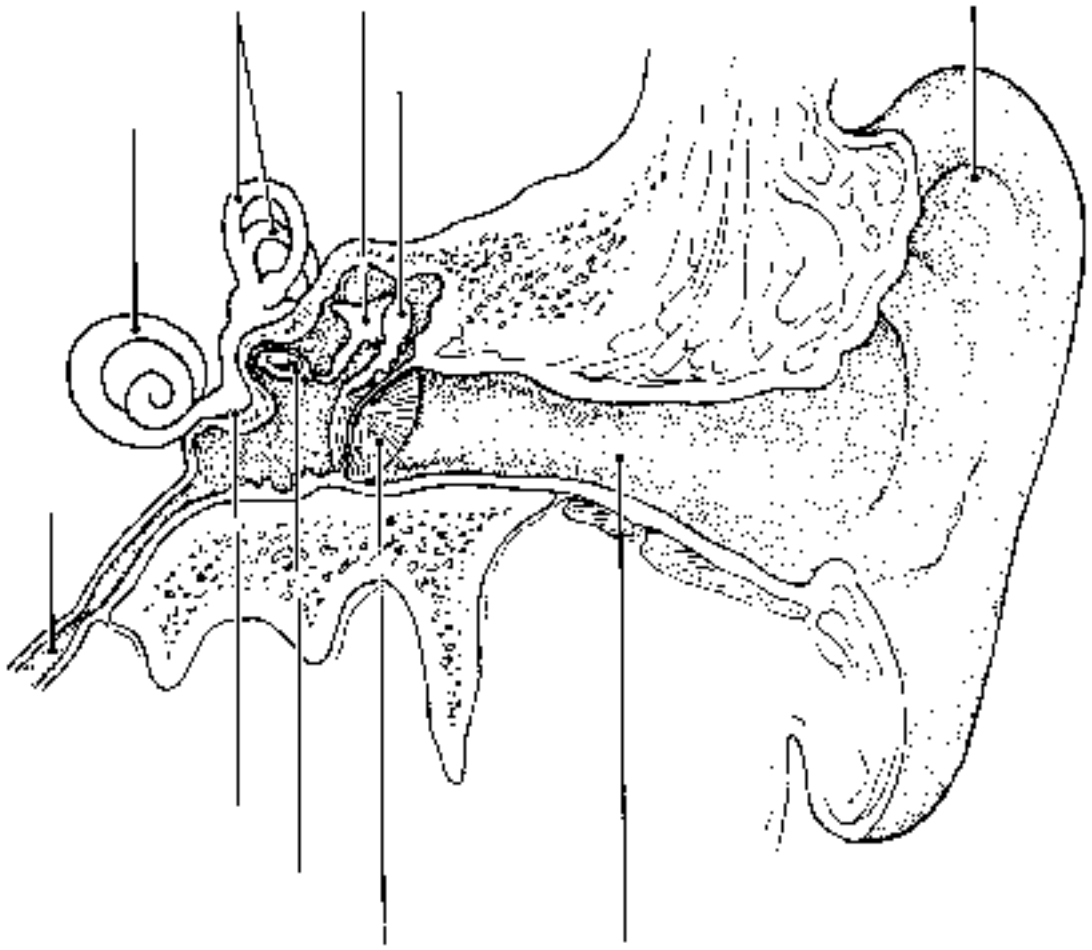


Figure 8–3

17. Sound waves hitting the eardrum set it into vibration. Trace the pathway through which vibrations and fluid currents travel to finally stimulate the hair cells in the organ of Corti. Name the appropriate ear structures in their correct sequence and insert your responses in the answer blanks.

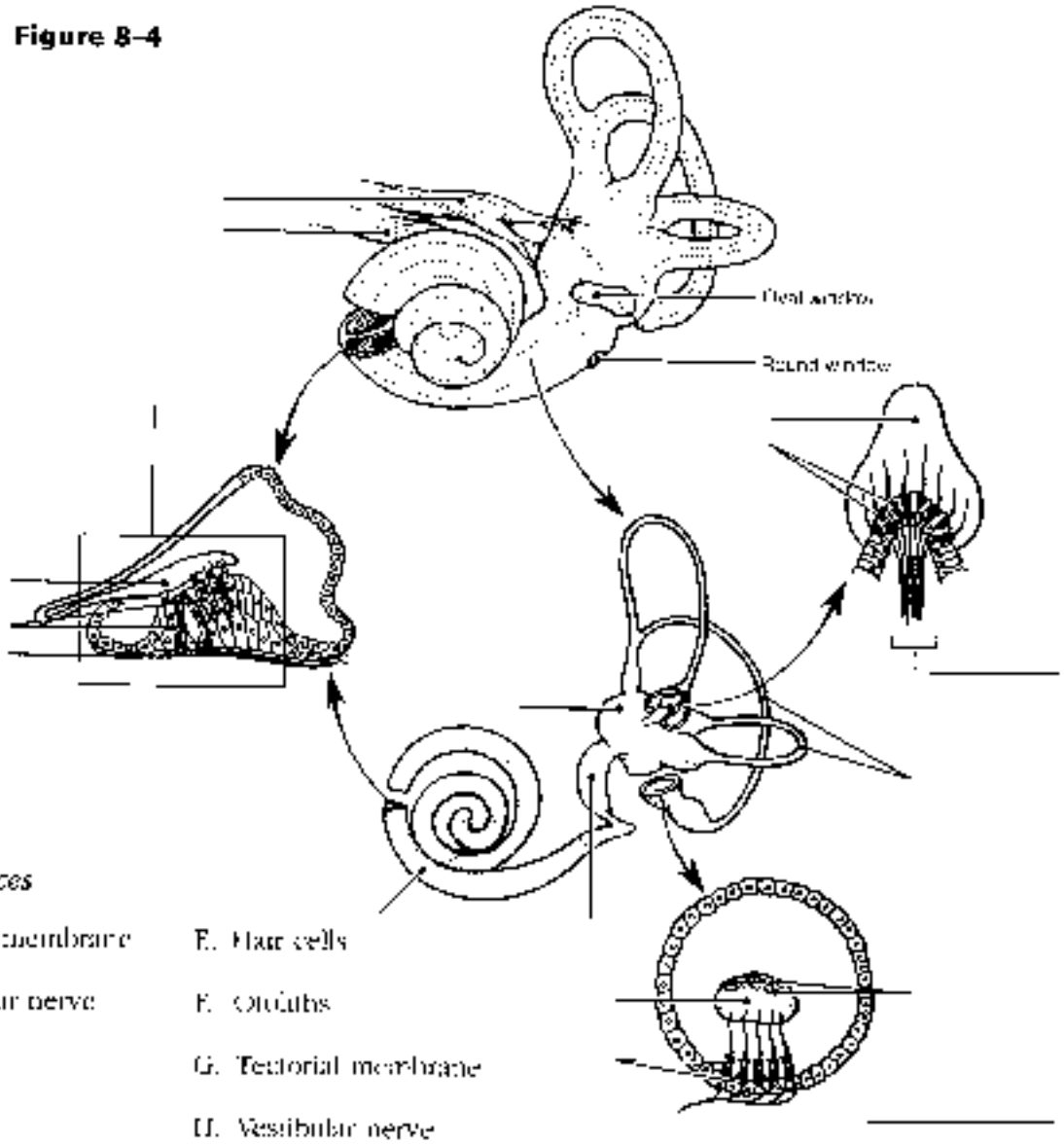
Eardrum → ___ _____ → _____ →

_____ → Oval window → _____ ___ →

___ ___ → ____ _____ → Hair cells

18. Figure 8–4 is a view of the structures of the membranous labyrinth. Correctly identify the following major areas of the labyrinth on the figure: *membranous semicircular canals*, *saccule* and *utricle*, and the *cochlear duct*. Next, correctly identify each of the receptor types shown in enlarged views (organ of Corti, crista ampullaris, and macula). Finally, using terms from the key choices below, identify all receptor structures provided with leader lines. (Some of these terms may need to be used more than once.)

Figure 8–4



Key Choices

A. Basilar membrane
B. Cochlear nerve
C. Cupula
D. Gel
E. Hair cells
F. Otoliths
G. Tectorial membrane
H. Vestibular nerve

19. Complete the following statements on the functioning of the static and dynamic equilibrium receptors by inserting the letter or term from the key choices in the answer blanks.

Key Choices

A. Angular/rotatory	E. Gravity	I. Semicircular canals
B. Cupula	F. Perilymph	J. Static
C. Dynamic	G. Proprioception	K. Utricle
D. Endolymph	H. Saccule	L. Vision

_____ 1. The receptors for __(1)__ equilibrium are found in the crista ampullaris of the __(2)__. These receptors respond to changes in __(3)__ motion. When motion begins, the __(4)__ fluid lags behind and the __(5)__ is bent, which excites the hair cells.

_____ 2.

_____ 3. When the motion stops suddenly, the fluid flows in the opposite direction and again stimulates the hair cells. The receptors

_____ 4. for __(6)__ equilibrium are found in the macular of the __(7)__

_____ 5. and __(8)__. These receptors report the position of the head in space. Tiny stones found in a gel overlying the hair cells roll

_____ 6. in response to the pull of __(9)__. As they roll, the gel moves and tugs on the hair cells, exciting them. Besides the equilibrium receptors of the inner ear, the senses of __(10)__ and

_____ 7. __(11)__ are also important in helping to maintain equilibrium.

_____ 8.

_____ 9.

10.

_____ 11.

20. Indicate whether the following conditions relate to conduction deafness (C) or sensorineural (central) deafness (S). Place the correct letter choice in each answer blank.

_____ 1. Can result from a plug wedged in the external auditory meatus

_____ 2. Can result from damage to the cochlear nerve

_____ 3. Sound is heard in one ear but not in the other, during both bone and air conduction

_____ 4. Often improved by a hearing aid

5. Can result from otitis media

_____ 6. Can result from otosclerosis, excessive earwax, or a perforated eardrum

_____ 7. Can result from a blood clot in the auditory cortex of the brain

21. List three things about which a person with equilibrium problems might complain. Place your responses in the answer blanks.

_____, _____, and _____.

22. Circle the term that does not belong in each of the following groupings.

1. Hammer Anvil Pinna Stirrup
2. Tectorial membrane Crista ampullaris Semicircular canals Cupula
3. Gravity Angular motion Sound waves Rotation
4. Utricle Saccule Auditory tube Vestibule
5. Vestibular nerve Optic nerve Cochlear nerve Vestibulocochlear nerve

CHEMICAL SENSES: SMELL AND TASTE

23. Complete the following statements by inserting your responses in the answer blanks.

Three cranial nerves involved in transmitting impulses for the sense of taste are the (1) _____, (2) _____, and (3) _____. Impulses for the sense of smell are transmitted by the (4) _____ nerve. The receptors for smell are located in the (5) _____ of the nasal passages; the act of (6) _____ increases the sensation because it brings more air into contact with the receptors. The receptors for taste are found in clusterlike areas called (7) _____, most of which are located on the sides of (8) _____ or (9) _____ papillae. The five basic taste sensations are (10) _____, (11) _____, (12) _____, (13) _____, and (14) _____. The most protective receptors are thought to be those that respond to (15) _____ substances. When nasal passages are congested, the sense of taste is decreased. This indicates that much of what is considered taste actually depends on the sense of (16) _____. It is impossible to taste substances with a (17) _____ tongue because foods must be dissolved (or in solution) to excite the taste receptors. The sense of smell is closely tied to the emotional centers of the brain (limbic region), and many odors bring back (18) _____.

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____
11. _____
12. _____
13. _____
14. _____
15. _____
16. _____
17. _____
18. _____