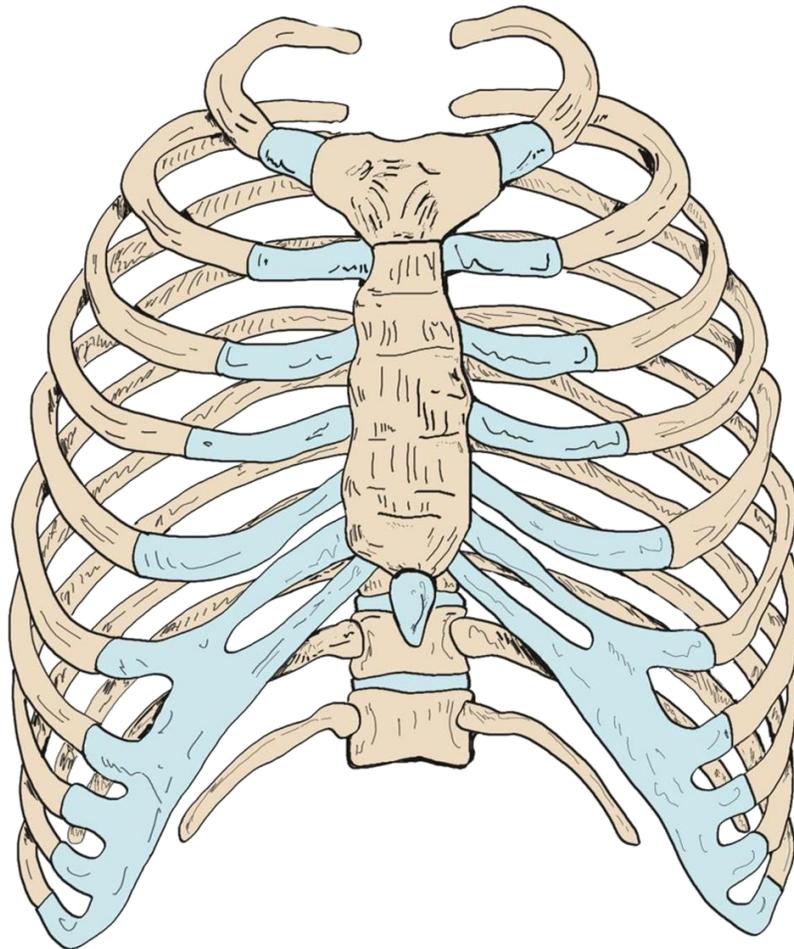


# Principles of **Anatomy & Physiology**

Second edition

Part 2 – Lab Workbook



Peter Reuter ♦ Valerie Weiss ♦ Nicola Khalaf ♦ Jason Craddock

► Reuter Academic Publishing ◀

# **Principles of Anatomy & Physiology**

**Second Edition**

## **Part 2 Lab Workbook**

**Peter Reuter**

**Valerie Weiss**

**Nicola Khalaf**

**Jason Craddock**

Department of Rehabilitation Sciences  
Marieb College of Health & Human Services  
Florida Gulf Coast University

Development, design, and production management: Reuter Academic Publishing

Copyright © 2022 Reuter Academic Publishing. All rights reserved.

Copyright © 2022 Reuter Academic Publishing on all illustrations provided.

Copyright © 2022 Valerie Weiss on all illustrations provided.

This publication is protected by Copyright and permission should be obtained from the publisher prior to any prohibited reproduction, storage in a retrieval system, or transmission in any form or by any means, electronic, digital, mechanical, photocopying, recording, or likewise.

To obtain permission(s) to use material from this work, please submit a written request to

Reuter Academic Publishing  
12721 Dresden Court  
Fort Myers, FL 33912  
USA  
Email: reutermedical@comcast.net



ISBN-13: 978-1-7346811-2-3

## About the Authors

### **Peter Reuter, MD, PhD**

Dr. Reuter received his medical degree and his research doctorate from Johannes Gutenberg University in Mainz/Germany. After publishing his first book in early 1989, Dr. Reuter focused on compiling medical, dental, and scientific dictionaries and databases for print and digital publications. In 1998, he moved to Florida and founded Reuter Medical Inc., a medical and scientific reference publishing company. Overall, he has authored or contributed to more than 100 dictionaries and textbooks as well as other publications published in six languages and nineteen countries.

In 2010, Dr. Reuter set out to fulfill his life-long ambition to teach at a university and to help students achieve their dream of becoming health professionals. He loves teaching undergraduate and graduate courses and tries to inspire students to push themselves to success when courses become challenging.

Outside of teaching, Dr. Reuter enjoys yoga, cycling, pickleball, and traveling as well as spending time with his growing family.

### **Valerie Weiss, MD, MS**

Dr. Weiss received her BA in visual arts from Brown University, including a year of study at the Rhode Island School of Design. She then earned an MD from Brown University Medical School followed by an MS in Medical Illustration from the Medical College of Georgia, where she further studied Anatomy and Physiology while learning to draw the human body.

Prior to becoming a professor, Dr. Weiss had her own business as a medical illustrator, providing medical illustrations to physicians, attorneys, educators, and other professionals. Her illustrations have been published in various books. Additionally, she has lectured to public and business groups about the connection between art and anatomy.

Dr. Weiss has been teaching at the University level since 2005. She previously taught at Hodges University from 2005 to 2012, culminating in being named Hodges University's Professor of the Year. In 2012, Dr. Weiss was excited about the opportunity to teach at Florida Gulf Coast University. She enjoys getting to know her students and challenging them to reach their potential.

Along with spending time with her family, Dr. Weiss enjoys running, swimming, and practicing yoga.

**Nicola Khalaf, PT, DPT, MSPT, MBA**

Dr. Khalaf completed her undergraduate degree at the University of California, Davis with a major in Nutrition and Physiology. After receiving her MS in Physical Therapy from the University of Miami, FL, she joined the rehabilitation team at Orlando Regional Medical center where she explored the vast specialties in the field of physical therapy. Dr. Khalaf then earned her DPT from the University of St. Augustine followed by an MBA from Florida Gulf Coast University.

Prior to starting her teaching career at Florida Gulf Coast University, Dr. Khalaf owned an outpatient physical therapy clinic, serving the rehabilitation needs of her community. Additionally, she merged her love for horses and her passion for her profession by becoming an Equine Rehabilitation Therapist. Additionally, she remains very active within her professional organization by providing seminars and continuing education to her peers.

Since starting at Florida Gulf Coast University in 2017, Dr. Khalaf has shown an interest in examining factors that lead to student success. Her teaching philosophy, therefore, is that every student is capable of learning and has the potential to succeed in reaching their goals provided the right environment, tools, and access and when held accountable for playing an active role in their learning process. She is currently enrolled in the EdD program in order to enhance her skills and competencies in education.

When she is not teaching or working on patients, Dr. Khalaf enjoys martial arts and horse-back riding.

**Jason Craddock, EdD, LAT, ATC, CSCS**

Dr. Craddock earned his Bachelor of Science in Sports Medicine with an emphasis in athletic training from Free Will Baptist Bible College, a Master of Science from Middle Tennessee State University, and his EdD from University of Central Florida.

Dr. Craddock is a Certified Athletic Trainer through the National Athletic Trainer's Association Board of Certification.

Before his appointment at Florida Gulf Coast University, Dr. Craddock worked in outpatient rehabilitation settings, secondary and intercollegiate athletic programs as well as club and professional athletic teams. He is also a Certified Strength and Conditioning Specialist through the National Strength and Conditioning Association and has served as the Strength and Conditioning Coordinator.

## Preface

Since the publication of the first edition of *Principles of Anatomy & Physiology* in 2019, many things have happened. We lived through a pandemic none of us saw coming and, undoubtedly, nobody had hoped for. Nevertheless, even the darkest of clouds usually has a silver lining and for us the challenges posed by pandemic-related restrictions pushed us to explore new ways of teaching our students the basics of Anatomy & Physiology online and in-person. Many of the lessons learned found their way into the changes and revisions we made for this second edition.

Most important, however, was the addition of new instructors to our teaching team and as co-authors to our writing team. Together we developed an improved content outline for *Part 1 Course Companion* and completely redesigned and rewrote *Part 2 Course Companion*.

Both parts are again organized into corresponding chapters. The chapters in *Part 1 Course Companion* introduce students to the chapter topic; the chapters in *Part 2 Lab Workbook* are designed for active learning in the lab and in study groups. The lab sessions of our courses are built around the book chapters, incorporating group learning and integrated lab activities.

One of the more significant features for students is the integration of medical terminology throughout *Part 1 Course Companion*. Students learn about word roots and commonly used prefixes and suffixes, and how to analyze or build new medical terms. Throughout the chapters, the roots of terms are explained to help students understand how medical terminology works in all areas of healthcare in addition to increasing their knowledge and understanding of the material discussed.

In another important change, we increased the *Test Your Knowledge* sections at the end of each chapter in *Part 1 Course Companion* by adding new elements, such as *Matching Word Parts*, *True/False*, and *Matching*, enhancing the sections' utility for self-study or study groups.

As always, we are aware that despite all our efforts this edition still contains errors and omissions, and we encourage readers to give critical feedback so we can improve the book in future editions.



## Table of Contents

	<b>Page</b>
Chapter 1 Introduction into Medical Terminology	1
Chapter 2 Basic Sciences Review	7
Chapter 3 Introduction into Anatomy & Physiology	13
Chapter 4 Histology	19
Chapter 5 Integumentary System	25
Chapter 6 Bones and Skeletal Tissues	31
Chapter 7 Skeleton	37
Chapter 8 Joints	49
Chapter 9 Muscle Tissue	57
Chapter 10 Muscular System	63
Chapter 11 Nervous Tissue	73
Chapter 12 Central Nervous System	77
Chapter 13 Peripheral Nervous System & Reflexes	85
Chapter 14 General & Special Senses	95
Chapter 15 Endocrine System	109
Chapter 16 Reproductive System and Pregnancy	115
Chapter 17 Cardiac Anatomy & Physiology	125
Chapter 18 Blood Vessels and Circulation	135
Chapter 19 Blood, Hemostasis, and Blood Groups	143
Chapter 20 Lymphatic System and Immunity	149
Chapter 21 Respiratory System	155
Chapter 22 Digestive System	163
Chapter 23 Urinary System	169
Chapter 24 Fluid, Electrolyte, and Acid-Base Balance	175



## Chapter 1 Introduction into Medical Terminology

### Complete the following sentences

1. The \_\_\_\_\_ is a modifier attached to the beginning of a root word and the \_\_\_\_\_ is a modifier attached to the end of a word root.
2. The medical term for *higher than normal blood pressure* is \_\_\_\_\_.
3. The combining form meaning *new* is \_\_\_\_\_.
4. The suffix denoting an *instrument used to measure* is \_\_\_\_\_.
5. An \_\_\_\_\_ such as "AIDS" is a word formed from the initial letters of other words.
6. The medical term for *hardening of a tissue* is \_\_\_\_\_.
7. The prefix *intra-* in the word *intracellular* means \_\_\_\_\_.
8. The suffix *-malacia* in the word *osteomalacia* means \_\_\_\_\_.
9. The combining form *melan(o)-* in the word *melanocyte* means \_\_\_\_\_.
10. The medical term meaning *between ribs* is \_\_\_\_\_.

### Review your knowledge

1. Complete the table by adding the correct medical terminology or definition.

Medical Terminology	Definition
path(o)-	
	combining form meaning <i>white</i>
contra-	
	prefix meaning <i>excessive or above normal</i>
	suffix meaning <i>removal</i>
contra-	
	prefix meaning <i>around</i>
	combining form meaning <i>blue</i>
pre-	
	suffix meaning <i>inflammation</i>
epi-	
	combining word meaning <i>stomach</i>
cyto-	
	combining word meaning <i>heart</i>

2. Complete the table by first adding which part of the medical terminology the words listed represent and then by creating your own medical term using the terminology.

Medical Terminology	Prefix, suffix, or combining form?	Medical term
intra-		
-al		
exo-		
hypo-		
oste(o)-		
arthr(o)-		
-oma		
brady-		

Divide each term into its component word parts and write these parts, in sequence, on the lines provided. (You may not need all the lines provided.)

3. **Poliomyelitis** is an inflammation of the gray matter of the spinal cord.

\_\_\_\_\_

4. **Tachycardia** is a term applied to a pathologically fast heartbeat.

\_\_\_\_\_

5. **Exocytosis** is a term meaning exiting the cell.

\_\_\_\_\_

6. **Pericarditis** is a term meaning inflammation around the heart.

\_\_\_\_\_

Use the information provided to build new terms and write the terms on the line provided.

7. Inflammation [-itis] of the larynx [laryng(o)]. \_\_\_\_\_

8. Relating to [-a] aorta [aort(o)] and kidney [ren(o)]. \_\_\_\_\_

9. Cancer [carcin(o)] formation [-genesis] \_\_\_\_\_

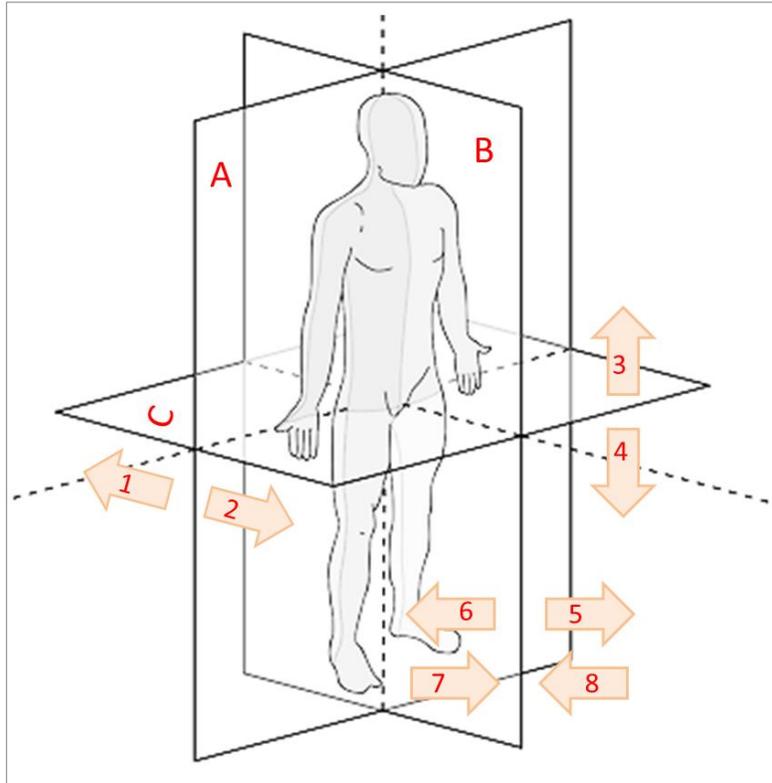
10. A disorder [-pathy] of the tongue [gloss(o)]. \_\_\_\_\_

11. A softening [-malacia] of the brain [encephal(o)] \_\_\_\_\_

12. Relating [-a] to colon [col(o)] and rectum [rect(o)]. \_\_\_\_\_

13. Match the planes with the letters and the directional terminology with the numbers on the image. Identify what each plane divides the body into. Note which two directional terminologies that go together but mean opposite directions.

- Midsagittal Plane \_\_\_\_\_
- Transverse Plane \_\_\_\_\_
- Coronal Plane \_\_\_\_\_
- Frontal Plane \_\_\_\_\_
- Horizontal Plane \_\_\_\_\_
- Superficial \_\_\_\_\_
- Lateral \_\_\_\_\_
- Superior \_\_\_\_\_
- Cranial \_\_\_\_\_
- Dorsal \_\_\_\_\_
- Medial \_\_\_\_\_
- Caudal \_\_\_\_\_
- Inferior \_\_\_\_\_
- Anterior \_\_\_\_\_
- Proximal \_\_\_\_\_
- Ventral \_\_\_\_\_
- Deep \_\_\_\_\_
- Posterior \_\_\_\_\_



14. Complete the table by adding the correct plane or directional term.

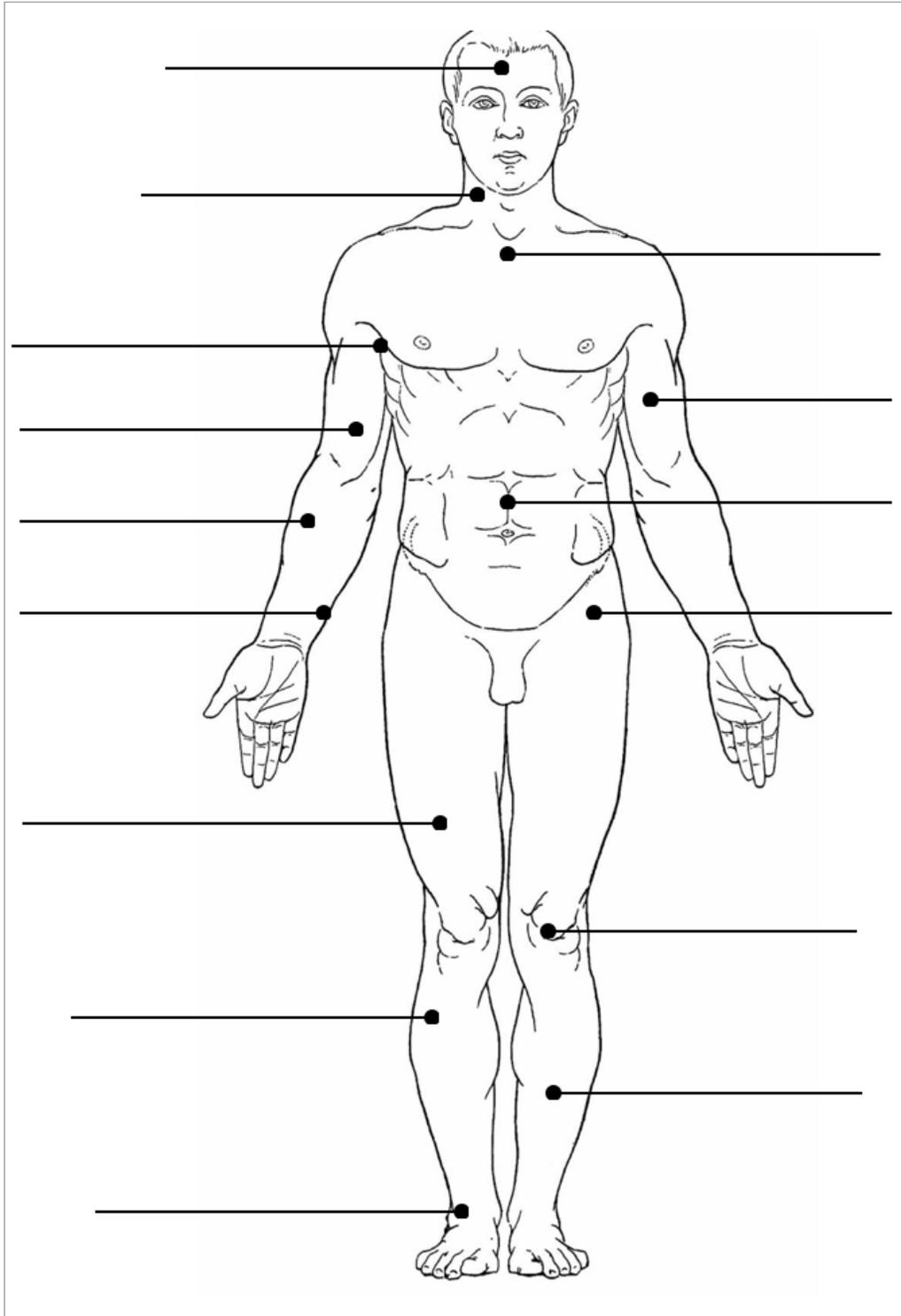
Description	Plane or directional term
Nearer/closer in attachment to the body (on a limb)	
Farther away in attachment from the body (on a limb)	
Close(r) to the surface	
The plane that divides the body into superior & inferior	
Closer to the front of the body	
On the same side of the body	
Away from the midline of the body	
Any sagittal plane except the median or midsagittal	

Use your understanding of directional and regional terminology to form a proper sentence from the given terms.

- 15.. Radius / medial / ulna \_\_\_\_\_
- 16. Femur / distal / patella \_\_\_\_\_
- 17. Cervical region / inferior / abdominal region \_\_\_\_\_
- 18. Axillary region / lateral / sternal region \_\_\_\_\_

19. Locate and label each of the regional terms listed below on the diagram.

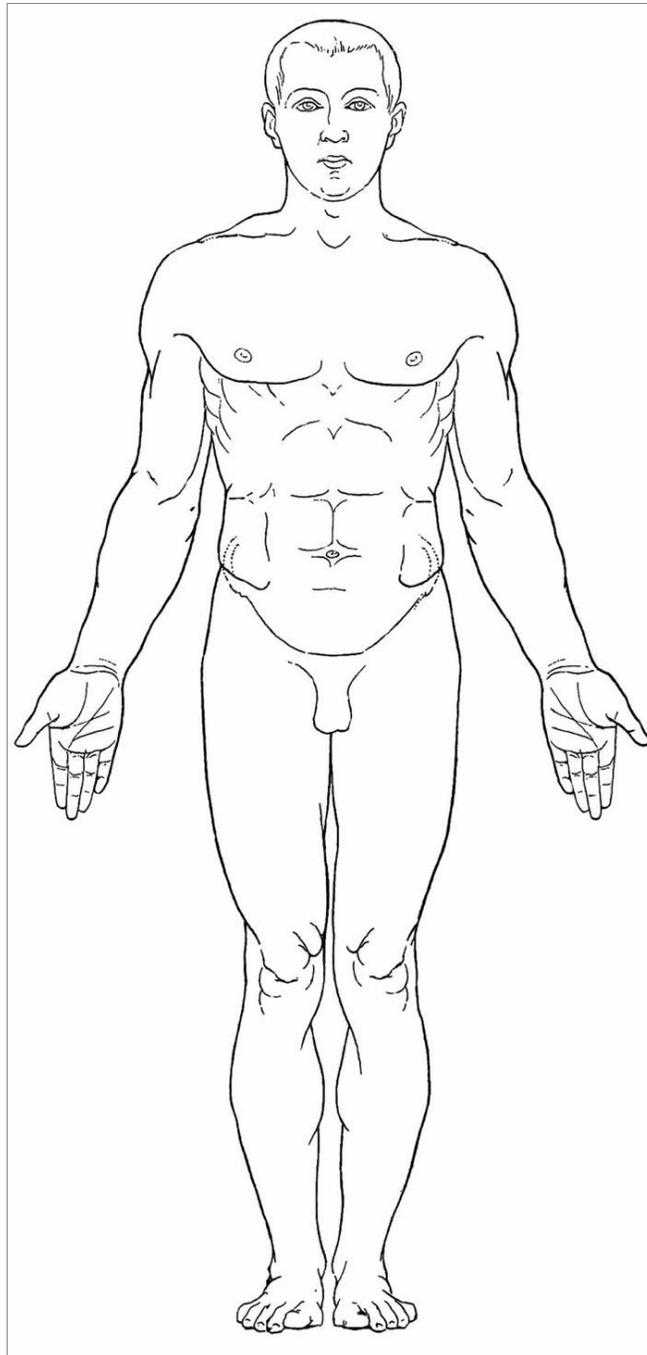
- abdominal
- patellar
- femoral
- brachial
- cervical
- malleolar
- axillary
- humeral
- cranial
- coxal
- radial
- ulnar
- tibial
- sternal
- fibular



### Apply your knowledge

*Put your understanding of medical, directional, and regional terminology to the test by placing the letters on the proper area according to the description provided.*

1. Place the letter "A" on the left distal radial region and the letter "B" on the contralateral proximal humeral region.
2. Place the letter "C" on the right proximal femoral region.
3. Place the letter "D" on the left axillary region.
4. Place the letter "E" on the right malleolar region and the letter "F" on the ipsilateral patellar region.
5. Place the letter "G" on the medial femoral region, superior to the patellar region.





## Chapter 2 Basic Sciences Review

### Complete the following sentences

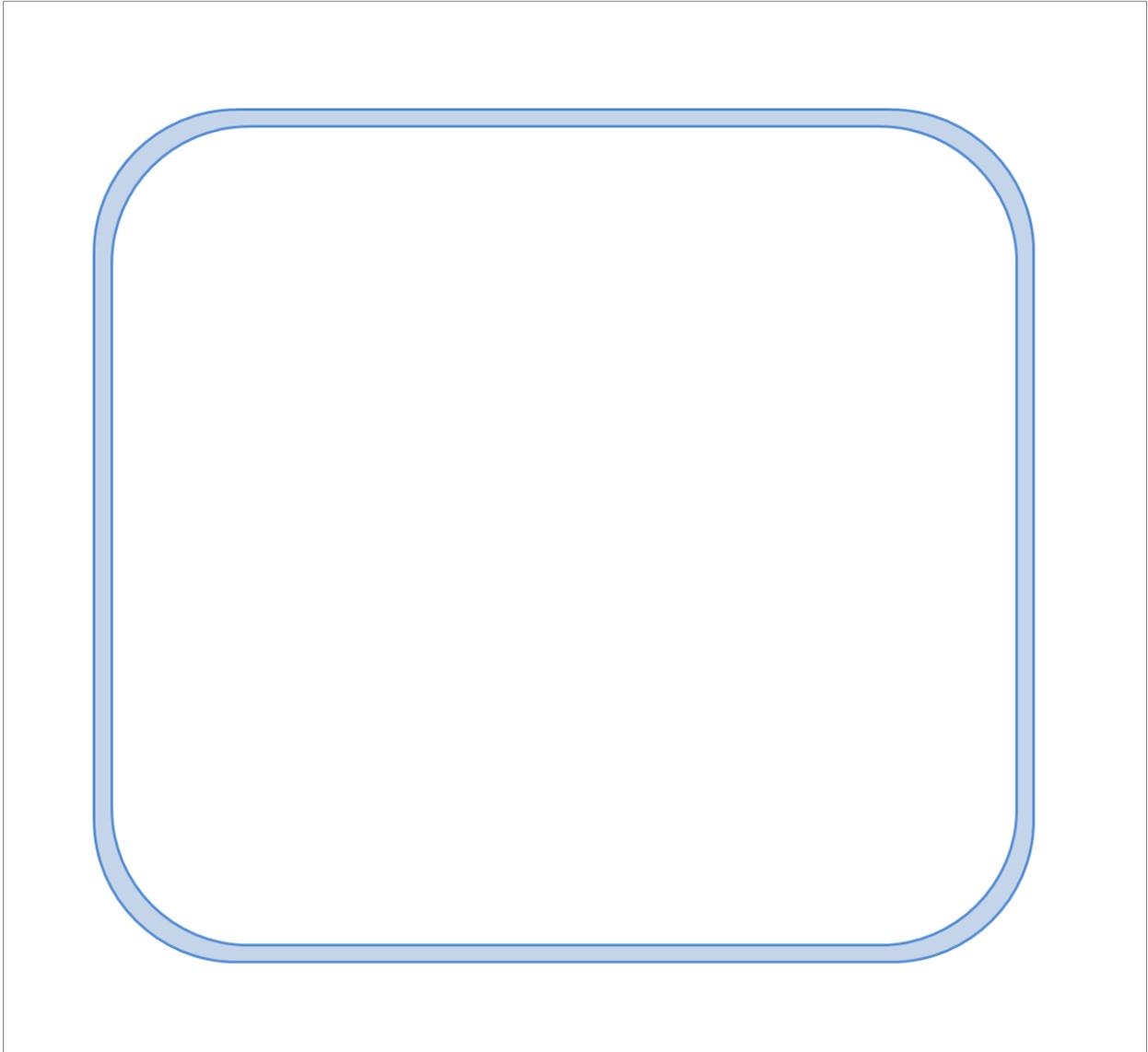
1. \_\_\_\_\_ and \_\_\_\_\_ are types of lipids that cell membranes are composed of.
2. \_\_\_\_\_ is the major form of energy storage in the human body.
3. \_\_\_\_\_ is an example of a simple sugar that serves as the main energy source for the human body.
4. Transportation channels found in the cell membrane are made of \_\_\_\_\_.
5. Table sugar is a \_\_\_\_\_ type of carbohydrate, while glucose is a \_\_\_\_\_.
6. \_\_\_\_\_ are the building blocks for proteins.
7. Steroid hormones are made of \_\_\_\_\_ type of lipids.
8. The \_\_\_\_\_ is the smallest structural and functional living unit.
9. The flexible outer boundary of the cell is called the \_\_\_\_\_.
10. Transport processes across membranes are subdivided into \_\_\_\_\_ and \_\_\_\_\_ transport processes.

### Review your knowledge

1. Use your knowledge of the three organic compounds to complete the table.

Compound	Elements & basic structure	Function or location	Examples
Carbohydrates			
Lipids			



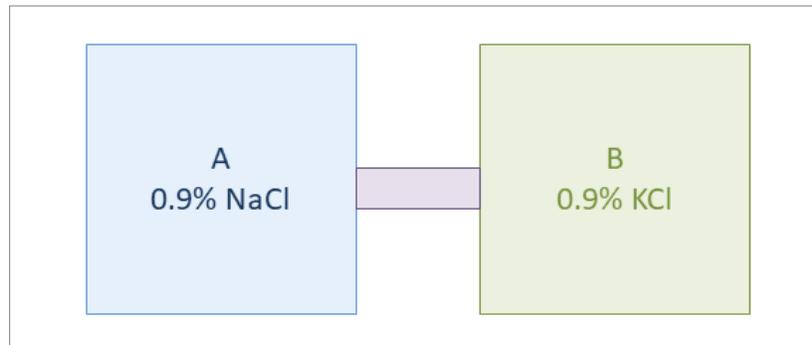


4. The intracellular fluid located between the plasma membrane and the nucleus is called \_\_\_\_\_.
5. Proteins and lipids are modified, concentrated, and packaged for transport by the \_\_\_\_\_.
6. The spherical membranous bags containing digestive enzymes (acid hydrolases) that can digest ingested bacteria, viruses, and toxins are known as \_\_\_\_\_.
7. Motile extensions on surfaces of cells that can move substances along the surface are called \_\_\_\_\_.
8. Cell extensions that propel the whole cell itself, such as the tail of a sperm, are called \_\_\_\_\_.
9. The fluid that surrounds the cells is also called the \_\_\_\_\_ fluid (IF).

10. There are three types of membrane junctions:

- a) \_\_\_\_\_: Prevent fluids and most molecules from moving between cells.
- b) \_\_\_\_\_: Rivets” or “spot-welds” that anchor cells together.
- c) \_\_\_\_\_: Transmembrane proteins form pores that allow small molecules to pass from cell to cell.

11. Put your understanding of diffusion and osmosis to test by filling in the table and answering the following questions regarding the two compartments below.



a)

Description	Compartment A or B?
Higher Na <sup>+</sup> concentration	
Higher K <sup>+</sup> concentration	
Higher water concentration	
Higher Cl <sup>-</sup> concentration	

b) If the tube connecting the two compartments is permeable for water only. Will water move from one side to the other? Why or why not? \_\_\_\_\_

\_\_\_\_\_

c) What happens if the tube connecting the two is permeable for Na<sup>+</sup> ions only? Which direction would the ion(s) move and why? \_\_\_\_\_

\_\_\_\_\_

d) What will happen if the tube is permeable for K<sup>+</sup> and water? Will the volume of fluid in both compartments stay the same? \_\_\_\_\_

\_\_\_\_\_

12. Use your knowledge of active and passive transportation across the cell membrane to determine which type of transportation process the description belongs to. Next, write each of the descriptions under the appropriate column.

- Requires energy in the form of ATP
- Aquaporins
- Endocytosis
- Cell membrane & protein carries needed
- Can occur across non-living cells
- Requires a concentration gradient
- Can only occur in living cells
- Movement of a substance AGAINST its concentration gradient
- Vesicular transport out of the cell
- Movement of a substance DOWN its concentration gradient
- Leakage channels
- Exocytosis
- Facilitated diffusion
- Osmosis
- Simple diffusion
- Na<sup>+</sup>/K<sup>+</sup> pump
- Voltage-gated channels
- Vesicular transport into the cell

Passive Transport	Active Transport

13. In passive transport substances move down their \_\_\_\_\_ gradient from the side of \_\_\_\_\_ concentration to the side with \_\_\_\_\_ concentration.
14. Facilitated diffusion is a form of \_\_\_\_\_ transport process.
15. Vesicular transport into the cell is called \_\_\_\_\_.
16. Vesicular transport out of the cell is called \_\_\_\_\_.
17. Movement of water across a selectively permeable membrane is called \_\_\_\_\_.
18. Water channels are referred to as \_\_\_\_\_.
19. Mem channels that are always open are called \_\_\_\_\_ or \_\_\_\_\_ channels.
20. Channels that can be opened or closed in response to a stimulus are called \_\_\_\_\_ channels.
21. In muscle and nerve cells, leakage channels are 75-100 times more permeable for \_\_\_\_\_ than \_\_\_\_\_.

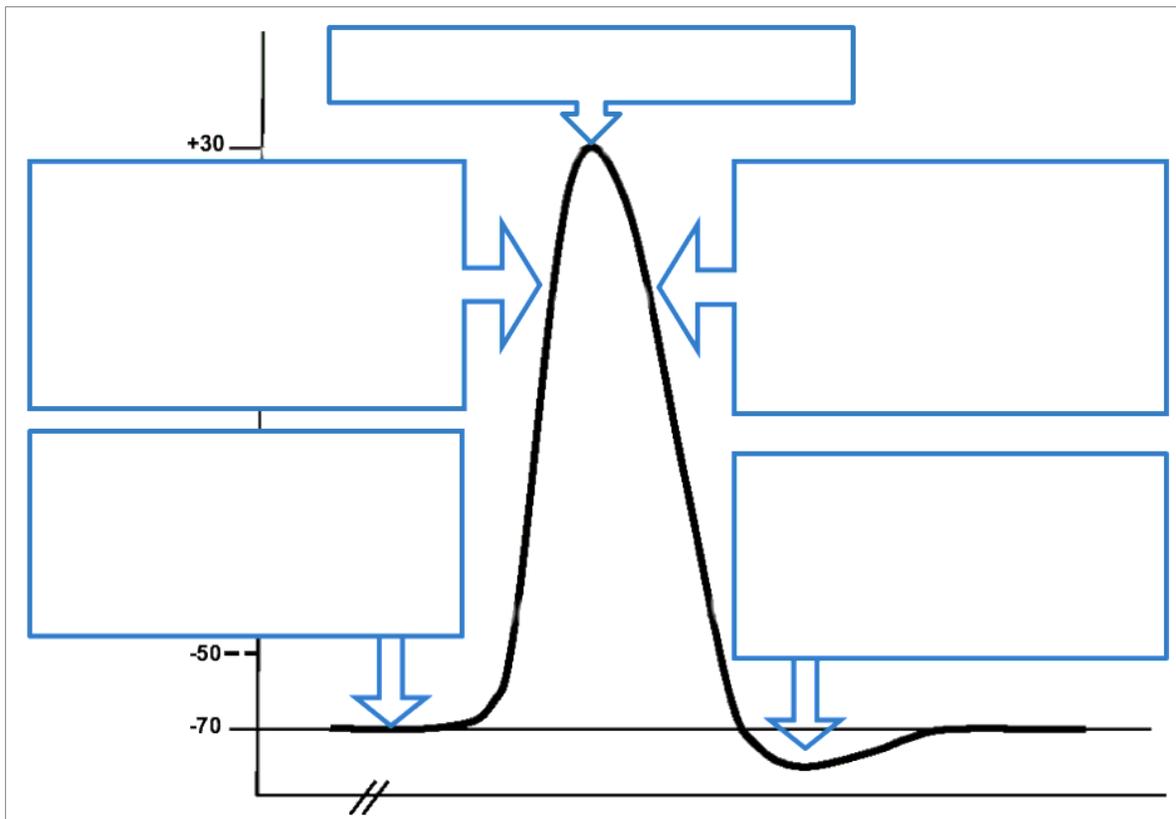
22. The \_\_\_\_\_ pump stabilizes the resting membrane potential by maintaining the concentration gradients for \_\_\_\_\_ and \_\_\_\_\_.

23. The sodium/potassium pump moves \_\_\_\_\_ ions out of the cell and \_\_\_\_\_ ions into the cell.

### Apply your knowledge

Put your understanding of cell membrane potential to test by labeling the phases of the action potential in the appropriate boxes. Then write each of the descriptions listed below under the appropriate action potential phase.

- |   |  |
|---|--|
| <ul style="list-style-type: none"> <li>• The potential difference across the plasma membrane of a resting cell</li> <li>• ICF is always negative when the cell is at rest</li> <li>• Na<sup>+</sup> Voltage-gated channel are open</li> <li>• The inside of the cell is becoming more negative than RMP</li> <li>• A reduction in membrane potential towards zero</li> <li>• Na<sup>+</sup> Voltage-gated &amp; K<sup>+</sup> Voltage-gated channels are closed</li> <li>• Potassium ions rush from ICF to ECF</li> <li>• An increase in the membrane potential away from zero</li> </ul> | <ul style="list-style-type: none"> <li>• Relative refractory period</li> <li>• Sodium ions rush from ECF to ICF</li> <li>• Na<sup>+</sup>/K<sup>+</sup> pump restores resting membrane potential</li> <li>• Amplitude of the action potential is always +30mV</li> <li>• Resting Membrane Potential (RMP)</li> <li>• Na<sup>+</sup> Voltage-gated channels become inactive &amp; K<sup>+</sup> Voltage-gated channels are open</li> <li>• Absolute refractory period</li> <li>• A period of increased K<sup>+</sup> ion permeability</li> <li>• The inside of the cell becomes more positive than RMP</li> </ul> |
|---|--|



## Chapter 3 Introduction into Anatomy & Physiology

### Complete the following sentences

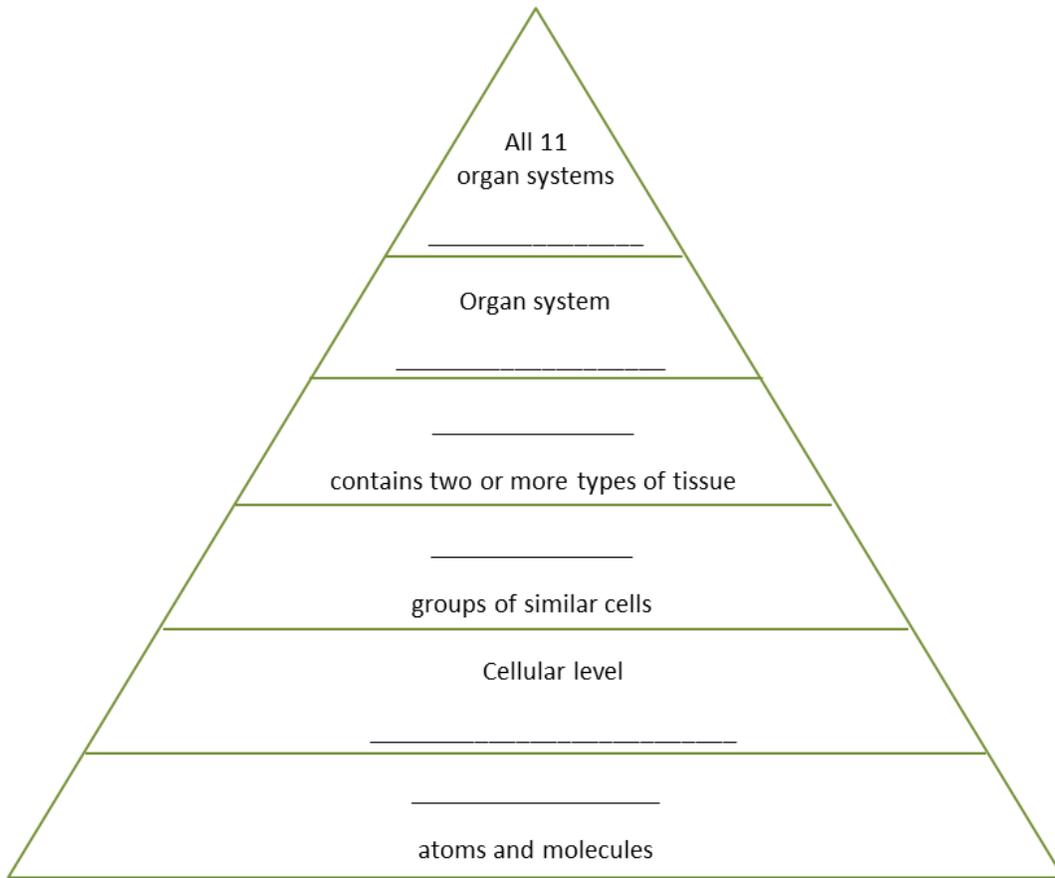
1. \_\_\_\_\_ is the study of the structure of the body or parts of it; whereas \_\_\_\_\_ studies the function of the whole body or its systems and organs.
2. The \_\_\_\_\_ states that Anatomy and Physiology are inseparable and that function always reflects structure.
3. In negative feedback, the response \_\_\_\_\_ or \_\_\_\_\_ the original stimulus.
4. The \_\_\_\_\_ index is used to classify people based on body weight and height.
5. A BMI of 18.5 – 24.9 is considered to indicate \_\_\_\_\_.
6. A lack of oxygen in tissues is called \_\_\_\_\_; if this lack is due to insufficient blood flow, it is called \_\_\_\_\_.
7. Men have a \_\_\_\_\_ body water content than women at \_\_\_\_% vs. \_\_\_\_%.
8. Our normal body temperature is \_\_\_\_\_ °F.
9. An increased body temperature is called \_\_\_\_\_.
10. A body temperature below normal with decreasing vital signs is called \_\_\_\_\_. If the core temperature falls below \_\_\_\_\_ °F cardiac arrest occurs.

### Review your knowledge

1. Define 'homeostasis': \_\_\_\_\_
2. Complete the table by indicating whether the description fits Anatomy or Physiology.

Description	Anatomy or Physiology
Study of how substances cross the cell membrane	
Study of where the heart is in relation to the lungs	
Study of what the cell membrane is composed of	
Study of the function of the whole body or its systems and organs	
Study of how we respond to pain	
Study of what the digestive system does	
Study of what skeletal muscles are made of	

3. Write the correct level of structural organization or description in the following diagram.



4. Complete the table by adding the necessary life functions and their definitions.

Necessary life function	Definition

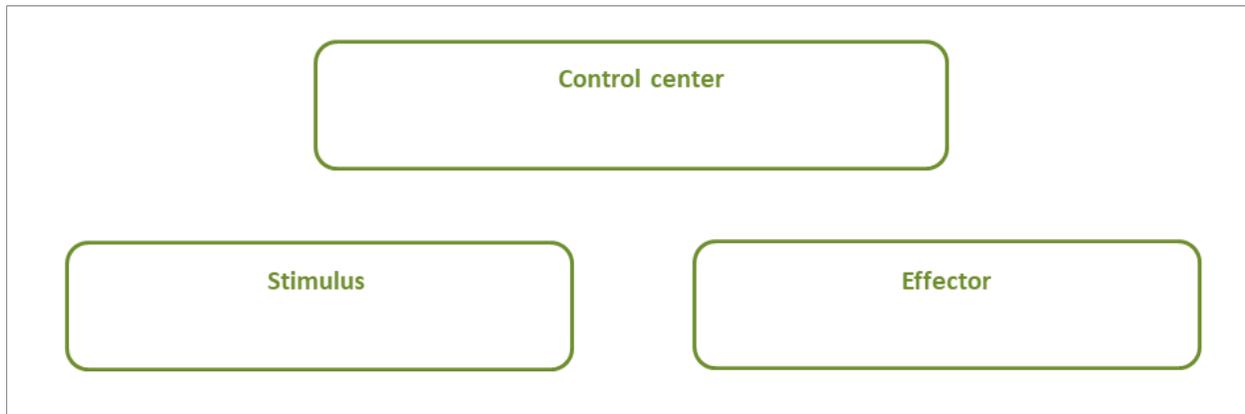
5. Add the name of one survival need and a brief description to each box.

--	--	--	--	--

6. Complete the table by adding the name of the organ system that fits the definition.

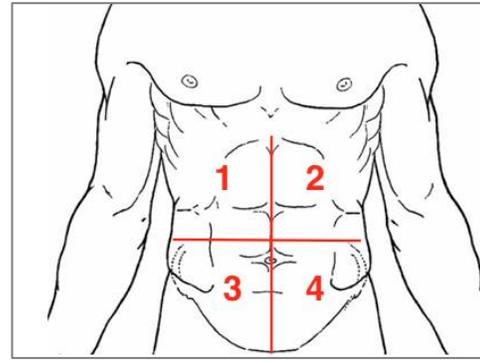
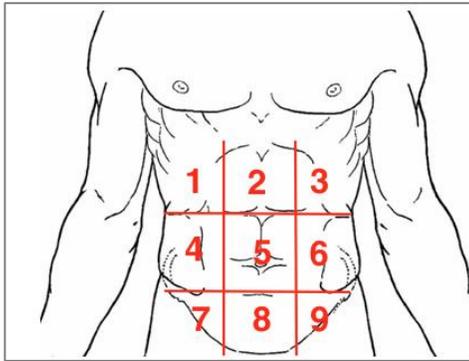
Description	Organ system
Forms the external body covering and protects deeper tissues from injury	
The heart pumps blood; blood vessels transport blood	
Keeps blood constantly supplied with oxygen and removes carbon dioxide	
Protects and supports body organs, and provides a framework the muscles use to cause movement	
Regulates water, electrolyte and acid-base balance of the blood	
Breaks down food into absorbable units that enter the blood for distribution to body cells	
Glands secrete hormones that regulate processes such as growth and reproduction	
Allows manipulation of the environment, locomotion, and facial expression	
Fast-acting control system of the body, responds to internal and external changes by activating appropriate muscles and glands	
Picks up fluid leaked from blood vessels and returns it to blood; mounts the attack against foreign substances within the body	
Overall function is production of offspring	

7. Use arrows to demonstrate the relationship between the three parts of the control system involved in homeostasis. Write a brief description of each part.



8. Match the abdominopelvic regions and quadrants to the numbers on below diagrams.

- |                     |       |                      |       |
|---------------------|-------|----------------------|-------|
| Right hypochondriac | _____ | Left lumbar          | _____ |
| Left hypochondriac  | _____ | Umbilical            | _____ |
| Epigastric          | _____ | Right iliac/inguinal | _____ |
| Right lumbar        | _____ | Left iliac/inguinal  | _____ |
| Hypogastric/pubic   | _____ | Right upper          | _____ |
| Left upper          | _____ | Left lower           | _____ |



Use the diagrams above to complete the following sentences.

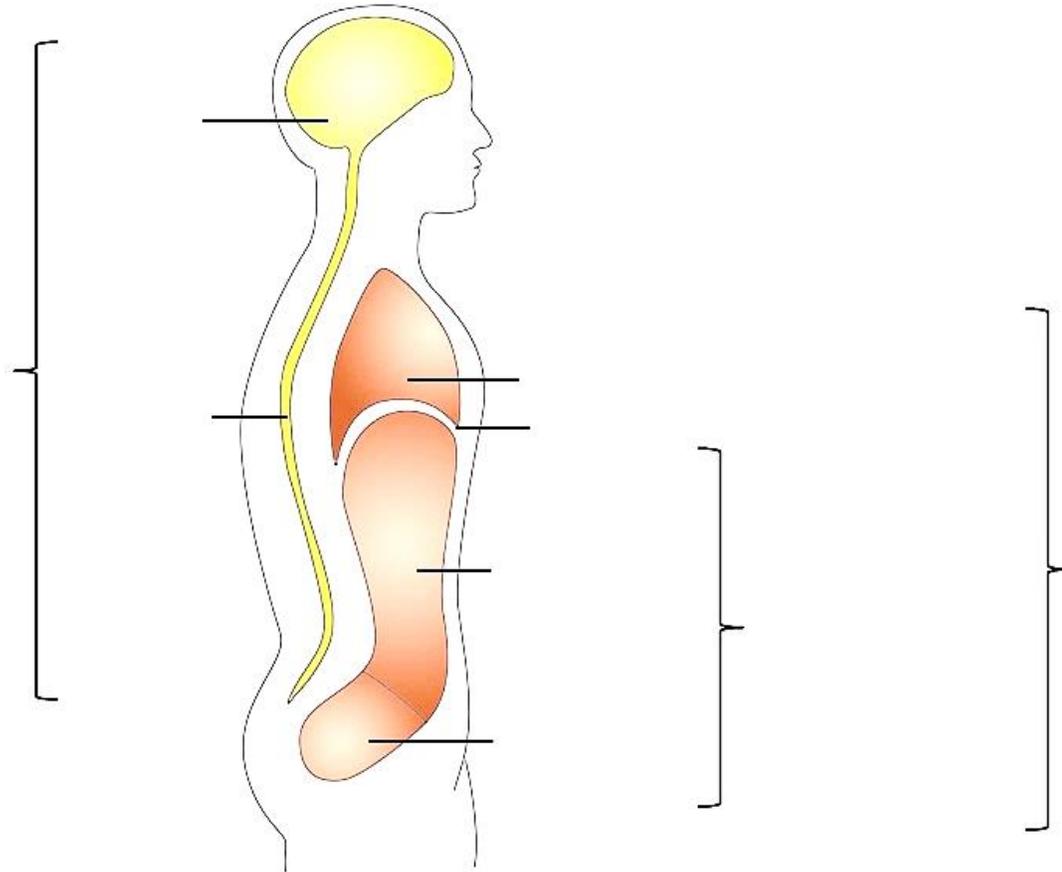
9. The region superior to the umbilical region is called \_\_\_\_\_. It is labeled # \_\_\_\_\_.
10. The region lateral to the epigastric region is called \_\_\_\_\_. It is labeled # \_\_\_\_\_.
11. The liver is located in the \_\_\_\_\_ region, labeled as # \_\_\_\_\_.
12. The spleen is located in the \_\_\_\_\_ quadrant, labeled as # \_\_\_\_\_.
13. Place each organ in the correct abdominopelvic region and quadrant.

Organ	Abdominopelvic region	Abdominopelvic quadrant
Stomach		
Spleen		
Liver		
Appendix		
Gallbladder		
Uterus		
Bladder		
Small intestine		
Large intestine		

Use your knowledge of the body cavities to complete the following sentences.

14. The two subdivisions of the abdominopelvic cavity are the \_\_\_\_\_ and the \_\_\_\_\_ cavities.
15. The cranial cavity and spinal cavity are two subdivisions of the \_\_\_\_\_ cavity.
16. The \_\_\_\_\_ cavity is superior to the abdominal cavity.
17. The abdominal cavity and thoracic cavity are separated by the \_\_\_\_\_.
18. The thoracic cavity protects the \_\_\_\_\_ and \_\_\_\_\_.
19. The stomach is located in the \_\_\_\_\_ cavity.

20. The \_\_\_\_\_ cavity is not protected by the skeletal system.
21. The spinal cord is protected by the \_\_\_\_\_ cavity.
22. The entire nervous system is protected by the \_\_\_\_\_ cavity.
23. Complete the diagram by coloring and adding the names of the different body cavities.



### Apply your knowledge

1. Your mom complains about pain in the epigastric region after going out for dinner. Which organ do you think could be the cause of her discomfort? \_\_\_\_\_
2. Your friend is involved in a motorbike accident. He suffers a fracture of his pelvis in the pubic region. His doctor wants to check for possible damage to internal organs in this region. Which organ would the doctor most likely be worried about? \_\_\_\_\_
3. Your friend is complaining of right lower quadrant pain. Which organ would the doctor most likely be worried about? \_\_\_\_\_

4. A patient is suffering from mononucleosis and complains of pain in the left hypochondriac region. What organ may be enlarged and causing her pain? \_\_\_\_\_
5. A woman with a BMI of 27.1 would be considered overweight, but a man with the same BMI would be of normal weight. Is this statement true or false and why?
6. Two men are 5'11" tall, they both weigh 225 pounds and their BMI of 31.4 indicates they are obese. One man has a body fat mass of 4.5%, the other one a body fat mass of 25.1%. What could be an explanation for them having a different body fat mass but an identical BMI?
7. Explain in your own words how negative feedback mechanisms control our temperature when exercising?
8. Why do you think is there no structure separating the abdominopelvic cavity into an abdominal and a pelvic cavity?

### Body Mass Index

**Supplies:** scales, measuring tape, calculator

- Step on the scales and record your weight. Take off shoes and clothes such as hoodies or cardigans to get a weight closer to your real weight.
- Measure your height with the help of another student using a measuring tape. Record the height **in inches**.
- Calculate your BMI using **BMI = wt (lb) x 705/ht (inches)<sup>2</sup>**

a) your height (inches) = \_\_\_\_\_

b) 705 divided by height<sup>2</sup> = \_\_\_\_\_

c) your weight times b) = \_\_\_\_\_ **Your BMI**

**Evaluation:** Your BMI of \_\_\_\_\_ puts you in category \_\_\_\_\_.

## Chapter 4 Histology

### Complete the following sentences

1. Tissues are made of groups of \_\_\_\_\_ that are \_\_\_\_\_ in structure and function.
2. \_\_\_\_\_ tissue is not defined by its cells.
3. The tissue that senses and responds to stimuli by generating electrical impulses is \_\_\_\_\_ tissue.
4. \_\_\_\_\_ is the only tissue that converts chemical energy to mechanical energy.
5. \_\_\_\_\_ tissue is made of extracellular matrix and living cells.
6. \_\_\_\_\_ tissue forms glands.
7. The two basic modes of secretion for exocrine glands are \_\_\_\_\_ and \_\_\_\_\_ secretion.
8. The extracellular matrix of connective tissue consists of a \_\_\_\_\_ and \_\_\_\_\_.
9. Juvenile connective tissue cells that are mitotically active are called \_\_\_\_\_, whereas mature cells are termed \_\_\_\_\_.
10. In \_\_\_\_\_ damaged cells are replaced with the same type of cell and the original function of the tissue is restored.

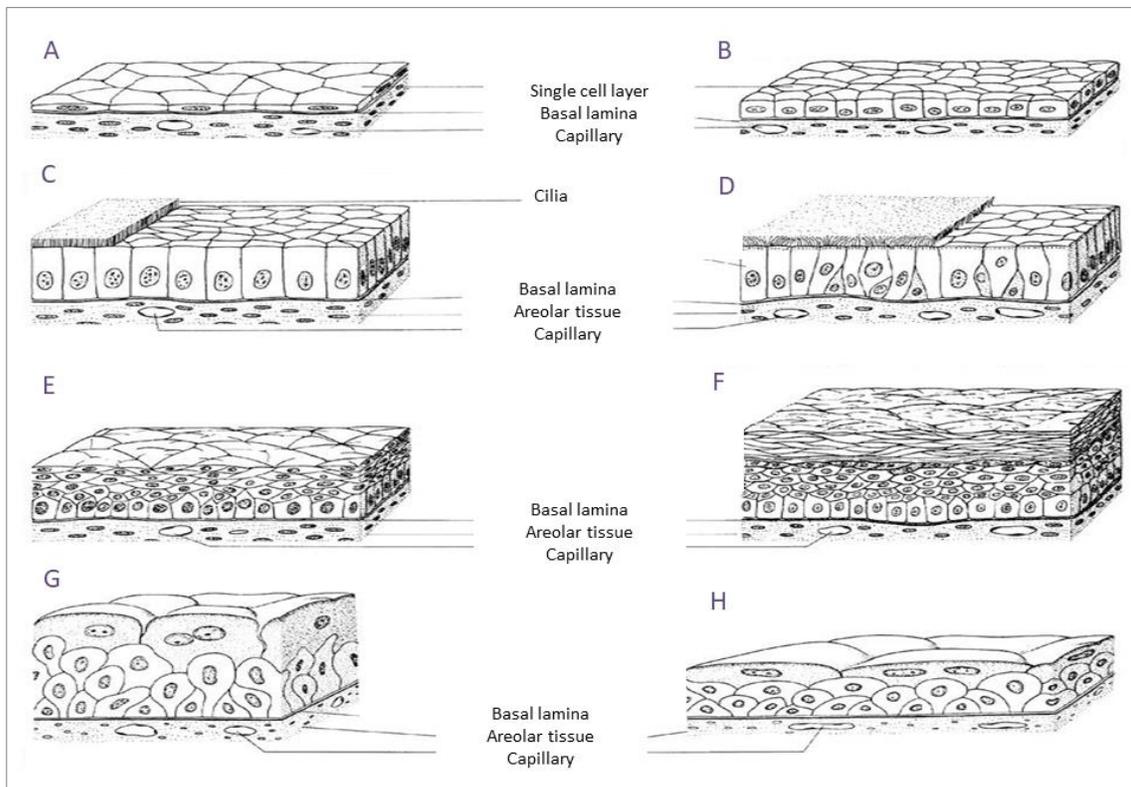
### Review your knowledge

1. Name the four primary tissues: \_\_\_\_\_  
\_\_\_\_\_
2. Define 'gland': \_\_\_\_\_
3. Use your knowledge of the four primary tissue types to place each of the following characteristics in the appropriate tissue box.
 

<ul style="list-style-type: none"> <li>• Defined by a nonliving extracellular matrix</li> <li>• Forms the brain, spinal cord and nerves</li> <li>• Avascular tissue</li> <li>• Binds, supports, protects, insulates and transports</li> <li>• Highly regenerative</li> <li>• Forms linings, coverings and glands</li> <li>• Has the ability to contract and create movement</li> <li>• Made of widely spread cells</li> </ul>	<ul style="list-style-type: none"> <li>• Defined by its cells</li> <li>• Has an abundant extracellular matrix</li> <li>• Allows for protection, absorption, filters, and excretion</li> <li>• Its cells are packed closely together with desmosomes and tight junctions</li> <li>• Has the ability to generate electrical signals</li> <li>• Forms boundaries between environments</li> <li>• Excitable tissue</li> </ul>
---	---

Primary Tissue	Tissue Characteristics
<b>Epithelial</b>	
<b>Connective</b>	
<b>Muscle</b>	
<b>Nervous</b>	

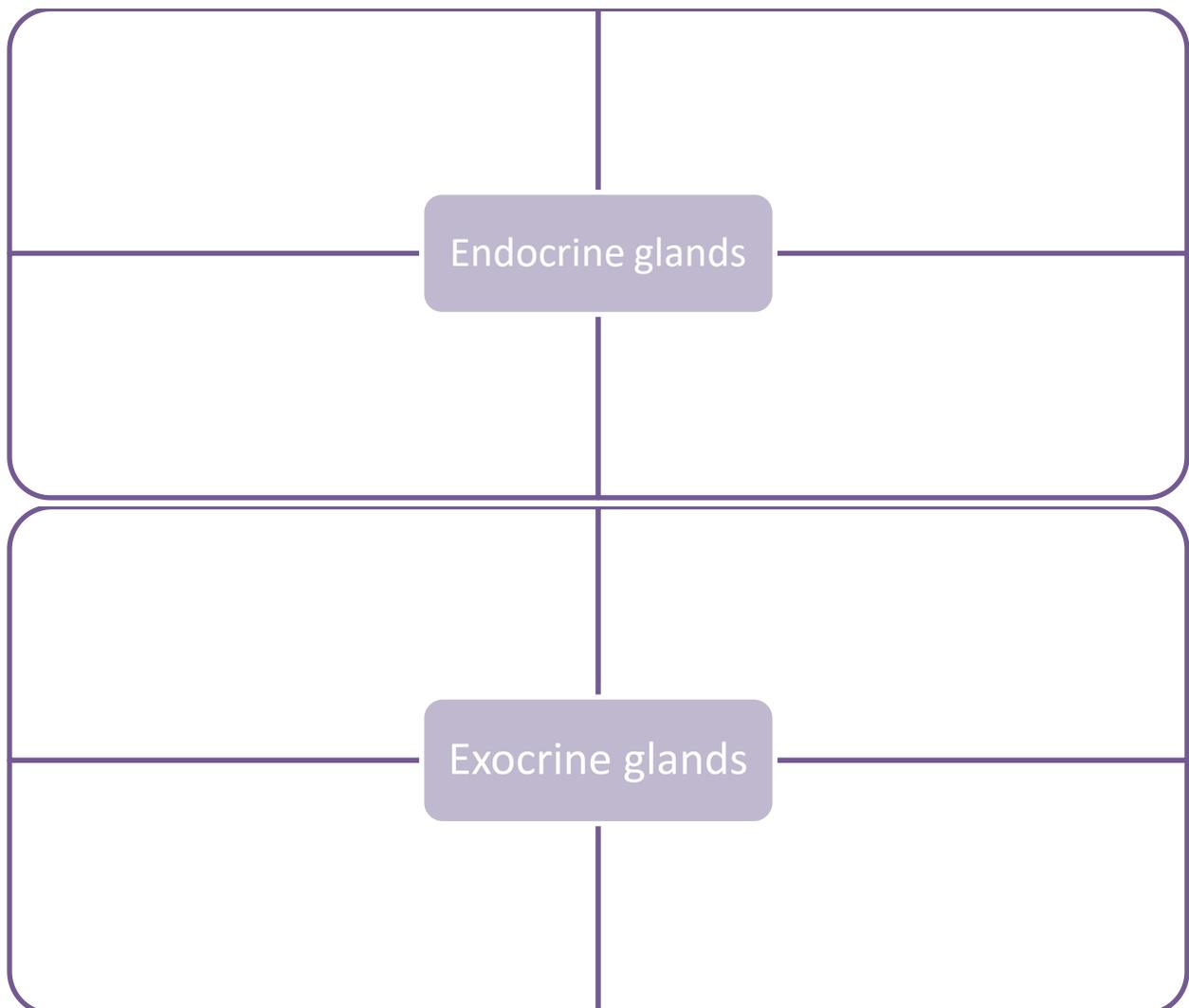
4. Complete the table of epithelia by adding the name of the tissue and the corresponding letter on the diagram.



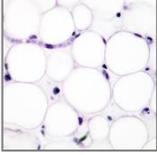
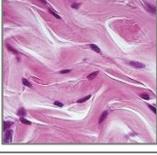
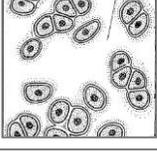
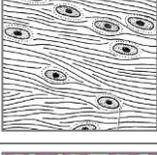
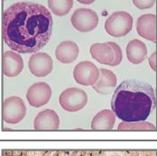
Definition/description	Epithelium	Letter
An epithelium with a single layer of flattened cells		
Consists of a single layer of tall cells with round to oval nuclei		

A thick epithelial membrane composed of several cell layers with surface cells that are flattened		
A stratified epithelium; surface cells dome shaped or squamous-like, depending on degree of organ stretch		
Single layer of cells of differing heights, some not reaching the free surface; nuclei seen at different levels		
Forms the lining of heart, blood vessels, and lymphatic vessels		
Found in ducts and secretory portions of small glands		
Nonciliated type lines most of the digestive tract		
Keratinized variety forms the epidermis of the skin		
Lines ureters, urinary bladder, and part of the urethra		

5. Use your knowledge of glandular epithelial to compare and contrast endocrine and exocrine glands by writing the unique characteristics of each gland in the diagrams below.

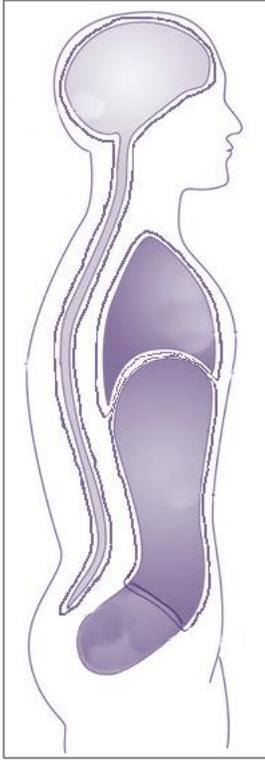


6. Complete the table of connective tissues by adding the name, description, function and location of the connective tissue in the body.

Tissue	Name	Description	Function	Locations
				
				
				
				
				
				
				
				
				

7. Body membranes are made of \_\_\_\_\_ tissue and \_\_\_\_\_ tissue.

8. Name the three body membranes: \_\_\_\_\_  
\_\_\_\_\_
9. \_\_\_\_\_ membranes or \_\_\_\_\_ line body cavities that are open to the exterior.
10. \_\_\_\_\_ membranes or \_\_\_\_\_ are only found in closed body cavities.
11. The serous layer lining an internal body wall is called \_\_\_\_\_ serosa; the layer covering the outside of internal organs, \_\_\_\_\_ serosa.
12. Add the names of the cavities that are open and closed to the outside.

Cavities open to the outside	Lined by mucous membranes	Cavities closed to the outside	Lined by serous membranes
			

**Apply your knowledge**

1. The basic difference between dense irregular and dense regular connective tissues is in the amount of elastic fibers and adipose cells present. Is this statement true and if not why not?
2. You are a pathologist and are examining a tissue sample from a patient's Achilles tendon under a microscope. What type of connective tissue would you expect to find in the sample? Explain.

3. Explain why we can say one of the functions of connective tissue is transportation.
  
4. You are looking at tissue under the microscope and notice the extracellular matrix is liquid. What tissue are you most likely looking at? Explain.
  
5. What kind of connective tissue would you expect to find as padding material between the skin and the ischial tuberosity (the part of the pelvis we are sitting on)?

## Chapter 5 Integumentary System

### Complete the following sentences

1. The skin, aka the \_\_\_\_\_, consists of three major regions: \_\_\_\_\_, \_\_\_\_\_, and \_\_\_\_\_.
2. The epidermis is made up of \_\_\_\_\_ epithelial tissue.
3. The epidermis in thick skin has \_\_\_\_\_ layers, while the epidermis of thin skin has \_\_\_\_\_ layers only.
4. The dermis has \_\_\_\_\_ layers: an upper \_\_\_\_\_ layer and a lower \_\_\_\_\_ layer.
5. The cells that produce the main skin pigment \_\_\_\_\_ are called \_\_\_\_\_.
6. Skin appendages are derivatives of the \_\_\_\_\_.
7. Sweat glands are also known as \_\_\_\_\_ glands.
8. \_\_\_\_\_ sweat glands are confined to axillary and anogenital areas.
9. The secretion of \_\_\_\_\_ glands is supposed to deter insects from crawling into the outer ear canal.
10. The fine body hair of children is called \_\_\_\_\_ hair.

### Review your knowledge

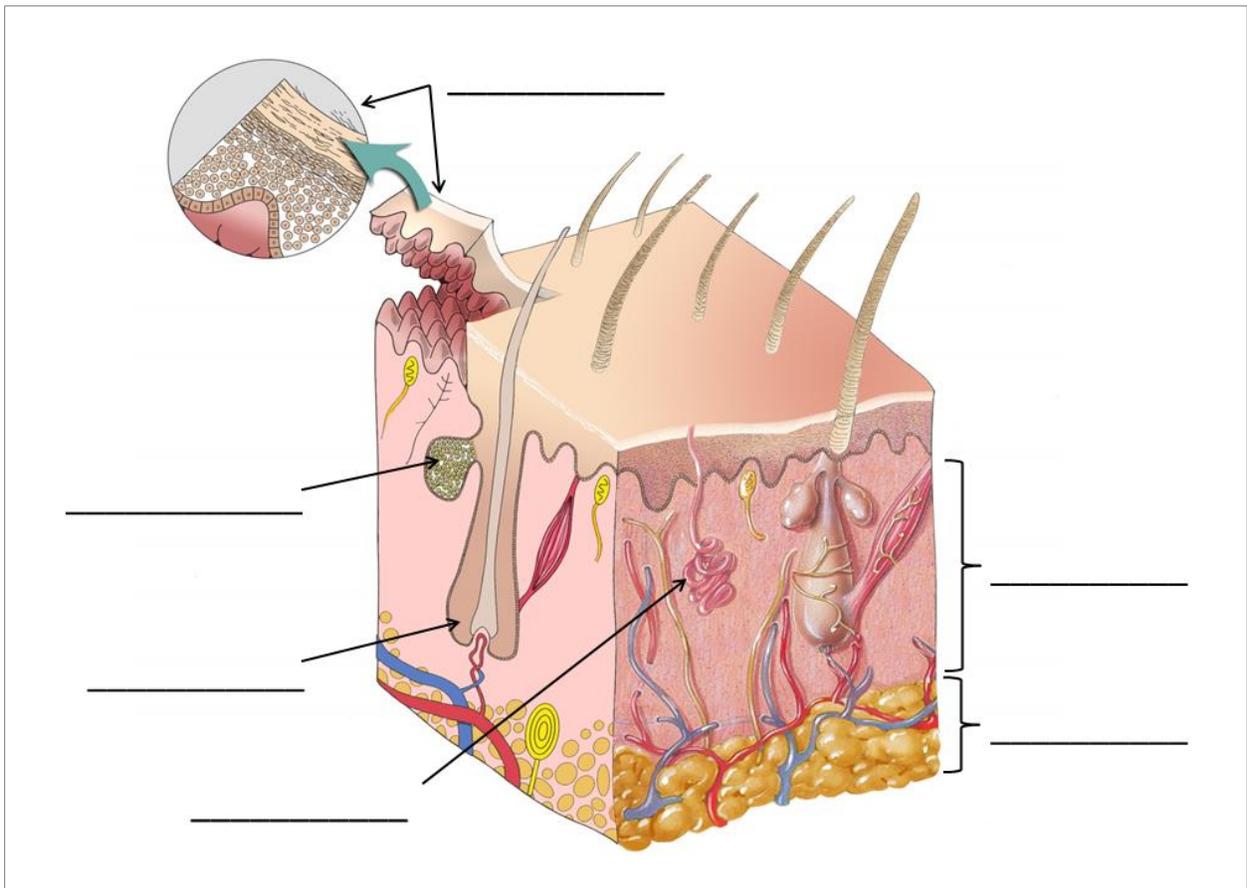
1. Use your knowledge of the three regions of skin to place each of the following characteristics in the appropriate region.
 

<ul style="list-style-type: none"> <li>• Consist of an upper 20% layer made of areolar connective tissue</li> <li>• The region visible to the eye (what we see)</li> <li>• Technically not part of skin</li> <li>• Avascular region</li> <li>• Skin appendages are derived from this region</li> <li>• Made of adipose connective tissue</li> <li>• Referred to as the subcutaneous region</li> <li>• 3<sup>rd</sup> degree burns reach this region</li> </ul>	<ul style="list-style-type: none"> <li>• 1<sup>st</sup> degree burns involve this region only</li> <li>• Consists of a deeper 80% layer made of dense irregular connective tissue</li> <li>• Synthesizes vitamin D</li> <li>• Consists of melanocytes, keratinocytes, dendritic cells and Merkel cells</li> <li>• 2<sup>nd</sup> degree burns reach this region</li> <li>• Contains hair follicles, sweat glands and oil glands</li> <li>• Supplies blood to the epidermis</li> </ul>
--	---

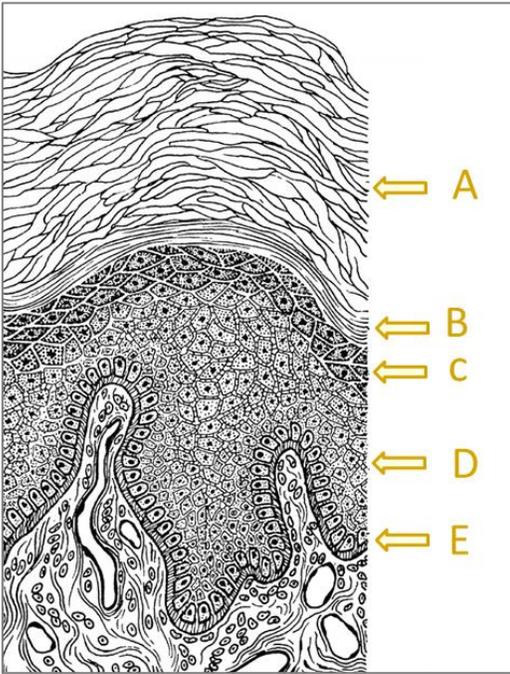
Region	Characteristics
Epidermis	
Dermis	
Hypodermis	

2. Locate and label the structures listed below.

- Epidermis
- Dermis
- Hypodermis
- Eccrine sweat gland
- Sebaceous gland
- Hair root



3. Use your knowledge of the epidermis to label the layers and place each of the following characteristics in the appropriate layer box.



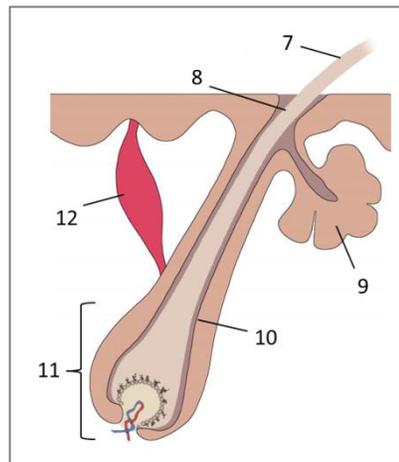
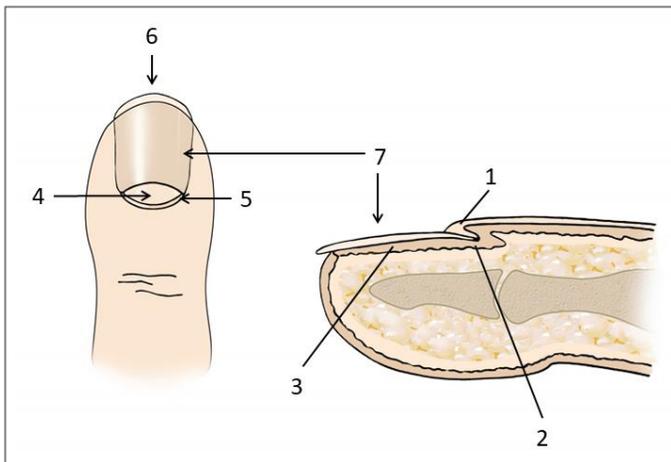
- Cells contain a web-like system
- Layer with stem cells that undergo rapid mitosis
- The layer that we see
- Protects against abrasion and penetration
- The layer that sloughs off
- Known as the prickly layer
- Basal cell carcinoma develops from cells in this layer
- Contains the youngest and healthiest cells
- Layer where cells are considered protective but nonviable
- Top layer of the epidermis that we see
- Layer where lamellated granules accumulate
- Dendritic cells found in this layer
- Found in thick skin only
- Consists of rows of dead keratinized epithelial tissue

Layer	Characteristics
A =	
B =	
C =	
D =	
E =	

4. Match the following structures to the labels on below diagrams.

- |                 |       |          |       |
|-----------------|-------|----------|-------|
| Cutting edge    | _____ | Nail bed | _____ |
| Sebaceous gland | _____ | Cuticle  | _____ |
| Hair shaft      | _____ | Lunula   | _____ |

Nail bed \_\_\_\_\_ Arrector pili muscle \_\_\_\_\_  
 Hair follicle \_\_\_\_\_ Nail root \_\_\_\_\_



5. Complete the table by adding the unique characteristics, function and location of each of the glands.

Gland	Characteristics	Function	Location
<b>Sudoriferous</b> aka: _____			
<b>Sebaceous</b> aka: _____			

6. Burn injuries that affect only part of the epidermis and dermis are classified as \_\_\_\_\_.

7. In \_\_\_\_\_-degree burns the upper part of the \_\_\_\_\_ has been damaged too and \_\_\_\_\_ are a typical sign.

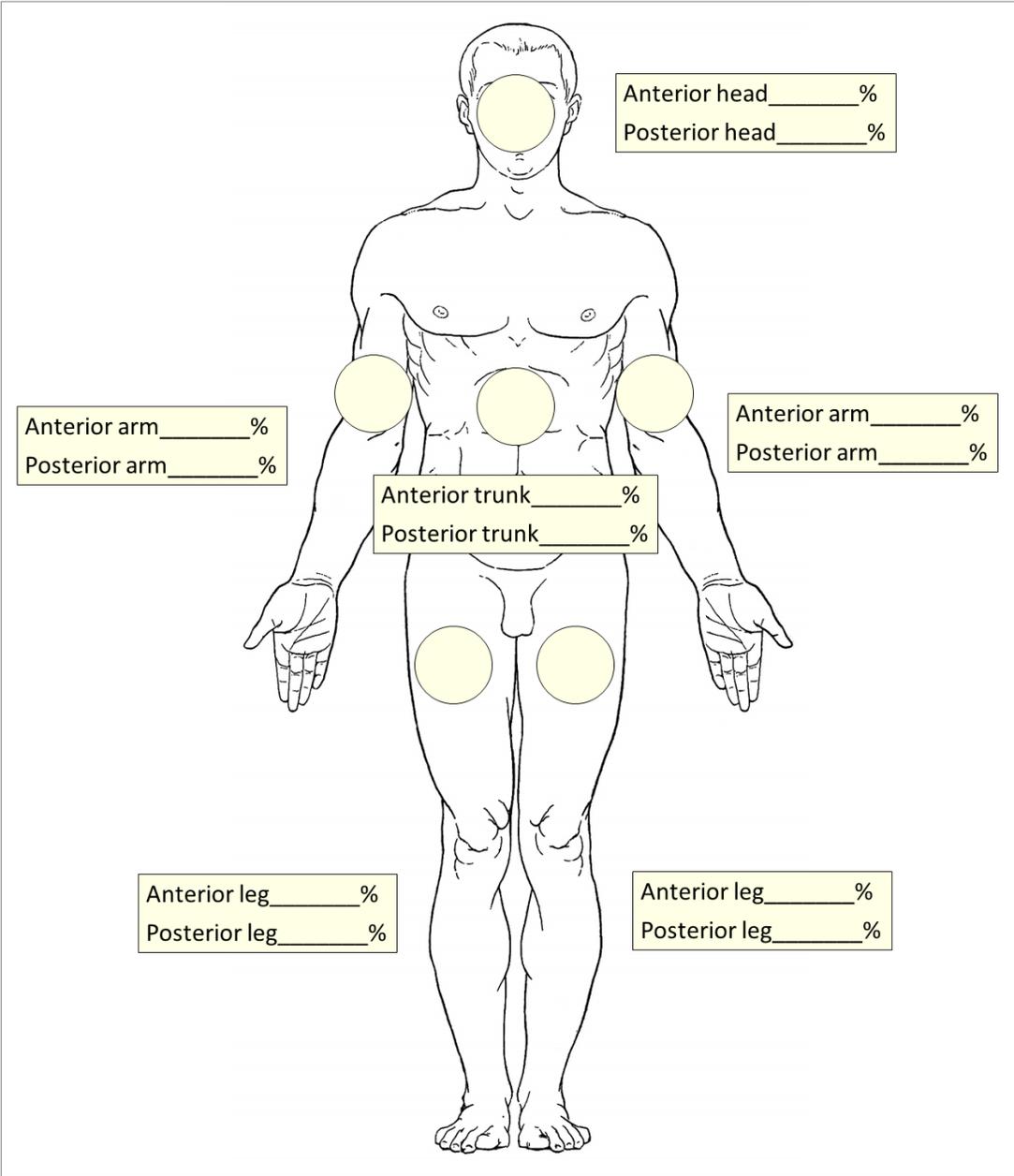
8. Once all layers of the skin have been damaged the injury is classified as a \_\_\_\_\_-degree burn.

9. Blisters are an indication of \_\_\_\_\_-degree burns.

10. The Rule of \_\_\_\_\_ is used to estimate the extent of \_\_\_\_\_ loss.

11. The Rule of Nines is used only in \_\_\_\_\_ degree and \_\_\_\_\_ degree burns.

12. Write the percent fluid loss according to the Rule of Nines in each box followed by the total percentage in each circle.



13. \_\_\_\_\_ (BCC) is the most common skin cancer.
14. \_\_\_\_\_, the second most common skin cancer, involves \_\_\_\_\_ of the stratum \_\_\_\_\_.
15. The least common, yet most dangerous form of skin cancer is called \_\_\_\_\_, because it arises from \_\_\_\_\_ and usually is of \_\_\_\_\_ color.
16. The most common risk factors for all types of skin cancer are \_\_\_\_\_ and \_\_\_\_\_ of the skin.

### Apply your knowledge

1. Which layer of the epidermis is the thickest layer? \_\_\_\_\_
2. Stem cells are only found in which layer? \_\_\_\_\_
3. Which layer of the epidermis is the thinnest layer? \_\_\_\_\_
4. Which sweat glands are found on hairless skin? \_\_\_\_\_
5. Which sweat glands do not function before puberty? \_\_\_\_\_
6. Which sweat glands play a major role in temperature regulation? \_\_\_\_\_
7. Which sweat glands are more active when we get nervous? \_\_\_\_\_
8. A man sustained second-degree burns on his chest, abdomen, and the anterior part of both arms, and third-degree burns on his entire left lower extremity. What percentage of his body is covered by burns based on the Rule of Nines?
9. Why may soap that has an alkaline base not be healthy for daily use?
10. Your roommate wants to have the hair on her legs removed by laser therapy. She is worried she might not be able to walk for a day or two because the laser could irritate the skin on the soles of her feet. Is that a valid concern?

## Chapter 6 Bones & Skeletal Tissues

### Complete the following sentences

1. Cartilage structures are surrounded by a connective tissue layer called \_\_\_\_\_, which contains blood vessels for nutrient delivery.
2. The three types of skeletal cartilage are \_\_\_\_\_ cartilage, \_\_\_\_\_ cartilage, and \_\_\_\_\_.
3. The middle part of a long bone is called the \_\_\_\_\_ or \_\_\_\_\_ and the two expanded ends are called \_\_\_\_\_.
4. Inside the shaft of a long bone is a hollow space called the \_\_\_\_\_; in babies it is filled with blood-forming \_\_\_\_\_.
5. The membrane covering the outside of a bone is called \_\_\_\_\_, while the membrane lining the inside surfaces of a bone is called \_\_\_\_\_.
6. All bones that are longer than wide are called \_\_\_\_\_ bones.
7. \_\_\_\_\_ bone and \_\_\_\_\_ bone are two types of bone tissue.
8. The basic structural unit of compact bone is called \_\_\_\_\_ or \_\_\_\_\_.
9. Bone tissue is the only tissue with an \_\_\_\_\_ and an \_\_\_\_\_ component.
10. The inorganic part forms approximately \_\_\_\_% of our bone mass. It gives bone tissue its \_\_\_\_\_ and the ability to withstand \_\_\_\_\_. It is mainly made of \_\_\_\_\_ crystals; that are collectively called \_\_\_\_\_.

### Review your knowledge

1. Define 'diplae': \_\_\_\_\_
2. Cartilage can grow by adding additional matrix to the outside of already existing cartilage. This process is called \_\_\_\_\_ growth.
3. In \_\_\_\_\_ growth the chondrocytes divide, secrete more matrix, and lead to a growth from within.

4. Use your knowledge of connective tissue to write a brief description of each type of cartilage.

<b>Hyaline cartilage</b>	
<b>Elastic cartilage</b>	
<b>Fibrocartilage</b>	

5. Complete the following table by adding the type of cartilage forming the structures.

Structure(s)	Cartilage type
Embryonic skeleton	
External ear	
Costal cartilages	
Intervertebral discs	
Epiglottis	
Menisci of knee joint	
Trachea	
Nose	
Auditory tube	
Pubic symphysis	

6. List six functions of the skeletal system.

- |                               |                               |
|-------------------------------|-------------------------------|
| <p>a.</p> <p>c.</p> <p>e.</p> | <p>b.</p> <p>d.</p> <p>f.</p> |
|-------------------------------|-------------------------------|

7. A round or oval opening in a bone is called \_\_\_\_\_.

8. If a shallow bone depression looks a bit like a basin, it is called a \_\_\_\_\_.

9. Round bone projections are called \_\_\_\_\_.

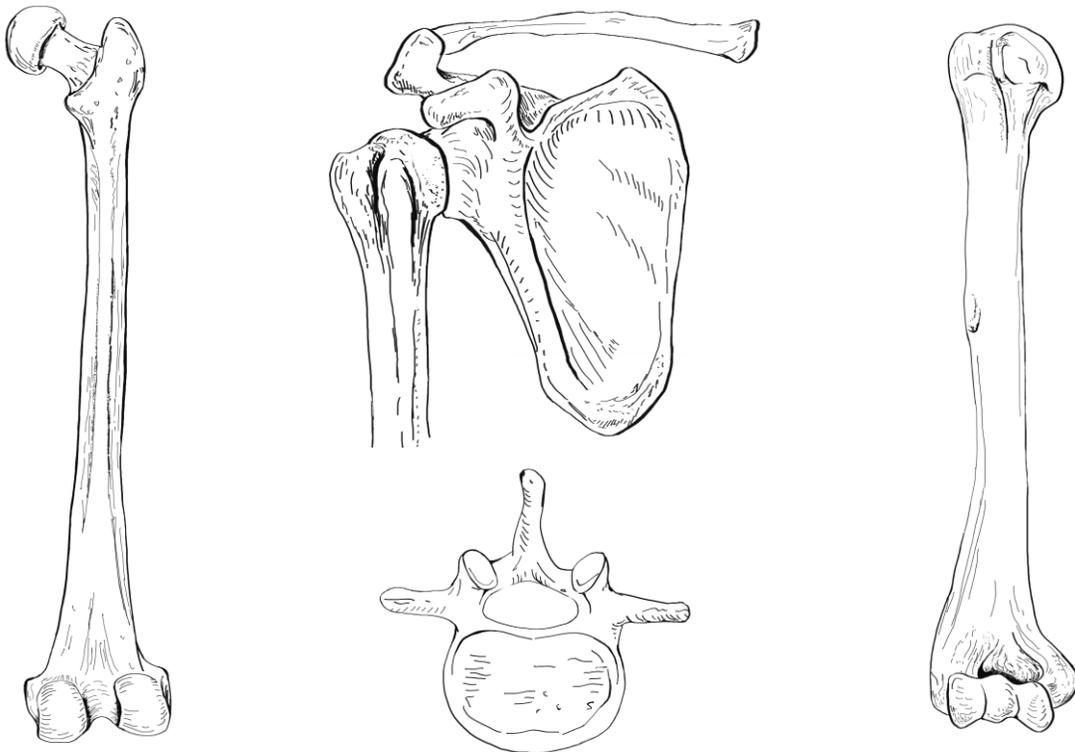
10. However, if a round bone projection helps form joints it is known as \_\_\_\_\_.

11. Complete the following table of bone markings by writing a brief description and giving an example of the bone markings listed below.

Bone marking	Description	Example
Condyle		

Facet		
Head		
Process		
Trochanter		
Tubercle		
Trachea		
Tuberosity		
Fissure		
Foramen		
Fossa		
Meatus		
Sinus		

12. Identify and label as many bone markings as you can on the images below.



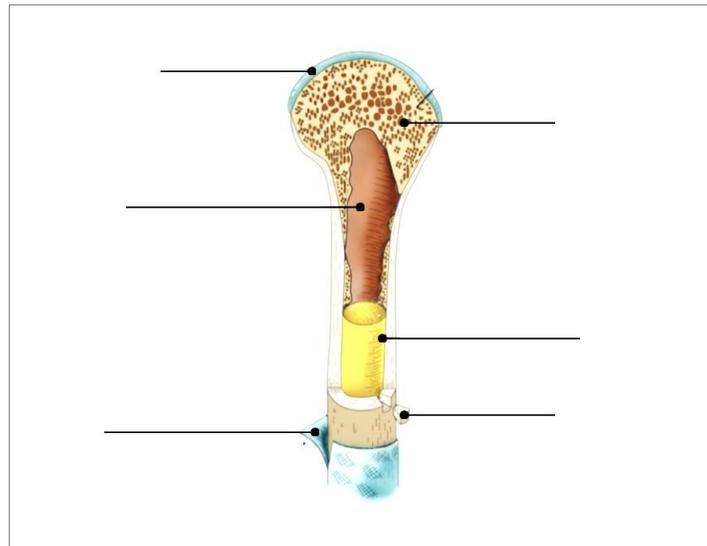
13. All bones that are longer than wide are called \_\_\_\_\_ bones.
14. Bones that are cube-shaped, i.e., are of equal length and width, are called \_\_\_\_\_ bones.
15. Flat bones have a sandwich structure with an outer and inner layer of \_\_\_\_\_ bone, and a middle layer of \_\_\_\_\_ bone.

16. Bone growth from the outside is called \_\_\_\_\_.
17. Bone growth that replaces cartilage is called \_\_\_\_\_.
18. Bone tissue formation is also known as \_\_\_\_\_ or \_\_\_\_\_.
19. Complete the following chart by listing a brief description of each of the three bone cells.

Osteoblast	Osteocyte	Osteoclast

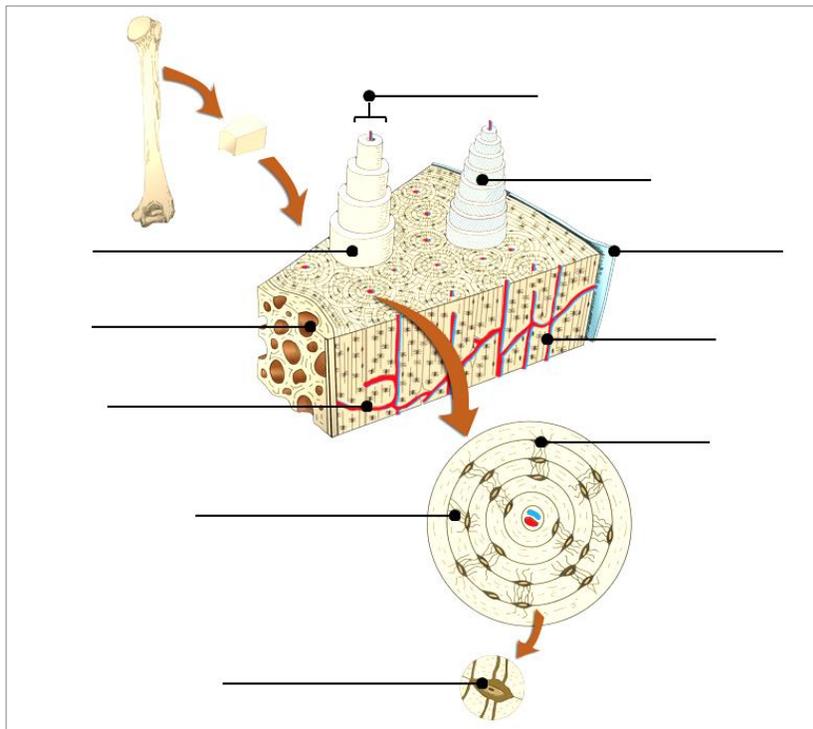
20. Complete the table by naming the structure. Next, identify and label each of the structures on the image below.

Description	Structure
Storage of fat	
Made up of osteons	
Outer membrane covering the compact bone	
Made of honeycomb structures called trabeculae	
Hollow cavity lined with endosteum	
Made of hyaline cartilage	

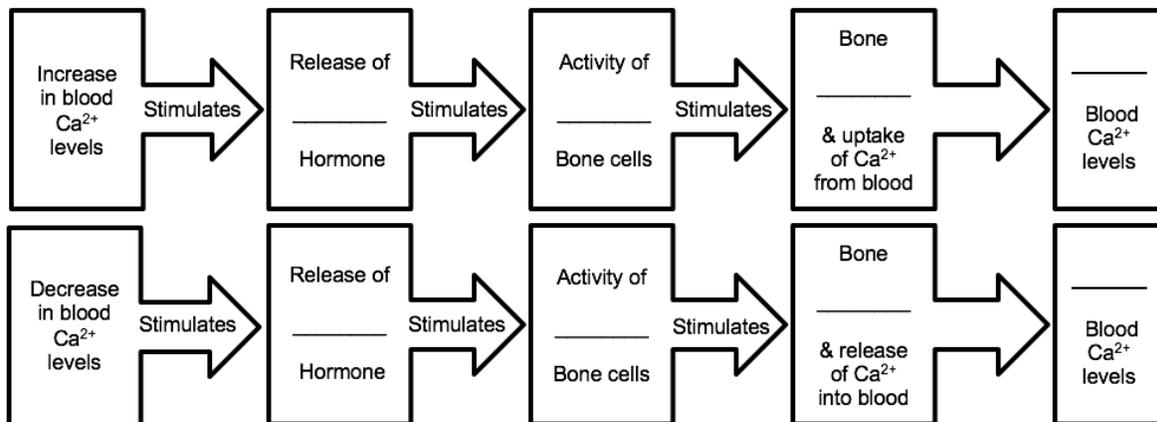


21. Compact bone consists of column-like tubes of extracellular matrix called \_\_\_\_\_.
22. At the center of each tube runs the \_\_\_\_\_ or \_\_\_\_\_ canal.
23. Canals that run at a right angle to the central canals are called \_\_\_\_\_ or \_\_\_\_\_ canals.

24. The organic bone matrix is secreted by \_\_\_\_\_.
25. Mature bone cells are called \_\_\_\_\_ and they reside in the \_\_\_\_\_.
26. \_\_\_\_\_ fibers give bone tissue flexibility and tensile strength
27. Instead of osteons, spongy bone is made of so-called \_\_\_\_\_.
28. *Locate and label each of the structures listed below.*
- Spongy bone
  - Osteon
  - Lamellae
  - Collagen fibers
  - Periosteum
  - Lacunae
  - Osteocytes
  - Perforating canal
  - Volkmann's canal
  - Canaliculi



29. *Use your understanding of bone cells and hormones to complete the following charts regarding calcium homeostasis.*



30. The amount of mineral material in the bone matrix is called \_\_\_\_\_.
31. We reach our peak bone mass (PBM) at around age \_\_\_\_\_.
32. The natural decline of bone density when we get older leads to \_\_\_\_\_.
33. If the bone substance becomes depleted and is susceptible to fracture under almost normal stress, we talk about \_\_\_\_\_.

### Apply your knowledge

1. Why is elastic cartilage not used to connect bones?
2. Your friend doesn't believe that there is such a thing as a "sesamoid bone" and asks you to show him such a bone in your body. Which bone would you point to?
3. Why do all bones have compact bone on the outside and spongy bone on the inside? Couldn't they have either compact or spongy bone on the outside?
4. What effect would premature closure of the epiphyseal growth plate of the shinbone of one leg have on the overall development of the skeletal structure of the leg?
5. You examine a young man during intake at a hospital. You notice that both of his legs are bowed out and you ask is he has suffered from bowlegs for a long time. He says no and that the condition only developed over the last few years. Based on this information you suspect the man is suffering from \_\_\_\_\_.
6. Based on Wolff's law the bones of a patient who has been immobilized for a period of six months would show which changes?
7. What could give you a clue as to how old the patient in the X-ray is?



## Chapter 7 Skeleton

### Complete the following sentences

1. The axial skeleton forms the \_\_\_\_\_ axis of our body. Usually, the axial skeleton consists of about \_\_\_\_\_ bones.
2. The appendicular skeleton is formed by the bones of the \_\_\_\_\_ and the \_\_\_\_\_ and \_\_\_\_\_ girdles.
3. Each hip bone is made of three bones: \_\_\_\_\_, \_\_\_\_\_, and \_\_\_\_\_.
4. There are \_\_\_\_\_ bones in the skull overall: \_\_\_\_\_ cranial bones and \_\_\_\_\_ facial bones.
5. The \_\_\_\_\_ or \_\_\_\_\_ house the eyes and lacrimal glands and are the sites of attachment for eye muscles.
6. The \_\_\_\_\_ is the backbone of our body. It consists of \_\_\_\_\_ cervical vertebrae, \_\_\_\_\_ thoracic vertebrae, \_\_\_\_\_ lumbar vertebrae, \_\_\_\_\_, and \_\_\_\_\_.
7. The \_\_\_\_\_ is the sole bone of the arm. Its upper end forms the rounded \_\_\_\_\_ that articulates with the \_\_\_\_\_ of the \_\_\_\_\_ to form the shoulder joint.
8. Fingers and toes are also known as \_\_\_\_\_. Each finger or toe has three bones called \_\_\_\_\_, \_\_\_\_\_, and \_\_\_\_\_ phalanx.
9. The exceptions are the \_\_\_\_\_ finger or toe, which have \_\_\_\_\_ phalanges only as the middle phalanx is missing.
10. The pelvis is subdivided into a \_\_\_\_\_ or \_\_\_\_\_ pelvis, which is located below the \_\_\_\_\_, and a \_\_\_\_\_ or \_\_\_\_\_ above the brim.

### Review your knowledge

1. Define 'scoliosis': \_\_\_\_\_
2. The jagged lines that connect the bones of the cranial vault are called \_\_\_\_\_.
3. The only bone of the skull that can move freely is the \_\_\_\_\_.
4. The sternum is also known as \_\_\_\_\_, the scapula as \_\_\_\_\_, the clavicle as \_\_\_\_\_, and the ischium as \_\_\_\_\_.

5. Assign the bones that make up the axial skeleton and appendicular skeletons from the list to the correct classification group.

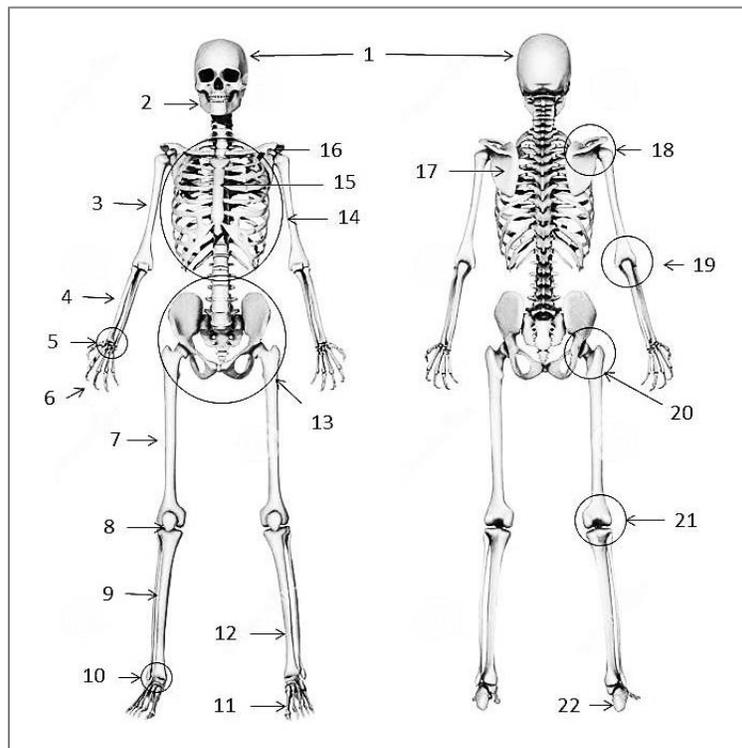
- Skull
- Pectoral girdle
- Upper limb
- Vertebral column
- Rib cage
- Lower limb
- Pelvic girdle

Axial skeleton

Appendicular skeleton

6. Locate and label each of the bones and joints listed below.

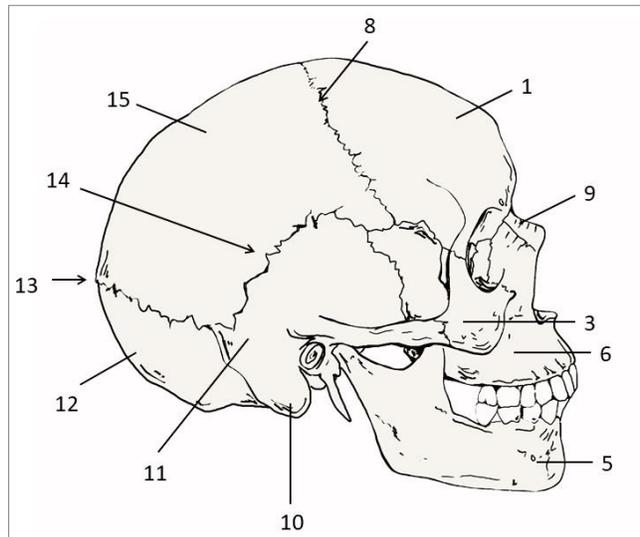
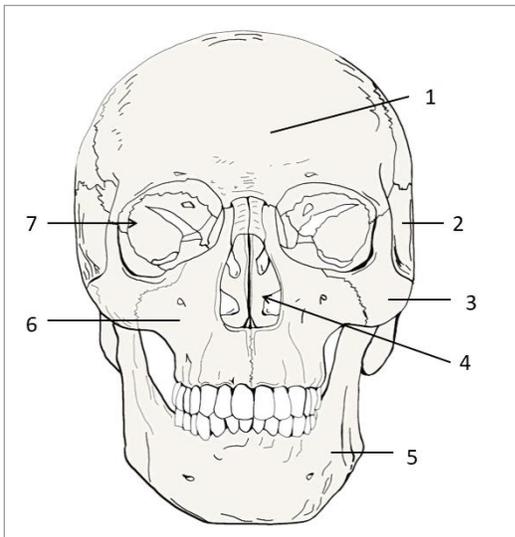
- |              |       |                  |       |
|--------------|-------|------------------|-------|
| • Skull      | _____ | • Humerus        | _____ |
| • Tibia      | _____ | • Phalanges      | _____ |
| • Sternum    | _____ | • Pelvis         | _____ |
| • Hip joint  | _____ | • Calcaneus      | _____ |
| • Mandible   | _____ | • Shoulder joint | _____ |
| • Carpals    | _____ | • Ankle          | _____ |
| • Fibula     | _____ | • Femur          | _____ |
| • Scapula    | _____ | • Rib cage       | _____ |
| • Knee joint | _____ | • Elbow joint    | _____ |



7. The air-filled spaces that lighten the skull and enhance resonance of the voice are called \_\_\_\_\_.

8. Paranasal sinuses are found in four bones: \_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_, and \_\_\_\_\_.
9. The only bone in the body that is not connected directly with any other bone is the \_\_\_\_\_.
10. The occipital bone articulates with the \_\_\_\_\_.
11. The large opening in the occipital bone is called \_\_\_\_\_.
12. Match the following structures to the labels on the diagrams.

Frontal bone	_____	Mandible	_____
Maxilla	_____	Temporal bone	_____
Occipital bone	_____	Nasal bone	_____
Orbit	_____	Cheek bone	_____
Parietal bone	_____	Mastoid process	_____

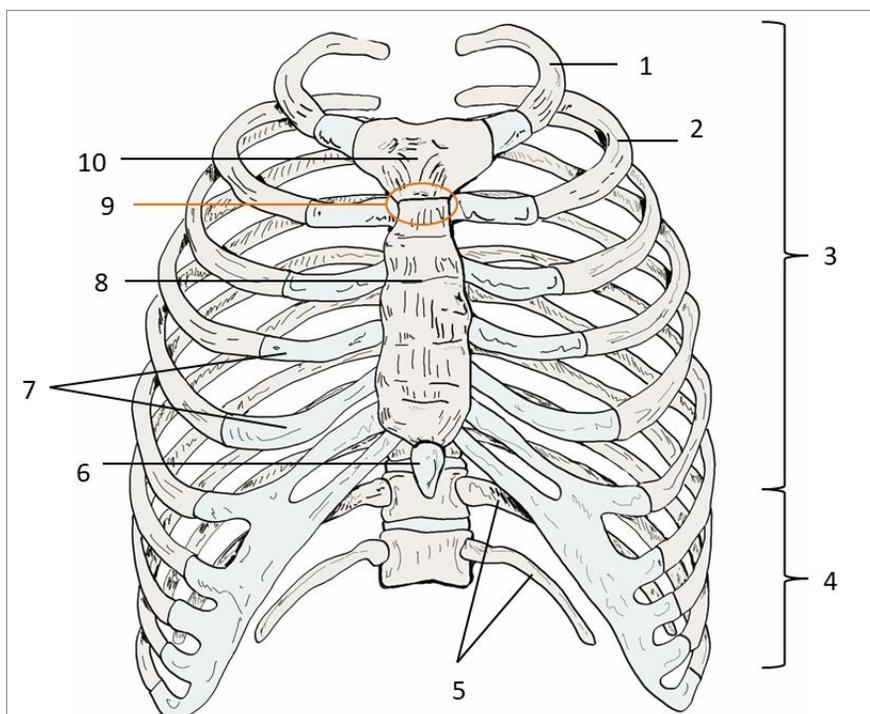


Use above diagrams to answer the following questions.

13. The suture connecting parietal bones and frontal bone is called \_\_\_\_\_.  
It is labeled # \_\_\_\_\_.
14. The \_\_\_\_\_ suture (labeled # \_\_\_\_\_) is connecting the parietal bones with \_\_\_\_\_ bone.
15. The suture connecting a parietal bone with a temporal bone is called \_\_\_\_\_ or \_\_\_\_\_.  
It is labeled # \_\_\_\_\_.
16. The backbone of our body, the \_\_\_\_\_ column, consists of \_\_\_\_\_ bones overall,

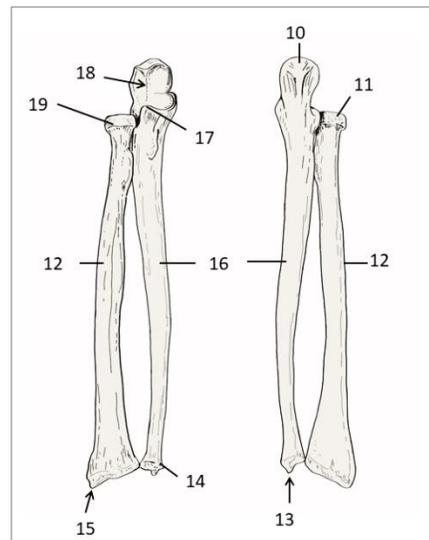
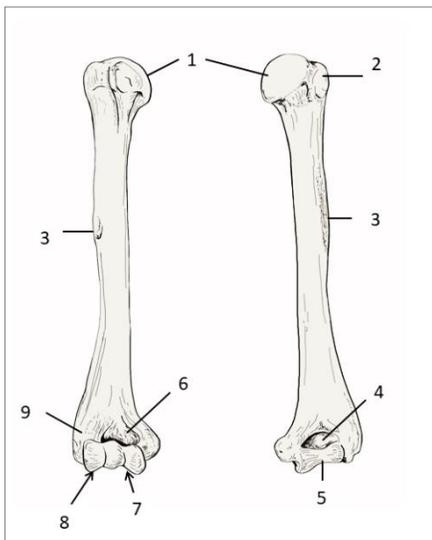
twenty four \_\_\_\_\_, the \_\_\_\_\_, and the \_\_\_\_\_.

17. There are \_\_\_\_\_ cervical vertebrae, \_\_\_\_\_ thoracic vertebrae, and \_\_\_\_\_ lumbar vertebrae.
18. Each vertebra but one has an anterior weight-bearing region called \_\_\_\_\_ or \_\_\_\_\_.
19. The posterior part that surrounds the vertebral \_\_\_\_\_ is the vertebral \_\_\_\_\_. All the foramina together make up the \_\_\_\_\_ canal, which houses the spinal cord.
20. The opening between each vertebra where spinal nerves exit out of is called \_\_\_\_\_.
21. \_\_\_\_\_ vertebrae are the smallest vertebrae, \_\_\_\_\_ the biggest.
22. \_\_\_\_\_ vertebrae have \_\_\_\_\_ in their transverse process. The first cervical vertebra is called \_\_\_\_\_, the second \_\_\_\_\_.
23. The cervical spine is the only part of the spine that allows for \_\_\_\_\_ as well as \_\_\_\_\_ and \_\_\_\_\_.
24. The sacrum consists of \_\_\_\_\_ fused vertebrae, the coccyx of \_\_\_\_\_ - \_\_\_\_\_ vertebrae.
25. The cushion-like pads between adjacent vertebrae are called \_\_\_\_\_ discs.
26. They are composed of two parts: an inner core called the \_\_\_\_\_ and an outer ring called \_\_\_\_\_.
27. The rib cage is also referred to as the \_\_\_\_\_.



Use the thorax diagram to answer the following questions.

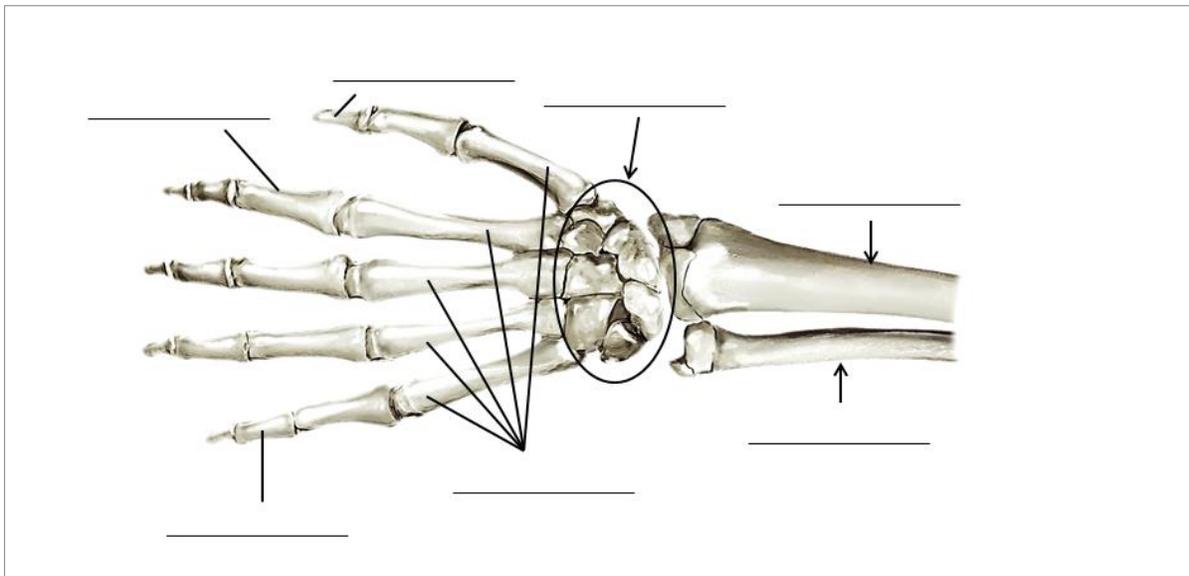
28. The 12 pairs of ribs are subdivided into two main groups: pairs \_\_\_ through \_\_\_ are called \_\_\_\_\_ or \_\_\_\_\_ ribs (labeled # \_\_\_) and pairs \_\_\_ through \_\_\_ (labeled # \_\_\_) are called \_\_\_\_\_ ribs.
29. \_\_\_\_\_ ribs (labeled # \_\_\_) do not attach to the sternum at all.
30. The sternum or \_\_\_\_\_ has three parts: a handle or \_\_\_\_\_ (labeled # \_\_\_), a \_\_\_\_\_ (labeled # \_\_\_), and a tip called the \_\_\_\_\_ (labeled # \_\_\_).
31. The connection between manubrium and body forms a visible and palpable prominence in the midline of our chest called the \_\_\_\_\_. It is labeled # \_\_\_\_\_.
32. The pectoral or \_\_\_\_\_ girdle includes the \_\_\_\_\_ and \_\_\_\_\_ bone.
33. The S-shaped clavicle or \_\_\_\_\_ connects the \_\_\_\_\_ on the lateral side with the \_\_\_\_\_ in the midline of the body.
34. The \_\_\_\_\_ of the scapula ends in an enlarged process called \_\_\_\_\_.
35. The acromion articulates with the lateral end of the clavicle to form the \_\_\_\_\_ joint.



Use above diagrams to answer the following questions.

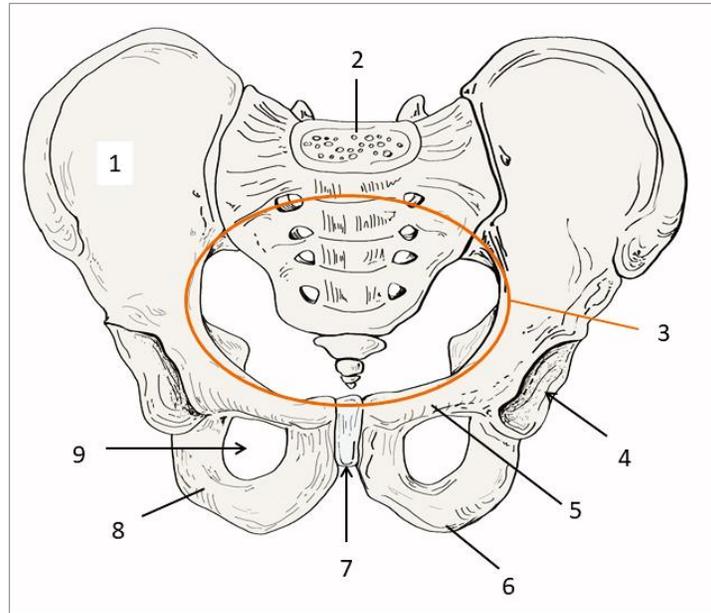
36. The \_\_\_\_\_ of the humerus (labeled # \_\_\_) articulates with the \_\_\_\_\_ of the scapula to form the shoulder joint.
37. Midway down the shaft of the humerus is the V-shaped \_\_\_\_\_ (labeled # \_\_\_), which is the attachment site for the \_\_\_\_\_ muscle.

38. The lower end of the humerus has two condyles: the medial \_\_\_\_\_ (labeled # \_\_\_\_ ) has an hour-glass shape; the lateral one is ball-shaped and is called \_\_\_\_\_ (labeled # \_\_\_\_).
39. The \_\_\_\_\_ (labeled # \_\_\_\_ ) is the bone found on the \_\_\_\_\_ side of the forearm; it forms the major part of the elbow joint.
40. Its thick, proximal end carries a deep concavity called \_\_\_\_\_ (labeled # \_\_\_\_), which is perfectly shaped to articulate with the \_\_\_\_\_ of the humerus (labeled # \_\_\_\_).
41. The bone found on the lateral side of the forearm is called \_\_\_\_\_. It is labeled # \_\_\_\_.
42. The wrist consists of eight \_\_\_\_\_ bones.
43. However, only the \_\_\_\_\_ and the \_\_\_\_\_ articulate with the radius to form the wrist joint
44. Identify and label the following structure on the diagram of the hand.
- Proximal phalanx
  - Carpals bones
  - Ulna
  - Metacarpal bones
  - Radius
  - Middle phalanx
  - Distal phalanx



45. Match the following structures to the labels on the diagram of the pelvis below.

Ilium	_____	Pubic symphysis	_____
Sacrum	_____	Pubis	_____
Ischium	_____	Acetabulum	_____
Obturator foramen	_____	Ischial tuberosity	_____



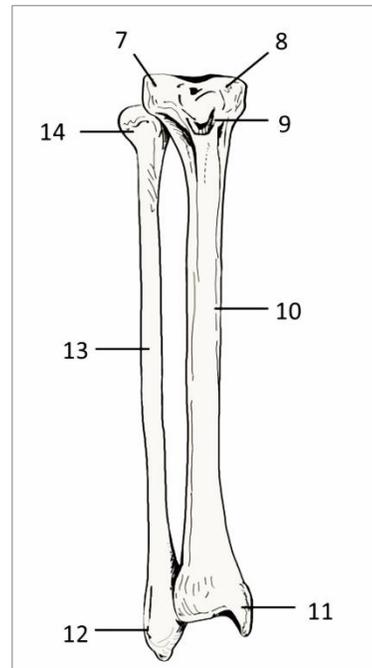
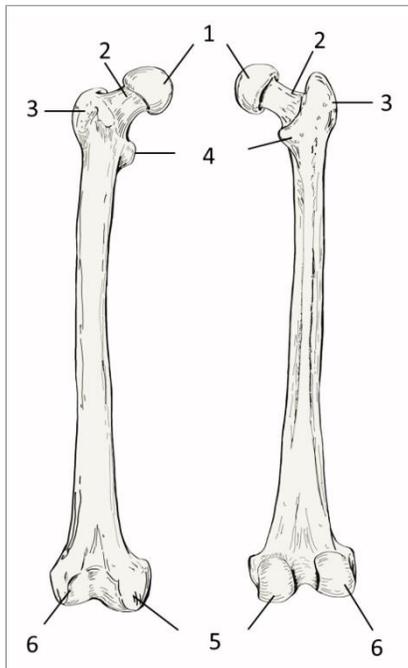
46. The \_\_\_\_\_ or \_\_\_\_\_ is the largest sesamoid bone of the body.

*Use the diagrams below to answer the following questions.*

47. The \_\_\_\_\_ (labeled # \_\_\_\_ ) and \_\_\_\_\_ trochanter (labeled # \_\_\_\_ ) are attachment sites for the large thigh and gluteal muscles.

48. The medial bone of the lower leg is called \_\_\_\_\_. It is labeled # \_\_\_\_.

49. The \_\_\_\_\_ (labeled # \_\_\_\_ ) is thinner than the tibia because it is a \_\_\_\_\_ bone.



50. Match the following structures to the labels on above diagrams.

- |                        |       |                        |       |
|------------------------|-------|------------------------|-------|
| Lateral malleolus      | _____ | Lateral tibial condyle | _____ |
| Medial femoral condyle | _____ | Head of fibula         | _____ |
| Tibial tuberosity      | _____ | Medial malleolus       | _____ |

51. The ankle region, also known as \_\_\_\_\_, has \_\_\_\_\_ bones only, compared with \_\_\_\_\_ bones in the wrist.

52. The \_\_\_\_\_ or \_\_\_\_\_ is the biggest and strongest of the tarsal bones.

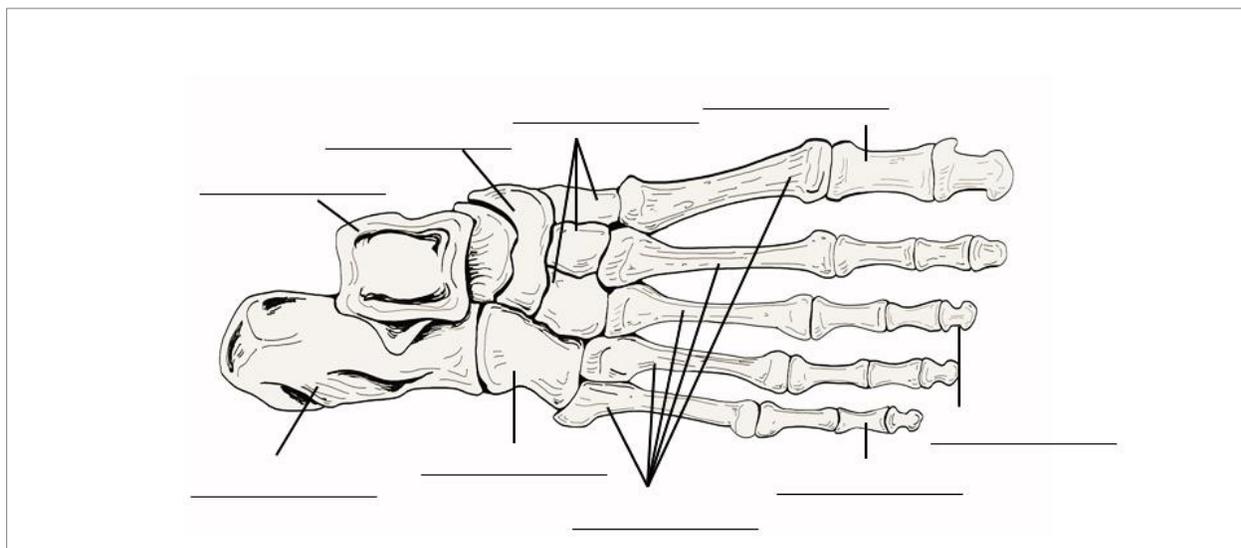
53. It is the attachment site for the strongest and thickest tendon of our body, the \_\_\_\_\_ or \_\_\_\_\_ tendon.

54. The distal head of the metatarsal bone 1 is enlarged and forms the so-called \_\_\_\_\_ of the foot.

55. The big toe is also called \_\_\_\_\_.

56. Identify and label the following structure on the diagram of the foot.

- Cuboid bone
- Calcaneus
- Cuneiform bones
- Middle phalanx
- Metatarsal bones
- Navicular bone
- Talus
- Distal phalanx
- Proximal phalanx



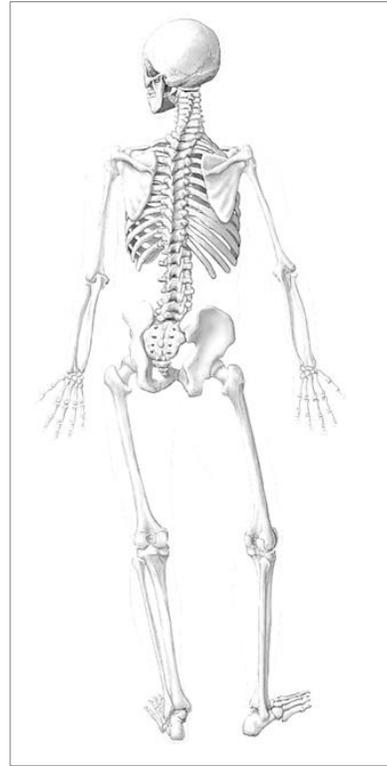
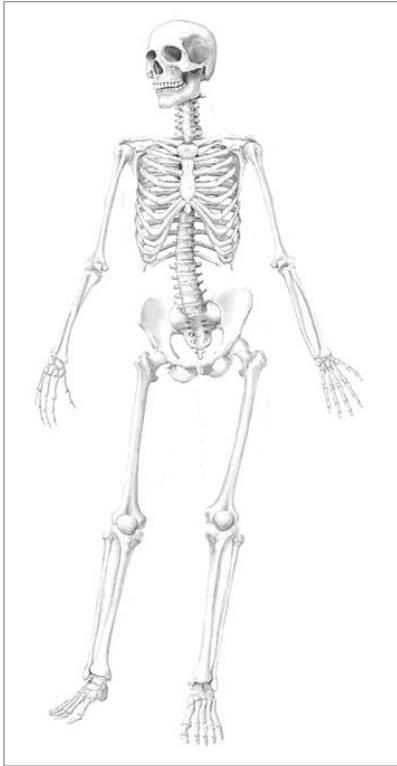
### Apply your knowledge

1. Why is the sternal angle an important landmark?

2. Why is the seventh cervical vertebra an important landmark?
3. What makes it easy to distinguish between a female and a male skeleton in forensic investigations?
4. What is the main difference between the thumb and the big toe and the other fingers and toes?
5. Why is the fibula so much thinner than the tibia?
6. Why are our fingers so much longer than our toes?
7. What happened to the body of the first cervical vertebra and why is this important for the way we can move our head?
8. Why do the facet joints between the thoracic vertebrae block the thoracic spine from being able to bend forward (flex)?
9. Why is it important for us to lift heavy weights with our spine straightened?
10. Why are the tarsal bones bigger than the carpal bones?

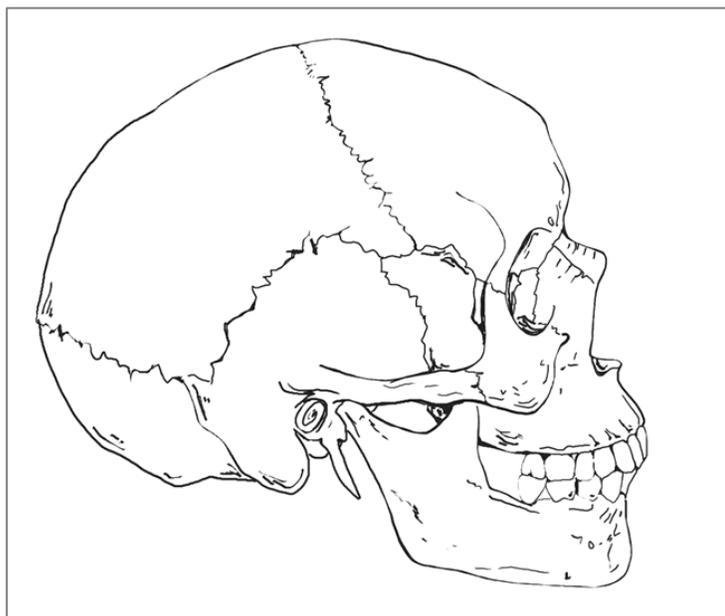
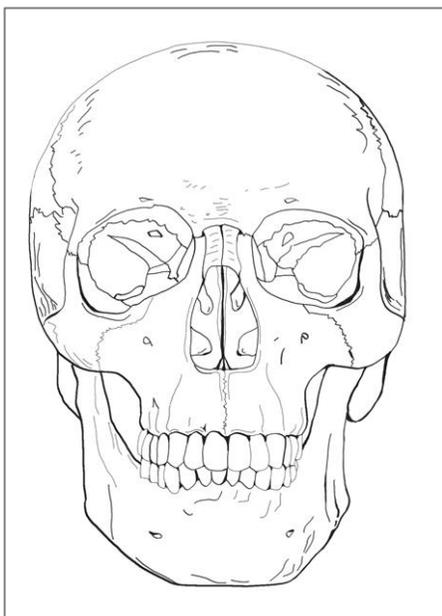
### Coloring fun

Locate and color the parts of the axial skeleton in one color and the parts of the appendicular skeleton in a different color.



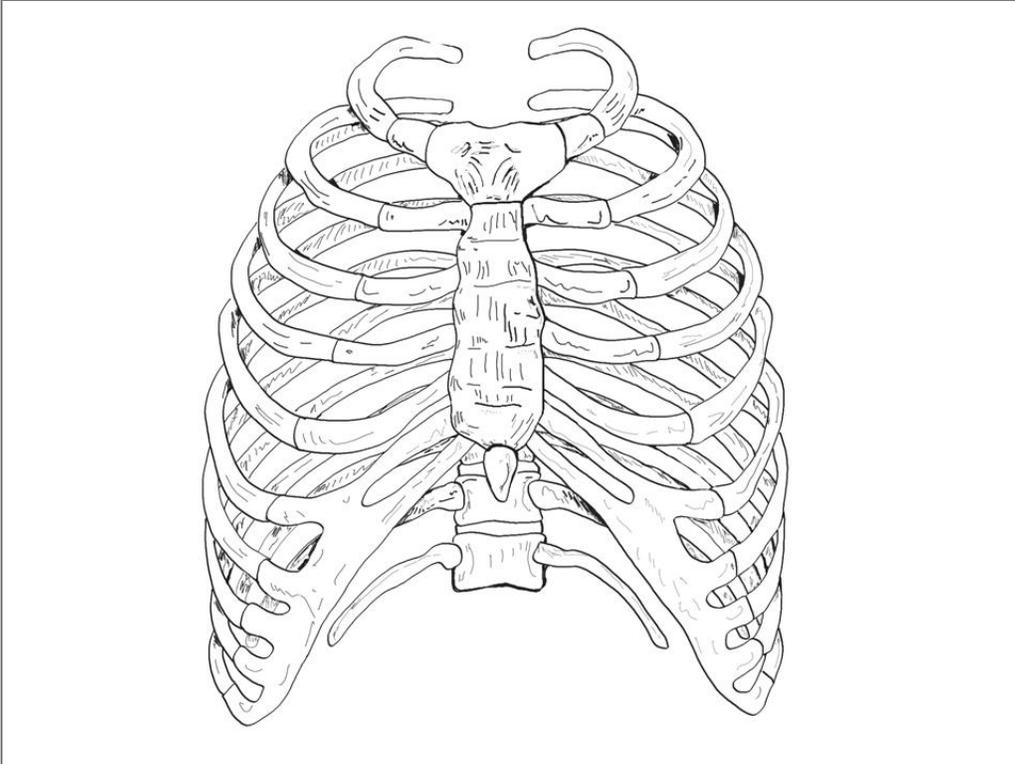
Locate, color, and label the parts of the skull.

- Frontal bone
- Maxilla
- Mandible
- Zygomatic bone
- Temporal bone
- Occipital bone
- Parietal bone
- Nasal bone
- Coronal suture
- Lambdoid suture
- Squamous suture



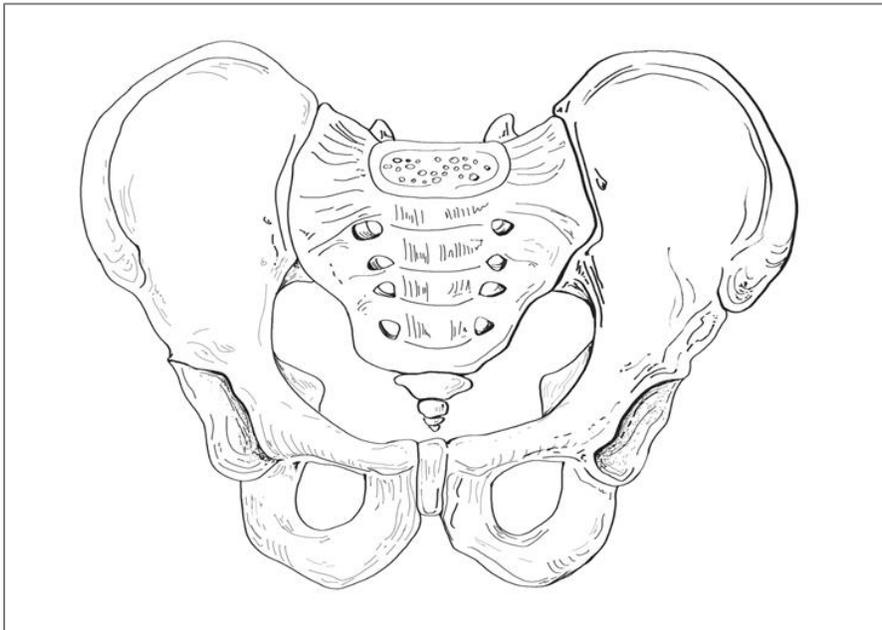
Locate, color, and label the parts of the thorax.

- Costal cartilage
- Manubrium
- Body of sternum
- Xiphoid process
- Vertebrae
- True ribs
- False ribs
- Floating ribs



Locate, color, and label the parts of the pelvis.

- Sacrum
- Coccyx
- Ilium
- Ischium
- Acetabulum
- Pubic symphysis
- Pubis





## Chapter 8 Joints

### Complete the following sentences

1. Joints can be classified based on the \_\_\_\_\_ that bind the bones together and whether or not a joint cavity is present. This is called a \_\_\_\_\_ classification.
2. In fibrous joints the bones are joined by \_\_\_\_\_. There is no \_\_\_\_\_ and most joints are \_\_\_\_\_.
3. \_\_\_\_\_ are rigid, interlocking joints between skull bones. Later in life they ossify and are then called \_\_\_\_\_.
4. In \_\_\_\_\_, the bones are connected by bands of fibrous tissue called \_\_\_\_\_. Movement in these joints varies from \_\_\_\_\_ to \_\_\_\_\_.
5. In \_\_\_\_\_ a bar or plate of \_\_\_\_\_ cartilage unites the bones creating a \_\_\_\_\_ joint
6. Most joints of the body, including all joints of our limbs are \_\_\_\_\_ joints.
7. The articular or \_\_\_\_\_ capsule consists of two layers, an outer \_\_\_\_\_ layer made of \_\_\_\_\_ connective tissue, and an inner \_\_\_\_\_ membrane of \_\_\_\_\_ connective tissue.
8. The most important stabilizing factor for synovial joints is the \_\_\_\_\_ of muscles or tendons that cross a joint.
9. Movements that change the angle between connected bones are called \_\_\_\_\_ movements.
10. \_\_\_\_\_ joints allow for movement in or around all three planes.

### Review your knowledge

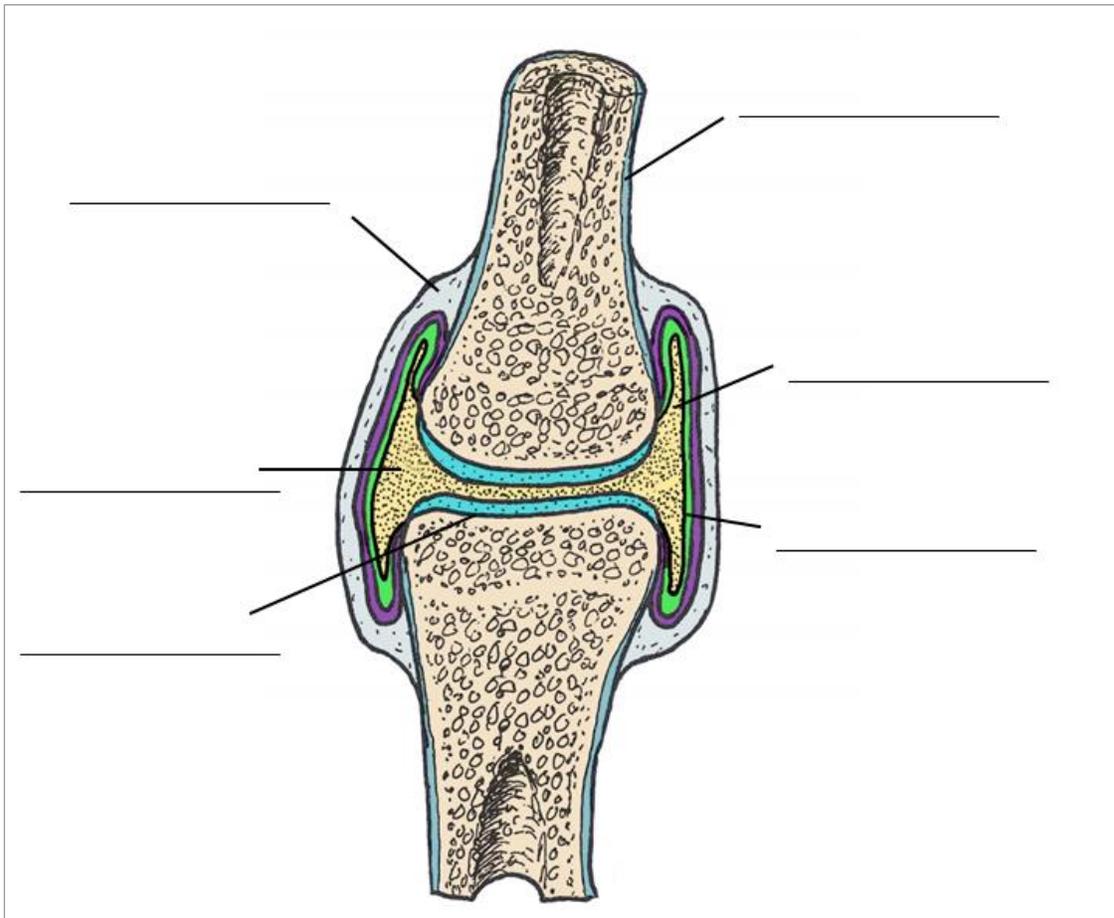
1. Define 'joint': \_\_\_\_\_
2. Complete the following table of joint classification.

Amount of movement	Structural classification	Description and examples	Functional classification
Some movement		<ul style="list-style-type: none"> <li>• Bone ends united by dense fibrous tissue               <ul style="list-style-type: none"> <li>○ Sutures</li> <li>○ Syndesmoses</li> <li>○ Gomphoses</li> </ul> </li> </ul>	

	Cartilaginous	<ul style="list-style-type: none"> <li>• Bone ends united by cartilage                     <ul style="list-style-type: none"> <li>○</li> <li>○</li> </ul> </li> </ul>	Synarthroses
Freely movable		<ul style="list-style-type: none"> <li>• Bone ends are covered with articular cartilage and enclosed within a fibrous capsule lined with synovial membrane                     <ul style="list-style-type: none"> <li>○</li> </ul> </li> </ul>	Diarthroses

3. Locate and label each of the structures of synovial joints.

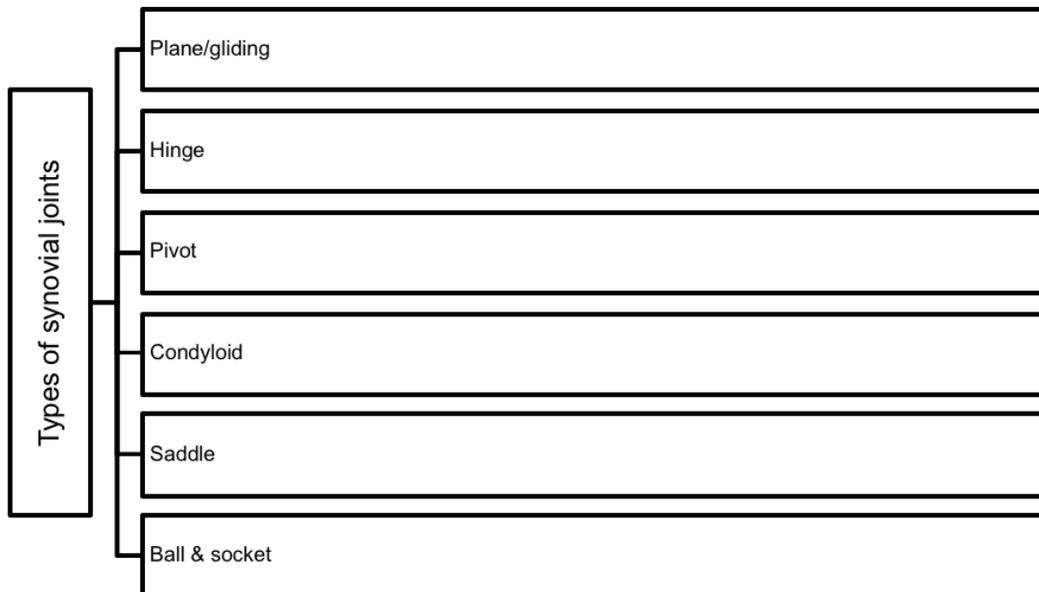
- Joint cavity/synovial fluid
- Synovial membrane
- Fibrous membrane
- Capsular ligament
- Articular cartilage
- Periosteum



4. Depending on the range of motion we can identify four kinds of joints:

- \_\_\_\_\_ joints: slipping movements only
- \_\_\_\_\_ joints: movement in one plane
- \_\_\_\_\_ joints: movement in two planes
- \_\_\_\_\_ joints: movement in or around all three planes

5. Write a description of each of the following types of synovial joints and provide an example.



6. Complete the following table by writing the angular movement being described.

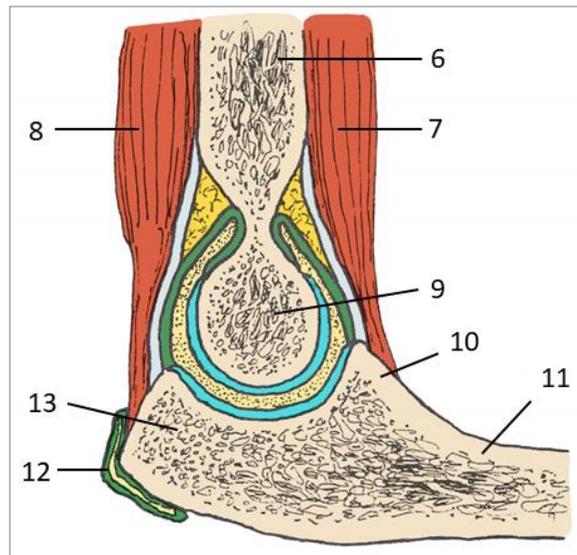
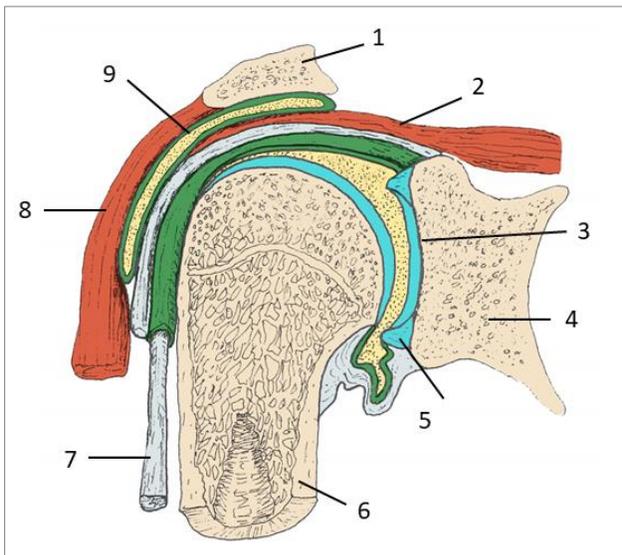
Description	Angular movement
Decreasing the angle of the joint	
Movement toward the midline	
Flexion + abduction + extension + adduction of a limb so as to describe a cone	
Increasing the angle of the joint	
Movement away from the midline	
Excessive extension beyond normal range of motion	

7. Please complete the following table of special movements:

Definition	Movement
Rotation of the forearm so that the palm faces anteriorly	
Anterior movement in a transverse plane	
Movement in the saddle joint so that the thumb touches the tips of the other fingers	
Lifting a body part superiorly	
Moving the foot upward	
Turning the sole laterally	
Moving a body part inferiorly	
Posterior movement in a transverse plane	
Turning the sole medially	
Moving the foot downward	

Rotation of the forearm so that the palm faces posteriorly	
--	--

8. The shoulder joint is also called \_\_\_\_\_ joint.
9. The joint is stabilized by muscle tendons that form the so-called \_\_\_\_\_.
10. It consists of the tendons of the \_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_, and \_\_\_\_\_ muscles.
11. The elbow joint is a strong \_\_\_\_\_ joint that is formed mainly by the \_\_\_\_\_ of the \_\_\_\_\_ and the \_\_\_\_\_ of the \_\_\_\_\_.



12. Match the following structures to the labels on the diagrams.

- |                  |       |                |       |
|------------------|-------|----------------|-------|
| Acromion         | _____ | Glenoid labrum | _____ |
| Deltoid          | _____ | Triceps        | _____ |
| Olecranon        | _____ | Humerus        | _____ |
| Coronoid process | _____ | Supraspinatus  | _____ |
| Scapula          | _____ | Trochlea       | _____ |
| Olecranon bursa  | _____ | Glenoid fossa  | _____ |

13. Use your knowledge of the shoulder and elbow joints to complete the following table.

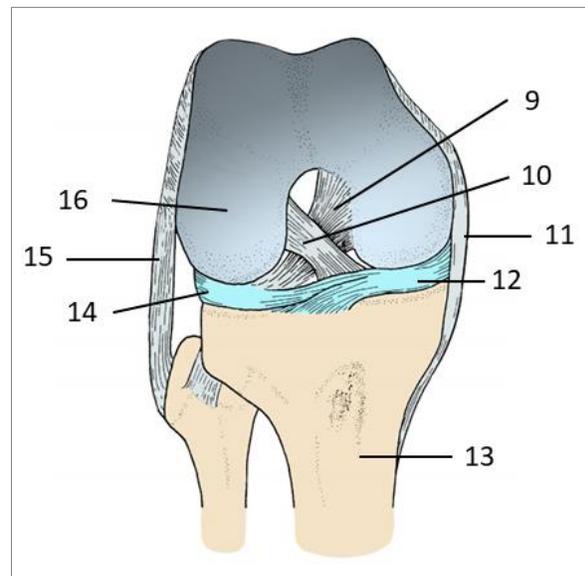
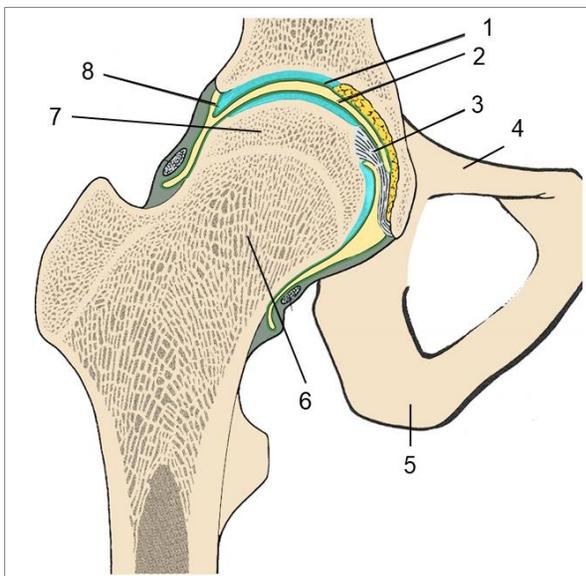
Description	Shoulder joint	Elbow joint
Structural classification		
Functional classification		

Amount of movement		
Type of synovial joint based on planes of movement		
Type of synovial joint		
Formed by articulation of which bones		
Specific structures of the bones that articulate		
Ligaments that stabilize the joint		
Muscles that stabilize the joint		
List the angular range of motions available		

14. The hip or \_\_\_\_\_ joint rarely dislocates due to the fact that its deep socket (\_\_\_\_\_) is enhanced by a circular \_\_\_\_\_ ring called \_\_\_\_\_ and the strength of the reinforcing ligaments.
15. The \_\_\_\_\_ joint is the largest and most complex joint of the body, because it consists of \_\_\_\_ joints that are surrounded by a single \_\_\_\_\_.
16. The \_\_\_\_\_ joint is a \_\_\_\_\_ joint between the articular surface on the posterior aspect of the \_\_\_\_\_ and the distal end of the \_\_\_\_\_.
17. The \_\_\_\_\_ and \_\_\_\_\_ joints connect the lateral and medial \_\_\_\_\_ of the femur with the articular surfaces of the condyles of the \_\_\_\_\_.
18. The \_\_\_\_\_ or \_\_\_\_\_ ligament (LCL) is the outer extracapsular ligament, the \_\_\_\_\_ or \_\_\_\_\_ ligament (MCL) the inner extracapsular ligament.
19. The intracapsular knee ligaments are called \_\_\_\_\_ ligaments, because they cross each other's path when looked at from the front.
20. The \_\_\_\_\_ and \_\_\_\_\_ meniscus are made of \_\_\_\_\_.
21. Use your knowledge of the hip and knee joints to complete the following table.

Description	Shoulder joint	Elbow joint
Structural classification		

Functional classification		
Amount of movement		
Type of synovial joint based on planes of movement		
Type of synovial joint		
Formed by articulation of which bones		
Specific structures of the bones that articulate		
Ligaments that stabilize the joint		
Muscles that stabilize the joint		
List the angular range of motions available		



22. Match the following structures to the labels on the diagrams.

- |                             |       |                            |       |
|-----------------------------|-------|----------------------------|-------|
| Ischial tuberosity          | _____ | Medial meniscus            | _____ |
| Lateral collateral ligament | _____ | Acetabular labrum          | _____ |
| Posterior cruciate ligament | _____ | Lateral meniscus           | _____ |
| Ligamentum teres            | _____ | Lateral femoral condyle    | _____ |
| Neck of femur               | _____ | Medial collateral ligament | _____ |
| Pubic bone                  | _____ | Anterior cruciate ligament | _____ |

23. The \_\_\_\_\_ or \_\_\_\_\_ joint is the only freely movable joint in the skull.
24. The joint cavity is subdivided by an \_\_\_\_\_ disc, which turns the TMJ into a joint with two types of movement: \_\_\_\_\_ and \_\_\_\_\_ of the mandible, and \_\_\_\_\_, i.e., side-to-side grinding movement.

### Apply your knowledge

1. What is the sequence of movements on the shoulder joint when you do jumping jacks?
2. Nodding your head in approval involves which movements in the atlanto-occipital joint?
3. Which joint do you use to turn your head to the left and right when you check whether it is safe to cross the road?
4. What do we call the type of synovial joint that allows our head to turn to the left and the right?
5. Which functional joint category allows for the least amount of movement?
6. Why are there no collateral ligaments to stabilize the shoulder joint?
7. Why is articular cartilage made of hyaline cartilage and not of elastic cartilage or fibrocartilage?
8. What type of structural type of joint are the joints between the superior and inferior articular process of adjacent vertebrae?
9. Why are we more likely to dislocate a finger in the knuckle joint between the metacarpal bone and the proximal phalanx than in the joints between the phalanges?

10. You got a summer job helping install carpet and laminate floors, which means that you spend a lot of time on your knees during working hours. After a few days you notice pain and swelling in front of the right knee but you can still bend the knee. What do you think the problem could be?

### Joint Assessment Activity

#### Measuring the range of motion (ROM) using a goniometer

##### Supplies per group (max. 4 students)

1 goniometer

A **goniometer** is an instrument that measures an angle, i.e., it is simply a protractor with two moving arms.

- How to use a goniometer to measure the ROM:
  - Align the fulcrum of the device with the fulcrum or the joint to be measured
  - Align the stationary arm of the device with the limb being measured
  - Hold the arms of the goniometer in place while measuring the joint's range of motion
  - **The degree between the endpoints represents the full range-of-motion.**

##### Important Tips:

- Stabilize the stationary portion of the body. It is important that the examinee does not move his/her body while moving the joint; this step isolates the joint movement allowing for a more accurate measurement.
- Look at the reading on the goniometer before removing it from the patient's body.

Joint	Range of motion
<b>Shoulder</b>	Flexion: _____ Extension: _____ Abduction: _____
<b>Elbow</b>	Flexion: _____ Extension: _____
<b>Wrist</b>	Flexion: _____ Extension: _____
<b>Hip</b>	Flexion: _____ Extension: _____ Abduction: _____
<b>Knee</b>	Flexion: _____ Extension: _____
<b>Ankle</b>	Dorsiflexion: _____ Plantar flexion: _____

## Chapter 9 Muscle tissue

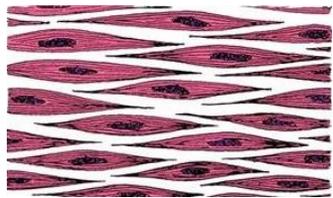
### Complete the following sentences

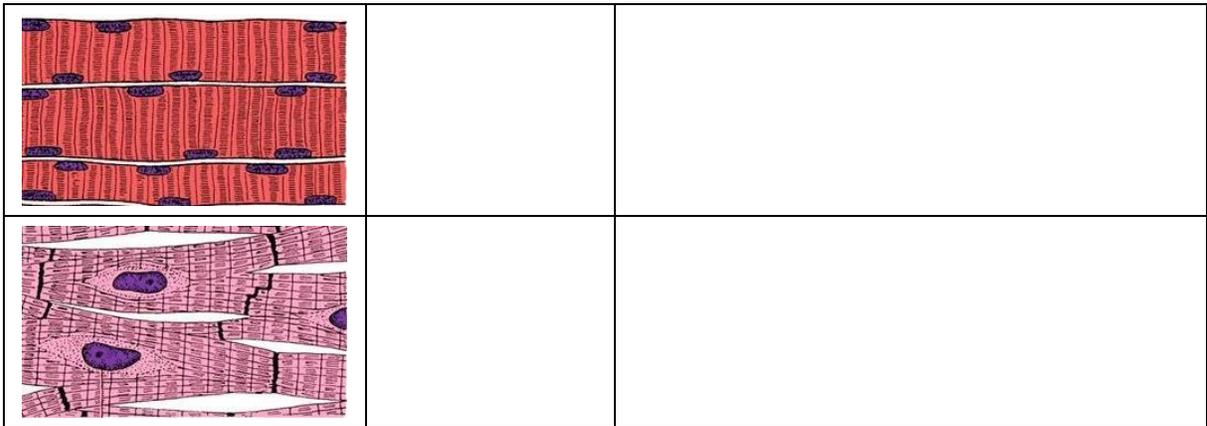
1. Muscle is the only tissue that can convert \_\_\_\_\_ energy into \_\_\_\_\_ energy.
2. Skeletal muscles have \_\_\_\_ connective tissue sheaths.
3. Starting from the inside, the connective tissue sheaths of skeletal muscle are called \_\_\_\_\_, \_\_\_\_\_, and \_\_\_\_\_.
4. The plasma membrane of skeletal muscle cells is called \_\_\_\_\_.
5. There is a special protein for oxygen storage called \_\_\_\_\_ and there are also glycogen granules called \_\_\_\_\_.
6. Myofibrils make up approx. \_\_\_\_% of the cell volume; because of their regular alignment inside the cells, these fibrils create a repeating series of dark \_\_\_\_ bands and lighter \_\_\_\_ bands.
7. The smallest contractile or \_\_\_\_\_ unit of a muscle fiber is called a \_\_\_\_\_.
8. Thick filaments are composed of the protein \_\_\_\_\_.
9. The smooth endoplasmic reticulum of muscle cells is called \_\_\_\_\_ reticulum.
10. The neurotransmitter released at the neuromuscular junction is \_\_\_\_\_.

### Review your knowledge

1. Define 'sarcomere': \_\_\_\_\_
2. Use your knowledge of the three muscle tissue types to place each of the following name and characteristics in the appropriate muscle tissue box.
 

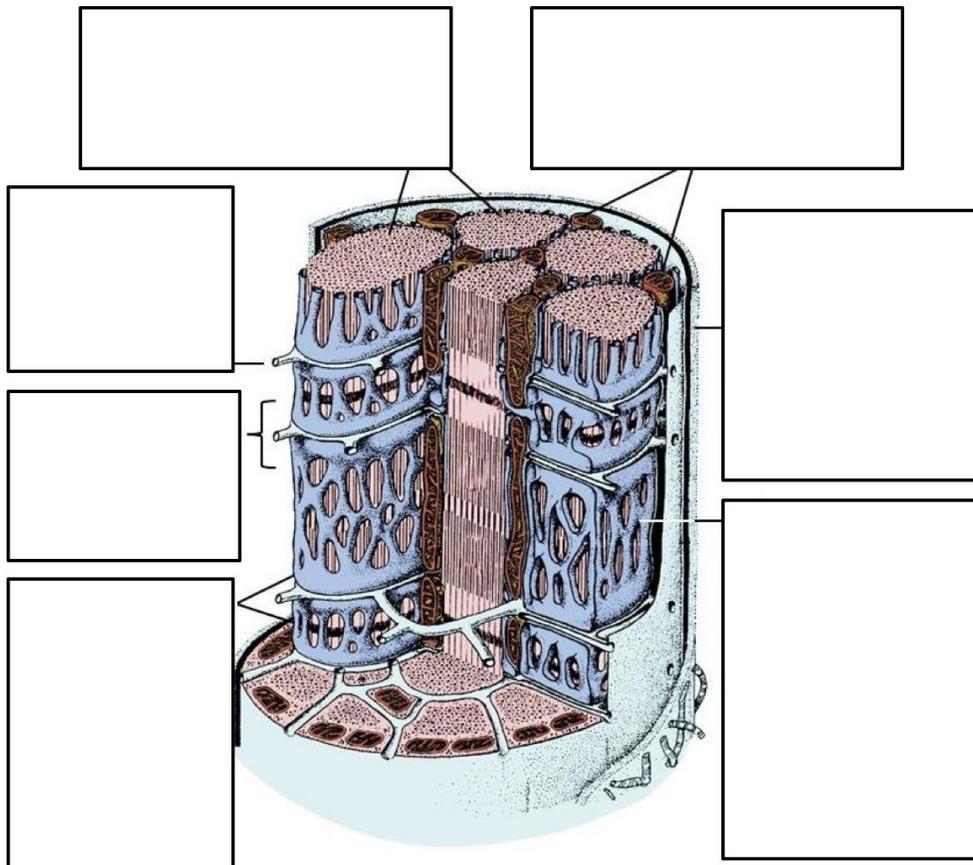
<ul style="list-style-type: none"> <li>• Under voluntary control</li> <li>• Not striated</li> <li>• Has striations</li> <li>• Under involuntary control</li> <li>• Found in walls of hollow organs</li> </ul>	<ul style="list-style-type: none"> <li>• Has abundant gap junctions</li> <li>• Has the greatest ability to regenerate</li> <li>• All muscle cells have individual neuromuscular junctions</li> <li>• Found in the wall of the heart</li> </ul>
---	--

	Muscle Tissue	Tissue Characteristics
		



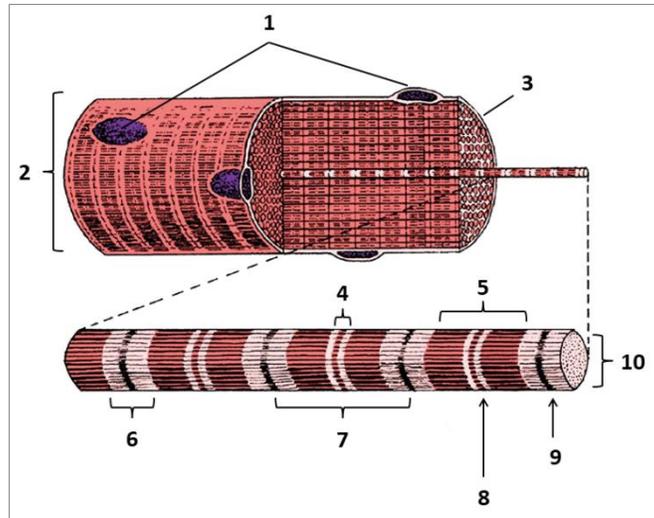
3. Bundles of muscle fibers held together by perimysium are called \_\_\_\_\_.
4. The entire muscle is wrapped with \_\_\_\_\_.
5. Muscle cells are also referred to as \_\_\_\_\_.
6. Add the structures below to the correct label of the muscle cell diagram.

- Myofibril
- Mitochondria
- Triad
- T-Tubule
- Terminal cisternae
- Sarcoplasmic reticulum
- Sarcolemma



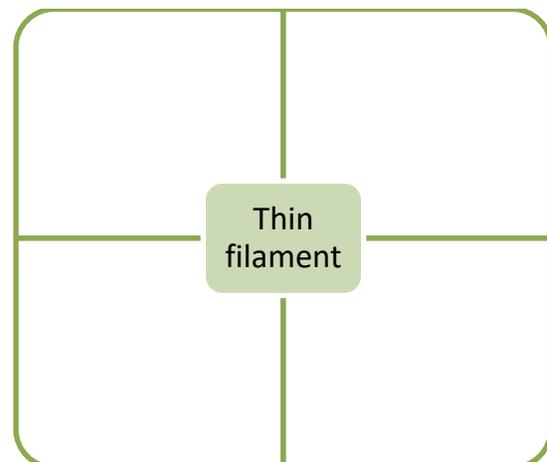
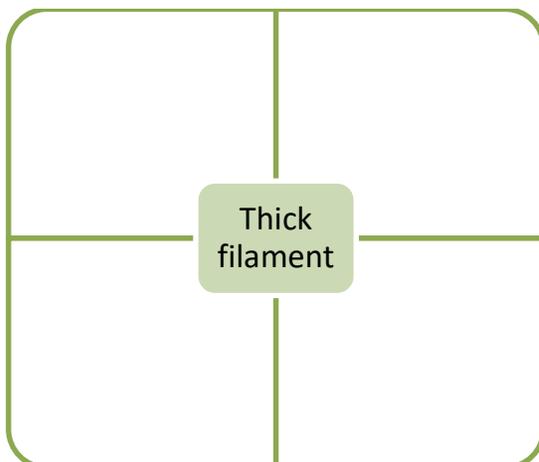
7. Complete the following table of sarcomere features.

Definition	Sarcomere feature
Coin-shaped sheet of proteins that anchors the thin filaments and connects myofibrils to one another	
Runs the entire length of an A band	
Line of protein that holds adjacent thick filaments together	
Lighter mid-region where filaments do not overlap	
Runs the length of the I band and partway into the A band	

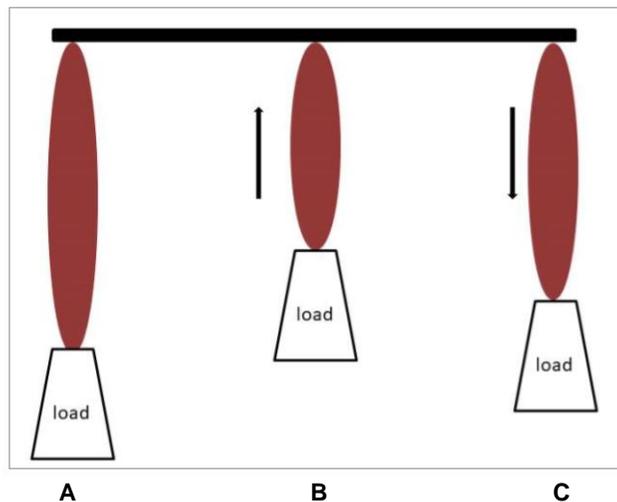


Use the diagram to answer the following question.

8. Z discs (labeled # \_\_\_\_ ) are found at the center of each \_\_\_\_\_ (labeled # 6).
9. Each muscle fiber (labeled # \_\_\_\_ ) contains thousands of \_\_\_\_\_ (labeled # 10).
10. The \_\_\_\_\_ (labeled # 4) is part of the A band (labeled # \_\_\_\_).
11. Compare and contrast thick and thin filaments by writing the unique characteristics of each myofilament in the diagrams below.



12. Muscle contraction is the \_\_\_\_\_.
13. The process of contraction is called the \_\_\_\_\_.
14. Muscle contraction does not always lead to a visible \_\_\_\_\_.
15. Shortening only occurs when the \_\_\_\_\_ generated is \_\_\_\_\_ than the forces resisting shortening.
16. Contraction only starts when the muscle cells receive a signal from their \_\_\_\_\_.
17. The interface between the nerve fiber carrying the signal and the muscle fiber is called \_\_\_\_\_.
18. The gap between the axon and the sarcolemma is the \_\_\_\_\_.
19. The area of sarcolemma containing receptors for the neurotransmitter is called the \_\_\_\_\_.
20. The functional unit of a motor neuron and the muscle fibers it supplies is called a \_\_\_\_\_.
21. Label the type of muscle contraction is occurring in the diagram and write a brief description regarding the change in length of the muscle and why the muscle is changing its length or not.



A	B	C

22. The only energy source used directly for muscle contraction is \_\_\_\_\_.
23. ATP can be regenerated via direct \_\_\_\_\_ or \_\_\_\_\_ and \_\_\_\_\_ respiration.

24. In the absence of \_\_\_\_\_, pyruvic acid is converted into \_\_\_\_\_ acid, which cannot be used by the muscle cells.

25. Use your knowledge of muscle metabolism to place each of the following descriptions in the appropriate source of ATP production box.

- |   |  |
|---|--|
| <ul style="list-style-type: none"> <li>• Produces 95% of ATP during rest and light to moderate exercise</li> <li>• Uses creatine phosphate (CP)</li> <li>• Takes place in the mitochondria</li> <li>• Transfer of one phosphate to resynthesize ATP from ADP</li> <li>• Can restore ATP in the muscle cell for 10-15 seconds of work</li> </ul> | <ul style="list-style-type: none"> <li>• During prolonged exercise most of a muscles ATP is generated via aerobic pathway</li> <li>• Process used during endurance training</li> <li>• Creates pyruvic acid which is then converted to lactic acid</li> <li>• Breakdown of glucose molecules in a process called glycolysis</li> </ul> |
|---|--|

Direct Phosphorylation	Aerobic Respiration	Anaerobic Respiration

26. Muscle fibers can be classified depending on the \_\_\_\_\_ of contraction into \_\_\_\_\_ or \_\_\_\_\_ fibers.

27. Based on the pathway used for energy production, fibers can be identified as \_\_\_\_\_ fibers that use \_\_\_\_\_ pathways and \_\_\_\_\_ fibers that use \_\_\_\_\_.

28. \_\_\_\_\_ fibers use aerobic pathways and have a \_\_\_\_\_ fatigue resistance.

29. They are \_\_\_\_\_ because of their high \_\_\_\_\_ content.

30. Most muscles in the human body consist of \_\_\_\_\_ of fiber types.

31. \_\_\_\_\_ or \_\_\_\_\_ exercises challenge the muscle to increase its \_\_\_\_\_ supply, the number of \_\_\_\_\_, and its \_\_\_\_\_ content.

32. \_\_\_\_\_ exercises, especially if they are anaerobic, lead to an \_\_\_\_\_ in muscle size, also called \_\_\_\_\_.

33. To get the muscle to grow even more it has to be pushed beyond the limit of its maximum load; this is called \_\_\_\_\_ principle.

### Apply your knowledge

1. Why are skeletal muscle cells also called muscle fibers?
2. The sarcomere shortens during contraction. Explain why the process is called sliding filament theory but not shortening filament theory.
3. Why do muscles, such as the biceps brachii of the arm, seem to increase in size when they contract?
4. Chicken and turkeys have white breast meat. What does that tell us about the composition and function of those muscles?
5. What is the importance of T tubules for the latent period, i.e., the time it takes for excitation-contraction coupling to occur?
6. You work as a waiter/waitress at a restaurant. You are asked to pick up a tray with food, to carry it over to a table, and to place it on the table. Describe the sequence of muscle contractions your arm muscles will go through during this process.
7. Your patient suffers from a chronically low calcium blood level (hypocalcemia). What effect will this condition have on the speed of skeletal muscle contraction and the power generated?
8. Your friend has been working out with free weights for weeks. He's now complaining that his arm muscles feel more toned but haven't increased in size, which was one of the objectives of the weight training. What do you think he needs to change to get the results he's aiming for?

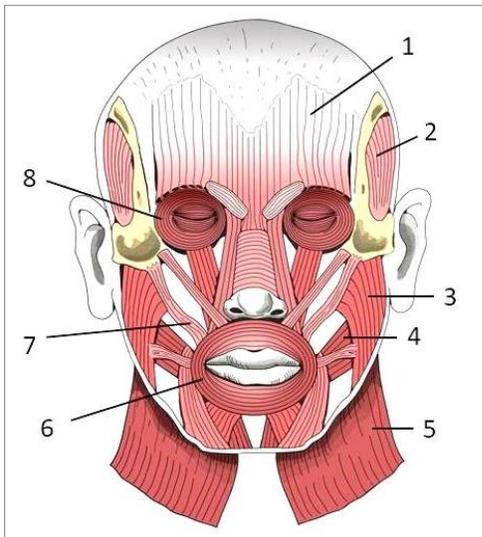
## Chapter 10 Muscular System

### Complete the following sentences

1. To achieve movement, muscles move \_\_\_\_\_ or other muscles by contracting.
2. Muscles generate movement by \_\_\_\_\_ on a bone or muscle.
3. Muscles always have an \_\_\_\_\_, which usually is the bone that cannot move or is less likely to move while the body is in the standard anatomical position.
4. The attachment into the movable bone is called \_\_\_\_\_.
5. Muscles that provide most of the force for a specific movement are called \_\_\_\_\_ or \_\_\_\_\_.
6. An \_\_\_\_\_ opposes or reverses the movement of the agonist.
7. A \_\_\_\_\_ adds force to a movement and assists the prime mover(s).
8. \_\_\_\_\_ immobilize a bone so that the prime mover(s) can perform the movement better.

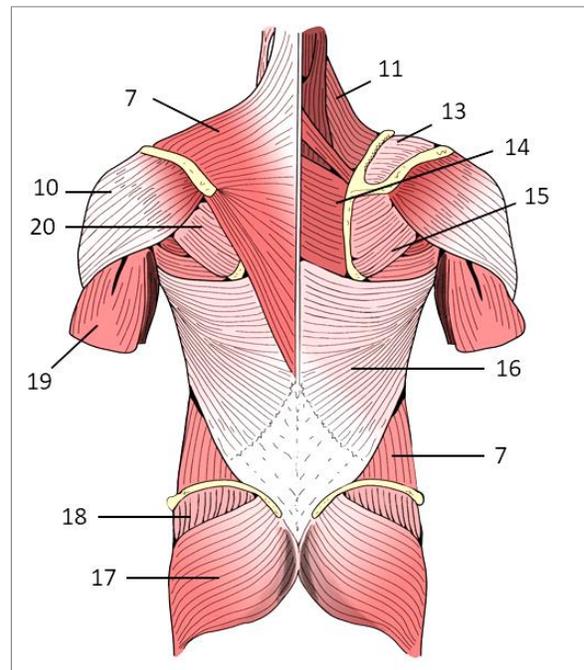
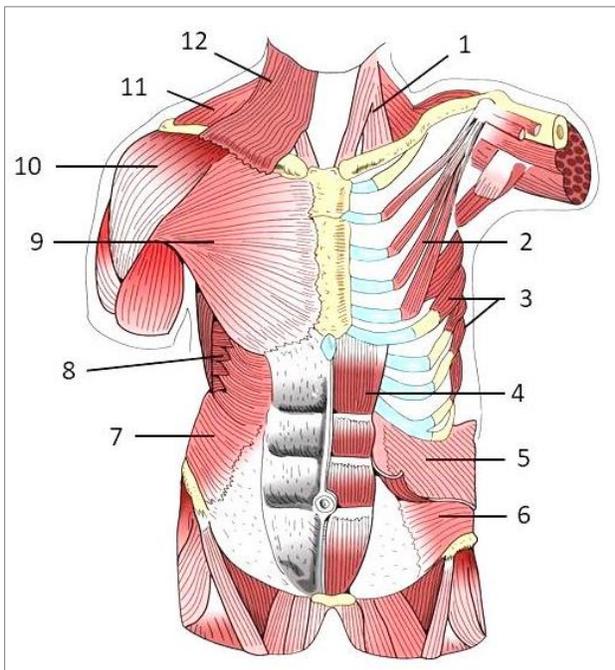
### Review your knowledge

1. The muscles of the head can be subdivided into muscles of \_\_\_\_\_ and muscles of \_\_\_\_\_.
2. All four muscles of mastication insert into the \_\_\_\_\_ and act on the \_\_\_\_\_ joint.
3. Most of the muscles of the anterior neck and throat are subdivided into \_\_\_\_\_ and \_\_\_\_\_ muscles.
4. They are involved in \_\_\_\_\_ and \_\_\_\_\_.
5. The four \_\_\_\_\_ muscles form the floor of the mouth (a.k.a. \_\_\_\_\_ cavity) and are mainly involved in \_\_\_\_\_.
6. These muscles anchor the tongue and elevate the \_\_\_\_\_ and the \_\_\_\_\_ bone.
7. The four strap-like \_\_\_\_\_ muscles are located inferiorly to the hyoid; they \_\_\_\_\_ the larynx and hyoid bone at the end of \_\_\_\_\_ and during \_\_\_\_\_.
8. The sternocleidomastoid muscles are the prime movers for \_\_\_\_\_ of the head/neck; this occurs with bilateral contraction. Unilateral contraction moves the head to the \_\_\_\_\_ side.



Use the diagram to answer the following questions.

9. The muscle used to close the eye is called \_\_\_\_\_. It is labeled # \_\_\_\_.
10. The \_\_\_\_\_ (labeled # 4) compresses the cheek to keep food between teeth.
11. We use the \_\_\_\_\_ (labeled # 6) to whistle.
12. The \_\_\_\_\_ (labeled #5) tenses the skin of the neck and pulls down the mandible.



13. Match the following structures to the labels on the diagrams.

- |                       |       |                   |       |
|-----------------------|-------|-------------------|-------|
| Pectoralis major      | _____ | Latissimus dorsi  | _____ |
| Rectus abdominis      | _____ | Deltoid           | _____ |
| Sternocleidomastoid   | _____ | Serratus anterior | _____ |
| External oblique      | _____ | Trapezius         | _____ |
| Transversus abdominis | _____ | Gluteus medius    | _____ |
| Infraspinatus         | _____ | Supraspinatus     | _____ |
| Triceps brachii       | _____ | Gluteus maximus   | _____ |

14. The intrinsic muscles of the vertebral column attach to vertebrae and help to maintain \_\_\_\_\_.

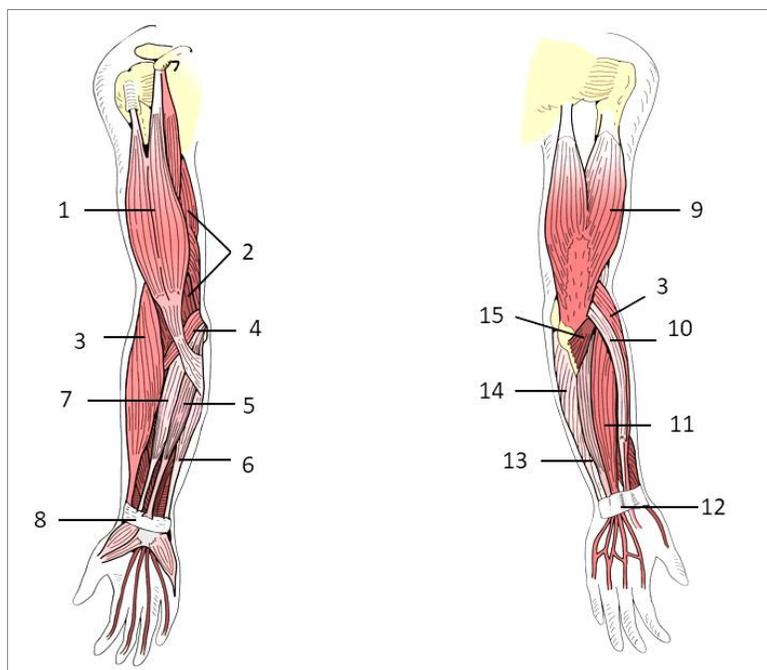
15. The erector spinae muscles are the prime movers for \_\_\_\_\_ of the vertebral column. Unilaterally, they \_\_\_\_\_ the vertebral column \_\_\_\_\_.
16. The primary function of the deep muscles of the thorax is to aid in \_\_\_\_\_.
17. The most important muscle for breathing is the \_\_\_\_\_. It separates the \_\_\_\_\_ and \_\_\_\_\_ cavities.
18. There are four paired muscles that form the abdominal wall together with their \_\_\_\_\_ and \_\_\_\_\_.
19. Two of them have oblique fibers: the \_\_\_\_\_ oblique muscle fibers run from superior to inferior (downward direction), whereas the \_\_\_\_\_ oblique muscle fibers run from inferior to superior (upward direction).
20. The fibers of the \_\_\_\_\_ muscle run horizontally; the fibers of \_\_\_\_\_ muscle vertically.
21. The pelvic floor or \_\_\_\_\_ is composed of two muscles called the \_\_\_\_\_ and \_\_\_\_\_. The main tasks are to \_\_\_\_\_ the pelvic organs.
22. The four rotator cuff muscles are: \_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_ and \_\_\_\_\_.
23. Use your knowledge of the muscles that move the shoulder to complete the following table.

Action	Prime mover	Synergist	Antagonist
Shoulder flexion			
Shoulder extension			
Shoulder abduction			
Shoulder adduction			
Shoulder internal rotation			
Shoulder external rotation			

24. Muscles that cross the elbow joint can either cause \_\_\_\_\_ or \_\_\_\_\_ because the joint is a \_\_\_\_\_ synovial joint.
25. Muscles crossing the joint anteriorly cause \_\_\_\_\_ of the elbow, muscles crossing posteriorly cause \_\_\_\_\_ of the elbow.
26. The muscles in the anterior arm compartment are all \_\_\_\_\_. The \_\_\_\_\_ and \_\_\_\_\_ are the prime movers for \_\_\_\_\_ of the elbow.

27. The anterior forearm muscles are mostly \_\_\_\_\_ of the wrist and digits; the posterior forearm muscles are mostly \_\_\_\_\_ of the wrist and digits.
28. The two pronators of the forearm are the \_\_\_\_\_ and \_\_\_\_\_.
29. The supinator of the forearm is the \_\_\_\_\_; the \_\_\_\_\_ muscle also supinates the forearm.
30. Use your knowledge of the muscles that move the elbow to complete the following table.

Action	Prime mover	Synergist	Antagonist
Elbow flexion			
Elbow extension			



31. Match the following structures to the labels on the diagram:

Biceps brachii	_____	Palmaris longus	_____
Brachioradialis	_____	Triceps brachii	_____
Carpal tunnel (flexor retinaculum)	_____	Brachialis	_____
Extensor digitorum	_____	Anconeus	_____

32. All gluteal muscles cross the hip and attach to two bones: \_\_\_\_\_ and \_\_\_\_\_.
33. The two major actions of gluteus maximus are \_\_\_\_\_ and \_\_\_\_\_ of the hip.
34. The gluteus medius and minimus \_\_\_\_\_ and \_\_\_\_\_ rotate the femur.

35. Thigh muscles that cross the hip anteriorly are \_\_\_\_\_ of the hip.
36. Since it crosses the hip \_\_\_\_\_, the iliopsoas is the prime mover for hip \_\_\_\_\_.  
It is comprised of two muscles: the \_\_\_\_\_ and \_\_\_\_\_.

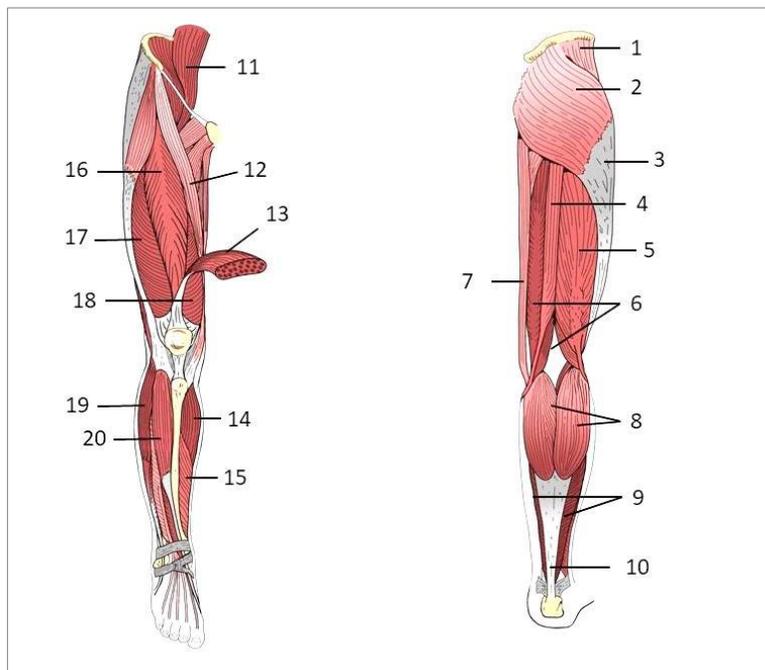
37. Use your knowledge of the muscles that move the femur to complete the following table.

Action	Prime mover	Synergist	Antagonist
Hip flexion			
Hip extension			
Hip abduction			
Hip adduction			

38. The \_\_\_\_\_ femoris consists of four muscles: \_\_\_\_\_,  
\_\_\_\_\_, \_\_\_\_\_, and \_\_\_\_\_.
39. All four quadriceps muscles cross the knee anteriorly and insert into the \_\_\_\_\_ tuberosity via the \_\_\_\_\_. Therefore, they \_\_\_\_\_ the knee.
40. Only one part of the quadriceps femoris, \_\_\_\_\_, crosses the hip joint as well and, thus, \_\_\_\_\_ the hip and is a \_\_\_\_\_ to the iliopsoas.
41. The \_\_\_\_\_ muscle is also located in the anterior thigh compartment. It is important for crossing the leg in a \_\_\_\_\_ position.
42. The muscles of the medial thigh all originate from the \_\_\_\_\_ bone and most insert into the \_\_\_\_\_, making them \_\_\_\_\_ of the hip.
43. The three muscles on the posterior thigh are collectively known as the \_\_\_\_\_.
44. They all originate on the \_\_\_\_\_ tuberosity and, together, \_\_\_\_\_ the hip.
45. However, they \_\_\_\_\_ the knee because they cross the knee \_\_\_\_\_.
46. We can \_\_\_\_\_ and \_\_\_\_\_ our toes, and \_\_\_\_\_ and \_\_\_\_\_ our ankle.
47. The three main muscles of the anterior leg \_\_\_\_\_ the ankle. The \_\_\_\_\_ is a prime mover for \_\_\_\_\_ of the foot.
48. The extensor digitorum longus and extensor hallucis longus are the prime movers for \_\_\_\_\_ of the toes.
49. The two muscles of the lateral leg (fibularis longus and brevis) help to \_\_\_\_\_ the ankle, but

they are the prime movers for \_\_\_\_\_ of the foot.

50. All of the muscles of the posterior leg cross the ankle \_\_\_\_\_ and, thus, \_\_\_\_\_ flex the ankle.
51. The \_\_\_\_\_ and \_\_\_\_\_ are prime movers for ankle plantar flexion. The two muscles are collectively known as \_\_\_\_\_ surae.
52. They insert into the \_\_\_\_\_ via the strongest and longest tendon of the body, which is known as the \_\_\_\_\_ or \_\_\_\_\_ tendon.
53. The \_\_\_\_\_ is a prime mover for inversion of the foot, whereas the flexor digitorum longus and flexor hallucis longus \_\_\_\_\_ the toes since they insert on the plantar/inferior surface of the toes.



54. Match the following structures to the labels on the diagram.

- |                   |       |                    |       |
|-------------------|-------|--------------------|-------|
| Iliopsoas         | _____ | Gastrocnemius      | _____ |
| Soleus            | _____ | Semimembranosus    | _____ |
| Semitendinosus    | _____ | Vastus intermedius | _____ |
| Sartorius         | _____ | Achilles tendon    | _____ |
| Iliotibial tract  | _____ | Vastus lateralis   | _____ |
| Tibialis anterior | _____ | Biceps femoris     | _____ |

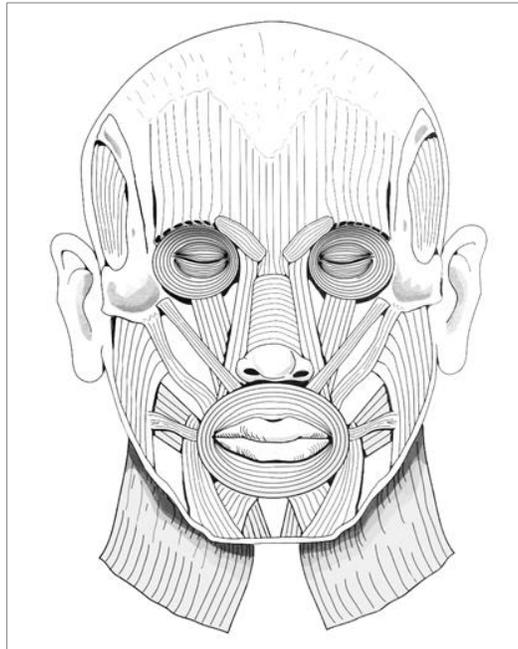
**Apply your knowledge**

1. Which two muscles, one on the thigh and one on the lower leg, have to spring into action if you want to extend your leg and plantar flex the foot to kick a ball?
2. Your brother suddenly cannot close his left eye anymore. This points to paralysis of which muscle?
3. Which two facial muscles do you need if you want to whistle?
4. You grab a door knob with your right hand. Which muscle(s) will help you turn the knob to open the door? Which muscle(s) would you need to open the same door with your left hand?
5. Paralysis of which muscle group would make an individual unable to flex the knee?
6. Name two muscles that abduct the thigh when you do jumping jacks.
7. Which two muscles will help you lift your arms up high and which ones to pull them down again?
8. Which neck muscle(s) do you use to look both ways before crossing a road? Explain the sequence of muscle action.
9. Which muscle(s) do you use when you bend over to touch your toes?
10. I am a flexor of the hip and an extensor of the knee. I am the longest and straightest muscle in a quartet. Can you guess my name?

## Coloring fun

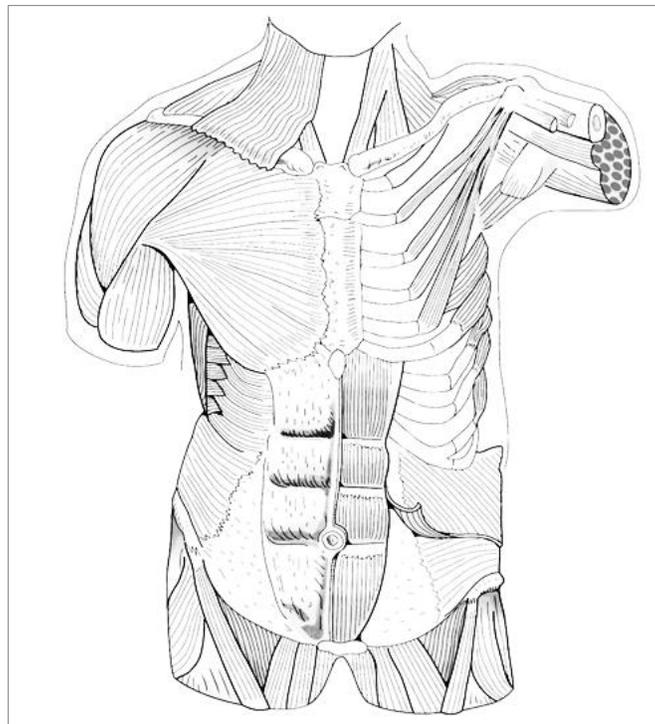
Locate, color, and label the muscles of the face.

- Orbicularis oculi
- Buccinator
- Frontalis
- Orbicularis oris
- Temporalis
- Epicranial aponeurosis
- Platysma
- Masseter
- Zygomaticus minor & major



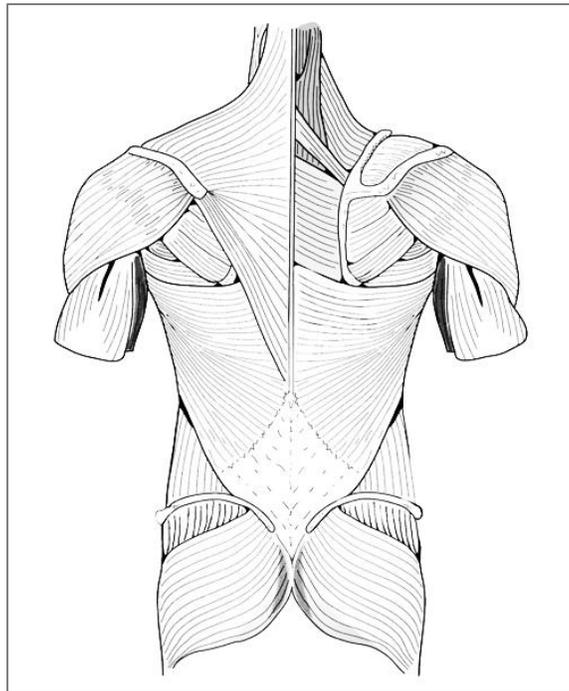
Locate, color, and label the muscles of the anterior trunk.

- Platysma
- Deltoid
- Pectoralis major
- Serratus anterior
- External oblique
- Internal oblique
- Sternocleidomastoid
- Pectoralis minor
- Rectus abdominis



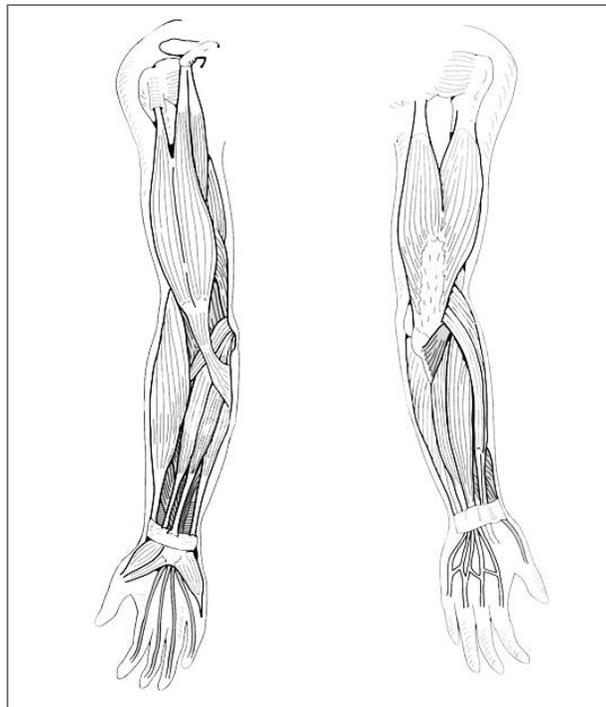
Locate, color, and label the muscles of the posterior trunk.

- Trapezius
- Deltoid
- Infraspinatus
- Triceps brachii
- Gluteus maximus
- Gluteus medius
- Supraspinatus
- Latissimus dorsi
- External oblique



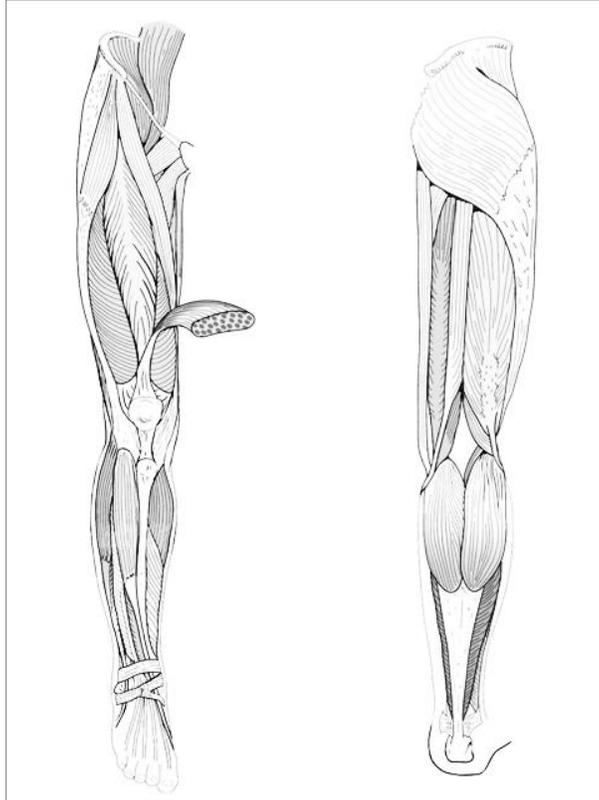
Locate, color, and label the muscles of the upper limbs.

- Biceps brachii
- Brachialis
- Flexor carpi radialis
- Extensor carpi ulnaris
- Triceps brachii
- Flexor retinaculum
- Flexor carpi ulnaris
- Brachioradialis
- Anconeus
- Extensor digitorum



Locate, color, and label the muscles of the lower limbs.

- Iliopsoas
- Vastus intermedius
- Vastus lateralis
- Vastus medialis
- Sartorius
- Gastrocnemius
- Soleus
- Tibialis anterior
- Gluteus medius
- Gluteus maximus
- Semitendinosus
- Semimembranosus
- Biceps femoris
- Gracilis



## Chapter 11 Nervous Tissue

### Complete the following sentences

1. The two subdivisions of the nervous system are the \_\_\_\_\_ and the \_\_\_\_\_.
2. Nervous tissue consists of two principal cell types: excitable cells called \_\_\_\_\_ or \_\_\_\_\_ and supporting cells called \_\_\_\_\_ or \_\_\_\_\_.
3. The cell body of a neuron is called \_\_\_\_\_ or \_\_\_\_\_.
4. The short, tapering, and diffusely branched processes of nerve cells are called \_\_\_\_\_. They form the \_\_\_\_\_ or \_\_\_\_\_ region and convey electrical signals toward the cell body.
5. Each neuron has one long process called \_\_\_\_\_ that arises from a cone-shaped area called \_\_\_\_\_.
6. The \_\_\_\_\_ or \_\_\_\_\_ classification is based on the function of neurons.
7. A reduction in the resting membrane potential toward zero is called \_\_\_\_\_. It is caused by influx of \_\_\_\_\_ ions and leads to the inside of the membrane becoming \_\_\_\_\_ negative.
8. \_\_\_\_\_ potentials are used as short-distance signals; \_\_\_\_\_ potentials are the long-distance signals.
9. The neuron conducting impulses toward a \_\_\_\_\_ is the \_\_\_\_\_ neuron; the neuron transmitting impulses away from a synapse is termed the \_\_\_\_\_ neuron.
10. Bundles of processes are called \_\_\_\_\_ inside the CNS and \_\_\_\_\_ in the PNS.

### Review your knowledge

1. Define 'synapse': \_\_\_\_\_
2. The most common neurotransmitter is \_\_\_\_\_.
3. Neurons that have one axon and several dendrites are classified as \_\_\_\_\_.

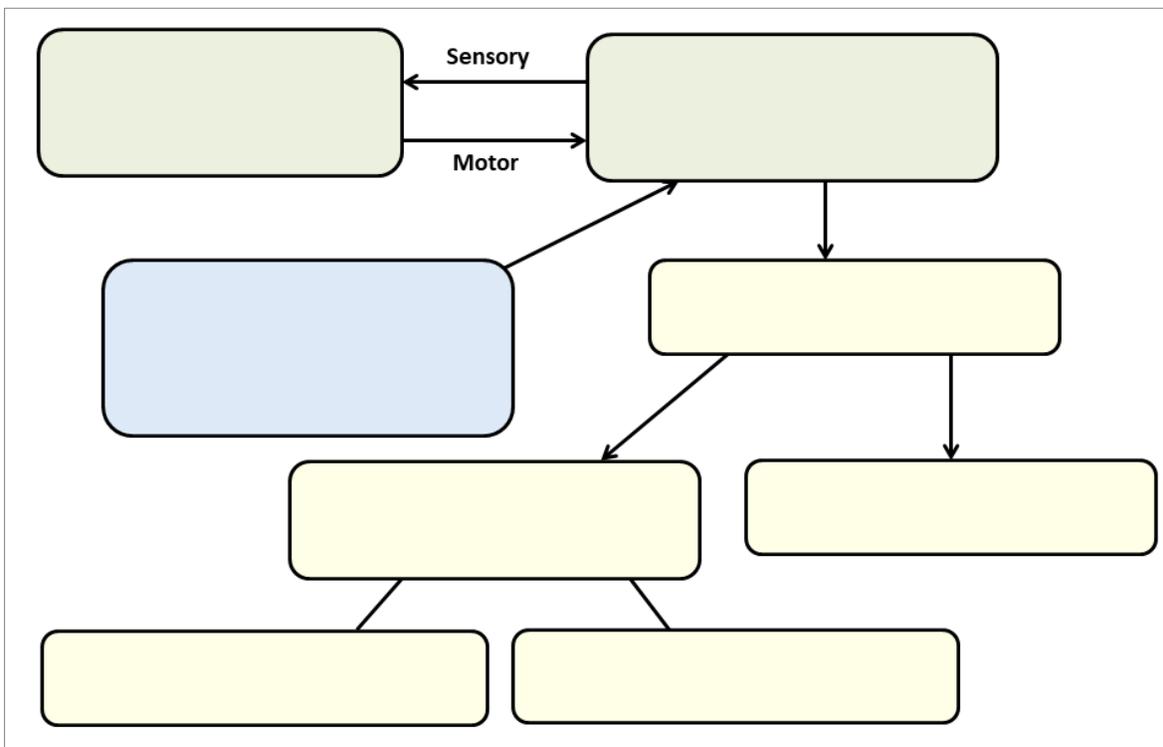
4. Complete the following table relating to neuroglia.

Function/description	Glial cell
Most abundant glial cell	
Phagocytizes microorganisms and neuronal debris	
Lines the central cavities of the brain and spinal column	
Processes wrap CNS nerve fibers, forming insulating myelin sheaths	
Surrounds neuron cell bodies in the PNS	
Helps determine capillary permeability	
Surrounds peripheral nerve fibers and forms myelin sheaths	
May be ciliated	
Vital to regeneration of damaged peripheral nerve fibers	
Branched cells	
Migrate toward injured neurons	

5. Synapses that release neurotransmitters are called \_\_\_\_\_.

6. In electrical synapses, adjacent cells are connected by \_\_\_\_\_.

7. Complete the following diagram.

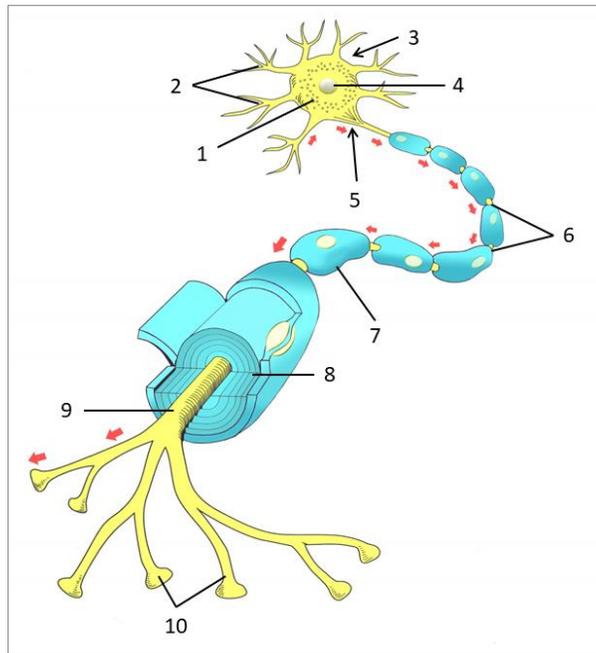


8. Name the three types of neurons based on their function.

a)

b)

c)



Use the diagram to answer the following questions.

9. The cell body of a neuron is called \_\_\_\_\_ or \_\_\_\_\_. It is labeled # \_\_\_\_\_.
10. In the PNS, the myelin sheath is formed by \_\_\_\_\_. One cell is labeled as # \_\_\_\_\_.
11. The rough endoplasmic reticulum is called \_\_\_\_\_ or \_\_\_\_\_. It is labeled # \_\_\_\_\_.
12. The gaps between adjacent Schwann cells are called the \_\_\_\_\_. One gap is labeled as # \_\_\_\_\_.
13. The axon (labeled # \_\_\_\_\_) carries action potentials from the \_\_\_\_\_ (labeled # 5) toward the \_\_\_\_\_ (labeled # 10).
14. The acronym 'EPSP' stands for \_\_\_\_\_.
15. Influx on negatively charged ions into a neuron causes \_\_\_\_\_.
16. Serotonin and histamine belong to a class of neurotransmitters known as \_\_\_\_\_.
17. If more than one signal arrives at different locations at the same time, we talk about \_\_\_\_\_.
18. The conduction velocity of neurons increases if the axon diameter \_\_\_\_\_.
19. Postsynaptic potentials are always \_\_\_\_\_.
20. Complete the following table relating to synapses:

Function/description	
Neuron conducting impulses toward the synapse	
Synapse between an axon of one neuron and a dendrite of another	
Filled with neurotransmitter	
Degraded by acetylcholinesterase	
Gap between the axon terminal and the postsynaptic membrane	
The time needed for the release of the neurotransmitter, its diffusion across the synaptic cleft, and its binding to a receptor	
Neurotransmitters that act as natural opiates and reduce pain perception	
Neuron carrying impulses away from the synapse	
Gated channel that reacts to binding of the neurotransmitter	

### Apply your knowledge

1. If you touch a hot plate, what type of neuron sends a pain signal to your brain?
2. The neuron from question #1 would be part of which division of the nervous system?
3. Which system would carry signals to your arm muscles to move the hand away from the hot plate?
4. Would those signals travel in a tract or a nerve? Explain your answer.
5. Which functional muscle group of the elbow would be activated to move the hand away from danger?
6. Why are neurons highly excitable but astrocytes are not?
7. What would happen if you injected a patient with a drug that blocks ACh receptors on the sarcolemma of neuromuscular junctions?
8. What is the advantage of most neurons having hundreds to thousands of dendrites?
9. An EPSP is generated when a neurotransmitter opens chemically-gated channels that allow simultaneous flow of  $\text{Na}^+$  and  $\text{K}^+$ . Why is  $\text{Na}^+$  influx greater than  $\text{K}^+$  efflux thus leading to depolarization?

## Chapter 12 Central Nervous System

### Complete the following sentences

1. The \_\_\_\_\_ is the part of the CNS inside the \_\_\_\_\_ of the skull, and the \_\_\_\_\_ is the part of the CNS inside the \_\_\_\_\_ of the spine.
2. The four \_\_\_\_\_ inside the brain are filled with \_\_\_\_\_.
3. Ridges on the surface of the cerebrum are called \_\_\_\_\_, shallow grooves \_\_\_\_\_, and deep grooves \_\_\_\_\_.
4. The cerebral hemispheres each have \_\_\_\_\_ lobes known as \_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_, and \_\_\_\_\_ lobe and \_\_\_\_\_.
5. The \_\_\_\_\_ area in the \_\_\_\_\_ lobe stores memories of sounds.
6. The brain stem consists of \_\_\_\_\_, \_\_\_\_\_, and \_\_\_\_\_, which contains most of its nuclei and centers.
7. The distinctive tree-like pattern of the \_\_\_\_\_ white matter is called \_\_\_\_\_ or "tree of life."
8. The two categories of memory are \_\_\_\_\_ memory, which contains factual knowledge, and nondeclarative memory, which includes \_\_\_\_\_, \_\_\_\_\_, and \_\_\_\_\_ memory.
9. The \_\_\_\_\_, the part of the central nervous system below the \_\_\_\_\_, has two enlargements, an upper \_\_\_\_\_ enlargement and a lower \_\_\_\_\_ enlargement.
10. The \_\_\_\_\_ or \_\_\_\_\_ horn of the spinal cord contains \_\_\_\_\_ neurons that send axons to \_\_\_\_\_ muscles.

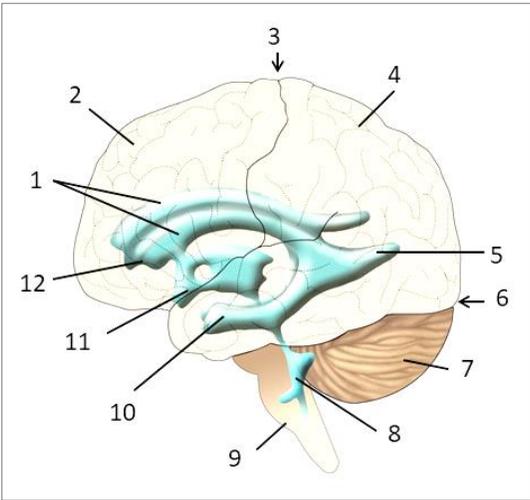
### Review your knowledge

1. Define 'memory': \_\_\_\_\_
2. Myelinated fibers that connect the gray matter of the two hemispheres are called \_\_\_\_\_.
3. The primary motor cortex is located in the \_\_\_\_\_.

4. The third ventricle is located in the \_\_\_\_\_.
5. Name the four regions of the adult brain:
  - a)
  - b)
  - c)
  - d)

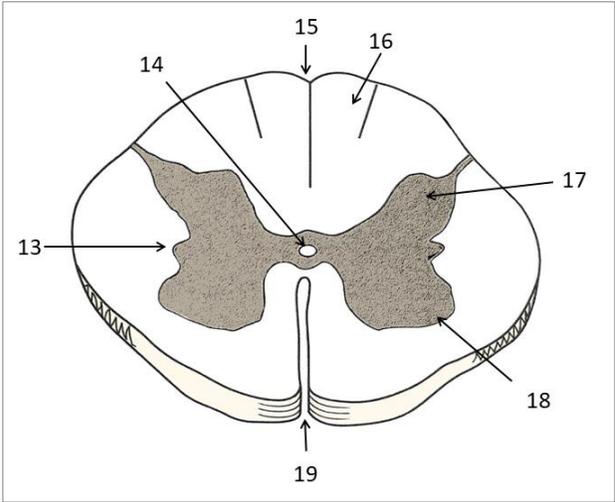
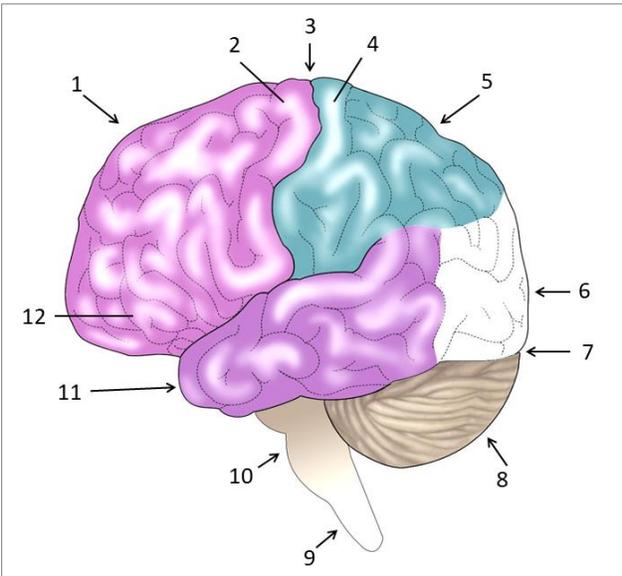
6. Complete the following table.

Function/description	Part of the brain or spinal cord
Fissure separating cerebrum and cerebellum	
Areas that give us conscious awareness of sensation	
Consists of ascending and descending tracts	
Center of conscious awareness of smells	
Its main function is maintaining our balance	
Oldest part of the brain	
Most complicated cortical region; involved with intellect, cognition, recall, and personality	
Directs voluntary eye movements	
'Soft mother'	
Motor speech area	
Fibers that connect different parts of the same hemisphere	
Absorbs CSF and returns it into the blood	
Gateway to the cerebral cortex	
Center for our emotional responses and interface between nervous and endocrine system	
Toughest meninx	
Has two hemispheres that are connected by the vermis	
Receives visual signal from the retina of the eye	
Region of conscious awareness of taste	
Where CSF flows	
Carry signals from the cerebral cortex to the spinal cord	
Separates the two hemispheres	
Newest part of the brain	
Site of the conscious mind	
Produces melatonin	
Contains somatic motor neurons that send axons to voluntary skeletal muscles	
Lower round end of the spinal cord	
Fluid secreted by choroid plexuses	
Formed by fibers connecting the cerebral hemispheres	



Use the diagram to answer the following questions.

- 7. The \_\_\_\_\_ sulcus (labeled # \_\_\_\_ ) separates the \_\_\_\_\_ (labeled # \_\_\_\_ ) and the \_\_\_\_\_ (labeled # \_\_\_\_).
- 8. Important survival centers are located in the \_\_\_\_\_, which is labeled # \_\_\_\_.
- 9. The two C-shaped \_\_\_\_\_ ventricles (labeled # \_\_\_\_ ) are located in the cerebral hemispheres and the \_\_\_\_\_ ventricle (labeled # \_\_\_\_ ) dorsal to the pons.
- 10. The occipital lobe and the \_\_\_\_\_ (labeled # \_\_\_\_ ) are separated by the \_\_\_\_\_ (labeled # \_\_\_\_).



11. Match the following structures to the labels on above diagrams.

- |                |       |               |       |
|----------------|-------|---------------|-------|
| Occipital lobe | _____ | Temporal lobe | _____ |
| Spinal cord    | _____ | Cerebellum    | _____ |

Orbitofrontal cortex	_____	Primary motor cortex	_____
Lateral horn	_____	Ventral horn	_____
Parietal lobe	_____	Anterior median fissure	_____
Primary somatosensory cortex	_____	Central canal	_____

12. The division of labor between hemispheres is described by the term \_\_\_\_\_.
13. Our emotional or affective brain is found in the so-called \_\_\_\_\_.
14. The system important for keeping us conscious and alert is the \_\_\_\_\_.
15. The memory used to store unlimited amounts of information for as long as live is the \_\_\_\_\_.
16. The sleep important for our physical recovery is called \_\_\_\_\_.
17. The hormone regulating our sleep cycle and circadian rhythms is \_\_\_\_\_.
18. REM sleep is important for \_\_\_\_\_.
19. Because there are blood vessels inside the brain, the brain has to be protected from toxins and pathogens by the \_\_\_\_\_.
20. Sensory signals from the spinal cord to the cerebellum travel in \_\_\_\_\_.

### Apply your knowledge

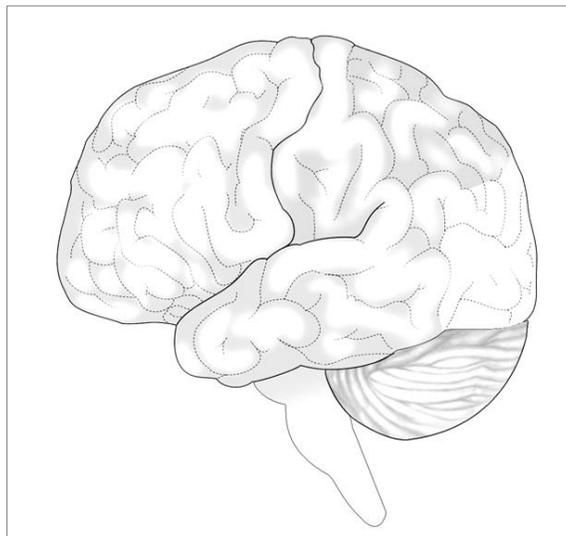
1. A patient can see a picture you show him but can't tell you what the object (a flower) in the picture is called. Which area of the CNS could be damaged in this patient?
2. Poliomyelitis can lead to weakness or paralysis of skeletal muscles by destroying motor neurons. Which area of the spinal cord is most likely affected by the virus?
3. A patient suffers from a stroke and is now unable to speak. Which area of the CNS has most likely been damaged by the stroke?
4. If you assume that the patient in question #3 above has normal cerebral dominance, the sensation of which limbs may be affected by the cerebrovascular accident?

5. You are performing a spinal tap to collect CSF. Under which spinous process would you insert the needle?
  
6. How would you identify the correct spinous process for the spinal tap?
  
7. You walk through an outlet mall and a display of handbags in a store window catches your attention. You go inside and ten minutes later walk out with a brand new (overpriced) designer handbag. Which part of your CNS most likely influenced your decision to spend money on this item?
  
8. Opioid overdoses, especially in combination with alcohol consumption, lead to respiratory depression (the patients breathing rate slows down) and death. Which area of the CNS could be affected by opioids to cause this issue?
  
9. Jet lag is caused by a discrepancy between our internal clock and the real time of the location where we are at the moment. For example, if you fly from London to Los Angeles and you arrive at 11 pm Los Angeles time, your internal clock will still be at 3 pm. What will be a sign of your body going through jet lag? What could you do to help your body adjust quicker other than just waiting for it to catch up on its own?
  
10. You read about a person who died in a house fire. According to the article, the person fell asleep with a burning cigarette, which then started the fire. Which function of the person's CNS was suppressed by the alcohol, leading to the person not waking up from the smell of the smoke?

### Coloring fun

Locate, color, and label the parts of the brain.

- |                 |                        |                                |
|-----------------|------------------------|--------------------------------|
| • Frontal lobe  | • Parietal lobe        | • Occipital lobe               |
| • Temporal lobe | • Cerebellum           | • Brain stem                   |
| • Spinal cord   | • Primary motor cortex | • Primary somatosensory cortex |



### Sheep Brain Dissection Activity

- **The specimens we use contain traces of the fixative formalin (formaldehyde).**
- **Formalin residue or vapor may be irritating – avoid skin and eye contact. Do not ingest. Wear protective gloves and wash hands thoroughly after handling.**
  - **Skin contact:** Wash thoroughly with soap and water.
  - **Eye contact:** Flush with running water for 15 minutes. Report to lab instructor.
  - **Ingestion:** Seek medical attention. Report to lab instructor.

#### Supplies per group (max. 4 students)

- 1 sheep brain
- 1 disposable scalpel
- 1 disposable tweezers
- 1 pair of scissors
- 1 probe
- 1 disposable dissection tray
- protective gloves

1. Take your time to examine the brain and to identify the structures listed in below table. Check off the structures as they are located.

Dura mater		Sulci		Cerebellum	
Falx cerebri		Occipital lobe		Spinal cord	
Tentorium cerebelli		Temporal lobe		Pons	
Longitudinal fissure		Parietal lobe		Medulla oblongata	
Pia mater		Frontal lobe		Optic chiasma	
Gyri		Cerebral hemispheres		Olfactory bulb	

#### You must obtain your instructor's permission prior to making a midsagittal cut!

Place the brain dorsal side up and using your disposable scalpel make a midsagittal section through the brain. Identify the structures listed in the table below and check them off once you have located them.

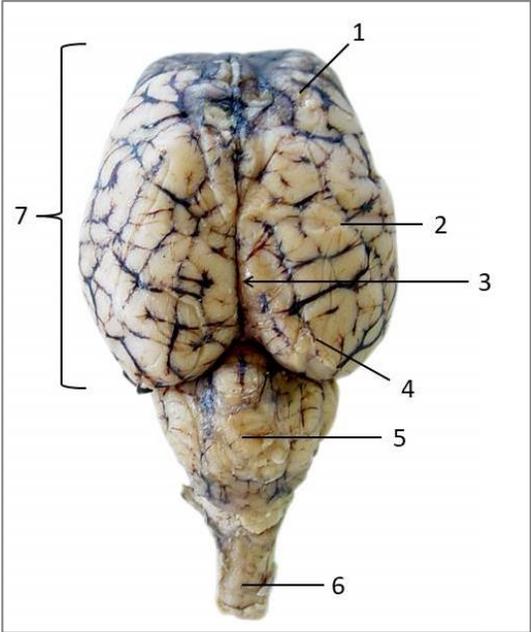
Gray matter		Epithalamus		Pineal gland	
White matter		Hypothalamus		Cerebellum	
Corpus callosum		Thalamus		Arbor vitae	

2. Dispose of tissue, disposable dissection tray and tweezers, and protective gloves by putting them into the bio-hazard bin; the disposable scalpel goes into the sharps container. Place the scissors and the probe into the tray provided. Clean the table surface using wet paper towels and 10% bleach.

**Wash your hands thoroughly with soap and water when you are done!**

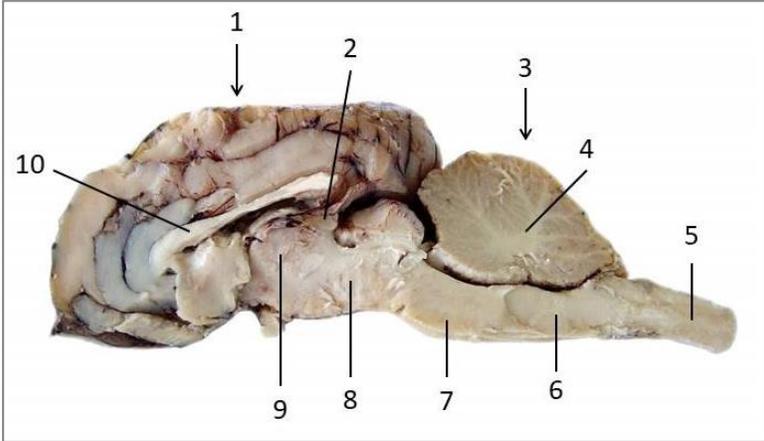
3. Complete below labeling exercises:

1. Sheep brain, dorsal view



- 1. \_\_\_\_\_
- 2. \_\_\_\_\_
- 3. \_\_\_\_\_
- 4. \_\_\_\_\_
- 5. \_\_\_\_\_
- 6. \_\_\_\_\_
- 7. \_\_\_\_\_

2. Sheep brain, midsagittal section



- 1. \_\_\_\_\_
- 2. \_\_\_\_\_
- 3. \_\_\_\_\_
- 4. \_\_\_\_\_
- 5. \_\_\_\_\_
- 6. \_\_\_\_\_
- 7. \_\_\_\_\_
- 8. \_\_\_\_\_
- 9. \_\_\_\_\_
- 10. \_\_\_\_\_



## Chapter 13 Peripheral Nervous System & Reflexes

### Complete the following sentences

1. The peripheral nervous system consists of a voluntary \_\_\_\_\_ part and an involuntary \_\_\_\_\_ part.
2. Based on where they leave the CNS, nerves can be classified as \_\_\_\_\_ and \_\_\_\_\_ nerves.
3. \_\_\_\_\_ are cord-like bundles of \_\_\_\_\_ and \_\_\_\_\_ axons enclosed by connective tissue sheaths.
4. \_\_\_\_\_ are collections of neuron cell \_\_\_\_\_ outside the \_\_\_\_\_.
5. Peripheral nerves can \_\_\_\_\_ after damage as long as the \_\_\_\_\_ is intact.
6. The main cells for nerve regeneration are \_\_\_\_\_ cells.
7. Two pairs of cranial nerves, the \_\_\_\_\_ and \_\_\_\_\_ nerve, arise from the \_\_\_\_\_, whereas the other \_\_\_\_ pairs arise from the \_\_\_\_\_.
8. Each spinal nerve has two roots: one \_\_\_\_\_ root with \_\_\_\_\_ fibers to muscles and one \_\_\_\_\_ root with \_\_\_\_\_ fibers.
9. The \_\_\_\_\_ division of the ANS promotes maintenance \_\_\_\_\_ and conserves body \_\_\_\_\_. It's also called the \_\_\_\_\_ division.
10. There are \_\_\_\_\_ paravertebral ganglia that form the sympathetic \_\_\_\_\_ or \_\_\_\_\_.

### Review your knowledge

1. Define 'dermatome': \_\_\_\_\_
2. Most nerves contain motor and sensory fibers, making the \_\_\_\_\_.
3. The outer connective sheath of a nerve is called \_\_\_\_\_.
4. The first two cranial nerves arise from the \_\_\_\_\_.
5. Cranial nerves VII, IX, and X carry signals from \_\_\_\_\_.
6. Three cranial nerves, CN III, IV, and VI, are mainly motor nerves for \_\_\_\_\_.

7. Four cranial nerves, CN III, VII, IX, and X, carry \_\_\_\_\_.
8. Complete the following table by adding both the name and the Roman numeral of the nerve.

Function/description	Cranial nerve (name and number)
Largest cranial nerve	
Chief motor nerves of the face with 5 major branches	
Innervates part of the tongue and pharynx for swallowing, and provides parasympathetic fibers to the parotid salivary glands	
Passes through the cribriform plate of the ethmoid bone	
Innervates the superior oblique muscle	
Carries afferent fibers from the hearing and equilibrium receptors	
Innervates extrinsic and intrinsic muscles of the tongue that contribute to swallowing and speech	
The only cranial nerves that extend beyond the head and neck region	
Carries taste fibers from the anterior two-thirds of the tongue	
Fibers conduct taste and general sensory impulses from the pharynx	
Purely sensory (visual) function	
Purely sensory (olfactory) function	
Has three divisions	
Innervates the lateral rectus muscle	
Arises from the retinas	
The mandibular nerve is one of its divisions	
Motor functions include facial expression	
Sensory fibers carry impulses from thoracic and abdominal viscera	
Innervates the trapezius and sternocleidomastoid muscles	
Conveys sensory impulses from various areas of the face	
Supplies motor fibers for mastication	
Relays parasympathetic impulses to lacrimal and salivary glands	
Carries impulses from carotid chemoreceptors and baroreceptors	
Rootlets pass into the cranium via foramen magnum	

9. The two roots of a spinal nerve unite to form the nerve, which emerges through the \_\_\_\_\_.
10. The ventral rami of the segments T<sub>2</sub>-T<sub>12</sub> form \_\_\_\_\_.
11. The uppermost plexus is the \_\_\_\_\_.

12. The rami connecting the spinal cord with the autonomic ganglia are called \_\_\_\_\_.

13. Complete the following table.

Function/description	Spinal nerve	Plexus
Innervates the skin, most flexors and pronators in the forearm		
Longest and thickest nerve of the body		
Innervates essentially all extensor muscles		
Innervates the deltoid and teres minor		
Innervates the diaphragm		
Supplies the skin of the medial aspect of hand		
Supplies the skin and joint capsule of the shoulder		
Innervates the biceps brachii and brachialis		
Innervates the quadriceps		
Joins the tibial nerve to form the sciatic nerve		
Innervates the hamstring muscles		
Innervates the posterior skin of the upper limb		
Enters the palm through the carpal tunnel		
Supplies the skin of the lateral forearm		
Supplies most intrinsic muscles of the hand		
Passes through the obturator foramen to innervate adductor muscles		
Supplies the skin of the anterior thigh and medial surface of the leg		

14. Because the ANS is not under our conscious control it is also called \_\_\_\_\_.

15. The ANS division that mobilizes the body during stress is called the \_\_\_\_\_ division.

16. The main center for control of the ANS in the CNS is the \_\_\_\_\_.

17. In the spinal cord, motor neurons of the sympathetic system form the \_\_\_\_\_.

18. Some preganglionic sympathetic fibers travel directly to the adrenal \_\_\_\_\_.

19. Preganglionic ANS fibers release the neurotransmitter \_\_\_\_\_.

20. ANS fibers that release NE are called \_\_\_\_\_.

21. Perceiving pain in internal organs as somatic pain is called \_\_\_\_\_.
22. Norepinephrine and epinephrine are released from the adrenal medulla as part of a \_\_\_\_\_  
\_\_\_\_\_.
23. Complete the following table by inserting the correct name of the ANS division.

Function/description	Division of the ANS
Shunts blood flow to skeletal muscles and heart	
Slows down the heart beat	
Raises blood glucose levels	
Mobilizes fats for use as fuels	
Constricts pupils	
Dilates bronchioles in the lungs	
Controls blood pressure, even at rest	
Increases the activity of the urinary system	
Is in charge of body temperature regulation	
Makes you sweat when you're nervous	
Helps you digest your double cheeseburger with French fries	

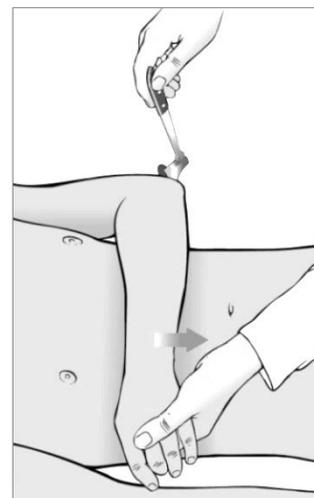
24. Cholinergic receptors bind with \_\_\_\_\_.
25. Activation of nicotinic receptors always leads to \_\_\_\_\_.
26. In spinal somatic reflexes, the integration center is in the \_\_\_\_\_.
27. The CNS receives information on the length of a specific muscle from \_\_\_\_\_.
28. Sudden lengthening of a muscle can trigger a \_\_\_\_\_ reflex.
29. Golgi tendon reflexes lead to muscle \_\_\_\_\_.
30. The diagram depicts testing of which reflex?

What is this type of reflex called?

Which nerve is being tested?

Which plexus does this nerve arise from?

Which spinal nerve roots form this plexus?



### Apply your knowledge

1. Damage to which spinal nerve could lead to wrist drop, i.e., the inability to extend the wrist and the fingers at metacarpophalangeal joints? Which nerve plexus does this nerve arise from?
2. A two-year old child receives an intramuscular injection into her left buttock. However, within a couple of days her mother notices that the girl seems to have problems bending her left knee and getting up on her toes. What could be the underlying cause of these muscular problems?

3. The woman in picture is suffering from shingles, a viral infection that causes a painful rash of a dermatome of a spinal or cranial nerve. Which cranial nerve or part of a cranial nerve is the cause of the rash on the woman's face?



4. Your roommate has had a cold for a few days. This morning she woke up and felt something was odd on the left side of her face. She went to the bathroom to look in the mirror and saw that the muscles on the lower part of the left side of her face didn't work. She was able to open and close her left eye, but her left side of the mouth didn't move, only the right side. She could, however, move her jaw up and down without problem. Damage to which cranial nerve could explain her condition?

5. Damage to which cranial nerve could explain the patient's inability to open her right eye, her dilated right pupil, and her right eye turning to the outside?



6. A patient notices that his left triceps has become weaker. On examination you find that he has diminished sensitivity over the skin of the left lateral forearm and thumb. What is your working diagnosis, i.e., what do you think can explain those symptoms?
7. Your friend complained about pain/discomfort in his right shoulder. You talk to him a few weeks later and learn that he went to doctor to have his shoulder checked out. However, he ended up having gallbladder surgery. What could explain the connection between shoulder discomfort and gallbladder surgery?

8. Your cousin joined an MMA club. During his first fight he gets hit hard on the nose without sustaining a fracture. A couple of weeks after the fight you visit his family. Your cousin pours you a glass of milk. Just when you're about to drink from the glass, you smell that the milk has gone sour. You tell your cousin, and he takes a sniff but says he can't smell anything. His mother, on the other hand, can smell the sour milk and pours it out. What could be the cause for your cousin's inability to smell the sour milk?
  
9. You help your sister move some furniture from the first floor of her house to the second floor. While carrying a mattress on your back up the stairs your left knee buckles and you almost fall down. Which reflex caused your knee to buckle?
  
10. You examine a patient who may have a disc prolapse in her lower spine. The skin on the anterior and medial side of her left thigh is less sensitive than the skin in the same area on the right side. Which reflex would you expect to be affected by the disc prolapse?

### Cranial Nerve Testing Activity

In this activity you will test the function of your partner's cranial nerves. Some of the tests you will perform only involve one cranial nerve, while others involve many of the cranial nerves functioning together.

**Please read and follow the instructions carefully!**

**Supplies per group** (max. 4 students)

- Container with cloves
- Container with cinnamon sticks
- 1 medical pen light
- 1 cotton swab per group member

**1. Olfaction**

- Have your partner cover one nostril and close their eyes.
- Hold one of the containers (cloves or cinnamon) to your partner's uncovered nostril and ask them to identify the smell.
- Record each nostril as normal (smell properly identified) or abnormal (unable to properly identify smell).

**Left nostril:** \_\_\_\_\_      **Right nostril:** \_\_\_\_\_

**Interpretation:** This procedure tests the function of the olfactory nerve (CN I). Inability to identify odors is known as anosmia and can result from damage to nerve endings in the nasal mucosa or damage to olfactory nerve fibers as they cross the cribriform plate. Other causes of impairment include nasal obstruction and intracranial lesions.

**2. Visual Field Testing**

- Stand facing your partner and ask them to look straight forward for the entire duration of the test.
- With your arms outstretched to the sides, hold up a finger and slowly bring it toward the center of your partner's visual field.
- Ask them to indicate when they are able to see the finger.

- Repeat the procedure with one eye covered and try varying the height and direction of your movement.
- This will allow you to map the entire visual field.

Does your partner's peripheral vision seem to be normal? \_\_\_\_\_

Do the visual fields for the left and right eye appear symmetrical? \_\_\_\_\_

**Interpretation:** Visual field testing is one of a number of tests that involves the optic nerve (CN II).

### 3. Pupillary Responses

- With your partner seated, ask them to gaze straight forward and observe both pupils noting the size symmetry.
- Shine the pen light into one eye and note the response of each pupil.
- Repeat the procedure on the other side.

Are the pupils symmetrical at rest? \_\_\_\_\_

When you shined the light into your partner's eye, what was the response of each pupil? \_\_\_\_\_

**Interpretation:** This procedure tests a reflex arc involving two cranial nerves. The afferent (sensory) component of this reflex is the optic nerve (CN II). The efferent (motor) component of this reflex is the oculomotor nerve (CN III). Damage to either of these nerves can result in an abnormal test. In a **normal response**, both pupils will constrict in response to the stimulus. Constriction of the pupil on the same side is known as the **direct pupillary response** and involves both CN II and CN III on the same side. Contraction of the opposite pupil is known as the **consensual pupillary response**. It involves CN II on the side that the light is shined in and CN III on the opposite side.

### 4. Extraocular Movements

- Have your partner face you and keep their head pointed forward.
- Instruct your partner to follow your finger with their eyes while you trace a large H-shaped pattern.
- Observe for a smooth and coordinated movement of the eyes and ask your partner if they experience any double vision.

Was the movement smooth and coordinated? \_\_\_\_\_

Did your partner experience any double vision? \_\_\_\_\_

**Interpretation:** This procedure tests oculomotor nerve (CN III), trochlear nerve (CN IV), and abducens nerve (CNVI). These nerves supply the extrinsic eye muscles. Damage to these nerves can cause the two eyes to fix on different points, resulting in diplopia (double vision).

### 5. Facial Sensation and Muscles of Mastication

To test **facial sensation**

- Have your partner close their eyes.
- Use a cotton swab to lightly brush the skin of your partner's face while they verbally identify which side of the face you are touching.

To test the **muscles of mastication**

- Simply palpate the masseter muscle (between the zygomatic arch and the angle of the mandible) while your partner clenches their jaw.
- Feel for a strong contraction and observe for any atrophy (muscle wasting).

Was your partner able to identify light touch on all areas of the face? \_\_\_\_\_

Assume that your partner was unable to detect light touch over the right side of her forehead. Which branch of which nerve would you suspect to be damaged? \_\_\_\_\_

**Interpretation:** Both of these procedures test the function of the trigeminal nerve (CN V). Checking sensation tests the afferent component while assessing the muscles of mastication tests the efferent component.

### 6. Muscles of facial expression

- Look at your partner's face and assess for any asymmetry of facial shape or skin folds.
- Give your partner the following cues to assess the function of their facial muscles: "smile", "show your teeth", "puff up your cheeks", "blink", "squint hard". Assess for any asymmetry of motion.

What type of nerve fibers are you assessing? \_\_\_\_\_

Which muscles are being used (there are many)? \_\_\_\_\_

**Interpretation:** These motions utilize many of the muscles of facial expression. They are all innervated by the facial nerve (CN V). Facial asymmetries are sometimes the result of damage to this nerve.

### 7. Hearing and Vestibular Sense

#### To assess hearing

- Stand behind your partner and direct them to look straight forward.
- Place your hands off to the sides of your partner, outside of their visual field and direct them to indicate "left" or "right" when they hear a sound.
- Gently rub your fingertips together to create sound on one side and then the other.

#### To assess for appropriate response.

- Stand up straight with your arms and hands at your sides. Don't lean against a table or wall or anything else that would support you in any way.
- Your lab partner(s) will tell you to close your eyes and to keep standing straight for about 30 seconds. They will observe you closely to see whether you can maintain posture or will start swaying forward/backward or to the side.
- They have to be prepared to support you and keep you from falling over if necessary.

**Swaying during balance test:** \_\_\_\_\_ (Yes/No)

Which nerve fibers are being assessed? \_\_\_\_\_

**Interpretation:** While there are many causes of hearing loss, successful completion of a hearing test helps to rule out damage to the cochlear part of the vestibulocochlear nerve (CN VIII). Likewise, damage to the vestibular portion of the nerve is one of the many causes of balance problems.

### 8. Palate elevation and gag reflex

#### To assess elevation of the soft palate

- Ask your partner to "say AAH" and observe to see if the palate elevates symmetrically.

We do not assess the **gag reflex**, however, this can be done by lightly brushing the posterior pharynx.

**Interpretation:** Soft palate elevation and the gag reflex both assess the function of the vagus nerve (CN X) which supplies motor function to the muscles that elevate the palate and pharynx. The gag reflex also involves the glos-

sopharyngeal nerve (CN IX) which supplies sensation to the pharynx.

**9. Muscles of articulation (speech)**

- Observe your partner’s speech while they name the three connective tissue sheaths of a nerve.
- Note any hoarseness, quietness, breathiness, slurring, or pitch changes.
- Have your partner repeat the following: “PA-PA-PA...”, “TA-TA-TA...”, “GA-GA-GA...”

**Interpretation:** Dysarthria (speech impairment due to motor loss) can result from injury to cranial nerves V, VII, XI, X, and XII. These nerves collectively supply many of the muscles of the palate, face, larynx, pharynx, and tongue that assist in speech production.

**10. Sternocleidomastoid and trapezius muscle**

- Observe the contours of your partner’s neck and shoulders for signs of asymmetry or atrophy (muscle wasting).
- Test the function of the upper trapezius by having your partner shrug their shoulders upward as you press downward.
- Test the function of the sternocleidomastoid by having them rotate their head to the opposite side of the muscle you are testing and hold it there while you provide gentle resistance in the opposite direction.

Did you notice asymmetry? What reasons can you think of to explain your observations? \_\_\_\_\_

**Interpretation:** Both of these muscles are innervated by the spinal accessory nerve (CN XI). Damage to this nerve can cause weakness and atrophy.

**11. Tongue Muscles**

- Ask your partner to stick their tongue out.
- Observe for deviation to either side.
- Ask your partner to press their tongue into the side of each cheek.

Which muscle protrudes the tongue? \_\_\_\_\_

**Interpretation:** This procedure tests the function of the hypoglossal nerve (CN XII). Injury to this nerve can cause weakness of the tongue musculature and deviation of the tongue toward the side of the weakness.

**Reflex Testing Activity**

**Supplies per group:**

- 1 Reflex hammer per each pair of students

**1. Stretch Reflexes**

- You will be testing stretch reflexes using a reflex hammer.
- Assess the response and attempt to grade the stretch reflexes based on the following scale

O	Absent Reflex
1+	Trace
2+	Normal
3+	Brisk
4+	Nonsustained clonus (repetitive vibratory movement)
5+	Sustained clonus (repetitive vibratory movement)

- The limbs should be in a relaxed and symmetric position, as you will be testing both sides for comparison.
- You will need to tap the tendon briskly so as to create a quick stretch in the muscle.
- Locate and assess the following deep tendon reflexes. Your lab instructor will provide additional guidance.
  - **Biceps** – tendon located in the cubital fossa (elbow pit)
  - **Brachioradialis** – tendon located over the distal radius, just proximal to the styloid process
  - **Triceps tendon** – tendon located on the posterior arm, just proximal to the olecranon process of the ulna
  - **Patellar** – tendon located between the inferior patella and the tibial tuberosity, continuous with quadriceps muscle via the patella
  - **Achilles** – tendon located superior to the calcaneus, continuous with gastrocnemius and soleus muscles

Deep tendon reflex	Peripheral Nerve	Assessment right side	Assessment left side
Biceps tendon (C5, C6)			
Brachioradialis tendon (C6)			
Triceps tendon (C7)			
Patellar tendon (L4)			
Achilles tendon (S1)			

## 2. Plantar Response

Using the metal end of your reflex hammer, stroke sharply along the lateral border of the plantar surface of your partner's right and left feet, moving from the heel toward the toes and then across the metatarsal region.

**Response right foot:** \_\_\_\_\_ **Response left foot:** \_\_\_\_\_

**Interpretation:** Flexion of the toes is considered a normal response in adults. Extension of the great toe with fanning of the other digits is considered normal in newborns, but abnormal in adults as this reflex is normally suppressed by higher brain centers. A positive test usually indicates damage to motor neurons in the brain.

## Chapter 14 General & Special Senses

### Part 1 General Senses & Vision

#### Complete the following sentences

1. Survival depends upon \_\_\_\_\_, which is the awareness of changes in the internal and external \_\_\_\_\_, and \_\_\_\_\_, which is the conscious \_\_\_\_\_ of those stimuli.
2. \_\_\_\_\_ is a change in the sensitivity of a receptor in the presence of a constant stimulus.
3. Receptors that adapt slowly or not at all, such as \_\_\_\_\_ receptors, are called \_\_\_\_\_ receptors.
4. \_\_\_\_\_ respond to stretch and pressure, \_\_\_\_\_ respond to light energy, and \_\_\_\_\_ respond to chemicals.
5. The \_\_\_\_\_ or \_\_\_\_\_ protect the eye anteriorly.
6. The \_\_\_\_\_ apparatus consists of the \_\_\_\_\_ or \_\_\_\_\_ gland and a duct system that drain the tear liquid into the \_\_\_\_\_.
7. The outermost, fibrous layer of the eyeball consists of the \_\_\_\_\_, which forms the \_\_\_\_\_ of the eye, and the anterior \_\_\_\_\_ that lets the light into the eye.
8. Light enters the eye through the \_\_\_\_\_ and then travels through the \_\_\_\_\_, \_\_\_\_\_, and \_\_\_\_\_ to the photoreceptors of the \_\_\_\_\_.
9. A normal or \_\_\_\_\_ eye can see anything beyond \_\_\_\_\_ feet without having to make any extra adjustments. This is called the \_\_\_\_\_ point of vision.
10. In \_\_\_\_\_, the focal point is in front of the retina when we look into the \_\_\_\_\_; because we can still focus light from close images this disorder is also called \_\_\_\_\_.

#### Review your knowledge

1. Define 'refraction': \_\_\_\_\_
2. Identification of the site of a stimulus is called \_\_\_\_\_
3. Third-order neurons in the thalamus conduct the impulses up to the \_\_\_\_\_
4. Receptors that are sensitive to changes in temperature are known as \_\_\_\_\_
5. Because pain warns us of actual or impending cell/tissue damage, nociceptor have to be \_\_\_\_\_

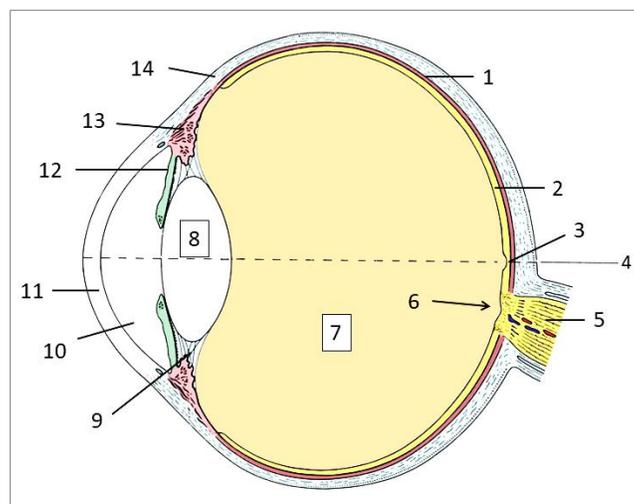
6. Complete the following table by adding the name of the receptor type based on the location of the receptor.

Function/description	Receptor type
Informs the brain of the body's movements	
Responds to stimuli arising in internal viscera and blood vessels	
Responds to stimuli arising outside the body	
Most special sense organs	
Responds to stretch in skeletal muscles, tendons, and joints	
Sensitive to chemical and temperature changes	
Receptors in the skin for touch, pressure, pain, and temperature	

7. The eyebrows overlie the \_\_\_\_\_.

8. To open, the upper lid needs to be lifted by the \_\_\_\_\_.

9. When irritated, the eyelashes initiate the \_\_\_\_\_.



Use the diagram to answer the following questions.

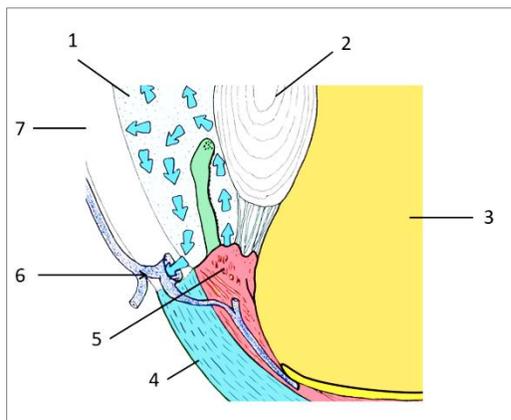
10. The middle layer of the eyeball is called \_\_\_\_\_ layer or \_\_\_\_\_. It is labeled # \_\_\_\_\_.

11. The optic axis of the eyeball (labeled # \_\_\_\_\_) runs through the \_\_\_\_\_ (labeled # \_\_\_\_\_) in the center of the macula lutea.

12. The axons of retinal neurons form the \_\_\_\_\_ nerve (labeled # \_\_\_\_\_), which leaves the eyeball at the \_\_\_\_\_ or \_\_\_\_\_ (labeled # \_\_\_\_\_).

13. The \_\_\_\_\_ (labeled # \_\_\_\_\_) separates the internal cavity into \_\_\_\_\_ and \_\_\_\_\_ segments.

14. The posterior segment contains the \_\_\_\_\_, a jelly-type liquid surrounded by a thin capsule. It is labeled # \_\_\_\_.
15. The pigmented anterior part of the uvea, the \_\_\_\_\_ (labeled # \_\_\_\_ ) regulates the amount of light entering the \_\_\_\_\_ (labeled # \_\_\_\_).
16. All six extrinsic eye muscles insert into the \_\_\_\_\_. It is labeled # \_\_\_\_.
17. The muscle that abducts the eye is the \_\_\_\_\_.
18. The trochlea nerve supplies one extrinsic eye muscle called \_\_\_\_\_.
19. Identify the following structures.



- |                  |       |
|------------------|-------|
| Sclera           | _____ |
| Anterior chamber | _____ |
| Canal of Schlemm | _____ |
| Ciliary process  | _____ |
| Vitreous body    | _____ |

20. Light refract at the interface of two media with different optic \_\_\_\_\_.
21. The two types of vision are called \_\_\_\_\_ and \_\_\_\_\_.
22. If an object is closer than 20 feet, the eye has to increase its refractive power to focus light on the \_\_\_\_\_.
23. Changing the lens shape to increase its refractive power is called \_\_\_\_\_.
24. The photoreceptors mainly found in the peripheral region of the retina are the \_\_\_\_\_.
25. Cones are mostly found in the macula lutea area; they provide us with \_\_\_\_\_.

**Apply your knowledge**

1. Dim light vision is fuzzy, color vision is high definition. Which feature of the receptors, not the energy of the light, explains this difference in visual acuity?
2. You brother tore his ACL in his right knee and had ACL replacement surgery. He is frustrated that the knee still hurts, especially during and after physical therapy sessions. Can you explain to him why feeling pain in his knee may be beneficial for him?

3. Shining a laser pointer into someone's eye can cause serious damage to the retina. Shining the same laser onto someone's skin usually doesn't bother them at all. Can you think of an explanation for that difference?
4. Why is 'pink eye', an inflammation of the conjunctiva, usually not a threat to our eyesight?
5. Why does the cornea have greater refractive power, i.e., bends the light more, than the lens?
6. Why can patients who suffer from a loss of photoreceptors in the area of the macula lutea (macular degeneration) see better at night than during day light?
7. Why do cats have bigger corneas than humans and pupils that can change from small slits to being almost completely dilated?
8. When people get a driver license, they have to take an eye test to check whether their distant vision is close to 20/20 or better. Why is that an important part of obtaining a driver license?
9. Your uncle has always had a strange fashion sense and, therefore, you are not surprised to find out that he has just been diagnosed with red-green color blindness. He found a website that offers a supplement containing vitamins, minerals, and plant extracts that are supposed to treat his condition. He isn't sure whether to spend the money and asks for your advice. What are you telling him?
10. Which eye muscle in which eye of the patient is most likely paralyzed? Which cranial nerve innervates this muscle?



### Cow Eye Dissection Activity

**The specimens we use contain traces of the fixative formalin (formaldehyde). Formalin residue or vapor may be irritating – avoid skin and eye contact. Do not ingest. Wear protective gloves and wash hands thoroughly after handling the specimen.**

- **Skin contact:** Wash thoroughly with soap and water.
- **Eye contact:** Flush with running water for 15 minutes. Report to lab instructor.
- **Ingestion:** Seek medical attention. Report to lab instructor.

#### Supplies per group (max. 4 students)

- 1 cow eye
- 1 disposable scalpel
- 1 disposable tweezers
- 1 pair of scissors
- 1 disposable dissection tray
- Protective gloves

1. Identify external eye structures, such as **cornea** (the fixative causes the cornea to be opaque and wrinkled instead of smooth and transparent), **sclera**, **optic nerve** and **extrinsic eye muscles**. If the posterior part of the eye is encased in fat tissue carefully remove it to expose the optic nerve.
2. Using the disposable scalpel carefully punch an opening into the sclera about 1/4-inch posterior to the cornea. You will probably be surprised by the toughness of the sclera. Be careful not to squeeze the eyeball to hard or liquid (**aqueous humor**) will squirt out. Once you've great an opening use the scissors to cut an incision all the way around the eyeball to separate it into two parts. The posterior part should contain the vitreous body and the anterior part the lens.
3. Carefully remove the **lens** from the anterior part. Note the **suspensory ligaments** attached to the lens. You should be able to identify **iris**, **pupil** and **ciliary muscle**.
4. Carefully remove the **vitreous body** from the posterior part. You can identify the **retina** as a thin beige layer that separates easily from the underlying **choroid**, apart from the **optic disc**, which is the only point of attachment of the retina.
5. The **choroid**, the dark middle layer of the eye wall, is iridescent in cows, but no in humans. You can separate the choroid from the tough outer most **sclera**.
6. Dispose of tissue, disposable dissection tray and tweezers, and protective gloves by putting then into the bio-hazard bin; the disposable scalpel goes into the sharps container. Place the scissors into the tray provided. Clean the table surface using wet paper towels and 10% bleach. Wash your hands thoroughly with soap and water when you are done.

---

### Visual Assessment Activity

#### 1. Locating the Blind Spot

##### Supplies per group (max. 4 students)

- Blind spot test card
- Ruler

- Hold the Blind spot test card (dot on the left side, X on the right side) with both hands and extended arms in front of you level with your eyes. Close your left eye, but keep the right eye open and focused on the dot. *Slowly* move the card towards you while keeping your eye focused on the black spot. If you move slowly enough the X will disappear when it crosses the blind spot on your eye, if you move too fast you will miss that point.
- Have a lab partner measure the distance the test card is from your eye when the X disappears. Then move the card slowly closer to your eye and the X will appear again.

**Blind spot distance for right eye:** \_\_\_\_\_

- Now extend your arms again, close your right eye and focus your left eye on the X. *Slowly* move the test card closer to you until the *black spot* disappears. Have a lab partner measure the distance between the test card and your eye.

**Blind spot distance for left eye:** \_\_\_\_\_

## 2. Measuring Distance Visual Acuity

**Supplies per group** (max. 4 students)

Snellen eye chart (already set up)

- ***If you wear corrective glasses or contact lenses you can remove them to determine your visual acuity without correction and then wear them again to determine the acuity with correction.***
- Stand on the line 20 feet away from the Snellen chart. Cover your left eye with your hand.
- One of your lab partners will ask you to read the line that has a value of 20/20 for visual acuity. If you can read half the letters or more correctly without squinting he/she will ask you to read the letters on the next, smaller line and so on until you come to a line where you cannot read at least half of the letters correctly.
- If you cannot read half the letters on 20/20 acuity you go up to the next line with bigger letters and try reading at least half of them correctly.
- Record your distance visual acuity for your right eye and then repeat the steps for your left eye.

**Distance visual acuity right eye:** \_\_\_\_\_

**Left eye:** \_\_\_\_\_

## 3. Testing for Astigmatism

**Supplies per group** (max. 4 students)

Astigmatism test card

- ***If you wear corrective glasses or contact lenses you should remove them to determine whether or not you have astigmatism.***
- Hold the test card with one hand approx. 12-15 inches away from your face.
- Cover your left eye with a hand and look at the center of the test chart with your right eye. All the radiating lines should appear equally sharp and dark. If some lines appear lighter or less distinct than others or are not straight then you have astigmatism in your right eye.
- Cover your right eye and repeat the procedure for the left eye.

**Astigmatism right eye:** \_\_\_\_\_ (Yes/No)

**Left eye:** \_\_\_\_\_ (Yes/No)

## 4. Testing for Color Blindness

**Supplies per group** (max. 4 students)

Ishihara Color Blindness test card

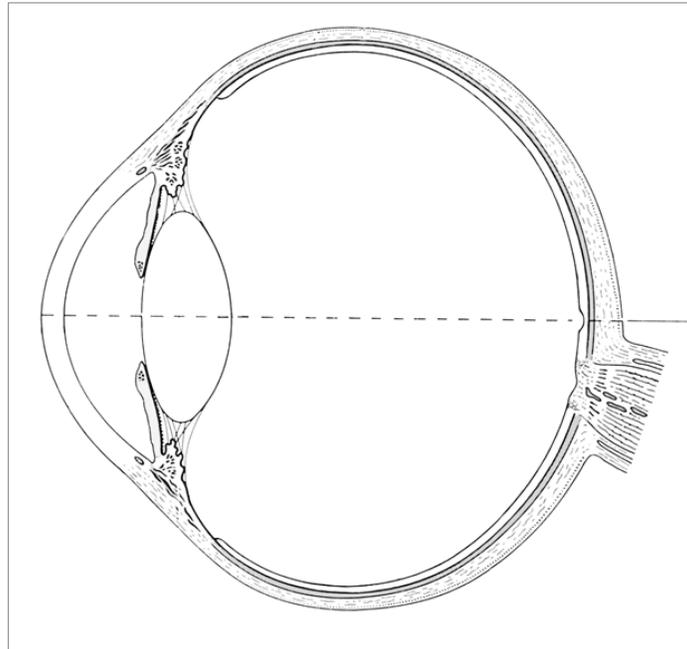
- Look at figure 7 and record the number you see: \_\_\_\_\_

- Look at figure 16 and record the number you see: \_\_\_\_\_
- If you have **normal color vision** you read 74 for figure 7 and 26 for figure 16.
- If you are **red color blind** you saw a 6 on figure 16.
- If you are **green color blind** you saw a 2 on figure 16.
- If you are **red-green color blind** you saw a 21 on figure 7.
- If you have **total color blindness** you didn't see any number just spots on figure 7.

### Coloring fun

Locate, color, and label the parts of the eyeball.

- |           |                   |                  |
|-----------|-------------------|------------------|
| • Sclera  | • Fovea centralis | • Vitreous humor |
| • Choroid | • Optic nerve     | • Lens           |
| • Retina  | • Optic disc      | • Iris           |
| • Cornea  | • Ciliary body    |                  |



## Part 2 Chemical Senses, Hearing, Balance & Equilibrium

### Complete the following sentences

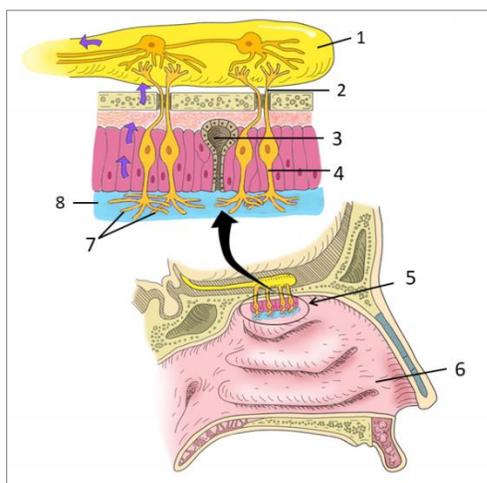
1. Both the sense of \_\_\_\_\_ and the sense of \_\_\_\_\_ use receptors that respond to chemicals in \_\_\_\_\_ solution.
2. Substances we can smell are called \_\_\_\_\_ and substances we can taste are known as \_\_\_\_\_.
3. The receptors for smell are part of the \_\_\_\_\_ epithelium in the \_\_\_\_\_ of the nose.
4. The axons of olfactory receptor cells form the \_\_\_\_\_ of the \_\_\_\_\_ nerve (cranial nerve \_\_\_\_\_).

5. The main nerve carrying taste signals from the \_\_\_\_\_ two-thirds of the \_\_\_\_\_ toward the brain is the \_\_\_\_\_ (cranial nerve \_\_\_\_).
6. Of the \_\_\_\_\_ basic taste sensations, \_\_\_\_\_ is caused by acids and \_\_\_\_\_ by metal ions.
7. Of the three parts of the ear, \_\_\_\_\_ and \_\_\_\_\_ ear are involved in \_\_\_\_\_ only, whereas the \_\_\_\_\_ ear is involved in both \_\_\_\_\_ and \_\_\_\_\_.
8. The inner ear consists of a bony \_\_\_\_\_ and a series of membranous \_\_\_\_\_ that are filled with \_\_\_\_\_.
9. The receptors for static equilibrium respond to \_\_\_\_\_ and changes in the position of the \_\_\_\_\_, whereas the receptors for dynamic equilibrium respond to \_\_\_\_\_ or \_\_\_\_\_ movement of the head.
10. The \_\_\_\_\_ ossicles \_\_\_\_\_ sound ten times and transmit it onto the \_\_\_\_\_ inside the scala \_\_\_\_\_ via the \_\_\_\_\_ window.

### Review your knowledge

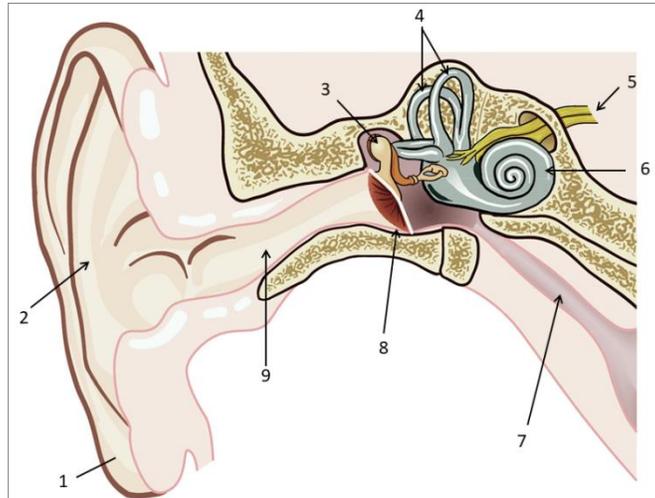
1. We can react emotionally to smells because the signals are processed in the \_\_\_\_\_.
2. The receptors for the taste are located in \_\_\_\_\_.
3. The vast majority of taste buds are found on the \_\_\_\_\_.
4. Taste is a complex sense because 80% of taste is actually \_\_\_\_\_.

Use the diagram to answer the following questions.



5. The \_\_\_\_\_ (labeled # \_\_\_\_ ) is an extension of the diencephalon.
6. Cilia (labeled # \_\_\_\_ ) interact with \_\_\_\_\_ dissolved in the fluid secrete by \_\_\_\_\_ (labeled # \_\_\_\_).
7. \_\_\_\_\_ filaments (labeled # \_\_\_\_ ) pass through tiny holes in the \_\_\_\_\_ plate of the \_\_\_\_\_ bone.

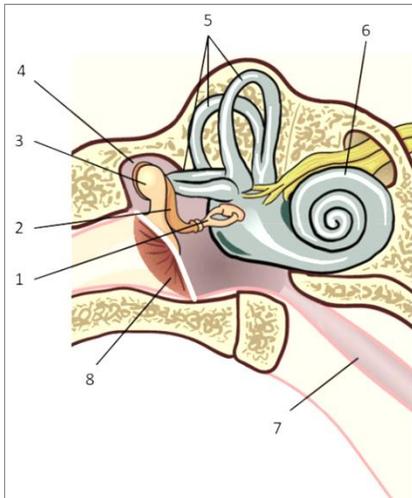
8. The thin membrane separating outer and middle ear is called \_\_\_\_\_ membrane or \_\_\_\_\_.
9. The middle ear is connected with the nasopharynx via the \_\_\_\_\_.
10. The scala tympani terminates at the \_\_\_\_\_.
11. We can only hear sounds with frequencies between \_\_\_\_\_.
12. The sensor containing receptor cells for hearing is called \_\_\_\_\_.



Use the diagram to answer the following questions.

13. The outer ear is formed by the \_\_\_\_\_ or \_\_\_\_\_. It is labeled # \_\_\_\_\_.
14. The short, curved tube leading to the tympanic membrane is called \_\_\_\_\_ or \_\_\_\_\_. It is labeled # \_\_\_\_\_.
15. The snail-shaped \_\_\_\_\_ (labeled # \_\_\_\_\_) contains the receptors for \_\_\_\_\_.
16. The three \_\_\_\_\_ (labeled # \_\_\_\_\_) contain receptors for dynamic equilibrium.
17. The \_\_\_\_\_ ossicles (labeled # \_\_\_\_\_) transmit sound waves from the \_\_\_\_\_ ear to the \_\_\_\_\_ ear.
18. Most sound is transmitted to the inner ear via \_\_\_\_\_.
19. Sound conduction via the bones of the skull is called \_\_\_\_\_.
20. The first, egg-shaped part of the inner ear is the \_\_\_\_\_.
21. The vestibule and the semicircular canals are filled with a liquid called \_\_\_\_\_.

22. Identify the following structures.

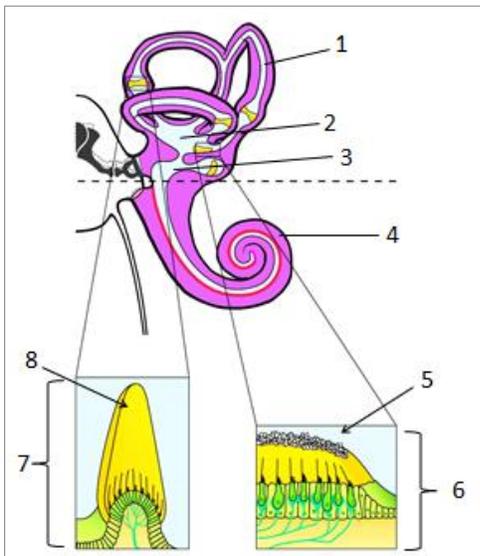


- Cochlea \_\_\_\_\_
- Epitympanic recess \_\_\_\_\_
- Tympanic membrane \_\_\_\_\_
- Stapes \_\_\_\_\_
- Malleus \_\_\_\_\_
- Eustachian tube \_\_\_\_\_

23. The liquid inside the semicircular ducts and the cochlear duct is known as \_\_\_\_\_.

24. The receptors for static equilibrium are called \_\_\_\_\_.

25. Identify the following structures.



- Semicircular duct \_\_\_\_\_
- Utricle \_\_\_\_\_
- Sacculle \_\_\_\_\_
- Macula \_\_\_\_\_
- Crista ampullaris \_\_\_\_\_
- Otoliths \_\_\_\_\_
- Cupula \_\_\_\_\_

**Apply your knowledge**

1. Why does cold milk have a different taste than hot milk and hot pizza a different taste than cold pizza?
2. Why could a loss of the sense of smell (anosmia) affect your appetite?
3. Bread is mainly made of flour, a long-chain carbohydrate that doesn't dissolve well in water and, thus, can hardly be tasted. If, however, you chew a piece of bread for some time it gradually starts tasting sweet. What could be

the reason for that change in taste?

4. You're going on vacation to Arizona. As part of the trip you hike in the desert near the Grand Canyon. After a few hours of hiking you pass by some blooming cacti. You wonder what the smell of the flowers would be and so you pick one and smell it. You are disappointed that it hardly smells at all, although your friend says his flower has a rather sweet smell. Why does your friend's flower smell but not yours?
5. Your neighbor uses a dog whistle to train his dog. When your little brother sees him use the whistle for the first time, he wonders why the man uses a whistle that doesn't make a sound. Can you explain it to him?
6. Why is ultrasound safe to use during pregnancy?
7. Why do our ears sometimes hurt during takeoff and landing of an airplane? What can you do to get rid of the pain?
8. Your sister asks you to help her with a Science Fair project. She has you taste different fruit juices with your eye closed so that you can't see what you taste. She then asks you to try the different fruit juices with your eyes open. However, all juices are and seem to taste more or less the same. She tells you that one of the juices was kiwi-flavored and another one was apple juice, she just dyed them red with food color. Why did you think those two juices tasted almost like strawberry (kiwi) and cherry juice (apple) when you saw their color but had their natural fruit taste when you had your eyes closed?
9. Which part of the inner ear will not work in weightlessness, for example, under water?
10. Rupture of the tympanic membrane will affect which type of sound conduction?

### Chemical Senses Testing Activity

#### 1. Olfactory Adaptation

**Supplies per group** (max. 4 students)

Stop watch

Cotton

Container with cloves

Container with cinnamon sticks

- Use some cotton to plug one nostril. Close both eyes. A lab partner will hold a container with either cloves or cinnamon below your nose and ask you to inhale through the open nostril and exhale from the mouth. You will be able to smell whatever is in the container. Tell your partner when you cannot smell it anymore and ask

him/her to note write down the time.

- Immediately pull the cotton out of your nostril, put some in the other nostril and inhale though the open nostril with the same container under your nose. Tell your partner whether or not you can smell the content.
- Repeat the procedure with the other container.

Odor	Time until smell disappears (adaptation)	Can you smell the odor after the nostril is unplugged?
Cloves		
Cinnamon		

## 2. What personality type are you?

**Supplies per group** (max. 4 students)

Stop watch

One cotton swab/Q-tip per person

One piece of thread per person

Lemon juice

- Tie a piece of thread exactly in the middle of the cotton swab. If you lift the swab by the thread it should hang horizontally and not dip to one side.
- Place one tip of the cotton swab on your tongue for 20 seconds.
- Put five drops of lemon juice on your tongue, swallow, and then put the other end of the cotton bud onto your tongue for 20 seconds.
- Hold the cotton swab dangling by the thread.
- If your reaction to the lemon juice made one end heavier this suggests that the juice caused you to salivate more than normal, which is a sign that – at a physiological level – you are an introvert. If the cotton bud is horizontal, this suggests you didn't react much to the lemon juice and that you are probably an extravert.

---

### Air and Bone Conduction Testing Activity

**Rinne** and **Weber tests** are exams that test for hearing loss. They determine what type of hearing loss (conductive vs. sensorineural) a patient has and help us to come up with a suitable treatment option.

**Supplies per group** (max. 4 students)

Tuning fork (512 Hz)

Hammer

Stop watch

**Rinne Test** - compares of air and bone conduction hearing

- Ask a student to down on a chair
- Strike the tuning fork softly
- Place the vibrating fork on the base of the mastoid bone
- Start the stop watch the moment the test subject hears the sound
- Ask the test subject to tell you when he/she no longer hears the sound
- Notice time on the stop watch and write it down
- Immediately move the tuning fork to the auditory meatus

- Ask the test subject to tell you when he/she no longer hears the sound
- Stop the stop watch and write down the total time.

**Time bone conduction:** \_\_\_\_\_

**Time air conduction:** (Total time – cone conduction): \_\_\_\_\_

**Evaluation:**

- In normal hearing air conduction will be twice as long as bone conduction
- In conduction hearing loss bone conduction sound is heard longer than or equally as long as air conduction
- In sensorineural hearing loss, air conduction is heard longer than bone conduction in affected ear, but less than 2:1 ratio for normal hearing

**Weber Test** - distinguishes between conductive or sensorineural hearing loss

- Ask a student to down on a chair
- Strike the tuning fork softly
- Place the vibrating fork on the middle of the head
- Ask the test subject if the sound is heard better in one ear or the same in both ears

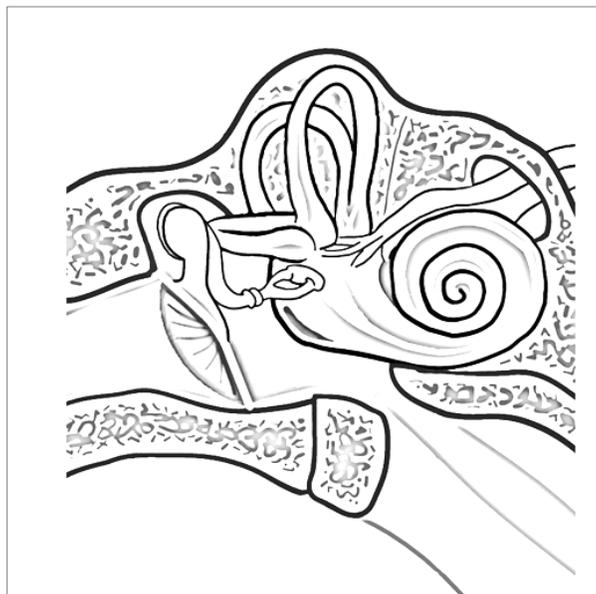
**Evaluation:**

- In normal hearing the sound is symmetrical with no lateralization (i.e., is heard the same on both sides)
- In conduction hearing loss the sound localizes toward the affected ear (i.e., is heard better on the affected side)
- In sensorineural hearing loss sound localizes toward the normal (good) ear (i.e., is heard better on the normal side)

**Coloring fun**

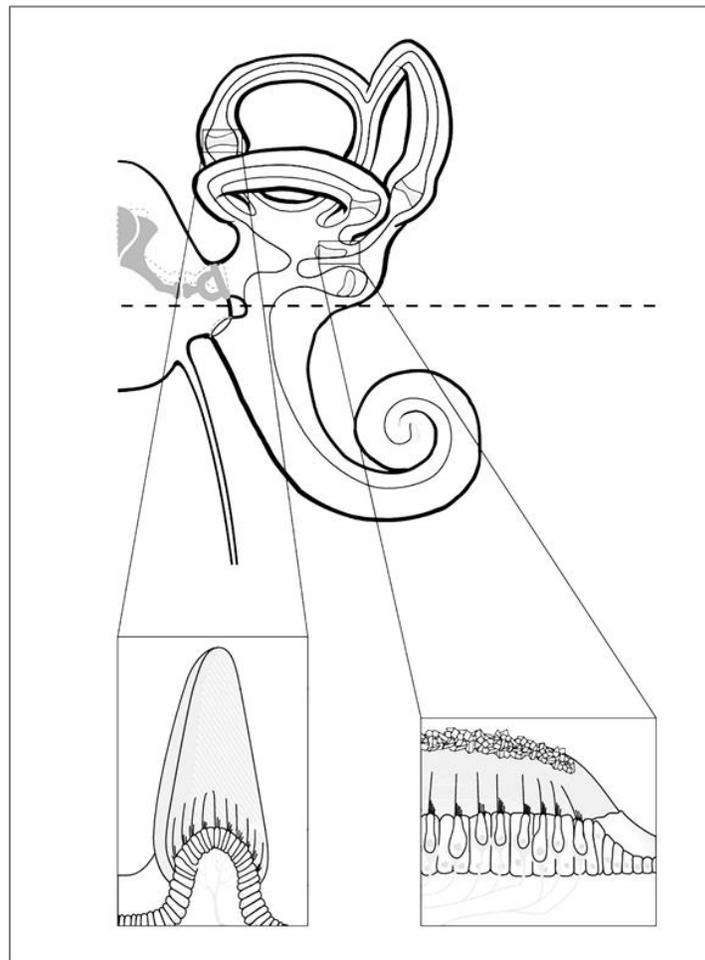
Locate, color, and label the parts of the middle and inner ear.

- |                 |                       |                            |
|-----------------|-----------------------|----------------------------|
| • Auditory tube | • Semicircular canals | • Tympanic membrane        |
| • Cochlea       | • Malleus             | • External auditory meatus |
| • Vestibule     | • Stapes              | • Vestibulocochlear nerve  |



Locate, color, and label the parts of the inner ear receptors.

- Semicircular canals
- Vestibule
- Cochlea
- Crista ampullaris
- Cupula
- Hair cells
- Macula
- Otoliths
- Otolithic membrane



## Chapter 15 Endocrine System

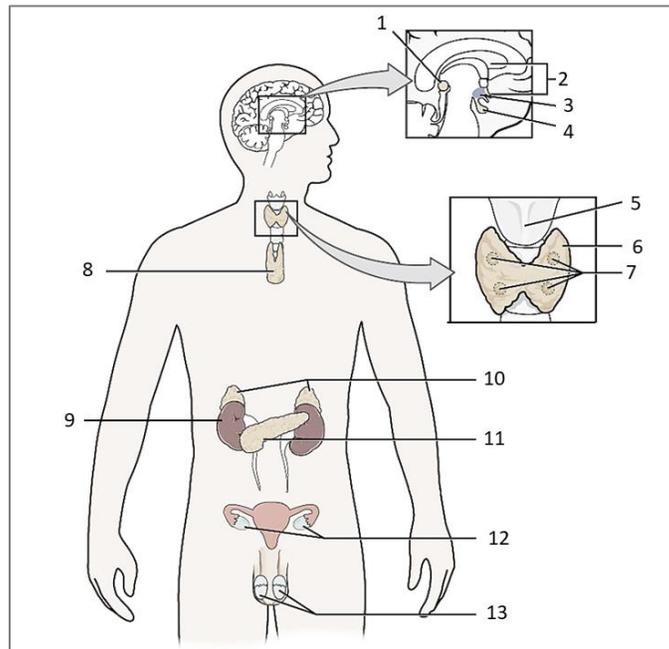
### Complete the following sentences

1. \_\_\_\_\_ are messengers used for long distance communication via the \_\_\_\_\_ or \_\_\_\_\_.
2. Hormones act at \_\_\_\_\_ cells because these cells have \_\_\_\_\_ specific for the hormones.
3. \_\_\_\_\_ hormones cannot enter target cells, while \_\_\_\_\_ hormones can cross the plasma membrane.
4. Because of their inability to cross the plasma membrane, \_\_\_\_\_ hormones interact with \_\_\_\_\_ in the plasma membrane and require a \_\_\_\_\_ system inside the cell.
5. \_\_\_\_\_ hormones act on \_\_\_\_\_ receptors that activate genes in the nucleus and the effects of these hormones can be attributed to the production of \_\_\_\_\_.
6. Hormones that stimulate other endocrine organs are called \_\_\_\_\_ hormones or \_\_\_\_\_.
7. Blood levels of almost all hormones are controlled by \_\_\_\_\_ feedback systems.
8. The hypothalamus produces \_\_\_\_\_ hormones that direct the \_\_\_\_\_ pituitary to either release a hormone or to stop releasing the hormone.
9. The pituitary gland has two major lobes: An \_\_\_\_\_ lobe or \_\_\_\_\_ (because it has gland tissue) and a \_\_\_\_\_ lobe or \_\_\_\_\_ (because it still is part of the \_\_\_\_\_).
10. The posterior pituitary hormones, \_\_\_\_\_ and \_\_\_\_\_ hormone, are called \_\_\_\_\_ because they are produced in the \_\_\_\_\_ and then transported down to the posterior lobe.

### Review your knowledge

1. Define 'paracrine hormone': \_\_\_\_\_
2. The process that leads to the formation of more receptors for a hormone is called \_\_\_\_\_.
3. A situation in which one or more hormones oppose the action of another hormone is called \_\_\_\_\_.

4. In a \_\_\_\_\_ stimulus, a hormone is released in response to a change in the blood level of a monitored variable.
5. If a hormone is released in response to a direct signal from the nervous system, we speak of a \_\_\_\_\_ stimulus.



Use above diagram to answer the following questions.

6. The gland that produces the two hormones that regulate blood sugar levels is called \_\_\_\_\_. It is labeled as # \_\_\_\_.
7. The \_\_\_\_\_ glands consist of two distinct parts: an outer cortex and an inner medulla. They are labeled as # \_\_\_\_.
8. The major hormone for the control of blood calcium levels is produced by the \_\_\_\_\_ glands. They are labeled as # \_\_\_\_.
9. The \_\_\_\_\_ gland produces the major metabolic hormone and a hormone to lower blood calcium levels. It is labeled as # \_\_\_\_.
10. The \_\_\_\_\_ produces hormones that are involved in the normal development of the immune system. It is labeled as # \_\_\_\_.
11. The \_\_\_\_\_ gland in the \_\_\_\_\_ produces a hormone of importance for our day/night cycle. The gland is labeled as # \_\_\_\_.
12. The \_\_\_\_\_ produce the major male sex hormone. They are labeled as # \_\_\_\_.

13. Complete following table by adding the name of the correct hormone.

Description	Hormone
Stimulates uterine contractions during childbirth	
In charge of the water balance of the body	
Stimulates milk production	
Stimulates Na <sup>+</sup> reabsorption and water retention by the kidneys	
Released by the heart in response to high blood pressure	
Produced in the skin and a precursor of vitamin D	
Controls the formation of red blood cells in the bone marrow	
Contains three or four atoms of iodine	
Stimulates development and secretory activity of the thyroid	

14. Complete following table by adding the name of the correct endocrine organ.

Description	Endocrine organ
Produces a hormone that plays a role in milk ejection	
Releases a hormone in response to elevated blood sugar levels	
Target organ for gonadotropin-releasing hormone	
Butterfly-shaped organ located on the front of the neck	
Produces three types of steroid hormones	
Part of the autonomic nervous system	
The biggest mixed endocrine-exocrine gland of the body	
Target of follicle-stimulating hormone in the female body	
Of vital importance for the normal development of the immune system	

### Apply your knowledge

1. Why is the posterior pituitary not a gland?
2. Why does an increase in the concentration of solutes in the blood plasma lead to the release of antidiuretic hormone?
3. Why are the follicle-stimulating hormone and the luteinizing hormones collectively known as gonadotropins?
4. Give an example of a hormone that has a negative feedback effect on both the anterior pituitary and the hypothalamus.

5. Give an example of a hormone that has a negative feedback on the hypothalamus only.
  
6. You suspect that your patient suffers from a lack of thyroid hormones (hypothyroidism). To confirm your working diagnosis you ask for blood levels for T<sub>3</sub>/T<sub>4</sub>, TSH, and TRH. How do you expect the blood levels of these parameters to be compared to a person with normal thyroid function if your patient has indeed hypothyroidism?
  
7. A young woman is admitted to a hospital with kidney stones. During her intake exam she mentions that her legs used to be straight, now they have turned into bowlegs. What could be the underlying issue that caused both the kidney stones and the bowlegs?
  
8. One of your uncles tells you that bones can grow longer even in older people. You explain to him that longitudinal growth ceases once the epiphyseal growth plate has disappeared. His counter argument is that his friend's hands and feet have grown so much that he now needs bigger shoes and gloves. What is your explanation for this unusual phenomenon?
  
9. Your mom she tells you that she thinks something is wrong with your little sister. She has noticed that your sister has gained weight and often complains about being hungry soon after a meal. For the last few days, she has been drinking a lot and, thus, needs to go to the bathroom all the time. When your mom asked her to drink less, she still needed to go to the bathroom and became very thirsty. Do you have any idea what your sister may be suffering from?
  
10. You have friends from Italy visiting with you. They arrive late in the afternoon and, although they are tired from the long trip, you stay up late to catch up on each other's life. However, instead of sleeping in the next morning, they are up at 3 am and make enough noise in the kitchen to wake you up. Why do you think they are doing that? What could you have done to make sure they'd sleep in?

### Modified Oral Glucose Tolerance Test (OGTT)

The **oral glucose tolerance test** (OGTT) measures the body's ability to metabolize glucose, i.e., to clear it out of the bloodstream. The test can be used to diagnose diabetes mellitus, gestational diabetes (diabetes during pregnancy), or prediabetes (a condition characterized by higher-than-normal blood sugar levels that can lead to type 2 diabetes).

Patients taking an OGTT eat a normal, balanced diet the week before taking the test. It is recommended that this diet include at least 150 to 200 grams of carbohydrates per day. Patients must fast for at least 8 to 12 hours before having the test.

In this exercise, we are performing a **modified OGTT** because most students did not fast for 8 – 12 hours prior to the test.

- **Students who are diabetic or pregnant should not take this test but work with their lab partners and use their test values.**
- Students who had a meal (not just a snack) within 90 minutes of the test can either complete the test as described below or skip the drink and just record their blood glucose levels now, after 1 hour, and after 2 hours.

**Supplies needed per group (max. 4 students)**

- 1 glucose meter
- 12 glucose test strips
- 12 safety lancets
- Cans of liquid nutritional drink (1 per student)

**Performing the test:**

1. Make sure you have all the supplies needed.
2. Check the code chip in your glucose meter against the code on your test strip vial. You can only use test strips from vials with codes that match the code of your code chip!
3. Wash hands with warm, soapy water. Rinse well and dry thoroughly.
4. Remove a test strip from vial and recap the vial immediately!
5. With glucose meter off, insert the test strip with contacts facing up into the test port of the glucometer; the meter turns on automatically. Keep the strip in the meter until testing is finished.
6. Lower your hand to waist level. Gently massage the chosen finger to get blood flowing.
7. Lance the finger using a Safety Lancet. Let a blood drop form.
8. Place the sample tip of the test strip against the blood drop and hold. Allow blood to be drawn into the test strip until the meter beeps or starts counting down.  
**If the meter does not beep or begin a countdown soon after touching the blood drop to the sample tip, discard the test strip and repeat the test with a new strip and a new blood drop.**
9. After the countdown, the result (blood glucose level in mg/dL) is displayed. Note this test value in the chart below as your initial blood glucose value. Remove the test strip and discard.
10. Open a can/bottle of nutritional drink and drink the content quickly.
11. Wait one hour, measure your blood glucose level (repeat steps 3-9), and record the value in the chart below.
12. Wait another hour, measure your blood glucose level again (repeat steps 3-9), and record the value in the chart below.

**Name of nutritional drink:**

**Total calories:**

**Calories from sugar/carbohydrates:**

**Calories from proteins:**

Initial blood glucose level [mg/dL]	1 hour blood glucose level [mg/dL]	2 hour blood glucose level [mg/dL]

**Evaluation:**



## Chapter 16 Reproductive System and Pregnancy

### Part 1 Male Reproductive System

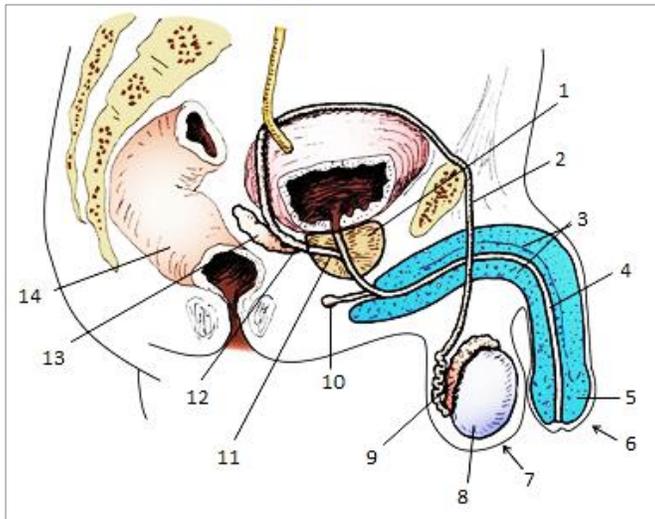
#### Complete the following sentences

1. The male and female \_\_\_\_\_ are the reproductive organs of the human body.
2. Men and women have one set of \_\_\_\_\_ sex organs or \_\_\_\_\_ each.
3. Ducts, glands, and external genitalia are \_\_\_\_\_ sex organs.
4. The male gonads are called \_\_\_\_\_ or \_\_\_\_\_; the female gonads are called \_\_\_\_\_.
5. The gonads produce \_\_\_\_\_ cells or \_\_\_\_\_ and steroid \_\_\_\_\_ hormones.
6. Sex hormones play an essential role in the development and function of the \_\_\_\_\_ reproductive organs and in sexual \_\_\_\_\_.
7. The formation of sex cells is called \_\_\_\_\_.
8. During the formation of sex cells, the number of chromosomes in the cells has to be reduced from \_\_\_\_\_ chromosomes down to \_\_\_\_\_ chromosomes.
9. Because they contain only one copy of each chromosome, sex cells are \_\_\_\_\_, whereas all other body cells are \_\_\_\_\_.
10. The process of transforming the bodies of young boys and girls into the bodies of sexually mature men and women is called \_\_\_\_\_.

#### Review your knowledge

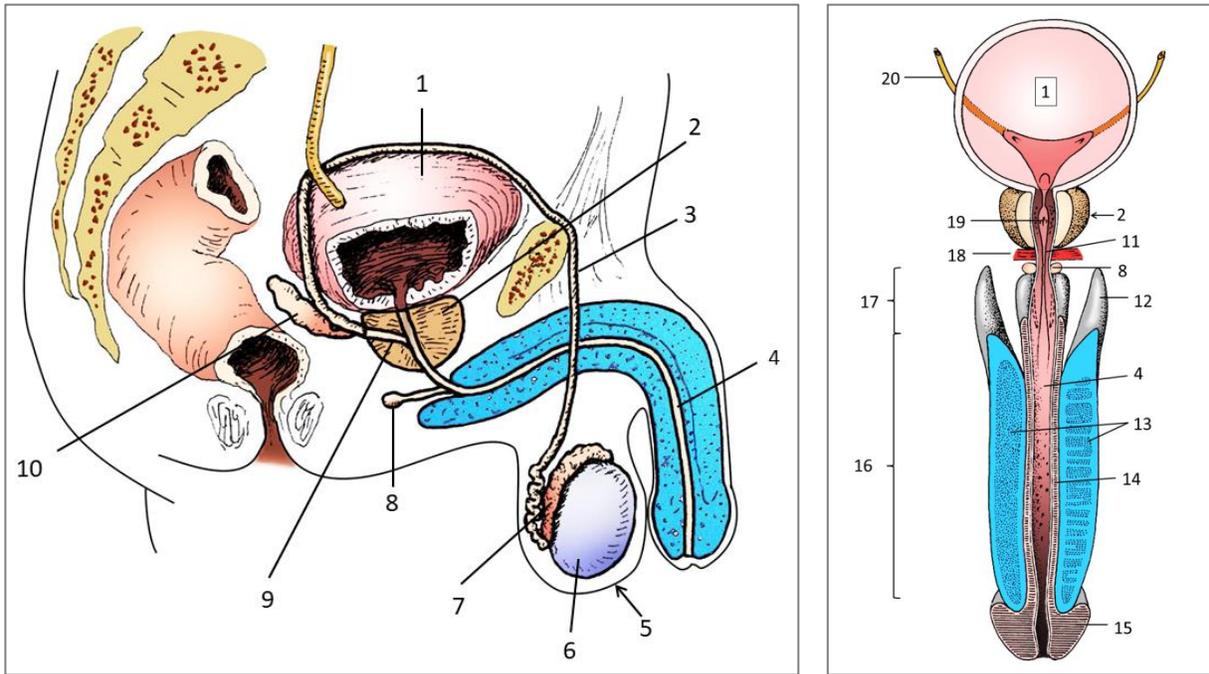
1. Define 'spermatogenesis': \_\_\_\_\_
2. The tough fibrous capsule of the testis is called \_\_\_\_\_.
3. Sperm production happens in the \_\_\_\_\_.
4. The smooth muscle that wrinkles the scrotal skin when the scrotum gets colder is called \_\_\_\_\_ muscle.
5. The duct carrying sperm from the testes toward the abdominal cavity is the \_\_\_\_\_.
6. The \_\_\_\_\_ hormone causes Sertoli cells to release androgen-binding protein.
7. The \_\_\_\_\_ is the male copulatory organ.

8. Propulsion of semen from the male duct system is known as \_\_\_\_\_.
9. The accessory gland that produces a viscous, alkaline fluid that makes up approximately 70% or more of the ejaculated semen is called \_\_\_\_\_.
10. The erectile tissue that surrounds the urethra and expands to form the glans is the \_\_\_\_\_.
11. The last part of the male urethra is called \_\_\_\_\_ or \_\_\_\_\_ urethra.
12. The ampulla of the vas deferens and the duct of the seminal vesicle join to form the \_\_\_\_\_ duct.
13. The cuff of loose skin covering the tip of the penis is called \_\_\_\_\_ or \_\_\_\_\_.



Use above diagram to answer the following questions.

14. The testes are located in the \_\_\_\_\_, which is labeled # \_\_\_\_\_.
15. The \_\_\_\_\_ is the first part of the duct system after the testis; it is labeled # \_\_\_\_\_.
16. The first part of the male urethra is found inside the \_\_\_\_\_, which is labeled # \_\_\_\_\_.
17. The pea-sized glands at the base of the penis are called \_\_\_\_\_ or \_\_\_\_\_ glands. One of them is labeled # \_\_\_\_\_.
18. The tip or head of the penis is also known as \_\_\_\_\_; it is labeled # \_\_\_\_\_.
19. Erection of the penis is achieved by filling the \_\_\_\_\_ (labeled # \_\_\_\_\_) with blood.



20. Match the following structures to the labels on the diagrams.

- |                      |       |                   |       |
|----------------------|-------|-------------------|-------|
| Glans penis          | _____ | Prostate          | _____ |
| Scrotum              | _____ | Urinary bladder   | _____ |
| Ductus/vas deferens  | _____ | Ureter            | _____ |
| Root of penis        | _____ | Seminal vesicle   | _____ |
| Urogenital diaphragm | _____ | Testis            | _____ |
| Spongy urethra       | _____ | Shaft of penis    | _____ |
| Cowper's glands      | _____ | Corpus spongiosum | _____ |
| Ejaculatory duct     | _____ | Prostatic urethra | _____ |

21. Complete following table by adding the name of the correct hormone.

Description	Hormone
Major male sex hormone	
Stimulates the anterior pituitary to release to follicle-stimulating hormone	
Causes Sertoli cells to release androgen-binding protein	
Stimulates Leydig cells to release testosterone	
Exerts feedback inhibition on the hypothalamus when the sperm count is high	

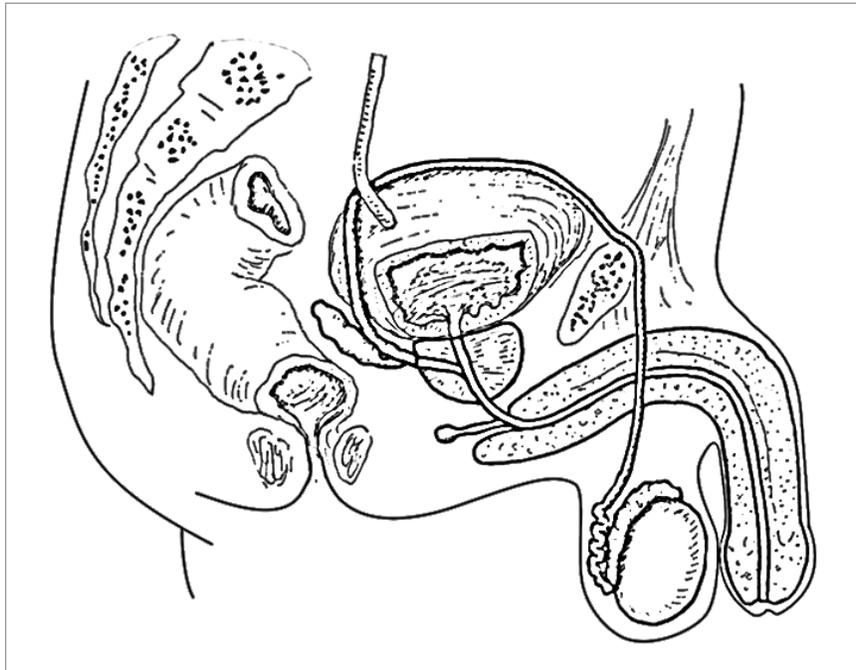
### Apply your knowledge

1. A boy suffers an injury to his anterior pituitary before puberty. Because of the injury, FSH is no longer released, but LH is normal. What would be the effect of a lack of FSH on his ability to father children as an adult?
2. Will the injury described above affect the boy's puberty?
3. Why do men have more issues with oily skin than women and are more likely to suffer from severe acne?
4. What effect would removal of the seminal vesicles have on the ejaculated semen?
5. In testicular torsion, the spermatic cord becomes twisted. Why is this condition an emergency that needs to be resolved within a few hours?
6. How can emotional and psychological factors cause erectile dysfunction?
7. In the past, men diagnosed with prostate cancer would often receive estrogen injections to suppress cancer growth. Nowadays, we are using substances that have the same action as luteinizing hormone-releasing hormone (LHRH agonists). Why is the use of LHRH agonists preferable to the use of estrogen injection?
8. Mr. A. is upset about his low sperm count and his inability to father children. He visits a "practitioner" who treats conditions of low sperm count with megadoses of testosterone. After receiving his injections, Mr. A. experiences a surge in sexual desire; his sperm count, however, is even lower than before the hormone treatment. Can you explain why?
9. Many men fear that a vasectomy will have a negative impact on their libido and refuse to have the procedure. What would you tell someone who asks you for advice?
10. Inflammation of the epididymis (epididymitis) can lead to damage to and scarring of the epididymis. Why could this lead to male infertility?

**Coloring fun**

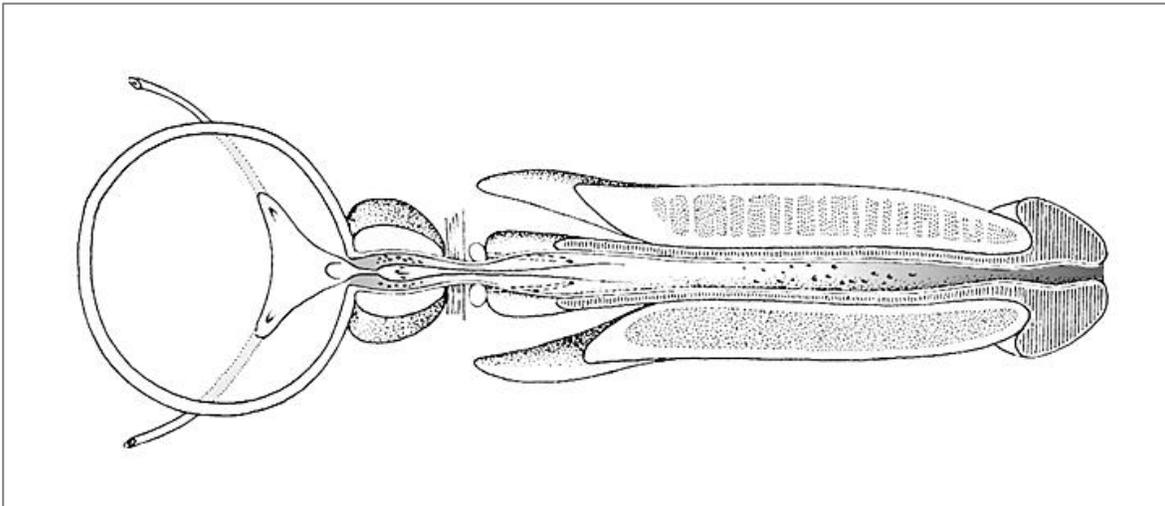
Locate, color, and label the structures of the male reproductive system.

- |              |                    |                       |
|--------------|--------------------|-----------------------|
| • Penis      | • Ductus deferens  | • Bulbourethral gland |
| • Testis     | • Seminal vesicle  | • Urethra             |
| • Epididymis | • Prostate         | • Bladder             |
| • Scrotum    | • Ejaculatory duct | • Ureter              |



Locate, color, and label the structures of the bladder and penis.

- |           |                        |                        |
|-----------|------------------------|------------------------|
| • Bladder | • Urethra              | • Urogenital diaphragm |
| • Ureter  | • Prostate             | • Corpus spongiosum    |
| • Trigone | • Bulbourethral glands | • Corpora cavernosa    |



## Part 2 Female Reproductive System and Pregnancy

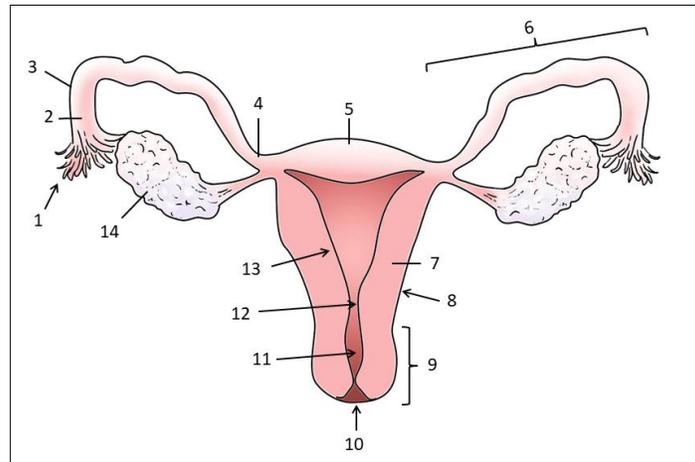
### Complete the following sentences

1. The \_\_\_\_\_ produce female gametes (\_\_\_\_\_) and secrete the female sex hormones \_\_\_\_\_ and \_\_\_\_\_.
2. The \_\_\_\_\_ tubes are also called \_\_\_\_\_ tubes or \_\_\_\_\_.
3. The \_\_\_\_\_ or \_\_\_\_\_ has a narrow neck called \_\_\_\_\_ that projects into the \_\_\_\_\_.
4. The mucosa of the uterus is called \_\_\_\_\_. It has two layers, a \_\_\_\_\_ layer that changes in response to ovarian hormones and is shed during \_\_\_\_\_, and a \_\_\_\_\_ layer from which a new \_\_\_\_\_ layer develops.
5. The \_\_\_\_\_ serves as \_\_\_\_\_ and organ of \_\_\_\_\_.
6. The external female genitalia are also called \_\_\_\_\_ or \_\_\_\_\_.
7. The \_\_\_\_\_ or \_\_\_\_\_ glands are modified \_\_\_\_\_ glands.
8. Pregnancy or \_\_\_\_\_ is the time from \_\_\_\_\_ until the infant is born.
9. The first trimester ends at the end of week \_\_\_\_\_ and the second trimester extends from the beginning of week \_\_\_\_\_ until the end of week \_\_\_\_\_.
10. The process of giving birth is called \_\_\_\_\_ or \_\_\_\_\_.

### Review your knowledge

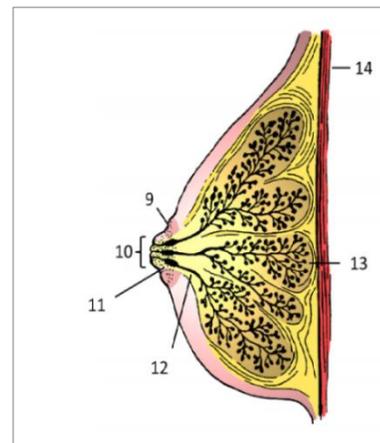
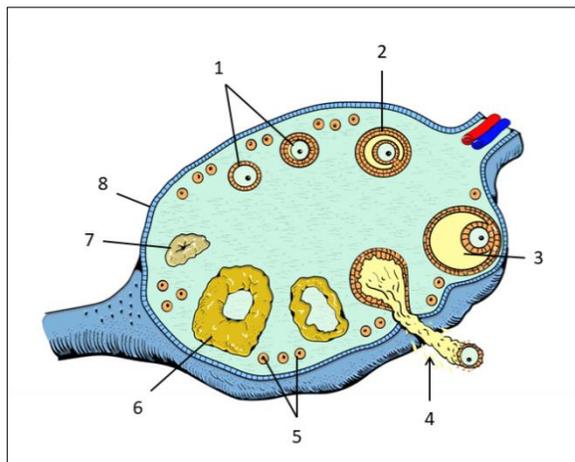
1. What is the main difference between oogenesis and spermatogenesis?
2. Define menopause: \_\_\_\_\_
3. The fatty area overlying the pubic symphysis in women is called \_\_\_\_\_.
4. The diamond-shaped region between the pubic arch and the coccyx is the \_\_\_\_\_.
5. During the first eight weeks of pregnancy, the baby is known as an \_\_\_\_\_.
6. The average duration of the gestation period is \_\_\_\_\_ days.
7. Implantation of the embryo in the uterus is usually completed \_\_\_\_\_ days after ovulation.
8. The nervous system and the epidermis of the skin develop from the outer germ layer called \_\_\_\_\_.
9. Blood vessels that connect the baby to the placenta found in the \_\_\_\_\_.

10. A baby with two X chromosomes is genetically a \_\_\_\_\_.



Use above diagram to answer the following questions.

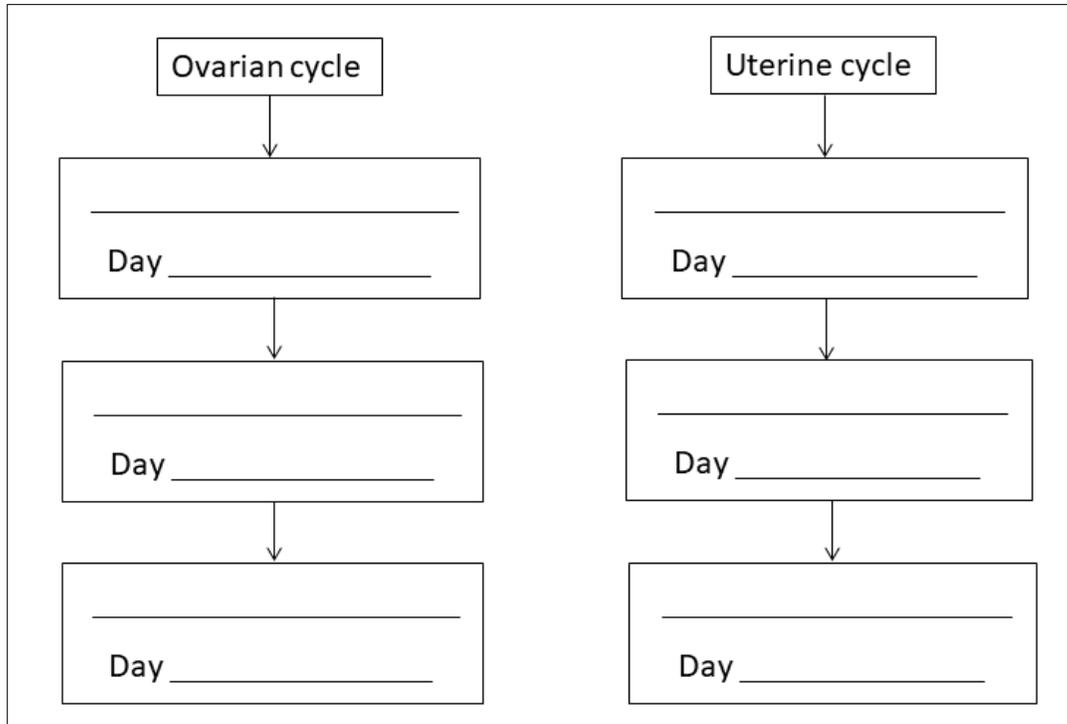
11. Sex cells are produced in the \_\_\_\_\_ which is labeled # \_\_\_\_\_.
12. The \_\_\_\_\_ connects the uterine cavity with the vagina. It is labeled # \_\_\_\_\_.
13. The rounded, superior region of the uterus is called \_\_\_\_\_. It is labeled # \_\_\_\_\_.
14. The expanded end of the ovarian tubes is called \_\_\_\_\_. It is labeled # \_\_\_\_\_.
15. Sperm has to be deposited as close as possible to the \_\_\_\_\_ of the cervix. It is labeled # \_\_\_\_\_.



16. Match the following structures to the labels on above diagrams.

- |                  |       |                      |       |
|------------------|-------|----------------------|-------|
| Tunica albuginea | _____ | Lactiferous sinus    | _____ |
| Nipple           | _____ | Primary follicles    | _____ |
| Corpus luteum    | _____ | Lactiferous duct     | _____ |
| Pectoralis major | _____ | Primordial follicles | _____ |
| Corpus albicans  | _____ | Graafian follicle    | _____ |

17. Complete the diagram by adding the names of the different stages and the days on which they happen.



18. Complete following table by adding the name of the correct hormone or hormones.

Description	Hormone
Major estrogen hormone	
Gets the endometrium ready for implantation of a fertilized ovum	
Essential for ovulation to occur	
Stimulate the growth of several follicles at the beginning of the ovarian cycle	
Causes cells surrounding the follicle to produce and secrete estrogens	
Stimulates the corpus luteum to continue secretion of progesterone and estrogen until about three months	
Stops the anterior pituitary from releasing FSH to make sure no additional follicle can develop during the pregnancy	
Supports estrogens and progesterone in getting the breast gland ready for lactation and promotes fetal growth	
Stimulates milk production by the by the mammary glands	
Causes the release of milk from the breast glands	

19. Complete following table by adding the name of the correct phase of the ovarian or menstrual cycle.

Description	Phase
First phase of the ovarian cycle	
Phase of ovarian cycle dominated by corpus luteum hormones	
Phase of ovarian cycle that is always 14 days as long as there is an ovulation	

Phase of ovarian cycle with the higher estrogen level	
Phase of menstrual cycle that is also called postovulatory cycle	
Phase of menstrual cycle that sees a regeneration of the endometrium	
Phase of menstrual cycle that is caused by very low levels of ovarian hormones	

20. Complete following table by adding the name of the correct anatomical structure.

Description	Structure
Creates an interface for the exchange of nutrients and waste products between the blood of the fetus and the mother	
Forms the transparent sac containing the embryo	
Releases the hormone that starts the monthly ovarian cycle	
Skin folds lying within the labia majora	

### Apply your knowledge

- On which day of a 34 day cycle would ovulation most likely occur?
- Why can we use medications containing estrogen and progesterone as birth control? Why don't they just cause the opposite effect?
- How are the reproductive hormones changed in postmenopausal women compared to normal? (Circle the right answer for each parameter)
 

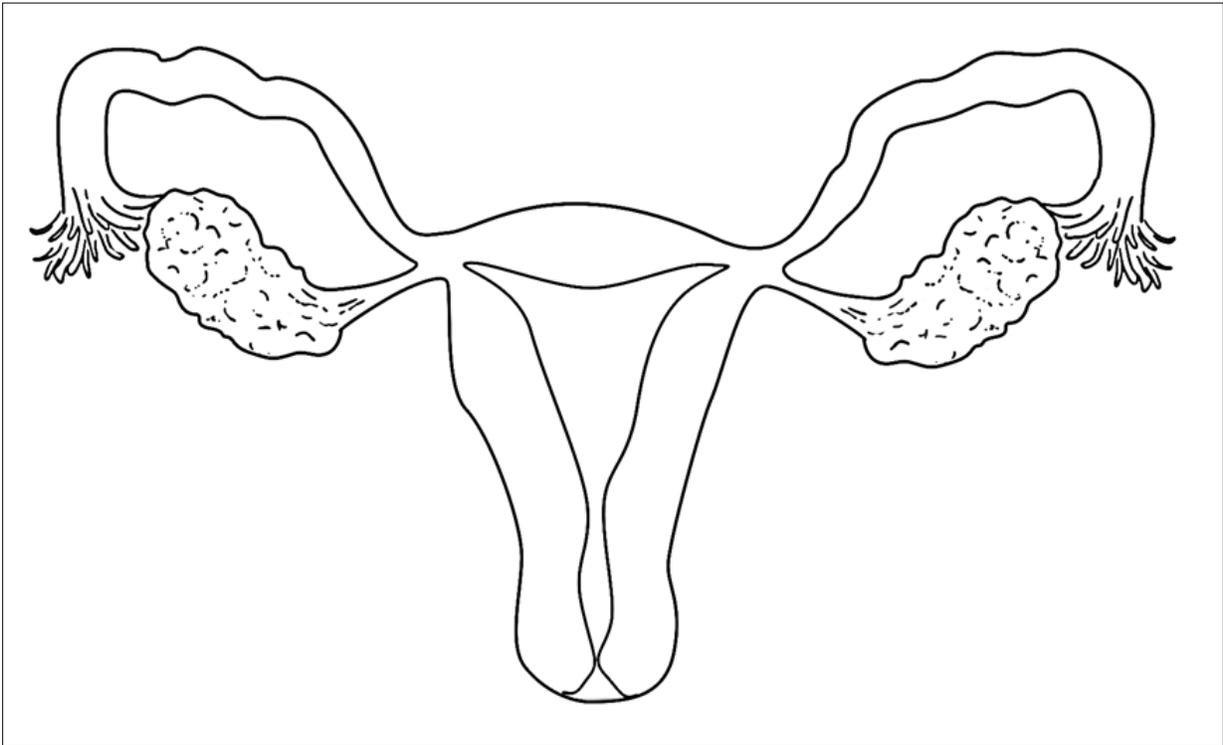
Estrogen:	↑	or	↓	or	↔
Progesterone:	↑	or	↓	or	↔
FSH:	↑	or	↓	or	↔
LH:	↑	or	↓	or	↔
- Your patient has suffered a number of miscarriages before week 8 of the pregnancy. Which endocrine gland do you suspect doesn't work properly during her early pregnancy causing the miscarriages?
- Why do women go into menopause but not men?
- A family friend is worried because her eight-year old daughter is in third grade and is already growing pubic hair. She remembers being in eighth grade when she started to grow pubic hair. She thinks her daughter growing pubic hair so early could be linked to hormones in chicken and other meat. What would you tell her?
- Your sister receives anti-estrogen therapy for her infertility due to anovulation. Explain to her how this will help her ovulate.
- What is the only thing we know for sure about sperm and the DNA they carry?

9. A woman has six children, three daughters and three sons. Her three sons suffer from color blindness but her daughters do not. Neither the woman nor her husband is color blind. What would explain the situation assuming that her husband is the father of all six children?
10. A very common complaint of pregnant women is the need to take frequent bathroom breaks. Explain why this happens.

### Coloring fun

Locate, color, and label the structures of the female reproductive system.

- |                |                    |                  |
|----------------|--------------------|------------------|
| • Ovary        | • Fallopian tube   | • Endometrium    |
| • Fimbriae     | • Isthmus          | • Myometrium     |
| • Infundibulum | • Fundus of uterus | • Cervix         |
| • Ampulla      | • Uterine cavity   | • Cervical canal |



## Chapter 17 Cardiac Anatomy & Physiology

### Part 1 Cardiac Anatomy

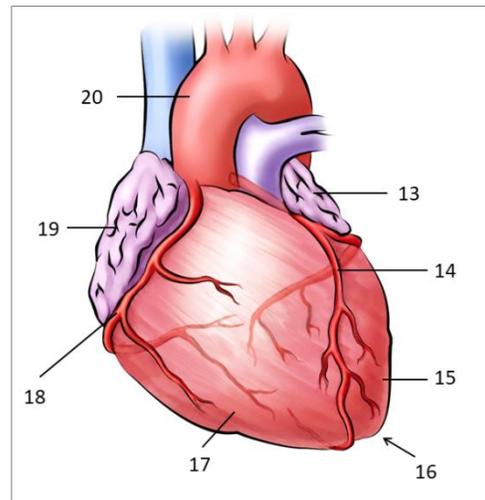
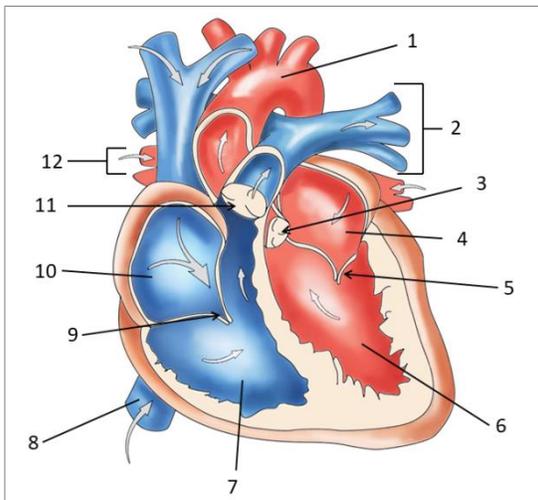
#### Complete the following sentences

1. The heart is located in the \_\_\_\_\_ between the \_\_\_\_\_ rib and \_\_\_\_\_ inter-costal space.
2. The space between the \_\_\_\_\_ pericardium and the \_\_\_\_\_ pericardium is called the \_\_\_\_\_ cavity.
3. The middle layer of the heart wall is called \_\_\_\_\_; it consists of \_\_\_\_\_ muscle cells.
4. The heart has \_\_\_\_\_ chambers: two \_\_\_\_\_ and two \_\_\_\_\_.
5. The atria are separated internally by the \_\_\_\_\_ septum and the ventricles by the \_\_\_\_\_ septum.
6. The valves between atria and ventricles are called \_\_\_\_\_ valves or \_\_\_\_\_ valves. Their task is to prevent \_\_\_\_\_ of blood from the \_\_\_\_\_ into the \_\_\_\_\_.
7. The valves preventing \_\_\_\_\_ of blood into the ventricles are called \_\_\_\_\_ valves.
8. The \_\_\_\_\_ valve prevents backflow flow into the \_\_\_\_\_ ventricle; the \_\_\_\_\_ valve prevents backflow into \_\_\_\_\_ ventricle.
9. We have two main circuits: the \_\_\_\_\_ circuit pumps blood from the heart to the lungs and the \_\_\_\_\_ circuit pumps blood to all body organs and tissues.
10. Each circuit has blood vessels that carry blood away from the heart, the \_\_\_\_\_, and vessels that carry it back to the heart, the \_\_\_\_\_.

#### Review your knowledge

1. Define 'artery': \_\_\_\_\_
2. The heart is approximately the size of a \_\_\_\_\_.
3. The innermost layer of the heart wall is called \_\_\_\_\_.
4. Atria are located above, whereas the ventricles are found below the \_\_\_\_\_.

5. The right and left pulmonary veins empty blood into the \_\_\_\_\_.
6. The double-walled sac enclosing the heart is called \_\_\_\_\_.
7. Cardiac muscles cells are connected by gap junctions and desmosomes that form \_\_\_\_\_.
8. The vessel carrying blood back from the myocardium to the right atrium is the \_\_\_\_\_.
9. The ventricle with the thinner wall is the \_\_\_\_\_.
10. The chorda tendineae are anchored to the ventricle wall by \_\_\_\_\_ muscles.



Use above diagrams to answer the following questions.

11. The tip of the heart is called \_\_\_\_\_. It is labeled # \_\_\_\_\_.
12. The valve preventing backflow of blood into the left ventricle is the \_\_\_\_\_ valve. It is labeled # \_\_\_\_\_.
13. The ear-like structure on top of the right atrium is called \_\_\_\_\_. It is labeled # \_\_\_\_\_.
14. The coronary arteries run in the \_\_\_\_\_, which is labeled # \_\_\_\_\_.
15. The \_\_\_\_\_ ventricle forms most of the anterior part of the heart. It is labeled # \_\_\_\_\_.
16. Match the following structures to the labels on above diagrams.

Tricuspid valve	_____	Aorta	_____
Left atrium	_____	Inferior vena cava	_____
Pulmonary valve	_____	Pulmonary arteries	_____
Aortic arch	_____	Anterior interventricular artery	_____

### Apply your knowledge

1. Describe the location of the heart in relation to the ribs in a patient with situs inversus (a congenital condition in which the major visceral organs are reversed from their normal positions). How much of the heart would be to the left and right of the midsternal line?
2. What is the difference between an artery and a vein as far as function is concerned?
3. Where in the heart would you look for pectinate muscles?
4. How can we tell from the outside where the left and right ventricles are when we look at the anterior side of the heart?
5. Where in the heart would you look for chordae tendineae?
6. Which chambers of the heart have the thinnest walls?
7. Which heart valve has three flaps (cusps) and chordae tendineae?
8. Why is there a fluid filled cavity between the visceral and parietal pericardium?
9. How can we estimate the size of the hearts of different people?
10. Where in the heart would you look for the opening into the coronary sinus?

### Pig Heart Dissection Activity

**The specimens we use contain traces of the fixative formalin (formaldehyde). Formalin residue or vapor may be irritating – avoid skin and eye contact. Do not ingest. Wear protective gloves and wash hands thoroughly after handling.**

- **Skin contact:** Wash thoroughly with soap and water.
- **Eye contact:** Flush with running water for 15 minutes. Report to lab instructor.
- **Ingestion:** Seek medical attention. Report to lab instructor.

#### Supplies per group (max. 4 students)

- 1 heart
- 1 disposable scalpel

- 1 disposable tweezers
- 1 pair of scissors
- 1 probe
- 1 disposable dissection tray
- Protective gloves

1. Carefully remove **adipose tissue** so that you can better identify **features on the anterior and posterior surface** of the heart on your checklist. Identify the **major blood vessels**. Insert the probe into the **superior vena cava** and maneuver the probe through the atrium until you can push it into the **inferior vena cava**.

Epicardium		Pulmonary trunk	
Apex		Aorta	
Right auricle		Inferior vena cava	
Left auricle		Superior vena cava	
Right ventricle		Coronary vessels in anterior interventricular sulcus	
Left ventricle		Coronary vessels in posterior interventricular sulcus	

2. Make a **coronal cut** using the scalpel. Start at the apex of the heart and cut toward the base. Cut through both atria and auricles, but not all the way through the base and the great vessels, so the two halves don't get separated!  
Identify the internal structures of the right and left atria and ventricles on your checklist. In the **right atrium**, identify the **opening of the coronary sinus** inferior to the opening of the inferior vena cava. Insert the probe and observe its movement inside the sinus from the posterior view. In the **right ventricle**, identify the **opening of the pulmonary trunk**. Take the scalpel and cut the wall of the trunk longitudinally to expose the **pulmonary valve**. Identify the openings of the **right and left coronary artery** behind and just above the cusps of the aortic valve.

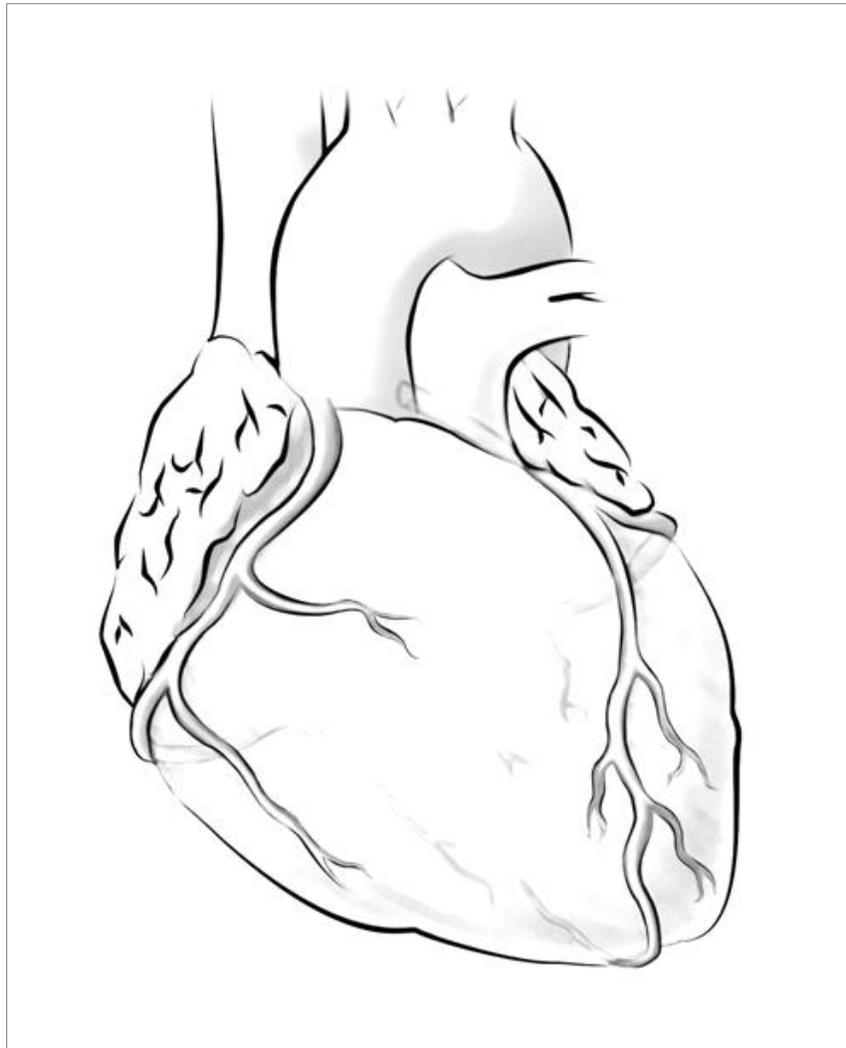
Right atrium		Tricuspid valve		Endocardium	
Right auricle		Right ventricle		Left atrium	
Pectinate muscles		Chordae tendineae		Left auricle	
Opening of inferior vena cava		Papillary muscles		Mitral valve	
Opening of superior vena cava		Interventricular septum		Left ventricle	
Opening of coronary sinus		Pulmonary trunk		Aorta	
Myocardium		Pulmonary valve		Aortic valve	

3. Dispose of tissue, disposable dissection tray and tweezers, and protective gloves by putting them into the bio-hazard bin; the disposable scalpel goes into the sharps container. Place the scissors and probe into the tray provided. Clean the table surface using wet paper towels and 10% bleach. Wash your hands thoroughly with soap and water when you are done.

### Coloring fun

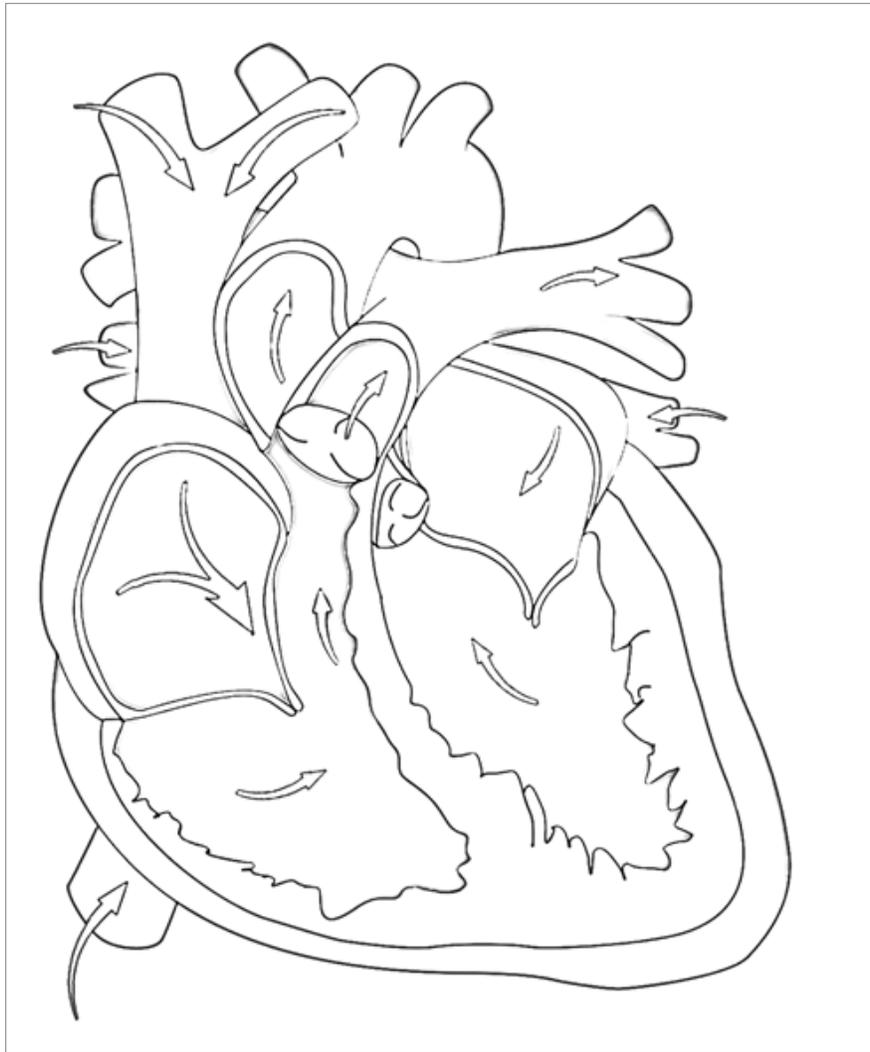
Locate, color, and label the outside of the heart and great vessels.

- |                           |                      |                                    |
|---------------------------|----------------------|------------------------------------|
| • Myocardium              | • Right ventricle    | • Left ventricle                   |
| • Interventricular septum | • Right atrium       | • Left atrium                      |
| • Inferior vena cava      | • Tricuspid valve    | • Mitral valve                     |
| • Superior vena cava      | • Pulmonary valve    | • Aortic valve                     |
| • Pulmonary veins         | • Pulmonary arteries | • Aortic arch                      |
| • Right coronary artery   | • Circumflex branch  | • Anterior interventricular artery |



Locate, color, and label the parts of the heart and great vessels.

- |                           |                      |                  |
|---------------------------|----------------------|------------------|
| • Myocardium              | • Right ventricle    | • Left ventricle |
| • Interventricular septum | • Right atrium       | • Left atrium    |
| • Inferior vena cava      | • Tricuspid valve    | • Mitral valve   |
| • Superior vena cava      | • Pulmonary valve    | • Aortic valve   |
| • Pulmonary veins         | • Pulmonary arteries | • Aortic arch    |



## Part 2 Cardiac Physiology

### Complete the following sentences

1. Depolarization of the heart muscle cells is \_\_\_\_\_ and \_\_\_\_\_.
2. Cardiac muscle cells have a \_\_\_\_\_ channel in addition to channels for \_\_\_\_\_ inflow and \_\_\_\_\_ outflow.
3. The \_\_\_\_\_ or \_\_\_\_\_ node is the physiological \_\_\_\_\_ of the heart. It generates \_\_\_\_\_ heart beats per minute.
4. The first event visible wave in the ECG, the \_\_\_\_\_, is caused by \_\_\_\_\_ of the \_\_\_\_\_ myocardium.

5. Blood attempting to flow from a ventricle \_\_\_\_\_ into an atrium causes the valves to \_\_\_\_\_. This leads to a turbulent blood flow, which can be heard as the \_\_\_\_\_ sound. It signals the beginning of the ventricular \_\_\_\_\_.
6. Contraction of heart muscle is called \_\_\_\_\_; relaxation is called \_\_\_\_\_.
7. The \_\_\_\_\_ cycle describes all mechanical events associated with blood flow through the heart during one complete \_\_\_\_\_.
8. During ventricular diastole, \_\_\_\_\_ valves are open but \_\_\_\_\_ valves are closed. Blood flows from the \_\_\_\_\_ into the \_\_\_\_\_.
9. The volume of blood in a ventricle at the end of the filling period is called \_\_\_\_\_ volume, the volume still remaining in the ventricle at the end of the ejection phase, \_\_\_\_\_ volume.
10. Cardiac output is the amount of blood \_\_\_\_\_ by each \_\_\_\_\_ in \_\_\_\_\_.

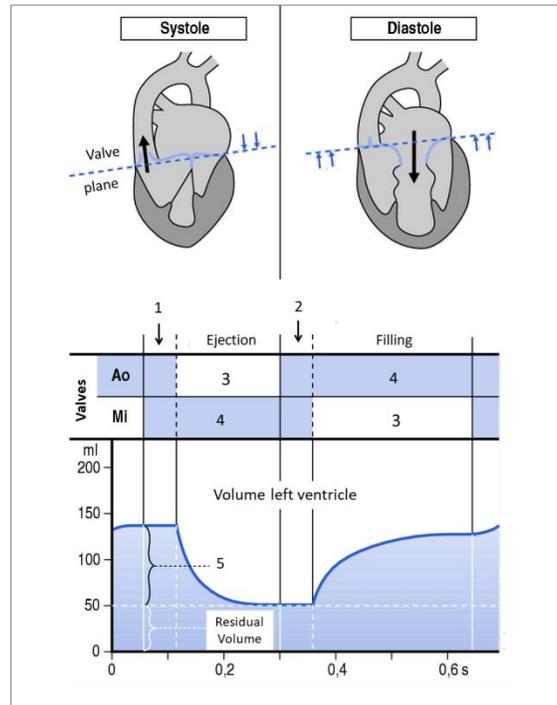
### Review your knowledge

1. Define 'stroke volume': \_\_\_\_\_
2. Compared with the AP of skeletal muscle cells, the AP of cardiac muscle cells is \_\_\_\_\_.
3. The network of specialized cardiac muscle cells that generate and transmit the action potential is called \_\_\_\_\_.
4. The degree of stretch of cardiac muscle cells before they contract is called \_\_\_\_\_.
5. The phase during which all four valves are closed and the ventricles contract is the \_\_\_\_\_.
6. Any sound heard in addition to the first and second heart sound is classified as a \_\_\_\_\_.
7. When the AV node takes over pacemaking, the heart rate will drop to \_\_\_\_\_.
8. Any factor that increases the contractility of cardiac muscle is said to be \_\_\_\_\_.
9. The cardiac output for a person with a resting heart rate of 70 bpm and an SV of 70 ml/beat is \_\_\_\_\_ ml/min or \_\_\_\_\_ l/min.
10. The resistance ventricles have to overcome to force the SL valves to open so that blood can be ejected is called \_\_\_\_\_.
11. The heart rate at rest is determined by the activity of the \_\_\_\_\_ system.

12. Indicate whether the AV and semilunar valves are open or closed during the phases of the cardiac cycle.

Phase	AV valves	Semilunar valves
Ventricular filling		
Isovolumetric contraction		
Ventricular ejection		
Isovolumetric relaxation		

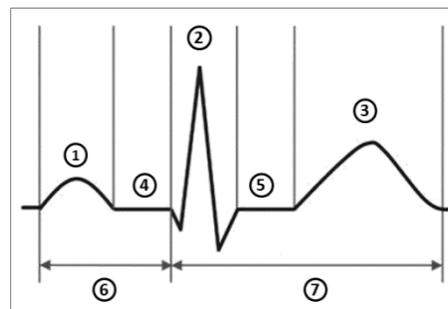
Use the diagrams to answer the following questions.



13. During phase # 3 of the cardiac cycle, the mitral valve will be \_\_\_\_\_.

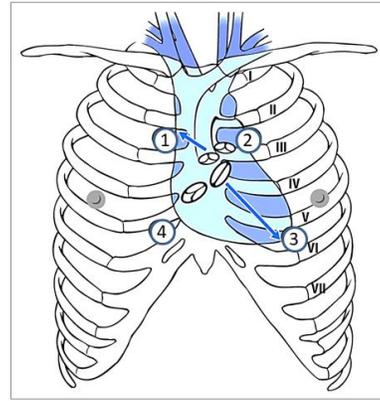
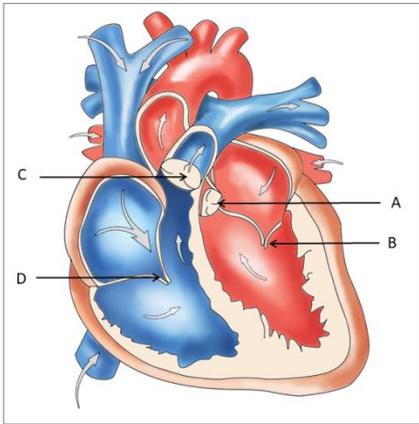
14. The volume labeled as #5 in the cardiac cycle diagram is the \_\_\_\_\_.

15. The phase of the cardiac cycle labeled as # 2 is called \_\_\_\_\_.



16. The wave labeled # 1 is caused by an action potential generated by the \_\_\_\_\_.

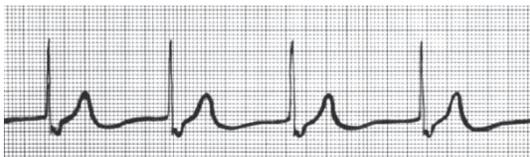
17. The segment labeled as # 4 in the EKG is caused by \_\_\_\_\_ of the AP transmission by the \_\_\_\_\_.



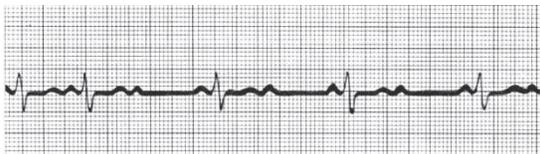
18. To listen to the aortic valve [labeled \_\_\_\_], you would put the stethoscope over the point # \_\_\_\_.
19. To listen to heart valve [D], you would put your stethoscope over point # \_\_\_\_.
20. Stenosis of valve [C] would cause a \_\_\_\_\_ murmur that could best heard best over point \_\_\_\_.

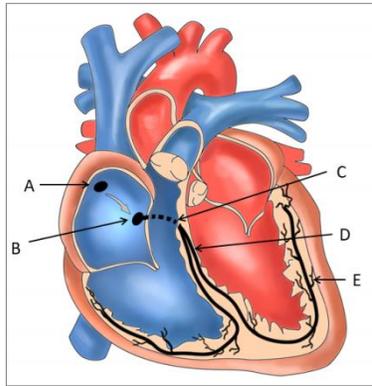
### Apply Your Knowledge

1. What is the maximum heart rate and why?
2. During ventricular systole, what closes the AV valves and what opens the semilunar valves?
3. Which volume is greater, EDV or ESV?
4. If both the heart rate and the SV double, what effect does that have on cardiac output exactly?
5. Why do Ca antagonists have a negative chronotropic effect?
6. Evaluate the EKG. Do you think it is a normal EKG? Why or why not?



7. Evaluate the EKG. Do you think it is a normal EKG? Why or why not?





8. How would a failure of the structure labeled [A] to generate an action potential affect the end-diastolic volume of both ventricles?

9. Your patient may have had an infection of her heart valves as a little girl. She doesn't speak much English and the letter from her former doctor is in French, which you don't speak or read. Still, you suspect she may suffer from mitral regurgitation. Where would you listen to her heart and what kind of murmur would you expect to hear?
10. You take vital signs of a new patient. His heart rate at rest is 45 bpm. What is the first question you should ask the patient?

### Heart Auscultation Activity

Auscultation is the listening to body sounds, usually by using a stethoscope. Because of the location of the heart and the valves and the flow of blood during the cardiac cycles, the best places to listen to the heart valves are in the **2<sup>nd</sup> intercostal space** to the **right (aortic valve)** and **left** of the sternum (**pulmonary valve**) and the **5<sup>th</sup> intercostal space** to the **right (tricuspid valve)** and **left** of the sternum (**mitral valve**).

**Remember:** The second rib is to the left and right of the sternal angle and the second intercostal space is between the second and third rib.

- Both team members should sit down and remain seated for the rest of the activity.
- Wipe the earpieces of the stethoscope with alcohol wipes and let air dry. Put the earpieces into your ear and gently tap the bell of the stethoscope to make sure it work and you can hear sounds.
- Place the stethoscope over the heart in the 3<sup>rd</sup> or 4<sup>th</sup> intercostal space to the left of the sternum. Take your time to listen and to identify the 1<sup>st</sup> and 2<sup>nd</sup> sound. The 1<sup>st</sup> sound usually is a little longer and louder than the 2<sup>nd</sup> sound. The pause between the 1<sup>st</sup> and 2<sup>nd</sup> sound is shorter than the pause between the 2<sup>nd</sup> and the 1<sup>st</sup> sound. If the heart sound is difficult to hear, ask your partner to bend slightly forward to tip the heart against the anterior thoracic wall.
- Once you have identified the sounds move your stethoscope down to the mitral valve. You may notice that the 1<sup>st</sup> sound will become louder. Now move over to the tricuspid valve and then up to the aortic and pulmonary valves, where you could hear the 2<sup>nd</sup> sound louder than before.

## Chapter 18 Blood Vessels & Circulation

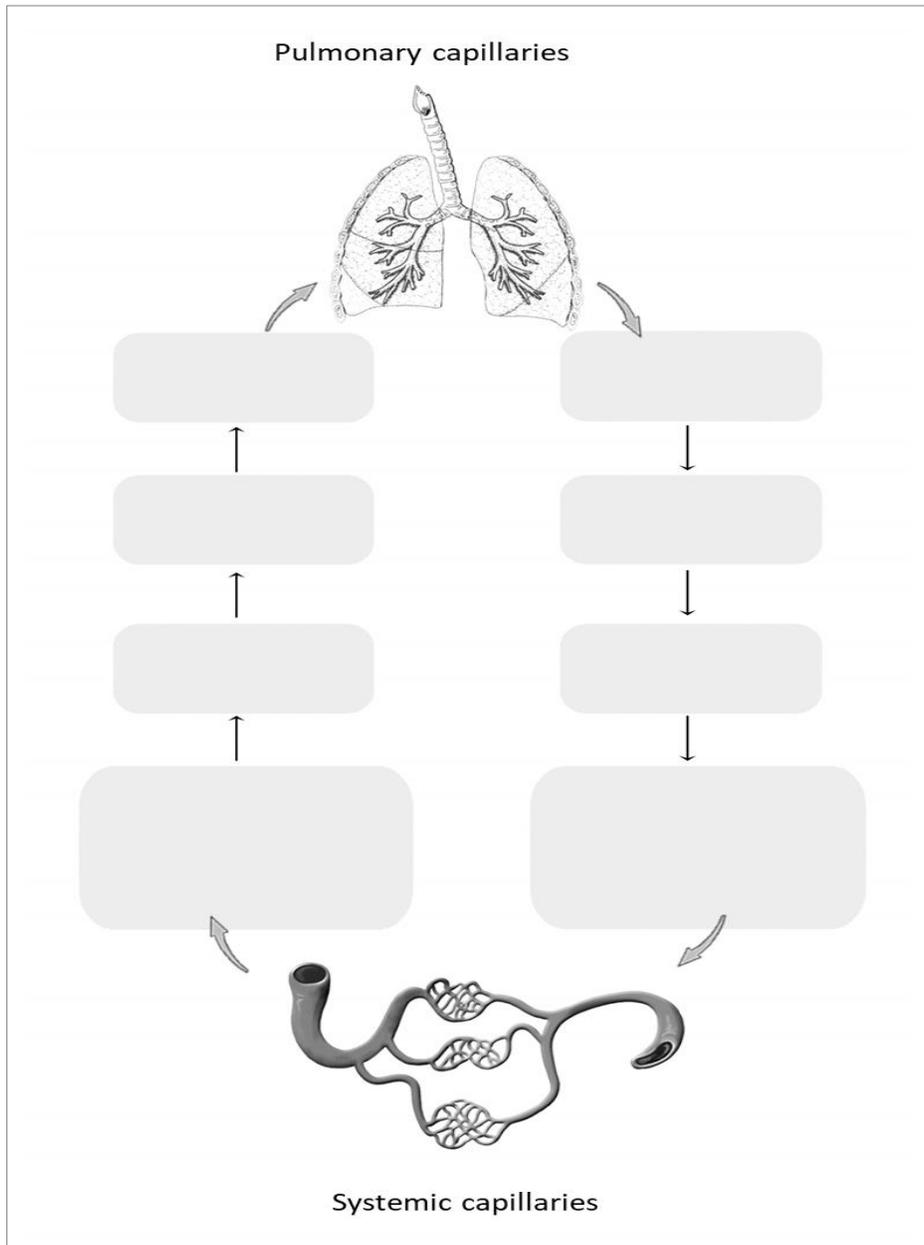
### Complete the following sentences

1. In the systemic circulation, arteries carry \_\_\_\_\_ blood; in the pulmonary system, they carry \_\_\_\_\_ blood.
2. The walls of \_\_\_\_\_ are thicker than the walls of \_\_\_\_\_ because they have to resist \_\_\_\_\_ pressure.
3. Veins can have \_\_\_\_\_ to assist in directing the flow of blood \_\_\_\_\_ the heart.
4. The driving force behind blood flowing through vessels is a \_\_\_\_\_ gradient, which causes blood to flow from areas of \_\_\_\_\_ pressure to areas of \_\_\_\_\_ pressure.
5. The difference between systolic and diastolic pressure is the \_\_\_\_\_ pressure.
6. Baroreceptors in the \_\_\_\_\_ protect the blood flow to the brain and receptors in the \_\_\_\_\_ help maintain an adequate pressure in the rest of the systemic circulation.
7. Aldosterone \_\_\_\_\_ blood volume by \_\_\_\_\_ the reabsorption of  $\text{Na}^+$  in the kidney and \_\_\_\_\_ the urine formation.
8. \_\_\_\_\_ is the blood flow through a vessel or the entire circulation in a given period.
9. Blood flow to our brain is \_\_\_\_\_ and \_\_\_\_\_ of our mental or physical activity.
10. If the \_\_\_\_\_ of a blood vessel is \_\_\_\_\_, resistance goes down to 1/16 of its original value, i.e. the volume of blood flowing through the vessel into the tissue \_\_\_\_\_ by \_\_\_\_\_ times.

### Review your knowledge

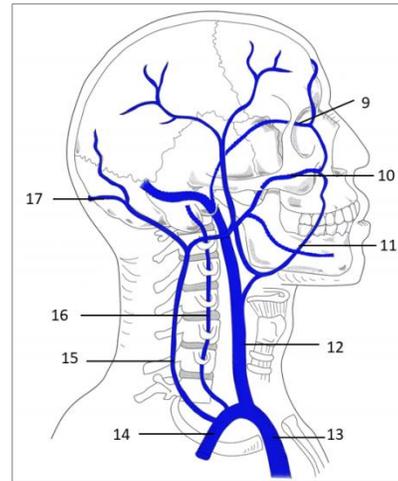
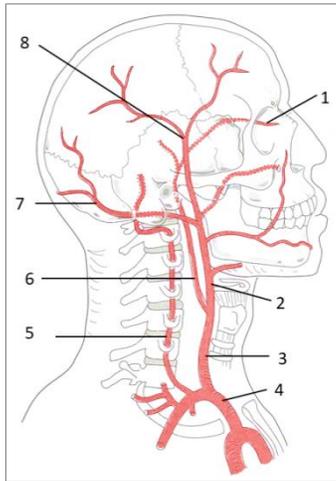
1. Why is blood in systemic arteries bright red and blood in systemic veins dark red? \_\_\_\_\_  
\_\_\_\_\_
2. The aorta and its major branches are elastic arteries and can act as a \_\_\_\_\_.
3. The blood vessels designed for exchange of gases and nutrients are the \_\_\_\_\_.
4. The thickest layer of artery walls is the \_\_\_\_\_.

5. Complete the diagram by adding the names of the structures that make up the pulmonary and systemic circulation.



6. Flattened veins with very thin walls found, for example, in the heart, are called \_\_\_\_\_.
7. The pressure in the pulmonary circulation is generated by the \_\_\_\_\_.
8. If the diastolic pressure is 60 mm Hg and the MAP is 90 mm Hg, the systolic pressure is \_\_\_\_\_ mm Hg and the pulse pressure is \_\_\_\_\_ mm Hg.
9. The hormone released by the heart in response to high blood pressure is the \_\_\_\_\_.
10. Long-term regulation of blood pressure depends on the kidney regulating \_\_\_\_\_.

11. The quickest way to regulate blood flow is by changing the \_\_\_\_\_.
12. Vasodilation slows down the speed of \_\_\_\_\_.
13. The majority of water and ions move in and out of the capillaries via \_\_\_\_\_.
14. The main force driving the outflow of water in the microcirculation is the \_\_\_\_\_  
\_\_\_\_\_ pressure.
15. The apparatus used to measure blood pressure is called a \_\_\_\_\_.
16. The hormone causing vasoconstriction and an increase in cardiac output is \_\_\_\_\_.

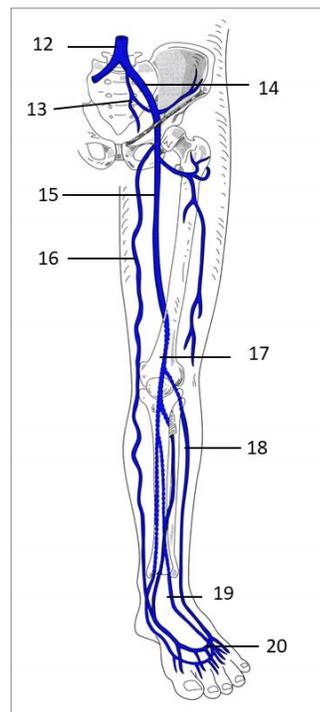
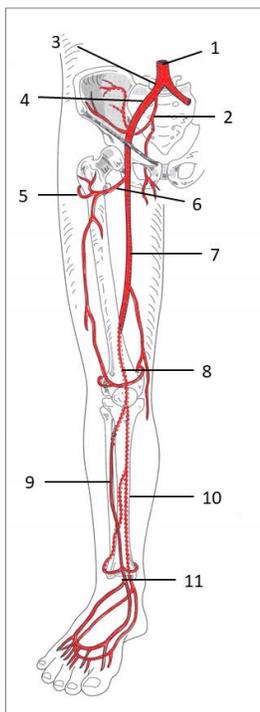


Use above diagrams to answer the following questions.

17. The vessel supplying blood to 80% of the brain is the \_\_\_\_\_. It is labeled # \_\_\_\_\_.
18. The vessel supplying the cerebellum with blood is the \_\_\_\_\_. It is labeled # \_\_\_\_\_.
19. The vessel collecting blood from the head and brain is called \_\_\_\_\_. It is labeled # \_\_\_\_\_.
20. The vessel carrying blood from the head and upper limb toward the heart is the \_\_\_\_\_. It is labeled # \_\_\_\_\_.
21. Complete following table by adding the name of the correct blood vessel(s).

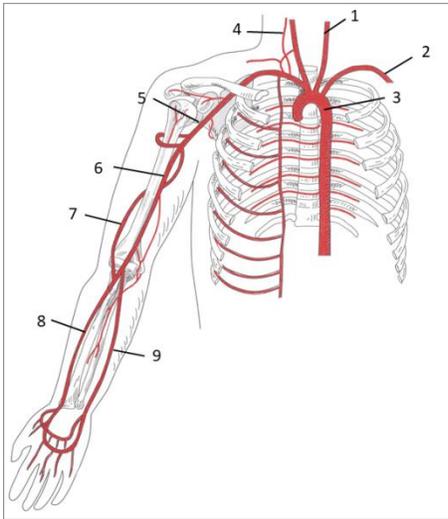
Description	Blood vessel(s)
Largest blood vessel of the human body	
Supplies all organs below the diaphragm and the lower limbs with blood	

First branches of the aorta	
Ascends through the transverse foramina of the cervical vertebrae	
Changes its name to axillary artery when entering the axilla	
Returns blood from areas below the diaphragm to the heart	
Carries nutrient rich blood toward the liver	
Unite to form the superior vena cava	
First branch of the abdominal aorta	
Can be used to insert a fairly big catheter into the left ventricle of a patient	
Can be used to insert a catheter into the right ventricle	



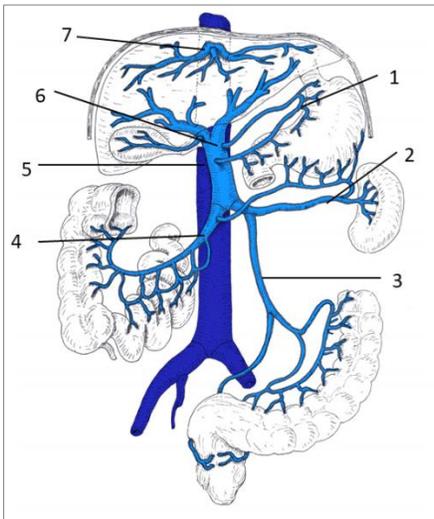
22. Match the structures to the labels on the diagrams.

- Common iliac artery \_\_\_\_\_
- External iliac vein \_\_\_\_\_
- Popliteal vein \_\_\_\_\_
- Anterior tibial artery \_\_\_\_\_
- Great saphenous vein \_\_\_\_\_
- Femoral artery \_\_\_\_\_
- Internal iliac artery \_\_\_\_\_
- Femoral vein \_\_\_\_\_



23. Match the structures to the labels on the diagram.

- Left subclavian artery \_\_\_\_\_
- Radial artery \_\_\_\_\_
- Brachial artery \_\_\_\_\_
- Common carotid artery \_\_\_\_\_



24. Match the structures to the labels on the diagram.

- Hepatic portal vein \_\_\_\_\_
- Splenic vein \_\_\_\_\_
- Inferior vena cava \_\_\_\_\_
- Superior mesenteric vein \_\_\_\_\_

**Apply your knowledge**

1. Why is the MAP closer to the diastolic pressure instead of being halfway between diastolic and systolic pressure?
2. Two people suffer from hypertension. The first one has a resting BP of 160/90 and the second one has a BP of 140/110. Which patient is at greater risk of suffering a heart attack in the long-term and why?
3. Why do people’s faces turn red when they blow up a balloon?
4. Why are aldosterone and atrial natriuretic peptide antagonists?
5. You are at the airport to pick up a friend. While he’s walking toward you, you notice that there’s an elderly lady walking in front of him holding her shoes in her hands. Why is she doing that? Is she confused about when to

take her shoes off for security?

6. Why does the capillary bed have only precapillary sphincters but no postcapillary sphincters?
7. If all our arteries were rigid tubes, like water pipes, how would that effect blood pressure and blood flow?
8. Why are there no valves in the veins of the neck and the head?
9. What could be one of the main long-term goals of physical exercise in cardiovascular rehab after a heart attack?
10. Why can an increased heart rate in people with coronary artery disease lead to a heart attack?
11. What is the reason behind the traditional advice 'Don't go swimming within 2 hours of eating'?
12. A patient has a history of congestive heart failure. Use the Frank-Starling law to explain why the patient suffers from pulmonary edema.

### **Blood Pressure Measurement/Pulse Rate Activity**

#### **Supplies per group (max. 4 students)**

Alcohol wipes  
Stop watch  
Sphygmomanometer (blood pressure cuff)  
Stethoscope

#### **Blood Pressure (BP) Measurement**

This exercise uses a sphygmomanometer and a stethoscope to measure the BP in the brachial artery. You should work in teams of two, alternating who will be the subject and who will measure the BP.

**Both team members should sit down and rest for approx. 5 minutes before the first measurement and should remain seated for the rest of the activity as to not increase their BP or heart rate.**

1. Make sure the blood pressure cuff is completely deflated. Place the cuff around the left arm of the subject with the inflatable part over the anterior surface of the arm. The bottom of the cuff should be approx. 1 inch above the elbow. Close the valve on the rubber bulb.
2. Wipe the earpieces of the stethoscope with alcohol wipes and let air dry. Put the earpieces into your ear and gently tap the bell of the stethoscope to make sure it work and you can hear sounds. Place the stethoscope over the brachial artery and listen for the brachial pulse.

3. Inflate the cuff to 160-180 mm Hg. You should not hear a brachial pulse at this pressure reading.
4. Immediately open the valve on the hand pump to **slowly** release air to deflate the cuff and listen for the **first Korotkoff sound**, which gives you the reading for the **systolic pressure**. Make a note of the reading.
5. Keeping watching the gauge while you continue to slowly release the air. The sound will at first increase, then muffle, and finally stop. The last faint sound gives you the reading for the diastolic pressure. Make a note of this reading.
6. Deflate the cuff completely; wait approx. 2 minutes before you repeat the measurement. Record the second reading in the table.
7. Change sides and repeat the measurement twice on the right arm. Record the measurements in the table below.

Arm	Systolic pressure	Diastolic pressure	Pulse pressure	Mean arterial pressure
Left	1.	1.		
	2.	2.		
	Avg.	Avg.		
Right	1.	1.		
	2.	2.		
	Avg.	Avg.		

**Measuring Pulse Rate (PR)**

Pulse is most commonly felt in the radial or carotid arteries. This activity uses the radial artery.

1. Practice locating and counting the radial pulse on yourself. Palpate the pulse by pressing down with your middle and index fingers in the groove between your radius and the tendon just medial to the radius. **Do not use your thumb!**
2. The test subject should sit down and rest for approx. 5 minutes before the pulse measurement.
3. Count the number of pulses in 15 seconds, multiply that number by 4 and record in below table.
4. Have the test subject run in place for 2 minutes and sit down again.
5. Immediately count the number of pulses in 15 seconds and record the data in below table.
6. Repeat pulse count after 2 minutes and 5 minutes and record the data in below table.

PR at rest	PR after exercise	PR 2 minutes after exercise	PR 5 minutes after exercise



## Chapter 19 Blood, Hemostasis, and Blood Groups

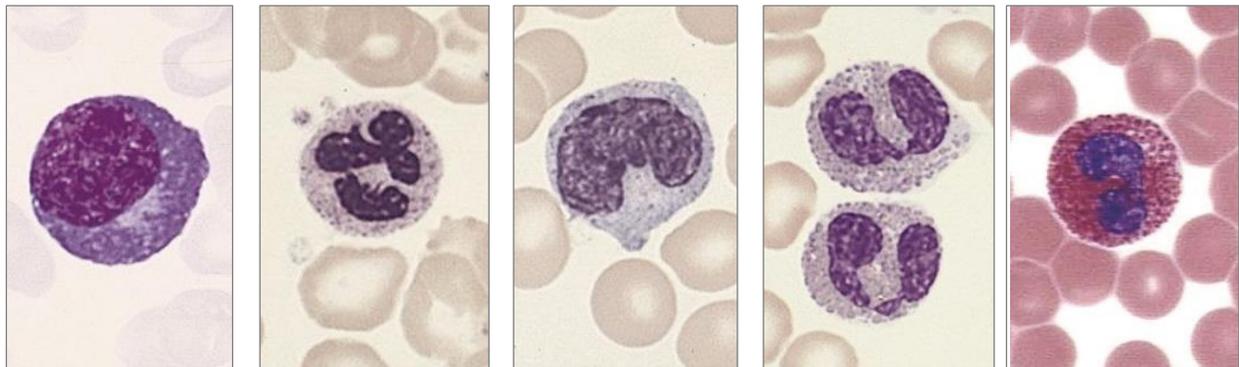
### Complete the following sentences

1. The percentage of the blood volume that consists of erythrocytes is called \_\_\_\_\_.
2. The liquid part of blood, the \_\_\_\_\_, makes up about \_\_\_\_\_ % of the total blood volume.
3. Blood makes up approx. \_\_\_\_\_% of our body weight or \_\_\_\_\_ l for men and \_\_\_\_\_ l for women.
4. \_\_\_\_\_ are by far the most numerous blood cells with approximately \_\_\_\_\_ per  $\mu\text{L}$  of blood.
5. Leukocytes can be subdivided based on the presence or absence of \_\_\_\_\_ in the cytoplasm into \_\_\_\_\_ and \_\_\_\_\_.
6. A white blood cell count of more than 11,000 per  $\mu\text{L}$  is called \_\_\_\_\_.
7. The series of reactions that is set in motion to stop bleeding is called \_\_\_\_\_.
8. \_\_\_\_\_ is a set of reactions that leads to the formation of insoluble \_\_\_\_\_ and a gel-like \_\_\_\_\_.
9. The \_\_\_\_\_ pathway of coagulation is most often initiated by \_\_\_\_\_.
10. Blood groups are based on the presence or absence of \_\_\_\_\_ on the outside of the plasma membrane of \_\_\_\_\_.

### Review your knowledge

1. Define 'erythropoiesis': \_\_\_\_\_
2. The normal pH of blood is between \_\_\_\_\_ and \_\_\_\_\_.
3. The white layer that separates red blood cells and plasma after centrifugation is the \_\_\_\_\_.
4. The proteins making up most of the blood proteins are called \_\_\_\_\_.
5. The formation of all formed blood elements starts with a stem cell called \_\_\_\_\_.
6. The mature red blood cell released into the blood is the \_\_\_\_\_.
7. Platelet formation is regulated by the hormone \_\_\_\_\_.
8. The oxygen-transporting protein on erythrocytes is called \_\_\_\_\_.
9. Complete following table by adding the name of the correct cell(s).

Description	Cell(s)
Most common white blood cell	
Transports oxygen and carbon dioxide	
Turns into a mature red blood cells after being released into the blood	
Have granules and are phagocytic	
Changes its name after leaving the blood	
Will attack parasitic worms, such as tapeworms	
Crucial to our immune system	
Play a key role in hemostasis	
Least common white blood cells	
Love to dine on bacteria	



**A**

**B**

**C**

**D**

**E**

10. Identify above cells and indicate for each if the cell a) is a granulocyte or agranulocyte and b) is phagocytic or not.

**A:** \_\_\_\_\_

**B:** \_\_\_\_\_

**C:** \_\_\_\_\_

**D:** \_\_\_\_\_

**E:** \_\_\_\_\_

11. In order to enhance the vasospasm, platelets release \_\_\_\_\_.

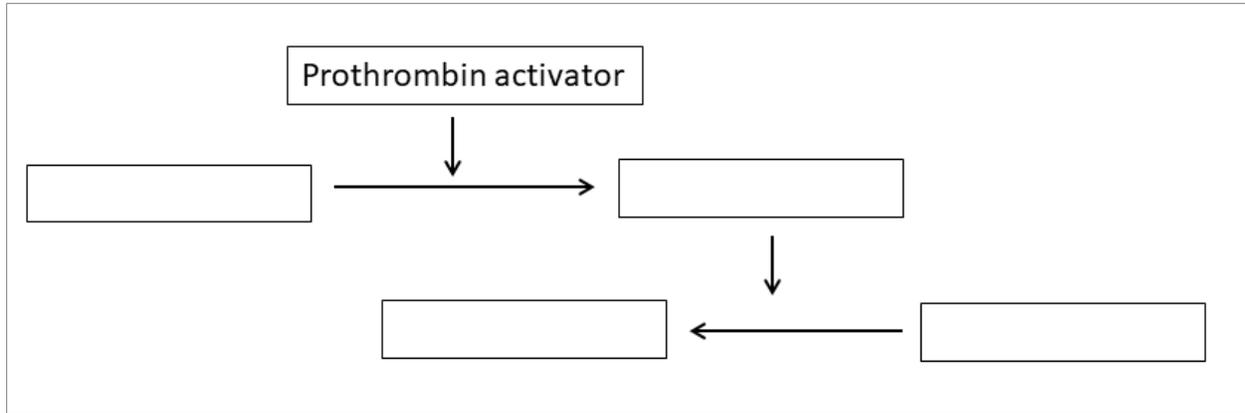
12. Tissue factor is the main factor to initiate the \_\_\_\_\_.

13. The ion important for various steps of blood clotting is \_\_\_\_\_,

14. Division of smooth muscle cells and fibroblasts during the healing stage is promoted by \_\_\_\_\_.

15. Enzymatic breakdown of fibrin is called \_\_\_\_\_.

16. Complete the diagram of stage 2 and 3 of blood coagulation.

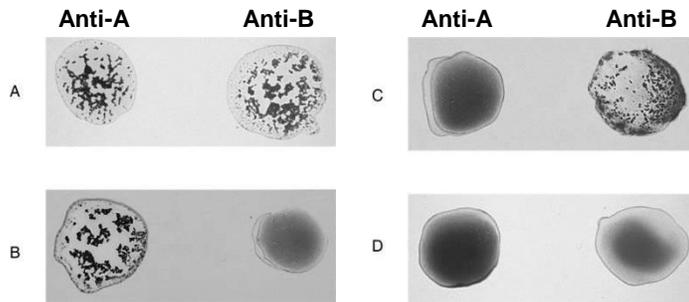


17. The most important of the more than 30 blood groups are the \_\_\_\_\_.

18. Rh incompatibility between mother and child is only possible if the mother is \_\_\_\_\_.

### Apply your knowledge

- How many RBCs need to be replaced each day in a person with 5L of blood?
- You are working in the orthopedic department in a hospital. A patient, who was admitted three days ago, has a reticulocyte index (RI) of 3.3. Can you think of a condition that explains this RI?
- A cyclist is suspected of using performance enhancing drugs (PEDs). A blood sample taken after a race has the following values: Hb 20 g/100 mL, HCT 60, WBC count 9,400/ $\mu$ L. Do you think these values could indicate PED usage? Which PED could have been abused?
- Would a hematocrit of 48 and an Hb of 16 be normal or abnormal for a woman and a man?
- A white blood count comes back as 10,500/ $\mu$ L with 60% neutrophils, 25% lymphocytes, 11% monocytes, 3% eosinophils, and 1% basophils. You suspected your patient may have a tapeworm disease. Do these numbers confirm your suspicion? Why or why not?
- A patient with blood group B<sup>+</sup> needs a whole blood transfusion. Which blood group(s) could you use? Which one would be the better match compared to the other(s) and why?
- You've been told that you can receive blood from donors with blood group A<sup>-</sup> and O<sup>-</sup>. What is your blood group?
- Why can we use substances that block Ca<sup>2+</sup>, such as EDTA, to stop donated blood from clotting?



9. What blood group would a patient with above blood typing results have? Explain your answer.
10. People with impaired liver function, for example, in chronic hepatitis or alcohol abuse, often suffer from spontaneous internal bleeding without a known cause. What could be the reason for their bleeding predisposition?

### Hematocrit/Hemoglobin Measurement Activity

Read and follow the instructions carefully. We use expensive scientific equipment. Any student causing damage to equipment used during this or any other lab activity may be held responsible.

**This activity uses human blood and you must protect yourself from contracting a blood-borne infectious disease by wearing gloves.** Make sure to dispose of any blood-stained materials in the biohazard container provided. Any sharps such as the lancets used have to go into the sharps container not the biohazard container. If a blood spill occurs, clean up the area using wet paper towels and 10% bleach.

#### Hematocrit

This activity uses heparinized capillary tubes and a microhematocrit centrifuge. Please make sure to read and follow the instructions carefully. The centrifuge has to be balanced in order to avoid damage.

#### Supplies per group (max. 4 students)

- Capillary tubes (1 per student)
- Alcohol wipes
- Safety lancets (1 per student)
- Sealing clay
- Magnifying glass

1. Clean a fingertip with an alcohol wipe and lance it with a new safety lancet.
2. Touch the end of the capillary tube to the blood and hold the tube at a downward angle. Take care not to get air into the tube while it is filling up with blood.
3. Fill the tube about 2/3 to 3/4 if possible.
4. Hold a finger over the end of the tube so blood cannot drain out. Push the blood end of the tube into the sealing clay with a twisting motion to seal the end. Pull it out carefully using a twisting motion again.
5. Place the sealed tube in the centrifuge with the sealed end on the rubber gasket pointing outward and away from the center.
6. Write down the groove number for you tube.





## Chapter 20 Lymphatic System & Immunity

### Complete the following sentences

1. The two tasks of the lymphatic system are to return \_\_\_\_\_ fluid left behind from bulk flow and to provide the structural basis for the \_\_\_\_\_ system.
2. Specialized \_\_\_\_\_ that drain the fluid from the intestinal mucosa are called \_\_\_\_\_.
3. The \_\_\_\_\_ duct carries the lymph from the \_\_\_\_\_ body and the \_\_\_\_\_ side of the \_\_\_\_\_ body to the \_\_\_\_\_.
4. The lymph of the \_\_\_\_\_ arm and the \_\_\_\_\_ side of the head and thorax is drained by the \_\_\_\_\_.
5. \_\_\_\_\_ tissues are scattered through all organs; \_\_\_\_\_, however, are solid, spherical bodies of tightly packed reticular elements and cells.
6. Lymphoid follicles found in the mucosa are collectively called \_\_\_\_\_ or \_\_\_\_\_.
7. The immune system has two intrinsic systems: a \_\_\_\_\_ or \_\_\_\_\_ defense and \_\_\_\_\_ or \_\_\_\_\_ defense.
8. The cardinal signs of an acute \_\_\_\_\_ are \_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_, and \_\_\_\_\_.
9. The two major groups of antimicrobial proteins are \_\_\_\_\_ and \_\_\_\_\_.
10. \_\_\_\_\_ is a systemic response caused by substances called \_\_\_\_\_ that reset the body's thermostat \_\_\_\_\_.

### Review your knowledge

1. Define 'immunity': \_\_\_\_\_
2. The first encounter between an antigen and a naive immunocompetent lymphocyte is called \_\_\_\_\_.
3. The first line of defense consists of \_\_\_\_\_.
4. The classic pathway of complement activation is started by \_\_\_\_\_.

complexes.

5. Our body considers foreign proteins and cells as \_\_\_\_\_.
6. The simplest lymphoid organs are the \_\_\_\_\_.
7. The largest lymphoid organ of the body is the \_\_\_\_\_.
8. Complement activation leads to the formation of the \_\_\_\_\_.
9. Covering foreign cells with a substance that attracts phagocytes is called \_\_\_\_\_.
10. The major self-antigens of our body are \_\_\_\_\_.
11. The chemical substances released by cells that are crucial for the growth and activity of immune cells are called \_\_\_\_\_.
12. Movement of a cell toward a chemical signal is called \_\_\_\_\_.
13. White blood cell can slip out of capillaries via \_\_\_\_\_.
14. Complete following table by adding the name of the correct cell(s).

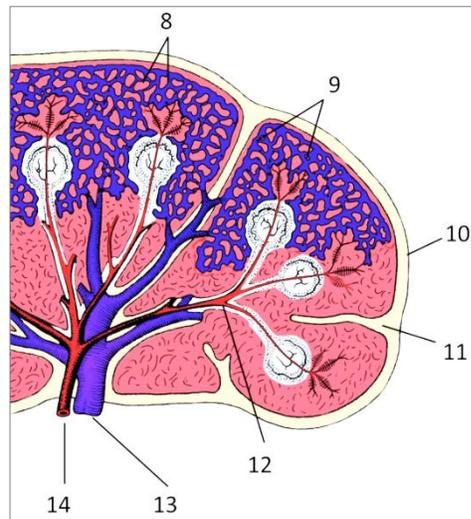
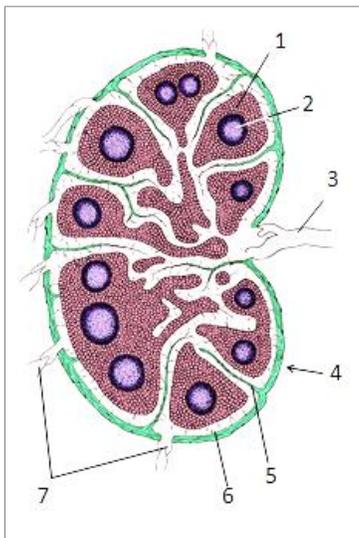
Description	Cell(s)
Provide defense against intracellular antigens	
Display class I and class II MHC proteins	
Become phagocytic on encountering infectious material, especially bacteria	
Phagocytic cells that are permanent residents of some organs	
Have granules containing histamine and are found outside the blood	
Roam the body looking for cells that don't have self-antigens	
Use lysosomal enzymes to destroy ingested material	
Graduate from the thymus	
Epidermal cells that present fragments of antigens T cells	
Antibody factories	
Backbone of active humoral immunity	
Turn into helper T cells when activated	
Seek out cells with changed class I MHC	
The most important immune cells	
Produce the reticular connective tissue that forms the skeleton of lymphoid organs	
Attracted to cell debris covered in C3b	
Activated by floating non-self-antigens	

15. Match the classes of antibodies (IgM, IgA, IgD, IgG, IgE) to the list of definitions/properties.

Description	Antibody class
Active in some allergies and parasitic infections	
First antibody released	
Found in mucus and other secretions	
Crosses the placental barrier	
Helps prevent entry of pathogens into body	
75–85% of antibodies in plasma	
Readily fixes and activates complement	
Potent agglutinating agent	
Released in secondary and late primary responses	
Causes mast cells and basophils to release histamine	

16. Complete following table by adding the name of the correct tissue graft.

Description	Tissue graft
Tissue transferred from a pig to a human	
Tissue transferred between identical twins	
Tissue transferred from a patient's leg to his chest	
Tissue transferred from a dad to his daughter	



17. Match the following structures to the labels on above diagrams:

- |                            |       |                   |       |
|----------------------------|-------|-------------------|-------|
| Germinal center            | _____ | Venous sinuses    | _____ |
| Splenic capsule            | _____ | Subcapsular sinus | _____ |
| Afferent lymphatic vessels | _____ | Splenic vein      | _____ |
| Central artery             | _____ | Lymphoid follicle | _____ |

### Apply your knowledge

1. Epidermal dendritic cells are an important group of antigen-presenting cells. Which property enables them to present antigens to T cells that are found inside lymph nodes?
2. Why are lymph nodes the most likely place for a first exposure to a foreign antigen?
3. You feel like you are getting a cold or strep throat before you go to bed at night. To your surprise, you are feeling better the next morning and by noon all symptoms are gone. What could account for this unexpected outcome?
4. Why do people who are born without a thymus die within a few years from infections?
5. What do people suffering from AIDS have in common with people born without a thymus?
6. What is odd about the fact that NK cells are granular lymphocytes?
7. A documentary about a man removing snakes from people's houses mentions that he has been hospitalized a number of times after he received antitoxins against snake bites. What could be the reason for his hospitalization if he already received the antitoxin?
8. Vaccine A protects against infection with a pathogen, but vaccinated people can still spread the pathogen that grows in their small intestinal mucosa. Vaccine B protects against the pathogen and stops it from establishing itself in the intestinal mucosa. What could be the cause of this difference between vaccine A and B?
9. Eye surgeons can restore the eyesight of people with damaged corneas by cutting out the cornea and replacing it with the cornea of a deceased person. Why does this transplant not lead to a rejection reaction?
10. Donating a kidney to your younger sister would be what type of transplant? Which cells in your sister's body would try to destroy the donated kidney because of the different MHC antigens?

### Blood Typing Activity

This activity uses human blood and you must protect yourself from contracting a blood-borne infectious disease by wearing gloves. Make sure to dispose of any blood-stained materials in the biohazard container provided. Any sharps used, such as the lancets, have to go into the sharps container not the biohazard container. If a blood spill occurs clean up the area using wet paper towels and 10% bleach.

#### Supplies per group (max. 4 students)

Blood typing plate (1 per student)

Alcohol wipes

Safety lancets (1 per student)

Anti-A serum

Anti-B serum

Rh serum

Tooth picks

1. Clean a fingertip (index, middle, or ring finger) with an alcohol wipe.
2. Using your thumb, lightly press the finger from the top of the knuckle towards the tip.
3. While applying light pressure towards the fingertip puncture the finger using a new safety lancet.
4. Gently squeeze 1-2 drops of blood into each of the depressions of the blood typing plate.
5. Add 1 drop of **Anti-A serum** to the blood in the depression marked with "A". Using a new toothpick mix the blood with the antiserum.
6. Add 1 drop of **Anti-B serum** to the blood in the depression marked with "B". Using a new toothpick mix the blood with the antiserum.
7. Add 1 drop of **Rh serum** to the blood in the depression marked with "Rh". Using a new toothpick mix the blood with the antiserum.
8. Wait 1 – 2 minutes and observe each sample for agglutination or evidence of clumping.
9. Record your observations in the table.
10. Dispose of the blood typing plates and toothpicks by putting them into the biohazard container. Used lancets go into the sharps container.

Depression	Agglutination/clumping observed (+)	Agglutination/clumping not observed (-)
<b>A</b>		
<b>B</b>		
<b>Rh</b>		

Your blood group: \_\_\_\_\_



## Chapter 21 Respiratory System

### Part 1 Anatomy of the Respiratory Tract and Pulmonary Ventilation

#### Complete the following sentences

1. Respiration involves two systems, the \_\_\_\_\_ system and the \_\_\_\_\_ system.
2. The conducting zone consists of: \_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_, and \_\_\_\_\_ bronchioles.
3. The \_\_\_\_\_ zone is the site of the gas exchange.
4. In clinical terms, the airways are subdivided into \_\_\_\_\_ and \_\_\_\_\_ airways.
5. The larynx skeleton has two big cartilages: an upper shield-shaped \_\_\_\_\_ cartilage with the \_\_\_\_\_ process that forms the so-called \_\_\_\_\_ in men, and the lower ring-shaped \_\_\_\_\_ cartilage.
6. The right lung has \_\_\_\_\_ lobes called \_\_\_\_\_, \_\_\_\_\_, and \_\_\_\_\_ lobe; the left lung is smaller (\_\_\_\_\_ lobes) because it has to mold around the \_\_\_\_\_.
7. Moving \_\_\_\_\_ into and out of the lungs is called \_\_\_\_\_ or \_\_\_\_\_.
8. The pressure inside the airways is called \_\_\_\_\_ pressure; it is described relative to the \_\_\_\_\_ pressure.
9. The relationship between \_\_\_\_\_ and \_\_\_\_\_ of a gas in a closed container is described in \_\_\_\_\_ law.
10. Inspiration is always an \_\_\_\_\_ process, whereas expiration can be a \_\_\_\_\_ or \_\_\_\_\_ process.

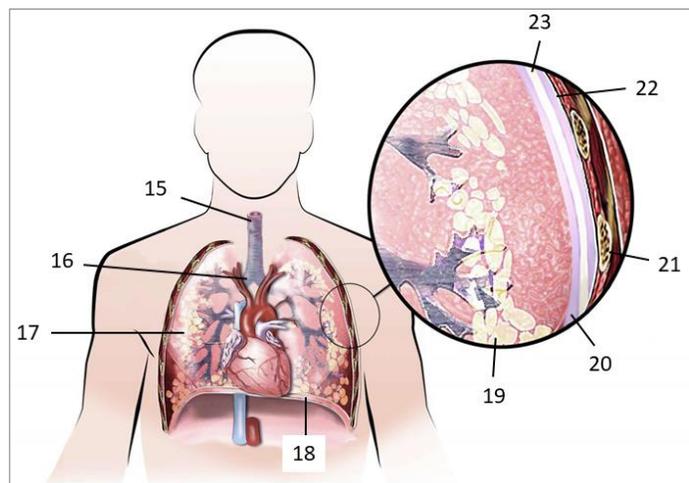
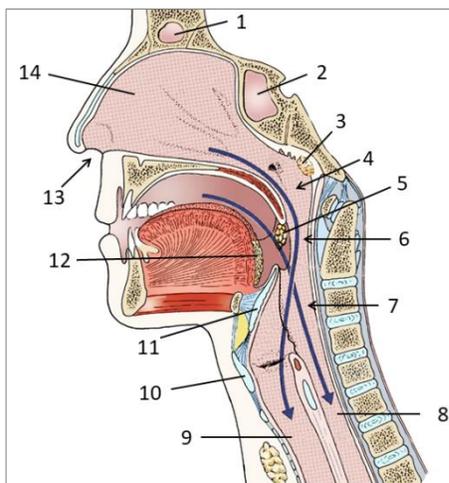
#### Review your knowledge

1. Define 'dead space': \_\_\_\_\_
2. Cleaning, warming, and moisturizing dry air is the main job of the \_\_\_\_\_.
3. Hairs growing in the nasal vestibule are called \_\_\_\_\_.
4. There are paranasal sinuses in four skull bones: \_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_, and \_\_\_\_\_ sinus.

5. Complete the following table.

Part(s) of the pharynx or larynx	Description
Nasopharynx	_____ to the nasal cavity.
	Passageway for food and air.
	Made of elastic cartilage.
Glottis	
	Posterior to the upright epiglottis.
Nasopharynx	_____ tonsil on posterior wall.
Nasopharynx	Passageway for _____ only.
	Pharyngotympanic tube opens into the lateral walls.
Thyroid cartilage	
	Posterior to the isthmus of the fauces.
	Also called false vocal cords.

- Because it is the major organ for voice production, the larynx is also called \_\_\_\_\_.
- The last tracheal cartilage is called \_\_\_\_\_.
- The first bronchi are called \_\_\_\_\_ or \_\_\_\_\_.
- Respiratory bronchioles are the first part of the \_\_\_\_\_ zone.
- The microscopic structure allowing the diffusion of gases is the respiratory \_\_\_\_\_.



Use above diagrams to answer the following questions.

- The lungs are covered by a serous membrane. The \_\_\_\_\_ (labeled # \_\_\_\_\_) covers the thoracic wall and the \_\_\_\_\_ (labeled # \_\_\_\_\_) covers all external lung surfaces.
- The paranasal sinus in the frontal bone is called \_\_\_\_\_. It is labeled # \_\_\_\_\_.

13. The lowest part of the pharynx is the \_\_\_\_\_. It is labeled # \_\_\_\_\_.
14. The major muscle for inspiration is the \_\_\_\_\_. It is labeled # \_\_\_\_\_.
15. Match the following structures to the labels on above diagrams:

Epiglottis	_____	Pharyngeal tonsil	_____
Right lung	_____	Carina	_____
Pleural cavity	_____	Alveolus	_____
Thyroid cartilage	_____	Esophagus	_____

16. Complete the table by adding the correct pressure of lung volume or capacity.

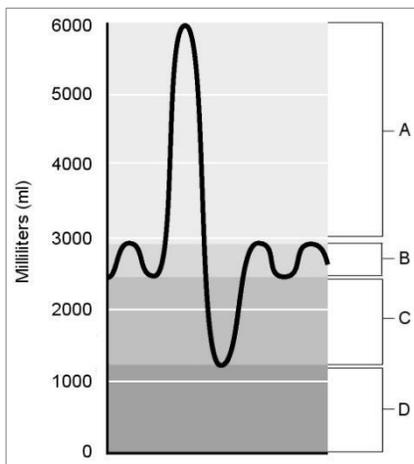
Description	Pressure or lung volume/capacity
Pressure exerted by the air surrounding the body	
Amount of air inhaled or exhaled with each breath under resting conditions	
Pressure inside the airways	
Maximum amount of air contained in lungs after a maximum inspiratory effort	
Pressure inside the lungs or alveoli	
Amount of air remaining in the lungs after forced exhalation	
Difference between intrapulmonary and intrapleural pressure	
Maximum amount of air that can be expired after a maximum inspiratory effort	
Pressure inside the pleural cavity	

17. The sum of anatomical and alveolar dead space is known as \_\_\_\_\_.
18. In a healthy young patient, the total dead space is approx. \_\_\_\_\_ ml.
19. The average amount of air flowing into and out of the airways with each breath is approx. \_\_\_\_\_ ml.
20. The amount of air flowing into and out of the alveoli during a particular time is called \_\_\_\_\_.

**Apply your knowledge**

1. Why do you think is it important that the respiratory mucosa of the nose is ciliated?
2. Why is external respiration called “external” when it actually happens deep inside our lungs?
3. Can you think of an application of Boyle’s law other than pulmonary ventilation?

4. Why does a lower respiratory tract infection, such as bronchitis, make it more difficult to breathe in and out?
5. Why do women have smaller lung volumes and capacities, other than tidal volume, than men?
6. What could explain why even healthy older people have a lower vital capacity than young people?
7. Student A has a tidal volume of 300 ml and a respiratory rate of 30, and student B a tidal volume of 600 ml and a respiratory rate of 15. Compare their minute ventilation and alveolar ventilation rate.
8. What effect would the loss of one lung have on tidal volume, breathing rate, and minute volume at rest?

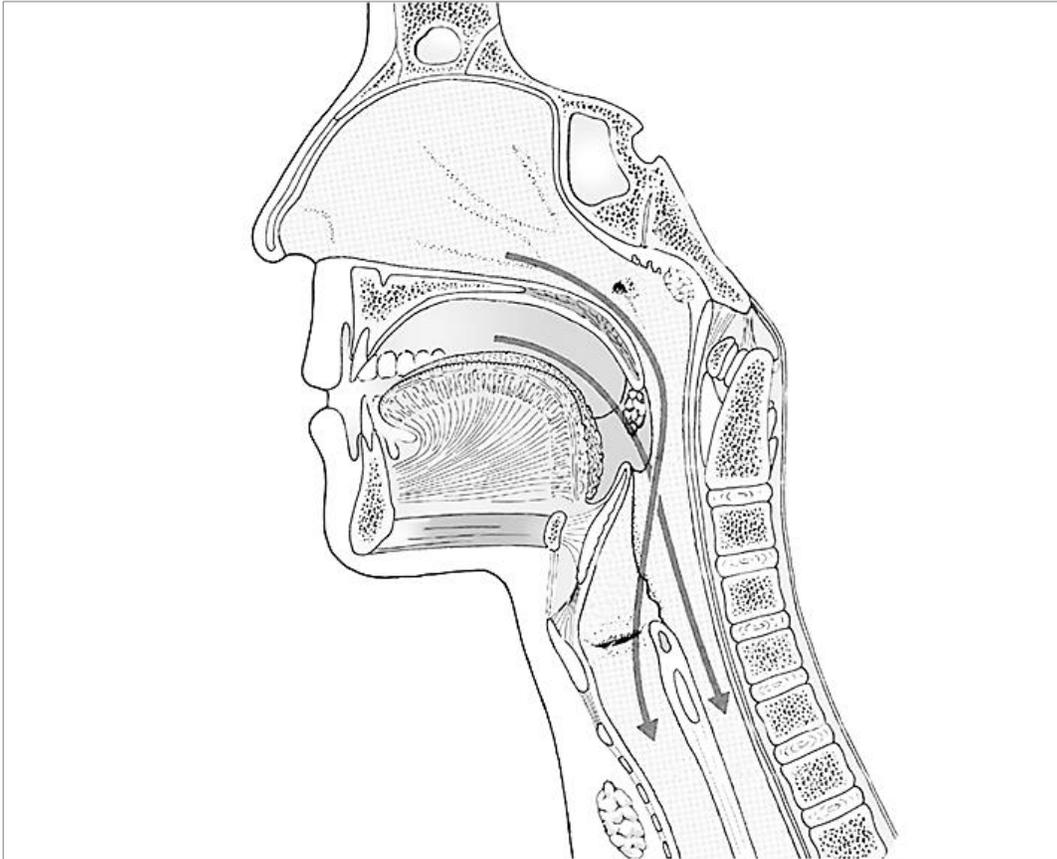


9. The amount of air inhaled and exhaled during a normal breath is called \_\_\_\_\_. It is indicated by letter \_\_\_\_.
10. The amount of air that remains in the lung after maximal exhalation is called \_\_\_\_\_. It is indicated by letter \_\_\_\_.

**Coloring fun**

Locate, color, and label the parts of the upper airways.

- Trachea
- Thyroid cartilage
- Epiglottis
- Tongue
- Lingual tonsil
- Nasal cavity
- Frontal sinus
- Ethmoid sinus
- Pharyngeal tonsil
- Palatine tonsil
- Nasopharynx
- Oropharynx
- Laryngopharynx
- Esophagus

**Part 2 External and Internal Respiration & Gas Transport****Complete the following sentences**

1. Gas exchange between the lungs and the blood is called \_\_\_\_\_ respiration, and gas exchange between the blood and the surrounding tissues is called \_\_\_\_\_ respiration.
2. External and internal respiration are based on \_\_\_\_\_ of gases along a concentration \_\_\_\_\_ from an area with a \_\_\_\_\_ concentration to an area with a \_\_\_\_\_ concentration.
3. \_\_\_\_\_ law of \_\_\_\_\_ pressure states that the \_\_\_\_\_ pressure exerted by a mixture of gases is the \_\_\_\_\_ of the pressures exerted by each gas.

- \_\_\_\_\_ law states that if a mixture of gases is in contact with a \_\_\_\_\_, each gas will dissolve in the \_\_\_\_\_ in proportion to its \_\_\_\_\_ pressure.
- Carbon dioxide is \_\_\_\_\_ times more soluble in water than \_\_\_\_\_.
- Alveolar gas has a different composition than \_\_\_\_\_ air; the  $P_{O_2}$  is \_\_\_\_\_, but the  $P_{CO_2}$  is \_\_\_\_\_ as is the  $P_{H_2O}$ .
- Loading of \_\_\_\_\_ with  $O_2$  is called \_\_\_\_\_; it leads to the formation of bright red \_\_\_\_\_ or \_\_\_\_\_.
- Because the \_\_\_\_\_ - \_\_\_\_\_ dissociation curve is S-shaped, hemoglobin is almost completely \_\_\_\_\_ with oxygen at a  $P_{O_2}$  of 70 mmHg.
- Carbon dioxide is mainly transported as \_\_\_\_\_ ions in plasma (\_\_\_\_%) and \_\_\_\_\_ in plasma (\_\_\_\_%).
- The partial pressure of \_\_\_\_\_ in arterial system blood is more important for the control of respiration than the partial pressure of \_\_\_\_\_.

### Review your knowledge

- Explain 'ventilation-perfusion coupling': \_\_\_\_\_  
\_\_\_\_\_
- The partial pressure gradient for oxygen between alveoli and blood is approximately \_\_\_\_\_ mm Hg.
- In systemic arterial blood, the  $P_{O_2}$  is \_\_\_\_\_ mm Hg.
- The partial pressure gradient for oxygen between blood and tissues is approximately \_\_\_\_\_ mm Hg.
- Bronchioles dilate where the alveolar  $P_{CO_2}$  is \_\_\_\_\_.
- Pulmonary arterioles carry blood to areas where the alveolar  $P_{O_2}$  is \_\_\_\_\_.
- The iron-containing pigment part of hemoglobin is called \_\_\_\_\_.
- Hemoglobin carrying four molecules of oxygen is \_\_\_\_\_.
- Factors other than  $P_{O_2}$  that affect hemoglobin's affinity to oxygen are \_\_\_\_\_, \_\_\_\_\_, and \_\_\_\_\_.
- The weakening of the Hb-oxygen bond caused by a decline in pH is called the \_\_\_\_\_.
- Under normal circumstances, arterial blood has an oxygen saturation of about \_\_\_\_\_%.

12. Carbon dioxide combines with water to form \_\_\_\_\_.
13. The enzyme in erythrocytes that catalyzes the formation of carbonic acid is called \_\_\_\_\_.
14. The exchange of bicarbonate and chloride ions between erythrocytes and plasma is called \_\_\_\_\_.
15. Breathing depth and rate can be influenced by higher brain centers, such as the \_\_\_\_\_.

### Apply your knowledge

1. Can you think of an everyday application for CO<sub>2</sub> being more soluble than O<sub>2</sub>?
2. Why is the P<sub>CO2</sub> of the air in the upper airways lower than the P<sub>CO2</sub> of alveolar air?
3. You are sitting in a sauna when someone comes in and pours a lot of water on the steamer. The room immediately starts filling up with steam. You start feeling like you can't get enough air into your lungs and you need to step outside. Why did you feel short of breath when the air in the sauna was filled with steam?
4. If a person hyperventilates, what will happen to the P<sub>CO2</sub> and the pH of the blood?
5. Planet AnP has a total atmospheric pressure of 900 mmHg. Oxygen makes up 30% of the atmosphere and CO<sub>2</sub> 5%. What is the partial pressure for each?
  - a) P<sub>O2</sub>:            mmHg
  - b) P<sub>CO2</sub>:            mmHg
6. If the atmospheric pressure on planet AnP increased to 1200 mmHg, what would the partial pressures then be for each gas?
  - a) P<sub>O2</sub>:            mmHg
  - b) P<sub>CO2</sub>:            mmHg
7. Why do people with congestive heart failure and pulmonary edema usually sleep sitting up?
8. Why do people with anemia complain about being tired and being unable to be physically active?
9. Why is the respiratory rate increased in people with fever?
10. Even very low concentrations of carbon monoxide in the air we breathe can lead to death because it accumulates in the blood and blocks the hemoglobin from transporting oxygen. Can you think of an explanation for this toxicity?



## Chapter 22 Digestive System

### Complete the following sentences

1. The \_\_\_\_\_ canal, also called \_\_\_\_\_ or \_\_\_\_\_ tract, digests and absorbs food.
2. Most digestive organs are located inside a subdivision of the \_\_\_\_\_ cavity called \_\_\_\_\_ cavity, which is lined by the \_\_\_\_\_.
3. All organs of the GI tract have four basic layers or \_\_\_\_\_: \_\_\_\_\_ (innermost layer), \_\_\_\_\_, \_\_\_\_\_, and \_\_\_\_\_.
4. As one of the older systems of our body, the digestive system relies heavily on \_\_\_\_\_ for \_\_\_\_\_.
5. The first, voluntary phase of swallowing is the \_\_\_\_\_ phase and the second, involuntary phase the \_\_\_\_\_ phase.
6. The digestive function of the liver is to produce \_\_\_\_\_, its main metabolic function is \_\_\_\_\_.
7. The \_\_\_\_\_ receives preliminary bile from the liver via the \_\_\_\_\_ and secretes bile into the \_\_\_\_\_ via the \_\_\_\_\_.
8. The first enzyme to start food digestion is \_\_\_\_\_ released by \_\_\_\_\_ glands into the \_\_\_\_\_ cavity; it targets complex \_\_\_\_\_ also known as \_\_\_\_\_.
9. The period during and shortly after eating, the \_\_\_\_\_ or \_\_\_\_\_ state, is regulated by \_\_\_\_\_, a hormone released by \_\_\_\_\_ cells of the \_\_\_\_\_.
10. Cholesterol is a major component of plasma \_\_\_\_\_, \_\_\_\_\_ hormones, and vitamin \_\_\_\_\_.

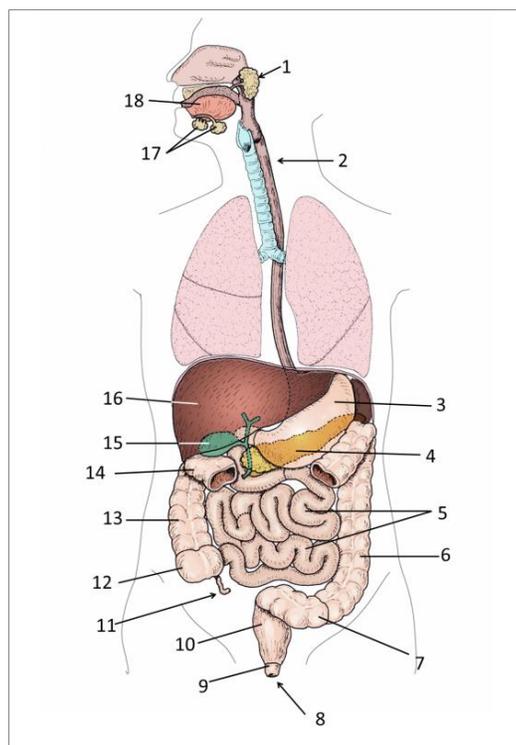
### Review your knowledge

1. Define 'chemical digestion': \_\_\_\_\_.
2. Name the six activities of the digestive system: \_\_\_\_\_  
\_\_\_\_\_

3. Complete the table by adding which of the six essential functions of digestion are performed by the organs of the GI tract.

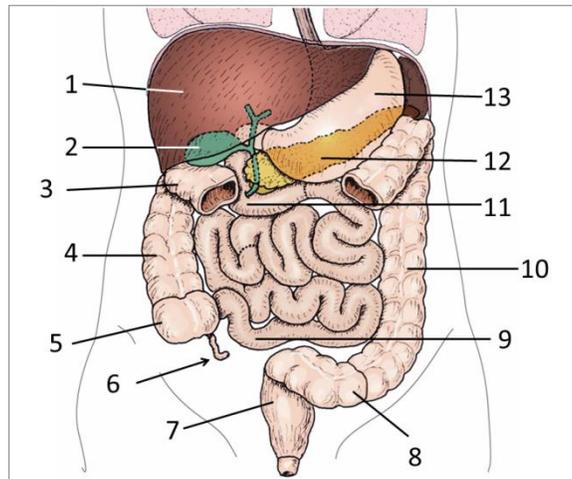
Organ(s)	Digestive function(s)
Mouth	
Pharynx	
Esophagus	
Stomach	
Small intestine	
Large intestine	

4. The muscle layers of the GI tract that produce peristaltic movement are regulated by \_\_\_\_\_  
\_\_\_\_\_.
5. The cells producing paracrines and hormones in the stomach and small intestine are \_\_\_\_\_  
cells.
6. Parasympathetic signals to the digestive organs are carried by the \_\_\_\_\_ nerve.
7. The reflex that regulates gastric emptying into the duodenum is the \_\_\_\_\_ reflex.
8. The teeth used for grinding or crushing food are the \_\_\_\_\_ and \_\_\_\_\_.
9. The salivary glands located outside the oral cavity are called \_\_\_\_\_ salivary glands.
10. The sphincter regulating inflow into the stomach is the \_\_\_\_\_ sphincter.



Use the diagram to answer the following questions.

11. The first part of the large intestine is called \_\_\_\_\_. It is labeled # \_\_\_\_\_.
12. The \_\_\_\_\_ produces enzymes to break down all food groups. It is labeled # \_\_\_\_\_.
13. The \_\_\_\_\_ connects pharynx and stomach. It is labeled # \_\_\_\_\_.
14. The biggest salivary gland is the \_\_\_\_\_ gland. It is labeled # \_\_\_\_\_.
15. Bile is produced in the \_\_\_\_\_ (labeled # \_\_\_\_\_) and stored in the \_\_\_\_\_ (labeled # \_\_\_\_\_).
16. The last straight part of the large intestine is called \_\_\_\_\_. It is labeled # \_\_\_\_\_.
17. The \_\_\_\_\_ initiates swallowing. It is labeled # \_\_\_\_\_.
18. The major organ for nutrient absorption is the \_\_\_\_\_. It is labeled # \_\_\_\_\_.



19. Match the following structures to the labels on above diagram.

- |                      |       |               |       |
|----------------------|-------|---------------|-------|
| Stomach              | _____ | Sigmoid colon | _____ |
| Descending colon     | _____ | Duodenum      | _____ |
| Ileum                | _____ | Pancreas      | _____ |
| Appendix vermiformis | _____ | Rectum        | _____ |
| Transverse colon     | _____ | Gallbladder   | _____ |

20. Complete following table by adding the name of the correct hormone or enzyme(s).

Description	Hormone or enzyme(s)
Causes increased HCl secretion and stimulates gastric emptying	
Breaks down flour in the mouth	
Causes increased bile production and release from the liver	

Causes contraction of the gallbladder and relaxation of the hepatopancreatic sphincter	
Starts protein digestion in the stomach	
Synthesized by enterocytes in the small intestine	
Released in response to acid chyme entering the duodenum	
Inhibits HCl production and stimulates insulin release	
Major hormone of the postabsorptive stage	
Breaks down disaccharides to monosaccharides	
Break down DNA and RNA	
Facilitated diffusion of glucose into muscle and adipose cells	

21. Secretion of gastric juice can be initiated by smelling food during the \_\_\_\_\_.
22. The most important substance produced by exocrine cells of the stomach is \_\_\_\_\_.
23. The stomach mucosa is protected from gastric acid and pepsin by the \_\_\_\_\_.
24. The paracrine released by enteroendocrine gastric cells that is important for the regulation of gastric acid production is \_\_\_\_\_.
25. The longitudinal muscle layer of the large intestine forms three bands called \_\_\_\_\_.
26. Most nutrients are absorbed using \_\_\_\_\_ transport.
27. As a rule, water-soluble nutrients are transported to the liver via the \_\_\_\_\_.
28. Nutrients, water and electrolytes are mostly absorbed in the \_\_\_\_\_.
29. Some vitamins can be produced by bacteria and be absorbed in the \_\_\_\_\_.

### Apply your knowledge

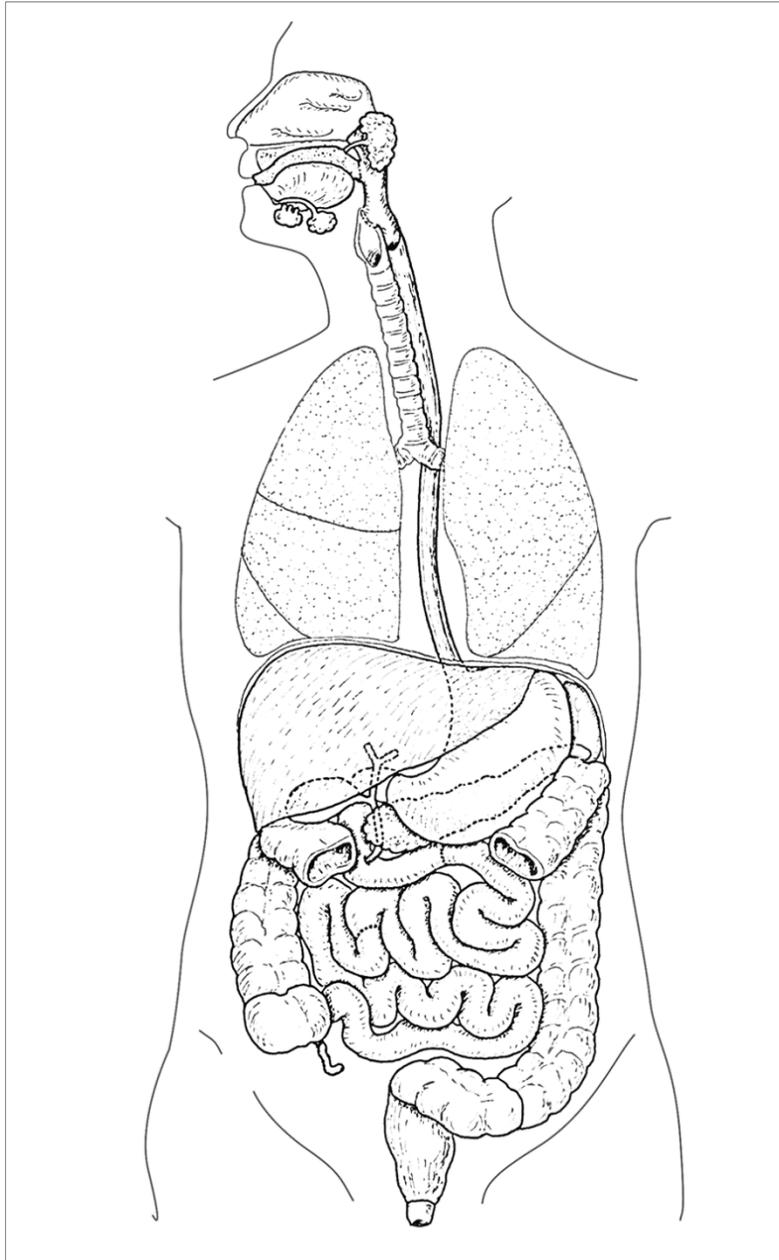
1. Why is swallowing a potentially life-threatening process?
2. Why does the esophagus have smooth muscle layers to actively move swallowed food and drinks down to the stomach? Why can't we just have a hollow tube, such as the trachea in the respiratory system?
3. Why do people who have to speak in public often develop a dry mouth (cotton mouth) and find it difficult to speak?
4. Why is rennin produced during early infancy only?

5. Secretin is sometimes called "nature's antacid". What is this label based on?
  
6. Why does the liver receive blood from the systemic circulation in addition to the blood coming in via the hepatic portal vein?
  
7. Why is pepsin released as an inactive proenzyme (pepsinogen) and has to be activated inside the stomach?
  
8. The small intestine can measure 14 feet more in length. Why does surgical removal of one third of its overall length cause nutritional problems when total removal of the colon doesn't?
  
9. Why does malabsorption lead to malnutrition?
  
10. Most bread types don't have much taste when eaten on their own. However, if you chew on a piece of bread for a couple of minutes it starts tasting sweet. What causes this change in taste?

### Coloring fun

Locate, color, and label the parts of the digestive system.

- Tongue
- Submandibular gland
- Sublingual gland
- Parotid gland
- Pharynx
- Esophagus
- Stomach
- Spleen
- Small intestine
- Liver
- Gallbladder
- Pancreas
- Appendix vermiformis
- Cecum
- Colon
- Sigmoid colon
- Rectum
- Anal canal



## Chapter 23 Urinary System

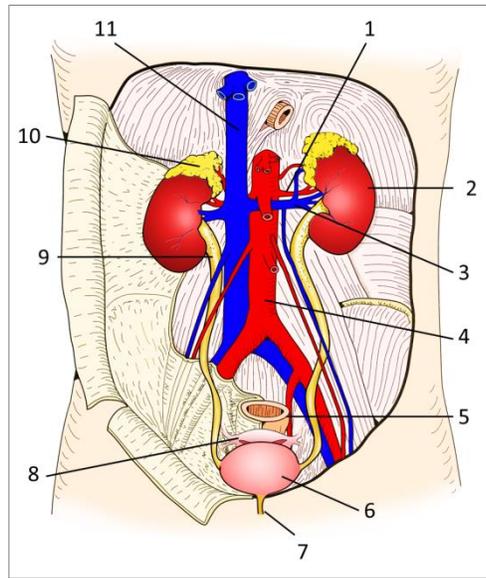
### Complete the following sentences

1. The urinary system consists of \_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_, and urethra.
2. Almost all physiologic functions of the urinary tract are taken over by the \_\_\_\_\_.
3. The kidneys are located \_\_\_\_\_ in the \_\_\_\_\_ lumbar region.
4. A \_\_\_\_\_ is the structural and functional unit that forms the urine.
5. Urine drips out of the tips of the renal \_\_\_\_\_ into cup-shaped structures called \_\_\_\_\_ that combine to form \_\_\_\_\_, which then form the renal \_\_\_\_\_.
6. The \_\_\_\_\_ transport urine from the kidneys to the \_\_\_\_\_.
7. The urethra has two sphincters: an involuntary \_\_\_\_\_ sphincter at the bladder-urethra junction and a voluntary \_\_\_\_\_ sphincter that surrounds the urethra.
8. The kidneys produce approximately \_\_\_\_\_ l filtrate per day, which is reduced to \_\_\_\_\_ l of urine.
9. Most reabsorption of water and electrolytes happens in the \_\_\_\_\_ tubule.
10. Facultative reabsorption is controlled by hormones, \_\_\_\_\_ for water and \_\_\_\_\_ for sodium.

### Review your knowledge

1. Define 'glomerular filtration rate': \_\_\_\_\_
2. The kidneys are located at the back of the abdominal cavity in the \_\_\_\_\_.
3. The kidneys have to maintain the plasma osmolality at the normal level of \_\_\_\_\_ mOsm.
4. The glomerulus together with the glomerular capsule forms a so-called \_\_\_\_\_.
5. Most nephrons are located in the \_\_\_\_\_.
6. Juxtamedullary nephrons have long \_\_\_\_\_.
7. A passive movement of a solute or solution through a porous membrane caused by a pressure difference is known as \_\_\_\_\_.

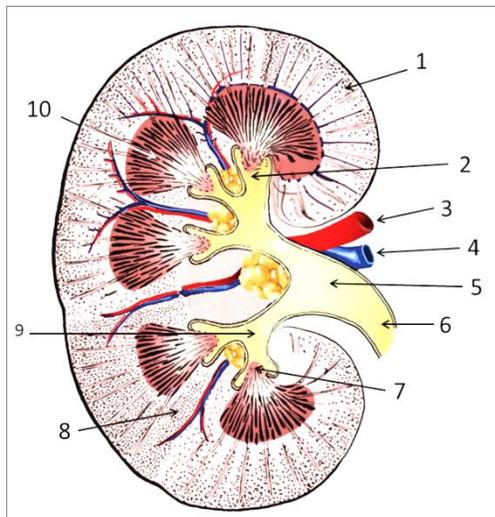
8. The odor of urine should be \_\_\_\_\_.



9. Match the following structures to the labels on above diagram:

Abdominal aorta	_____	Adrenal gland	_____
Urethra	_____	Inferior vena cava	_____
Uterus	_____	Bladder	_____
Ureter	_____	Renal artery	_____
Renal vein	_____	Rectum	_____

Use the diagram to complete the following statements.



10. The outer region of the kidney is called \_\_\_\_\_.

It is labeled # \_\_\_\_.

11. The renal \_\_\_\_\_ (labeled # \_\_\_\_.) goes over

into the \_\_\_\_\_ (labeled # \_\_\_\_).

12. Long loops of Henle are found in the \_\_\_\_\_.

One it labeled as # \_\_\_\_.

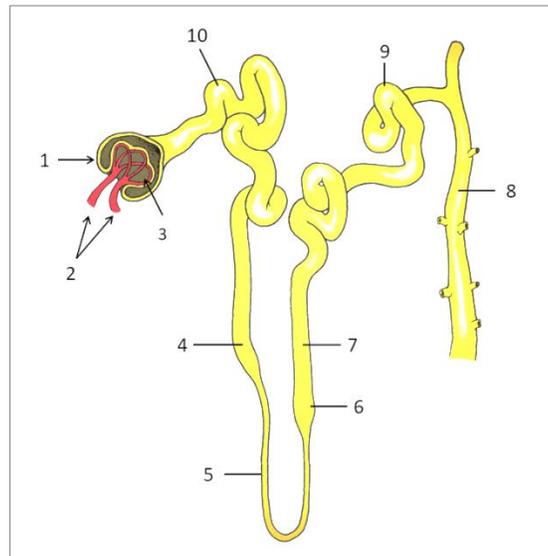
13. Blood vessels make their way to the cortex-medulla junction

via \_\_\_\_\_. One is labeled as # \_\_\_\_.

14. Granular cells of the JGA react to changes in \_\_\_\_\_.

15. Macula densa cells measure the NaCl concentration of the \_\_\_\_\_.

16. The NaCl concentration of the filtrate is used to regulate the \_\_\_\_\_.
17. Intercalated cells of the collecting duct are important for \_\_\_\_\_.
18. Selective addition of substances into the filtrate is called \_\_\_\_\_.
19. The volume of plasma cleared of a particular substance in a given time is known as \_\_\_\_\_.
20. The number of carriers available for secondary active transport for a specific substance determines the \_\_\_\_\_.
21. The filtrate arriving at the distal convoluted tubule is \_\_\_\_\_.
22. If we are dehydrated, the kidney produces a \_\_\_\_\_.



Use the diagram to answer the following questions.

23. Afferent and efferent arterioles (labeled # \_\_\_\_ ) form the so-called \_\_\_\_\_ (labeled # \_\_\_\_).
24. The \_\_\_\_\_ (labeled # \_\_\_\_ ) has \_\_\_\_\_ cells that respond to antidiuretic hormone.
25. The \_\_\_\_\_ of the Henle loop is freely permeable for water only. It is labeled # \_\_\_\_.
26. Complete the following table

Part of the urinary system	Description
	Collects urine dripping out of a papilla

	Voluntary control of urination
	Gland not found in women
	Mechanoreceptors for blood pressure
	Facultative reabsorption of water and electrolytes
	Obligatory reabsorption of electrolytes only
	Filtration of plasma minus proteins
	Reabsorption of nutrients
	Triangular area outlined by the openings for the ureters and the urethra
	Cells with foot-like extensions
	Temporary storage unit for urine

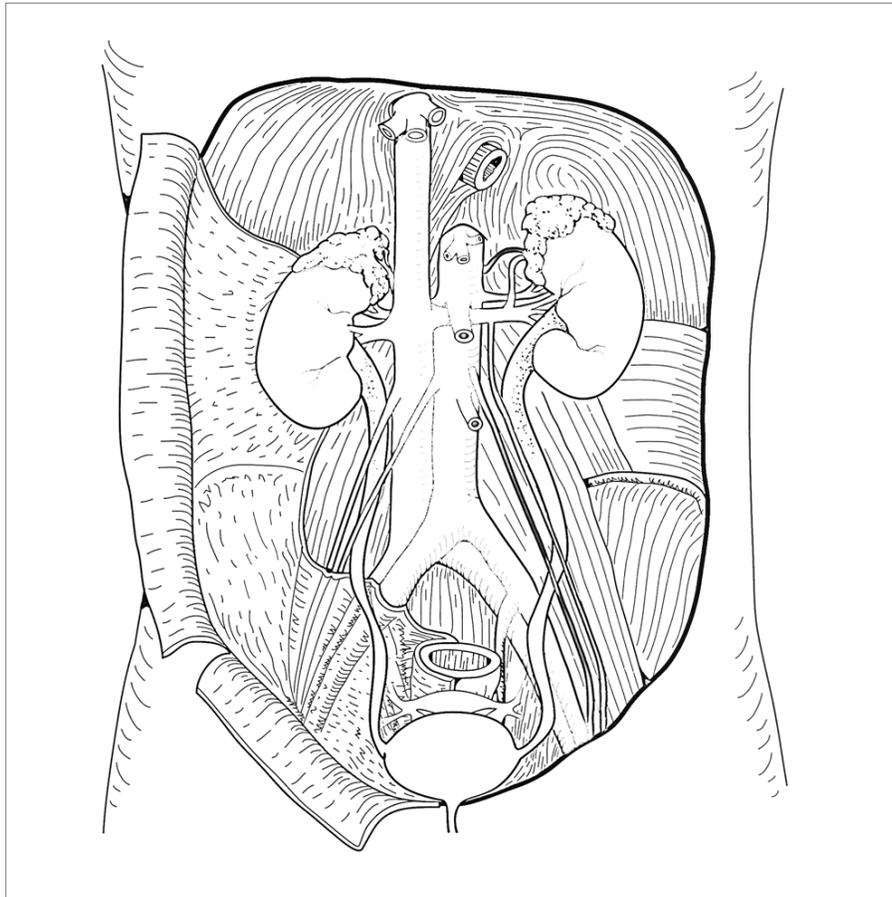
### Apply your knowledge

1. The  $T_m$  for amino acid A is 120 mg/100 ml and the concentration of that amino acid in the blood is 230 mg/100 ml. Will the amino acid be excreted in the urine? Why or why not?
2. How would the JG cells react if the renal artery became partially blocked with an impaired blood flow to the kidney?
3. Why are cortical nephrons not important for water conservation?
4. ACE inhibitors are popular drugs to treat hypertension. What do you think the mode of action for the drugs could be?
5. Why is the kidney more susceptible to low blood pressure than all other tissues but the brain?
6. What is a big difference between the urinary bladder and the gallbladder as far as their function is concerned?
7. Going back to the Frank-Starling law of bulk flow, what effect will it have if the kidney starts losing protein via the urine?
8. Why is it important that angiotensin II activates the thirst center in the hypothalamus?

### Coloring fun

Locate, color, and label the parts of the urinary system and retroperitoneum.

- Diaphragm
- Adrenal glands
- Kidneys
- Ureters
- Bladder
- Urethra
- Rectum
- Uterus
- Inferior vena cava
- Abdominal aorta
- Renal arteries
- Renal veins



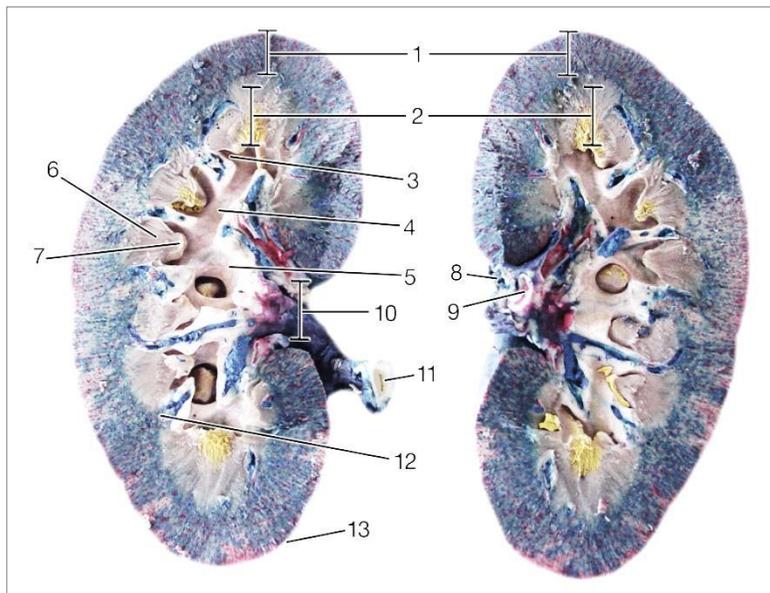
### Kidney Dissection Activity

- **The specimens we use contain traces of the fixative formalin (formaldehyde).**
- **Formalin residue or vapor may be irritating – avoid skin and eye contact. Do not ingest. Wear protective gloves and wash hands thoroughly after handling.**
  - **Skin contact:** Wash thoroughly with soap and water.
  - **Eye contact:** Flush with running water for 15 minutes. Report to lab instructor.
  - **Ingestion:** Seek medical attention. Report to lab instructor.

#### Supplies per group (max. 4 students)

- |                       |                              |
|-----------------------|------------------------------|
| 1 kidney              | 1 probe                      |
| 1 disposable scalpel  | 1 disposable dissection tray |
| 1 disposable tweezers | Protective gloves            |
| 1 pair of scissors    |                              |

1. Identify external structures, such as **hilum**, **ureter**, and **renal artery and vein**.
2. Using the disposable scalpel carefully cut the kidney along the frontal plane into anterior and posterior sections. Observe the cut surface. You should be able to identify **cortex**, **medulla**, **renal columns**, **renal pyramids**, **papillae**, **minor and major calyces**, and **renal pelvis**.
3. Because the arteries and veins have been injected with blue and red latex, you should be able to see **glomeruli** as blue and red dots in the cortex.
4. Complete the labeling on the labeling sheet. You're not finished with the activity until you have identified and labeled all structures!
5. Dispose of tissue, disposable dissection tray and tweezers, and protective gloves by putting them into the bio-hazard bin; the disposable scalpel goes into the sharps container. Place the scissors and probe into the tray provided. Clean the table surface using wet paper towels and 10% bleach. Wash your hands thoroughly with soap and water when you are done.
6. **You are not finished with the activity until you have identified and labeled all structures in the labeling exercise!**



- |          |           |
|----------|-----------|
| 1. _____ | 8. _____  |
| 2. _____ | 9. _____  |
| 3. _____ | 10. _____ |
| 4. _____ | 11. _____ |
| 5. _____ | 12. _____ |
| 6. _____ | 13. _____ |
| 7. _____ |           |

## Chapter 24 Fluid, Electrolyte, and Acid-Base Balance

### Complete the following sentences

1. Our body water content depends on our \_\_\_\_\_ and \_\_\_\_\_; men have \_\_\_\_\_% body water, women have \_\_\_\_\_%, and infants \_\_\_\_\_%.
2. \_\_\_\_\_ are substances that dissociate into positive and negative ions in water; positively charged ions are called \_\_\_\_\_ and negatively charged ions are called \_\_\_\_\_.
3. Fluid movement among the compartments is regulated by \_\_\_\_\_ and \_\_\_\_\_ pressures.
4. Sodium levels are linked to blood \_\_\_\_\_ and blood \_\_\_\_\_ control mechanisms; if one or both of those two parameters goes \_\_\_\_\_, sodium reabsorption goes \_\_\_\_\_.
5. Elevated potassium plasma levels cause release of \_\_\_\_\_ from the adrenal cortex and \_\_\_\_\_ of potassium in exchange for \_\_\_\_\_.
6. In osmosis, water moves from the side of \_\_\_\_\_ solute concentration to the side with \_\_\_\_\_ solute concentration.
7. A cell placed in a \_\_\_\_\_ solution will shrink because water has a \_\_\_\_\_ concentration \_\_\_\_\_ the cell.
8. Acids are proton \_\_\_\_\_, whereas \_\_\_\_\_ are proton \_\_\_\_\_.
9. The \_\_\_\_\_ and \_\_\_\_\_ systems make up the \_\_\_\_\_ buffer systems.
10. Protein buffer systems are important \_\_\_\_\_ the cells and in the \_\_\_\_\_.

### Review your knowledge

1. Define 'tonicity': \_\_\_\_\_
2. The total body water of a woman with a body weight of 100 lbs. is \_\_\_\_\_ lbs. or \_\_\_\_\_ l.
3. The biggest fluid compartment is the \_\_\_\_\_.
4. The major cation ion in the ECF is \_\_\_\_\_.
5. If a solution outside a cell has the same solute concentration than the solution (cytosol) inside the cell it is considered to be \_\_\_\_\_.

6. If the plasma is hypertonic, water will move from the \_\_\_\_\_ into the plasma.
7. If the interstitial fluid becomes diluted, water will move \_\_\_\_\_ cells.
8. The average adult has a water turnover of about \_\_\_\_\_ ml/day.
9. The thirst center is located in the \_\_\_\_\_.
10. Losing more water than taking in will lead to \_\_\_\_\_.
11. Substances that do not dissociate into ions in water are called \_\_\_\_\_.
12. Electrolytes that contain metal cations are called \_\_\_\_\_.
13. A solution with a pH of 3 is called an \_\_\_\_\_.
14. An accumulation of interstitial fluid with tissue swelling is called \_\_\_\_\_.
15. Complete following table by adding the name of the correct hormone(s).

Description	Hormone(s)
Released in response to low plasma calcium levels	
In charge of the water balance of the body	
Released in response to increased plasma osmolarity	
Stimulates Na <sup>+</sup> reabsorption and water retention by the kidneys	
Released by the heart in response to high blood pressure	
Released in response to high plasma potassium levels	
Structurally very close to aldosterone and have similar mineralocorticoid effects	
Released in response to high plasma calcium levels	
Released by the kidneys in response to low blood pressure	
Decreases ADH, renin, and aldosterone production	
Increase water retention during the menstrual cycle and pregnancy	

16. In acidosis, potassium outflow from the cells can lead to \_\_\_\_\_.
17. Vomiting is the most common cause of \_\_\_\_\_.
18. The kidney compensates for respiratory acid-base imbalances by adjusting \_\_\_\_\_.
19. The kidney can produce bicarbonate because it has the enzyme \_\_\_\_\_.
20. Complete following table relating to acid-base balance or imbalance.

Description	Acid-base balance/imbalance
Range of normal pH of systemic arterial blood	
pH >7.45	

Only important buffer system of the ECF	
Least common acid-base imbalance	
Mixture of sodium salts of $\text{H}_2\text{PO}_4^-$ and $\text{HPO}_4^{2-}$	
Can eliminate carbon dioxide from our body	
pH < 7.35 and $\text{P}_{\text{CO}_2} > 45$	
Caused by hyperventilation	
Can eliminate acids and bases from our body	
pH > 7.45 and $\text{P}_{\text{CO}_2}$ 35-45	
Found in patients with COPD	

### Apply your knowledge

- Reabsorption of which ion is inhibited by an aldosterone antagonist?
- In metabolic alkalosis, show what happens to the following: (use  $\uparrow$  or  $\downarrow$ )
  - \_\_\_\_\_ plasma pH
  - \_\_\_\_\_ bicarbonate levels
  - \_\_\_\_\_ respiratory rate
  - \_\_\_\_\_ renal excretion of bicarbonate
- In respiratory acidosis, show what happens to the following: (use  $\uparrow$  or  $\downarrow$ )
  - \_\_\_\_\_ plasma pH
  - \_\_\_\_\_ respiratory rate
  - \_\_\_\_\_ renal excretion of  $\text{H}^+$
  - \_\_\_\_\_ renal excretion of bicarbonate
- Your patient has a pH of 7.38 and a  $\text{P}_{\text{CO}_2}$  of 42. What is your diagnosis?
- You went out last night to celebrate your 21<sup>st</sup> birthday and decided to finally find out what alcoholic drinks are all about. This morning, you woke up with a terrible headache. What is the pathophysiology underlying your hangover? What can you do, other than taking medication, to improve your headache?
- What kind of acid-base imbalance would a crying infant develop?
- A patient is severely dehydrated and is given 2.0 l of water i.v. How will this change the following parameters? (use  $\uparrow$  or  $\downarrow$ )
  - Extracellular Fluid Volume \_\_\_\_\_
  - Extracellular Fluid Osmolality \_\_\_\_\_
  - Intracellular Fluid Volume \_\_\_\_\_
  - Intracellular Fluid Osmolality \_\_\_\_\_
- Your patient has an arterial blood pH of 7.25, a  $\text{P}_{\text{CO}_2}$  30 mm Hg, and a breathing rate of 25/min with a minute ventilation of 17,500 ml/min. What do you think is going on?

9. Patients with severe diarrheal disorders, such as cholera, often develop signs of mental confusion, become lethargic, and have heart palpitations. Untreated, they may fall into a coma and die. What do you think could cause the central nervous symptoms in these patients?

10. Which of the following sets of plasma levels would you expect in a subject chronically maintained on a high sodium diet?

	<u>Plasma sodium</u>	<u>Aldosterone</u>	<u>ANP</u>
a.	↑	↓	↑
b.	↑	↑	↔
c.	↓	↑	↔
d.	↔	↑	↑

### Urinalysis Activity

This activity uses human urine and you must protect yourself from contracting an infectious disease by wearing gloves. Make sure to dispose of any urine-stained materials in the biohazard container provided.

#### Supplies per group (max. 4 students)

- 1 Bottle with Multistix 7 test strips
- 1 marker
- 1 stopwatch
- 1 urine container per student
- 3 random urine samples (pick any three for the group)

**Urine sticks** are widely used in health facilities to quickly measure physical characteristics. Depending on the parameters tested, first-morning urine may be preferable, but random samples are useful for most applications. The sticks we use test for protein, blood, leukocytes, nitrite, glucose, ketone and pH.

1. Take a urine container, go to the rest room, and collect a urine sample. For best results, you should try to get a "clean-catch" urine sample by collecting the sample of urine in midstream. A small amount of urine should initially fall into the toilet bowl first (this clears the urethra of contaminants). Then, in a clean container, catch about 1 to 2 ounces of urine and remove the container from the urine stream.
2. Back in the lab, look at the sample and write down color, clarity and smell.
3. Open the bottle with test strips, take one out and close the bottle again. **Do not touch the test pads on the strip!**
4. Dip all the pads of the strip into the urine and remove the strip immediately. Start the stopwatch the moment you remove the strip from the urine.
5. Read each pad at the time shown on the label of the bottle, starting with the shortest time (glucose). Hold the strip close to the color blocks and match carefully. Read the pads in sufficient light.
6. Record your readings in the table below.
7. Repeat the testing for the 3 random samples.
8. Dispose of used test strips by placing them in the biohazard container.

Parameter	Your urine sample	Sample #	Sample #	Sample #
Color				
Clarity				
Smell				
Glucose				
Ketone				
Blood				
pH				
Protein				
Nitrite				
Leukocytes				

**Evaluation**

**Your sample:**

**Sample #** :

**Sample #** :

**Sample #** :



# Principles of **Anatomy & Physiology**

Second edition

Part 2 – Lab Workbook

**Twenty-four chapters with color illustrations, coloring exercises, and lab activities**

- Chapter 1 Introduction into Medical Terminology
- Chapter 2 Basic Sciences Review
- Chapter 3 Introduction into Anatomy & Physiology
- Chapter 4 Histology
- Chapter 5 Integumentary System
- Chapter 6 Bones & Skeletal Tissues
- Chapter 7 Skeleton
- Chapter 8 Joints
- Chapter 9 Muscle Tissue
- Chapter 10 Muscular System
- Chapter 11 Nervous Tissue
- Chapter 12 Central Nervous System
- Chapter 13 Peripheral Nervous System & Reflexes
- Chapter 14 General & Special Senses
- Chapter 15 Endocrine System
- Chapter 16 Reproductive System and Pregnancy
- Chapter 17 Cardiac Anatomy & Physiology
- Chapter 18 Blood Vessels and Circulation
- Chapter 19 Blood, Hemostasis, and Blood Groups
- Chapter 20 Lymphatic System & Immunity
- Chapter 21 Respiratory System
- Chapter 22 Digestive System
- Chapter 23 Urinary System
- Chapter 24 Fluid, Electrolyte, and Acid-Base Balance

► **Reuter Academic Publishing** ◀

© 2022 Reuter Academic Publishing [www.reuteracademicpublishing.com](http://www.reuteracademicpublishing.com)