Saladin *Human Anatomy*, 6th Edition
Answers to *Apply What You Know* and *Testing Your Comprehension* Questions

Chapter 1 Answer Key

Apply What You Know

Page 5—The production of useful diagnostic images had to await computer technology that did not exist in 1948.

Page 5—Situs inversus could affect emergency diagnosis (for example, the location of pain from appendicitis) or surgical treatment, so it is advantageous for an emergency medical team to know of this condition before they begin treatment. (It also affects the electrocardiogram, although students would not have a basis for knowing that at this point in their study.)

Testing Your Comprehension

1. Angiography is invasive because it requires the injection of a radiopaque substance into the circulatory system. A PET scan is invasive because it requires the injection of radioisotopes, and angiography is invasive because it requires injection of a contrast medium. MRI is noninvasive because it requires no injection, other breaks in the body surface, or probing of any body cavity. Sonography and CT scans can be either noninvasive or invasive (as when an esophageal, vaginal, or rectal ultrasound probe is used, or a contrast medium is injected for a CT scan).
2. Both internal and external anatomy are variable, so anyone being trained for careers involving patient examination, diagnostic imaging, surgery, and so forth must be well aware of this variability and familiar with the most common variations so that he or she will be less inclined to make false assumptions about a patient.
3. (a) Transverse, (b) sagittal, (c) transverse, (d) frontal, (e) sagittal, (f) frontal.
4. It is a misunderstanding of the word *plantar*, the surface where such warts commonly occur.
5. Eponyms are uninformative; they don't describe anything of the form or function of a structure. Presumably most students would regard noneponymous terms to their advantage. The committee named structures in Latin because it is a static and internationally neutral language, so it is relatively apolitical. Students might object to this, but if everyone in the world had a vote on the language in which to name things, anatomical terms might be in Mandarin Chinese!

Instructor's Manual for Laboratory Manual to accompany Saladin: *Human Anatomy*, Sixth Edition

The laboratory manual that this Instructor's Manual accompanies can be used independently or can be used with Saladin's *Human Anatomy* text. Below is a correlation guide listing the chapters in Saladin's *Human Anatomy* text that correspond to the exercises in the Wise: *Human Anatomy Laboratory Manual*, 6th edition.

Wise: *Human Anatomy Laboratory Manual*, 6e Exercises	**Saladin: *Human Anatomy*, 6e Chapters**
1. Organs, Systems, and Organization of the Body	1. The Study of Human Anatomy
2. Microscopy	2. Cytology—The Study of Cells
3. Cell Structure	2. Cytology—The Study of Cells
4. Tissues	3. Histology—The Study of Tissues
5. The Integumentary System	5. The Integumentary System
6. Introduction to the Skeletal System	6. The Skeletal System I: Bone Tissue
7. Axial Skeleton 1: Skull	7. The Skeletal System II: Axial Skeleton
8. Axial Skeleton 2:Vertebrae, Ribs, Sternum	7. The Skeletal System II: Axial Skeleton
9. Appendicular Skeleton	8. The Skeletal System III: Appendicular Skeleton
10. Joints	9. The Skeletal System IV: Joints
11. Axial Muscles 1: Muscles of the Head and Neck	10. The Muscular System I: Muscle Cells 11. The Muscular System II: Axial Musculature
12. Axial Muscles 2: Muscles of the Trunk	11. The Muscular System II: Axial Musculature
13. Appendicular Muscles 1: Muscles of the Shoulder and Upper Limb	12. The Muscular System III: Appendicular Musculature
14. Appendicular Muscles 2: Muscles of the Hip, Thigh, Leg, and Foot	12. The Muscular System III: Appendicular Musculature
15. Introduction to the Nervous System	13. The Nervous System I: Nervous Tissue
16. Spinal Cord and Spinal Nerves	14. The Nervous System II: Spinal Cord and Spinal Nerves 16. The Nervous System IV: Autonomic Nervous System and Visceral Reflexes
17. Brain and Cranial Nerves	15. The Nervous System III: Brain and Cranial Nerves
18. Sensory Receptors	17. The Nervous System V: Sense Organs
19. The Endocrine System	18. The Endocrine System
20. Blood Cells	19. The Circulatory System I: Blood
21. The Heart	20. The Circulatory System II: Heart
22. Introduction to Blood Vessels and Blood Vessels 1: Blood Vessels of the Axial Region	21. The Circulatory System III: Blood Vessels
23. Blood Vessels 2: Blood Vessels of the Appendicular Region	21. The Circulatory System III: Blood Vessels
24. The Lymphatic System	22. The Lymphatic System and Immunity
25. The Respiratory System	23. The Respiratory System
26. The Digestive System	24. The Digestive System
27. The Urinary System	25. The Urinary System
28. The Male Reproductive System	26. The Reproductive System
29. The Female Reproductive System and Development	26. The Reproductive System

Exercise 1

Organs, Systems, and Organization of the Body

INTRODUCTION

In this exercise, you should introduce the field of anatomy with directional terms and general discussions of the systemic study of anatomy. Comparisons of organ systems with regional anatomy are useful for students, and students should list what organs belong to what system and what constitutes an organ. Torso models and organ models are good to set out so that students can begin to associate organs with organ systems.

When discussing the atomic level of organization, having available MRIs from local hospitals or physicians allows students to examine the importance of anatomic study from various perspectives and technologies. It is also important to compare directional terms for quadrupeds with those for humans, as *superior* and *inferior* are specific terms for humans. The terms *anterior/ventral* and *posterior/dorsal* are synonymous in humans while the anterior end of a quadruped is toward the nose and the dorsal side is along the vertebral column.

Planes of sectioning are also important concepts in the study of anatomy. Illustrations of organs that have been sectioned or thin sections of organs embedded in plastic make good tools for discussing sectioning planes. Likewise, the use of torso models for the discussion of body cavities provides a good visual medium for demonstration.

Most students have an intuitive sense and some familiarity with the regions of the body. Particular notice should be given to the specific use of "arm" (from the shoulder to the elbow) and "leg" (from the knee to the ankle) used in anatomy. Descriptions of the abdominal region are also reasonably comprehensible. The term "hypochondriac" comes from the Greek words meaning "under the cartilage." In earlier times the hypochondriac area was thought to be the center of melancholy.

TIME 1-1.5 hours

MATERIALS

Models of human torso
Charts of human torso

ANSWERS TO FIGURE 1.2

1. Integumentary
2. Skeletal
3. Muscular
4. Lymphatic
5. Respiratory
6. Urinary
7. Nervous
8. Endocrine
9. Circulatory
10. Digestive
11. Reproductive

IN-TEXT ANSWERS FOR PAGE 8

Shin – crural	Shoulder – acromial
Elbow – cubital	Thigh – femoral
Neck – cervical	Knee – patellar
Toes – digital	

REVIEW ANSWERS

1. Anatomy

2. Organ systems

3. Anatomical position

4. Abdominal

5. Urinary

6. Digestive

7. Anterior

8. Anterior

9. Proximal

10. Abdominal

11. Right hypochondriac

12. To the shoulder. Proximal refers to being closer to the trunk.

13. On the calf

14. Thoracic

15. Pelvic

16. a. Shoulder and elbow

17. b. Knee and ankle

18. c. Organelle

Use correct anatomical terminology to describe the following relationships:

19. Superior

20. Distal

21. Deep

22. Anterior/ventral

23. Respiratory

24. Circulatory

25. d. Dorsal

26. The abdomen is the region of the belly and the abdominal cavity is a space in the abdominal region.

27.
a. Cephalic
b. Axillary
c. Brachial
d. Antebrachial
e. Carpal
f. Frontal
g. Cervical
h. Acromial
i. Sternal
j. Pectoral
k. Abdominal
l. Coxal
m. Genital
n. Femoral
o. Crural
p. Pedal

28.
a. Frontal
b. Median
c. Transverse

29. The arms are contralateral to each other.

30. The visceral peritoneum is deep to the parietal peritoneum.

Interactive Case Studies and the Human Body (1-10)

The Female Body

Case Study 1

Hematology

AIDS

Answers:

1. This individual has Acquired Immunodeficiency Syndrome (AIDS) caused by the Human Immunodeficiency Virus (HIV).
2. The hematocrit abnormality is caused by the dehydration.
3. Some current treatments include: AZT (Zidovudine) and ddI (Didanosine), both antiretroviral agents which slow the replication of the virus, prevent occurrence or recurrence of opportunistic infections, and boost the immune system.
4. The individual is experiencing hypokalemia prior to treatment.
5. This abnormal potassium level could cause cardiac arrhythmias due to the hyperpolarization of the resting membrane potential.

Interactive Case Studies and the Human Body (11-20)

The Male Body

Case Study 11

Hematology

Polycythemia

Answers:

1. The disorder of this individual is polycythemia.
2. The arterial O_2 saturation and erythropoietin levels are important in confirming that the increased hematocrit is not due to hypoxemia or an abnormally elevated erythropoietin level. The O_2 saturation level would indicate if there is a physiologic stimulus for the increased erythrocyte production.
3. Phlebotomy is the letting of blood for transfusion pheresis, diagnostic testing, or experimental procedures.
4. Phlebotomy (removal of the whole blood) removes both blood cells and plasma. The plasma volume is replaced within days, whereas the erythrocytes take several weeks to be replaced.
5. Myelosuppressive therapy is therapy for the suppression of the bone marrow's production of blood cells and platelets.
6. Myelosuppressive therapy may be needed to suppress the erythrocyte production in the myeloid tissue if the hematocrit continues to rise after the phlebotomies.

Saladin: *Human Anatomy*, 6th Edition Instructor's Manual

Chapter 1: The Study of Human Anatomy

Chapter Overview

Chapter one places the study of anatomy within the context of biological sciences. This text emphasizes a functional perspective that addresses the fundamental question of why structures are shaped and arranged as they are in the human body. A functional perspective affords a profound understanding of the human body that goes beyond naming and description of structures.

Our current understanding of anatomy did not spring from thin air but is the product of centuries of effort by many individuals. Greek and Roman scientists laid the foundation for the scientific study of the human body and their observations were the mainstay of anatomical and medical understanding in Europe until the Renaissance. Islamic scientists advanced in knowledge in the Medieval era, while science in general languished in Europe. The modern discipline of anatomy traces it roots to Vesalius, a 16th century anatomist who ushered in a new era. He combined medical illustration with cadaver demonstrations and lectures, transforming pedagogy—a legacy that remains with us today. The tradition of beautifully illustrated anatomy texts, for example, began with *De Humani Corporis Fabrica* by Vesalius.

There are many approaches to the study of anatomy, including gross anatomy, microscopic anatomy, and comparative anatomy. The word "anatomy" means to cut, and, for many centuries, the only way to visualize what lay beneath the skin was to perform cadaver dissections. Today, cadaver dissection still plays an important role in the training of health care professionals, but over the past 100 years or so, new techniques have offered exciting insights into human structure, and have expanded the avenues for study of anatomy in living individuals.

Current subdisciplines of anatomy correspond to the expansion of techniques used to study the body. Gross anatomy refers to the study of structures visible to the naked eye, and includes dissection, surface anatomy, and radiologic anatomy. Microscopic anatomy (histology) is the study of tissues and the cells that are found in each tissue type. Histology is important for its role in assessing disease processes.

Systemic and regional anatomy are two different pedagogical approaches to the study of anatomy. Most introductory courses focus on a systemic approach, where one body system at a time is explored. That is the approach of this text. Advanced anatomy courses in medical schools, for example, focus on regional anatomy, where one area of the body is examined with respect to the relationship of the muscles, bones, blood vessels, and connective tissue in a region such as the hand or forearm.

Another subdiscipline of anatomy is comparative anatomy. As humans, we are part of the living world, and our anatomy is best understood in comparison to other living things. We share with all life, from ancient forms which existed billions of years ago to extant forms alive today, certain characteristics that distinguish us from non-living matter. We are composed of cells, beginning as single-celled organisms. Our cells contain DNA, which underlies our ability to grow, develop, and reproduce and pass genes to future generations. Over generations, the genetic make-up of human populations has changed the basis for evolution. Human anatomy has been shaped over millions of years through the mechanism of natural selection, a concept explained by Charles Darwin. Like other living forms, humans have adapted to changing environmental conditions. The comparative, evolutionary perspective helps us understand that our current anatomy is the result of millions of years of selection pressures. The role this plays in modern health is a focus of Darwinian medicine, which attempts to understand diseases within the context of our evolutionary and cultural history.

Much about the anatomy of a living person can be gleaned by using our senses of sight, touch, and sound to examine the external body. For example, physicians routinely assess anatomy through visual inspection of the skin, eyes, etc. and through manual palpation. They also listen to the sounds of the body (auscultation), often with the help of a stethoscope.

To see more deeply, dissection is required. Indeed, dissection was the main source of anatomical information for centuries. Dissection is still essential for a deep understanding of the body, and cadavers continue to be a source of profound learning experiences for students of health professions.

However, in the past 100 years, new techniques have been developed to visualize internal structures in living patients. The oldest is radiography, which photographs internal structures with X-rays. X-rays are especially useful for seeing pathologies in dense tissues, such as bones and teeth, and can be used to diagnose tumors. Computed tomography is a more sophisticated application of X-rays that relies on computer analysis to reveal three-dimensional, soft tissue anatomy. Sonography relies on sonar technology using ultrasound waves. Sonography is frequently used in obstetrics to assess fetal age and position. Magnetic Resonance Imaging (MRI) uses magnetic fields to visualize soft tissues and has especially been effective in images of the spinal cord and brain. For example, functional MRI reveals moment to moment changes in tissue activity associated with brain function. Positron Emission Tomography (PET) is used to assess metabolic status of tissues. It produces color images that show which area is using the greatest amount of glucose. PET scans and functional MRI have revolutionized our understanding of brain function because images produced while a person is performing specific tasks, such as movement or cognitive tests, reveal what part of the brain is active during specific activities.

Hundreds of years of anatomical studies have revealed that there is significant anatomical variation among individuals. Variation is due to sex, age, genetic heritage, and experiences during life such as injury and disease. It is important for students to

remember that textbooks, atlases, and lectures typically address the most common, average anatomical form, but each human body is unique. This is especially important for clinicians to remember!

Anatomy is best understood in the context of levels of structural complexity, from the most basic level, the atom, all the way up to the complex organism. The molecular biology explosion of recent decades has illuminated the structure and function of DNA, genes, and proteins. It is clear that the tiniest aspects of cell structure and function relate to the structure and function of an entire individual. At every level, structure relates to function, or "form follows function." For example, the double helical nature of DNA enables replication and the elongated shape of muscle fibers makes contraction possible.

The final part of chapter one presents common terms and organizational tools that are essential for the student's understanding of anatomy. The 11 organ systems are introduced. Terms associated with body orientation are presented, beginning with an explanation of the anatomical position. Descriptions of the major body regions, including cavities, are accompanied by vivid illustrations that will be a reference for students as they explore later chapters.

Finally, the chapter ends with a useful discussion of the language of anatomy. Anatomical terms emerged over centuries and some terms have obscure origins. The chapter provides tools for grappling with Greek and Latin that will help students feel less overwhelmed. The section demonstrates how students may identify roots, prefixes, suffixes, singular and plural forms to both understand and utilize anatomical terms more effectively. It is important that students learn to use terms correctly because anatomical language forms the basis for effective communication in medical practice.

Key Concepts

- **Functional Morphology**
  The study of the form and function of anatomical structures
- **Gross Anatomy**
  The study of visible structures traditionally approached through cadaver dissection
- **Microscopic Anatomy**
  Study of the structure of tissues and cells
- **Radiologic Anatomy**
  Study of internal structure using X-rays and other medical imaging techniques
- **Systemic Anatomy**
  Approach to learning anatomy that emphasizes study of one organ system at a time
- **Regional Anatomy**
  Approach to learning anatomy by dissecting specific areas of the body, and studying the relationship of structures related to multiple organ systems such as blood vessels, nerves, tendons, etc.

- **Comparative Anatomy**
  Study of more than one species to identify and analyze structural similarities and differences
- **Historical Context**
  Modern knowledge rests on centuries of study, dating from Greek and Roman contributions
- **Medical Imaging**
  Methods for viewing structures inside a living person, such as radiographs, CT scans, MRIs, and PET scans
- **Human Variation**
  Each body has unique features, even though the average, typical form (often a single specimen) is presented in atlases
- **Structural Levels**
  Organism, organ systems, organs, tissues, cells, organelles, molecules, atoms, subatomic particles
- **Organ Systems**
  There are 11 organ systems and an immune system whose function relies on cells rather than organs
  - Integumentary system
  - Skeletal system
  - Muscular system
  - Nervous system
  - Endocrine system
  - Circulatory system
  - Lymphatic system
  - Immune system
  - Respiratory system
  - Urinary system
  - Digestive system
  - Reproductive System
- **Anatomical Position**
  Standing with palms facing forward is the standard reference position • Location and orientation of structures are from the point of view of the subject • For example, in an illustration of the heart, the left atrium refers to the subject's left side
- **Anatomical Planes**
  - The **sagittal plane** divides the body or organ into right and left halves
  - The **frontal plane** divides the body or organ into anterior and posterior portions
  - The **transverse plane** divides the body or organ into superior and inferior portions perpendicular to the long axis
- **Directional Terms**
  Commonly used terms such as anterior, posterior, etc. are defined in Table 1.1
  • Students must learn these in order to understand terminology in following chapters
- **Axial Region**
  The axial region consists of the head, neck, and trunk • The trunk is further divided into the thoracic region and the abdominal region • For clinical purposes, the

abdomen is divided into quadrants or nine regions (e.g. hypochondriac, epigastric, etc.)

Appendicular Region

The appendicular region consists of the upper and lower limbs (the appendages)

- **Body Cavities and Membranes**
  - **The Cranial Cavity and Vertebral Canal**
  - The cranial cavity is enclosed by the skull and contains the brain • The vertebral canal is enclosed by the bony vertebrae and contains the spinal cord • Three membrane layers called the meninges line the cranial cavity and vertebral canal
  - **The Thoracic Cavity**
  - The thoracic cavity is separated from the abdominopelvic cavity by the diaphragm • The thoracic cavity contains the heart and lungs • The mediastinum is the region between the lungs that contains the heart, great vessels, and other structures • A two-layered membrane, the pericardium, surrounds the heart • The wall of the thoracic cavity is lined with a serous membrane called the parietal pleura; the visceral pleura adheres to the surface of the lungs
  - **The Abdominopelvic Cavity**
  - The abdominopelvic cavity is divided into a superior abdominal cavity and a pelvic cavity below • The abdominopelvic cavity wall is lined with parietal peritoneum while visceral peritoneum covers the surface of many organs
  - **Potential Spaces**
  - Often, membranes are so closely pressed together that there is no actual space between them • Because the membranes are not physically attached, fluid or other material can sometimes create a space • For example, normally there is no space in the lumen of the uterus but during pregnancy a fetus occupies the space

Learning Strategies/Teaching Tips

- Highlight a particular scientist and his/her work when discussing functional, comparative anatomy. Anatomy is a dynamic discipline and research about human form is continuous. One example is using comparative anatomy to understand human locomotor anatomy associated with bipedal walking.
- Find studies in journals (including on the Internet) that demonstrate the use of functional imaging in current studies. There are many examples that use PET scans for understanding brain function.
- Use forensic science as an example of an application that relies on human variation. For example, forensic anthropologists can gather clues to a person's identity by assessing stature and sex, and can even gain insight into ethnicity, occupation, injuries and disease by examining unique features of skeletons.
- Use the concept that structure relates to function ("form follows function") as a theme in lectures. Use examples from macromolecules to organelles, to cells, to organs.
- In lab, use skeletons to compare anatomical features of a cat or other quadrupedal mammal, a quadrupedal primate such as a monkey, and a human. In small groups, have the students devise lists of features that are similar and different, and then

discuss the functional reasons for the differences. For example, cats have claws versus nails, humans have a broad, bowl-shaped pelvis, etc.

- Have students assume the anatomical position and use appropriate terminology to describe relationships among common body parts. For example, the elbow is proximal to the wrist.

Additional Reading

Hayes, Bill. 2007. *The Anatomist: A True Story of Gray's Anatomy.* Random House.

Shubin, Neil. 2008. *Your Inner Fish: A Journey into the 3.5 Billion Year History of the Human Body.* Random House.

Vance, Erik. 2008. "Truly gross anatomy." *Nature,* Vol. 452, pp. 525-526.

Zihlman, Adrienne. 2000. *The Human Evolution Coloring Book.* Harper Collins.

Table of Contents

LearnSmart Labs: Blood

General Lab Outline

Total Time: 2 hr, 15 min

I. Core Concepts: Blood (15 min)
II. Blood Smear and Differential White Cell Count (40 min)
III. Hematocrit (20 min)
IV. Hemoglobin Content (20 min)
V. Blood Typing Test (20 min)
VI. Final Summary Questions (10 min)
VII. Reports

Assessed Learning Outcomes

1. Core Concepts: Blood
    a. Recall that blood is composed of plasma and the formed elements
    b. Structure and function of the formed elements
        i. Recall the structure and function of red blood cells
        ii. Recall the structure and function of white blood cells
        iii. Recall the structure and function of platelets
        iv. Compare the structure and function of the formed elements
    c. Understand the basis of blood typing
        i. Recall the red blood cells are covered in antigens, and plasma contain antibodies for foreign antigens
        ii. Match blood types and antibodies
        iii. Explain when transfusion reactions occur
    d. Recall how to safely handle human blood
2. **Blood Smear and Differential White Cell Count**
    a. Pre-lab Briefing
        i. Recall the steps to perform a blood smear
        ii. Recall how to perform a differential white blood cell count
    b. Identify different white blood cells
        i. Identify platelets in a blood smear slide
        ii. Identify erythrocytes in a blood smear slide
        iii. Identify neutrophils in a blood smear slide
        iv. Identify lymphocytes in a blood smear slide
        v. Identify monocytes in a blood smear slide
        vi. Identify eosinophils in a blood smear slide
        vii. Identify basophils in a blood smear slide

c. Stimulation of Blood Smear and Differential White Cell Count
    i. Prepare a blood smear
        1. Add a drop of blood
        2. Smear the blood drop
        3. Let blood smear dry in the air
    ii. Stain the blood smear
        1. Add Wright's stain to blood smear
        2. Let Wright's stain react for a suitable time
        3. Add distilled water to the slide with stain
        4. Let the stain and water mixture react for a suitable time
        5. Rinse the stained blood smear
        6. Let the slide air dry
    iii. Perform the correct procedure without guidance
    iv. Dispose of materials contaminated with blood in biohazard container
    v. Perform a different count on prepared microscope slide
    vi. Differential cell count
        1. Count the correct number of neutrophils
        2. Count the correct number of lymphocytes
        3. Count the correct number of monocytes
        4. Count the correct number of eosinophils
        5. Count the correct number of basophils
    vii. Infer the patient's health problem from the results of the differential white cell count
d. Post-lab probing
    i. Explain the outcome if the stain acts for the wrong time
    ii. Identify the normal values of a differential's white blood cell count
    iii. Know the relationship between an abnormal differential white cell count and likely diseases

3. Hematocrit
    a. Pre-lab Briefing
        i. Recall how to prepare a blood sample for a hematocrit test
    b. Stimulation of Hematocrit Test
        i. Fill a capillary tube with blood
        ii. Seal capillary tubes
        iii. Separate blood and plasma in the centrifuge
        iv. Measure the hematocrit for one blood sample
        v. Test all 5 blood samples
        vi. Balance centrifuge
        vii. Recall how to place the capillary tubes in centrifuge
        viii. Infer whether test results indicate doping
        ix. Use safe blood handling practices
        x. Avoid cross-contamination samples

    c. Post-lab Probing
        i. Explain the purpose of a hematocrit test
        ii. Recall the normal hematocrit levels
4. Hemoglobin Content
    a. Pre-lab Briefing
        i. Recall how to prepare a blood sample for a hemoglobin test
    b. Simulation of Hemoglobin Test
        i. Test the three blood samples and positive and negative controls
        ii. Stir until all hemoglobin is out of the red blood cells
        iii. Measure the hemoglobin content
        iv. Use safe blood handling practices
        v. Avoid cross-contaminating samples
        vi. Recall why hemolysis applicators are used
        vii. Infer whether test results indicate doping
    c. Post-lab Probing
        i. Explain the purpose of hemoglobin test
        ii. Recall the normal hemoglobin content
5. Blood Typing Test
    a. Pre-lab Briefing
        i. Recall how to determine the blood type
        ii. Recall which transfusions lead to transfusion reactions
    b. Simulation of Blood Typing Test
        i. Test all blood samples
        ii. Label the test slides
        iii. Recall how the slides should be labeled
        iv. Add blood from only one patient to each slide
        v. Add the test serum to the labeled spot on the slide
        vi. Determine the blood type
        vii. Use safe blood handling practices
        viii. Avoid cross-contaminating blood samples
        ix. Recall why toothpicks are used in this experiment
        x. Use your results to determine who can donate blood to whom
    c. Post-lab Probing
        i. Realize the need for type O packed cell transfusion when donor and recipient do not exactly match
6. Final Summary Questions
    a. Differentiate between the purpose of the various blood tests

INSTRUCTOR NOTE: Safety requirements for blood handling may vary slightly from those used in this lab. Students may become frustrated if they begin to miss questions. Remind them that when missing a question they should remediate using the provided learning resource, most often a Slide, or the Library for that topic.

Student Instructions for Lab Experiments

Overview for All Experiments:

In the following exercises you will perform tests that allow you to examine the nature of blood and also let you evaluate different samples of blood.

These tests are useful diagnostic tools for physicians because blood composition reflects the status of many body functions and malfunctions.

Before getting started on the actual lab, I would like to go over some core concepts related to blood testing. Then you will proceed with the experiments.

Differential WBC Count:

In this experiment, you will prepare a microscope slide with a blood smear and perform a differential white blood cell count.

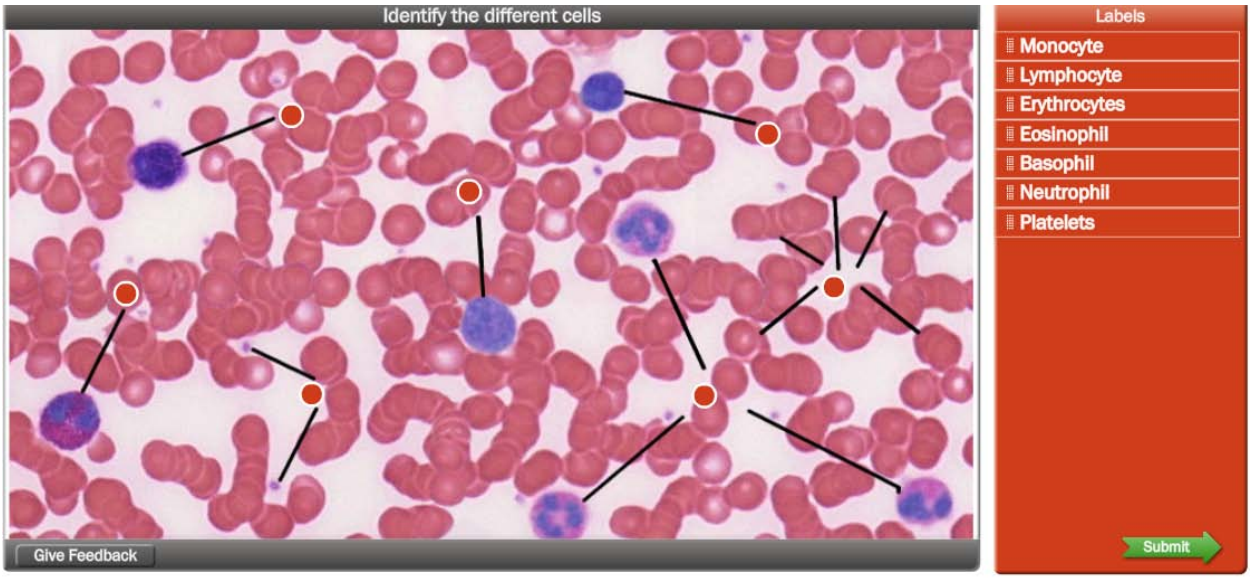
Before you start, I want to make sure that you have the necessary knowledge to execute the experiments.

Let's make sure you know how to prepare a blood smear microscope slide and how to perform a differential white blood cell count.

Important to Know About Blood Samples:

- What is a blood smear and how to make one
- How to stain a blood sample
- How to identify the different white blood cells
- What is a differential white blood cell count

Drag the labels from the right hand side to the correct locations on the slide. Select "Submit" when you are done.



INSTRUCTOR NOTE: Often the Coach will appear at the top right. Sometimes students think she is in the way of completing the exercise. However, if they are patient, she will disappear when she completes talking. Students can reactivate her and make her repeat instructions by clicking on her refresh icon.

Drag the labels from the right hand side to the correct locations on the slide. Select "Submit" when you are done.

Simulator:

Click the Instructions button and follow the steps to make a blood smear.

Move the slide to the microscope to view it.

First, correctly focus the microscope slide. Move to the x40 objective to complete the count.

Hematocrit:

In this experiment, you will measure the hematocrit of blood samples.

Before we begin, I want to make sure you have the knowledge you need to execute the experiment and interpret your results.

Let's learn more about the hematocrit of a blood sample

Important to Know About Hematocrit Testing:

- What is the hematocrit value
- How is a hematocrit test performed

Drag the labels from the right hand side to the correct locations on the slide. Select "Submit" when you are done.

Simulator:

Click the Instructions button and follow the steps to determine the hematocrit.

Compare the hematocrit to blood doping samples.

INSTRUCTOR NOTE: Students will see a number of possible combinations of doping results and hematocrit levels. If they repeat the experiment, they should expect different results. Each student should have different results.

Hemoglobin Content:

In this experiment, you will measure the hemoglobin content of blood samples.

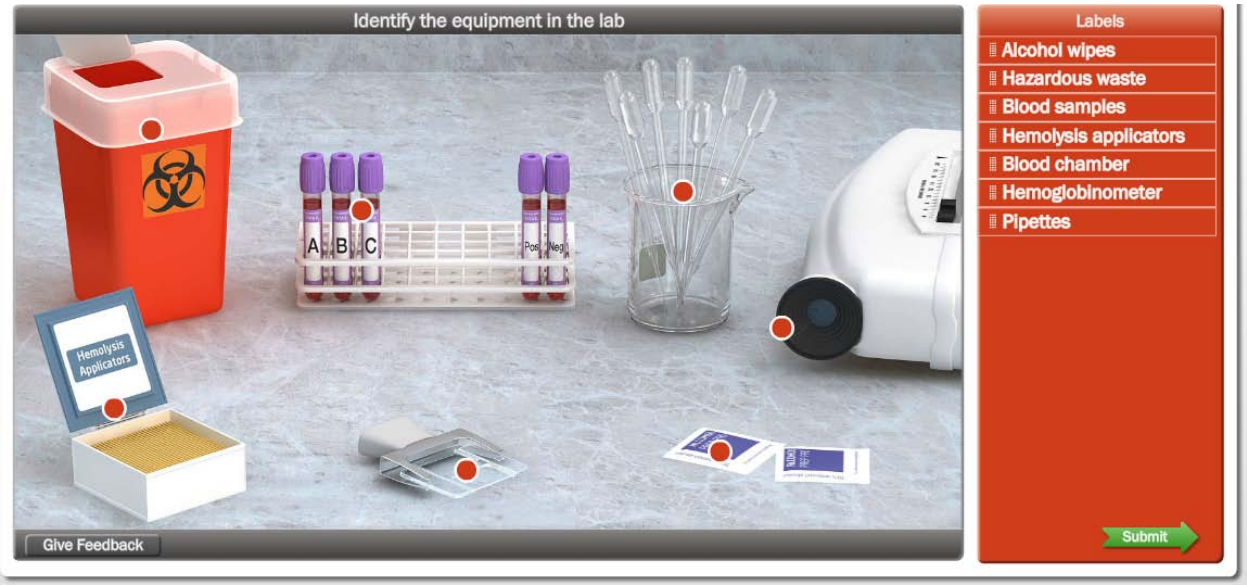
Before we begin, I want to make sure you have the knowledge you need to execute the experiment and interpret your results.

Let's learn more about the hemoglobin content of blood and how to determine it.

Important to Know About Hemoglobin

- Hemoglobin in red blood cells
- How to measure the hemoglobin content of blood

Student labeling activity before entering lab simulation



Simulator:

Click the Instructions button and follow the steps to determine the hemoglobin content.

Compare the hemoglobin content to blood doping samples.

INSTRUCTOR NOTE: The two halves in the hemoglobinometer will not have a line between them when the correct reading is available. Students will see a number of possible combinations of doping results and hemoglobin concentrations. If they repeat the experiment, they should expect different results. Each student should have different results.

Blood Typing:

In this experiment, you will determine the blood type of some blood samples.

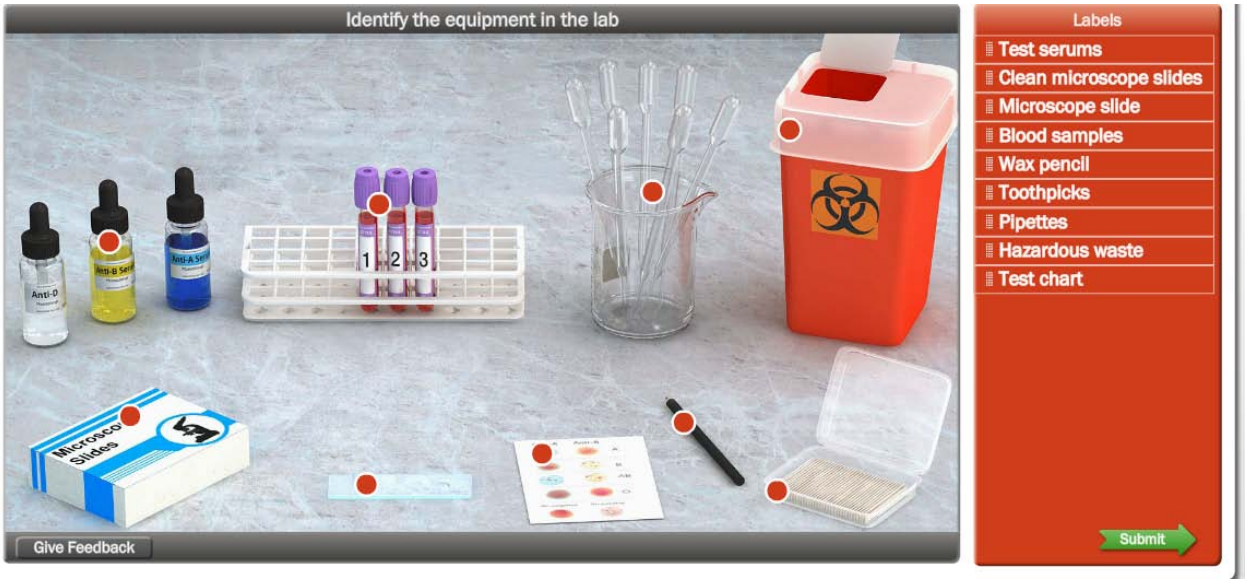
Before we begin, I want to make sure you have the knowledge you need to execute the experiment and interpret your results.

Let's learn more about the blood typing test.

Important to Know About Blood Typing

- How to determine the blood type
- Transfusion reactions

Student labeling activity before entering lab simulation



Simulator:

Click the Instructions button and follow the steps to determine the blood types.

Remember to label your slides with the sample and test types.

INSTRUCTOR NOTE: Students will see a number of possible combinations of blood types. If they repeat the experiment, they should expect different results. Each student should have different results.

Final Summary Questions

a. Differentiate between the purpose of the various blood tests

INSTRUCTOR NOTE: These final summary questions are designed to assess students that have completed all components of the lab. If you only assign some of the exercises and have not instructed students on the other techniques in class, your students may struggle with some of these questions.

Type of Student Report

Students are provided the following types of reports at the conclusion of these lab experiments.

I. Blood Smear and Differential White Cell Count – ***Debriefing***
II. Hematocrit – ***Debriefing***
III. Hemoglobin Content – ***Debriefing***
IV. Blood Typing Test – ***Debriefing***