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PREFACE

Organization of this Instructor Guide

The Instructor Guide for the fifth edition of Essentials of Human Anatomy & Physiology Laboratory Manual by Elaine N. Marieb features a wealth of information for the anatomy & physiology laboratory instructor.

Each exercise in this manual includes detailed directions for setting up the laboratory, comments on the exercise (including common problems encountered), some additional or alternative activities, and answers to the new pre-lab quizzes and activity questions that appear in the text of the lab manual. (Answers to questions regarding student observations and data have not been included.)

Answers to the Review Sheets that are offered in the laboratory manual have been integrated to conveniently follow each exercise. In some cases several acceptable answers have been provided.

The time allotment at the beginning of each exercise, indicated by the hour glass icon, is an estimate of the amount of in-lab time it will take to complete the exercise, unless noted otherwise. If you are using multimedia, add the running time to the time allotted for a given exercise.

Suggested multimedia resources, indicated by the computer icon, are listed for each exercise. Format options include VHS, CD-ROM, DVD, and 3-Year streaming. The resources are also listed by system in Multimedia Resources in Appendix A (page 189) of the guide. Information includes title, distributor, running time, and format. The key to format abbreviations is on the first page of this appendix. A listing of the multimedia resource distributors, along with address and contact information, can be found in Appendix B (page 197). In addition, a list of supply houses is in Appendix C (page 201).

Suggested Essentials of Interactive Physiology® modules are listed at the beginning of relevant exercises and included in Multimedia Resources in Appendix A. Students are enabled to understand, rather than memorize, difficult physiological concepts with these detailed interactive animations, puzzles, quizzes, and other tools. Nine major topic areas are covered: Muscular System; Nervous System; Cardiovascular System; Respiratory System; Urinary System; Fluids, Electrolytes, and Acid/Base Balance; Endocrine System; Digestive System; and Immune System. Available on CD-ROM.

Each exercise includes directions for preparing needed solutions, indicated by the test tube icon.

Laboratory Safety

Always establish safety procedures for the laboratory. Students should be given a list of safety procedures at the beginning of each semester and should be asked to locate exits and safety equipment. Suggested procedures are on page vii, along with a student acknowledgment
form. These pages may be copied and given to the students. Signed student acknowledgment forms should be collected by the instructor once the safety procedures have been read and explained and the safety equipment has been located.

Special precautions must be taken for laboratories using body fluids. Students should use only their own fluids or those provided by the instructor. In many cases, suitable alternatives have been suggested. All reusable glass and plasticware should be soaked in 10% bleach solution for 2 hours and then washed with laboratory detergent and autoclaved if possible. Disposable items should be placed in an autoclave bag for 15 minutes at 121°C and 15 pounds of pressure to ensure sterility. After autoclaving, items may be discarded in any disposal facility.

Disposal of dissection materials and preservatives should be arranged according to state regulations. Be advised that regulations vary from state to state. Contact your state Department of Health or Environmental Protection Agency or their counterparts for advice. Keep in mind that many dissection specimens can be ordered in formaldehyde-free preservatives; however, even formaldehyde-free specimens may not be accepted by local landfill organizations.
Human Anatomy and Physiology
Laboratory Safety Procedures

1. Upon entering the laboratory, locate exits, fire extinguisher, fire blanket, chemical shower, eye wash station, first aid kit, broken glass containers, and cleanup materials for spills.

2. Do not eat, drink, smoke, handle contact lenses, store food, and apply cosmetics or lip balm in the laboratory. Restrain long hair, loose clothing, and dangling jewelry.

3. Students who are pregnant, taking immunosuppressive drugs, or who have any other medical condition (e.g., diabetes, immunological defect) that might necessitate special precautions in the laboratory must inform the instructor immediately.

4. Wearing contact lenses in the laboratory is inadvisable because they do not provide eye protection and may trap material on the surface of the eye. If possible, wear regular eyeglasses instead.

5. Use safety glasses in all experiments involving liquids, aerosols, vapors, and gases.

6. Decontaminate work surfaces at the beginning and end of every laboratory period, using a commercially prepared disinfectant or 10% bleach solution. After labs involving dissection of preserved material, use hot soapy water or disinfectant.

7. Keep liquids away from the edge of the lab bench to help avoid spills. Liquids should be kept away from the edge of lab benches. Clean up spills of viable materials using disinfectant or 10% bleach solution.

8. Properly label glassware and slides.

9. Use mechanical pipetting devices; mouth pipetting is prohibited.

10. Wear disposable gloves when handling blood and other body fluids, mucous membranes, or nonintact skin, and/or when touching items or surfaces soiled with blood or other body fluids. Change gloves between procedures. Wash hands immediately after removing gloves. (Note: cover open cuts or scrapes with a sterile bandage before donning gloves.)

11. Place glassware and plasticware contaminated by blood and other body fluids in a disposable autoclave bag for decontamination by autoclaving or place them directly into a 10% bleach solution before reuse or disposal. Place disposable materials such as gloves, mouthpieces, swabs, and toothpicks that come into contact with body fluids into a disposable autoclave bag, and decontaminate before disposal.

12. To help prevent contamination by needle stick injuries, use only disposable needles and lancets. Do not bend needles and lancets. Needles and lancets should be placed promptly in a labeled puncture-resistant leakproof container and decontaminated, preferably by autoclaving.


14. Report all spills or accidents, no matter how minor, to the instructor.

15. Never work alone in the laboratory.

16. Remove protective clothing and wash hands before leaving the laboratory.
Laboratory Safety Acknowledgment Sheet

I hereby certify that I have read the safety recommendations provided for the laboratory and have located all of the safety equipment listed in Safety Procedure Number 1 of these procedures.

Student’s Name ____________________________

Course ____________________________ Date __________

Instructor’s Name ____________________________

Adapted from:


EXERCISE 1

The Language of Anatomy

If time is a problem, most of this exercise can be done as an out-of-class assignment.

Time Allotment: (in lab): 1/2 hour.

Multimedia Resources: See Appendix A for a list of multimedia resource distributors.
- Organ Systems Working Together (WNS, 14 minutes, VHS)
- The Human Body: The Ultimate Machine (CBS, 27 minutes, DVD)

Advance Preparation

1. Set out human torso models and have articulated skeletons available.
2. Obtain three preserved kidneys (sheep kidneys work well) and three bananas. Cut one of each in transverse section, one in longitudinal section (usually a sagittal section), and leave one uncut. Label the kidneys and put them in a demonstration area. You may wish to add a fourth kidney to demonstrate a frontal section.
3. The day before the lab, prepare gelatin or Jell-O® using slightly less water than is called for and cook the spaghetti until it is al dente. Pour the gelatin into several small molds and drop several spaghetti strands into each mold. Refrigerate until lab time.
4. Set out gelatin spaghetti molds and scalpel.

Comments and Pitfalls

1. Students will probably have the most trouble understanding proximal and distal; other than that there should be few problems.

Answers to Pre-Lab Quiz (p. 1)

1. false
2. b, toward or at the body surface
3. b, sagittal
Answers to Activity Questions

Activity 3: Practicing Using Correct Anatomical Terminology (p. 3)

1. The wrist is proximal to the hand.
2. The trachea (windpipe) is anterior or ventral to the spine.
3. The brain is superior or cephalad to the spinal cord.
4. The kidneys are inferior or caudal to the liver.
5. The nose is medial to the cheekbones.
6. The chest is superior to the abdomen.
7. The skin is superficial to the skeleton.
The Language of Anatomy

Surface Anatomy
1. Match each of the following descriptions with a key term, and record the term in front of the description.

<table>
<thead>
<tr>
<th>Key</th>
<th>brachial</th>
<th>buccal</th>
<th>carpal</th>
<th>cervical</th>
<th>deltoid</th>
<th>digital</th>
<th>patellar</th>
<th>scapular</th>
</tr>
</thead>
<tbody>
<tr>
<td>buccal</td>
<td>1. cheek</td>
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<tr>
<td>digital</td>
<td>2. referring to the fingers</td>
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<tr>
<td>scapular</td>
<td>3. shoulder blade region</td>
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<td>carpal</td>
<td>4. wrist area</td>
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<tr>
<td>patellar</td>
<td>5. anterior aspect of knee</td>
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<tr>
<td>brachial</td>
<td>6. referring to the arm</td>
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<tr>
<td>deltoid</td>
<td>7. curve of shoulder</td>
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<tr>
<td>cervical</td>
<td>8. referring to the neck</td>
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</tbody>
</table>

Body Orientation, Direction, Planes, and Sections
2. Several incomplete statements are listed below. Correctly complete each statement by choosing the appropriate anatomical term from the key. Record the key terms on the correspondingly numbered blanks below.

<table>
<thead>
<tr>
<th>Key</th>
<th>anterior</th>
<th>distal</th>
<th>inferior</th>
<th>lateral</th>
<th>posterior</th>
<th>proximal</th>
<th>superior</th>
<th>transverse</th>
<th>frontal</th>
<th>medial</th>
<th>sagittal</th>
</tr>
</thead>
<tbody>
<tr>
<td>anterior</td>
<td>1.</td>
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<td>posterior</td>
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<tr>
<td>superior</td>
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<td>medial</td>
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<tr>
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<td>anterior</td>
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<tr>
<td>medial</td>
<td>8.</td>
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<td>proximal</td>
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<tr>
<td>superior</td>
<td>10.</td>
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<tr>
<td>anterior</td>
<td>11.</td>
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<tr>
<td>inferior</td>
<td>12.</td>
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<tr>
<td>distal</td>
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<tr>
<td>transverse</td>
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<tr>
<td>frontal</td>
<td>15.</td>
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<tr>
<td>transverse</td>
<td>16.</td>
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<tr>
<td>frontal</td>
<td>17.</td>
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</tbody>
</table>

In the anatomical position, the umbilicus and knees are on the 1 body surface; the buttocks and shoulder blades are on the 2 body surface; and the soles of the feet are the most 3 part of the body. The ears are 4 and 4 to the shoulders and 5 to the nose. The breastbone is 6 to the vertebral column (spine) and 7 to the shoulders. The elbow is 8 to the shoulder but 9 to the fingers. The thoracic cavity is 10 to the abdominopelvic cavity and 11 to the spinal cavity. In humans, the ventral surface can also be called the 12 surface; however, in quadruped animals, the ventral surface is the 13 surface.

If an incision cuts the brain into superior and inferior parts, the section is a 14 section; but if the brain is cut so that anterior and posterior portions result, the section is a 15 section. You are told to cut a dissection animal along two planes so that the lungs are observable in both sections. The two sections that meet this requirement are the 16 and 17 sections.

3. A nurse informs you that she is about to give you a shot in the lateral femoral region. What portion of your body should you uncover? Side of upper thigh
4. Correctly identify each of the body planes by inserting the appropriate term for each on the answer line below the drawing.

1. **Median (mid-sagittal) plane**
2. **Frontal**
3. **Transverse**

**Body Cavities**

5. Which body cavity would have to be opened for the following types of surgery? Insert the key term(s) in the same-numbered blank. More than one choice may apply.

<table>
<thead>
<tr>
<th>Key:</th>
<th>abdominopelvic</th>
<th>dorsal</th>
<th>thoracic</th>
</tr>
</thead>
<tbody>
<tr>
<td>cranial</td>
<td>spinal</td>
<td>ventral</td>
<td></td>
</tr>
</tbody>
</table>

   1. surgery to remove a cancerous lung lobe
   2. removal of an ovary
   3. surgery to remove a ruptured disk
   4. appendectomy
   5. removal of the gallbladder

6. Correctly identify each of the described areas of the abdominal surface by inserting the appropriate term in the answer blank preceding the description.

   - **hypochondriac region**: overlies the lateral aspects of the lower ribs
   - **umbilical region**: surrounds the “belly button”
   - **hypogastric region**: encompasses the pubic area
   - **epigastric region**: medial region overlying the stomach

7. What are the bony landmarks of the abdominopelvic cavity? **Rib cage and pelvis**

8. Which body cavity affords the least protection to its internal structures? **Abdominopelvic cavity**
Organ Systems Overview

**Exercise 2**

**Time Allotment:** 1 1/2 hours (rat dissection—1 hour; human torso model—1/2 hour).

**Multimedia Resources:** See Appendix A for a list of multimedia resource distributors.

- *Homeostasis* (FHS, 20 minutes, VHS, DVD, 3-Year Streaming)
- *Homeostasis: The Body in Balance* (HRM, IM, 26 minutes, VHS, DVD)
- *The Human Body: The Ultimate Machine* (CBS, 27 minutes, DVD)
- *Organ Systems Working Together* (WNS, 14 minutes, VHS)

**Advance Preparation**

1. Make arrangements for appropriate storage and disposal of dissection materials. Check with the Department of Health or the Department of Environmental Protection, or their counterparts, for state regulations.

2. Designate a disposal container for organic debris, set up a dishwashing area with hot soapy water and sponges, and provide lab disinfectant such as Wavicide-01 (Carolina) for washing down the lab benches.

3. Set out safety glasses and disposable gloves for dissection of freshly killed animals (to protect students from parasites) and for dissection of preserved animals.

4. Decide on the number of students in each dissecting group (a maximum of four is suggested, two is probably best). Each dissecting group should have a dissecting pan, dissecting pins, scissors, blunt probe, forceps, twine, and a preserved or freshly killed rat.

5. Preserved rats are more convenient to use unless small mammal facilities are available. If live rats are used, they may be killed a half hour or so prior to the lab by administering an overdose of ether or chloroform. To do this, remove each rat from its cage and hold it firmly by the skin at the back of its neck. Put the rat in a container with cotton soaked in ether or chloroform. Seal the jar tightly and wait until the rat ceases to breathe.

6. Set out human torso models and a predissected rat.

**Comments and Pitfalls**

1. Students may be overly enthusiastic when using the scalpel and cut away organs they are supposed to locate and identify. Have blunt probes available as the major dissecting
tool and suggest that the scalpel be used to cut only when everyone in the group agrees that the cut is correct.

2. Be sure the lab is well ventilated, and encourage students to take fresh air breaks if the preservative fumes are strong. If the dissection animal will be used only once, it can be rinsed to remove most of the excess preservative.

3. Organic debris may end up in the sinks, clogging the drains. Remind the students to dispose of all dissection materials in the designated container.

Answers to Pre-Lab Quiz (p. 9)

1. The cell
2. nervous
3. respiratory
4. urinary
5. diaphragm

Answers to Activity Questions

Activity 6: Examining the Human Torso Model (pp. 15–16)

2. From top to bottom, the organs pointed out on the torso model are: brain, trachea, thyroid gland, lung, heart, diaphragm, liver, stomach, large intestine, small intestine

3. Digestive: esophagus, liver, stomach, pancreas, small intestine, large intestine (including rectum)
   Urinary: kidneys, ureters, bladder
   Cardiovascular: heart, descending aorta, inferior vena cava
   Endocrine: thyroid gland, pancreas, adrenal gland
   Reproductive: none
   Respiratory: lungs, bronchi, trachea
   Lymphatic: spleen
   Nervous: brain, spinal cord, medulla of adrenal gland
Organ Systems Overview

1. Using the key choices, indicate the body systems that match the following descriptions. Then, circle the organ systems (in the key) that are present in all subdivisions of the ventral body cavity.

<table>
<thead>
<tr>
<th>Key: cardiovascular</th>
<th>integumentary</th>
<th>nervous</th>
<th>urinary</th>
<th>muscular</th>
<th>respiratory</th>
<th>endocrine</th>
<th>lymphatic</th>
<th>digestive</th>
<th>reproductive</th>
<th>skeletal</th>
</tr>
</thead>
<tbody>
<tr>
<td>urinary</td>
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<td>endocrine</td>
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<tr>
<td>skeletal</td>
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<td>cardiovascular</td>
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<td>integumentary</td>
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<td></td>
</tr>
<tr>
<td>integumentary</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. rids the body of nitrogen-containing wastes
2. is affected by removal of the adrenal gland
3. protects and supports body organs; provides a framework for muscular action
4. includes arteries and veins
5. composed of “ductless glands” that secrete hormones
6. external body covering
7. houses cells involved in body immunity
8. breaks down ingested food into its absorbable units
9. loads oxygen into the blood
10. uses blood as a transport vehicle
11. generates body heat and provides for locomotion of the body as a whole
12. regulates water and acid-base balance of the blood
13. necessary for childbearing
14. is damaged when you fall and scrape your knee

2. Using the above key, choose the organ system to which each of the following sets of organs or body structures belongs:

<table>
<thead>
<tr>
<th>Lymphatic</th>
<th>1. lymph nodes, spleen, lymphatic vessels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skeletal</td>
<td>2. bones, cartilages, ligaments</td>
</tr>
<tr>
<td>Endocrine</td>
<td>3. thyroid, thymus, pituitary</td>
</tr>
<tr>
<td>Integumentary</td>
<td>4. skin, nails, hair</td>
</tr>
<tr>
<td>Respiratory</td>
<td>5. trachea, bronchi, alveoli</td>
</tr>
<tr>
<td>Reproductive</td>
<td>6. uterus, ovaries, vagina</td>
</tr>
<tr>
<td>Cardiovascular</td>
<td>7. arteries, veins, heart</td>
</tr>
<tr>
<td>Digestive</td>
<td>8. esophagus, large intestine, rectum</td>
</tr>
</tbody>
</table>
3. Using the key below, place the following organs in their proper body cavity:

Key: abdominopelvic cranial spinal thoracic

<table>
<thead>
<tr>
<th>abdominopelvic</th>
<th>1. stomach</th>
<th>abdominopelvic</th>
<th>6. urinary bladder</th>
</tr>
</thead>
<tbody>
<tr>
<td>thoracic</td>
<td>2. esophagus</td>
<td>thoracic</td>
<td>7. heart</td>
</tr>
<tr>
<td>abdominopelvic</td>
<td>3. large intestine</td>
<td>thoracic</td>
<td>8. trachea</td>
</tr>
<tr>
<td>abdominopelvic</td>
<td>4. liver</td>
<td>cranial</td>
<td>9. brain</td>
</tr>
<tr>
<td>spinal</td>
<td>5. spinal cord</td>
<td>abdominopelvic</td>
<td>10. rectum</td>
</tr>
</tbody>
</table>

4. Using the organs listed in item 3 above, record, by number, which would be found in the following abdominal regions:

| 3, 6, 10 | 1. hypogastric region |
| 3       | 2. right lumbar region |
| 3       | 3. umbilical region    |
| 3       | 4. epigastric region   |
| 1       | 5. left iliac region   |
| 1       | 6. left hypochondriac region |

5. The five levels of organization of a living body, beginning with the cell, are: cell, tissue, organ, organ system, and organism.

6. Define organ: A structure composed of two or more tissues that performs a specialized function.

7. Using the terms provided, correctly identify all of the body organs provided with leader lines in the drawings below. Then name the organ systems by entering the name of each on the answer blank below each drawing.

Key: blood vessels heart nerves spinal cord urethra brain kidney sensory organ ureter urinary bladder

1. Nervous
2. Cardiovascular
3. Urinary
EXERCISE 3

The Cell—Anatomy and Division

*The Anatomy of the Composite Cell section can be given as an out-of-class assignment to save time. This might be necessary if audiovisual material is used.*

**Time Allotment:** 2 hours.

**Multimedia Resources:** See Appendix A for a list of multimedia resource distributors.
- *A Journey Through the Cell* (FHS, 2-part series, 20 minutes each, DVD, 3-Year Streaming)
- *An Introduction to the Living Cell* (CBS, 30 minutes, DVD)
- *Inside the Living Cell* (WNS, set of 5, 50 minutes, VHS, DVD)
- *Mitosis and Meiosis* (DS, 2-part series, VHS, DVD)

**Advance Preparation**
1. Set out slides (one per student) of simple squamous epithelium, teased smooth muscle, human blood cell smear, sperm, and whitefish blastulae. Students will also need lens paper, lens cleaning solution, immersion oil, and compound microscopes.
2. Set out a model or a lab chart of a composite cell, and models of mitotic stages.
3. Set out pipe cleaners and chalk.
4. If available, arrange a viewing area for the mitosis video.

**Comments and Pitfalls**
1. Observing differences and similarities in cell structure often gives students trouble, as many of them have never seen any cells other than epithelial cells. Slides or pictures of these cell types might help.
Answers to Pre-Lab Quiz (p. 19)

1. The structural and functional unit of all living things.
2. a, chromatin
3. Ribosomes
4. c, mitochondria
5. interphase
6. b, interphase

Answers to Activity Questions

Activity 4: Observing Differences and Similarities in Cell Structure (p. 22)

3. Simple squamous epithelial cells are relatively large and irregularly (“fried egg”) shaped. Smooth muscle cells are also relatively large, but are long and spindle shaped. Red blood cells and sperm are both examples of small cells. Red blood cells appear round, while sperm cells are streamlined with long flagella.

Cell shape is often directly related to function. Epithelial cells fit tightly together and cover large areas. Elongated muscle cells are capable of shortening during contraction. The red blood cells are small enough to fit through capillaries, and are actually biconcave in shape, which makes them flexible and increases surface area (not obvious to the students at this point). Sperm cells’ streamlined shape and flagella are directly related to efficient locomotion.

The sperm cells have visible projections (flagella), which are necessary for sperm motility. The function of sperm is to travel through the female reproductive system to reach the ovum in the uterine tubes. This requires motility.

None of the cells lack a plasma membrane. Mature red blood cells have no nucleus. Nucleoli will probably be clearly visible in the epithelial cells, and possibly visible in the other nuclei.

No. Identifiable organelles are not visible in most of these cells. Filaments may be visible in the smooth muscle preparations. The details of organelle structure are usually below the limit of resolution of the light microscope. Unless special stains are used, there is no way to see or distinguish the organelles at this level.