INSTRUCTOR GUIDE

# Human Anatomy & Physiology Laboratory Manual

**CAT VERSION,** Tenth Edition
**MAIN VERSION,** Ninth Edition
**FETAL PIG VERSION,** Tenth Edition
**RAT VERSION,** First Edition

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# PREFACE

## Organization of this Instructor Guide

The Instructor Guide for Human Anatomy & Physiology Laboratory Manuals, Rat Version, First Edition, Main Version, Ninth Edition, and Cat and Fetal Pig Versions, Tenth Editions by Elaine N. Marieb and Susan J. Mitchell continues to feature a wealth of information for the anatomy and 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 lab manual Review Sheets have been integrated to follow each exercise. In some cases several acceptable answers have been provided. Answers to the dissection review questions are located in this guide with the dissection exercises.

Directions for use of the kymograph have been removed from the lab manual but appear in Exercise 16 in the Instructor Guide. Several complete exercises incorporating PowerLab®, iWorx®, and Intelitool® computer data acquisition and compilation systems, as well as instructions for the BIOPAC® software and 2-channel unit, can be downloaded from the Instructor Resource section of the new myA&P website for the Human Anatomy & Physiology Laboratory Manuals, and may be duplicated for student use.

The time allotment at the beginning of each exercise, indicated by the hourglass 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, Website, and streaming webcast. Information includes title, format, running time, and distributor. The key to distributor abbreviations is in the Guide to Multimedia Resource Distributors, Appendix B. Street and Web addresses of the distributors are also listed in Appendix B.

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

*Trends in Instrumentation* includes information about laboratory techniques and equipment, including information on PowerLab®, iWorx®, and Intelitool®. There are some suggestions about additional investigations using techniques and equipment not described in the laboratory manual.

The Laboratory Materials list in each exercise is intended as a convenience when ordering. Amounts listed assume a laboratory class of 24 students working in groups of four. Information about several supply houses appears in Appendix A. Note: The information provided is not an exhaustive list of suppliers.

## 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 may be found on pp. viii–ix, 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 glassware 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.

## Acknowledgments

Thanks to the team at Benjamin Cummings: Serina Beauparlant, Editor-in-Chief; Nicole Graziano, Associate Editor; Stacey Weinberger, Senior Manufacturing Buyer; and Derek Perrigo, Marketing Manager. Many thanks also to Michele Mangelli, Production Manager, and Leslie Austin, Production Supervisor.

Susan J. Mitchell

# 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, or 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. Clean up spills of viable materials using disinfectant or 10% bleach solution.
8. Properly label glassware and slides.
9. Use mechanical pipeting devices; mouth pipeting 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.
13. Do not leave heat sources unattended.
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 Form

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:

*Biosafety in Microbiological and Biomedical Laboratories* (BMBL), 5th Edition. 2007. US Government Printing Office. Washington, D.C. www.cdc.gov/od/OHS/biosfty/bmbl5/bmbl5toc.htm

Centers for Disease Control. 1996. "Universal Precautions for Prevention of Transmission of HIV and Other Bloodborne Infections." Washington, D.C. http://www.cdc.gov/ncidod/dhqp/bp_universal_precautions.html

Johnson, Ted, and Christine Case. 2010. *Laboratory Experiments in Microbiology*, Ninth Edition. San Francisco, CA: Pearson Benjamin Cummings.

S*chool Chemistry Laboratory Safety Guide*. 2006. U.S. Consumer Product Safety Commission. Bethesda, MD. http://www.cpsc.gov/CPSCPUB/PUBS/NIOSH2007107.pdf

# Trends in Instrumentation

Robert Anthony and Alan Wade, Triton College
Peter Zao, North Idaho College
Susan J. Mitchell, Onondaga Community College

*This section is designed for instructors interested in incorporating additional laboratory technologies and instrumentation into their anatomy and physiology courses. The following techniques will introduce students to some standard approaches and instrumentation currently used in clinical and research facilities. Although these techniques are used in various biology and chemistry laboratory courses, many students in basic anatomy and physiology are not routinely introduced to these skills. Rather than detailing specific laboratory procedures, this discussion will provide insight into some of the options for bringing technology into the introductory anatomy and physiology laboratory.*

*One of the standard methods available to medical technicians and researchers is computerized data acquisition. Currently available computer packages can measure and analyze various aspects of cardiac, reflex, muscle, and respiratory physiology. Other standard methods include chromatography, spectrophotometry, and electrophoresis. Applications of available computer data acquisition systems and clinical technologies for use in an anatomy and physiology laboratory are listed on the following pages. Included in each application are relevant exercises in the laboratory manual and a brief description of each possible application. A list of companies offering appropriate products is included in Appendix A.*

## Computerized Data Acquisition

Computerized equipment is commonly used to monitor patients in today's allied health areas. We have found that students appreciate the brief exposure to computers in our labs and begin to realize that a computer is not an intimidating machine, but a tool that allows them to perform specific tasks. Incorporating computer-based exercises into the lab also generates increased interest because most students realize that they will be using computers in their chosen professions.

Analog-to-digital converters can be used to create customized physiological data collection systems. Easy to use computer data acquisition systems include BIOPAC®, PowerLab®, Intelitool®, iWorx®, and Vernier® systems. The packages are designed for use in college-level courses and require minimal computer experience.

Directions for BIOPAC® are included in the lab manual. Exercises using PowerLab®, iWorx®, and Intelitool® can be downloaded from the Instructor Resource section of the myA&P companion website for the lab manuals at www.myaandp.com. The Vernier system can be easily adapted to sections of Exercises 31 and 31A.

## General Tips for Computer Data Acquisition Systems Use in the Laboratory

The following ideas are general guidelines designed as an introduction to the operation of computer acquisition systems. Each system contains the software, equipment, and basic instructions needed to conduct the experiments on a computer.

### Starting the Laboratory

- Prepare the laboratory for a computer-assisted data acquisition exercise by connecting the transducers and cables to the computer.
- Run through each exercise yourself so that you have a good idea of how much time is required to complete the activities in the given lab time period.

- You may wish to start the program so that the main menu is visible as the students sit down to work. If computer novices are left to start and prepare the system by themselves, their initial frustration may waste valuable lab time and detract from the experience.
- Once the program menu is up, students should be able to follow the exercise procedures without difficulty.
- It may be helpful to have an introductory lab designed to introduce the students to the general operation of the system.

## Exercises Based on the PowerLab® System

Laboratory Exercises with PowerLab® instructions are available for download from the Instructor Resource section of myA&P for the following lab exercises:

| | |
|---|---|
| Exercise 16A | Skeletal Muscle Physiology: Frogs and Human Subjects |
| Exercise 22 | Human Reflex Physiology |
| Exercise 31 | Conduction System of the Heart and Electrocardiography |
| Exercise 33A | Human Cardiovascular Physiology: Blood Pressure and Pulse Determinations |
| Exercise 34A | Frog Cardiovascular Physiology: Wet Lab |
| Exercise 37A | Respiratory System Physiology |

Comments and tips specific to each exercise are included in the instructions.

## Exercises Based on iWorx®

Laboratory Exercises with iWorx® instructions are available for download from the Instructor Resource section of myA&P for the following lab exercises:

| | |
|---|---|
| Exercise 16A | Electromyography in a Human Subject Using iWorx® |
| Exercise 20 | Electroencephalography Using iWorx® |
| Exercise 22 | Measuring Reaction Time Using iWorx® |
| Exercise 31 | Electrocardiography Using iWorx® |
| Exercise 33A | Measuring Pulse Using iWorx® |
| Exercise 34A | Recording Baseline Frog Heart Activity |
| Exercise 37A | Measuring Respiratory Variations |

## Exercises Based on Intelitool® Systems

Laboratory exercises with Intelitool® instructions are available for download from the Instructor Resource section of myA&P for the following lab exercises:

| | |
|---|---|
| Exercise 16A | Muscle Physiology |
| Exercise 22 | Human Reflex Physiology |
| Exercise 31 | Conduction System of the Heart and Electrocardiography |
| Exercise 37A | Respiratory System Physiology |

Comments and tips specific to each exercise are included on a separate Tips for Instructors page preceding each exercise.

## Exercises in Cell Physiology and Clinical Chemistry

Modern cell physiology lab exercises frequently involve biochemical analysis of cellular components and products. A number of techniques can be used to detect and quantify the constituents of cells and body fluids.

Some of the more commonly used clinical and research techniques include chromatography, spectrophotometry, and electrophoresis.[1]

## Chromatography

**Exercise 4: The Cell: Anatomy and Division** Introduce molecular separation techniques when discussing the cell (or macromolecules).

**Exercise 29: Blood** Separate protein and lipid components during blood analysis.

### *Application*

Chromatographic techniques have a number of applications in cell physiology and chemistry. Chromatography is used for separation and identification of components in mixtures containing amino acids, nucleic acids, sugars, vitamins, steroids, antibiotics, and other drugs.

The major forms of chromatography for the college physiology laboratory include thin-layer, paper, column, gas-liquid, and high-performance liquid chromatography. Descriptions of these procedures and their clinical applications can be found in a number of clinical method manuals.[2]

Gas and high-performance liquid chromatography offer the greatest sensitivity and quantitative ability, but the high initial investment usually makes these systems prohibitive unless they are already in place.

Thin-layer and paper chromatography are economical, and they can be performed with a minimum of equipment. Both methods can be used as qualitative or semiquantitative screening techniques to detect the presence of both endogenous and exogenous compounds.[3]

An example of a clinically significant screening test is the determination by thin-layer chromatography of abnormal levels of certain amino acids that are associated with genetic diseases affecting metabolism. The disorders phenylketonuria, alkaptonuria, and homocystinuria result in abnormal levels of phenylalanine, homogentisic acid, and methionine, respectively, in the urine and blood. The sample and standards are applied to a thin-layer plate coated with cellulose acetate, or a silica gel, or to a Whatman #4 chromatography paper, and run in a butanol/acetic acid/water solvent. For visualization and identification of amino acids, an indicator such as ninhydrin may be used. The color intensity for the appropriate amino acids can be compared to normal values.

## Spectrophotometry

**Exercise 29A: Blood** Analyze protein or lipid composition, or enzyme hydrolysis.

**Exercise 41A: Urinalysis** Analyze various substances present in urine.

**Exercise 39A: Chemical and Physical Processes of Digestion** Quantitative spectrophotometric analysis of enzyme hydrolysis.

### *Application*

Spectrophotometry is a common procedure used in clinical and research settings for determining concentrations of substances in solution, based on the amount of radiant energy transmitted through or absorbed by a substance in solution. Spectrophotometric measurements include total protein, total lipid, cholesterol, lipoprotein, and hemoglobin.

Spectrophotometry can also be used as a quantitative measure of enzymatic hydrolysis using commercially available colorigenic substrates. Most determinations in spectrophotometry utilize wavelengths in visible or ultraviolet ranges. For a more detailed description of the theory of spectrophotometry and use of the equipment, refer to a biochemistry or clinical methods manual.

1. Due to the hazards associated with the laboratory use of human body fluids, it may be advisable to avoid using student-drawn blood samples for analysis. There are a wide variety of commercially available blood components, both normal and abnormal, as well as blood component standards.
2. A. J. Pesce and L. A. Kaplan. 1987. *Methods in Clinical Chemistry*. C.V. Mosby Co.; M. L. Bishop, J. L. Duben-Von Laufen, E. P. Fody. 2000. *Clinical Chemistry: Principles, Procedures, Correlations*, Fourth Edition. Lippincott Williams & Wilkins.
3. J. C. Touchstone and M. F. Dobbins. 1992. *The Practice of Thin-Layer Chromatography*, Third Edition. John Wiley and Sons.

Diagnostic kits (for specific diseases) include:

1. Bilirubin (liver disease)
2. Total cholesterol and HDL cholesterol (atherosclerosis)
3. Creatine kinase (striated muscle damage)
4. Hemoglobin (anemia)
5. Creatinine (kidney disease)

### Electrophoresis

**Exercise 29A: Blood** Analyze protein and lipid components of blood.

**Exercise 45: Principles of Heredity** DNA fingerprinting systems, comparison of adult and sickle-cell hemoglobin.

#### *Application*

Electrophoretic techniques, which demonstrate the migration and separation of charged solutes in an electrical field, have many important applications in cell and molecular biology. The most commonly used techniques involve zone electrophoresis, in which migration occurs within a semisolid support medium. In a majority of these procedures, agarose, polyacrylamide, or sodium dodecyl sulfate gels are used as the support medium. Sample migration can be horizontal or vertical, depending on the type of apparatus. Directions for agarose gel separation of hemoglobin can be found in Exercise 45 of the laboratory manual.

An increasing number of supply companies are recognizing the importance of studies in molecular biology and their impact on the study of cell physiology and human disease. The companies are becoming involved with biotechnology education by offering lab systems that are designed to introduce the methods of molecular biology and biotechnology to students at the pre-college and college levels. These systems are often in kit form and facilitate hands-on experience with a variety of important procedures. Some of the experimental systems available are:

1. Molecular weight determination (proteins)
2. Separation and identification of serum proteins
3. Cardiac risk assessment—analysis of lipoproteins
4. DNA fingerprinting—restriction fragmentation patterns

### Sources of Equipment and Reagents

Supplies for the biochemical techniques described in the above section can be obtained from the supply houses listed in Appendix A. The list is by no means complete but includes companies that are familiar to most educators. The Intelitool® products are best obtained directly from the company rather than through another vendor, as delivery times are much quicker.

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**: 1/2 hour (in lab).

**Multimedia Resources**: See Appendix B for Guide to Multimedia Resource Distributors.

*A.D.A.M.® Interactive Anatomy 4.0* (AIA: CD-ROM, DVD)

## Laboratory Materials

*Ordering information is based on a lab size of 24 students, working in groups of 4. A list of supply house addresses appears in Appendix A.*

1–2 human torso models
2 human skeletons, one male and one female
3–4 preserved kidneys (sheep)
Scalpels
Gelatin-spaghetti molds

## Advance Preparation

1. Set out human torso models and have articulated skeletons available.
2. Obtain three preserved kidneys (sheep kidneys work well). Cut one 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, often confusing these terms with superior and inferior. They also find the terms anterior/ventral and posterior/dorsal confusing because these terms refer to the same directions in humans, but different directions in four-legged animals. Other than that there should be few problems.

## Answers to Pre-Lab Quiz (p. 1)

1. false
2. axial
3. b, toward or at the body surface
4. b, sagittal
5. cranial, vertebral
6. Heart

## Answers to Activity Questions

### Activity 2: Practicing Using Correct Anatomical Terminology (p. 4)

The wrist is *proximal* to the hand.

The trachea (windpipe) is *anterior* or *ventral* to the spine.

The brain is *superior* or *cephalad* to the spinal cord.

The kidneys are *inferior* or *caudal* to the liver.

The nose is *medial* to the cheekbones.

The thumb is *lateral* to the ring finger.

The thorax is *superior* or *cephalad* to the abdomen.

The skin is *superficial* to the skeleton.

### Activity 4: Identifying Organs in the Abdominopelvic Cavity (p. 9)

Name two organs found in the left upper quadrant: *stomach, spleen, large intestine*

Name two organs found in the right lower quadrant: *small intestine, large intestine, appendix*

What organ is divided into identical halves by the median plane line? *urinary bladder*

NAME _____

LAB TIME/DATE _____

REVIEW SHEET 1

EXERCISE

# The Language of Anatomy

## Surface Anatomy

**1.** Match each of the following descriptions with a key equivalent, and record the key letter or term in front of the description.

*Key:* a. buccal c. cephalic e. patellar
b. calcaneal d. digital f. scapular

*a; buccal* 1. cheek

*d; digital* 2. pertaining to the fingers

*f; scapular* 3. shoulder blade region

*e; patellar* 4. anterior aspect of knee

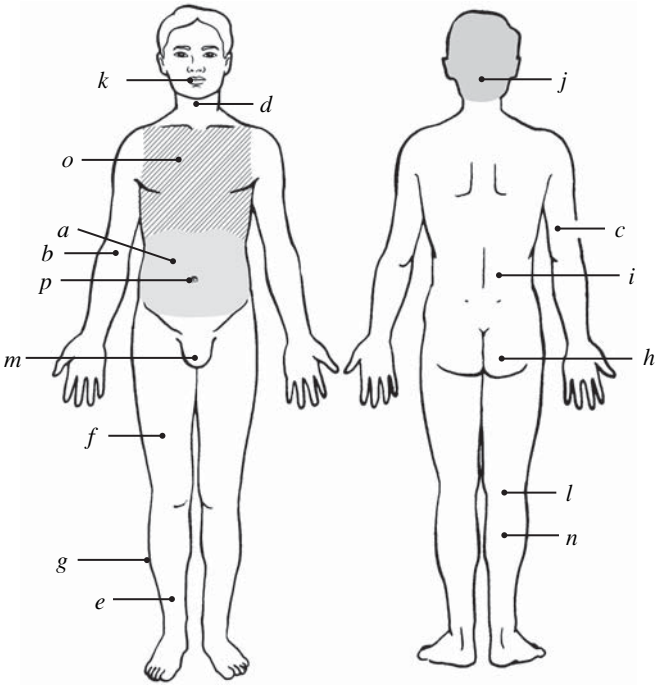
*b; calcaneal* 5. heel of foot

*c; cephalic* 6. pertaining to the head

**2.** Indicate the following body areas on the accompanying diagram by placing the correct key letter at the end of each line.

*Key:*

a. abdominal
b. antecubital
c. brachial
d. cervical
e. crural
f. femoral
g. fibular
h. gluteal
i. lumbar
j. occipital
k. oral
l. popliteal
m. pubic
n. sural
o. thoracic
p. umbilical




**3.** Classify each of the terms in the key of question 2 above into one of the large body regions indicated below. Insert the appropriate key letters on the answer blanks.

*b, c, e, f, g, l, n* 1. appendicular

*a, d, h, i, j, k, m, o, p* 2. axial

## Body Orientation, Direction, Planes, and Sections

**4.** Describe completely the standard human anatomical position. *Standing erect, feet together, head and toes pointed forward, arms hanging at sides with palms forward.*

**5.** Define *section*. *A cut along an imaginary plane through the body wall or organ.*

**6.** Several incomplete statements are listed below. Correctly complete each statement by choosing the appropriate anatomical term from the key. Record the key letters and/or terms on the correspondingly numbered blanks below.

*Key:*

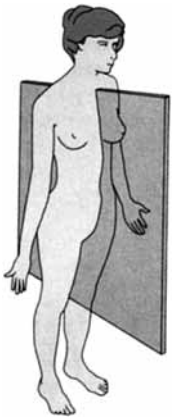
| | | | | | | | |
|---|---|---|---|---|---|---|---|
| a. | anterior | d. | inferior | g. | posterior | j. | superior |
| b. | distal | e. | lateral | h. | proximal | k. | transverse |
| c. | frontal | f. | medial | i. | sagittal | | |

In the anatomical position, the face and palms are on the _1_ body surface; the buttocks and shoulder blades are on the __2_ body surface; and the top of the head is the most _3_ part of the body. The ears are _4_ and _5_ to the shoulders and _6_ to the nose. The heart is _7_ to the vertebral column (spine) and _8_ to the lungs. The elbow is _9_ to the fingers but _10_ to the shoulder. The abdominopelvic cavity is _11_ to the thoracic cavity and _12_ to the spinal cavity. In humans, the dorsal surface can also be called the _13_ surface; however, in quadruped animals, the dorsal surface is the _14_ surface.

If an incision cuts the heart into right and left parts, the section is a _15_ section; but if the heart is cut so that superior and inferior portions result, the section is a _16_ section. You are told to cut a dissection animal along two planes so that both kidneys are observable in each section. The two sections that will always meet this requirement are the _17_ and _18_ sections. A section that demonstrates the continuity between the spinal and cranial cavities is a _19_ section.

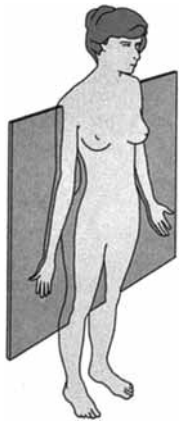
1. *a; anterior*
2. *g; posterior*
3. *j; superior*
4. *f; medial*
5. *j; superior*
6. *e; lateral*
7. *a; anterior*
8. *f; medial*
9. *h; proximal*
10. *b; distal*
11. *d; inferior*
12. *a; anterior*
13. *g; posterior*
14. *j; superior*
15. *i; sagittal*
16. *k; transverse*
17. *c; frontal*
18. *k; transverse*
19. *i; sagittal*

**7.** Correctly identify each of the body planes by inserting the appropriate term for each on the answer line below the drawing.



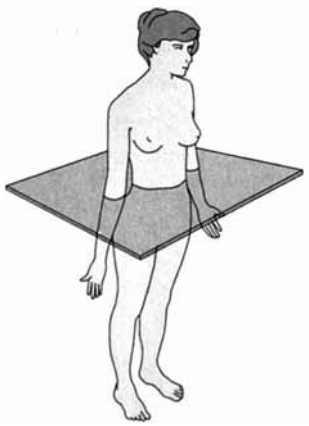
**(a)**

*median (mid-sagittal) plane*



**(b)**

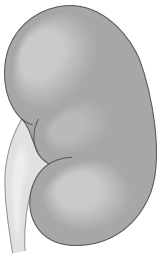
*frontal plane*

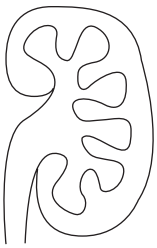


**(c)**

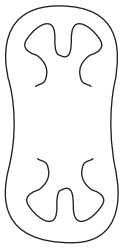
*transverse plane*

**8.** Draw a kidney as it appears when sectioned in each of the three different planes.

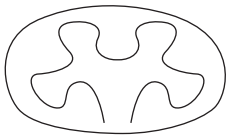




*frontal section*



*sagittal section*



*transverse section*

**9.** Correctly identify each of the nine areas of the abdominal surface by inserting the appropriate term for each of the letters indicated in the drawing.

a. *epigastric region*

b. *right hypochondriac region*

c. *left hypochondriac region*

d. *umbilical region*

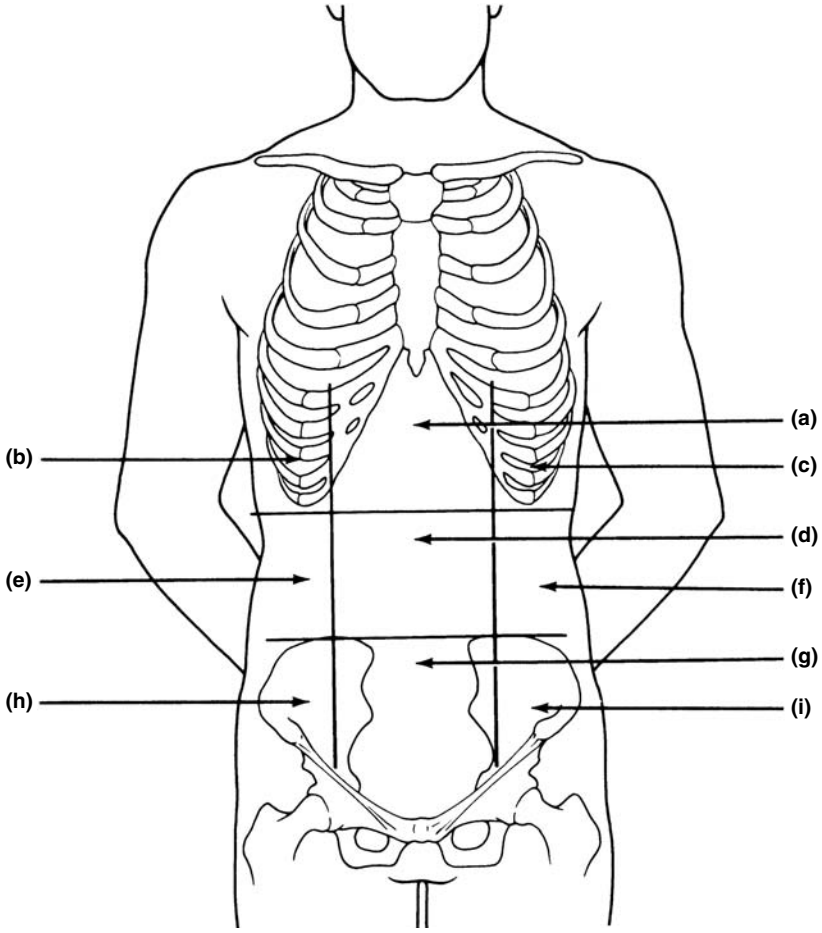
e. *right lumbar region*

f. *left lumbar region*

g. *hypogastric (pubic) region*

h. *right iliac reigon*

i. *left iliac region*




## Body Cavities

**10.** Which body cavity would have to be opened for the following types of surgery or procedures? (Insert letter of key choice in same-numbered blank. More than one choice may apply.)

*Key:* a. abdominopelvic b. cranial c. dorsal d. spinal e. thoracic f. ventral

*e, f* 1. surgery to remove a cancerous lung lobe

*a, f* 2. removal of the uterus, or womb

*b, c* 3. removal of a brain tumor

*a, f* 4. appendectomy

*a, f* 5. stomach ulcer operation

*d, c* 6. delivery of pre-operative "saddle" anesthesia

**11.** Name the muscle that subdivides the ventral body cavity. *Diaphragm*

**12.** Which organ system would not be represented in any of the body cavities? *Skeletal, muscular, integumentary*

**13.** What are the bony landmarks of the abdominopelvic cavity? *Dorsally, the vertebral column; laterally and anteriorly, the pelvis*

**14.** Which body cavity affords the least protection to its internal structures? *Abdominal*

**15.** What is the function of the serous membranes of the body? *The serous membranes produce a lubricating fluid (serous fluid) that reduces friction as organs slide across one another or against the cavity walls during their functioning.*

**16.** Using the key choices, identify the small body cavities described below.

*Key:* a. middle ear cavity; b. nasal cavity; c. oral cavity; d. orbital cavity; e. synovial cavity

*d; orbital cavity* 1. holds the eyes in an anterior-facing position

*a; middle ear cavity* 2. houses three tiny bones involved in hearing

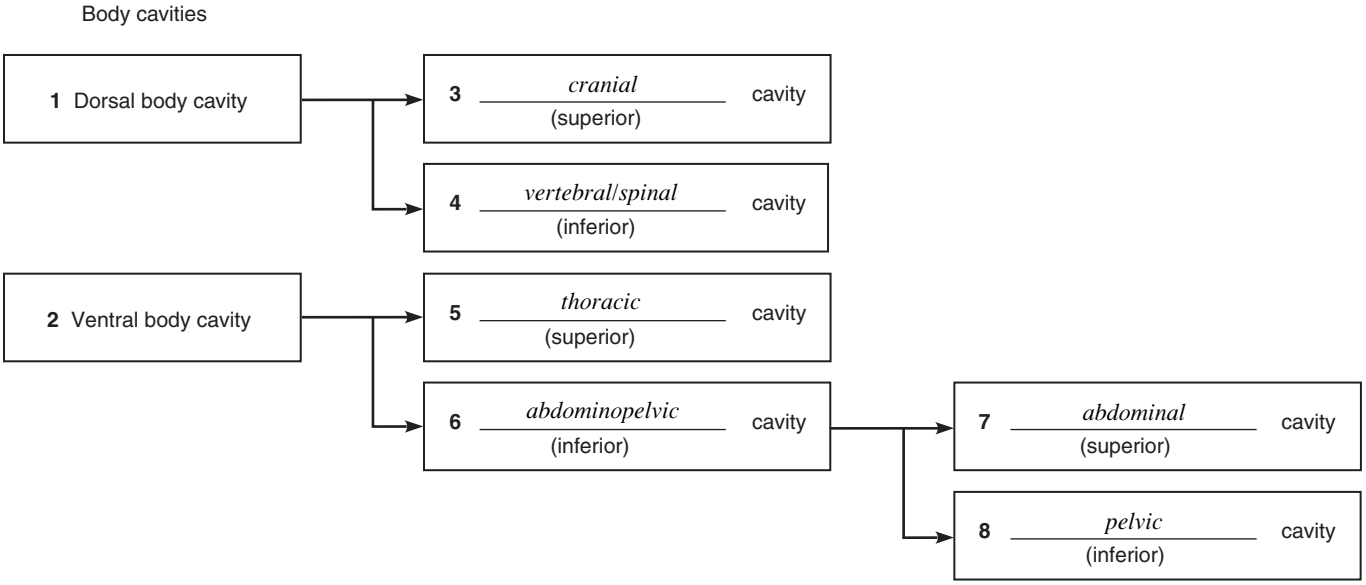
*b; nasal cavity* 3. contained within the nose

*c; oral cavity* 4. contains the tongue

*e; synovial cavity* 5. lines a joint cavity

**17.** On the incomplete flowchart provided below:

- Fill in the cavity names as appropriate to boxes 3–8.
- Then, using either the name of the cavity or the box numbers, identify the descriptions in the list that follows.




*1* a. contained within the skull and vertebral column

*8* b. houses female reproductive organs

*1, 3, or 4* c. the most protective body cavity

*2* d. its name means belly

*5* e. contains the heart

*6 or 7* f. contains the small intestine

*5* g. bounded by the ribs

*6 or 7* h. its walls are muscular

EXERCISE 2

# Organ Systems Overview

**Time Allotment**: 1 1/2 hours (rat dissection: 1 hour; if performing reproductive system dissection, 1/2 hour each for male and female; dissectible human torso model: 1/2 hour).

**Multimedia Resources**: See Appendix B for Guide to Multimedia Resource Distributors.

*Homeostasis* (FHS: 20 minutes, VHS, DVD, 3-year streaming webcast)
*Homeostasis: The Body in Balance* (HRM: 26 minutes, VHS, DVD)
*Organ Systems Working Together* (WNS: 14 minutes, VHS)
*Practice Anatomy Lab™ 2.0* (*PAL*) (BC: CD-ROM, Website)

**Solutions**:

*Bleach Solution, 10%*
Measure out 100 milliliters of household bleach. Add water to a final volume of 1 liter.

## Laboratory Materials

***Ordering information is based on a lab size of 24 students, working in groups of 4. A list of supply house addresses appears in Appendix A.***

Dissectible human torso model or cadaver
6–12 forceps
6–12 scissors
6–12 blunt probes
Disposable gloves, soap, and sponges
6–12 freshly killed or preserved rats
Twine or large dissecting pins
6–12 dissecting trays
Lab disinfectant or 10% bleach solution

## 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) or bleach solution 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 dissectible human torso models and a dissected human cadaver if available.

## Comments and Pitfalls

1. Students may be overly enthusiastic when using the scalpel and cut away organs they are supposed to locate and identify. Therefore, use scissors to open the body. Have blunt probes available as the major dissecting tool.
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.
4. Inferior vena cava and aorta may be difficult to distinguish in uninjected specimens.

## Answers to Pre-Lab Quiz (p. 15)

1. The cell
2. c, organ
3. nervous
4. respiratory
5. urinary
6. diaphragm

## Answers to Activity Questions

### Activity 5: Examining the Human Torso Model (p. 24)

2. From top to bottom, the organs pointed out on the torso model are: *brain, trachea, thyroid gland, lung, heart, diaphragm, liver, stomach, spleen, large intestine, greater omentum, small intestine*
3. Dorsal body cavity: *brain, spinal cord*

   Thoracic cavity: *aortic arch, bronchi, descending aorta (thoracic region), esophagus, heart, inferior vena cava, lungs, and trachea*

   Abdominopelvic cavity: *adrenal gland, descending aorta (abdominal region), greater omentum, inferior vena cava, kidneys, large intestine, liver, mesentery, pancreas, rectum, small intestine, spleen, stomach, ureters, urinary bladder*

   Note: The diaphragm separates the thoracic cavity from the abdominopelvic cavity.

   Right Upper Quadrant: *right adrenal gland, right kidney, large and small intestine, liver, mesentery, pancreas, stomach, right ureter*

   Left Upper Quadrant: *left adrenal gland, descending aorta, greater omentum, left kidney, large and small intestine, mesentery, pancreas, spleen, stomach, left ureter*

   Right Lower Quadrant: *large and small intestine, mesentery, rectum, right ureter, urinary bladder*

   Left Lower Quadrant: *descending aorta, greater omentum, large and small intestine, left ureter, urinary bladder*
4. Digestive: *esophagus, liver, stomach, pancreas, small intestine, large instestine (including rectum)*

   Urinary: *kidneys, ureters, urinary bladder*

   Cardiovascular: *aortic arch, heart, descending aorta, inferior vena cava*

   Endocrine: *pancreas, adrenal gland, thyroid gland*

   Reproductive: *none*

   Respiratory: *lungs, bronchi, trachea*

   Lymphatic/Immunity: *spleen*

   Nervous: *brain, spinal cord*

NAME _____

LAB TIME/DATE _____

REVIEW SHEET EXERCISE 2

# Organ Systems Overview

**1.** Use the key below to indicate the body systems that perform the following functions for the body. Then, circle the organ systems (in the key) that are present in all subdivisions of the ventral body cavity.

*Key:* a. (cardiovascular) b. (digestive) c. (endocrine) d. integumentary e. (lymphatic/immunity) f. muscular g. (nervous) h. reproductive i. respiratory j. skeletal k. urinary

*k; urinary* 1. rids the body of nitrogen-containing wastes

*c; endocrine* 2. is affected by removal of the thyroid gland

*j; skeletal* 3. provides support and levers on which the muscular system acts

*a; cardiovascular* 4. includes the heart

*c; endocrine (h; reproductive)* 5. causes the onset of the menstrual cycle

*d; integumentary* 6. protects underlying organs from drying out and from mechanical damage

*e; lymphatic/immunity* 7. protects the body; destroys bacteria and tumor cells

*b; digestive* 8. breaks down ingested food into its building blocks

*i; respiratory* 9. removes carbon dioxide from the blood

*a; cardiovascular* 10. delivers oxygen and nutrients to the tissues

*f; muscular* 11. moves the limbs; facilitates facial expression

*k; urinary* 12. conserves body water or eliminates excesses

*c; endocrine* and *h; reproductive* 13. facilitate conception and childbearing

*c; endocrine* 14. controls the body by means of chemical molecules called hormones

*d; integumentary* 15. is damaged when you cut your finger or get a severe sunburn

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

*e; lymphatic/immunity* 1. thymus, spleen, lymphatic vessels

*j; skeletal* 2. bones, cartilages, tendons

*c; endocrine* 3. pancreas, pituitary, adrenals

*i; respiratory* 4. trachea, bronchi, alveoli

*d; integumentary* 5. epidermis, dermis, and cutaneous sense organs

*h; reproductive* 6. testis, ductus deferens, urethra

*b; digestive* 7. esophagus, large intestine, rectum

*f; muscular* 8. muscles of the thigh, postural muscles

**3.** Using the key below, place the following organs in their proper body cavity.

*Key:*

a. abdominopelvic b. cranial c. spinal d. thoracic

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| *a; abdominopelvic* | 1. | stomach | *a; abdominopelvic* | 4. | liver | *d; thoracic* | 7. | heart |
| *d; thoracic* | 2. | esophagus | *c; spinal* | 5. | spinal cord | *d; thoracic* | 8. | trachea |
| *a; abdominopelvic* | 3. | large intestine | *a; abdominopelvic* | 6. | urinary bladder | *a; abdominopelvic* | 9. | rectum |

**4.** Using the organs listed in question 3 above, record, by number, which would be found in the abdominal regions listed below.

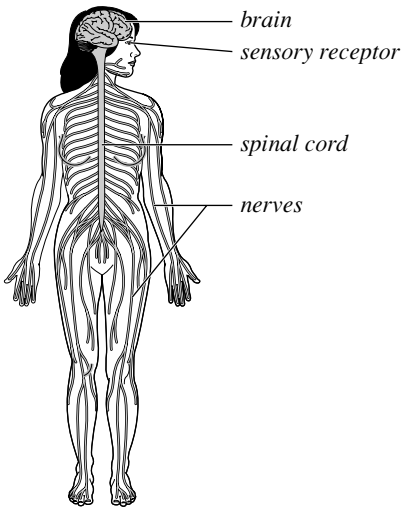
| | | | | | |
|---|---|---|---|---|---|
| *3, 6, 9* | 1. | hypogastric region | *1, 3, 4* | 4. | epigastric region |
| *3* | 2. | right lumbar region | *3* | 5. | left iliac region |
| *3* | 3. | umbilical region | *1, 3, 4* | 6. | left hypochondriac region |

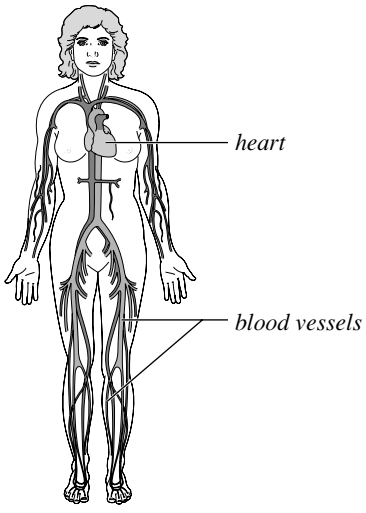
**5.** The levels of organization of a living body are chemical, *cell*, *tissue*, *organ*, *organ system*, and organism.

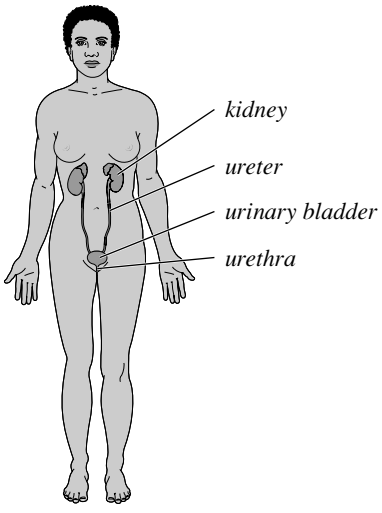
**6.** Define *organ*. *A body part (or structure) that is made up of two or more tissue types and performs a specific body function, e.g., the stomach, the kidney*

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

*Key:* blood vessels, brain, heart, kidney, nerves, sensory receptor, spinal cord, ureter, urethra, urinary bladder




a. *nervous system* b. *cardiovascular system* c. *urinary system*

**8.** Why is it helpful to study the external and internal structures of the rat? *Many of the external and internal structures are similar to those in the human. Studying the rat can help you to understand your own structure.*

EXERCISE 3

# The Microscope

*If students have already had an introductory biology course where the microscope has been introduced and used, there might be a temptation to skip this exercise. I have found that most students need the review, so I recommend spending this time early in the course to make sure they are all comfortable with the microscope, as it is used extensively throughout the laboratory manual.*

**Time Allotment**: 2 hours.

**Solutions**:

*Bleach Solution, 10%*
Measure out 100 milliliters of household bleach. Add water to a final volume of 1 liter.

*Methylene Blue Solution (Loeffler's)*
Weigh out 0.5 gram methylene blue, 1 milliliter 1% potassium hydroxide solution, and 30 milliliters ethanol, absolute. Add to 100 milliliters distilled water. Warm the water to about 50 degrees C, stir in methylene blue and add other ingredients; filter.

*Physiologic Saline (Mammalian, 0.9%)*
Weigh out 9 grams of NaCl. Add distilled/deionized water to a final volume of 1 liter. Make fresh just prior to experiment.

## Laboratory Materials

*Ordering information is based on a lab size of 24 students, working in groups of 4. A list of supply house addresses appears in Appendix A.*

24 compound microscopes, lens cleaning solution, lens paper, immersion oil
24 millimeter rulers
24 slides of the letter *e*
24 slides with millimeter grids
24 slides of crossed colored threads (threads should cross at a single junction)
Filter paper or paper towels
1 box of microscope slides
1 box of coverslips
1 box of flat-tipped toothpicks
8–12 dropper bottles of physiologic saline
8–12 dropper bottles of methylene blue stain (dilute) or iodine
24 slides of cheek epithelial cells
10% bleach solution
Autoclave bag, disposable

## Advance Preparation

1. Provide each student with a compound microscope, millimeter ruler, bottle of immersion oil, lens paper, and millimeter grid slide. A supply of glass cleaner, such as Windex™, should be available for lens cleaning.
2. Have available slides of the letter *e* and slides of crossed colored threads. Some instructors prefer to have slides for an entire semester available in individual boxes, which can be handed out to students. Others prefer to keep the slides on trays to be distributed as needed.
3. Set up an area for wet mount supplies, including clean microscope slides and coverslips, flat-tipped toothpicks, *physiologic saline*, methylene blue stain or iodine, and filter paper, or set out prepared slides of cheek epithelial cells.