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.

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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

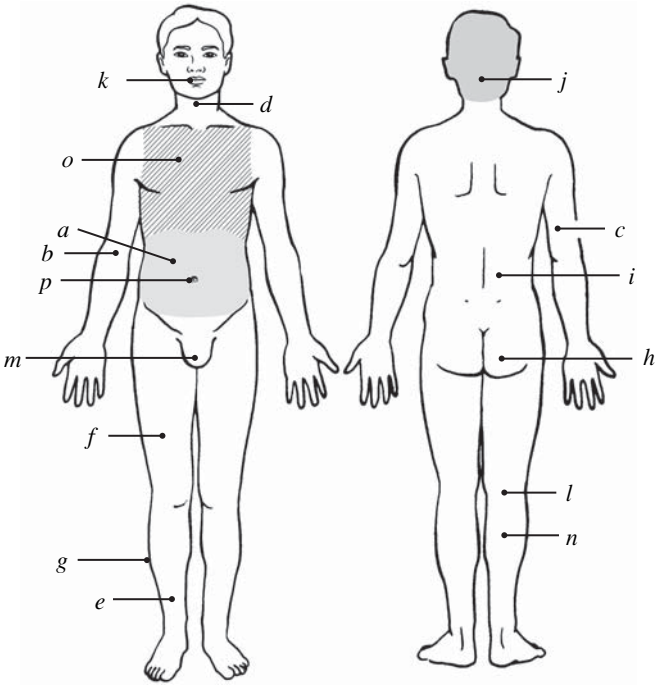
b; calcaneal 5. heel of foot

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:

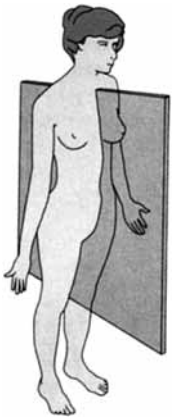
a.	anterior	d.	inferior	g.	posterior	j.	superior
b.	distal	e.	lateral	h.	proximal	k.	transverse
c.	frontal	f.	medial	i.	sagittal		

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.

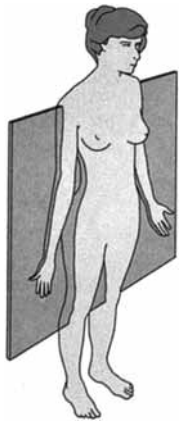
1. *a; anterior*
2. *g; posterior*
3. *j; superior*
4. *f; medial*
5. *j; superior*
6. *e; lateral*
7. *a; anterior*
8. *f; medial*
9. *h; proximal*
10. *b; distal*
11. *d; inferior*
12. *a; anterior*
13. *g; posterior*
14. *j; superior*
15. *i; sagittal*
16. *k; transverse*
17. *c; frontal*
18. *k;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



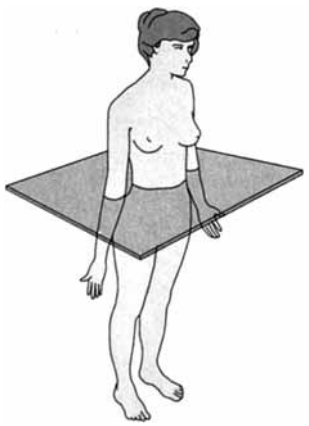
(a)

median (mid-sagittal) plane



(b)

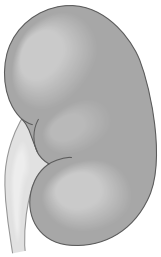
frontal plane

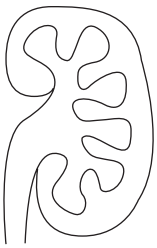


(c)

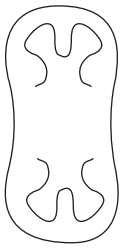
transverse plane

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

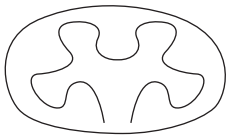




frontal section



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*

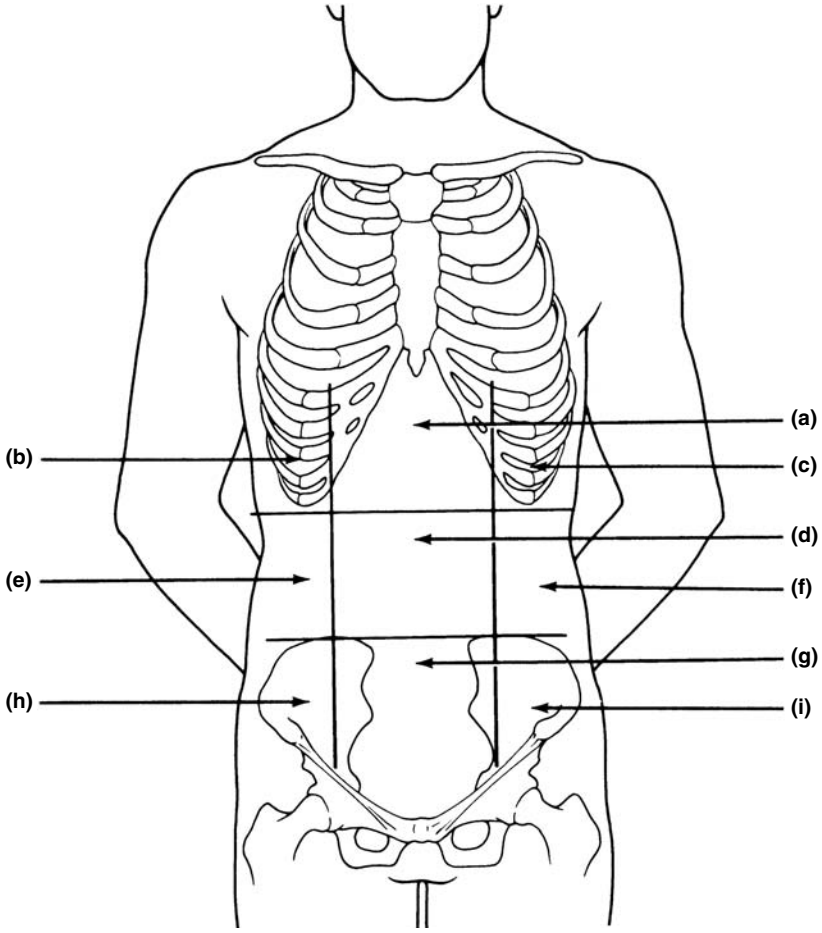
e. *right lumbar region*

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

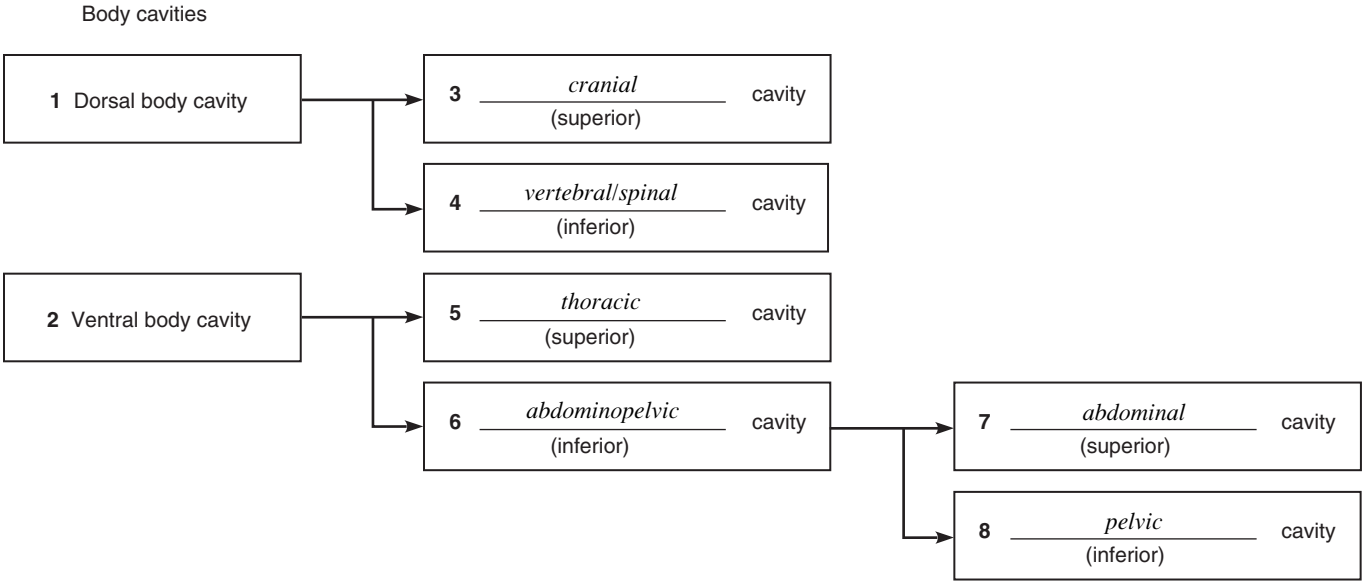
b; nasal cavity 3. contained within the nose

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.

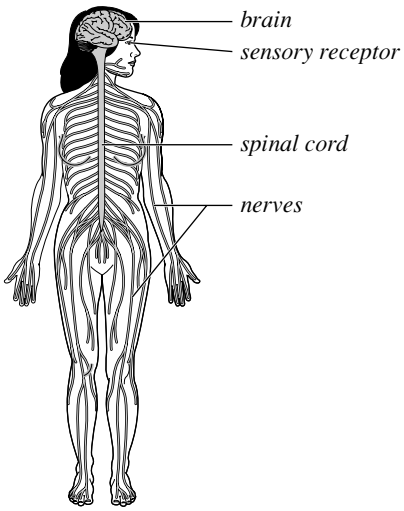
3, 6, 9	1.	hypogastric region	*1, 3, 4*	4.	epigastric region
3	2.	right lumbar region	*3*	5.	left iliac region
3	3.	umbilical region	*1, 3, 4*	6.	left hypochondriac region

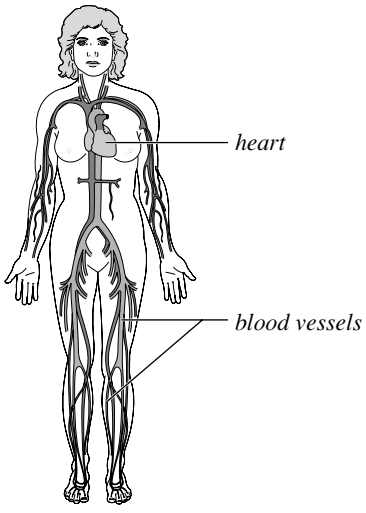
5. The levels of organization of a living body are chemical, *cell*, *tissue*, *organ*, *organ system*, and organism.

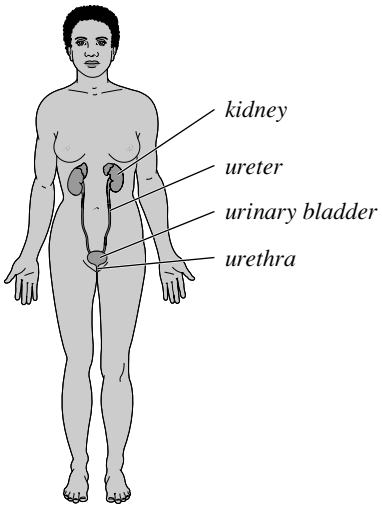
6. Define *organ*. *A body part (or structure) that is made up of two or more tissue types and performs a specific body function, e.g., the stomach, the kidney*

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.

4. Set up a disposal area containing a 1L beaker of *10% bleach solution* and an autoclave bag. Note: Detailed instructions for treatment and disposal of materials used in labs involving human tissue and excretions are found in the preface of this Instructor Guide.
5. If the microscopes are binocular rather than monocular, give additional instructions on focusing.
   a. After the parts of the microscope have been identified, turn on the light and adjust the interpupillary distance so that a single circle of light is visible through the eyepieces. This is difficult for some students, usually because they are moving back and forth and changing their eye position. Have each student record his/her own interpupillary distance for later use.
   b. For a microscope with an adjustable left eyepiece, focus the microscope as directed, using the right eye only.
   c. Focus using the left eyepiece with the right eye closed. Both eyepieces should now be focused on the specimen. (Reverse the directions if the right eyepiece is adjustable.)
6. The directions for perceiving depth (p. 33) are for microscopes with objective lenses that advance and retract during focusing. If the stage moves during focusing, the superior thread will come into focus first if these directions are followed. Alter instructions if necessary.

Comments and Pitfalls

1. Be sure to have the students check the orientation of the letter *e* on the slide before putting the slide on the microscope. If they forget to check, they will miss the point of the exercise.
2. Beware of common focusing problems: dirty lenses, inverted slide, objective lens not securely in place, and wrong lens in position (oil immersion instead of high-power).
3. It is difficult to use a millimeter ruler to measure the working distance of the high-power and oil immersion lenses on some microscopes. A best estimate is usually sufficient.
4. Many students have difficulty with the section on determining the size of the microscope field. The direct measurement is usually no problem, although some students measure area rather than diameter, and some students will have both the letter *e* slide and the grid on the stage at the same time. Emphasize that direct measurement should be done using only one lens. Otherwise, measuring discrepancies cause confusion. The problem is often with the math involved. It is probably worthwhile to stop the class and work through the use of the formula (p. 32) when you see that most students are at this point in the exercise.
5. Clarify what is meant by "detail observed" in the chart on p. 31.
6. Students may forget safety precautions when preparing the wet mount. Emphasize the importance of following directions for safe disposal of toothpicks and proper cleanup of glassware.
7. Many students forget to adjust the iris diaphragm and may end up using the light at its highest intensity, which is hard on the bulb. Remind students that the iris diaphragm should be adjusted so that the field is just filled with light when observed with the ocular lens removed. In practice, it may be necessary to adjust the iris diaphragm for best contrast, although some resolution may be lost.

Answers to Pre-Lab Quiz (p. 27)

1. d, stage
2. b, the slide should be in focus at higher magnifications once it is properly focused at lower magnifications.
3. 350×
4. c, with special lens paper and cleaner
5. false
6. true

Answers to Activity Questions

Activity 2: Viewing Objects Through the Microscope (pp. 30–31)

5. Answers will vary depending on the lenses used. Working distance decreases as lens power increases. The *e* appears upside down and backwards.
6. The image moves toward you. The image moves to the right.
7. and 8. Grains begin to appear and are very visible with the high-power lens.

   The image is much larger.

   The entire *e* is visible with the low-power lens, but less than 1/4 of the letter is probably visible with the high-power lens.

   The field is smaller.

   The object must be centered so that it falls into the field of the higher power lens.

   The light to the field is reduced as the iris diaphragm is closed.

   The light intensity often must be increased when changing to a higher magnification, as the lens has a smaller diameter and therefore lets in less light. In practice, if the microscope does not have a variable light intensity adjustment, the iris diaphragm should be adjusted to obtain the best contrast.
9. Yes. Grains are very visible.

   The working distance is less than that of the high-power lens.

   It is desirable to begin focusing with a low-power lens because the field is larger, making it easier to find the specimen on the slide, and the working distance is larger, reducing the chance of hitting the slide with the lens.

Activity 3: Estimating the Diameter of the Microscope Field (pp. 32–33)

3. Answers depend on the field diameter of lenses used. For lenses with field diameters of 1.8 millimeters, 0.45 millimeter, and 0.18 millimeter, respectively, the estimated lengths are about 1.2 millimeters, 0.14 millimeter, and 0.18 millimeter.
4. No. The entire length of the object cannot be seen in one field. The estimate should be made with a lower-power objective lens.

Activity 4: Perceiving Depth (p. 33)

2. When the stage descends, the first clearly focused thread is the bottom thread; the last clearly focused thread is the top one.

   Answers depend on the order of the threads on the particular slides used.

Activity 5: Preparing and Observing a Wet Mount (pp. 33–34)

8. Most of the cells are separated from each other rather than in a continuous sheet.
10. A cheek epithelial cell is about 80–100 micrometers (μ) (0.08–0.1 millimeter) in diameter.

    They are more similar to those in Figure 3.5 and easier to measure because they are in a continuous sheet.

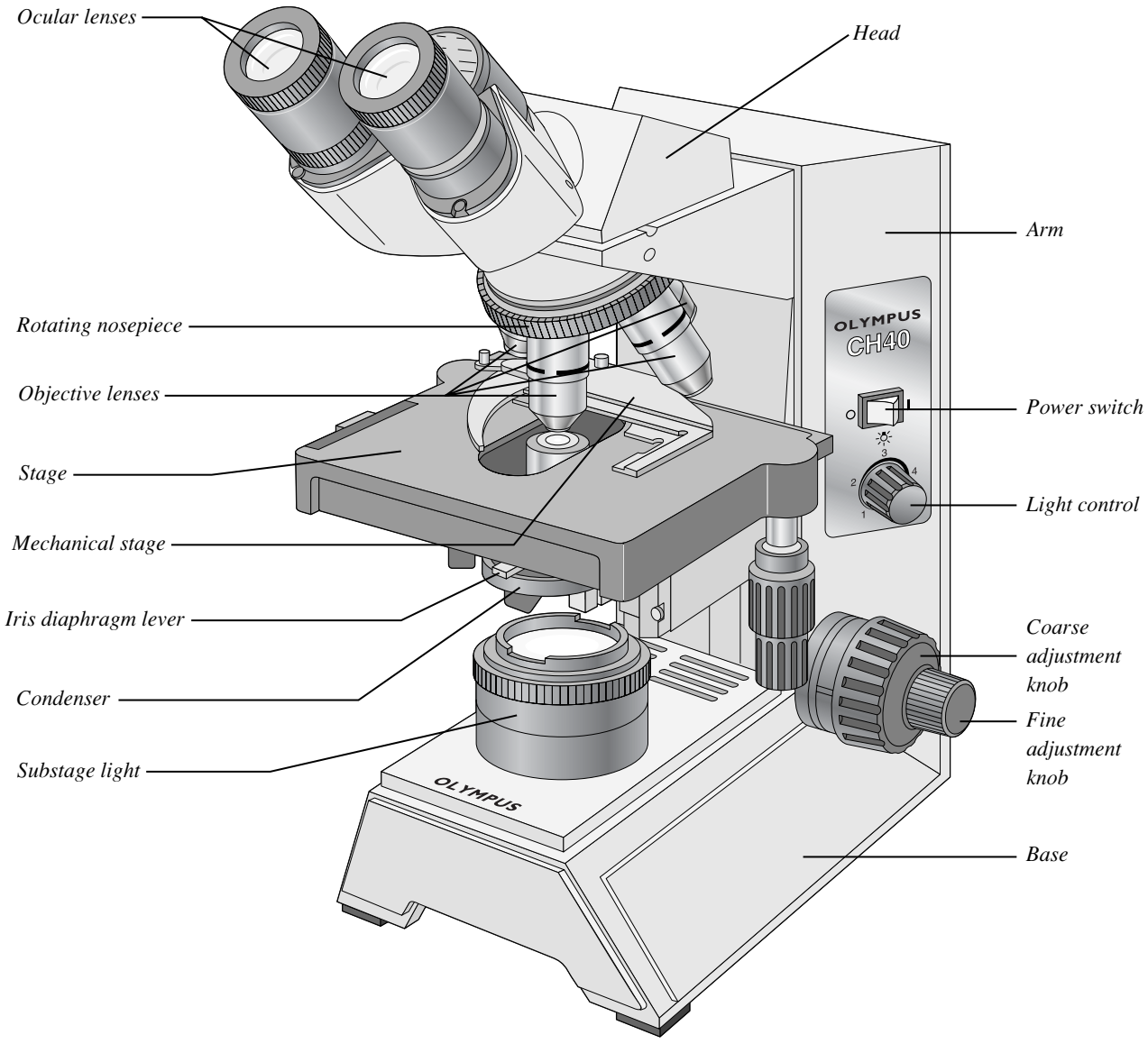
NAME _____

LAB TIME/DATE _____

The Microscope

Care and Structure of the Compound Microscope

1. Label all indicated parts of the microscope.



2. Explain the proper technique for transporting the microscope.

Carry with two hands—one supporting the base, the other holding the arm.

3. The following statements are true or false. If true, write *T* on the answer blank. If false, correct the statement by writing on the blank the proper word or phrase to replace the one that is underlined.

with grit-free lens paper 1. The microscope lens may be cleaned <u>with any soft tissue</u>.

low-power or scanning 2. The microscope should be stored with the <u>oil immersion</u> lens in position over the stage.

T 3. When beginning to focus, the <u>lowest power</u> lens should be used.

away from 4. When focusing, always focus <u>toward</u> the specimen.

T 5. A coverslip should always be used <u>with wet mounts and the high-power and oil lenses</u>.

4. Match the microscope structures given in column B with the statements in column A that identify or describe them.

Column A

i 1. platform on which the slide rests for viewing

d 2. used to increase the amount of light passing through the specimen

e 3. secure(s) the slide to the stage

b 4. delivers a concentrated beam of light to the specimen

c 5. used for precise focusing once initial focusing has been done

f 6. carries the objective lenses; rotates so that the different objective lenses can be brought into position over the specimen

Column B

a. coarse adjustment knob
b. condenser
c. fine adjustment knob
d. iris diaphragm
e. mechanical stage or spring clips
f. movable nosepiece
g. objective lenses
h. ocular
i. stage

5. Define the following terms.

virtual image: *An image that is erect and appears to be where it is not.*

resolution: *Ability to discriminate two closely situated objects as separate.*

Viewing Objects Through the Microscope

6. Complete, or respond to, the following statements:

working distance 1. The distance from the bottom of the objective lens in use to the specimen is called the _____.

to the left 2. Assume there is an object on the left side of the field that you want to bring to the center (that is, toward the apparent right). In what direction would you move your slide?

field 3. The area of the specimen seen when looking through the microscope is the _____.

95 4. If a microscope has a 10× ocular and the total magnification at a particular time is 950×, the objective lens in use at that time is _____×.

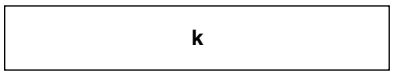
increases contrast 5. Why should the light be dimmed when looking at living (nearly transparent) cells?

parfocal 6. If, after focusing in low power, only the fine adjustment need be used to focus the specimen at the higher powers, the microscope is said to be _____.

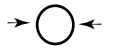
0.75 7. If, when using a 10× ocular and a 15× objective, the field size is 1.5 mm, the approximate field size with a 30× objective is _____ mm.

0.4 8. If the size of the high-power field is 1.2 mm, an object that occupies approximately a third of that field has an estimated diameter of _____ mm.

7. You have been asked to prepare a slide with the letter *k* on it (as shown below). In the circle below, draw the *k* as seen in the low-power field.



8. Figure out the magnification of fields 1 and 3, and the field size of 2. (*Hint:* Use your ruler.) Note that the numbers for the field sizes below are too large to represent the typical compound microscope lens system, but the relationships depicted are accurate.

1. 5 mm

50 ×

2. *2.5* mm

100×

3. 0.5 mm

500 ×

9. Say you are observing an object in the low-power field. When you switch to high power, it is no longer in your field of view.

Why might this occur? *The field decreases proportionately as magnification increases. Therefore, unless the object is centered at low power, it might be outside the higher-power field.*

What should be done initially to prevent this from happening? *Center the object that you wish to view.*

10. Do the following factors increase or decrease as one moves to higher magnifications with the microscope?

resolution: *increases (to a point)*

amount of light needed: *increases*

working distance: *decreases*

depth of field: *decreases*

11. A student has the high-dry lens in position and appears to be intently observing the specimen. The instructor, noting a working distance of about 1 cm, knows the student isn't actually seeing the specimen.

How so? *The working distance for the h.p. lens is closer to 1 mm.*

12. Describe the proper procedure for preparing a wet mount.

Place the specimen on the slide with a medicine dropper or place a drop of water or saline on the slide. Mix specimen into drop using a toothpick. If staining, add a drop of stain and mix with a toothpick. Hold a coverslip with forceps so that the coverslip touches one side of the specimen drop, and then ***slowly*** *and* ***carefully*** *lower the angled coverslip onto the specimen.*

13. Indicate the probable cause of the following situations arising during use of a microscope.

a. Only half of the field is illuminated: *The lens is not correctly rotated into place.*

b. Field does not change as mechanical stage is moved: *The slide is not correctly positioned in the clamp on the mechanical stage and does not move when the mechanical stage moves.*