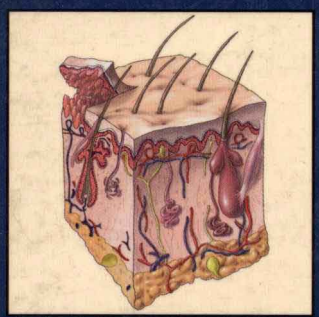
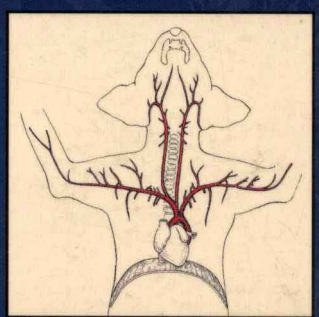
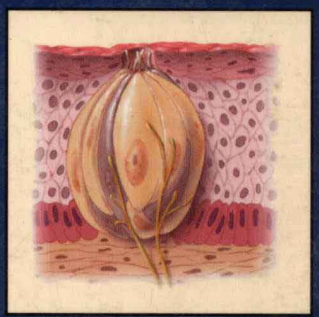
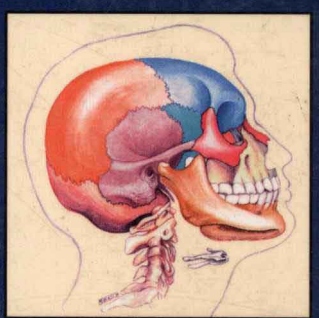
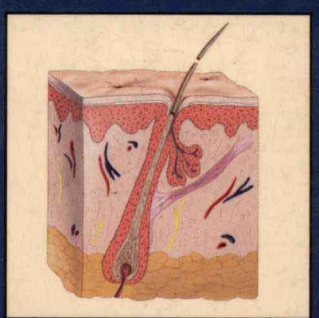
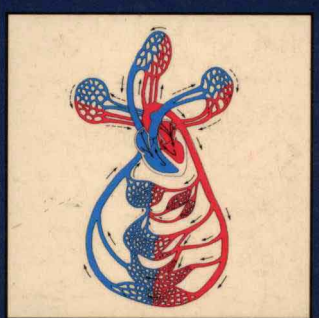
Laboratory Exercises in

Anatomy and Physiology

with Cat Dissections

Sixth Edition

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Laboratory Exercises in ANATOMY AND PHYSIOLOGY with Cat Dissections

SIXTH EDITION

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Preface

Laboratory Exercises in Anatomy and Physiology with Cat Dissections, Sixth Edition, has been written to guide students in the laboratory study of introductory anatomy and physiology. The manual was written to accompany most of the leading anatomy and physiology textbooks.

COMPREHENSIVENESS

This manual examines virtually every structure and function of the human body that is typically studied in an introductory anatomy and physiology course. Because of its detail, the need for supplemental handouts is minimized; the manual is a strong teaching device in itself.

USE OF THE SCIENTIFIC METHOD

Anatomy (the science of structure) and physiology (the science of function) cannot be understood without the practical experience of laboratory work. The exercises in this manual challenge students to understand the way scientists work by asking them to make microscopic examinations and evaluations of cells and tissues, to observe and interpret chemical reactions, to record data, to make gross examinations of organs and systems, to dissect, and to conduct physiological laboratory work and interpret and apply the results of this work.

ILLUSTRATIONS

The manual contains a large number and variety of illustrations. The illustrations of the body systems of the human have been carefully drawn to depict structures that are essential to students' understanding of anatomy and physiology. Numerous photographs, photomicrographs, and scanning electron micrographs are presented to show students how the structures of the body actually look. We feel that this laboratory manual has better and more complete illustrations than any other anatomy and physiology manual.

IMPORTANT FEATURES

Among the key features of this manual are (1) dissection of the white rat, and selected mammalian organs; (2) numerous physiological experiments; (3) emphasis on the study of anatomy through histology; (4) lists of appropriate terms accompanying drawings and photographs to be labeled; (5) inclusion of numerous scanning electron micrographs and specimen photos; (6) phonetic pronunciations and derivations for the vast majority of anatomical and physiological terms; (7) diagrams of commonly used laboratory equipment; (8) laboratory report questions and reports at the end of each exercise that can be filled in, removed, and turned in for grading if the instructor so desires; (9) three appendixes dealing with units of measurement, a periodic table of elements, and eponyms used in the laboratory manual; and (10) emphasis on laboratory safety throughout the manual.

NEW TO SIXTH EDITION

Numerous changes have been made in the sixth edition of this manual in response to suggestions from instructors and students. A significant change is the inclusion of objectives at the beginning of each exercise. We have also added some new physiology experiments, line drawings, cadaver photographs, photomicrographs, and phonetic pronunciations and derivations. The number of orientation diagrams has also been greatly expanded. Virtually all black-and-white photomicrographs have been replaced with color ones. The principal additions to various exercises are as follows:

In Exercise 5, "Integumentary System," there is a new illustration of the skin.

In Exercise 7, "Bones," there is a new section on types of ribs, and joint names have been added for the various articulations.

In Exercise 8, "Articulations," joints have been reorganized by structure. The section on synovial joints has been expanded. The exercise includes a new section on axes of movements at synovial joints, a new table on the principal joints of the body, and a new illustration on movements at synovial joints.

Exercise 9, "Muscle Tissue," has revised sections on the characteristics of muscle tissue, skeletal muscle fibers, and cardiac and smooth muscle tissue.

In Exercise 10, "Skeletal Muscles," there is a new section on synergists, an expanded table on naming skeletal muscles, greatly expanded overviews in all muscle tables, and a new table on intrinsic muscles of the foot.

Exercise 11, "Surface Anatomy," has been completely rewritten and expanded, and the black-and-white photos have been replaced with color photos. In addition, several new photos have been added.

Exercise 13, "Nervous System," now contains a new section on midbrain nuclei, new color photos of the spinal cord and brain, and new illustrations on cerebral white matter and the cerebellum.

In Exercise 14, "Sensory Receptors and Sensory Motor Pathways," the discussions of generator potentials and cutaneous receptors have been expanded. There is also a new photomicrograph on the retina.

In Exercise 15, "The Endocrine System," all hormone functions have been updated, and the histology of the pituitary gland has been revised.

In Exercise 16, "Blood," there is a new section with an accompanying illustration dealing with hemopoiesis. There is also a revised discussion on leukocytes.

Several new illustrations have been added to Exercise 17, "The Heart." Also, there are new discussions on the borders and surface projection of the heart. The discussion of the pericardium, chambers of the heart, valves of the heart, and blood vessels of the heart have also been revised.

In Exercise 18, "Blood Vessels," descriptions of arteries and veins in the tables have been greatly expanded, several new flow diagrams have been added, and several new illustrations have been added.

Exercise 20, "The Lymphatic and Immune System," has a new introduction; newly rewritten sections dealing with the thymus gland, lymph nodes, the spleen, and lymphatic nodules; and several new photomicrographs.

In Exercise 21, "Respiratory System," new art has also been added for the trachea, along with a new photo of the lungs.

In Exercise 22, "Digestive System," the introduction is new, and sections dealing with the pharynx, stomach, small intestines, and large intestines have been expanded. Several new illustrations dealing with histology have also been added.

In Exercise 23, "Urinary System," there is a new illustration on the histology of a nephron.

In Exercise 25, "Reproductive System," a new section has been added on the scrotum, and the section dealing with the penis has been revised. Several new cadaver photos have been added.

CHANGES IN TERMINOLOGY

In recent years, the use of eponyms for anatomical terms has been minimized or eliminated. Anatomical eponyms are terms named after various individuals. Examples include Fallopian tube (after Gabriello Fallopio) and Eustachian tube (after Bartolommeo Eustachio).

Anatomical eponyms are often vague and nondescriptive and do not necessarily mean that the person whose name is applied contributed anything very original. For these reasons, we have also decided to minimize their use. However, because some still prevail, we have provided eponyms, in parentheses, after the first reference in each chapter to the more acceptable synonym. Thus, you will expect to see terms such as ***uterine (Fallopian) tube*** or ***auditory (Eustachian) tube.*** See Appendix C.

INSTRUCTOR'S GUIDE

A complementary instructor's guide by the authors to accompany the manual is available from the publisher. This comprehensive guide contains: (1) a listing of materials needed to complete each exercise, (2) suggested audiovisual materials, (3) answers to illustrations and questions within the exercises, and (4) answers to laboratory report questions.

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Laboratory Safety*

In 1989, The Centers for Disease Control and Prevention (CDC) published "Guidelines for Prevention of Transmission of Human Immunodeficiency Virus and Hepatitis B Virus to Health-Care and Public-Safety Workers" (*MMWR*, vol. 36, No. 6S). The CDC guidelines recommend precautions to protect health care and public safety workers from exposure to human immunodeficiency virus (HIV), the causative agent of acquired immunodeficiency syndrome (AIDS), and hepatitis B virus (HBV), the causative agent of hepatitis B. These guidelines are presented to reaffirm the basic principles involved in the transmission of not only the AIDS and hepatitis B viruses, but also any disease-producing organism.

Based on the CDC guidelines for health care workers, as well as on other standard additional laboratory precautions and procedures, the following list has been developed for your safety in the laboratory. Although specific cautions and warnings concerning laboratory safety are indicated throughout the manual, read the following ***before*** performing any experiments.

A. GENERAL SAFETY PRECAUTIONS AND PROCEDURES

1. Arrive on time. Laboratory directions and procedures are given at the beginning of the laboratory period.
2. Read all experiments before you come to class to be sure that you understand all the procedures and safety precautions. Ask the instructor about any procedure you do not understand exactly. Do not improvise any procedure.
3. Protective eyewear and laboratory coats or aprons must be worn by all students performing or observing experiments.
4. Do not perform any unauthorized experiments.
5. Do not bring any unnecessary items to the laboratory and do not place any personal items (pocketbooks, bookbags, coats, umbrellas, etc.) on the laboratory table or at your feet.
6. Make sure each apparatus is supported and squarely on the table.
7. Tie back long hair to prevent it from becoming a laboratory fire hazard.
8. Never remove equipment, chemicals, biological materials, or any other materials from the laboratory.
9. Do not operate any equipment until you are instructed in its proper use. If you are unsure of the procedures, ask the instructor.
10. Dispose of chemicals, biological materials, used apparatus, and waste materials according to your instructor's directions. Not all liquids are to be disposed of in the sink.
11. Some exercises in the laboratory manual are designed to induce some degree of cardiovascular stress. Students should not participate in these exercises if they are pregnant or have hypertension or any other known or suspected condition that might compromise health. Before you perform any of these exercises, check with your physician.
12. Do not put anything in your mouth while in the laboratory. Never eat, drink, or taste chemicals, lick labels, smoke, or store food in the laboratory.
13. Your instructor will show you the location of emergency equipment such as fire extinguishers, fire blankets, and first-aid kits as well as eyewash stations. Memorize their locations and know how to use them.
14. Wash your hands before leaving the laboratory. Because bar soaps can become contaminated, liquid or powdered soaps should be used. Before leaving the laboratory, remove any protective clothing, such as laboratory coats or aprons, gloves, and eyewear.

*The authors and publisher urge consultation with each instructor's institutional policies concerning laboratory safety and first-aid procedures.

B. PRECAUTIONS FOR WORKING WITH BLOOD, BLOOD PRODUCTS, OR OTHER BODY FLUIDS

1. Work only with *your own* body fluids, such as blood, saliva, urine, tears, and other secretions and excretions; blood from a clinical laboratory that has been tested and certified as noninfectious; or blood from a mammal (other than a human).
2. Wear gloves when touching another person's blood or other body fluids.
3. Wear safety goggles when working with another person's blood.
4. Wear a mask and protective eyewear or a face shield during procedures that are likely to generate droplets of blood or other body fluids.
5. Wear a gown or an apron during procedures that are likely to generate splashes of blood or other body fluids.
6. Wash your hands immediately and thoroughly if contaminated with blood or other body fluids. Hands can be rapidly disinfected by using (1) a phenol disinfectant-detergent for 20 to 30 seconds (sec) and then rinsing with water, or (2) alcohol (50 to 70%) for 20 to 30 sec, followed by a soap scrub of 10 to 15 sec and rinsing with water.
7. Spills of blood, urine, or other body fluids onto bench tops can be disinfected by flooding them with a disinfectant-detergent. The spill should be covered with disinfectant for 20 minutes (min) before being cleaned up.
8. Potentially infectious wastes, including human body secretions and fluids, and objects such as slides, syringes, bandages, gloves, and cotton balls contaminated with those substances, should be placed in an

autoclave container. Sharp objects (including broken glass) should be placed in a puncture-proof sharps container. Contaminated glassware should be placed in a container of disinfectant and autoclaved before it is washed.

9. Use only single-use, disposable lancets, and needles. Never recap, bend, or break the lancet once it has been used. Place used lancets, needles, and other sharp instruments in a *fresh* 1 : 10 dilution of household bleach (sodium hypochlorite) or other disinfectant such as phenols (Amphyl), aldehydes (glutaraldehyde, 1%), and 70% ethyl alcohol and then dispose of the instruments in a puncture-proof container. These disinfectants disrupt the envelope of HIV and HBV. The fresh household bleach solution or other disinfectant should be prepared for *each* laboratory session.
10. All reusable instruments, such as hemocytometers, well slides, and reusable pipettes, should be disinfected with a *fresh* 1 : 10 solution of household bleach or other disinfectant and thoroughly washed with soap and hot water. The fresh household bleach solution or other disinfectant should be prepared for *each* laboratory session.
11. A laboratory disinfectant should be used to clean laboratory surfaces *before* and after procedures, and should be available for quick cleanup of any blood spills.
12. Mouth pipetting should never be done. Use mechanical pipetting devices for manipulating all liquids in the laboratory.
13. All procedures and manipulations that have a high potential for creating aerosols or infectious droplets (such as centrifuging, sonicating, and blending) should be performed carefully. In such instances, a biological safety cabinet or other primary containment device is required.

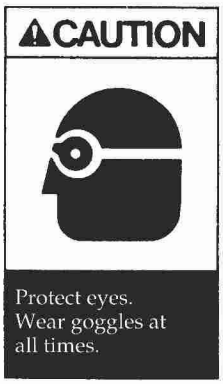
C. PRECAUTIONS RELATED TO WORKING WITH REAGENTS

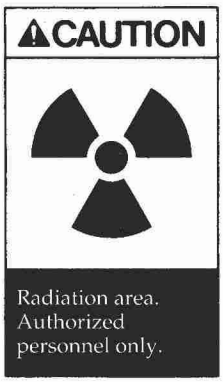
1. Use extreme care when working with reagents. Should any reagents make contact with your eyes, flush with water for 15 min; or, if they make contact with your skin, flush with water for 5 min. Notify your instructor immediately should a reagent make contact with your eyes or skin, and seek immediate medical attention.
2. Report all accidents to your instructor, no matter how minor they may appear.
3. When you are working with chemicals or preserved specimens, the room should be well ventilated. Avoid breathing fumes for any extended period of time.
4. Never point the opening of a test tube containing a reacting mixture (especially when heating it) toward yourself or another person.
5. Exercise care in noting the odor of fumes. Use "wafting" if you are directed to note an odor. Your instructor will demonstrate this procedure.
6. Do not force glass tubing or a thermometer into rubber stoppers. Lubricate the tubing and introduce it gradually and gently into the stopper. Protect your hands with toweling when inserting the tubing or thermometer into the stopper.
7. Never heat a flammable liquid over or near an open flame.
8. Use only glassware marked Pyrex or Kimax. Other glassware may shatter when heated. Handle hot glassware with test tube holders.
9. If you have to dilute an acid, always add acid (AAA) to water.
10. When shaking a test tube or bottle to mix its contents, do not use your fingers as a stopper.
11. Read the label on a chemical twice before using it.
12. Replace caps or stoppers on bottles immediately after using them. Return spatulas to their correct place immediately after using them and do not mix them up.
13. Mouth pipetting should never be done. Use mechanical pipetting devices for manipulating all liquids in the laboratory.

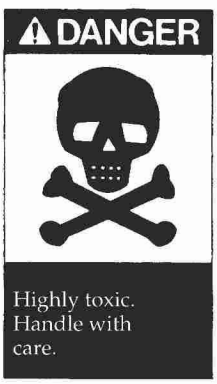
D. PRECAUTIONS RELATED TO DISSECTION

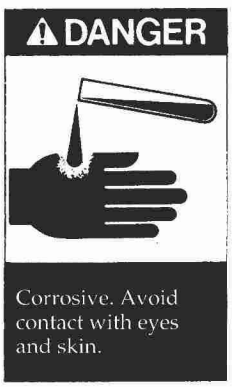
1. When you are working with chemicals or preserved specimens, the room should be well ventilated. Avoid breathing fumes for any extended period of time.
2. Wear rubber gloves when dissecting.
3. To reduce the irritating effects of chemical preservatives to your skin, eyes, and nose, soak or wrap your specimen in a substance such as "Biostat." If this is not available, hold your specimen under running water for several minutes to wash away excess preservative and dilute that remains.
4. When dissecting, there is always the possibility of skin cuts or punctures from dissecting equipment or the specimens themselves, such as the teeth or claws of an animal. Should you sustain a cut or puncture in this manner, wash your hands with disinfectant soap, notify your instructor, and seek immediate medical attention to decrease the possibility of infection. A first-aid kit should be readily available for your use.
5. When cleaning dissecting instruments, always hold the sharp edges away from you.
6. Dispose of any damaged or worn-out dissecting equipment in an appropriate container supplied by your instructor.

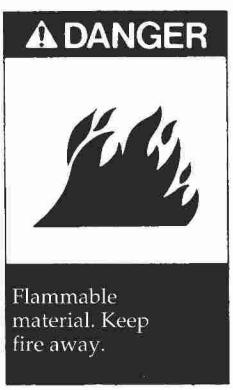
SELECTED LABORATORY SAFETY SIGNS/LABELS

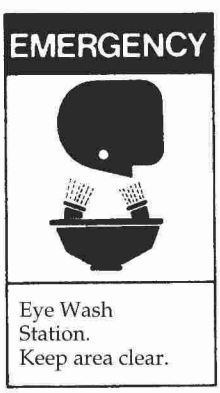


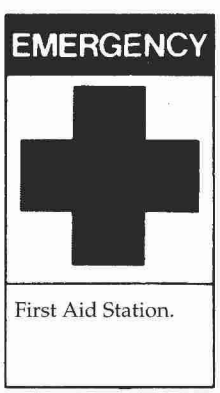


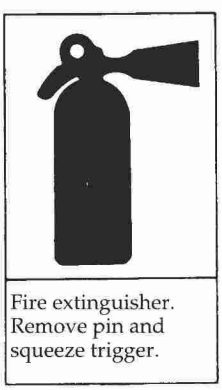




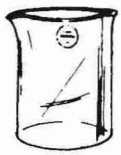








COMMONLY USED LABORATORY EQUIPMENT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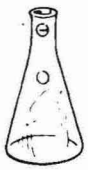

Erlenmeyer flask


Florence flask


funnel


Graduated cylinder


Pipet


Mortar and pestle

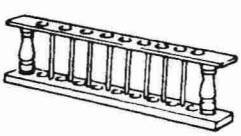

Watch glass


Stirring rod


Test tube


Test tube brush


Test tube holder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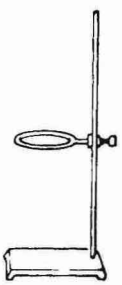
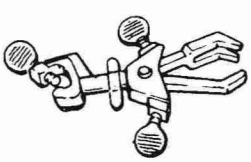

Ring stand and ring


Pinch clamp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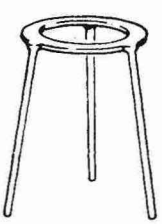
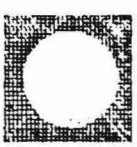
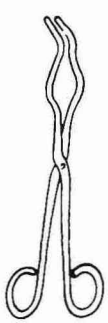
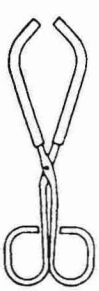

Tripod


Clay triangle


Wire gauze


Crucible tongs


Beaker tongs


Forceps


Medicine dropper


Nichrome wire


Spatula

Pronunciation Key

A unique feature of this revised manual is the phonetic pronunciations given for many anatomical and physiological terms. The pronunciations are given in parentheses immediately after the particular term is introduced. The following key explains the essential features of the pronunciations.

1. The syllable with the strongest accent appears in capital letters; for example, bilateral (bī-LAT-er-al) and diagnosis (dī-ag-NŌ-sis).
2. A secondary accent is denoted by a single quote mark ('); for example, constitution (kon'-sti-TOO-shun) and physiology (fiz'-ē-OL-ō-jē). Additional secondary accents are also noted by a single quotation mark; for example, decarboxylation (dē'-kar-bok'-si-LĀ-shun).
3. Vowels marked with a line above the letter are pronounced with the long sound, as in the following common words:

ā as in *māke*	*ī* as in *īvy*
ē as in *bē*	*ō* as in *pōle*

4. Unmarked vowels are pronounced with the short sound, as in the following words:

e as in *bet*	*o* as in *not*
i as in *sip*	*u* as in *bud*

5. Other phonetic symbols are used to indicate the following sounds:

a as in *above*	*yoo* as in *cute*
oo as in *soon*	*oy* as in *oil*

Contents

Microscopy

1

Objectives: *At the completion of this exercise you should understand:*

a. The parts and proper use and care of a light microscope.
b. The interpretation of images viewed through a light microscope, including the concept of magnification.

Note: Before you begin any laboratory exercises in this manual, please read the section on LABORATORY SAFETY on page viii.

One of the most important instruments that you will use in your anatomy and physiology course is a compound light microscope. In this instrument, the lenses are arranged so that images of objects too small to be seen with the naked eye can become highly magnified; that is, apparent size can be increased, and their minute details can be revealed. Before you actually learn the parts of a compound light microscope and how to use it properly, discussion of some of the principles employed in light microscopy (mī-KROS-kō-pē) will be helpful.

A. COMPOUND LIGHT MICROSCOPE

A ***compound light microscope*** uses two sets of lenses, ocular and objective, and employs light as its source of illumination. Magnification is achieved as follows. Light rays from an illuminator are passed through a condenser, which directs the light rays through the specimen under observation; from here, light rays pass into the objective lens, the magnifying lens that is closest to the specimen; the image of the specimen then forms on a prism and is magnified again by the ocular lens.

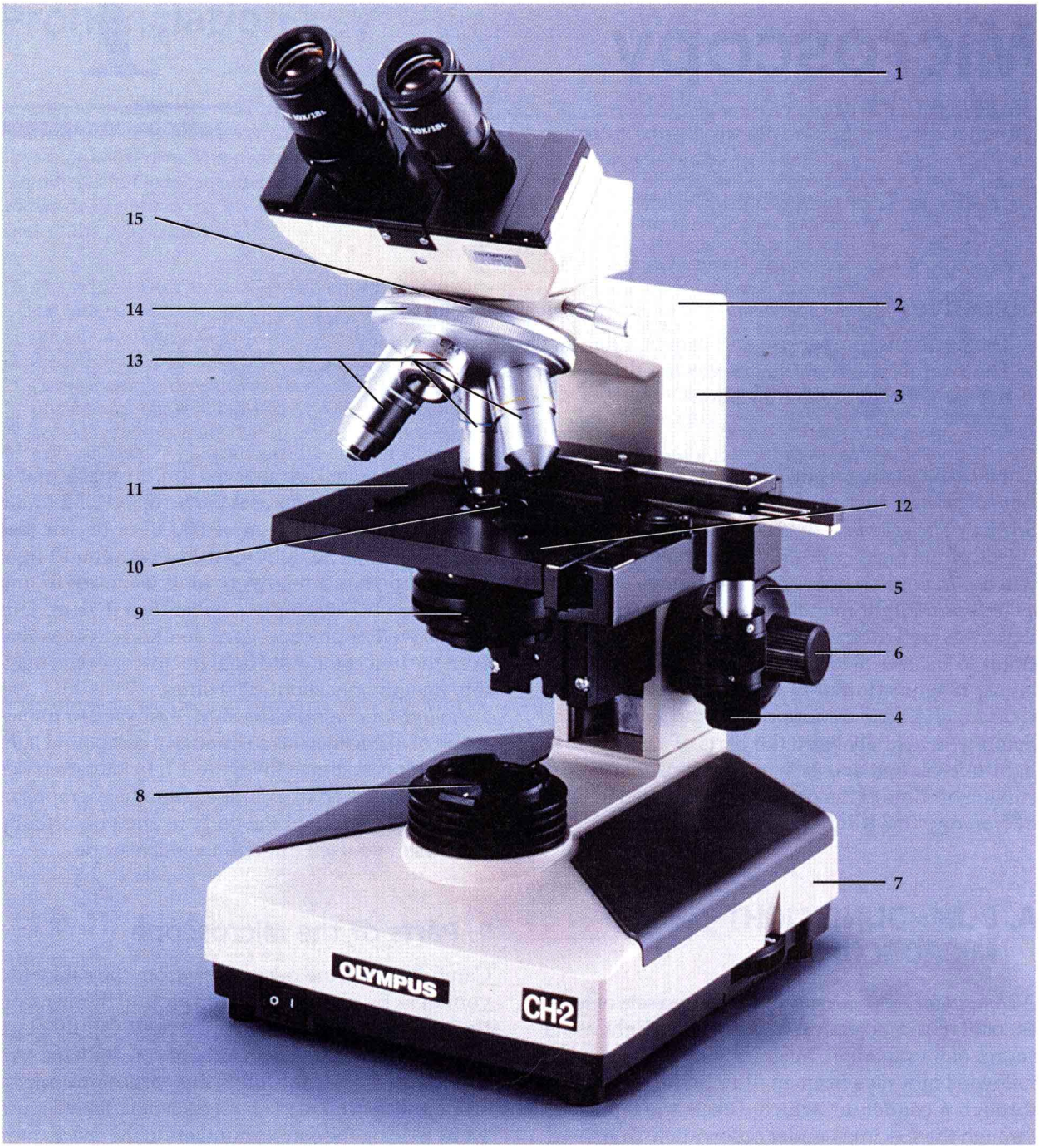
A general principle of microscopy is that the shorter the wavelength of light used in the instrument, the greater the resolution. ***Resolution (resolving power)*** is the ability of the lenses to distinguish fine detail and structure, that is, to distinguish between two points as separate objects. As an example, a microscope with a resolving power of 0.3 micrometers (mī-KROM-e-ters), symbolized μm, is capable of distinguishing two points as separate objects if they are at least 0.3 μm apart. 1 μm = 0.000001 or 10^{-6} m. (See Appendix A.) The light used in a compound light microscope has a relatively long wavelength and cannot resolve structures smaller than 0.3 μm. This fact, as well as practical considerations, means that even the best compound light microscopes can magnify images only about 2000 times.

A ***photomicrograph*** (fō-tō-MĪ-krō'-graf), a photograph of a specimen taken through a compound light microscope, is shown in Figure 4.1. In later exercises you will be asked to examine photomicrographs of various specimens of the body before you actually view them yourself through the microscope.

1. Parts of the Microscope

Carefully carry the microscope from the cabinet to your desk by placing one hand around the arm and the other hand firmly under the base. Gently place it on your desk, directly in front of you, with the arm facing you. Locate the following parts of the microscope and, as you read about each part, label Figure 1.1 by placing the correct numbers in the spaces next to the list of terms that accompanies the figure.

1. ***Base*** The bottom portion on which the microscope rests.
2. ***Body tube*** The portion that receives the ocular.
3. ***Arm*** The angular or curved part of the frame.
4. ***Inclination joint*** A movable hinge in some microscopes that allows the instrument to be tilted to a comfortable viewing position.
5. ***Stage*** A platform on which microscope slides or other objects to be studied are placed. The



___ Arm
___ Base
___ Body tube
___ Coarse adjustment knob
___ Condenser
___ Diaphragm
___ Fine adjustment knob
___ Mechanical stage knob
___ Nosepiece
___ Objectives
___ Ocular
___ Revolving nosepiece
___ Stage
___ Stage clip of mechanical stage
___ Substage lamp

FIGURE 1.1 Olympus CH-2 microscope.

opening in the center, called the ***stage opening,*** allows light to pass from below through the specimen being examined. Some microscopes have a ***mechanical stage***. An adjustor knob below the stage moves the stage forward and backward and from side to side. With a mechanical stage, the slide and the stage move simultaneously. A mechanical stage permits a smooth, precise movement of a slide. Sometimes a mechanical stage is fitted with calibrations that permit the numerical "mapping" of a specimen on a slide.

6. ***Stage (spring) clips*** Two clips mounted on the stage that hold the microscope slide securely in place.
7. ***Substage lamp*** The source of illumination for some light microscopes with a built-in lamp.
8. ***Mirror*** A feature found in some microscopes below the stage. The mirror directs light from its source through the stage opening and through the lenses. If the light source is built-in, a mirror is not necessary.
9. ***Condenser*** A lens located beneath the stage opening that concentrates the light beam on the specimen.
10. ***Condenser adjustment knob*** A knob that functions to raise and lower the condenser. In its highest position, it allows full illumination and thus can be used to adjust illumination.
11. ***Diaphragm*** (DĪ-a-fram) A device located below the condenser that regulates light intensity passing through the condenser and lenses to the observer's eyes. Such regulation is needed because transparent or very thin specimens cannot be seen in bright light. One of two types of diaphragms is usually used. An ***iris diaphragm,*** as found in cameras, is a series of sliding leaves that vary the size of the opening and thus the amount of light entering the lenses. The leaves are moved by a ***diaphragm lever*** to regulate the diameter of a central opening. A ***disc diaphragm*** consists of a plate with a graded series of holes, any of which can be rotated into position.
12. ***Coarse adjustment knob*** A usually larger knob that raises and lowers the body tube (or stage) to bring a specimen into general view.
13. ***Fine adjustment knob*** A usually smaller knob found below or external to the coarse adjustment knob and used for fine or final focusing. Some microscopes have both coarse and fine adjustment knobs combined into one.
14. ***Nosepiece*** A plate, usually circular, at the bottom of the body tube.
15. ***Revolving nosepiece*** The lower, movable part of the nosepiece that contains the various objective lenses.
16. ***Scanning objective*** A lens, marked 5× on most microscopes (× means the same as "times"); it is the shortest objective and is not present on all microscopes.
17. ***Low-power objective*** A lens, marked 10× on most microscopes; it is the next longer objective.
18. ***High-power objective*** A lens, marked 40×, 43×, or 45× on most microscopes; also called a ***high-dry objective;*** it is an even longer objective.
19. ***Oil-immersion objective*** A lens, marked 100× on most microscopes and distinguished by an etched colored circle (special instructions for this objective are discussed later); it is the longest objective.
20. ***Ocular (eyepiece)*** A removable lens at the top of the body tube, marked 10× on most microscopes. An ocular is sometimes fitted with a pointer or measuring scale.

2. Rules of Microscopy

You must observe certain basic rules at all times to obtain maximum efficiency and provide proper care for your microscope.

1. Keep all parts of the microscope clean, especially the lenses of the ocular, objectives, condenser, and also the mirror. *You should use the special lens paper that is provided and never use paper towels or cloths, because these tend to scratch the delicate glass surfaces.* When using lens paper, use the same area on the paper only once. As you wipe the lens, change the position of the paper as you go.
2. Do not permit the objectives to get wet, especially when observing a ***wet mount***. You must use a ***cover slip*** when you examine a wet mount or the image becomes distorted.
3. Consult your instructor if any mechanical or optical difficulties rise. *Do not try to solve these problems yourself.*
4. Keep *both* eyes open at all times while observing objects through the microscope. This is difficult at first, but with practice becomes natural. This important technique will help you to draw and observe microscopic specimens without moving your head. Only your eyes will move.
5. Always use either the scanning or low-power objective first to locate an object; then, if necessary, switch to a higher power.
6. If you are using the high-power or oil-immersion objectives, *never focus using the coarse adjustment knob*. The distance between these objectives and the slide, called ***working distance,*** is very small

and you may break the cover slip and the slide and scratch the lens.

7. Some microscopes have a stage that moves while focusing, others have a body tube that moves while focusing Be sure you are familiar with which type you are using. Look at your microscope from the side and using the scanning or low power objective, gently turn the coarse adjustment knob. Which moves? The stage or the body tube? *Never focus downward* if the microscope's body tube moves when focusing. *Never focus upward* if the microscope's stage moves when focusing. By observing from one side you can see that the objectives do not make contact with the cover slip or slide.
8. Make sure that you raise the body tube before placing a slide on the stage or before removing a slide.

3. Setting Up the Microscope

PROCEDURE

1. Place the microscope on the table with the ocular toward you and with the back of the base at least 1 inch (in.) from the edge of the table.
2. Position yourself and the microscope so that you can look into the ocular comfortably.
3. Wipe the objectives, the top lens of the ocular, the condenser, and the mirror with lens paper. Clean the most delicate and the least dirty lens first. Apply xylol or alcohol to the lens paper only to remove grease and oil from the lenses and microscope slides.
4. Position the low-power objective in line with the body tube. When it is in its proper position, it will click. Lower the body tube using the coarse adjustment knob until the bottom of the lens is approximately 1/4 in. from the stage.
5. Admit the maximum amount of light by opening the diaphragm, if it is an iris diaphragm, or turning the disc to its largest opening, if it is a disc diaphragm.
6. Place your eye to the ocular, and adjust the light. When a uniform circle (the ***microscopic field***) appears without any shadows, the microscope is ready for use.

4. Using the Microscope

PROCEDURE

1. Using the coarse adjustment knob, raise the body tube to its highest fixed position.
2. Make a temporary mount using a single letter of newsprint, or use a slide that has been specially prepared with a letter, usually the letter "e." If you prepare such a slide, cut a single letter—"a," "b," or "e"—from the smallest print available and place this letter in the correct position to be read with the naked eye. Your instructor will provide directions for preparing the slide.
3. Place the slide on the stage, making sure that the letter is centered over the stage opening, directly over the condenser. Secure the slide in place with the stage clips.
4. Align the low-power objective with the body tube.
5. Lower the body tube or raise the stage as far as it will go *while you watch it from the side*, taking care not to touch the slide. The tube should reach an automatic stop that prevents the low-power objective from hitting the slide.
6. While looking through the ocular, turn the coarse adjustment knob counterclockwise, raising the body tube. Or, turn the coarse adjustment knob clockwise, lowering the stage. When focusing, always *raise* the body tube or *lower* the stage. Watch for the object to suddenly appear in the microscopic field. If it is in proper focus, the low-power objective is about 1/2 in. above the slide. When focusing, always *raise* the body tube.
7. Use the fine adjustment knob to complete the focusing; you will usually use a counterclockwise motion once again.
8. Compare the position of the letter as originally seen with the naked eye to its appearance under the microscope.
   Has the position of the letter been changed?

   _____

9. While looking at the slide through the ocular, move the slide by using your thumbs, or, if the microscope is equipped with them, the mechanical stage knobs. This exercise teaches you to move your specimen in various directions quickly and efficiently.
   In which direction does the letter move when you move the slide to the left?

   _____

   This procedure, called "scanning" a slide, will be useful for examining living objects and for centering specimens so you can observe them easily.

   Make a drawing of the letter as it appears under low power in the microscopic field in the space on the top of page 5.