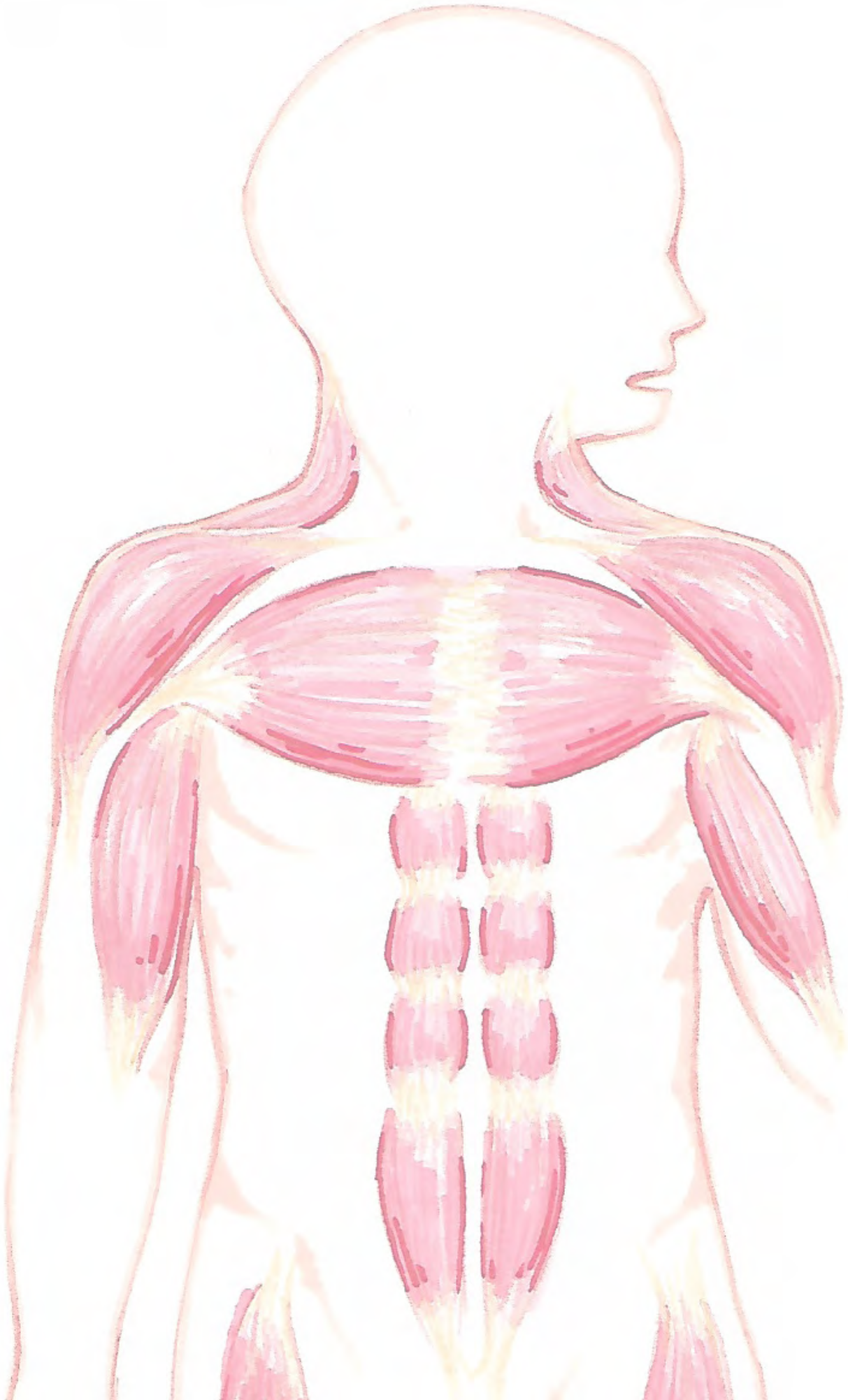
Health Education Tactile Graphics

Instructional Guidebook for Teachers and Students

AMERICAN PRINTING HOUSE



In keeping with our philosophy to provide access to information for people who are blind or visually impaired, the American Printing House for the Blind (APH) provides accessible versions of this book for large print and braille readers. Accessible PDF and braille-ready files (BRF) in Unified English Braille (UEB) are available from the Downloadable Product Manuals web page on the APH website: sites.aph.org/manuals/.

Health Education Tactile Graphics Instructional Text for Teachers and Students

Catalog Number 1-08055-00

American Printing House for the Blind
1839 Frankfort Avenue
Louisville, KY 40206
(800) 223-1839
www.aph.org
info@aph.org

Reference Citation: Hoffmann, R., & Otto, F. (2020). Health education tactile graphics instructional guidebook for teachers and students. Louisville, KY: American Printing House for the Blind.

Project Staff

Rosanne Hoffmann, Ph.D., Project Leader and Author

Fred Otto, B.A., Project Leader, Illustrator, and Author

Lara Kirwan, M.F.A, Research Assistant

Frank Hayden, Director of Technical & Manufacturing Research

Katherine Corcoran, B.A., Artist and Pattern Maker

Adam Clark, B.A., Manufacturing Specialist

Jeffrey Williams, Manufacturing Specialist

Cecilia Peredo, M.S., Director of Grants

Emily Grimany, B.A., Braille Transcriber

Anthony D. Jones, B.F.A., Art Design/Production Manager

Matt Poppe, B.A., Graphic Designer

Contents

Health Education Tactile Graphics

Introduction

This collection of tactile graphics was developed to make illustrations and diagrams typically associated with middle school and high school health education curricula accessible to students with visual impairments. It is intended to provide information for teachers as well as allow students to use the graphics independently, if appropriate. This collection is best used in combination with health education textbooks and publications in addition to three-dimensional models, where possible. We also recommend the APH publication *Health Education for Students With Visual Impairments: A Guidebook for Teachers* (catalog number 1-08054-00) for more information on teaching these topics.

This guidebook provides instructional information for each graphic and is available in braille by downloading the BRF (in Unified English Braille, or UEB) and accessible PDF from the Downloadable Product Manuals web page on the APH website (sites.aph.org/manuals/).

Notes for Teachers

The design of each full color graphic contains as much detail as possible without sacrificing tactile readability. Different textures, thicknesses, and heights of arrows, lines, and structures combine to make the images clear and tactually engaging. In some cases, the graphics are simplified for readability (for example, images of the respiratory and circulatory systems). Students should understand that, even when details are not 100% accurate, the structural organization of the diagrams is correct in each of the depicted anatomical systems.

Students who are blind are likely to have had less exposure to graphics and imagery than those with sight. It's safe to assume that many of the conventions used in print textbook images can require a bit of explanation before they make sense to the tactile reader. Here are some considerations to bear in mind when reading the tactile images:

The outline of the body is often presented in both front (anterior) and back (posterior) views. It's important to note that the anterior view can be confusing with regard to what is located on the right or left side of the body or an organ. In the anterior view, the arms are held away from the torso with palms facing forward (that is, thumbs to the outside). When organs and vessels are shown within this front-facing body outline, features appearing on the right side of a diagram are actually found in the left side of the body and vice versa. This is particularly important

to remember in the context of asymmetric body systems and organs such as the digestive system and the heart. Note also that this left and right ambiguity is not inherent in the posterior presentation of the body and its organs.

When the structures within both arms are similar, one arm may be shown truncated in order to save space. Likewise, the upper or lower parts of the body may be truncated in order to expand the rest of the diagram. Some comparison with other diagrams may be helpful in these cases to get oriented to the presentation.

Teachers are encouraged to include three-dimensional models of as many components of the anatomical systems presented here as possible to augment their lessons. For example, use actual bones or simulated models for demonstrations of various parts of the skeletal system. Also, student-made clay models of the kidney and other parts of the excretory system can reinforce concepts, especially if they are life-size.

The presentation and subject matter of these diagrams assume a certain level of tactile reading aptitude on the part of the learner. As with all tactile graphics, there are physical features that have been simplified or distorted in the attempt to portray them in a readable format. Because it’s assumed that students have the prerequisite experience and tactile reading skill to access them, there are some additional ways in which these diagrams vary from standard tactile graphic practice in presenting keys, namely:

- Keys are presented on the same page with the images in order to reduce the number of pages. They appear at the upper left, and ample space is allowed between the keys and the images.
- Key symbols (letters) are chosen to relate to the item or feature being labeled, such as pl for the pineal gland. This minimizes the need to refer back and forth to the key once the reader becomes familiar with the image. In some cases, there are multiple items in an image beginning with the same letter; thus, pl for pineal gland, pt for pituitary gland, and p for pancreas are used on the same diagram.
- Single-cell key symbols are used, either to save space or because they represent the most sensible labeling option. Because of the context, students are not expected to interpret these as short-form braille words or contractions.
- The same symbol may be used to label different items in different diagrams. For example, br represents the brain in one image and the bronchi in another. Students should rely on understanding the context of each diagram rather than memorizing the labels and expecting the same meaning throughout.

- In order to make the keys more readable to sighted and low-vision users, the label definitions in both print and braille have been aligned in a column, typically with two spaces following the labels. Braille readers may find this alignment unusual, but it is not expected to present an inconvenience.

Notes on the Diagrams

1a Human Skeleton (anterior view)

The first part of this graphic presents the anterior, or front, view of a human skeleton. It is located in the center of the page. It shows all of the larger and more easily identifiable bones that have anterior presentations, including the clavicle, humerus, radius, ulna, pelvis, femur, patella, tibia, and fibula (all shown in yellow/beige). Because they are very small, some of the bones of the fingers, toes, and skull appear fused. In this simplified view, the wrists and ankles show fewer bones than are actually present.

The right side of the page presents details of the right hand and right foot as viewed from above, including the eight carpal bones (two of which are superimposed), all seven tarsal bones, plus part of the articulating long bones (the tibia and fibula). These images are presented to show the number and complexity of the small bones that compose the hands and feet rather than their actual shapes and placement, which cannot be represented at this scale.

In the graphic, the yellow/beige-colored bones of the arms and legs and the pelvic and pectoral girdles compose the appendicular skeleton. The axial skeleton includes the light blue-colored bones depicting the skull and vertebral column and the dark blue-colored ribcage.

1b Human Skeleton (posterior view)

This graphic depicts the human skeleton from the back above the femur bones, including the pelvic girdle but excluding the hands. It provides a view of structures that are obscured in the anterior view. These include the spinal column and its attachment with the pelvis; the scapulae, which are found behind the ribcage; and the back of the skull with its bony plates. These structures are emphasized in the diagram with a higher relief than the other bones depicted. The color distinctions between the axial (blue) and appendicular (yellow/beige) skeleton are the same in this graphic as in Image 1a.

1c Human Spine and Vertebrae

The left-hand portion of the page shows the spine as seen from the right side, with dimension lines that identify specific sections. On the right side of the page are examples of the three vertebral types, as viewed from the top, or superior, surface.

Referring back and forth between diagrams 1a, 1b, and 1c may help to form a complete mental image of the spine, which is a complex structure. When viewed from the front or the back, the spine appears to be a straight vertical column, but as Image 1c shows, several curves are apparent when viewed from the side. Tracing a fingertip from the top to the bottom of the spine along either the left or right side of the graphic reveals the four curves found in the adult human spine that correlate with each vertebral type and the sacrum and coccyx.

The right-hand portion of Image 1c alters the viewing perspective, as in the hand and foot images in 1a. The top, or superior, view of these vertebrae shows that each one has an opening through which the spinal cord passes (as shown in Image 3), a kind of "plate" known as the vertebral body, and a tail-like structure known as the spinous process (located opposite to the vertebral body). In the spinal column shown on the left side of the page, each vertebra has the spinous process to the left and the vertebral body to the right. All vertebrae also possess transverse processes on either side of the central spinous process, although these structures are greatly reduced in the cervical vertebrae.

2 Muscular System

The diagram shows anterior (left) and posterior (right) views of the muscular system. The large muscles and muscle groups are shown in high relief with a slight texture that suggests the striated or fibrous nature of skeletal muscle. In both parts of the diagram, the arms and legs of the body are truncated to save space and allow for easier side-by-side comparison.

In reality, muscles cover the entire body and many muscle groups overlap. This simplified view illustrates the basic shapes and locations of the muscles that are depicted. Notice that most of the muscles occur in pairs on the left and right sides of the body, including the rectus abdominis, depicted in the center of the anterior view with four vertically arranged pairs of muscles and identified as abdominals.

3 Nervous System

The most tactually prominent feature of the diagram is, of course, the central nervous system, comprising the brain and spinal cord. The network of peripheral nerves is greatly simplified, but the branching nature of the nerves and places where they are highly concentrated are shown.

The spinal column is not included in the diagram. Recalling Image 1c, readers can try to form an image of the spinal cord descending through the central

openings in the vertebrae and of the peripheral nerves branching out from the spinal cord in the spaces between the vertebrae. Note that the cervical, thoracic, lumbar, and sacral nerves are located in body regions that correspond to the cervical, thoracic, lumbar, and sacral vertebrae of the spine, as shown in 1c.

4 Neuron

For those who are accustomed to thinking of a typical cell as having a simple, roundish or oblong shape, the nerve cell can appear exotic. In this image, the cell body, with its dendrites, or branched processes, is on the left, and the nucleus is shown as a raised dot in the center of it. Extending from the cell body to the right is the axon, which ends in another branching region featuring axon terminals with their widened tips. In this diagram, the axon is a tubular structure that is covered with four oval-shaped yellow Schwann cells with gaps between them. The number of Schwann cells covering the axon of a nerve cell depends upon axon length. Schwann cells insulate the axon and increase the speed at which an electrical impulse travels from the cell body to the axon terminals. There are always gaps between Schwann cells along the axon; these are known as the nodes of Ranvier (not labeled).

An arrow indicates the direction traveled by the electric impulse along a nerve cell: from the dendrites in the cell body to the axon terminals.

5 Circulatory System

Along with the standard coloration used in circulatory diagrams (red for oxygenated blood, blue for deoxygenated), this image uses a dotted texture for oxygenated blood to differentiate the two. Small vessels known as capillaries are shown as narrow lines connecting the veins and arteries and are darker in color.

An anterior view of the heart (raised relief) and the lungs (recessed) are the central features of the image. Although the action within the lungs is actually the same, the two lungs in this graphic are presented differently to reduce tactual clutter. The right lung simply shows a pulmonary artery and a pulmonary vein, which carry blood from the heart to the lung and from the lung to the heart, respectively. The left lung shows how capillaries branch off to take up oxygen, then reunite to carry the oxygenated blood back to the heart.

Students may note how the blood vessels become narrower the farther they are from the heart. This is due to the branching off of smaller vessels, which occurs countless times; this branching is indicated here but is not shown in detail. Students should also note that where the paths of a vein and an artery overlap, one vessel in the diagram is broken to allow the other to pass through.

6 Flow of Blood in the Heart

The same technique used in Image 5 for marking oxygenated and deoxygenated blood flow (lines with and without dotted texture, respectively) is used in this close-up, anterior view of the heart in longitudinal section. In this diagram, the veins and arteries are expanded and shown as wide channels, and the blood flow is indicated with smooth or textured arrows. (Note that the arrows in this diagram are larger than typically encountered in tactile images in order to guide the reader's fingers along the blood pathways. Readers may need some extra study to interpret them correctly.)

A suggested approach to interpreting this image is to look for arrows that start outside the heart and lead into it (the superior and inferior vena cavae leading to the right atrium on the left side of the image, and the pulmonary veins leading to the left atrium on the right). Although the vessels overlap in places and the pathways appear interrupted, the arrows actually represent continuous paths taken by the blood flowing into, through, and out of the heart. As an example, following the direction indicated by the textured arrow at the pulmonary veins leads to another textured arrow in the left ventricle; following this arrow (with some mental and tactual persistence) leads to another one going through the aorta. Instructors can explain to students that the aorta starts behind the main trunk of the pulmonary arteries, causing a break

in vessel continuity in this diagram. The same method of tracking can be used with the smooth arrows, which eventually exit the pulmonary arteries.

It is important to view the valves, such as those located between the right atrium and right ventricle and between the left atrium and left ventricle, as flexible, moving structures like flaps. They are shown in an open position, as when the circulating blood moves through them. Students should try to envision how the sides of the valve come together with each contraction, preventing the blood from moving backward into the atria. Another set of valves regulates the movement of blood into the large vessels (aorta and pulmonary trunk) and prevents backflow into the ventricles.

The function of the valves can be modeled by placing your two hands together, facing each other with the palms apart and fingertips touching. The fingertips represent the valves. It is then easy for a fellow student to push an object such as a ruler or pencil one way through the fingers (i.e., starting at the palms and going out through the fingertips), but not in the reverse direction (starting at the tops of the fingertips). This object, of course, represents the flowing blood, which is pushed through the valves in only one direction.

Encourage students to learn the pathway of blood throughout the heart, lungs, and body in the correct order: Deoxygenated blood from the body returns to the heart via the inferior and superior vena cavae and then flows through the right atrium and right ventricle; from there the blood moves to the lungs via the pulmonary arteries and lung circulation; oxygenated blood returns to the heart via the pulmonary veins; and oxygenated blood flows into the left atrium, the left ventricle, and finally the aorta, which supplies the rest of the body. Identifying where the valves are located in this pathway presents an added challenge.

7 Lymphatic System

The seemingly disparate parts of the lymphatic system work together (with help from an intimate association with the circulatory system) to provide humans with protective immunity from invading organisms and viruses.

This image in anterior view presents the lymphatic vessels and connected lymph nodes as a discrete tubular system, but in reality these vessels run parallel to arteries, veins, and capillaries and physically connect with the circulatory system in specific places. Lymphatic vessels circulate a fluid called lymph, which is derived from the liquid portion of the blood. Lymph also carries white blood cells capable of identifying potential pathogens and initiating their doom when necessary. Lymph nodes

filter lymph and remove invading organisms; they are presented in somewhat exaggerated size in this graphic. Lymph nodes tend to be more numerous near openings that communicate with the environment (head and neck, armpits, groin).

Similar in structure to lymph nodes, but larger, the tonsils are located in the throat and protect the body from harmful organisms that may enter via the nose or mouth.

The thymus, located in the upper region of the chest, is a gland that increases in size until age one, after which it decreases in size with age. Certain populations of white blood cells mature in the thymus gland and are ultimately responsible for immunity against specific illnesses.

The bone marrow, a spongy tissue located inside most of the bones of the body, is represented by a long, red rectangle in the right forearm in this graphic. The red bone marrow has two main functions: It is the source of all cellular components of the blood, including red blood cells, white blood cells, and platelets, and it is responsible for the maturation of certain populations of white blood cells involved in specific immunity.

The spleen, represented by the red, bean-shaped organ in the graphic, is found on the left side of the body. In addition to filtering the blood and removing old red blood cells, the spleen houses white blood cells involved in mounting an immune response.

8 Respiratory System

This image focuses on the head (turned to one side) and upper torso, showing the anterior view of a longitudinal section of the organs involved in breathing and in the production of sounds.

Within the head are the nasal cavity and mouth; these are open spaces represented in pink in the graphic. Inside the mouth (but not labeled) is the tongue. Behind the tongue, the nasal and oral cavities join together in the pharynx.

The larynx, which houses the vocal cords, is shown as a red, raised, box-like area. A flap located just above the larynx (but not labeled) is the epiglottis, which tilts down over the opening to the larynx during swallowing to prevent food and liquid from entering the trachea or windpipe. Supported by incomplete rings of cartilage down its entire length, the trachea is represented in the graphic as a single tube with bumpy sides leading to the left and right bronchi and the lungs.

The lungs, of course, function identically, but the left lung is shown greatly simplified to allow labeling of specific structures (alveoli and bronchioles). The two bronchi branch to the left and right at the lowest part of the trachea and between the lungs. The bronchi give rise to smaller and smaller tubular structures called bronchioles, which end in the round alveoli

clustered like grapes. Gas exchange takes place in the alveoli, allowing for oxygenation of the blood and release of carbon dioxide.

The diaphragm is presented in the same color as the lungs, but it's important to note that it is a sheet of muscle shown in cross section in this graphic, which explains why it appears as a thin wedge-like structure. The movements of the diaphragm along with certain rib muscles cause the changes in lung volume that allow inhalation and exhalation to take place.

It may be helpful to examine the more detailed parts of this diagram using a stylus. Tracing the stylus point within the mouth to locate the tongue, or along the bronchioles as they lead to the rounded alveoli, may give a clearer picture of these intricate structures.

9 Digestive System

In this diagram, the outer body outline is omitted, and only the side-facing head is shown as a point of reference. An anterior view of the digestive organs is presented here, which means that left and right sides are inverted, as in other anatomical diagrams in this guide.

As in the previous diagram, this image begins with the oral and nasal openings in the head, which unite to form the pharynx (not labeled), a pathway common to the digestive and respiratory systems. Food mixes

with saliva as it is chewed in the mouth. The graphic shows the location of salivary glands in the head region. The tongue and mouth muscles form the food into a bolus, convenient for swallowing.

Jutting out into the pharynx is the epiglottis (shown as a small flap over the opening to the trachea). As explained in the description of the respiratory system (Image 8), in the up-tilted position, the epiglottis lets air enter and leave the trachea (of which only the upper part is shown in this image) during normal breathing. During swallowing, however, the epiglottis tilts down and blocks the trachea as food or liquid enter the esophagus. This prevents choking during the process of consuming food and drink.

The digestive process is a type of journey. After food is swallowed, it passes through the tubular esophagus and enters the pouch-like stomach, where it mixes with digestive juices. After some time spent there, this mixture moves into the first part of the small intestine (shown in pink), where digestive juices from the liver, gall bladder, and pancreas enter by way of ducts (not labeled). While these organs are not drawn to accurate scale, it is relevant to note that the liver is quite large, as depicted here. Note also that the stomach and pancreas are on the left side of the body and the liver and gall bladder are on the right. All of the organs are compressed together within the abdomen as well, though the diagram shows them spaced apart for clarity.

The adult small intestine (including the initial pink section mentioned above and the remaining purple length) is about 6 meters (or 20 feet) long but is quite abbreviated in this graphic for simplicity. The small intestine winds and turns, and at its lower end joins the large intestine, which is about 1.5 meters (5 feet) long in an adult. Traceable with a finger, the graphic shows the ascending, transverse, descending, and sigmoid sections typical of the large intestine. The last stage of the path ends with the rectum and anus. The location of the appendix is also indicated near the juncture of the small and large intestine. The internal structure of the appendix suggests it has a role in immunity and is a repository for beneficial bacteria.

10 Excretory System

This expanded anterior view shows only the lower torso, with both the upper body and the legs truncated.

The kidneys, ureters, bladder, and urethra are the prominent features of the diagram and are shown in the highest relief. The adrenal glands, located on top of the kidneys, are less prominent tactually because they are part of the endocrine system, shown in Image 11.

The circulatory system has an intimate anatomical and functional association with the excretory system, as shown by the renal veins and renal arteries branching from the vena cava and aorta, respectively. The blood vessels in this image retain the texture

and color coding used in previous diagrams (smooth and light blue for deoxygenated blood in veins and pink with a dotted texture for oxygenated blood in arteries).

11 Endocrine System

This image shows an anterior view of the body with the locations of the endocrine glands, along with other organs to enhance positional understanding. It also uses a convention common to print images, namely, showing both the female and male gonads, or ovaries and testes, respectively, on one body diagram.

Endocrine glands are ductless, which means their hormonal secretions are released into the bloodstream and have an effect only on specific target organs. For this reason, the diagram shows gland location and not the more complex functional pathways.

In the diagram, the pale pink recessed area within the head represents the brain, and within the brain are the hypothalamus (dark pink in the graphic), pineal gland (blue), and pituitary gland (purple). These are represented in a stylized form that indicates their location more than their true size and shape. The hypothalamus and pituitary gland function together and with other organs in the body to regulate energy levels, reproductive cycles, and the response to stress. The pineal gland produces melatonin, a hormone that modulates sleep-wake cycles.

The thyroid gland is a butterfly-shaped organ that resides in the neck region. It produces hormones that affect the use of energy by the body. The parathyroid glands are represented as four dot-like patches on top of the thyroid gland. In reality, each patch is the size of a grain of rice. The parathyroid glands produce a hormone that regulates calcium levels in the blood.

The pancreas is nestled behind the stomach toward the left side of the upper abdomen (see Image 9). In addition to secreting digestive juice released into ducts and ultimately the small intestine, the pancreas has patches of tissue that secrete hormones such as insulin into the bloodstream, which helps regulate blood sugar levels.

In a reversal from Image 10, the triangle-shaped adrenal glands in this graphic are more prominent than the kidneys, on which they sit. The adrenal glands secrete hormones that help regulate stress responses, reproduction, blood pressure, and the immune system.

The paired ovaries are shown in close association with the uterus and oviducts to better demonstrate their location in females. The ovaries produce several hormones that regulate reproductive cycles, including the release of an egg each month in adult females.

In the graphic, the paired testes are shown superimposed on the thighs; in reality they are located between the thighs and behind the penis in males. Not shown is the sac or scrotum in which they

reside, which technically hangs outside the body. Testes within the scrotum are referred to as testicles. These glands produce hormones that regulate reproduction in males in addition to producing sperm.

12a Female External Genitalia

Unlike most of the preceding images, this graphic shows external rather than internal features of the body. The presentation in this diagram is a "doctor's view," that is, a view in which a female is lying down with her legs apart. The truncated legs are indicated with labels on the left and right.

Students can begin with the anus, a structure common to both males and females, located at the bottom of the graphic. In the graphic the labia majora are shown as gentle folds that extend upward from this area on the left and right sides; the braille label (ma) is only on the left. Internal to these structures are the labia minora, which run parallel but are much thinner; the braille label (mi) is just above the anus. The labia envelop two more openings: the vagina (v), or birth canal, and above that, the urethra (u). The clitoris (cl) is a small knob-like structure located at the very top.

12b Female Reproductive System (internal front view)

This internal view focuses on the lower abdomen, with both the upper body and the legs truncated.

Students should understand that this image is a longitudinal section showing the anterior view of the reproductive organs. Some areas are raised, such as the ovaries (shown with a bumpy texture) and the walls of the Fallopian tubes, or oviducts, and the uterus, cervix, and vagina. The recessed areas show the space within these tubular organs. Using a stylus, students can trace the path of an egg released from an ovary, through the Fallopian tube, into the uterus, and eventually out the vagina. The path of sperm prior to conception is discovered by tracing with the stylus in the opposite direction, starting with the vagina.

12c Female Reproductive System (internal side view)

This graphic shows the lower abdomen with the upper body and legs truncated. The image is a longitudinal section showing a side view of the reproductive organs, along with organs from other anatomical systems for reference.

The internal organs are bracketed by the pubic bone on the left (front of the body) and the bones of the spine on the right (back of the body). To the left of the spine are the rectum and anus, signaling the

end of the digestive tract. The ovary, Fallopian tube, uterus, and vagina lie in the center of the diagram, and the urinary bladder and urethra are to the left of these structures. The labia majora are shown at the bottom of the diagram enclosing the openings of the vagina and urethra. The clitoris is located just beneath the pubic bone. Students should understand that the arrangement of the openings to the various systems (digestive, reproductive, excretory) in this graphic is the same as in Image 12a, just viewed from a different perspective.

13 Tampon Insertion (side view)

This diagram shows the placement of a tampon with before and after views. Because these are side views in longitudinal section, students may need back-and-forth comparison with earlier images in order to correlate the pathway of tampon insertion with the organs shown in previous presentations.

The organs and structures shown (which are not labeled, to avoid clutter), starting from the leftmost or front (anterior) side, include the labia, urethra, and bladder; the vagina and uterus; and the rectum and anus. The tail end of the spine is also shown in the rightmost posterior position.

The drawing illustrates the tampon entering the vaginal opening at an angle, as shown by the arrow and raised dashed line. The user should imagine a line or path pointing toward the lower back when inserting it, after spreading the labia apart. The second part of

the drawing shows the tampon in place, with the end of the string remaining outside the vagina.

14a Male External Genitalia

As with diagram 12a, this image focuses only on the area of the genitalia; the rest of the body is not shown.

The tactile difference between the left and right parts of the image is very subtle. The left side of the diagram shows an uncircumcised penis; the foreskin covers the head of the penis except for a small round opening at the tip, where the urethral opening is. The right side of the diagram shows a circumcised penis in which the foreskin has been removed. In this case, the head is fully exposed and more tactually defined. In both images, the pubis is shown as the raised area behind the penis, with short, raised lines indicating hair.

14b Male Reproductive System (internal side view)

This diagram presents a left side view in longitudinal section of the lower abdomen and includes, for reference, structures seen in other diagrams, such as the pubic bone and lower spine, rectum and anus, and urinary bladder. Students will note that only one of the paired structures (i.e., the left testicle, epididymis, vas deferens, and seminal vesicle) is visible in this diagram.

Tracing the different tubular structures that are shown will take some careful attention. Students will note that the urinary bladder, the seminal vesicle, and the vas deferens (which starts at the testicles and loops up and over the bladder) all feed into the urethra. Further, they should all be seen as passing through the prostate gland. The ejaculate, or semen, comprises secretions from the seminal vesicles and the prostate gland in addition to the sperm produced in the testes (and stored in the epididymides before ejaculation). Tracing the incised pathways of semen production to the urethral opening with a stylus might be helpful.

15 Fertilization

The sections of this diagram are numbered 1 through 5, beginning at the upper left and progressing clockwise.

The first section shows a close-up of a sperm cell and some of its parts (nucleus, acrosome, and flagellum). From there we see stages in the process of fertilization of an egg cell. The sperm cells swarm around the egg cell, with one sperm eventually entering the egg. In the fourth section, the outer region of the egg creates a barrier to prevent other sperm cells from entering. The fifth section gives a close-up of the fertilized egg. The nuclei from the egg and successful sperm have fused, and the tail of the sperm cell is cast off.

AMERICAN
PRINTING
HOUSE

1839 Frankfort Avenue,

Louisville, KY 40206

502-895-2405

info@aph.org

www.aph.org

Catalog No. 1-08055-00