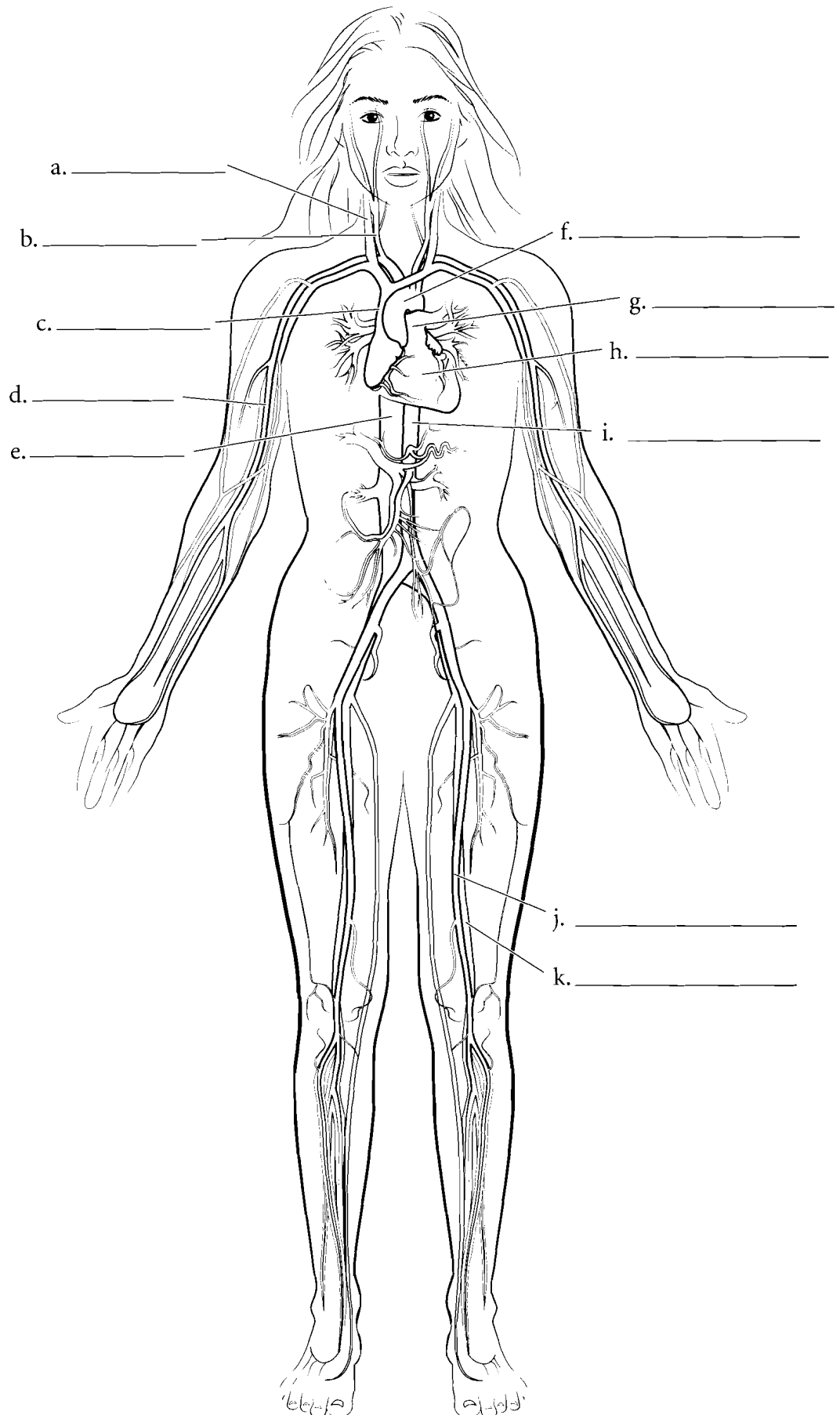


OVERVIEW OF THE CARDIOVASCULAR SYSTEM

The cardiovascular system consists of the heart as a pump, blood vessels that take blood away from the heart (arteries), and blood vessels that take blood back to the heart (veins).

Locate the **heart** on the illustration and color it in purple. Label the **common carotid artery** and color it in red. Arteries are typically colored in red and veins are colored blue.

Label and color in the **internal jugular vein** too. The internal jugular vein takes blood to the **superior vena cava** which takes blood to the heart. Label and color the **aortic arch** red and find the continuation of the **aorta** that travels down the left side of the body, splits and takes blood to the **femoral artery**. The vessel parallel to the femoral artery is the **femoral vein** and it should be colored blue. The femoral vein takes blood to the **inferior vena cava** before it goes to the heart. Blood travels to the arm by the **brachial artery** and deoxygenated (color it blue) blood travels to the lungs in the **pulmonary trunk**.



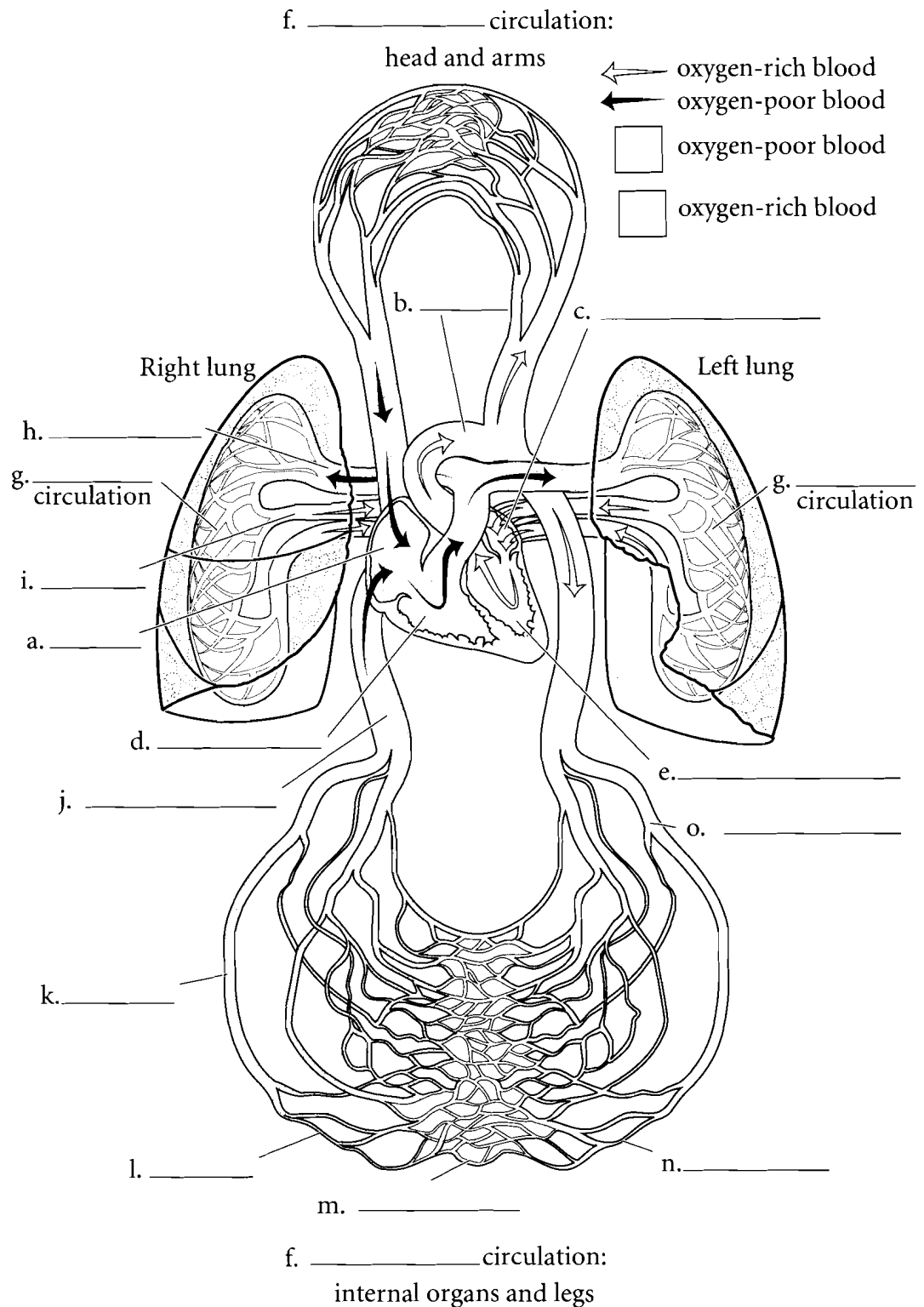
Answer Key: a. Internal jugular vein, b. Common carotid artery, c. Superior vena cava, d. Brachial artery, e. Inferior vena cava, f. Aortic arch, g. Pulmonary trunk, h. Heart, i. Aorta, j. Femoral artery, k. Femoral vein.

CIRCULATION

The heart has four chambers including the superior atria and the inferior ventricles. There is a typical coloring pattern for the cardiovascular system. Vessels or chambers that carry deoxygenated blood are colored in blue while vessels that carry oxygenated blood are colored red. Label and color the **right atrium** (blue), **right ventricle** (blue), **left atrium** (red) and **left ventricle** (red). Remember the heart is in anatomical position so the right atrium is on the left in the illustration.

There are two major circulations in the body. One goes to the lungs and this is called the **pulmonary circulation**. Deoxygenated blood leaves the right ventricle of the heart and travels through the **pulmonary artery** (blue) to the lungs where the blood is oxygenated. Blood returns from the lungs to the left atrium of the heart by the **pulmonary veins** (red). The other main circulation in the body is called the **systemic circulation** where blood travels from the left ventricle of the heart and goes to the other regions of the body. Arteries are vascular tubes that take blood away from the heart while veins are vessels that return blood to the heart. Most arteries carry oxygenated blood and most veins carry deoxygenated blood but there are a few exceptions.

The first vessel that leaves the heart is the **aorta** which is part of the arterial system. Color it red. **Arteries** receive blood from the aorta and take blood throughout the body. They branch and become smaller until they become **arterioles**. The arterioles are the structures that control blood pressure in the body. As they get smaller they become capillaries. The **capillaries** are the site of exchange with the cells of the body. Label and then color the capillaries purple. Purple is a good choice because the capillaries are the interchange between the arteries (red) and the veins (blue). On the return flow the capillaries enlarge and turn into **venules**, which take blood to the veins. Color the venules and remaining **veins** of the body blue. Blood from the inferior portion of the heart returns to the heart by the **inferior vena cava**.



Answer Key: a. Right atrium, b. Aorta, c. Left atrium, d. Right ventricle, e. Left ventricle, f. Systemic, g. Pulmonary, h. Pulmonary artery, i. Pulmonary vein, j. Inferior vena cava, k. Vein, l. Venule, m. Capillary, n. Arteriole, o. Artery

BLOOD

Blood consists of **plasma** and **formed elements**. The plasma is the fluid portion of the blood and consists of water, proteins, and dissolved materials such as oxygen, carbon dioxide, electrolytes (ionic particles) and other materials. Plasma makes up about 55% of the blood volume. Formed elements make up about 45% of the blood volume and consist of **erythrocytes** (red blood cells), **leukocytes** (white blood cells) and **thrombocytes** (platelets). Label and color in the red blood cells with a light red color. Label the white blood cells and color in the nucleus with purple and the cytoplasm a light blue. Label and color the thrombocytes purple. There are about 200,00-450,00 thrombocytes per cubic millimeter of blood. They assist the body in clotting to prevent blood from flowing out of small ruptures in blood vessels.

There are about 5 million erythrocytes per cubic millimeter of blood. The erythrocytes do not have a nucleus and they appear like a donut with a thin spot instead of the donut hole. About a third of the weight of a red blood cell is due to **hemoglobin** which makes the cells red. Color in the surface view and cross section of the red blood cell. Note also the size of the thrombocyte.

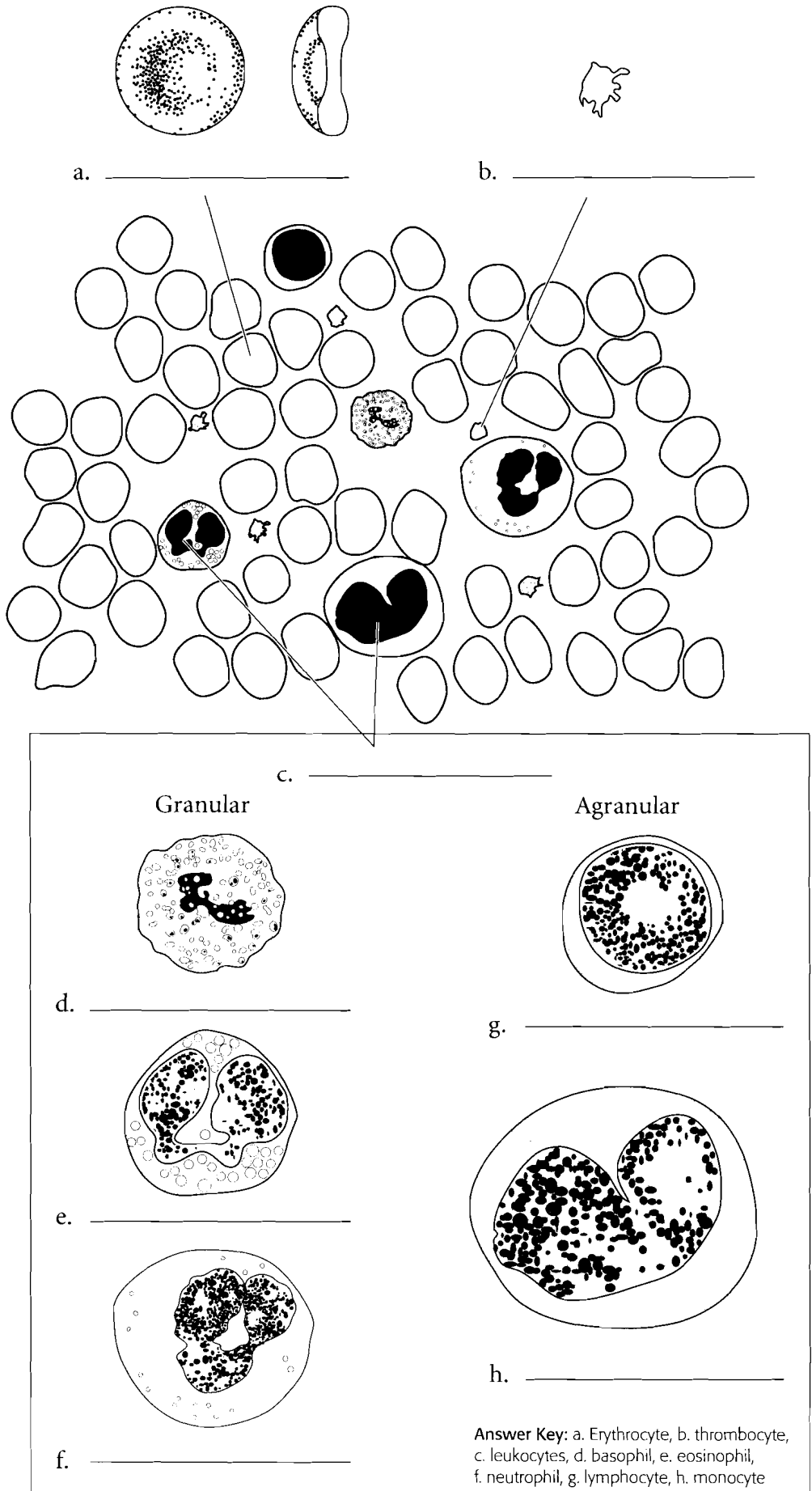
There are about 7 thousand leukocytes per cubic millimeter of blood. There are two main types of leukocytes; **granular leukocytes** and **agranular leukocytes**. The granular leukocytes have cytoplasmic granules that either stain pink, dark purple or do not stain much at all. The granular leukocytes that do not stain much at all are called **neutrophils** because the granules are neutral to the stains. They are the most numerous of the leukocytes making up 60-70% of the leukocytes. Neutrophils have a three to five lobed nucleus. Color in the cells by shading the cytoplasm light blue and coloring in the nucleus purple.

The **eosinophils** are granular leukocytes that have pink or orange staining granules. The nucleus is generally two-lobed. Color in the eosinophil by first coloring in the purple nucleus and then adding orange to the cytoplasm. Eosinophils make up about 3 percent of the white blood cells.

Basophils are a rare granular leukocyte in that they make up less than one percent of the white blood cells. The nucleus is S-shaped but it is frequently difficult to see because it is obscured by the dark staining cytoplasmic granules. Label the basophil and color in the granules a dark purple.

The two kinds of agranular leukocytes are the **lymphocytes** and the **monocytes**. The lymphocytes can be large or small and they make up 20-30% of the leukocytes. The cytoplasm is light blue and the nucleus is purple. The nucleus of the lymphocyte is dented or flattened. Lymphocytes come in two kinds. **B cells** secrete antibodies (antibody-mediated immunity) and **T cells** which are involved in cell-mediated immunity. Label and color the lymphocytes.

The monocytes are large cells (about 3 times the size of a red blood cell) and they have a strongly lobed nucleus. Some people say this looks like a kidney bean or a horseshoe. They represent only about 5% of the leukocytes. Color in the nucleus with a purple and the cytoplasm a light blue.

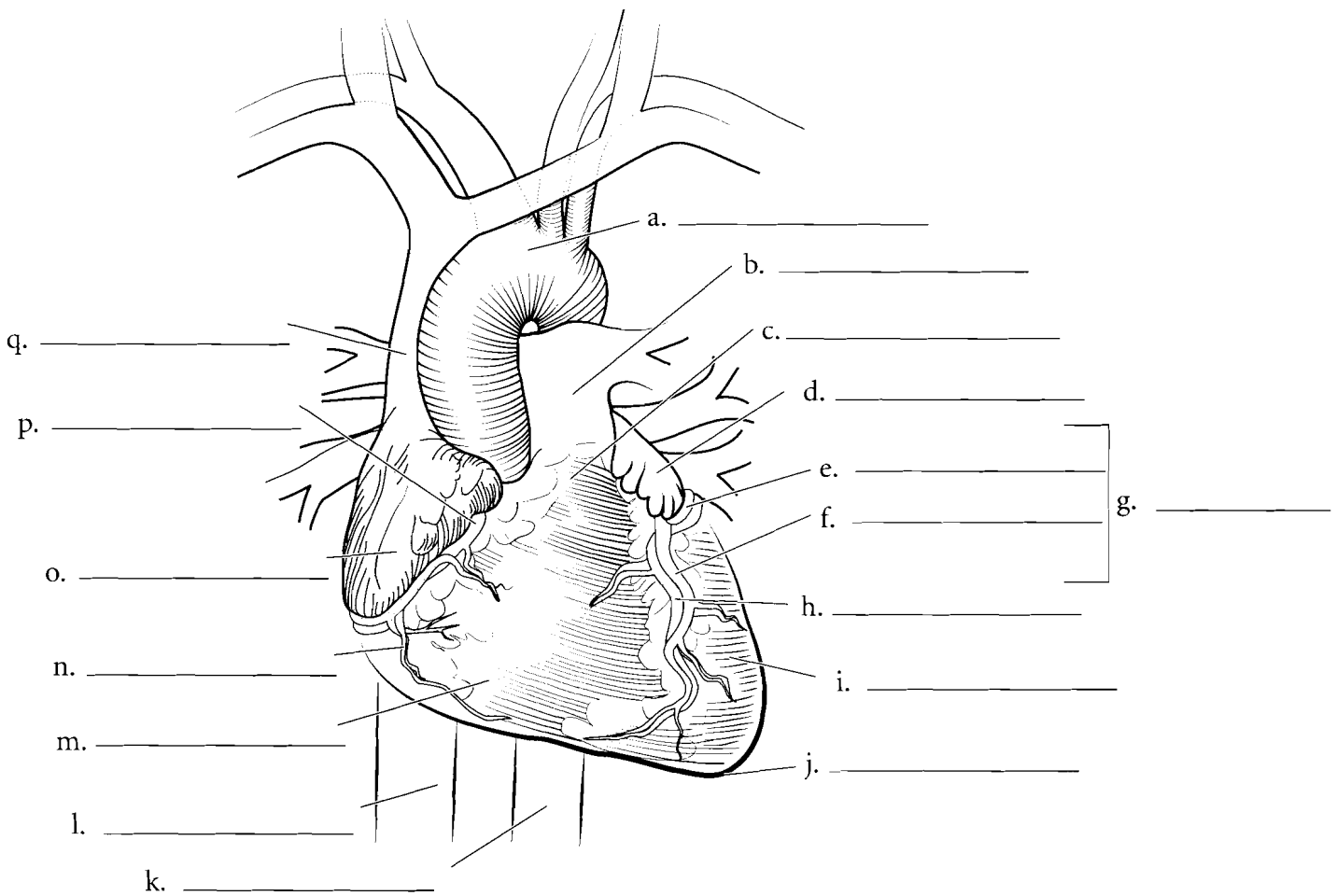


Answer Key: a. Erythrocyte, b. thrombocyte, c. leukocytes, d. basophil, e. eosinophil, f. neutrophil, g. lymphocyte, h. monocyte

ANTERIOR SURFACE VIEW OF HEART

The **apex** of the heart is inferior and the **base** is superior. Label each chamber of the heart and color them each a different color. Locate the **coronary arteries** and their branches and color them in red. The **right coronary artery** leads to the **right marginal artery**. The **left coronary artery**

artery takes blood to the **anterior interventricular branch** and the **circumflex branch**. The **cardiac veins** can also be seen on the anterior side. The **great cardiac vein** runs in the interventricular sulcus on the anterior side. Label all of the major vessels entering and exiting the heart.

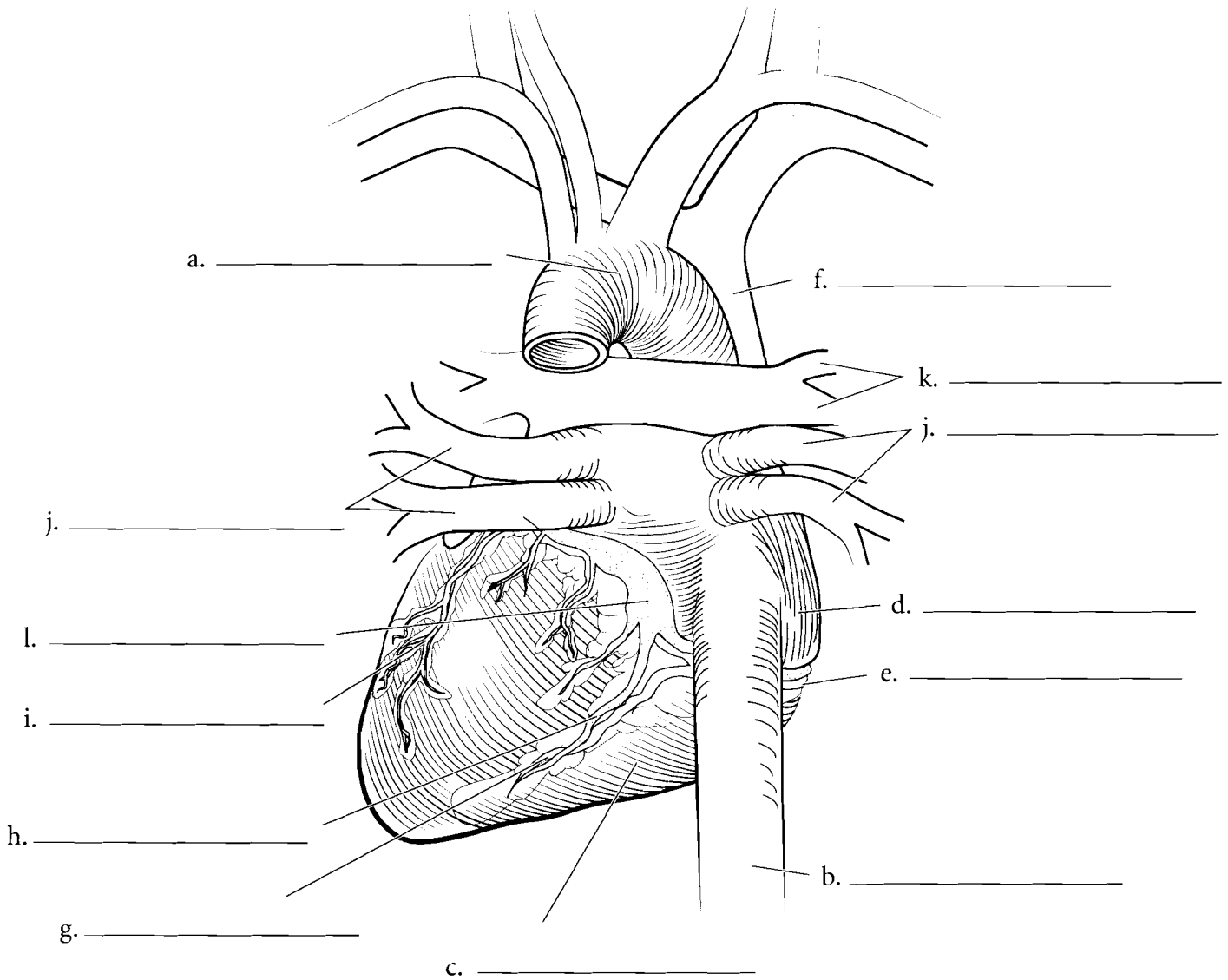


Answer Key: a. Aortic arch, b. Pulmonary trunk, c. Base of heart, d. Left atrium, e. Circumflex branch, f. Anterior interventricular branch, g. Left coronary artery, h. Great cardiac vein, i. Left ventricle, j. Apex of heart, k. Descending aorta, l. Inferior vena cava, m. Right ventricle, n. Right marginal artery, o. Right atrium, p. Right coronary artery, q. Superior vena cava

POSTERIOR SURFACE OF HEART

On the posterior side of the heart are additional arteries and veins. The **posterior interventricular artery** occurs between the ventricles on the posterior surface. It receives blood from the **right coronary artery**. The **middle cardiac vein** runs the opposite direction and takes blood into the **coronary sinus**. The **small cardiac vein** is also found on the posterior

surface of the heart and enters the coronary sinus from the opposite direction. Label the posterior features of the heart and color the arteries in red (except for the **pulmonary arteries** that carry deoxygenated blood—they should be colored in blue). Color the veins in blue (except for the **pulmonary veins** which should be colored in red).



Answer Key: a. Aortic arch, b. Inferior vena cava, c. Right ventricle, d. Right atrium, e. Right coronary artery, f. Superior vena cava, g. Posterior interventricular artery, h. Middle cardiac vein, i. Coronary sinus, j. Pulmonary veins, k. Pulmonary arteries, l. Small cardiac vein

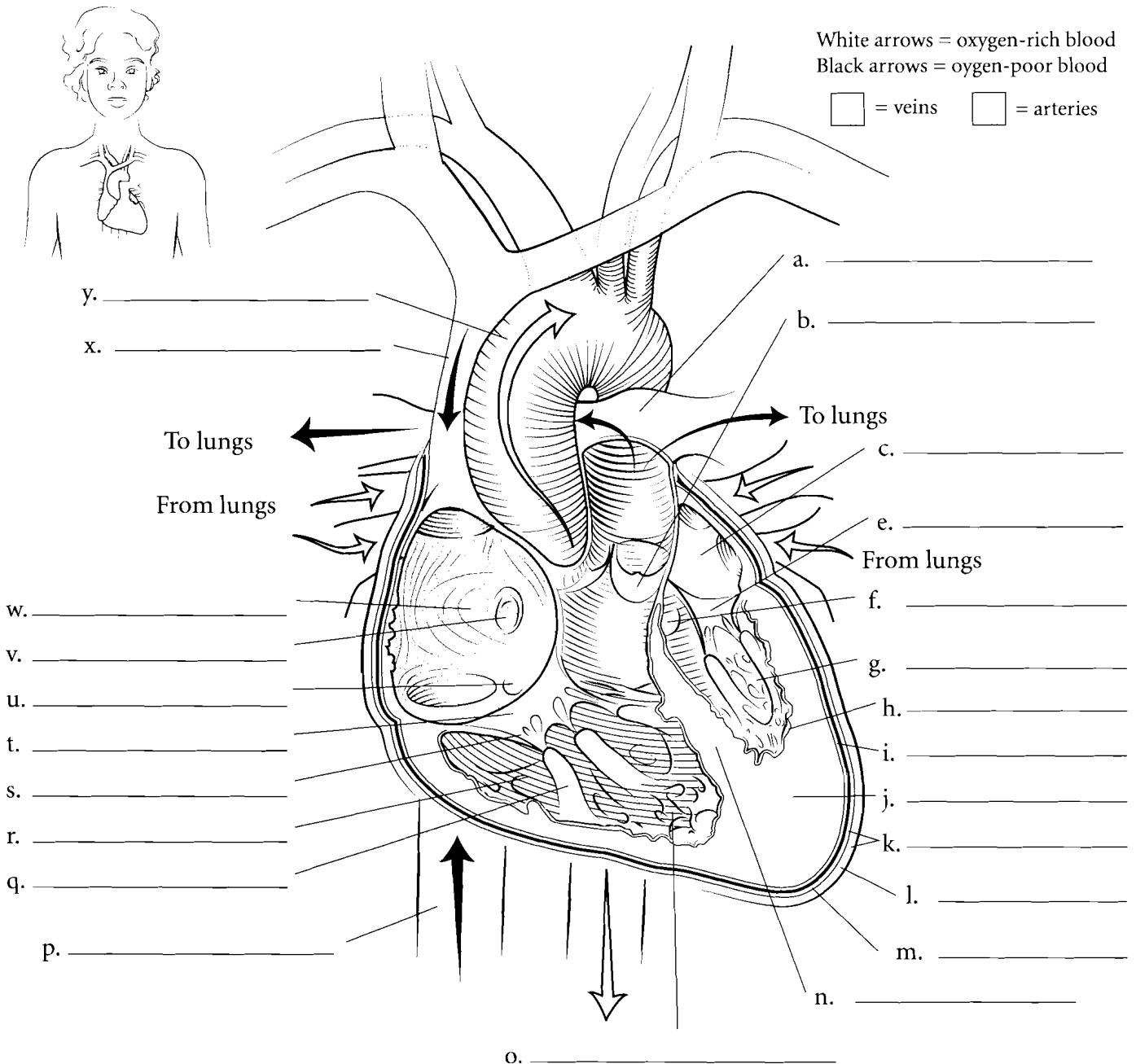
CORONAL SECTION OF HEART

The heart is located in a tough, fibrous sac known as the **parietal pericardium** which has an outer **fibrous layer** and an inner **serous layer**. If this sac is opened you can see a space called the pericardial cavity. The heart is in this cavity. The outer surface of the heart is called the **visceral pericardium** or the **epicardium**. Inside of this is the main portion of the heart wall called the **myocardium** (made of cardiac muscle) and the innermost layer of the heart is the **endocardium**.

Deoxygenated blood enters the **right atrium** of the heart by three vessels: the **superior vena cava**, the **inferior vena cava** and the **coronary sinus**. The walls of the right atrium are thin-walled as they only have to pump blood to the **right ventricle**. The blood in the right atrium is in contact with the **fossa ovalis** which is a thin spot in the interatrial septum. This thin spot is a remnant of a hole in the fetal heart know as

the **foramen ovale**. Blood in the right atrium flows through the cusps of the **tricuspid** or **right atrioventricular valve** into the **right ventricle**. The tricuspid valve is made of the three cusps, the **chordae tendineae** and the **papillary muscles** that hold the chordae tendineae to the ventricle wall. The ventricle wall is lined with **trabeculae carneae** that act as struts along the edge of the wall. The wall between the ventricles is known as the **interventricular septum**.

From the right ventricle, blood passes through the **pulmonary semilunar valve** and into the **pulmonary trunk** where the blood goes to the lungs. In the lungs the blood is oxygenated. From the lungs the blood returns to the **left atrium** of the heart. Blood in the left atrium moves to the **left ventricle** through the **left atrioventricular valve** or the **bicuspid valve**. This valve has two cusps, chordae tendineae and papillary muscles. When the left ventricle contracts, the blood moves through the **aortic semilunar valve** and into the **ascending aorta**.

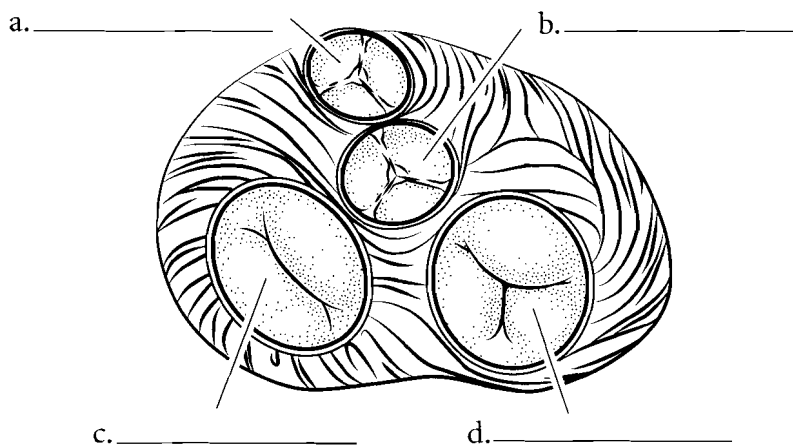


Answer Key: a. Pulmonary trunk, b. Pulmonary semilunar valve, c. Left atrium, e. Left atrioventricular valve, f. Aortic semilunar valve, g. Left ventricle, h. Endocardium, i. Epicardium, j. Myocardium, k. Parietal pericardium, l. Fibrous layer, m. Serous layer, n. Interventricular septum, o. Trabeculae carneae, p. Inferior vena cava, q. Papillary muscle, r. Right ventricle, s. Chordae tendineae, t. Right atrioventricular valve, u. Opening of coronary sinus, v. Fossa ovalis, w. Right atrium, x. Superior vena cava, y. Aorta

SUPERIOR ASPECT OF THE HEART

This view of the heart is seen as if the atria and the major vessels have been removed. You should be able to see all of the major valves of the heart. The most anterior valve is the **pulmonary semilunar valve** that occurs between the right ventricle and the pulmonary trunk. Label and color this valve blue. Posterior to this is the **aortic semilunar valve**. It occurs between the left ventricle and the aorta. Label this valve and color it in red. Both of these valves prevent blood from returning to the

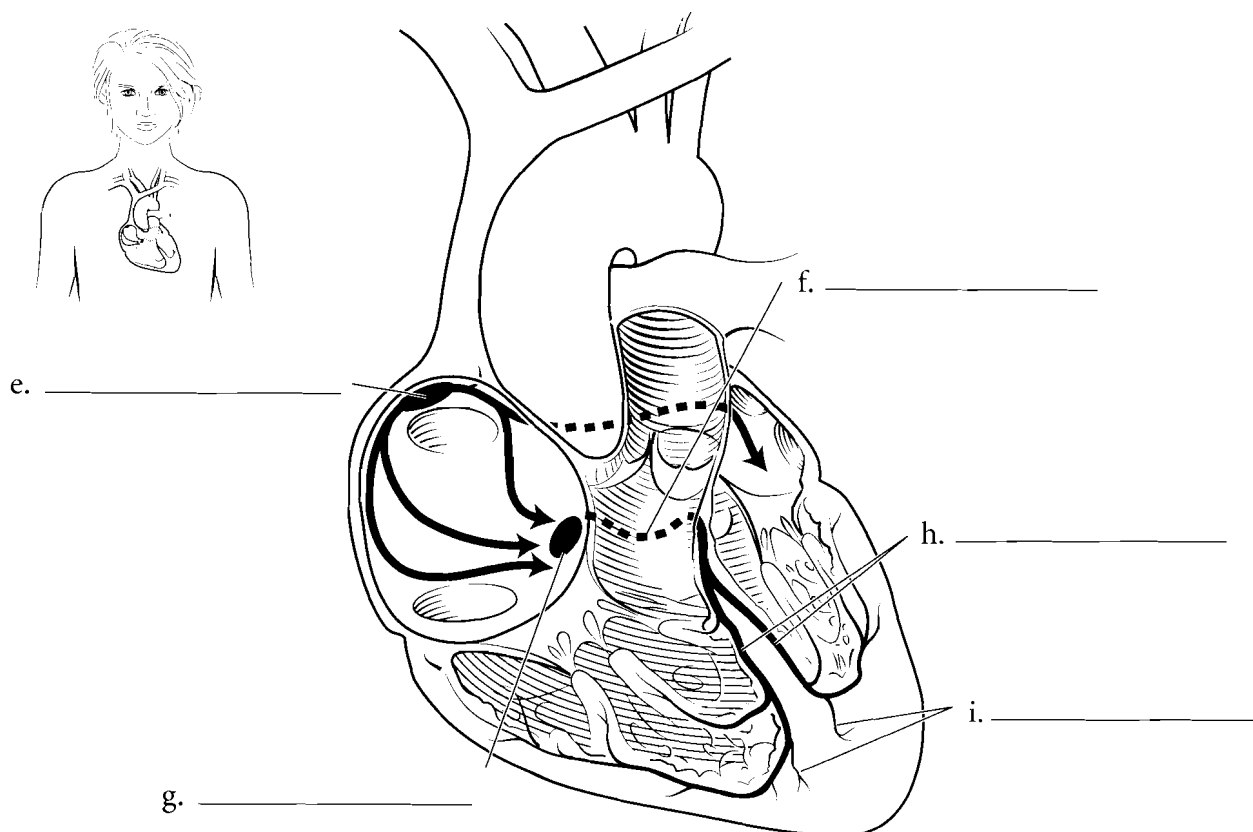
ventricles once they have finished contracting. On the right side of the illustration (and on the right side of the heart) is the **right atrioventricular (or tricuspid) valve**, so named because it has three flaps or cusps. This valve occurs between the right atrium and the right ventricle. It prevents the blood from returning to the right atrium during ventricular contraction. Label this valve and color it blue. On the left side of the heart is the **left atrioventricular (bicuspid) valve**. It prevents blood from moving back to the left atrium when the left ventricle contracts.



ECG—CONDUCTION PATHWAY

The heart has specialized cells that initiate an electrical impulse that radiates throughout the heart. The cells are clustered in a particular area known as the **sinoatrial node** or the pacemaker. These cells produce a depolarization that travels across the atria which depolarize and then contract. Depolarization is an electrical event while contraction is a mechanical event. Between the wall of the right atrium and the right

ventricle is a lump of tissue known as the **atrioventricular (AV) node**. Once the impulse reaches this area the AV node pauses a moment before sending the impulse to the **atrioventricular bundle**. This bundle divides into the **bundle branches** and then the impulse travels to the **conduction (Purkinje) fibers**. These fibers reach the muscle of the ventricles and stimulate them to contract. Color each of the components of the conduction pathway a different color.



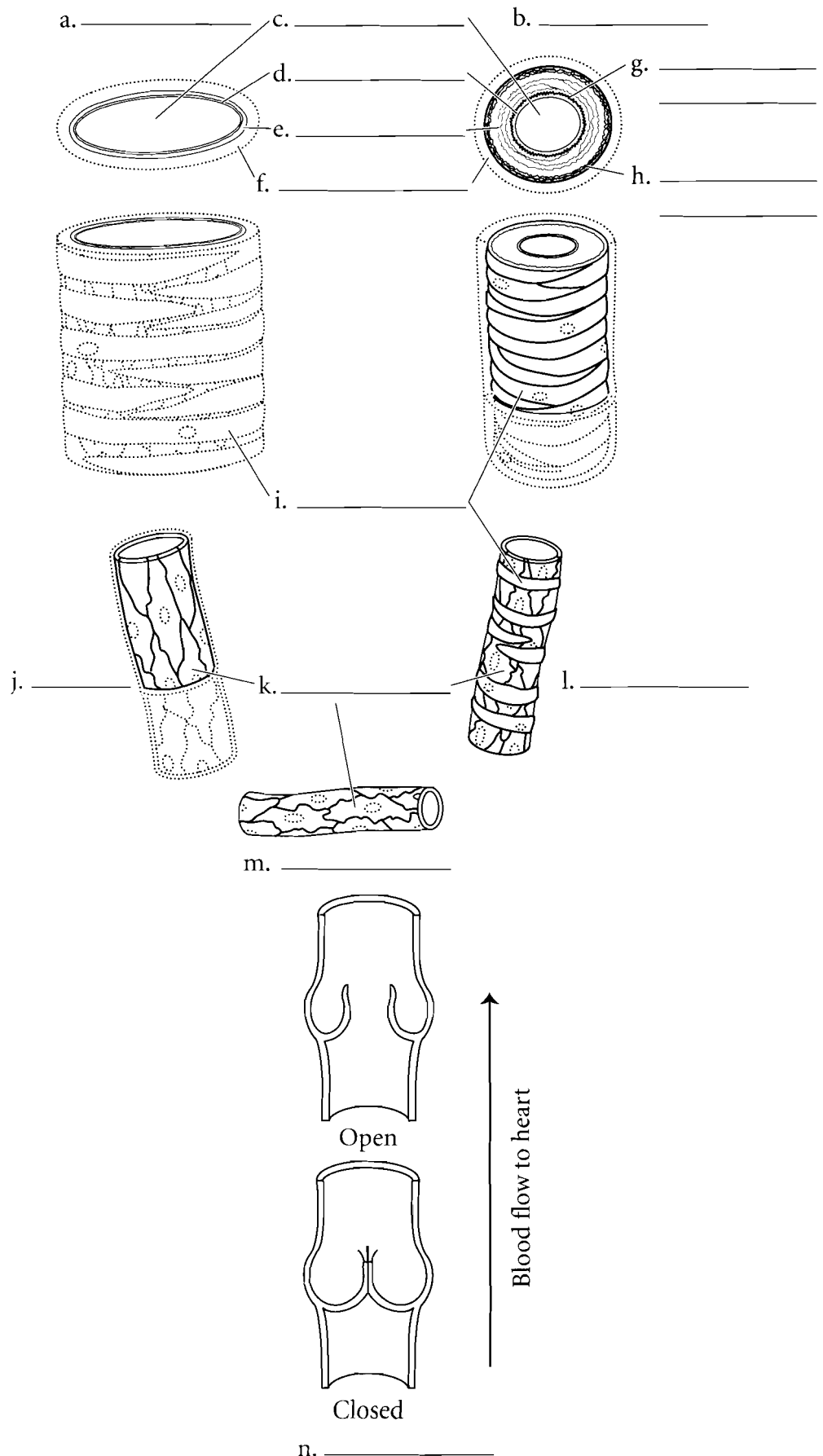
Answer Key: a. Pulmonary semilunar valve, b. Aortic semilunar valve, c. Left atrioventricular valve, d. Right atrioventricular valve, e. Sinoatrial node, f. Atrioventricular bundle, g. Atrioventricular node, h. Bundle branches, i. Purkinje fibers

VESSELS OVERVIEW

The blood vessels have different thickness due to the differences in pressure that occur in them or their function with respect to exchanging nutrients with the cells. **Arteries** have thick walls due to the higher pressure found in them. Just as high pressure hoses have thick walls so do arteries. The outer layer of the artery is the **tunica externa (tunica adventitia)**. You should locate the tunica externa and color it in. The middle layer of the artery, the **tunica media** is the thickest layer and it is made of **smooth muscle** and **elastic fibers**. Color the tunica media red. The innermost layer of the artery is the **tunica intima (tunica interna)** and it has a special elastic layer called the **lamina elastica interna**. Color this layer. The area in the artery where the blood flows is called the **lumen**.

Veins are thinner walled than arteries and they do not have the same elastic fibers in the tunica media as arteries. Color the tunica media of the veins red and select the same colors as you did for the arteries for the tunica externa and the tunica interna. The tunica interna of veins is folded into valves that allow for a one-way flow of blood through veins.

Capillaries are different from both arteries and veins in that they are composed of only simple squamous epithelium (called **endothelium**). The thin nature of capillaries allows them to exchange nutrients, water, carbon dioxide and oxygen with the cells. Color in the endothelium of the capillary with the same color that you selected for the tunica interna.

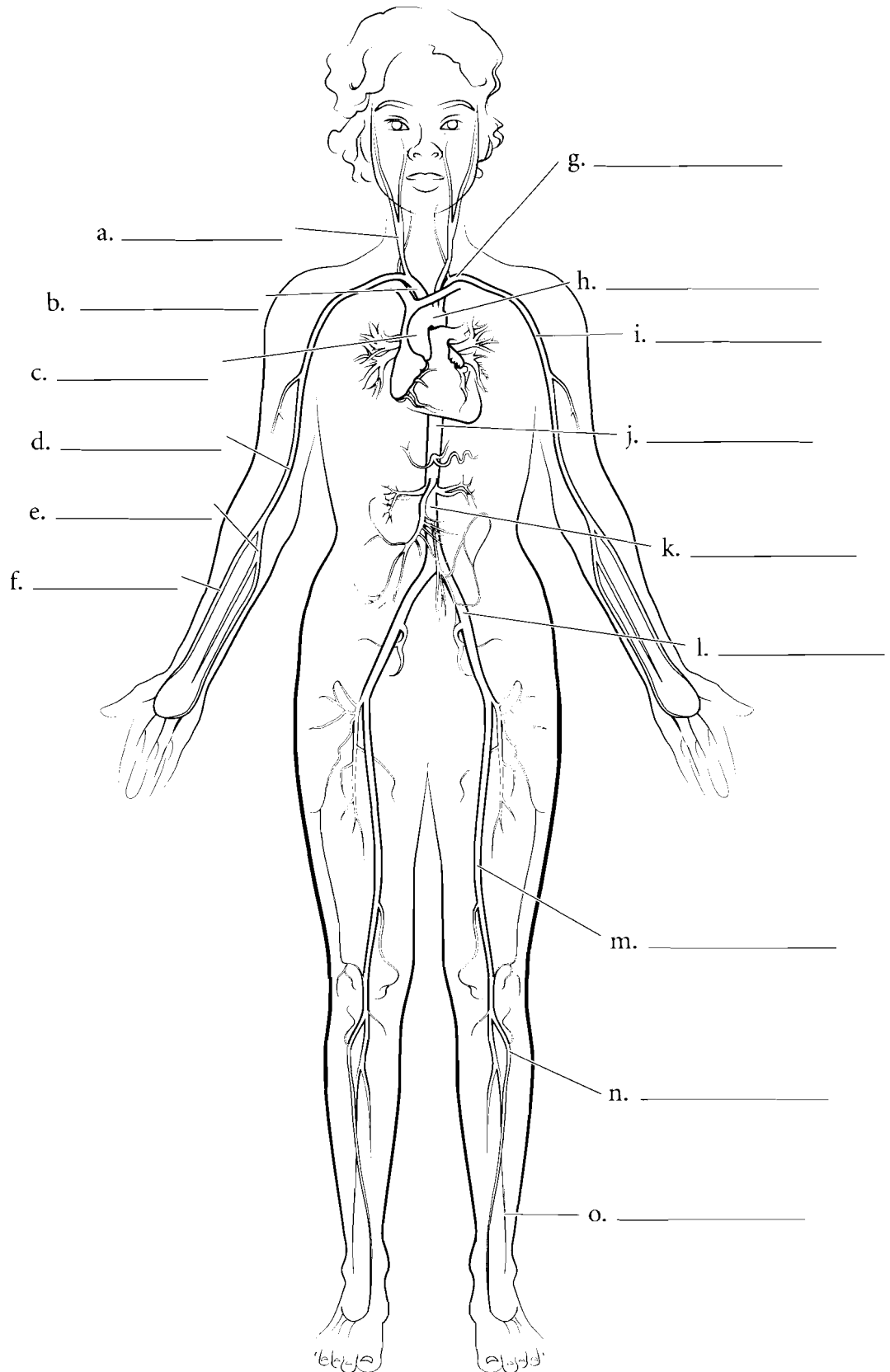


Answer Key: a. Vein, b. Artery, c. Lumen, d. Tunica intima, e. Tunica media, f. Tunica externa, g. Lamina elastica interna, h. Lamina elastica externa, i. Smooth muscle, j. Venule, k. Endothelium, l. Arteriole, m. Capillary, n. Venous valve

ARTERY OVERVIEW

One of the ways to study arteries is to draw them as if you were making a street map. Begin with the heart and draw the blood vessels that occur as you take blood to the fingers, toes or to a particular organ of the body. Arteries are typically colored red and you should select that color for this illustration. Use the following artery list and label the appropriate arteries and color them in red. The abbreviation for artery is *a.*

- Ascending aorta
- Aortic arch
- Thoracic aorta
- Abdominal aorta
- Brachiocephalic trunk
- Common carotid artery
- Subclavian artery
- Axillary artery
- Brachial artery
- Radial artery
- Ulnar artery
- Common iliac artery
- Femoral artery
- Anterior tibial artery
- Fibular artery



Answer Key: a. Common carotid a., b. Brachiocephalic trunk, c. Ascending aorta, d. Brachial a., e. Ulnar a., f. Radial a., g. Subclavian a., h. Aortic arch, i. Axillary a., j. Thoracic aorta, k. Abdominal aorta, l. Common iliac a., m. Femoral a., n. Anterior tibial a., o. Fibular a.