

CIRCULATORY AND ENDOCRINE SYSTEM

Pattern of Circulation

The circulatory system functions to deliver oxygen, nutrients, and hormones to all the cells of the body as well as transport wastes. In mammals the circulatory system has two major circuits the blood follows: a systemic circuit and a pulmonary circuit. The **systemic circuit** carries blood from the heart to all the major organs and returns to the heart. Thick walled **arteries** leave the heart and deliver blood rich in oxygen to all the major regions of the body. They terminate in thin walled **capillaries** where materials enter and leave the system. The capillaries are continuous with **veins** which carry blood low in oxygen back toward the heart. In your Rats most of the arteries contain red latex and would transport highly oxygenated blood and most of the veins contain blue latex and transport poorly oxygenated blood. An exception to this pattern is found in the **pulmonary circuit**. The **pulmonary arteries** (blue) carry blood low in oxygen from the heart to the lungs where it is oxygenated. The **pulmonary veins** (uninjected or red) carry highly oxygenated blood back to the heart so it can enter the systemic circulation. Make sure you understand the importance of this exception.

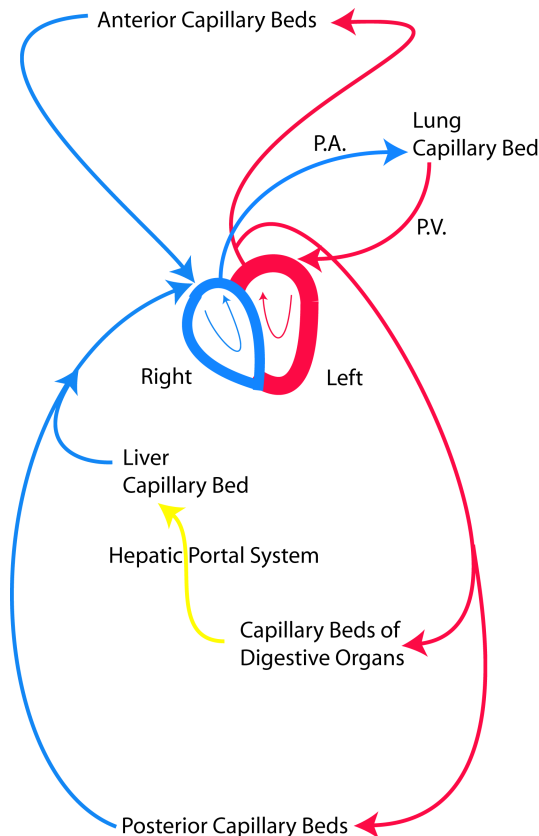


Figure 6.1. General pattern of circulation. Red lines represent vessels carrying blood high in oxygen and blue lines represent vessels carrying blood low in oxygen.

The pattern from artery → capillary bed → vein is interrupted in portal systems. Portal systems begin and end in capillary beds. The **hepatic portal system** functions to transport materials from the digestive system to the liver where toxins are removed and nutrients are processed for storage. This system begins in the capillary beds of the digestive organs and ends in the capillary beds of the liver. From the liver material is returned to the heart (Fig. 6.1). Because latex does not move easily through capillary beds the hepatic portal system must be specially injected. The hepatic portal system is injected with yellow latex in your rats.

Pulmonary Circuit - Heart ►Lung ►Heart (Fig. 6.2-6.4) We will focus on the major vessels leading anteriorly and take only a superficial look at vessels below the diaphragm. *Carefully remove the heart from the pericardial sac taking care not to cut the vessels associated with it.* The heart has four chambers. Locate the two small **atria** that lie above the two muscular **ventricles**. The right atrium receives blood from the systemic system and the left atrium receives blood from the pulmonary system. Gently poke the ventricles to determine which is larger. Why is there this difference? *Trace the path the blood would take from the right atrium to the right ventricle, out the pulmonary artery to the lungs and back toward the heart in the pulmonary vein.* The pulmonary artery will contain blue latex since it carries blood returning from the body and the pulmonary vein will not be injected or have red latex if blood backed up from the arteries that leave the left side of the heart. Oxygen rich blood flows from the left atrium into the left ventricle and out the **aorta** to the rest of the body. As it leaves the heart the aorta gives off two **coronary arteries** to supply the heart muscle with blood. The coronary arteries are difficult to locate.

the pulmonary vein will not be injected or have red latex if blood backed up from the arteries that leave the left side of the heart. Oxygen rich blood flows from the left atrium into the left ventricle and out the **aorta** to the rest of the body. As it leaves the heart the aorta gives off two **coronary arteries** to supply the heart muscle with blood. The coronary arteries are difficult to locate.

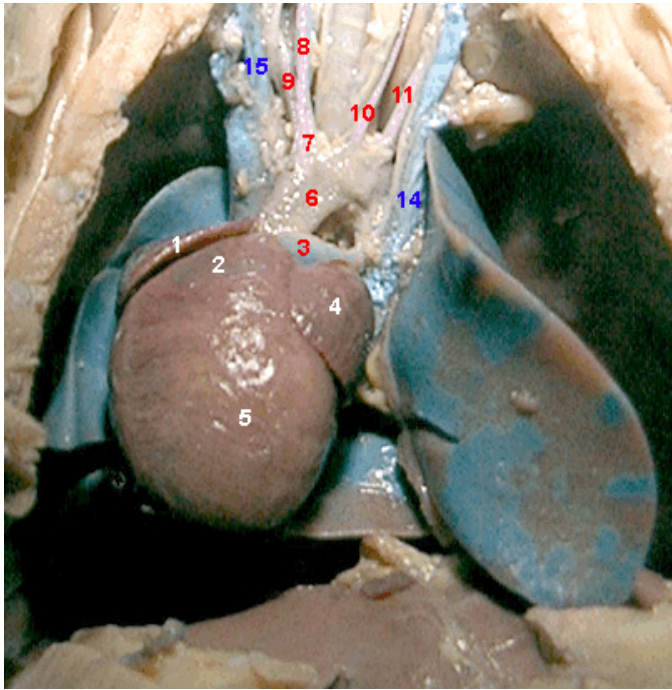


Figure 6.2. Arterial circulation about the heart.

Pulmonary Circuit (Fig 6.2)

(Check the structures you find.)

- Right atrium (1)**
- Right ventricle (2)**
- Pulmonary artery (3)** How does this artery differ from other arteries?

- Pulmonary vein**
(Figure 6.3, blue 3)
How does this vein differ from other veins?

- Left atrium (4)**
- Left ventricle (5)**

Anterior Systemic Arterial Circuit - Heart ► Body (Fig. 6.2, red latex)

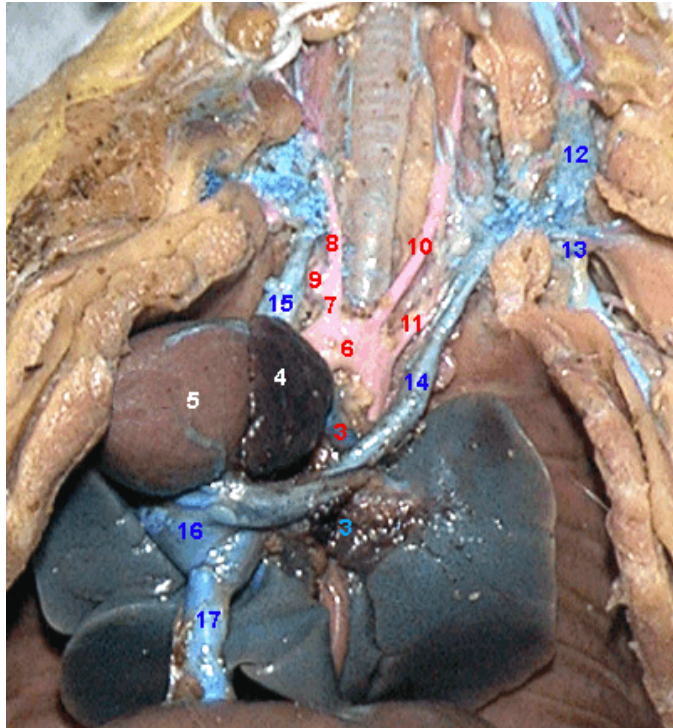
After leaving the heart the aorta curves forming the **aortic arch** and continues as the **descending aorta**.
Locate the major arteries that arise from the aortic arch.

Anterior Systemic Arteries (red latex and labels)

(Check the structures you find.)

- Aorta (6)** - supplies oxygenated blood to the entire body.
- Brachiocephalic artery (7)** - carries blood from the aorta toward the head.
- Right (8) & left (10) common carotid** -supply the head and neck and brain.
- Right (9) & left (11) subclavian** - supply the shoulder and forearm regions.

Anterior Venous Systemic Circuit - Body ➤Heart (Figs. 6.2-6.4, blue latex) Veins are thin-walled and may have ruptured when latex was injected. Veins return blood low in oxygen to the heart so it can enter the pulmonary circulation and be reoxygenated. *Trace the path of blood returning to the heart.*



Anterior Systemic Veins (blue latex and labels)

- **Left external jugular (12)** drains the head and neck.
- **Left subclavian (13)** - drains the arm.
- **Left (14) & right (15) cranial vena cava** - receives blood from the anterior regions of the body.
- **Coronary sinus (16)** - receives deoxygenated blood from all three vena cavas.
- **Caudal vena cava (17)** - receives deoxygenated blood from the posterior regions of the body.

Figure 6.3 Pattern of circulation about the heart. The heart was reflected to the right to show how the caudal and cranial vena cavas meet in the coronary sinus. The pulmonary vein (blue 3) is not injected and can be traced under the left cranial vena cava.

*Reflect the heart towards the head to see how the **cranial vena cavas** meet the **caudal vena cava** in the **coronary sinus** (Fig. 6.4). *Cut through the apex of the heart to reveal the ventricles.* Are the two ventricles the same? Why might they differ in size?*



*Reflect the heart and lungs to the left, you should also be able to find the **azygous vein** that drains the back muscles (Fig 4.8).*

Figure 6.4. Cross-section through the heart. Note the difference in the wall thickness of the two ventricles.

Systemic Arterial Circulation below the Diaphragm - Heart ► Organs

Posterior to the aortic arch the aorta continues into the abdominal cavity where it gives off branches to the digestive and reproductive organs. *Reflect the lungs and heart to the right and trace the **descending aorta** posteriorly as it passes through the diaphragm (Fig. 4.8). The arteries that arise after the aorta enters the abdominal cavity are listed below in the order they arise. For the most part they parallel the veins of the same name. If time permits see how many you can find.*

Posterior Arterial System - Optional (Fig. 6.5, red labels) *Check the arteries you locate.*

- **Aorta (4)** - carries oxygenated blood to organs below the diaphragm.
- **Celiac artery** - branches to supply the stomach, liver, spleen, pancreas, duodenum
- **Cranial mesenteric artery** - branches in the mesentery to supply the small intestine
- **Renal arteries (5)** - these paired arteries supply the kidneys
- **Genital arteries (2)** - these arteries supply the ovary and uterus in females and the testes in males
- **Iliolumbar artery (3)** - supplies lumbar region
- **Caudal mesenteric artery** - supplies the colon and rectum
- **Common iliac arteries (1)** - these paired arteries supply the muscles of the hindlimbs
- **Sacral artery** - supplies the tail

Posterior Venous Circulation - Organs ► Heart

Posterior Venous System - Optional - *check the veins you locate.*

- **Common iliac veins (1)** - these paired veins collect blood from the hindlimbs and join to form the caudal vena cava (4).
- **Genital veins (2)** - collect blood from the reproductive organs.
- **Iliolumbar veins (3)** - collect blood from the dorsal lumbar region.
- **Caudal vena cava (4)** - collects blood from the legs, kidneys, back muscles, bladder, and reproductive organs.
- **Renal veins (5)** - collect blood from the kidney.
- **Adrenal veins (6)** - collect blood from the adrenal glands
- **Hepatic veins** - collect blood from the liver (not shown). *Lift the diaphragm and remove some of the liver tissue to see these veins as they join the **caudal vena cava**.*

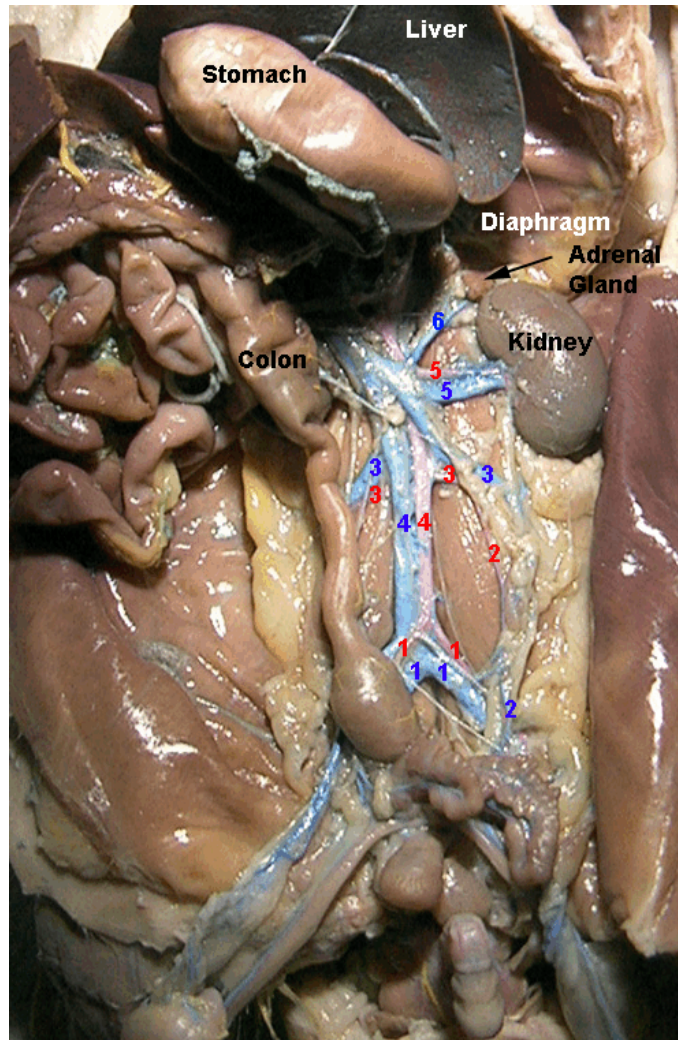
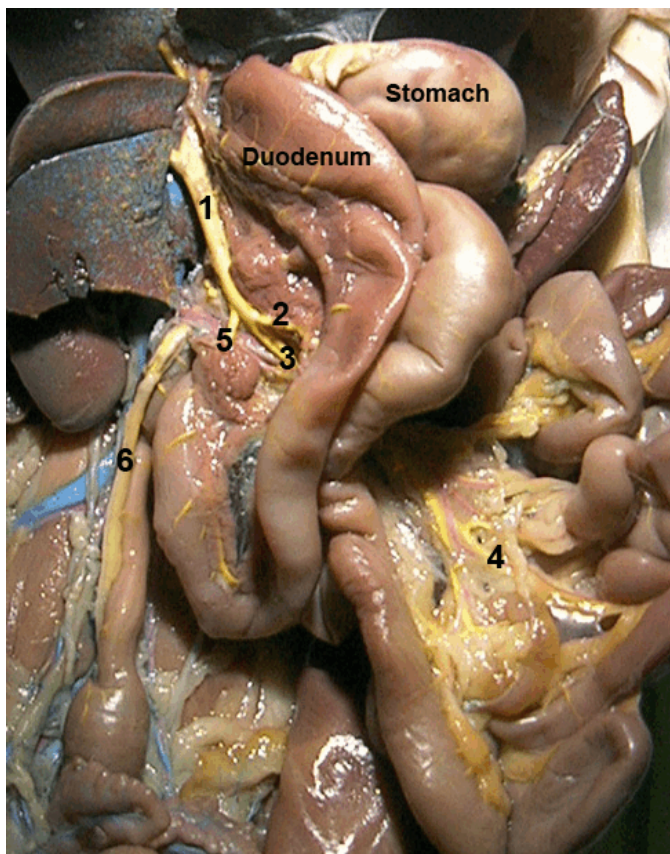


Figure 6.5. Systemic circulation below the diaphragm.

Hepatic Portal System (Fig. 6.6) (yellow latex) - *Required*

The importance of this system was explained earlier. *Try to locate the large hepatic portal vein (1) as it enters the liver.* The hepatic portal vein receives nutrient rich blood from the small intestine, large intestine, stomach, pancreas and spleen and transports it to the liver. In the liver the hepatic portal vein branches into a capillary bed that connects to veins that will eventually flow into the caudal vena cava. Glucose is removed from the circulation in the capillary bed and stored as glycogen in the liver.

Examine the abdominal region and see if you can find some of the smaller vessels associated with the hepatic portal system. If your cat has not had the hepatic portal system injected the vessels associated with it will not contain latex. If they contain blood they will have a brown coloration, otherwise they will be transparent. You should still be able to find these vessels if you start at the liver and work toward the digestive organs that they drain. In most cases the veins of the hepatic portal system parallel the arteries that supply blood to the digestive organs.



- **Hepatic portal vein (1)** - receives nutrient rich blood from the small intestine, large intestine, stomach, pancreas and spleen and transports it to the liver.
- **Gastrosplenic vein (2)** - drains the spleen and stomach.
- **Cranial mesenteric vein (3)** - is formed by the union of the intestinal veins that course through the mesentery.
- **Intestinal veins (4)** - drain from the small intestine into the cranial mesenteric vein.
- **Pancreaticoduodenal vein (5)** - drains the pancreas and duodenal portion of the small intestine.
- **Caudal mesenteric vein (6)** - receives blood from the colon.

Figure 6.6. Hepatic portal system.

Endocrine Glands

During your dissection you examined a number of glands that comprise part of the endocrine system. These ductless glands function to control and coordinate bodily activities through the secretion of hormones directly into the bloodstream. The bloodstream carries hormones to their target organs. Growth, metabolism, and sexual maturation are a few of the processes controlled by endocrine hormones. Hormones are often released at a distance from the target organ and it may take time for a response, however the level of response will depend on the amount of hormone secreted and can have long lasting effects. Endocrine glands that you have already located are summarized in figure 6.7.

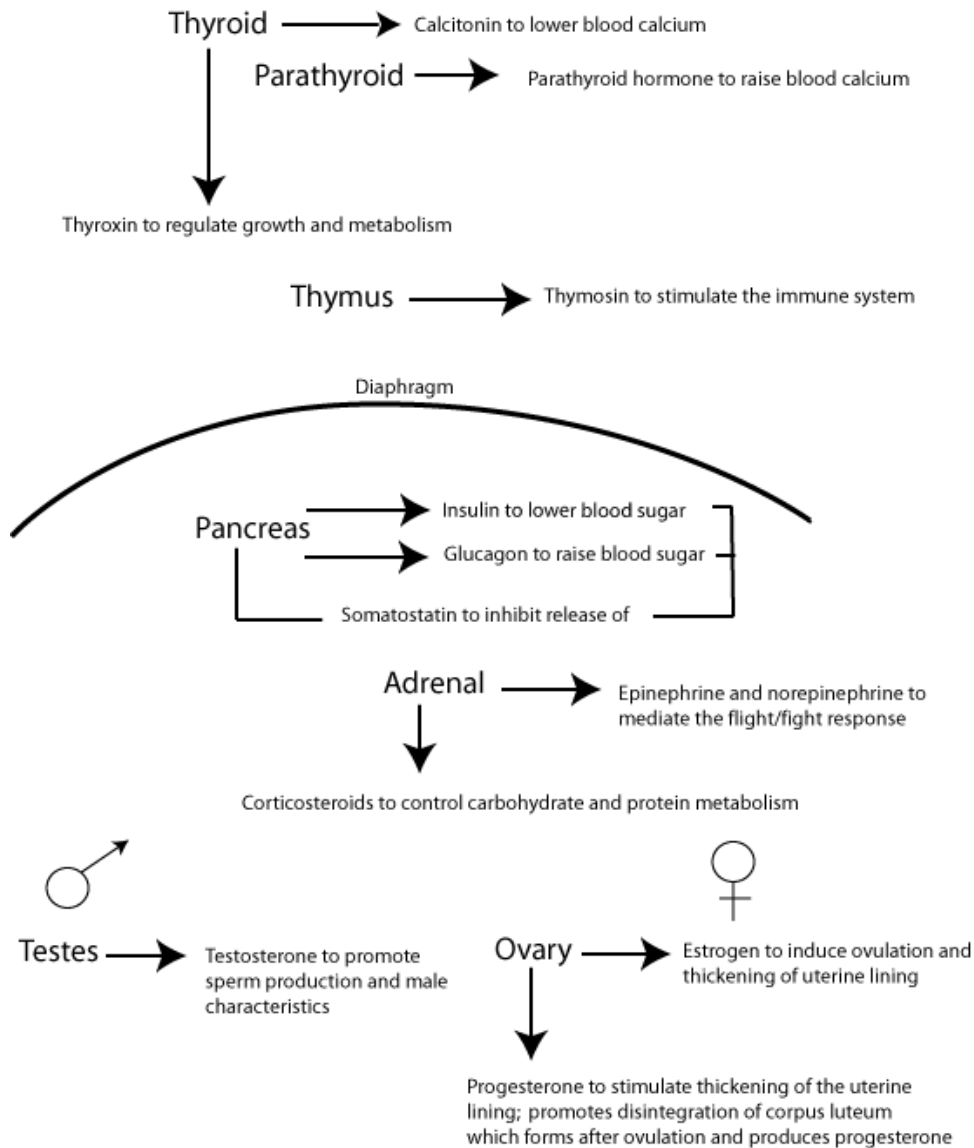


Figure 6.7. A partial list of endocrine glands and some of their associated hormones.

The hypothalamus and pituitary are two important endocrine glands associated with the brain. They will not be found during dissection. The hypothalamus and pituitary regulate other endocrine glands and are regulated by them through a complex feedback system responsive to environmental and internal signals.