Veterinary Bioscience: Cardiovascular System

PRACTICAL CLASS 1: GROSS ANATOMY OF THE HEART

TEACHING STAFF

- Professor Simon Bailey bais@unimelb.edu.au
- Dr Christina Murray cmmurray@unimelb.edu.au

LOCATION

Building 125 Dissection lab

INTENDED LEARNING OUTCOMES

At the end of this practical class students should be able to:

- Be familiar with the external and internal features of the heart
- Identify the pericardial sac and cavity
- Understand the functional implications of the various structures which act in concert to achieve a proper pumping system
- To compare the hearts of the different species of domestic animals.

MATERIAL PROVIDED

Each group of students will have one sheep and/or pig heart. In addition, demonstration specimens will be available including the bovine and equine heart.

All fresh specimens are dependent on availability that week, so the species may vary. Since these specimens were obtained from the abattoir, the major vessels entering and leaving the heart might have been cut too short and the pericardium might be damaged or not present. However, on the whole they should suffice for this exercise.

OVERVIEW

Before comparing the heart of the different species, you should firstly be acquainted with the pericardium and the external and internal features of the heart. Take any heart provided on your table for this purpose. This prac therefore has two parts:

Part1 Dissection of either a pig or sheep heart, to identify the structures of the heart and pericardium that are listed below. An excerpt from the sections on the heart and pericardium in Miller's Guide to the Dissection of the Dog are also provided in this manual to assist you with finding these structures.

Part 2: Examining the demonstration specimens provided to determine the differences between species with respect to the anatomy of the heart.

A table of information is also provided to assist you in determining the species from which the different hearts originate.

PART 1: DISSECTION OF THE HEART

PERICARDIUM

The pericardium is the fibro-serous covering of the heart. Identify the **base** and the **apex** of the heart and visualise how the heart is anchored in position in the thoracic cavity in life. What is the ligament which attaches the apex of the sac to the sternum and mediastinal pleura?

Make an incision from the base to the apex of the pericardium. Note that the pericardium and the **epicardium** are continuous at the base of the heart. Between these two layers is the **pericardial cavity**, which contains a small amount of fluid – **pericardial fluid**. What is the colour and nature of this fluid? Recall the function of this fluid. You may now reflect the pericardium and sever it carefully from the heart.

EXTERNAL FEATURES OF THE HEART

Note the size and shape of the heart, and the colour and texture of the fat on the heart. Refer to the table of information and determine from which species this heart was obtained.

Identify the following (you may use Miller's Guide 4th Ed, pp 143-149):

- Base
- Apex
- Atrial surface
- Auricular surface
- Coronary groove
- Interventricular grooves
    - subsinuosal interventricular groove
    - paraconal interventricular groove
- Right and left atrium and the auricles
- Right and left ventricles
- Major vessels entering and leaving the heart:
    - cranial vena cava
    - caudal vena cava
    - pulmonary trunk
    - aorta
- Major vessels supplying the heart wall:
    - right coronary artery
    - left coronary artery
    - circumflex and interventricular branches
    - coronary sinus and great cardiac vein

INTERNAL FEATURES OF THE HEART: THE FOUR CHAMBERS

Dissect in the manner as described in Miller's Guide 4th Edn pp 144-148:

RIGHT ATRIUM

Identify and examine the following:

- Opening of the caudal vena cava, coronary sinus, cranial vena cava
- Right atrioventricular orifice
- Interatrial septum
- Fossa ovalis (what was it in the foetus?)
- Right auricle
- Pectinate muscles

- Endocardium

RIGHT VENTRICLE

Identify and examine the following:

- Pulmonary valve
- Right atrioventricular valve
- Chordae tendineae (function?)
- Papillary muscles
- Trabeculae carneae (what similar structures are found in the atrium and what could be their function?)
- Conus arteriosus

RIGHT ATRIUM

Identify and examine the following:

- Note the openings of the pulmonary veins
- Left auricle
- Pectinate muscles
- Valve of foramen ovale

RIGHT VENTRICLE

Compare the thickness of the wall with that of the right ventricle.

Identify and examine the following:

- Left atrioventricular valve
- Chordae tendineae (compare with right ventricle)
- Papillary muscles (compare with right ventricle)
- Aortic valve
- Aortic sinus
- Opening of right and left coronary arteries

PART2: COMPARING HEARTS FROM DIFFERENT SPECIES:

Since you are now familiar with the various components of the heart, with the help of the table provided:

- Identify from which species the other hearts were obtained
- Compare the distinctive characteristic features of the other hearts.

SPECIES COMPARISONS

HEART

	Horse	Cow	Sheep	Pig	Dog	Cat
Weight	About 9 lb. (3.4 kg.), great variation. 0.6 to 0.7% body weight	About 5.5 lb. (2.23 kg.), 0.4 to 0.5% body weight	About 0.5 lb. (220 to 240 g.), 0.4% body weight	1 lb. or less (450 g.), 0.35% body weight. 2.2 to 6.1 g. per kg. body weight	5 to 15 oz. (150 to 450 g.), 0.8 to 1.4% body weight. 5.9 to 13 g. per kg. body weight	3.9 to 8.54 g. per kg. body weight
Shape	Irregularly flattened cone	Relatively longer than horse, with shorter base	Apex more or less pointed than cow	Broad, short, and blunt	Ovoid with round blunt apex	As dog
Vena hemiazygos	Vena hemiazygos does not reach heart	Vena hemiazygos opens into great cardiac vein below posterior vena cava	As cow	As cow	As horse	As horse
Os cordis	Absent	2 ossa cordis	1 os cordis	Absent	Absent	Absent
Brachiocephalic trunk	Brachiocephalic trunk only from aorta	As horse	As horse	Brachiocephalic and left subclavian arteries arise from aorta independently	As pig but brachiocephalic artery may be divided into right subclavian artery and bicarotid trunk	As pig
Fat	Soft, yellow, and oily	Soft and yellow	Hard and white	Softer than sheep and white to cream color	Very little fat unless animal in very fat condition. When white, oily fat present	Generally very little fat

MILLER'S

GUIDE TO THE DISSECTION OF THE DOG

FOURTH EDITION

Evans & deLahunta

HEART AND PERICARDIUM

The **pericardium** (Fig. 96) is the fibroserous covering of the heart. It is a thin but strong layer consisting of three inseparable components: an inner parietal serous pericardium, a middle **fibrous pericardium**, and an outer pericardial mediastinal pleura. The heart and pericardium are located in the middle part of the mediastinum from the level of the third to the sixth rib. The continuation of the fibrous pericardium to the sternum and diaphragm forms the **phrenicopericardial ligament**. The **serous pericardium** is a closed sac that envelops most of the heart. The **parietal layer** adheres to the fibrous pericardium. At the base of the heart it is continuous with the **visceral layer**,

or **epicardium**, which tightly adheres to the heart. Between the parietal and visceral serous pericardium is the pericardial cavity, which contains a small amount of pericardial fluid. Incise the combined pericardial mediastinal pleura, fibrous pericardium, and parietal serous pericardium to expose the heart.

The **heart** (Figs. 105–107) consists of a dorsal base where the great vessels are attached and an apex that faces ventrally, caudally, and usually to the left depending on the shape of the thorax. The side of the heart facing the left thoracic wall is called the **auricular surface** because the tips of the two auricles project on this side. The auricles are small appendages of each atrium. The opposite side facing the right thoracic wall is the **atrial surface**. The thin-walled right ventricle winds across the cranial surface from the atrial surface of the heart.

Trace the **coronary groove** around the heart. It lies between the atria and ventricles and contains coronary vessels and fat. The **interventricular grooves** are the superficial separations of the right and left ventricles. They represent the approximate position of the interventricular septum. The **subsinuosal interventricular groove** is a short furrow that lies caudodorsally on the atrial surface and marks the approximate position of the interventricular septum. It contains the terminal part of the left coronary artery, the subsinuosal interventricular branch. Obliquely traversing the auricular surface of the heart is the **paraconal interventricular groove**. Longer and more distinct than the sub-

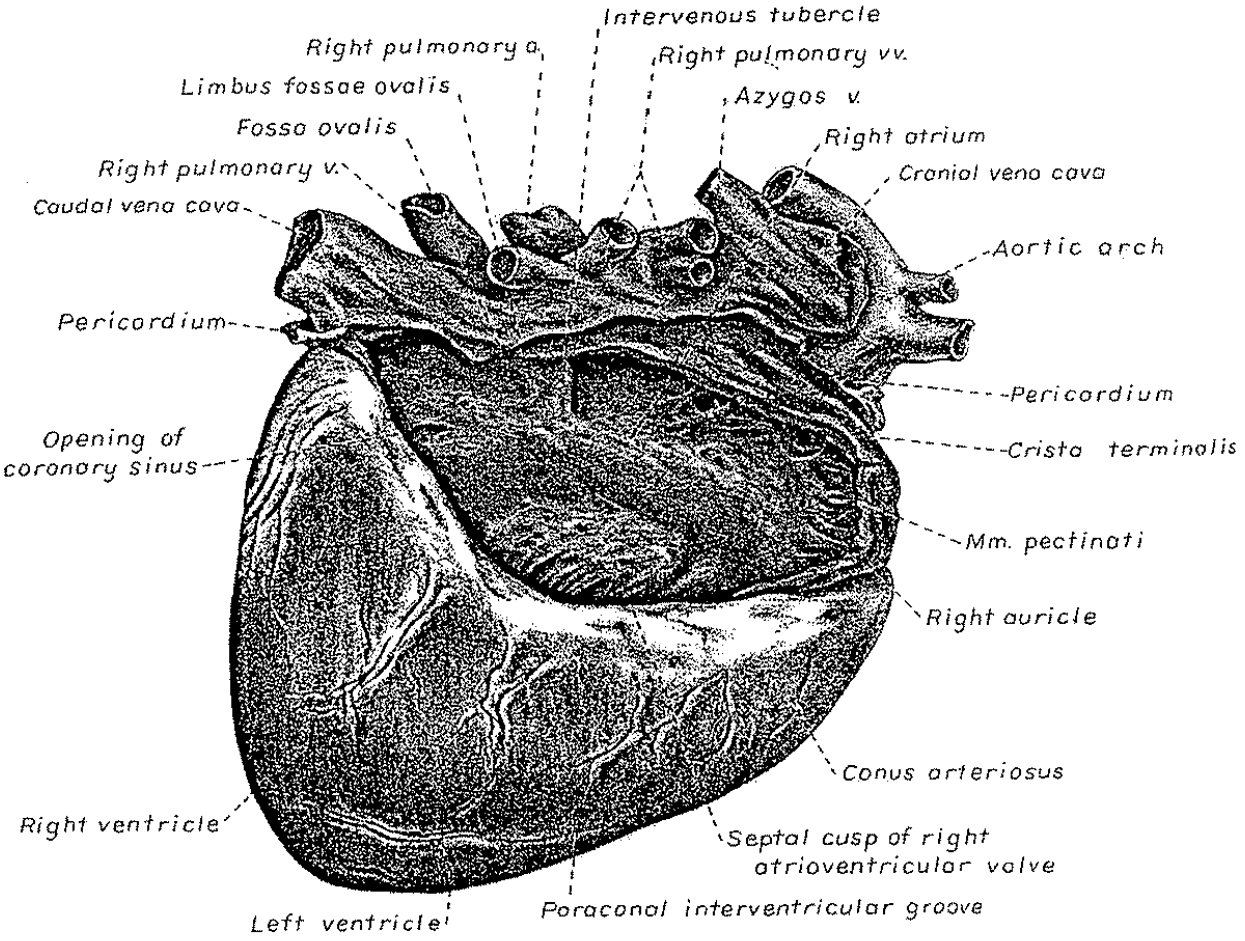

FIGURE 106A. Interior of the right atrium, lateral aspect.

sinuosal, it begins at the base of the pulmonary trunk, where it is covered by the left auricle. It contains the paraconal interventricular branch of the left coronary artery.

The **right atrium** (Fig. 106A) receives the blood from the systemic veins and most of the blood from the heart itself. It lies dorsocranial to the right ventricle. It is divided into a main part, the **sinus venarum**, and a blind cranial part, the **right auricle**.

Open the right atrium by a longitudinal incision through its lateral wall from the cranial vena cava to the caudal vena cava. Extend a cut from the middle of the first incision to the tip of the auricle.

There are four openings into the sinus venarum of the right atrium. The **caudal vena cava** enters the atrium caudally. Ventral to this opening is the **coronary sinus**, the enlarged venous return for most of the blood from the heart. The subsinuosal interventricular groove is ventral to this sinus on the atrial surface of the heart. The **cranial vena cava** enters the atrium dorsally and cranially. Ventral and cranial to the coronary sinus is the large opening from the right atrium to the right ventricle, the **right atrioventricular orifice**. The valve will be described with the right ventricle.

Examine the dorsomedial wall of the sinus venarum, the **interatrial septum**. Between the two caval openings is a transverse ridge of tissue, the **intervenous**

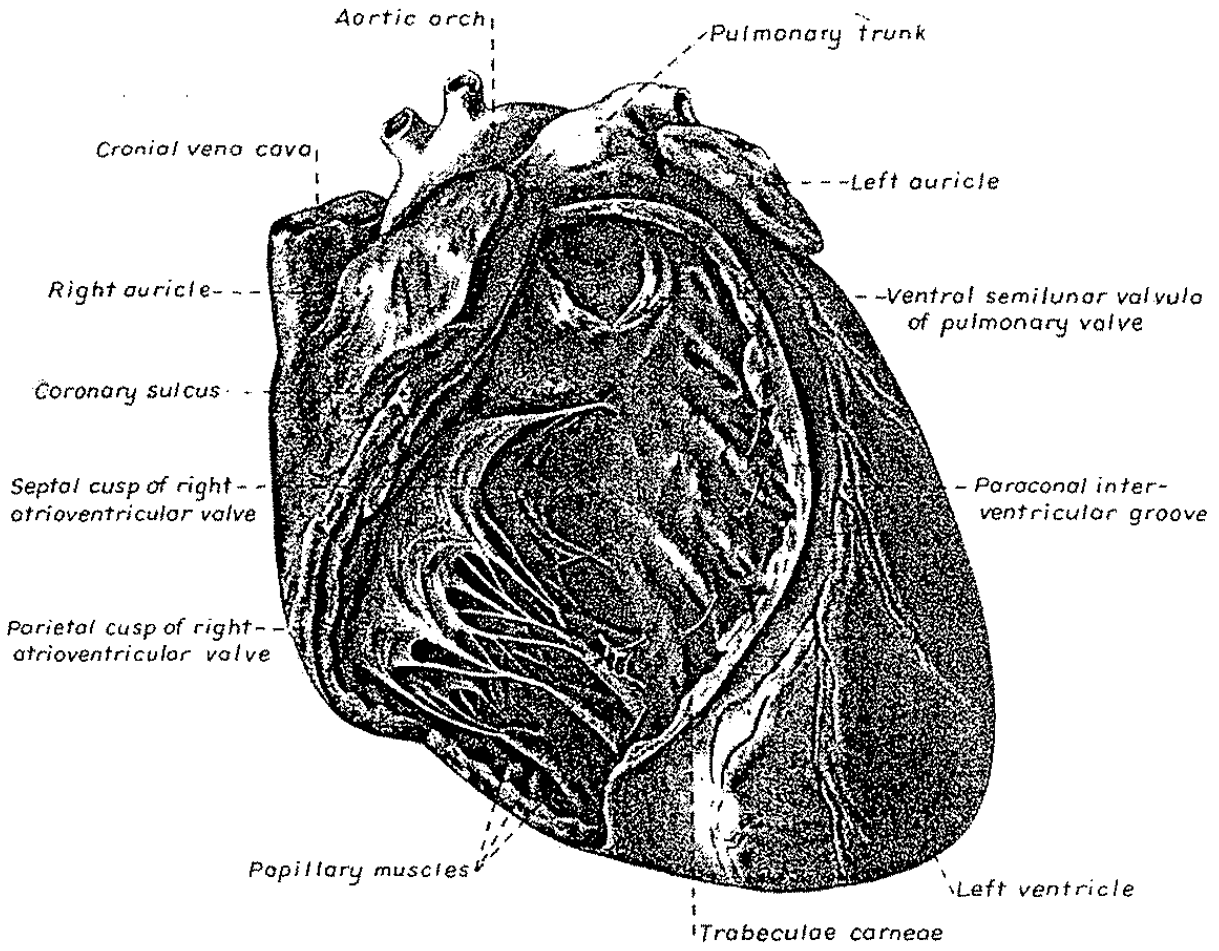

FIGURE 106B. Interior of right ventricle, left lateral aspect.

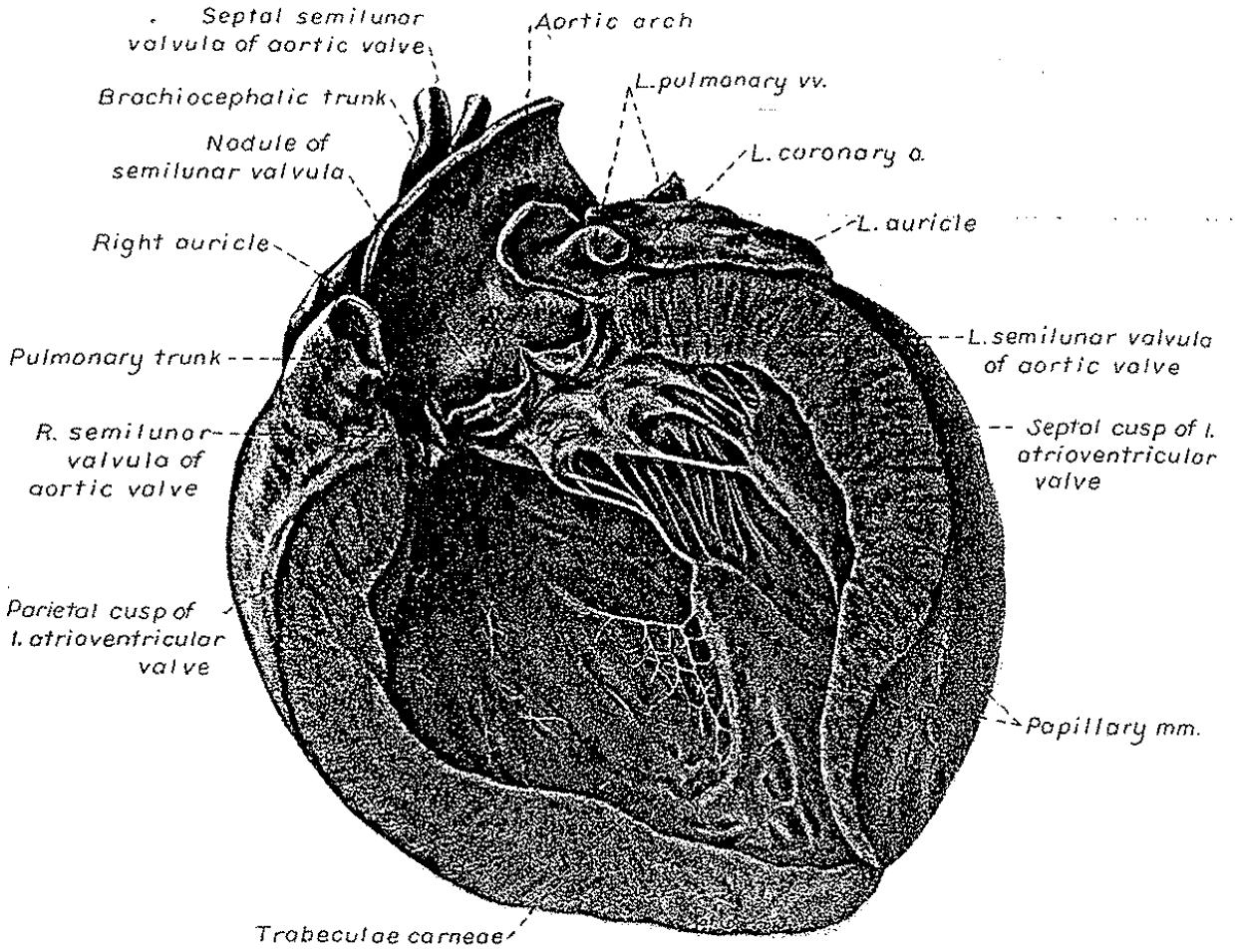

FIGURE 107. Interior of left ventricle, left lateral aspect.

tubercle. It diverts the inflowing blood from the two caval veins toward the right atrioventricular orifice. Caudal to the intervenous tubercle is a slitlike depression, the **fossa ovalis**. In the fetus there is an opening at the site of the fossa, the foramen ovale, which allows blood to pass from the right to the left atrium.

The **right auricle** is the blind, ear-shaped pouch of the right atrium that faces cranially. The internal surface of the wall of the right auricle is strengthened by interlacing muscular bands, the **pectinate muscles** (Fig. 106A). These are also found on the lateral wall of the atrium proper. The internal surface of the heart is lined everywhere with a thin, glistening membrane, the **endocardium**, which is continued in the blood vessels as the endothelium-lined tunica intima. The **crista terminalis** is the smooth-surfaced, thick portion of heart muscle shaped like a semilunar crest at the entrance into the auricle. Pectinate muscle bands radiate from this crest into the auricle.

Locate the **pulmonary trunk** leaving the right ventricle at the left craniodorsal angle of the heart. Begin at the cut end of the left pulmonary artery and extend an incision through the wall of this artery, the pulmonary trunk, and the wall of the right ventricle along the paraconal interventricular groove. Continue this cut around the right ventricle following the interventricular septum to the

origin of the subsinuosal interventricular groove. Cut through the caudal angle of the right atrioventricular valve and reflect the ventricular wall.

The greater part of the base of the right ventricle communicates with the right atrium through the atrioventricular orifice. This opening contains the **right atrioventricular valve** (Figs. 106B, 108). There are two main parts to the valve in the dog: a wide but short flap that arises from the parietal margin of the orifice, the **parietal cusp**, and a flap from the septal margin, the **septal cusp**, which is nearly as wide as it is long. Subsidiary leaflets are found at each end of the septal flap. The points of the flaps of the valve are continued to the septal wall of the ventricle by the **chordae tendineae**. The chordae tendineae are attached to the septal wall by means of conical muscular projections, the **papillary muscles**, of which there are usually three to four. The **trabeculae carneae** are the muscular irregularities of the interior of the ventricular walls. The **trabecula septomarginalis** is a muscular strand that extends across the lumen of the ventricle from the septal to the parietal wall. The septal attachment is often to a papillary muscle. The right ventricle passes across the cranial surface of the heart and terminates as the funnel-shaped **conus arteriosus**, which gives rise to the pulmonary trunk. This is at the left craniodorsal aspect of the heart. The paraconal interventricular groove is adjacent to the caudal border of the conus arteriosus on the auricular surface of the heart.

At the junction between the right ventricle and the pulmonary trunk is the pulmonary valve consisting of three **semilunar cusps** (Fig. 106). A small fibrous **nodule** is located at the middle of the free edge of each cusp. The pulmonary trunk bifurcates into right and left pulmonary arteries, each going to its respective lung.

Open the left side of the heart with one longitudinal cut through the lateral wall of the left atrium, left atrioventricular valve, and left ventricle midway between the subsinuosal and paraconal interventricular grooves. Extend the incision into the left auricle.

The **left atrium** is situated on the left dorsocaudal part of the base of the heart dorsal to the left ventricle. Five or six openings mark the entrance of the pulmonary veins into the atrium. The inner surface of the atrium is smooth

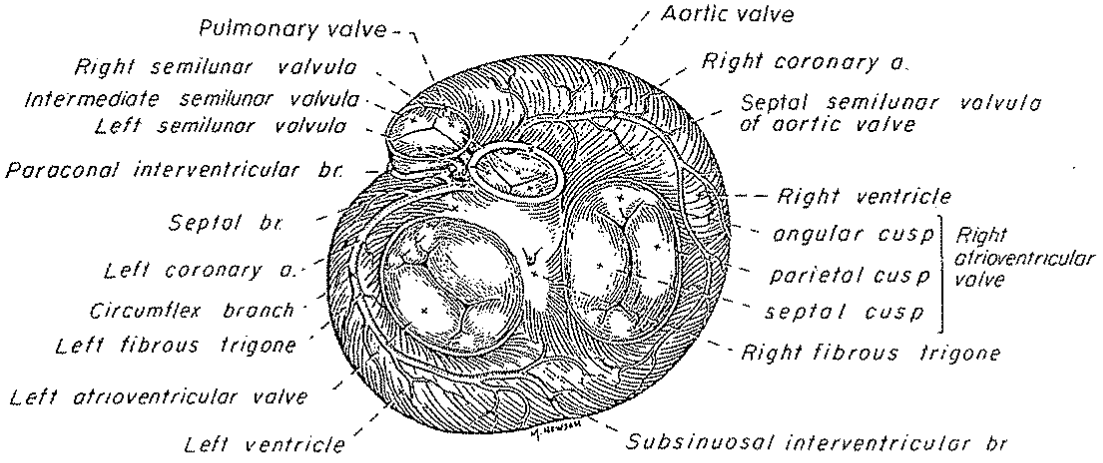

FIGURE 108. Atrioventricular, aortic, and pulmonary valves, dorsoventral view.

except for pectinate muscles confined to the **left auricle**. A thin flap of tissue is present on the cranial part of the interatrial septal wall. This is the **valve of the foramen ovale**, a remnant of the passageway for blood from the right atrium to the left atrium in the fetus.

Notice the thickness of the left ventricular wall as compared with the right. The **left atrioventricular valve** (Figs. 107, 108) is composed of two major cusps, the **septal** and **parietal**, but the division is indistinct. Secondary cusps are present at the ends of the two major ones. Notice the two large papillary muscles and their chordae tendineae attached to the cusps. The trabeculae carneae are not as numerous in the left ventricle as in the right.

Remove the fat, pleura, and pericardium from the aorta. In doing this, isolate the **ligamentum arteriosum**, a fibrous connection between the pulmonary trunk and the aorta just caudal to the left subclavian artery (Fig. 102). In the fetus it was the patent *ductus arteriosus* and served to shunt the blood destined for the nonfunctional lungs to the aorta. Observe the left recurrent laryngeal nerve as it turns around the caudal surface of the ligamentum arteriosum. Isolate the origins of the pulmonary trunk and aorta.

From the left ventricle insert scissors into the aortic valve, located beneath the septal cusp of the left atrioventricular valve, and cut the aortic valve, aortic wall, and left atrium. This exposes the aortic valve and the first centimeter of the ascending aorta. The **aortic valve**, like the pulmonary, consists of three semilunar cusps (Figs. 107, 108). Notice the nodules of the semilunar cusps in the middle of their free borders. Behind each cusp, the aorta is slightly expanded to form the **sinus** of the aorta.

The **right coronary artery** (Figs. 102, 108) leaves the right sinus of the aorta. It encircles the right side of the heart in the coronary groove and often extends to the subsinuosal interventricular groove. It sends many small and one or two large descending branches over the surface of the right ventricle. Remove the epicardium and fat from its surface and follow the artery to its termination.

The **left coronary artery** (Figs. 102, 108) is about twice as large as the right. It is a short trunk that leaves the left sinus and immediately terminates in (1) a **circumflex branch**, which extends caudally in the left part of the coronary groove, and (2) a **paraconal interventricular branch**, which obliquely crosses the auricular surface of the heart in the paraconal interventricular groove. Both of these branches send large rami over the surface of the left ventricle. Expose the artery and its large branches by removing the epicardium and fat. A **septal branch** courses into the interventricular septum, which it supplies.

The **coronary sinus** is the dilated terminal end of the great cardiac vein. The **great cardiac vein**, which begins in the paraconal interventricular groove, returns blood supplied to the heart by the left coronary artery. Clean the surface of the great cardiac vein and open the coronary sinus. Usually one or two poorly developed valves are present in the coronary sinus.

Live Dog

Observe the thorax and watch it expand and contract with each inspiration and expiration, respectively. Place the middle finger of one hand over the dorsal