

**Top of Form**

**Cardiovascular System or (circulatory system)**

|  |  |
| --- | --- |
| The contents | **Page no.** |
| **The Functions of the Canine Cardiovascular System** | **2** |
|

|  |
| --- |
| **Heart Anatomy.** |
|  |

 | 2

|  |
| --- |
|  |
|  |  |  |

 |
| **From the Outside View the heart.** |  2211 |
| **From the Inside View of the Heart** | **2** |
| **Heart Anatomy & Development in** puppy | **3** |
| **Heart diseases:** | **5** |
| **Acquired valvular disease**.  | **5** |
| **Heart failure** | **5** |
| **Congestive heart failure (CHF)** | **6** |
| **Dilated cardiomyopathy (DCM).**  | **6** |
| **Arrhythmias**.  | **6** |
| **Heartworm disease**.  | **6** |
| **Congenital heart defects**. | **9** |
| **Aortic stenosis**  | **9** |
| **Pulmonic stenosis**  | **9** |
| **Patent ductus arteriosus (PDA)** | **9** |
| **Small holes in the septum of the heart**.  | **9** |
| **Infectious endocarditis.** | **9** |
| **Pericarditis and pericardial effusion.** | **9** |
| **Hypertrophic cardiomyopathy (HCM).** | **10** |
| **Thrombo embolism.** | **10** |
| **Arteritis or vasculitis.**  | **10** |
| **Diagnostic methods for heart diseases**  | **10** |
| **Symptoms of Bottom of Form****Heart disease in dogs.** | **13** |
| Indication of heart surgery | **13** |
| **Treatment of heart disease:** | **14** |

**The Functions of the Canine Cardiovascular System**:

**The** **Cardiovascular System** consists of the heart and blood vessels, arteries, veins and capillaries.

* The circulatory system transports to the tissues and organs of the body the oxygen, nutritive substances, immune substances, hormones and chemicals necessary for normal function and activities.
* It also carries away waste products and carbon dioxide.
* helps to regulate body temperature,
* Helps to maintain normal water and electrolyte balance
* Maintained the blood pressure.

**Heart Anatomy:**

**From the Outside View the heart.**



**From the Inside View of the Heart.**



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| **Heart Anatomy & Development in puppy**  |
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 | http://www.peteducation.com/images/dot_clear.gif |

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| * In the puppy, the most abnormalities are those associated with the circulatory system. All puppies should have their initial veterinary exam by twelve weeks of age so the heart functions can be monitored.
* With the stethoscope most **congenital** heart defects can be detected at this early age.
* Many heart defects cause abnormal heart sounds called murmurs. **Murmurs are the result of turbulent or abnormal blood flow** **created by narrowed vessels, valves, or abnormal openings between heart chambers**.
* many puppies with heart murmurs can indicate life threatening
* **The left ventricle is the most heavily muscled, and therefore, the strongest of the chambers**
* Blood from the **fetus** travels through the **umbilical cord** where it receives oxygen from the mother, waste products and carbon dioxide are passed to the mother. **The lungs serve no function until birth, in which the infant is exposed to breathable air**.
* Blood in the fetus therefore bypasses the lungs and flows directly from the right heart chambers to the left via a **vessel called the ductus arteriosus**.
* At birth, the **ductus arteriosus** closes off forever, forcing blood to flow through the lungs for the oxygen/carbon dioxide exchange.
* Similarly within the fetus, vessels bypass the **liver**until birth.
* The fetus depends on the mother's liver to provide needed functions.
* At birth, the vessels close and the infant's blood is then routed through the puppy's **liver**.
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* **The heart consists of** :

The heart is located in the chest between the right and left lungs and contained in thin sac called the pericardial sac. The heart extends approximately from the **3rd inter costal space to the 6th rib of the dog.**

1. **The right atrium** is the **collecting chamber** for blood from distant parts of the body in various veins. The **oxygen levels** are **very low**. As the right atrium contracts, blood flows through the **tricuspid valve** into the right ventricle.
2. **The right ventricle** is the **pumping chamber**. sends blood into the pulmonary artery. The **pulmonary valve sits** at the opening of the pulmonary artery are prevents blood from moving backwards into the right ventricle after it contracts. The pulmonary artery carries the blood into the lungs where it **picks up oxygen and gets rid of carbon dioxide**. **The carbon dioxide leaves the body during expiration and oxygen is taken during inspiration.**
3. **The left atrium**. Is **a collecting chamber** of Blood high in oxygen , and sends this oxygenated blood to the left ventricle, by the **mitral valve** that separates the left atrium from the left ventricle.
4. **The left ventricle** is the major pumping chamber of the heart **,pumping oxygen-rich blood to the rest of the body**,enters the **aorta** through the **aortic valve**..
5. **Cardiac muscle A muscular wall called the septum**, which separates the left side of the heart from the right side of the heart that continuously contracts and relaxes.
6. **The coronary arteries** are the network of blood vessels that carry oxygen- and nutrient-rich blood to the heart itself.
7. **Arteries** are strong, muscular blood vessels ,carry oxygen-rich blood from the heart to the body. Their wall consists of an outer coat **(tunica adventitia**), a middle coat **(tunica media)**, and an inner coat **(tunica intima**). Small arteries are called **arterioles**.
8. **Veins** are thin blood vessels that carry blood from various the body back the heart. **Like arteries, veins have three coats, but the coats are not as thick**. So their volume and size vary with blood pressure, contain **valves**, which allow blood flow in only one direction, towards the heart and stop blood from flowing backward towards the organs. Small blood vessels called **venues**.
9. **Capillaries** are the site of the greatest exchange of material between the blood and the tissues of the body **(oxygen , carbon dioxide, water, electrolytes (e.g. sodium, potassium), nutrients, and minerals.** smallest of all blood vessels , in many instances **only a few red blood cells can pass** through the center of the capillary at a time**. Capillaries usually lie between the arterioles and venues.** Its walls act as a **membrane** that allows various substances to travel between the blood and the tissues.

 **Heart diseases:**

* **Acquired valvular disease**.

Acquired valvular disease of the **mitral valve** is the most common form of heart disease encountered in small and medium-sized dogs. It affects many different breeds, **as dog's age, the mitral valve degenerates and begins to leak**. The degeneration is usually progressive, and causes **the left side of the heart to change** as more and more blood leaks back into the left atrium. **Eventually, left-sided heart failure may develop**, as the workload of the heart continuously increases. Degenerative valve disease accounts for approximately **75% of all heart disease in dogs**.

* **Heart failure**

 Inability of the heart to maintain a sufficient body's needs circulation



* **Congestive heart failure (CHF)**

 Occurs as a result of impaired pumping ability **and is associated with water and sodium retention,may** arise with severe acquired **valvular disease**, **certain forms of cardiomyopathy, from heartworm disease, from inflammation of the heart, secondary to pericardial diseases, and tumors**. Heart failure may develop on either the right or left side of the heart, and sometimes involves both sides.

* **Dilated cardiomyopathy (DCM).**

Is disease where the heart muscles become weak and very flabby. the chambers of the heart enlarge in size or become dilated. **This disease primarily affects the left side of the heart**. Weakening of the muscles decreases the ability of the heart to pump blood to the rest of the body. In dogs, this disease occurs most **often in large breeds**, such as the boxer, Doberman pinscher and Great Dane. It may also occur in some smaller dogs, such as the American cocker spaniel. **In cockers, the disease has been associated with a deficiency in the amino acids, carnitine and taurine. The cause in most other dogs is unknown, but may involve genetic factors**.

* **Arrhythmias**.

Cardiac arrhythmias are disturbances in heart rate or rhythm. The electrical activity of the heart is altered, which may greatly affect the ability of the heart to coordinate the contractions of its different chambers. Arrhythmias can be **mild** and insignificant, or be **serious** enough to cause **heart failure** and sudden death. Arrhythmias may arise in conjunction with almost any form of heart disease, and can also develop with other diseases in the body, **such as high potassium levels**, low **oxygen levels, infections, hormone imbalances, drugs, trauma, and organ failure**.

* **Heartworm disease**.

Heartworm infection is disease of both domestic and wild canines ,It is caused by a parasite **(Dirofilaria immitis)** that enters the body through the bite of an infected mosquito. **The adult worms prefer to live in the pulmonary vessels** **that lead from the right heart to the lungs**. Heartworm disease in the dog most often causes

* Obstruction of the **pulmonary artery**, with **secondary right heart failure**.
* Damage to the heart and blood vessels as a result of the heartworms living in them.
* the body's attempt to rid itself of the worms **results in chronic immune stimulation**, Which further complicates the disease?
* **Thrombo embolism**.





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* **Congenital heart defects**.

Several congenital heart defects occur in the dog.

* **Aortic stenosis**

Narrowing of the aortic opening as it leaves the left ventricle is an inherited condition that affects primarily large-breed dogs, such as the Newfoundland , rottweiler, German shepherd dog, golden retriever, etc.

* **Pulmonic stenosis**

Narrowing of the opening of the pulmonary artery as it leaves the right ventricle) is seen in the English bulldog, beagle, keeshond, bullmastiff, mastiff, terrier breeds, etc.

* **Patent ductus arteriosus (PDA)**

 Is a deformity that arises when a **small communication between the aorta and the pulmonary artery** **(that is present before birth) fails to close after birth**. This disease affects **female dogs more often than male** dogs, and is seen in many different breeds.

* **Small holes in the septum of the heart may also occur**.

They may be located between the two atria (atrial septal defects) or between the two ventricles (ventricular septal defects). Most of these congenital disorders affect the function of the heart and may give rise to clinical signs of heart disease and eventual heart failure.

* **Infectious endocarditis.**

 Infectious endocarditis is an inflammation of the heart caused by some sort of infectious agent, such as bacteria, protozoa, and viruses. This condition **is uncommon in the dog, but may arise with bacterial or viral infections**.

* **Pericarditis and pericardial effusion.**

 **Pericarditis** is inflammation of the pericardium, which is the fibrous sac that encloses the heart. **Pericardial effusion** is the accumulation of fluid within the pericardial sac. As fluid accumulates in this sac it applies pressure to the heart and decreases the ability of the heart to pump blood. **Pericardial diseases in the dog arise with infections (e.g. bacterial and fungal), tumors, blood clotting disorders, trauma, foreign bodies, kidney failure, and for unknown reasons**. **Pericardial effusion** occurs most often in large breed dogs.

* **Hypertrophic cardiomyopathy (HCM).**

 Cardiomyopathy is a disease of heart muscle. In hypertrophic cardiomyopathy the muscles of the heart become tremendously thickened. This disease most often affects the muscles of the left ventricle and septum of the heart. As the muscular walls increase in size, the size of the heart chambers becomes smaller, which reduces the amount of blood that can flow through the heart? **This form of cardiomyopathy is rare in the dog and occurs for unknown reasons**.

* **Thrombo embolism.**

 A thrombus is a blood clot that develops within the heart or a blood vessel. An embolus is a blood clot that arises in one area of the circulatory system and is transported in the bloodstream to a distant site, where it becomes lodged in a blood vessel. **The most common form of this disease in dogs occurs with heartworm disease**. When adult heartworms die or are killed, they break apart and float to the lungs where they lodge in the small blood vessels.**This causes a severe inflammatory** reaction in the lungs and may significantly decrease the functional capacity of the lungs.

* **Arteritis or vasculitis.**

This is an inflammation of arteries or veins that may be caused by viruses, bacteria, parasites or immune-mediated diseases. This type of inflammation is uncommon in the dog.

**Diagnostic methods for heart diseases**

1. **Auscultation of the heart**:

Listening to the heart by stethoscope. The valves make certain sounds as they close , diseased valves produce abnormal sounds, called **murmurs**. **Arrhythmias may also sometimes be detected on auscultation.**

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 Listening to a dog's heart.

1. **Palpation of pulses**:

A Pulses are caused by blood traveling through arteries after contraction of the left ventricle. **They represent the heart beat and provide information about its regularity and strength**.

1. **Color of gums of the mouth ,mucous membrane and .**

**Blue or cyanotic gums (**oxygen levels are low in the blood, **unoxygenated hemoglobin increased more than 5 gm/100 ml .clear mostly in the respiratory disturbances more than heart affection except intracardic shunts)**.

**Pale** **gums (anemia)**.

 **Very bright red** gums (high levels of blood carbon monoxide)

1. **capillary refilling time:**

After pressure is applied to the gums to provide information on **the circulation of blood to the body tissues** If the gums take more **than two seconds to have their color return (prolonged capillary refill time), then circulation to the tissues is poor.**

1. **Electrocardiogram (ECG)**:

 Is a graphic recording of electrical currents generated by the heart to study the **action of heart muscle.** And can be performed awake in most dogs. It provides information on the **size of the heart chambers, the regularity and speed of the heart beat, and defines the type of any arrhythmia present.**

1. **Thoracic radiography**;

Chest X-rays allow the heart to be examined, (**the size ,contour of the heart**, **the size of the chambers, and the blood vessels around the heart ).** Chest X-rays also provide important information **about the lungs**, which affected by heart disease.

1. **Echocardiography**:

Echocardiography is an **ultrasound study** of the heart. The position and motion of the heart, valves and chambers,detect pericardial effusion (fluid around the heart), tumors of the heart, and thrombi within the heart and Heart worms.

1. **Doppler**:

Color flow ultrasonography the dynamics of blood flow within and around the heart, can also be studied with

1. **Certain laboratory tests**:

 To assess functions of the body and circulatory system.

* A complete blood count (anemia).
* Biochemistry organ profile (evaluated the organ function like liver, kidney, muscles, electrolytes imbalance).
* Urinalysis may detect abnormalities such as anemia, kidney disease, and chemical imbalances.
* Blood may be submitted for heartworm tests.
1. **blood gas analysis:**

Measurement of oxygen and carbon dioxide of arteries and veins.

1. **Blood culture**:

 If bacterial infections of the blood stream are suspected.

1. **Cardiac catheterization and angiocardiography**.

 With this procedure a catheter is inserted into a vein or artery and guided into the interior of the heart. A dye is injected into the catheter that shows up white on X-rays**. A video X-ray is acquired** as the dye travels through the different chambers and vessels of the heart. **Cardiac catheterization with angiocardiography is uncommonly performed in the dog, and has been replaced in large part by echocardiography**. It is most often used to detect certain congenital heart defects.

**Symptoms of Bottom of Form**

**Heart disease in dogs.**

* Cardiac murmur and abnormal heart rate and rhythms.
* Dyspnea
* Loss of appetite (a common complication of dog's heart disease).
* Color of the mucous membranes
* Coughing and collapse



* Ascities and edema
* tire easily,
* Indication of heart surgery
1. Congenital heart anomaly.
2. Patent ductus arteriosus.
3. Persistent aortic arch
4. Pulmonary stenosis
5. Ventrical septal defect
6. Tetrology of fallot
7. Heart worm disease
8. Complete heart block
9. Aortic embolism
10. Arteriovenius fistules
* Montoring blood pressur especially in thoracic surgery.
* Caution in the heart surgery for providing heart stimulation
* Tracheal intubation to provide oxygen (3-5 minutes oxygen ventilation, not lead to animal resistanse or stress on the animal).
* Veneous catheterization for blood transfusion and drugs administration

**Treatment of heart disease:**

1. Medical treatment
* Heart worm disease.
* Digoxin
* Diuretics
* Vitamins
* minerals
1. Surgical treatment.
* Heart anomalies.
* Heart defect
* Remove of heart worms

### [Home Care of a Dog with Heart Disease or Heart Failure](http://vetmedicine.about.com/od/diseasesandconditions/a/CW-HeartDiseaseCare.htm)

Proper care and monitoring can help delay the onset of heart failure and help alert if pet's condition worsens.