Pathology of Cardiovascular System

College of Veterinary Medicine and animal sciences
University of Gondar,
Gondar, Ethiopia
girma.birhan@uog.edu.et
girmanana@gmail.com

Objectives

- At the end of this session students will able to
  - Explain heart failure
  - Explain the developmental anomalies of heart and
  - Pathology of pericardium and epicardium

Heart

- The heart is located in the thoracic cavity between the lungs attached to mediastinum.

- This specialized blood vessel acts as the pumping station and pumps blood to different parts of the body.

Compensation

- Compensation is the ability of the heart to adapt to varying physiological needs and pathological abnormalities.
  - e.g: whenever there is resistance to blood flow as in case of pulmonary fibrosis or chronic nephritis, the heart has to contract forcibly to force the blood through the blood vessels.
- Hence the heart muscles have to do more function and become hypertrophied.
- The hypertrophy of cardiac musculature is a compensatory mechanism.

Decompensation

- When the heart is unable to cope up with the demands and becomes fatigued and fails,
- The heart is unable to compensate for the ever-increasing workload.
- The decompensation is a gradual process.
- The decompensated heart has dilated ventricles.

Cardiac Failure

- It is a syndrome of failing circulation in various organs due to decompensation and loss of contractility.
- Heart failure occurs when the output from the heart is no longer able to meet the body's metabolic demands for oxygen.
- Heart failure is an important cause of illness and death in dogs and cats.

Causes of heart failure

- Increased resistance to outflow: it occurs in case of, narrowing of valvular orifice, thrombosis, arteriosclerosis and hypertension.

- Alteration in the venous return: when the venous return is high or low continuously, the heart may fail at the end.

- Impaired cardiac contraction: this occurs when the myocardial contractility is lost as in the case of myocardial necrosis due to coronary vascular insufficiency

- Mitral valve regurgitation: The mitral valve is the valve that separates the left atrium from the left ventricle.

- The failure of one side of heart leads to failure of the other side also, hence cardiac failure is usually bilateral.
- To arrive at a diagnosis, it is essential to examine other organs too along with heart.

✓ **Forms of heart failure**

- Right sided heart failure: back ups in the area that collects "used" blood.
- Left sided heart failure: failure to properly pump out blood to the body.
- Congestive heart failure: fluid collects around heart

Left-sided heart failure

- Caused by Aortic valvular disease, Mitral valvular disease, Hypertension, Congenital heart disease, Myocardial degeneration, and Myocarditis.

Pathogenesis of LSHF

- Left sided heart failure leads to diminished blood supply to various organs
  - Anoxia of brain causes increased irritability, restlessness and in far advanced cases stupor and coma
  - Renal anoxia causes impaired renal function. Salt and water are retained which causes increased blood volume and edema in dependant parts of the body

- Diminished excretion of nitrogenous substances leads to prerenal uremia
- Pulmonary congestion occurs due to venous stasis and leads to pulmonary edema.
- Edema fluid irritates the respiratory mucosa and causes cough and Impaired exchange of gases.
- Hypoxia leads to stimulation of carotid sinus and respiratory centre which causes reflex dyspnoea

- Clinical signs are due to the affections of lungs, kidneys and brain (Restlessness, and coma)
- The clinical signs of LSHF are primarily pulmonary **(lungs)**, and include dyspnea on exertion, cough, and orthopnea.
- Lesions in the Lungs due to
  - damming back of blood in the lungs pulmonary congestion occurs.
  - Because of alveolar congestion edema fluid accumulates in alveoli
  - Sometimes small capillaries rupture leading to small haemorrhages in alveoli (Heart failure cells can be seen)

Right-sided heart failure

- Usually RSHF occurs along with left sided heart failure. Rarely occurs in a pure form
- Causes as those for left sided heart failure
- Causes for the pure form of RSHF: Increased resistance to flow of blood in the lungs as in emphysema and chronic interstitial pneumonia, Hydropericardium as blood entering the heart is blocked

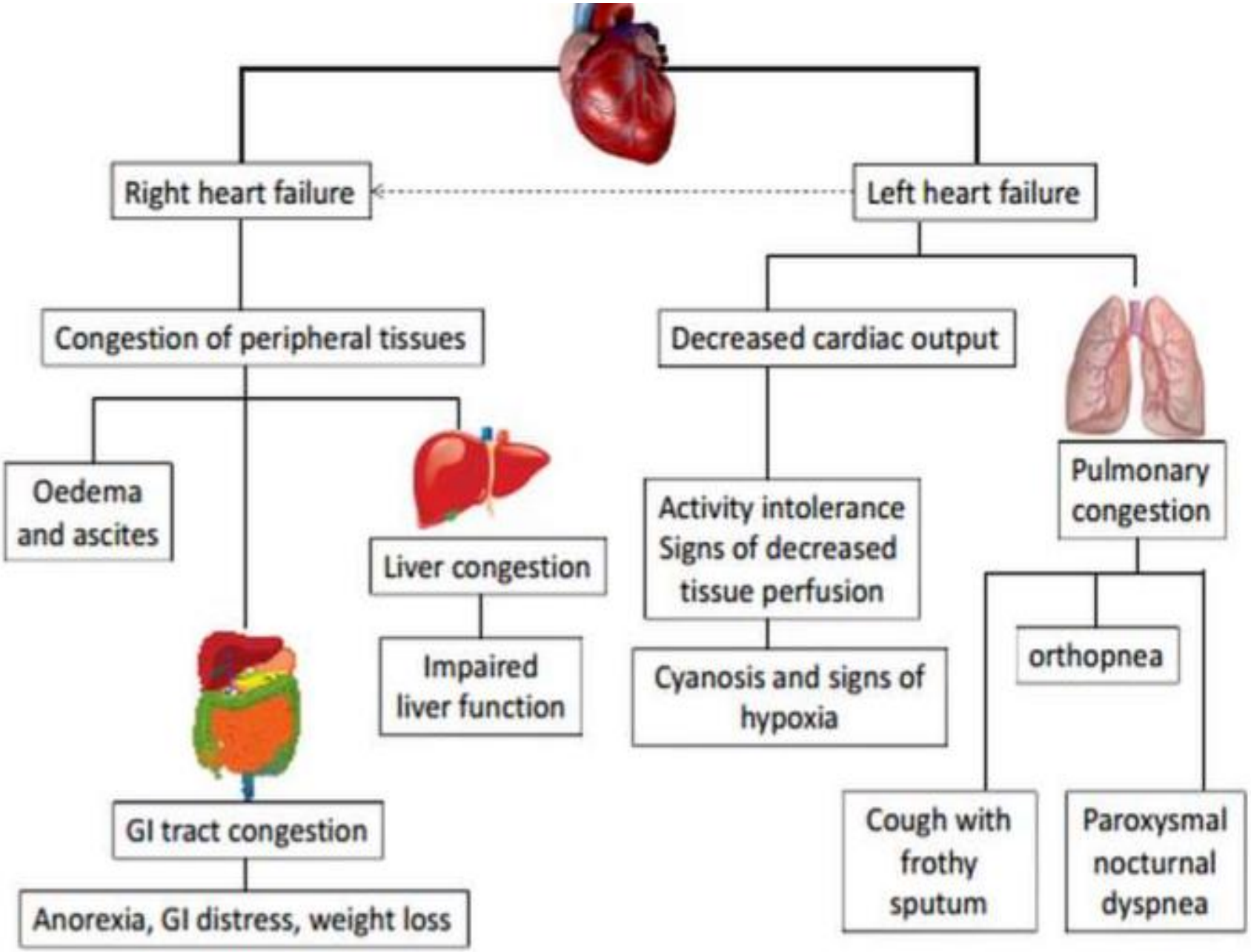
- **Pathogenesis**
  - Pulmonary congestion that occurs in LSHF ultimately affects the right ventricle and auricle
  - There is damming back of blood in the systemic and portal venous circulation
  - with consequent decreased flow of blood into the left auricle from the lungs
  - So venous stagnation produces interstitial edema and Anoxia occurs later which affects visceral organs

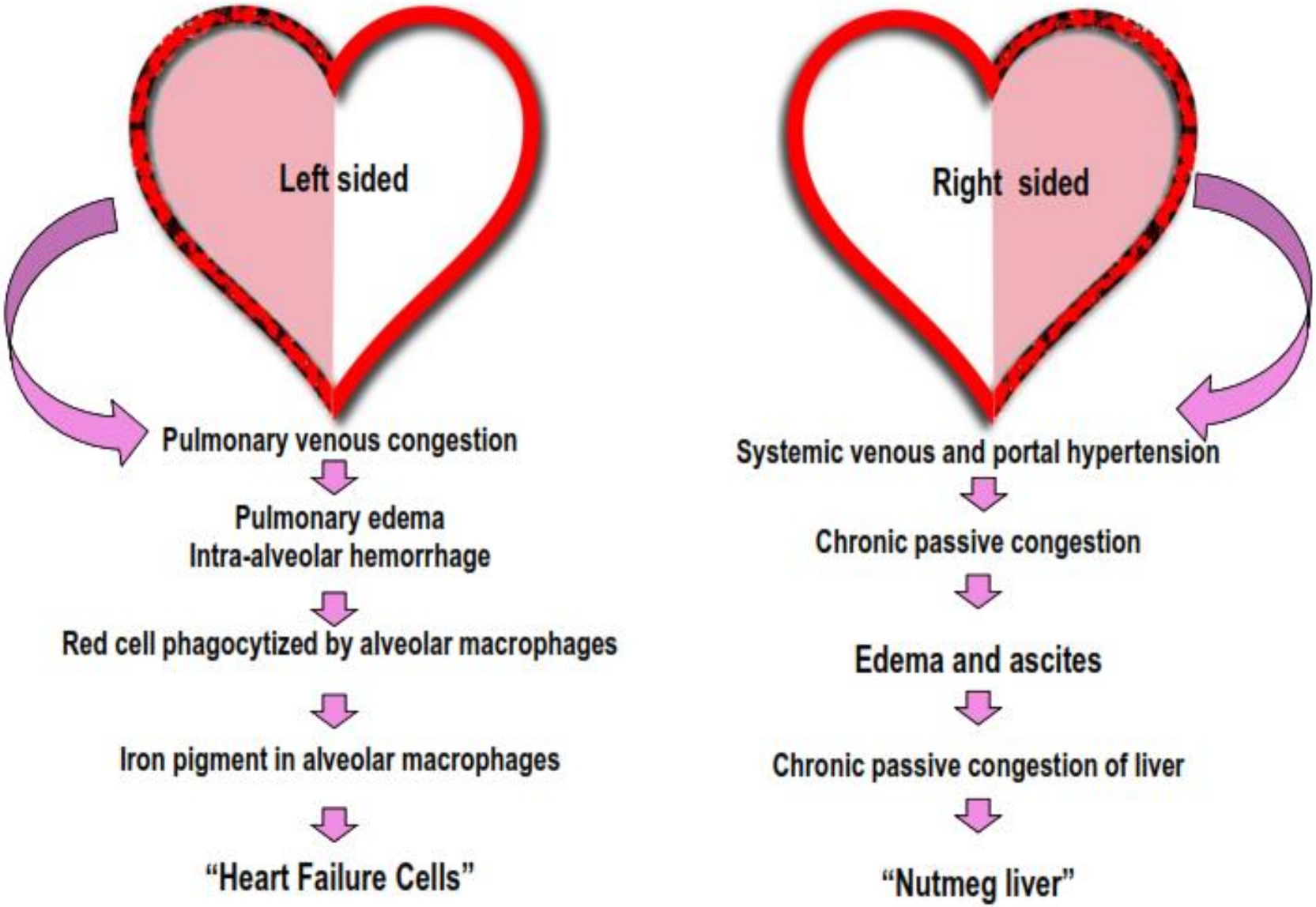
- Decreased renal blood flow causes reduced glomerular filtration rate and hence reduced sodium filtration. Also salt is reabsorbed and the retention of salt also pulls more water from the tubules which ultimately increases the blood volume. So edema occurs.

- **Clinical signs**
  - Clinical signs of RSHF are the manifestations of generalized venous congestion, and include distention of the jugular and other superficial veins, liver and spleen enlargement, and an accumulation of fluid in serous cavities and in tissues **(generalized edema).**
  - Cyanosis , Icterus, Diarrhoea, and edema is seen subcutaneously in the dependent parts in the horse and ox.
  - In the dogs ascites is manifested, in cats pleurisy

- Grossly : Enlarged and congested liver, kidney and spleen. And congested intestine.

- Histopathologcally
  - Haemorrhages around the central vein of liver
  - Atrophy and necrosis of hepatic cords around the central vein
  - Later in chronic stage fibrosis around the central vein occurs (Cardiac cirrhosis)

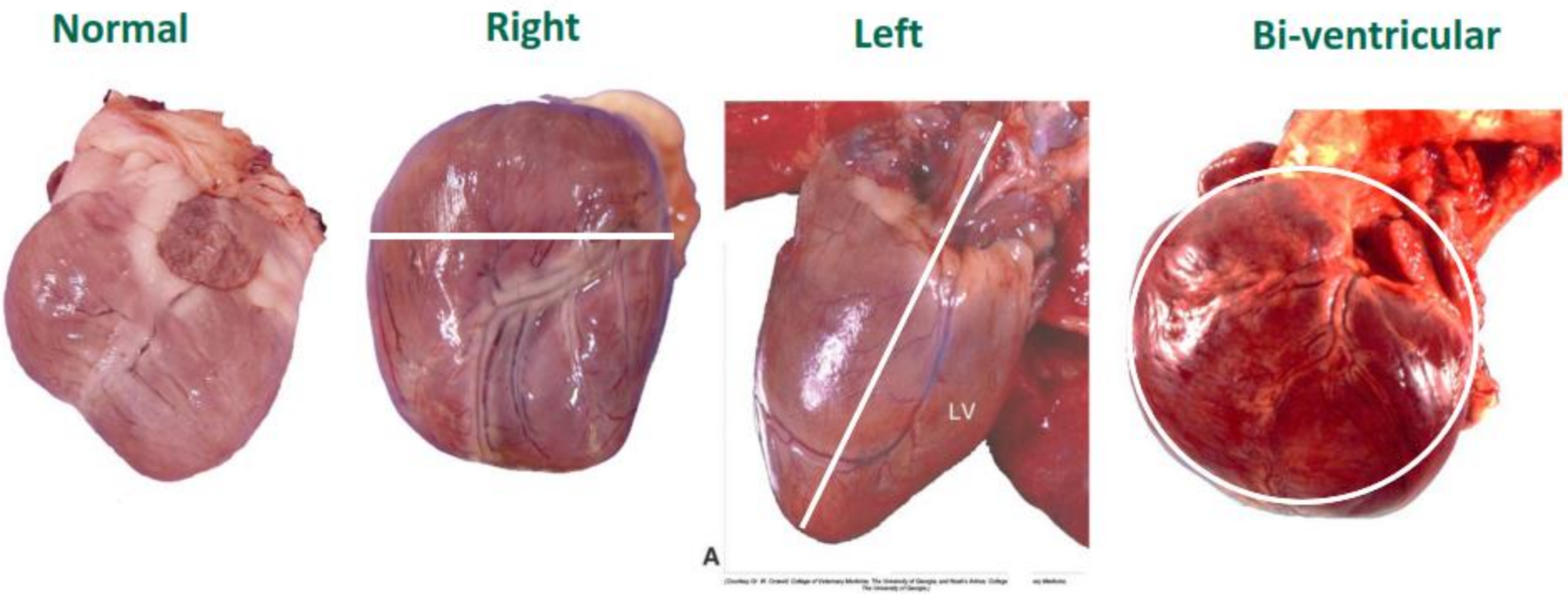

Right heart failure
Left heart failure
Congestion of peripheral tissues
Decreased cardiac output
Oedema and ascites
Liver congestion
Impaired liver function
Activity intolerance
Signs of decreased tissue perfusion
Cyanosis and signs of hypoxia
Pulmonary congestion
orthopnea
Cough with frothy sputum
Paroxysmal nocturnal dyspnea
GI tract congestion
Anorexia, GI distress, weight loss


Left sided
Pulmonary venous congestion
Pulmonary edema
Intra-alveolar hemorrhage
Red cell phagocytized by alveolar macrophages
Iron pigment in alveolar macrophages
"Heart Failure Cells"
Right sided
Systemic venous and portal hypertension
Chronic passive congestion
Edema and ascites
Chronic passive congestion of liver
"Nutmeg liver"

Hypertrophy and Dilatation of the Heart

- Myocardial hypertrophy is an increase in bulk of cardiac muscle due to an increase in size of component fibers.
- Hypertrophy affects the left heart more frequently than the right and the ventricles more frequently than the atria.
- Hypertrophy of the right heart makes the heart broader at the base; whereas hypertrophy of the left heart increases the organ length.
- Bilateral hypertrophy results in a more rounded shape than normal.

- Grossly, increased thickness and a rubbery firmness are the best indices of cardiac hypertrophy.

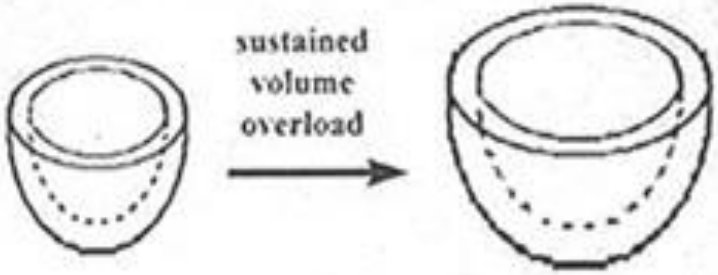


❖ There are **two descriptive types** of hypertrophy:

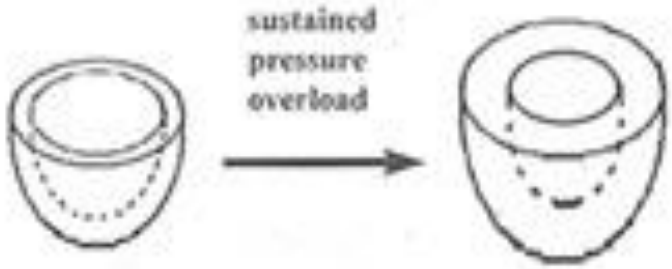
- **Eccentric Hypertrophy** Is the term used when there is both hypertrophy and dilatation of the heart.
  - Due to Volume overload hypertrophy
  - Example:- Valvular insufficiencies or septal defects.

- **Concentric Hypertrophy** Is the term used when hypertrophy results in a decrease in size of the heart chambers.
  - Due to Pressure overload hypertrophy
  - Example:- systemic or pulmonary hypertension or aortic/pulmonic stenosis.

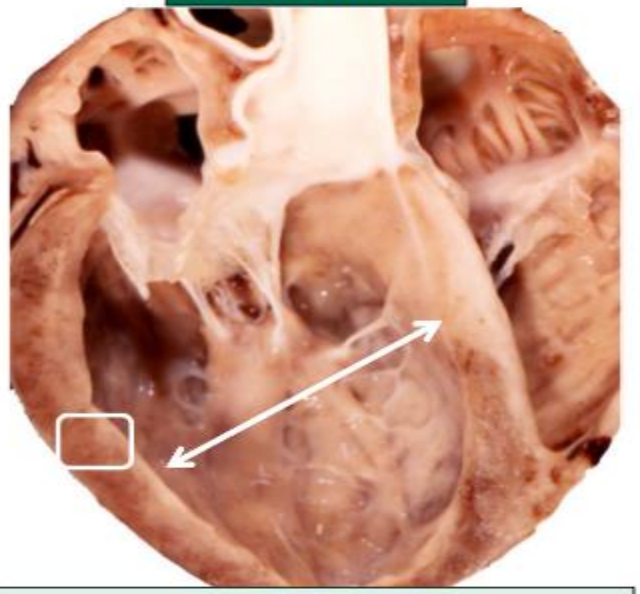
Eccentric Hypertrophy



Concentric Hypertrophy

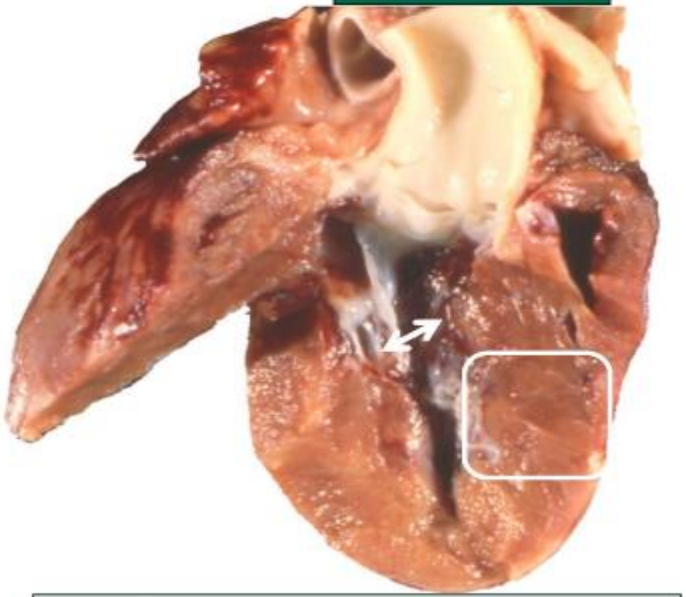


Eccentric



Note thin ventricular wall (square) and distended ventricle (arrow).

Concentric

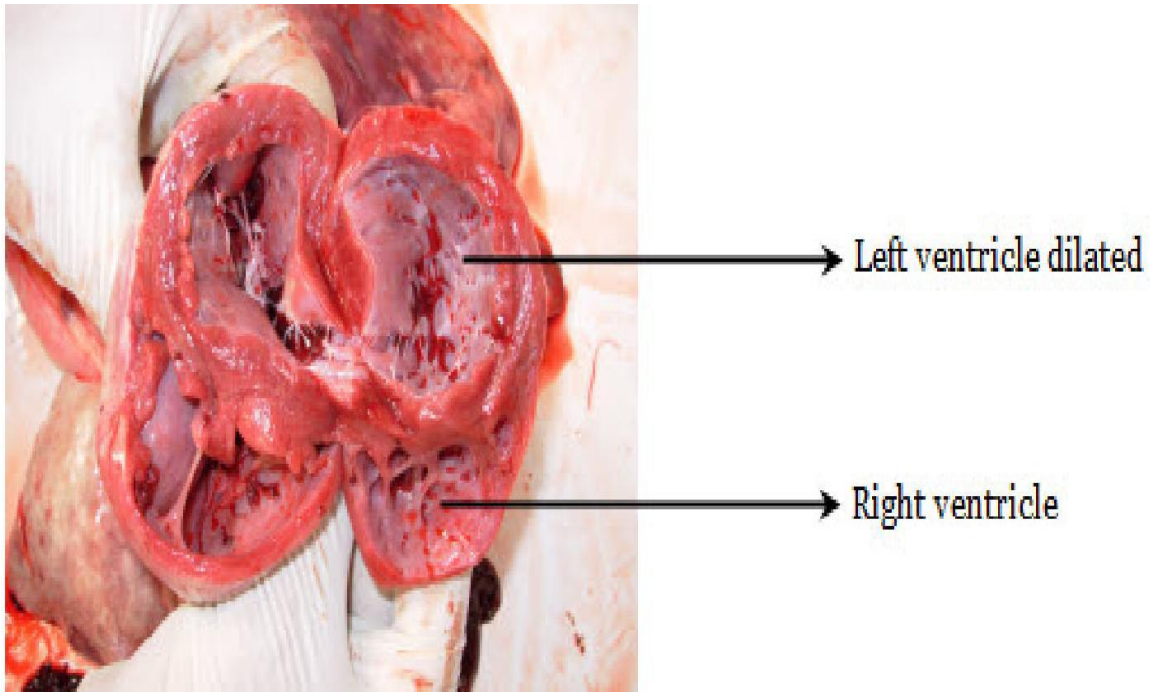


Note thick ventricular wall (square) and reduced ventricular space (arrow).

Dilatation

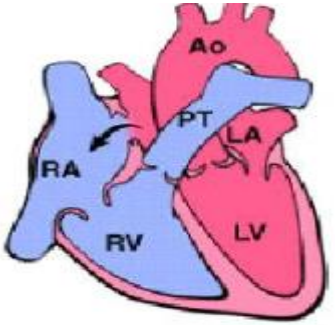
- Cardiac dilatation occurs due to deficient emptying during systole one or more chambers of heart may under go enlargement.
- Right ventricle is more commonly affected
- Very great dilatation of heart of man is called cor bovinum
- Dilatation of heart leads to Congestive heart failure
- Sudden acute dilatation occurs in severe acute intoxicating conditions and infections
  - Causing myocardial degeneration and myocarditis
- Chronic dilatation usually occurs along with hypertrophy in which it is a terminal lesion

- Grossly, the dilated heart is globose shaped, the walls are soft, pliable, and thin. The endocardium is usually diffusely thickened and opaque.



Cardiovascular Malformations

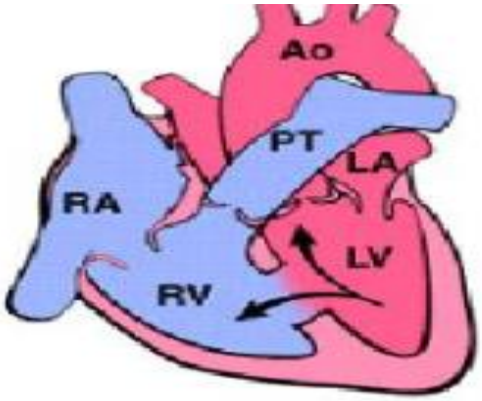
- Anomalies or malformations of the heart and vessels occur with frequency in domestic animals.



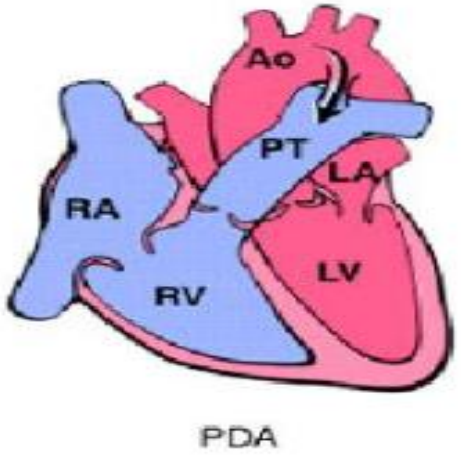
1. Auricular Defect

- **Patent foramen ovale**
  - In this condition the foramen ovale which communicates the right auricle with the left during foetal life becomes persistent even after birth.
  - Hence, the blood flows from right auricle to left auricle i.e the unoxygenated blood is pumped through left ventricle through out the body.
  - Patent foramen ovale has been met with in calves.

2. Ventricular Defects



- **Interventricular septal foramina**
  - Interventricular septal foramina below 5 mm are of no consequence. But when it exceeds 5 mm functional changes are observed in the ventricles.
  - As the blood flows from left ventricle to right ventricle during systole of left ventricle, greater flow of blood in to the right ventricle occurs and so the right ventricle has to contract more forcibly and so hypertrophy of the right ventricle occurs.



PDA

3. Defects in Blood Vessels

a) Patent ductus arteriosus

- The shunt which connects the pulmonary artery with the aorta should obliterate within a few weeks after birth.
- Sometimes the shunt may be patent and hence blood might enter from aorta in to the pulmonary artery causing increased pressure in the pulmonary artery.
- This leads to hypertrophy of right ventricle. And the animals may be cyanotic.

b) Coarctation of the aorta

- This is narrowing of the lumen of the aorta.
- Because of the narrowing of the aorta there is resistance to the flow of blood. This leads to hypertrophy of the left ventricle.

c) Transposition of the aorta

- In this condition, the aorta arises from right ventricle or from both the ventricle. This is incompatible with life.

4. Multiple Defects in the Heart

- Tetralogy of Fallot
  - This refers to four defects in the heart. (Interventricular septal defect, Dextraposed aorta, Stenosis of pulmonary valves and Hypertrophy of right ventricle.
  - The affected animals are stunted and their mucous membranes are cyanotic.

Other defects of the heart

- Acardia is a condition in which there is complete absence of heart. This condition is incompatible with life.
- Diplocardia is a condition in which two hearts are present.
- Ectopia cardis when the heart is found outside the thorax usually in the neck region or abdominal cavity.

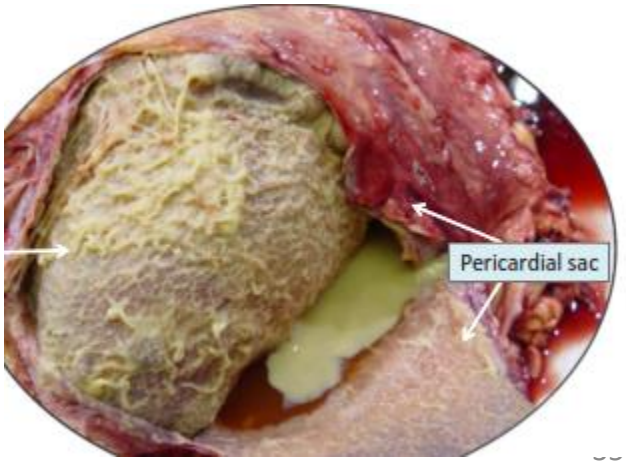
- **Reading assignments**
  - Persistence of the right aortic arch
  - Subaortic stenosis
  - Pulmonic stenosis
  - Congenital aneurysm of the aorta and pulmonary artery

Pathology of Pericardium

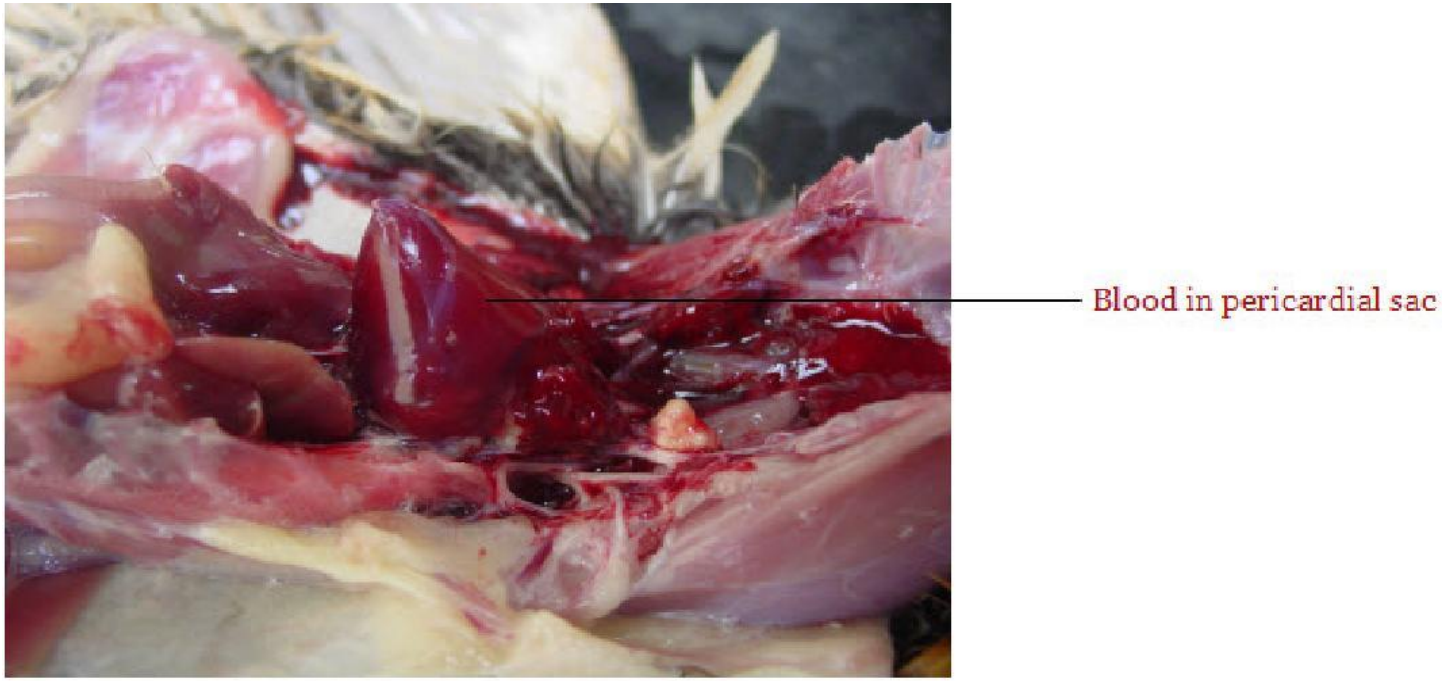
- The pericardium is the fibro-serous sac which encloses the heart.
- The fibrous or outer layer is rather thin but strong and inelastic.
- Most diseases of the pericardium are secondary to disease processes in the heart, lungs, pleura, and other sites in the body.
- Usually, pericardial diseases are detected clinically only when they cause an accumulation of fluid within the pericardial sac. These are :-

- ✓ Hydropericardium: excess of serous fluid in pericardial sac.
  - Grossly: The fluid is straw-coloured and clear. In infections, the fluid may contain floccules.
  - This is due to damage of the capillary endothelium and much protein flows out into the exudates.
  - If the fluid in the pericardial sac persists for a long time, it may become turbid and organized giving a shaggy (bun-butter) appearance to the pericardium and epicardium.

Pericardial sac distended with straw coloured fluid



- ✓ Hemopericardium means accumulation of blood in the pericardial sac. Caused by Trauma to heart and Rupture of heart, aorta or coronary artery.
  - If the blood clot completely encloses the heart, the condition is known as cardiac tamponade.



Haemopericardium - J.Quail
(Due to Cardiac puncture during blood collection)

- ✓ Pyopericardium means pus in the pericardial sac. It can be caused by Rupture of myocardial abscess, Purulent pericarditis and Tuberculosis.

- ✓ Pneumopericardium means accumulation of gas in the pericardial sac, and this can be caused by
  - Gas may escapes into the pericardium in traumatic reticulitis by gas producing
  - Gas may enter from outside in compound fracture of ribs.

PERICARDITIS

- Pericarditis refers to inflammation of both the parietal and visceral surfaces of the pericardium.
- A true pericarditis is nearly always infectious with an accumulation of exudate within the sac.
- Based on the lesion or exudates pericarditis is classified as
  - Fibrinous pericarditis
  - Suppurative pericarditis (Purulent Pericarditis)
  - Uric acid pericarditis

✓ Fibrinous pericarditis

- is a characterized by an accumulation of fibrin within the pericardial sac.
- Grossly, the fluid is grayish to yellow, and flecks of blood may be present.
- The deposition of fibrin on the pericardium and into the sac gives the appearance of bread and butter - Such a heart is also called **shaggy heart.**

- In cattle it is commonly a part of blackleg, pasteurellosis, contagious bovine pleuropneumonia, and some forms of neonatal coliform infections.
- In swine, fibrinous pericarditis is frequently associated with Glasser's disease, pasteurellosis, and salmonellosis.
- In the horse, streptococci are usually present.
- In serve infections, adhesions develop with organization of fibrinous exudate and the heart finally fails Occassionally caseation or calcification of the exudates may occur.

✓Purulent Pericarditis

- is characterized by the accumulation of pus in the pericardial sac **(due to pyogenic bacteria).**
- It occurs most commonly as a result **traumatic pericarditis**.
- Also, in traumatic pericarditis the exudate may be fibrinous or fibrino-purulent in nature.
- Pus within the pericardial sac may appear as a thin cloudy exudate, as frank creamy exudate, or as a mixture of purulent exudate and masses of pus.

- The accumulation of pus in the sac places tension on the pericardium which may be reflected in pooling of venous blood **(congestive heart failure)**.

- *Causes*
  - Salmonellosis in poultry
  - Traumatic reticulopericarditis in cattle
  - Secondary to suppurative pleuritis and bronchopneumonia

- *Sequelae*
  - Resolution is impossible
  - Toxins from exudate causes toxaemia and death

✓Traumatic Pericarditis

- This condition occurs in cattle as a result of traumatic perforation of the pericardium by a foreign body originating in the reticulum (**traumatic reticulitis).**

- Ingested foreign bodies enter the reticulum; pierce the wall of the reticulum, overlying peritoneum and diaphragm and enter the thoracic cavity.

- Subsequently the foreign body may enter the pericardial sac **(**as well as the myocardium and endocardium) resulting in an exudative pericarditis).

Pathology of Myocardium

1. Hypertrophy

- Hypertrophy of the heart muscle means increase in the size of the individual myocardial fibres.
- Left side of heart is more often affected and Ventricles suffer more frequently.
- Physiological hypertrophy due to greater strain on heart as in race horses and grey hounds.
- Grossly: Heart is enlarged and walls become thicker

- Sequelae of hypertrophy
  - The thickened heart muscle fibers need more nutrition, which may not be adequately supplied by coronary vessels.
  - Because of inadequate blood supply waste products cannot be eliminated. Both the factors lead to degeneration of myocardial fibers.
  - Continuous work load further stresses the heart and makes it weak. Ultimately atrophy of heart muscle takes place.
  - Atrophied heart muscle undergoes decompensation and so dilates which ends in heart failure.

2. Degenerative and Related Changes of the Myocardium

- There is a greater tendency for heart muscle to undergo degenerative changes as a response to non-specific causes.

- Myocardial degenerations includes cloudy swelling, fatty degeneration , fatty infiltration and hyaline degeneration (*refer your gen. pathology*).

- **hyaline changes (and necrosis)** of the myocardium occurs as a part of Vit E deficiency "white muscle disease syndrome“, calcium deficiency and gossypol poisoning.
- Hyaline degeneration is a prenecrotic lesion usually terminating in necrosis and calcification
- Grossly: Heart contains scattered grayish spots and usually focal

- Microscopically: Coagulative necrosis of myocardial fibers will be seen.
  - become hypereosinophilic, lose striations

- **Calcification** of the myocardium is usually dystrophic in type, and it occurs whenever there are dead or dying myocytes. In organomercurial poisoning of cattle, calcium salts are selectively deposited in the purkinje network.

- Excessive calcium deposits appear microscopically as a **dark-blue granules** in the sarcoplasm.

3. Necrosis and Ischemia of the Myocardium

- Myocardial infarction precipitated by arteriosclerosis of the coronary artery is a burden of aging humans, but is rare in domesticated animals.
- In animals however, acute obstruction of the coronary arteries due to emboli occurs with some frequency, with the development of infarction.
- If the coronary obstruction is chronic, the end result is diffuse scarring of the myocardium and markedly altered function.

- Coagulative necrosis of the myocardium is a lesion commonly associated with vitamin E and selenium deficiency **(white muscle disease)** in lambs, calves, and pigs.

4. **Inflammation of The Myocardium**

- Myocarditis refers to inflammation of the myocardium, which is usually secondary to a wide variety of systemic diseases.
- The causative agents may reach the myocardium by extension or by the hematogenous route.
- The lesions are usually focal and may be overlooked on causal gross inspection.
- inflammation of myocardium includes suppurative myocarditis, eosinophilic myocarditis, and parasitic myocarditis

- **Suppurative Myocarditis** Is associated with the presence of pyogenic organisms, and abscess formation is common.

- **Eosinophilic Myocarditis** is characterized by an infiltration of eosinophils in the myocardium. The condition is occasionally observed in cattle, and the cause is unknown.
  - In addition, an eosinophilic myocarditis is observed in animals given excessive amounts of sulfonamides and occasionally in penicillin hypersensitivity.

- **Parasitic Myocarditis :** May be caused by a variety of parasites ***(reading assignment).***
  - Sarcocystis tenella, Echinococcus granulosus, *Toxoplasma gondii*,

Pathology of Endocardium

- The endocardium lines the cavities of the heart, and is continuous with the intima of vessels which enter and leave the organ.
- Its free surface is smooth and glistening and is formed by a layer of endothelial cells.
- This endothelial layer rest on a thin layer of fibroelastic tissue which is connected to the myocardium by subendothelial elastic tissue containing nerves and vessels.

1. Inflammation of the Endocardium

- Endocarditis refers to inflammation of the endocardium which may be valvular or mural.
  - Inflammation of valves is common and is called valvular endocarditis
  - Inflammation of septal endocardium is called mural endocarditis

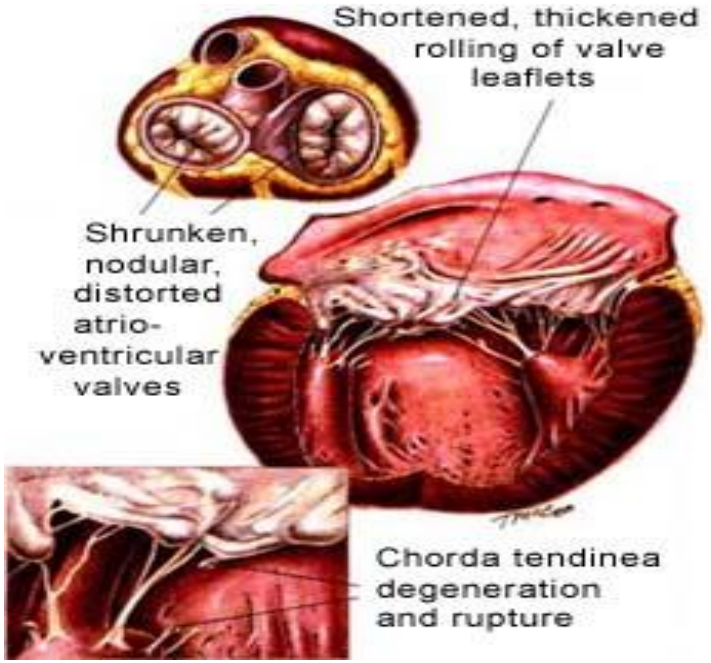
- In domestic animals, valvular endocarditis occurs more frequently than mural.

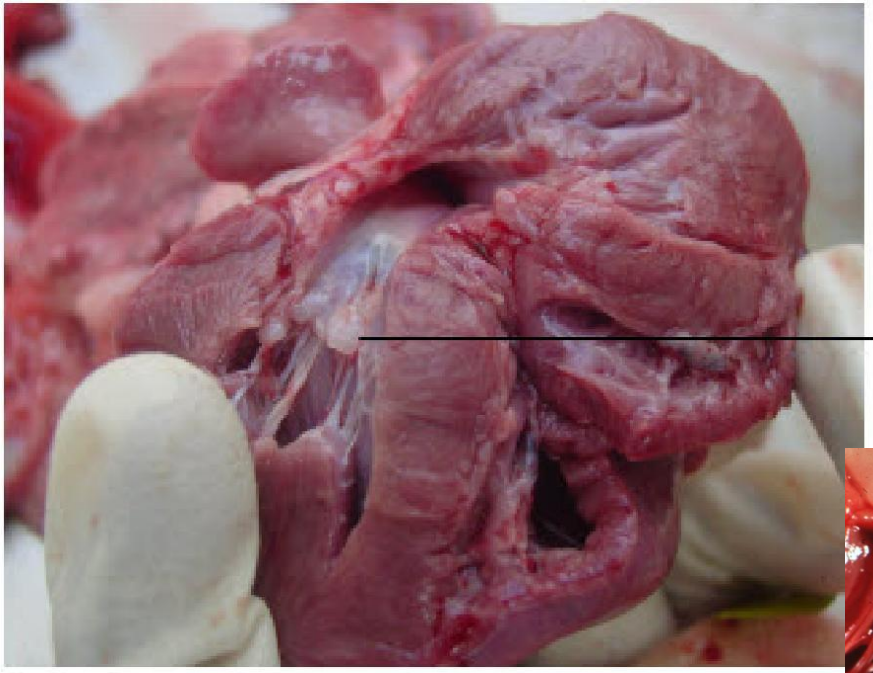
- The location of endocarditis varies with the animal species involved. In cattle, lesions are most common in the right heart; whereas in the horse. dog, and pig, endocarditis occurs most frequently in the left heart.

- In the dog and horse, *streptococci* and *staphylococci* are most commonly isolated from *valvular lesions*: whereas *Corynebacterium pyogenes* is most frequently recovered in cattle. In swine, streptococci are common.

2. Valvular Endocardiosis

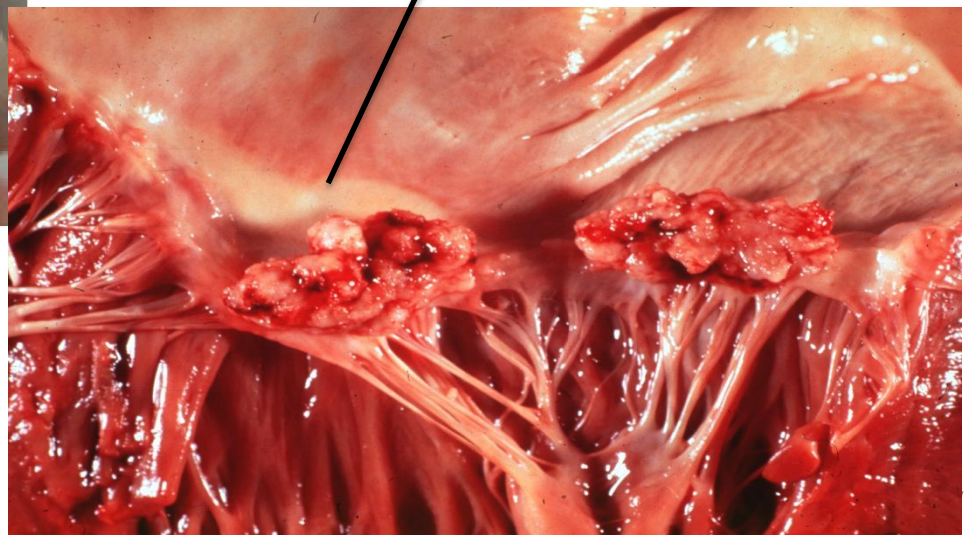
- This condition is also referred to as "**nodular fibrosis**", and it is characterized by fibrous thickening of the heart valves.
- Valvular endocardiosis occurs primarily in dogs and the mitral valve is most frequently and severely affected.
- Valves are thickened due to fibroelastic tissue with abundant mucous ground substance. The valve cusps are shortened and thickened.
- The incidence of valvular endocardiosis increases with age, and may cause congestive heart failure.





Endocardiosis - Bitch

Thick, shrunken and distorted mitral valve with nodular thickening on the borders



- **Results of Valvular Lesions:**
  - The results of valvular lesions depend upon the valve involved and the extent of the valvular injury
- **Reading assignment**
  - **Insufficiency of the tricuspid valve**
  - **Stenosis of the tricuspid valve**
  - **Insufficiency of the pulmonary valve**
  - **Stenosis of the pulmonary valve**
  - **Insufficiency of the mitral valve**
  - **Stenosis of the aortic valve**
  - **Insufficiency of the aortic valve**
  - **Stenosis of the mitral valve**

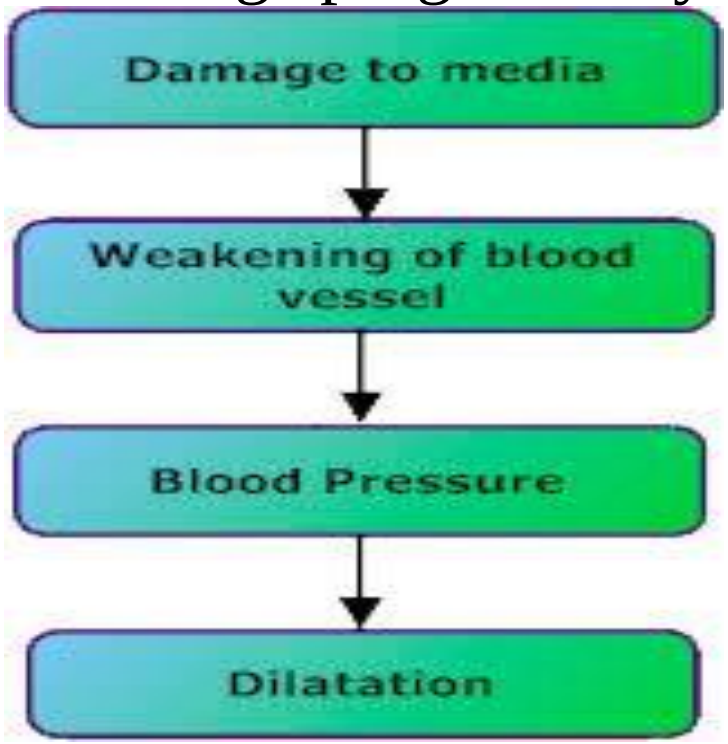
Arterial diseases

1. Inflammation of arteries

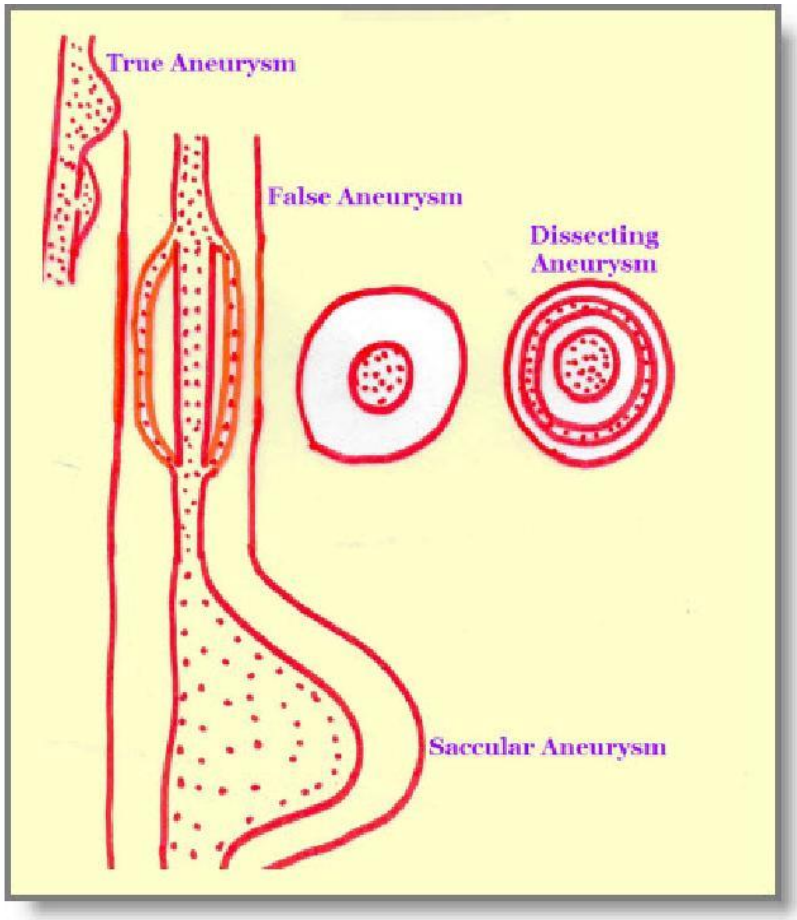
- Inflammation of the wall of artery is called arteritis. Inflammation of tunica intima is called endarteritis.
- Based on the course, arteritis is classified as acute (Virus – Equine viral arteritis, equine herpes virus,) and chronic arteritis (Larvae of *Strongylus vulgarisi)*.
- Inflammation of the intima results in the formation of a thrombus at the site called thromboendarteritis .

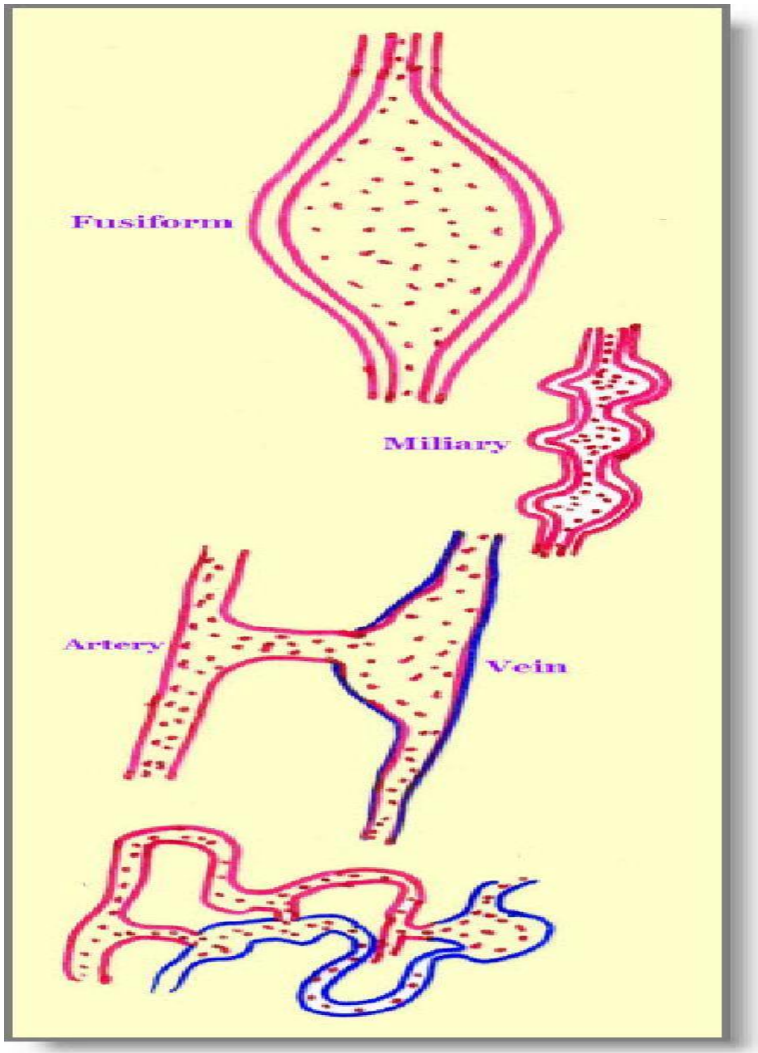
2. Aneurysm of Arteries

- Aneurysm is Localized circumscribed dilatation of an artery, vein or cardiac chamber.
- The arterial wall is composed of stretched intima and adventitia with only remnants of media. There is a tendency for aneurysms to enlarge progressively and to ultimately rupture.



Type of aneurysm





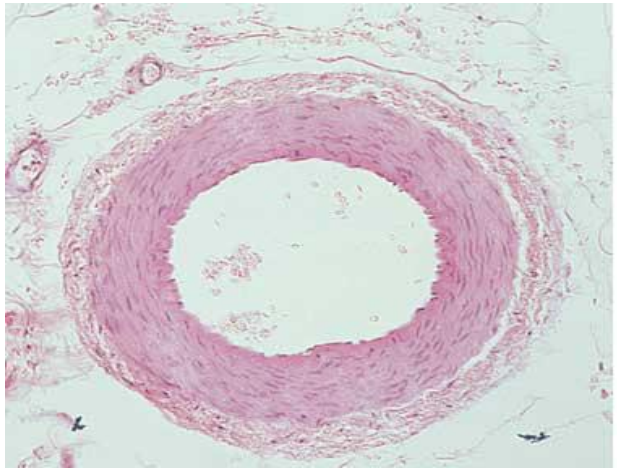
- Cardiac aneurysm: This is focal dilatation of cardiac chamber.
- Bacterial aneurysm : is due to bacterial infection which weakens the wall. This is usually associated with vegetative endocarditis.
- Parasitic aneurysm: This is due to parasites which weaken the wall.
  - e.g. *Stongylus vulgaris* in the anterior mesenteric artery in horses.

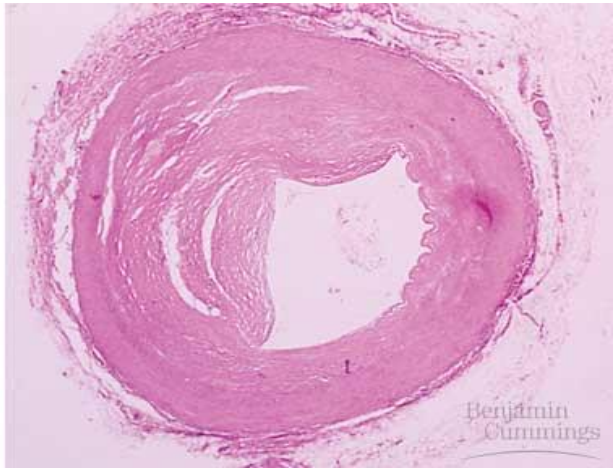
- Sequelae aneurysm
  - Thrombus formation or emboli formation which may occlude the vessel
  - e.g. *Stongylus vulgaris in the anterior mesenteric artery in horses lead to colic.*
  - Atrophy of vessel wall - fibrosis - calcification
  - Compensatory hypertrophy of tunica adventitia
  - Rupture of vessel wall - haemorrhage
  - Pressure atrophy of surrounding tissue

3. Arteriosclerosis

- Arteriosclerosis is hardening of the arteries.
- It includes those degenerative changes characterized by induration **(fibrous thickening),** loss of elasticity, and narrowing of the lumen.
- The **"hallmark"** of arteriosclerosis is the fibrous plaque which appears as a white, firm, glistening elevation on the luminal surface of arteries.
- It is not common in animals.
- Etiology**:** Johne's disease ,Toxins Hypertension, Hypothyroidism in old dogs

- Grossly the Artery be come Thick, hard on section, stand prominently , narrow Lumen, Loss of elasticity
- Histopathologically **:** Wall of artery – Thick with homogenous pink collagenous fibrosis
  - Intima to media - Hyaline degeneration, fibrosis and calcification
- Sequelae
  - Hypertrophy and dilatation of left ventricle
  - Focal myocardial fibrosis





- Subclassifications within the broad category of arteriosclerosis are atherosclerosis, medial sclerosis, and arteriolosclerosis.

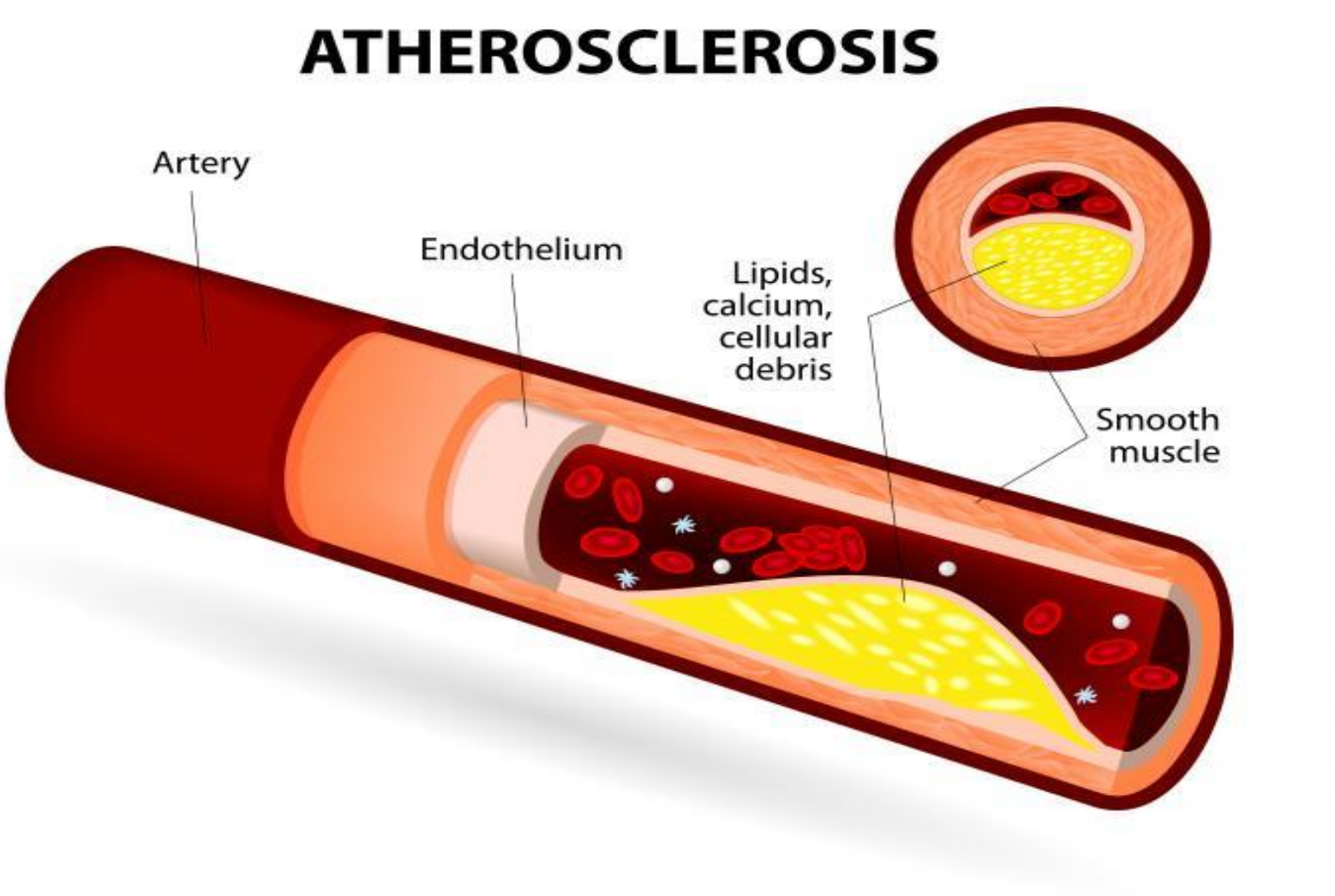
- Atherosclerosis is characterized by the accumulation of lipid in larger arteries in the form of elevated, lipid-filled plaques called atheromas.
- Athere means a soft, mushy, gruel like substance.

- Atherosclerosis is a condition such a substance is deposited in the intima of larger elastic arteries.

- The atheroma begins as an intimal lesion which progressively extends into and affects the media.

- In animals, atherosclerosis occurs primarily in the aorta and small muscular arteries.
- In the dog, severe systemic atherosclerosis is associated with advanced age, obesity, and hyperlipoproteinemia.
- Aggregates of foam cells appear grossly as small elevated fatty streaks in the arterial luminal surface. In progressively expanding lesions, foam cells become necrotic and the liberation of free lipid incites fibrosis and calcification.
- Advanced atheromas are complicated by hemorrhage, thrombosis, ulceration, and the infiltration of the lesions by plasma proteins.

- Gross pathology
  - The affected vessel is enlarged, less pliable and the wall is thickened
  - The intima of aorta may reveal round or oval fatty areas (0.1 to 2.0 c.m diameter)
- Histopathology - Aorta
  - The endothelium shows hydropic degeneration and appears thickened
  - Foam cells appear in the area (Subendothelial or middle and outer layers)
  - Fibroblastic proliferation occurs around the leison
  - Muscle fibres show hydropic degeneration


ATHEROSCLEROSIS
Artery
Endothelium
Lipids,
calcium,
cellular
debris
Smooth
muscle

Venous diseases

1. Inflammation of Veins

- Phlebitis is characterized by the presence of inflammatory exudate in the wall of veins. The condition is less common than arteritis.

- Acute phlebitis occurs in **"naval infection" (Omphalophlebitis)** of calves, lambs and foals.

- The resulting bacteremia may lead to acute death or give rise to wide-spread suppurative lesions **(abscesses).**

2. Varicose Veins

- Dilated and elongated veins are referred to as varicose veins.

- Such veins follow an irregular and tortuous course and hold an abnormally large amount of blood.
- Varicose veins are less common in animals than in man.

pathology of lymphatics

1. Inflammation of Lymphatics

- Lymphangitis is inflammation of lymphatic vessels.
- In most instances, the involved vessels are so small as to have no significance; however, in some cases, the involvement of larger vessels results in serious consequences.

- Lymphangitis is associated with several specific diseases, including:
  - Anthrax in dogs, pigs and horses **(acute thrombolic lymphangitis),**
  - Mycobacterium infections **(granulomatous lymphadenitis)** and
  - Cutaneous glanders of horses **(ulcerative lymphangitis).**
    - ulcerative lymphangitis**:** of horses is a chronic progressive inflammation of the subcutaneous lymphatics.
    - The condition is caused by Corynebacterium ovis **(C. pseudotuberculosis)** which is the pathogen responsible for caseous lymphadenitis of sheep and goat

2. Dilatation and Rupture of Lymphatics

- **Dilatation (ectasis)** of lymph channels usually develops subsequent to some form of obstruction.
  - This lead to the accumulation of excess interstitial fluid in the drainage area **(local edema)**.
  - The more common causes of lymphatic obstruction include infiltrating neoplasms and thrombosis of the channels.

- **Ruptures** of lymph channels are important only when the thoracic duct or larger vessels are the sites of injury.
  - Leakage of lymph usually occur in the thoracic cavity and the condition is referred to as chylothorax.
  - Chylothorax occurs most frequently in cats.

Specific Diseases Affecting The Heart

1. High altitude Disease of Cattle

- Also referred to as "High Mountain Disease" "Brisket Disease", and "Pulmonary Hypertensive Heart Disease".
- High altitude disease of cattle develops subsequent to chronic hypoxia of a high altitude environment which causes increased pulmonary vascular resistance and increased pulmonary arterial pressure.
- Young cattle are more susceptible than adults and the morbidity rate is highest in animals exposed to high altitudes for the first time.

- The disease is characterized by dilatation and hypertrophy of the right ventricle and atrium with the ultimate development of cardiac decompensation and signs related to **"congestive heart failure."**

- Affected cattle reside in mountainous altitudes **(usually above 7,000 feet).** There is a failure of the cardiorespiratory system to adjust to the chronic anoxia.

- In animals transported from low altitudes to about 10,000 feet, the incidence of severe pulmonary hypertension may not affect more than **2%.**

- The disease usually develops slowly and generalized edema is a prominent feature.
- Edematous swelling in the ventral pectoral region is responsible for the term "**brisket disease**".
- Due to chronic venous congestion, liver lesions may vary from early "**nutmeg**" appearance to severe centrilobular fibrosis.
- The lungs exhibit varying degrees of atelectasis and emphysema.
- Microscopically, hypertrophy of the media of small pulmonary arteries may be observed.

2. Mulberry Heart Disease of Swine

- Also referred to as Dietetic Microangiopathy
- Mulberry heart disease occurs primarily in pigs from 3-4 months of age and the cause is unknown.
  - it is widely felt that a deficiency of vitamin E and selenium plays a prime role.

- Grossly, the disease is characterized by extensive hemorrhages throughout the myocardium, as well as subepicardial and subendocardial hemorrhages.
  - The pericardial sac is usually distended with straw-colored fluid and flakes of fibrin.

- Microscopically, the walls of arterioles and capillaries often time contain an amorphous material of glycoprotein nature (microangiopathy).

3. **Parvovirus Infection in Dogs**

- Parvovirus infection in pups is characterized by a severe non-suppurative myocarditis which causes sudden death in the 4 to 6-week age range. The viral myocarditis is apparently a new disease entity in the dog.
- Grossly, pulmonary edema is the most prominent lesion; the myocardium is grossly normal.
- Microscopically, there is a rather intense infiltration of the myocardium with mononuclear cells. Basophilic intranuclear inclusion bodies are found within cardiac myofibrils in association with the myocarditis.

Specific Diseases Affecting Arteries

1. Equine Viral Arteritis

- Equine viral arteritis is an acute contagious disease of horses characterized by extensive necrosis in the media of small muscular arteries of the intestine, lymphoid tissue, and visceral organs.

- Initially, the virus destroys the endothelium in the vascular supply of small muscular arteries. Subsequently, there is endothelial swelling and necrosis of the media of small muscular arteries.

- Grossly, the lesions of equine viral arteritis are attributable to the vascular changes and consist principally of extensive hemorrhages and generalized edema.

- The distribution of edema in the intestine is considered to be characteristic. "Edematous segments of the intestine (1 to 3 feet), alternate with segments of normal thickness."

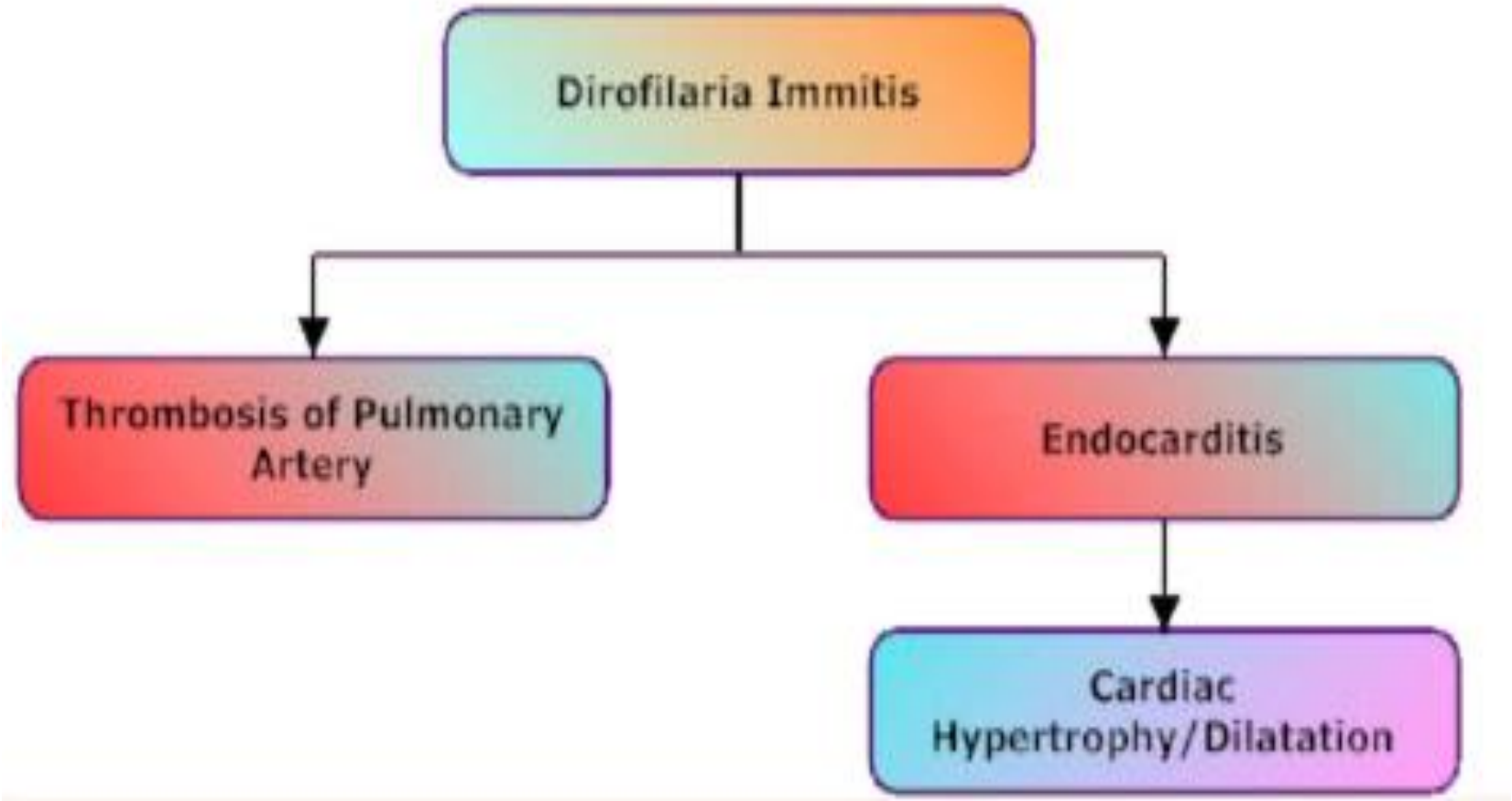
- Clinically, the disease is characterized by depression, fever, leukopenia, limb edema, abortion of pregnant mares **(up to 80%),** enteritis and pneumonic complications.

2. Dirofilariasis

- Adults of *Dirofilaria immitis* live in the right heart and pulmonary artery where they interfere with the circulation of blood.

- The parasites may cause a variety of arterial lesions in the pulmonary circulation. Extensive arteriosclerotic changes including intimal fibrosis and villous proliferations occur in the pulmonary artery.

- Smaller pulmonary arteries show medial hypertrophy with almost complete obliteration of the lumen. Also. dead parasites may become embolic in the lungs and provoke thrombosis and infarction.


Dirofilaria Immitis
Thrombosis of Pulmonary Artery
Endocarditis
Cardiac Hypertrophy/Dilatation


QUESTIONS