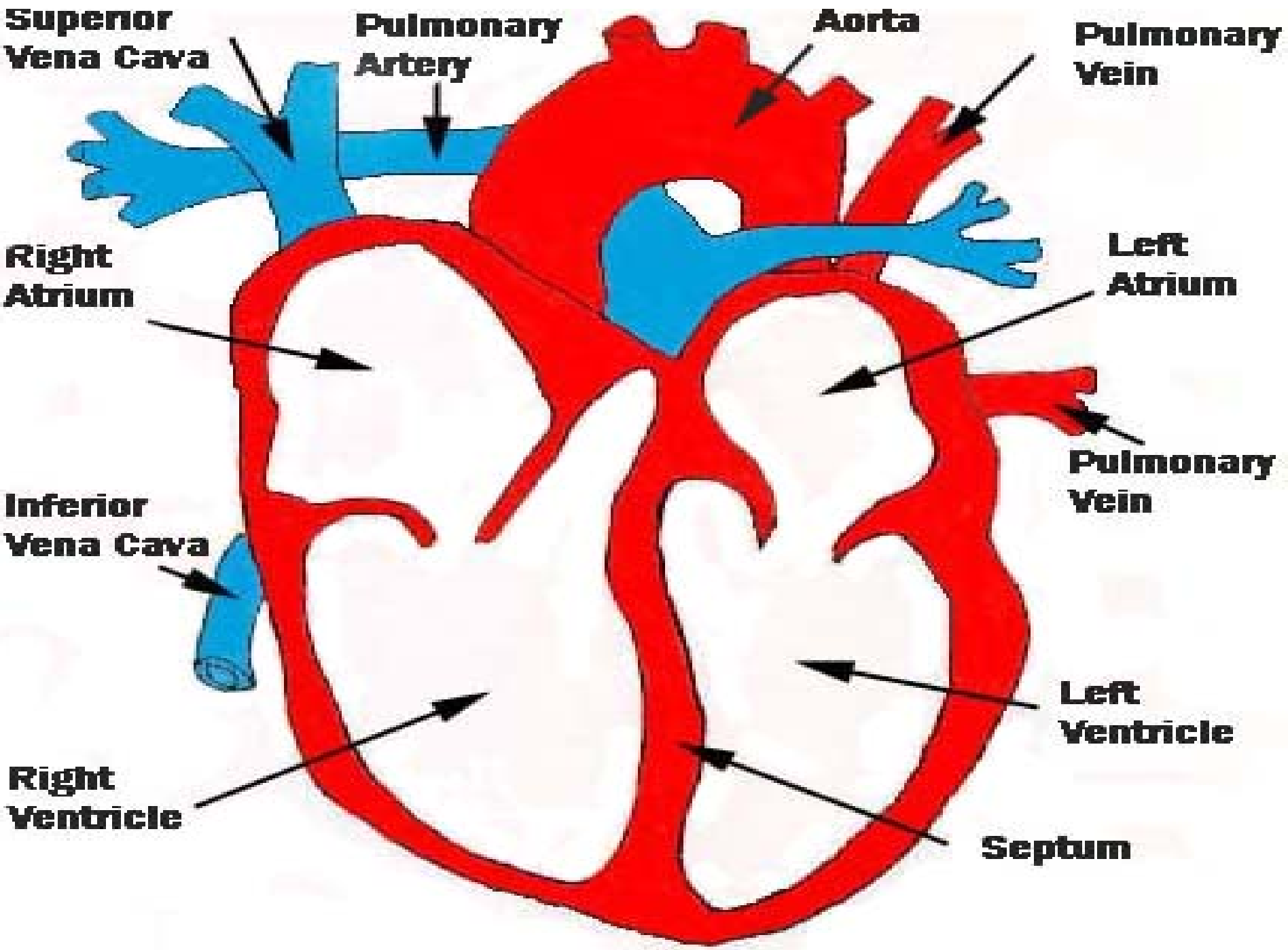
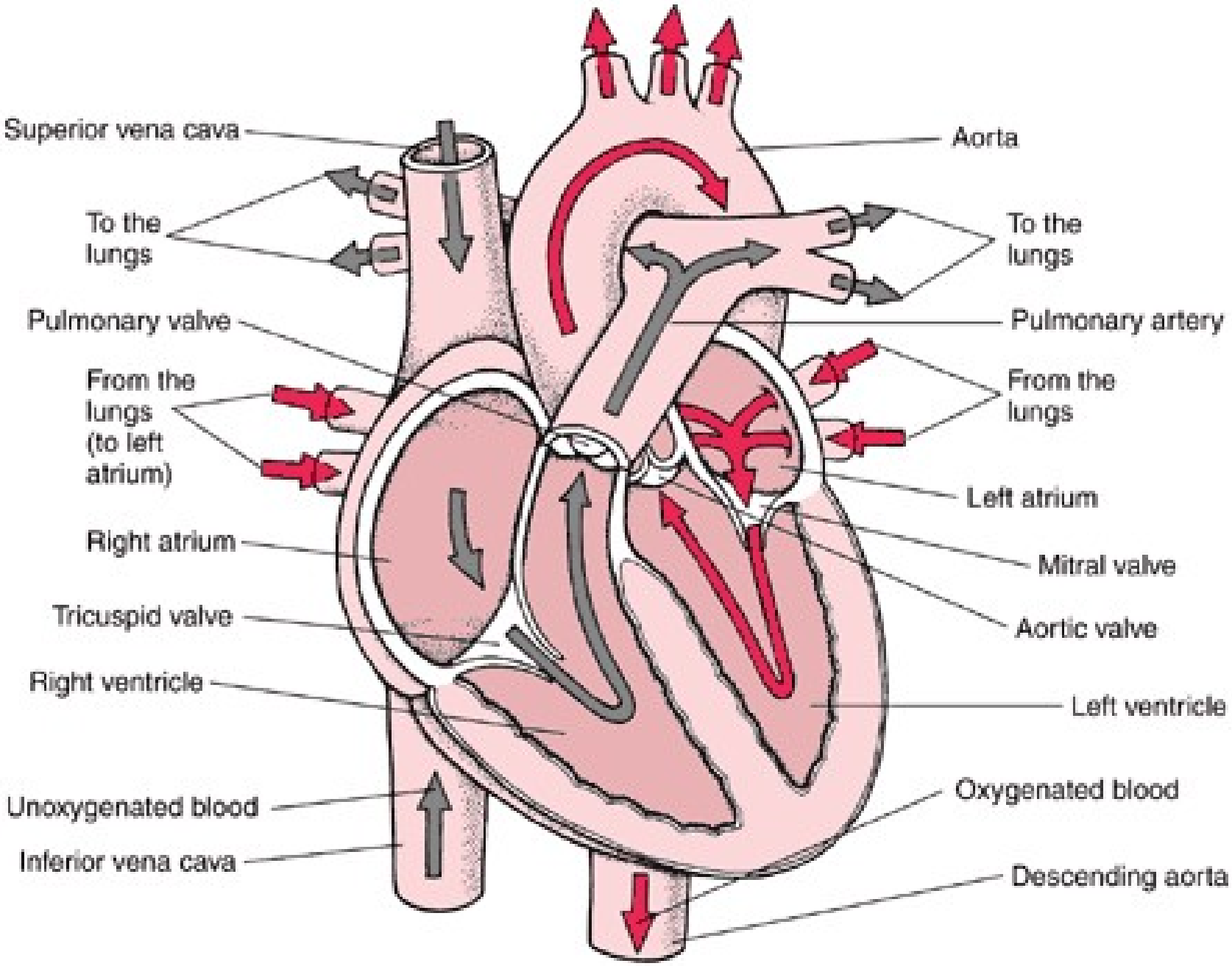
Normal structure of Heart
Heart Failure

- Weight
  - ♀: 250 to 300 gm
  - ♂: 300 to 350 gm
- Thickness of free wall
  - R.V = 0.3- 0.5 cm
  - L.V = 1.3 – 1.5 cm
- Cardiomegaly: ↑ weight or size of heart
  1. Hypertrophy: ↑ weight/ wall thickness
  2. Dilation: ↑ chamber size


Superior Vena Cava
Pulmonary Artery
Aorta
Pulmonary Vein
Right Atrium
Left Atrium
Pulmonary Vein
Inferior Vena Cava
Left Ventricle
Right Ventricle
Septum


Superior vena cava
Aorta
To the lungs
To the lungs
Pulmonary valve
Pulmonary artery
From the lungs (to left atrium)
From the lungs
Left atrium
Right atrium
Mitral valve
Tricuspid valve
Aortic valve
Right ventricle
Left ventricle
Unoxygenated blood
Oxygenated blood
Inferior vena cava
Descending aorta

M/E

- Myocardium- specialized muscle cells called cardiac myocytes arranged in spiral/ circumferential orientation
- Contain ↑ mitochondria; 23% of cell vol vs 2% in skeletal muscle cells; *complete dependence of cardiac muscle on aerobic respiration*
- Systole : contraction of ventricular muscle
- Diastole: relaxation of ventricular muscle

- Sarcomere: functional intracellular contractile unit of cardiac muscle comprising thick myosin and thin actin filaments
- Length: 1.6- 2.2 μm; shorter lengths have overlap of actin & myosin filaments with reduction in contractile force, longer sarcomere lengths enhance contractility (Frank Starling mechanism)→ moderate dilation of heart during diastole → ↑ contraction during systole
- Myocytes comprise 25% of total no. of cells; 90% of myocardial volume
- Atrial myocytes are smaller, store atrial natriuretic peptide, secreted under atrial distension
- ANP induces vasodilation, diuresis, natriuresis

Cardiac conduction system

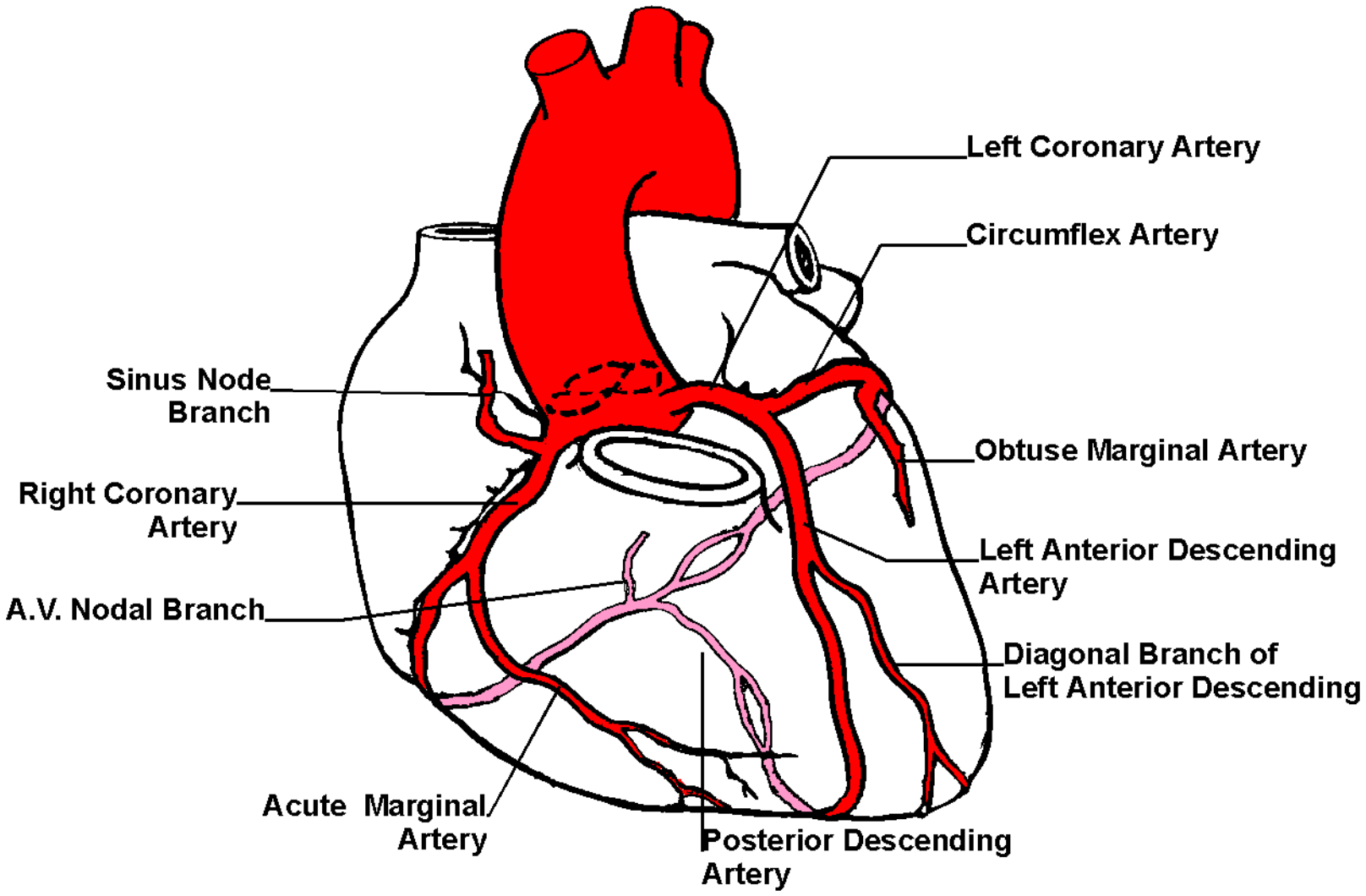
- Excitory and conducting myocytes involved in maintaining rate and rhythm of the heart
- SA (sino-atrial) node: present at junction of right atrial appendage and SVC
- AV (atrio-ventricular) node: in RA near atrial septum
- Bundle of His: from RA to summit of ventricular septum
- Right and left bundle branches

Blood Supply

- Coronary A run across the external surface of the heart as epicardial A and penetrate myocardium as intramural A →arterioles →capillary network; one vessel next to each cardiac muscle
- 3 major epicardial A
  1. Left ant descending (LAD)
  2. Left circumflex (LCX)
  3. Right coronary (RCA)

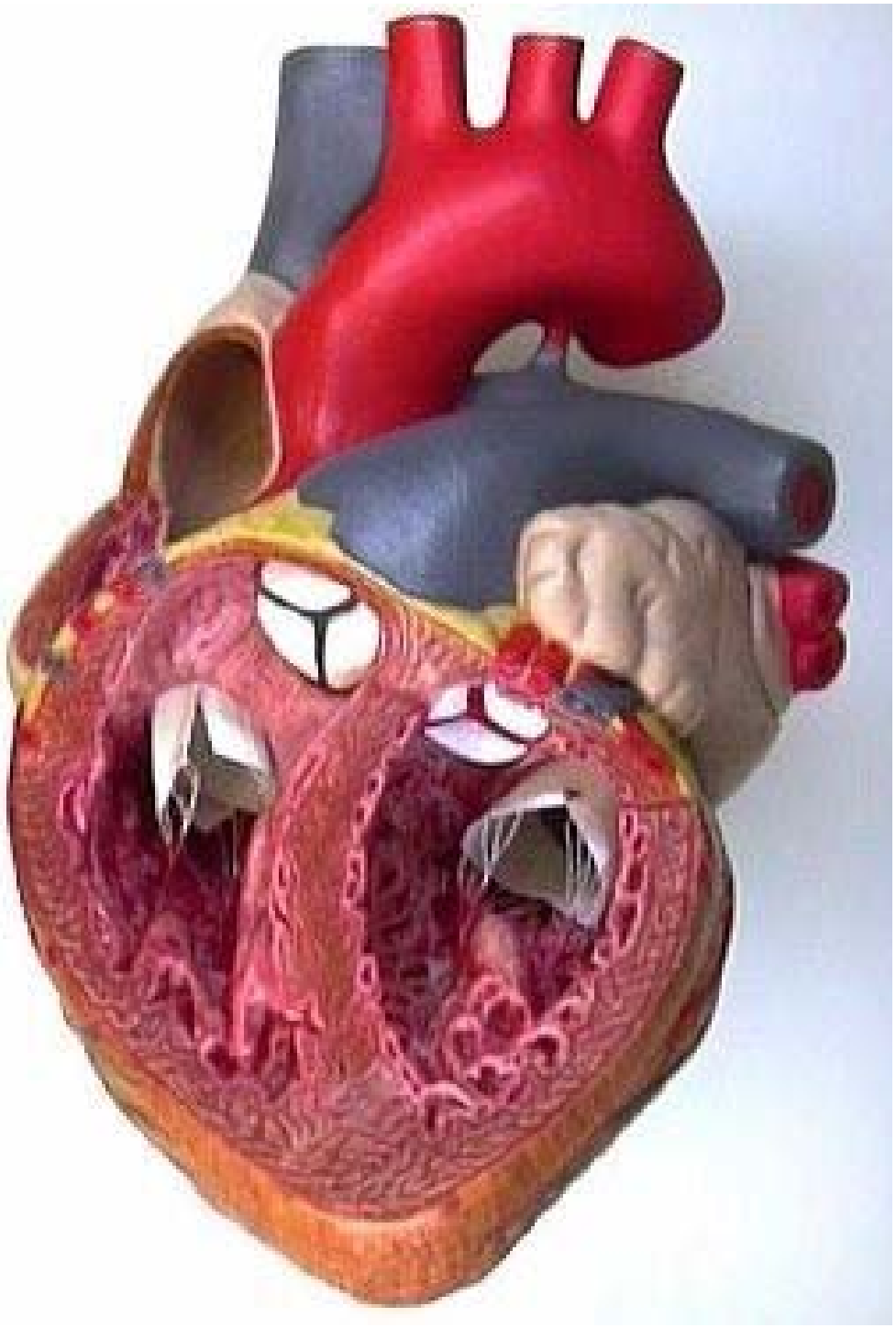
- LAD : apex, ant wall of LV, ant 2/3 of AV septum
- LCX: lat wall of LV
- RCA: RV free wall, postero basal wall of LV, post 1/3 of septum
- Anastomosis b/w these vs – collateral circulation, enlarge in ischemia
- If collateral flow is inadequate, subendocardium is most susceptible to ischemic damage

Coronary Arteries



Valves

- 4 cardiac valves: Tricuspid, Pulmonary, Mitral, Aortic
- Ability of valves to maintain unobstructive unidirectional forward flow depends on their mobility & pliability of leaflets & cusps
- Lined by endothelium;
- a dense collagenous core (fibrosa)
- loose connective tissue (spongiosa)
- layer rich in elastin (ventricularis)



Heart Failure

- Congestive heart failure (CHF): heart is unable to pump blood at a rate sufficient to meet metabolic demands of tissues
- Common, recurrent, poor prognosis
- Clinical synd arising from poor perfusion of organs (forward ischemic effects) + congestive effects of failing circulation (backward flow of blood)

Maintenance of arterial pressure & perfusion of various organs

- Frank- Starling mech: ↑ preload of dilation enhances contractility
- Myocardial hypertrophy: ↑ mass of contractile tissue
- Activation of neurohormonal systems:

1. Release of nor-epinephrine: ↑rate, contractility
2. Activation of renin-angiotensin-aldosterone system
3. Release of ANP

Heart Failure

- Forward faillure; diminished cardiac output

  Backward failure: damming back of blood in venous system
- Left sided heart failure

  Right sided heart failure

Left Sided Heart Failure

- Systolic dysfunction i.e deterioration of myocardial contractile function
- **Etiology**:

1) Pump dysfunction

- Ischemic heart disease
- Myocarditis
- Cardiomyopathies

2) Increased workload on heart (pressure overload)

- Systemic hypertension
- Aortic and mitral valvular stenosis
- Chronic lung disease

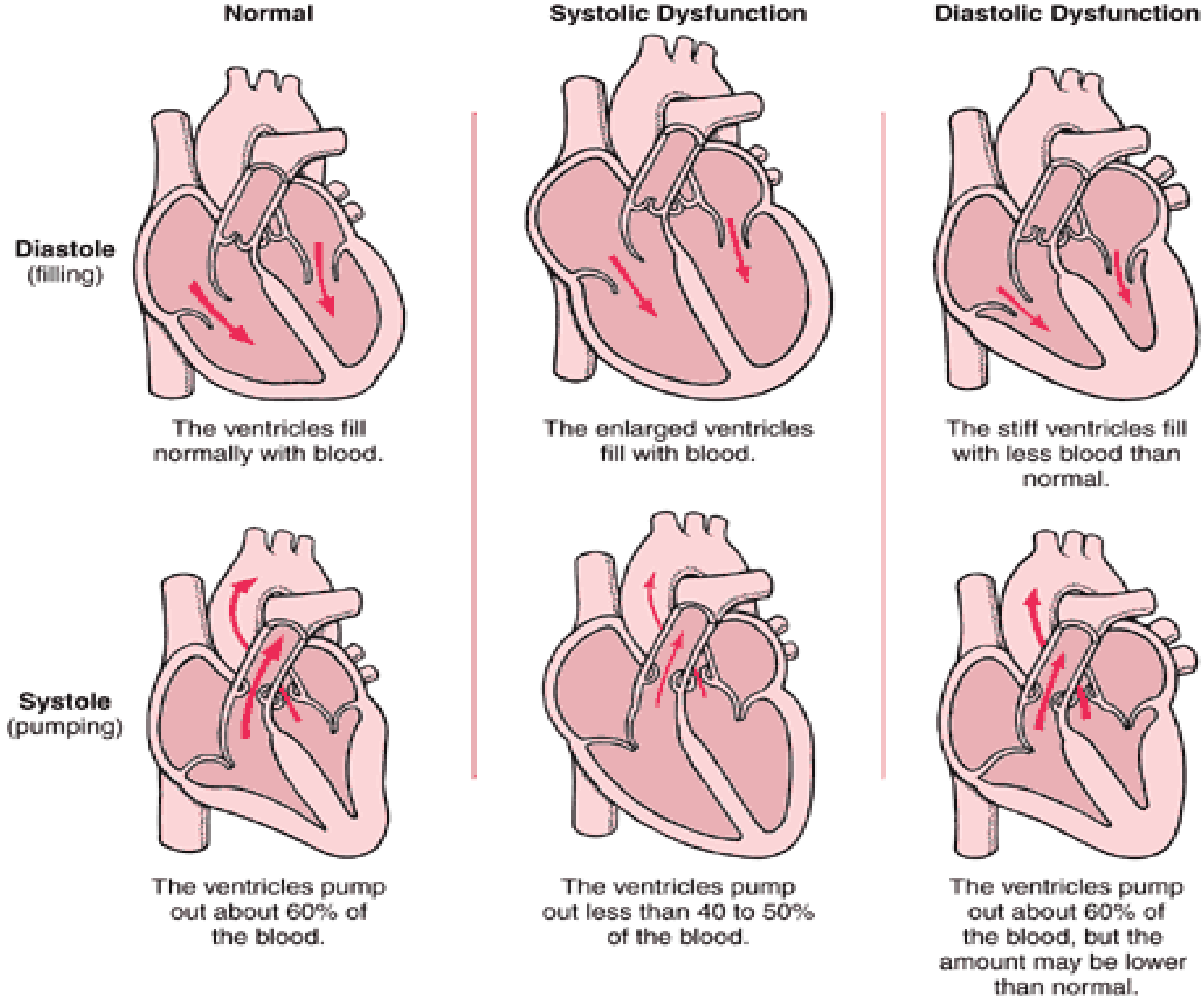
Left Sided Heart Failure

Volume overload

- Valvular insufficiency
- Severe anemia
- Thyrotoxicosis

3) Diastolic dysfunction: inability of the chamber to relax, expand and fill during diastole

- myocardial fibrosis
- amyloid deposition
- constrictive pericarditis
- LV hypertrophy


Normal
Systolic Dysfunction
Diastolic Dysfunction
Diastole
(filling)
The ventricles fill normally with blood.
The enlarged ventricles fill with blood.
The stiff ventricles fill with less blood than normal.
Systole
(pumping)
The ventricles pump out about 60% of the blood.
The ventricles pump out less than 40 to 50% of the blood.
The ventricles pump out about 60% of the blood, but the amount may be lower than normal.

Morphology (Forward effects /Ischemic)

- Kidneys:

- ↓ renal perfusion→ activation of RAA system → retention of salt & water → expansion interstitial fluid and blood vol →worsens pulmonary edema

- severe perfusion deficit → impairment of renal function →↓ excretion of nitrogenous products → accumulation of nitrogenous waste products in blood (prerenal azotemia)

- Brain: affected in advanced CHF

  - Hypoxic encephalopathy: irritability, loss of attention span, restlessness and stupor

Morphology (Backward effect)

Lungs: ↑ pressure in pulm veins → ↑ pressure in arteries & capillaries → pulm congestion & edema, heavy wet lungs

Micro: perivascular & interstitial transudate: Kerley B lines on X-ray

- Edematous widening of interalveolar septae
- Accumulation of fluid in alveolar space
- Heart failure cells

- **Dyspnea:** earliest and cardinal complaint, ↑ on exertion
- **Orthopnea**: breathlessness on lying down; relieved on sitting/ standing
- **Paroxysmal nocturnal dyspnea**: attacks of extreme dyspnea bordering on suffocation, usually occuring at night, assoc with cough

Right Sided Heart Failure

- Pure Rt heart failure is rare; occurs most often with chronic severe pulmonary HT; called **cor pulmonale**
- Usually secondary consequence of Lt side heart failure leading to ↑ pulmonary circulatory pressure
- Rt ventricle is burdened by pressure overload due to ↑ resistance within pulmonary circulation

Morphology (Backward effects)

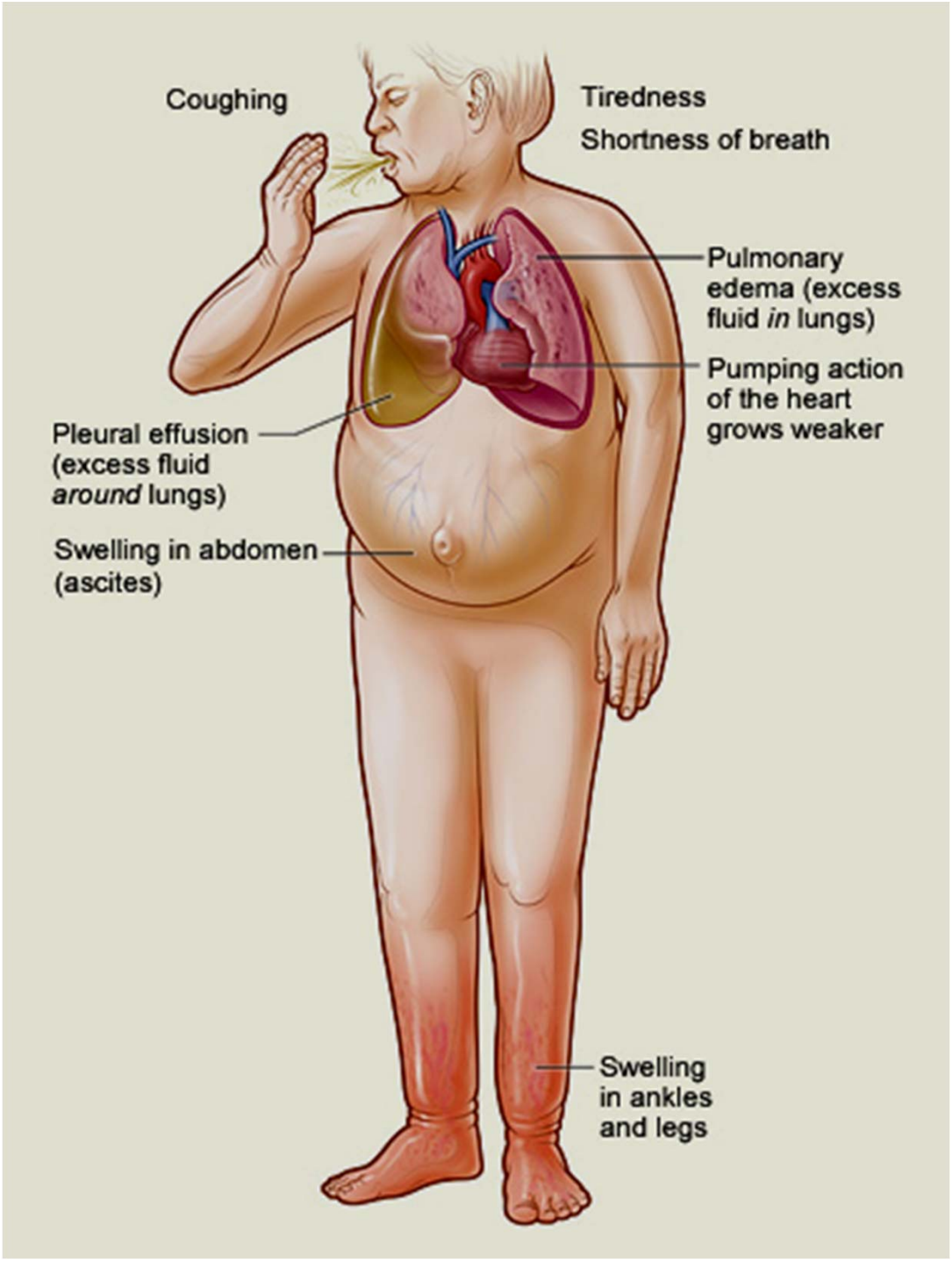
- **Liver & portal system**: ↑ size & wt (congestive hepatomegaly)

  M/E: Passive congestion→ congested red centres of lobules with centrilobular necrosis, surrounded by paler, fatty peripheral regions

  - Long standing RHF → central fibrosis →cardiac cirrhosis/ sclerosis
- **Congestive splenomegaly**: 300-500gm, tense

  M/E: marked sinusoidal dilatation
- **Ascites**: transudate in peritoneal cavity
- **Bowel wall**: edema, interfere wit absorption of nutrients

- **Kidneys**: ↑renal congestion: RHF > LHF→ more fluid retention, peripheral edema & prerenal azotemia
- **Subcutaneous tissue**: peripheral edema of ***dependant portions of the body*** or generalized massive edema (**anasarca**)
- **Pleural & pericardial spaces**: accumulation of fluid
- **Brain:** venous congestion, hypoxic injury


Coughing
Tiredness
Shortness of breath
Pulmonary edema (excess fluid *in* lungs)
Pumping action of the heart grows weaker
Pleural effusion (excess fluid *around* lungs)
Swelling in abdomen (ascites)
Swelling in ankles and legs

Cardiac Hypertrophy

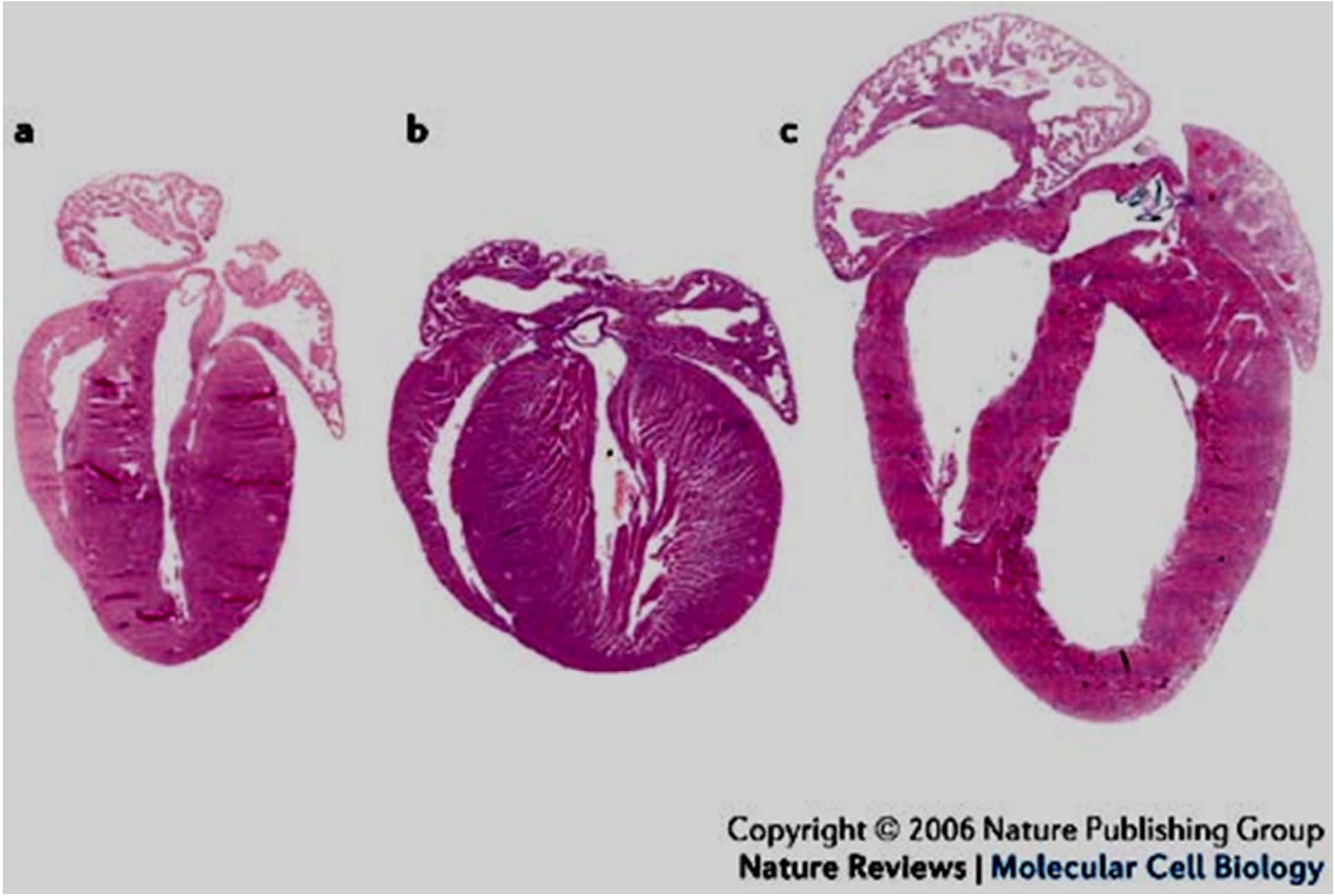
- Increase in size and weight of myocardium
- D/t increase pressure/ volume overload
- **LV hypertrophy:**
  1. Systemic HT
  2. Aortic stenosis
  3. Mitral regurgitation
  4. Coarctation
- **RV hypertrophy**
  1. Pulmonary stenosis
  2. Tricuspid insufficiency
  3. Chronic lung dis

Morphology

- **Concentric**:
  - hypertrophy without dilatation; lumen is smaller than normal
  - LV wall thickness: > 1.5 – 2 cm
- **Eccentric:**

- associated with dilatation; lumen greater
- wall thinned; dilatation and hypertrophy of right heart as well
- wt > 500g

Micro: increase in fibre size, foci of degenerative changes and necrosis



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Cardiac Dilatation

Compensatory mechanism

Causes:

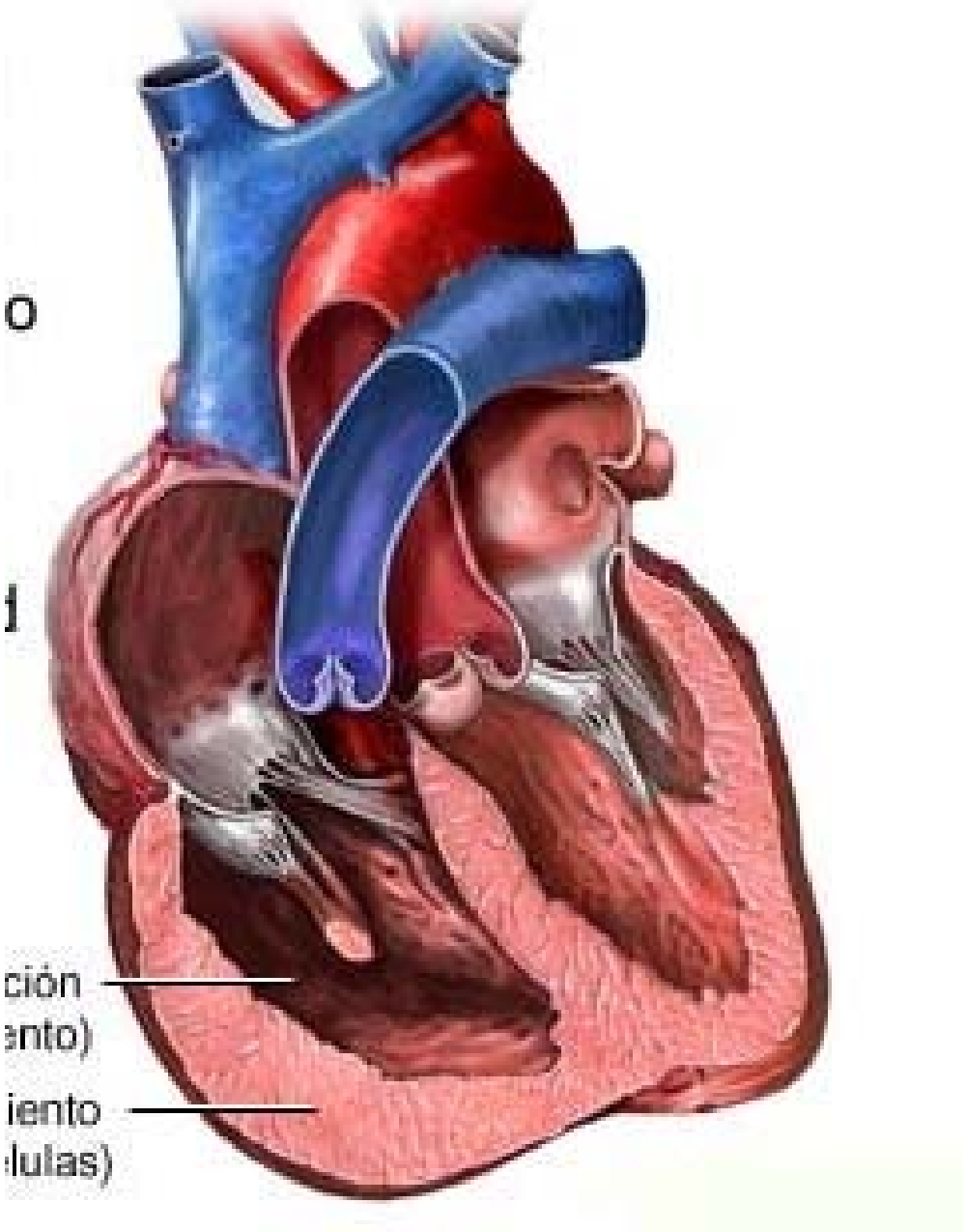
- Valvular insufficiency
- L to R shunt
- Cardiomyopathies
- Thyrotoxicosis

Hypertensive Heart disease

- Eccentric hypertrophy
- d/t Prolonged systemic Ht
- 2nd most common cause after ischemic heart dis
- Pts often have **atherosclerosis**
- **Progressive ischemic heart dis**
- Causes of death: **Dissecting aneurysm**
- **Renal failure following arteriolar nephrosclerosis**
- **Cerebrovascular stroke**

Cor pulmonale

- **Right heart failure d/t disorder of lungs.**
- **RV dilatation or hypertrophy**
- **Acute cor pulmonale**: massive pulmonary embolus
- **Chronic cor pulmonale**: chronic dis of lungs: chr emphysema, chr bronchitis, etc: heal by fibrosis: fibrosis around pulmonary vs: increase resistance: pressure overload of rt heart: rt heart failure
- Morpho: increase thickness of vs wall upto 1 cm with dilatation of chamber.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