Pathology of Heart Failure

Dr G Mahendra
Dept of Pathology

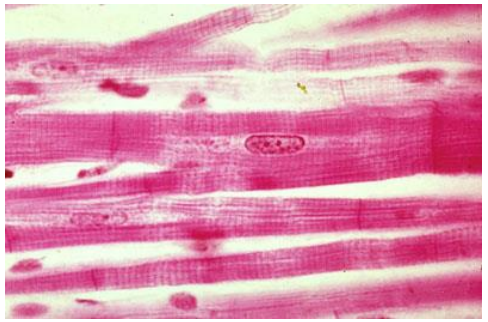
Pathology of Heart failure

At the end of this lecture the students should be able to

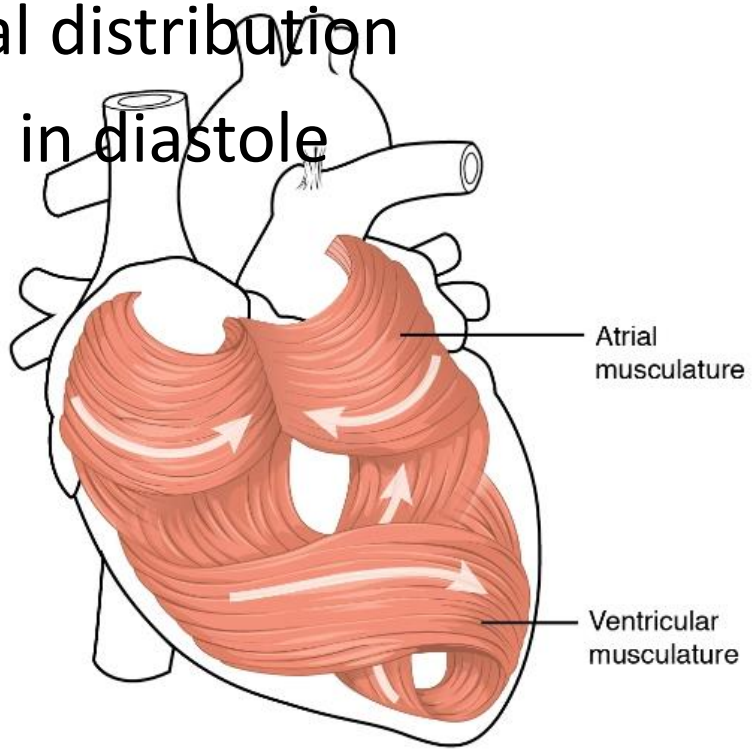
- Recapitulate the normal pumping action of the heart
- Define cardiac failure
- Describe the pathophysiological mechanisms of heart failure
- Explain the pathological basis of each of the clinical features in left and right heart failure
- Describe the morphological changes of heart in left and right heart failure
- Describe the effects of heart failure on lung. liver, kidney and brain

Normal pumping function of the heart

- Cardiac muscle is composed of specialized cells - Cardiac myocytes

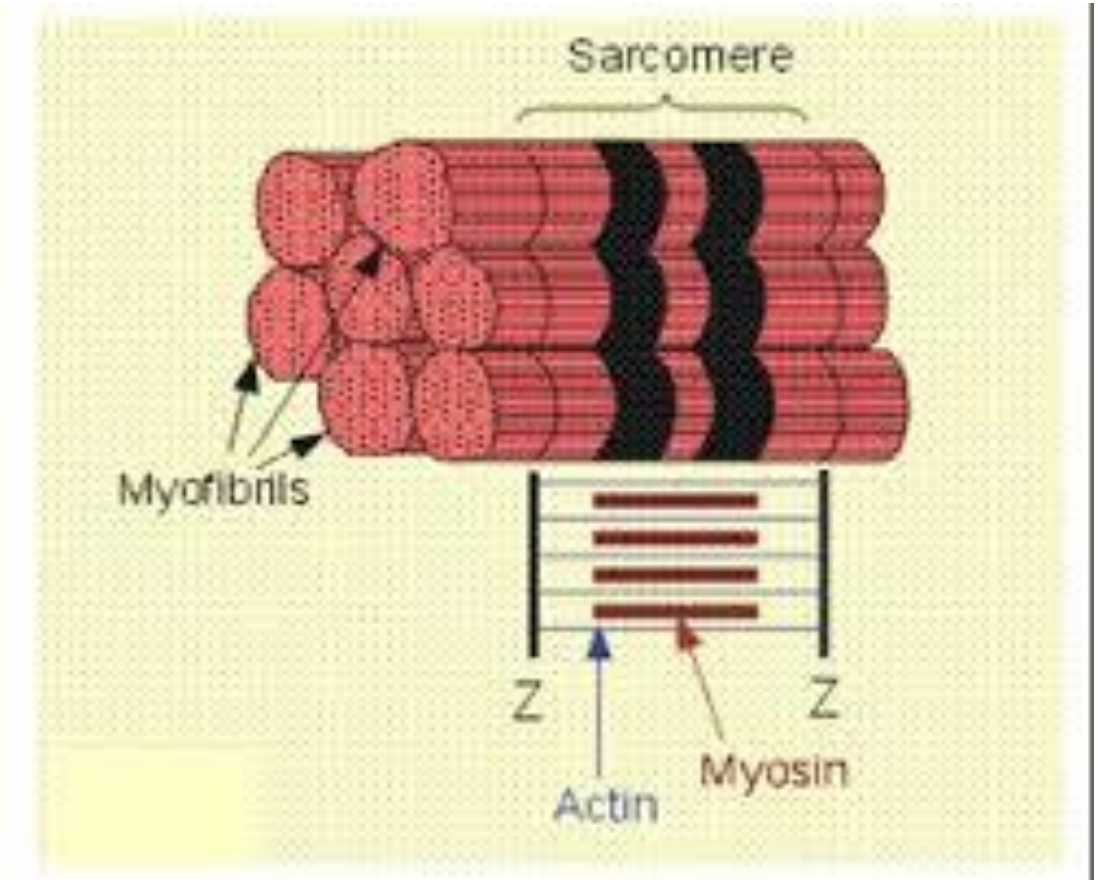


- Ventricular myocytes-
  - Arranged concentrically in a spiral distribution
  - Contract during systole and relax in diastole

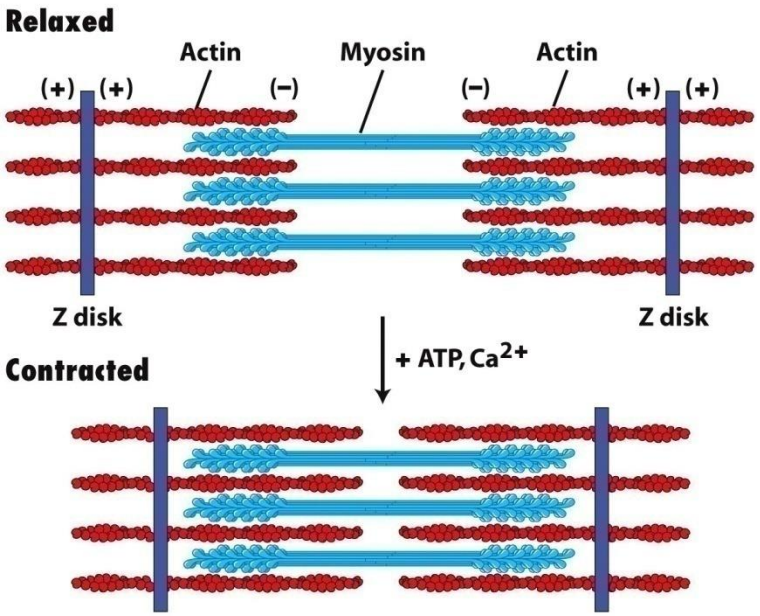


Normal pumping function of the heart

Contractile unit- sarcomere



Normal pumping function of the heart



- The amount of force generated is determined by the distance each sarcomere shortens
- Moderate ventricular dilatation in diastole-
  - Increase the extent of sarcomere shortening
  - Therefore increase the force of contraction in systole

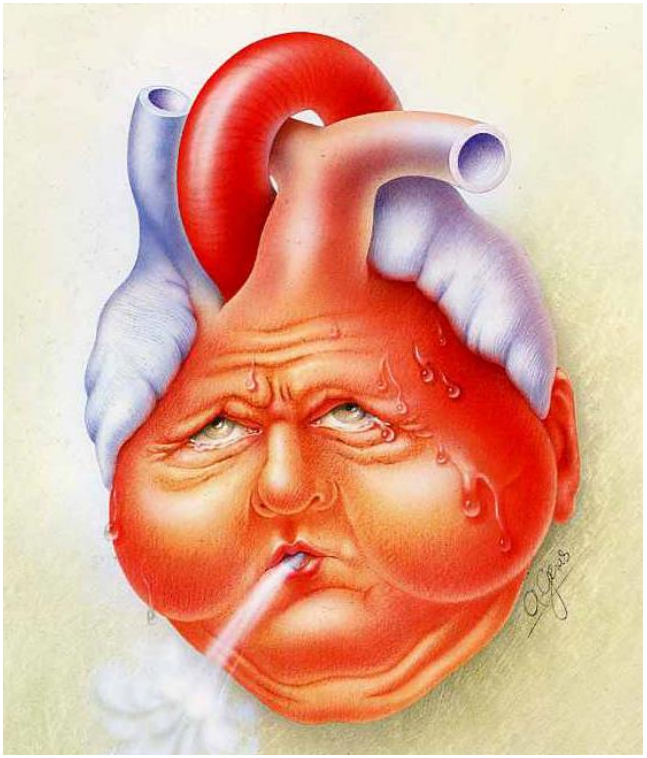
Heart failure/Congestive heart failure (CHF)

- A state in which impaired cardiac function failed to maintain a circulation adequate for the metabolic needs of the body
- A complication of many forms of heart diseases which causes,

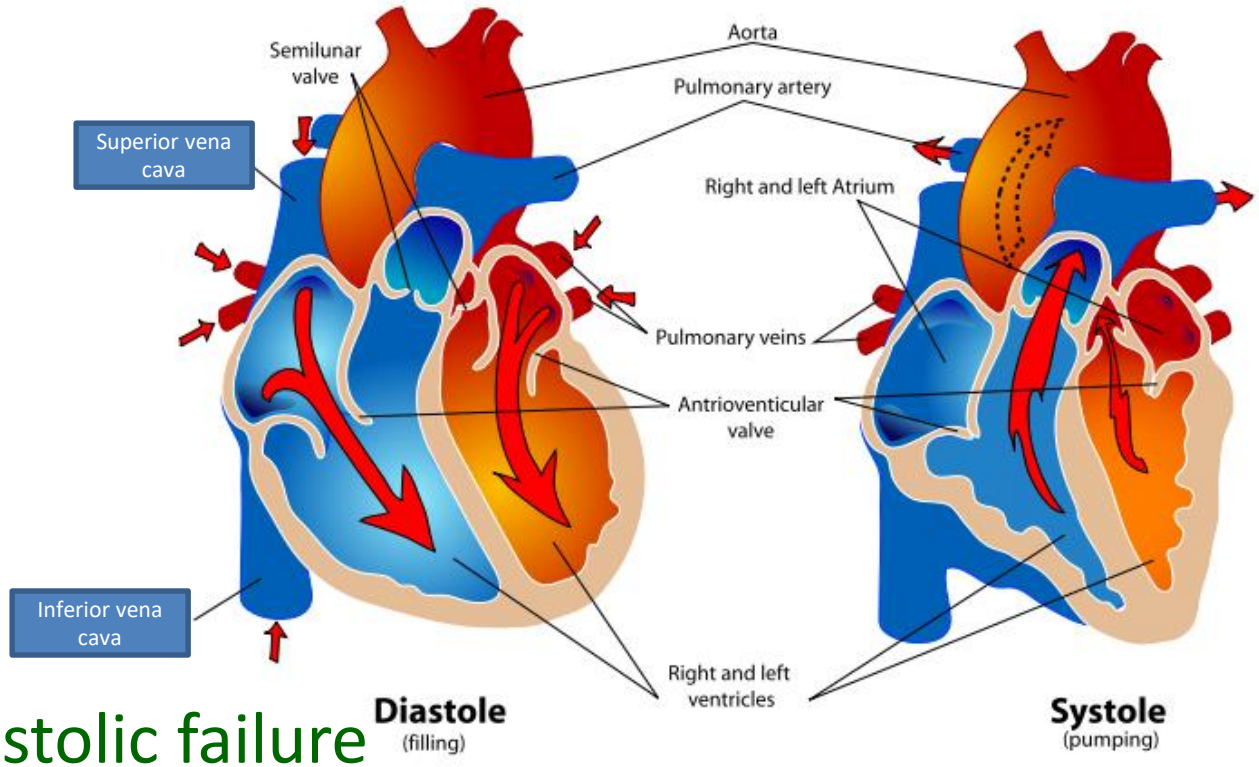
  .Increase work load on heart

  .Inefficiency of myocardium

  .both



Pathophysiology of Heart Failure



Diastolic failure

.Pericardial diseases

.MV/TV stenosis

.Atrial fibrillation

.Reduced myocardial compliance

Systolic failure

.Impaired ventricular contractility

.Increased volume load on ventricles- MR/TR

.Pressure overload

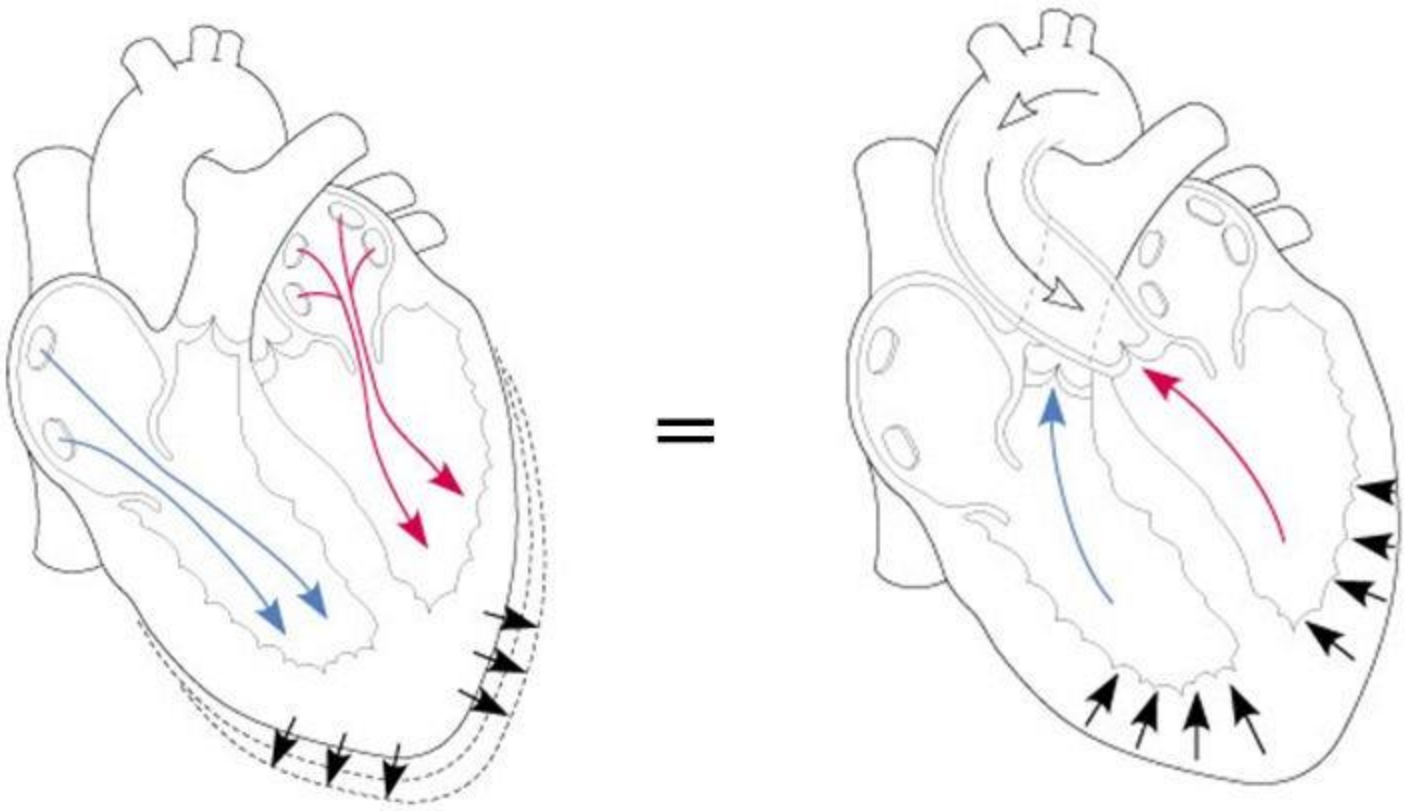
Pathophysiology of CHF

When cardiac function is impaired or the work load of the heart is more , several physiological mechanisms are operated to maintain BP and perfusion of vital organs.

Know these mechanisms thoroughly

- Frank-Starling mechanism
- Myocardial hypertrophy
- Activation of neuro-humoral mechanism
  - Release of norepinephrin
  - Activation of renin-angiotensin-aldesteron mechanism
  - Release of Atrial Natriuretic Peptide

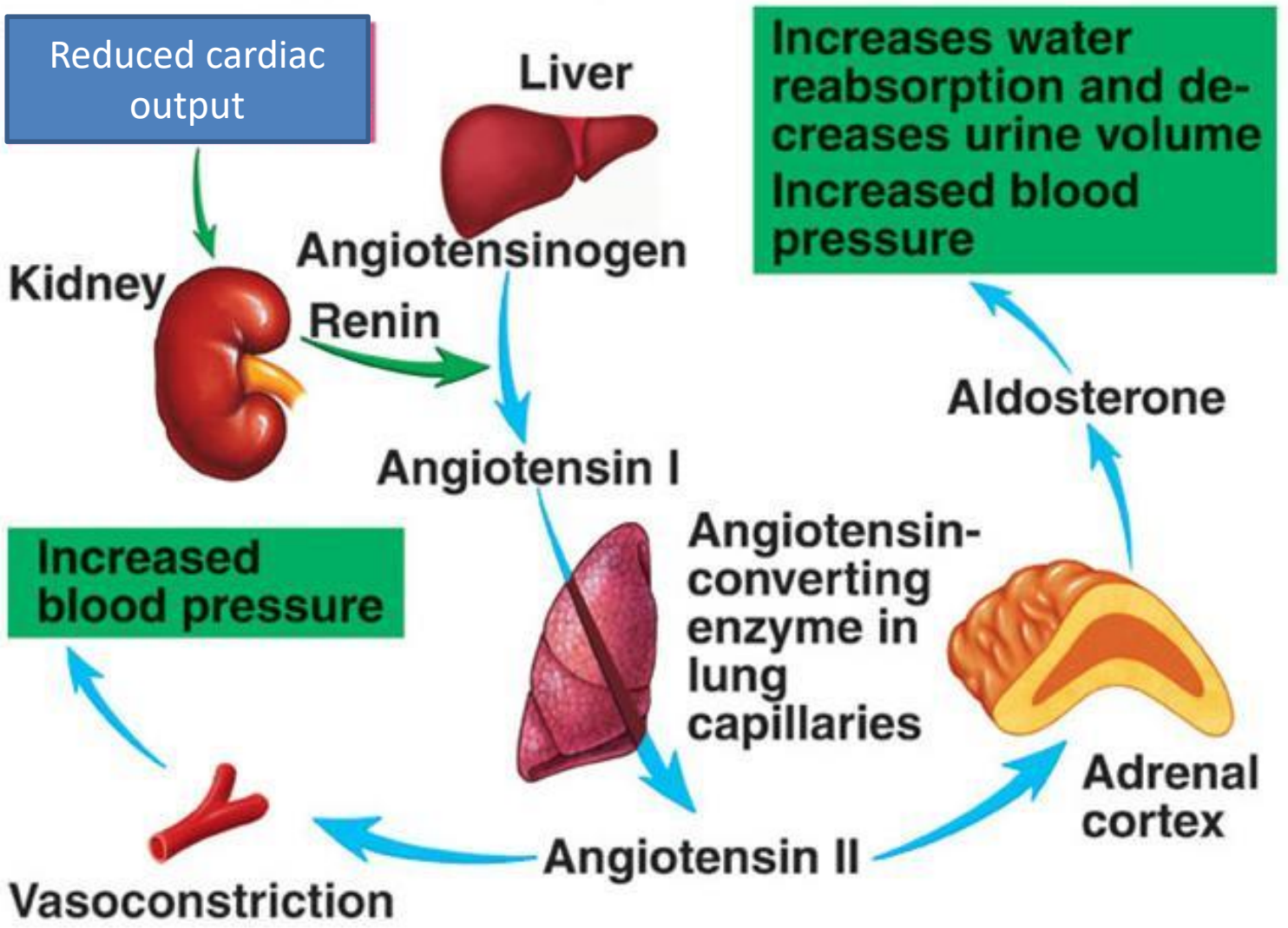
Frank-Starling law of the heart



Increased blood volume = increased stretch of myocardium

Increased force to pump blood out.

Renin-angiotensin-aldesteron mechanism



Pathophysiology of CHF

- The capacity of these physiological/adaptative mechanisms will be ultimately overwhelmed.
- Pathologic changes are superimposed.
  - Myocyte apoptosis
  - Cytoskeleton alterations
  - Extracellular material deposition
- The deterioration of cardiac function progresses

What are the structural and functional differences between physiological and pathological hypertrophy of heart?

Cardiac hypertrophy

Pressure/volume overload

Increased trophic signals

Increased mechanical work load

↓

Ventricular hypertrophy with or without dilatation

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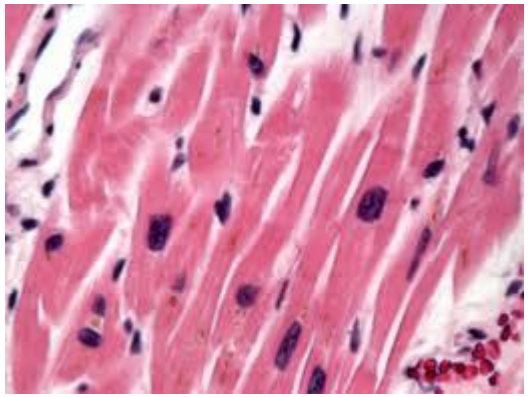
Increased cardiac weight

Hypertropic myocyte

- Increased protein synthesis
- Additional sarcomeres
- Increased mitochondria
- enlarged nuclei (Increased DNA ploidy)
- Induction of immediate early genes& fetal genes
- Abnormal proteins
- fibrosis



Hypertrophic cardiac muscle

- Oxygen consumption and metabolic demand of myocytes are increased
- The increased myocyte size is not accompanied by increased blood supply
- Therefore hypertrophic heart is vulnerable for decompensation

Cardiac dysfunction

- Heart failure
- Arrythmias
- Neurohumoral stimulation

Manifestations of heart failure

- Depend on,

1. Rate of development of heart failure

2. Predominantly affecting ventricle
   - .left heart failure
   - .right heart failure
   - .biventricular / congestive heart failure

Depending on the rate of development of heart failure

- Acute heart failure- causal factor develops rapidly
  - – myocardial infarctions
  - –pulmonary embolism
  - –myocarditis
  - –Rheumatic fever

- Chronic heart failure - prolonged course
  - –myocardial ischemia
  - –systemic hypertension
  - – chronic valvular problems

Left heart failure /LHF

Common causes

- Ischemic heart disease
- Hypertension
- Aortic and mitral valve diseases
- Myocardial diseases

Left heart failure /LHF

Left ventricle can't pump out blood effectively
(reduced ejection fraction)

↓

Increased end systolic volume

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Left ventricular dilatation

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Mitral valve ring stretched

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Mitral regurgitation

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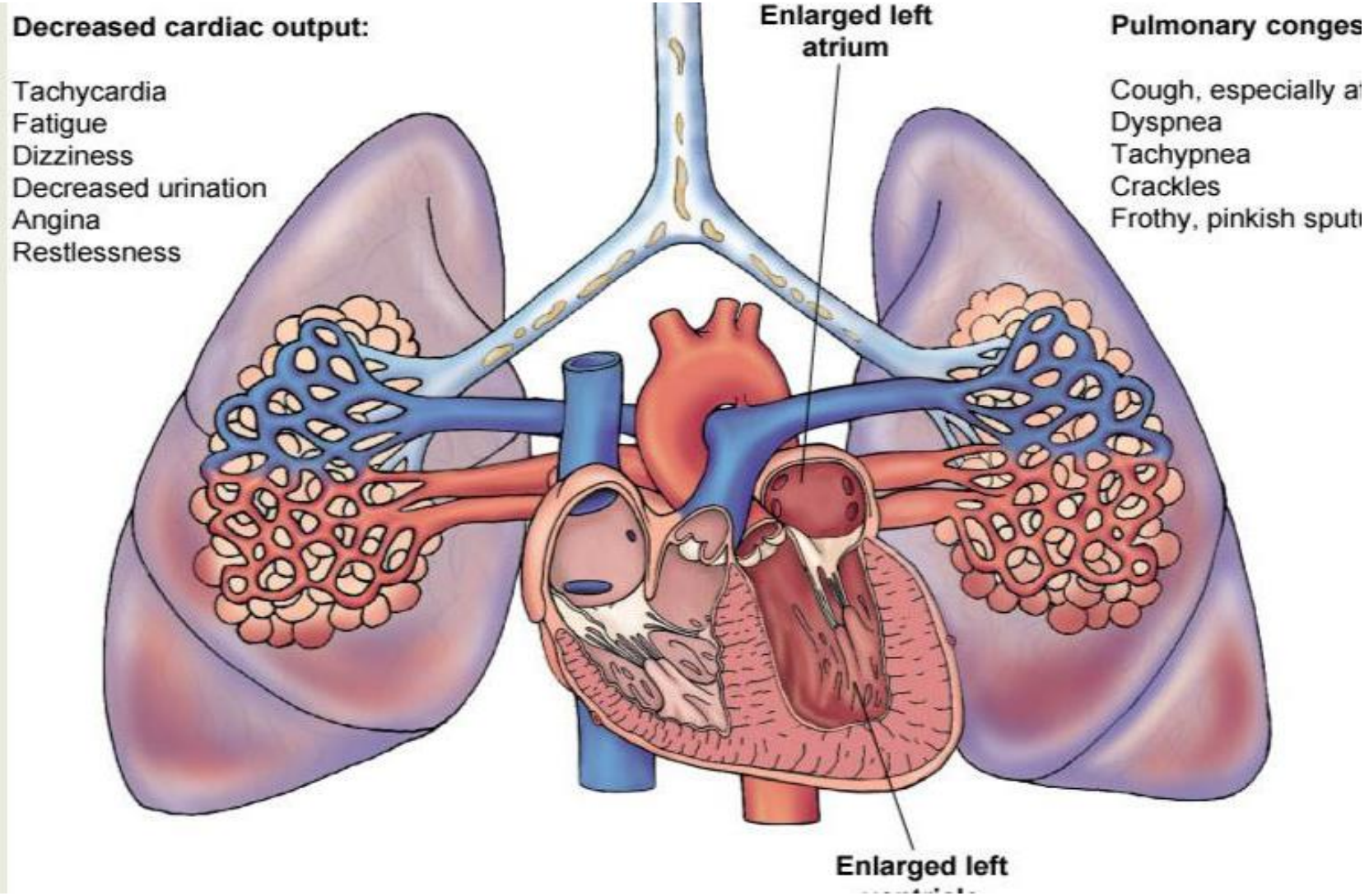
Pulmonary congestion and oedema

Dyspnoea, cough, haemoptysis with rusty sputum

Left heart failure /LHF



Morphology of heart in LHF

- **Vary depending on the underlying disease process**
  - MI, Valvular deformities, HT
- Usually the heart is hypertrophied with or without dilatation
- Can have left atrial dilatation and thrombi formation
- Microscopically –myocyte hypertrophy and interstitial fibrosis

Microscopic changes in the lungs in LHF -KNOW

Right heart failure /RHF

- Mostly RHF is a result of LHF. Increase in pulmonary pressure caused by LHF burdens the right heart.
- Pure RHF is less frequent.
  - Following chronic lung diseases -Co-pulmonale
    - Chronic parenchymal lung diseases
    - Pulmonary vascular diseases
  - Tricuspid or pulmonary valve diseases
  - Myocardial diseases affecting right side

Right ventricular failure

Reduction **of right ventricular outflow**

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Right ventricular dilatation

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Dilatation of tricuspid valve ring

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Increased right atrial pressure

↓

INCREASED CENTRAL VENOUS PRESSURE

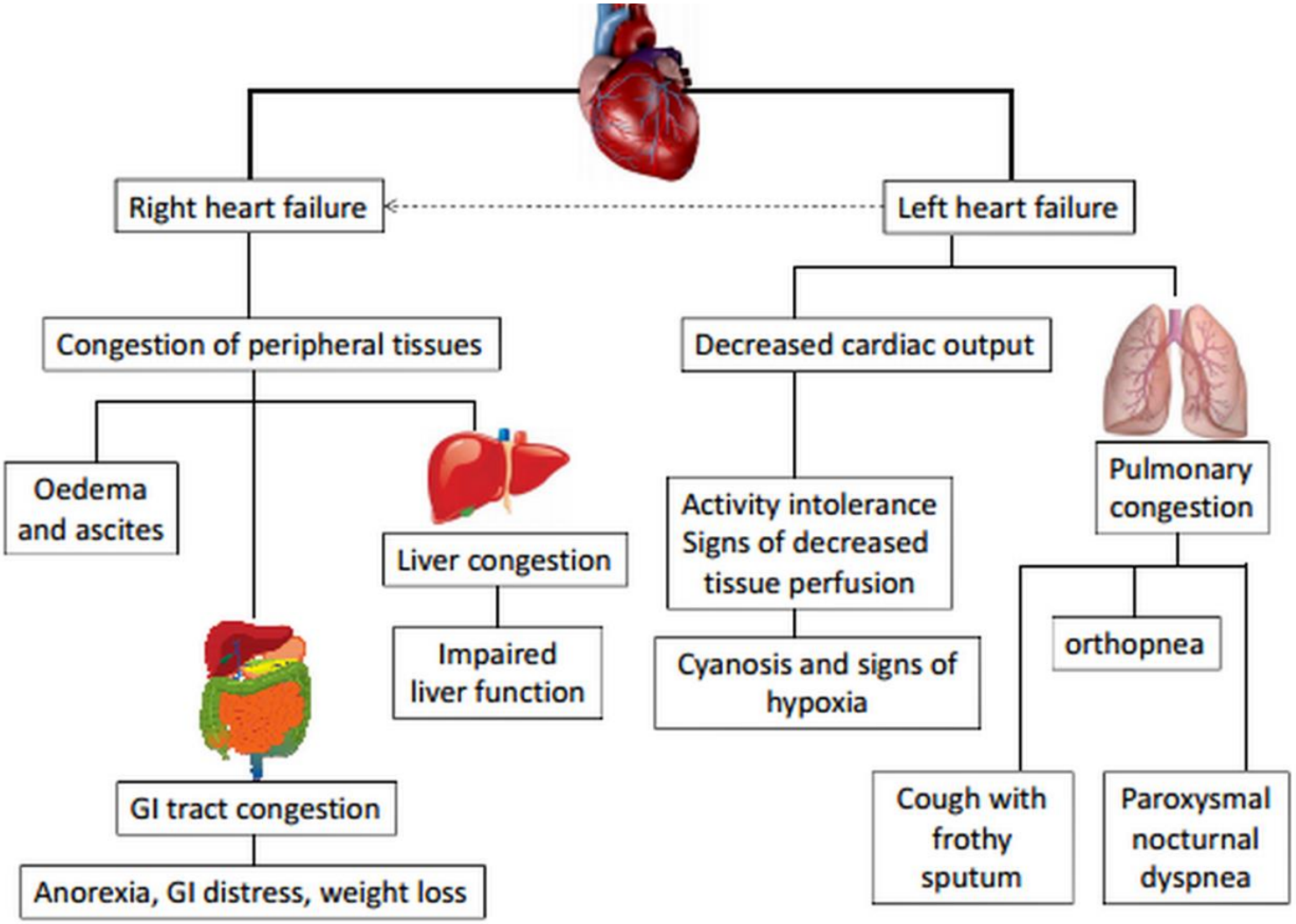
↓

Systemic venous congestion & edema

Morphology of RHF

- Varies with the cause
- Majority of cases will have hypertrophy and dilatation of right ventricle and atrium.
- Engorgement of systemic and portal circulation is the key feature in RHF
- Congestive hepatomegally –Nutmeg liver
- Congestive splenomegally
- Congestion of the bowel wall
- Effusions in pleural peritoneal and pericardial spaces
- Dependant oedema

Explain the pathophysiological basis of each symptom & sign of LHF



Congestive cardiac failure/biventricular failure-causes

- Usually following LVF
- extensive myocardial damage
- Persistently elevated cardiac output
  - Thyrotoxicosis
  - Anaemia

‘High output failure’

What are the effects/pathologic changes that occur in following organs due to heart failure?

- Liver
- Kidney
- Brain
- lung

READ