

Heart function and Heart failure in children

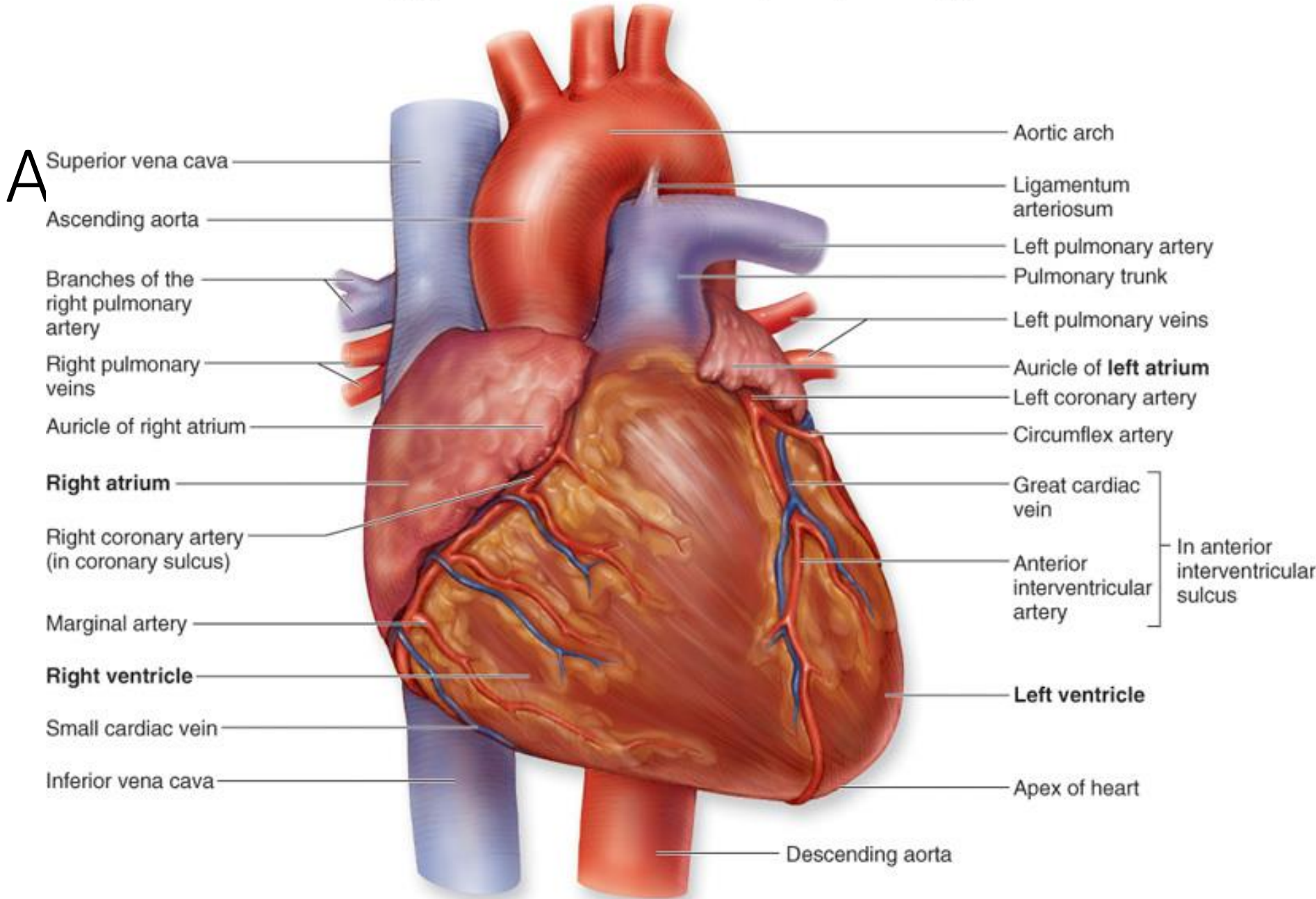
Iyad AL-Ammouri

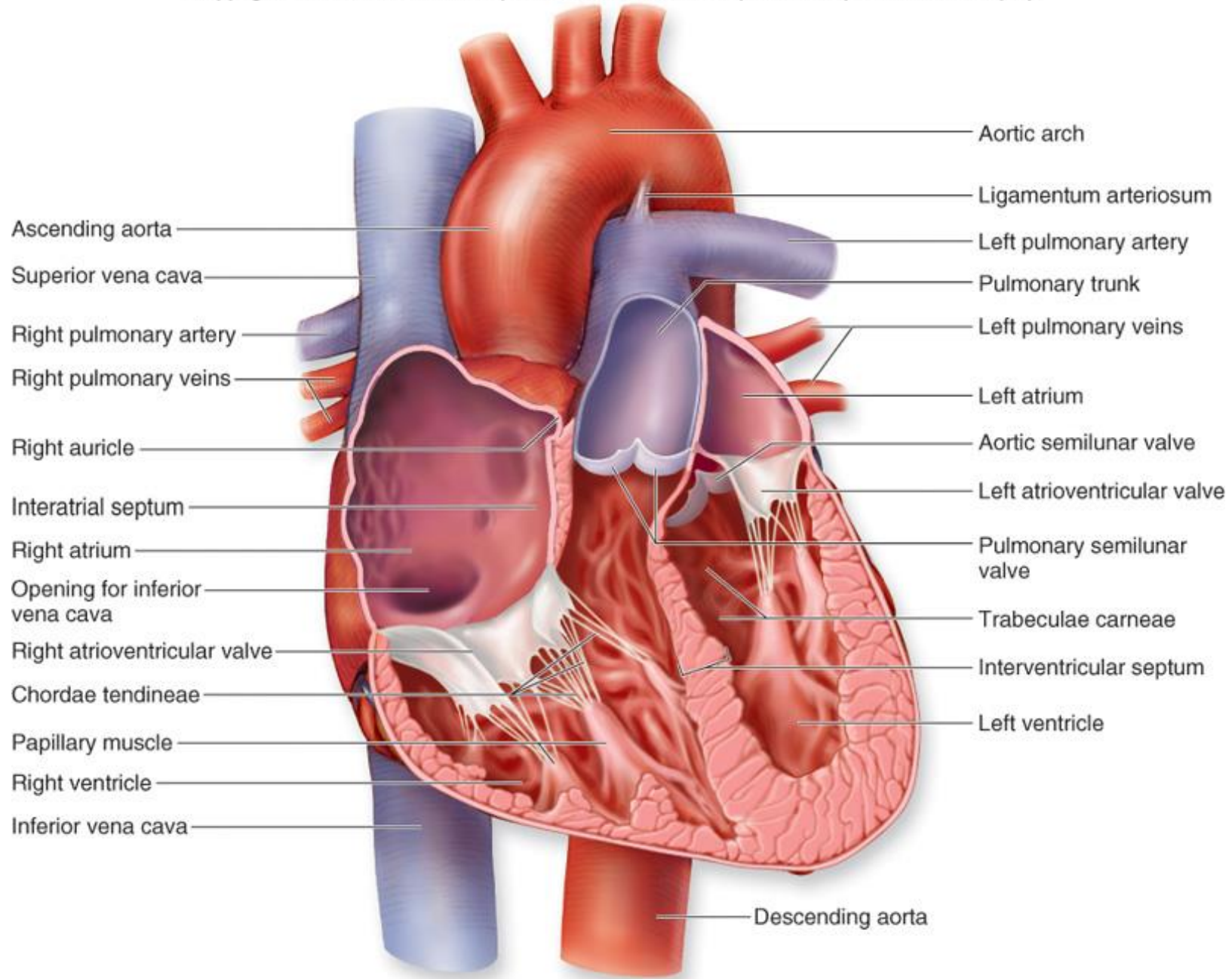
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Outline

- Introduction
 - Anatomy revision
 - Physiology and cardiac output
 - Cardiac cycle revision
- Heart failure
 - Definition
 - Pathophysiology
 - Clinical picture and diagnosis
 - Etiology
 - Management guide





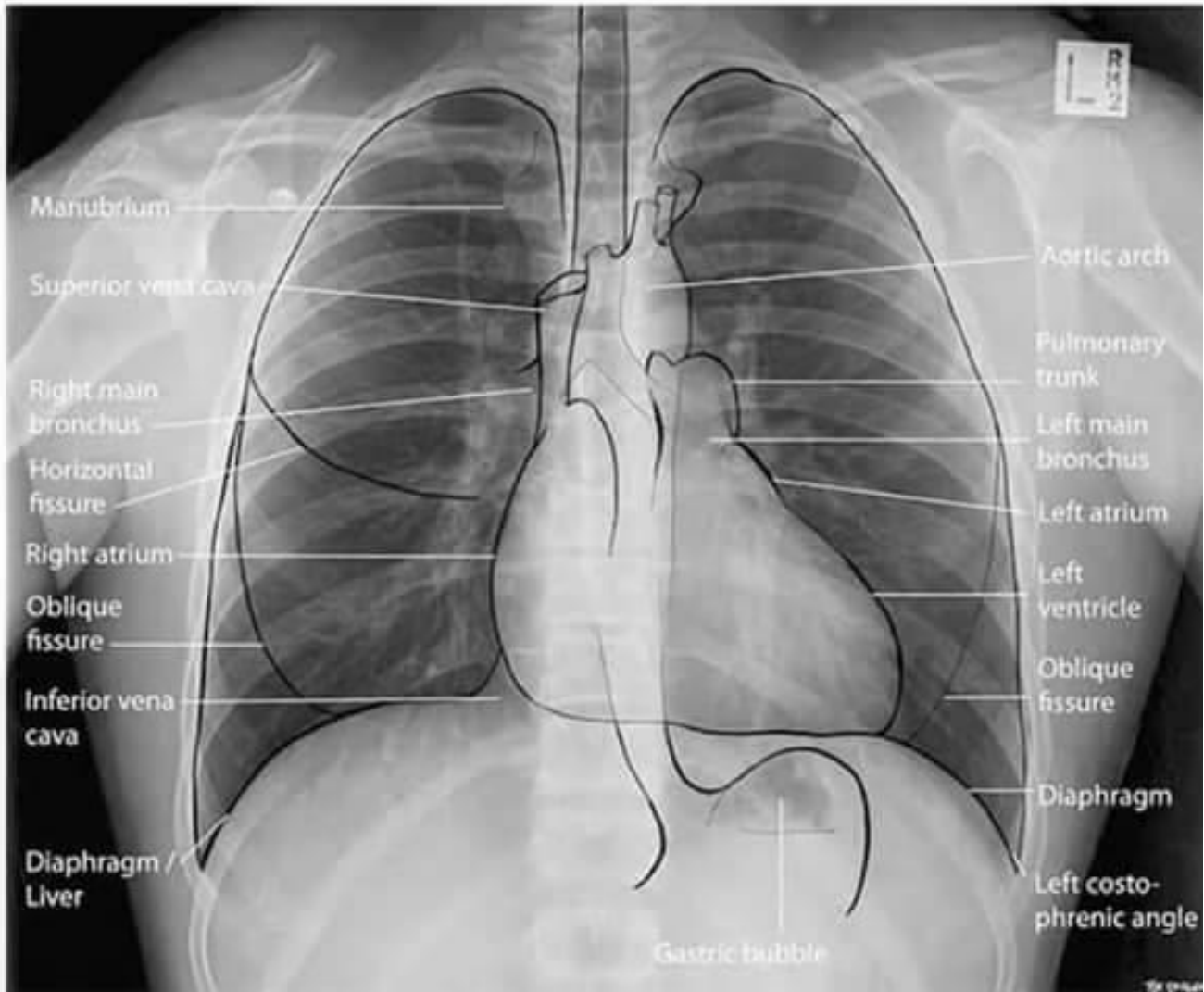
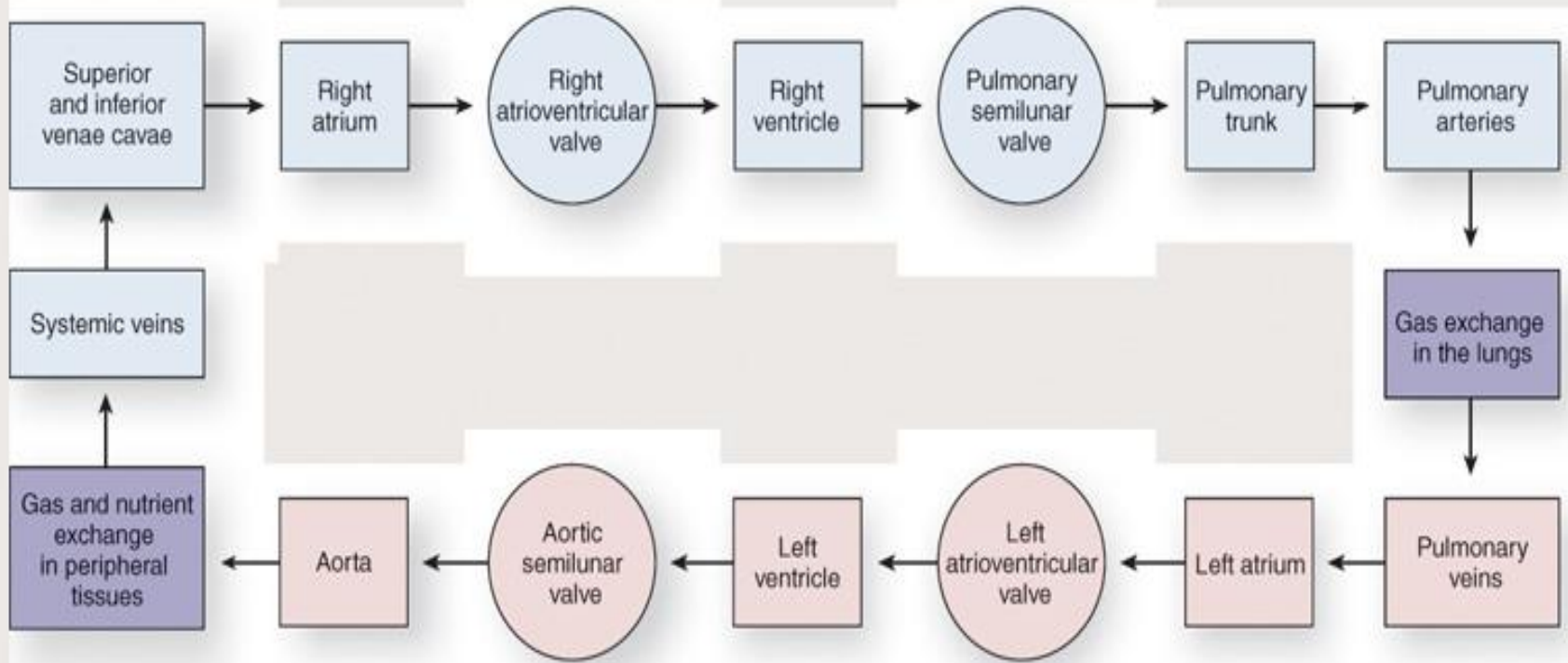


Table 22.3

Blood Flow Through the Heart

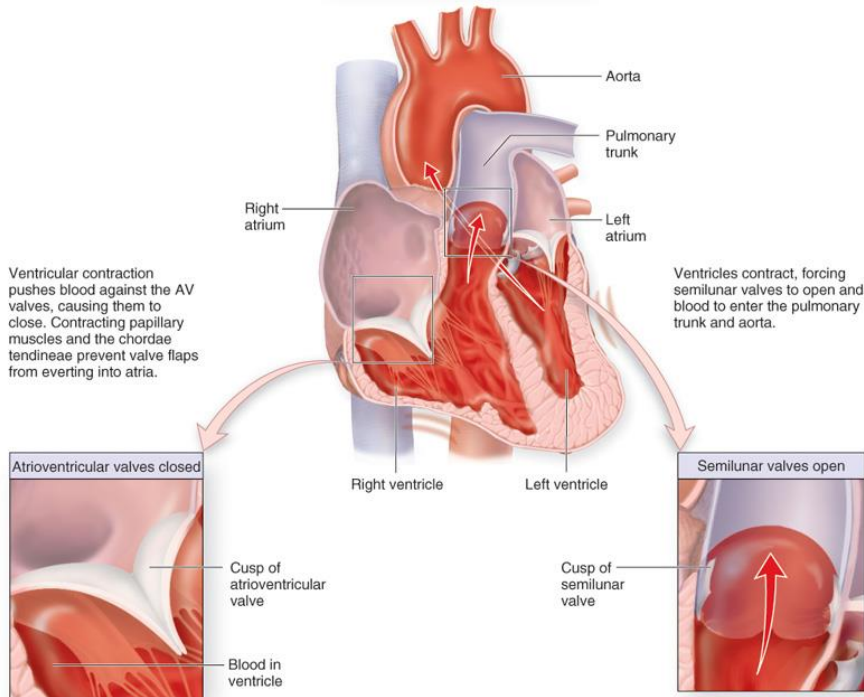


Chamber of the Heart	Receives Blood From	Sends Blood To	Valves Through Which Blood Flows
Right atrium	Superior vena cava, inferior vena cava, coronary sinus	Right ventricle	Right AV valve
Right ventricle	Right atrium	Pulmonary trunk (blood enters pulmonary circuit of vessels)	Pulmonary semilunar valve
Left atrium	Pulmonary veins	Left ventricle	Left AV valve
Left ventricle	Left atrium	Aorta (blood enters systemic circuit of vessels)	Aortic semilunar valve

Ventricular systole and diastole

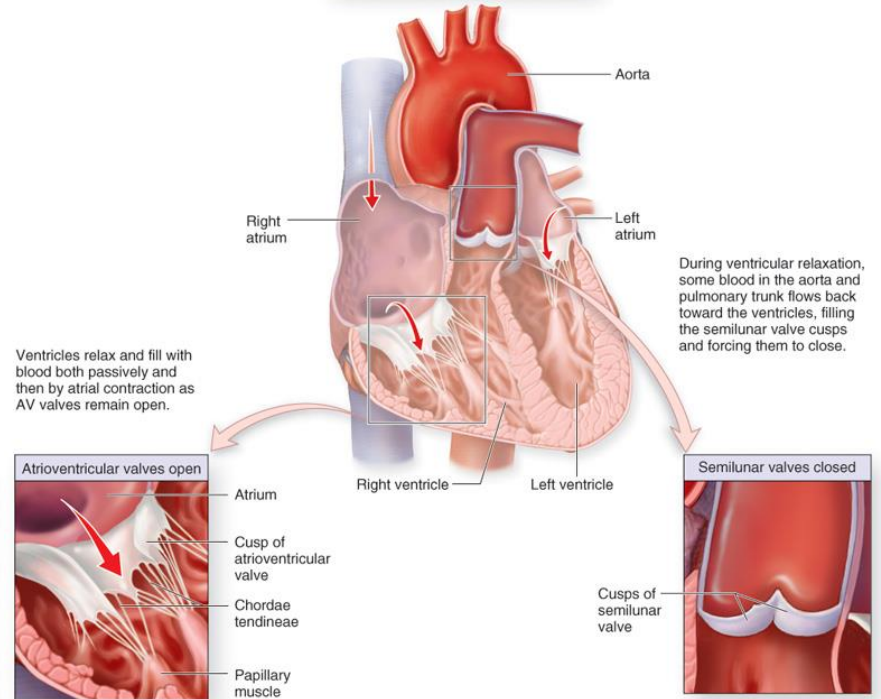
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Ventricular Systole (Contraction)



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Ventricular Diastole (Relaxation)



Cardiac function

- Pumping of oxygenated blood to the systemic organs through systemic circulation, and pumping of de-oxygenated blood to the pulmonary circulation
- Blood flow to the systemic circulation is measured as liters/minute and is called (Cardiac output)
- Cardiac output is regulated by tissue demand for oxygen
- Cardiac output is a result of : stroke volume X heart rate per minute
- Stroke volume is the volume of blood ejected to the systemic circulation in one beat
- In normal heart

stroke volume = end diastolic volume - end systolic volume

Cardiac output

Heart rate

X

Stroke Volume

Regulated by
sympathetic and
Parasympathetic
nervous system

Symp → ↑
Parasymp → ↓

Determined by:

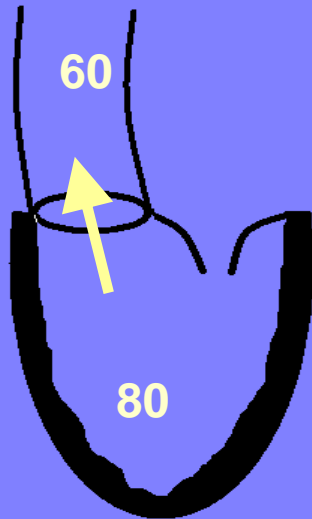
- Preload (volume)
- Afterload (resistance)
- Contractility

Stroke volume

LVEDV=80 (preload)

LVESV=20

Stroke volume= LVEDV-LVESV=60



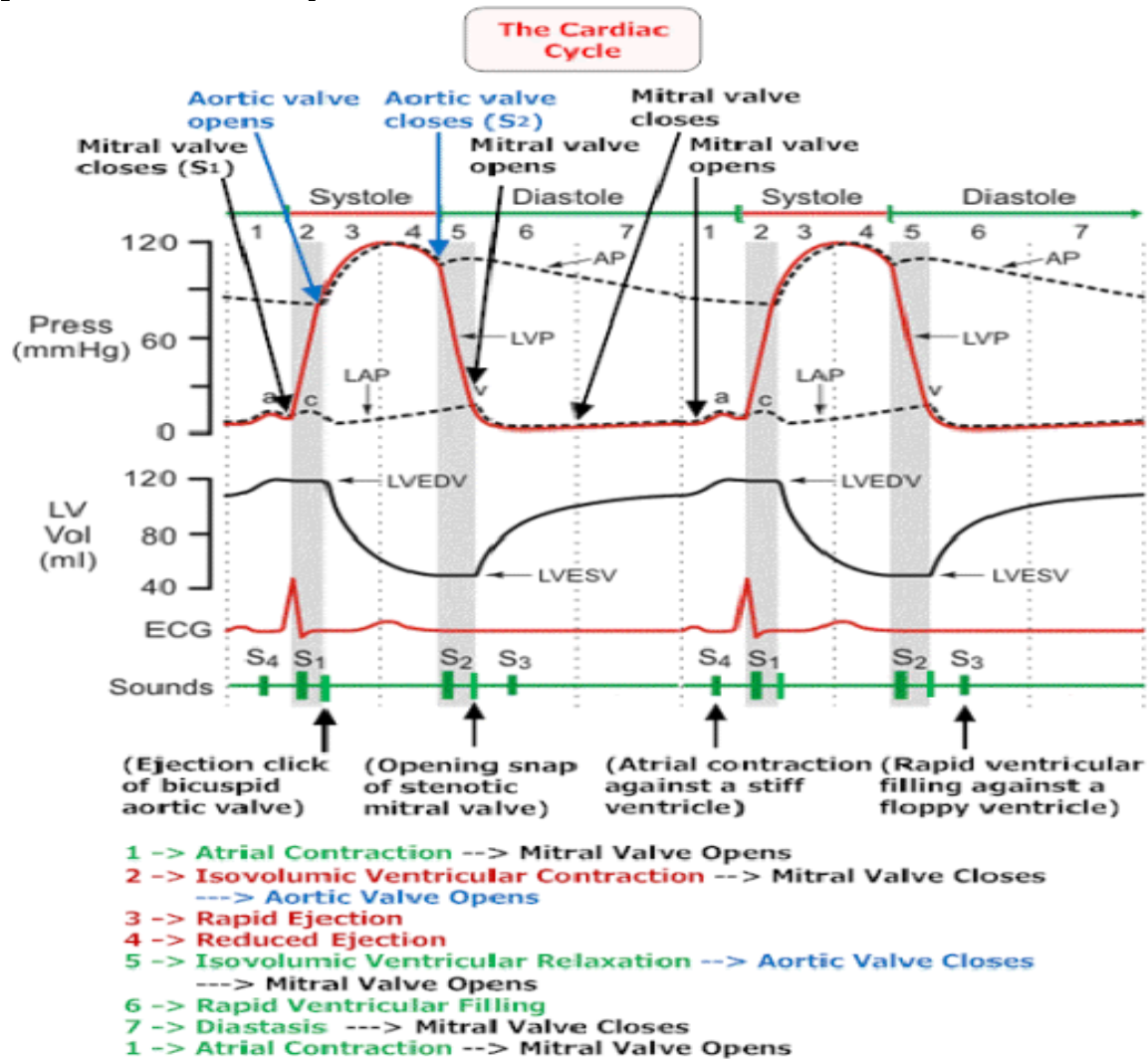
Preload: volume of blood in LV at end diastole

(venous return)

Afterload: resistance against which the LV is pumping

Contractility: degree of shortening of the muscle when it contracts (strength of muscle)

Card



Heart Failure

- Simply stated

Heart failure is the failure of the heart to produce cardiac output that meets the metabolic demand

Etiology and clinical presentation differs significantly between children and adults.

Pathophysiology

What happens when supply becomes less than demand

Compensation mechanisms
start to operate

Renin-Angiotensin-Aldosterone

Main effects:

- Fluid retention
- vasoconstriction

Autonomic nervous system

Main effects:

- Tachycardia
- Increased myocardial contractility
- vasoconstriction

Clinical presentations (SIGNS & SYMPTOMS)

S&S related to Fluid retention → congestion

Pulmonary congestion:
tachypnea, dyspnea,
respiratory distress

Systemic congestion:
edema, hepatomegaly,
increased venous
pressure

S&S related to symp.
stimulation

Tachycardia/ palpitation
Diaphoresis (infants)
Irritability (infants)
S&S of vasoconstriction
(cold extremities, poor
pulses)

S&S related to low
tissue perfusion

Decreased capillary refill time
Exercise intolerance/fatigue (**in
infants this results in poor
feeding and poor weight gain**)
Low urine output
Altered level of consciousness
S&S of metabolic acidosis

AND: S&S of the etiology of heart failure

Diagnosis of heart failure

Mainly depends on the clinical features

Other helpful investigations:

ECG: if there is suspicion of arrhythmogenic cause, or secondary rhythm disturbance. Also helps in some structural heart disease

CXR: May show cardiomegaly (not specific for etiology), shows the degree of pulmonary adema

Echocardiography: Very helpful in determining etiology of HF

Other investigations helps determining severity/complications/etiology:

1)

2)

3)

Etiology of HF in children

CHD with increased pulmonary blood flow

- **VSD** (holosystolic murmur)
- **PDA** (machinery murmur, wide pulse pressure)
- **AV canal defect** (Down syndrome)
- **Truncus arteriosus**
(mild desaturation, possible ejection click, wide pulse pressure)

CHD with flow obstruction

- **Aortic stenosis** (click, radiation to the neck)
- **Coarctation of aorta** (high blood pressure, poor femoral pulses)

Poor myocardial contractility

- **Dilated cardiomyopathy** (family history)
- **Myocarditis** (hx of viral infection)
- **Sepsis:** resulting in septic shock/ organ damage
- **Rare-** coronary artery anomalies

HF due to dysrhythmia

- **SVT** (HR >220)
- **Bradycardia** (complete heart block), congenital CHB presents earlier

High output failure: High demands
Examples: thyrotoxicosis, Severe anemia, extensive AV malformation

Management guide for HF in children

Nutritional support

Increase caloric intake (fortified formulas, more frequent feeds, NG feeding if needed)

Medications

Diuretics: (examples: furosemide, spironolactone) decrease the congestion, improves respiratory distress

Afterload reduction (Examples: ACE, ARB): improve tissue perfusion, in some cases may manipulate the shunts (in CHD)

Inotropic support: Examples are sympathomimetics, phosphodiesterase inhibitors, digoxin

Beta-blockers: for long term use

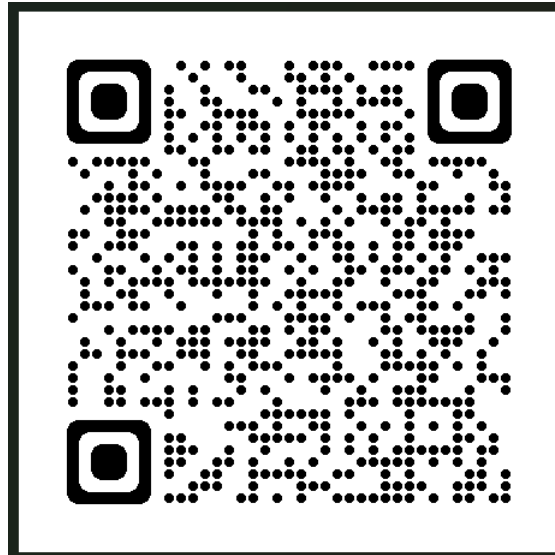
Treating the etiology

CHD → repair

Arrhythmia → Rhythm control, pacemakers..

Devices and transplant for refractory cases

END



Additional reading: [Pediatric Heart Failure: A Practical Guide to Diagnosis and Management - Pediatrics & Neonatology \(pediatr-neonatol.com\)](#)