

## 5<sup>th</sup> Lecture

---

# CARDIAC CYCLE-1

Physiology Team - 430

---

Abdulaziz Al-Nami - Abdul Salam Baqays

Akeel Al-Mahdaly - Ali AL-Kahtani

Bader Al-Omair - Dalal Alqadi

Hanan AL-Amer - **Hanoof AL-Khalaf**

Layan akkielah - Lujayne Bukhari

**Reem Al jurayyad - Suliman AL-Shammari**

**Cardiac Cycle** : Events that occur from the beginning of one heartbeat to the beginning of the next ( **one contraction and one relaxation** )

What events ..? This is what we'll talk about in this lecture

**Diastole** : period of **relaxation** ( **during heart fills with blood** )

**Systole** : period of **contraction**

**Diastole** always **longer** than **systole** ( in atrial and Ventricular)

**Because it receive Blood**

**AV – valves** : Mitral valve **and** Tricuspid valve

**Semilunar valves** : Aortic valve **and** pulmonary valve

**Tachycardia** → short cardiac cycle

**Bradycardia** → Long cardiac cycle

### ■ Cardiac cycle :

1- Atrial Cycle : 0,8 sec

2- Ventricular Cycle : 0,8 sec

All happening at the **same time**

So, **duration** of the cardiac cycle

**0,8 sec**

### ■ Time overlap :

Phase	Atrial systole	Early ventricular systole	Late ventricular systole	Early ventricular diastole	Late ventricular diastole
Structure					
Atria	Contract	Relax		Relax	
Ventricles	Relax	Contract		Relax	

### Three Phases :

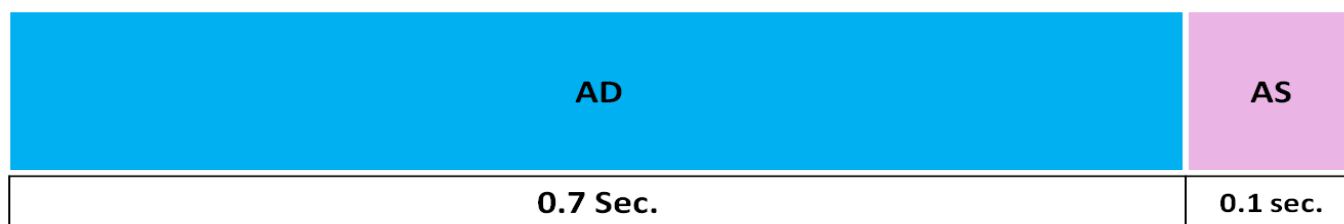
1- Atrial **Contract** , ventricles will be **Relax**

2- Atrial **Relax** , Ventricles will be **Contract**

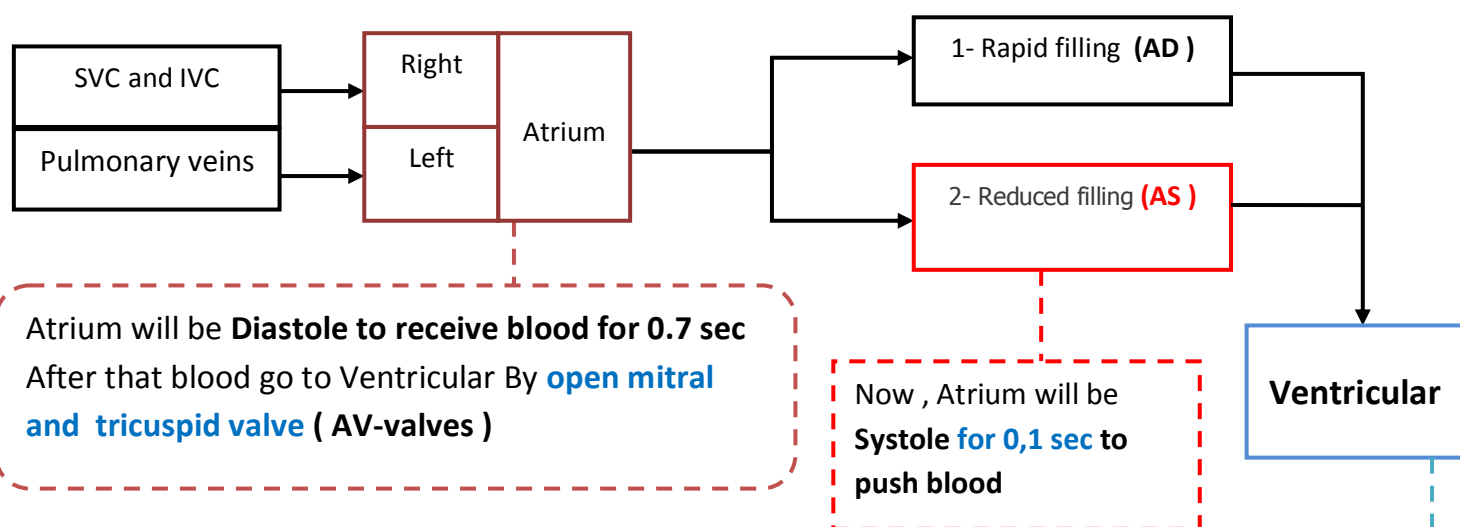
3- Atrial and ventricles **Relax**

■ **Atrial & Ventricular Systole (Contract) NEVER overlap**

## Atrial Cycle :



AS – Atrial Systole; AD – Atrial Diastole



All blood from atrium has come to Ventricular So ,  
Intraventricular pressure will be **higher** than atrium , that it will cause **closing AV- valves** and will be produce **1<sup>st</sup> heart sound**

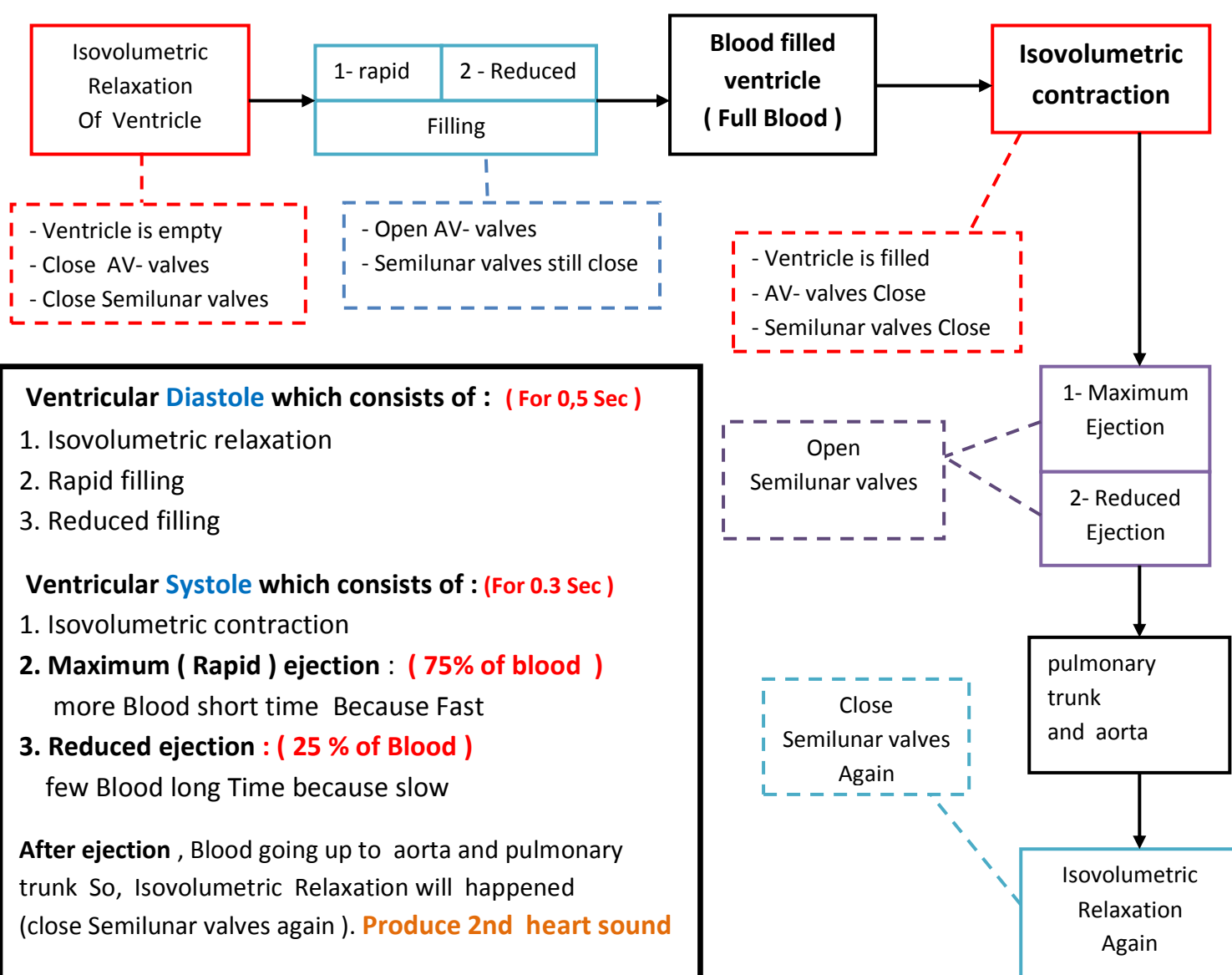
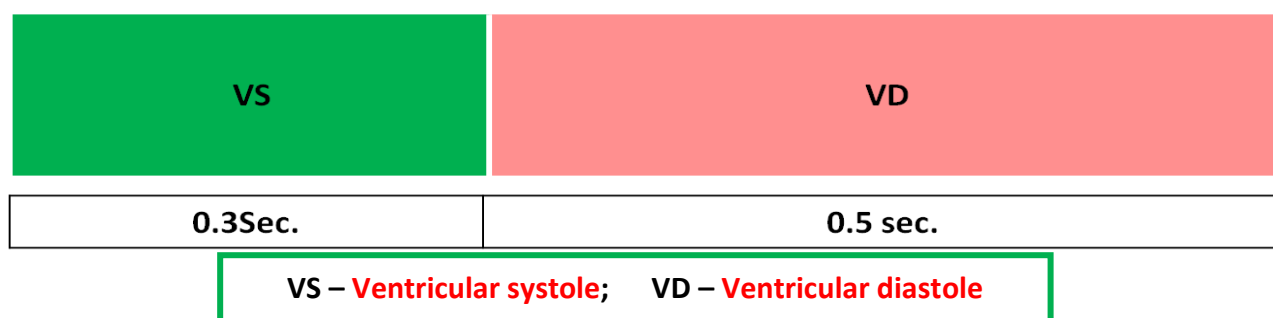
**The Blood passes through mitral and tricuspid valve from atrium to Ventricular by two ways :**

- 1- **Rapid filling** : By graphite ( **70 % of blood** )
- 2- After that **Reduced filling** : By contract of atrium ( **30 % of blood** )

**Extra note :**

**Between two ways** : small amount of blood normally **passing through the atrium** from veins **directly** into the ventricular)

## Ventricular Cycle :



### Ventricular Diastole which consists of : ( For 0,5 Sec )

1. Isovolumetric relaxation
2. Rapid filling
3. Reduced filling

### Ventricular Systole which consists of : (For 0.3 Sec )

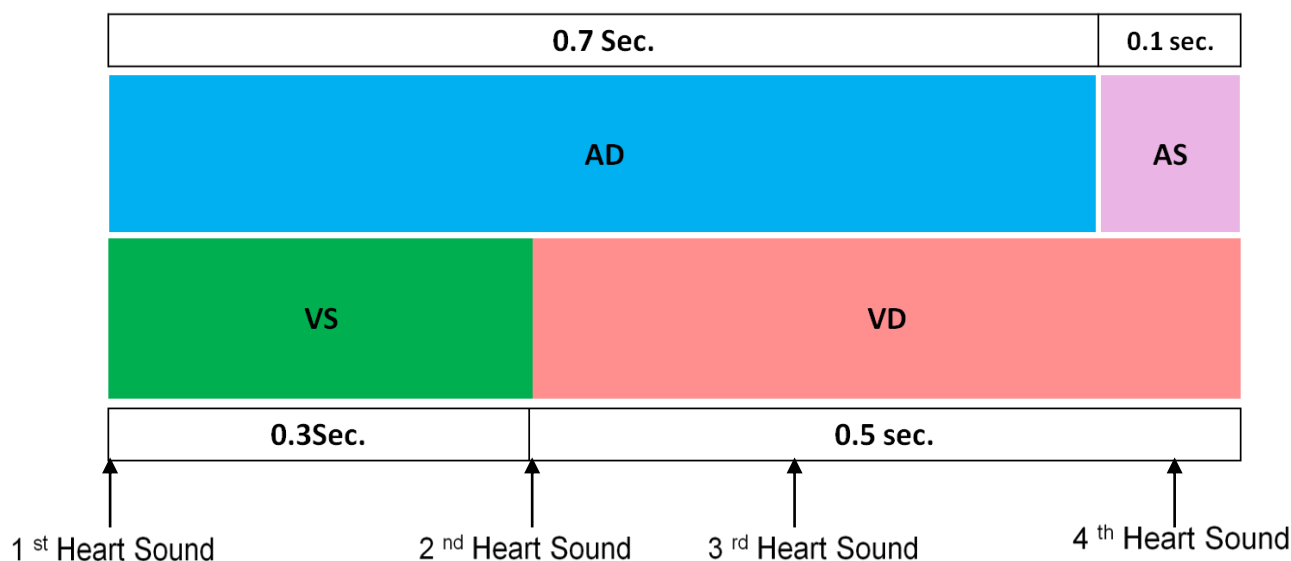
1. Isovolumetric contraction
2. **Maximum ( Rapid ) ejection : ( 75% of blood )**  
more Blood short time Because Fast
3. **Reduced ejection : ( 25 % of Blood )**  
few Blood long Time because slow

**After ejection** , Blood going up to aorta and pulmonary trunk So, Isovolumetric Relaxation will happened (close Semilunar valves again ). **Produce 2nd heart sound**

**Close cavity** : when **All valves Close** in ventricular ( That Happen during Isovolumetric Relaxation and contraction )

Isovolumetric = isometric  
**Isometric** : No Change in length  
**Isotonic** : shorten

## Heart sound



**1<sup>st</sup> heart sound** : start of the VS , Caused By close A-V valves

**2<sup>nd</sup> heart sound** : start of the VD , Caused By close Semilunar valves

**3<sup>rd</sup> heart sound** : At Rapid filling phase , Caused By passage of blood through the narrow place ( A-V valves )

**4<sup>th</sup> heart sound** : ( Atrial heart sound ) At Reduced filling Phase , Caused By contraction of atrium

## Volumes :

### 1- End-diastolic volume (EDV) :

Volume of blood in ventricle at end of diastole

**EDV = 120 ml**

### 2- End-systolic volume (ESV) :

Amount of blood left in each ventricle at end of systole

**ESV = 50 ml**

### 3- Stroke volume (SV) :

Amount of blood ejected from each ventricle during systole

**SV = EDV - ESV = 120 - 50 = 70 ml/beat**

## This table summarizes all phases

The phase	Pressure change	Volume changes	valves	Heart sounds	Atrial pressure curve (waves)	ECG
<b>1-Atrial systol</b>	The pressure in the atrium slightly increase.  *The pressure in the aorta is more than the pressure in the ventricle	when atria contract ,, it fills the ventricle with 27 -30% with blood	The A-V valve is open  The Aortic valve is closed	S4 sound Due to excessive contraction of atrium when the ventricle is hypertrophic	"A" wave  Due to increase in the atrial pressure	"P" wave Due to atrial depolarization
<b>2-Isovolumetric Contraction</b>	Pressure increases rapidly and becomes higher than atrium  It reaches 80 mmHg by the end of this phase	No volume change  (that's because the ventricle is contracting as a closed chamber )	A-V valve closed  Aortic valve also closed	1 <sup>st</sup> heart sound due to closure of the A-v valve	"c" wave <u>Ascending limb</u>  Produced due to little bulge in the A-v valve by blood from the ventricle	"QRS"  Due to ventricular depolarization
<b>3- Rapid ejection phase</b>	When the pressure reaches 81 ,, the ventricular pressure becomes more than the aortic pressure	Ventricular volume decreases rapidly	The A-V valve is closed  Semilunar valve is opened	No Sound	Descending limb of "c" wave  Due to pulling down of Av cusp & ventricular contraction	No deflection
<b>4-Reduced ejection phase</b>	Ventricular pressure starts falling but is still higher than aortic pressure	Ventricular volume decreases slowly	Av- valve is closed  Semilunar valve is opened	No sound	No wave	T- wave
<b>5-Isovolumetric relaxation phase</b>	The pressure in the ventricle rapidly falls	Volume in the ventricle is the same which is ESV	Both valves are closed	S2 sound  Due to closure of semilunar valve	"V" wave is recorded Due to back flow of blood coming from the lung "venous return " that hits the closed Av- valve	No deflection

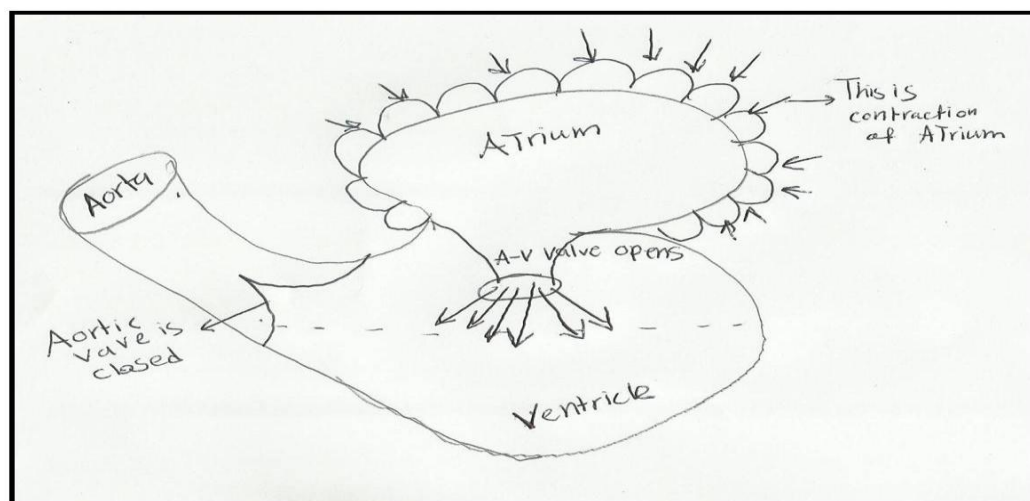
<b>Rapid filling Phase :</b>	The atrial pressure is higher than the ventricular pressure	Ventricular volume increases rapidly	The Av- valve is opened  The semilunar valve is closed	S3 heart sound due to Rapid passive ventricular filling (usually during exercise due to high level of venous return blood in the peripheral tissues )	"V" wave  Down descending of AV valve	No deflection
<b>Reduced filling phase (Diastasis)</b>	Ventricular pressure decreases reaching zero	Ventricular volume increases slowly (remaining atrial blood flows slowly into ventricles )	AV- valve still open  Semilunar valve still closed	No heart sound	No wave	No deflection

**:: توضيح ::**

- الصفحة الثانية والثالثة :: شرح شامل بشكل مبسط على طريقة شرح الدكتور أشرف
- الجدول :: أيضا شامل للخطوات بطريقة مرتبة ، ويبين ما يحدث من تغيرات في كل مرحلة ( مثلا التغير في الـ ECG عند Reduced ejection phase )
- الصفحات القادمة : شرح واضح ومفصل وبطريقة مرتبة ومتسلسلة ( يعني إذا ما فهمت من فوق بتفهم منها ) وإذا كنت فاهم راح تستمتع ( ^ \_ ^ )
- نقطة أخيرة : راح تشوف أسماء ما شرحناها قبل مثل ( a wave ) هذي راح نأخذها في الجزء الثاني من المحاضرة فلا تخاف ☺

The following points are **just explanation to make you understand more :**

## Phase 1:



### 1- Atrial systole :

(in this phase there will be communication between the atrium and the ventricle , but there will be no communication between the ventricle and the aorta )

(in this phase , the AV -valve is opened while the semilunar valve is closed )

### Events :

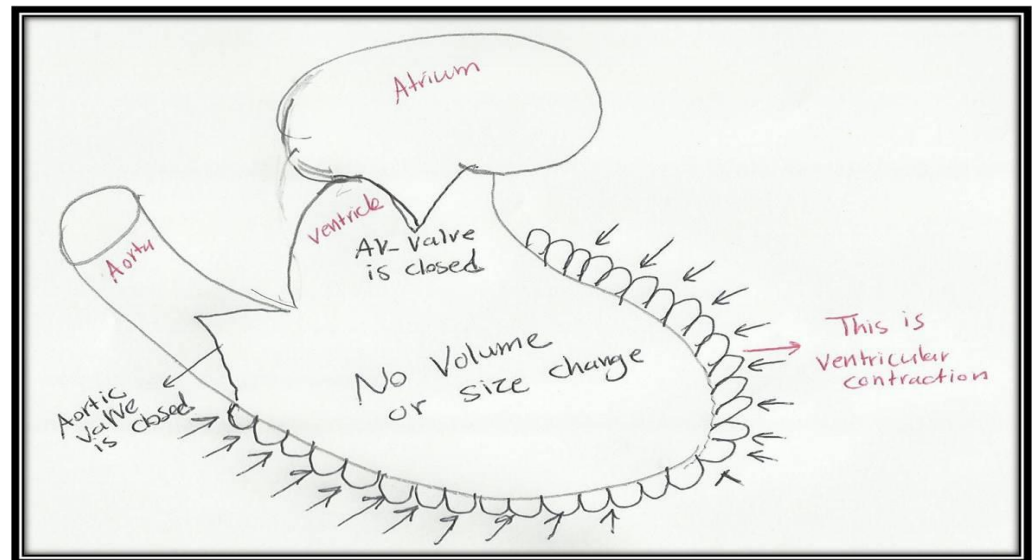
- 1) before the atrium start contracting , the ventricle is already filled with 80% blood "Passive filled" , So when the atrium contract is just adding the last 20%
- 2) When the atrium contract , the pressure in it slightly increases (which produce A wave )
- 3) The AV- valve is opened causing movement of blood into the ventricle
- 4) The Aortic valve (semilunar ) is closed ,because the pressure in the aorta is more than the pressure in the ventricle .
- 5) S4 sound maybe produced in this phase

**Explanation :** In some people with hypertrophic ventricle , the atrium must contract stronger to push the blood ,, and this pushing of blood may cause this sound

**Note that :** when we hear this sound , it indicates a pathological condition



## Phase 2:



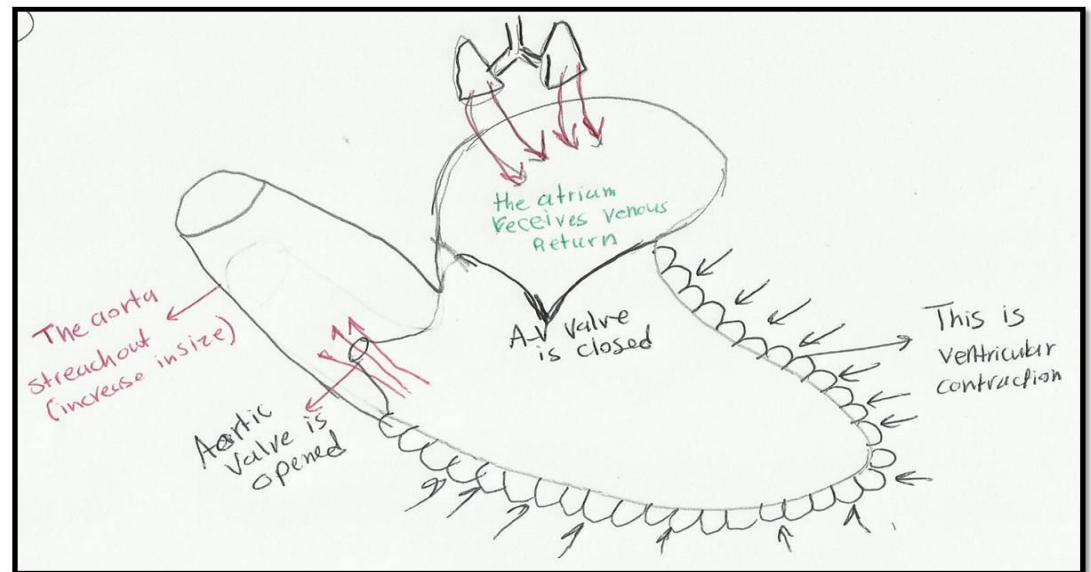
### 2- Isovolumetric ventricular contraction :

- 1) At the very beginning of ventricular contraction , the pressure is building up inside the ventricle , so it increases and it becomes slightly higher than the atrial (it reaches 5 mmHg)
- 2) As a result , the blood will try to go back to the atrium , but the AV- valve will be closed
- 3) the closure of the AV- valve **produces the 1<sup>st</sup> heart sound**
- 4) the ventricle is contracting as a closed chamber (until pressure reaches 80 mmHg)
- 5) the volume of blood inside the ventricle is the same during this phase (No blood is leaving the ventricle , and no blood is entering it )

Note that :

- The back pressure from ventricular contraction causes a little bulge in the AV- valve and this will cause a pressure wave **called "c" wave**
- In this phase the atrium is working as a tank , it receives blood from the lung "venous return"

## Phase 3:

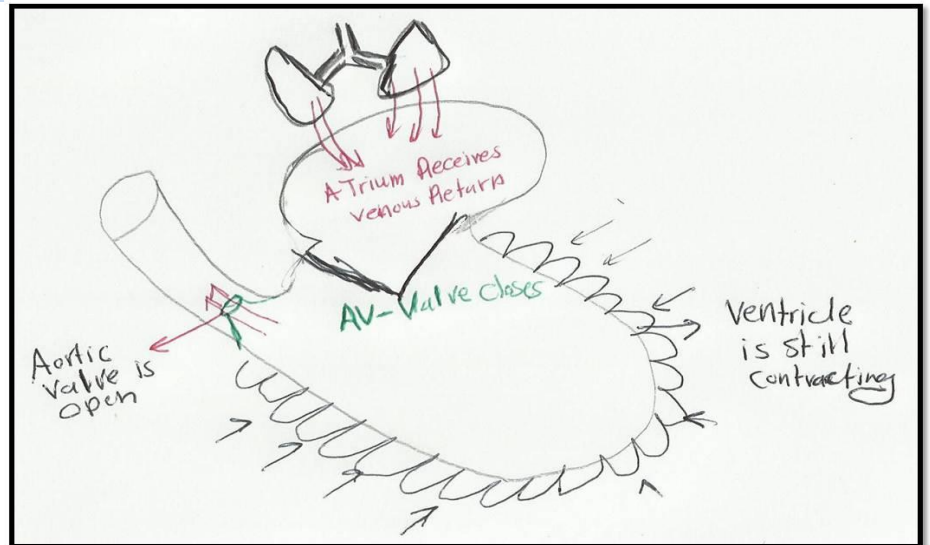


### 3- Rapid ventricular ejection phase :

- 1) Ventricular pressure reaches 81 , So the ventricular pressure becomes more than the aortic pressure , this will lead to the opening of the Aortic valve "semilunar valve "
- 2) blood start ejected rapidly from the ventricle to the aorta
- 3) the aorta is elastic -so it stretches out- to accumulate more volume
- 4) the ventricle keeps contracting and the pressure may reach the peak of 120
- 5) As the aortic valve is opened , the ventricle and the aorta are working as a single chamber ( so the pressure in aorta reaches 120 )
- 6) The atrium still working as a tank receiving blood from the lung

**Note that :** the pressure in the ventricle is higher in the atrium

## Phase 4:



### 4- Reduced ventricular ejection phase :

- 1) the pressure in the ventricle start falling , so the ejection become slow , but the ventricle is still contracting .
- 2) The atrium still working as a tank , receiving venous return blood
- 3) ventricular pressure still more than the aortic pressure
- 4) The pressure in the aorta also fall
- 5) the aorta keeps squeezing blood , so ejection continues but slowly

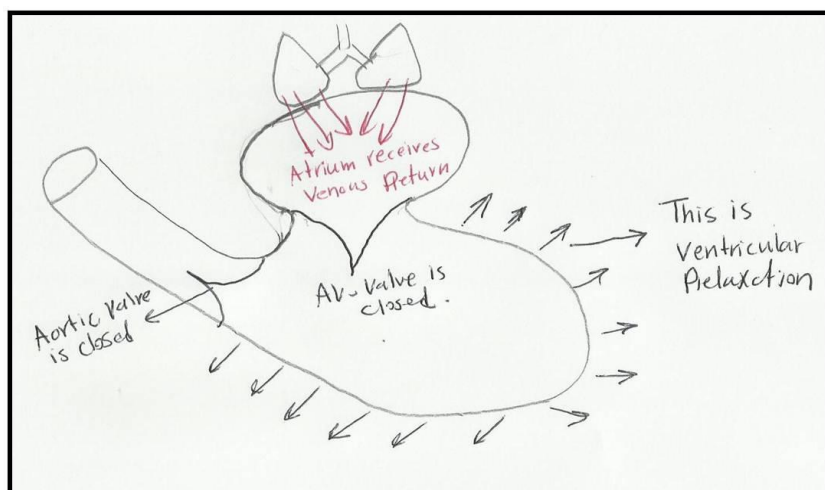
### Note that :

During this phase the aortic(semilunar ) valve is opened , and the Av- valve is closed

- There is no heart sound here .

**At the end of this phase,** the aortic valve will close(because the pressure in the aorta becomes higher than pressure in the ventricle )

## Phase 5 :

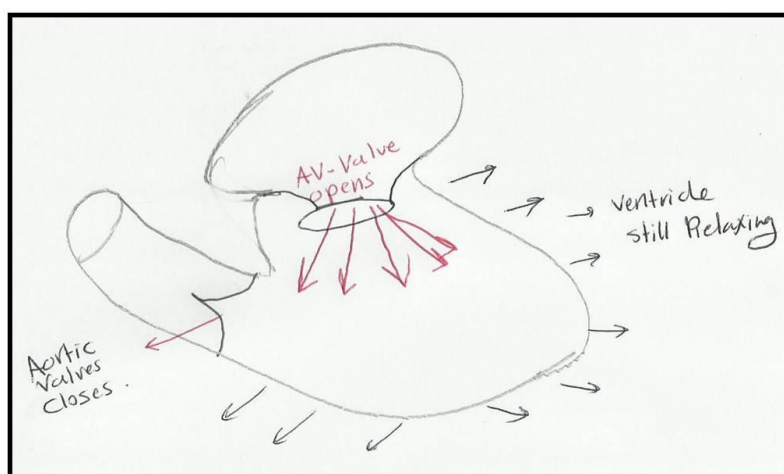


### 5- Isovolumetric relaxation phase :

- 1) the ventricle start relaxing , its pressure rapidly fall
- 2) Both valves are closed
- 3) the atrium continues to work as a tank , receiving blood from the lung

**Note that :** 2<sup>nd</sup> heart sound

## Phase 6:

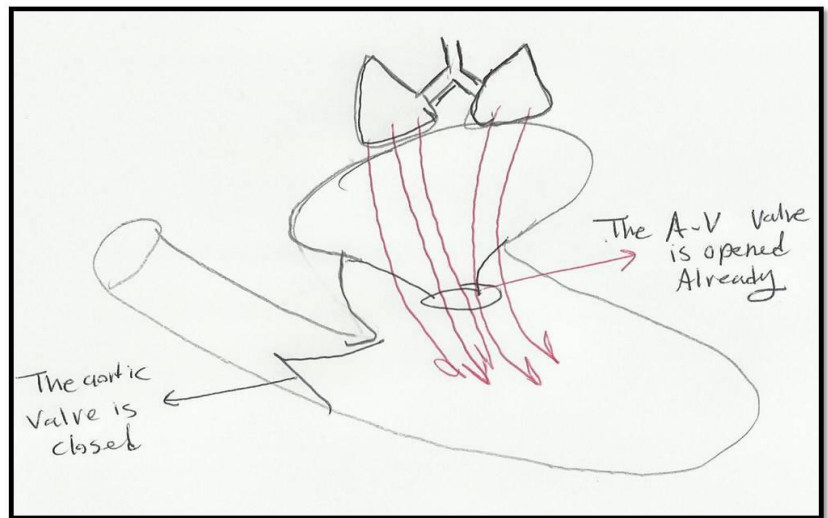


### 6- Rapid passive ventricular filling phase

The ventricle continues relaxing , when its pressure become less than the atrial pressure m the AV- valve will open

- 2) the blood which was accumulating inside the atrium , will rapidly fall into ventricle
- 3) In this phase , "S3" sound maybe produced due to rapid passive ventricular filling

## Phase 7 :



### 7) Slow passive ventricular filling :

The blood "venous return" that comes to the lung, passes directly to the ventricle because the Av- valve is opened already

So the atrium here is working as a passage or as a pipe

**Note that:** the aortic valve is closed

# Good Luck

