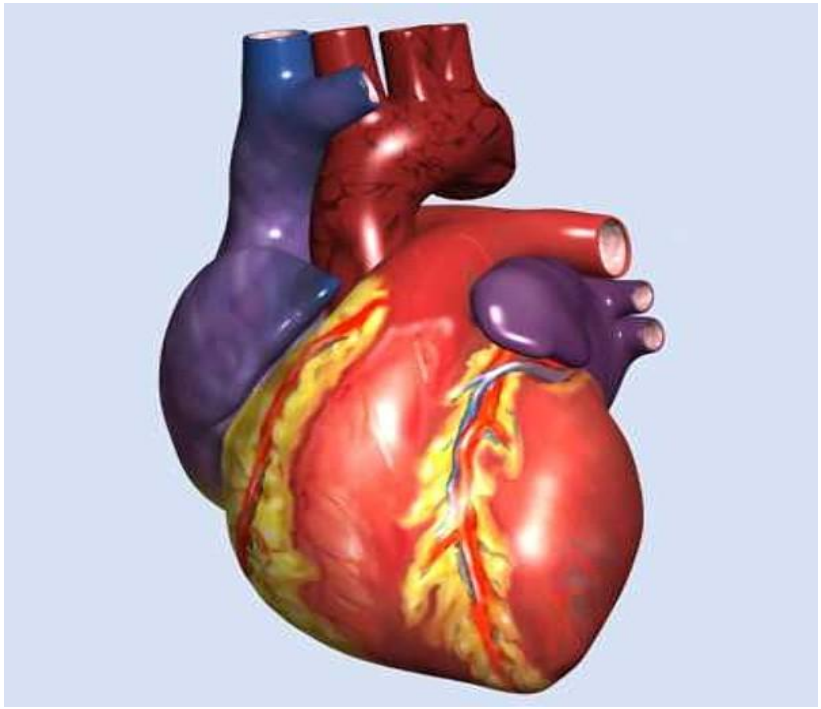
PHYSIOLOGY OF CARDIOVASCULAR SYSTEM



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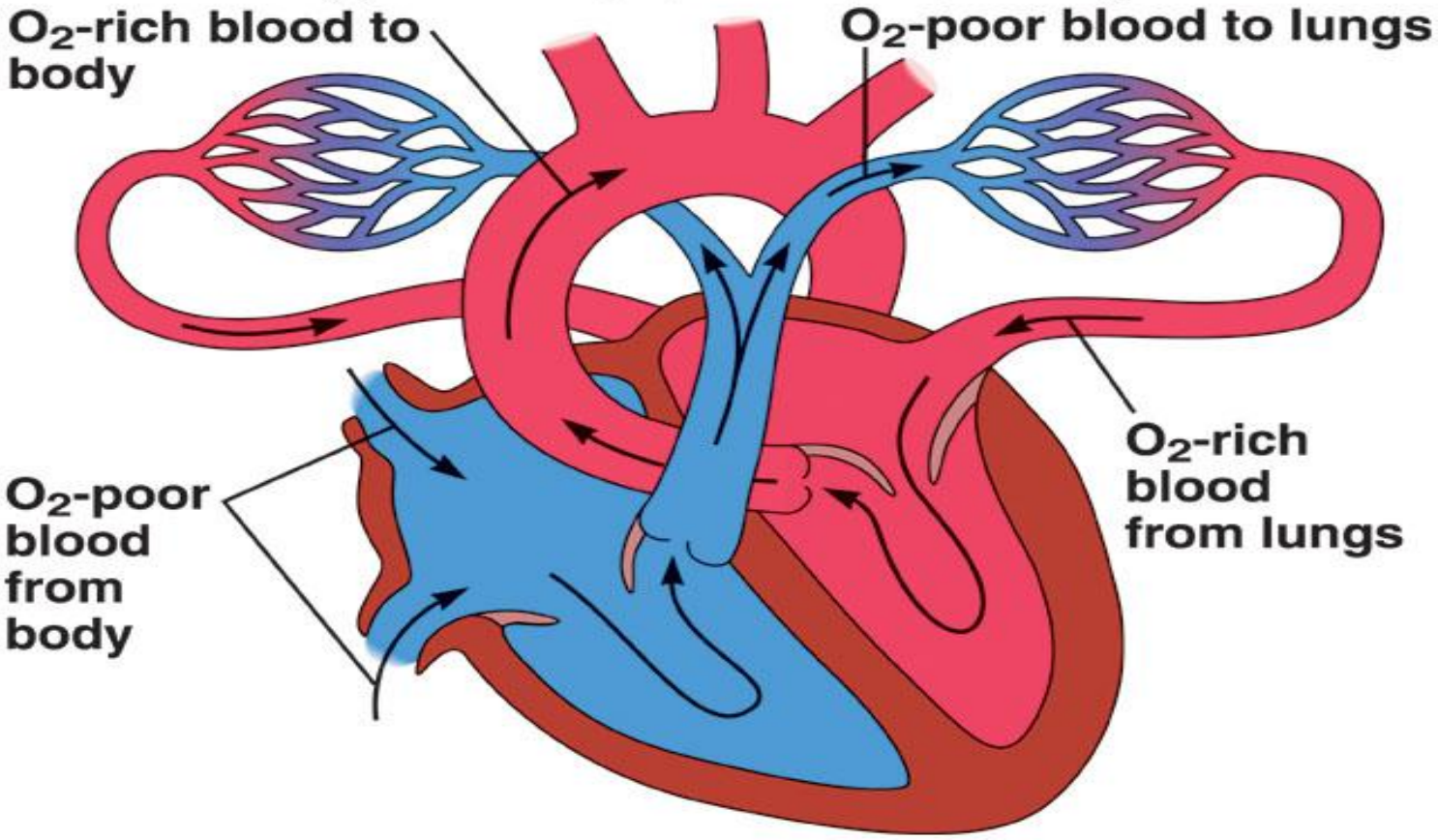
18/01/2018



CARDIAC CYCLE

CARDIAC CYCLE

- **DEFINITION:-**
  - changes occurs in the heart during **each beat** & repeated in same order in next beat called cardiac cycle.

- **TIME :**
  - Normal HR – 75 /60 sec
  - So time for one cycle – 60/75 = **0.8 sec**
  - Time for cardiac cycle is inversely related to HR.

CARDIAC CYCLE

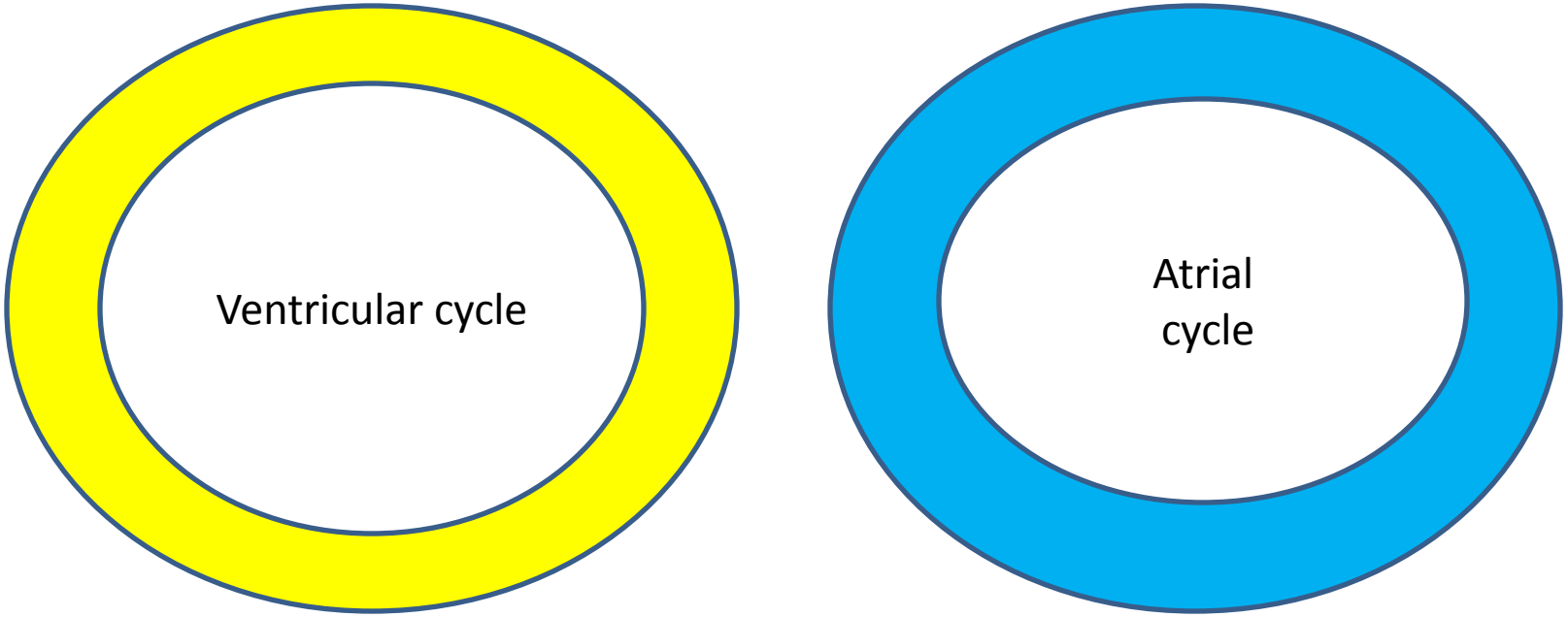
- each cardiac cycle can be consists

- **ATRIAL CYCLE**
  - Atrial systole (contraction): 0.1 sec
  - Atrial diastole (relaxation) : 0.7 sec

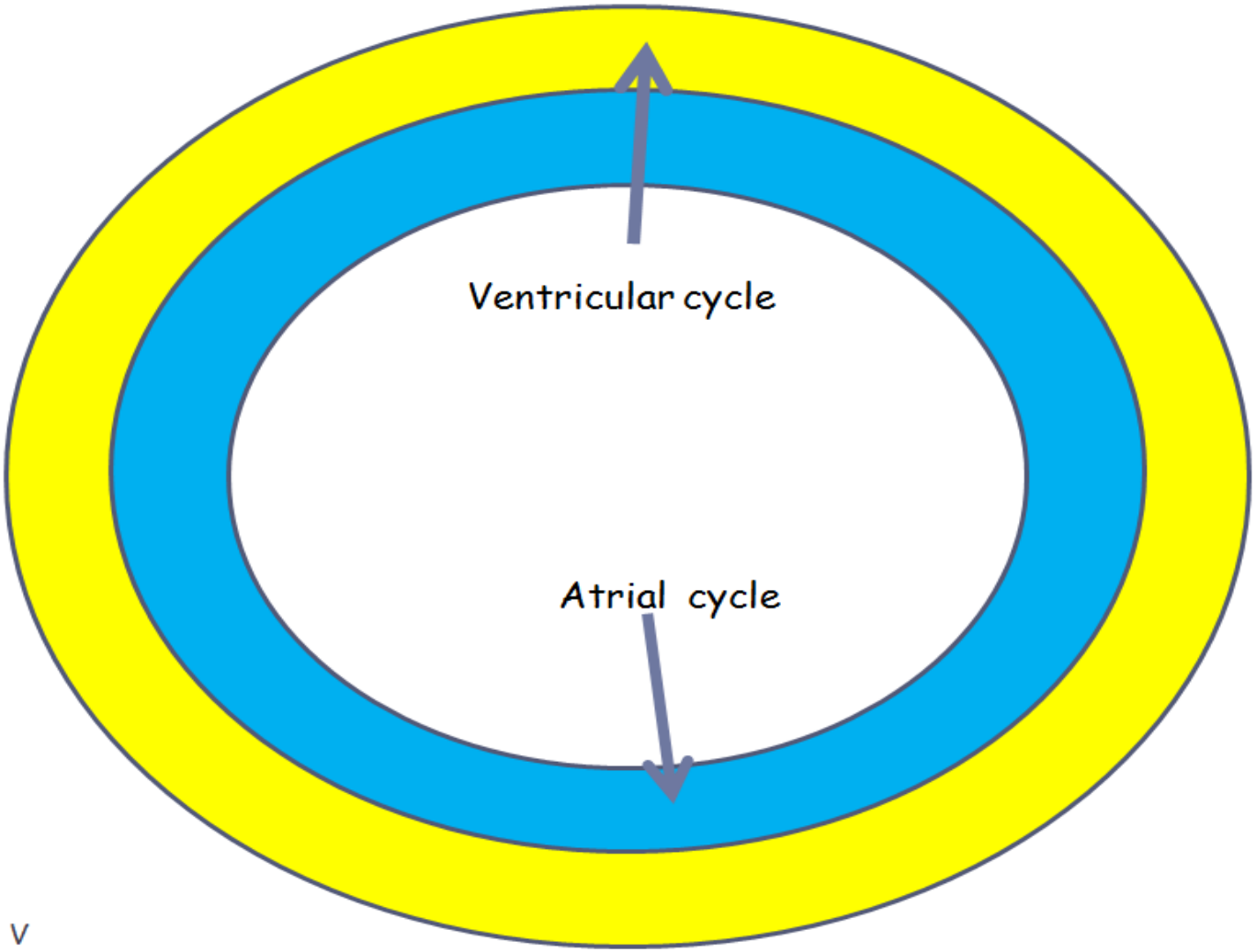
- **VENTRICULAR CYCLE**
  - Ventricular systole : 0.3 sec
  - Ventricular diastole : 0.5 sec

CARDIAC CYCLE

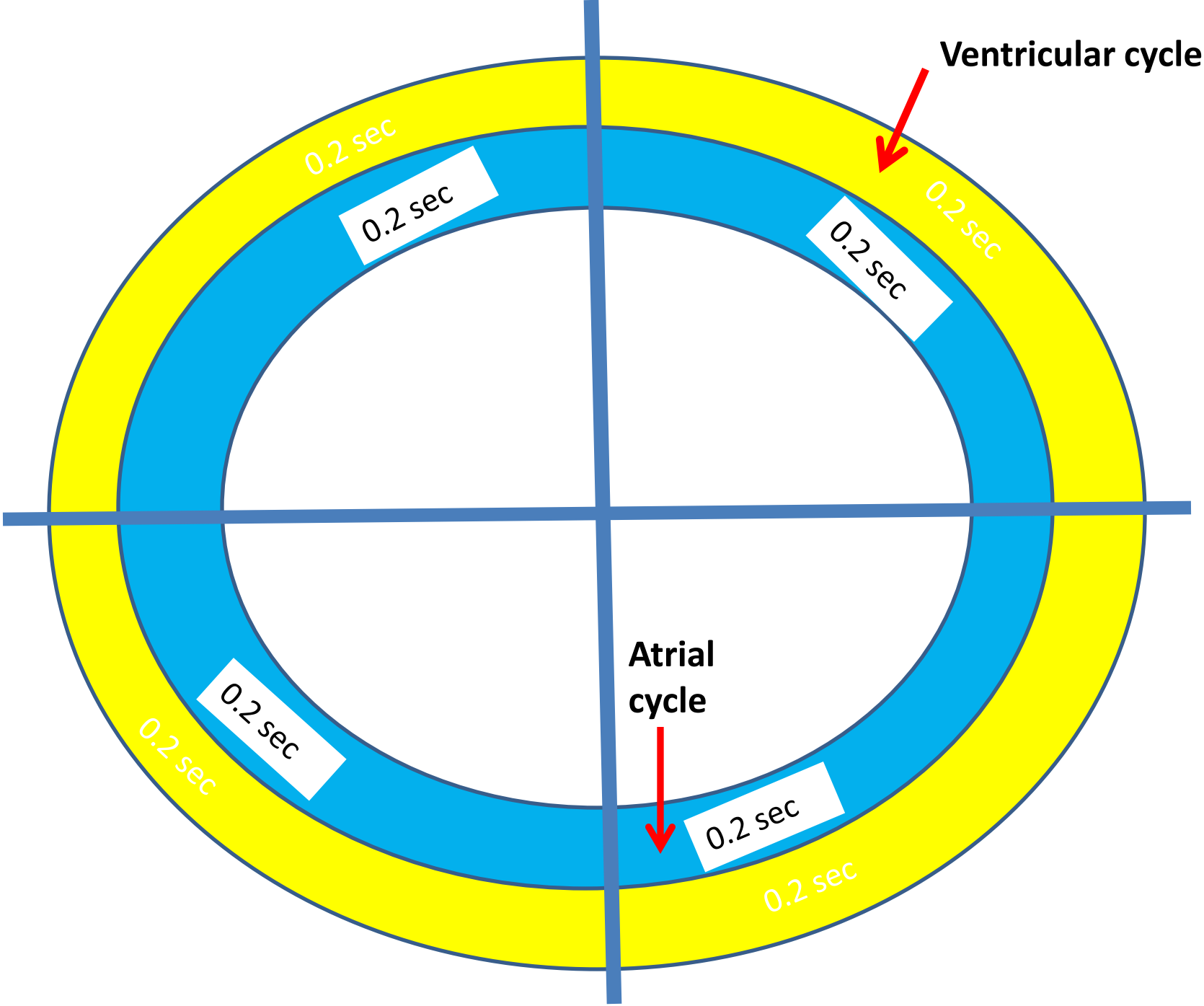
- Figure of bicycle for atrial & ventricular cycle.

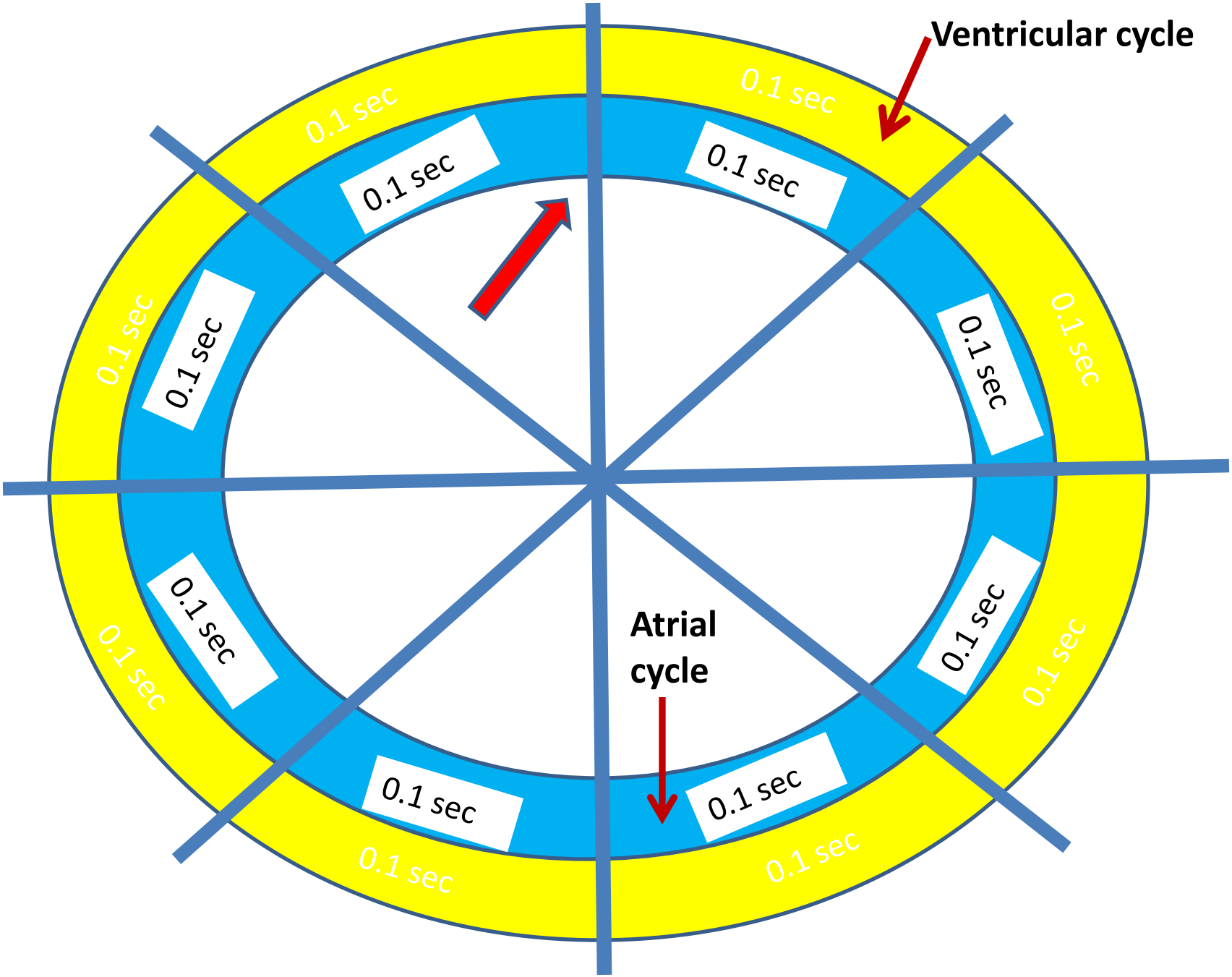


Cardiac cycle :- 0.8 sec



V

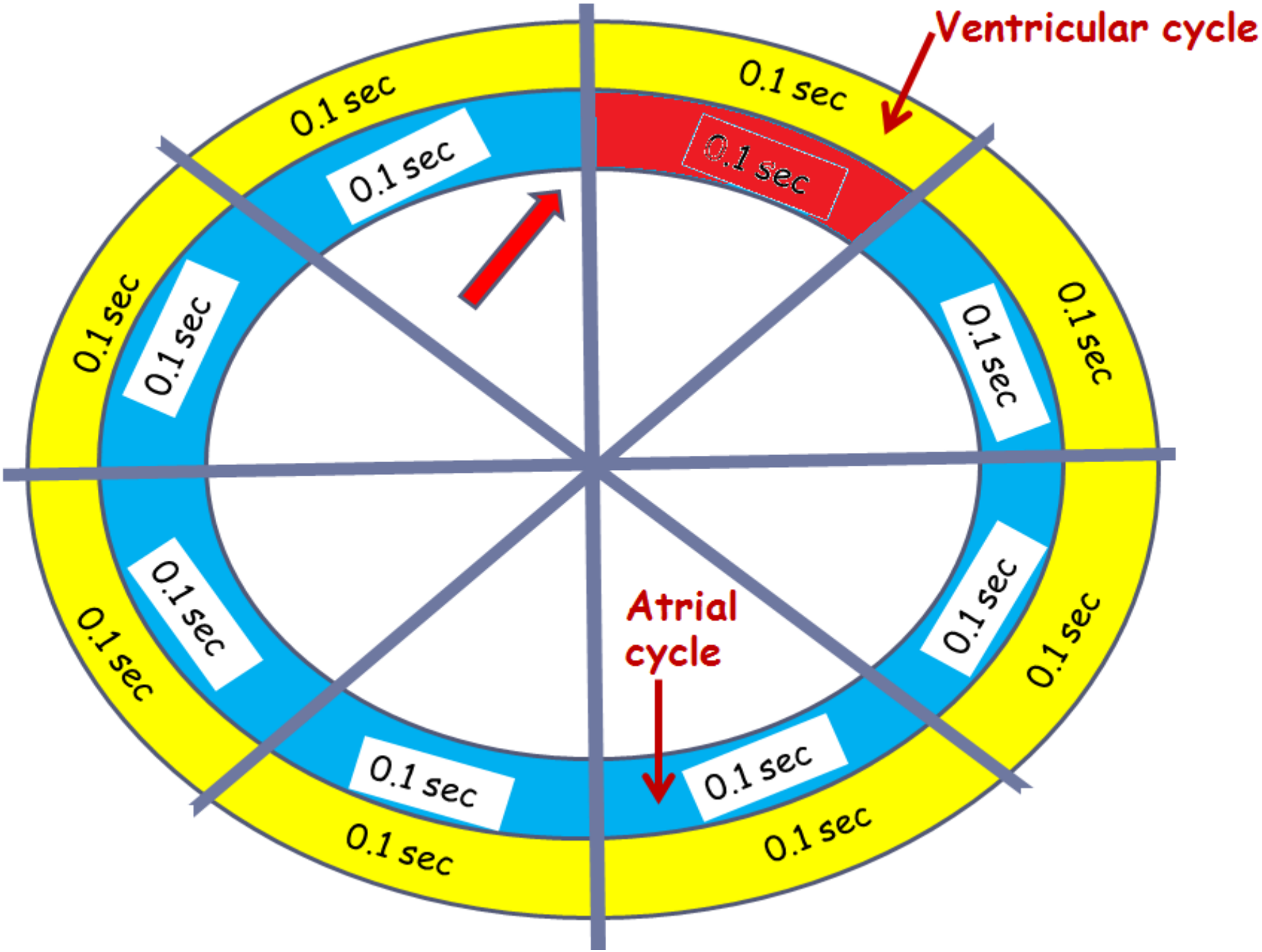

Ventricular cycle
0.2 sec
0.2 sec
0.2 sec
0.2 sec
Atrial cycle
0.2 sec
0.2 sec
0.2 sec
0.2 sec


Ventricular cycle
Atrial cycle
0.1 sec
0.1 sec
0.1 sec
0.1 sec
0.1 sec
0.1 sec
0.1 sec
0.1 sec
0.1 sec
0.1 sec
0.1 sec
0.1 sec
0.1 sec
0.1 sec
0.1 sec
0.1 sec

ATRIAL SYSTOLE

- **Before atrial systole**,
  - AV valve is open & blood flow from great veins to atria and from atria to ventricle. Thus atria & ventricle are forming continuous cavity.

- **When atrial systole begins**,
  - about 75 % of the blood is already flown into ventricles. Thus atrial contractions usually cause an additional 25 % filling of ventricle.

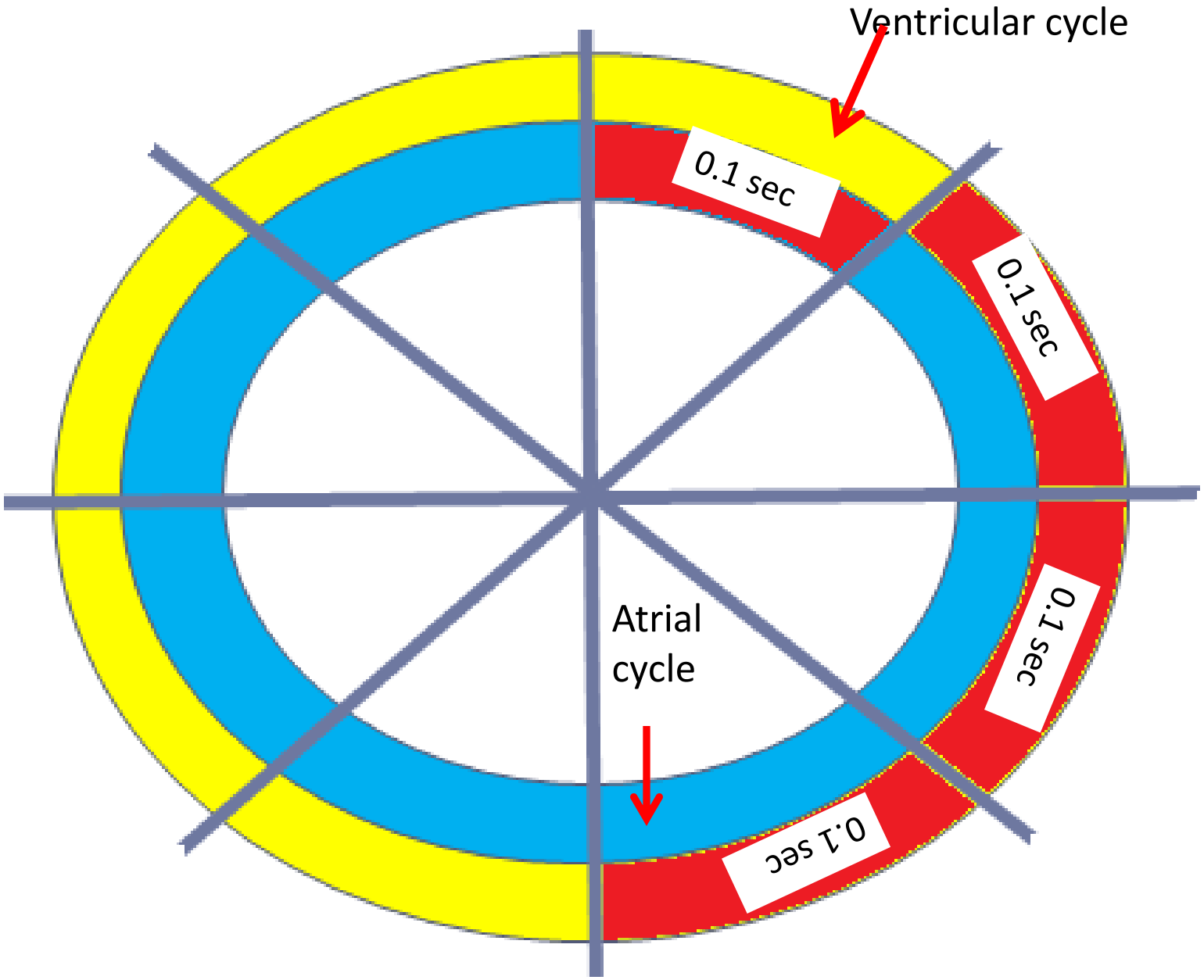

Ventricular cycle
Atrial cycle
0.1 sec
0.1 sec
0.1 sec
0.1 sec
0.1 sec
0.1 sec
0.1 sec
0.1 sec
0.1 sec
0.1 sec
0.1 sec
0.1 sec
0.1 sec
0.1 sec
0.1 sec
0.1 sec

ATRIAL SYSTOLE

- During atrial systole,
- ↑ Intra- atrial pressure
  - **4 – 6 mmHg** in right atrium
  - **7 – 8 mmHg** in left atrium.

ATRIAL DISTOLE

- Atrial muscle relaxes & there is gradual filling of atria due to continuous VR.
- **Duration** : 0.7 sec.


Ventricular cycle
0.1 sec
0.1 sec
0.1 sec
0.1 sec
Atrial
cycle

VENTRICULAR SYSTOLE (CONTRACTION)

- At onset of ventricular systole,

↑ Interventricular pressure

↓

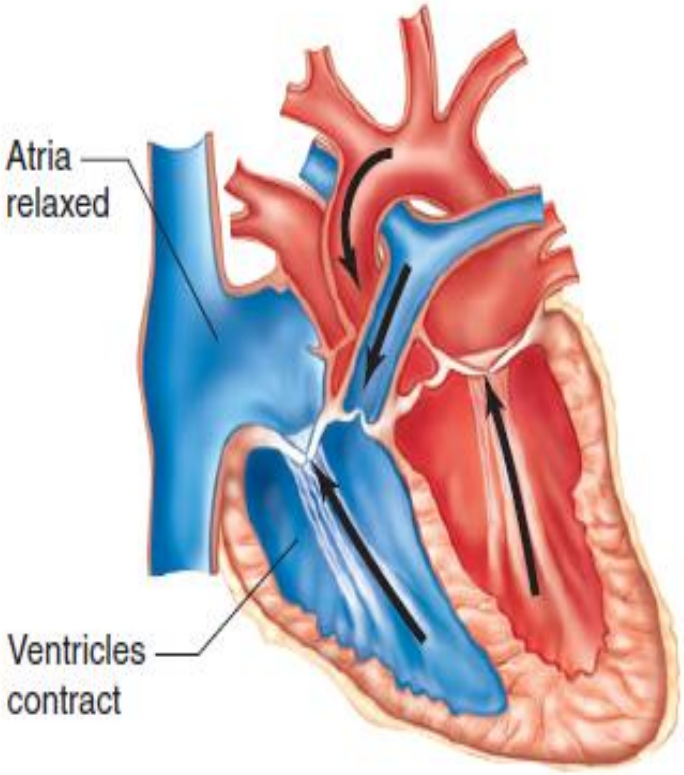
Raise pressure inside ventricle than respective atria

↓

Closure of AV valve & 1st Heart sound heard

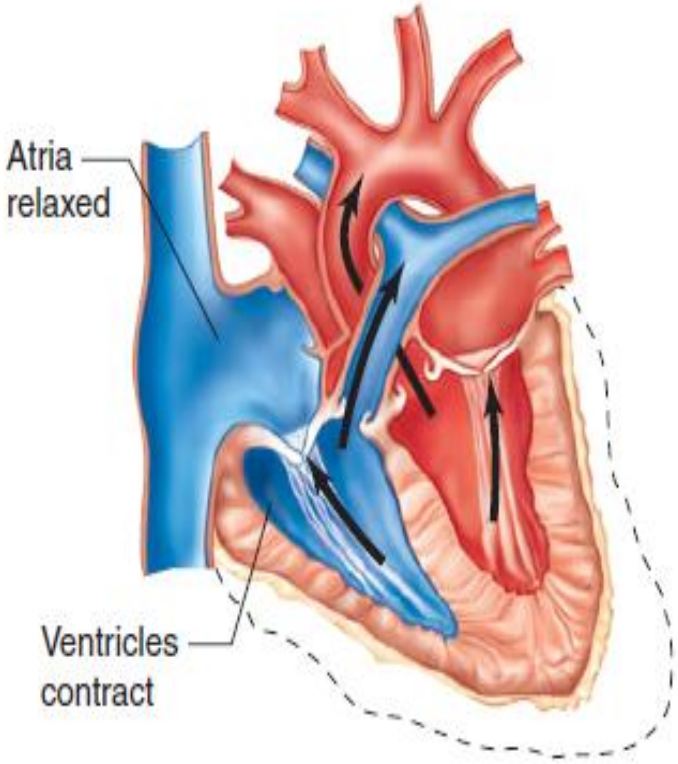
A Systole

Isovolumetric ventricular contraction

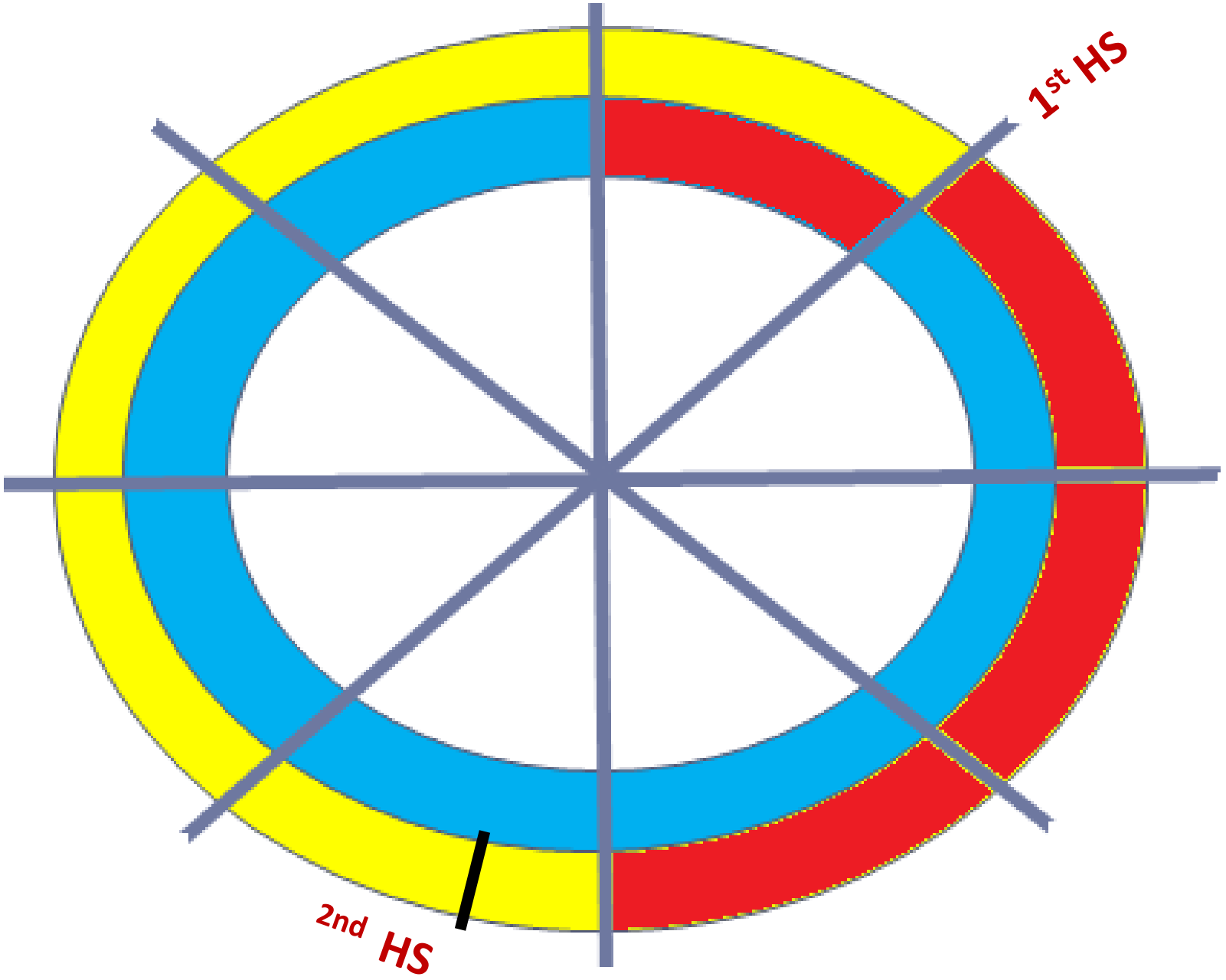


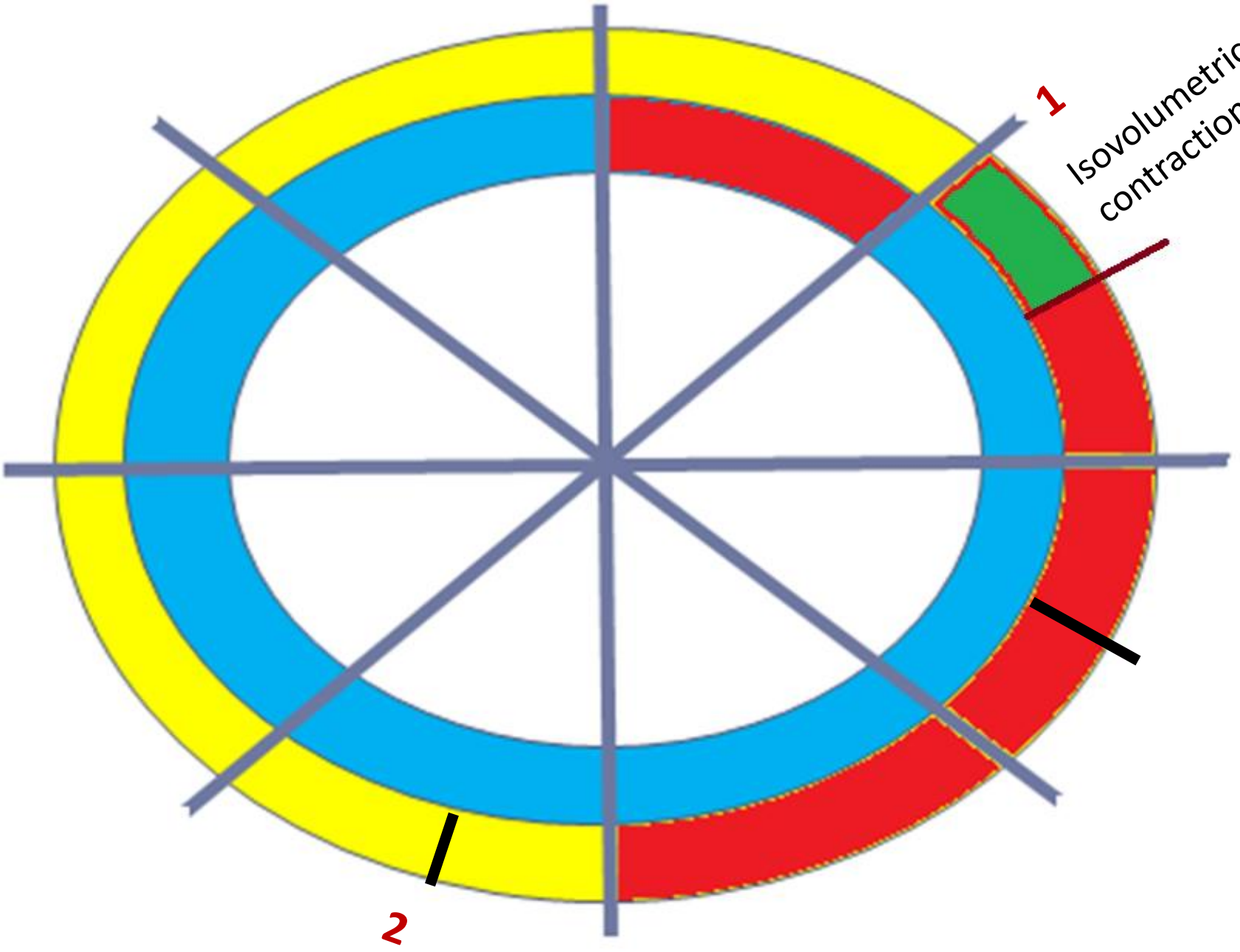
Ventricular ejection

Blood flows out of ventricle



AV valves:	Closed	Closed
Aortic and pulmonary valves:	Closed	Open


1st HS
2nd HS


1
Isovolumetric
contraction
2

VENTRICULAR SYSTOLE

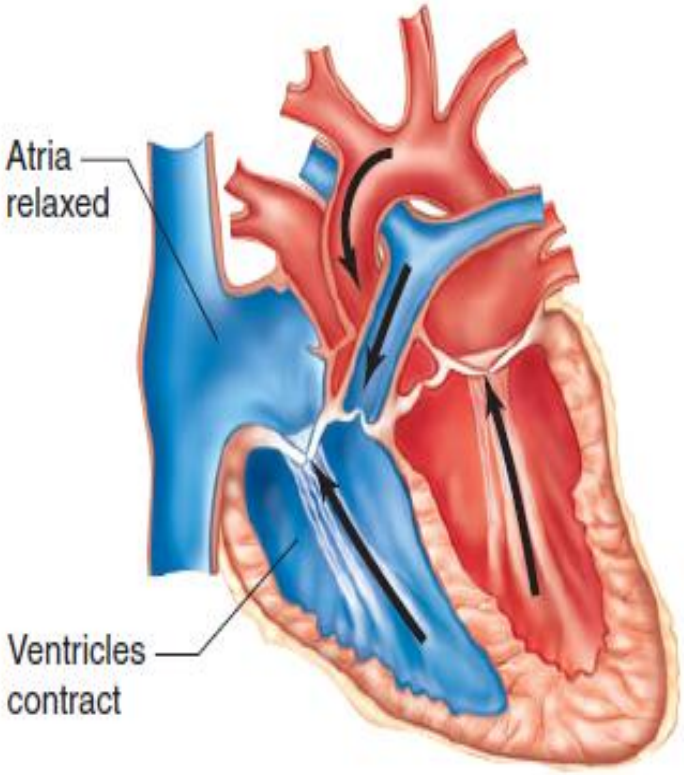
- In the beginning of ventricular contraction,
  - When both valve closed & ventricle contracts but no ejection occurs called ISOMETRIC CONTRACTION PERIOD (0.05 sec).

- At the **end of isometric contraction phase**,
  - When the pressure inside **LV** exceeds the pressure in the aorta (80mmHg) & pressure inside **RV** exceeds the pressure in pulmonary artery (10mmHg).

- Semilunar valve open & ejection is starts.

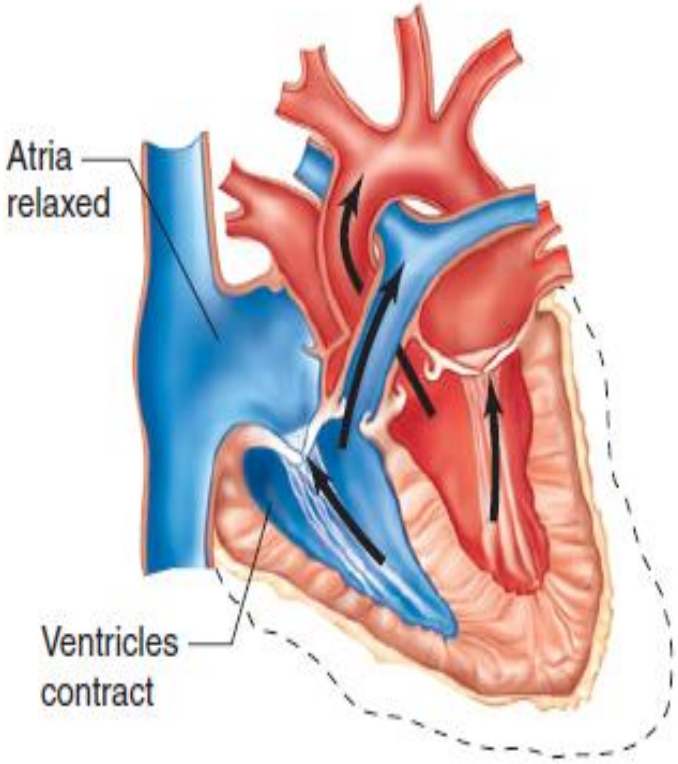
A Systole

Isovolumetric ventricular contraction

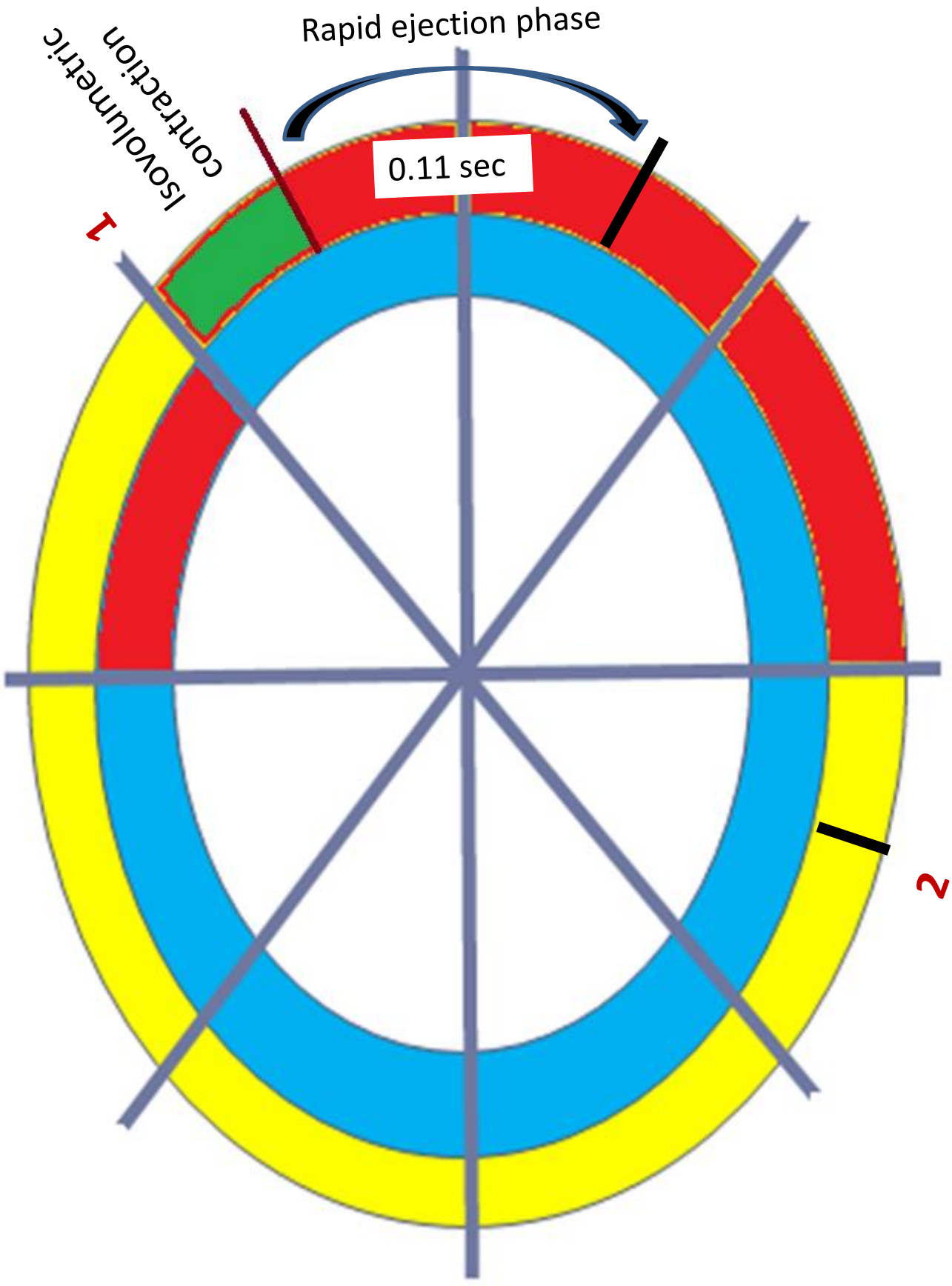


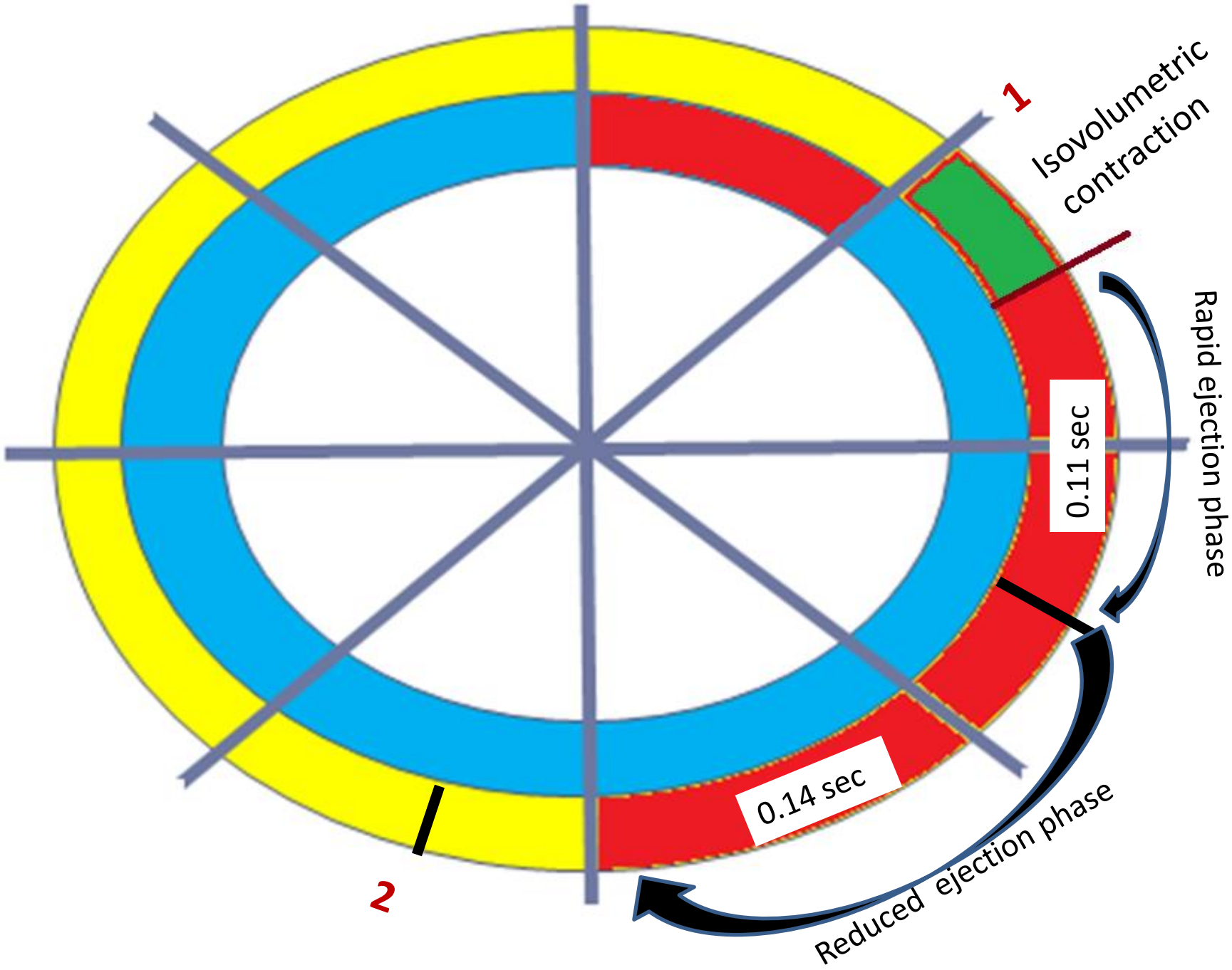
Ventricular ejection

Blood flows out of ventricle



AV valves:	Closed	Closed
Aortic and pulmonary valves:	Closed	Open


Rapid ejection phase
0.11 sec
Isovolumetric contraction
1
2


1
Isovolumetric contraction
Rapid ejection phase
0.11 sec
0.14 sec
Reduced ejection phase
2

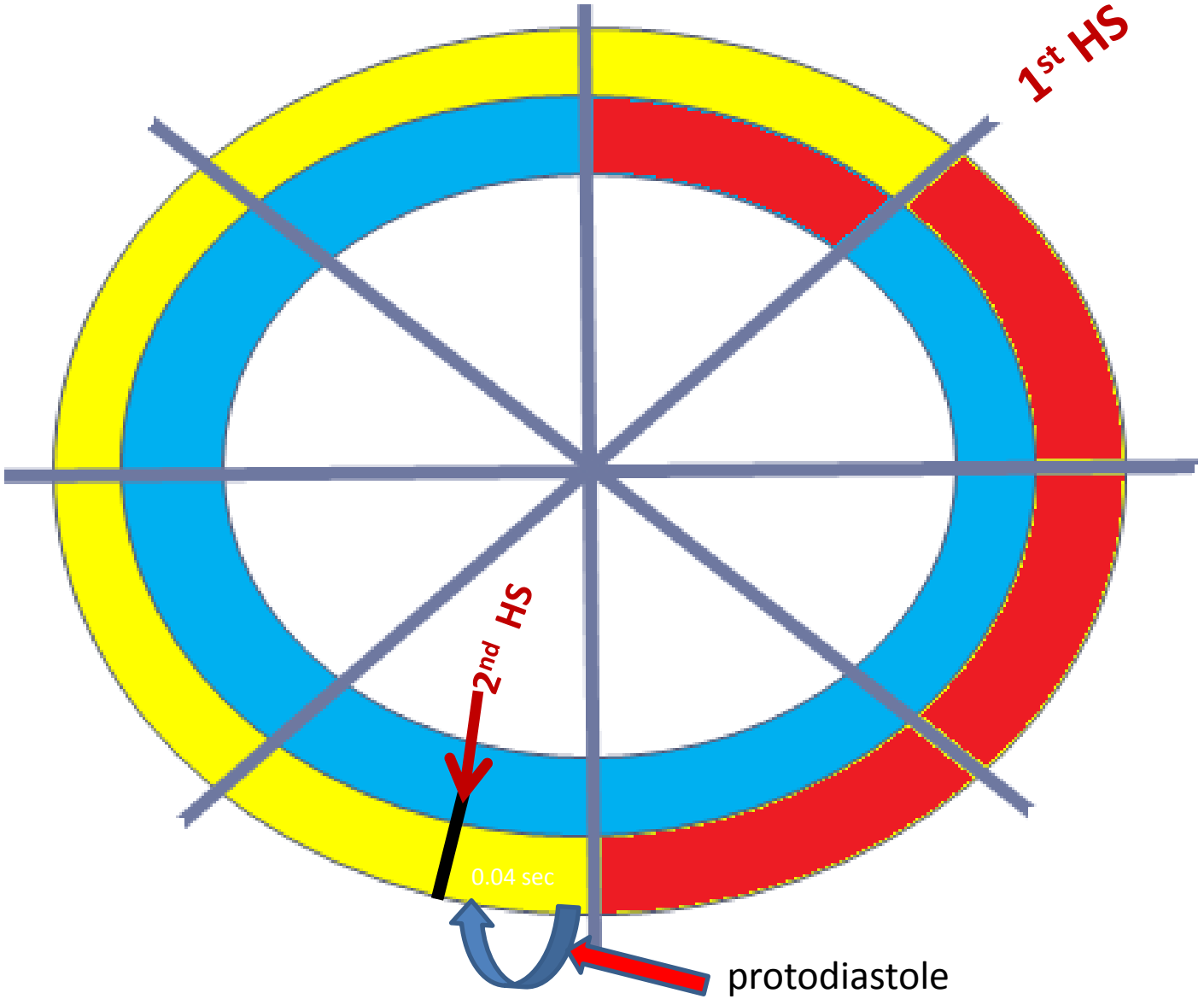
VENTRICULAR SYSTOLE

- Ventricular ejection is divided into 2 phase,

1. **Rapid ejection phase (0.11 sec)**
   - Pressure rise to 120 mmHg in **LV** & 25 mmHg in **RV**.
   - Volume of blood ejected is same in both the ventricle but velocity of RV ejection is less than that of LV.

2. **Slow ejection phase (0.14 sec)**
   - It is a last phase of ejection & refer to latter 2/3 of systole.

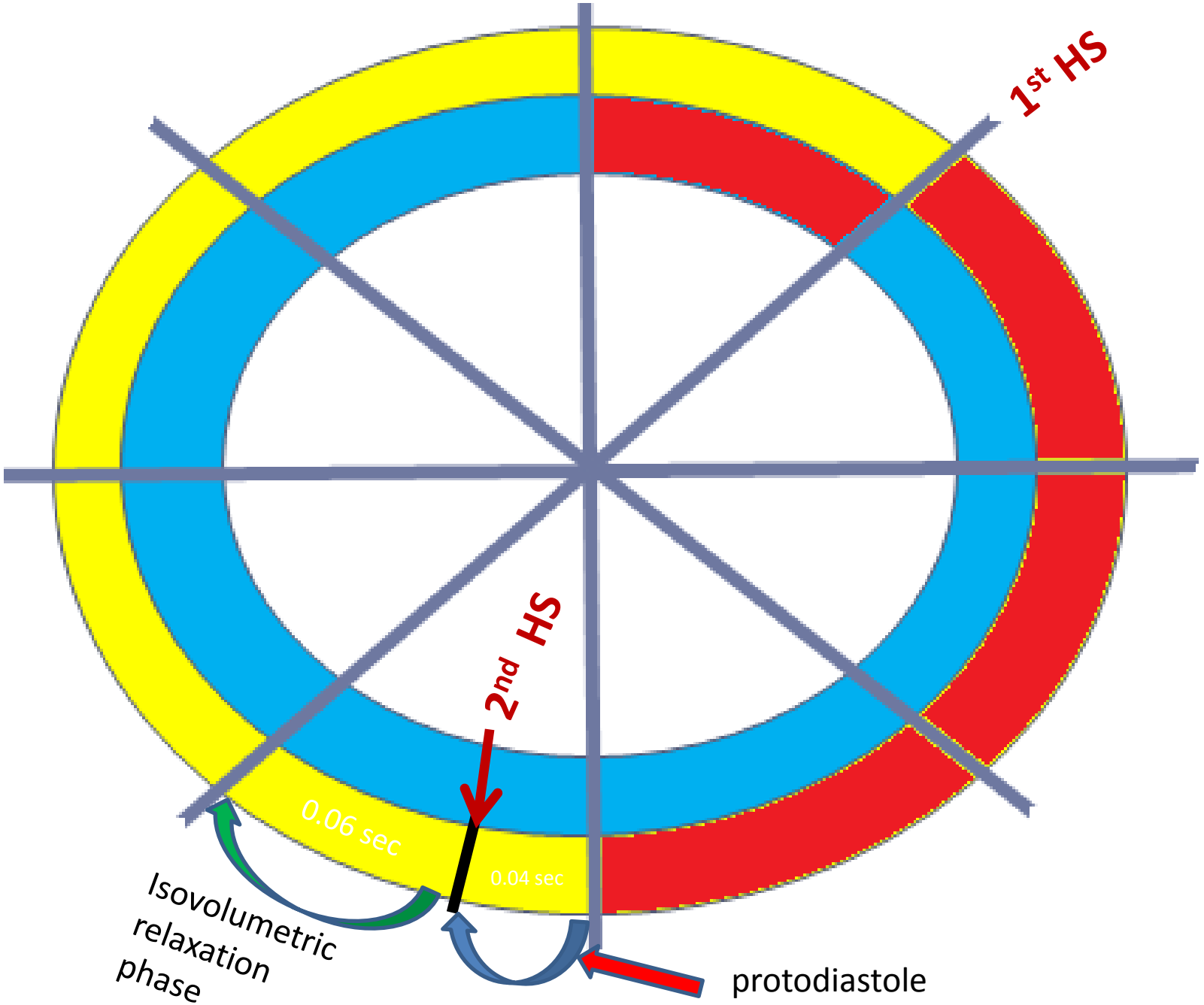
VENTRICULAR DIASTOLE



VENTRICULAR DIASTOLE (0.5 sec)

- **PROTODIASTOLE:**

- Time period between ventricle start relaxing & SL valve closed.


1st HS
2nd HS
0.06 sec
0.04 sec
Isovolumetric relaxation phase
protodiastole

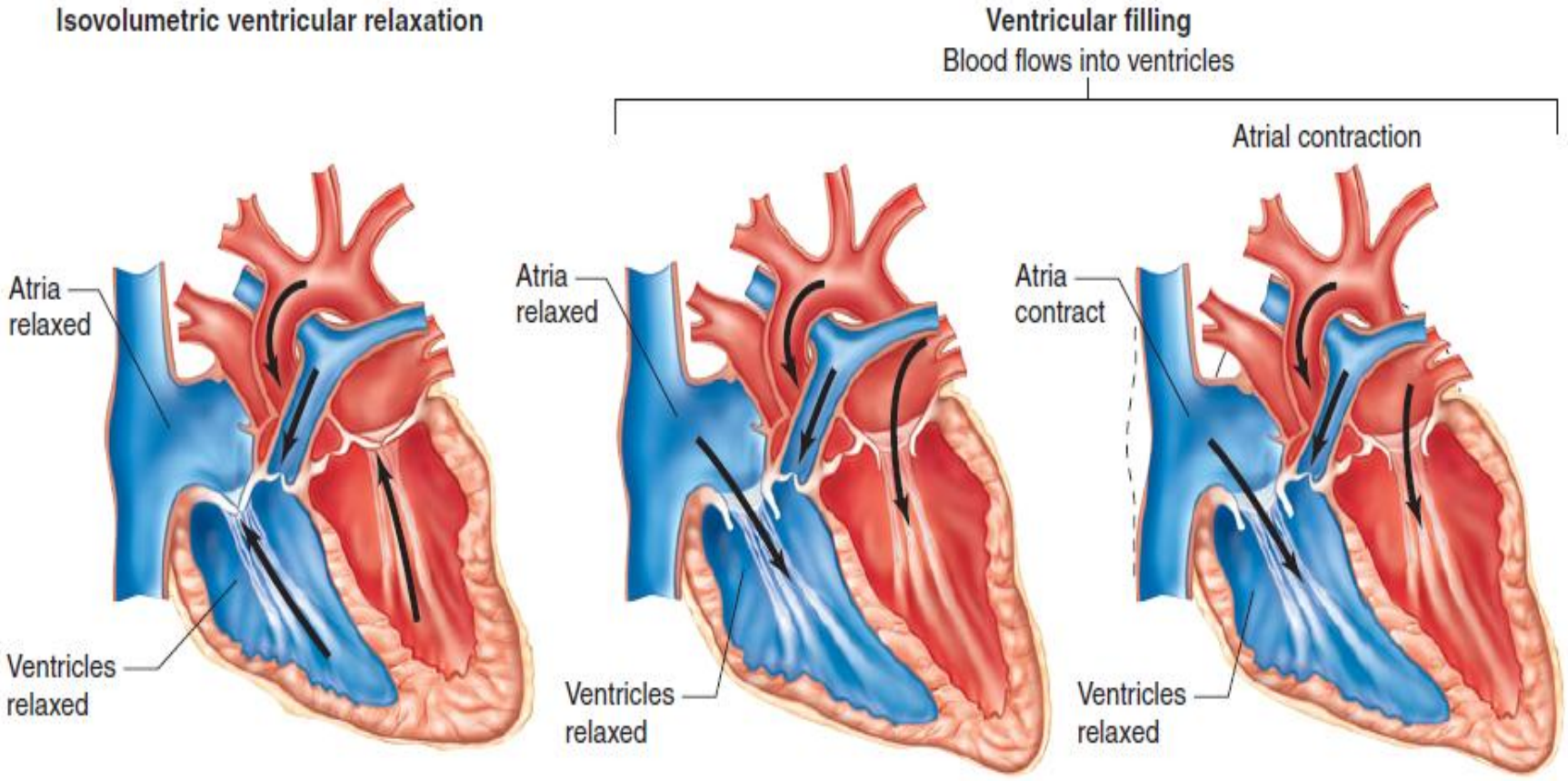
VENTRICULAR DIASTOLE

- **ISOMETRIC RELAXATION PHASE (**0.06 sec**)**
- The ventricles continue to **relax as closed chambers** as semilunar valves are closed and AV valves are not yet open.
- This causes **rapid ↓ of pressure** inside ventricles (from **80mmHg** to about **2 to 3 mmHg** in **LV**)

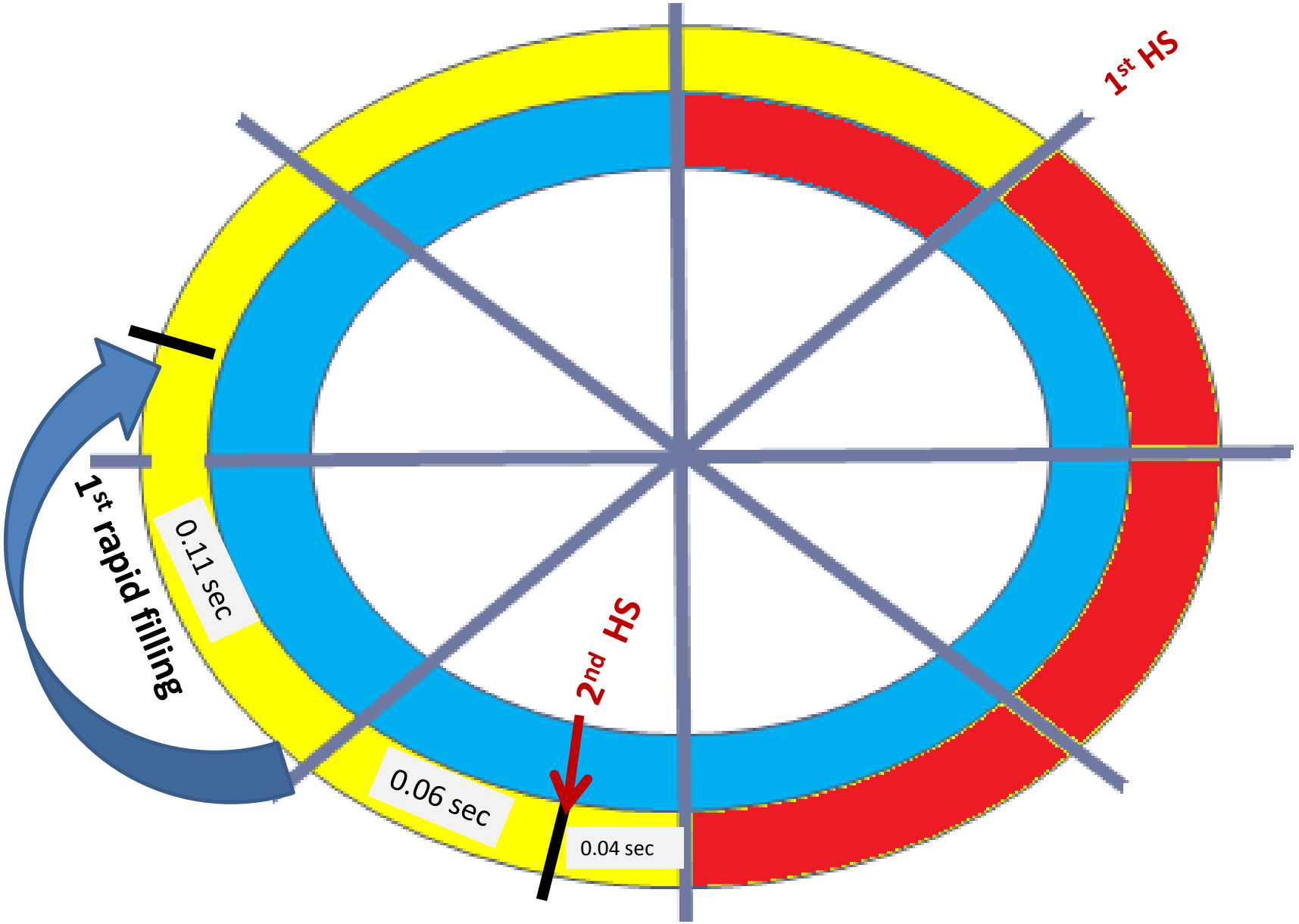
- Because the ventricular volume remains constant this phase is called **isovolumic phase**.

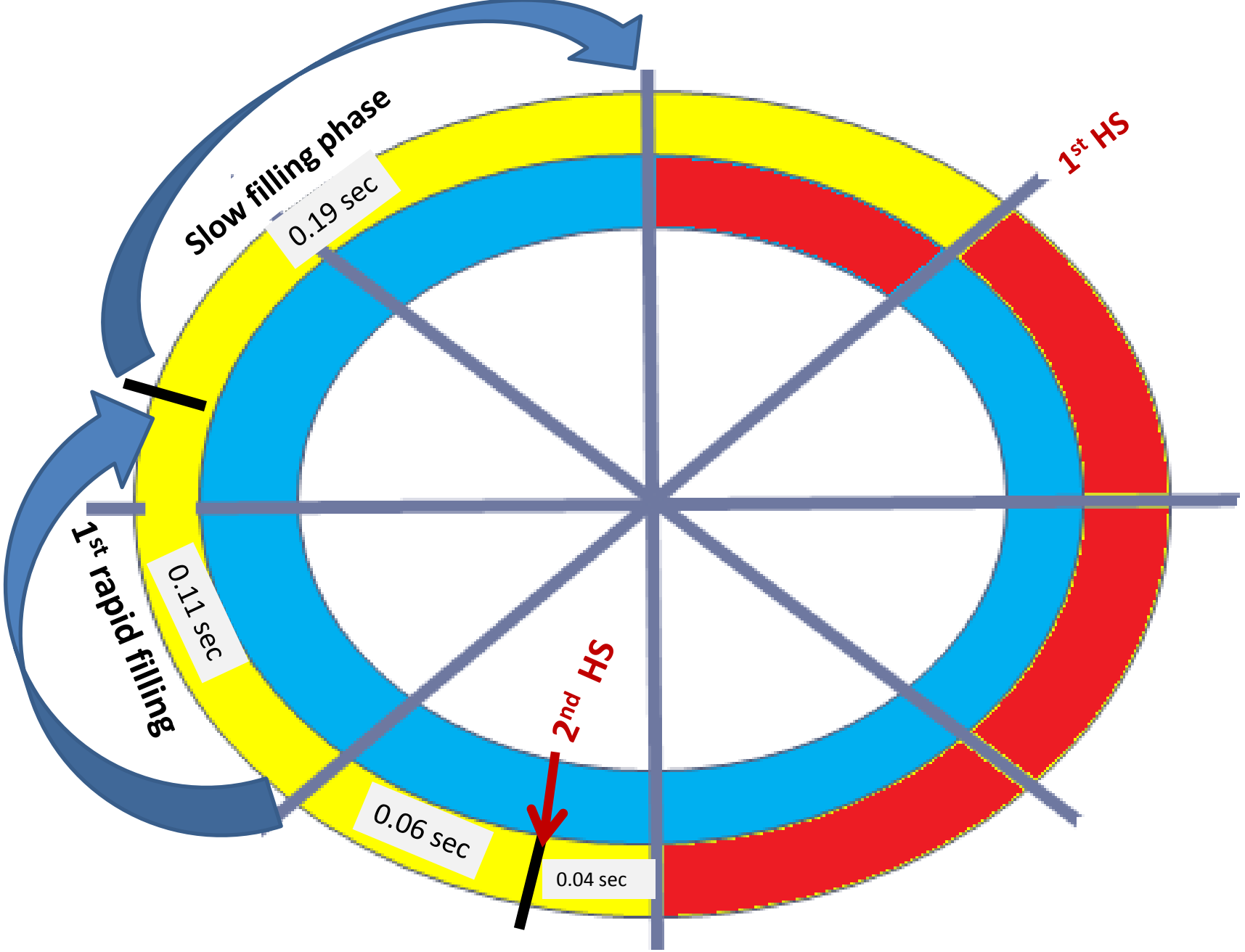
– AV valve is open & blood rush into ventricle & filling begins.

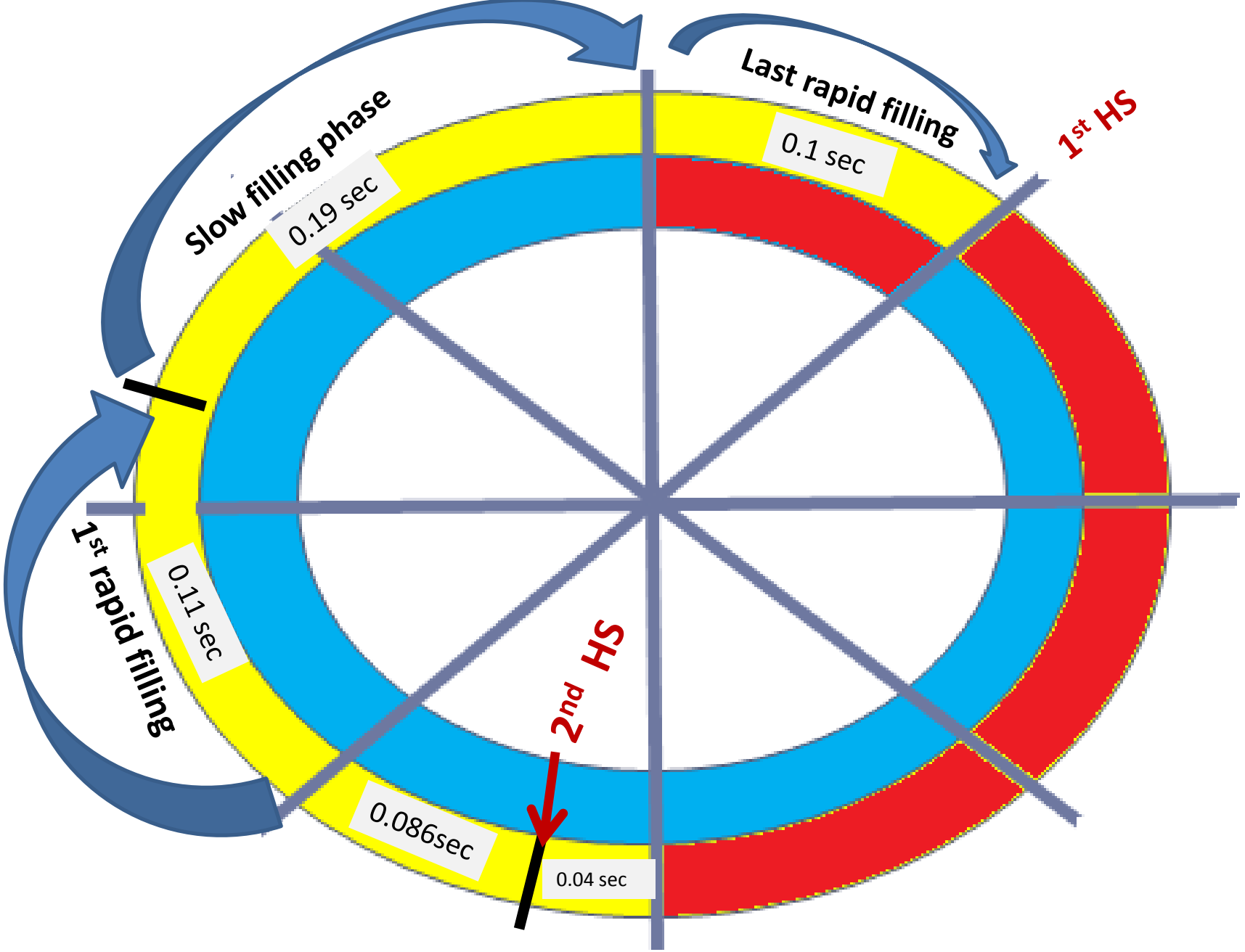
B Diastole



AV valves:	Closed	Open	Open
Aortic and pulmonary valves:	Closed	Closed	Closed


1st HS
2nd HS
1st rapid filling
0.11 sec
0.06 sec
0.04 sec


Slow filling phase
0.19 sec
1st HS
1st rapid filling
0.11 sec
2nd HS
0.06 sec
0.04 sec


Slow filling phase
0.19 sec
Last rapid filling
0.1 sec
1st HS
1st rapid filling
0.11 sec
2nd HS
0.086sec
0.04 sec

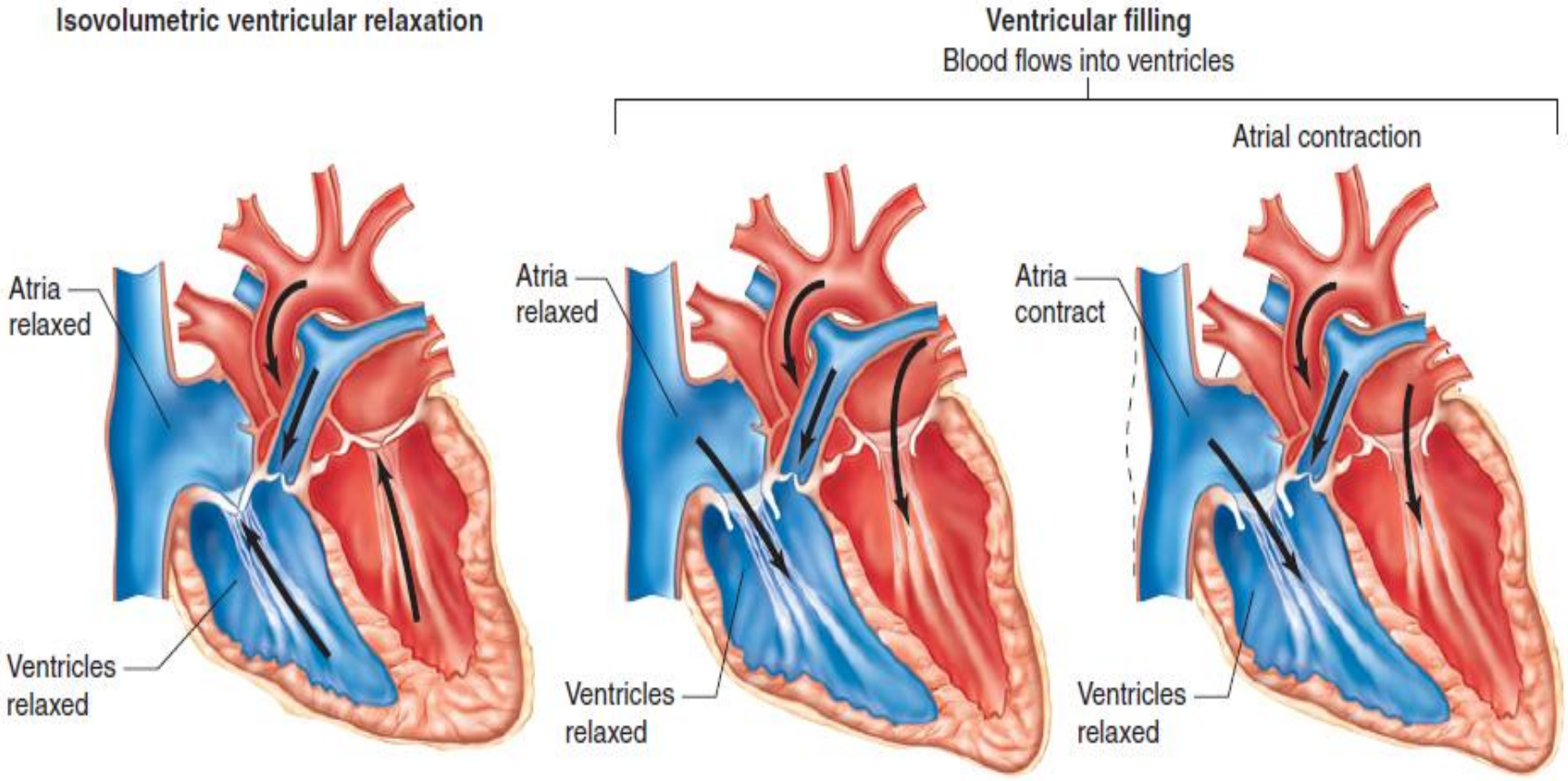
VENTRICULAR DIASTOLE

- 1st 1/3 of filling phase called **rapid filling phase (0.11 sec)** due to rapid rush of blood , **3rd Heart sound** is produced.

- 2nd 1/3 of filling phase, rate of filing is slow down called **slow filiing phase** or **DIASTASIS,(0.19 sec)**

- Last 1/3 of filling phase called **last rapid filling phase**, **(0.1 sec)** atria start to contract & blood rush into ventricle rapidly again. this rapid rush produced **4th heart sound.**

B Diastole



AV valves:	Closed	Open	Open
Aortic and pulmonary valves:	Closed	Closed	Closed

VENTRICULAR CYCLE

- **Ventricular systole : 0.3 sec**
  1. Isometric contraction phase : 0.05 sec
  2. Maximum ejection phase : 0.11 sec
  3. Reduced ejection phase : 0.14 sec

- **Ventricular diastole : 0.5 sec**
  1. Protodiastole : 0.04 sec
  2. Isometric relaxation phase : 0.06 sec
  3. 1st rapid filling phase : 0.11 sec
  4. Reduced filling phase : 0.19 sec
  5. Last rapid filling phase : 0.1 sec