Lecture Physiology 4

Phases of Cardiac Cycle

Def. It is cardiac events that occur from the beginning of one beat to the beginning of the next beat. It consists of alteration of periods of systole & diastole.

-It lasts about 0.8 sec. (when the HR is 75/ min.).

	Systole	Diastole
- *Atria*	0.1 Sec.	0.7 Sec.
- *Ventricles*	0.3 Sec. (3 phases)	0.5 Sec. (5 phases)

1-Atrial Systole

Definition	The atria contraction of the atria to pump 30% of its blood to the ventricles.
Duration	0.1 sec
Atrial Pressure	It initially increases (from 4 to 8 mmHg) due to atrial contraction then it decreases (to 4 mmHg) due to evacuation of blood into ventricle.
Ventricular Volume	It increases slightly due to entry of blood from atria to reach the end diastolic volume (EDV) = 140 ml.
Ventricular Pressure	It initially increases slightly (from 4 to 8 mmHg) (due to entry of blood from atria) then it decreases (to 4 mmHg) due to dilatation of ventricle to accommodate the blood passing to it.
Aortic Pressure	It decreases due to flow of blood from aorta to peripheral arteries.
Heart Sound	4^{th} heart sound.
Valves	A-V valves are open while, the semilunar valves are closed.

Ventricular Systole

3 phase

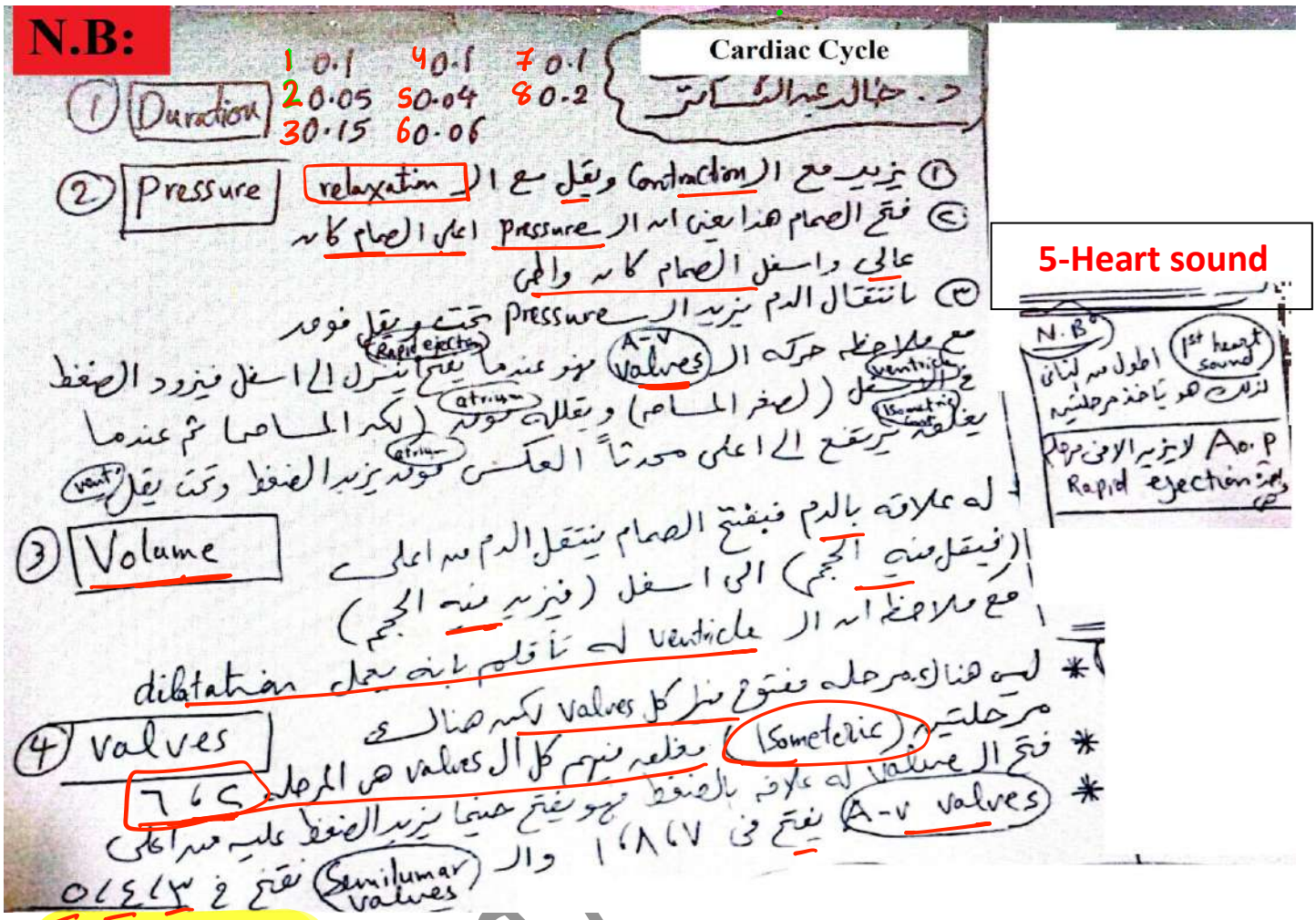
	2-Isometric (Isovolumetric) contraction	3-Rapid (maximum) ejection (for 70%)	4-Reduced ejection (for 30%)
Definition	It begins by closure of A.V. valve and the ventricles begin to contract isometrically (without change in muscle fiber length) - Thus, the ventricles are closed chambers filled with blood.	It begins by opening of the aortic valve and rushing of blood into the aorta where 70% of stroke volume ejected in this phase.	the remaining 30% of stroke volume is ejected to the aorta.
Duration	0.05 sec	0.15 sec	0.1 sec
Atrial Pressure	It increases due to closure of A-V valve and bulging of its cusps toward the atria.	It is initially decreased (due to pulling down of A-V valve cusps toward the ventricles) then it is gradually increased (due to venous return and return of cusps again to normal position)	It is still increasing (due to continual accumulation of venous return)
Ventricular Volume	Constant. important	It rapidly decreases (due to pump of blood).	It decreases to reach end systolic volume (=70 ml).
Ventricular Pressure	It increases from 4 mmHg to 80 mmHg in the left ventricle. and ventricular pressure exceeds atrial pressure → closure of AV valves	It increases to maximum value 120 mmHg (in left ventricle) due to contraction	It decreases (to 110 mmHg) due to decrease of ejection the blood
Aortic Pressure	It still decreases to 80 mmHg (diastolic pressure) due to flow of blood from aorta	It rapidly increases (from 80 mmHg to 120 mmHg)	It slightly decreases due to pumping blood in aorta becomes smaller than amount of blood leaving the aorta
Heart Sound	1st heart sound (due to closure of AV valves)	1st sound continuous	No sound
Valves	All valves are closed	A-V valves remain closed while semilunar valves open	A-V valves remain closed and semilunar valves remain open

في مراحل ال iso كل ال valves بتكون مسكره.

آخر مرحلة قبل

Ventricular Diastole

	5- Protodiastolic (end of systole and beginning of diastole).	6-Isometric Relaxation	7-Rapid (maximum) filing (for 60%)	8-Reduced filing (for 10%)
Definition	the period between the end of ventricular systole and the closure of the aortic valve.	it begins by closure of the aortic valve and the ventricles relax isometrically without change in the ventricular volume.	It begins by opening of A.V. valve due to the increased atrial pressure above the ventricular pressure (60% of SV is rushed to the ventricle).	10% of the stroke volume flow slowly to the ventricle.
Duration	0.04 sec	0.06 sec	0.1 sec	0.2 sec
Atrial Pressure	It is still increasing due to continuous venous return	It is still increasing due to continuous venous return	It initially decreases rapidly (due to flow of blood from atria)	It is still decreases
Ventricular Volume	It remains constant	It remains constant	It increases rapidly (due to flow of blood)	It increases slowly (= diastasis)
Ventricular Pressure	It decreases to value below aorta (90 mmHg)(due to relaxation of ventricular wall)	It decreases rapidly (to 5 mmHg)	It initially decreases below the atrial (0 mmHg) then it gradually increases	It increases slowly to 4 mmHg
Aortic Pressure	It decreases rapidly due to escape of blood but it becomes higher than ventricular pressure → regurgitates blood toward the ventricle → closure of the valve sharp decrease in aortic pressure called diacrotic (incisura) notch.	It initially increases (diacrotic wave) due elastic recoil then it decreases (due to flow of blood from aorta to peripheral arteries)	It decreases gradually (due to flow of its blood from aorta to peripheral arteries)	It is still decreasing due to continuous flow of blood from aorta
Heart Sound	**No sound**	2nd heart sound (due to closure of semilunar valves)	3rd heart sound	3rd heart sound
Valves	**A-V** valves remain **closed and semilunar** valves remain **open**	All valves are closed	A-V valves are open while the semilunar valves remain closed	A-V valves are open while the semilunar valves remain closed



- Isometric means:

a-All valves are closed.

b-Ventricular volume is constant.

c-1st heart sound occurs in isometric contraction & 2nd heart sound is in isometric relaxation due to closure of valves.

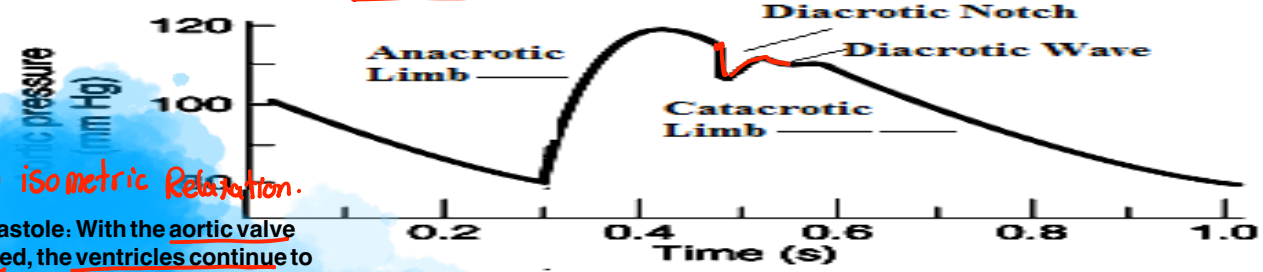
d-Ventricular pressure increases in isometric contraction & decreases in isometric relaxation.

e- Isometric relaxation is the phase 6 and its duration is 0.06.

- No phases with all valves are opened but in isometric phases 2 & 6 all valves are closed.

- Aortic pressure increases in one phase only = rapid ejection.

- Arterial Pressure Pulse Curve



in isometric Relaxation.

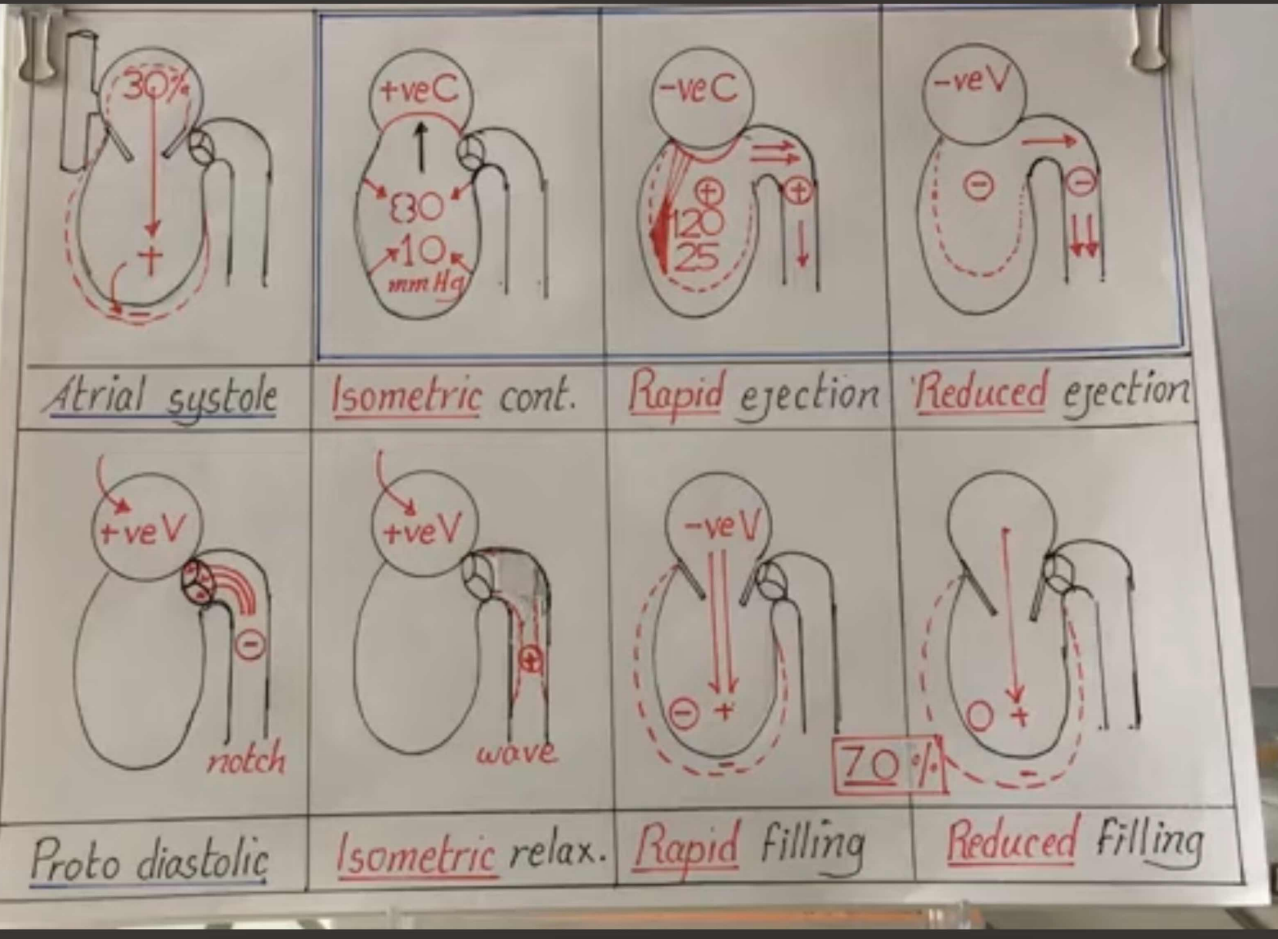
2. Diastole: With the aortic valve closed, the ventricles continue to relax and fill with blood from the atria. During this time, the aortic pressure is higher than the ventricular pressure.

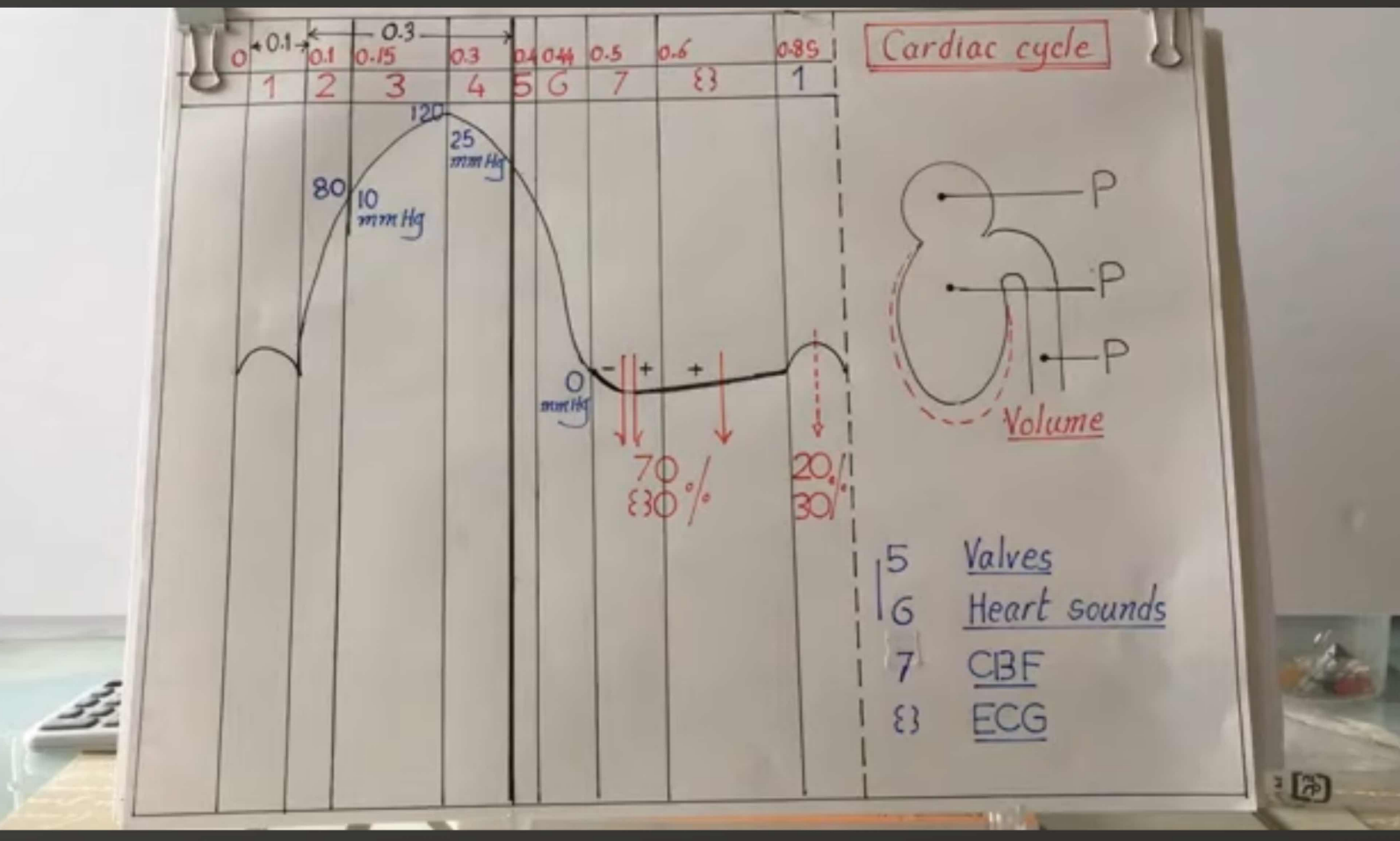
8 Phases

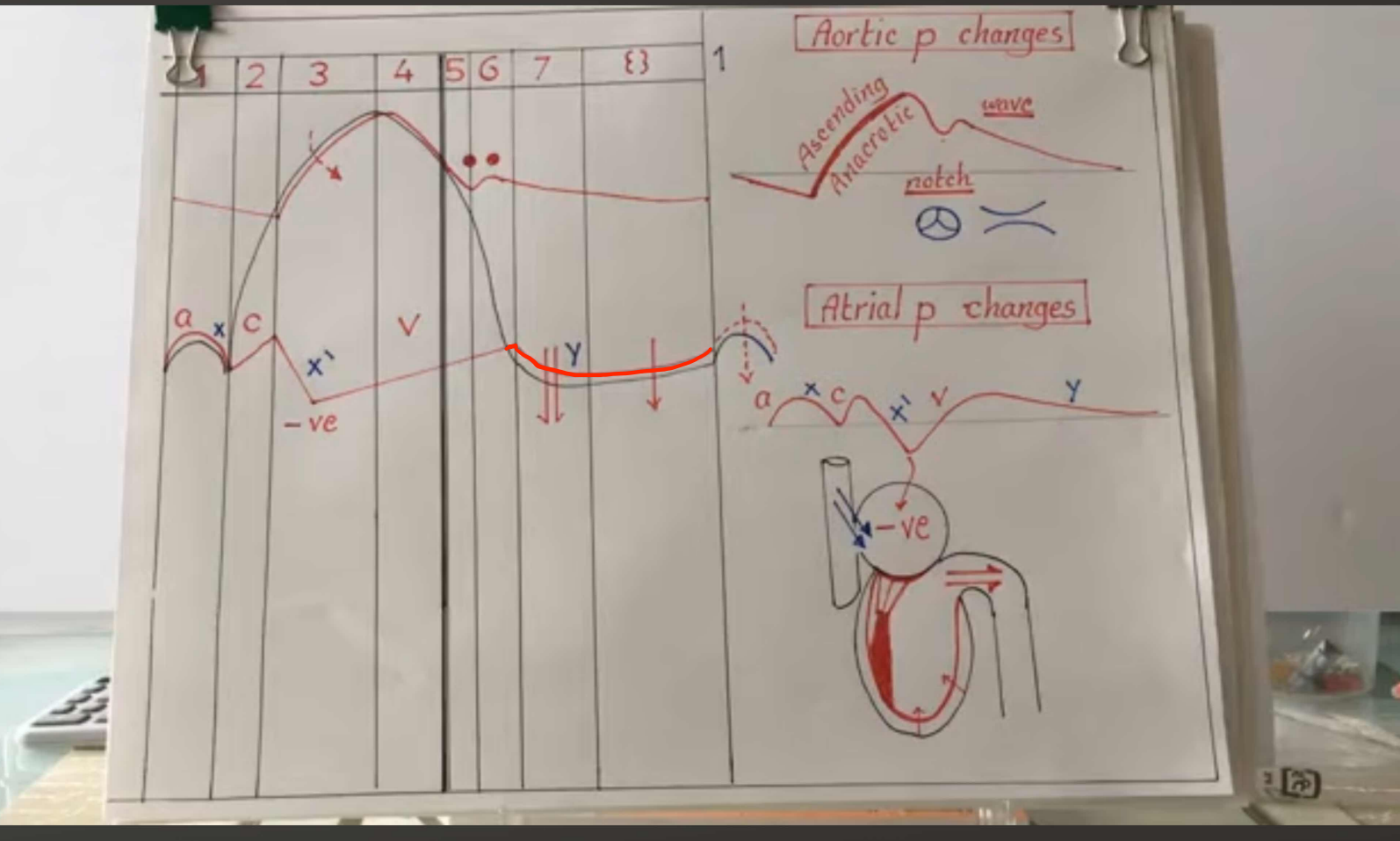
1 Atrial systole
2 Isometric (isovolumetric) contraction
3 Maximum (rapid) ejection
4 Reduced ejection
5 Proto diastolic
6 Isometric (isovolumetric) relaxation
7 Maximum (rapid) filling
8 Reduced filling

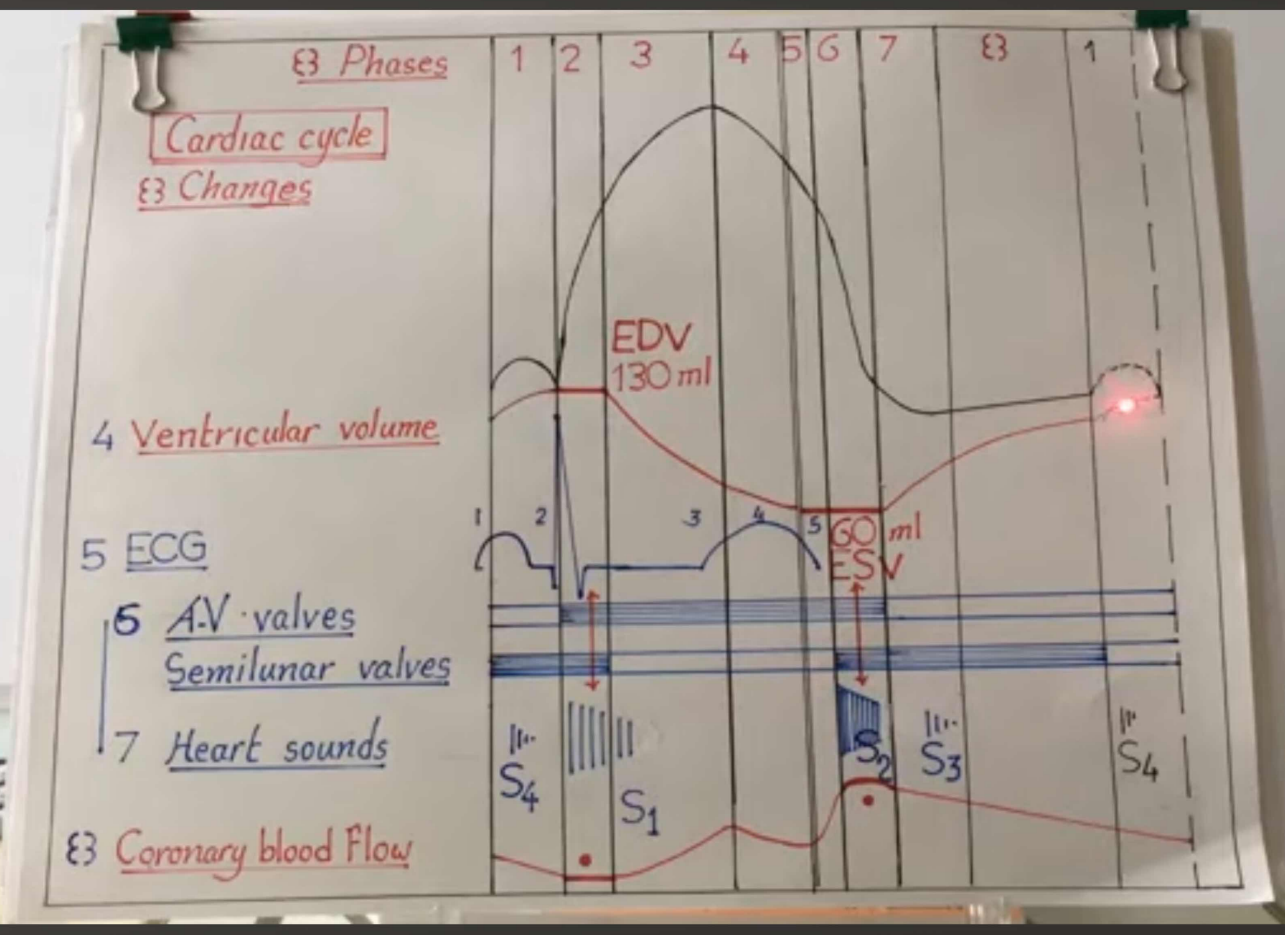
Ventricular systole	
2	isometric
3 & 4	isotonic

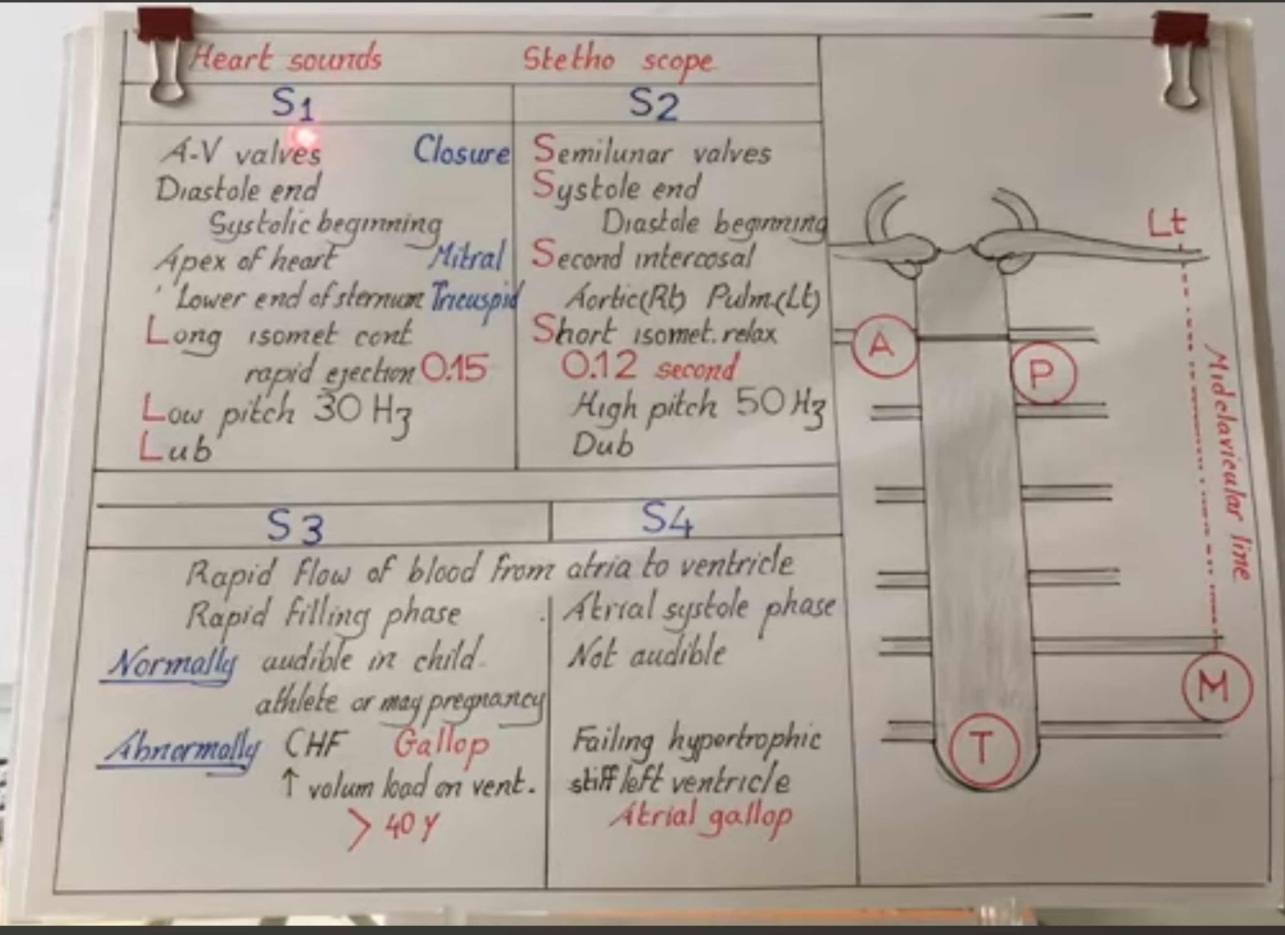
Ventricular diastole	
5, 6 & 7	early
8	mid
1	late

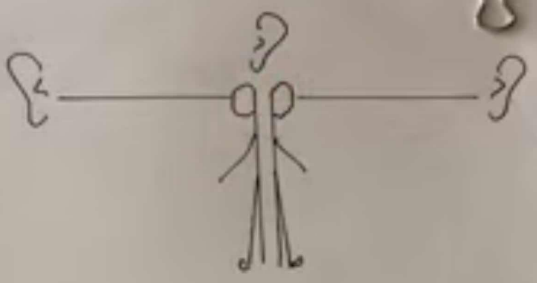



Cardiac cycle
0 0.1 0.3
0 0.1 0.15 0.3 0.4 0.44 0.5 0.6 0.85
1 2 3 4 5 6 7 8 1
120
25 mm Hg
80
10 mm Hg
0 mm Hg
70 %
30 %
20 %
30 %
P
P
P
Volume
5 Valves
6 Heart sounds
7 CBF
8 ECG


1 2 3 4 5 6 7 8
a x c x' v y
-ve
Aortic p changes
Ascending
Anacrotic
wave
notch
Atrial p changes
a x c x' v y
-ve


8 Phases
Cardiac cycle
8 Changes
4 Ventricular volume
5 ECG
6 A-V valves
Semilunar valves
7 Heart sounds
8 Coronary blood Flow
1 2 3 4 5 6 7 8 1
EDV
130 ml
60 ml
ESV
S4
S1
S2
S3
S4


Heart sounds
Stetho scope
S1
A-V valves Closure
Diastole end
Systolic beginning
Apex of heart Mitral
Lower end of sternum Tricuspid
Long isomet cont
rapid ejection 0.15
Low pitch 30 Hz
Lub
S2
Semilunar valves
Systole end
Diastole beginning
Second intercosal
Aortic(Rt) Pulm.(Lt)
Short isomet. relax
0.12 second
High pitch 50 Hz
Dub
S3
Rapid flow of blood from atria to ventricle
Rapid filling phase
Normally audible in child athlete or may pregnancy
Abnormally CHF Gallop
↑ volum load on vent.
> 40 y
S4
Atrial systole phase
Not audible
Failing hypertrophic stiff left ventricle
Atrial gallop
Lt
A
P
T
M
Midclavicular line

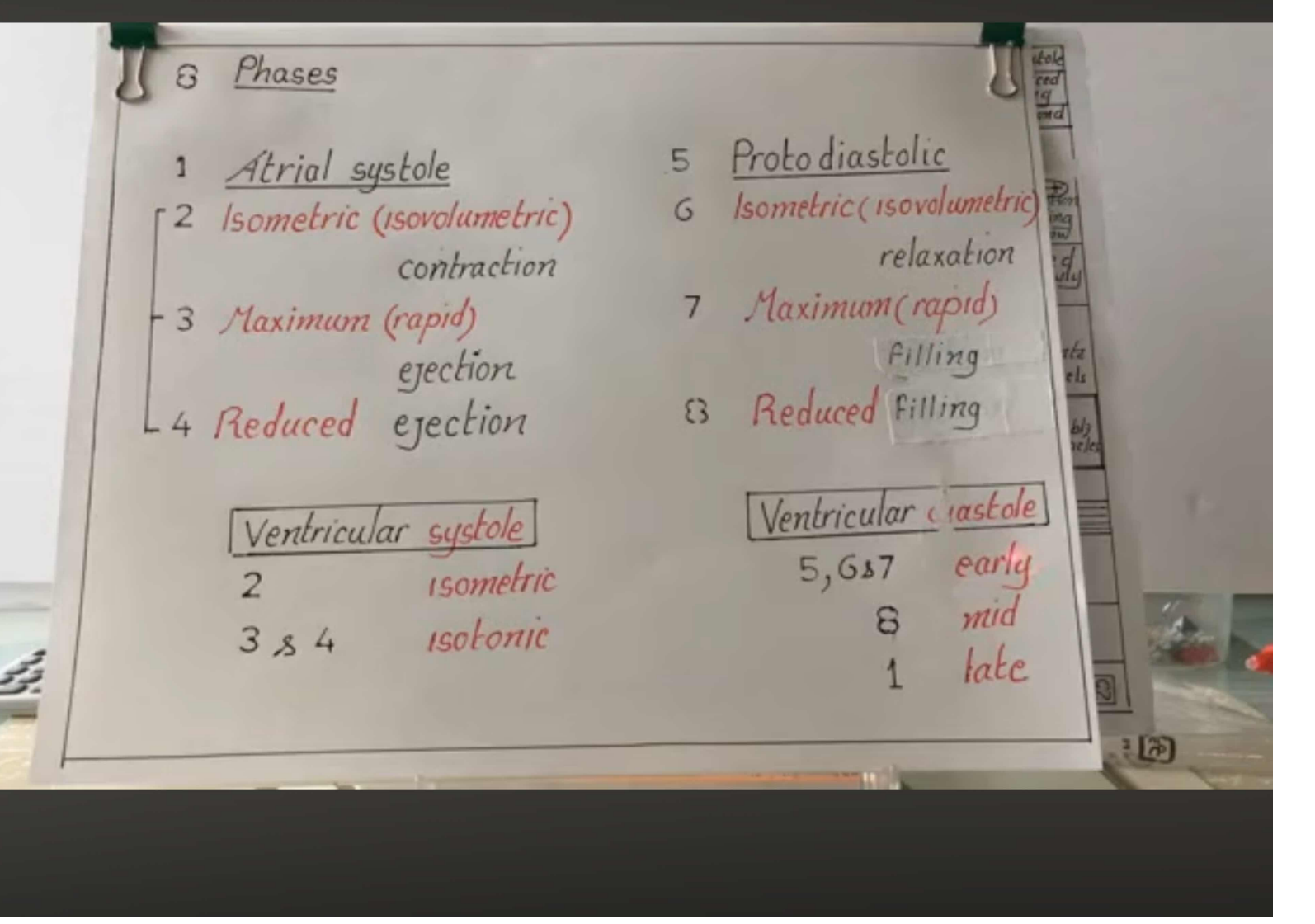


Systole — Diastole

S_1 S_2 S_1

Second

Phase / Change	Late diastole	Ventricular Systole			Early diastole			Mid diastole
	1 A. systole	2 Isometric (isovol) cont.	3 Maximum (rapid) ejection	4 Reduced ejection	5 Proto diastolic	6 Isometric (isovol.) relax.	7 Maximum (Rapid) filling	8 Reduced filling
	0.1 sec.	0.05 sec.	0.15 sec.	0.1 sec.	0.04 sec.	0.06 sec.	0.1 sec.	0.2 second
1 Ventricular Pressure	(++) due to A. systole then (−−) due to V. diastole	(++) to 80 mmHg Lt V. 10 mmHg Rt V. ends by opening of semilunar valves	(++) to maximum 120 mmHg Lt V 25 mmHg Rt V	(−−)	(−−)	(−−) to 0 mmHg Lt V 0 mmHg Rt V	- Early (−−) V. relax > V. filling - Then (++) Vent. filling > V. relaxation Rate of vent. filling: Rapid / Slow	
2 Ventricular Volume	Increased 30% (50 ml / 130 ml)	Constant	Decreased rapidly / slowly (50 ml / 80 ml)		Constant		Increased rapidly 70% / slowly	
3 Aoric Pressure	Catacrotic Blood leaves aorta Aortic p. drops to minimum 80 mmHg by end of this phase	Ascending Anacrotic Bl. ejected in aorta > Bl leaving aorta 120 mmHg	(Closed) Bl enters aorta < Bl leaves = Aortic p. exceeds vent. p.		Dicrotic notch (incisura) sudden closure of aortic valve	wave ++ elastic recoil of aorta	Blood leaves aorta to peripheral vessels	
4 Atrial Pressure	a +ve Atrial systole / x −ve Bl leaves atria to vent.	C +ve Bulge A-V cusps	X −ve Decline	V +ve Accumulation of VR in atrium			Y −ve Passage of VR (bl) from atria to ventricles	
5 A-V valves	open	C	L	O	S	E	D	open
Semilunar ,,	C−l−o	s−e−d	open	open	open	C−l−o	s−e−d	
6 Heart Sounds	4th HS (S_4) vent. filling by A. systole	1st HS (S_1) Sudden closure of A-V valves Long Low pitch LUB				2nd HS (S_2) closure of aortic & pulm. valves	3rd HS (S_3) rapid vent. filling	
7 ECG	P starts 0.02s before A cont	QRS starts 0.02s before V. cont		T wave begins				
8 Coronary bl. Flow		MINIMUM	Slight ++ with ++ aortic p	Slight −− with −− aortic p		MAXIMUM		


8 Phases
1 Atrial systole
2 Isometric (isovolumetric) contraction
3 Maximum (rapid) ejection
4 Reduced ejection
5 Proto diastolic
6 Isometric (isovolumetric) relaxation
7 Maximum (rapid) filling
8 Reduced filling
Ventricular systole
2 isometric
3 & 4 isotonic
Ventricular diastole
5, 6 & 7 early
8 mid
1 late

Cardiac cycle & heart Sounds

- It is the period from the End of one heart contraction to the end of the next.

- It stats by systole of both atria followed by systole of both ventricles and then diastole of the whole heart.

- The cycle is initiated by S.A node.

- The action potential travels rapidly through the atria and then thraugh the A-V bundle in to the ventricles.

- However there is a delayed period of 0.1 seconds in the A-V node allows the atria to pumping before the ventricular contraction

→ The complete cardiac cycle last about 0.8 sec if the heart rate is 75 beat/minute.

* The ventricular systole 0.3 sec.
* The ventricular diastole 0.5 sec.
* The atria systole 0.1 sec.
* The atria diastole 0.7 sec.

* when the heart rate increases, the cycle shortens, especially the diastole
Relaxation.

0.1 0.3 0.5 0.7

Ventrical

Atrium.

No!
* when the Atrium (systol), the ventrical (diastole)

→ The Function of Systol → Contracting (pumping).
→ The Function of diastole → Fill / Rest / Coronary Blood flow.

The Cardiac cycle includes the Following phases:

1. Atrial contraction
2. Isometric contraction
3. (maximum) ejection Rapid
4. Reduced (minimum) ejection
5. proto diastolic
6. Isometric relaxation
7. maximal (rapid) filling
8. Reduced filling

* The change in cardic cycle

1. ventricular prusser
2. Atriume prusser
3. Aortic prusser
4. volume of ventrical
5. valve
6. Heart Sound
7. Coronary Blood flow.
8. ECG [redacted]

---

① Atral contraction phase (Late diastole):

Duration: 0.1 sec

Events: the atria contract and pump 30% of the ventricular filling (to the ventricles).

The Atrial pressure rise from 4 mm Hg → 8 mmHg → 4 mmHg at the end of this phase (انقباض) due to the atria evacution

The ventricular pressure. rise from 4 mm Hg → 8 mm Hg → 4 mmHg at the end of this phase due to dilate the ventrical to accomdate the blood passing to it.

- Ventricular volume: Increased by (20mL) to reach the end diastolic volume (E.D.V = 140 mL) حجم.
  ↳ the volume of Blood in ventricaal finlly Relasation of ventrical.
- Heart Sounds: The 4th heart Sound wrch is weak and inaudible due to vibration اهتزاز of atrial muscle during the contraction and rushing of blood in the ventricles
  * The 4th Sound don't heart. الصوت الرابع لا يسمع بواسطه جهاز
    ↳ normaly can't hear this Sound.
- Valve: The Semiluner valves are closed
  The A.V valve are open.

(2) Isometric (iso volumetric) Contraction phase:

Duration: 0.05 sec

Events: It begins by closure of AV valve and the ventricles beg in to contract isometrically (with out chang in muscle fiber Length). Thus the ventricles are closed chambers filled with blood.

Atrial pressure
rise due to bulging انتفاخ of A.V valve into the atria and also due to regurgitation of some blood into the atria before closure of the A.V valves.

Ventricular pressure
rise from 4 mmHg to 80 mmHg in the left ventricle.

Venticular volume:
is constant (isometric) this is become the blood is not compresed.

Heart Sounds; the first components of the 1st heart Sound. due to closure of the A.V valves. (long). Loop في الرسم
valve are closed (A.V valve and Semilunar valve).

③ Rapid (maximum) ejection phase:

Duration: 0.15 sec

Events: it begins by opening of the aortic valve and rushing of blood into the aorta where 70% of Stroke volume ejected in this phase.

Atrial pressure	Ventricular and aortic pressures
decreases due to down displacement of the A.V valve during Shortening of ventricular muscles	rise from 80 → 120 mmHg Because the amount of Blood ejected through the aortic valve exceeds that which Leaves the aorta

- Ventricular volume: decreases greatly due to Change of the isometric contraction to isotonic contraction and ejection of the blood.

Heart Sound: the Second Component of the 1st heart Sound. due to rushing of blood into the aorta and vibration of the aortic wall.

Valves: The semilunar valves are opened. The A-V valve is closed.

④ Reduced (minimum) ejection phase:

Duration: 0.1 sec

- Events: the remaining 30% of Stroke volume is ejected to the aorta.

Atrial pressure	ventricular and aortic pressures
increased increased due to venous return.	reach their maximum and begin to decrease (due to escape of blood to peripheral circulation is more than the amount of blood ejected from the ventricle.

Ventricular volume: decreases to reach the end systolic volume ESV = 70 ml. → الحجم في نهاية الوقت

↳ why the ESV = 70 because supply the ventrical Because the coronary is closed

⑤ Pro to diastolic Phase * important

Duration: 0.04 sec

Events: the period between the end of ventricular Systole and the closure of the aortic valve.

ventricular and aortic pressure

* the ventricle begin to relax but still contracted
* the prusser decrease 20 mmHg.
* aortic pressure → due to escape of blood to peripheral circulation). But still above the ventricular pressure.

→ this causes the blood in the aorta to regurgitate to the ventricles leading to Closure of the aortic valve at the end of this phase. (5)

* normaly NO Regurgitate the Blood from Aorta to left ventricle Because (close the Valve (tricuspid valve)

- The closure of semilunar valve occurs as a result of fall of ventricular pressure below that of aortic and pulmonary arteries.

- The closure of the aortic valve and the change of potential energy to kinetic energy leads to sharp momentary fall in the aortic pressure called the diacrotic notch.

Ventricular volume: is constant.

All the valve is closed.

(6) Isometric relaxation phase

Durtion: 0.06

Events: it begin by closure of the aortic valve and the ventricles relax isometrically without change in the ventricular volume.

Atrial pressure	ventricular pressure	Aortic pressure
increads above the ventricular prusser due to accumulation of venous return. this prusser can open the A-V valve at the end of this phase	falls rapidly from 80 → 90 → 0 mm Hg	increased due to elastic recial of the aorta is leading to upward (dicrotic) wave.

Heart Sounds: the 2th heart Sound due to clousre of the aortic valve and pulmonary valve (Semilunar valves).

All the valve are closed. (6)

* At the end this phase the A-V valves open.

⑦ maximal (rapid) filling phase.

→ Duration: 0.1 sec

Event: it begin by opening of A.V valve due to the increased atrial pressure above the ventricular pressure (60 % of stroke volume is rushed to ventricle).

Atrial and ventricular pressure.	Aortic pressure	Ventricular volume.
Around Zero	decreases due to escape of blood to peripheral vessels.	increased.

Heart Sound: the 3rd heart Sound due to rushing of blood into ventricles and vibration of the ventricular wall
→ this Sound are spikes to sound (cardiologest or child pieces).

⑧ Reduced filling phase.

→ Duration: 0.2 sec.

Events: (10 %) of the Stroke volume flow slowly to the ventricle

- The ventricular volume increase gradually
- The ventricular pressure rises to 4 mm.Hg.

* Changes in pressures during the cardiac cycle.

* During the diastole: (what the Benefits of diastol ?)

→ The ventricular filling occurs in early diastole.
→ The ventricles rest
→ The coronary blood flow occurs.

@ * The Highest of cardiac Blood flow accurs during?

* اي مرحله من ال (2) مراحل رح يكون عندي ال Ventrical مملتئ بأكبر كمية ممكنة 140m؟

Isometric Relaxation phase

وفي هاي المرحله رح يكون أعلى من ال Aortic prusser أقل من ال Ventricular prusser

	Rt. vent	L. vent	pul. art	Aorta
systolic pr	25	120	25	120
diast pr	0	0	8	80

Thank you ...

ما تنسونا من دعواتكم ♥

بالتوفيق للجميع

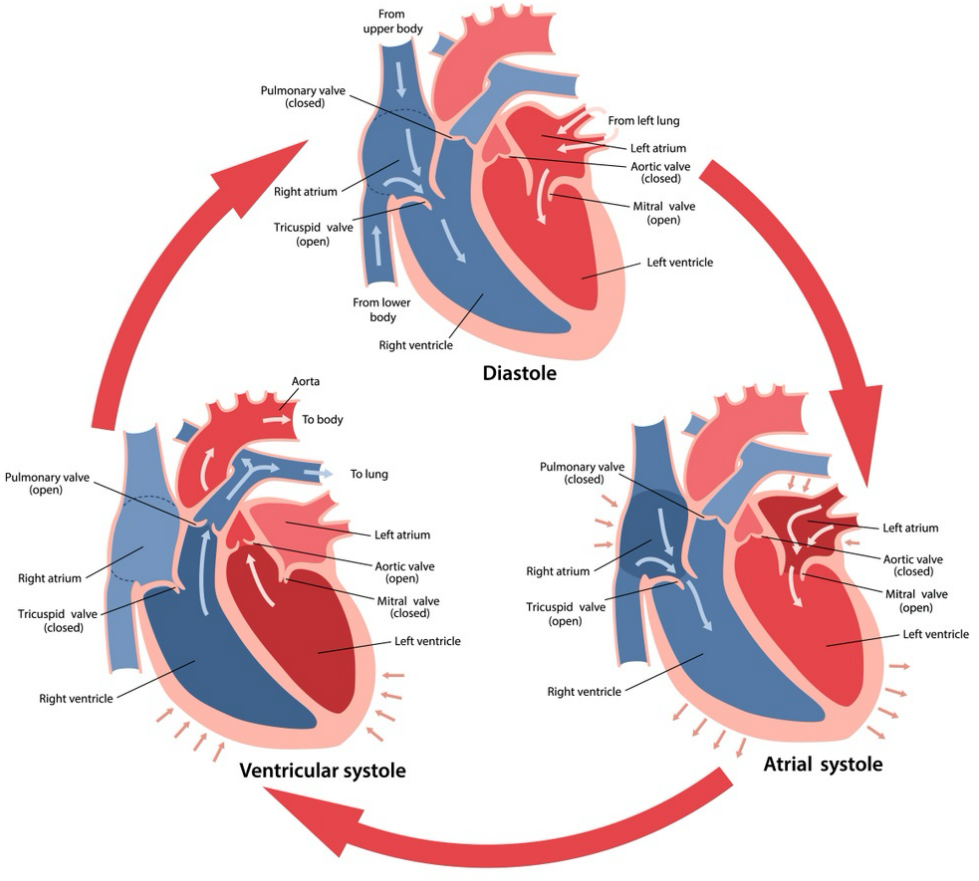
أذار 2022

0.1 0.1 0.1
0.05 0.4 0.2
0.15 0.06

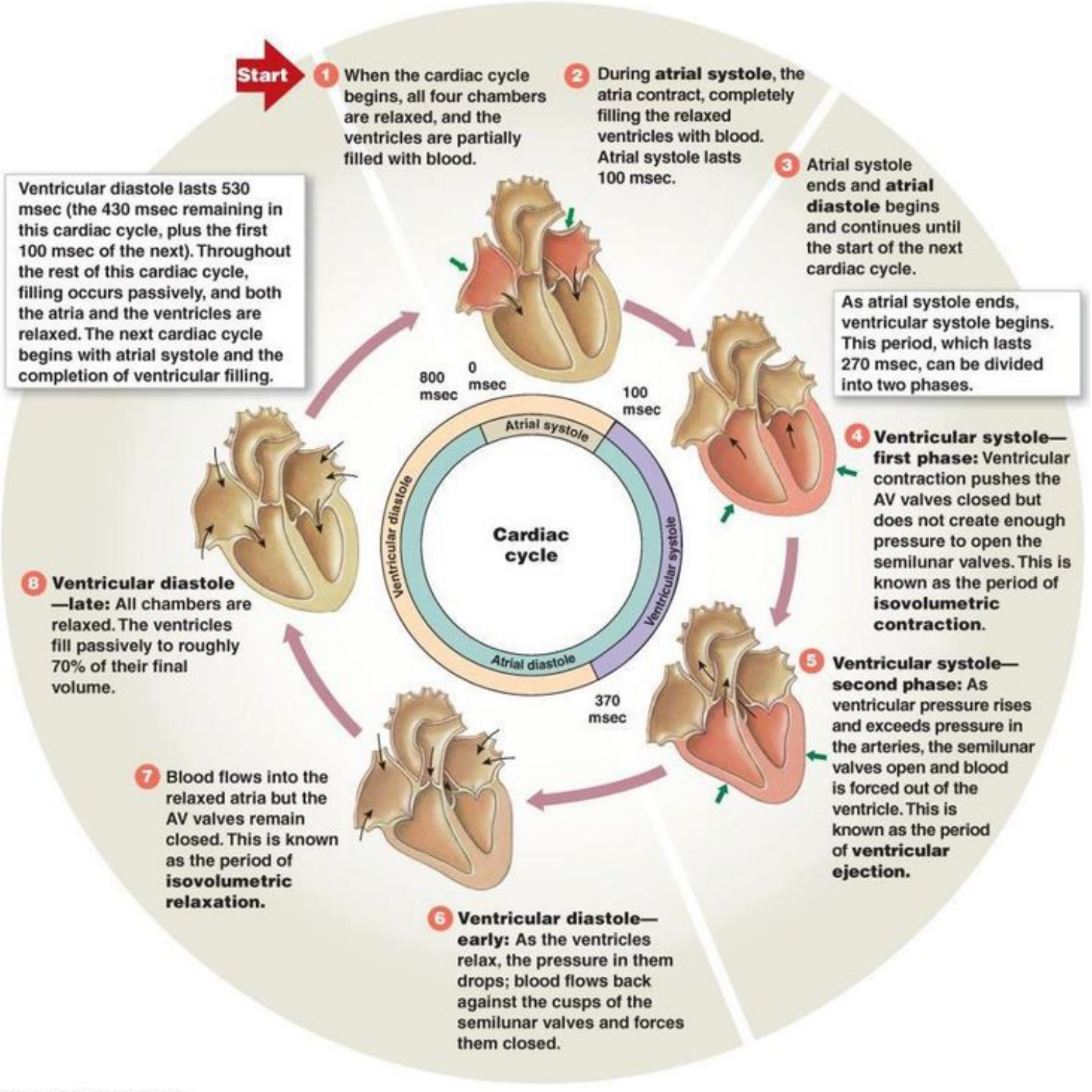
	A.S	Isometric Contractile*	Rapid ejection	Reduced ejection	Protodiastolic*	Isometric relaxation*	Rapid filling	Reduced filling
Def	contraction of atrium to pump 30%.	contraction of closed ventricle without shorting	Pump 70%	Pump 30%	Last few sec of systolic just befor diastolic	relaxation of closed ventricle without shorting	Pass of 60% of atrial blood without Atrial cont	Pass of 10% atrial blood without Atrial cont
Duration	0.1s	0.5s	0.15s	0.1s	0.04s	0.06s	0.1s	0.2s
Atrial Pressure	↑↑ then ↓↓ contraction / evacuate	↑↑ bulge of cusps	↓↓ then ↑↑ V.R Pulling down of cusps	↑↑ V.R	↑↑ V.R	↑↑ VR	↓↓ flow of blood cl.	↓↓
Ventricle Vol	↑	Constant	↓	↓	Constant	Constant	↑	↑
Ventricle Pressure	↑ then ↓ Blood enter dilatation	↑ contraction	↑ contraction	↓ مقارنة بالمرحلة قبل	↓↓↓	↓↓	↓↓ then ↑↑ flow of blood	↑ flow of blood
Aortic Pressure	↓ خروج الدم من الأورطي flow of blood	↓ خروج الدم من الأورطي flow of blood	120 دخول الدم إلى الأورطي Blood of AORTA	↓ مقارنة بالمرحلة قبل	↓↓ SHARP dicrotic notch	↑ مقارنة بالمرحلة قبل elastic recoil	↓	↓
Heart sound	4th	1st heart sound طويل في الوقت ليأخذ مرحلتين		No Sound		2nd Heart sound	3rd Heart sound	
Valves*	AV open SV close	All valves are closed	A.V closed S.V Open			All Valves are closed	A.V open SV closed	

N.B
S.V are opened (3,4,5)
A.V are opened (7,8,1)
All are closed (2,6)

Cardiac cycle



The phases of the cardiac cycle for a heart rate of 75 beats per minute



Here are some multiple-choice questions (MCQs) about the cardiac cycle:

1. Which phase of the cardiac cycle involves ventricular contraction?
A. Atrial Systole
B. Ventricular Diastole
C. Ventricular Systole
D. Atrial Diastole
Answer: C. Ventricular Systole
2. What causes the "lub" (S_1) sound of the heart?
A. Closing of the aortic and pulmonary valves
B. Opening of the AV (atrioventricular) valves
C. Closing of the AV valves (mitral and tricuspid)
D. Opening of the aortic and pulmonary valves
Answer: C. Closing of the AV valves (mitral and tricuspid)
3. During which phase of the cardiac cycle is the aortic pressure higher than the ventricular pressure?
A. Atrial Systole
B. Isovolumetric Contraction
C. Ventricular Ejection
D. Isovolumetric Relaxation
Answer: D. Isovolumetric Relaxation
4. The T wave in an ECG represents:
A. Atrial depolarization
B. Ventricular depolarization
C. Ventricular repolarization
D. Atrial repolarization
Answer: C. Ventricular repolarization
5. What occurs during ventricular diastole?
A. The ventricles are contracting
B. The ventricles are filling with blood
C. The AV valves are closed
D. The aortic valve is open
Answer: B. The ventricles are filling with blood
6. Which phase immediately follows ventricular systole in the cardiac cycle?
A. Atrial Systole
B. Isovolumetric Relaxation
C. Ventricular Ejection
D. Atrial Diastole
Answer: B. Isovolumetric Relaxation
7. What triggers the opening of the aortic valve?
A. When atrial pressure exceeds ventricular pressure
B. When ventricular pressure exceeds aortic pressure
C. When aortic pressure exceeds ventricular pressure
D. When atrial pressure exceeds aortic pressure
Answer: B. When ventricular pressure exceeds aortic pressure
8. The second heart sound ("dub" or S_2) is caused by:
A. Opening of the AV valves
B. Closing of the AV valves
C. Opening of the semilunar valves
D. Closing of the semilunar valves
Answer: D. Closing of the semilunar valves
9. During which phase is all four heart valves closed?
A. Ventricular Filling
B. Atrial Systole
C. Isovolumetric Contraction
D. Ventricular Ejection
Answer: C. Isovolumetric Contraction
10. What percentage of ventricular filling is passive before atrial systole occurs?
A. 10%
B. 30%
C. 70%
D. 90%
Answer: C. 70%

Type y

Here are some more multiple-choice questions on the cardiac cycle:

11. Which of the following best describes isovolumetric contraction?
A. Ventricles contract with all valves closed
B. Ventricles relax with all valves open
C. Atria contract with all valves closed
D. Ventricles fill with blood from the atria
Answer: A. Ventricles contract with all valves closed

12. Which of the following valves prevents backflow of blood into the left ventricle?
A. Tricuspid valve
B. Mitral valve
C. Aortic valve
D. Pulmonary valve
Answer: C. Aortic valve

13. What is the main purpose of the atrial systole in the cardiac cycle?
A. To increase ventricular pressure
B. To open the semilunar valves
C. To increase ventricular filling
D. To close the AV valves
Answer: C. To increase ventricular filling

14. Which event marks the end of the ventricular ejection phase?
A. Closure of the AV valves
B. Opening of the aortic valve
C. Closure of the semilunar valves
D. Opening of the mitral valve
Answer: C. Closure of the semilunar valves

15. What does the QRS complex in an ECG represent?
A. Atrial depolarization
B. Atrial repolarization
C. Ventricular depolarization
D. Ventricular repolarization
Answer: C. Ventricular depolarization

16. During which phase do the ventricles reach their maximum volume (end-diastolic volume)?
A. Atrial Systole
B. Isovolumetric Relaxation
C. Isovolumetric Contraction
D. Ventricular Ejection
Answer: A. Atrial Systole

17. Which phase of the cardiac cycle is the longest under normal resting conditions?
A. Atrial Systole
B. Ventricular Ejection
C. Ventricular Diastole
D. Isovolumetric Contraction
Answer: C. Ventricular Diastole

18. What is the function of the SA node in the cardiac cycle?
A. It generates impulses to start the cycle
B. It delays impulses from the atria to the ventricles
C. It contracts to help fill the ventricles
D. It closes the semilunar valves
Answer: A. It generates impulses to start the cycle

19. The dicrotic notch on the aortic pressure curve is caused by:
A. Closure of the AV valves
B. Closure of the aortic valve
C. Opening of the aortic valve
D. Opening of the mitral valve
Answer: B. Closure of the aortic valve

20. During atrial systole, which valves are open?
A. AV valves only
B. Semilunar valves only
C. Both AV and semilunar valves
D. No valves are open
Answer: A. AV valves only

21. The term "afterload" refers to:
A. The volume of blood in the ventricles at the end of diastole
B. The pressure the ventricles must overcome to eject blood
C. The volume of blood ejected by each ventricle per beat
D. The strength of contraction of the ventricular myocardium
Answer: B. The pressure the ventricles must overcome to eject blood

22. Which of the following structures delays the electrical impulse from the atria to the ventricles?
A. SA node
B. AV node
C. Purkinje fibers
D. Bundle of His
Answer: B. AV node

23. In which phase does passive filling of the ventricles primarily occur?
A. Ventricular Ejection
B. Atrial Systole
C. Ventricular Diastole
D. Isovolumetric Contraction
Answer: C. Ventricular Diastole

24. When ventricular pressure exceeds atrial pressure, which valves close?
A. Semilunar valves
B. AV valves
C. Both AV and semilunar valves
D. No valves close
Answer: B. AV valves

25. What is the significance of end-systolic volume (ESV) in the cardiac cycle?
A. It represents the blood left in the ventricles after ejection
B. It is the maximum blood volume in the ventricles before contraction
C. It represents the pressure in the aorta at the end of diastole
D. It is the volume of blood that enters the atria
Answer: A. It represents the blood left in the ventricles after ejection

Let me know if you need further questions or help with any of these topics!

26. Which of the following conditions would most likely increase the end-diastolic volume (EDV) of the ventricles?
A. Increased heart rate
B. Decreased venous return
C. Increased venous return
D. Increased afterload
Answer: C. Increased venous return

27. If the atrioventricular (AV) node were damaged and slowed the conduction between the atria and ventricles, what would most likely occur in an ECG reading?
A. Prolonged QRS complex
B. Prolonged PR interval
C. Absent P wave
D. Shortened PR interval
Answer: B. Prolonged PR interval

28. Which of the following best describes the Frank-Starling law of the heart?
A. As preload increases, stroke volume decreases
B. As afterload increases, cardiac output increases
C. As preload increases, stroke volume increases
D. As heart rate increases, end-systolic volume increases
Answer: C. As preload increases, stroke volume increases

29. During ventricular systole, which of the following events occurs in the left ventricle?
A. Ventricular pressure falls below atrial pressure
B. Ventricular volume reaches its maximum
C. Ventricular pressure exceeds aortic pressure, opening the aortic valve
D. Ventricular pressure is lower than aortic pressure, causing the aortic valve to close
Answer: C. Ventricular pressure exceeds aortic pressure, opening the aortic valve

30. What effect would an increase in afterload have on the heart if all other factors remained constant?
A. It would increase end-systolic volume (ESV)
B. It would decrease end-systolic volume (ESV)
C. It would increase end-diastolic volume (EDV)
D. It would decrease end-diastolic volume (EDV)
Answer: A. It would increase end-systolic volume (ESV)

31. Which of the following explains why blood does not backflow into the atria during ventricular systole?
A. The semilunar valves prevent backflow
B. The pressure in the ventricles is lower than in the atria
C. The AV valves are closed
D. The atria contract simultaneously to prevent backflow
Answer: C. The AV valves are closed

32. When blood flows into the ventricles primarily due to pressure differences rather than active contraction, this phase is known as:
A. Active ventricular filling
B. Isovolumetric relaxation
C. Passive ventricular filling
D. Isovolumetric contraction
Answer: C. Passive ventricular filling

33. What is the impact of increased sympathetic nervous system stimulation on the heart?
A. It decreases heart rate and contractility
B. It increases heart rate and decreases contractility
C. It increases both heart rate and contractility
D. It decreases heart rate but increases contractility
Answer: C. It increases both heart rate and contractility

34. A sudden drop in blood pressure would likely trigger which of the following compensatory responses?
A. Decreased heart rate and increased stroke volume
B. Increased heart rate and decreased stroke volume
C. Increased heart rate and increased cardiac output
D. Decreased heart rate and cardiac output
Answer: C. Increased heart rate and increased cardiac output

35. In the context of heart function, preload can best be described as:
A. The force the heart must overcome to eject blood
B. The degree of stretch of the heart muscle before contraction
C. The pressure in the ventricles at the end of systole
D. The pressure in the ventricles during isovolumetric contraction
Answer: B. The degree of stretch of the heart muscle before contraction

36. The main purpose of isovolumetric contraction in the cardiac cycle is to:
A. Eject blood into the aorta and pulmonary artery
B. Equalize pressure between the atria and ventricles
C. Increase ventricular pressure to open the semilunar valves
D. Open the AV valves for passive filling
Answer: C. Increase ventricular pressure to open the semilunar valves