Cardiac Cycle and BP

Definitions

Blood pressure – measurement of the force against the walls of the arteries (mmHg)

Systolic pressure – maximum aortic pressure during LEFT ventricular contraction

Diastolic pressure – minimal aortic pressure during left ventricular relaxation

Pulse pressure – strength of contraction (systolic – diastolic = pulse pressure)

Mean arterial pressure – diastolic pressure – 1/3 pulse pressure

Importance of MAP

MAP is important as the heart does NOT spend an equal amount of time in systole and diastole.

+ 1/3 systole - contraction
+ 2/3 diastole – relaxation + filling

This allows the heart to be more efficient at filling with blood

Formulae

Blood pressure = Cardiac output x peripheral resistance

Cardiac output = stroke volume x heart rate

Stroke volume = EDV – ESV

Ejection fraction = stroke volume / EDV

+ Normal EF = 55%–75%

Stroke volume

Stroke volume = amount of blood transferred from left ventricle to aorta in SYSTOLE

3 factors affect SV:

1. **Preload** – volume of blood that ventricles can pump
2. **Contractility** – force that the muscle can contract with
3. **Afterload** – arterial pressure against which the ventricle will contract against

(left ventricle NEVER completely empties at the end of systole)

LEARN WHAT CAUSES INCREASE/DECREASE IN THE 3 FACTORS

Cardiac cycle

1) Atrial systole

2) Isovolumetric ventricular contraction – pressure increases, NO change in volume

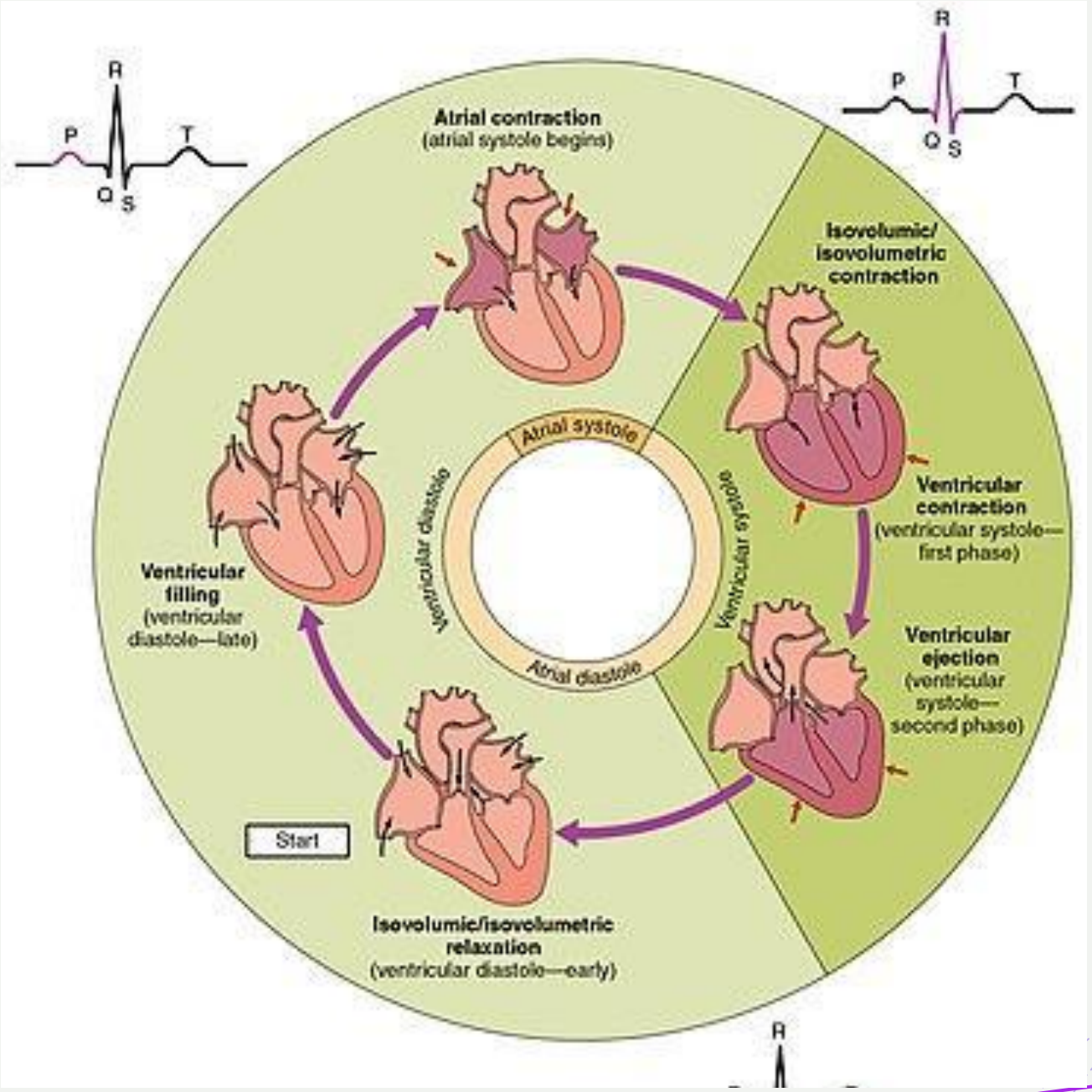
3) Rapid ventricular ejection

4) Isovolumetric ventricular relaxation – pressure decreases, NO change in volume

5) Rapid ventricular filling

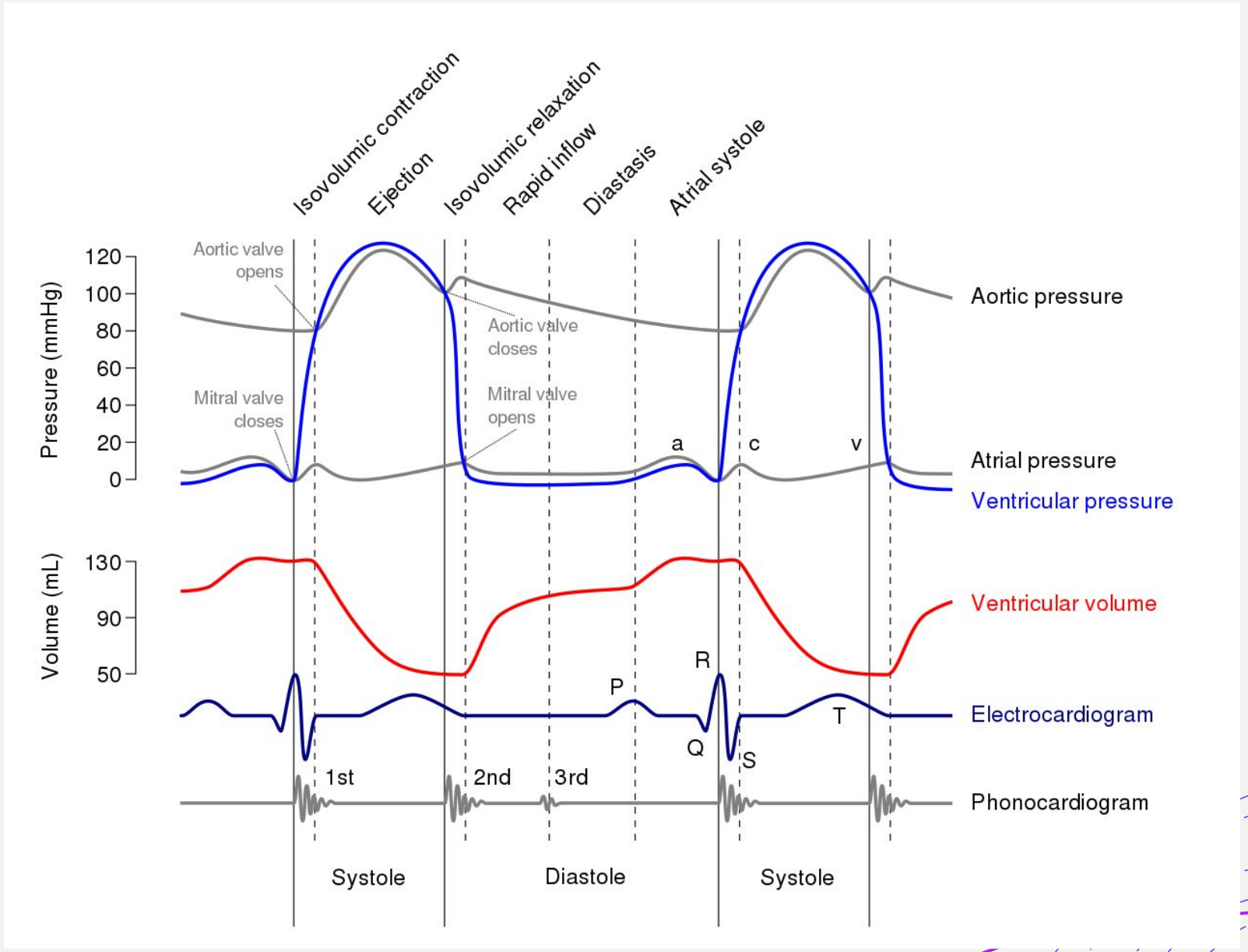
Valves open - high volume behind them increases pressure, causing valves to open

Valves close – high pressure in front of them


R
P
T
Q
S
Atrial contraction
(atrial systole begins)
Isovolumic/
isovolumetric
contraction
Ventricular
contraction
(ventricular systole—
first phase)
Ventricular
ejection
(ventricular
systole—
second phase)
Isovolumic/isovolumetric
relaxation
(ventricular diastole—early)
Ventricular
filling
(ventricular
diastole—late)
Start
Atrial systole
Atrial diastole
Ventricular diastole
Ventricular systole

Wigger's diagram

Learn when valves open and close – HIGH YIELD



Control of the cardiac cycle

Controlled by 2 mechanisms:

+ Endocrinal – long term
+ Neuronal – short term

Endocrine - RAAS

1) Macula densa cells – detects low Na+ = low BP
2) Juxtaglomerular cells secrete renin
3) Renin converts angiotensinogen (released by liver) to angiotensin I
4) Lungs release ACE to convert angiotensin I into angiotensin II
5) Angiotensin II increases blood pressure

LEARN THE RAAS SYSTEM

Functions of angiotensin II

1) SYSTEMIC VASOCONSTRICTION – main function

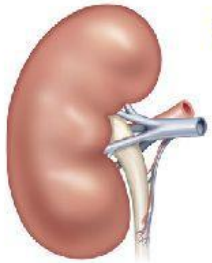
2) Cardiac and vascular hypertrophy

3) Acts on adrenal cortex – aldosterone – increases NaCl retention – increases BP

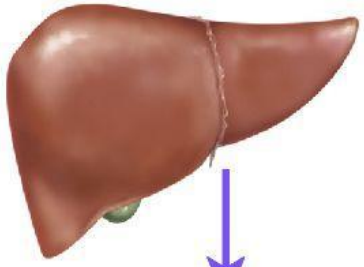
4) Acts on posterior pituitary gland – ADH – increase H2O retention

Renin-angiotensin system

Drop in blood pressure
Drop in fluid volume



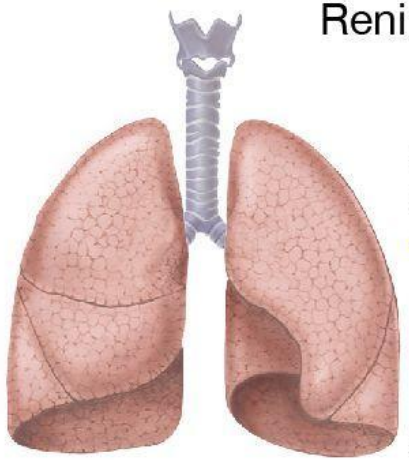
Renin release from kidney



liver

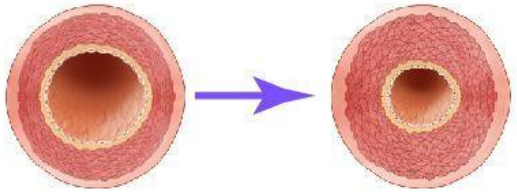
angiotensinogen

Renin acts on angiotensinogen to form **angiotensin I.**

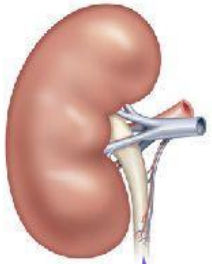


ACE (angiotensin-converting enzyme) release from lungs

ACE acts on angiotensin I to form **angiotensin II.**



Angiotensin II also acts directly on blood vessels, stimulating vasoconstriction (narrowing).



NaCl
H_2O

Neuronal

Cardiovascular centre:

+ located in medulla – regulates HR and SV

Sensory receptors:

+ Proprioceptors – increase HR if there is anticipation – exercise
+ Baroreceptors – detect change in blood pressure
+ Chemoreceptors – detect chemical changes

Baroreceptors – aortic arch and carotid sinus

+ prevent excessive fall in blood pressure when you stand up quickly

Chemoreceptors – carotid sinus + aortic body

Neuronal- ANS

Sympathetic nervous system:

+ Increases BP – cardiac accelerator nerves – noradrenaline is released and acts on Beta 1 adrenoreceptors

3 effects:

1. Positive chronotropic effect – increase HR
2. Positive ionotropic effect – increase in contractility – increase CO
3. Peripheral vasoconstriction via alpha 1 adrenoreceptors – increase in peripheral resistance

Neuronal - ANS

Parasympathetic control:

+ Decreases BP – vagus nerve – acetylcholine acts on M3 receptors

Main effect:

1. Negative chronotropic effect – decreases HR

(Little effect on contractility)

Autonomic control

Beta 1 adrenoreceptors:

+ Increase HR + contractility

Beta 2 adrenoreceptors:

+ Vasodilation

Alpha 1 adrenoreceptors:

- Vasoconstriction

Alpha 2 adrenoreceptors:

- Vasodilation

Questions ☺

1) What releases RENIN?

2) How do you calculate CO?

3) What 3 things does SV depend on?

4) What is the main function of AGII?

5) What do baroreceptors do?

Questions ☺

1) What is the main function of the sympathetic nervous system regarding blood pressure?

2) What nerve is involved in the parasympathetic control of BP?

3) Where is the cardiovascular centre located?

ANSWERS

1) Juxtaglomerular cells
2) SV x HR
3) Preload, afterload, contractility
4) Peripheral vasoconstriction
5) Detect changes in BP
6) Increase BP
7) Vagus nerve (CNX)
8) Medulla (oblongata)

Cardiac cycle:

Atrial systole:

- Atria contract

isovolumetric ventricular contraction:

- A-V + S-L valves = shut
- Volume remains the same
- ventricular contraction = ↑ pressure

rapid ventricular ejection:

- ↑ pressure in ventricles > pressure of blood in S-L cusps
- ↓ volume as blood enters aorta + P.A.

isovolumetric ventricular relaxation:

- diastole
- S-L, A-V valves = closed
- volume remains same
- blood enters atria

rapid ventricular filling:

- ↑ pressure in atria > pressure in ventricles
- AV valves open

Short term BP regulation:

- ANS
- baroreceptors – aortic arch + carotid sinus → medulla } Pressure
- Chemoreceptors – peripheral / central → medulla } pH, O_2, CO_2
  - peripheral → aortic arch, carotid artery
  - central → medulla

Parasympathetic:

↑ B.P

↓

baroreceptors — aortic arch, carotid sinus

↓

medulla

↓

vagus nerve — efferent parasympathetic fibres

↓

↓ HR + contractility

↓

↓ CO

Sympathetic:

↓ BP

↓

baroreceptors

↓

medulla

↓

Sympathetic response

- β1 → ↑ HR + contractility
- K1 → vasoconstriction → ↑ peripheral resistance

ng term BP regulation:

RAAs