

PASSION ACADEMIC TEAM

*YU - MEDICINE*

# Cardiovascular System

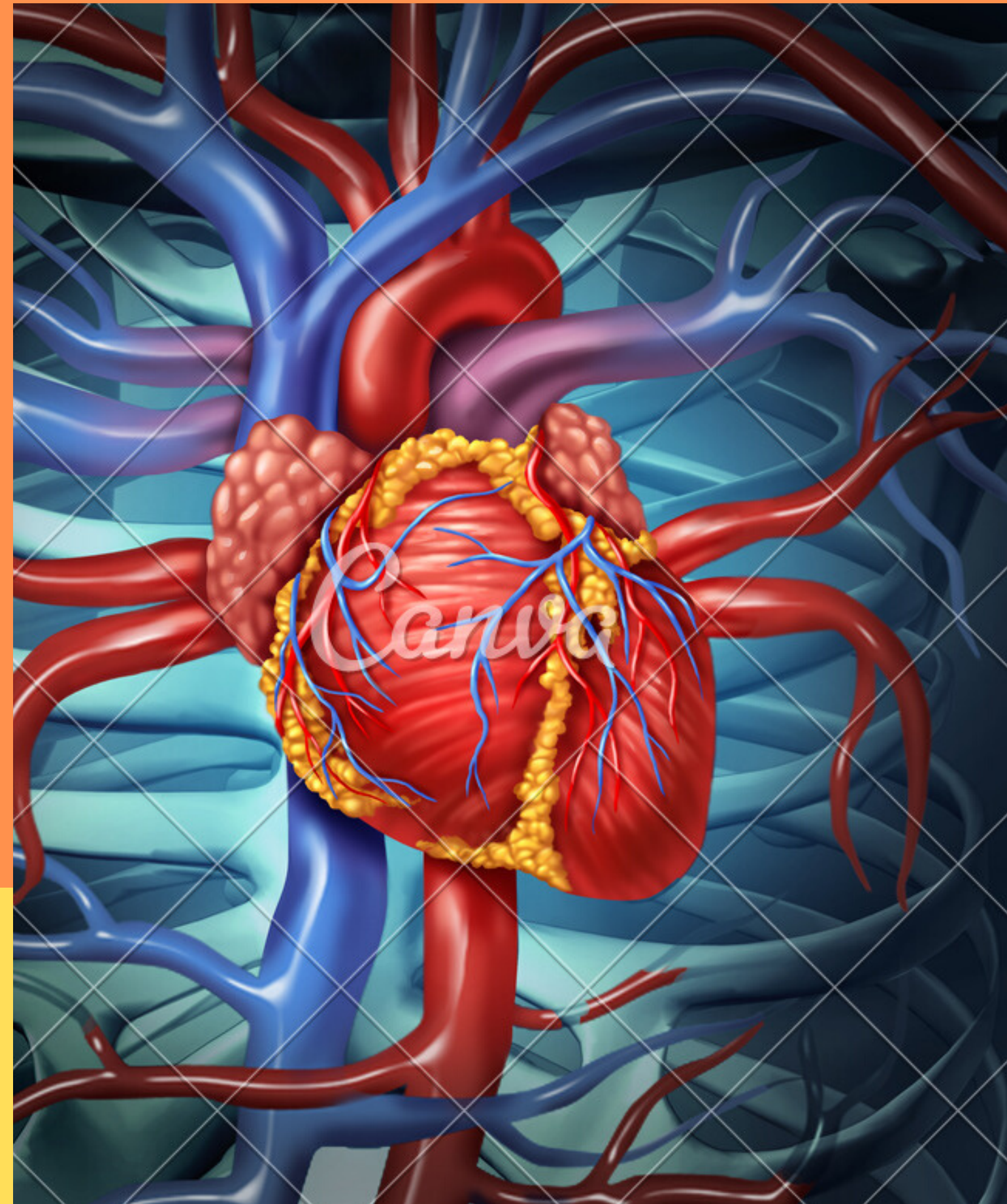
Sheet# 6 + 7 ( Part 1)

Lec. Date :

Lec. Title : Blood Pressure Regulation

Written By : Abdullah A Ananzeh

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[shaghafbatch@gmail.com](mailto:shaghafbatch@gmail.com)



# BLOOD PRESSURE REGULATION



# Determinants of Mean Arterial Pressure

$$MAP = Q \times R$$

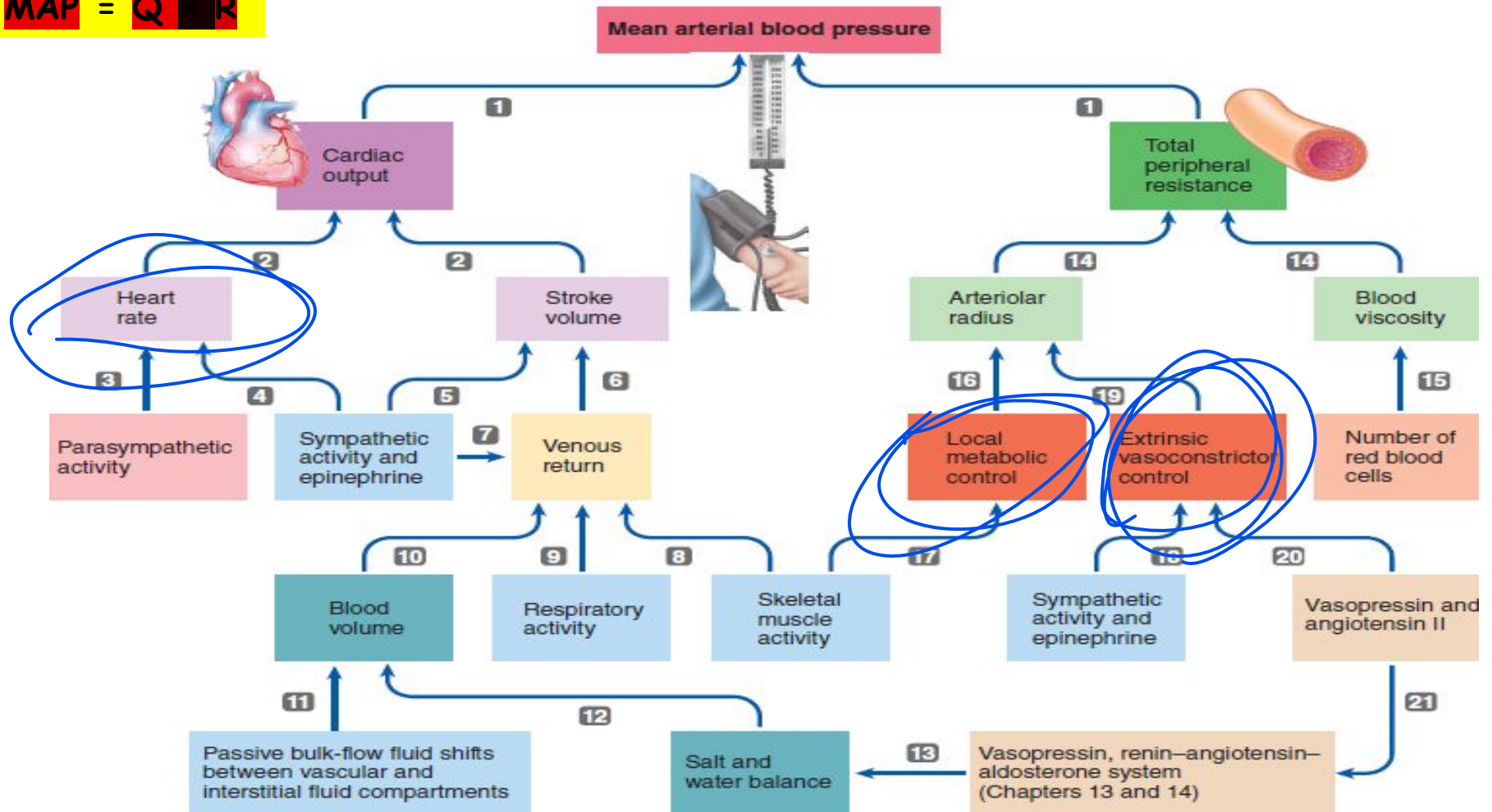


FIGURE 10-20 Determinants of mean arterial blood pressure. Note that this figure is based on the following equation:  $MAP = CO \times TPR$ .

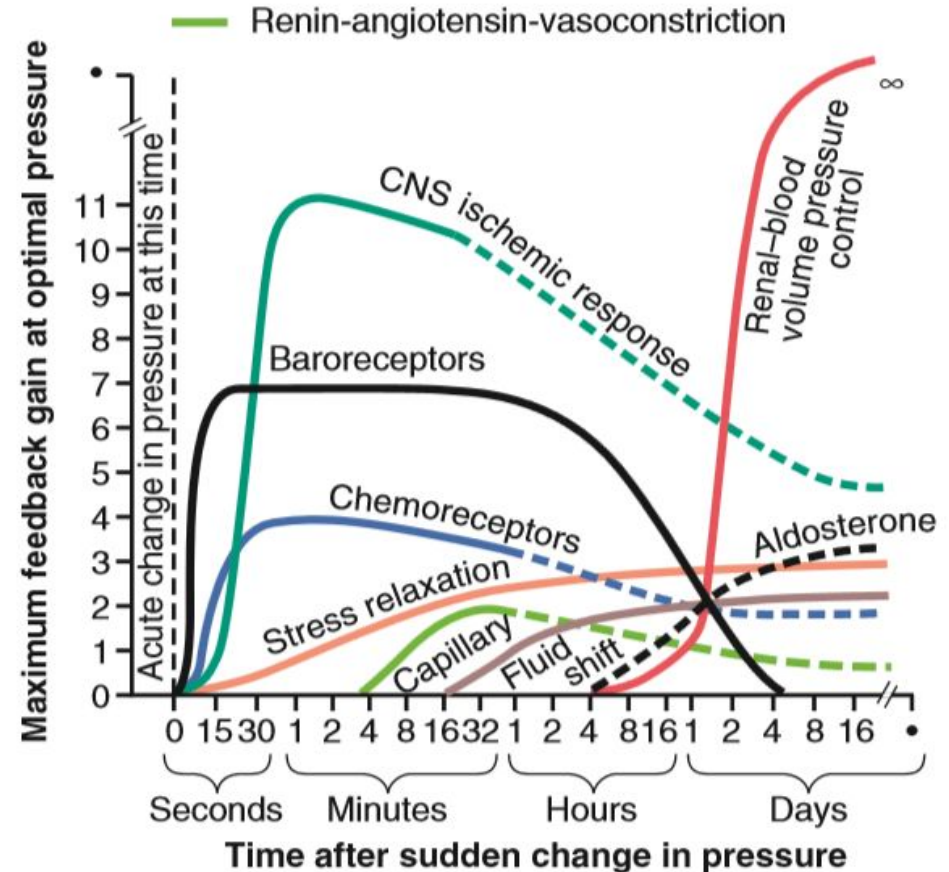
# REGULATION OF ARTERIAL BLOOD PRESSURE

The mechanisms involved in regulation of blood pressure can be divided broadly into two categories:

## 1. Shortterm regulation:

- Regulation of blood pressure within seconds or minutes to hours.
- Shortterm regulation occurs mainly by the neural mechanisms, though the vascular and hormonal mechanisms also contribute to it

## 2. Longterm regulation is mainly hormonal and renal



# REGULATION OF ARTERIAL BLOOD PRESSURE

Shortterm regulation of blood pressure are as follows:

## 1. Neural mechanisms

- Autonomic regulation
  - Sympathetic control
  - Parasympathetic control
- Medullary control
- Reflex regulation
  - Baroreceptor reflex
  - Chemoreceptor reflex
  - CNS-ischemic response(Cushing reflex)
  - Atrial stretch reflex

## 2. Vascular mechanisms

- Capillary fluidshift
- Stress relaxation

## 3. Hormonal mechanisms

- Catecholamines
- Reninangiotensin system
- Antidiuretic hormone (ADH)
- Atrial natriuretic peptide (ANP)

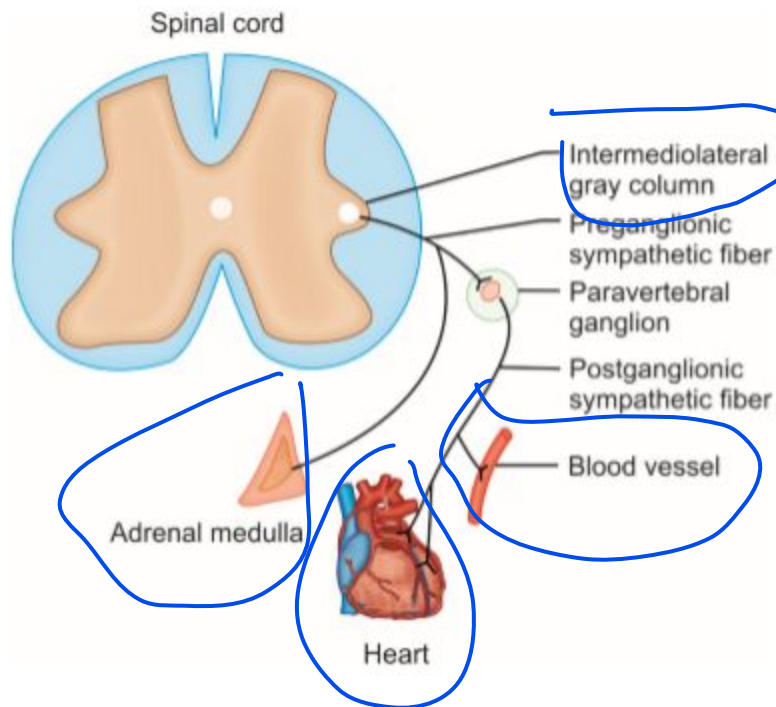
Longterm regulation of blood pressure occurs by:

- Renal and
- Hormonal mechanisms

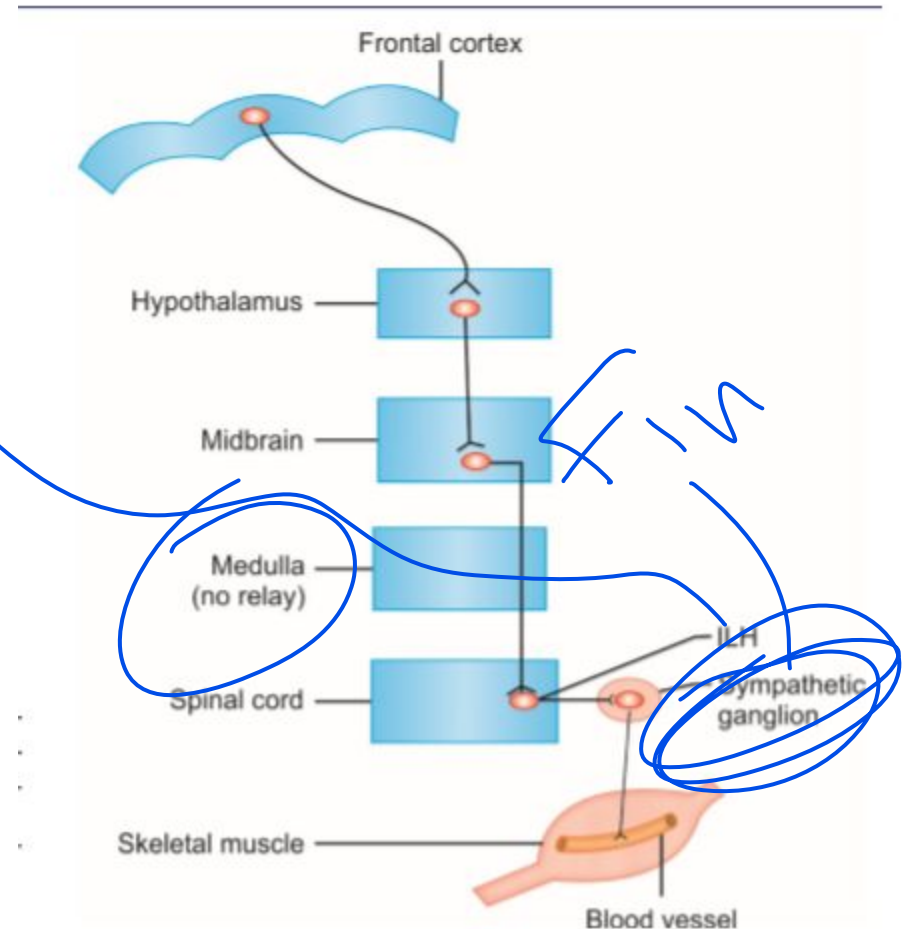
# Autonomic regulation

## Autonomic Regulation:

- Sympathetic regulation
- Parasympathetic

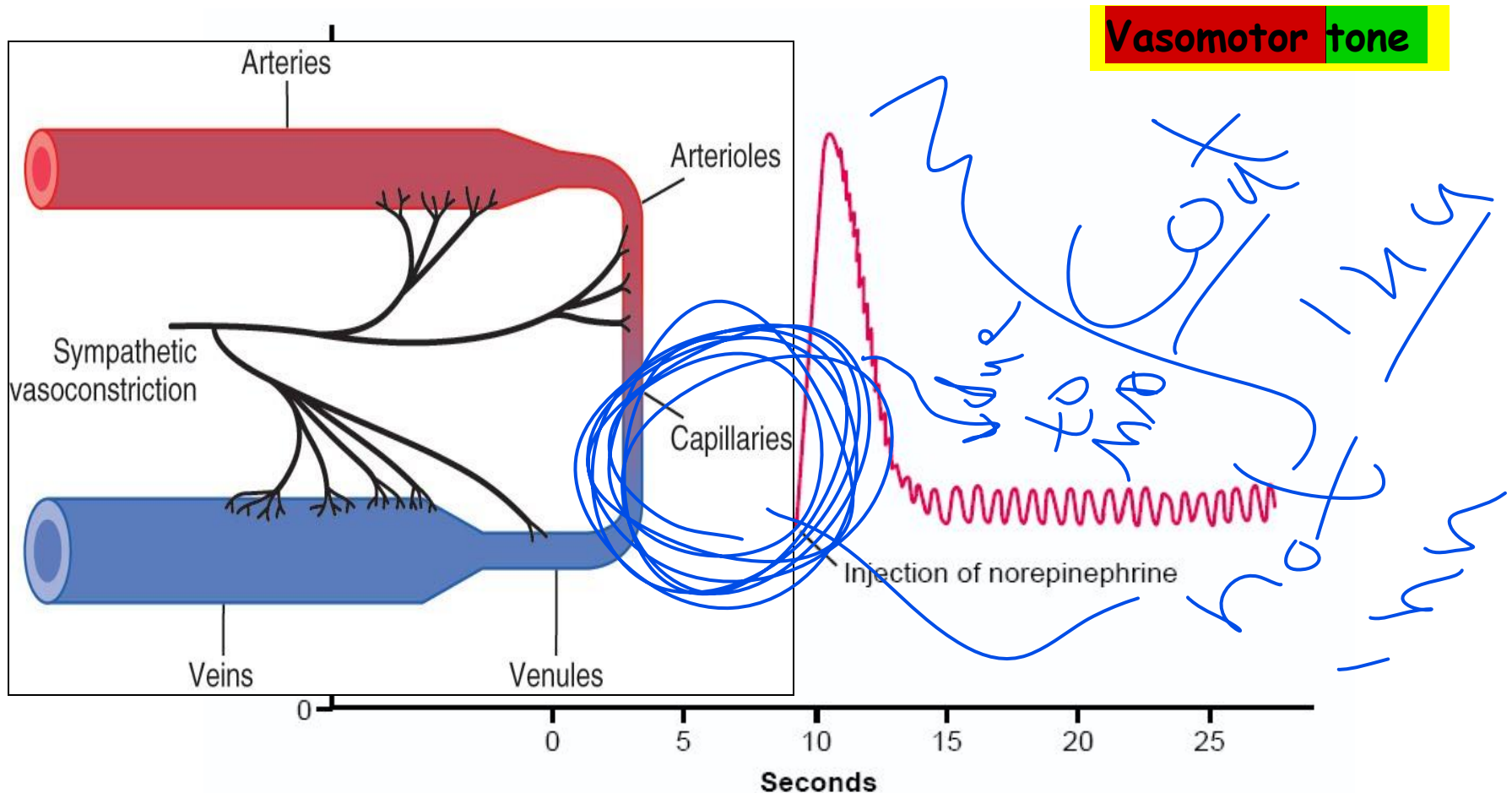


Sympathetic vasoconstrictor system



Sympathetic vasodilator system

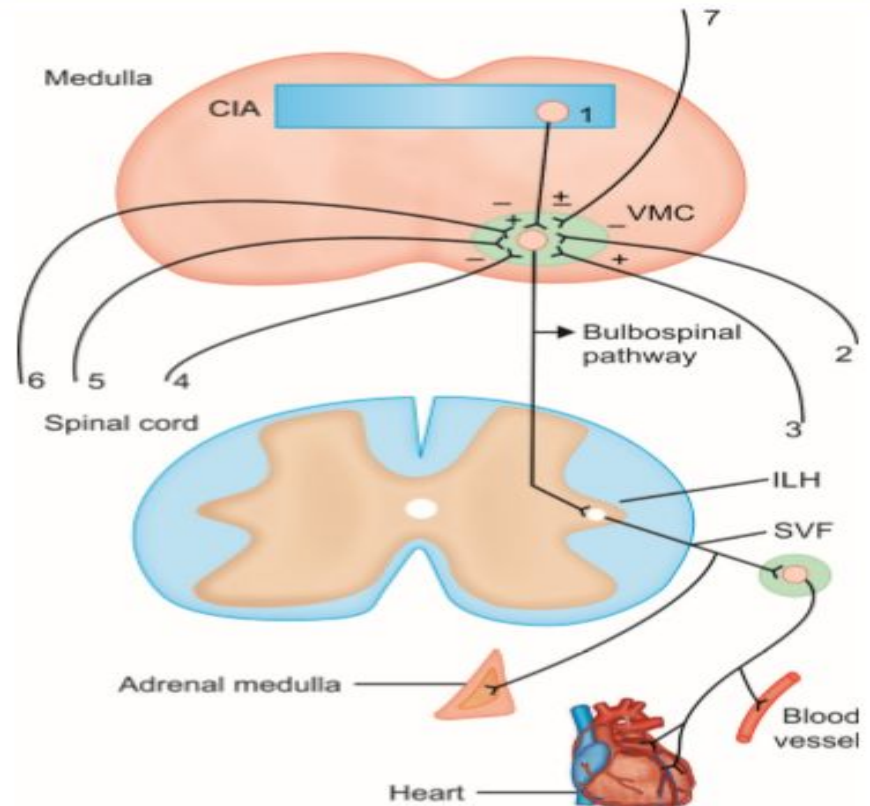
# How does sympathetic NS activity increase BP



# Medullary Control

## Medullary Control:

- Medullary cardiovascular centers are mainly located in the medulla
- These centers primarily control the autonomic output on heart and blood vessels, which is the major cardiovascular regulatory pathway
- Medullary centers are broadly divided into two centers:
  - vasomotor center and
  - cardioinhibitory centers.

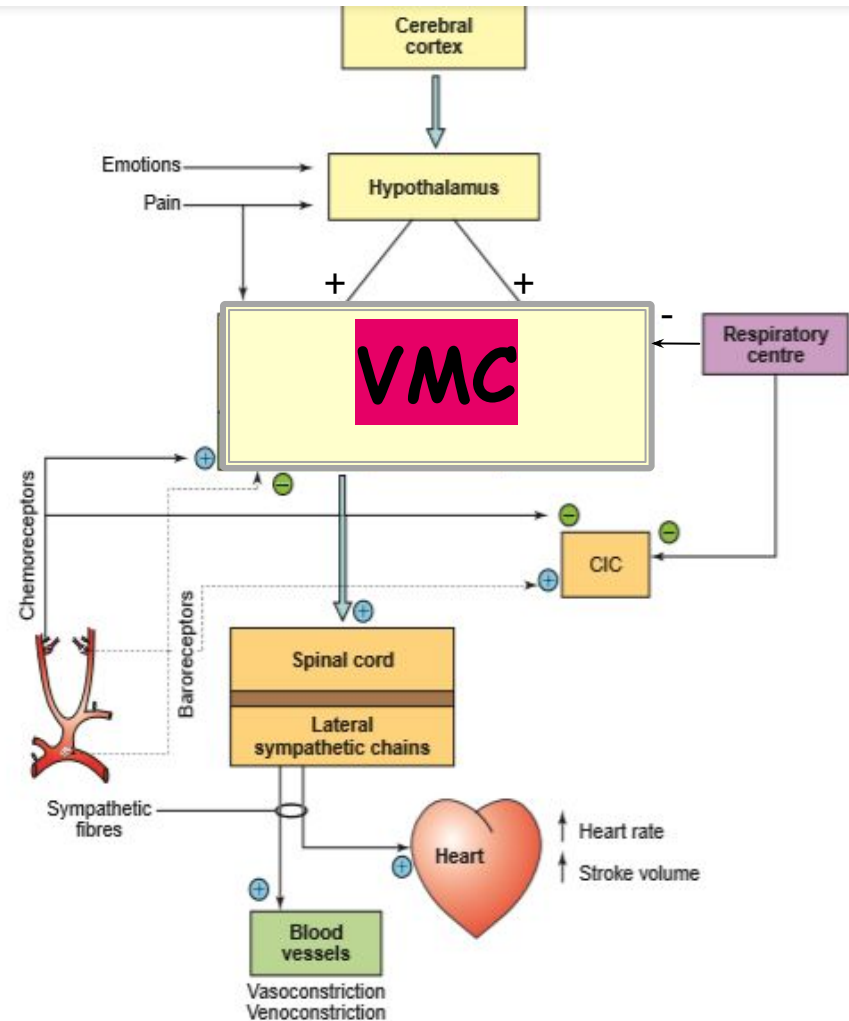


(cardioinhibitory area (CIA  
(Vasomotor center (VMC  
(Sympathetic vasoconstrictor fibers (SVF  
(Intermediolateral horn (ILH



# AFFERENT IMPULSES TO MEDULLARY CARDIOVASCULAR CENTERS

The **medullary control centres** are influenced by afferent control impulses from the **higher centres** and a large number of other areas.



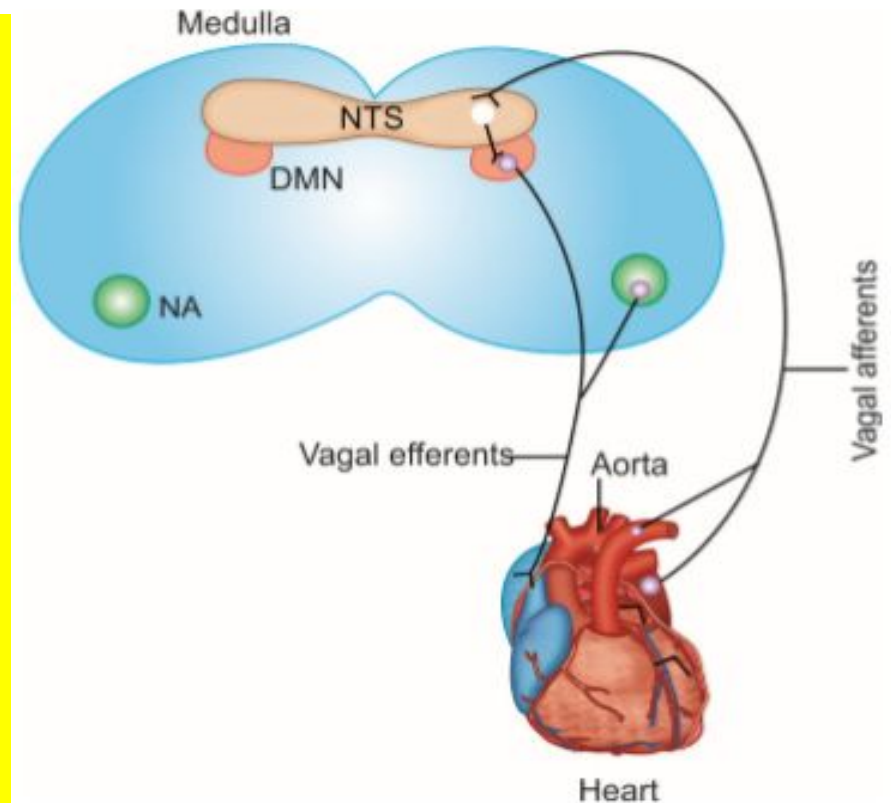
# Medullary Control

Cardioinhibitory center in the medulla is formed by:

- nucleus tractus solitarius (NTS)
- nucleus ambiguus and
- dorsal motor nucleus of vagus.

Stimulation of these areas results in bradycardia and decreased cardiac output by two mechanisms.

1. vagus nerve originates mainly from NTS
2. NTS inhibits vasomotor center via local inhibitory interneurons.



Nucleus tractus solitarius (NTS)  
Dorsal motor nucleus (DMN) of vagus Nucleus ambiguus (NA).

# Reflex Regulation

## Reflex Regulation of Blood Pressure:

- baroreceptor reflex
- chemoreceptor reflex and
- Cushing's reflex

# Baroreceptor Reflex

- The receptors for baroreceptor reflex are **baroreceptors**.
- Functionally, baroreceptors can be grouped as:

1. High-pressure baroreceptors, are located in:

- the ventricle and
- arterial side of circulation, these include:
  - Carotid sinus
  - Aortic arch

2. Low-pressure baroreceptors, are mainly present in:

- the atria and pulmonary circulation (cardiopulmonary baroreceptors) receptors.

Baroreceptors = stretch receptors in the walls of

- Heart

Atria

Volume receptors

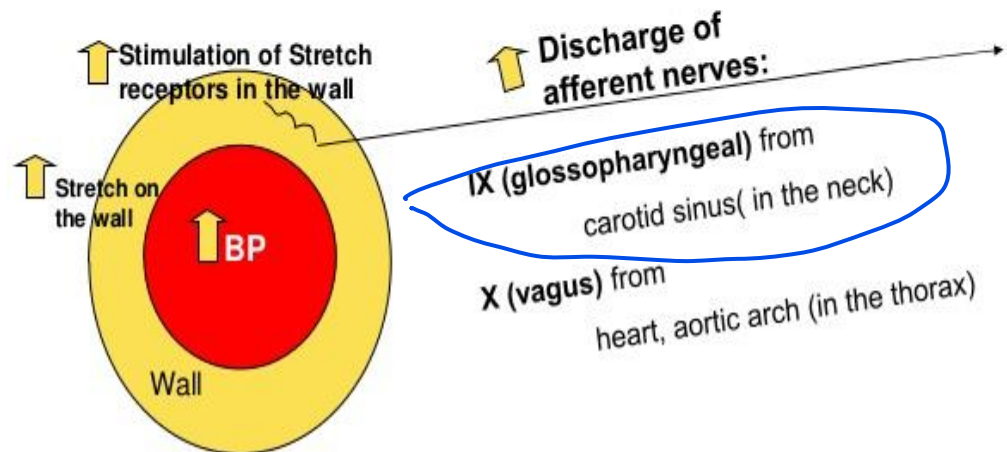
Low pressure baroreceptors

- Arteries (arterial baroreceptors)

Aortic arch

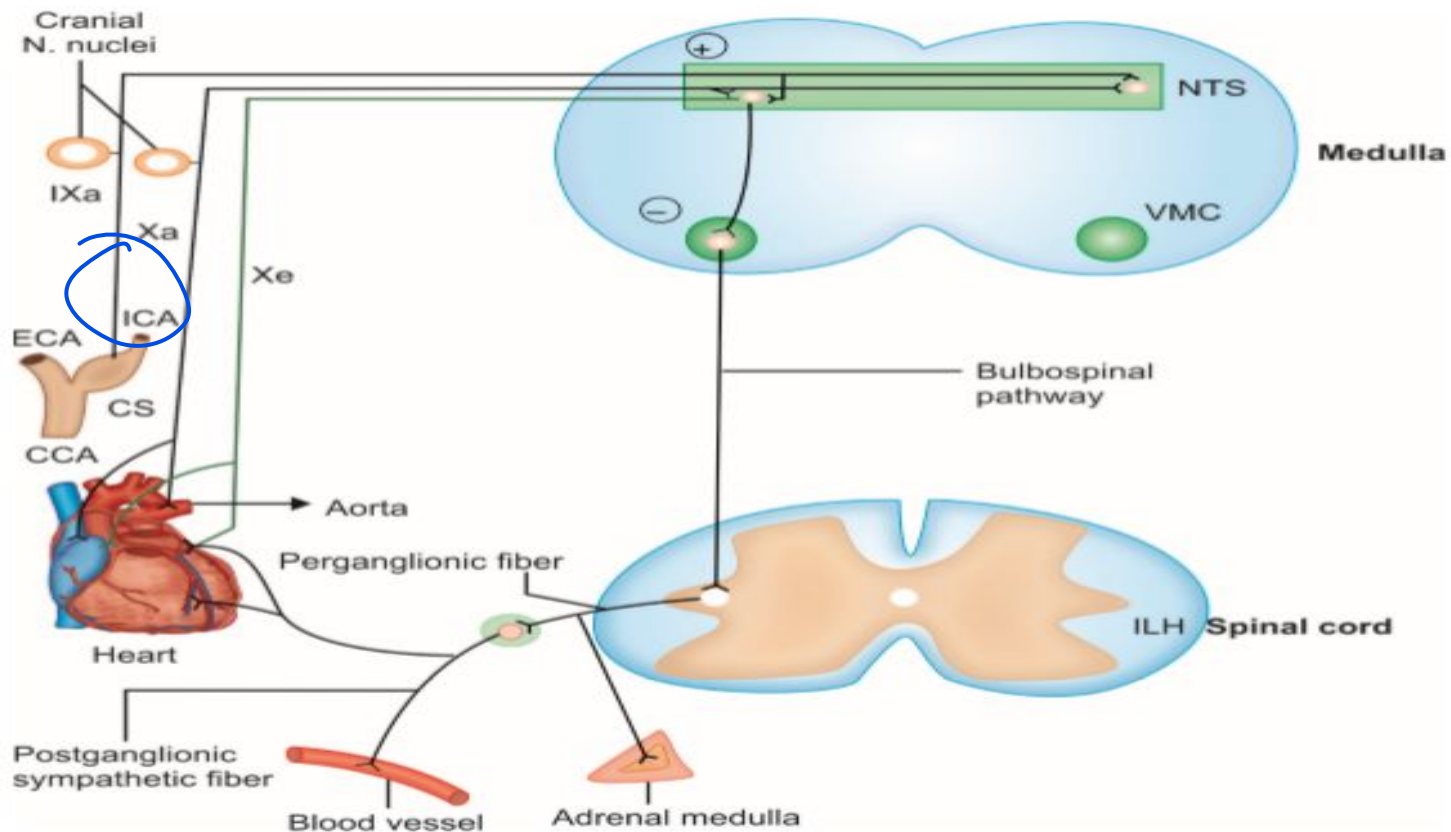
Carotid sinus

High pressure baroreceptors





# Baroreceptor reflex



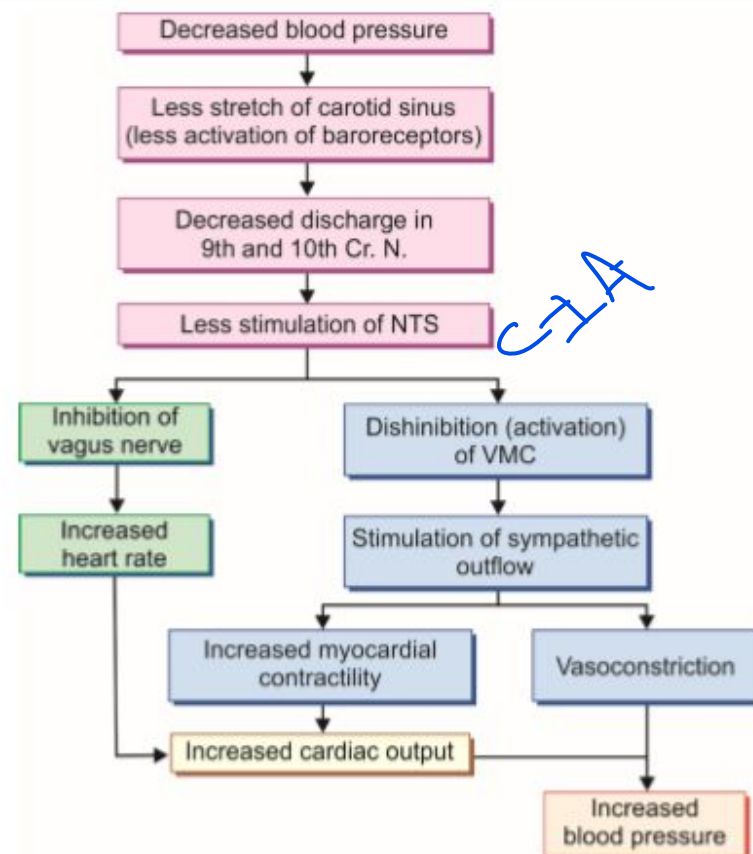
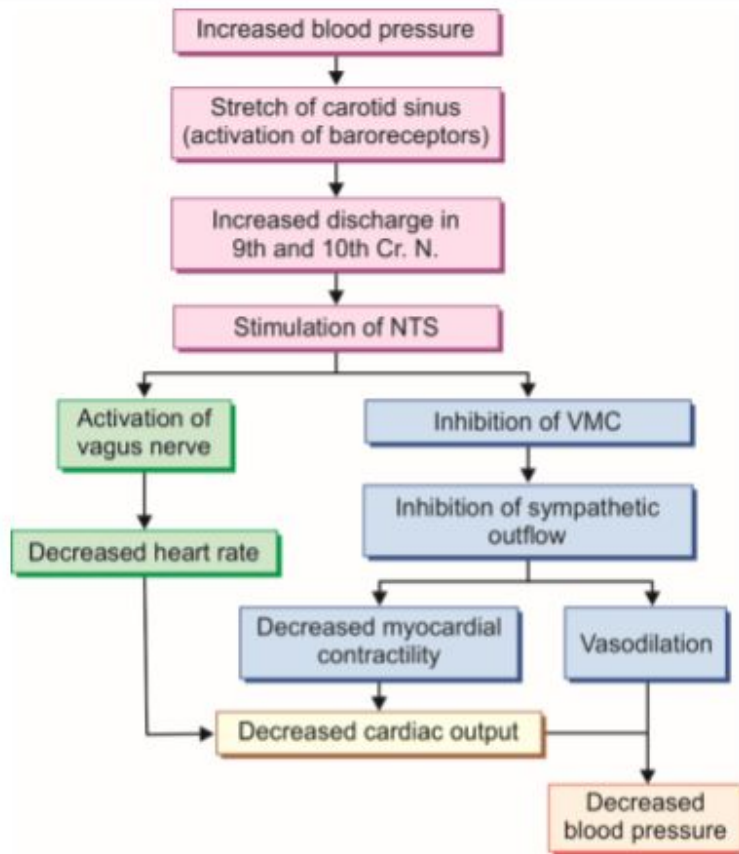
Afferent pathway is formed by 9th (IXa) and 10th cranial nerves (Xa) and Efferent fibers of 10th cranial nerve (Xe)

CCA: Common carotid artery

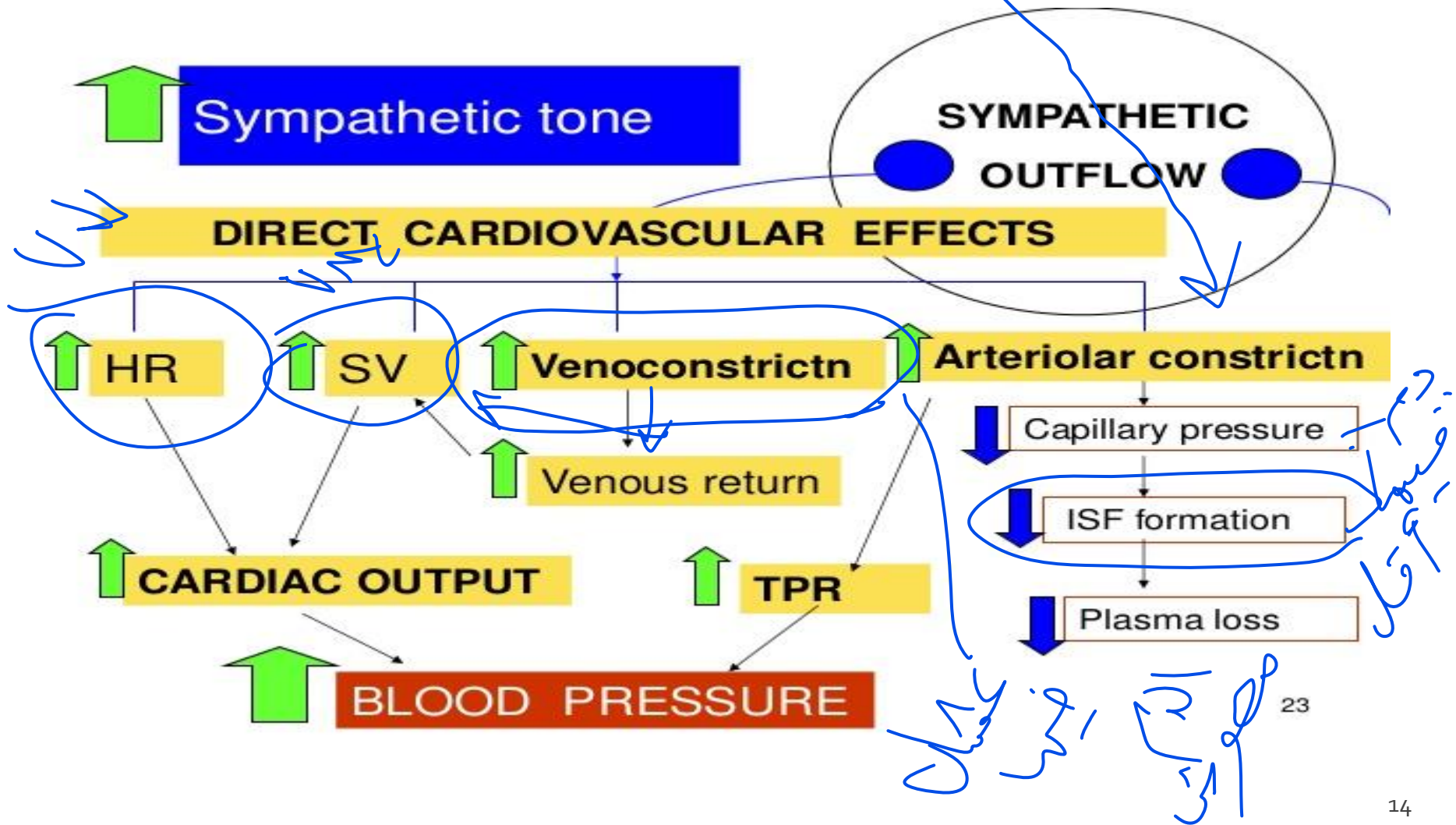
ICA: Internal carotid artery; ECA: External carotid artery; CS: Carotid sinus

+: Excitatory neurotransmitter like glutamate; -: Inhibitory neurotransmitter like GABA.

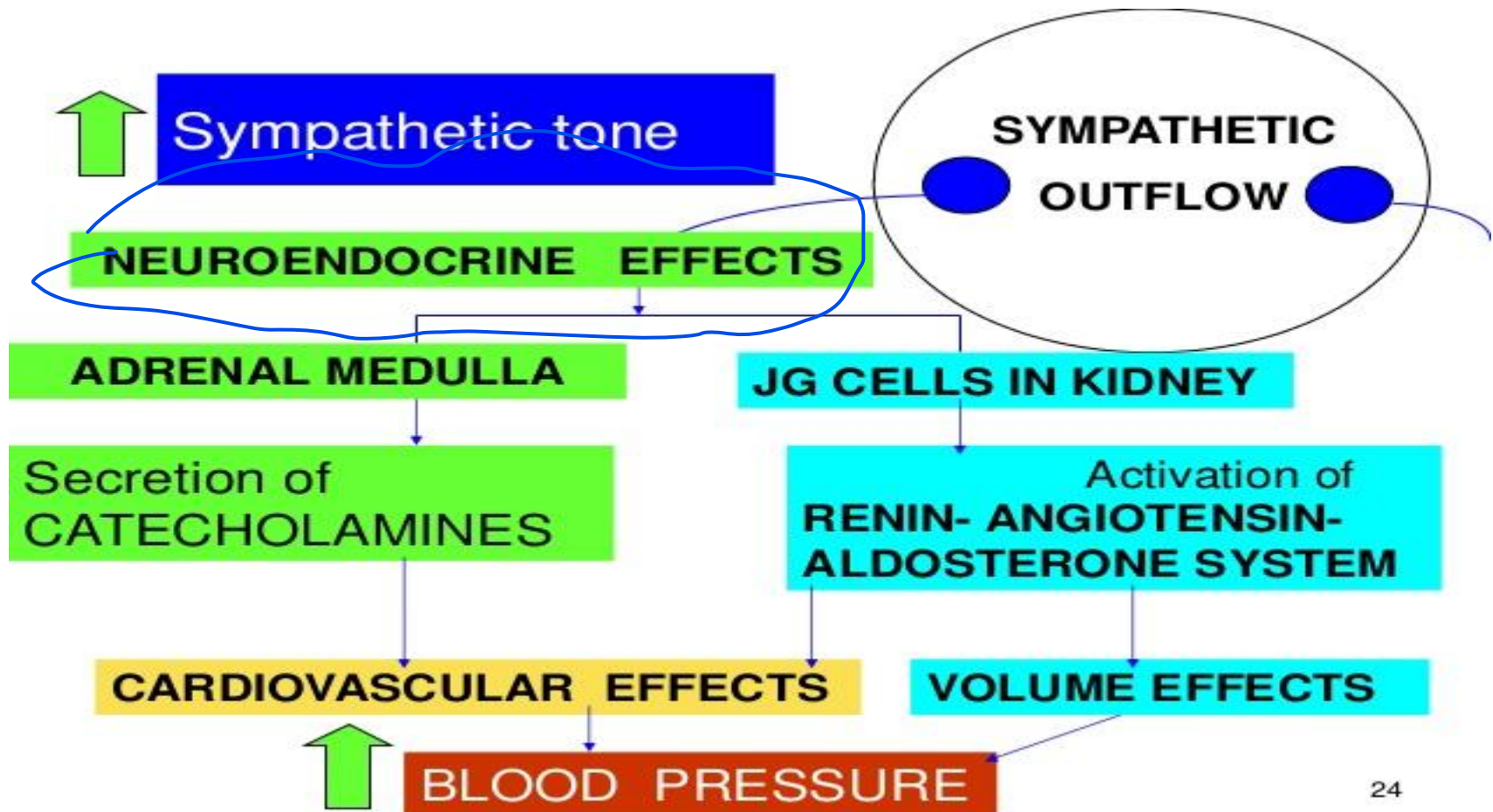
# Baroreceptor reflex



# Sympathetic efferent pathways and effector organs

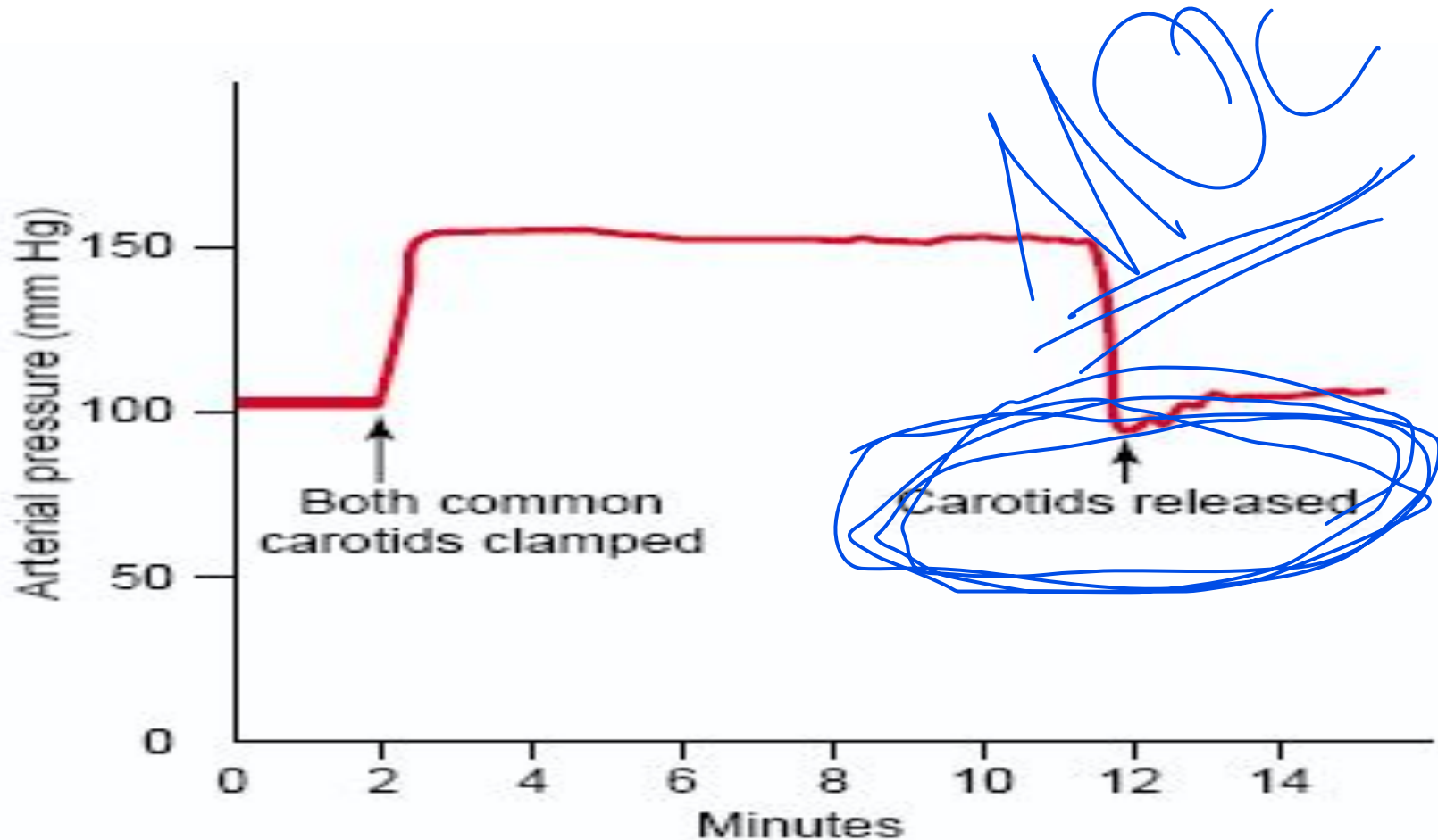


# Sympathetic efferent pathways and organs

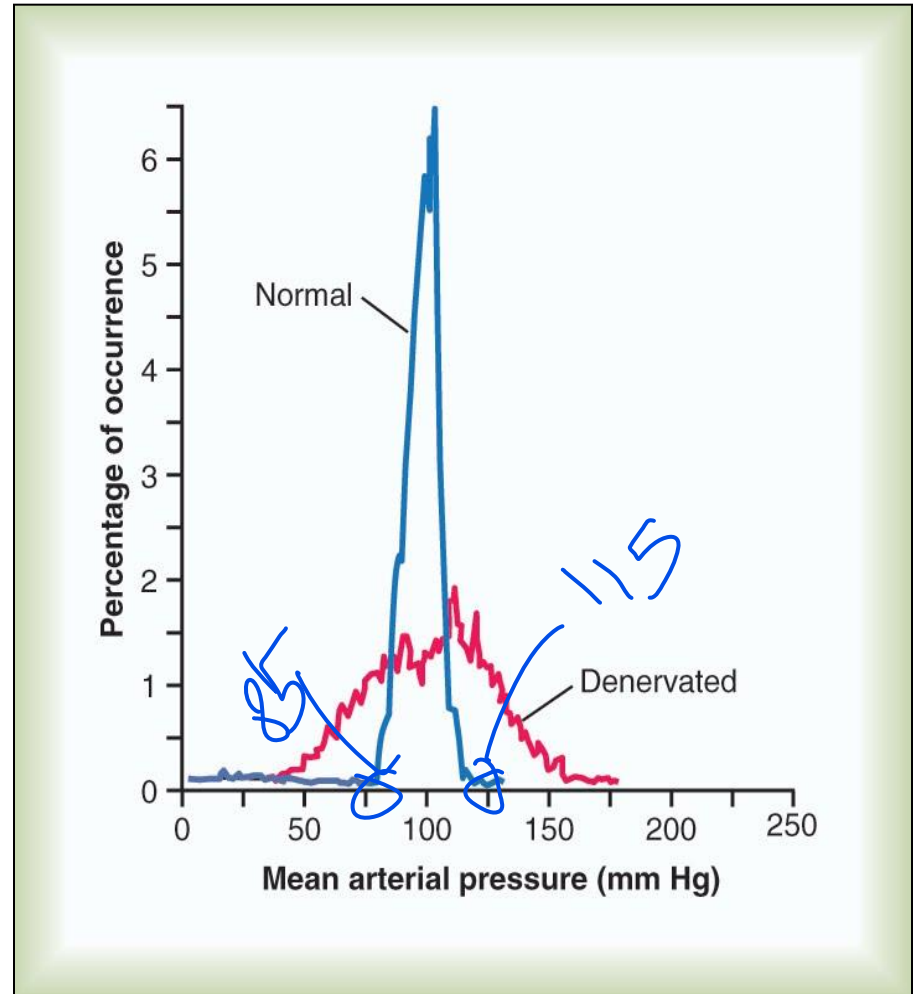
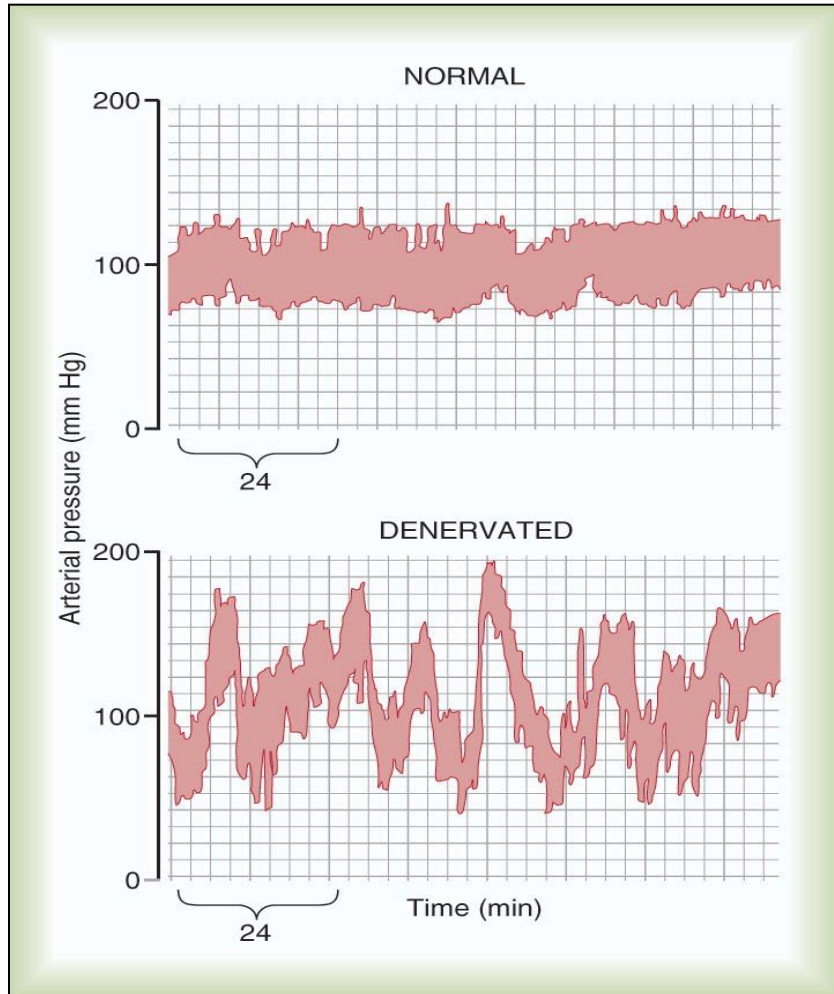




# Response of carotid and aortic baroreceptors to pressure

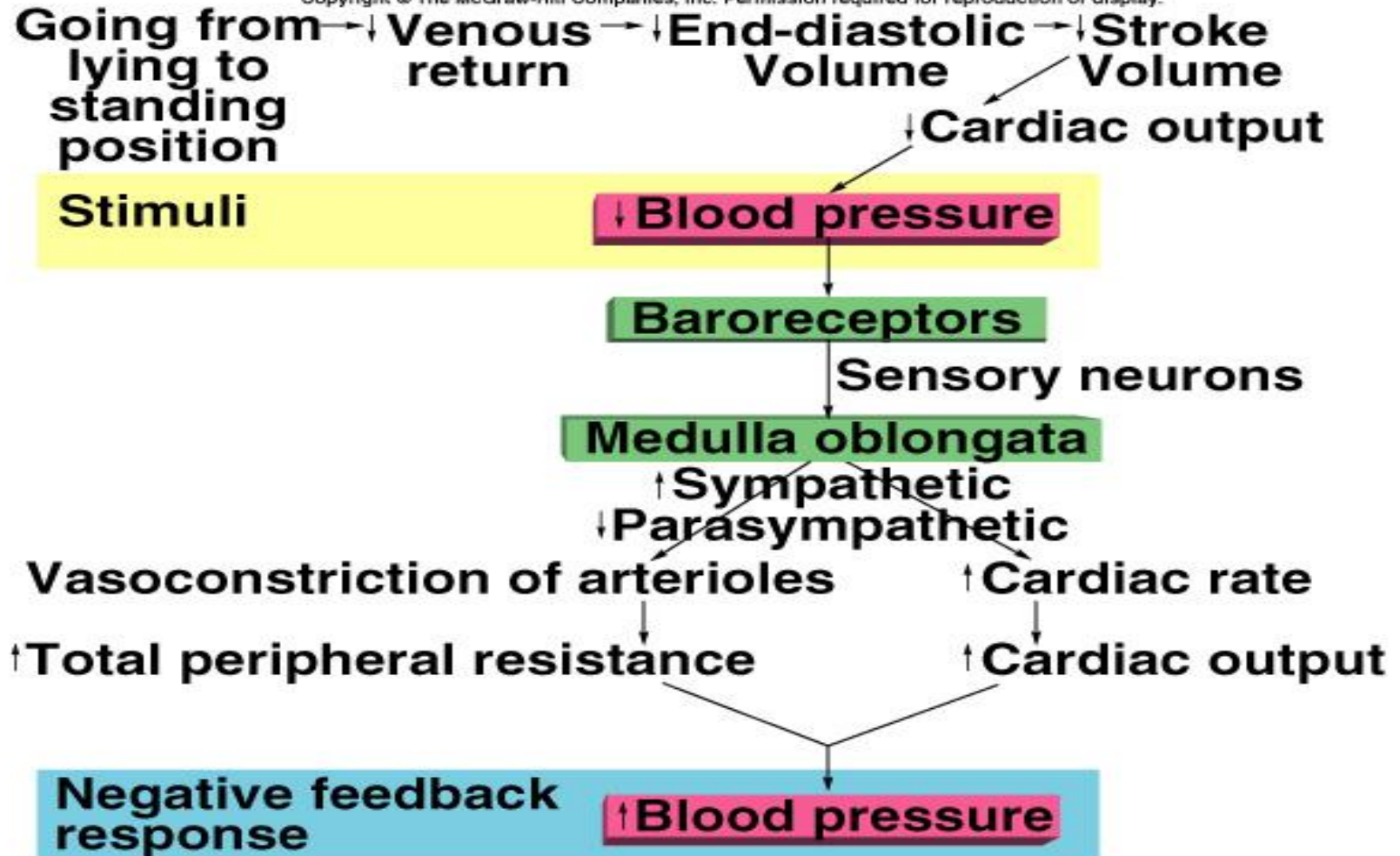


# Pressure "Buffer" Function of the Baroreceptor Control System.

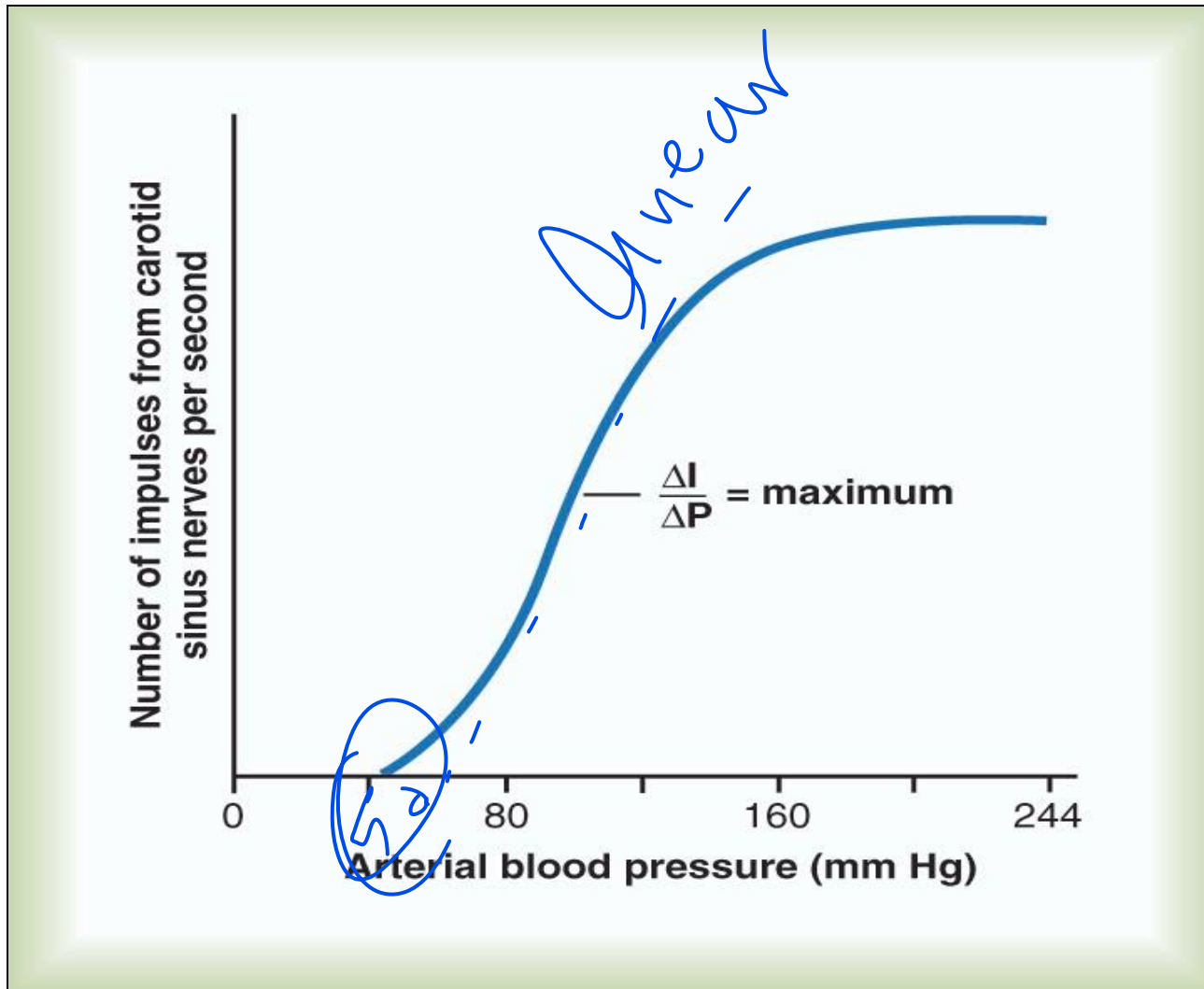


# Physiological Significance of Baroreceptor Reflex

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# Pressure range of baroreceptor reflex

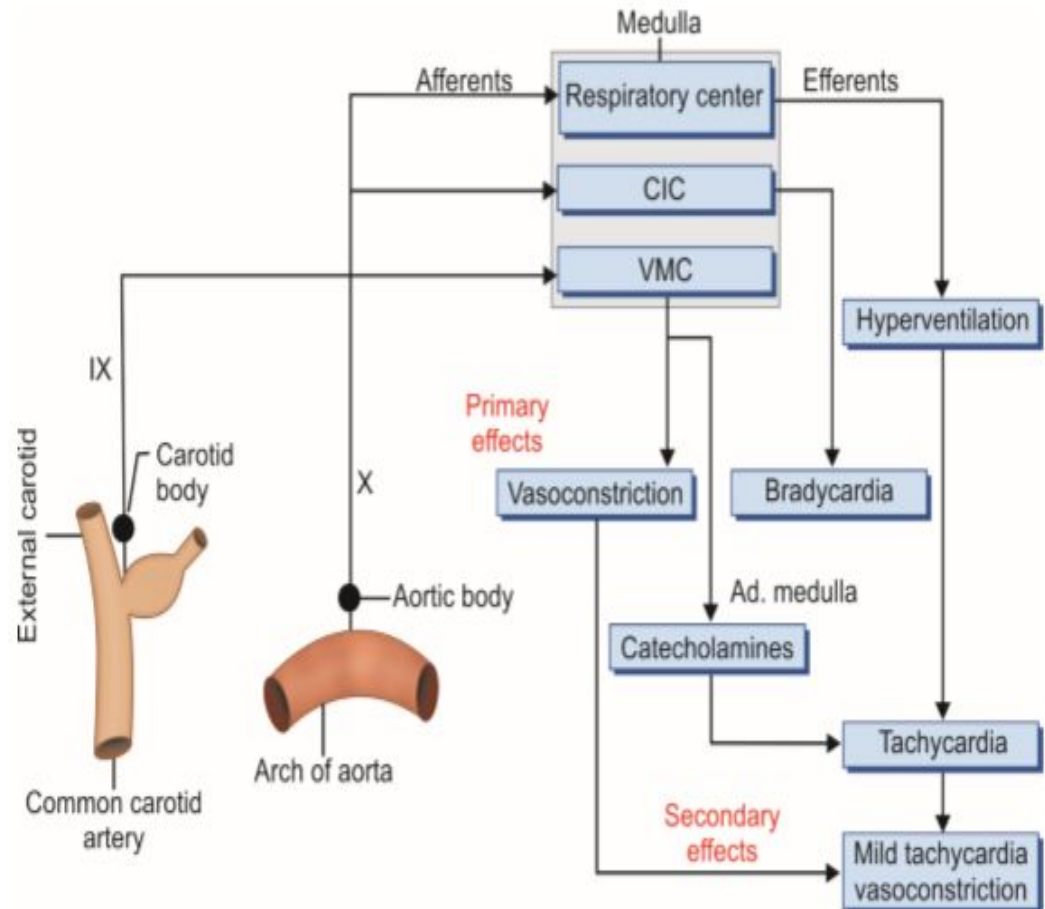




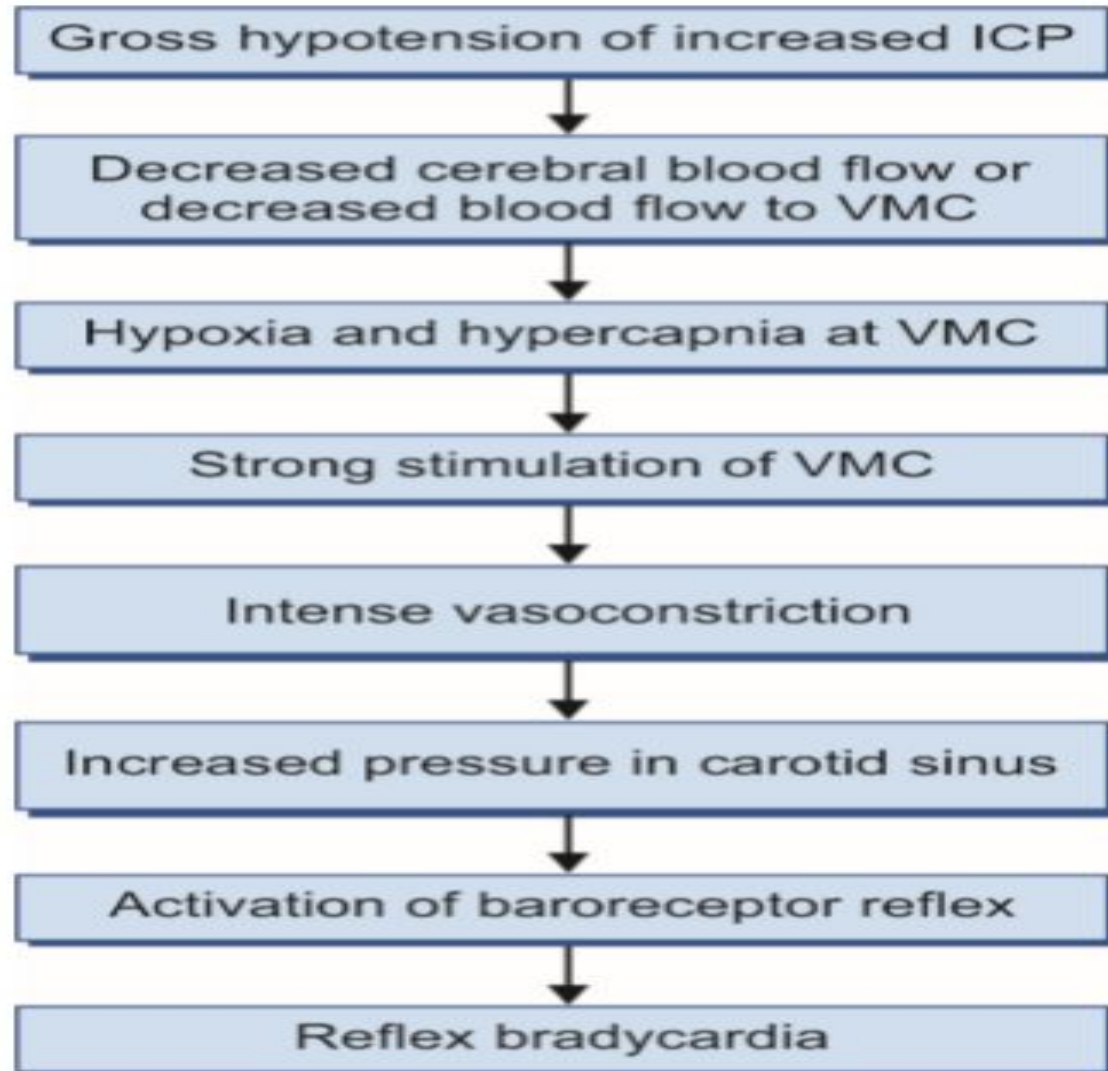
# Chemoreceptor Reflex

Chemoreceptors are located in:

- the aortic and carotid bodies.
- They respond to change in chemical composition of blood that includes hypoxia, hypercapnia, and acidosis.



# CNS Ischemic Response (Cushing's Reflex)



# Atrial Stretch Reflex

Baroreceptors = stretch receptors in the walls of

- Heart  
Atria

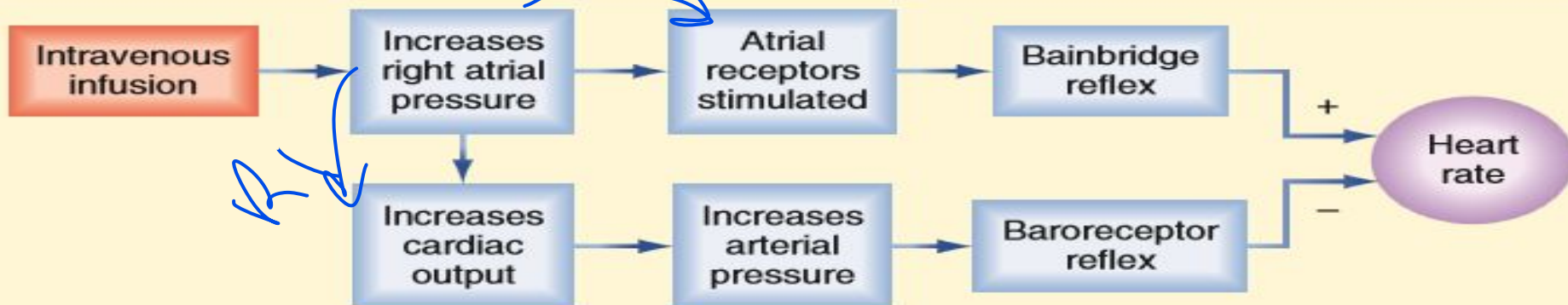
Volume receptors  
Low pressure baroreceptors

- Arteries (arterial baroreceptors)  
Aortic arch  
Carotid sinus

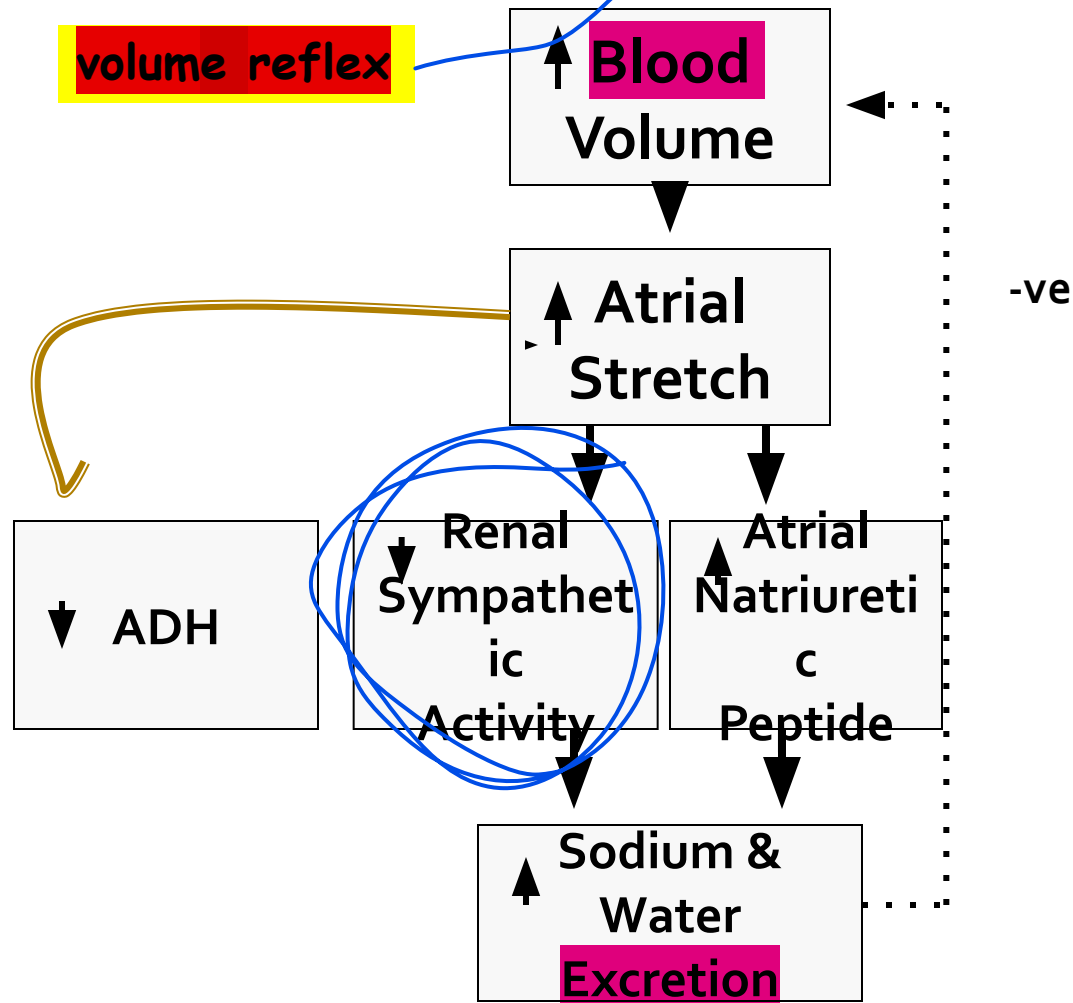
High pressure baroreceptors



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# Atrial Stretch Reflex



# Vascular Mechanisms

- The vascular mechanisms operate within **seconds to minutes** of alteration in blood pressure.

These are:

- **capillary fluid shift**
- stress relaxation.

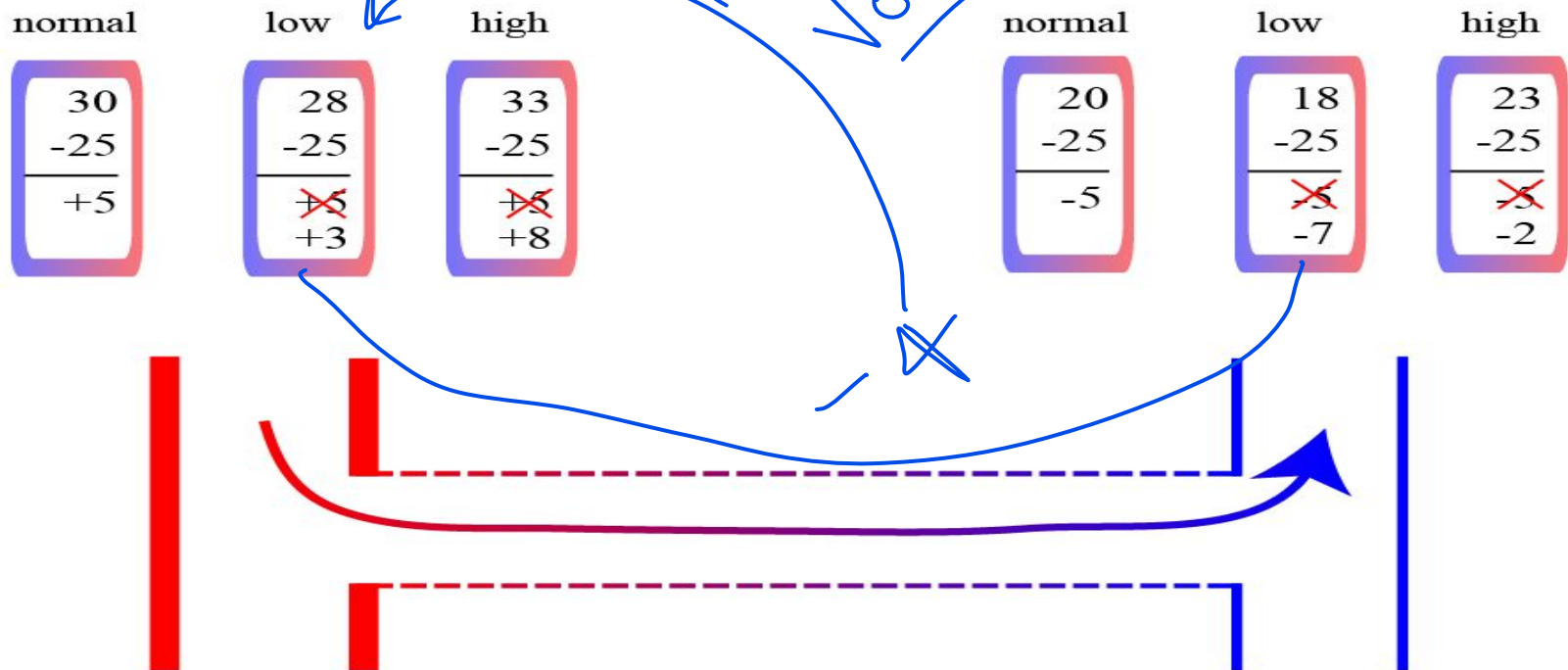


# Capillary Fluid Shift

## Capillary Fluid Shift

pressures at the beginning  
of the capillary

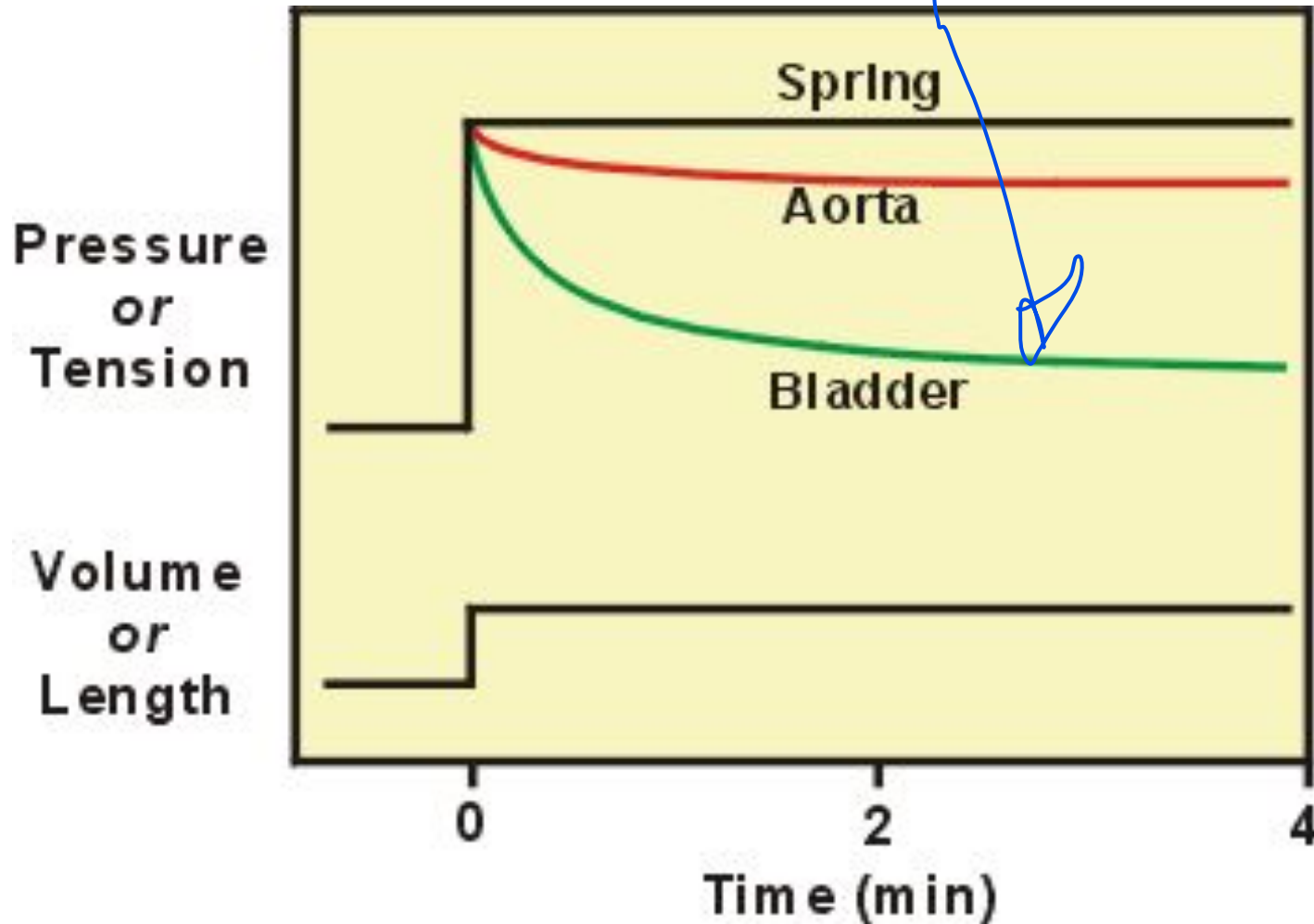
pressures at the end  
of the capillary



p.s. The oncotic pressure is set at 25 mmHg in this example.

BasicPhysiology.com

# Stress Relaxation



# HUMORAL CONTROL MECHANISMS

Vasoconstrictors	Vasodilators
Epinephrine (through $\alpha_1$ receptors) ✓	Epinephrine (through $\beta_2$ receptors)
Serotonin	Histamine
ANG II	ANP
AVP	Bradykinins
Endothelin	PGE <sub>2</sub> , PGI <sub>2</sub> NO

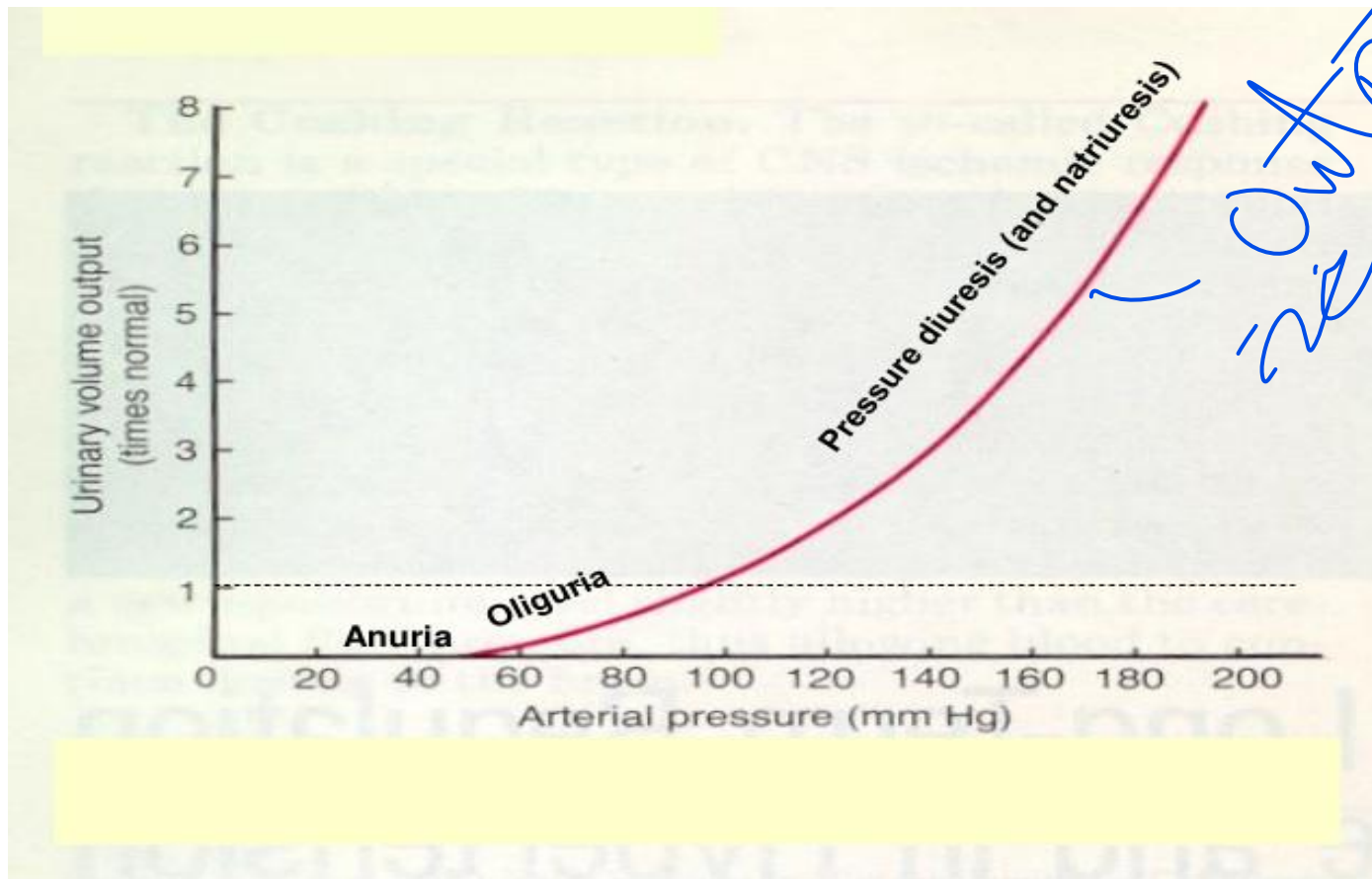


SJM



# Long-term regulation of blood Pressure

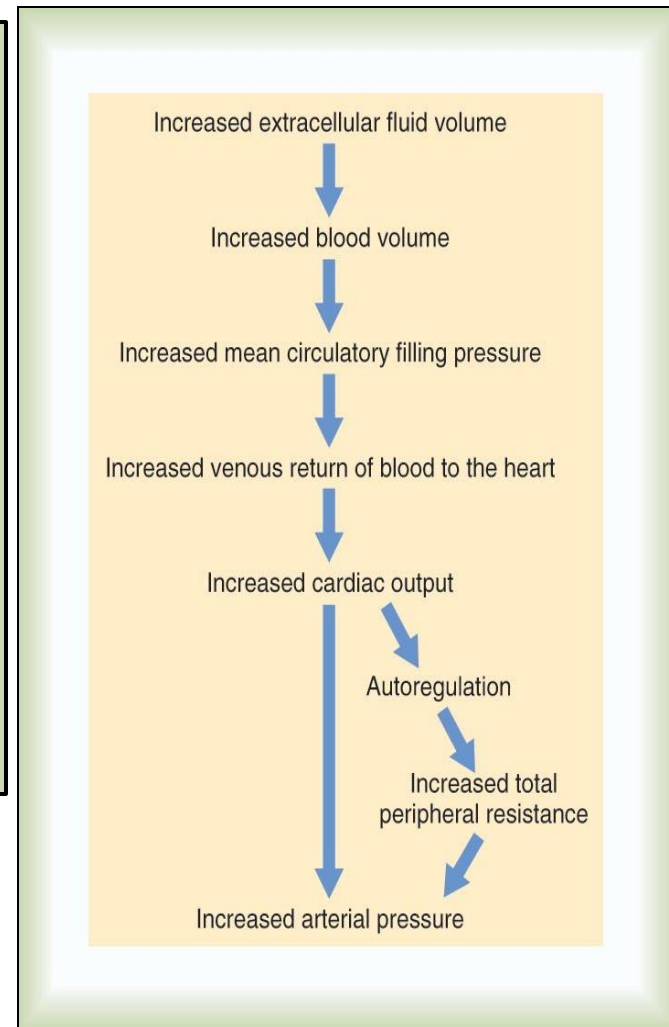
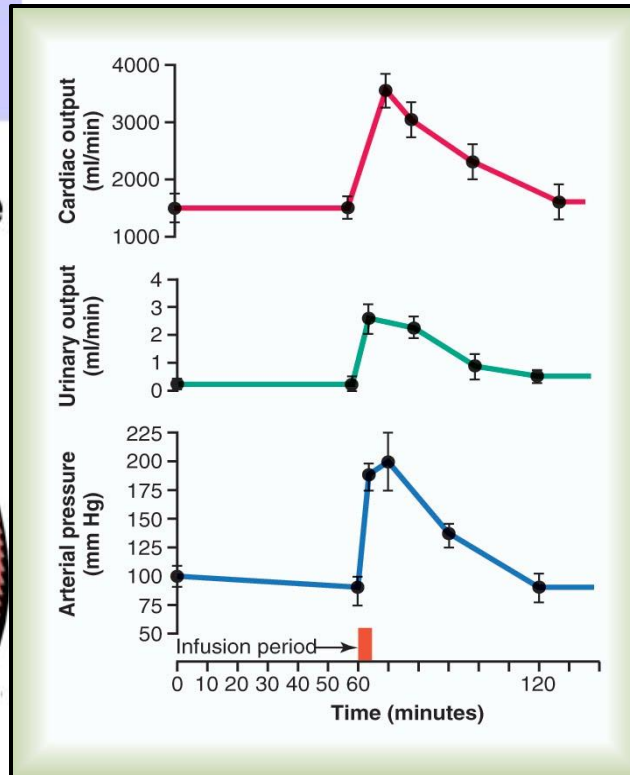
## Renal Mechanism



# Long-term blood pressure control mechanisms

## Renal regulation of B.P.

- I. Physical : by variation of Glomerular filtration pressure → variation in urine formation
- II. Hormonal : by secretion of renin
  - → Renin-Angiotensin (AGII)-Aldosterone system (RAAS)





# Hormonal Mechanisms

Hormones that are involved in longterm control of blood pressure are:

Renin-Angiotensin-Aldosterone System

- ADH
- ANP

These hormones act on kidney to regulate water and sodium excretion.

