

# **Blood Pressure Regulation**

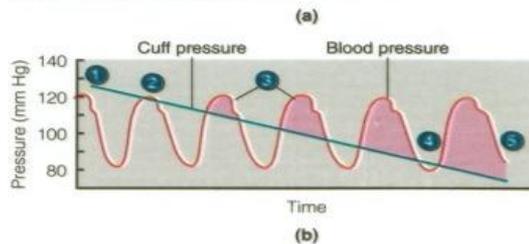
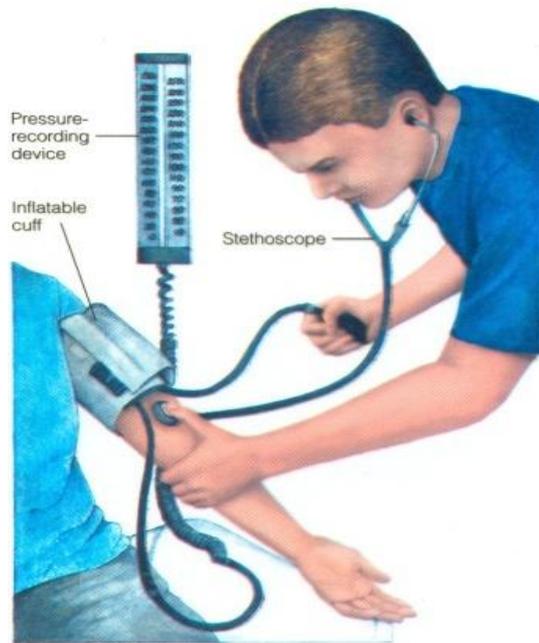
Faisal I. Mohammed, MD, PhD

# Objectives

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- Outline the short term and long term regulators of BP
- Know how baroreceptors and chemoreceptors work
- Know function of the atrial reflex.
- Know function of CNS ischemic reflex.
- Know the role of Epinephrine, Antidiuretic hormone (ADH), Renin-Angiotensin-Aldosterone and Atrial Natriuretic Peptide (ANP) in BP regulation
- Know the role of Kidney-body fluid system in long term regulation of BP

# Sphygmomanometry



When blood pressure is 120/80:



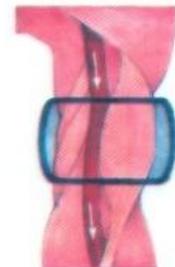
When cuff pressure is greater than 120 mm Hg:

No blood flows through the vessel.  
No sound is heard.



When cuff pressure is between 120 and 80 mm Hg:

Blood flow through the vessel is turbulent whenever blood pressure exceeds cuff pressure.  
Intermittent sounds are heard as blood pressure fluctuates throughout the cardiac cycle.



When cuff pressure is less than 80 mm Hg:

Blood flows through the vessel in smooth, laminar fashion.  
No sound is heard.

(c)

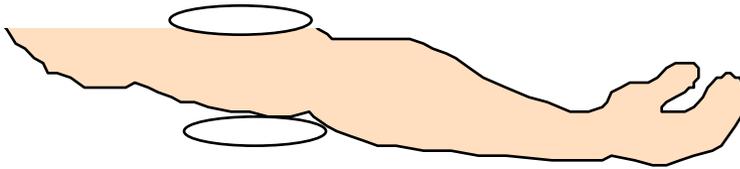
# Measurement of Systolic and Diastolic Pressures

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- *Auscultatory* method is the most commonly used method for measuring systolic and diastolic pressures.
- When cuff pressure reaches systolic pressure, one begins to hear *tapping* sounds in the antecubital artery; as the cuff pressure reaches diastolic pressure, one hears *muffled* sounds and then Korotkoff sounds *disappear*.
- Mean arterial pressure can be estimated by adding 40% of systolic pressure to 60% of diastolic pressure.

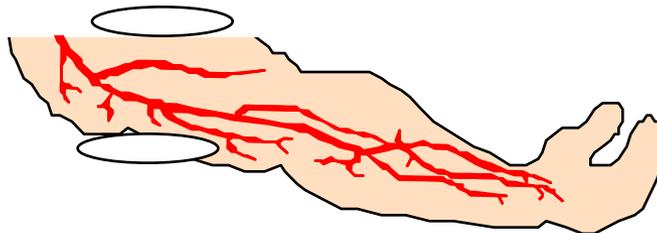
# Effect of Cuff Pressure on Brachial Blood Flow

**Cuff Pressure > 120**



**NO FLOW**

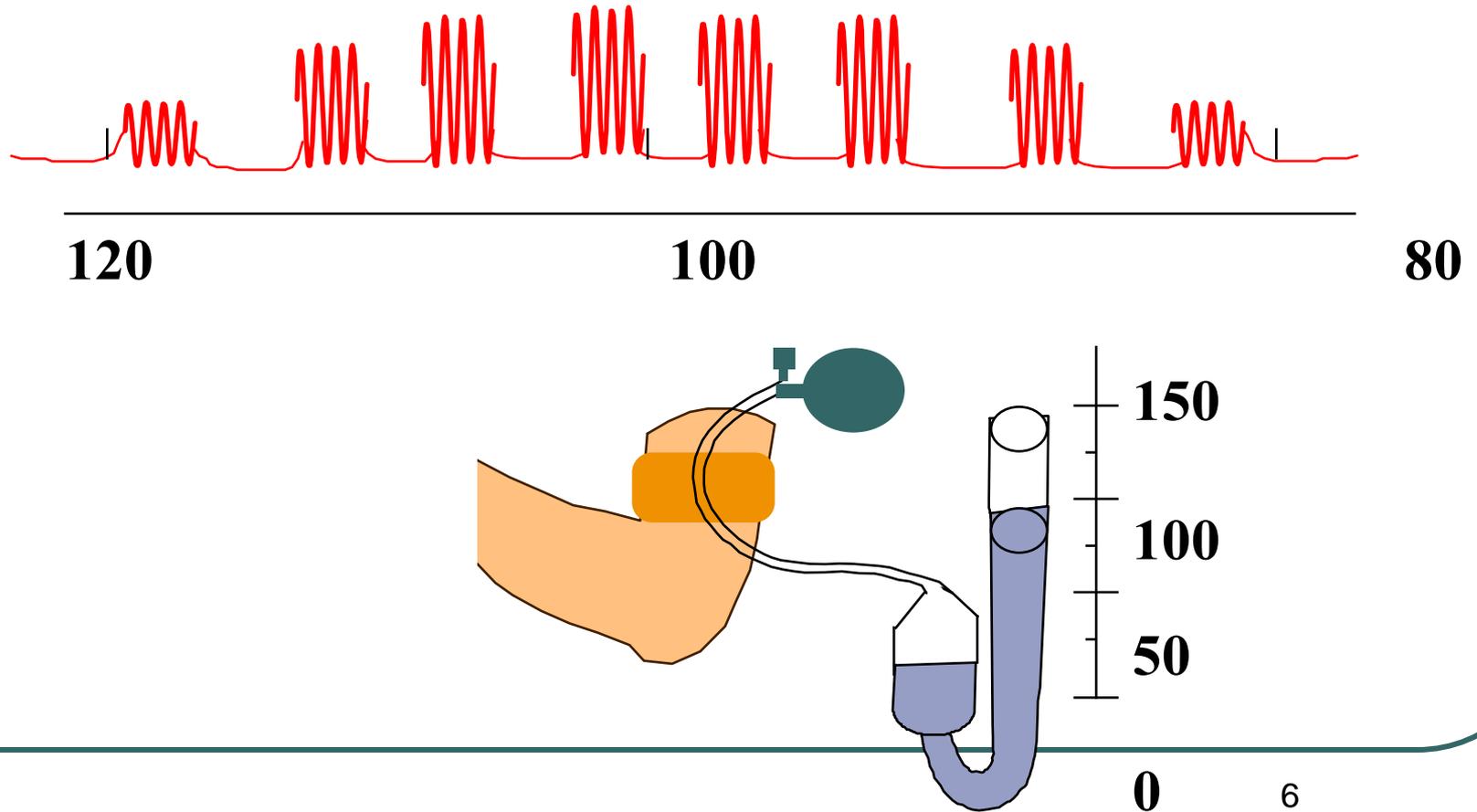
**Cuff Pressure < 80**



**FREE FLOW**

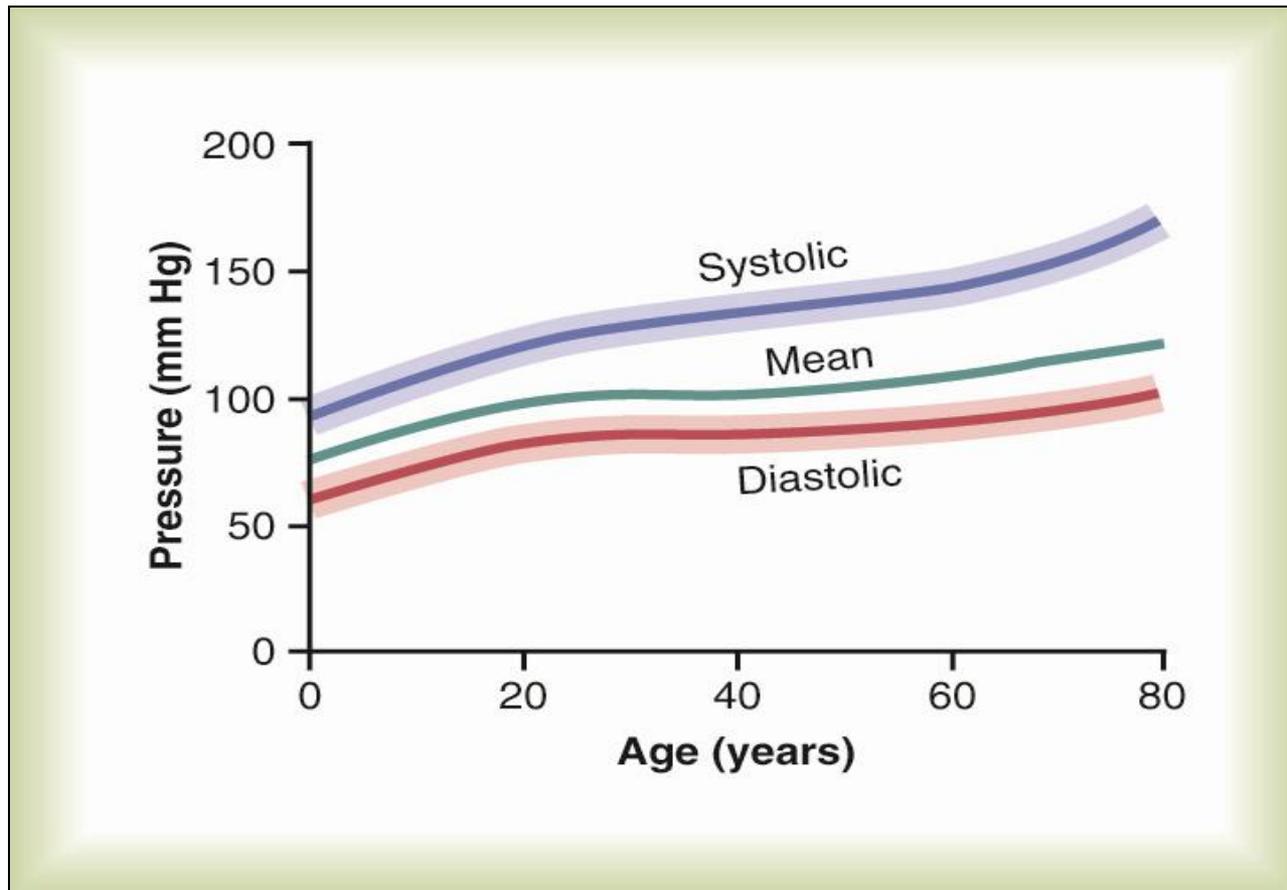
# Measurement of Blood Pressure

## *Use of Korotkoff Sounds*

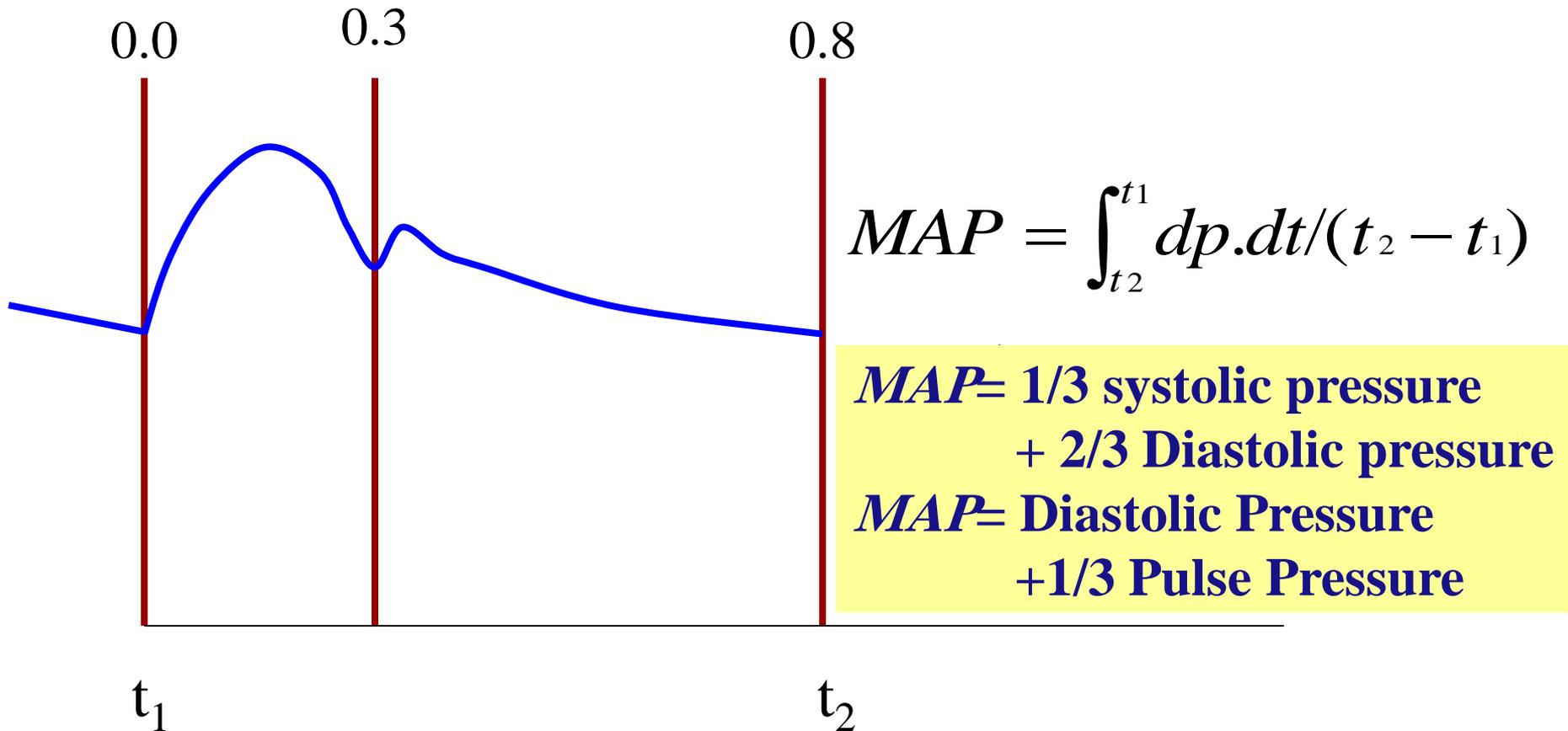


# Mean Arterial Pressure

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# Mean Arterial Pressure (MAP)



# Blood Pressure Regulation

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- Mean Arterial Pressure (MAP) = 1/3 systolic pressure + 2/3 diastolic pressure
- MAP= Diastolic Pressure+1/3 Pulse Pressure

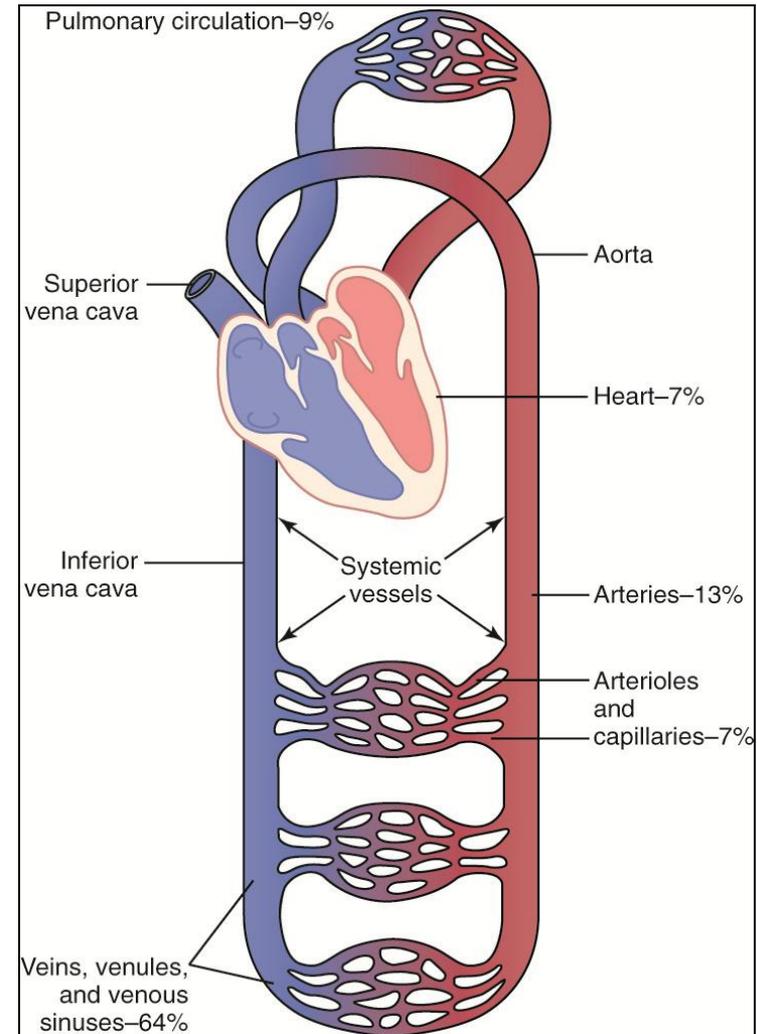
$$CO = \frac{MAP}{TPR}$$

$$MAP = CO * TPR$$

# Arterial Pressure = Cardiac Output x Total Peripheral Resistance

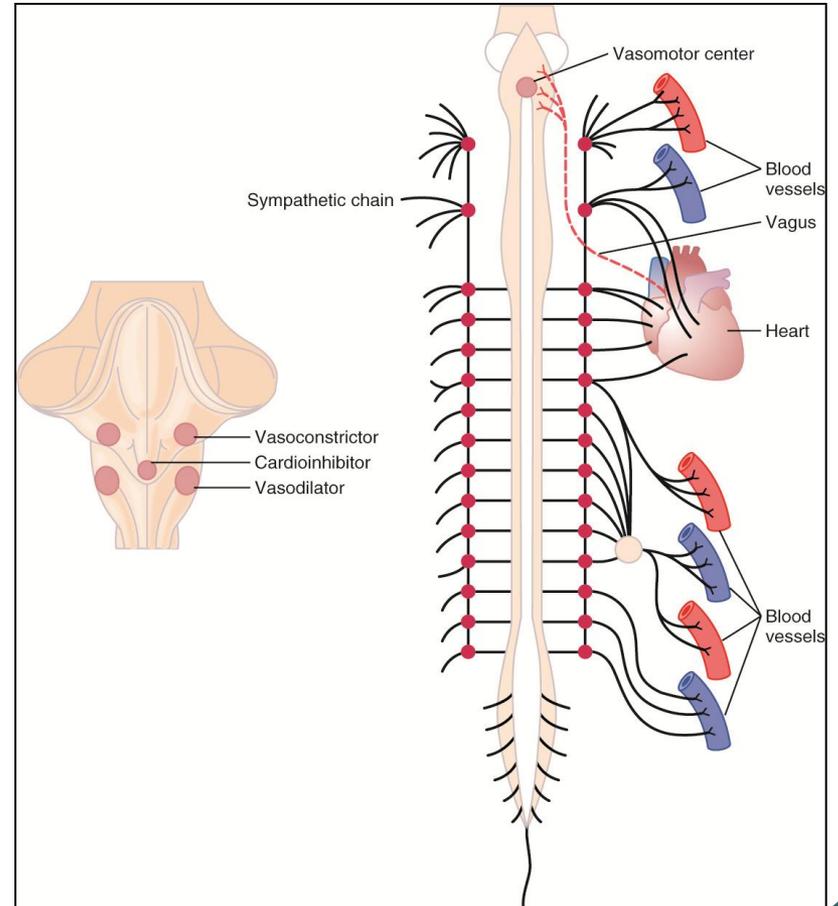
Arterial Pressure can be increased by:

- Constricting almost all arterioles of the body which increases total peripheral resistance.
- Constricting large vessels of the circulation thereby increasing venous return and cardiac output.
- Directly increasing cardiac output by increasing heart rate and contractility.



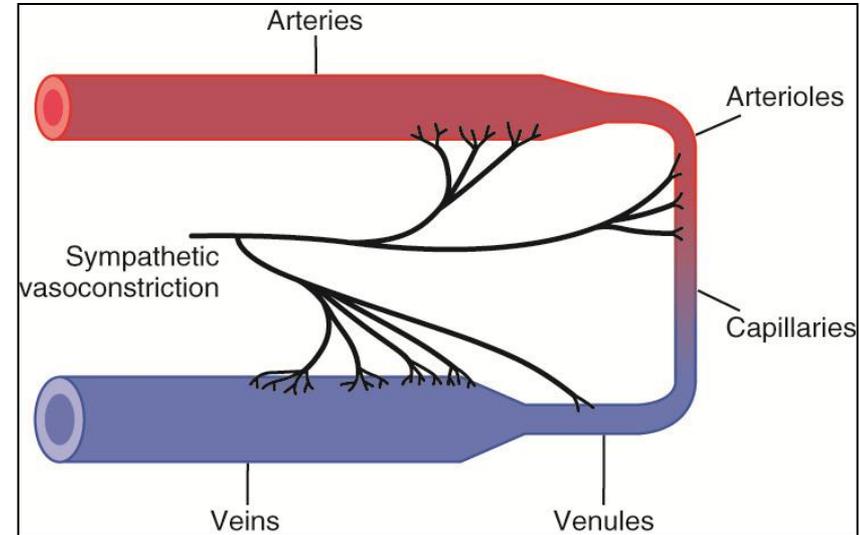
# Autonomic Nervous System

- Sympathetic nervous system is important in *control of circulation*.
- Parasympathetic nervous system is important in regulating *heart function*.



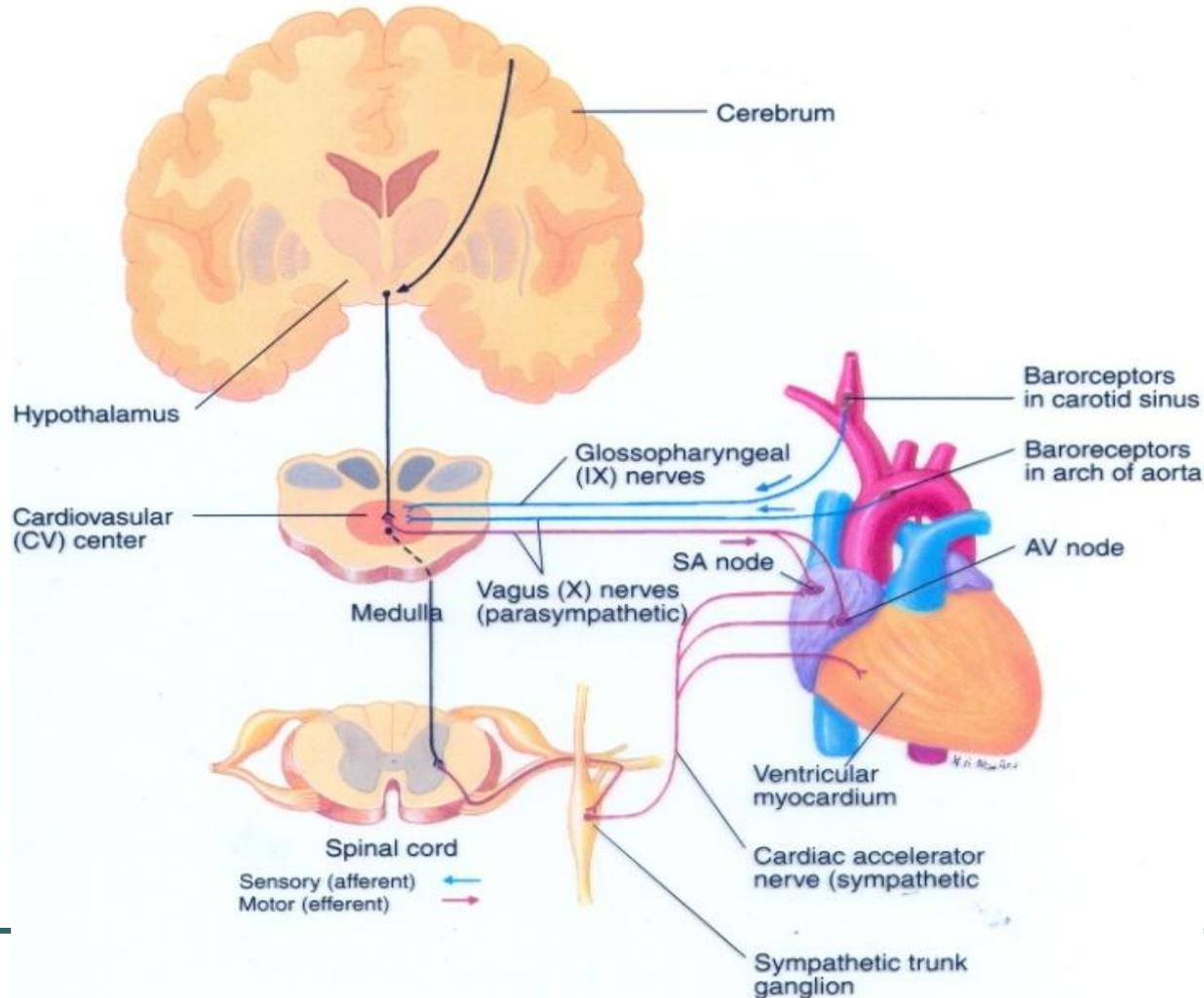
# Sympathetic Innervation of Blood Vessels

- ***Sympathetic*** nerve fibers innervate *all* vessels *except* capillaries and precapillary sphincters and some metarterioles.
- Innervation of small arteries and arterioles allow sympathetic nerves to *increase vascular resistance*.
- *Large veins* and *the heart* are also sympathetically innervated.
- ***Parasympathetic*** nervous system is mainly important in control of *heart rate* via the vagus nerve.

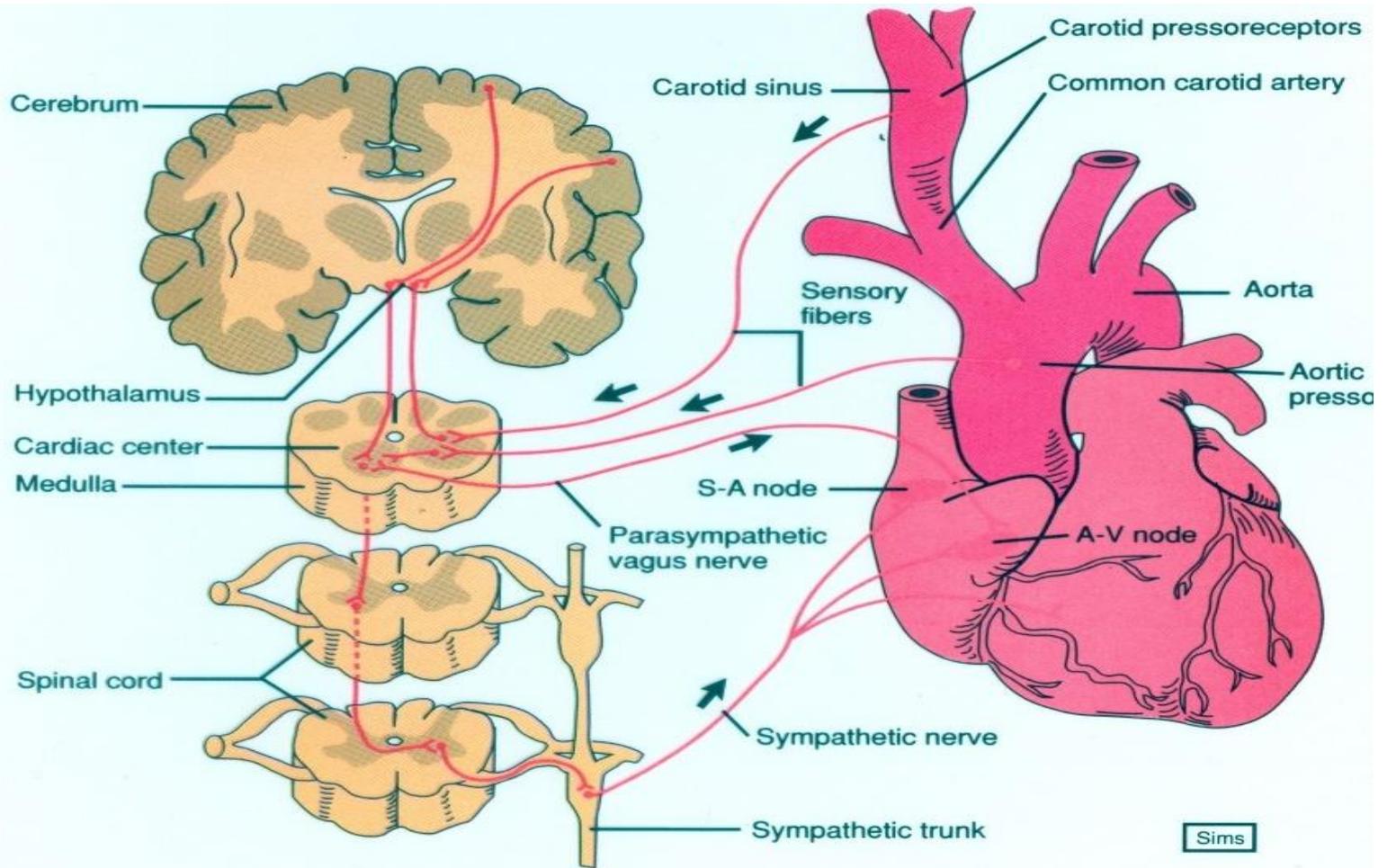


# Short term regulation of BP

1. Baroreceptors or pressoreceptors (High pressure)
2. Carotid and Aortic Baroreceptors



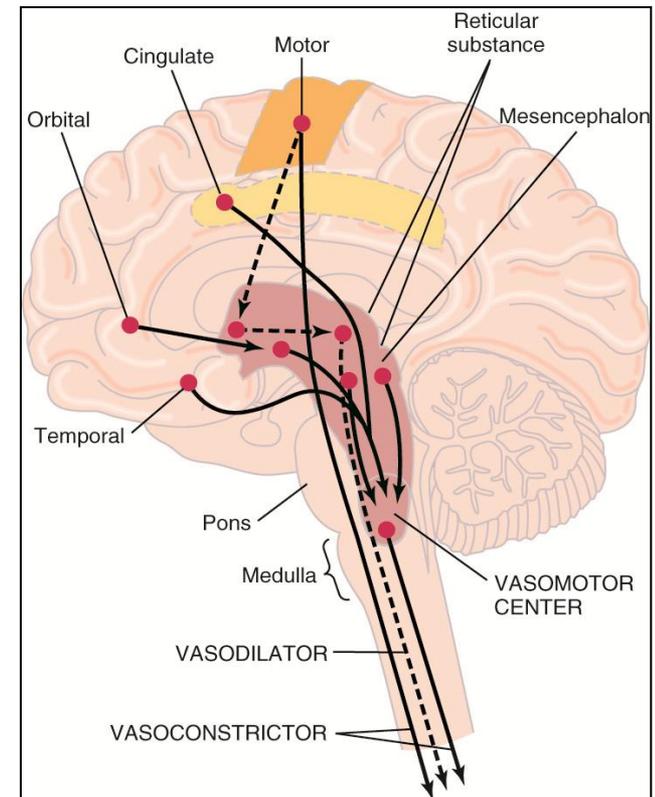
# Short term regulation of BP cont...



## 1. Baroreceptors or pressoreceptors (High pressure)

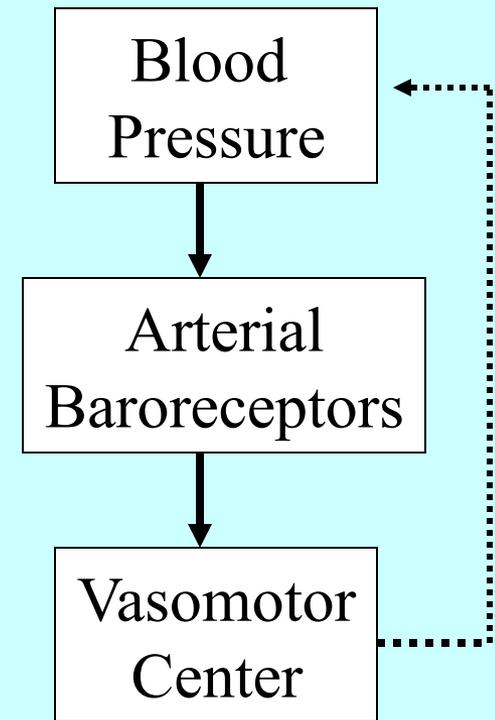
# The Vasomotor Center (VMC)

- The VMC transmits impulses downward through the cord to almost all blood vessels.
- VMC is located bilaterally in the reticular substance of the medulla and the lower third of the pons.
- The VMC is composed of a vasoconstrictor area, vasodilator area, and sensory area.



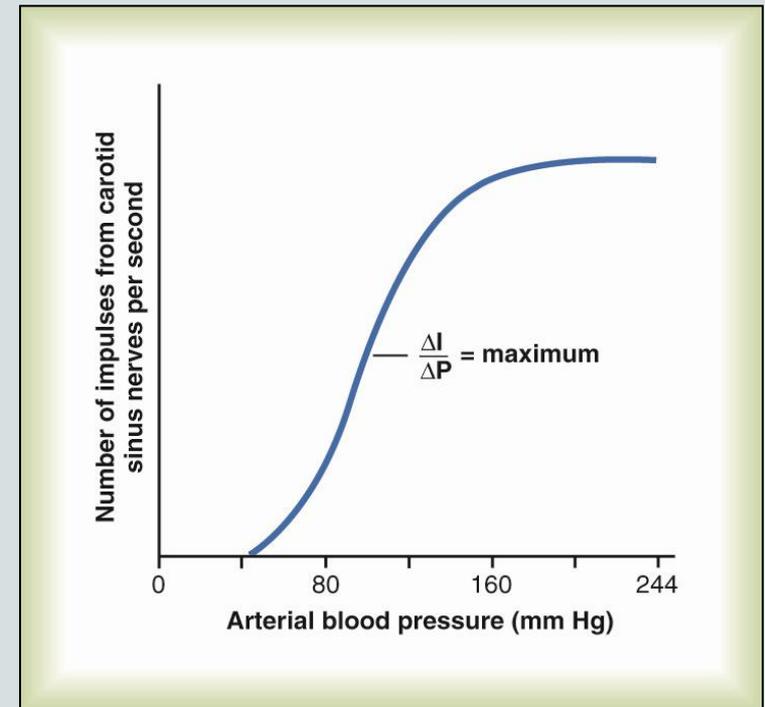
# Arterial Baroreceptor Reflex

- Important in *short term regulation* of arterial pressure.
- Reflex is initiated by stretch receptors called *baroreceptors* or *pressoreceptors* located in the walls of the large systemic arteries.
- A rise in pressure stretches baroreceptors and causes them to transmit signals to the VMC and feedback signals are sent via the autonomic nervous system to the circulation to reduce AP back to normal.



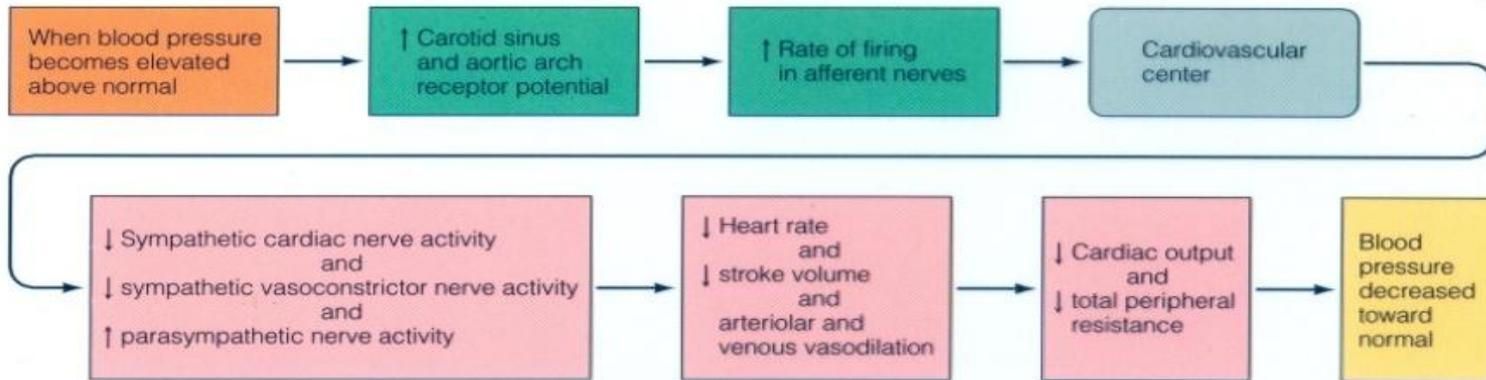
# Response of the Baroreceptors to Arterial Pressure

- Carotid sinus baroreceptors respond to pressures between *60 and 180 mmHg*.
- Baroreceptors respond to *changes* in arterial pressure.
- Baroreceptors reflex is most sensitive at a pressure of *100mmHg*.
- As pressure *increases* the number of impulses from carotid sinus *increases* which results in:
  - 1) inhibition of the vasoconstrictor
  - 2) activation of the vagal center

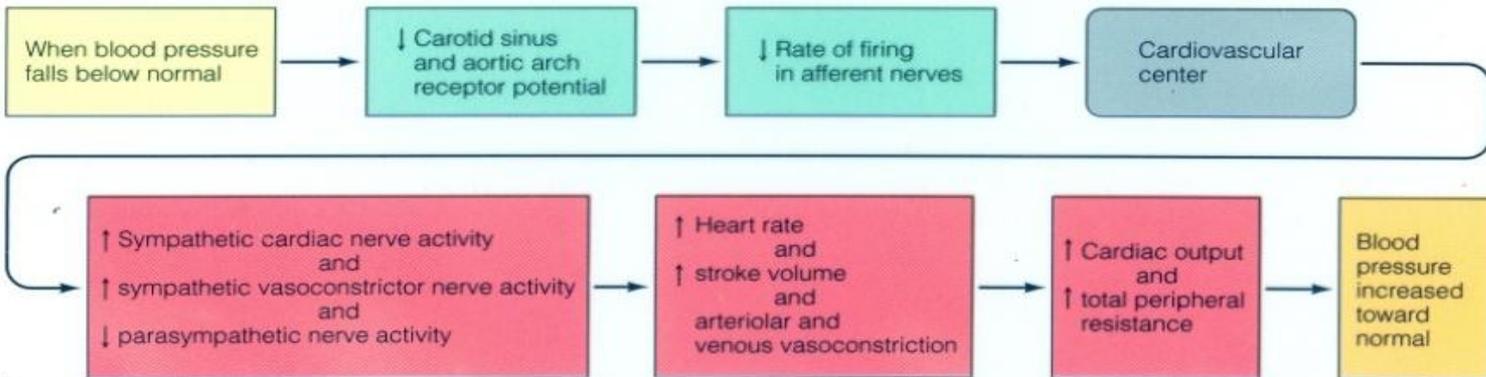


# Baroreceptor mechanism

## Baroreceptor Reflexes to Restore Blood Pressure to Normal



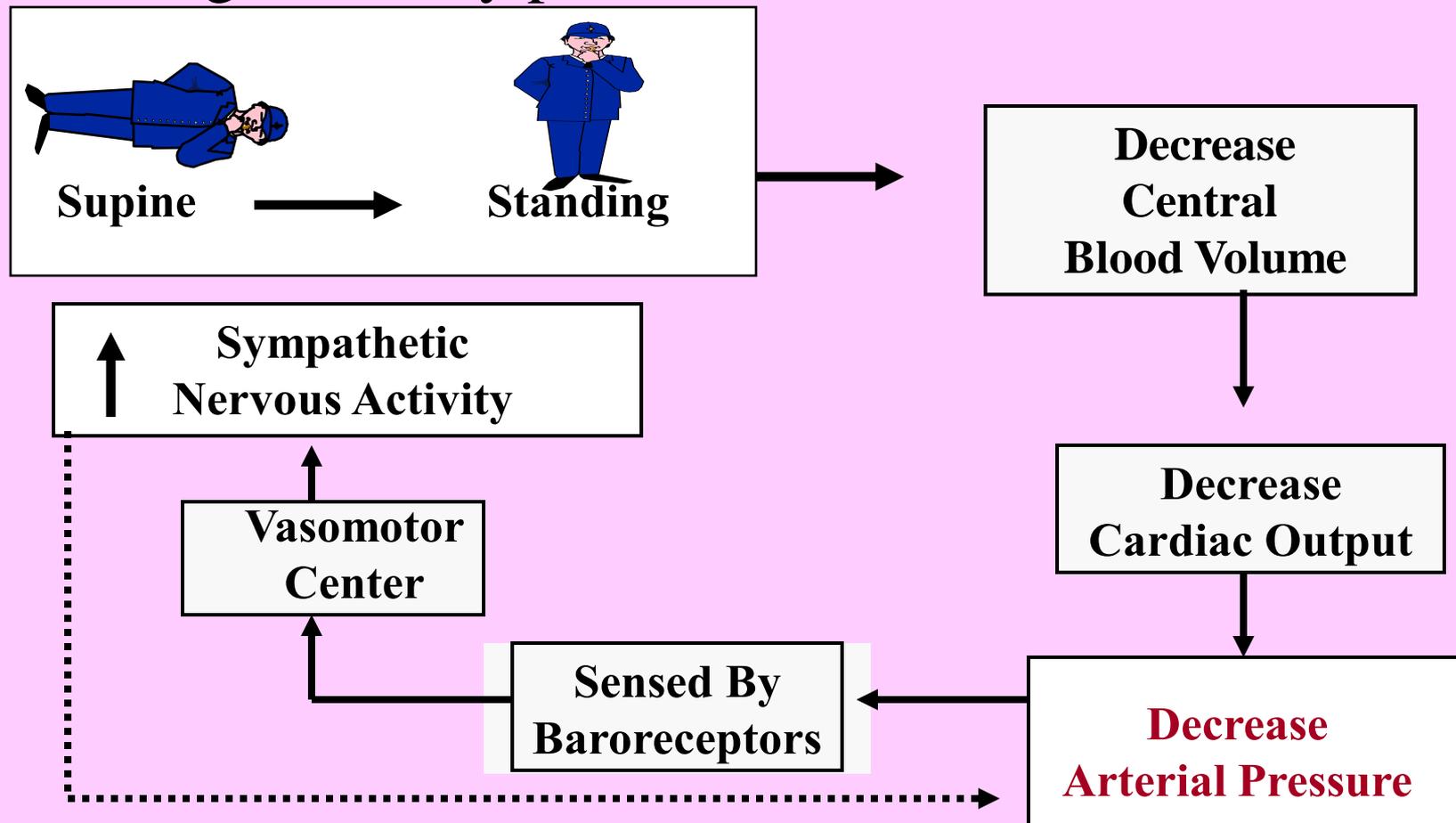
(a)



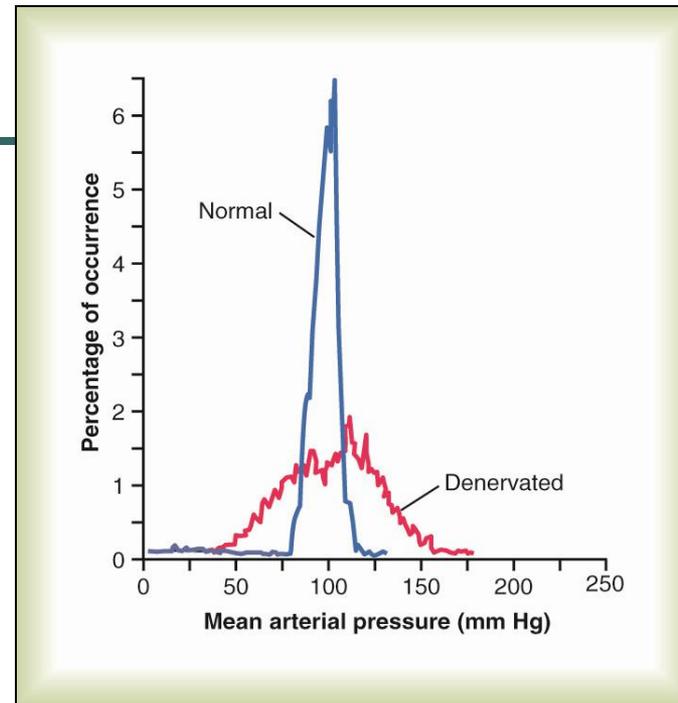
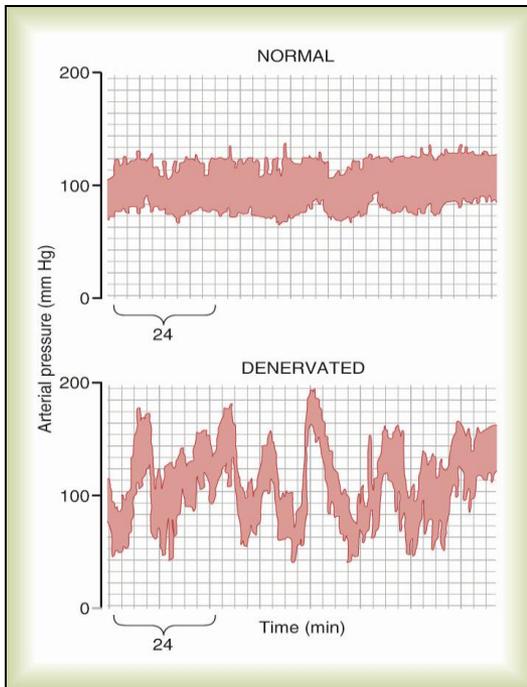
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# Functions of the Baroreceptors

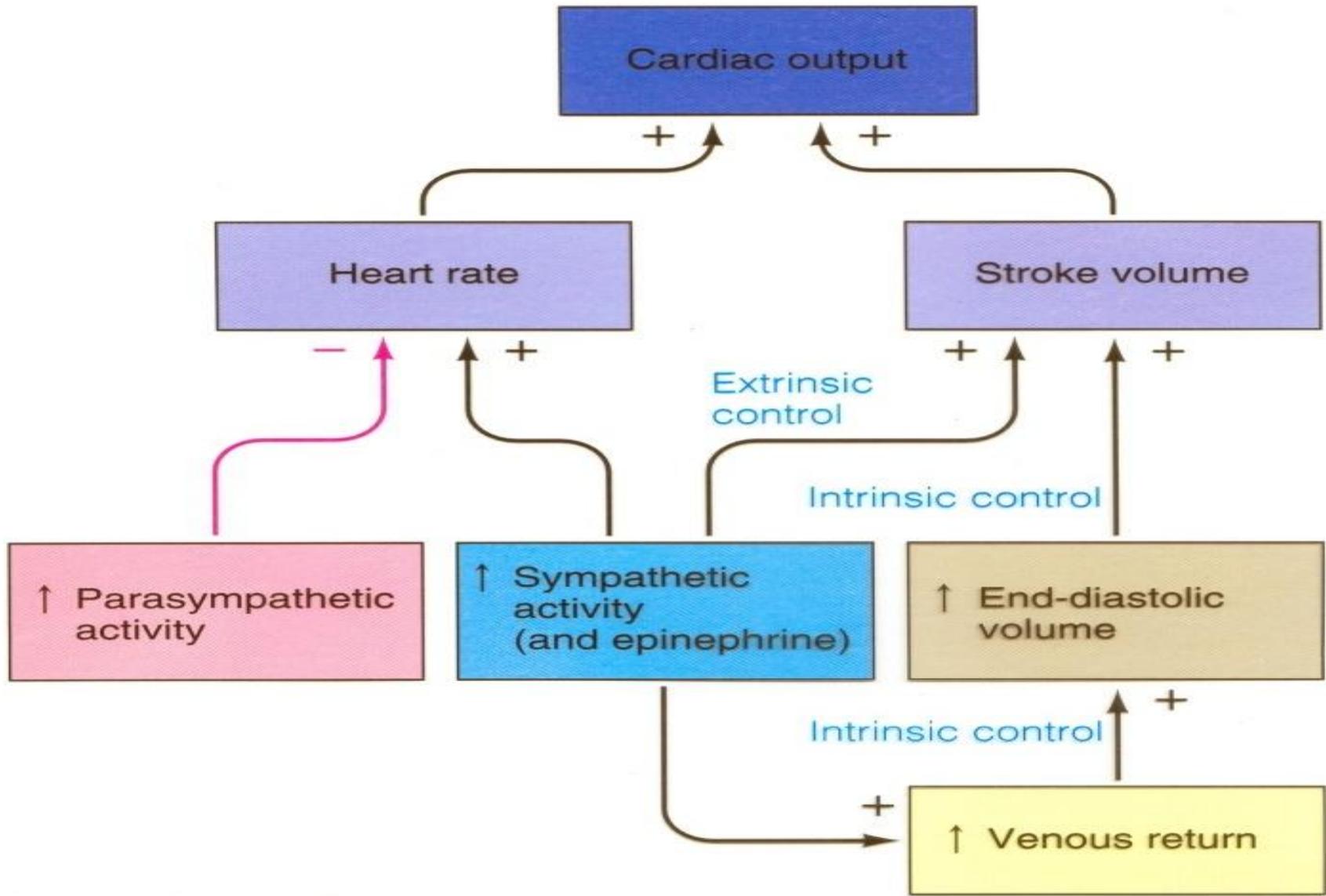
- Maintains relatively constant pressure despite changes in body posture.



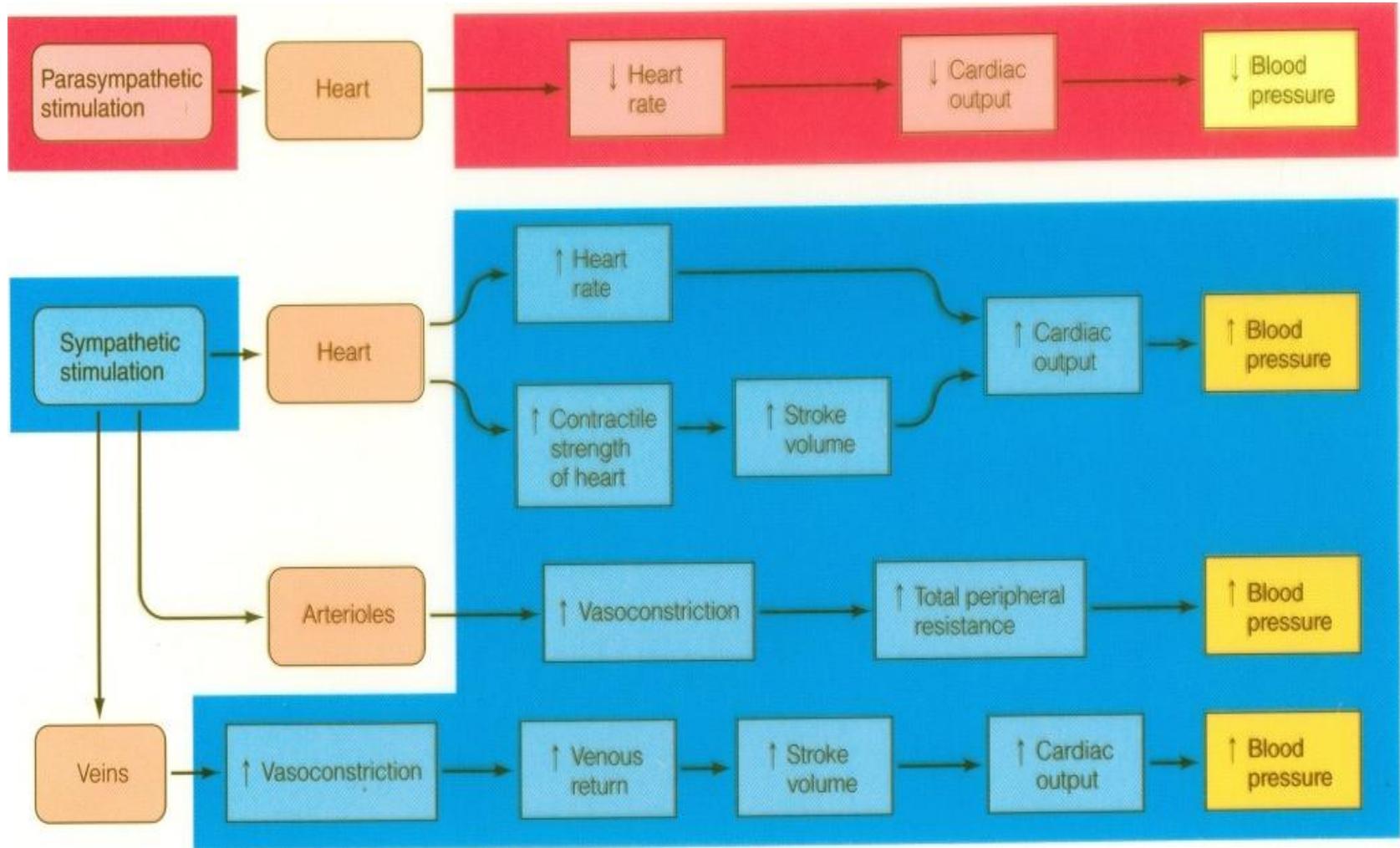
# Functions of the Baroreceptors



- Opposes either increases or decreases in arterial pressure thereby *reducing daily variations* in arterial pressure.
- They are *unimportant in long term control* of arterial pressure because the baroreceptors adapt.



# Effect of Parasympathetic and Sympathetic Nervous Systems on Factors that Influence the Mean Arterial Pressure



# Short term regulators cont...

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## 2. Low Pressure Baroreceptors:

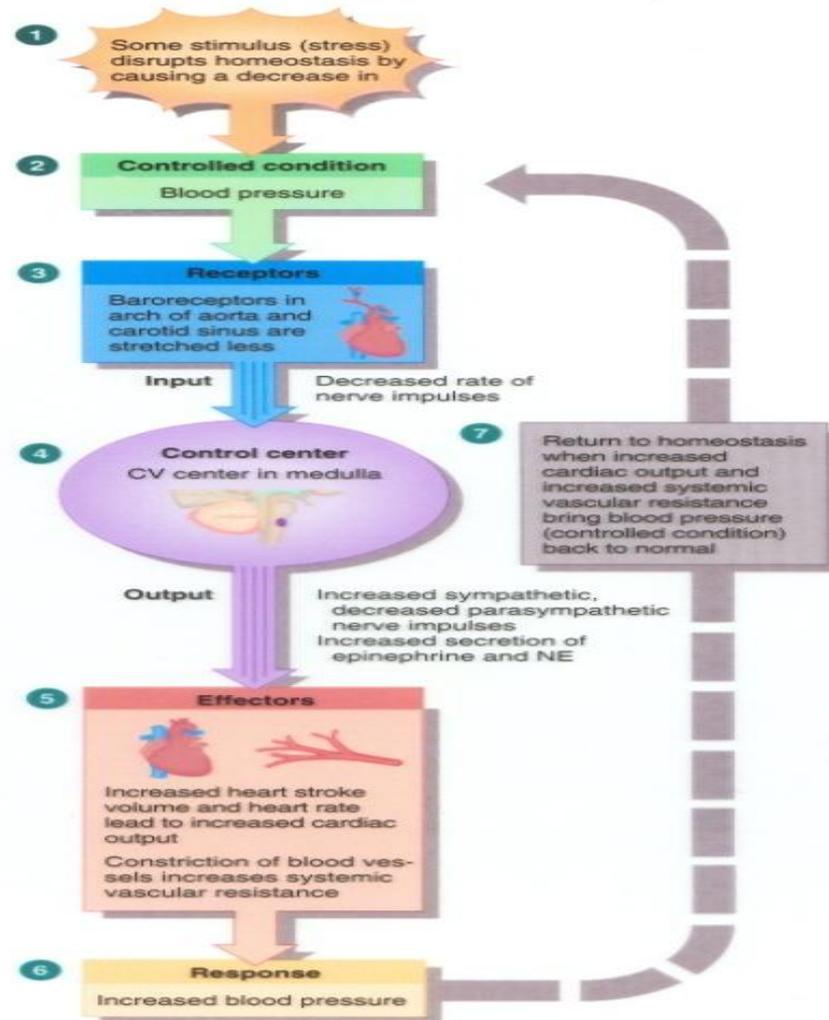
- Located at Rt. Atrium, Rt. Ventricle ? Pulmonary artery
- Sensitive to changes in Volume
- An increase in volume → increase in venous return → increase in cardiac output → increase in MAP and vice versa
- This work through atrial-hypothalamic reflex through stimulating Anti Diuretic Hormone (ADH) – Vasopressin- in case of low BP or inhibiting ADH in case of high BP i.e this will affect the volume and so the BP through its effect on urine output and also on TPR since ADH (Vasopressin) is strong vasoconstrictor.

## Short term regulators cont...

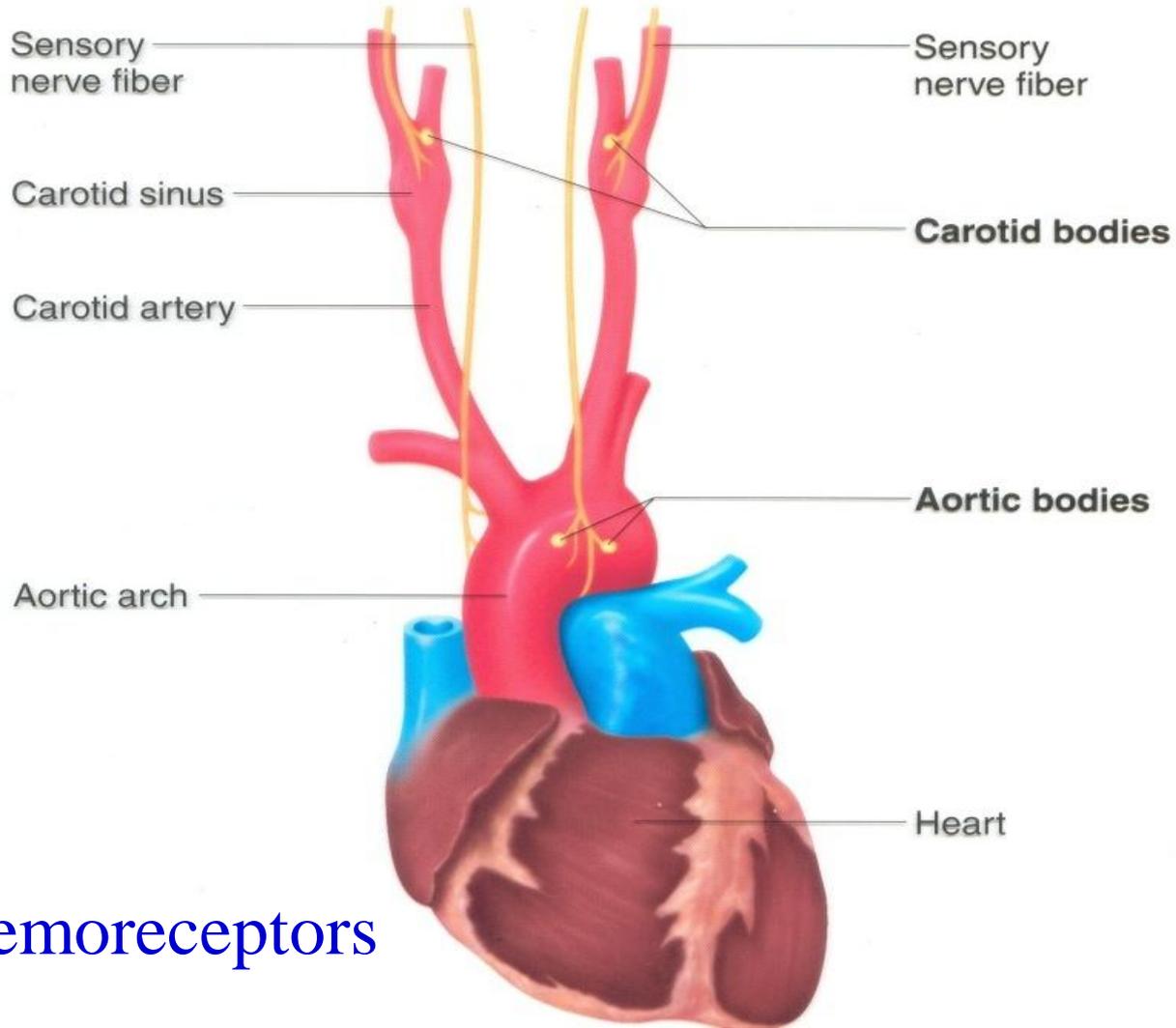
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- Low pressure baroreceptors work also through affecting the Glomerular Filtration Rate (GFR) by causing Afferent arteriolar dilation in case of high BP due to high volume or Vasoconstriction in case of low BP due to low volume
- Affecting the GFR means affecting the urine volume

# Negative Feedback Regulation of Baroreceptor Reflex



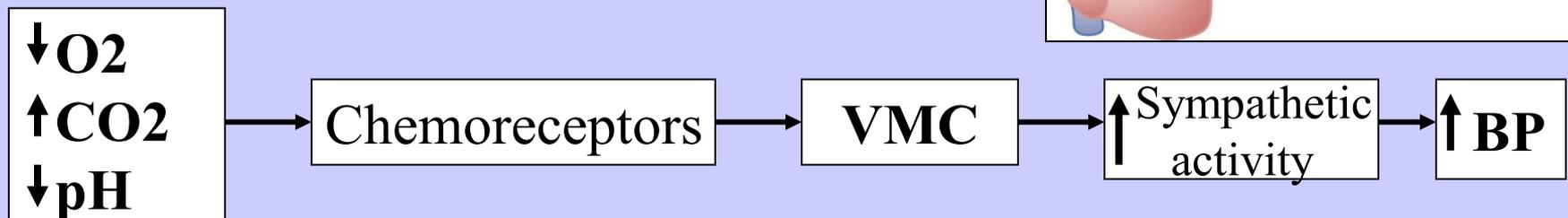
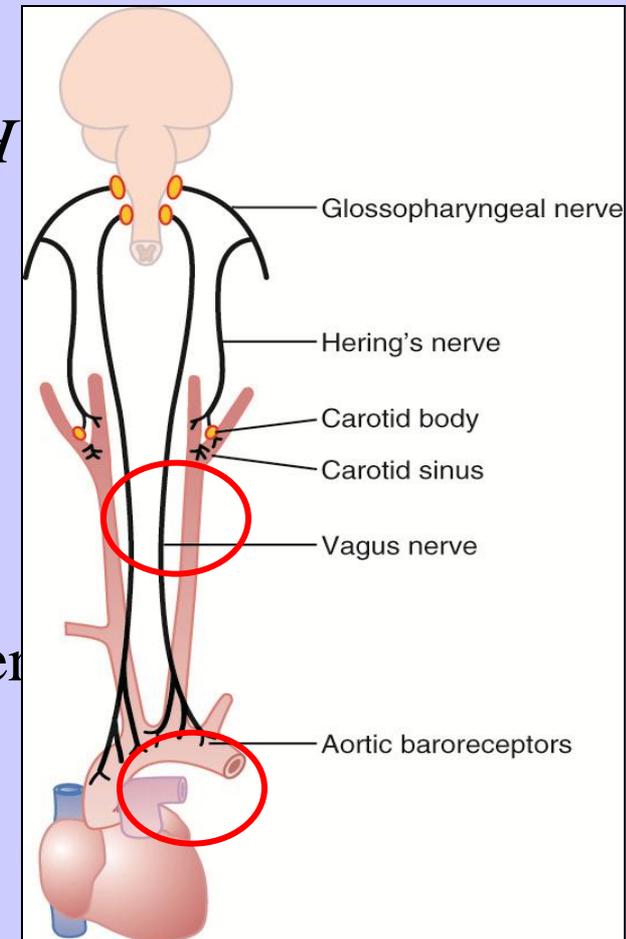
# Short term regulation of BP cont...



## 3. Chemoreceptors

# Carotid and Aortic Chemoreceptors

- *Chemoreceptors* are chemosensitive cells sensitive to *oxygen lack*, *CO<sub>2</sub> excess*, or *H<sup>+</sup> ion excess*.
- Chemoreceptors are located in *carotid bodies* near the carotid bifurcation and on the arch of the aorta.
- Activation of chemosensitive receptors results in *excitation* of the vasomotor center.
- Chemoreceptors are not stimulated until pressure falls *below 80mmHg*.



# Thank You

