Blood Pressure Regulation

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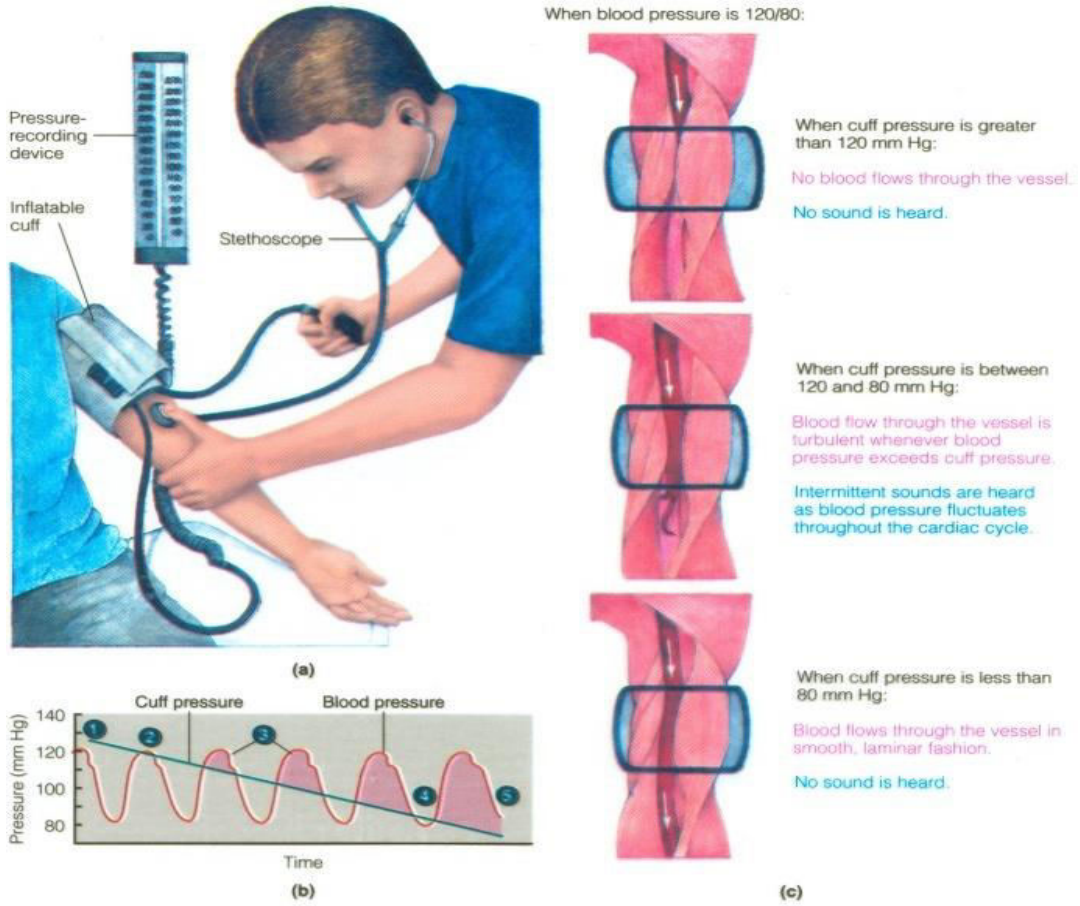
Objectives

- 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

Shygmomanometry

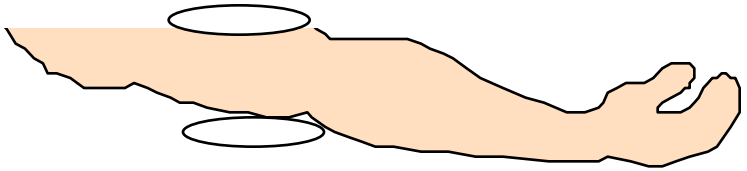


Measurement of Systolic and Diastolic Pressures

- *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.

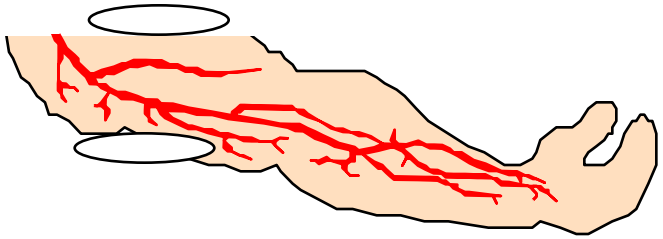
Effect of Cuff Pressure on Brachial Blood Flow

Cuff Pressure > 120



NO FLOW

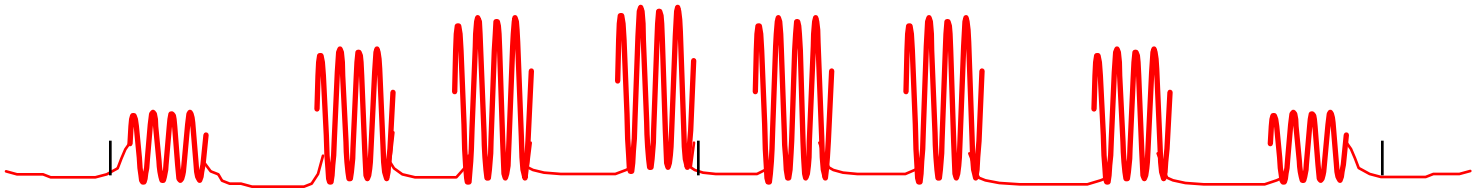
Cuff Pressure < 80



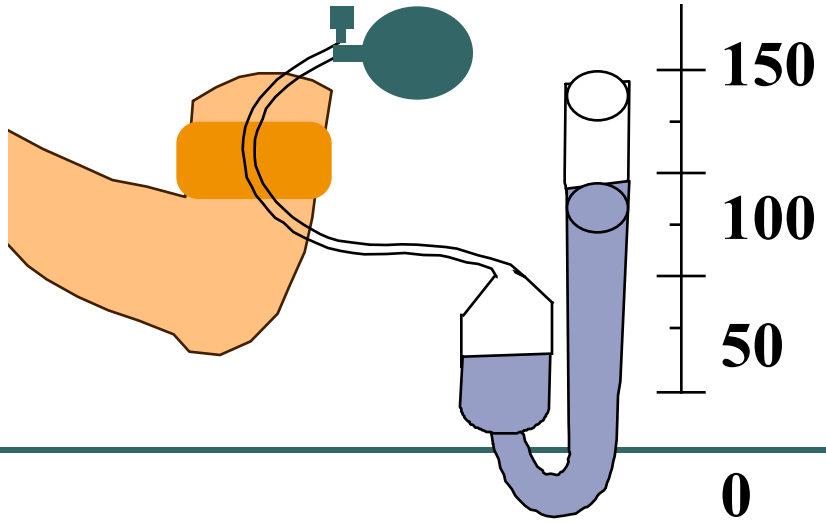
FREE FLOW

Measurement of Blood Pressure

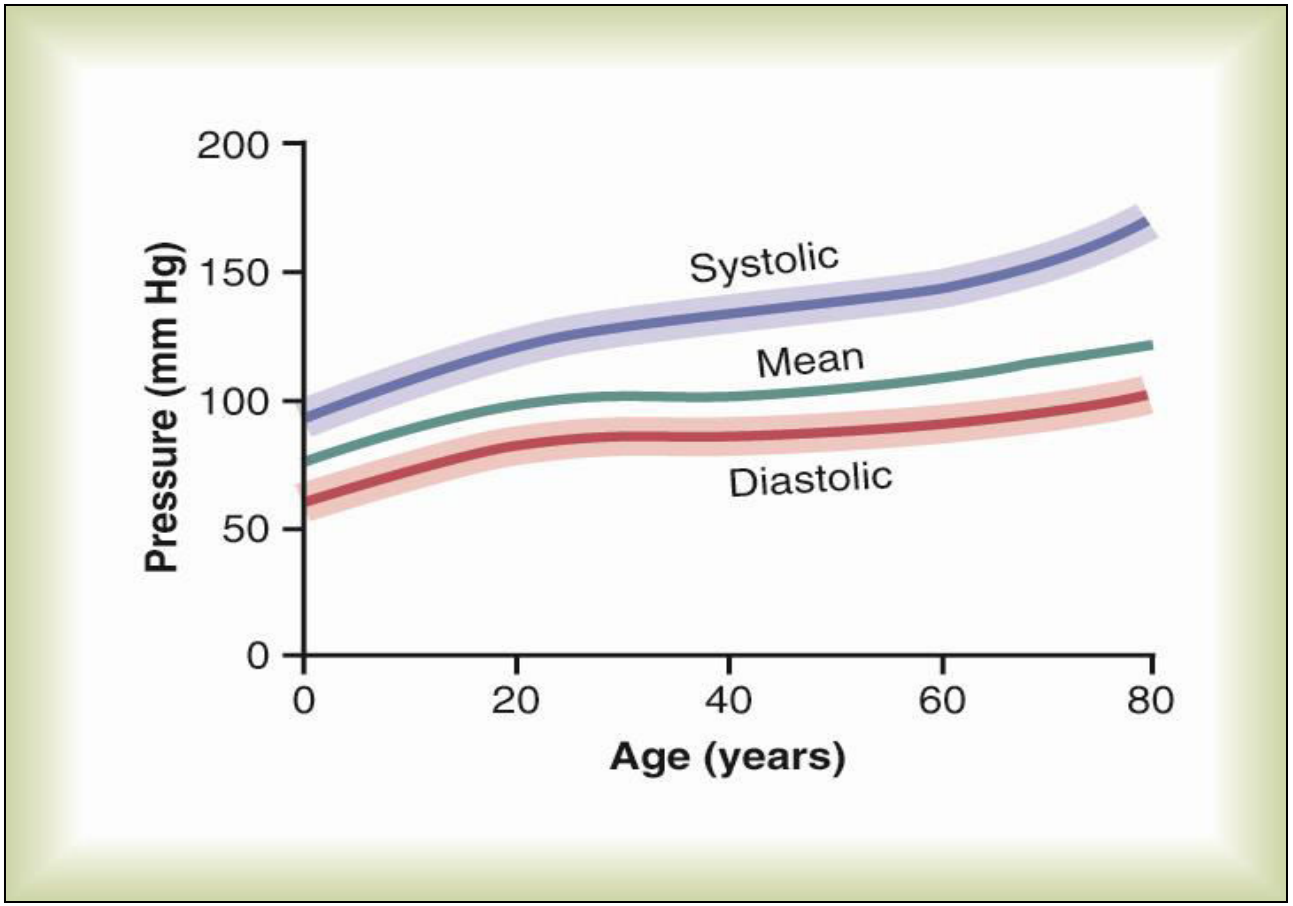
Use of Korotkoff Sounds



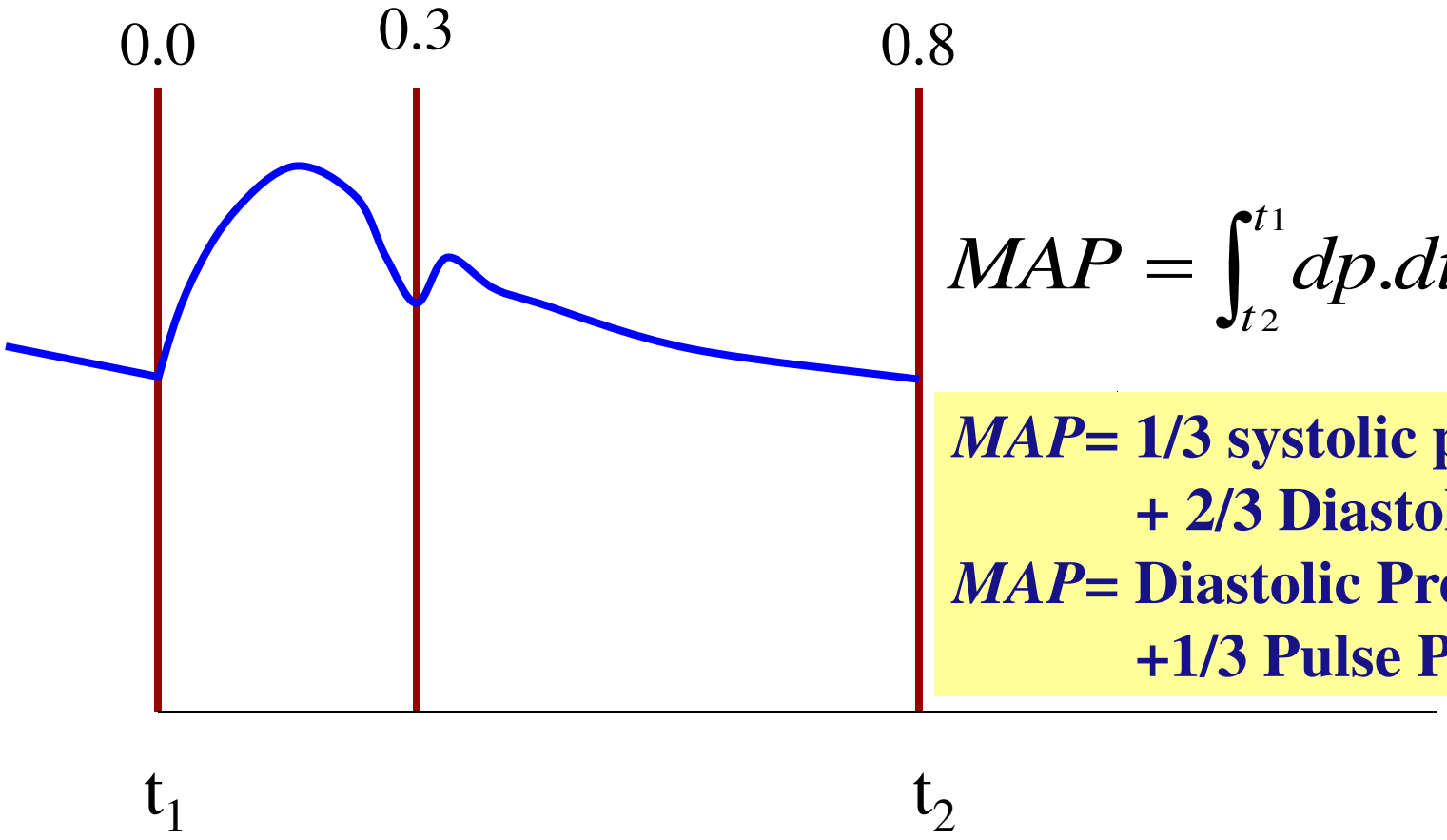
120 100 80



Mean Arterial Pressure



Mean Arterial Pressure (MAP)



$$MAP = \int_{t2}^{t1} dp.dt/(t_2 - t_1)$$

***MAP*= 1/3 systolic pressure**
+ 2/3 Diastolic pressure
***MAP*= Diastolic Pressure**
+1/3 Pulse Pressure

Blood Pressure Regulation

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

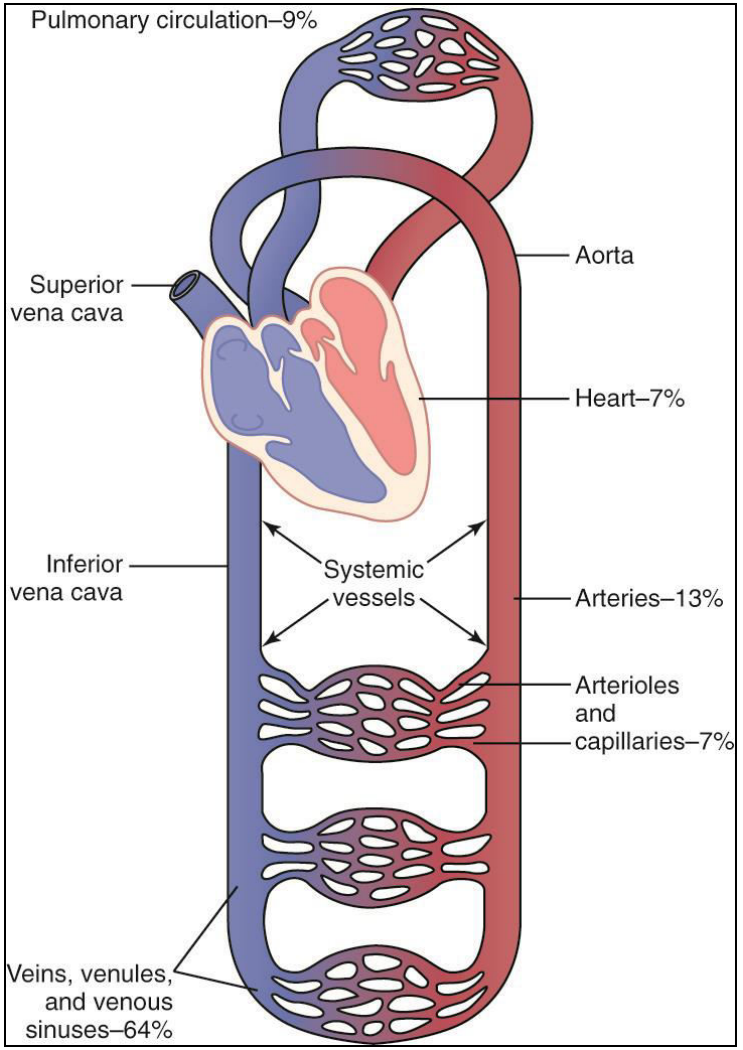
$$CO = \frac{MAP}{TPR}$$

$$MAP = CO * TPR$$

Arterial Pressure = Cardiac Output xTotal Peripheral Resistance

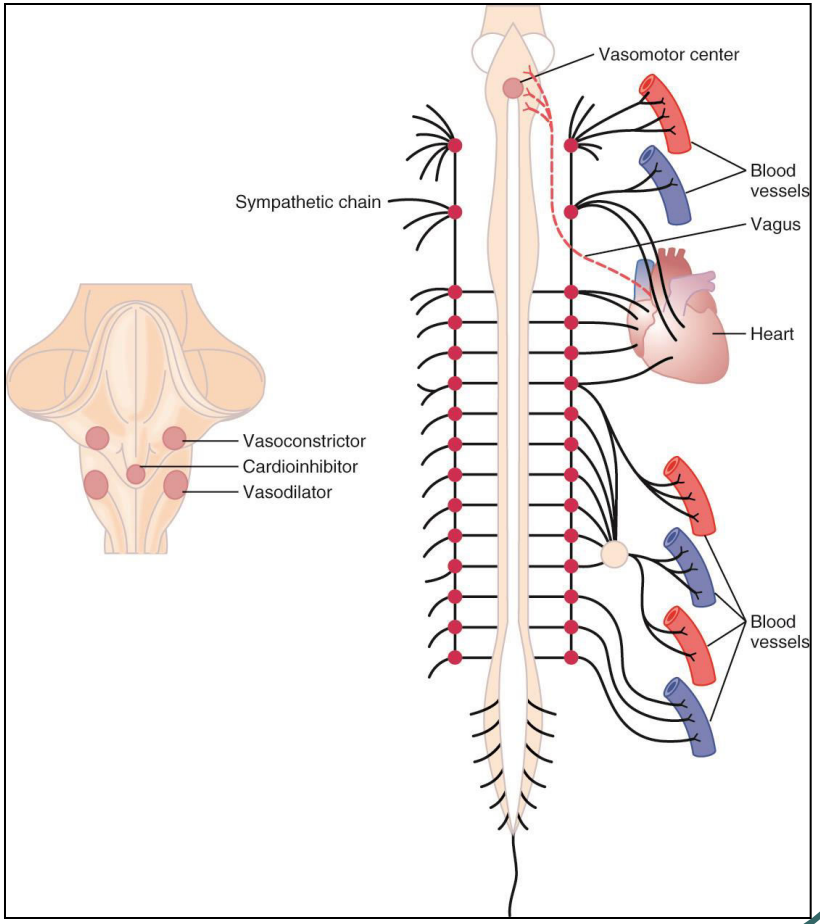
Arterial Pressure can be increased by:

- 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.



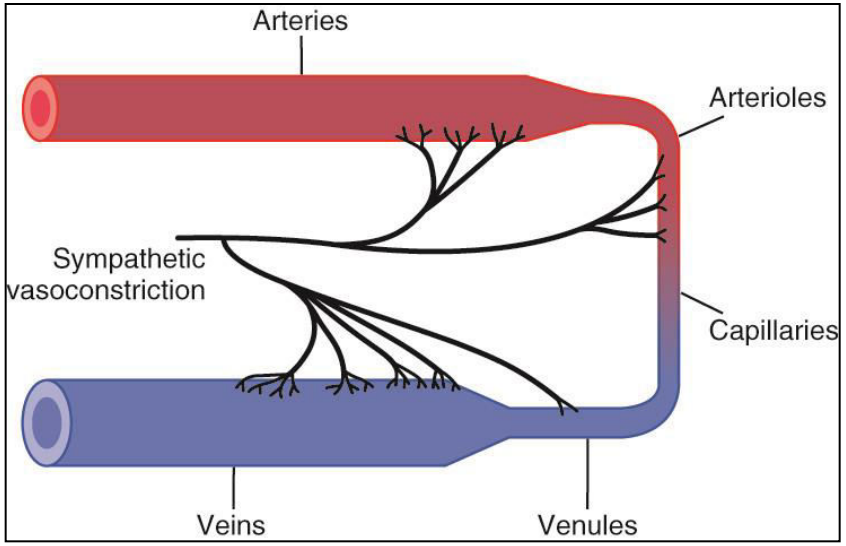
Autonomic Nervous System

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



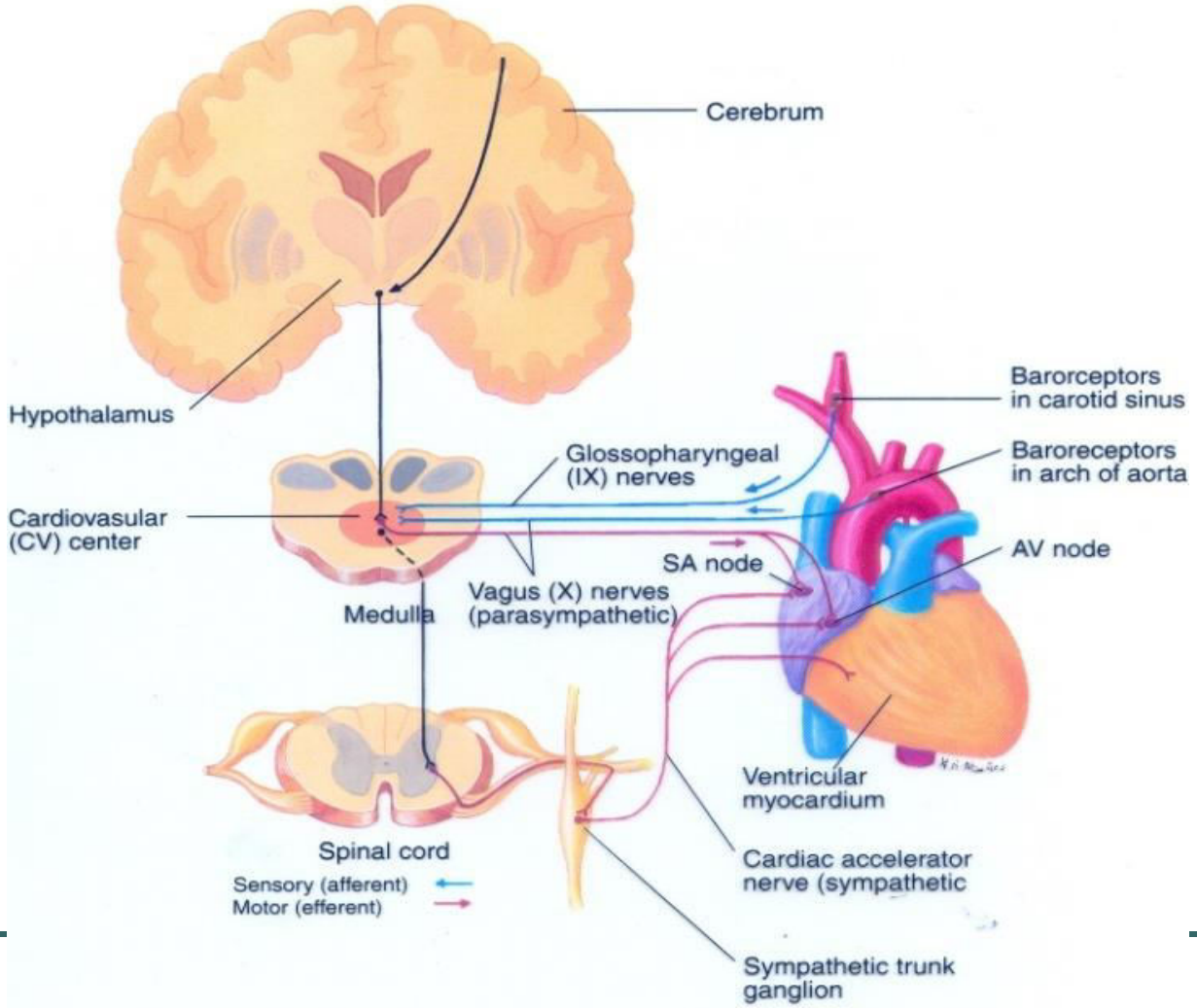
Sympathetic Innervation of Blood Vessels

- ***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.

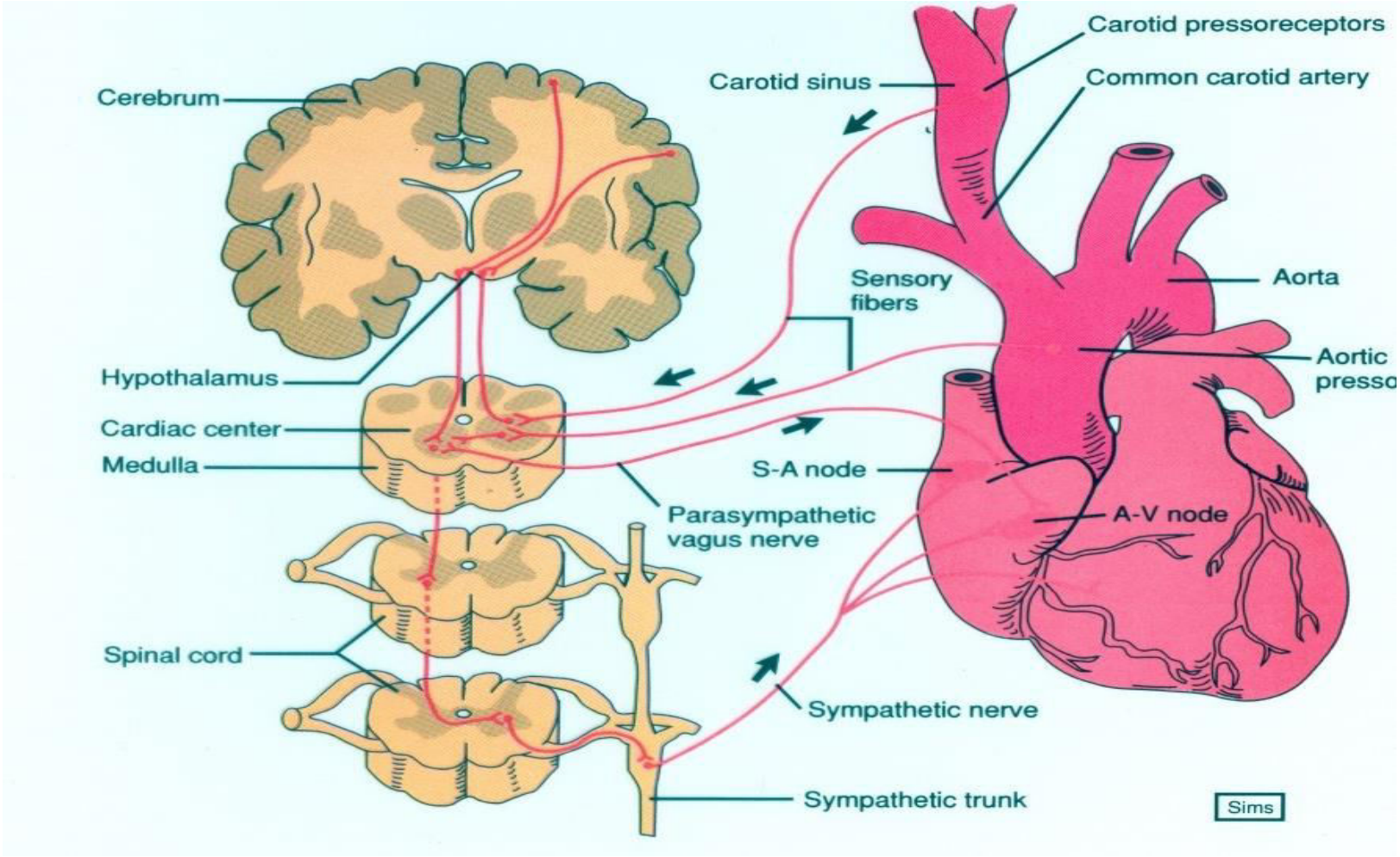


Short term regulation of BP

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



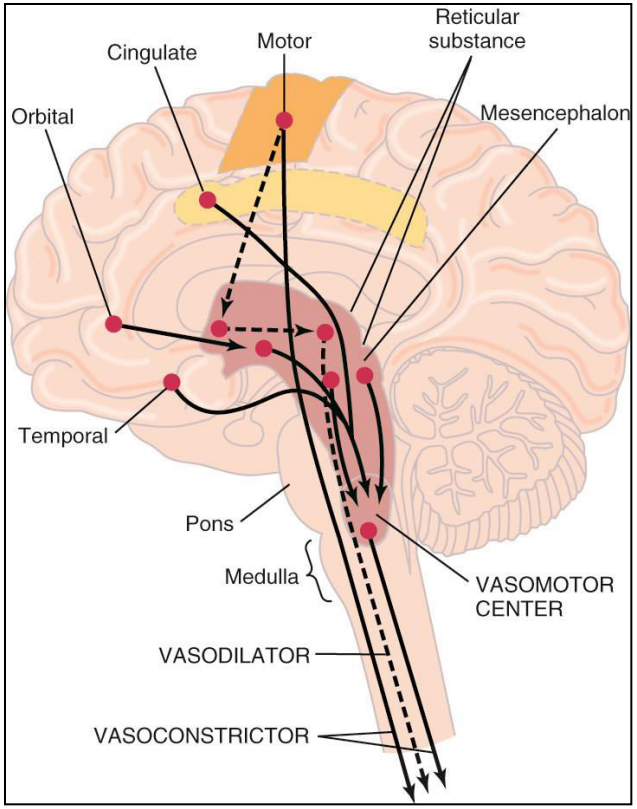
Short term regulation of BP cont…



1. Baroreceptors or pressoreceptos (High pressure)

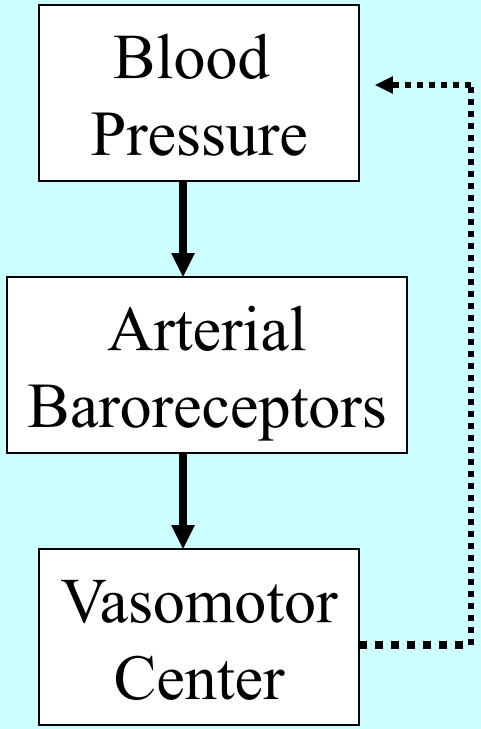
The Vasomotor Center (VMC)

- 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.



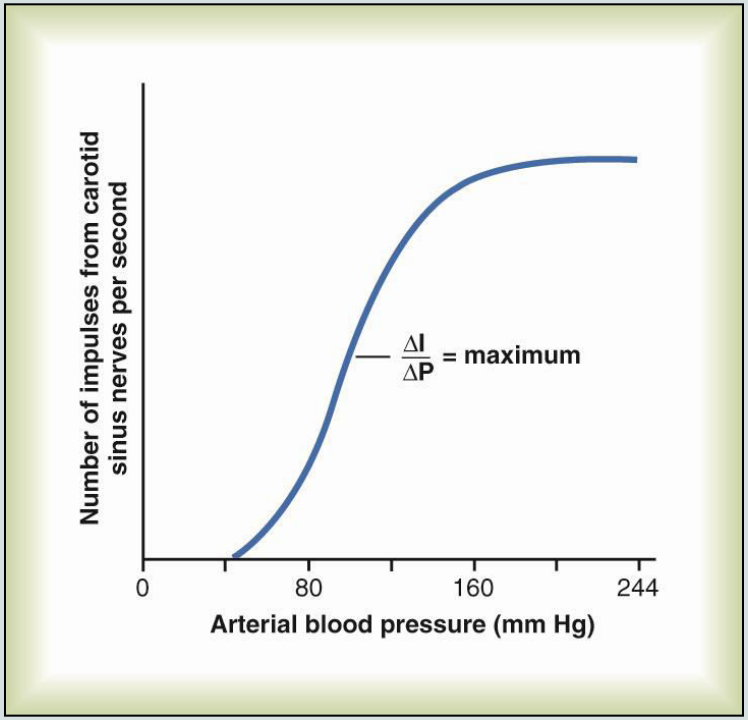
Arterial Baroreceptor Reflex

- 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 automonic nervous system to the circulation to reduce AP back to normal.

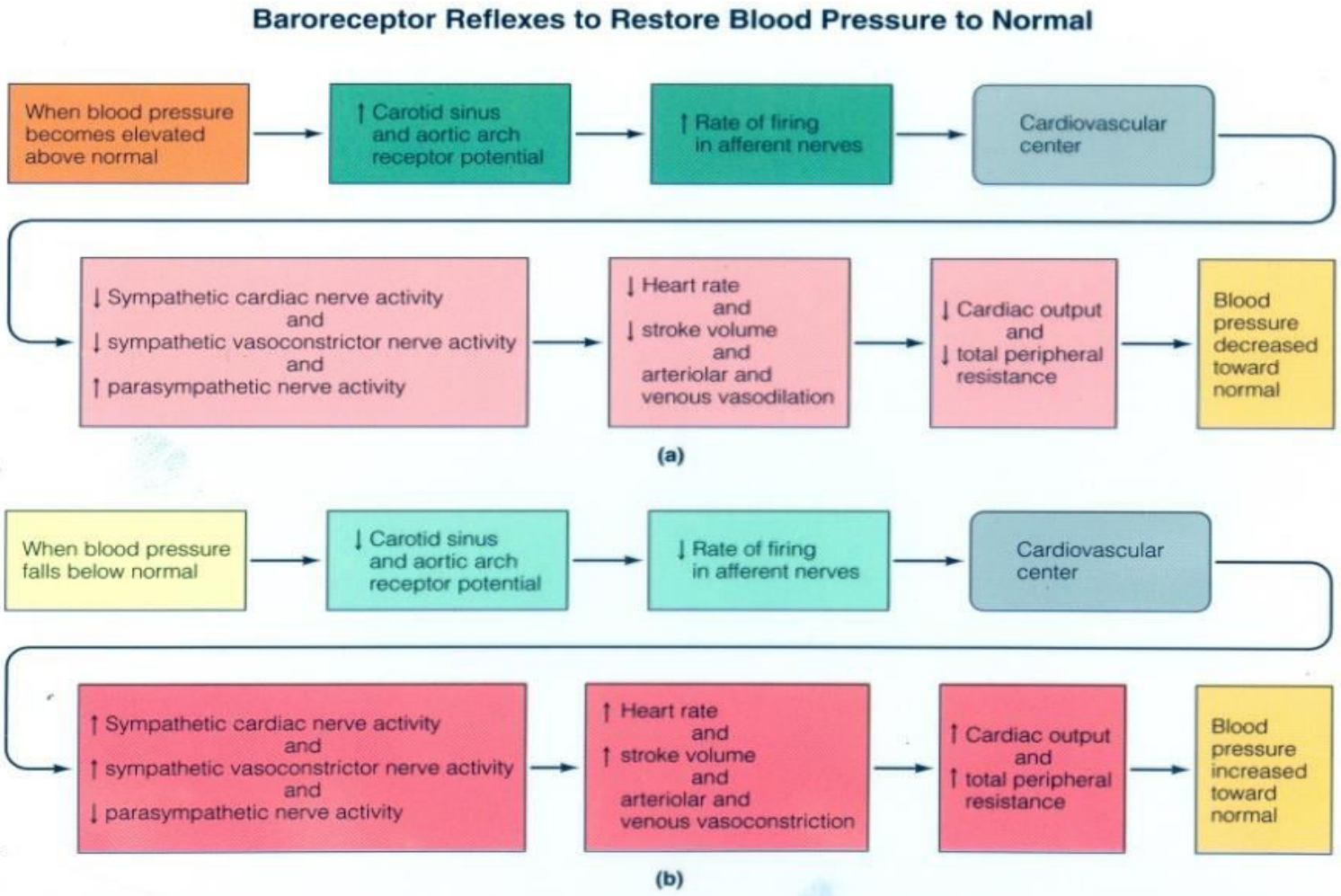


Response of the Baroreceptors to Arterial Pressure

- 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

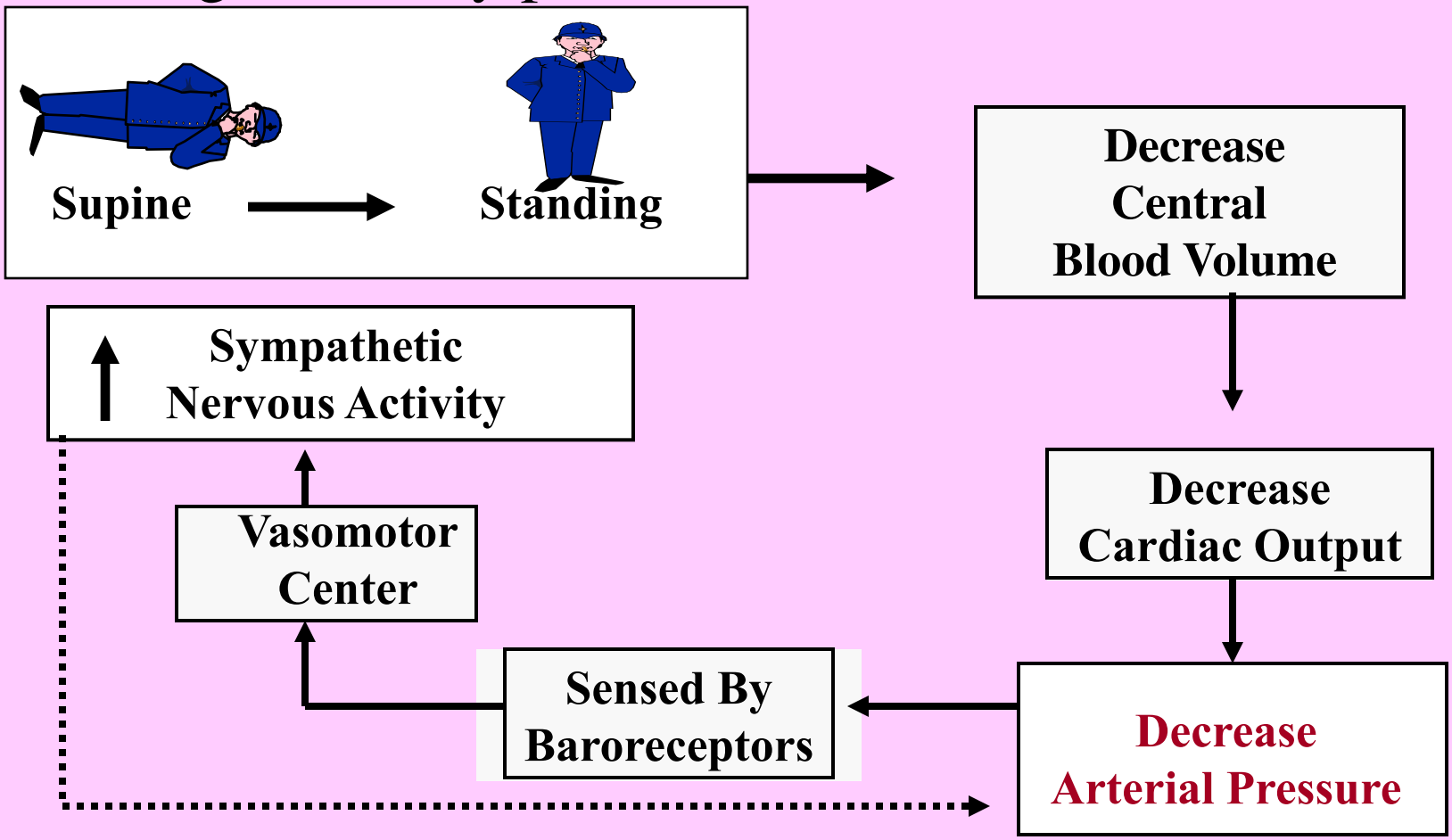


Baroreceptor mechanism

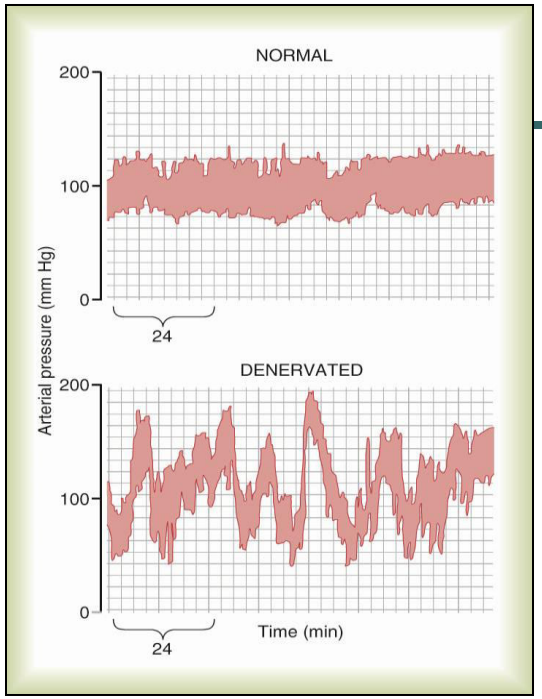


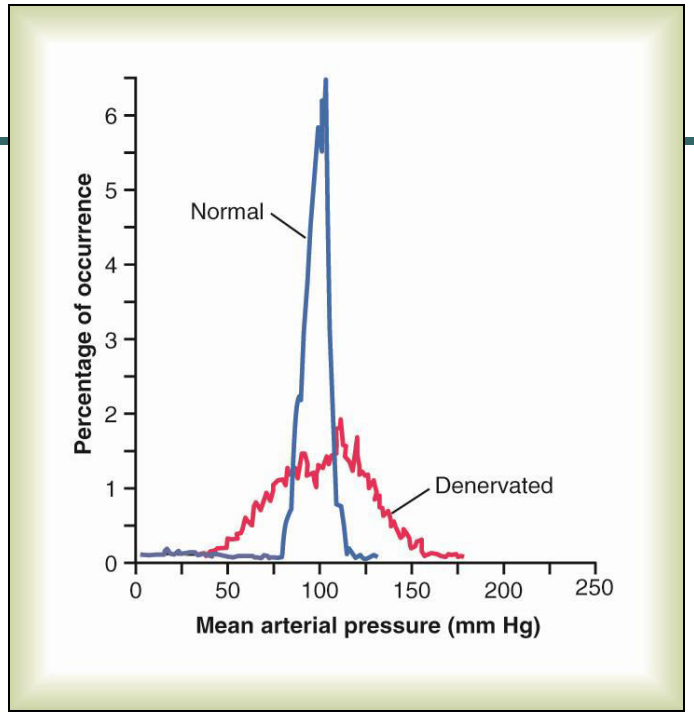
Functions of the Baroreceptors

- Maintains relatively constant pressure despite changes in body posture.

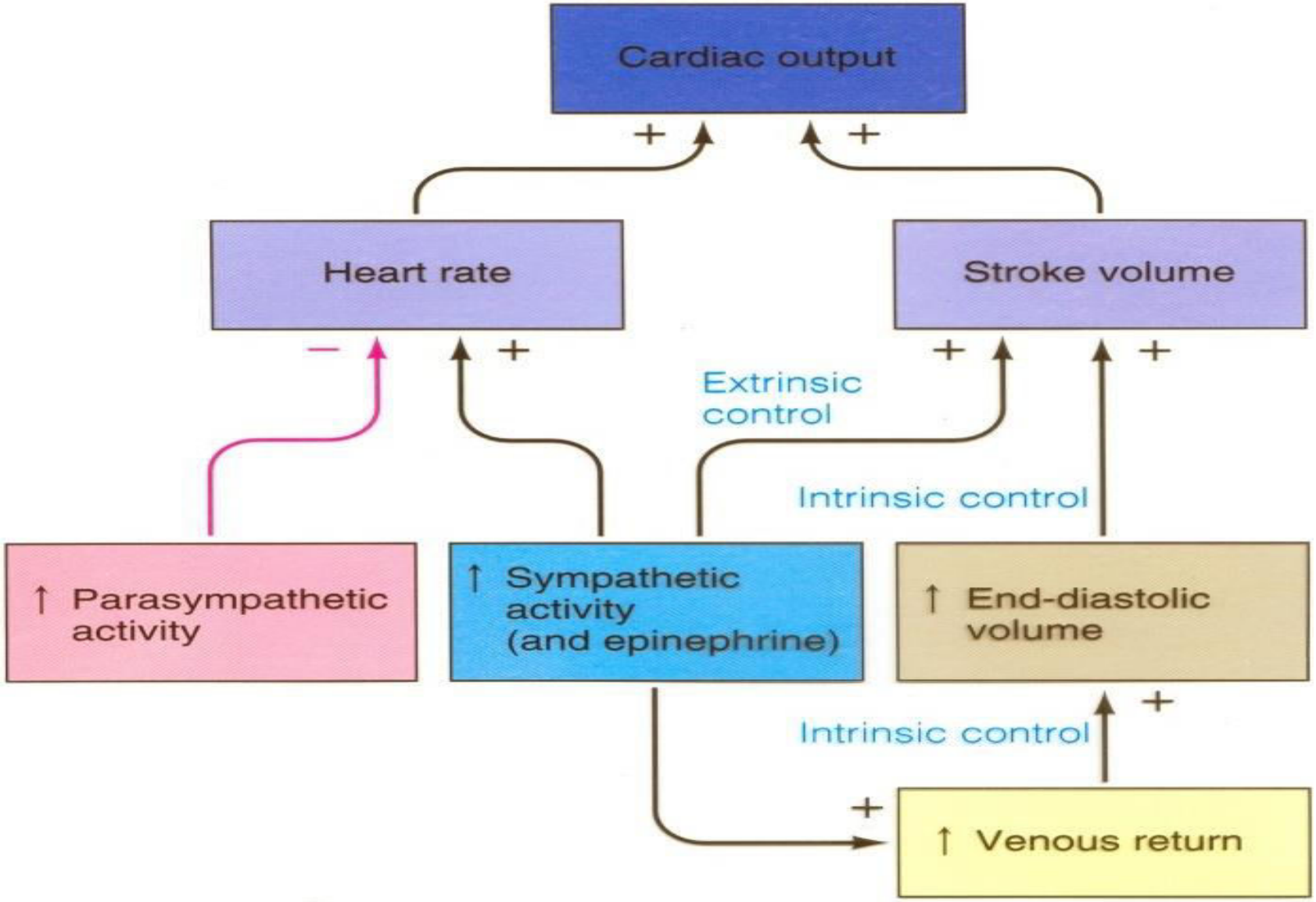


Functions of the Baroreceptors

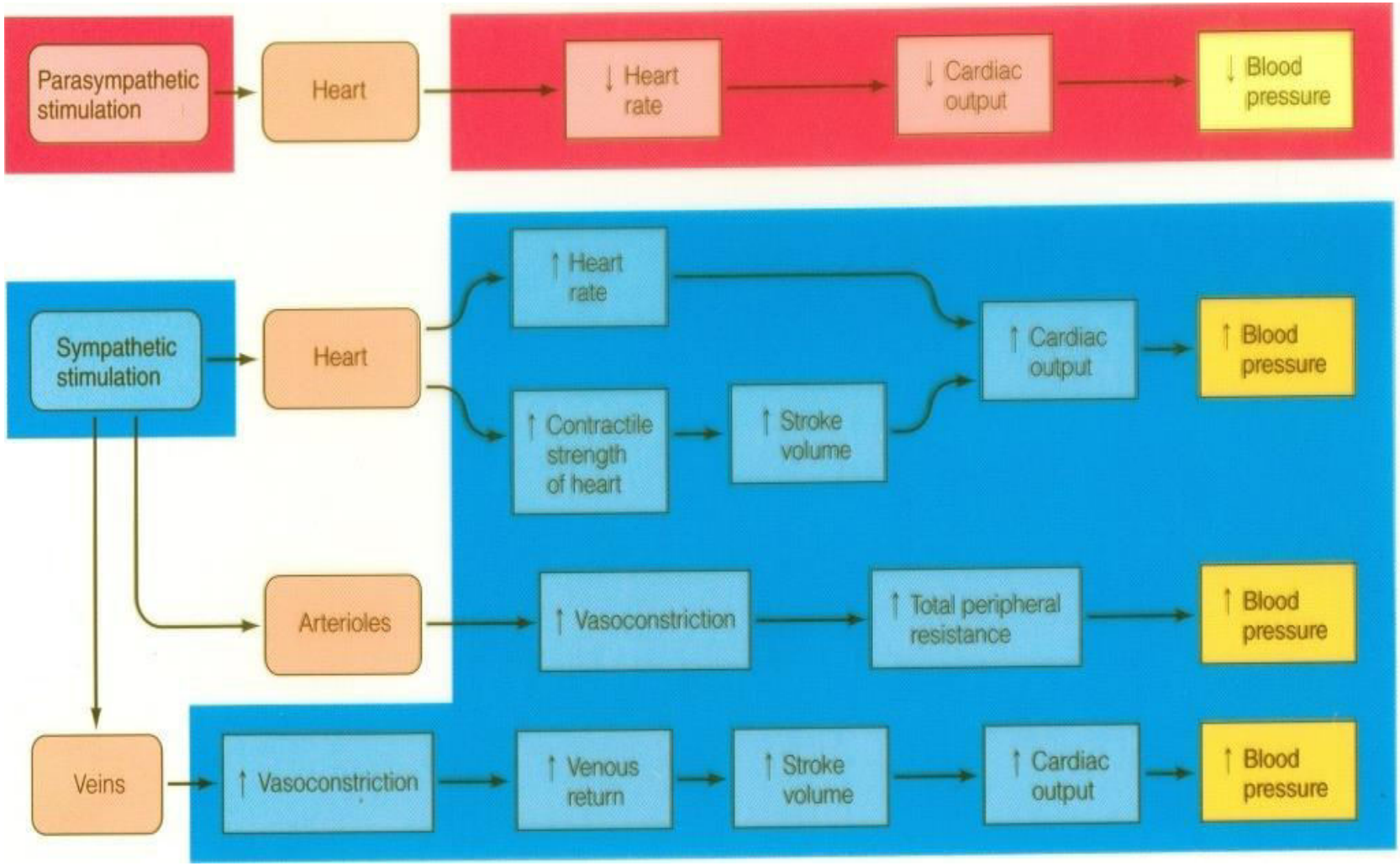




- Opposes either increases or decreases in arterial pressure thereby *reducing daily variations* in arterial pressure.
- They are *unimportant in long term control* of arterial pressure because the baroreceptors adapt.


Cardiac output
+
+
Heart rate
Stroke volume
−
+
+
+
Extrinsic control
Intrinsic control
↑ Parasympathetic activity
↑ Sympathetic activity (and epinephrine)
↑ End-diastolic volume
+
Intrinsic control
+
↑ Venous return

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



Short term regulators cont…

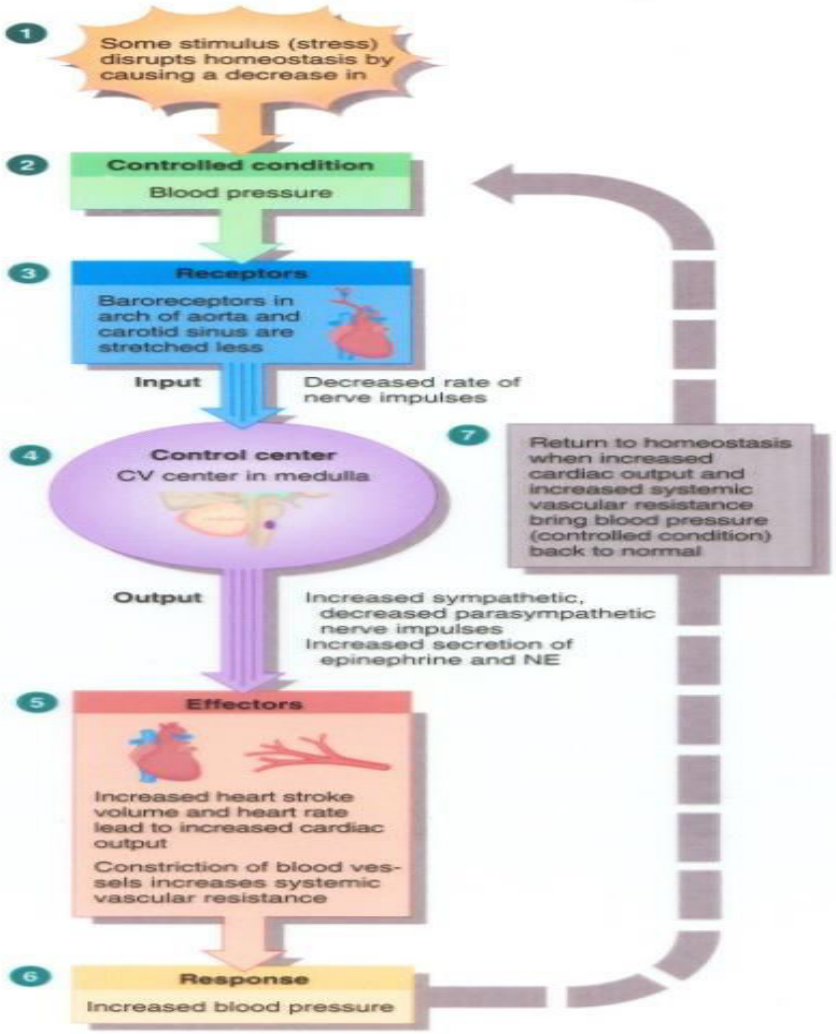
2. Low Pressure Baroreceptors:

- 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.

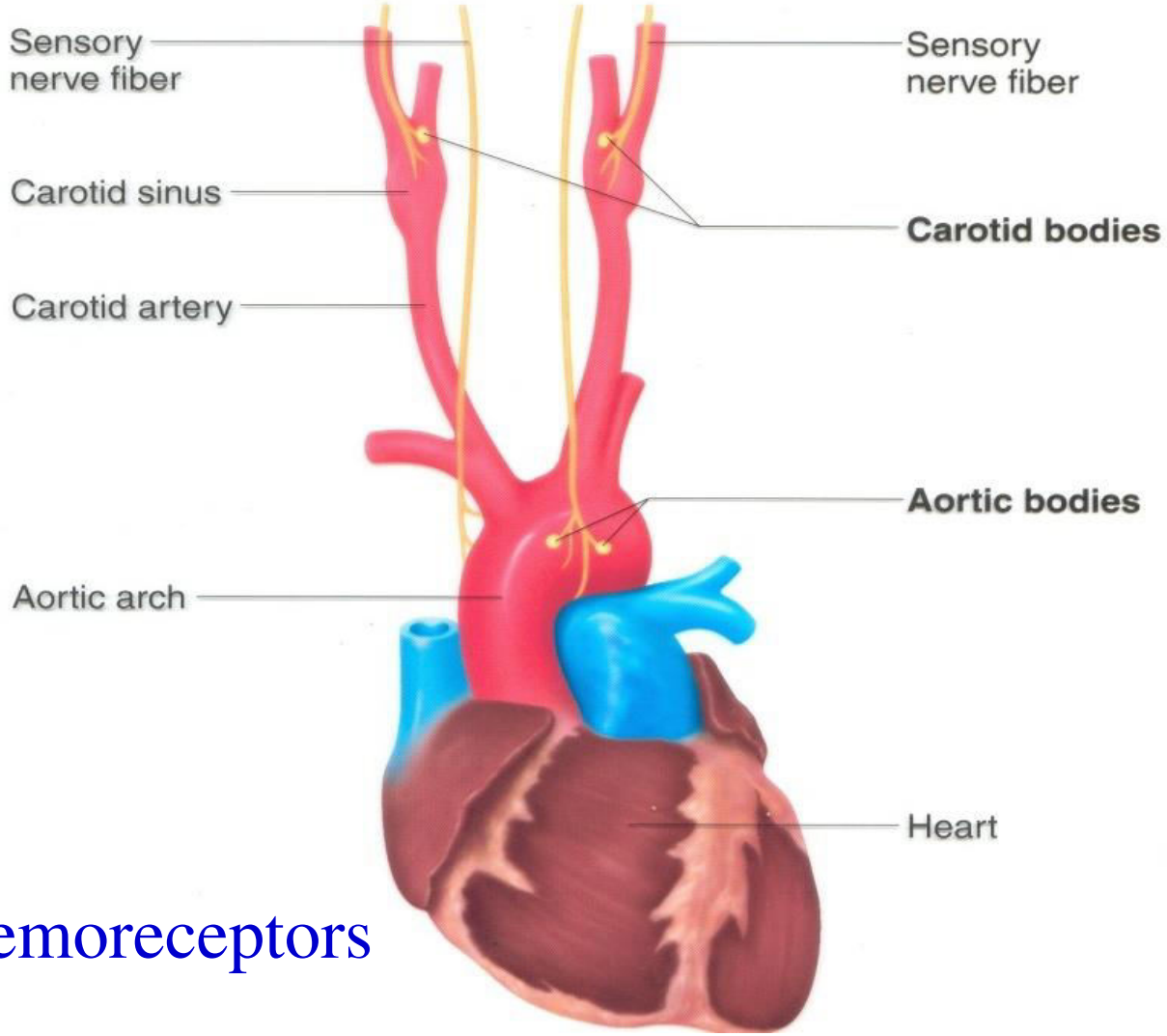
Short term regulators cont…

- 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



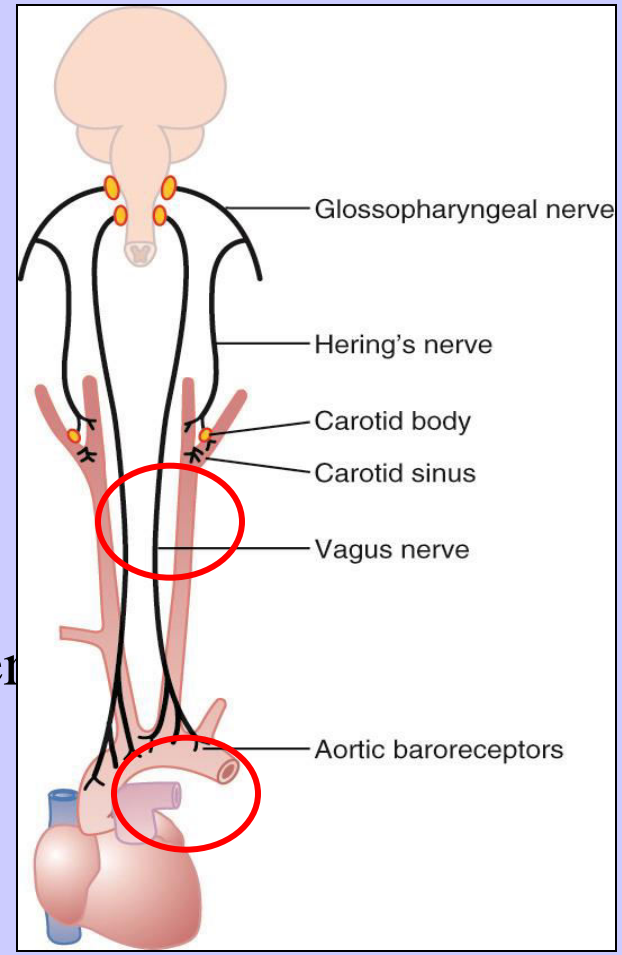
Short term regulation of BP cont…



3. Chemoreceptors

Carotid and Aortic Chemoreceptors

- *Chemoreceptors* are chemosensitive cells sensitive to *oxygen lack, CO2 excess, or H 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.*



↓O2
↑CO2
↓pH
→ Chemoreceptors → **VMC** → ↑Sympathetic activity → ↑**BP**

Thank You