بِسۡمِ ٱللَّهِ ٱلرَّحۡمَٰنِ ٱلرَّحِيمِ

The only person you should try to be better than...

is the person you were yesterday.

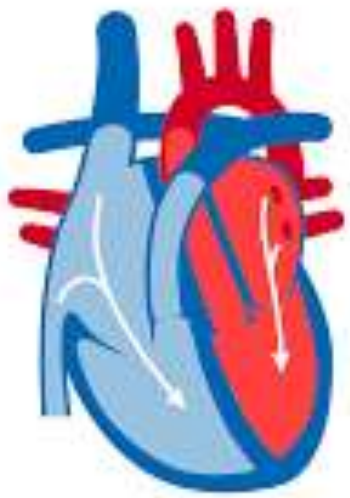
QUOTEDIARY.ME

# Blood Pressure

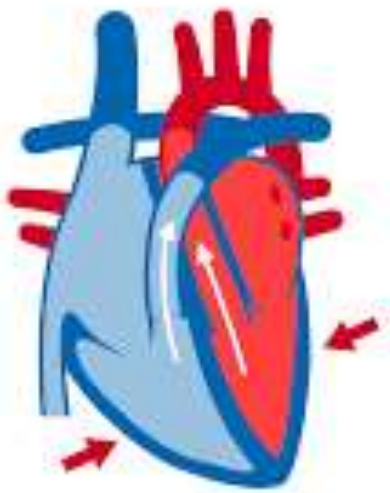
Dr Zubia Shah

# Learning Objectives

- Define blood pressure.
- Describe the short-term control of blood pressure.



Diastolic Blood Pressure



Systolic Blood Pressure

# Definition of Blood Pressure

The lateral pressure exerted on the walls of blood vessels

1. **Systolic Blood Pressure-**

maximum pressure exerted in arteries during systole

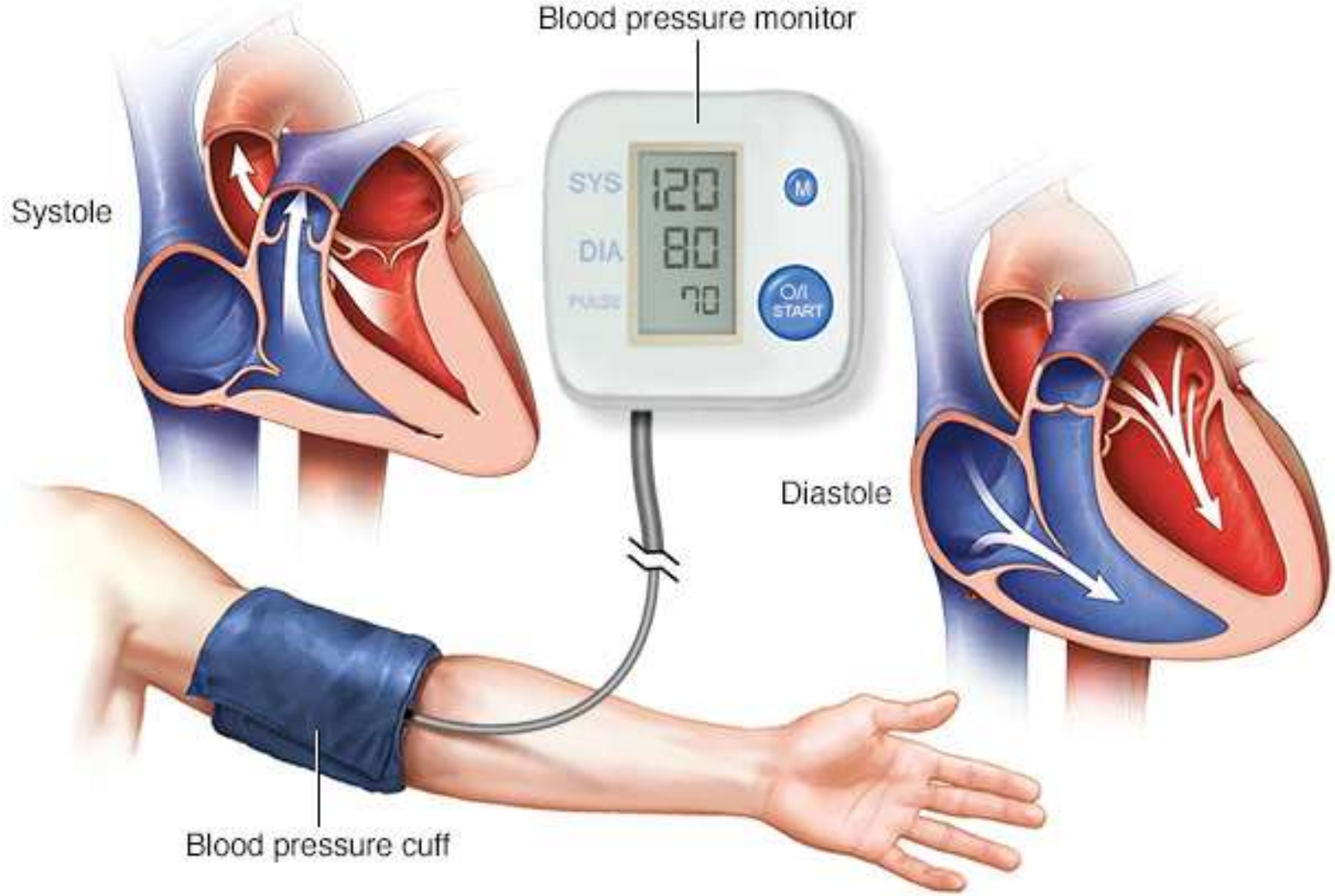
2. **Diastolic Blood Pressure**

Minimum pressure exerted in arteries during diastole

3. **Mean Arterial Pressure**

Average pressure during entire cardiac cycle that drives blood to tissues

MAP = Diastolic pressure + 1/3 pulse pressure



# Normal Blood Pressure Range

| AGE Group | SYSTOLIC BP (mmHg) | DIASTOLIC BP (mmHg) |
|---|---|---|
| More than 60 years | <150 | <90 |
| Less than 60 years | <140 | <90 |

# Calculate The Mean Arterial Pressure

- **Systolic Blood Pressure = 140 mmHg**
- **Diastolic Blood Pressure = 80 mm Hg**

- Mean Arterial Pressure (MAP) = ?
- MAP = Diastolic Pressure + 1/3 Pulse Pressure

**= 80 + 1/3(140-80)**

**= 80+ 20 = 100 mmHg**

# Control of Mean Arterial Pressure

- Cardiac output (CO) = MAP/TPR

(mean arterial pressure/ total peripheral resistance)

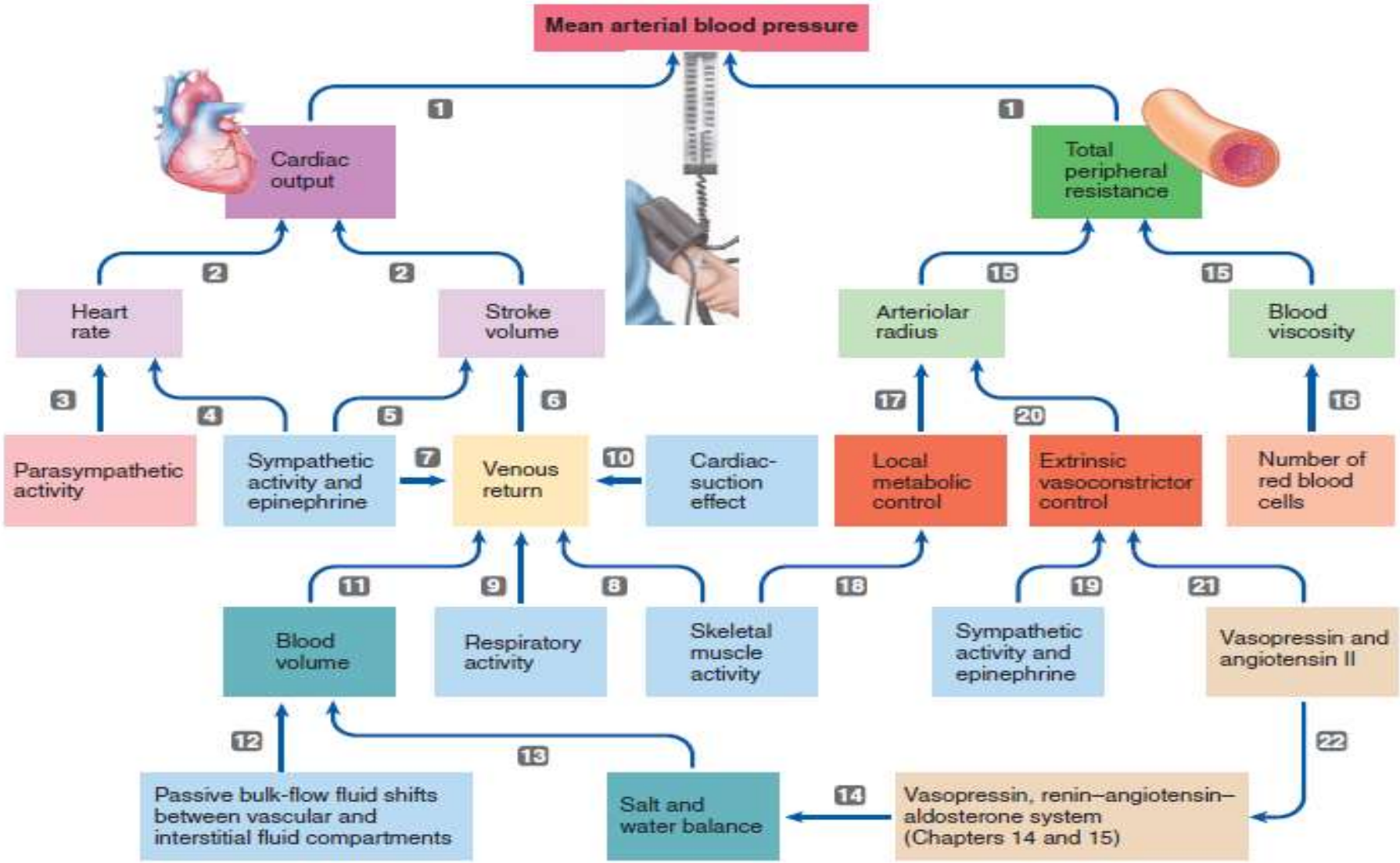
**MAP = CO x TPR**

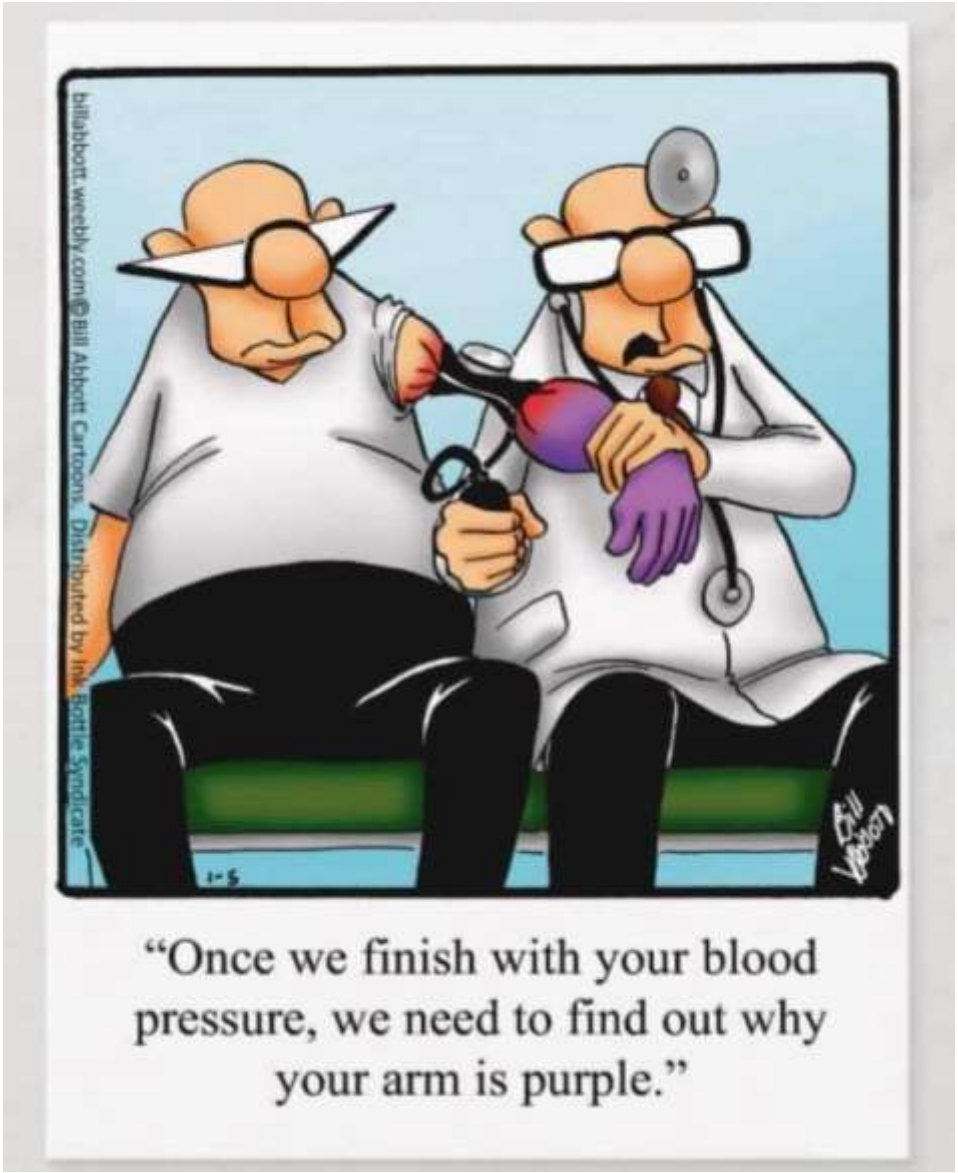
CO depends on **stroke volume** and **heart rate**

TPR depends on **arteriolar resistance** and **blood viscosity**

So, all these affect MAP

# Mean Arterial Pressure






"Once we finish with your blood pressure, we need to find out why your arm is purple."

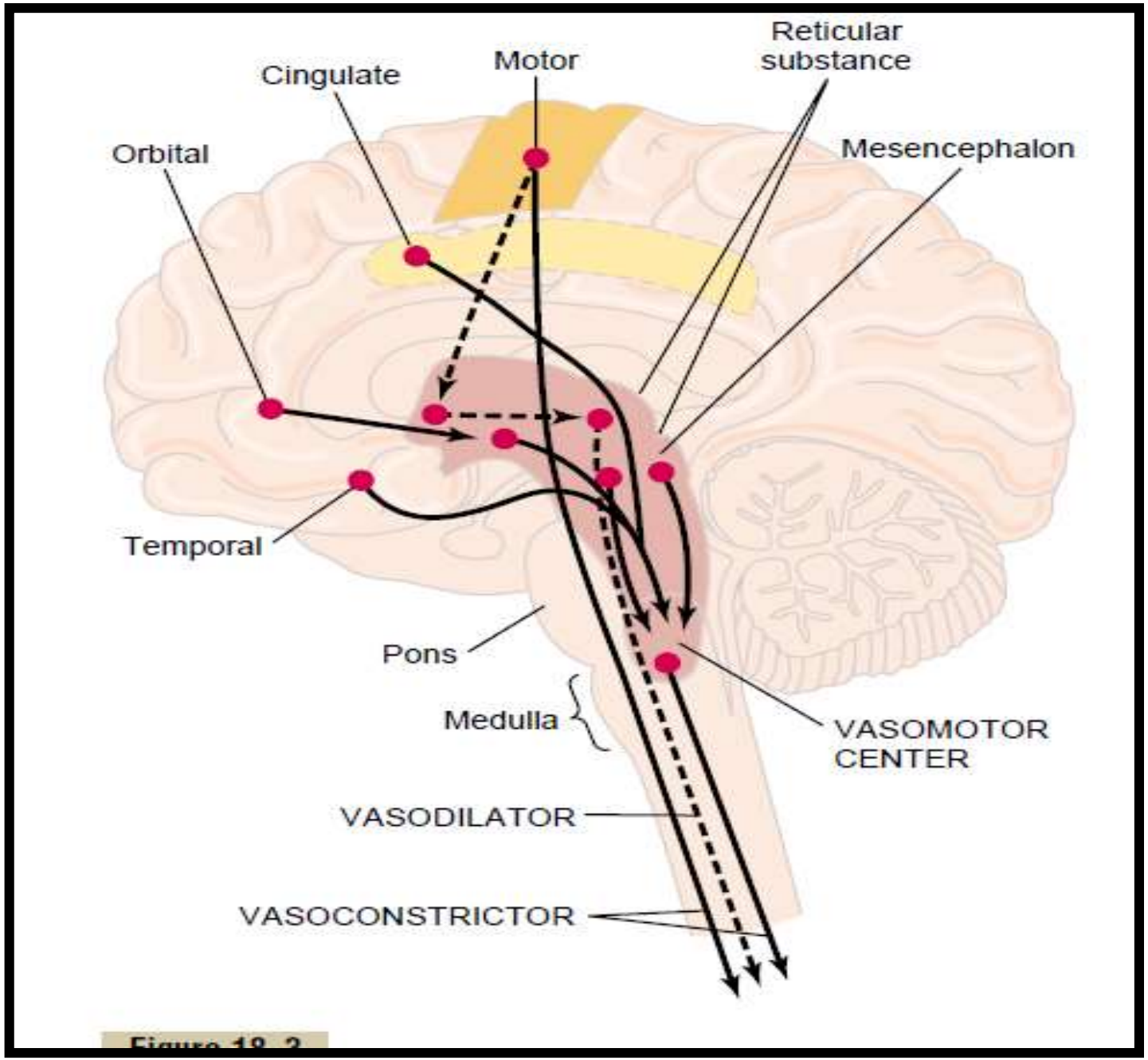
# Brain Areas in Nervous Regulation of Circulation

**Vasoconstrictor area** located bilaterally in the upper medulla→ inhibit vasodilator area→ vasoconstriction

**Vasodilator area** located bilaterally in the lower half of the medulla→ inhibit vasoconstrictor activity→ vasodilation

**Sensory area** located in the *tractus solitarius* in the medulla and lower pons→ to control activities of both the vasoconstrictor and vasodilator areas of the vasomotor center

# Vasomotor Areas



# Control of Heart Activity by the Vasomotor Center

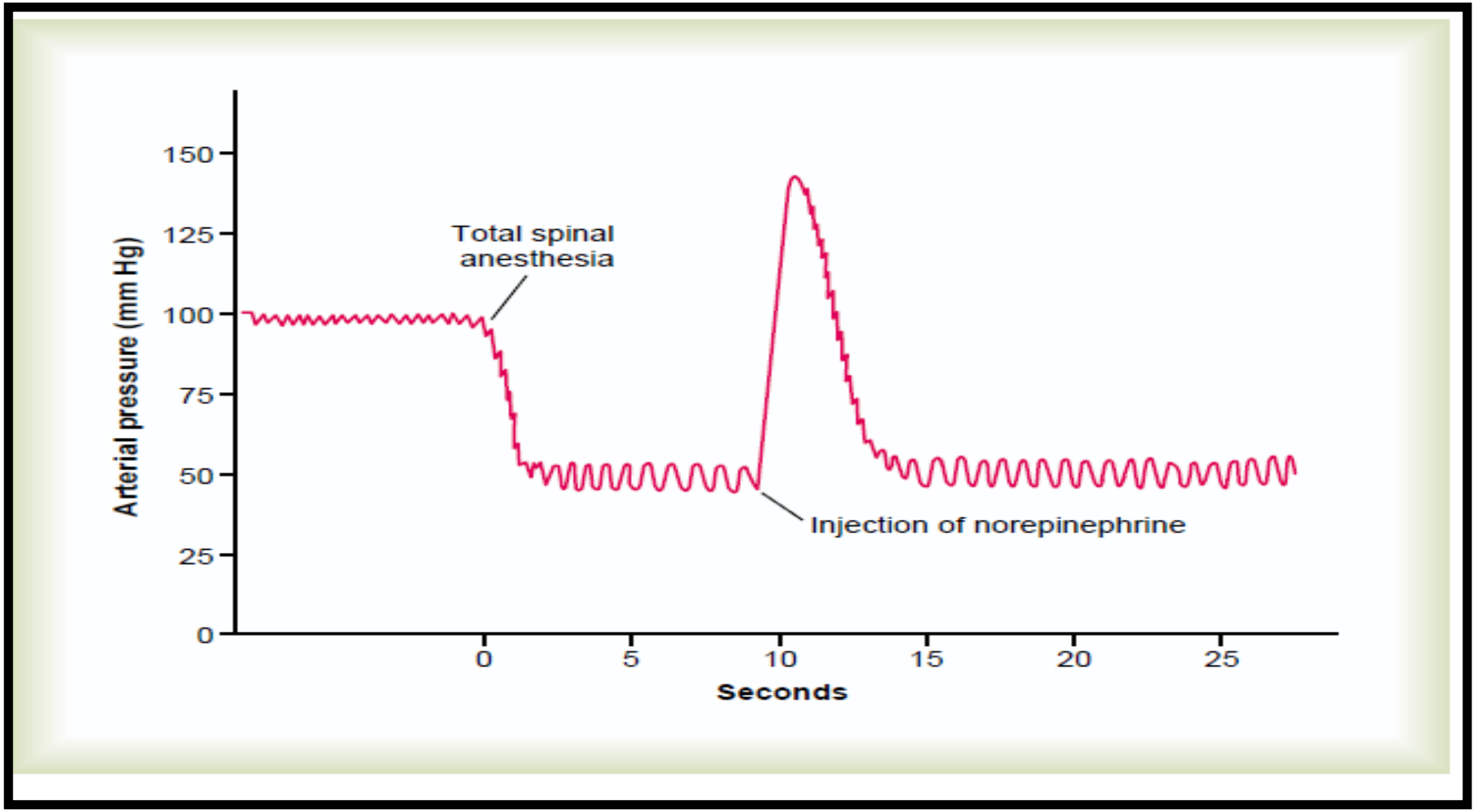
- The **Lateral** portion →

via the **sympathetic nerve fibers** to the heart when there is need to **increase heart rate** and **contractility**

- The **Medial** portion →

dorsal motor nuclei of **Vagus nerves** → **parasympathetic impulses** to the heart to **decrease heart rate and heart contractility**

# Effect of Spinal Anesthesia on Arterial Pressure




WiseGEEK

- A mother on hearing the news of the death of her son
- Intense emotional stress
- Anxiety
- Fear
- Pain
- Orthostatic hypotension

# Emotional Fainting—Vasovagal Syncope

**Also called cardio-neurogenic syncope**

- **Intense Emotional disturbances → Fainting**

**Mechanism**

- The Muscle vasodilator system is activated

- The Vagal center transmits strong signals to slow the heart rate

- The **Arterial Pressure falls rapidly** → reducing blood flow to the brain and causes the person to **lose consciousness**

# Disturbing Thoughts- Vasovagal Syncope

| VASODILATOR CENTER IN HYPOTHALAMUS | TO HEART VIA VAGUS NERVES | TO SYMPATHETIC VASODILATOR NERVES OF THE MUSCLES |
|---|---|---|
| **VASODILATION** | **BRADYCARDIA** | **VASODILATION IN MUSCLES** |

# Regulation of Arterial Pressure

| Rapidly Acting Pressure Control Mechanisms | Intermediate Arterial Pressure Control Mechanisms | Long Term Arterial Pressure Control Mechanisms |
|---|---|---|
| Seconds to Minutes | Act after many minutes | After a Few Hours |
| **Autonomic Nervous system**<br><br>**Reflex Mechanisms**<br>Baroreceptor Feedback Mechanism<br>Chemoreceptor Mechanism<br>Volume, Atrial and Bainbridge Reflexes<br><br>**CNS Ischemic Response** | **1. Renin angiotensin Vasoconstrictor Mechanism**<br><br>**2. Stress Relaxation of Vasculature**<br><br>**3. Capillary Fluid Shift** | **Renin Angiotensin Aldosterone System** |

# Control of Blood Pressure

**A. Rapid/ Short Term/Nervous Control of Blood pressure**

**1. Autonomic nervous system**

**2. Reflex Mechanisms**

i. Baroreceptor Reflex

ii. Carotid and Aortic Chemoreceptors

iii. Atrial and Pulmonary Artery reflexes

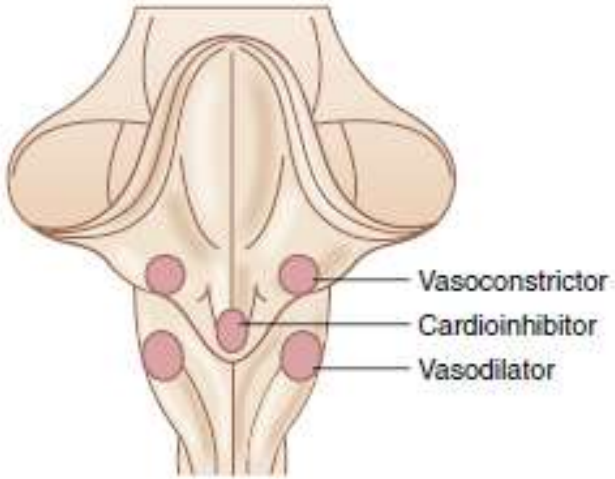
iv. The Volume Reflex

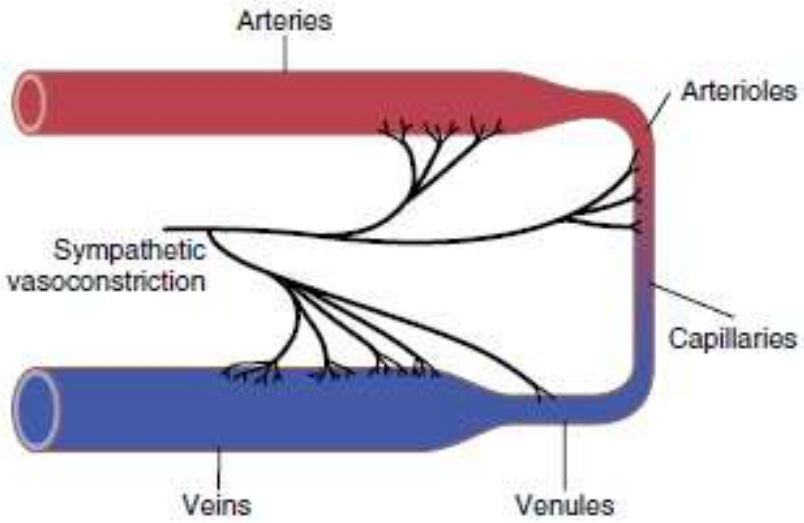
v. The Bainbridge Reflex

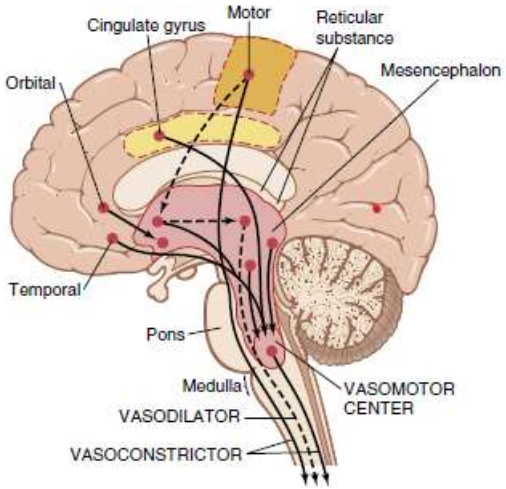
**3. The CNS Ischemic Response**

**B. Long Term Control of Blood pressure – Renin Angiotensin Aldosterone System**

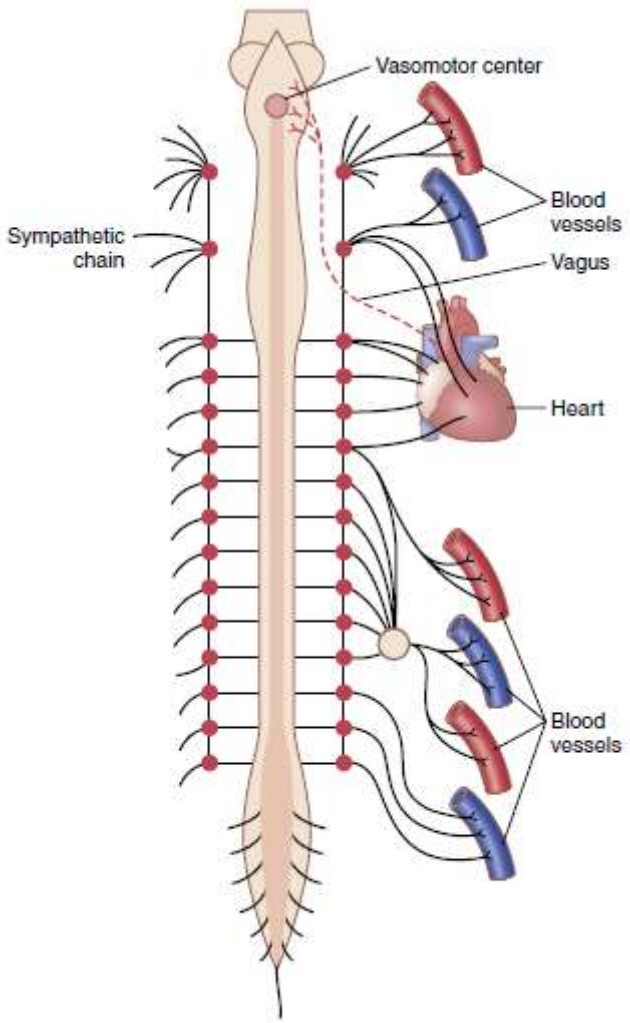
# Nervous Regulation of BP



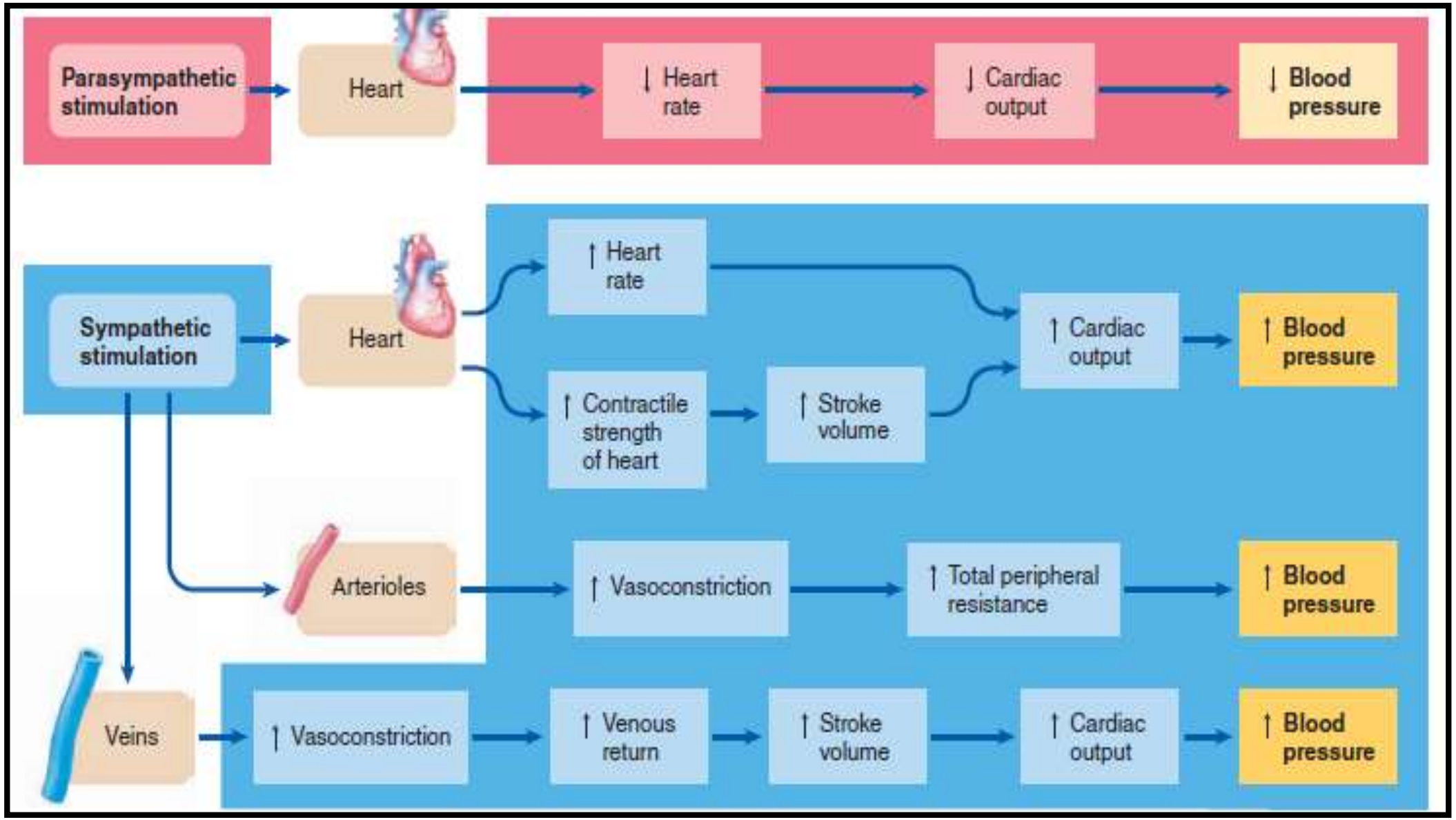



# Sympathetic Nervous System



# Effects of Autonomic Nervous System on B.P



# Increase In Arterial Pressure During Muscle Exercise and Stress

- **Exercise**→ Activation of Brain and increased muscle blood flow→
- Activation of **Reticular Activating System** of Brain →
- Stimulation of **Vasomotor and Cardio acceleratory** areas →
- **Rise in Arterial Pressure** → to keep up with increased muscle activity

# Reflex Mechanisms

1. Baroreceptor Reflex

2. Carotid and Aortic Chemoreceptors

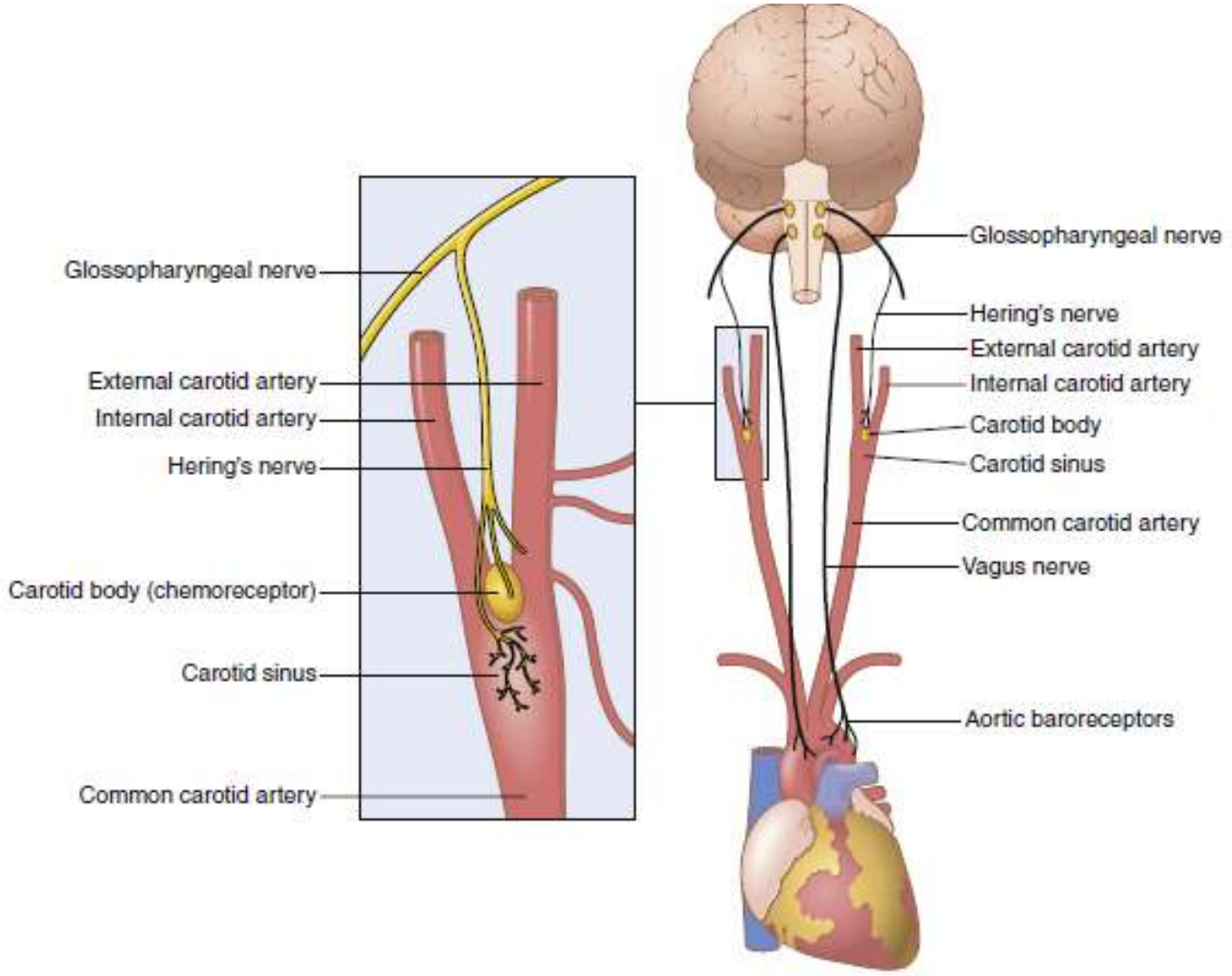
3. Atrial and Pulmonary artery reflexes

4. The Volume Reflex

5. The Bainbridge Reflex

# Baroreceptor Reflex

# Baroreceptor System for Controlling BP



# Baroreceptor Reflexes

## Effect of Baroreceptors

Baroreceptors entered the medulla (tractus solitarius)

↓

Secondary signals inhibit the vasoconstrictor center of medulla and excite the vagal parasympathetic center

↓

EFFECT

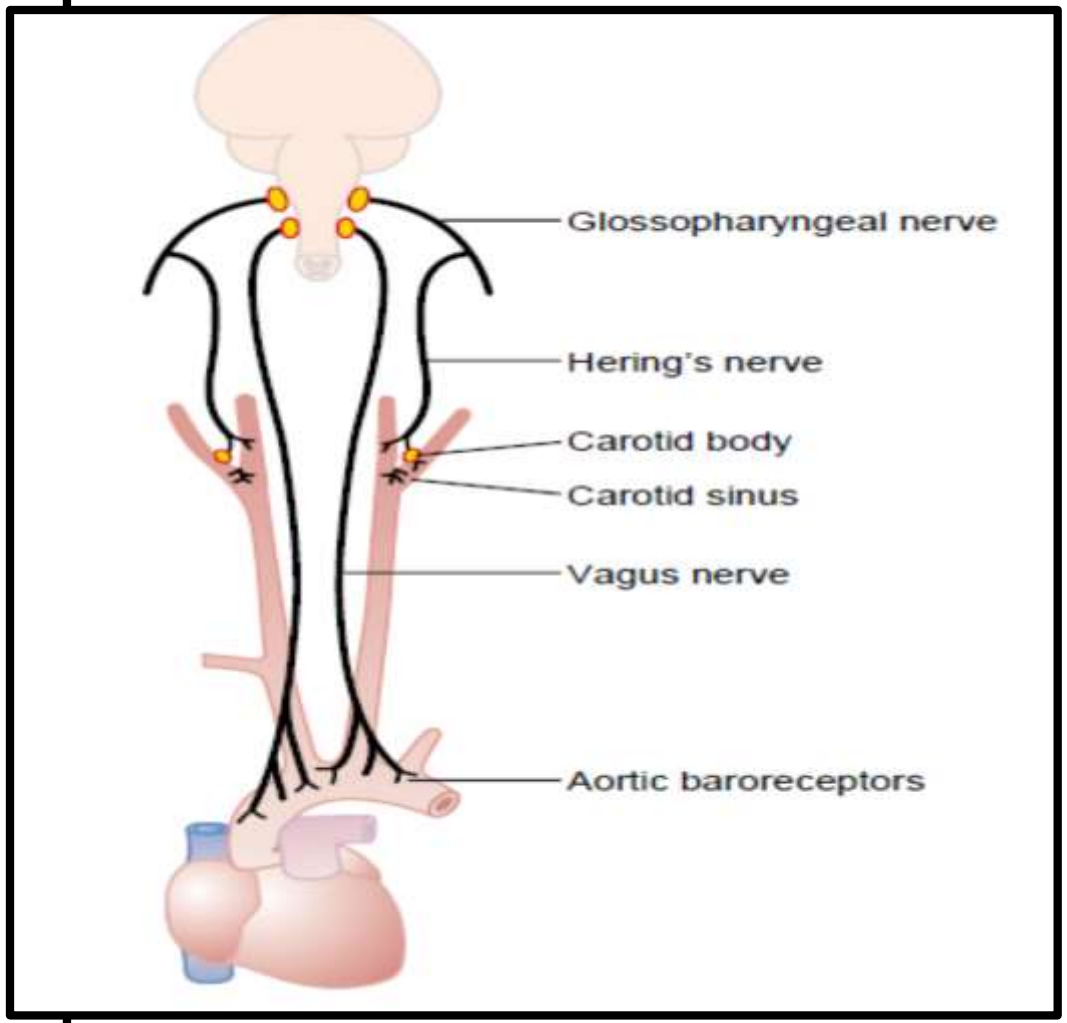
**VASODILATATION OF THE VEINS AND ARTERIOLES**

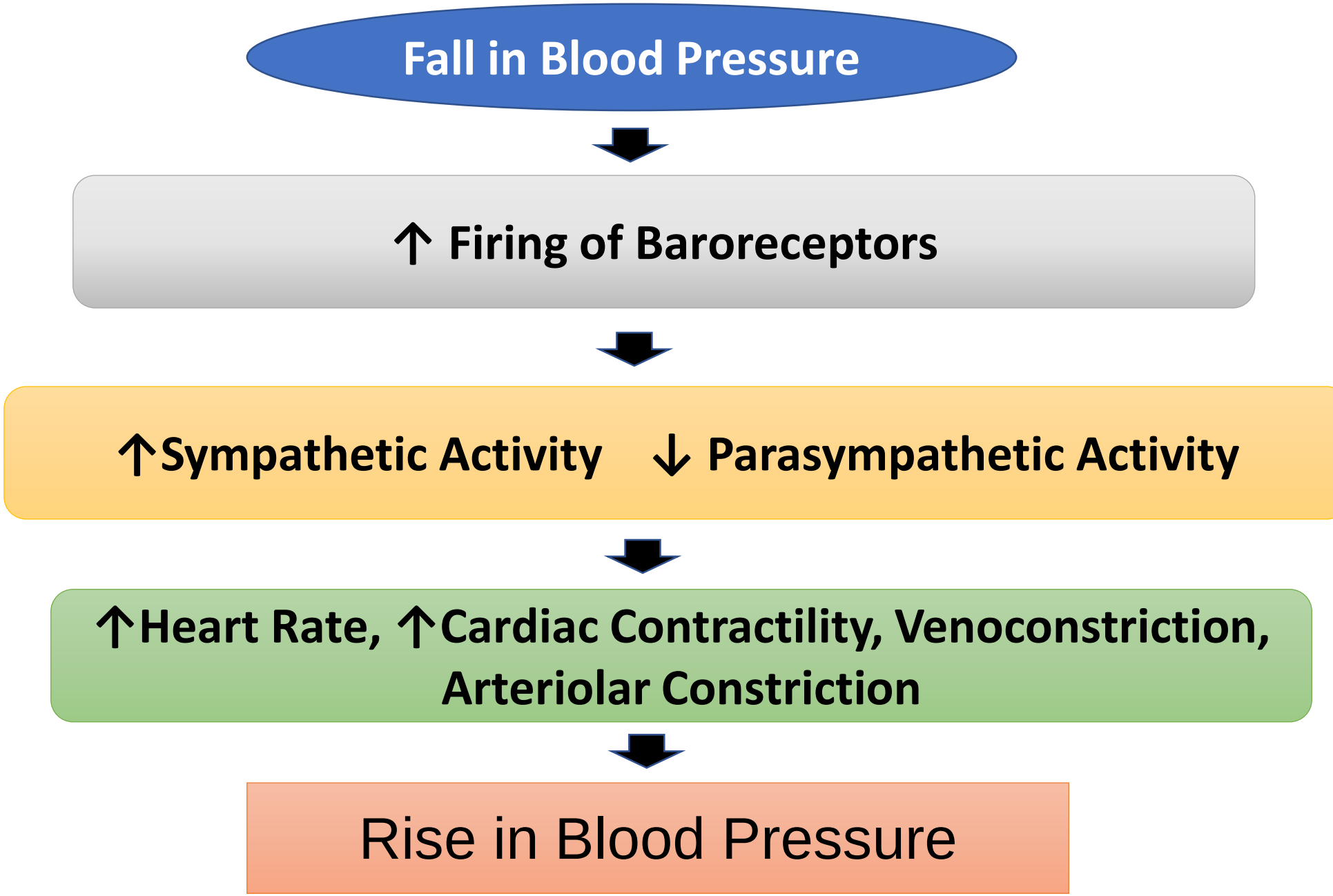
**DECREASED HEART RATE AND STRENGTH OF HEART CONTRACTION**

↓

Therefore, excitation of baroreceptors by high pressure in the arteries reflexly causes arterial pressure to decrease (as decrease in PR and CO)

NOTE : Conversely, low pressure has opposite effects,reflexly causing the pressure rise back to normal.




Fall in Blood Pressure
↑ Firing of Baroreceptors
↑Sympathetic Activity ↓ Parasympathetic Activity
↑Heart Rate, ↑Cardiac Contractility, Venoconstriction, Arteriolar Constriction
Rise in Blood Pressure

# Baroreceptor Response To Arterial Blood Pressure

- **Carotid Sinus ones** stimulated by BP

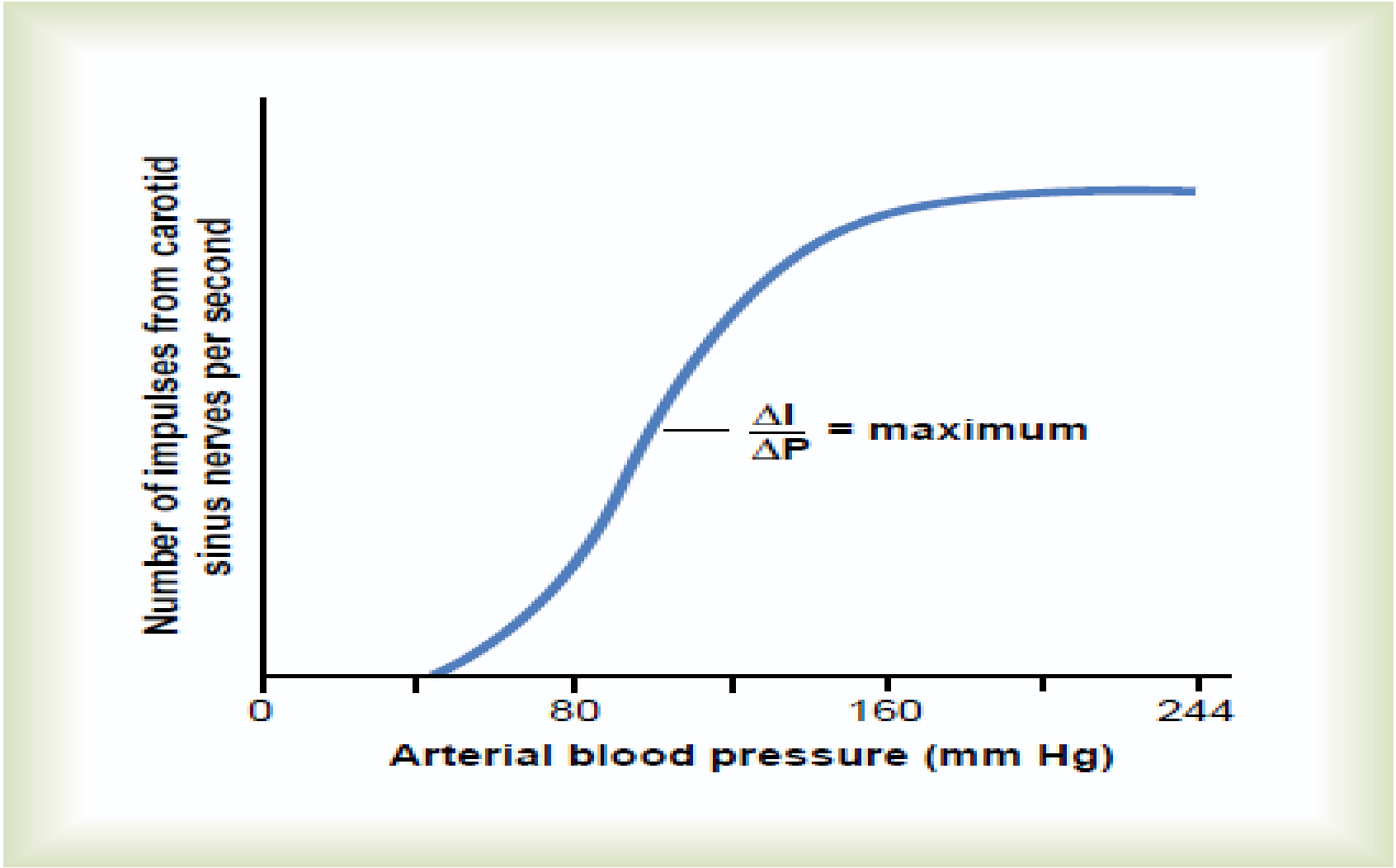
**above 50 to 60 mm Hg** and reach a maximum at about **180 mm Hg**

- **Aortic baroreceptors** operate at pressure levels **about 30 mm Hg higher**

- Respond more to a **Rapidly Changing Pressure** than to a stationary pressure

- Pressure Buffer system- buffer nerves

# Change in Carotid Sinus Nerve Impulses per second with Change in Arterial B.P



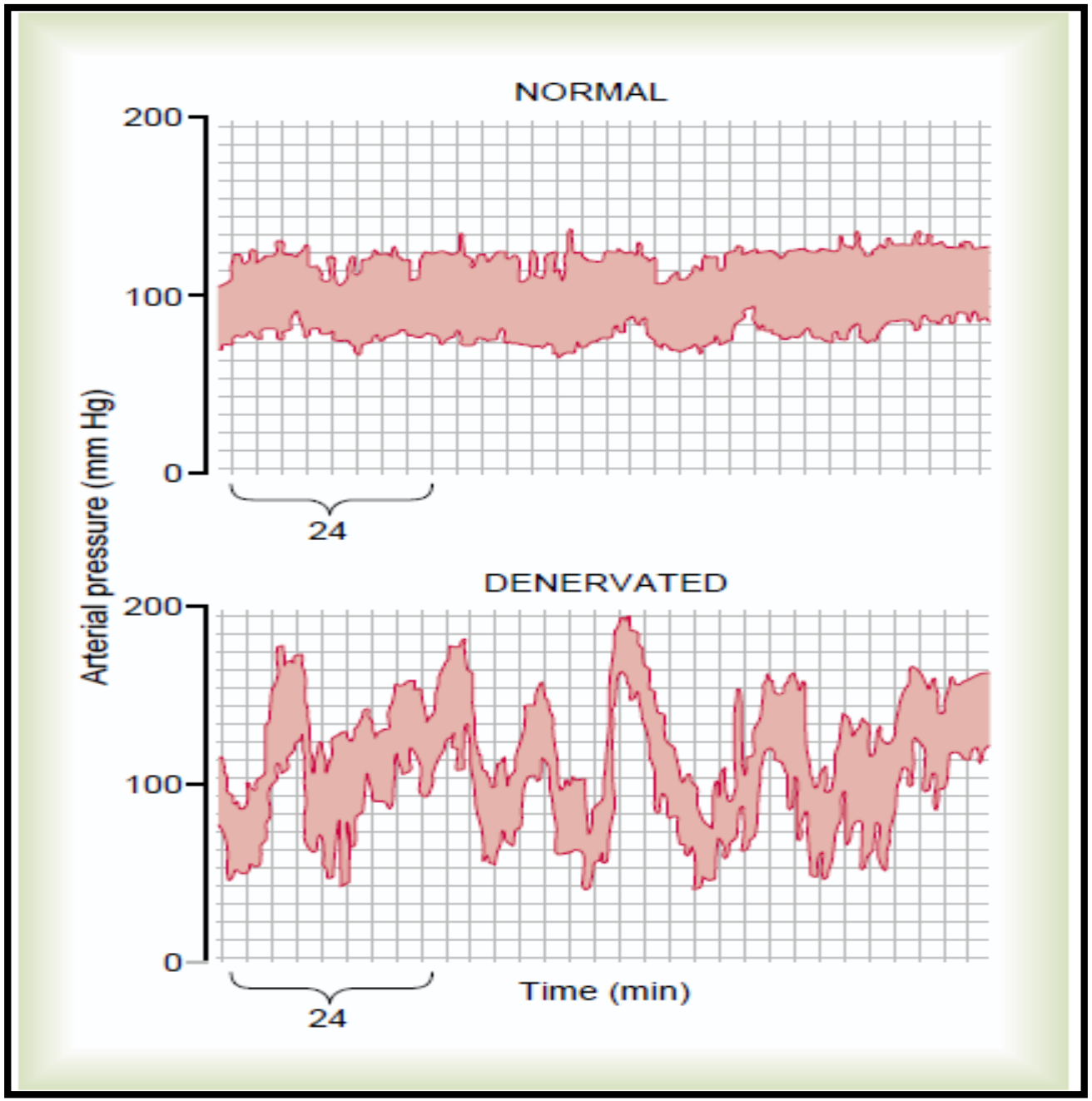
# Function of the Baroreceptors During Changes in Body Posture

**On standing**, the BP in the head and upper part of the body tends to fall → may cause loss of consciousness

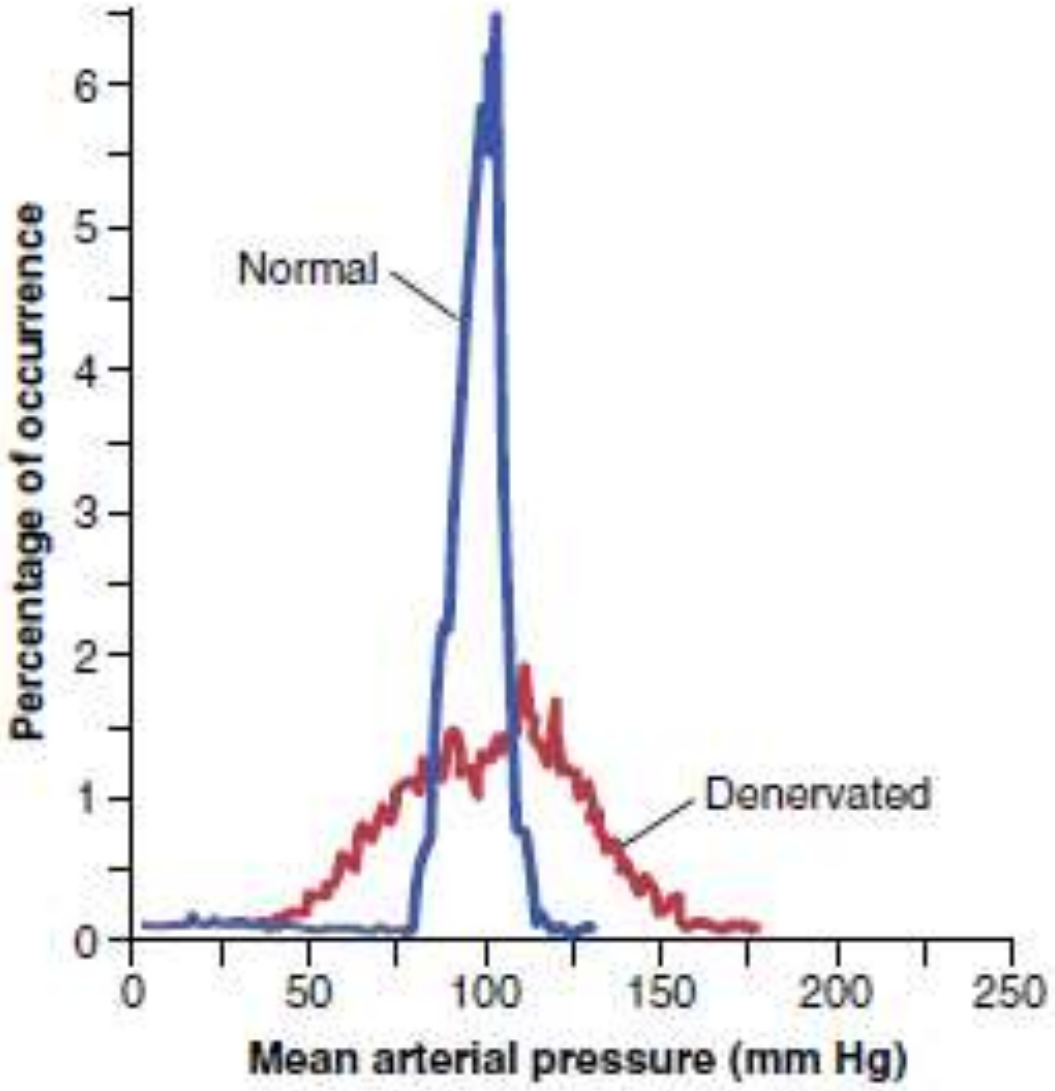
**↓BP at the baroreceptors** → immediate reflex → resulting in strong **Sympathetic discharge** throughout the body

This minimizes the decrease in pressure in the head and upper body

# Arterial B.P Recording in Normal and After Baroreceptor Denervation



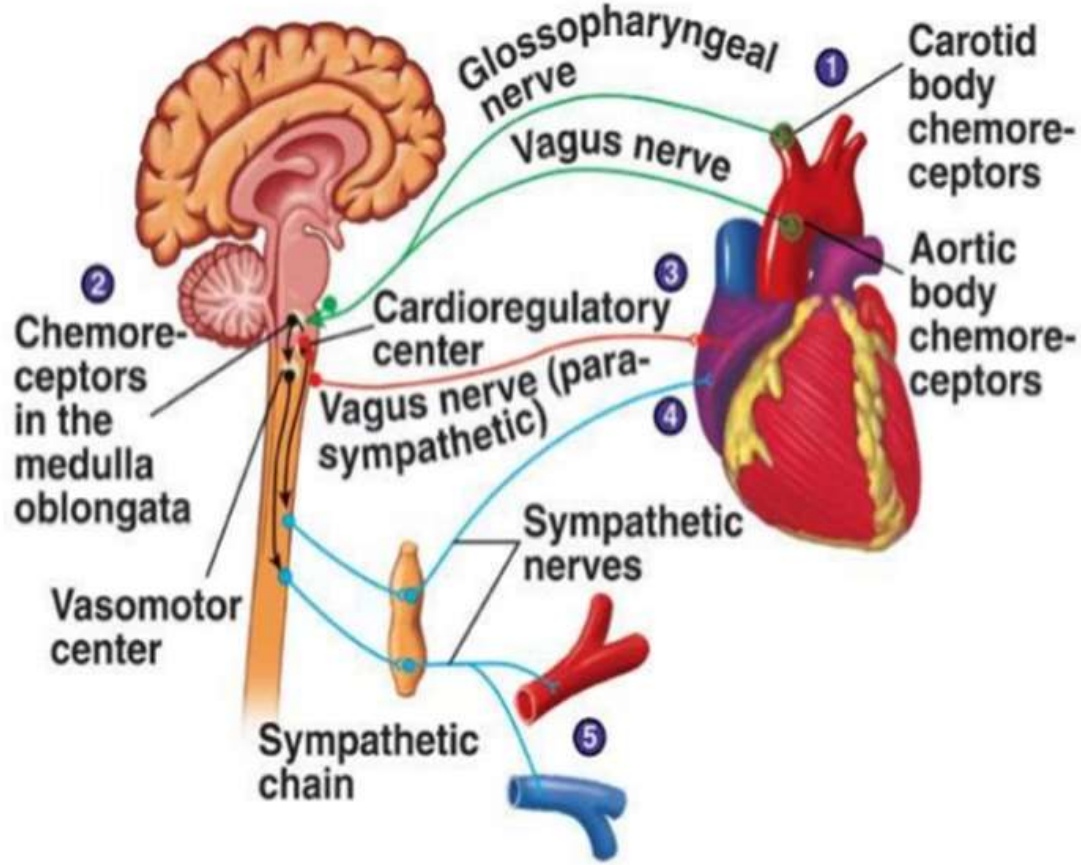
Arterial pressure for a 24-hour period in a normal dog and in the same dog several weeks after the baroreceptors had been denervated



# Chemoreceptor Reflex

# II. Chemoreceptor

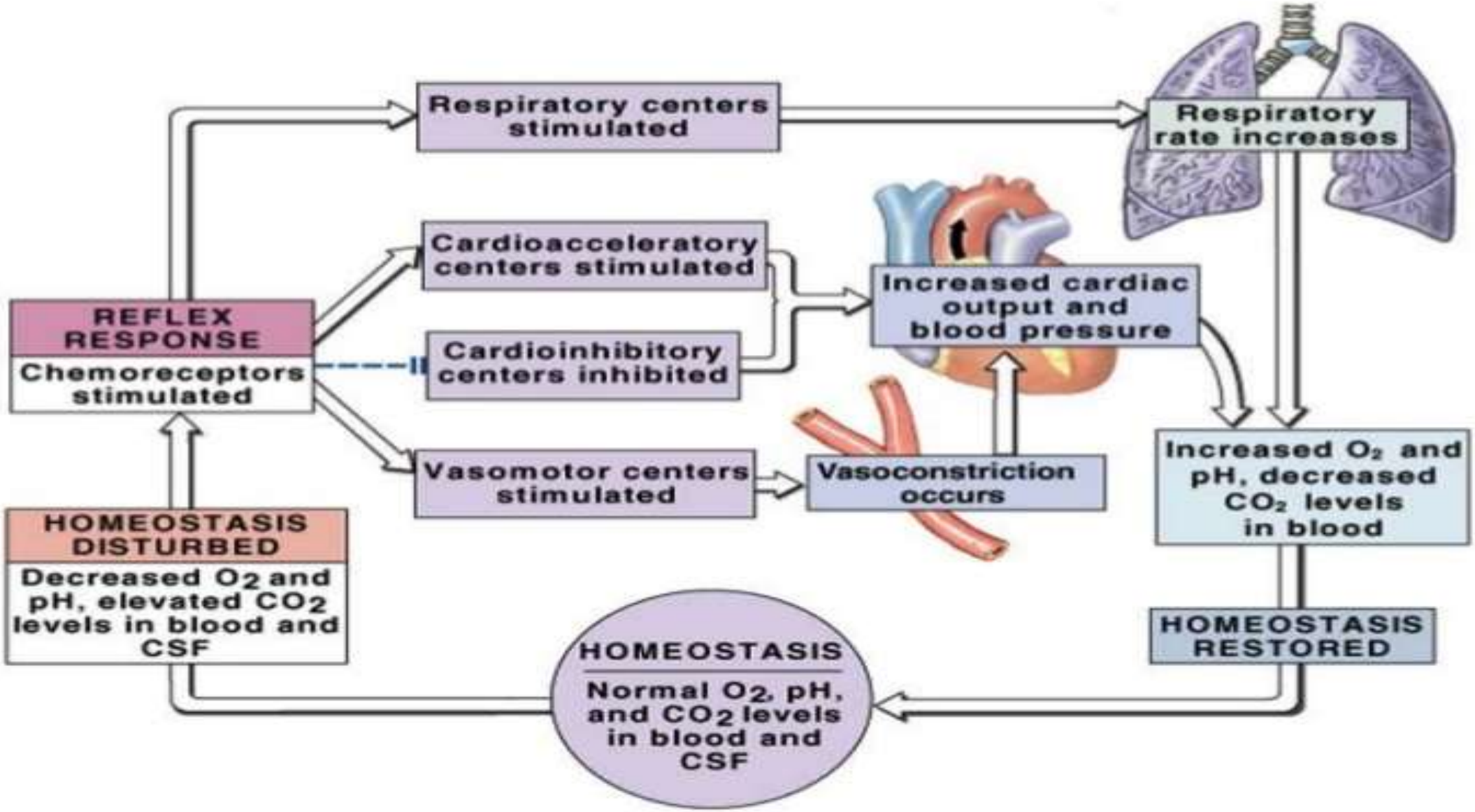




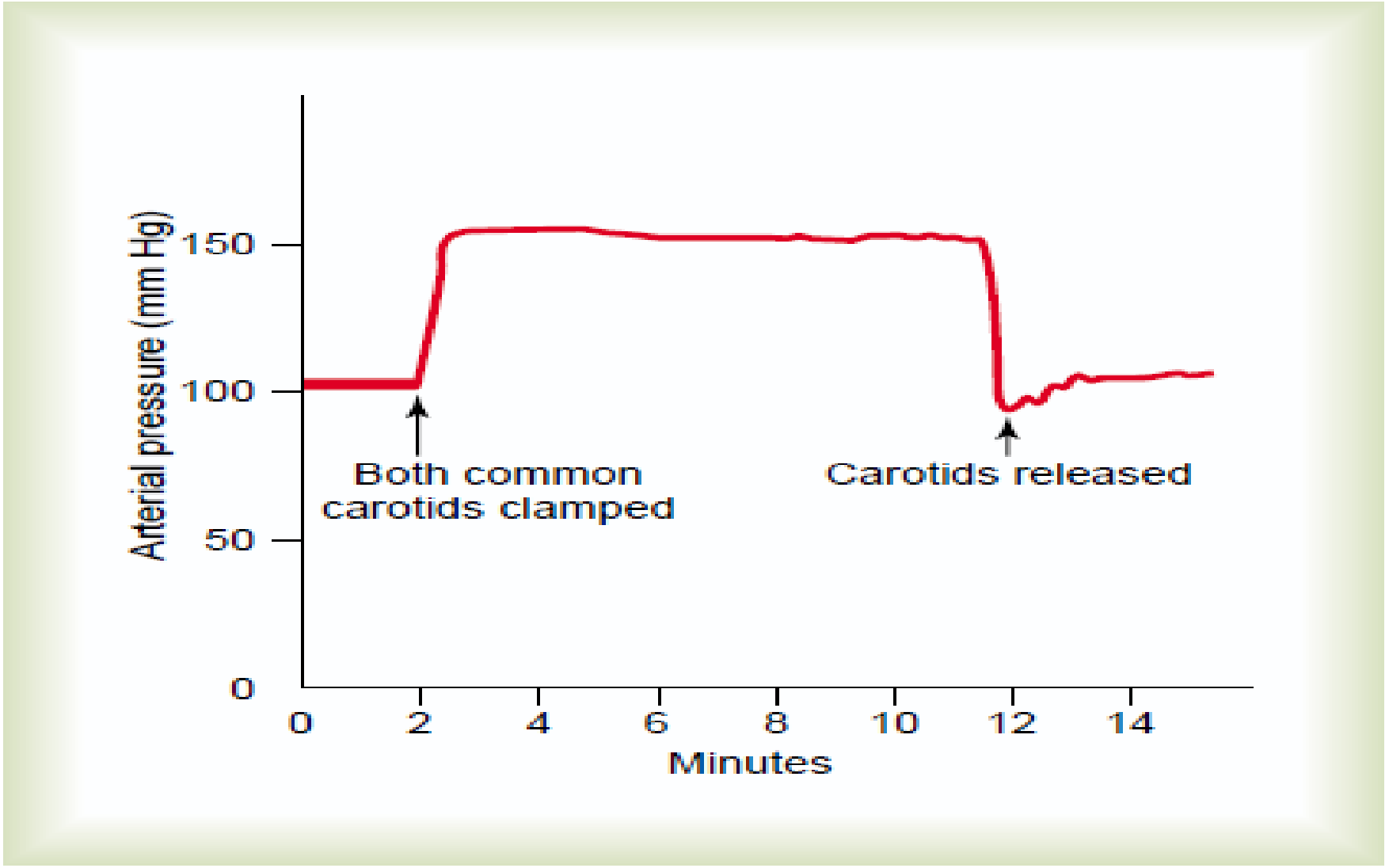
# Chemoreceptor Reflex

- Sensitive to **Oxygen lack**, **Carbon dioxide excess**, and **Hydrogen ion excess**
- Chemoreceptor Organs (2 mm) in **Carotid and Aortic** bodies
- Through **Hering's** and **Vagus nerves** into the **Vasomotor center** of the brain stem
- Not a powerful Arterial pressure controller until it **falls below 80 mm Hg**

# Chemoreceptor Reflex



# Typical Carotid Sinus Reflex



# Atrial and Pulmonary artery reflexes

# Atrial and Pulmonary Artery Reflexes

**Low-pressure receptors**

Arterial baroreceptors denervated → Rise in pressure to **40 mm Hg**

**Low-pressure receptors** → are denervated, the pressure rises **about 100 mm Hg**

# The Volume Reflex

# The Volume Reflex

- (Stretch of Atria → Release of Atrial Natriuretic Peptide → loss of fluid in Urine → Homeostasis)
- Stretch of Atria → Signals to Hypothalamus → ↓ ADH

↘ Decreases Afferent Arteriolar Resistance

↓ Afferent Arteriolar Resistance → ↑ in Glomerular Capillary Pressure

↓ ADH leads to less reabsorption of fluid from kidneys

Increase in filtration of Fluid in Kidney Tubules

+

↓ADH → ↓ Reabsorption of Water from Kidneys → ↑ Fluid loss

# The Bainbridge Reflex

# The Bainbridge Reflex

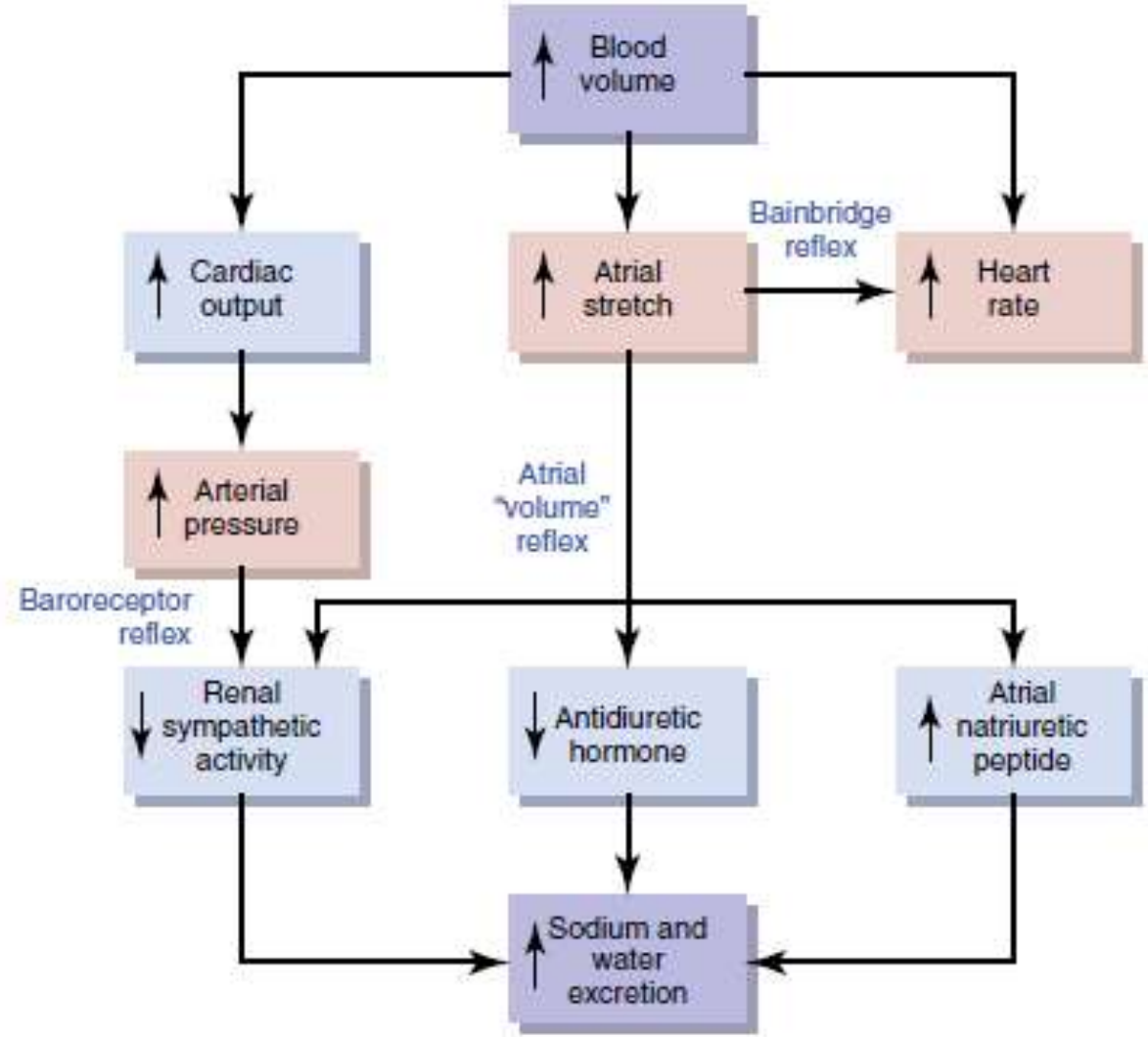
Increase In Atrial Pressure Stretch Atrial Receptors

Afferent signals via Vagus to Medulla

Efferent signals via Vagus and Sympathetic

**↑in Heart Rate and Strength of Contraction by 40-60%**

Prevents Damming Of Blood In Veins, Atria And Pulmonary Circulation


Blood volume
Cardiac output
Atrial stretch
Bainbridge reflex
Heart rate
Arterial pressure
Atrial "volume" reflex
Baroreceptor reflex
Renal sympathetic activity
Antidiuretic hormone
Atrial natriuretic peptide
Sodium and water excretion

# Central Nervous System Ischemic Response

# Central Nervous System Ischemic Response

When BP falls below 60 mmHg

↓

↓ Blood Flow To Lower Brain Stem→ Cerebral Ischemia

↓

↑ $CO_2$, Lactic Acid Accumulation, Acidic substances

↓

Excitation of Vasoconstrictor And Cardioaccelerator Neurons

↓

**↑ in Arterial Pressure**

# Importance of CNS Ischemic Response As a Regulator of Arterial Pressure

**Emergency Pressure Control System**

- to prevent further decrease in arterial pressure whenever blood flow to the brain decreases dangerously close to the lethal level
  - BP falls below **60mmHg to 15-20mmHg**
  - **"Last Ditch Stand"** pressure control mechanism

# Cushing's Reaction

- A special type of **CNS ischemic response** →
- **Increased Pressure of CSF** around brain to equal the Arterial Pressure →
- Compressing brain and arteries and **cuts off blood supply**→
- Initiating a CNS ischemic response causing the Arterial Pressure to rise

When **Arterial Pressure rises higher than CSF Pressure** →

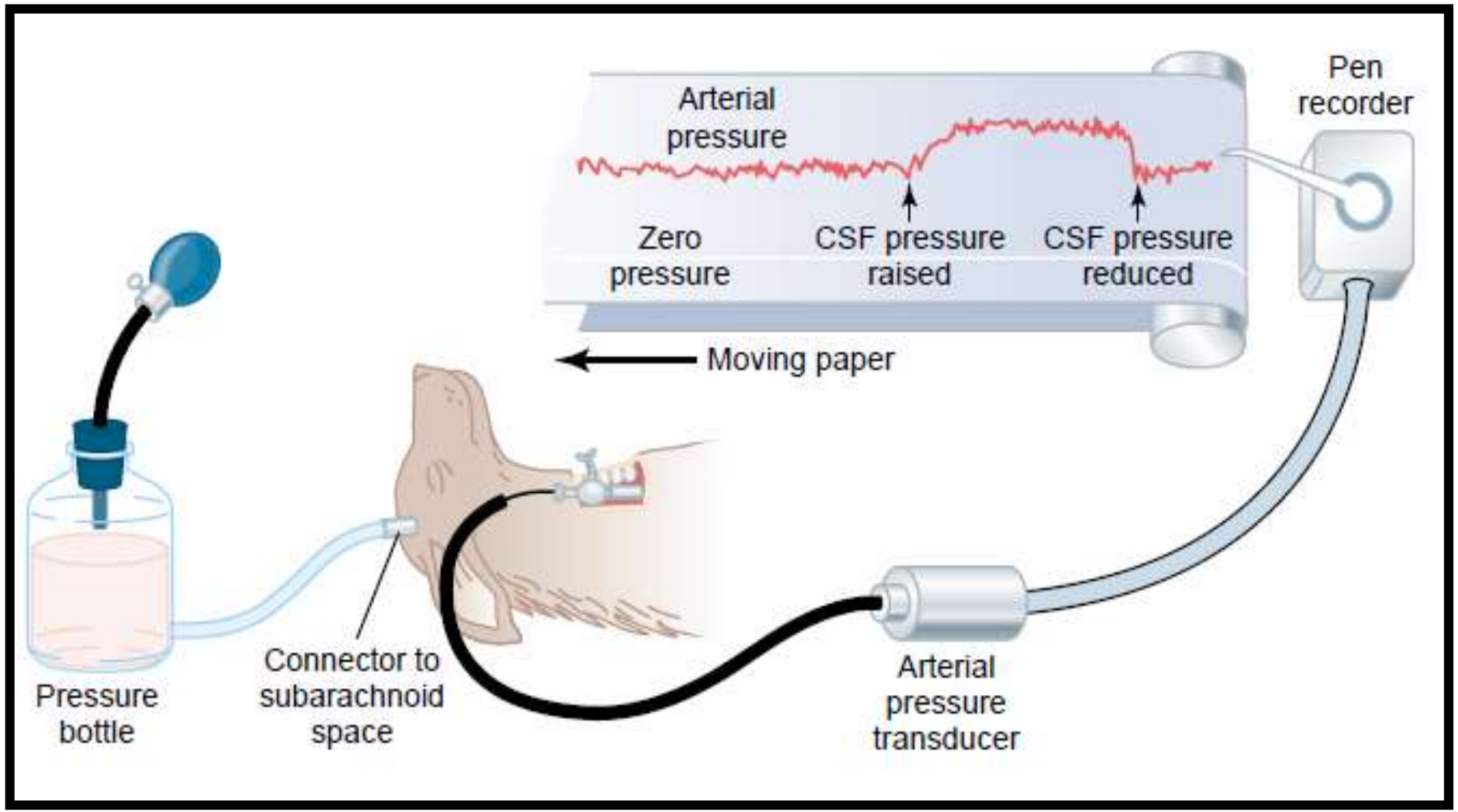
blood will start flow into the vessels of the brain

# Cushing's Reaction…

- Helps protect the **Vital Centers** of the brain from

**loss of nutrition** if the cerebrospinal fluid pressure rises enough to compress brain tissue

# Cushing Reaction



# Special Features of Nervous Control of Arterial Pressure

**Role of the Skeletal Nerves and Skeletal Muscles in Increasing Cardiac Output and Arterial Pressure**

→ **Abdominal Compression Reflex**

→ Increased Cardiac Output and Arterial Pressure Caused by **Skeletal Muscle Contraction During Exercise**

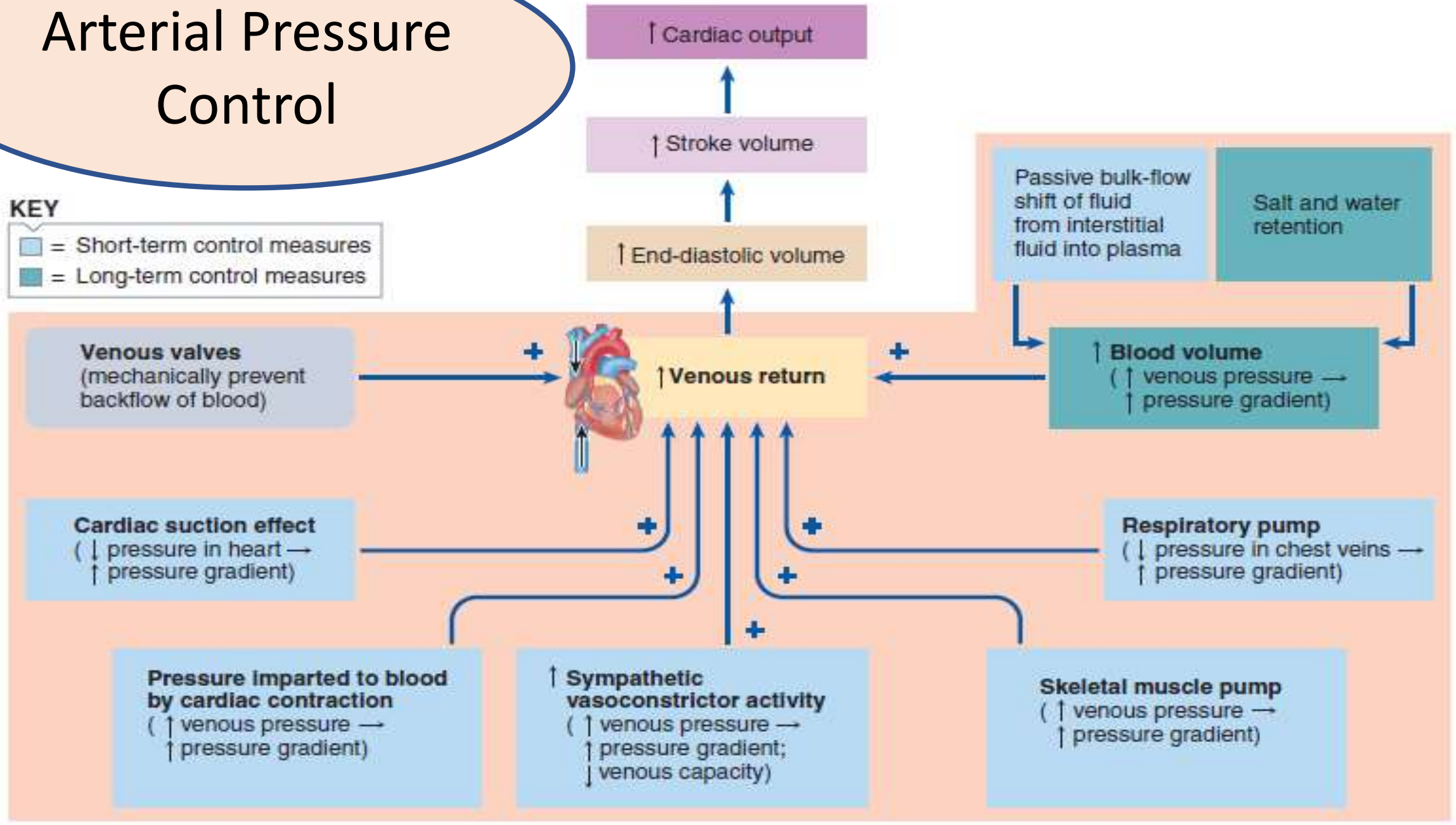
# Renal–Body Fluid System for Arterial Pressure Control

- **↑ Extracellular fluid** → ↑ the blood volume and

  **↑ Arterial Pressure**

- The rising pressure causes the kidneys to excrete the excess extracellular fluid returning the pressure back toward normal

# Arterial Pressure Control



| Rapidly Acting Pressure Control Mechanisms | Intermediate Arterial Pressure Control Mechanisms | Long Term Arterial Pressure Control Mechanisms |
|---|---|---|
| **Seconds to Minutes** | **Act after many minutes** | **After a Few Hours** |
| Autonomic Nervous system<br><br>Reflex Mechanisms<br>Baroreceptor Feedback Mechanism<br>Chemoreceptor Mechanism<br>Voume, Atrial and Bainbridge Reflexes<br><br>CNS Ischemic Response | 1. Renin angiotensin Vasoconstrictor Mechanism<br><br>2. Stress Relaxation of Vasculature<br><br>3. Capillary Fluid Shift | Renin Angiotensin Aldosterone System |

# References


- Guyton and Hall
- Sherwood Physiology


Thank
you