# Lecture 26. The regulation of blood circulation.

# Control of blood pressure and blood flow

- Interconnected negative feedback systems control blood pressure by adjusting heart rate, stroke volume, systemic vascular resistance, and blood volume
- Some act faster that others
- Some shorter- or longer-term

# Role of cardiovascular center (CV)

- In medulla oblongata
- Helps regulate heart rate and stroke volume
- Also controls neural, hormonal, and local negative feedback systems that regulate blood pressure and blood flow to specific tissues
- Groups of neurons regulate heart rate, contractility of ventricles, and blood vessel diameter
- Cardiostimulatory and cardioinhibitory centers
- Vasomotor center control blood vessel diameter
- Receives input from both higher brain regions and sensory receptors

# CV Center

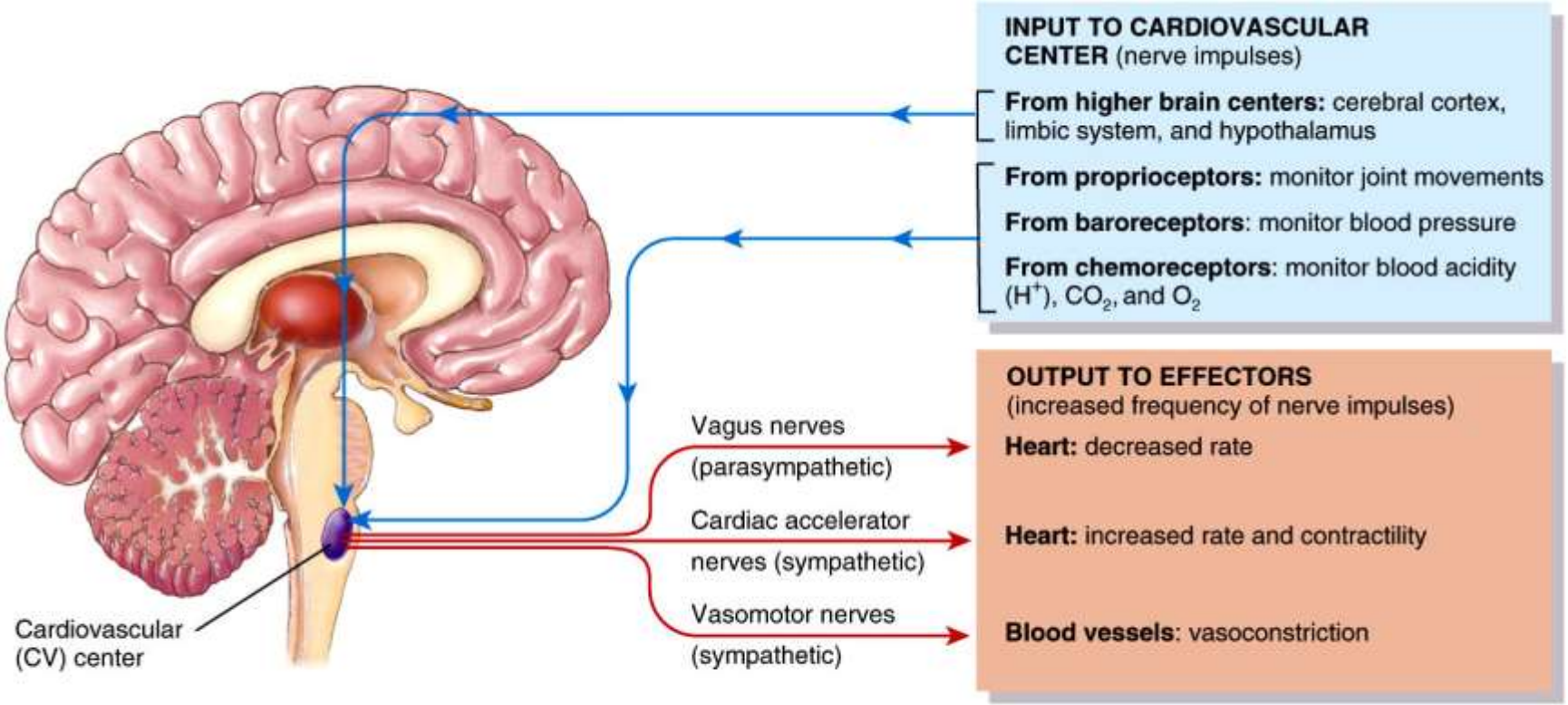


Figure 21.12 Tortora - PAP 12/e

# 3 main types of sensory receptors

- Proprioceptors – monitor movements of joints and muscles to provide input during physical activity
- Baroreceptors – monitor pressure changes and stretch in blood vessel walls
- Chemoreceptors – monitor concentration of various chemicals in the blood

- Output from CV flows along neurons of ANS
  - Sympathetic (stimulatory) opposes parasympathetic (inhibitory)

# Neural regulation of blood pressure

- Negative feedback loops from 2 types of reflexes

1. Baroreceptor reflexes
   - Pressure-sensitive receptors in internal carotid arteries and other large arteries in neck and chest
     - Carotid sinus reflex helps regulate blood pressure in brain
     - Aortic reflex regulates systemic blood pressure
   - When blood pressure falls, baroreceptors stretched less, slower rate of impulses to CV
   - CV decreases parasympathetic stimulation and increases sympathetic stimulation

# Neural regulation of blood pressure

2. Chemoreceptor reflexes
   - Receptors located close to baroreceptors of carotid sinus (carotid bodies) and aortic arch (aortic bodies)
   - Detect hypoxia (low $O_2$), hypercapnia (high $CO_2$), acidosis (high $H^+$) and send signals to CV
   - CV increases sympathetic stimulation to arterioles and veins, producing vasoconstriction and an increase in blood pressure
   - Receptors also provide input to respiratory center to adjust breathing rate

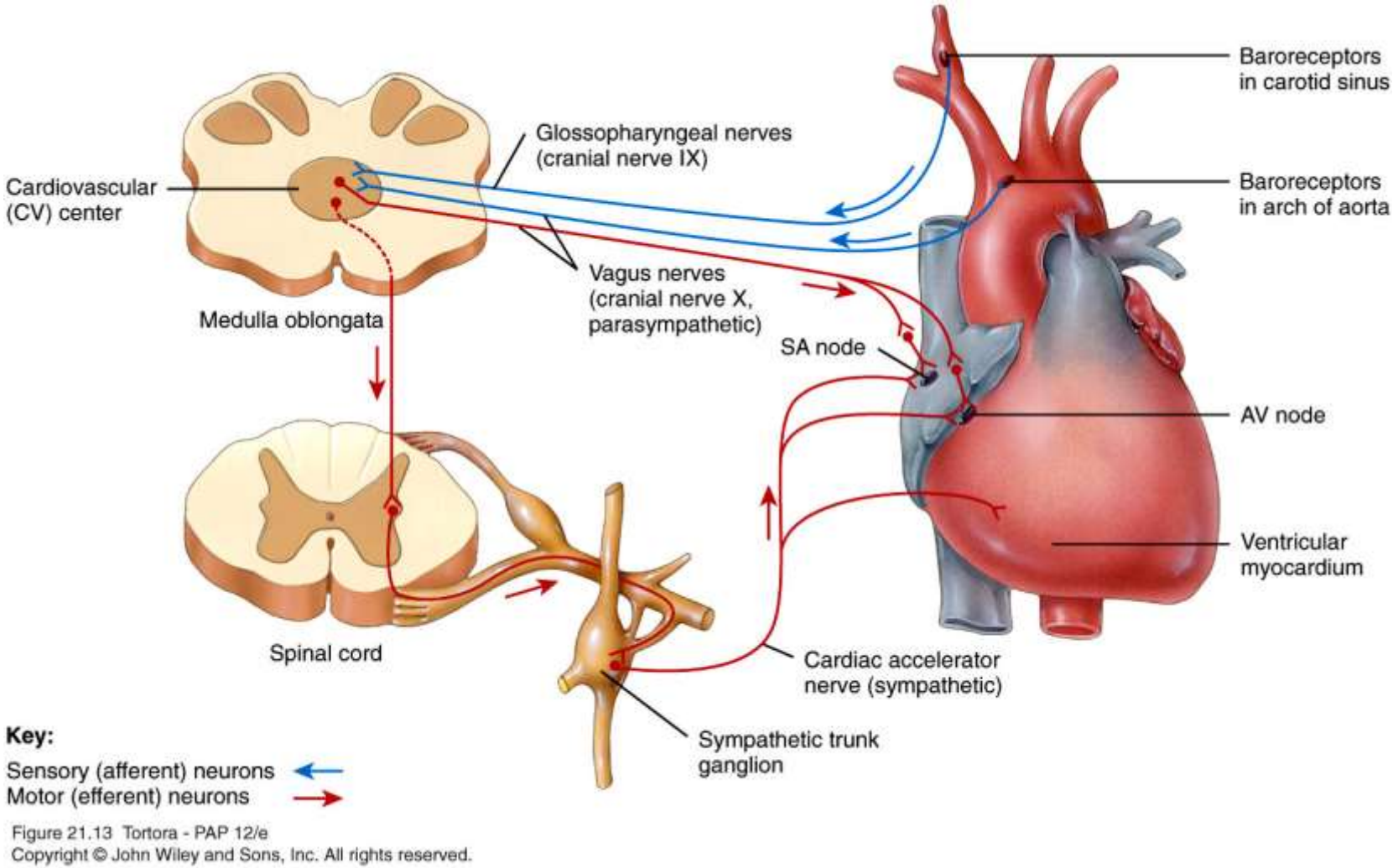


Figure 21.13 Tortora - PAP 12/e

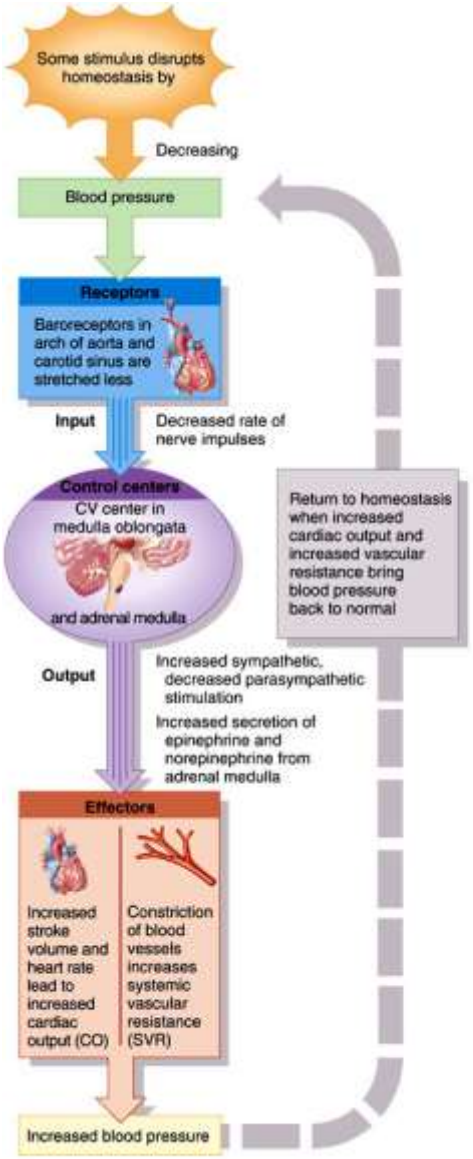


Figure 21.14 Tortora - PAP 12/e

# Hormonal regulation of blood pressure

- Renin-angiotensin-aldosterone (RAA) system
  - Renin (released by kidney when blood volume falls or blood flow decreases) and angiotensin converting enzyme (ACE) act on substrates to produce active hormone angiotensin II
    - Raises BP by vasoconstriction and secretion of aldosterone (increases water reabsorption in kidneys to raise blood volume and pressure)

# Hormonal regulation of blood pressure

- Epinephrine and norepinephrine
  - Adrenal medulla releases in response to sympathetic stimulation
  - Increase cardiac output by increasing rate and force of heart contractions
- Antidiuretic hormone (ADH) or vasopressin
  - Produced by hypothalamus, released by posterior pituitary
  - Response to dehydration or decreased blood volume
  - Causes vasoconstriction which increases blood pressure

# Atrial natriuretic peptide (ANP)

- Released by cells of atria
- Lowers blood pressure by causing vasodilation and promoting loss of salt and water in urine
- Reduces blood volume

# Autoregulation of blood pressure

- Ability of tissue to automatically adjust its blood flow to match metabolic demands
- Demand of $O_2$ and nutrients can rise tenfold during exercise in heart and skeletal muscles
- Also controls regional blood flow in the brain during different mental and physical activities
- 2 general types of stimuli
  1. Physical – temperature changes, myogenic response
  2. Vasodilating and vasoconstricting chemicals alter blood vessel diameter

# Circulation

- Important difference between pulmonary and systemic circulation in autoregulatory response
  - Systemic blood vessel walls dilate in response to low $O_2$ to increase $O_2$ delivery
  - Walls of pulmonary blood vessels constrict under low $O_2$ to ensure most blood flows to better ventilated areas of lung

# End of Chapter 21