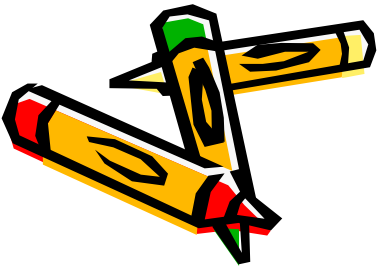
Cardiovascular Module

Cardiovascular Physiology

Lect. five

Heart rate & Stroke volume



Prof. Dr. Najeeb Hassan Mohammed

Objectives:

- **Define heart rate and Stroke volume.**
- **Summarize the factors that regulate heart rate and Stroke volume.**
- **Describe how EDV, total peripheral resistance interact to control stroke volume.**

Heart rate

- **The heart rate refers to the ventricular rate of beating per minute.**
- **Normally, it averages 72 beats/minute (range 60-100 beats/minute).**
- **Tachycardia….higher than 100 beats/min.**
- **Bradycardia… lower than 60 beats/min.**

Regulation of Heart Rate

- Positive chronotropic factors increase heart rate
  - Chrono = time
- Negative chronotropic factors decrease heart rate
- Can be neural, chemical, or physical factors

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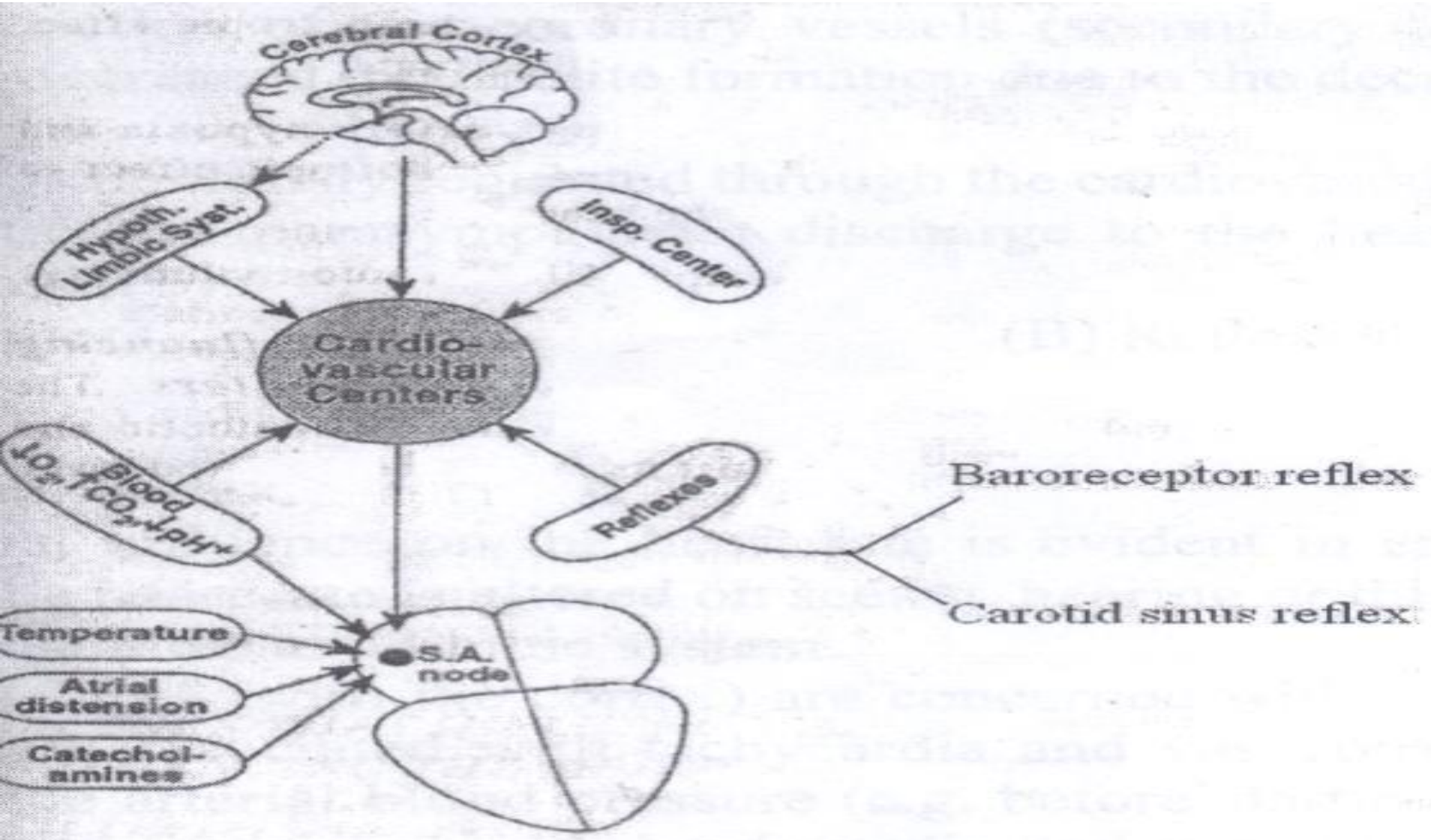
Regulation of Heart rate



Cardiovascular centers

1- Vasomotor center (VMC):

A- Vasoconstrictor center (VCC):

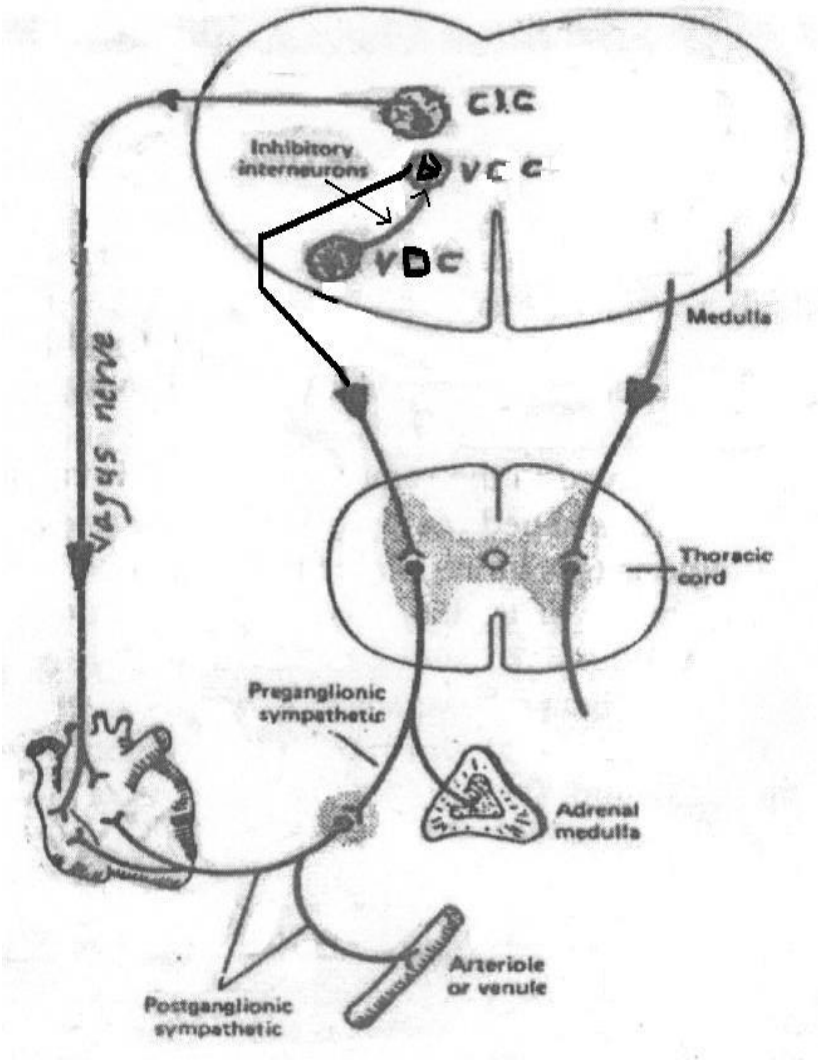
- **The blood vessels (leading to generalized vasoconstriction (VC)).**
- **The adrenal medullae (leading to secretion of Catecholamines).**
- **The heart (increasing heart rate).**

B- Vasodilator center (VDC):

inhibiting the activity of VCC causing generalized vasodilatation.

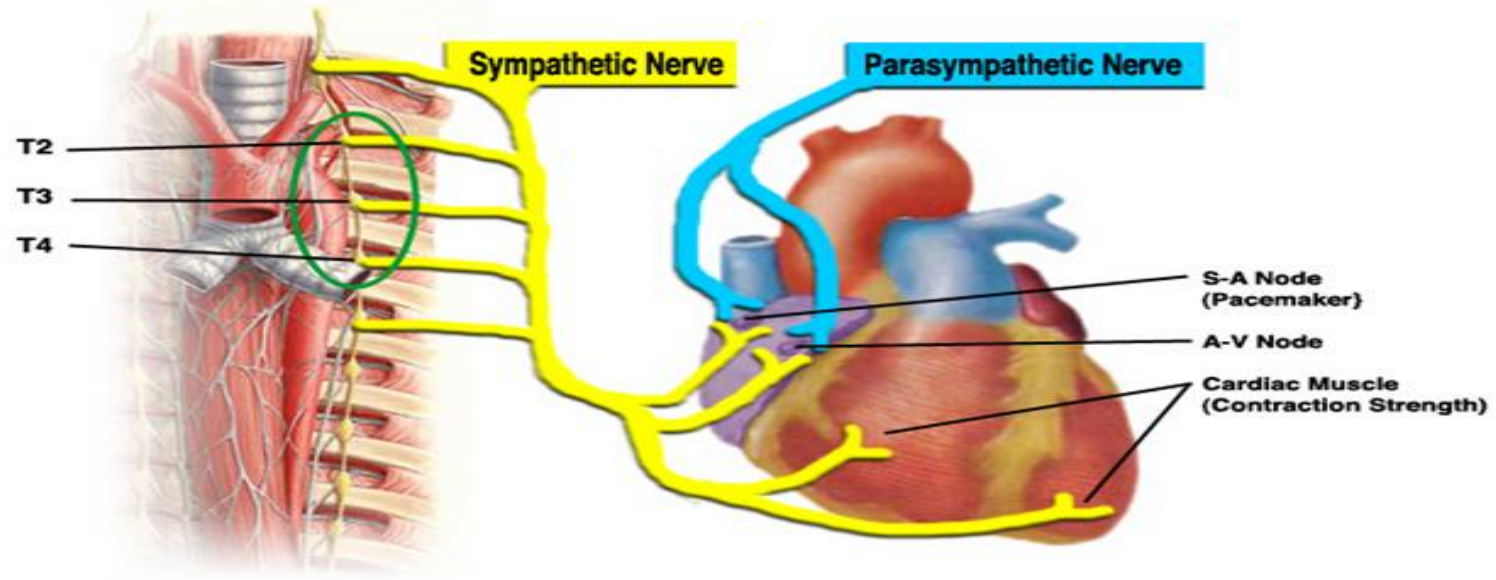
2- Cardioinhibitory center (CIC).

Decreasing heart rate.



Neural regulation of the heart rate

- **Sympathetic nerves:** supply all parts of the heart (atria, ventricles, and conduction system). When activated they increase Heart rate (+ve chronotropic effect).
- **Parasympathetic nerves:** supply atria, SA & AV nodes **but not the ventricles.** When activated, they decrease Heart rate (-ve chronotropic effect).



Reflexes

- **Bainbridge reflex (atrial stretch reflex)**

  right atrial pressure or distention leads to heart acceleration through medullary VCC.

- **Baroreceptor reflex**

  stretch receptors, carotid sinus and aortic arch, glossopharyngeal and vagus nerves, inhibit the VCC and excite the vagal center (CIC) resulting in vasodilation, and decreased heart rate.

- **The carotid sinus reflex**

  pressure on carotid sinus area, reflex slowing of heart rate and vasodilation. reflex increase in the vagal tone (bradycardia) and decrease in the sympathetic vasoconstrictor tone (vasodilation).

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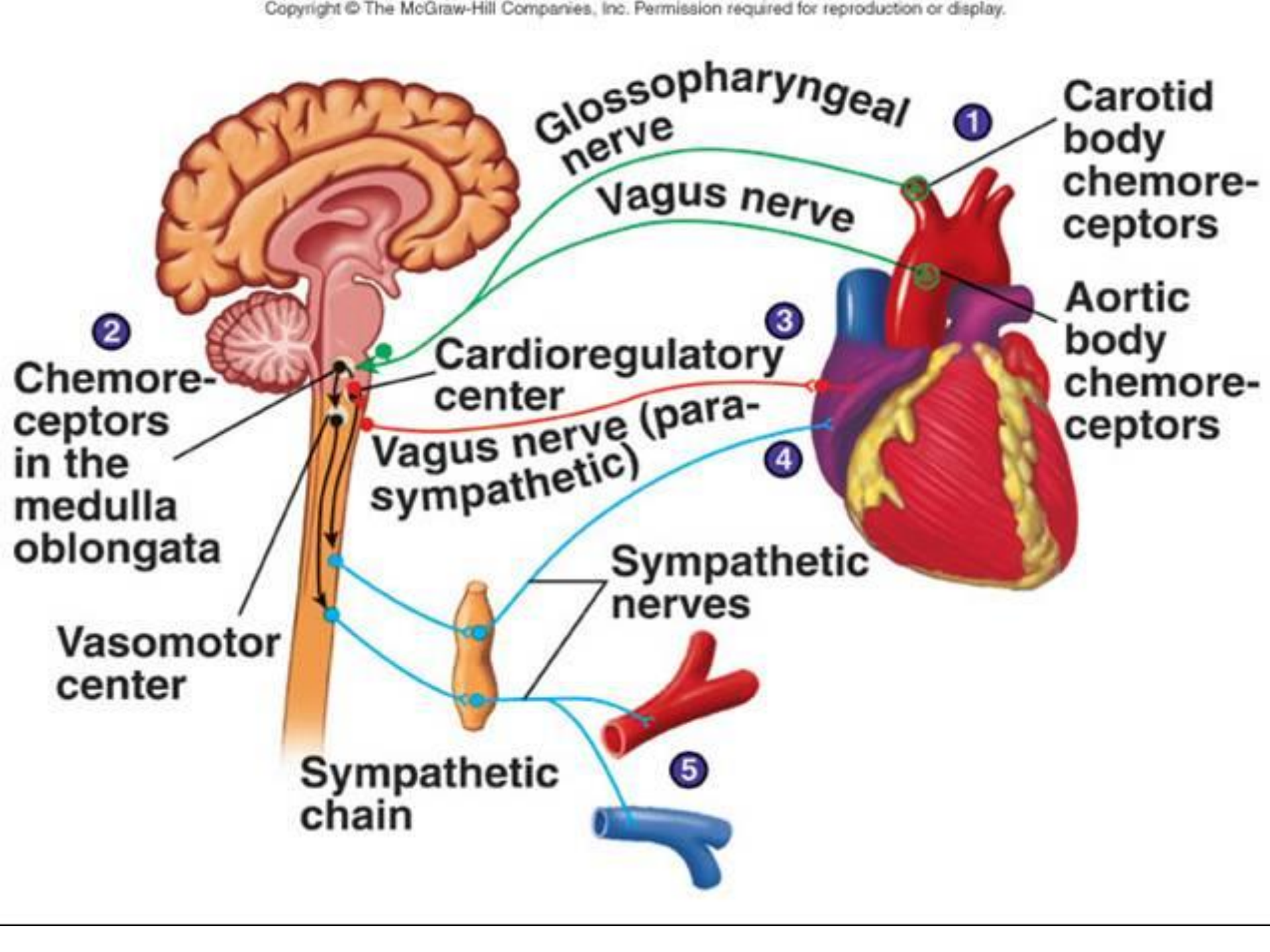
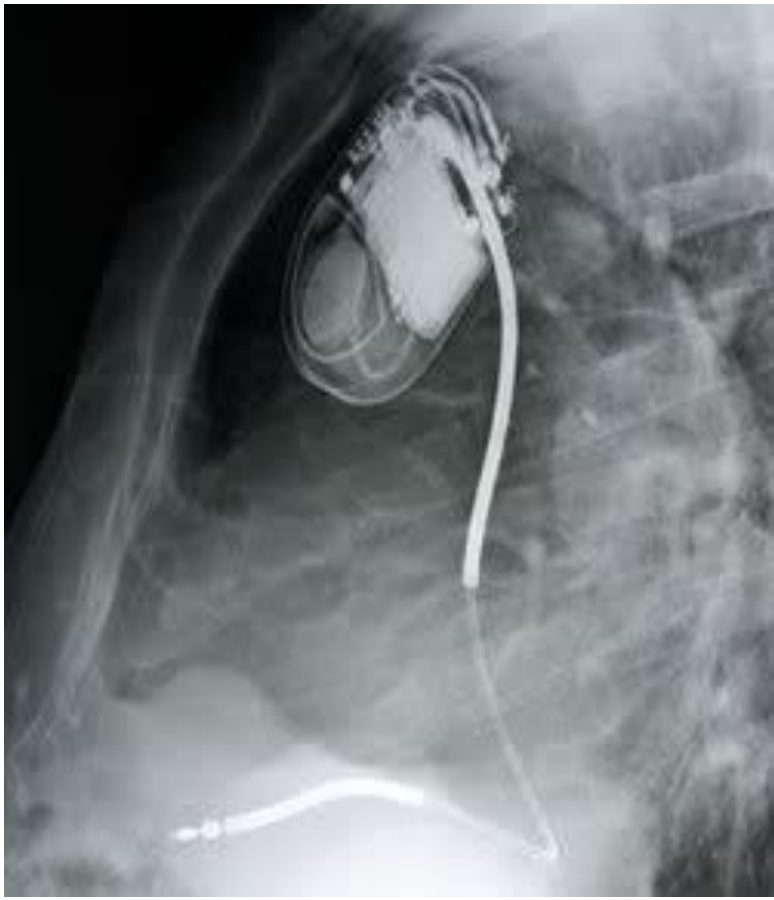


SA node activity

Factors directly affect SA node activity:

- **Physical factors: Body temperature; 1 °C increases the heart rate by 10-20 beats/minute.**
- **Mechanical factors; Right atrial distension may directly excite the SA node leading to tachycardia.**



Stroke Volume (SV)

- **Stroke volume (SV) is defined as Volume of blood ejected by each ventricle per one beat.**
- **It is about 70 ml/beat at rest but may increase to 150 ml/beat with exercise.**
- **the ventricles don't completely empty themselves of blood during contraction.**
- **2/3 of blood is ejected (ejection fraction), 1/3 is left there.**

Stroke Volume

- **SV = EDV - ESV.**
- **EDV: volume of blood in ventricles at end of diastole (110 to 120 ml).**
- **ESV: volume of blood in ventricles at end of systole (40 ml).**

SV = 70 to 80 ml.

SV = End-diastolic volume - End-systolic volume

130 ml - 60 ml

= 70 ml.

Regulation of Stroke Volume

SV = EDV - ESV

Determined by 3 variables:

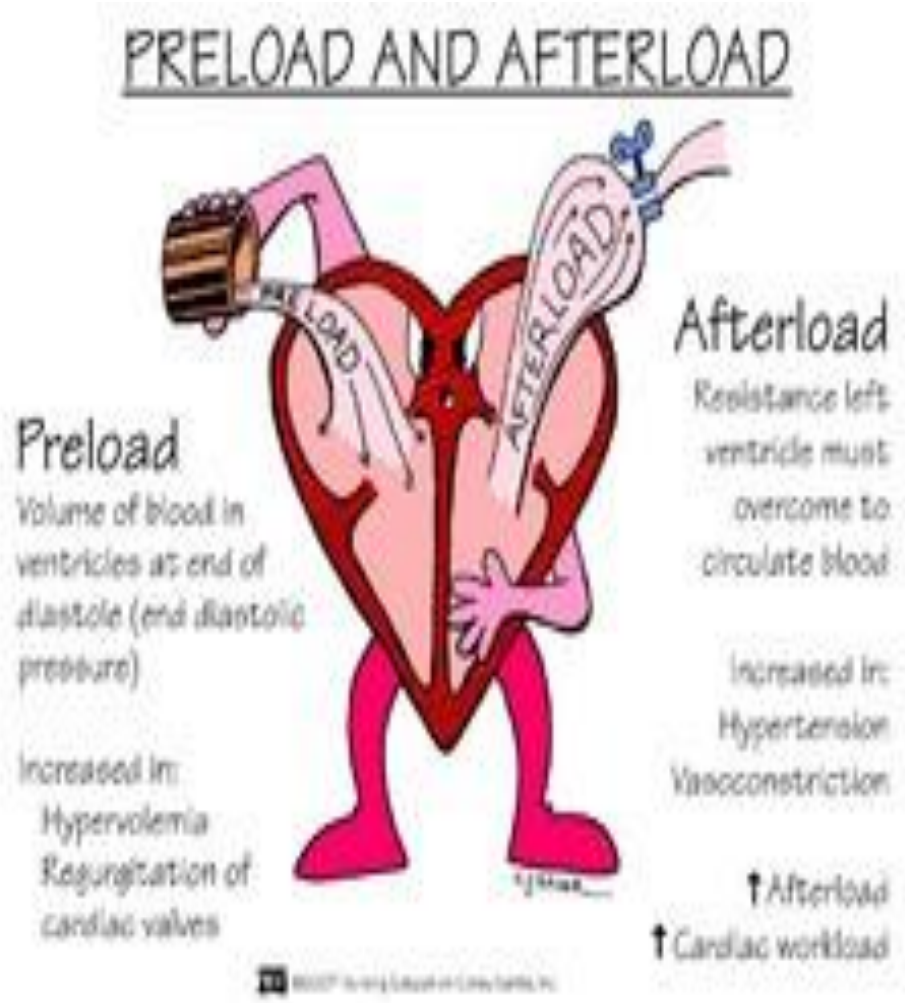
Preload: affects mainly **EDV**.

Afterload: affects mainly **ESV**.

Inotropy: affects mainly **ESV**.

Regulation of Stroke Volume

- **End diastolic volume (EDV). It is workload on heart prior to contraction (preload).**
- **Total peripheral resistance (TPR) = which impedes ejection from ventricle; impedance to blood flow in arteries (afterload).**



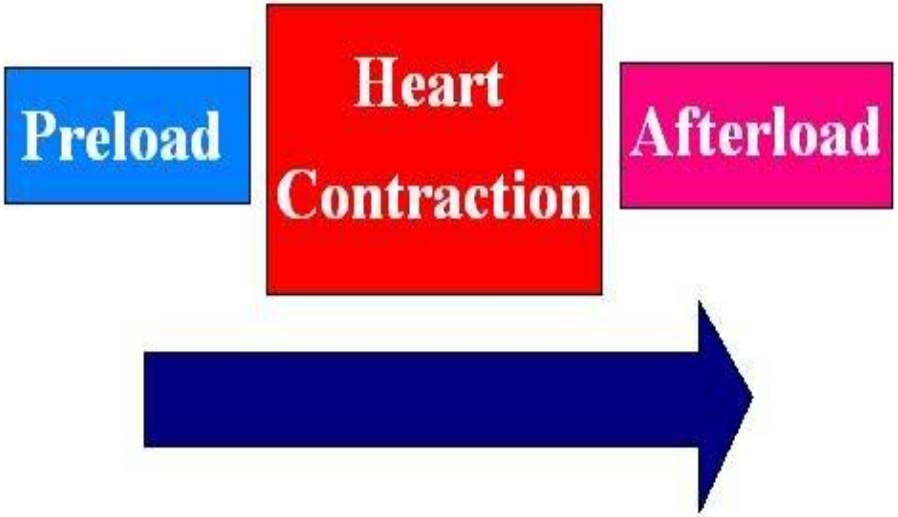
Regulation of Stroke Volume

- **End-diastolic volume (EDV):** **SV is directly proportional to preload; an increase in EDV results in an increase in stroke volume (Frank-Starling law).**

- **The total peripheral resistance:** **SV is inversely proportional to TPR (afterload); it is the aortic impedance; higher peripheral resistance; higher arterial pressure) that reduce the stroke volume.**

- **Sympathetic input (Inotropy):** **Strength of contraction varies directly with EDV; myocardial contractility is directly proportional with SV.**

Thank you



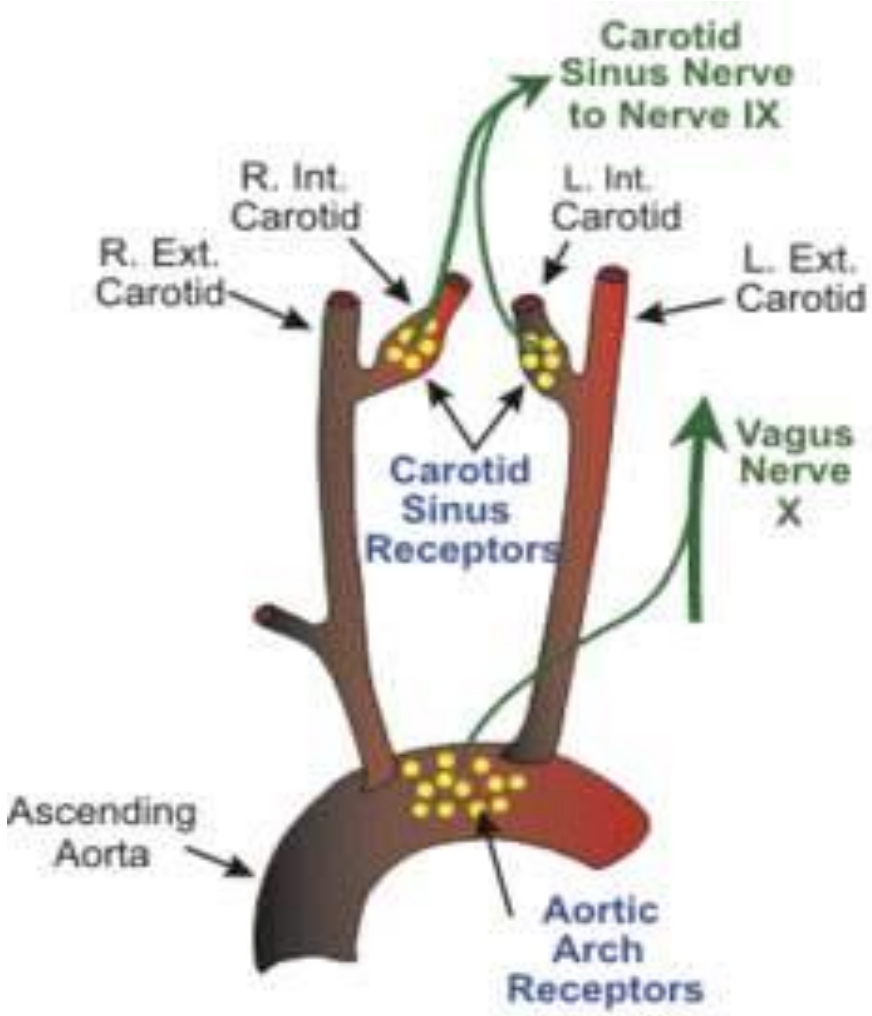


Figure 1. Location and innervation of arterial baroreceptors.