

HEART RATE AND ITS REGULATION



Introduction

Normal – 72/minute .Ranges between 60 and 80/min

Taccycardia – Increase in heart rate above 100/min

Physiological conditions

- ❖ **Childhood**
- ❖ **pregnancy**
- ❖ **Exercise & Emotional conditions such as anxiety.**

Pathological conditions

- ❖ **Fever**
- ❖ **Anaemia**
- ❖ **Hypoxia**
- ❖ **Hyperthyroidism**
- ❖ **Hypersecretion of cathecholamines,**
- ❖ **Cardiomyopathy**
- ❖ **Diseases of heart valves**



Bradycardia –Decrease in heart rate below 60/min

Pathological conditions

Sleep & Athletes .

Physiological conditions

- ❖ Hypothermia
- ❖ Hypothyroidism
- ❖ Heart attack
- ❖ Congenital heart disease.
- ❖ Degeneration process of aging
- ❖ Obstructive jaundice
- ❖ Increased ICP



Regulation

- ❖ Altered heart rate quickly brought back to normal in physiological conditions
- ❖ Due to perfectly tuned regulatory mechanism in the body.

Regulated by nervous mechanism

A. Vasomotor center

B. Motor (efferent) nerve fibers to the heart

C. Sensory (afferent) nerve fibers from the heart

VASOMOTOR center –Cardiac center

- ❖ Nervous center is same for regulating BP so called **CARDIAC CENTER.**
- ❖ Situated bilaterally in the reticular formation of medulla oblongata and lower part of pons.
- ❖ 3 areas.



Vasoconstrictor Area

Situation

- ❖ Reticular formation of medulla in floor of IV ventricle and forms lateral portion of vasomotor center.
- ❖ Otherwise called PRESSOR AREA or CARDIOACCELERATOR AREA.

Function

- ❖ Increases the heart rate by sending accelerator impulses to the heart ,through sympathetic nerves.
- ❖ Causes constriction of blood vessels.

Control

Hypothalamus & Cerebral cortex



Vasodilator Area

Situation

- ❖ Reticular formation of medulla in floor of IV ventricle and forms medial portion of vasomotor centre.
- ❖ Otherwise called DEPRESSOR AREA or CARDIOINHIBITORY AREA.

Function

- ❖ Decreases the heart rate by sending inhibiting impulses to the heart through vagus nerves.
- ❖ Causes dilatation of blood vessels.

Control

Hypothalamus & Cerebral cortex .Also from baroreceptors ,chemoreceptors and other sensory impulses via afferent nerves.



Sensory area

Situation

- ❖ **Posterior part of vasomotor centre lies in NUCLEUS OF TRACTUS SOLITARIUS in medulla and pons.**

Function

- ❖ **Receives impulses via glossopharyngeal nerve and vagus nerve from periphery ,particularly from baroreceptors.**
- ❖ **Controls both vasoconstrictor & vasodilator area.**



MOTOR (Efferent)Nerve fibers to the heart

- ❖ Efferent nerve fibers from both the divisions of autonomic nervous system.
- ❖ Parasympathetic fibers arise from medulla oblongata and pass through vagus nerve.
- ❖ Sympathetic fibers – T1 to T4 segments of spinal cord.

PARASYMPATHETIC NERVE FIBERS

- ❖ Cardio inhibitory nerve fibers
- ❖ Reaches the heart through cardiac branch of vagus nerve.

ORIGIN

- ❖ Arise from dorsal nucleus of vagus.
- ❖ Situated in the floor of IV ventricle in medulla oblongata and close contact with vasodilator area.



Distribution

- ❖ **Preganglionic parasympathetic nerve fibres from dorsal nucleus of vagus nerve reach the heart by passing through main trunk of vagus and cardiac branch of vagus.**
- ❖ **Terminates – Post ganglionic neurons – This innervates the heart muscle.**
- ❖ **Right vagus – SA node & atrial muscle & AV node**
- ❖ **Left Vagus – AV node & some fibres to SA node and atrial muscle.**

Function

- ❖ **Cardio inhibitory in function and carries inhibitory impulses from vasodilator area to the heart.**



VAGAL TONE

- ❖ **Continuous stream of inhibitory impulses from vasodilator area to heart via vagus nerve.**
- ❖ **Heart rate is under control.**
- ❖ **Impulses reach the heart and exert inhibitory effect on heart.**
- ❖ **Heart is inversely proportional to vagal tone.**
- ❖ **Impulses from different parts of body regulates the heart rate through vasomotor center, by altering vagal tone.**
- ❖ **Otherwise called cardio inhibitory tone or parasympathetic tone.**



Effect of Stimulation of Vagus nerve



Right Vagus nerve –vagal escape

- ❖ **Escape of ventricle from inhibitory effect of vagal stimulation.**
- ❖ **If stimulation stops – Heart starts beating normally.**

Causes

- ❖ **Stops the heart beat due to the inhibition of SA node and atria. Ventricles not supplied by vagus.**
- ❖ **Stoppage of heart beat is continued for some time ,a part of ventricular musculature becomes pacemaker and starts producing impulses – VAGAL ESCAPE**
- ❖ **Rhythmicity – less than 20 /minute.**



Effect of Stimulation of Vagus nerve



- ❖ **Left Vagus nerve –Nerve block**
- ❖ **Mainly AV node**
- ❖ **Stimulation with strong stimulus causes stoppage of ventricular contraction called heart block.**
- ❖ **Complete inhibition of AV node and prolongation causes IDIOVENTRICULAR RHYTHM.**
- ❖ **Some impulses from SA node are not conducted to ventricles called partial block. 2:1 ,3 : 1 & 4 : 1**
- ❖ **Mode of action – Neurotransmitter substance called ACETYLCHOLINE**



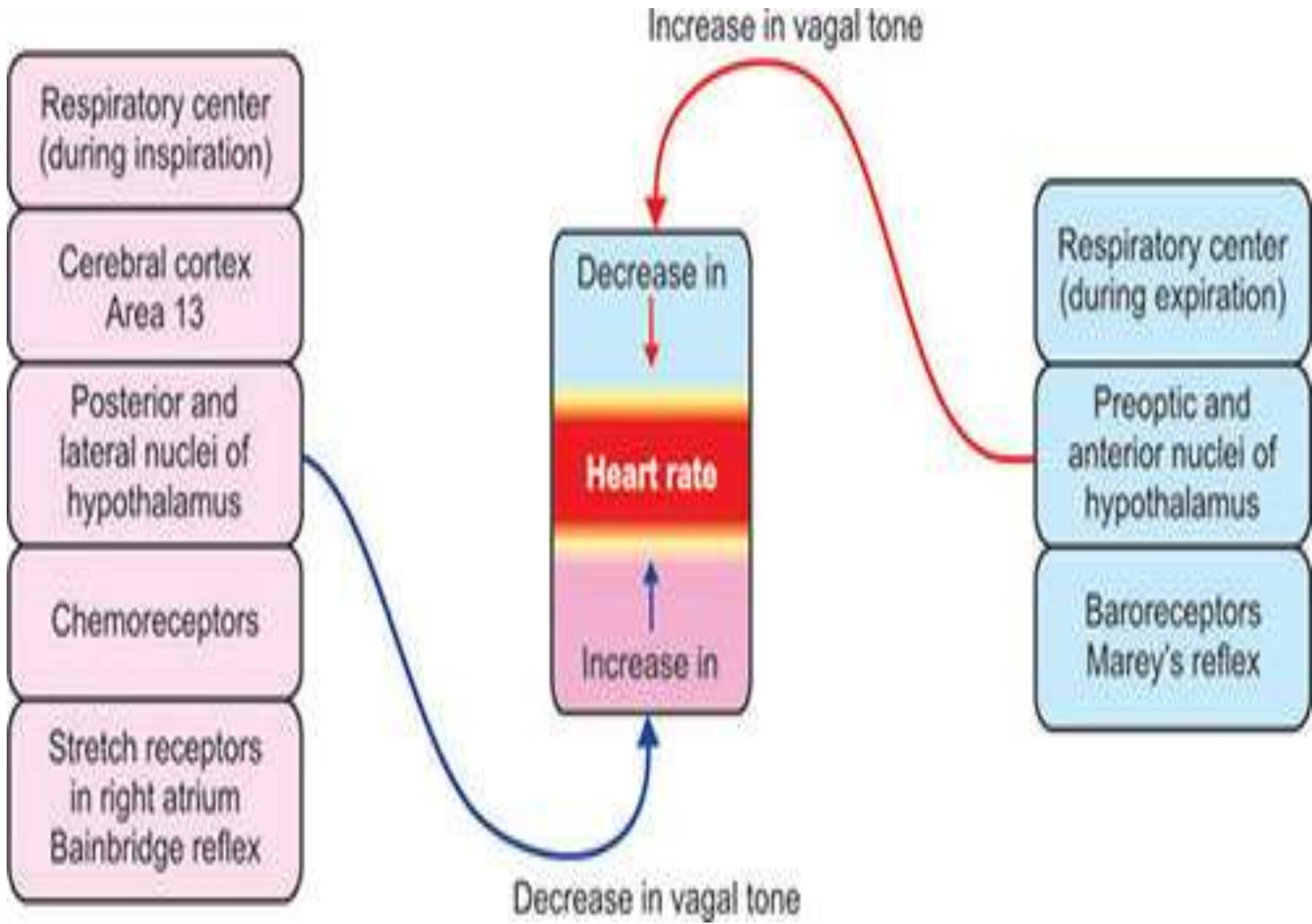
SENSORY (Afferent) nerve fibres from the heart



- ❖ Afferent nerve fibres from the heart pass through inferior cervical sympathetic nerve.
- ❖ Sensations – Pain & stretch from heart to the brain via spinal cord

FACTORS AFFECTING VASOMOTOR CENTER –REGULATION OF VAGAL TONE

- ❖ 1. Impulses from higher centres
- ❖ Cerebral cortex
- ❖ Area 13 – Emotional reactions of the body
- ❖ Sends inhibitory impulses to vasodilator area causes reduction in vagal tone.





Factors (contd.....)



- ❖ **Hypothalamus**
 - ❖ **Stimulation of posterior & lateral hypothalamic nuclei causes tachycardia**
 - ❖ **Preoptic and anterior nuclei - Bradycardia**
- 2. Impulses from respiratory centre**
- ❖ **In forced breathing, heart rate increases during inspiration and decreases during expiration called SINUS ARRHYTHMIA .**
 - ❖ **Sinus arrhythmia - Alteration in vagal tone because impulses from respiratory center during inspiration.**
 - ❖ **Impulses inhibit vasodilator area - Decrease in vagal tone and increase in heart rate.**
 - ❖ **During expiration - Stops sending impulses to vasodilator center causes increase in vagal tone and decrease in heart rate.**



Factors (contd.....)



3. Impulses from baroreceptors – Marley reflex

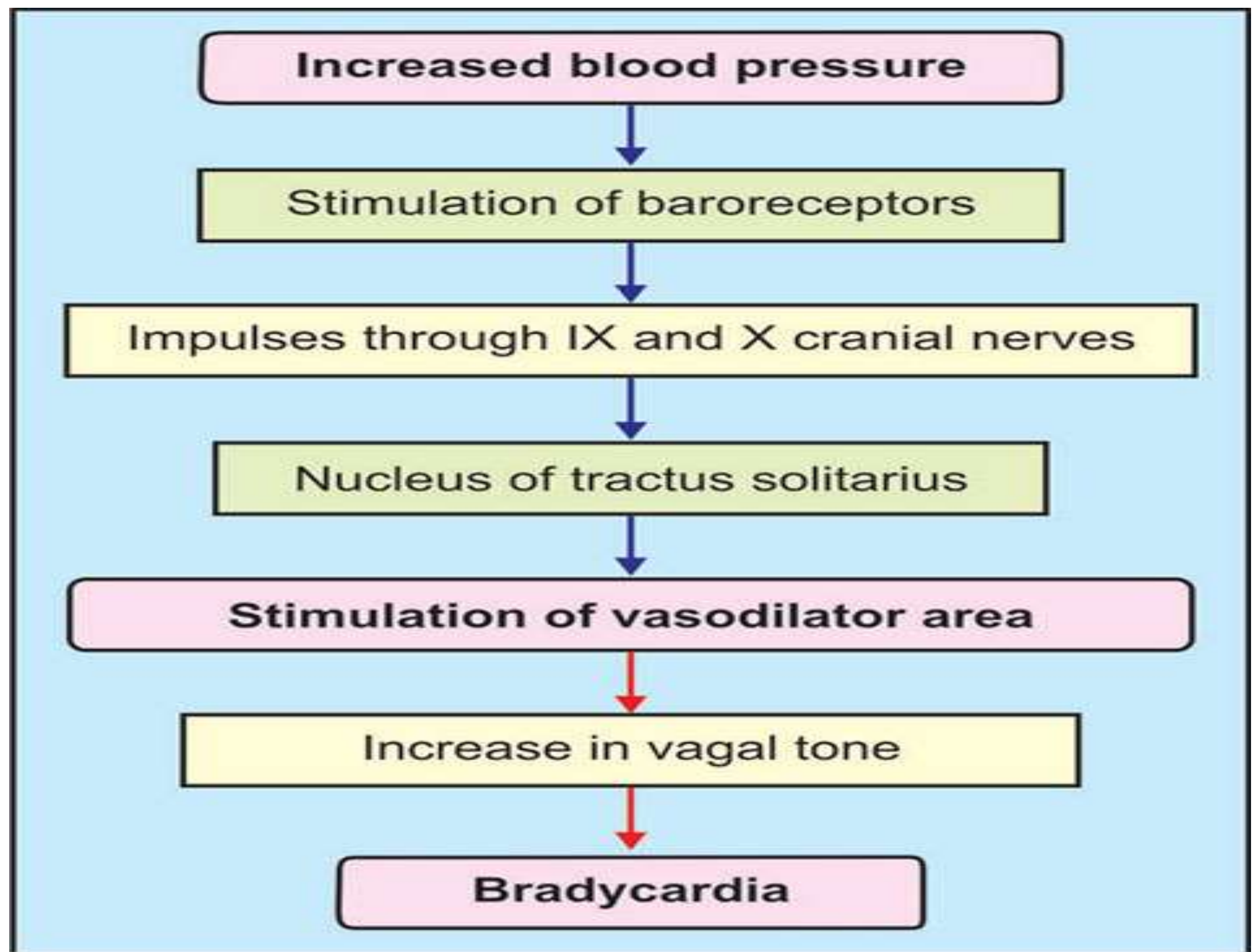
Baroreceptors –Receptor which give response to change in BP called pressoreceptors.

Situation

Carotid baroreceptors- Carotid sinus at internal carotid artery

Through HERING NERVE

Aortic baroreceptors – wall of arch of aorta through aortic branch of VAGUS NERVE.





Factors (contd.....)

3. Impulses from chemoreceptors.

- ❖ Receptors giving response to change in chemical constituents of blood, O_2 , CO_2 and hydrogen ion concentration.
- ❖ Situation – Adjacent to baroreceptors.

Function

- ❖ Hypoxia, Hypercapnea and increased hydrogen ion concentration

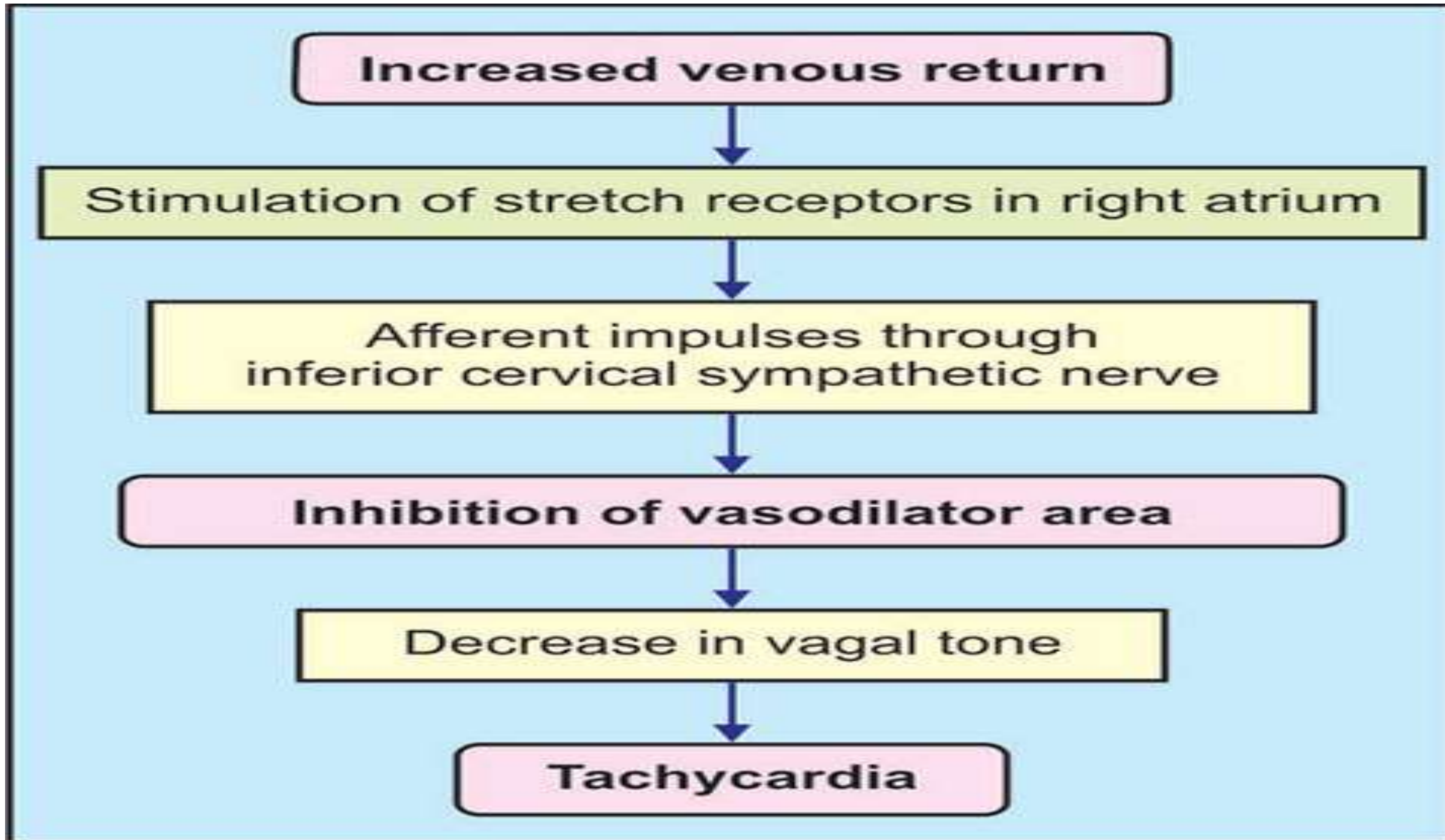


- ❖ Chemoreceptors stimulated & inhibitory impulses sent to vasodilator area.

- ❖ Vagal tone decreases and heart rate increases.

Factors (contd.....)

3. BAINBRIDGE REFLEX or RIGHT ATRIAL REFLEX





Factors contd



6. Impulses from other afferent nerves

Nasal mucosal membrane – Bradycardia.

Painful stimuli – Tachycardia.

7. BEZOLD – JARISCH REFLEX

Bradycardia + Hypotension – stimulation of chemoreceptors present in the wall of left ventricles by substances such as ALKALOIDS

Coronary chemoreflex

Occurs in pathological condition

MI ,Hemorrhage ,Aortic stenosis ,Syncope.

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Thank You