PASSION ACADEMIC TEAM

YU - MEDICINE

Cardiovascular System

Sheet#

Lec. Date :

Lec. Title : **BP part 2**

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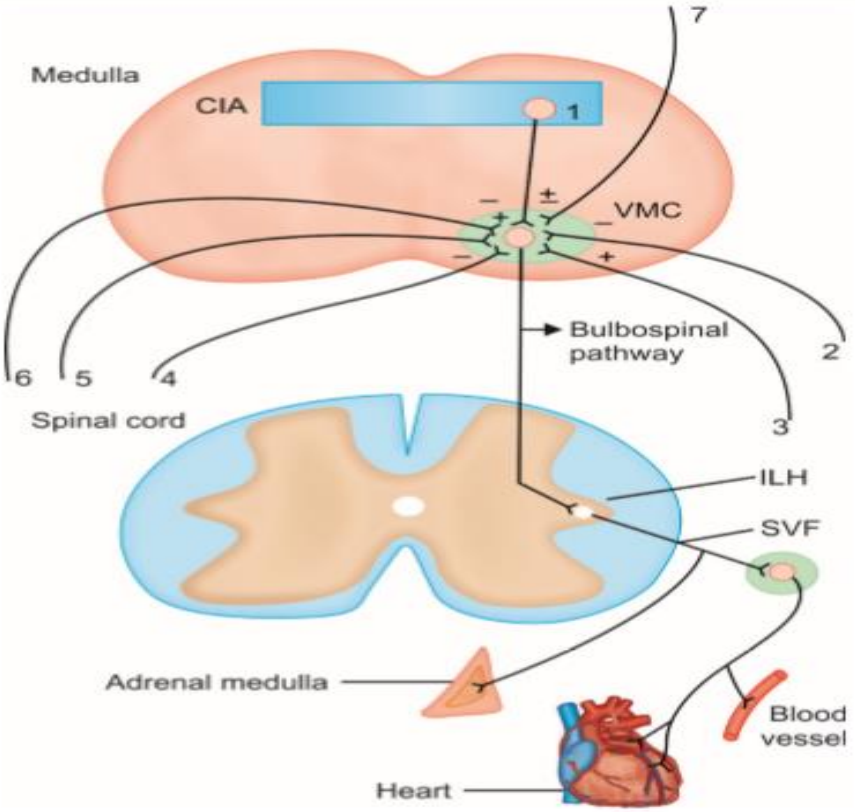
Medullary Control

Medullary Control:

- Medullary cardiovascular centers are mainly located in the medulla
- These centers primarily control the autonomic output on heart and blood vessels, which is the major cardiovascular regulatory pathway
- Medullary centers are broadly divided into two centers:
  - vasomotor center and
  - cardioinhibitory centers.



cardioinhibitory area (CIA)
Vasomotor center (VMC)
Sympathetic vasoconstrictor fibers (SVF)
Intermediolateral horn (ILH)

Slide 7

- Medullary control is a neural control of BP.

Description of the figure :

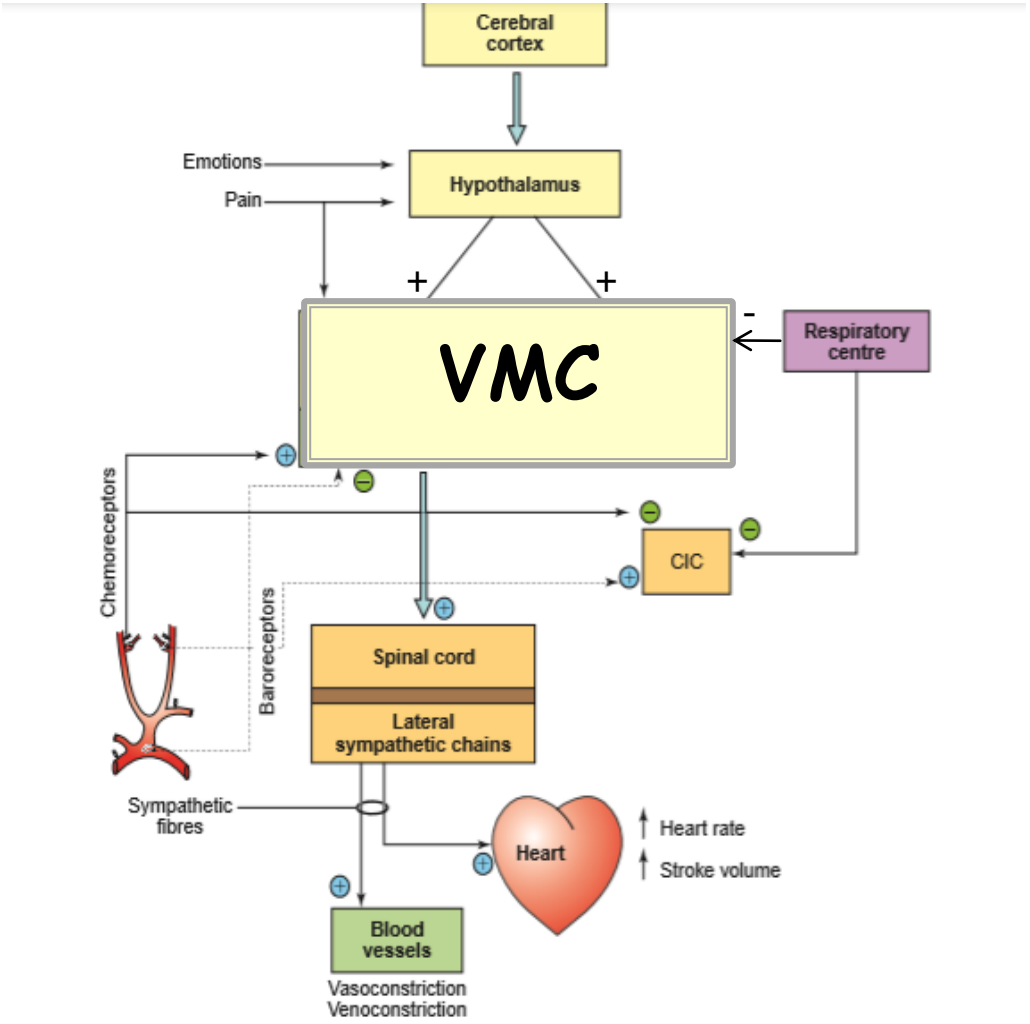
- Medullary cardiovascular center divided into :1- center vasomotor center . 2-cardioinhibitory center .
- Stimulation of vasomotor center (VMC) intense vasoconstriction (lead to increase Resistance) and cardioacceleration (lead to increase HR + contractility of the heart which leads to increase CO) that increase BP.
- While inhibition of VMC causes vasodilation and cardioinhibitory that decease BP
- The output impulses transmitted from VMC via bulbospinal pathway to spinal cord (intermediolateral horn "ILH" exactly)from where preganglionic sympathetic vasoconstriction fibers originate that affect on periphery , blood vessels , the heart and the adrenal Modella --- overall lead to increase BP.

AFFERENT IMPULSES TO MEDULLARY CARDIOVASCULAR CENTERS

The medullary control centres are influenced by afferent control impulses from the higher centres and a large number of other areas.

(+) stimulation

(-) Inhibition



Slide 8

Description of the figure :

- VMC affected by inhibitory and excitatory impulses .
- this input originate from periphery :

1. cardioinhibitory area . (inhibition impulses) .. " Stimulation of cardioinhibitory center lead to inhibition of VMC which will decrease BP".
2. Aortic and carotid baroreceptor and from the lungs . (inhibition impulses)
3. Aortic and ceratoid chemoreceptor + ascending vein pathways + proprioceptive inputs + limbic system " management of change in BP during emotion and excitement . (excitation impulses)

الخلاصة :

- So , there is afferent neurons (inputs)originate from periphery to VMC that could be inhibitory or excitatory .

- Q : what are the consequence of transection of the spinal cord ?

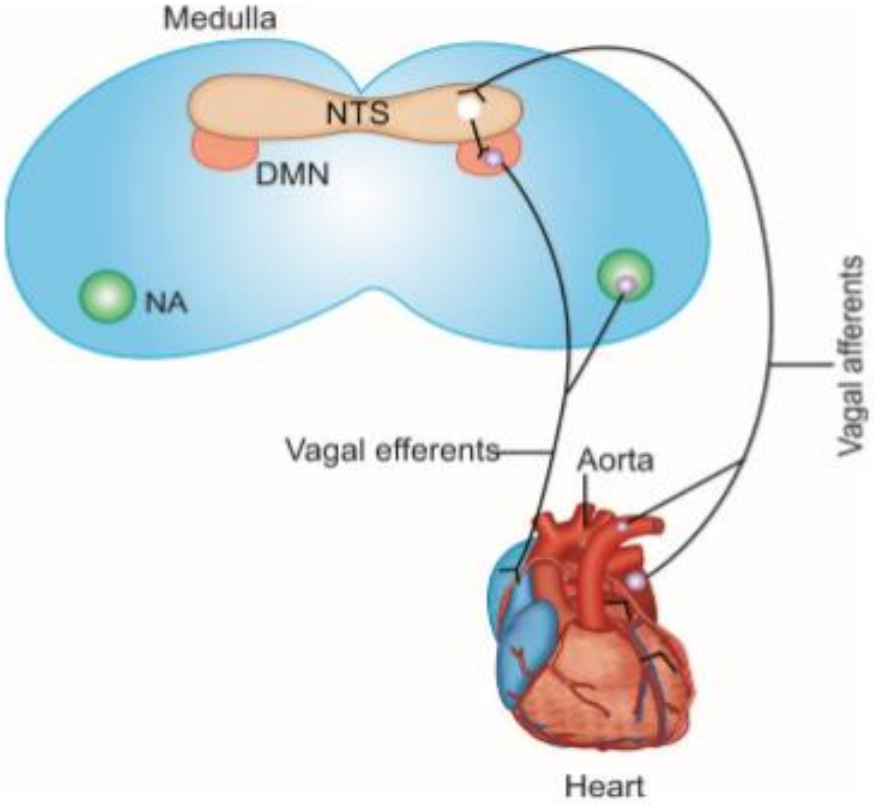
Medullary Control

Cardioinhibitory center in the medulla is formed by:

- **nucleus tractus solitarius (NTS)**
- **nucleus ambiguous (NA) and**
- **dorsal motor nucleus of vagus(DMN).**

Stimulation of these areas results in bradycardia and decreased cardiac output by two mechanisms.

1. **vagus nerve originates mainly from NTS**
2. **NTS inhibits vasomotor center via local inhibitory interneurons.**



Nucleus tractus solitarius (NTS)
Dorsal motor nucleus (DMN) of vagus Nucleus ambiguous (NA).

Slide 9

- stimulation of cardioinhibitory area result in bradycardia .
- Stimulation of VMC result in tachycardia .

- stimulation of cardioinhibitory area leads to reduction on contractility then reduction on CO which result in reduction of BP.
- also , stimulation of cardioinhibitory area mainly NTS inhibits VMC , deceases sympathetic activity and increases vagal activity which will leads to bradycardia and reduction on CO in addition to vasodilation , over all causes reduction in BP.

Reflex Regulation

Reflex Regulation of Blood Pressure:

- baroreceptor reflex
- chemoreceptor reflex and
- Cushing's reflex

Baroreceptor Reflex

- The receptors for baroreceptor reflex are baroreceptors.
- Functionally, baroreceptors can be grouped as:
  1. High-pressure baroreceptors, are located in:
     - the ventricle and
     - arterial side of circulation, these include:
       - Carotid sinus
       - Aortic arch
  2. Low-pressure baroreceptors, are mainly present in:
     - the atria and pulmonary circulation (cardiopulmonary baroreceptors). receptors.

Baroreceptors = stretch receptors in the walls of

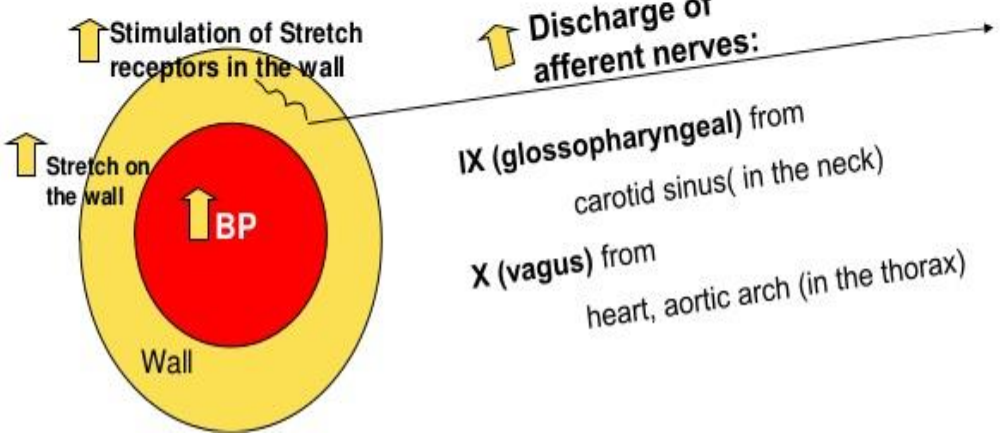
- Heart
  - Atria

Volume receptors

Low pressure baroreceptors

- Arteries (arterial baroreceptors)
  - Aortic arch
  - Carotid sinus

High pressure baroreceptors



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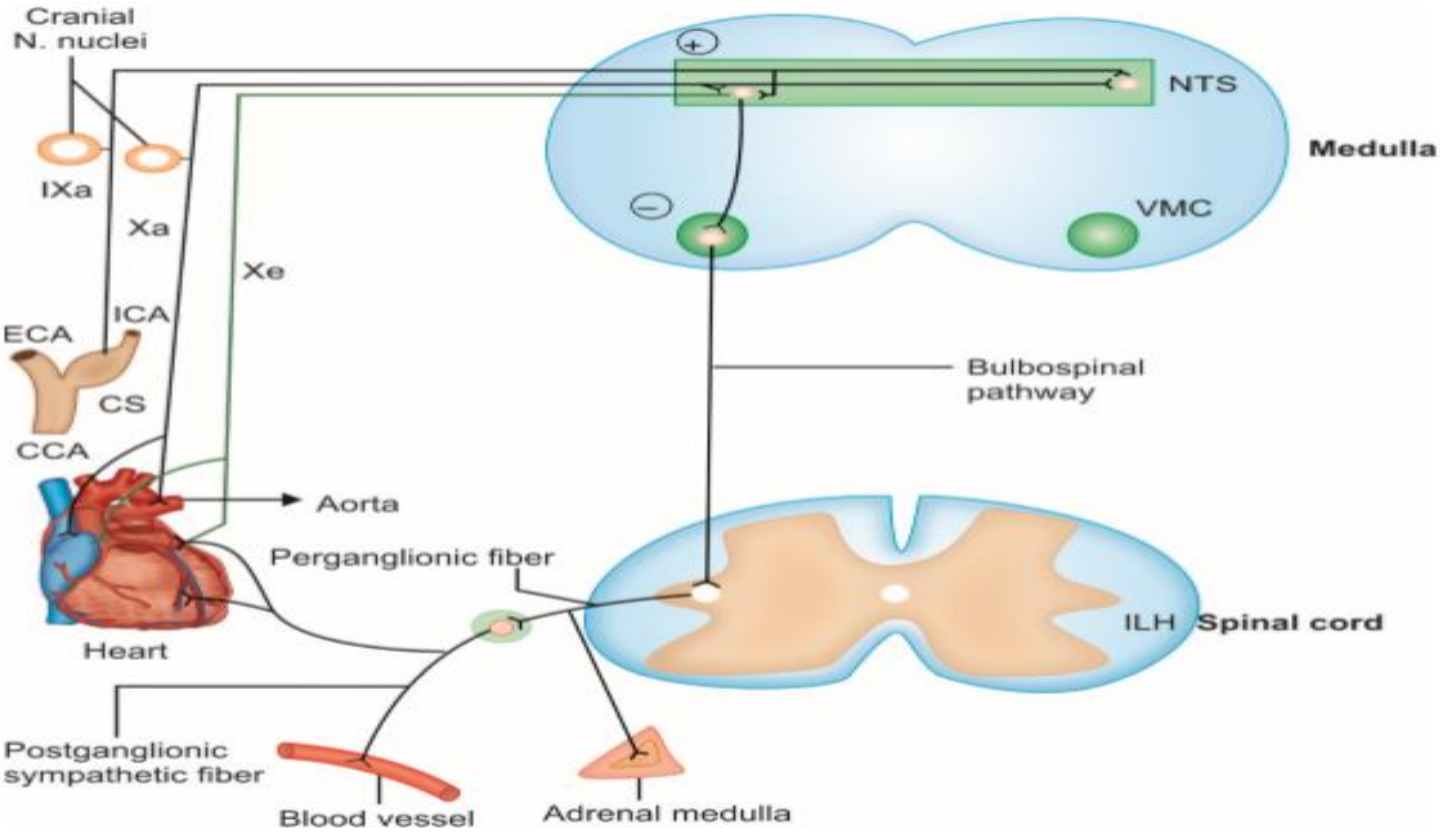
Slide 10

- Baroreceptors are very important because it regulate BP within second therefore this reflex is a life saving reflex .
- it's strechoreceptor or mechanoreceptor located in the wall of the heart (RA) and the wall of arteries .
- in the right atria : its call too volume receptor that response to any change on blood plasma or blood volume so this receptor detect any change on veins pressure " Any change in blood volume reflects on vein pressure and Venous return depend on ΔP ".
- Baroreceptors that located in arteries are two types :

  1- aortic arch

  2- carotid sinus " located in dilated portion of the internal carotid artery ".

Baroreceptor reflex

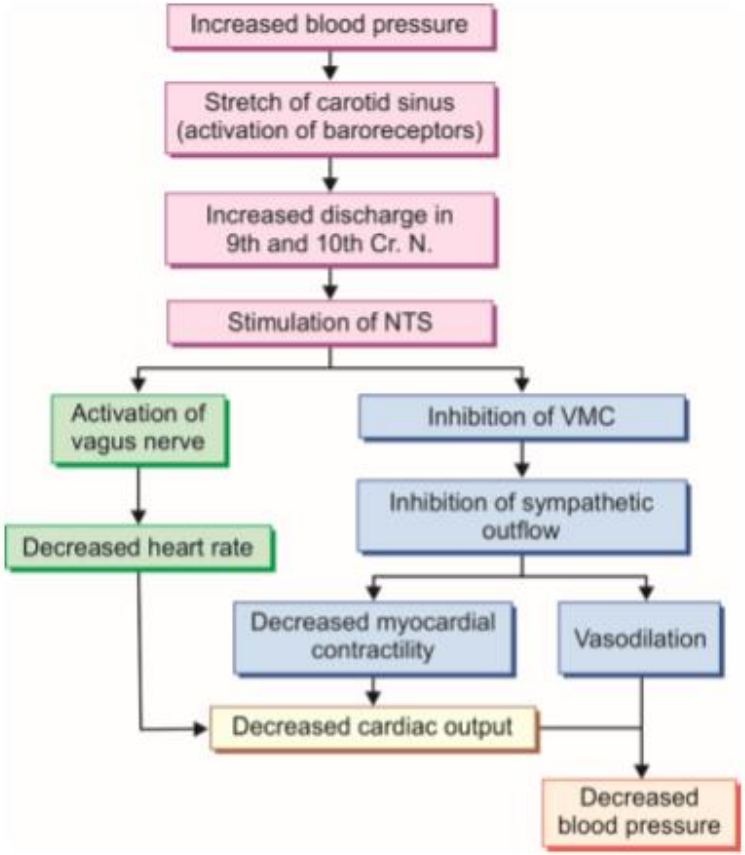


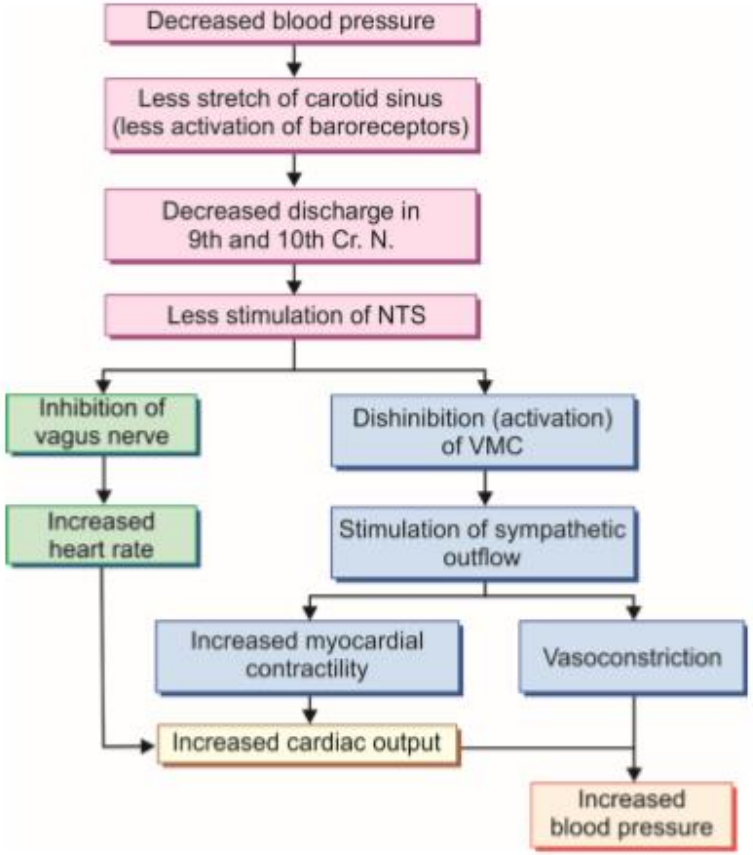
Afferent pathway is formed by 9th (IXa) and 10th cranial nerves (Xa) and Efferent fibers of 10th cranial nerve (Xe)
CCA: Common carotid artery
ICA: Internal carotid artery; ECA: External carotid artery; CS: Carotid sinus
+: Excitatory neurotransmitter like glutamate; –: Inhibitory neurotransmitter like GABA.

Slide 11 (high pressure receptor)

- Any change in BP; increase or decrease BP, leads to mechano changes ; increase or decrease stretching respectively.
- This receptor transform this mechano changes to action potential , this AP transport via afferent neurons 9^{th} cranial nerve(glossopharyngeal nerve that originated from carotid sinus)or 10^{th} cranial nerve (vagus nerve that originated from aortic arch) to cardio vascular center (medullary cardio vascular center) .
- Increase BP → distension on ceratoid sinus or aortic arch → stretching on this receptor → high firing rate of AP
- Decrease BP→ less distension → less stretching → less firing rate .
- This impulses will transport via 9^{th} and 10^{th} ceratoid artery to cardiovascular center where AP will translate to suitable firing impulses from medullary center via efferent pathway (bulbospinal pathway)… (we talk about this pathway before)

Baroreceptor reflex



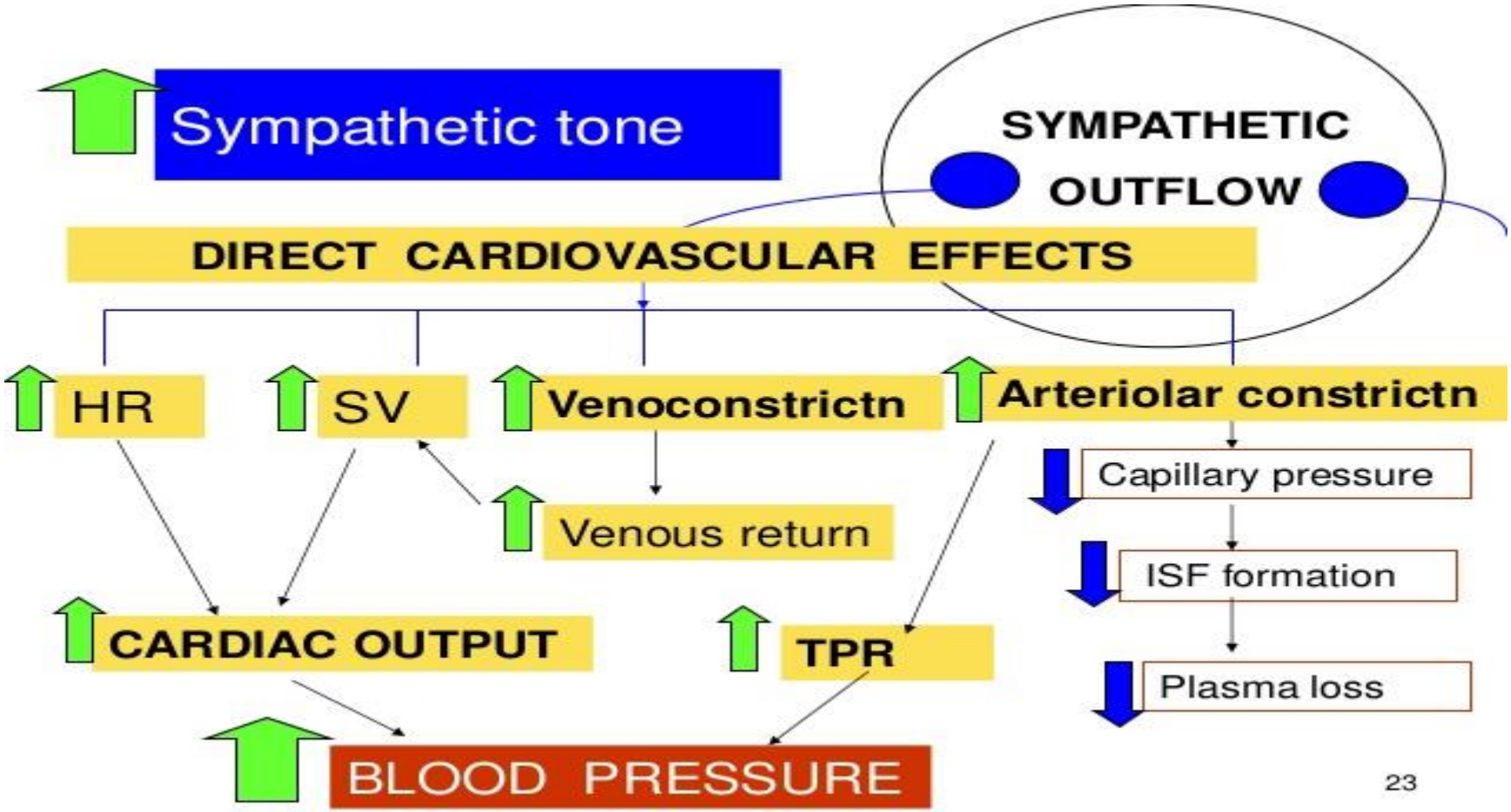


Slide 12

- Response depend on nature of change in BP and the degree of the change → all this will affect on medulla to make suitable response (increase or decrease BP) .

READ THE FIGURE CAREFULLY .

Sympathetic efferent pathways and effector organs

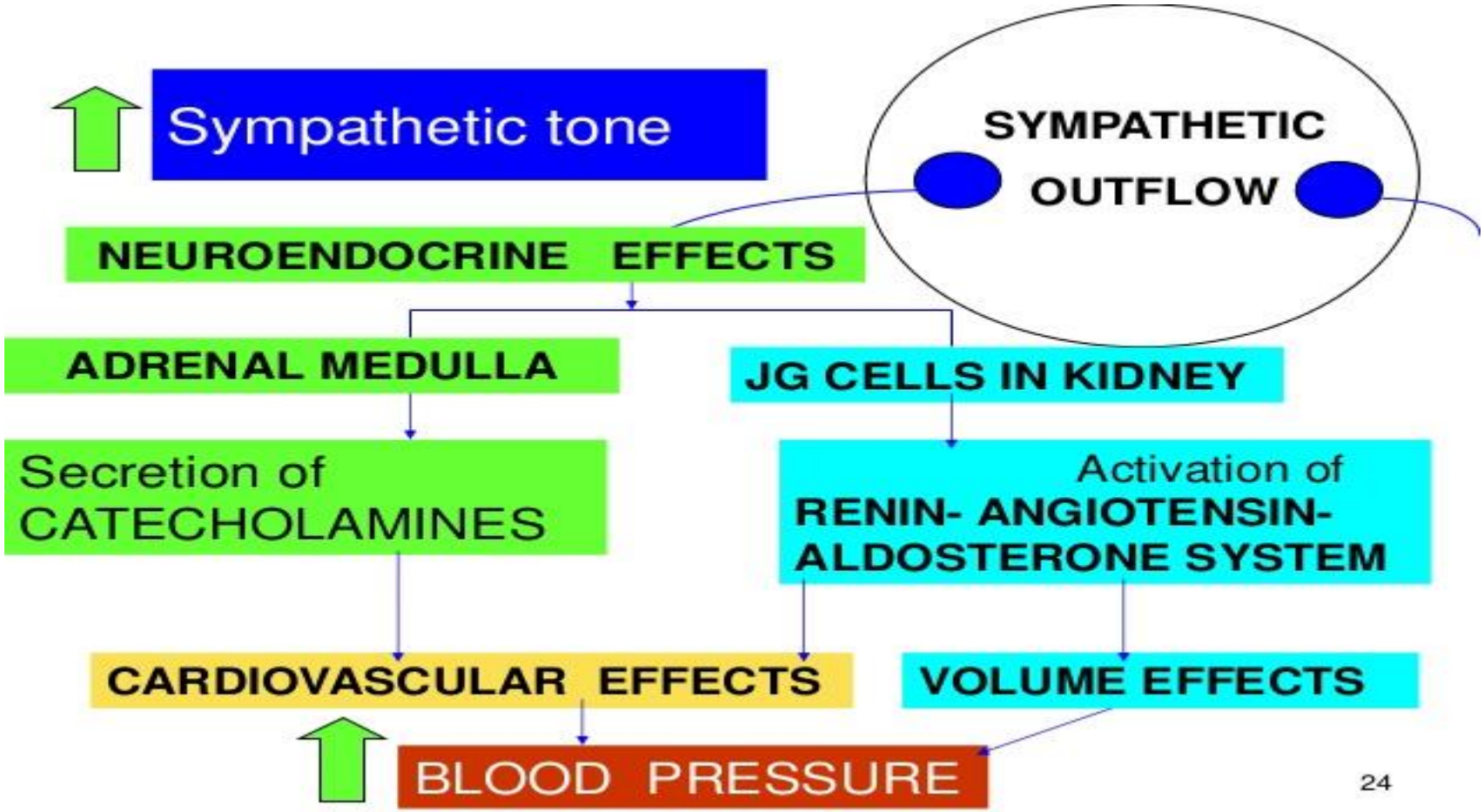


Slide 13

- Firing of sympathetic innervation → direct cardio vascular effect → increase HR and SV → increase CO → increase BP.
- Sympathetic output → venoconstriction → decrease compliance → contraction on veins → increase VR " because we increase $\Delta P = (P_{\text{central venous}} - P_{RA})$ through increase of central venous pressure ". → more filling → more in diastolic volume → increase CO → increase BP .
- Sympathetic affect on arterioles too → constriction of arterioles → less capillary pressure" why ?? Because contraction of arterioles will decrease volume of blood that receive to capillaries " →hydrostatic pressure will decrease → passive bulk flow from interstitial fluid to capillary → increase blood plasma → increase VR→ increase filling… cont

All of this happened when BP decrease – to return it to normal BP .

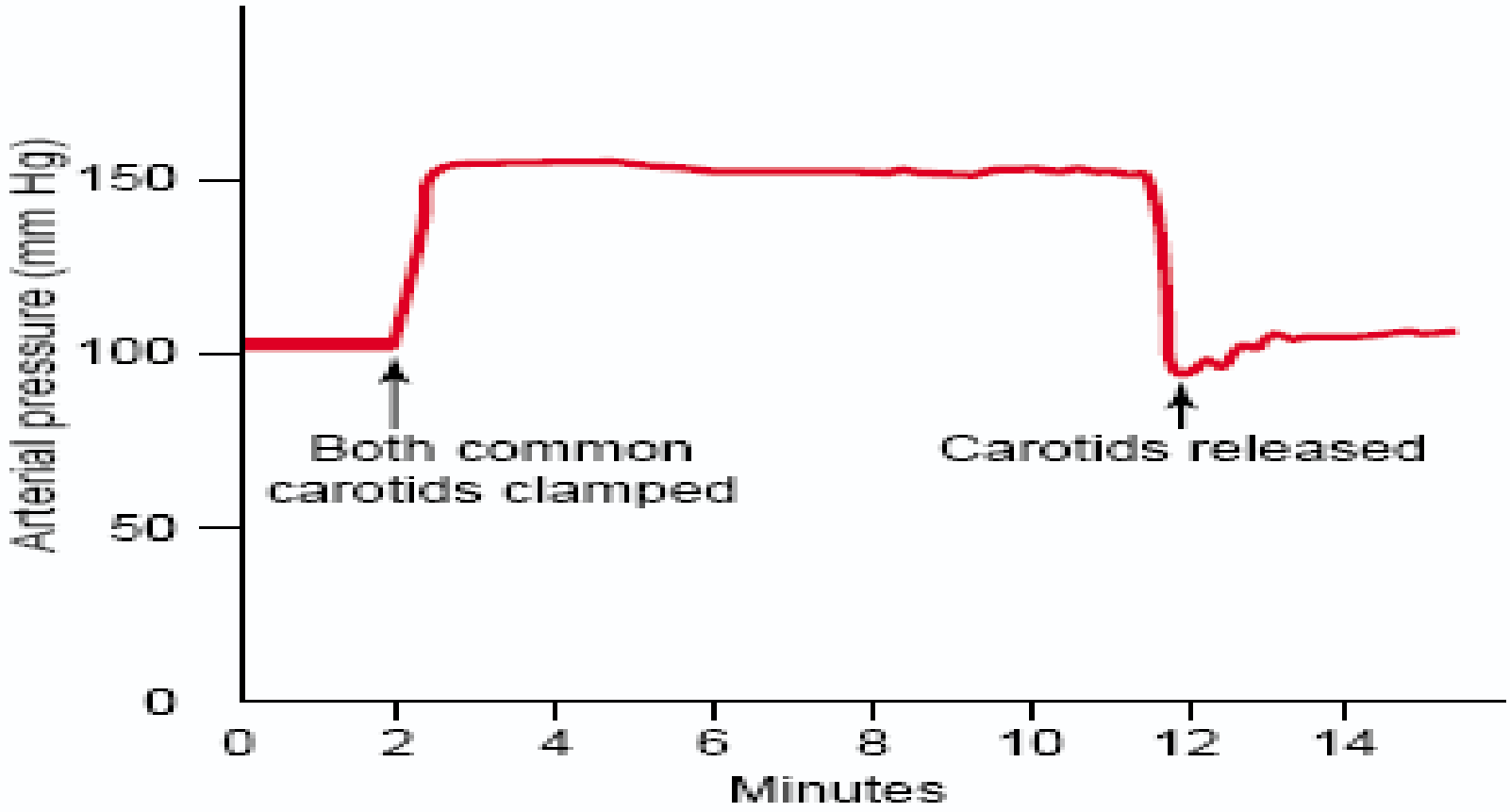
Sympathetic efferent pathways and organs



Slide 14

- Here sympathetic affect on neuroendocrine
- Sympathetic stimulate the adrenal medulla to secrete epinephrine that will increase contractility of the heart → increase CO → increase BP.
- Sympathetic stimulate cells called " JG cells " in kidneys , this cells when activated will secrete renin , then renin will transform angiotensinogen to angiotensin I (renin –angiotensin – aldosterone system) cause retention of water and reabsorption of sodium → increase blood volume → increase VR→ increase CO→ increase BP .

Response of carotid and aortic baroreceptors to pressure



Slide 15 (experience that show importance of baroreceptor in regulation BP)

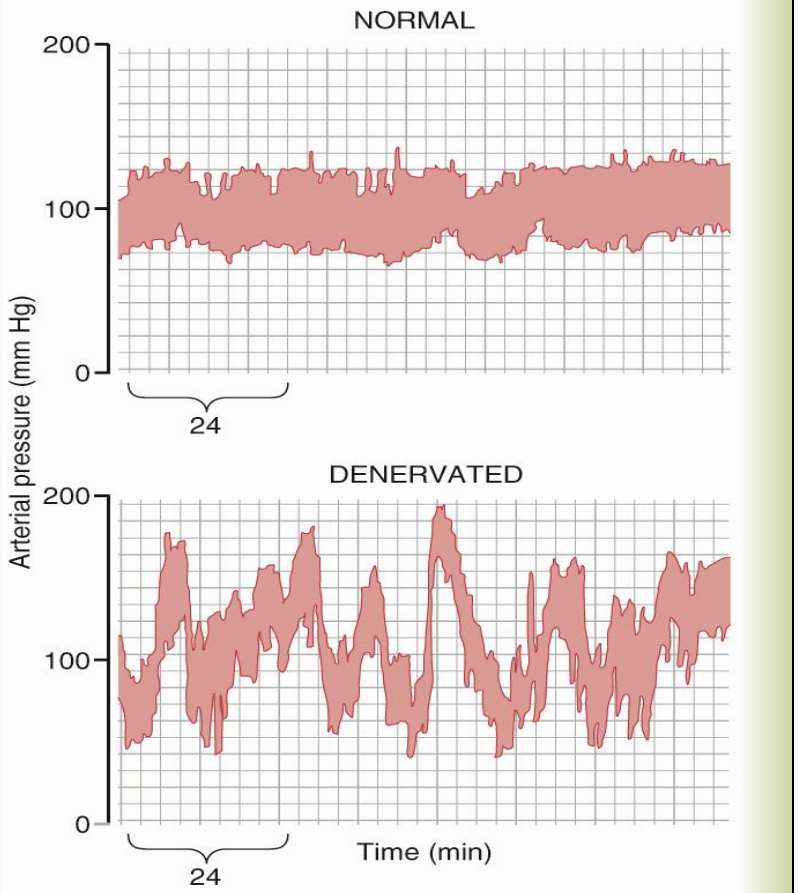
Left side of the curve

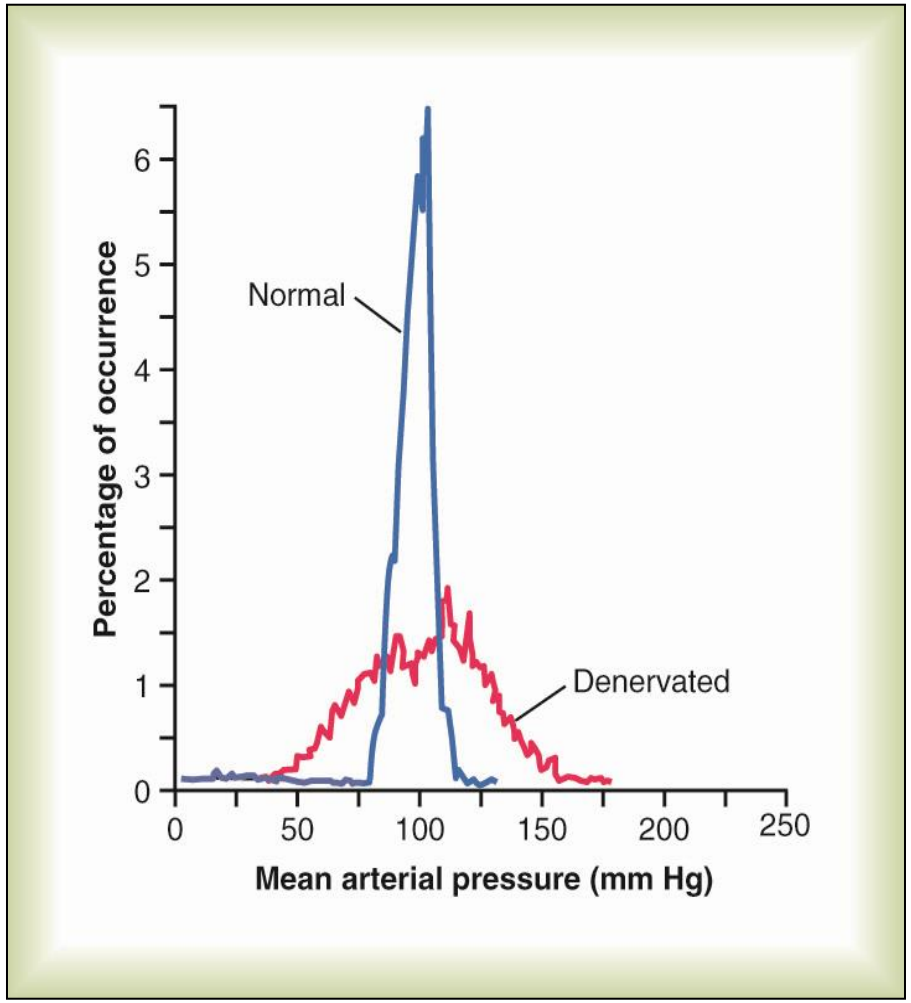
- arterial pressure normally = 100 mmHg , but if occlusion of blood flow occur in common ceratoid artery m flow will decease or absent in carotid sinus for example so blood pressure will completely reduces → less distension → less stretching → baroreceptor become inactive and they loss their inhibitory effect in VMC → activation of VMC → …→…→… → increase BP (100 to 150) .

Right side of the curve

- Occlusions is removed so condition return to normal → return normal pressure → baroreceptor return to inhibition VMC → inhibition VMC effect →reduction in BF (150 to 100) " at the beginning blood pressure reduce to less than 100 and that because momentary overcompensation mechanism . "

Pressure "Buffer" Function of the Baroreceptor Control System.

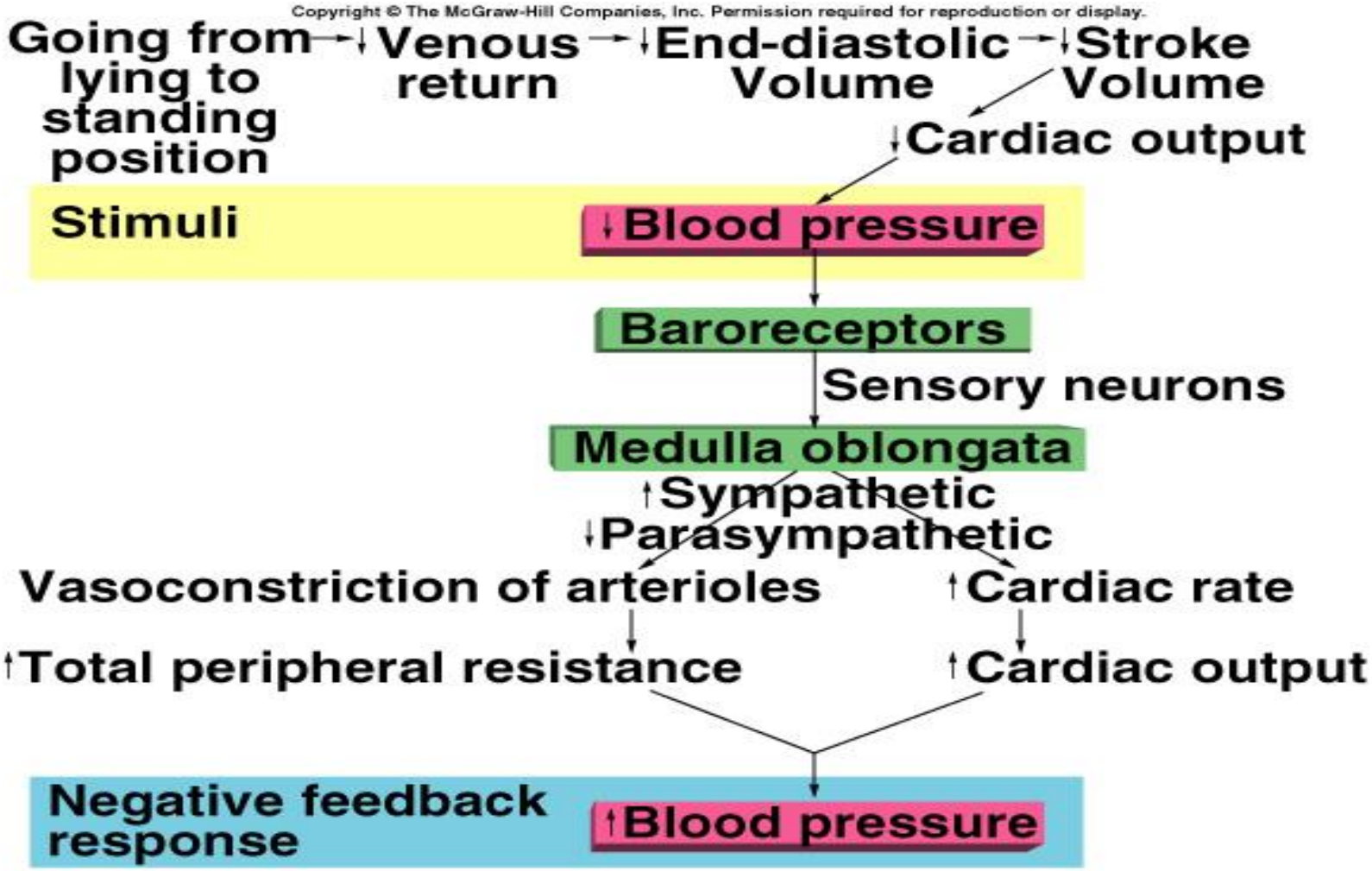




Slide 16 (experience)

- When baroreceptor well function , the mean arterial pressure remained through out a very narrowing rang between (85-115 mmHg)
- **Blue curve** (normal) → baroreceptor well function → blood pressure fluctuate between (85-115)"mean arterial pressure " → this fluctuation is normal because of different activity that human do over the day .
- **Red curve** (abnormal) → if baroreceptor disfunction (denervated) → there will be a wide change in P (below 50- over than 160) almost 2.5 fold reduction or increase BP .
- Nerve that originate from this receptor called buffer nerves , because this system prevent sudden rise or fall in BP .

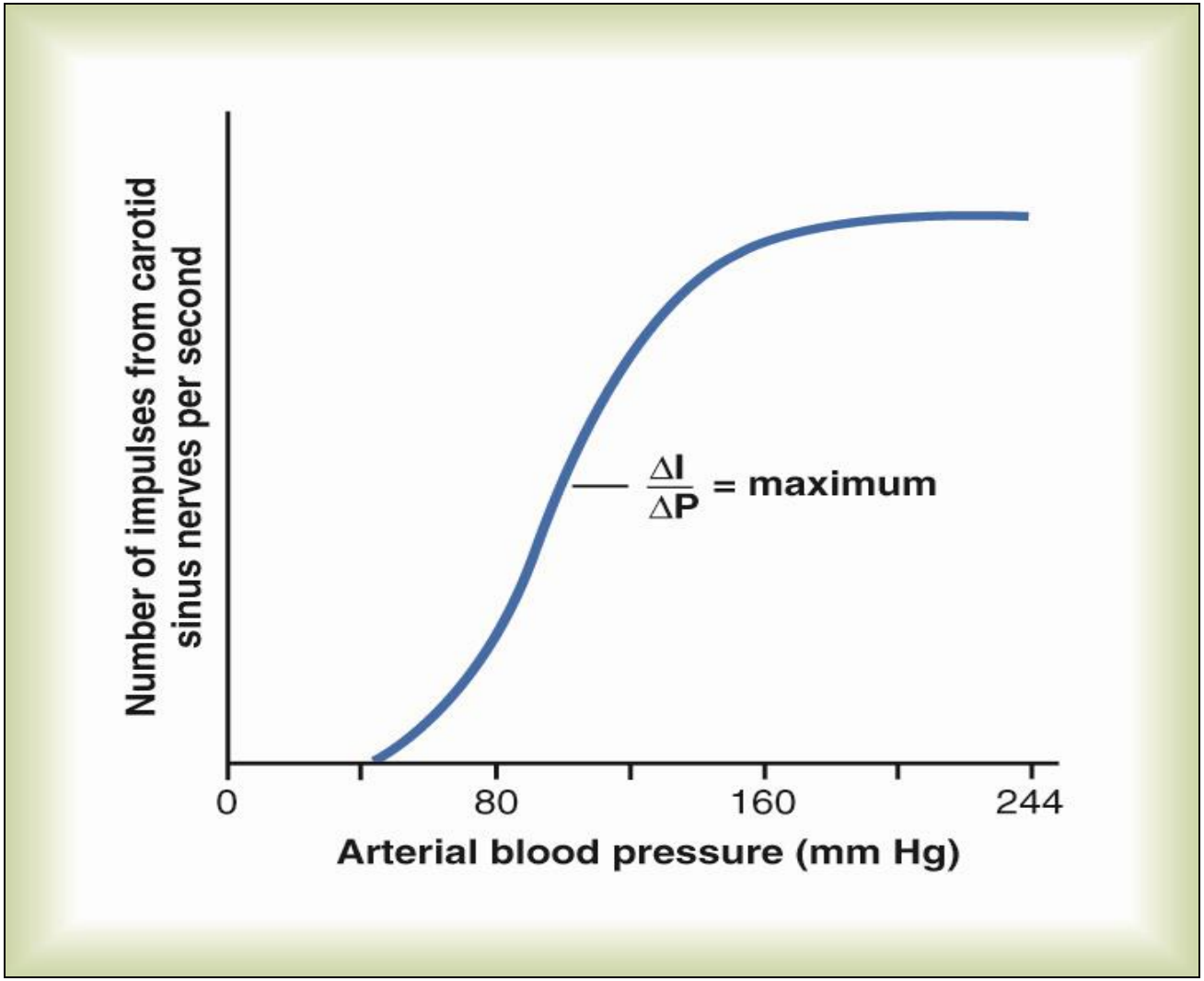
Physiological Significance of Baroreceptor Reflex



Slide 17

- This receptors are the first and the forth most reflex for regulation the blood pressure within second , for example when BP drop 30% when change from lying posture to standing posture , this drop caused by gravity which pooling the blood in lower limbs → decrease VR → …→…→ decrease BP ,,, but baroreceptor rapidly response → activation of VMC → increase sympathetic innervation → increase in HR, increase in total peripheral resistance → increasing in BP.

Pressure range of baroreceptor reflex



Slide 18

- Baroreceptor not response to any pressure change less than 50 mmHg .
- The minimum pressure at which baroreceptor is sensitive is 50 mmHg (called threshold of baroreceptor reflex)
- 50 to 200 mmHg response : 50-160mmHg laminar relationship is observed for BP and baroreceptor activity (great sensitive → high firing) , after 160 mmHg there is no farther increase in response " stabling ".
- Aortic arch receptors have higher range (less sensitive) 30mmHg more " 80 instead 50 ".
- Baroreceptors have **resetting ability** to reset themselves in 1-2 days to whatever pressure they exposed . (ex : chronic hypertension) " if it exposed to high P for a long time it will reset themselves in which reflex mechanism of this baroreceptor maintain higher P than normal "
- No long-term role in maintain BP (rapidly and quickly for short time).