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Regulation of Arterial Blood Pressure

M1 – Cardiovascular/Respiratory Sequence

Louis D'Alecy, Ph.D.

Monday 11/03/08, 11:00

The Regulation of Arterial Blood Pressure

Regulation requires both a **sensor** and a **set point** about which the variable is **controlled**.

Arterial Baroreceptor Reflex

24 slides, 50 min.

Arterial Baroreceptor Reflex

1. “Simplified” Flow Equation
2. Total Peripheral Resistance
3. Determinants of Mean Arterial Pressure
4. Baroreceptor Function
5. Basic Arterial Baroreceptor Reflex
6. Generalized vs.Localized Vasoconstriction
7. Medullary Cardiovascular Center

$$\text{Flow} = \frac{P_{art} - P_{ven}}{R}$$

When we assume:

- $P_{ven,\ i.e.}$ venous pressure is zero
- $P_{art,\ I.e.}$ arterial pressure in MAP
- **Flow** is cardiac output
- **R** systemic vascular resistance is **TPR**

Then the simplified flow equation says:

$$CO = \frac{MAP}{TPR}$$

Total Peripheral Resistance (TPR)
or
Systemic Vascular resistance (SVR)

- from root of aorta to right atrium
- excludes heart and lungs
- cardiac output flows through this resistance
- changes with **generalized** vasoconstriction
  -or **generalized** vasodilation

$$CO = \frac{MAP}{TPR}$$

Rearrange to focus on primary variable regulated in the cardiovascular system: ARTERIAL BLOOOD PRESSURE

$$MAP = CO \times TPR$$

Think of it as stating that

MAP is directly determined by CO and TPR.

To Regulate Arterial Blood Pressure:

MAP = CO X TPR

Regulated Variable must be sensed:

Arterial Blood Pressure (~MAP)

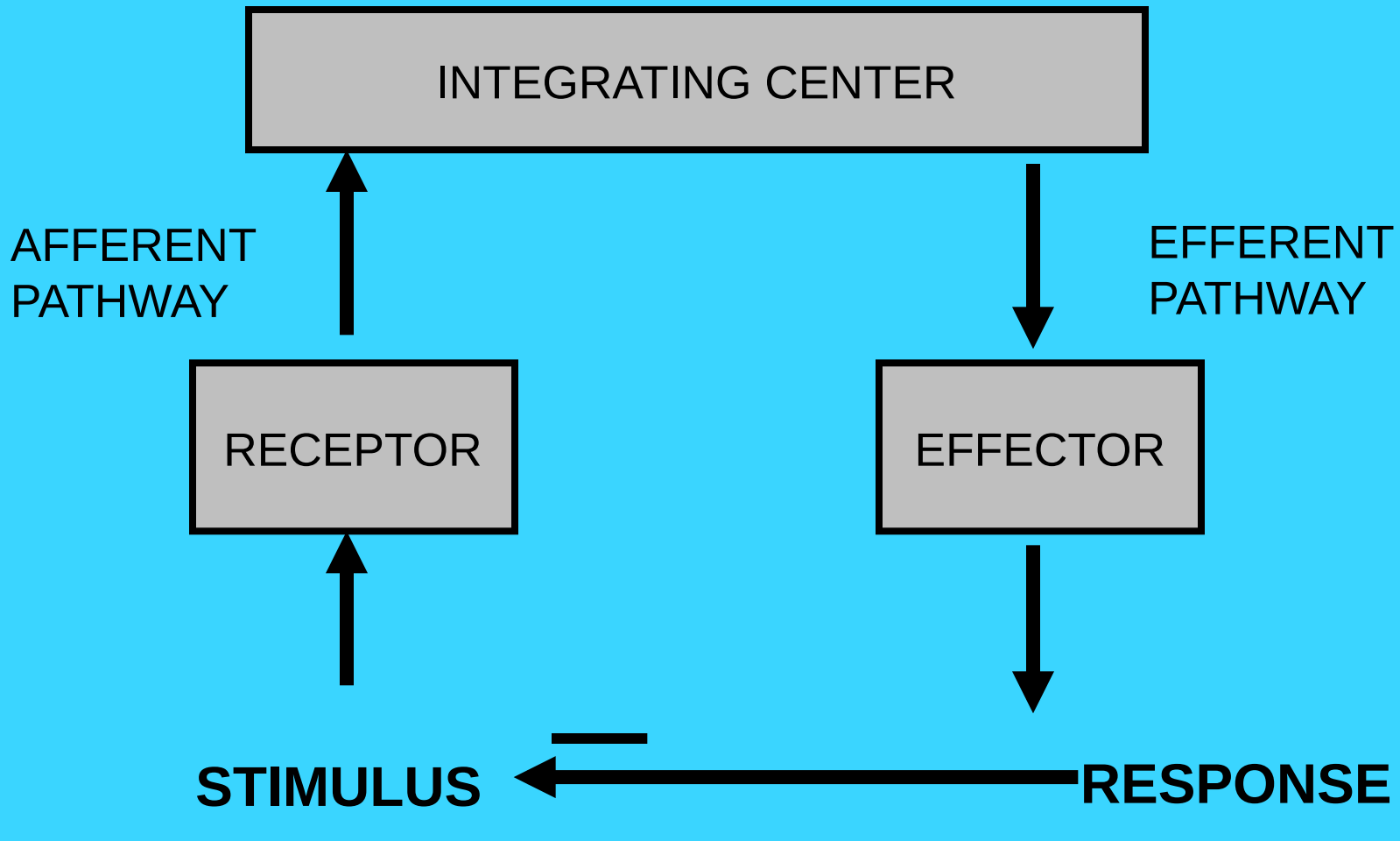
Effectors must be controlled:

CO thus HR x SV

and or

TPR

REFLEX ARC AS NEGATIVE FEEDBACK CONTROL SYSTEM



NEGATIVE FEEDBACK

Arterial Baroreceptors

Hering's nerves via glossopharyngeal

Image of arterial baroreceptors removed

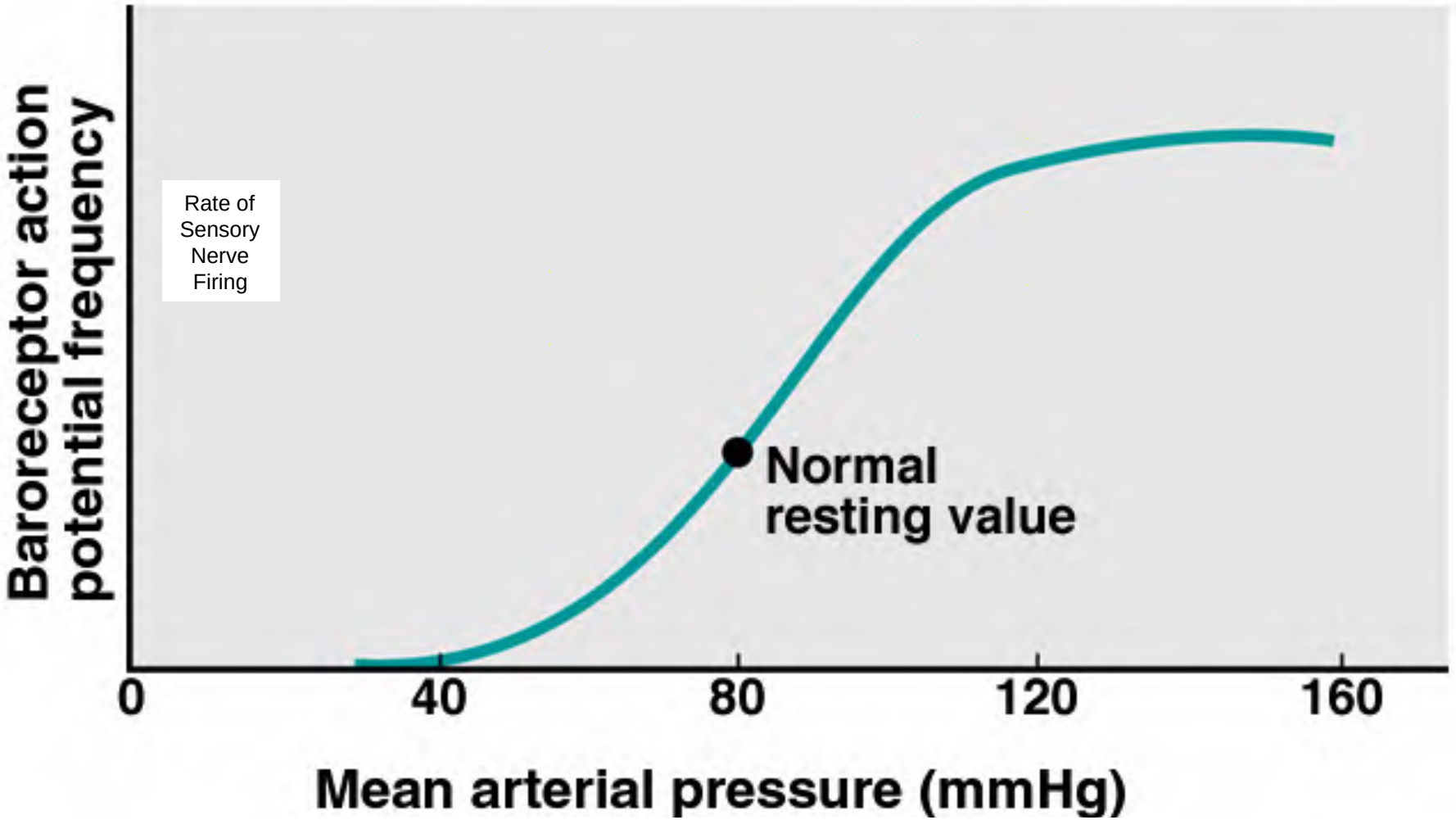
Carotid Pressure Receptors

Aortic Arch Pressure Receptors

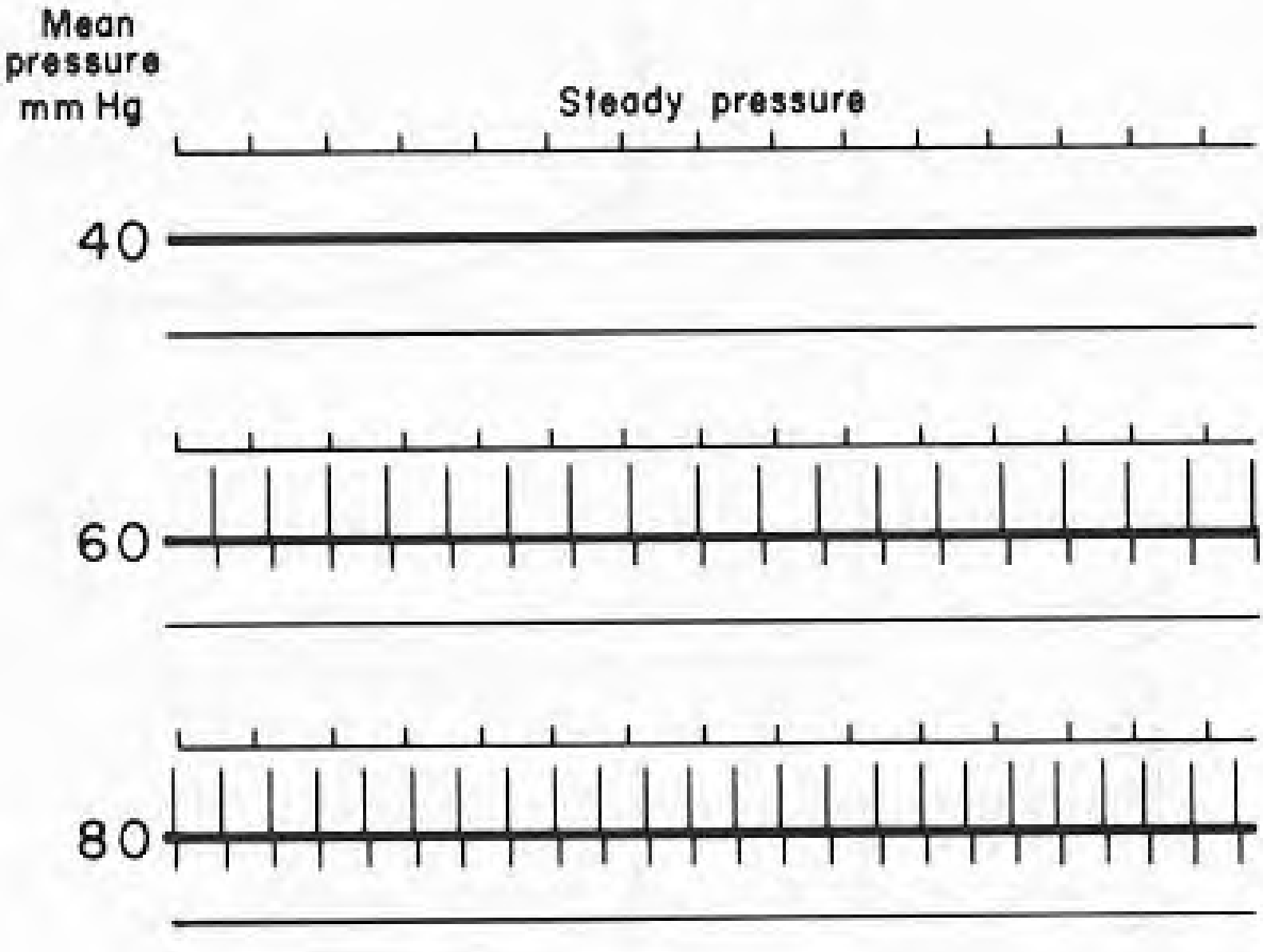
via Vagus

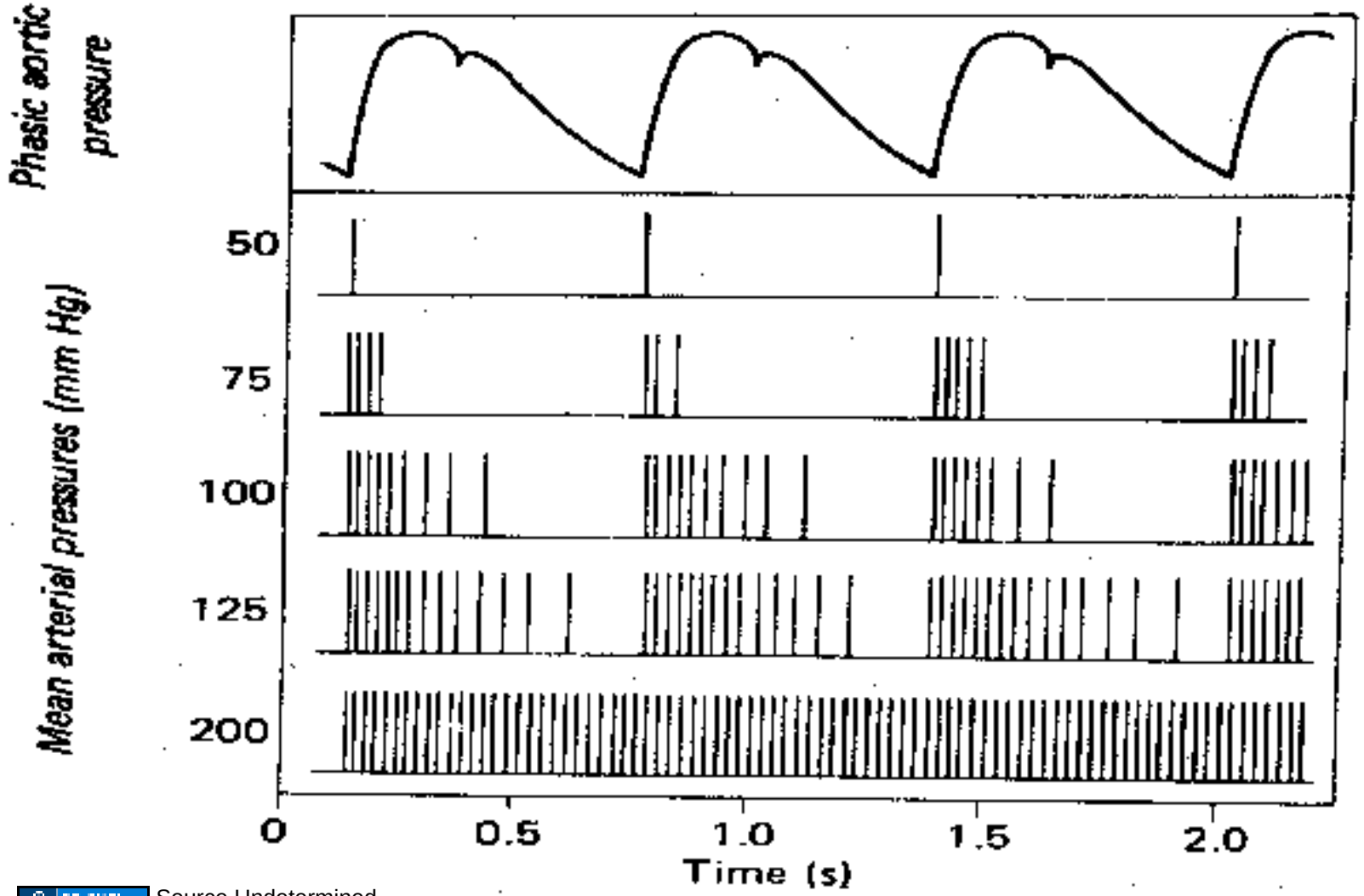
Please see: http://mor.phe.us/jtw/Gateway/Projects/Vertebrates/images/EvolutionOfTheHeart/ArterialBaroreceptors.gif

Mean arterial pressure (MAP)



Steady State Response





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Baroreceptor afferents thus contain not only steady pressure information but heart rate and pulse pressure information.

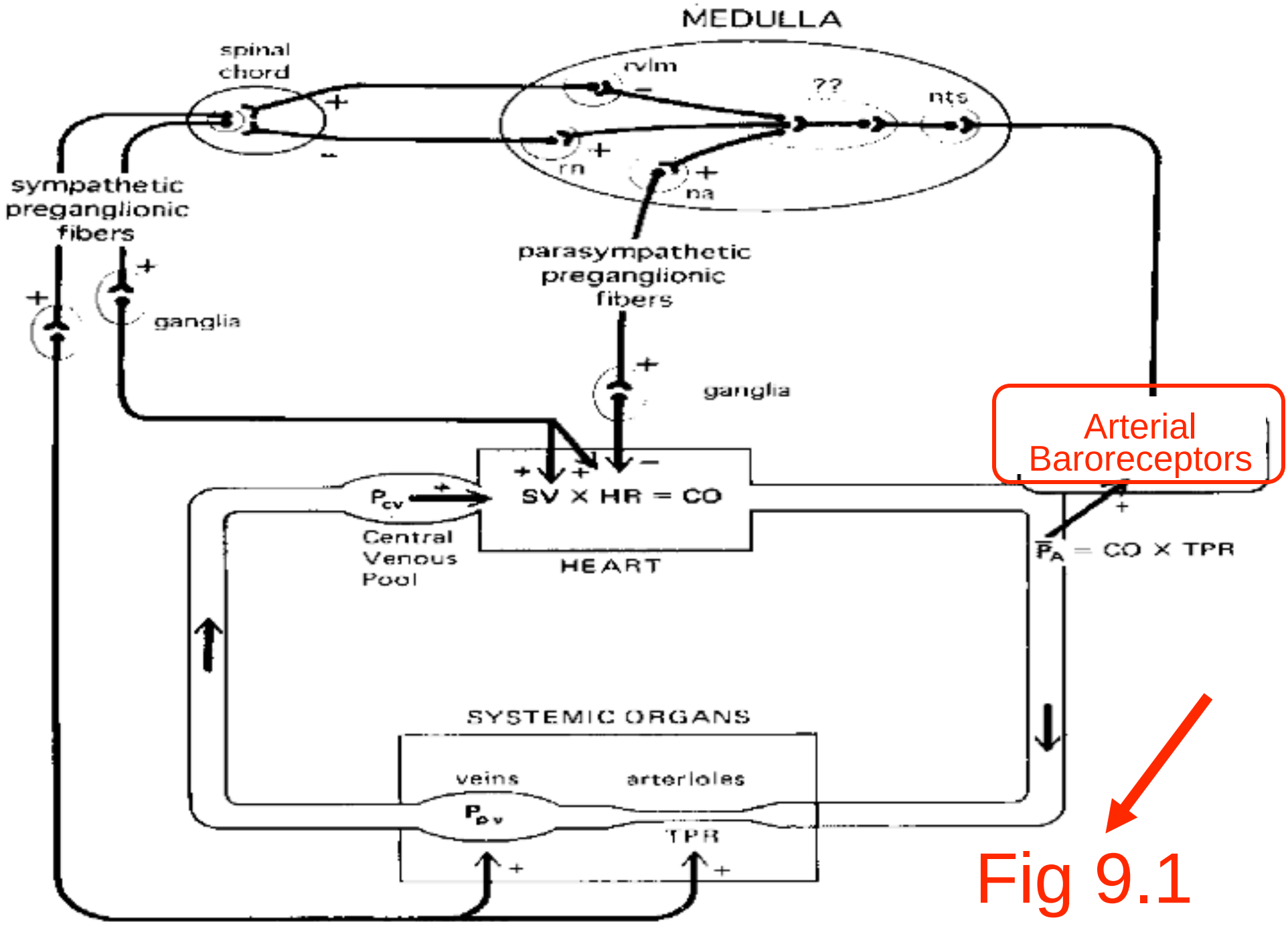


Fig 9.1

 Mohrman and Heller. Cardiovascular Physiology. McGraw-Hill, 2006. 6th ed.

Arterial Baroreceptor Reflex(s)

-minimize changes in arterial blood pressure
- tend to restore MAP to initial value
- move pressure pressure in opposite direction of disturbance (negative feedback)
- utilizes (controls) HR, SV, TPR, “other” changes
- can be over ridden by other reflexes and controls

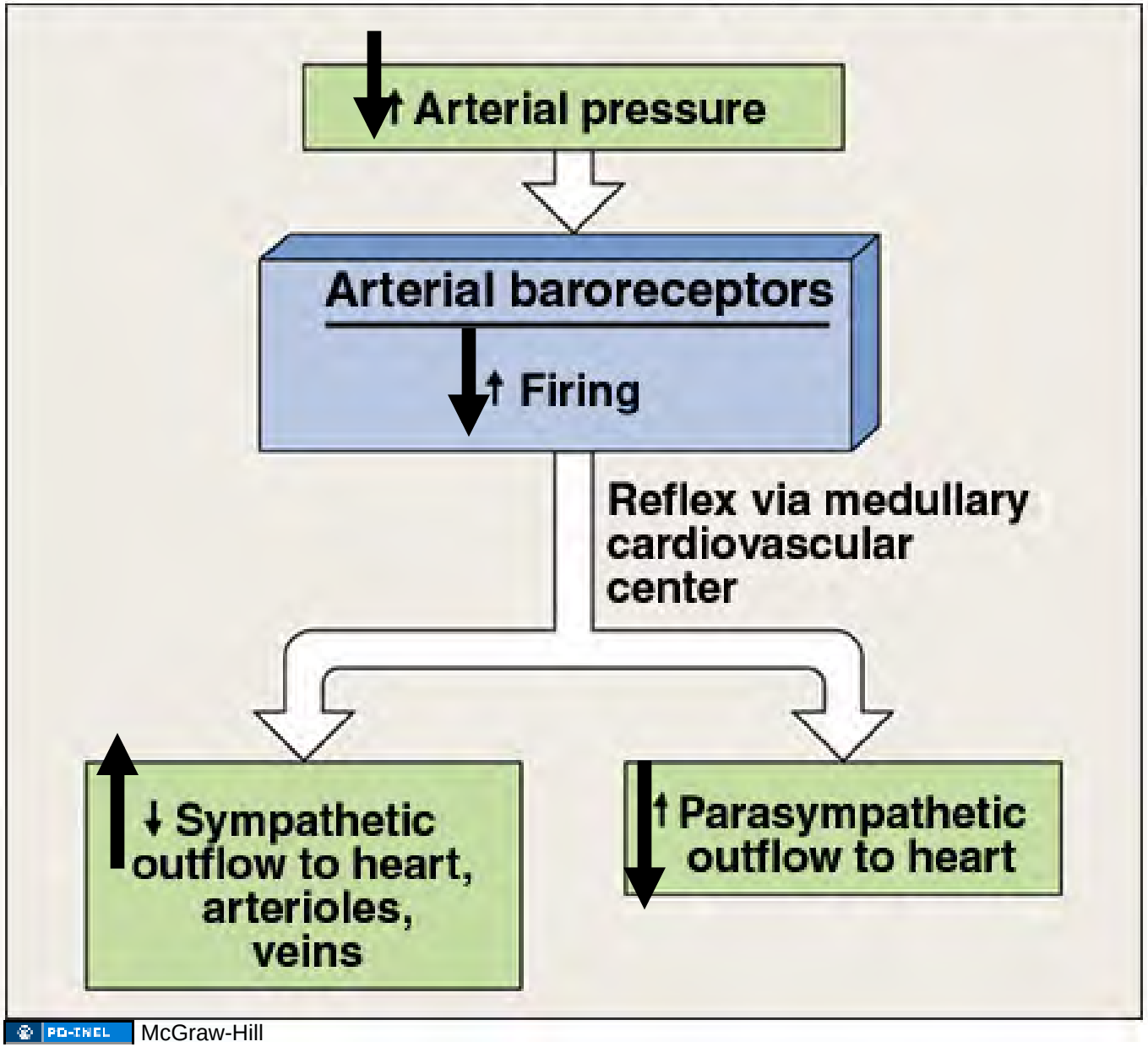
Responses (Effectors)

must be controlled:

CO thus HR x SV

and or TPR

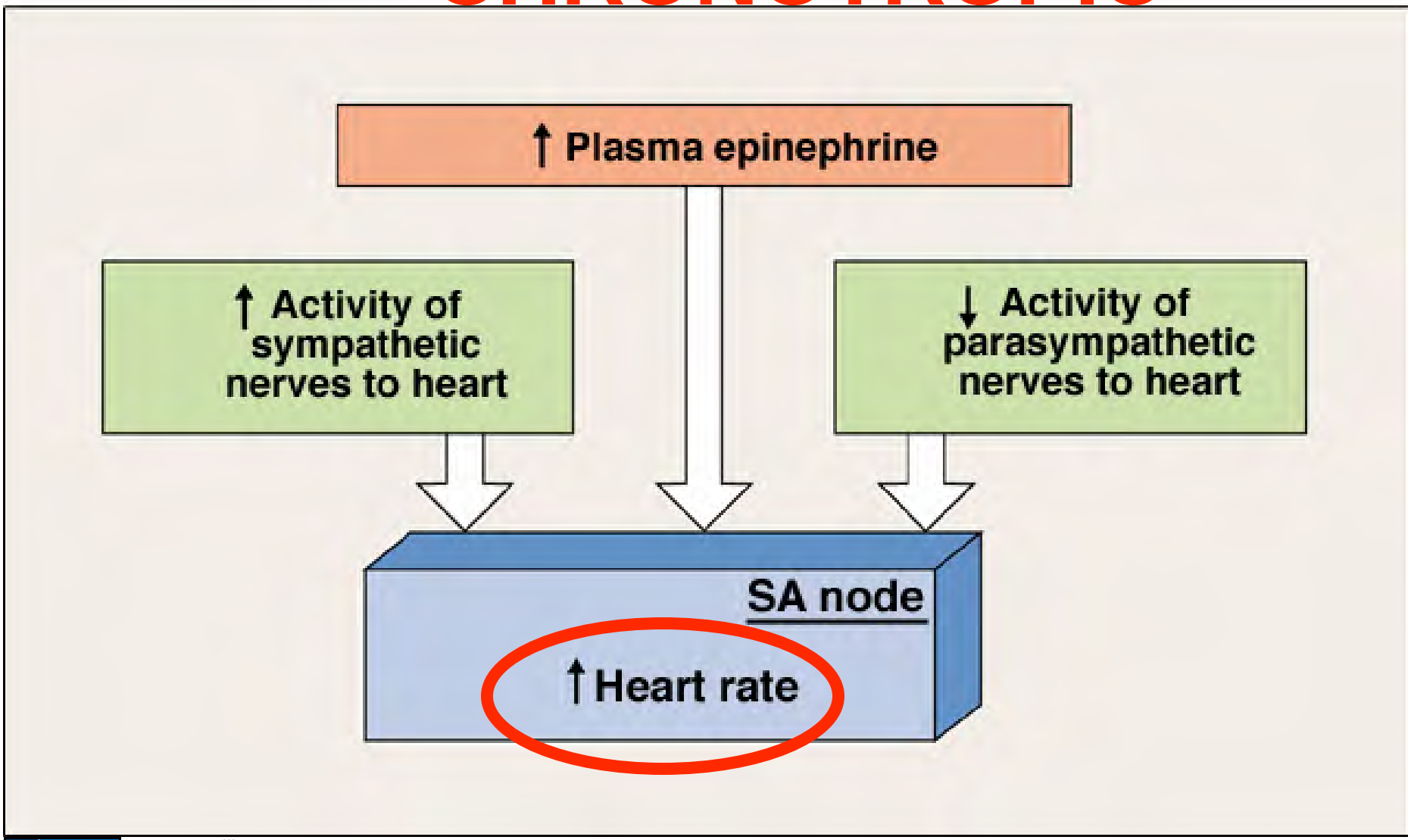
Arterial baroreceptor reflex



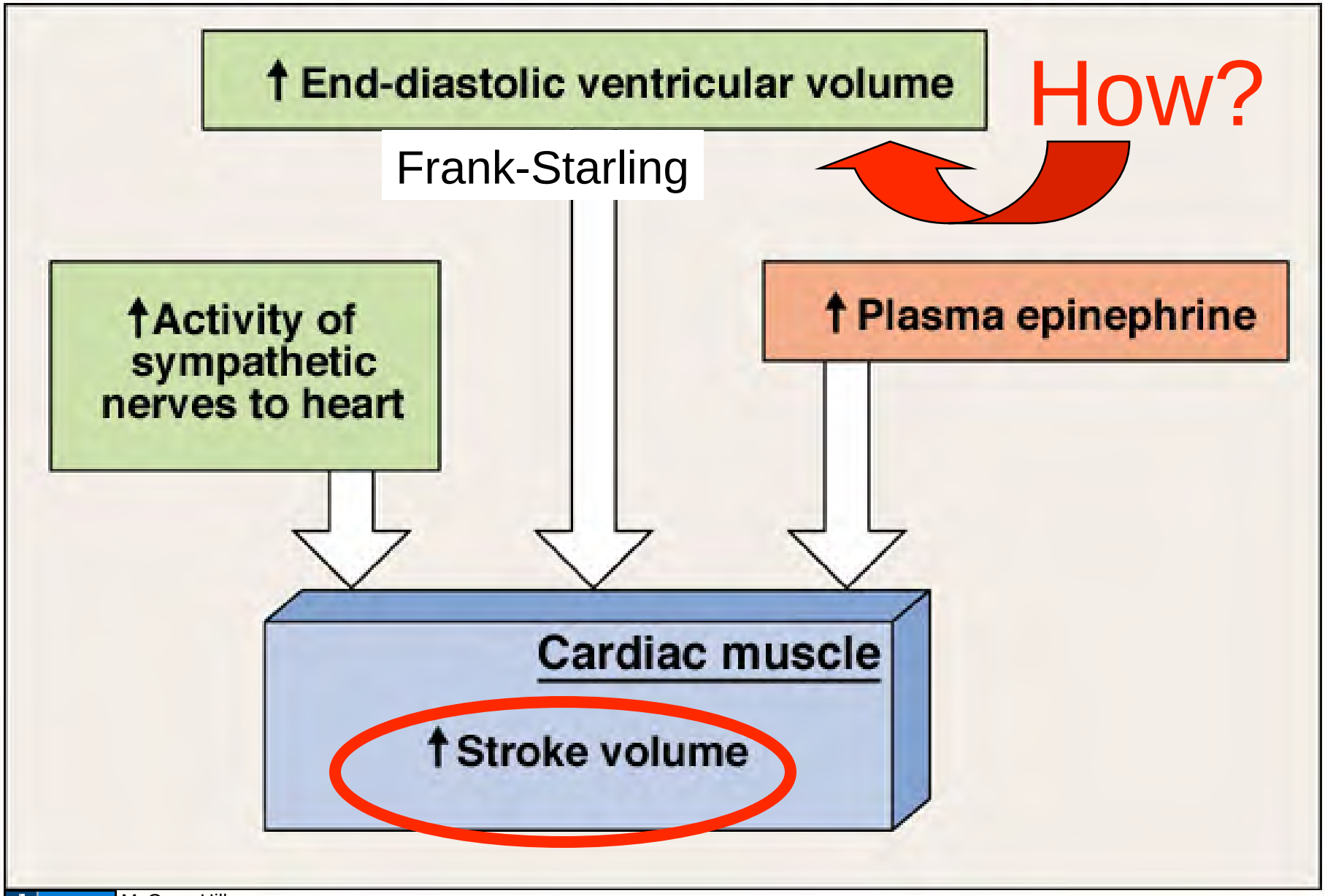
To restore Arterial Pressure

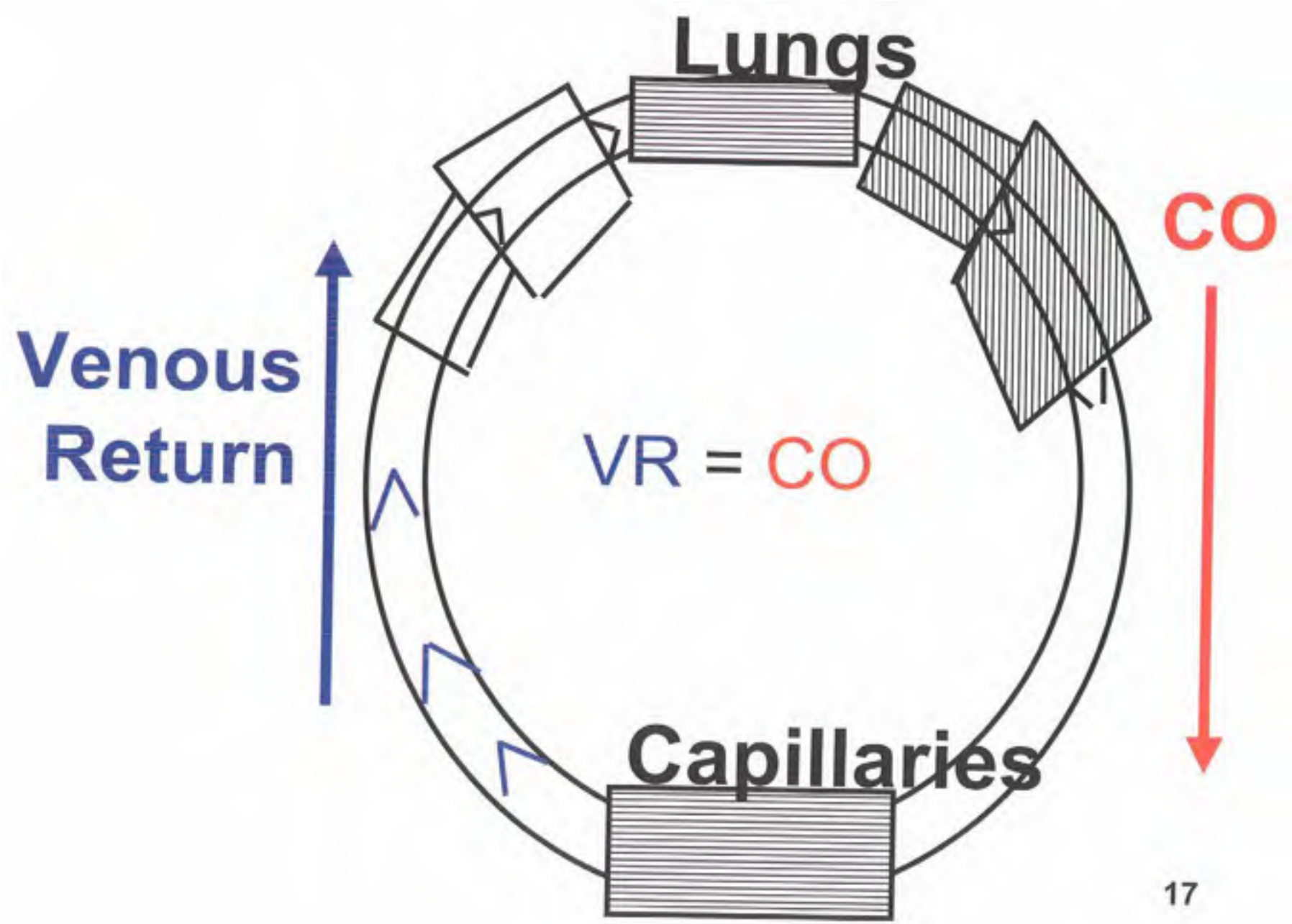
Factors influencing heart rate

+ CHRONOTROPIC

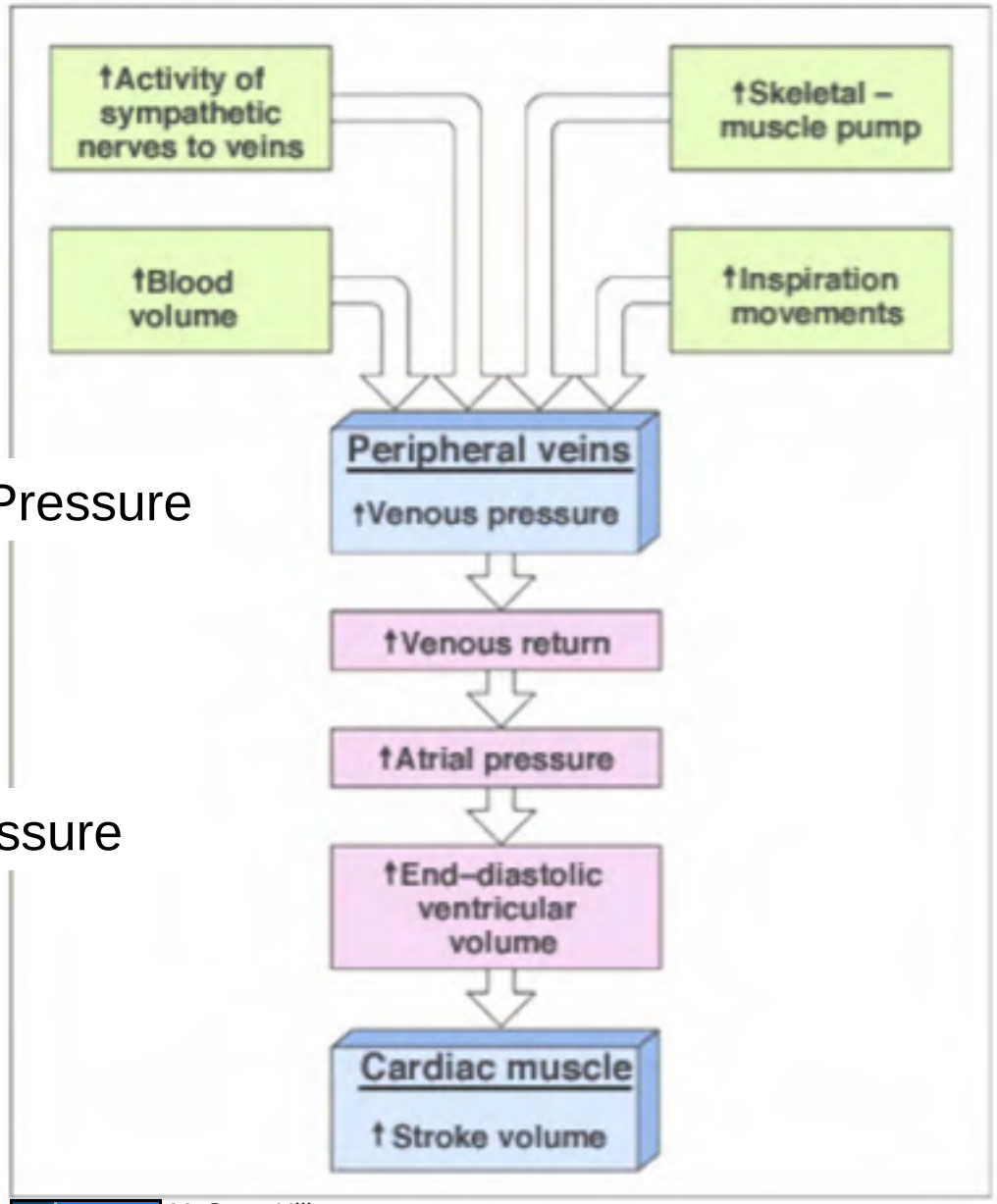


Controllers of stroke volume




Lungs
CO
Venous Return
VR = CO
Capillaries

Peripheral venous pressure

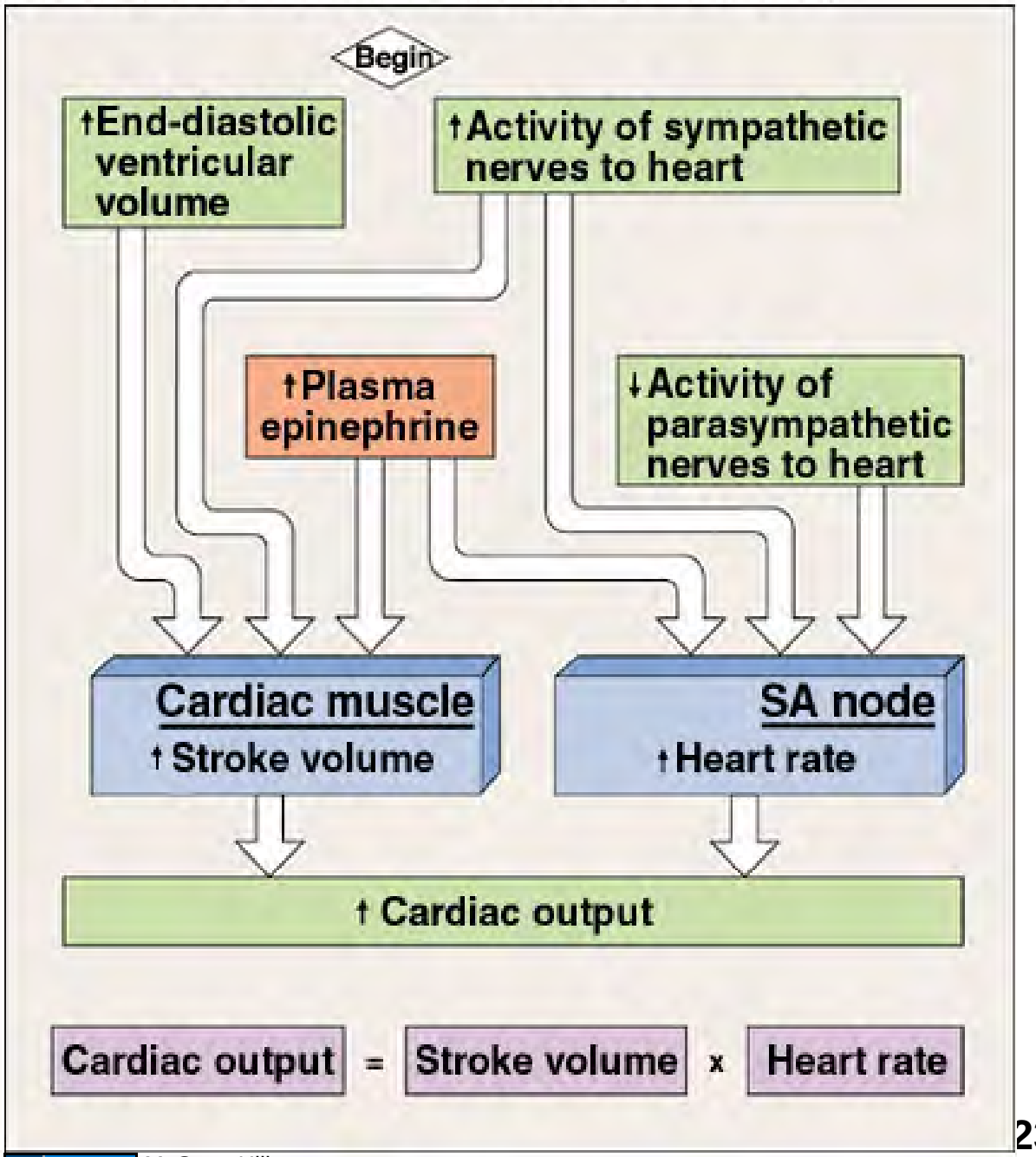


Peripheral Venous Pressure

VR

Central Venous Pressure

Cardiac output



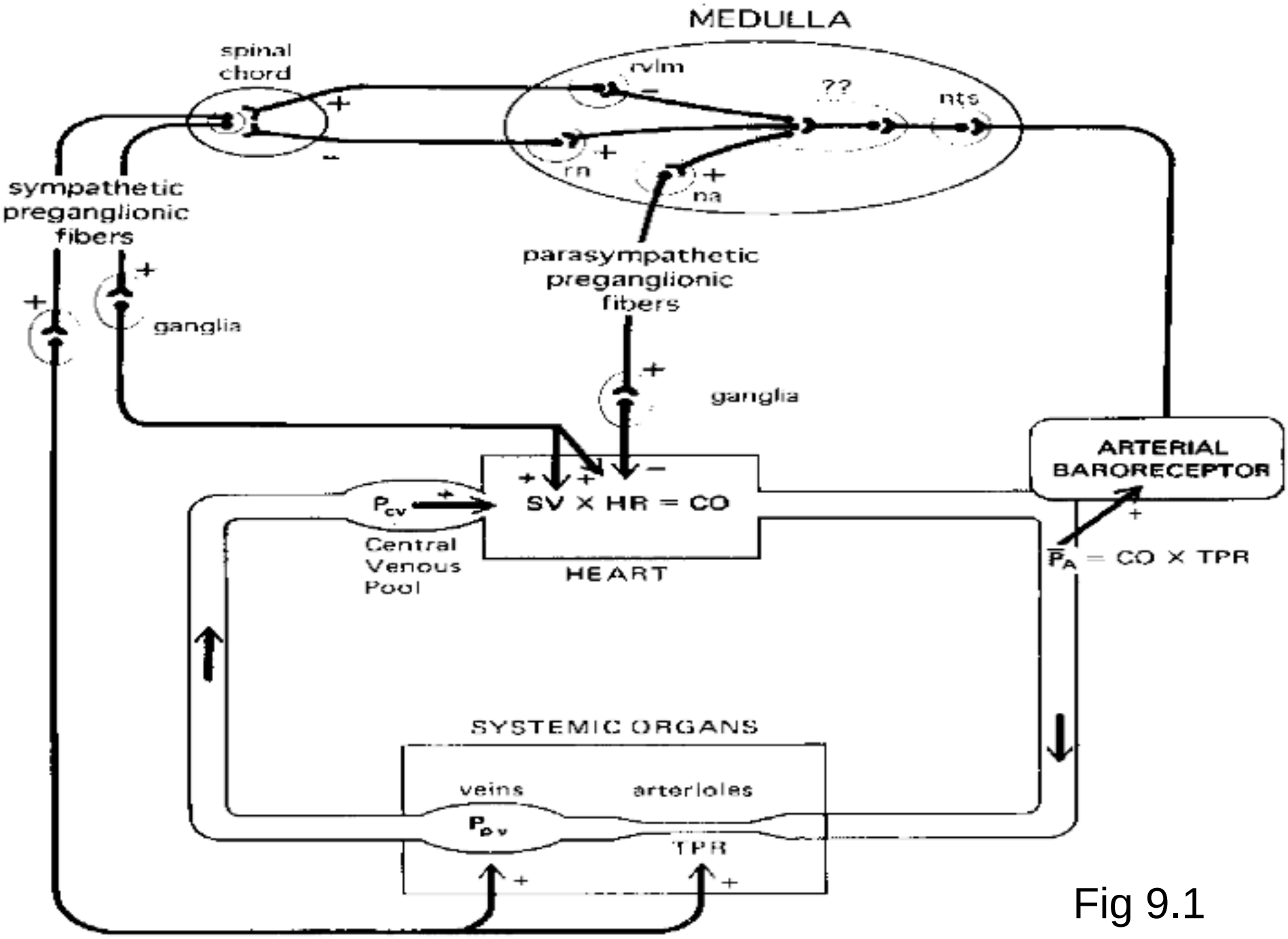
SYSTEMIC VASCULAR
(TOTAL PERIPHERAL RESISTANCE)

- Vasoconstriction (generalized) ⇒ ⇓ **r** ⇒ ⇑ **TPR** ⇒ ⇑ **MAP** **or** ⇓ **CO**

- Vasodilation (generalized)

⇒ ⇑ **r** ⇒ ⇓ **TPR** ⇒ ⇓ **MAP** **or** ⇑ **CO**

⇑⇑MAP = CO X ⇑⇑TPR



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Other MCVC Inputs

Higher Centers

Cortex-- cerebral , cerebellar

Hypothalamus-- Na, H_2O, Pain, C°, Emotion, Activity

Chemoreceptors

Carotid and aortic bodies

Hypoxia--vasodilation BUT hypertension reflex

Cardiopulmonary low pressure baroreflexes

-sense central venous volume

-respond to alter fluid balance (renal effects)

-long-term blood pressure response

TISSUE RESISTANCE

(*Assume Perfusion Pressure is Constant ***)**

LOCAL -- COMPETES WITH BAROREFLEX

- Vasoconstriction $\Rightarrow \Downarrow r \Rightarrow \Uparrow R_{tissue} \Rightarrow \Downarrow F_{tissue}$

- Vasodilation

$\Rightarrow \Uparrow r \Rightarrow \Downarrow R_{tissue} \Rightarrow \Uparrow F_{tissue}$

$$F_{tissue} = \frac{\text{Perfusion Pressure}}{R_{tissue}}$$

Additional Source Information

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Slide 10: D'Alecy
Slide 11: Please see: http://mor.phe.us/jtw/Gateway/Projects/Vertebrates/images/EvolutionOfTheHeart/ArterialBaroreceptors.gif
Slide 12: McGraw-Hill
Slide 13: Source Undetermined
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Slide 21: D'Alecy
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Slide 25: Mohrman and Heller. Cardiovascular Physiology. McGraw-Hill, 2006. 6th ed.