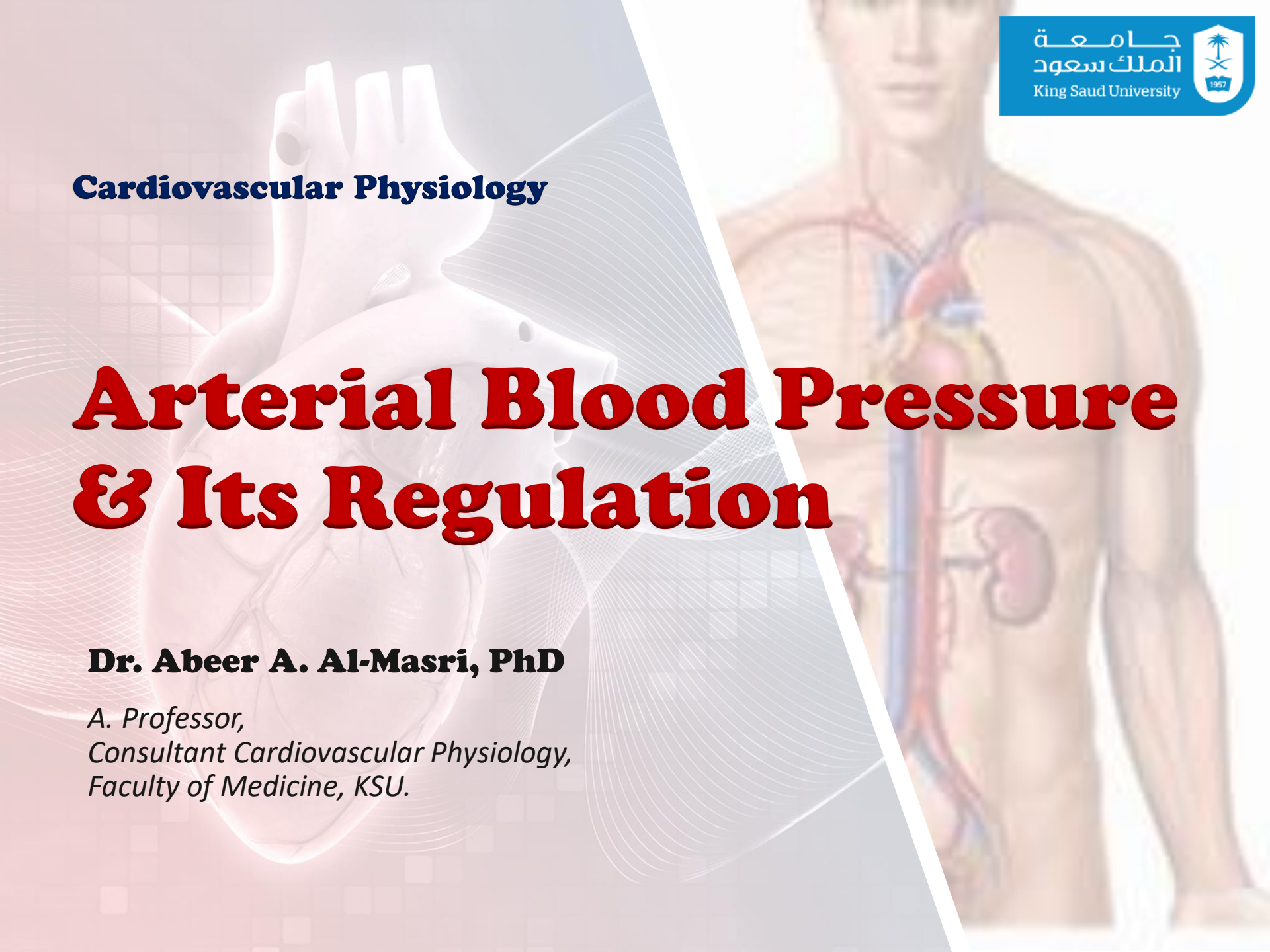


Cardiovascular Physiology

Arterial Blood Pressure & Its Regulation

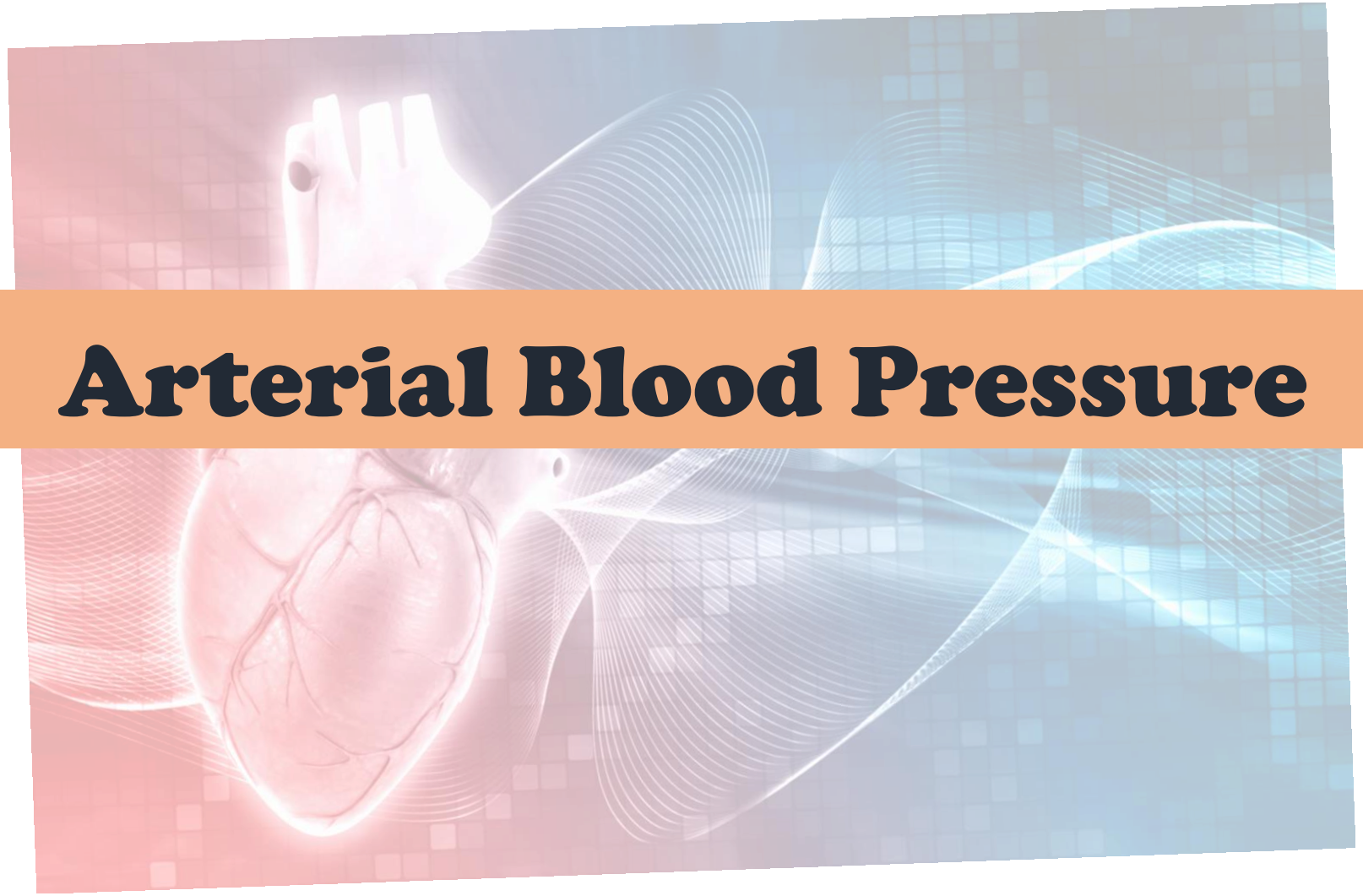
Dr. Abeer A. Al-Masri, PhD

A. Professor,
Consultant Cardiovascular Physiology,
Faculty of Medicine, KSU.

Types of Blood Pressure

Depending on the nature of the blood vessels

- Arterial Blood Pressure.
- Venous Blood Pressure.
- Capillary Blood Pressure.



Arterial Blood Pressure

جامعة الملك سعود
King Saud University

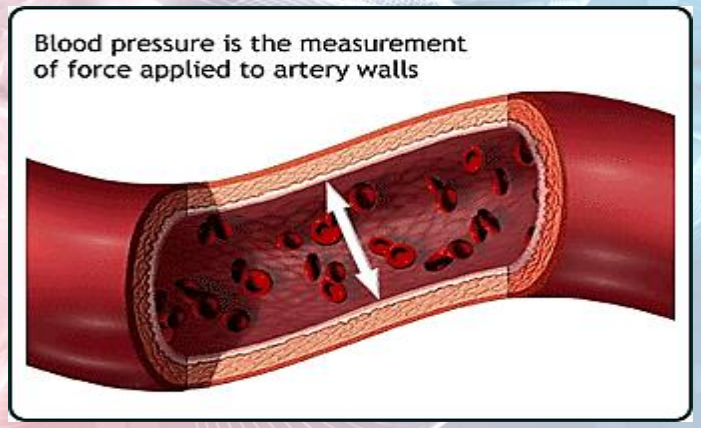
Arterial Blood Pressure

Lecture Objectives

- Concept & definition of blood pressure.
- Normal values of systolic & diastolic blood pressure.
- Physiological variations in arterial blood pressure.
- Pulse & Mean arterial pressures.
- Factors affecting & determining blood pressure.
- Relationships between blood pressure, Cardiac Output, & Total Peripheral Resistance.

Definition of Arterial Blood Pressure

= It is the lateral pressure force exerted by the blood flow on the arterial wall against any unit area of the vessel wall.



The force of blood flow is created by the pumping force of the heart.

https://www.youtube.com/watch?v=J97G6BeYW0I

- **Arterial blood pressure (BP) is one of the most important vital signs.**
- **It is important to keep normal levels of blood pressure for proper blood flow to the body's organs & tissues.**
- **Measured in (mmHg), & sometimes in (cmH_2O).**
  (1mmHg = 1.36 cmH_2O)

Arterial Blood Pressure

Systolic Blood Pressure

- The maximum force exerted by the blood flow against any unit area of the vessel wall while the heart is maximally contracting (Systole). = 120 mmHg.

Diastolic Blood Pressure

- The minimum force exerted by the blood flow against any unit area of the vessel wall while the heart is maximally relaxing (Diastole). = 80 mmHg.

Normal arterial blood pressure = 120 mmHg systolic/80 mmHg diastolic.

Guyton and Hall, pp 174

Normal Levels of Arterial Blood Pressure

In normal adult ≈ 120/80 mmHg

- **Top number (Systolic Pressure):**
  = Arterial Pressure recorded during maximum contraction of the heart.
- **Bottom number (Diastolic):**
  = Arterial Pressure recorded during maximum relaxation of the heart.

Both numbers are important to determine the state of the heart health.

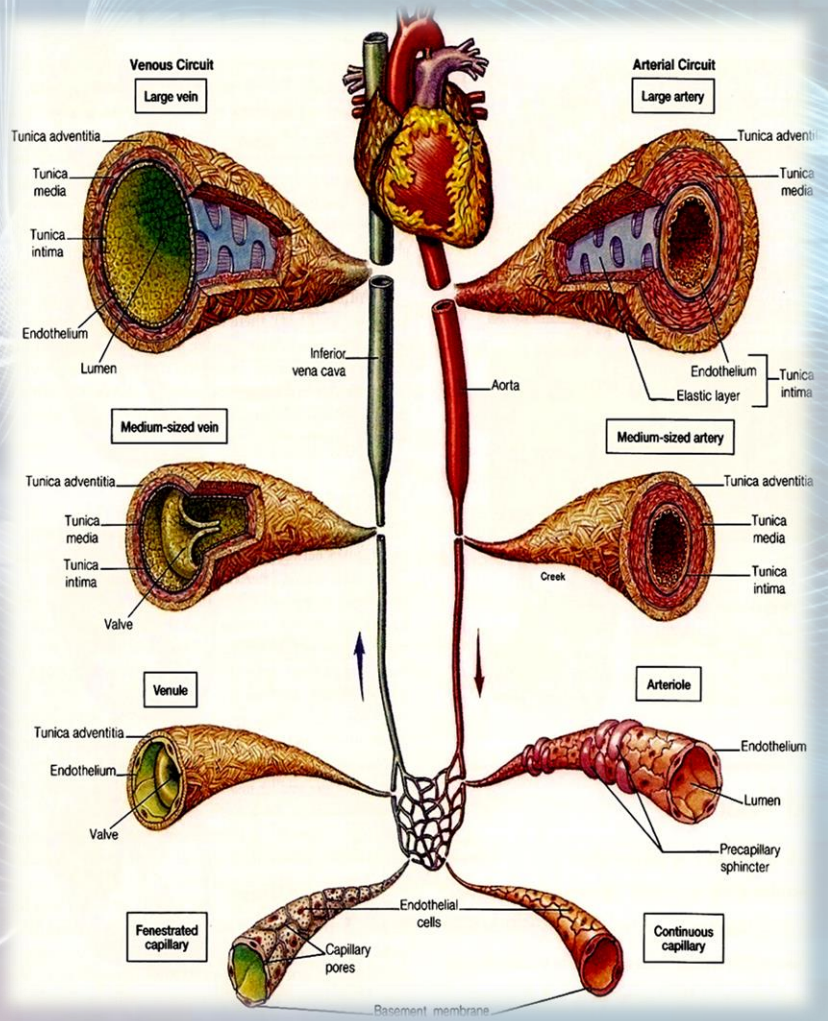
Arteries are Pulsatile.

- **Normal Arterial Pressure range:**
  - 90 – 120 mmHg systolic.
  - 60 – 80 mmHg diastolic.

Greater numbers than the ideal range indicate that the heart is working too hard to pump blood to the rest of the body.

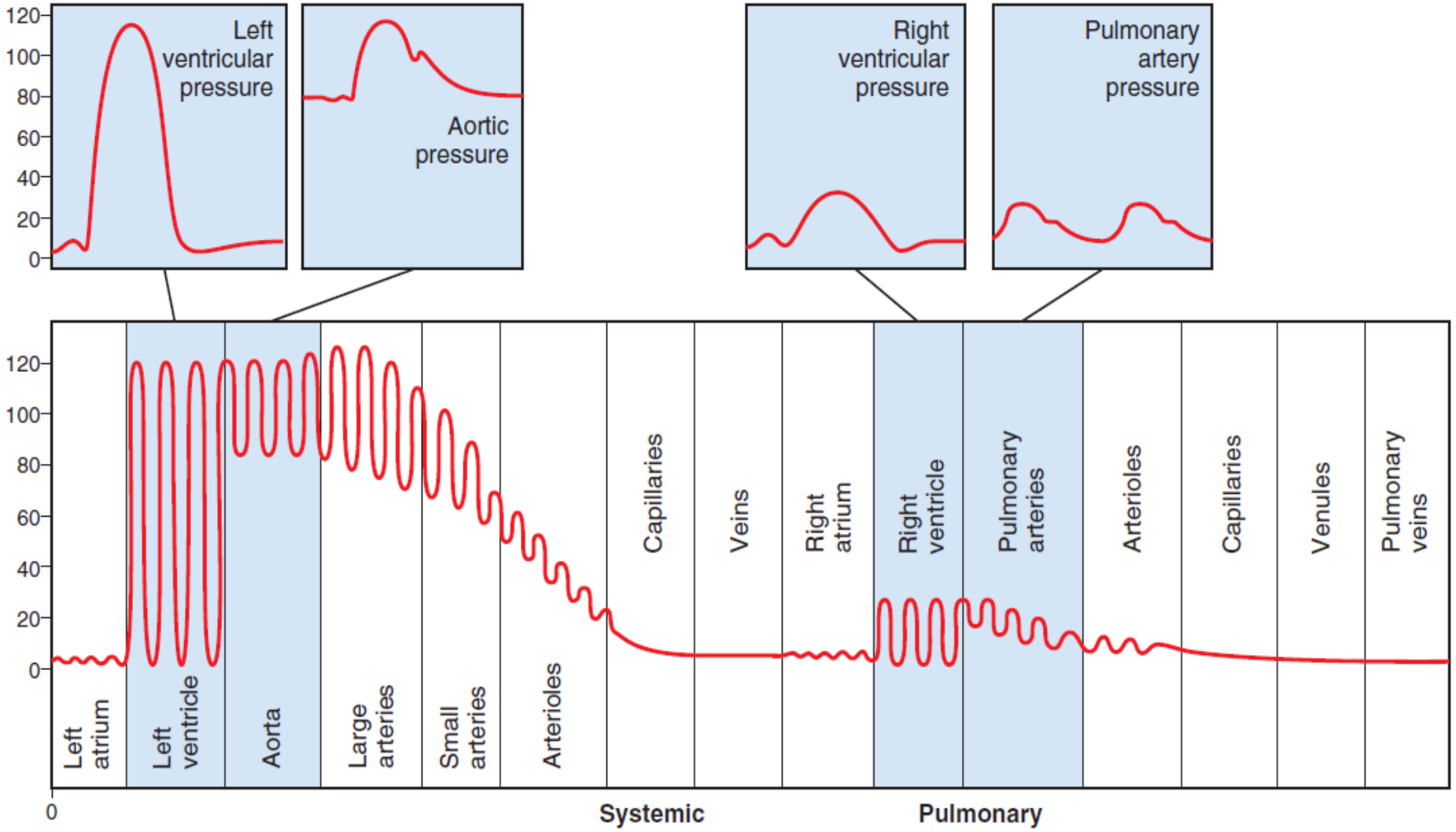
Pressure Changes Throughout Systemic Circulation

- **Blood flows down a pressure gradient.**
- Pressure is **highest** at the heart (driving Pressure), & **decreases** over distance.
- Pressure decreases more than 90% from aorta to vena cava.
- **Greatest drop** in pressure occurs in **arterioles** which regulate blood flow through tissues.
- No large fluctuations of pressure in capillaries & veins.
- BP averages **120 mmHg** in aorta & drops to **2 mmHg** in Right Atrium.



https://www.youtube.com/watch?v=qWti317qb_w

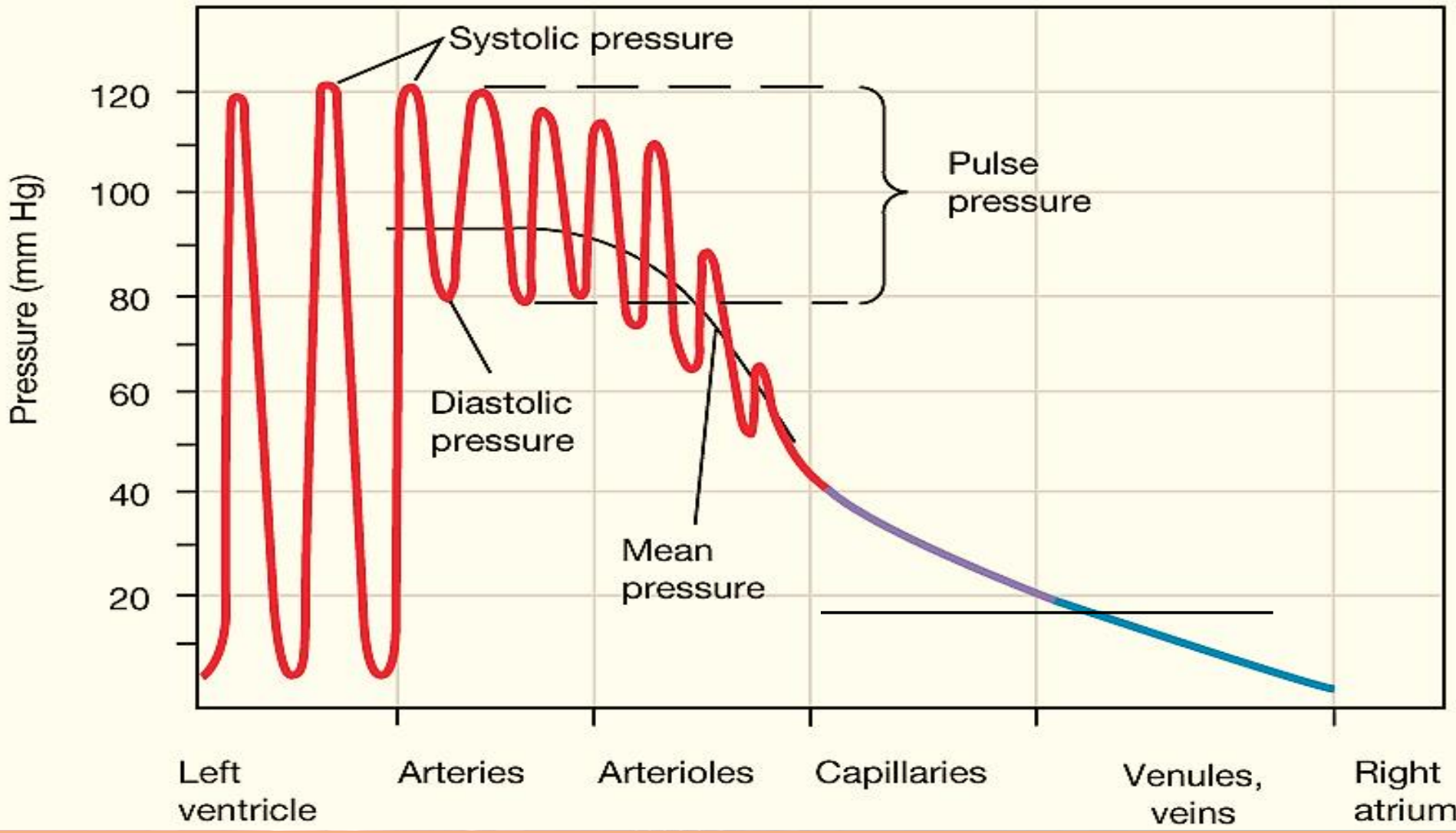
Blood Pressure Changes



Blood pressure in different parts of the circulatory system.

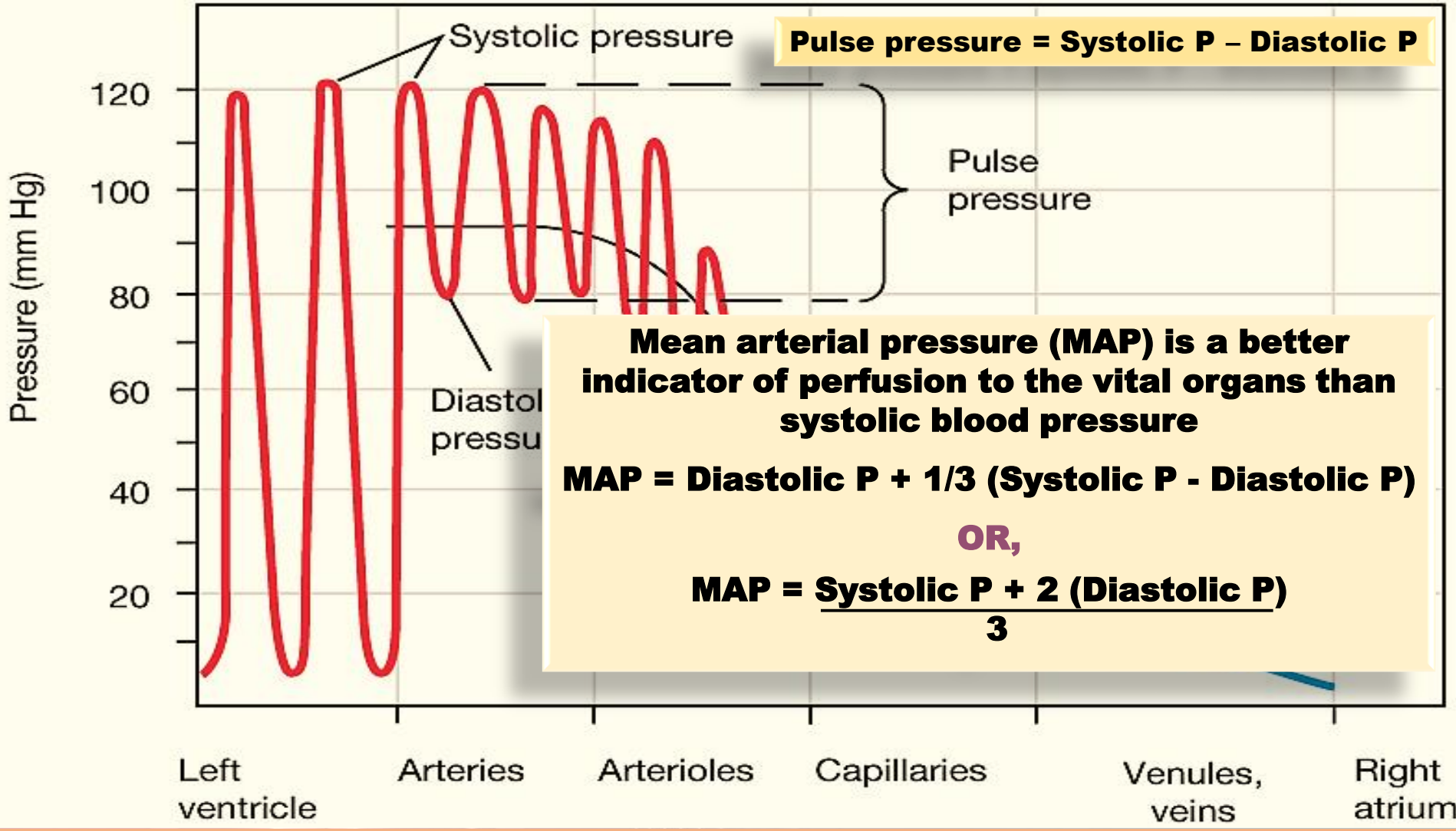
Guyton and Hall, pp 171.

Pulse and Mean Arterial Pressures



Arterial pressure is pulsatile, so a single value is used to represent the overall driving pressure. This is called the Mean Arterial Pressure.

Pulse and Mean Arterial Pressures



Mean arterial pressure (MAP) is a better indicator of perfusion to the vital organs than systolic blood pressure

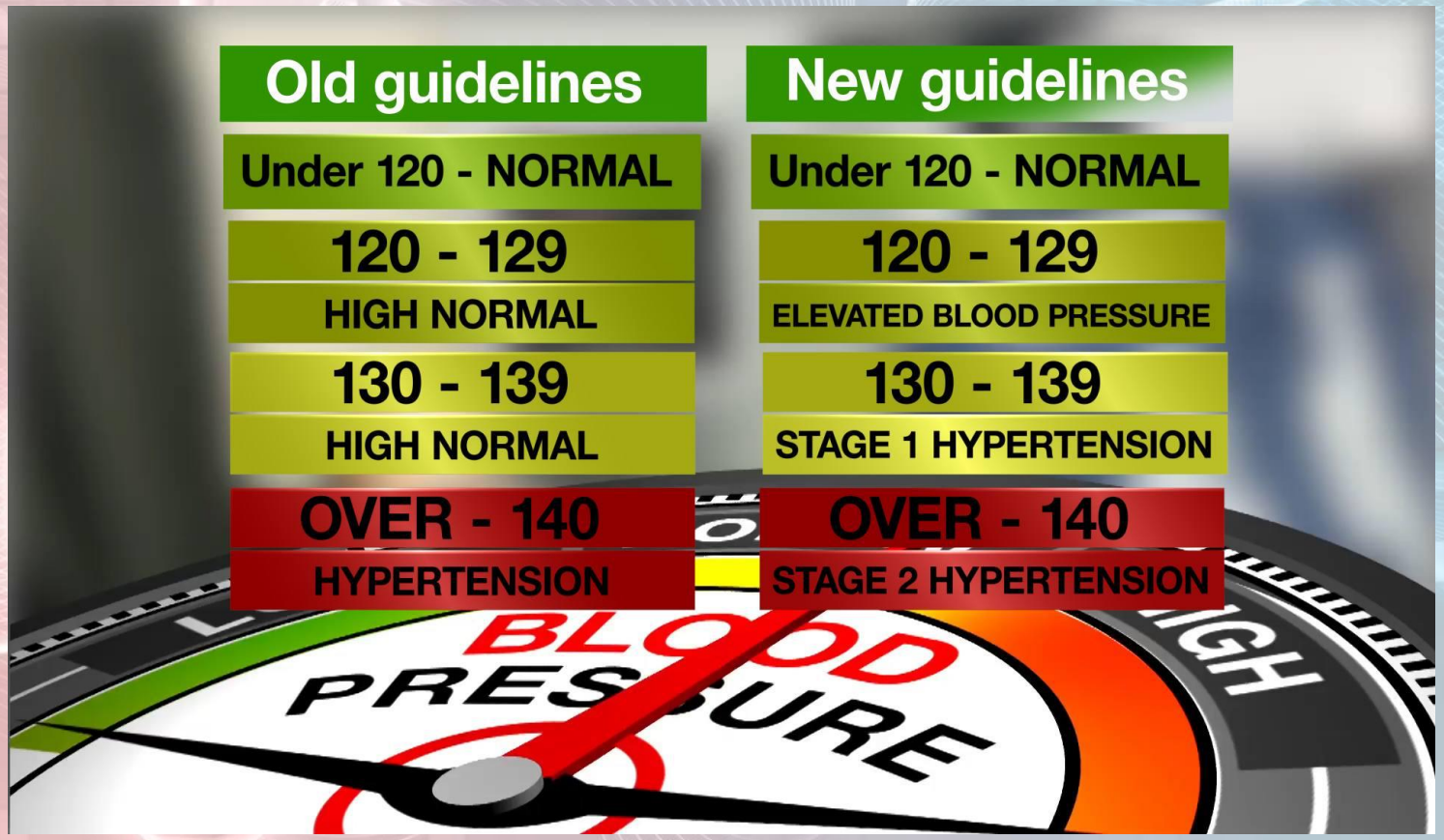
MAP = Diastolic P + 1/3 (Systolic P - Diastolic P)

OR,

$$MAP = \frac{\text{Systolic P} + 2(\text{Diastolic P})}{3}$$

Arterial pressure is pulsatile, so a single value is used to represent the overall driving pressure. This is called the Mean Arterial Pressure.

Arterial Blood Pressure Guidelines



Adult BP range: 90 – 120 / 60 – 80 mmHg

Blood Pressure Chart

جامعة الملك سعود
King Saud University

American Heart Association

Blood Pressure Categories under new guidelines

Nov 2017

Blood Pressure Categories

American Heart Association | American Stroke Association

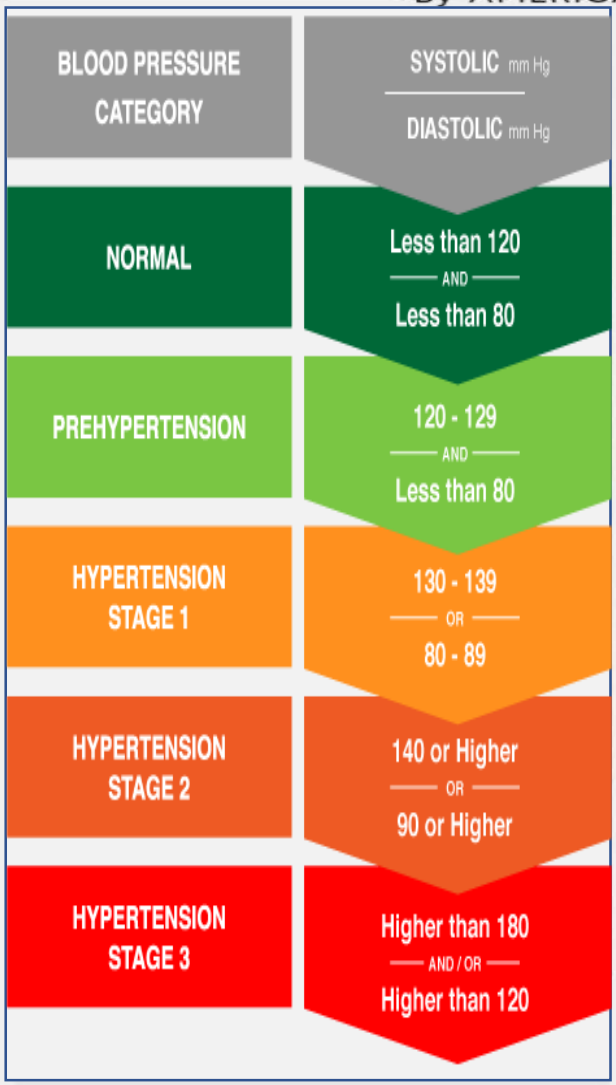
BLOOD PRESSURE CATEGORY	SYSTOLIC mm Hg (upper number)		DIASTOLIC mm Hg (lower number)
NORMAL	LESS THAN 120	and	LESS THAN 80
ELEVATED	120 – 129	and	LESS THAN 80
HIGH BLOOD PRESSURE (HYPERTENSION) STAGE 1	130 – 139	or	80 – 89
HIGH BLOOD PRESSURE (HYPERTENSION) STAGE 2	140 OR HIGHER	or	90 OR HIGHER
HYPERTENSIVE CRISIS (consult your doctor immediately)	HIGHER THAN 180	and/or	HIGHER THAN 120

heart.org/bplevels

https://www.bing.com/videos/search?q=what+is+blood+pressure&&view=detail&mid=A54D3D66D3EF07C8A18AA54D3D66D3EF07C8A18A&&FORM=VRDGAR

KNOW YOUR BLOOD PRESSURE
—AND WHAT TO DO ABOUT IT

By AMERICAN HEART ASSOCIATION NEWS



The newest guidelines for hypertension:

NORMAL BLOOD PRESSURE
*Recommendations: Healthy lifestyle choices and yearly checks.

ELEVATED BLOOD PRESSURE
*Recommendations: Healthy lifestyle changes, reassessed in 3-6 months.

HIGH BLOOD PRESSURE / STAGE 1
*Recommendations: 10-year heart disease and stroke risk assessment. If less than 10% risk, lifestyle changes, reassessed in 3-6 months. If higher, lifestyle changes and medication with monthly follow-ups until BP controlled.

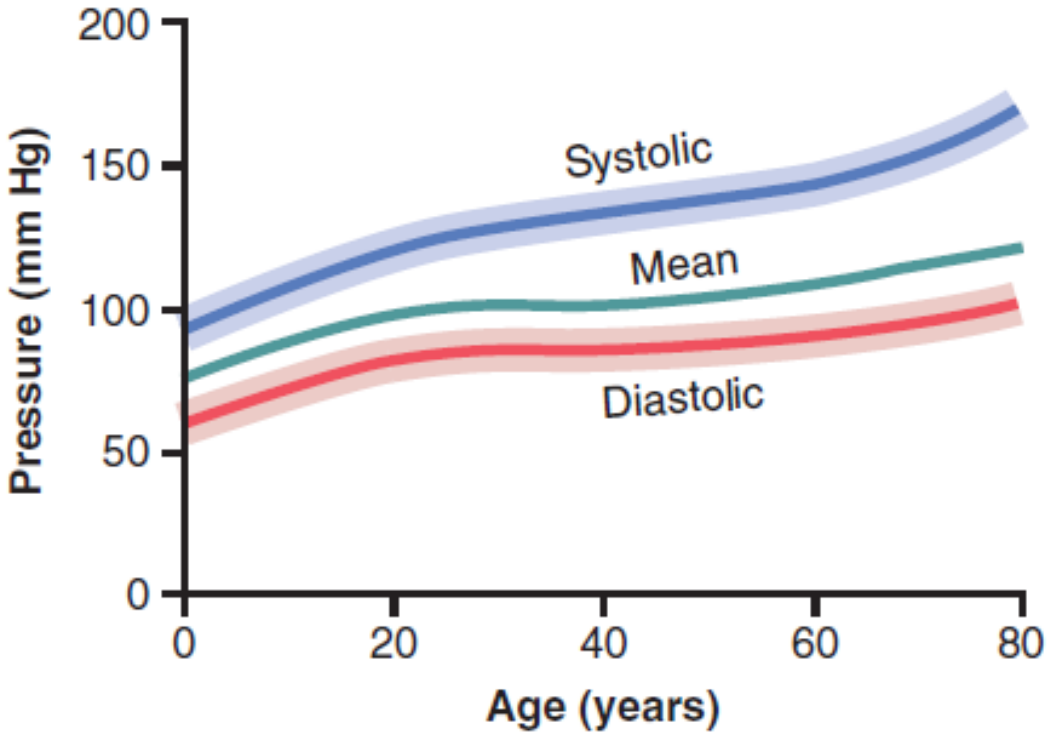
HIGH BLOOD PRESSURE / STAGE 2
*Recommendations: Lifestyle changes and 2 different classes of medicine, with monthly follow-ups until BP is controlled.

**Individual recommendations need to come from your doctor.*
Source: American Heart Association's journal Hypertension
Published Nov. 13, 2017

Physiological Factors Affecting Arterial Blood Pressur

- **Sex:** Male > Female … (equal at menopause)
- **Age:** BP rises with age, elderly > children …(due to atherosclerosis, diabetes, …
- **Body mass index:** BP rises with body size.
- **Emotions:** BP (↑) due to neural & hormonal factors.
- **Exercise:** (↑) BP due to ↑ venous return.
- **Hormones:** Some hormones like adrenaline, noradrenaline & thyroid H (↑) BP.
- **Gravity:** BP is higher in lower limbs than upper limbs.
- **Race:** (? dietary factors, or stress)
- **Sleep:** BP (↓) due to ↓ venous return.
- **Pregnancy:** BP (↑) due to ↑ in metabolism.
- **Temperature:** BP (↓) with Heat due to vasodilatation, & (↑) with Cold due to vasoconstriction.

Physiological Factors Affecting Arterial Blood Pressure: Age



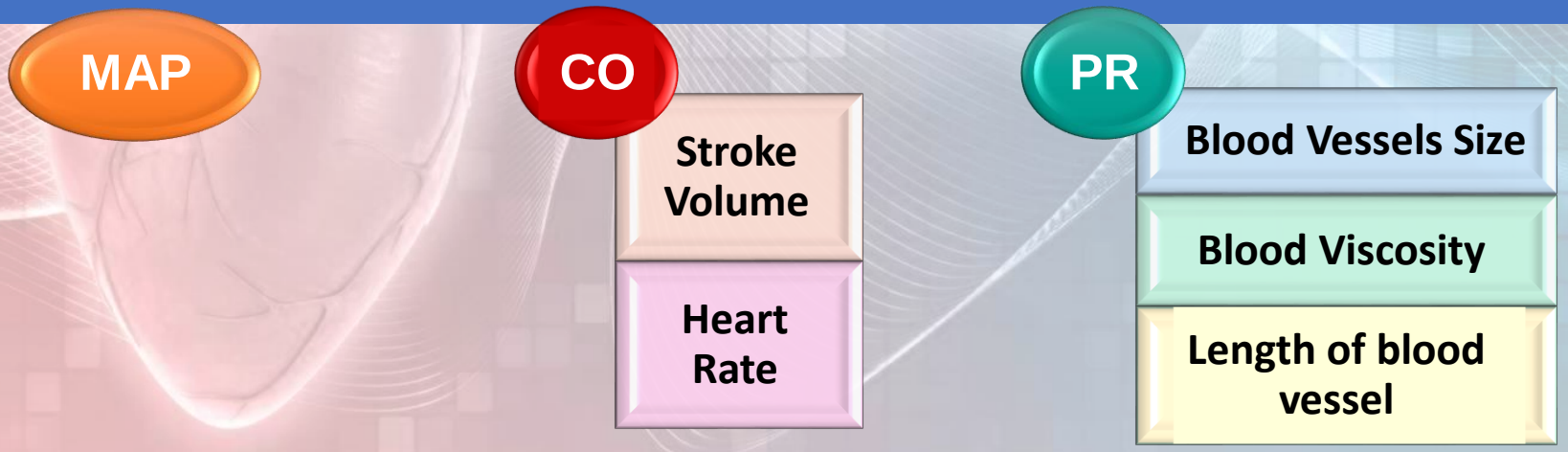
Changes in systolic, diastolic, and mean arterial pressures with age. The shaded areas show the approximate normal ranges.

Guyton and Hall, pp 183

Factors Determining Arterial Blood Pressure

- Cardiac output (Flow.)
- Peripheral Resistance.
- Blood volume.

Blood Pressure = Cardiac Output X Peripheral Resistance



CO = Stroke volume X Heart rate
(SV) X (HR)

Heart Rate
(↑)

Stroke Volume
(↑)

↑CO

Resistance depends on:
Size & length of blood vessel.
Thickness (viscosity) of blood.

Peripheral Resistance

↑PR

(Increase) Blood Pressure

MAP

(↑) Blood Volume

Blood Volume depends on:

- **Fluid intake & Fluid loss**

SV

Regulation of Stroke Volume

Stroke Volume = End-diastolic Volume – End-systolic Volume
(EDV) (ESV)

- **Stroke volume (SV) is regulated by 3 variables:**

I: End diastolic Volume (EDV):
Affected by the preload (venous return).

II: Contractility (Strength of contraction):
Affected by Starling's law & sympathetic innervation.

III: Total peripheral resistance (afterload).

SV

Factors Affecting End- diastolic Volume

End-diastolic pressure is affected by the pre-load (venous return), which is affected by:

1. Blood volume.
2. Pressure gradient.
3. Gravity.
4. Veno-constriction: caused by sympathetic nervous system.
5. Presence of valves in the large veins.
6. Skeletal muscles pump.
7. Respiratory activity (breathing).

SV

Factors Affecting End- systolic Volume

- **End- systolic volume (ESV) is determined by:**

I: Cardiac contractility:

Intrinsically affected by: end diastolic volume (EDV) & Frank Starling's law of the heart.

Extrinsically affected by sympathetic stimulation, hormones and drugs.

↑↑ contractility → ↑↑ SV → ↓↓ ESV

↓↓ contractility → ↓↓ SV → ↑↑ ESV

II: Total Peripheral Resistance (Afterload):

In response to all regulatory mechanisms,

↑↑ resistance (Vasoconstriction)→ ↓↓ Flow → ↓↓ SV → ↑↑ ESV

↓↓ resistance (Vasodilatation) → ↑↑ Flow → ↑↑ SV → ↓↓ ESV

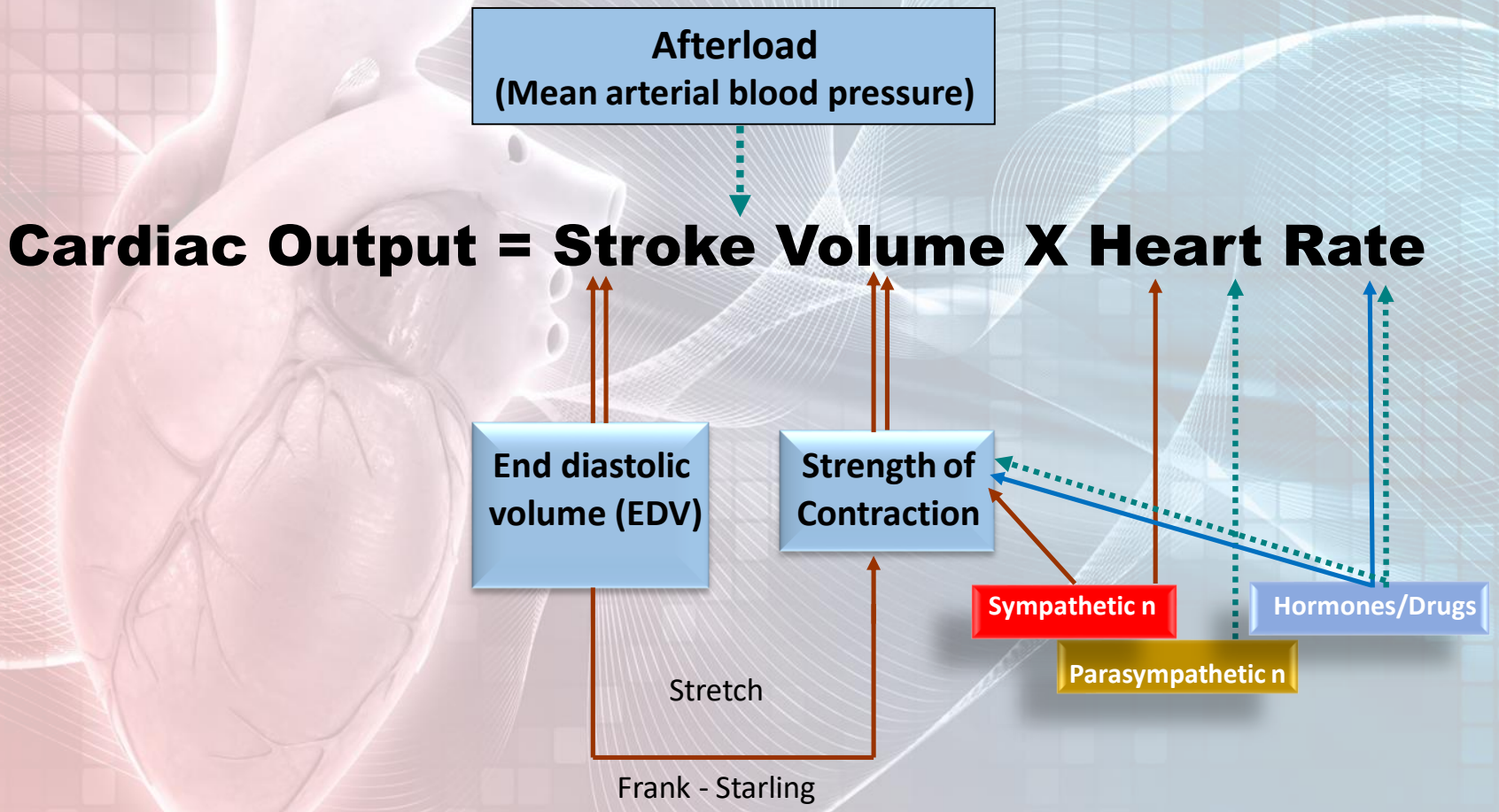
HR

Regulation of the Heart Rate

HR is regulated by:

- **Autonomic nervous system through <u>cardiac control centers</u> in medulla oblongata in the brain stem:**
  - Cardiac-accelerator Center (Vasomotor center) … Sympathetic nerve fibers.
  - Cardiac-inhibitory Center … Parasympathetic nerve fibers.
- **Hormones/Drugs.**

Regulation of Cardiac Output

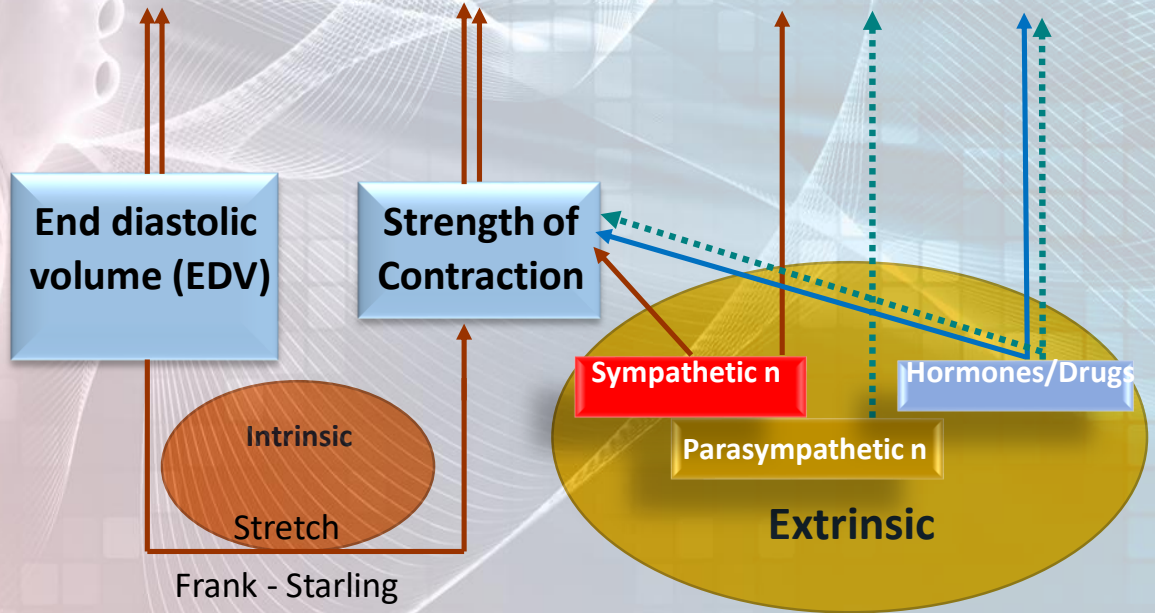


Starling's law of the heart – the more the cardiac muscle is stretched, the stronger the contraction

Regulation of Cardiac Output

Afterload
(Mean arterial blood pressure)

Cardiac Output = Stroke Volume X Heart Rate



Starling's law of the heart – the more the cardiac muscle is stretched, the stronger the contraction

HR

The Heart Rate

- Normal heart rate (HR) = 60-100 beats/min
- > 100 beats/min → Tachycardia
- < 60 beats/min → Bradycardia

Autonomic nervous system:

- Sympathetic nerves, increase HR.
- Parasympathetic nerves (vagus nerve), slow HR.

Hormones or Drugs:

- Epinephrine & thyroxine, increase HR.
- Decrease blood calcium, decreases HR.

Blood Flow: Affecting factors

- Blood flow is the amount of blood moving through a vessel in a given time period.
- Generally is equal to the Cardiac output (CO).
- Affected by the pressure difference & the resistance:

$$Q = \frac{\Delta P}{R}$$

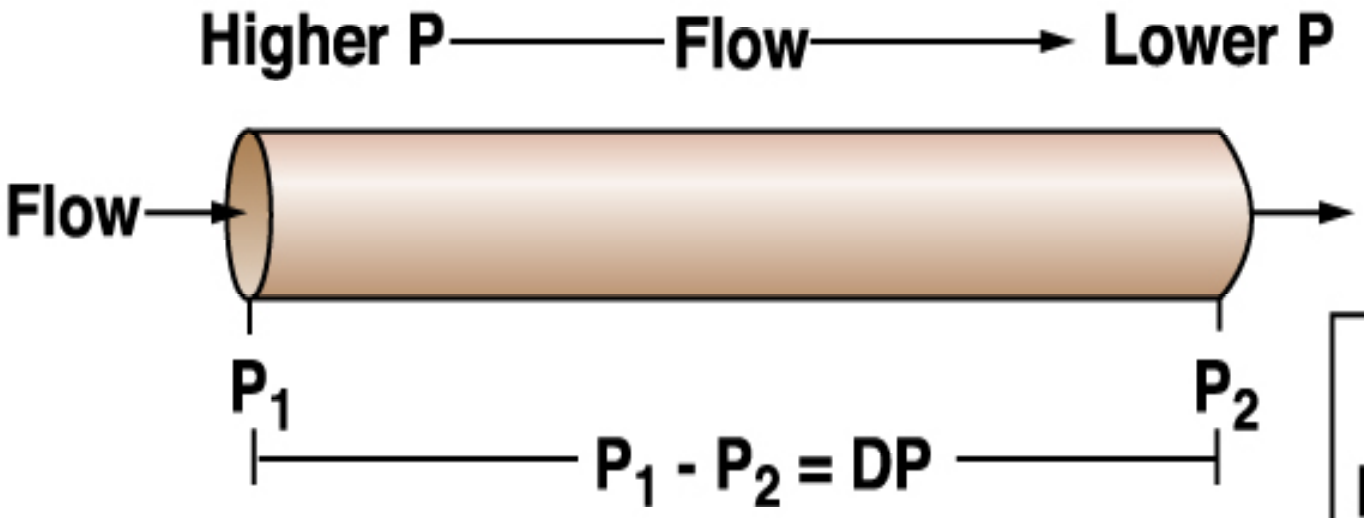
- **Directly** proportional to the **pressure difference.**
- **Inversely** proportional to the **resistance**.

Blood Flow and Pressure

Pressure difference is directly proportional to the Flow

Resulting pressure is called the driving pressure in vascular system

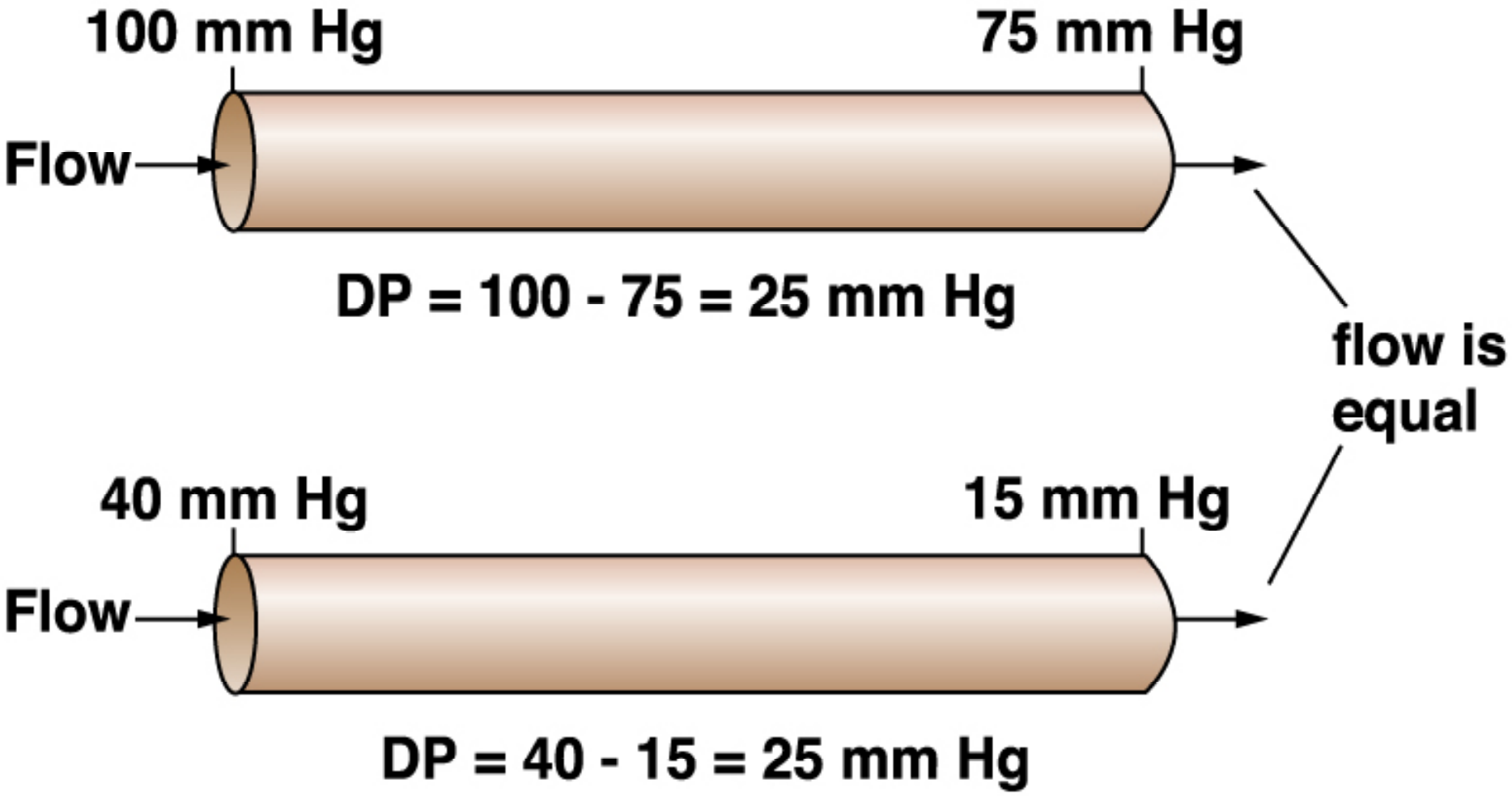
- Blood flows down a pressure gradient.
- Absolute value of pressure is not important to flow, but the difference in pressure (DP or gradient) is important to determining flow.



$$Q = \frac{\Delta P}{R}$$

P = Pressure
DP = Pressure gradient

How does the flow differ in these two vessels?



Resistance (R) and Flow:

Affecting Factors

Resistance = tendency of vascular system to oppose flow.

$$\text{Flow} = \frac{1}{R}$$

Resistance is influenced by:

Length of the tube (**L**), radius of the tube (**r**), & viscosity of the blood (η)

- In a normal human, length of the vascular system is fixed, so blood viscosity & radius of the blood vessels have the largest effects on the resistance.

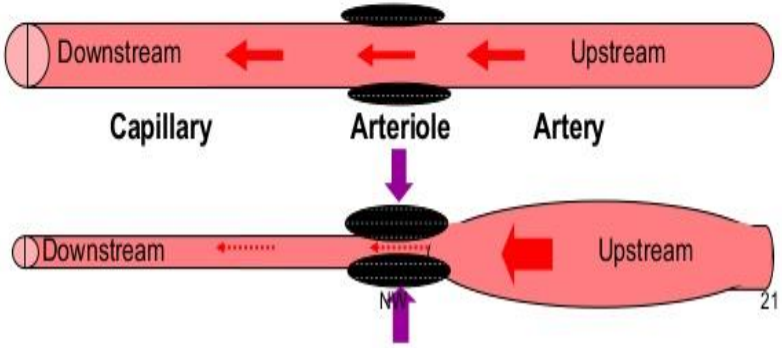
Poiseuille's Law $R = 8\eta L / \pi r^4$

Effect of Radius (r) on flow & Pressure

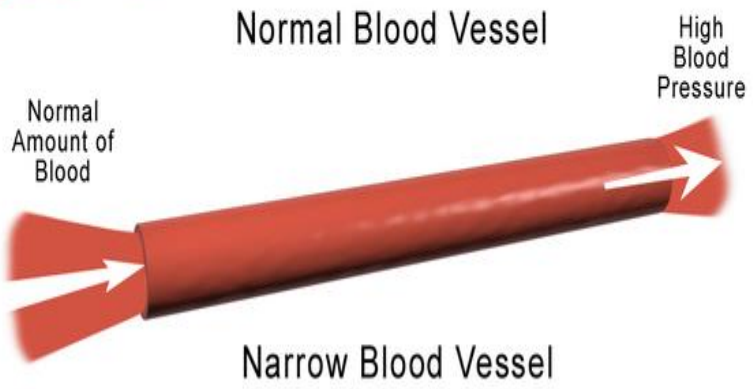
Directly proportional to flow.

Vascular tone - effects

- Increased tone in a segment of blood vessel
- e.g. **increased arteriolar tone**
- → decreased radius of arteriole
- → greatly increased resistance to blood flow
- → greatly decreased blood flow across the arteriole
- → the effects on blood volume
  - Increased upstream (in the artery)
  - Decreased downstream(in the capillaries)



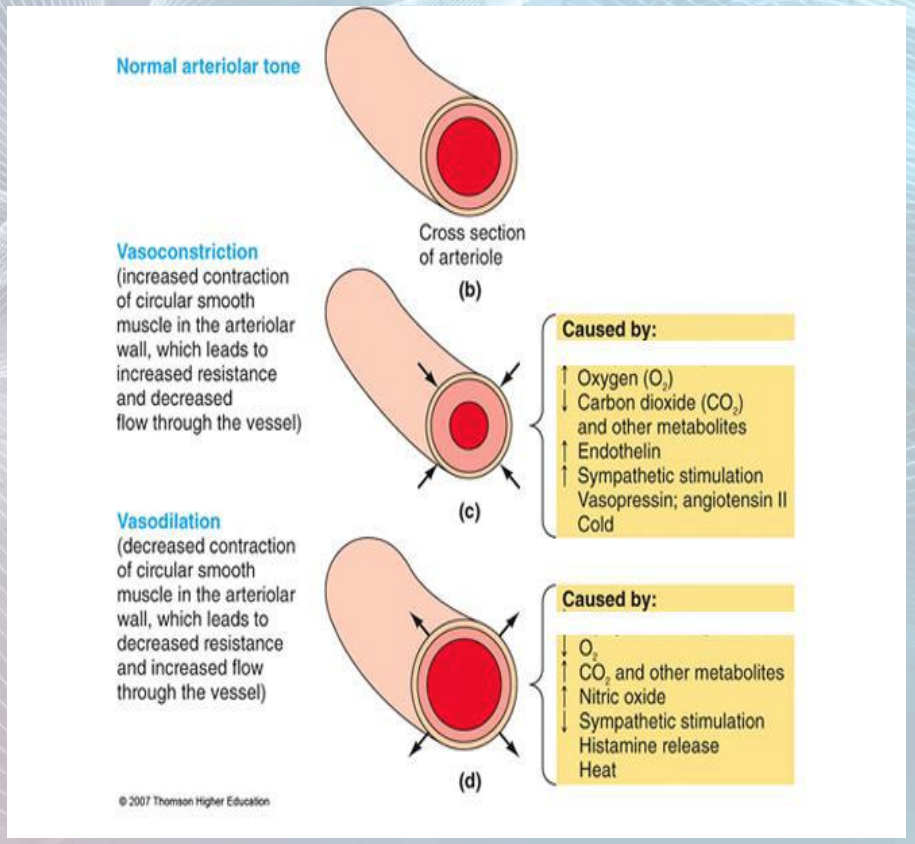
Inversely proportional to pressure.



Blood Pressure Blood Flow

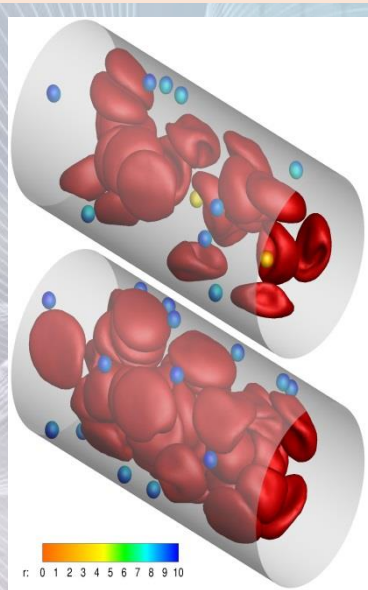
Factors Affecting Vessel Diameter: Radius (r)

- **Vasodilator agents:**
  - CO2 & other metabolites.
  - Nitric oxide.
  - Histamine.
  - Atrial natriuretic peptide (ANP).
  - Prostacyclin; PGI_2.
- **Vasoconstrictor agents:**
  - Oxygen (O2).
  - Norepinephrine.
  - Angiotensin II.
  - Vasopressin.
  - Endothelin-1.
  - Thromboxane A_2.
  - Cold.

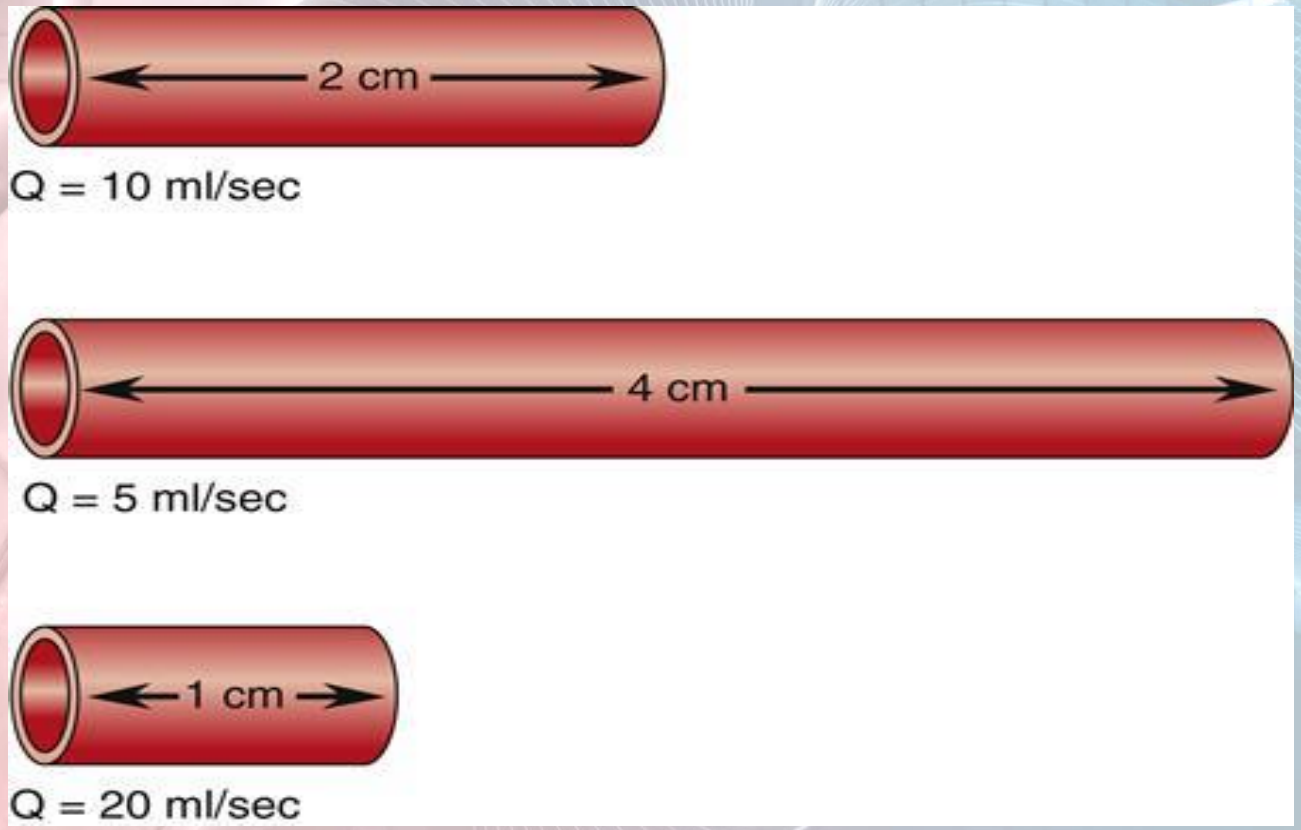


Effect of Viscosity (η) on flow

- Blood viscosity is the thickness & stickiness of the blood.
- It is an important factor that determines the resistance of blood to flow.
- Human blood is five times more viscous than distilled water.
- Viscosity of the whole blood is mainly due to cells, & that of plasma is due to plasma proteins.
- **Viscosity is inversely proportional to the flow.**



Effect of Length (L) on Flow



Length is inversely proportional to the flow.

N.B. In a normal human, length of the vascular system is fixed.

Flow and Poiseuille's Law

- Fluid Flow (Q) through Cylindrical Tubes.
- Flow decreases (↓) when resistance increases.
- Flow resistance decreases (↓) when vessel diameter increases.

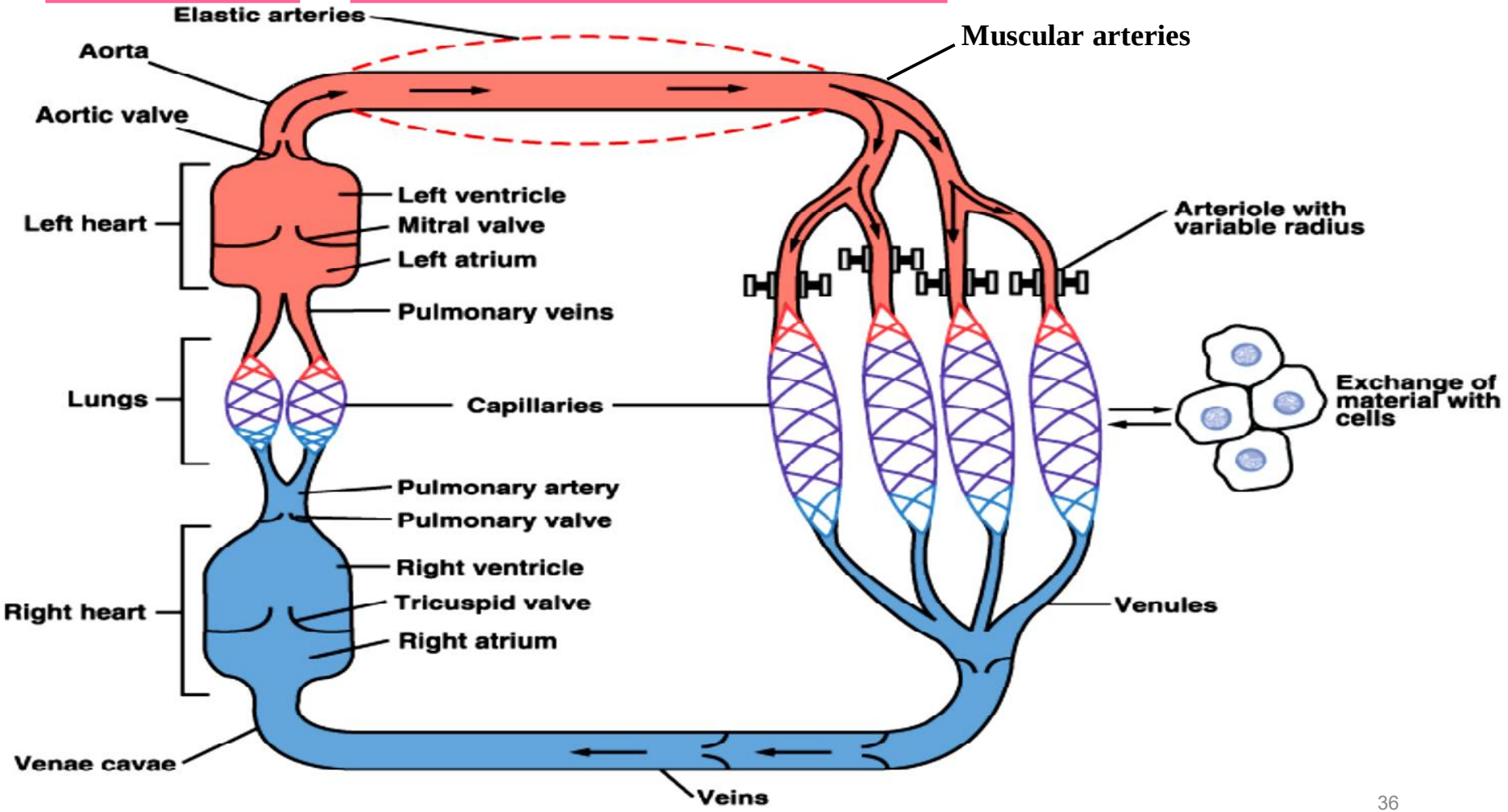
$$Q = \frac{\Delta P}{R}$$

$$Q = \frac{(Pi - Po)\,\pi\, r^4}{8\eta L}$$

- **Difference in Pressure**
- **Viscosity**
- **Length**
- **Radius**

Vascular system possesses different mechanisms for promoting continuous flow of blood to the capillaries:

Elastic recoil | Smooth m. regulation of diameter | Sphincter | Valves



Total Peripheral Resistance (TPR):

Affecting Factors

$$R = \frac{\Delta P}{Q}$$

Systemic Circulation

$$TPR = \frac{\text{Aortic Pressure - RAP}}{\text{Flow}}$$

$$TPR = \frac{120 - 2 \text{ mmHg}}{83.3 \text{ ml/sec (5 L/min)}}$$

TPR = 1.2 (PRU's)

Pulmonary Circulation

$$PulR = \frac{\text{Pulmonary Pressure - LAP}}{\text{Flow}}$$

$$PulR = \frac{15 - 3 \text{ mmHg}}{83.3 \text{ ml/sec (5 L/min)}}$$

PulR = 0.12 (PRU's)

TPR= Total Peripheral Resistance; Pul R= Pulmonary Resistance; RAP= Right Atrial Pressure; LAP= Left Atrial Pressure; PRU= Peripheral Resistance Units.

Resistance to Flow in the Cardiovascular System

Basic Concepts

Series Resistance

$R_{Total} = R1 + R2 + R3$

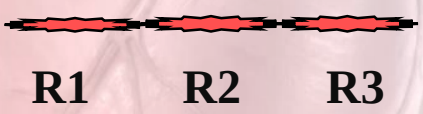
More Resistance

Parallel Resistance

$1/R_{Total} = 1/R1 + 1/R2 + 1/R3$

Less Resistance

Series



Parallel

Arterioles

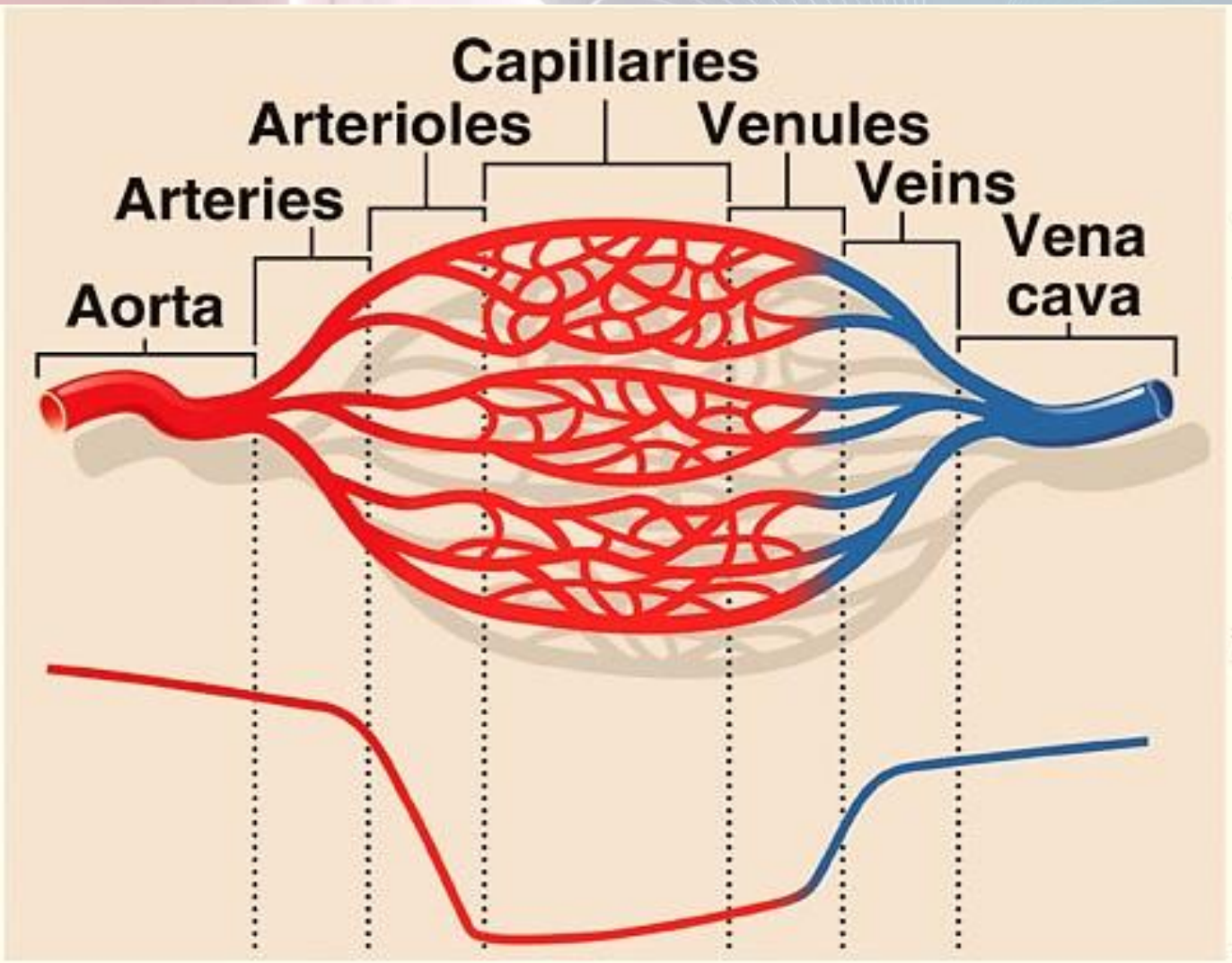
Higher R

Capillaries

Lower R

R= Resistance; R_{Total}= Total Resistance.

Cross-Sectional Area

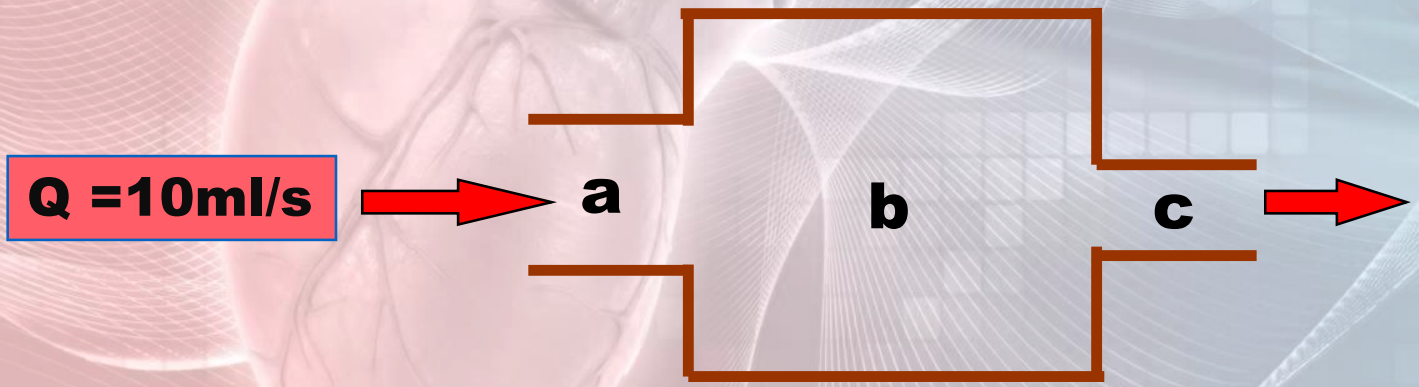


As diameter of vessels ↓, the total cross-sectional area ↑ & velocity of blood flow ↓

Velocity: Affecting Factors

$$V = Q / A$$

A = $2cm^2$	$10cm^2$	$1cm^2$



V = 5cm/s	1cm/s	10cm/s

V= Velocity; Q= Flow; A= Cross Sectional Area.

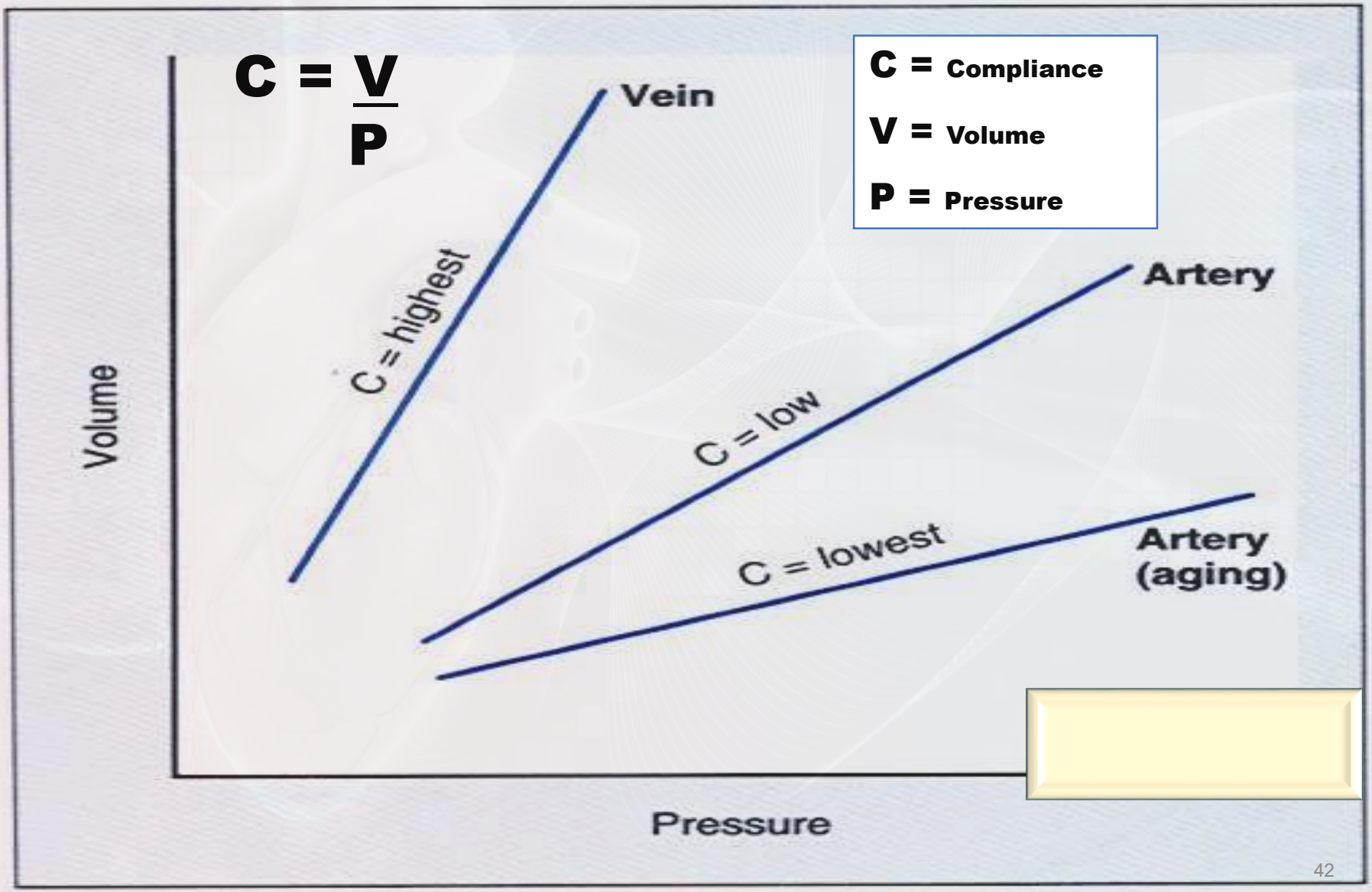
Compliance of Blood Vessels:
Affecting Factors

- **Compliance = Distensibility.**
- Compliance is the volume of blood that the vessel can hold at a given pressure.

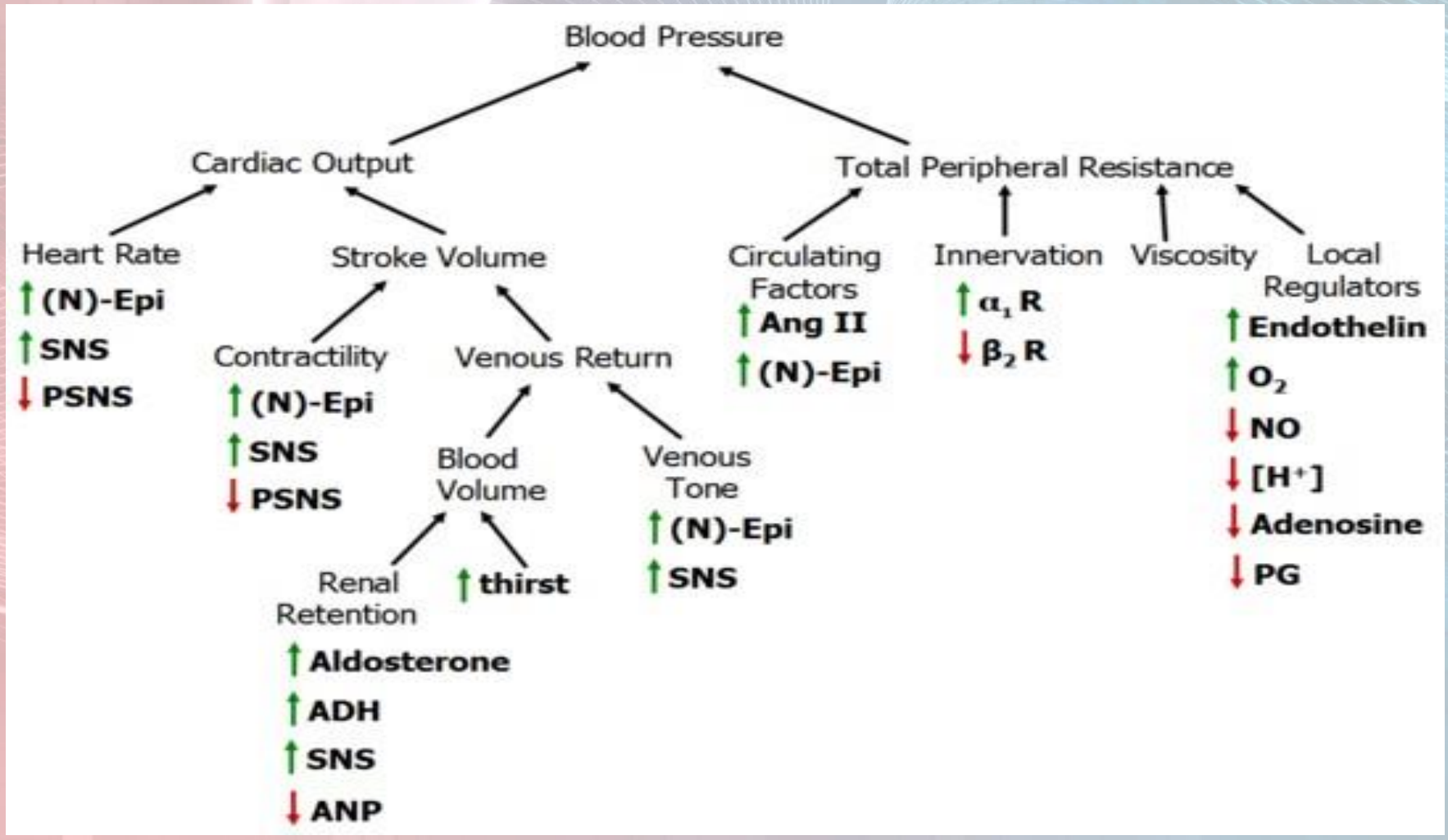
$$C = \frac{V}{P}$$

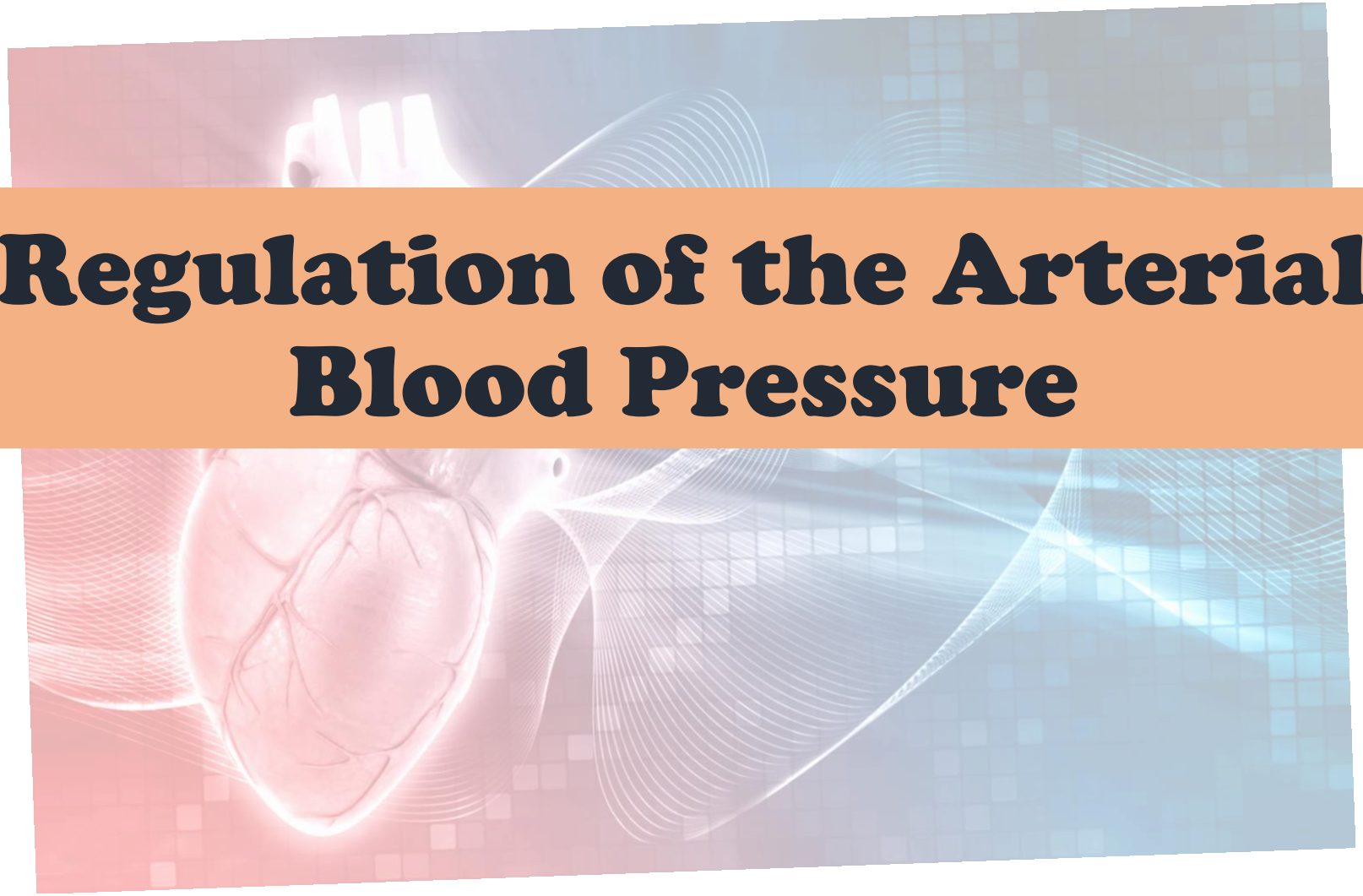
- Venous system has a large compliance & acts as a blood reservoir (high volume & low pressure).

- **Venous system has the highest compliance, while the arterial system has a low compliance.**



Summary: Physiological Factors Affecting Arterial Blood Pressure





Regulation of the Arterial Blood Pressure

جامعة الملك سعود
King Saud University

Lecture Outcomes

- Recognize short, intermediate & long- term regulatory mechanisms of ABP.
- Recognize different neural & hormonal mechanisms that regulates ABP.
- Baroreceptors regulatory mechanism of ABP.
- Chemoreceptors regulatory mechanism of ABP.
- Role of Kidney in long- term regulation of ABP.

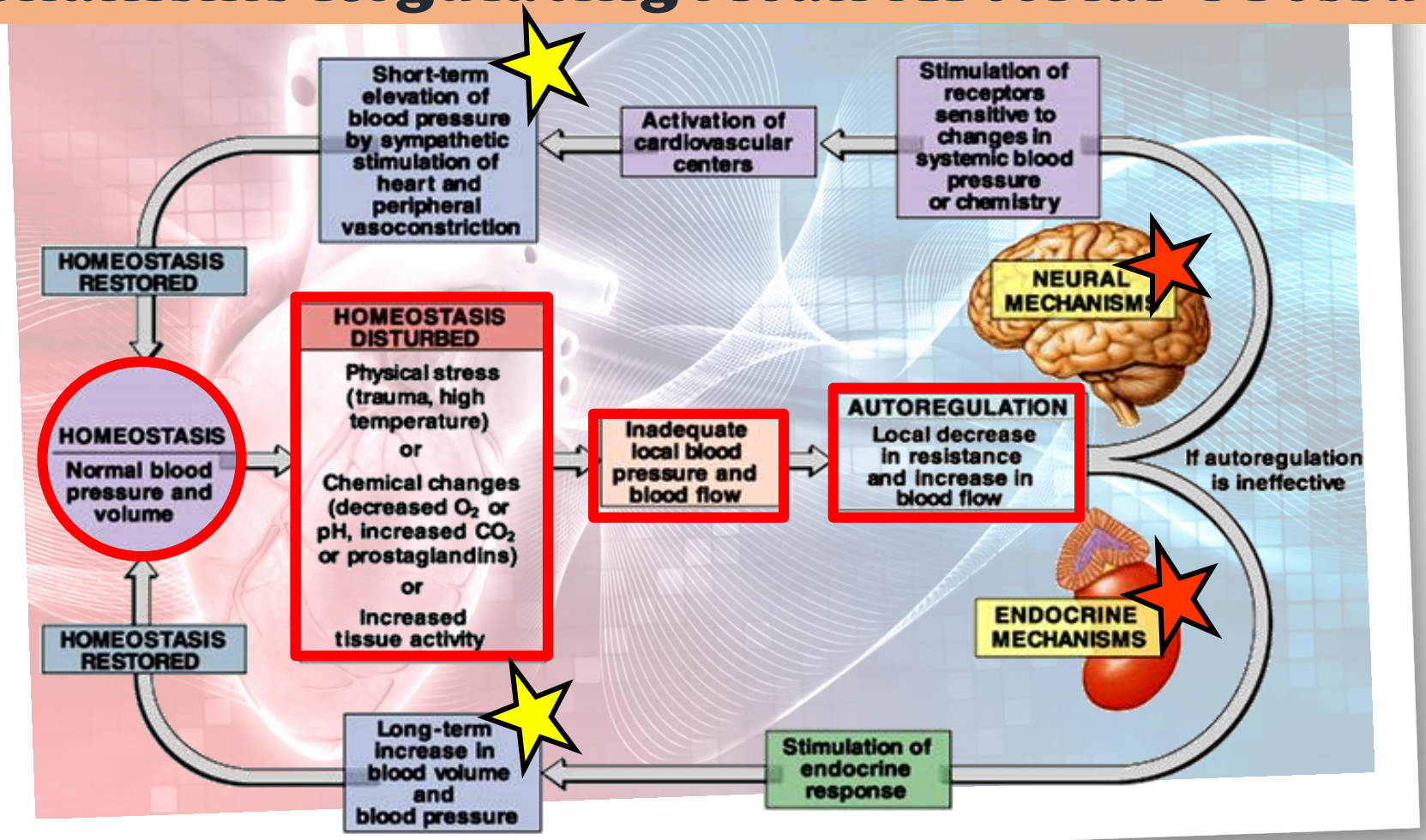
Regulation of Arterial Blood Pressure

- Maintaining BP is important to ensure a steady blood flow (perfusion) to the tissues.
- Inability to regulate blood pressure can contribute to diseases.

In order to regulate the blood pressure, determining factors should be regulated:

- Cardiac Output.
- Peripheral Resistance.
- Blood Volume.

Mechanisms Regulating Mean Arterial Pressure



Neurally- Mediated Regulation of ABP

Fast Response
(Short- Term)

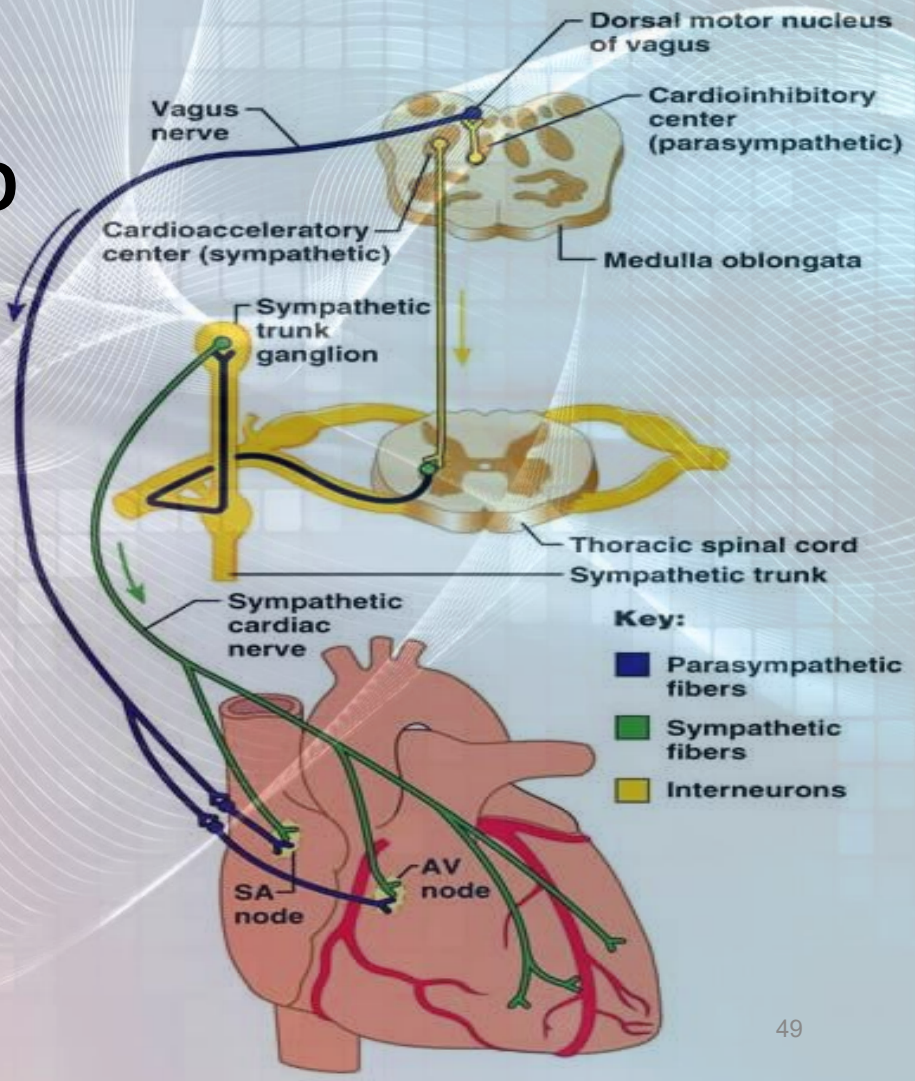
Concerned in regulating
Cardiac Output & Peripheral Resistance

Rapidly Acting Control Mechanisms

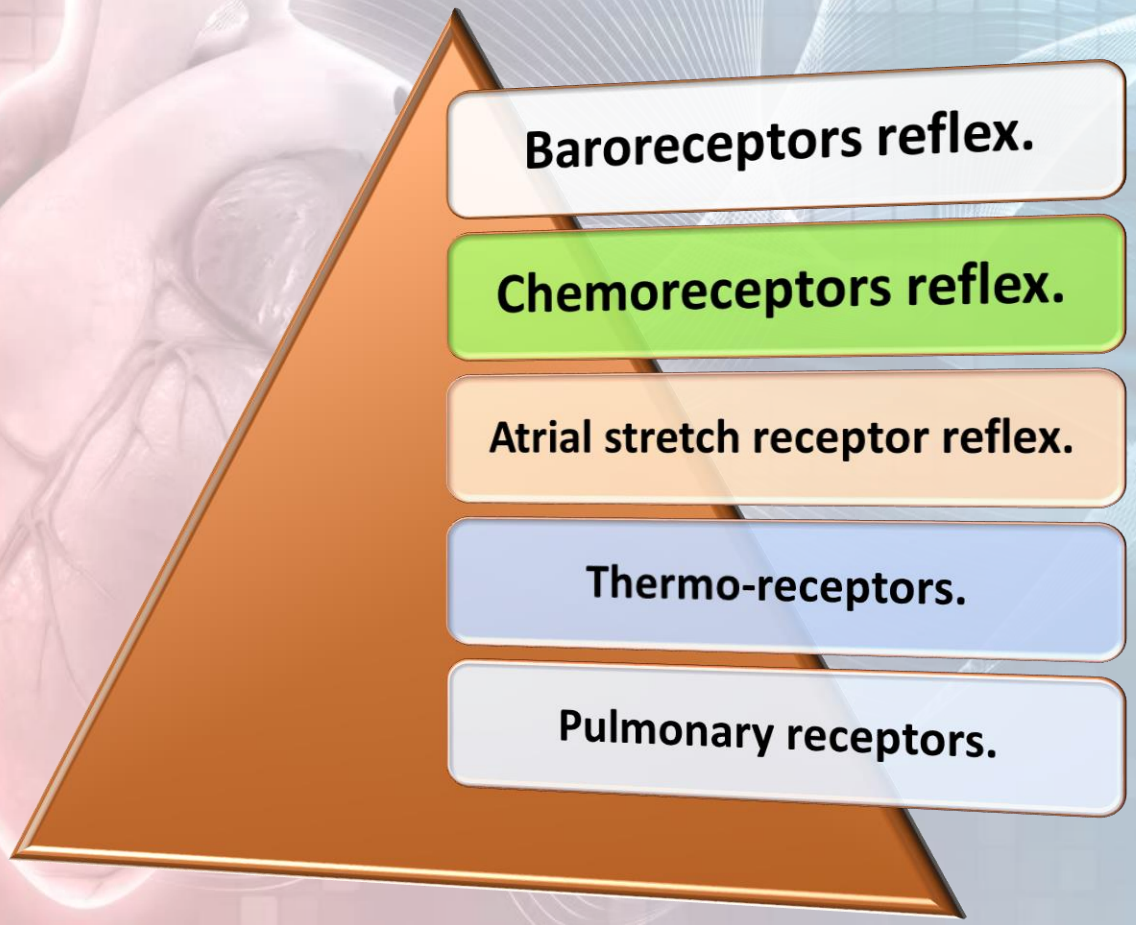
- Acts within sec/min.
- Concerned in regulating CO & PR.
- Reflex mechanisms that act through autonomic nervous system:

Centers in Medulla Oblongata:

- Vasomotor Center (VMC)
  … Sympathetic nervous system.
- Cardiac Inhibitory Center (CIC)
  … Parasympathetic nervous system.



Short Term ABP Regulatory Reflex Mechanisms



Baroreceptor Reflex

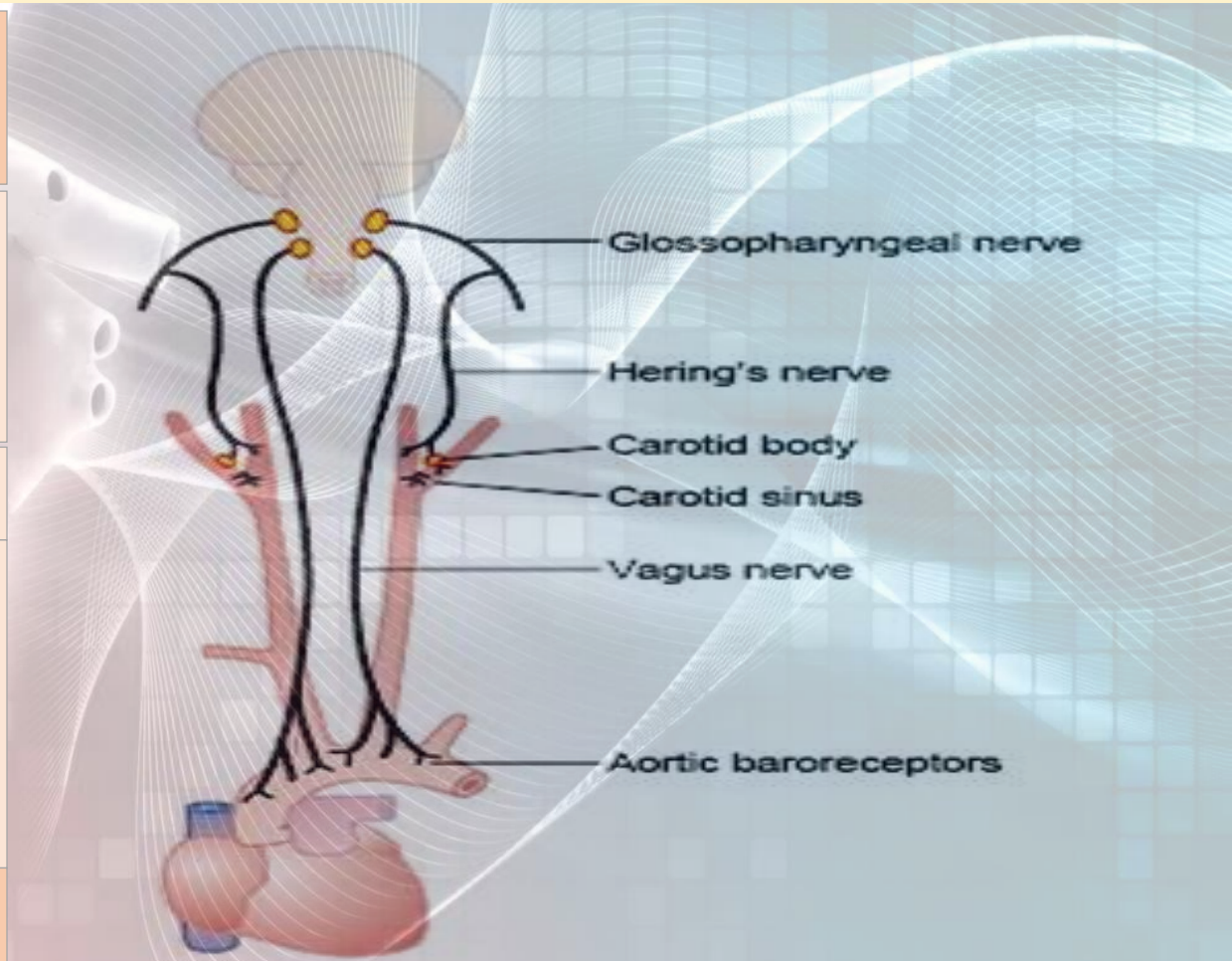
Mechano-stretch receptors.

Located in the wall of carotid sinus & aortic arch.

Fast & neurally mediated

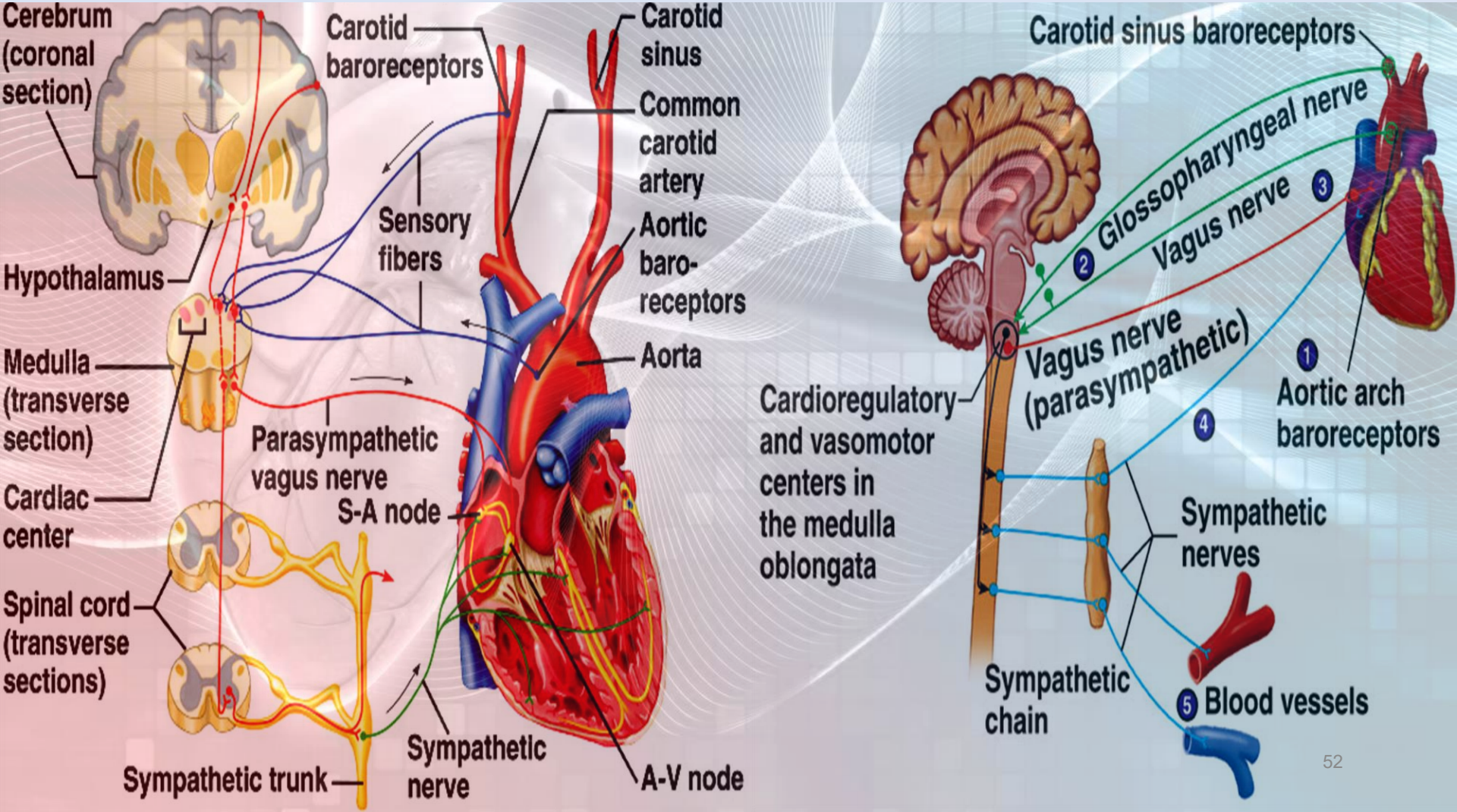
Provide powerful moment-to-moment control of arterial blood pressure

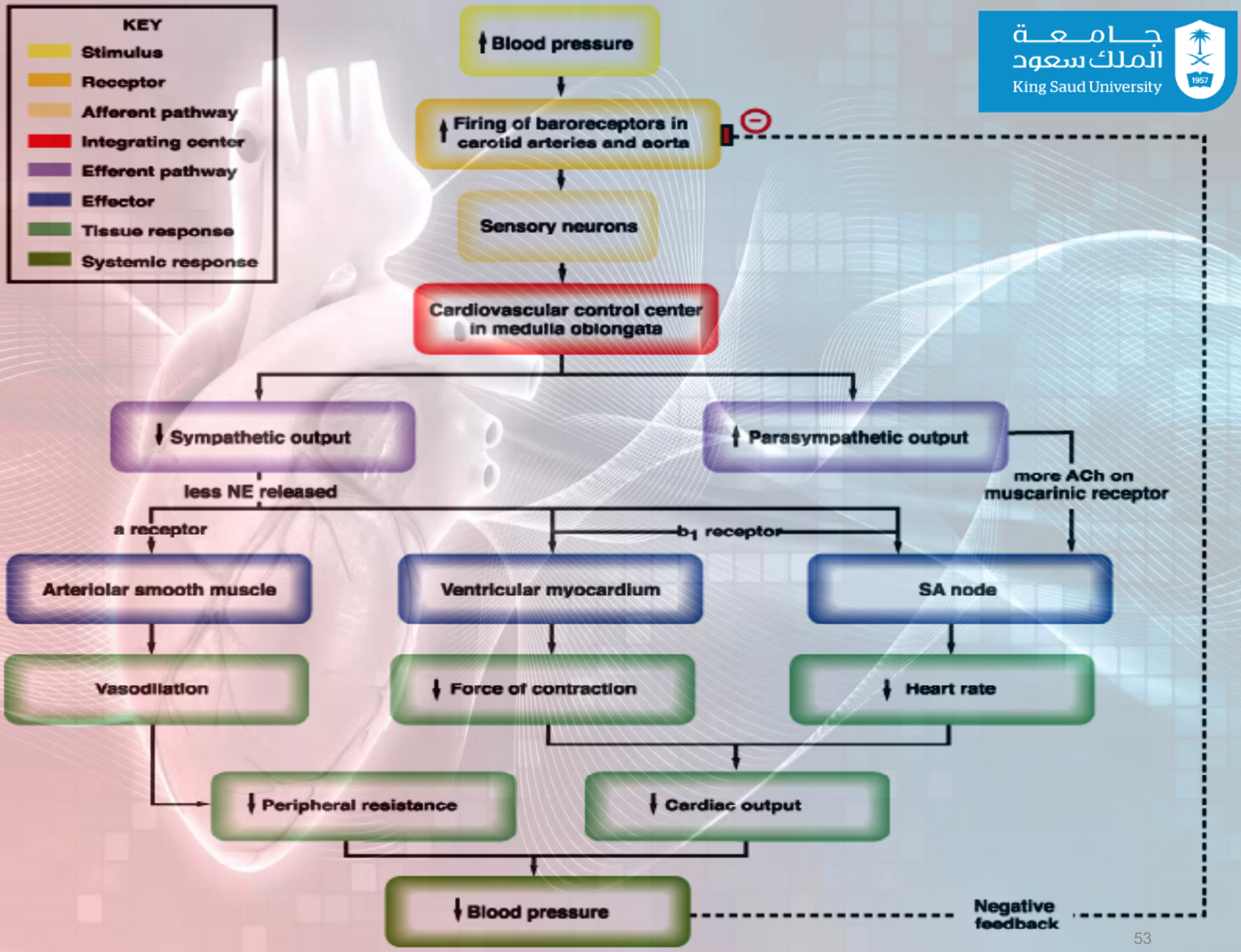
Stimulated in response to blood pressure changes

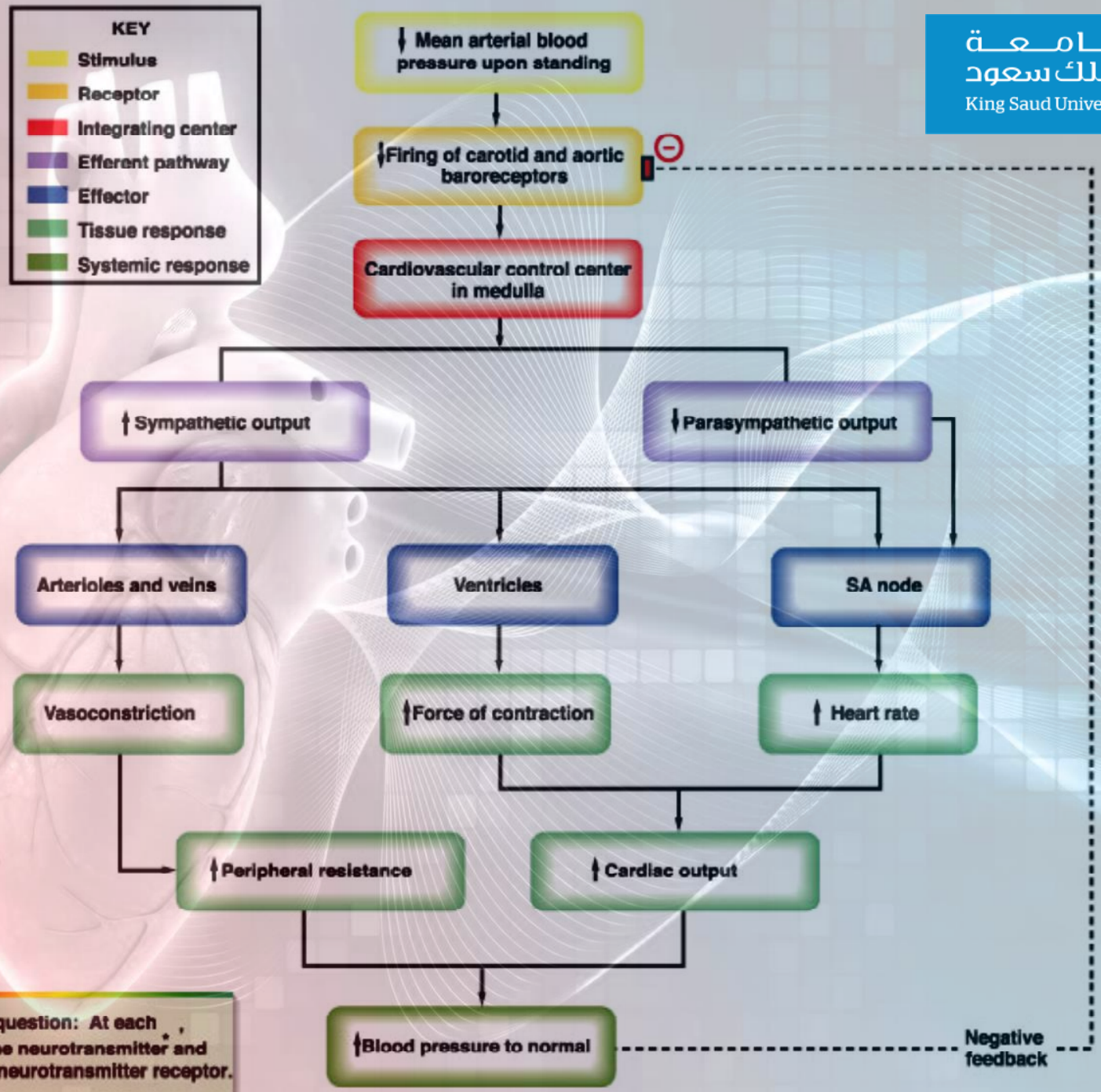


The baroreceptor system for controlling arterial pressure.

Baroreceptor Reflex




KEY
Stimulus
Receptor
Afferent pathway
Integrating center
Efferent pathway
Effector
Tissue response
Systemic response
Blood pressure
Firing of baroreceptors in carotid arteries and aorta
Sensory neurons
Cardiovascular control center in medulla oblongata
Sympathetic output
Parasympathetic output
less NE released
more ACh on muscarinic receptor
a receptor
b1 receptor
Arteriolar smooth muscle
Ventricular myocardium
SA node
Vasodilation
Force of contraction
Heart rate
Peripheral resistance
Cardiac output
Blood pressure
Negative feedback


KEY
Stimulus
Receptor
Integrating center
Efferent pathway
Effector
Tissue response
Systemic response
Mean arterial blood pressure upon standing
Firing of carotid and aortic baroreceptors
Cardiovascular control center in medulla
Sympathetic output
Parasympathetic output
Arterioles and veins
Ventricles
SA node
Vasoconstriction
Force of contraction
Heart rate
Peripheral resistance
Cardiac output
Blood pressure to normal
Negative feedback
Figure question: At each *, name the neurotransmitter and type of neurotransmitter receptor.

Baroreceptor Reflex Mechanism During Changes in Body Posture

- Immediately on standing, arterial pressure in the head & upper part of the body tends to fall … ? cause loss of consciousness.
- Falling pressure at the baroreceptors elicits an immediate reflex, resulting in **strong sympathetic discharge** throughout the body.
- This minimizes the decrease in pressure in the head & upper body.

Chemoreceptor Reflex

- Closely associated with the baroreceptor pressure control system.
- **Chemoreceptor reflex** operates in much same way as the baroreceptor reflex, EXCEPT that chemoreceptors are *chemo-sensitive cells* instead of stretch receptors.

Chemoreceptor Reflex

- Chemoreceptors have high blood flow (1200 ml/min/g tissue), which make it easy for these cells to **detect changes in O_2, CO_2, & H^+**.
- Reduced blood flow (due to reduced MAP) stimulates the **chemoreceptor**s through oxygen lack, increased hydrogen ions or carbon dioxide.
- Chemoreceptors are stimulated when the MAP is lower than 60 mmHg.
- Their response is **excitatory**, NOT inhibitory; mainly through activation of sympathetic nervous system.

Chemoreceptor Reflexes:
Two Types

Peripheral chemoreceptors:

Periphearl

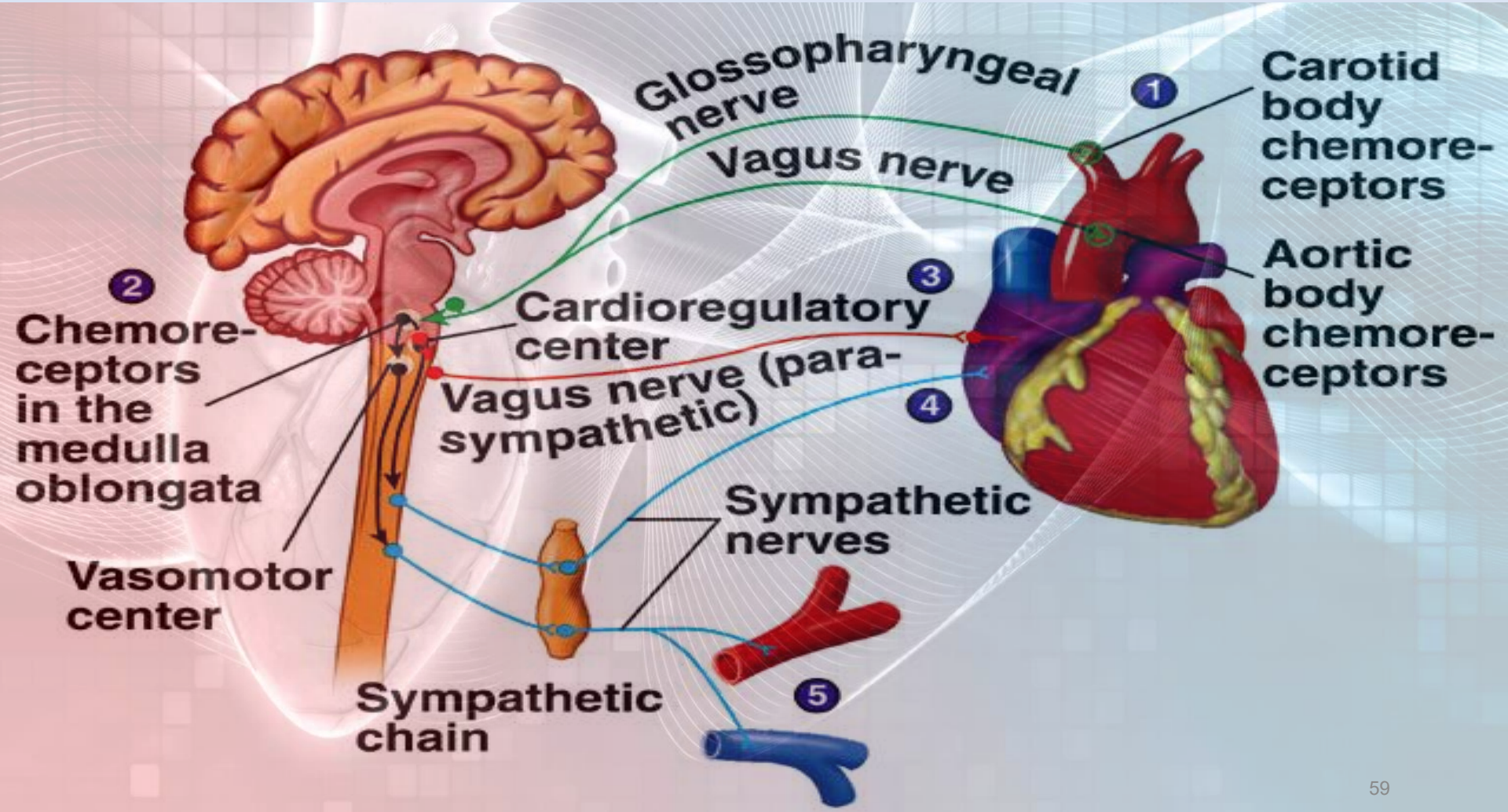
- Sensory receptors located in carotid & aortic bodies.
- Sensitive to O_2 lack (↓), CO_2 (↑ or ↓), & pH (↓ or ↑.)
- Chemoreceptors' stimulation excite nerve fibers, along with baroreceptor fibers.

Central Chemoreceptors:

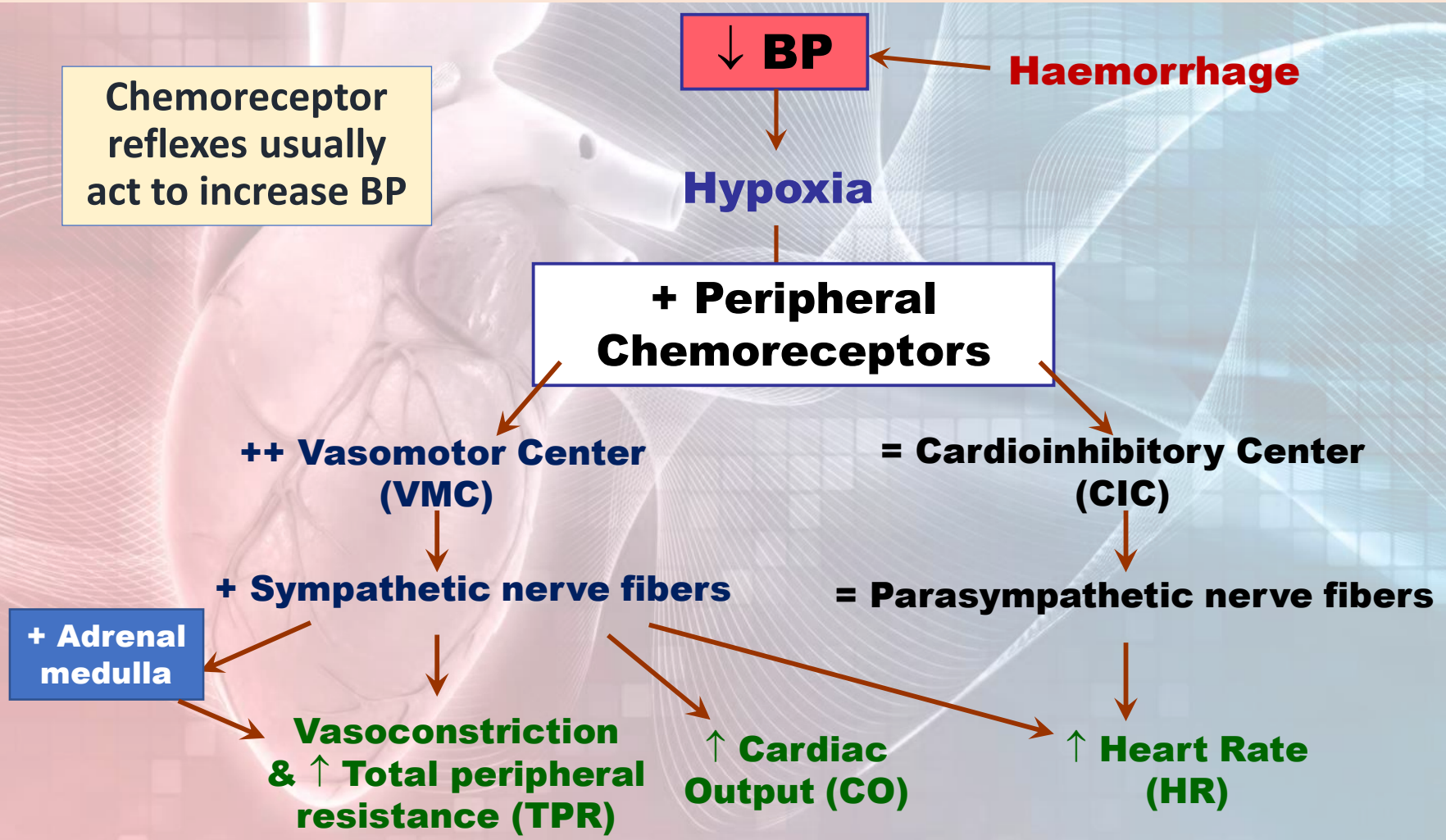
Central

- Sensory receptors located in the medulla itself.
- Very sensitive to CO_2 excess (↑) & (↓) pH in medulla.

Peripheral Chemoreceptor Reflex



Peripheral Chemoreceptor Reflexes



CNS Ischemic Response:

"Last ditch stand" pressure control mechanism

- It is not one of the normal regulatory mechanisms of ABP. It operates principally as an **emergency pressure control** system to prevent further decrease in arterial pressure
- It's one of the most powerful activators of the sympathetic vasomotor (vasoconstrictor system) nervous control areas in medulla oblongata.
- It acts rapidly and very powerfully.
- It acts whenever blood flow to the brain ↓ dangerously close to the lethal level (MAP < 20mmHg with high accumulation of local CO_2 & lactic acid), in order to prevent further decrease in arterial pressure (MAP).

Other Vasomotor Reflexes

1. Atrial stretch receptor reflex:

- Receptors in large veins close to heart, walls of the atria (response of blood volume).

↑ Venous Return (increase blood volume) ⇒ ++ stretch atria & activate atrial stretch receptors ⇒ sensory afferent nerves to medulla ⇒ inhibiting the cardiovascular center ⇒ reflex decrease in blood volume & ↓ ABP through:

(a) **↓ sympathetic drive to kidney:**

- → dilate afferent arterioles → ↑ glomerular capillary hydrostatic pressure →↑ GFR → ↓ blood volume (towards normal).
- ↓ renin secretion (Renin is an enzyme which activates angiotensinogen in blood). Inhibition of renin secretion → inhibit RAAS → inhibit aldosterone production → ↓ Blood volume (towards normal)

(b) **↓ ADH secretion** → ↓ blood volume (towards normal).

(c) **↑ Atrial Natriuretic Peptide (ANP)** causes loss of blood volume.

Other Vasomotor Reflexes

2. **Thermo-receptors:** (in skin / hypothalamus)
   - ❑ Exposure to heat ⇒ vasodilatation.
   - ❑ Exposure to cold ⇒ vasoconstriction.

3. **Pulmonary receptors:**

   Lung inflation ⇒ vasoconstriction.

Hormonally- Mediated Regulation of ABP

Slow Response
(Long- Term)

Concerned in regulating blood volume

Long- Term Regulation of ABP

- Hormonally mediated.
- Takes few hours to begin showing significant response.
- **Mainly renal:** Acts if BP is too low
  1. Renin-Angiotensin-Aldosterone System.
  2. Vasopressin [Anti-diuretic hormone (ADH)] Mechanism.
- **Others:**
  3. Atrial Natriuretic Peptide Mechanism (Low-pressure volume receptors.)
  4. Erythropoietin (EPO).

1. Renin – Angiotensin Aldosterone System

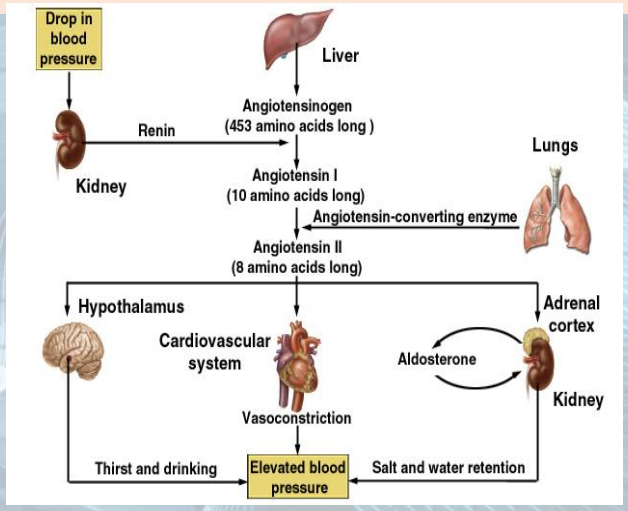
↓ renal blood flow &/or ↓ Na^+

↓

++ Juxtaglomerular apparatus of kidneys
(considered volume receptors)

↓

Renin



Angiotensinogen
(Plasma protein)

→ **Angiotensin I**

(Lungs) Angiotensin converting enzymes (ACEs)

↓

Angiotensin II
(powerful vasoconstrictor + Thirst stimulation)

→ **Angiotensin III**
(powerful vasoconstrictor)

↓ Adrenal cortex

Corticosterone

→ **Aldosterone**

→ **(Na^+ & Water retention)**
At kidney tubules

2. Anti-diuretic hormone (ADH), or vasopressin:

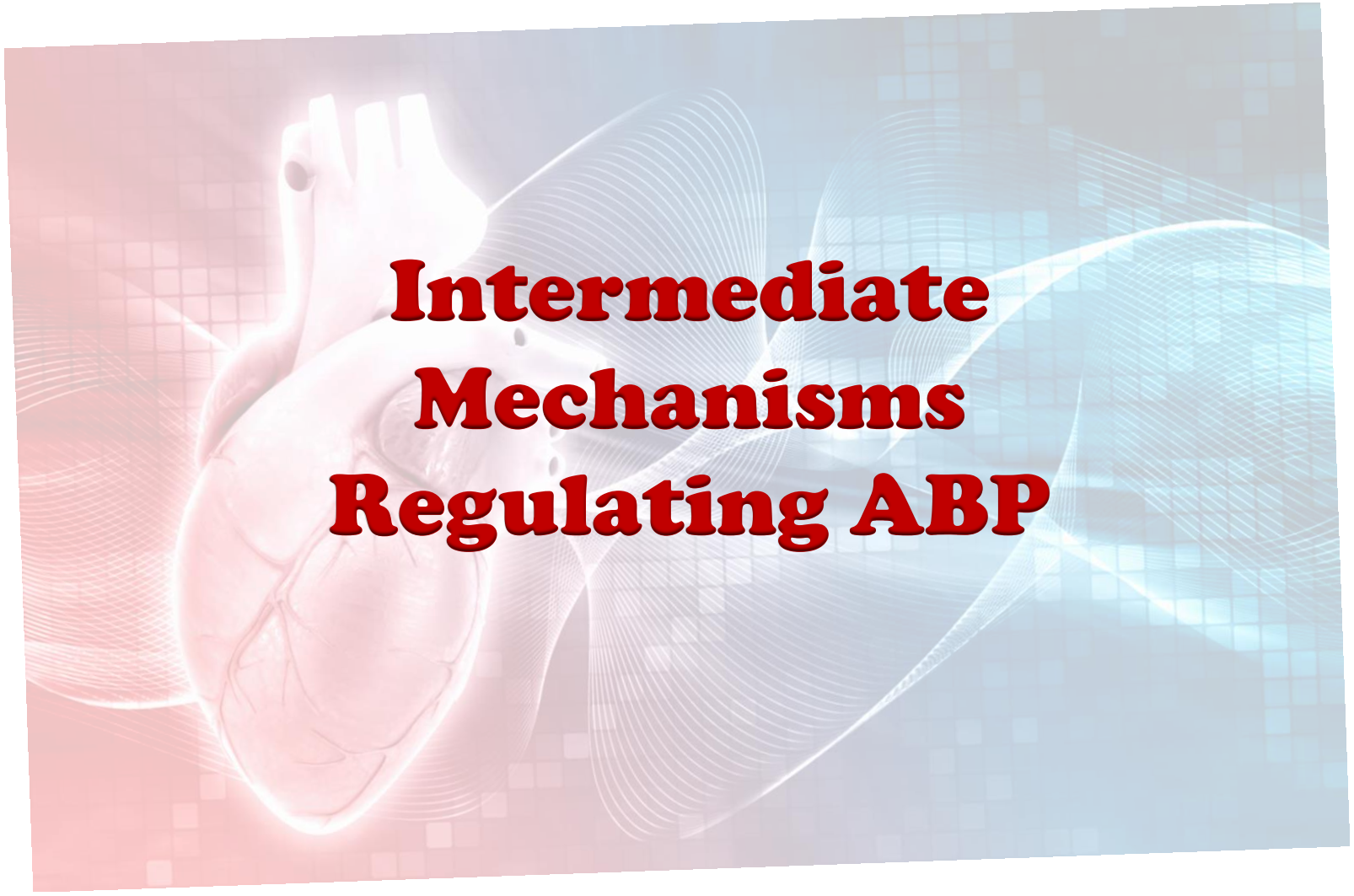
- Hypovolemia & dehydration stimulates Hypothalamic Osmoreceptors.
- ADH will be released from posterior pituitary gland:
  - Promotes **water reabsorption** at kidney tubules …↑ blood volume.
  - Causes **vasoconstriction**, in order to ↑ ABP.
- Thirst stimulation.
- Usually, when secreted aldosterone is secreted.

3. Low-pressure volume receptors:

- **Atrial Natriuretic Peptide (ANP) hormone:**
  - Hormone released from cardiac muscle cells (wall of right atrium) as a response to an increase in ABP in order to decrease the blood volume.
  - Simulates an ↑ in urinary production, causing a ↓ in blood volume & blood pressure.

4. Erythropoietin (EPO)

- Secreted by the kidneys when blood volume is too low.
- Leads to RBCs formation → ↑ blood volume.



Intermediate Mechanisms Regulating ABP

Intermediate Mechanisms:

Activated within 30 min to several hrs.

1. Renin-angiotensin vasoconstriction mechanism.
2. ADH vasoconstriction mechanism.
3. Fluid-Shift mechanism.
4. Stress-relaxation of the vasculature.

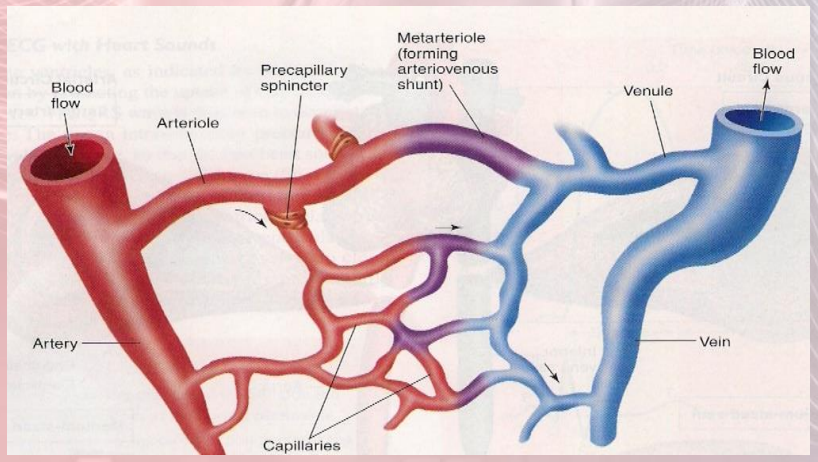
- **During this time, the nervous mechanisms usually become less & less effective.**

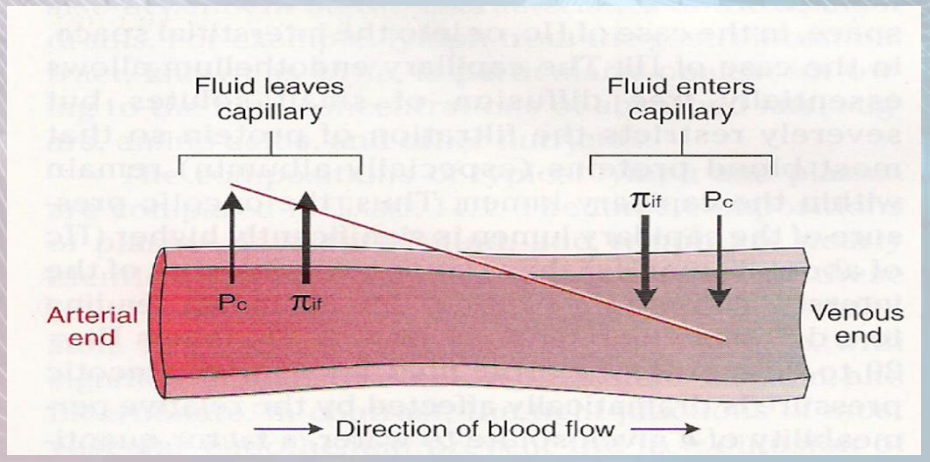
1. Angiotensin Vasoconstriction System

2. ADH Vasoconstriction System

3. Fluid Shift Mechanism

- Movement of fluid from interstitial spaces into **capillaries** in response to ↓ **BP** to maintain blood volume.
- Conversely, when **capillary pressure ↑ too high**, fluid is lost out of circulation into the tissues, reducing blood volume as well as all pressures throughout circulation.

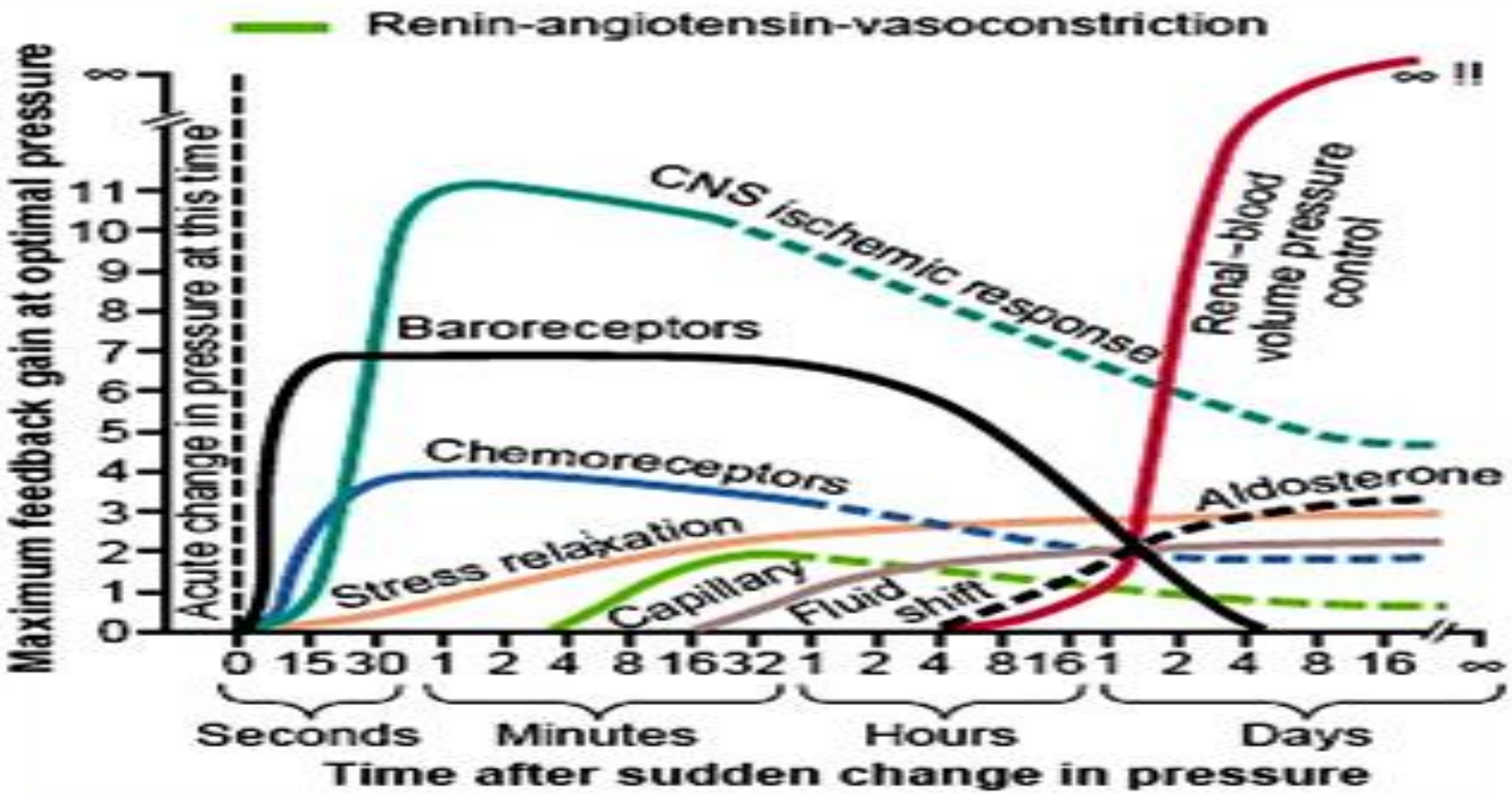




4. Stress-Relaxation Mechanism

- Adjustment of blood vessel smooth muscle to respond to changes in blood volume.
- When pressure in blood vessels becomes **too high**, they become stretched & keep on stretching more & more for minutes or hours; resulting in fall of pressure in the vessels toward normal.
- This continuing stretch of the vessels can serve as an intermediate-term pressure “buffer.”

control mechanisms at different time intervals after onset of a disturbance to the arterial pressure.



Thank You