



لُجَانُ الْكُتُبُ

PHYSIOLOGY

MORPHINE ACADEMY

MORPHINE
ACADEMY



PHYSIOLOGY

FACULTY OF PHARMACEUTICAL SCIENCES

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LECTURE 9-PARTS (1) & (2) : STRUCTURE AND FUNCTION OF BLOOD VESSELS AS WELL AS
FACTORS AFFECTING BLOOD FLOW AND BLOOD PRESSURE

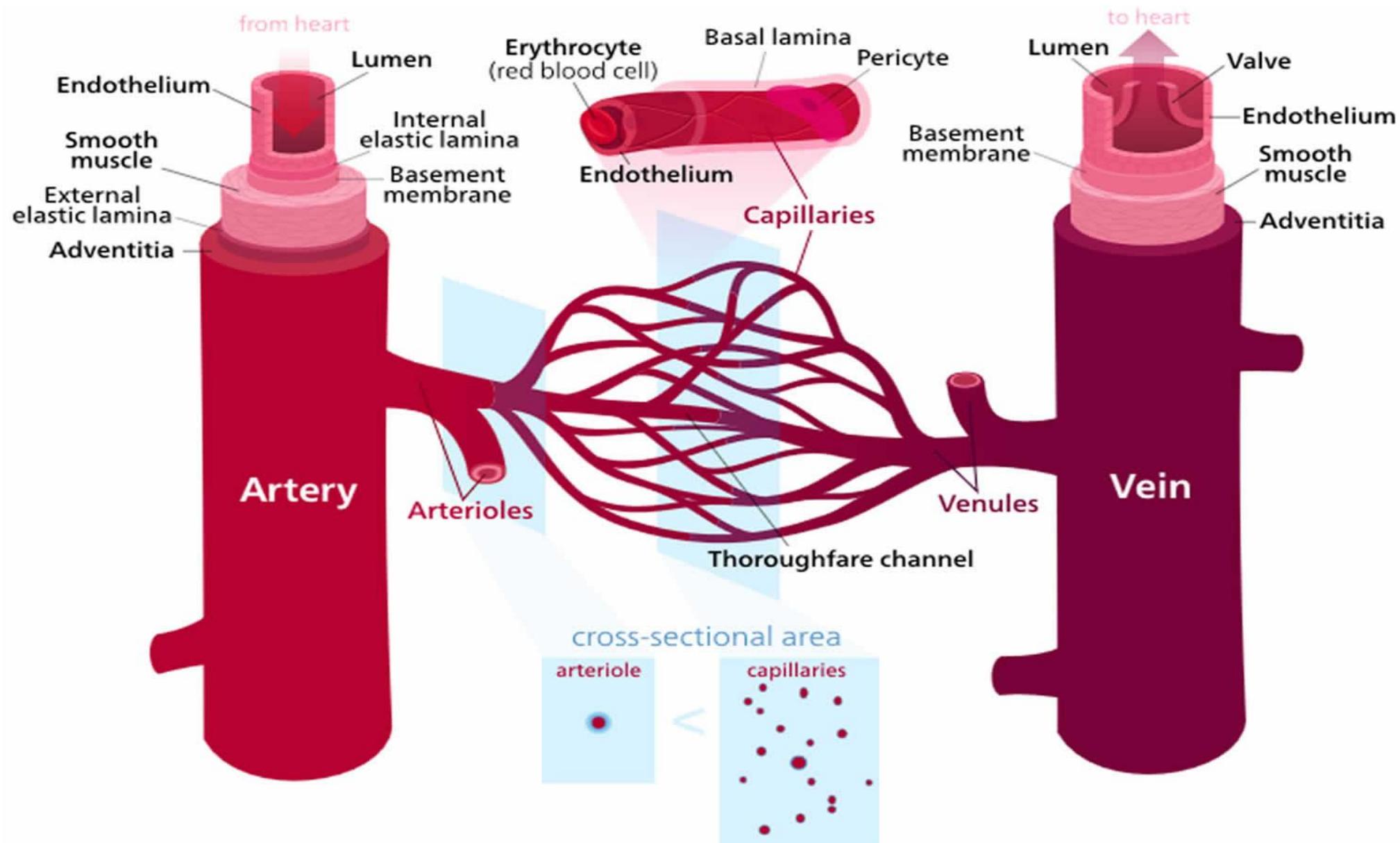
Objectives

1. Discuss **structure** and **function** **of blood vessels.**
2. Describe **capillary exchange.**
3. Explore **hemodynamics:** **factors** **affecting blood flow.**

(Pages 730- 743 of the reference)

Objectives

4. Discuss **control of blood pressure and blood flow.**
5. Describe **checking circulation.**
6. Explore **shock and homeostasis.**
(Pages 744- 753 of the reference)



STRUCTURE AND FUNCTION OF BLOOD VESSELS

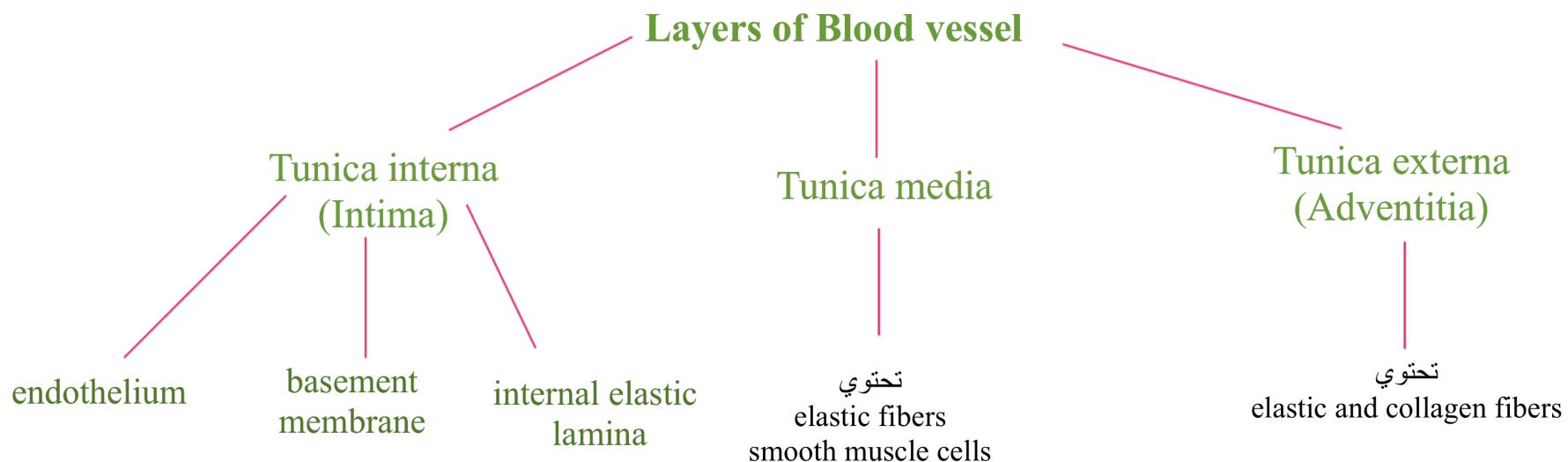
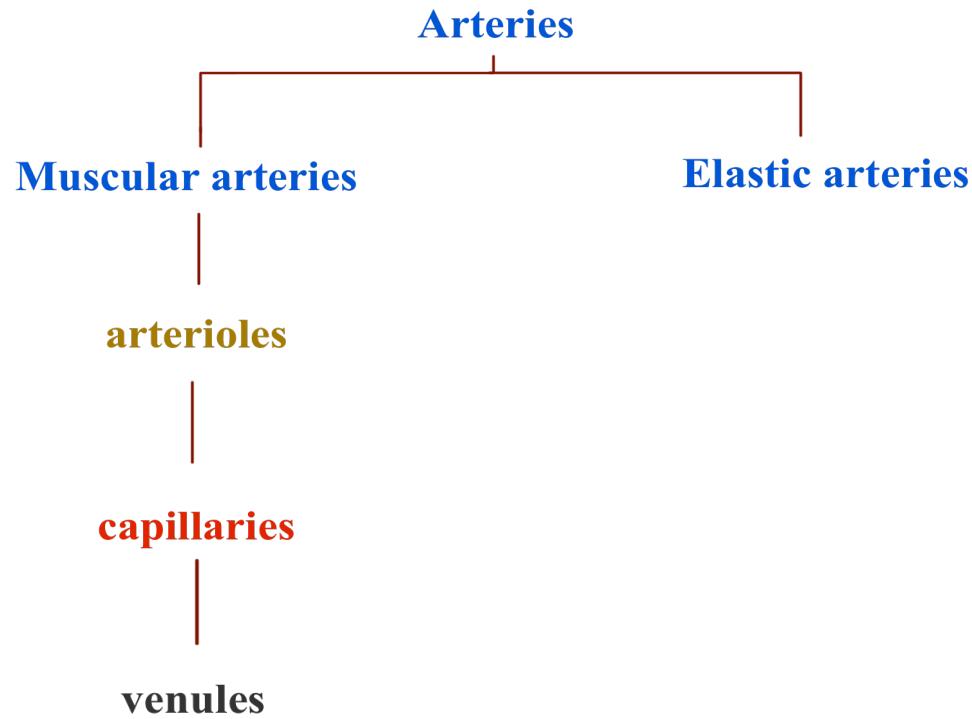
- The five main types of blood vessels are **arteries, arterioles, capillaries, venules, and veins.**

الشريان الذي طالع من القلب
- **Arteries** carry blood away from the heart to other organs. Large, elastic arteries leave the heart and divide into medium-sized, muscular arteries that branch out into the various regions of the body. Medium-sized arteries then divide into small arteries, which in turn divide into still smaller arteries called **arterioles.** ←

هؤول الذي رح يوصلوا الغذاء والاكسجين الى الخلايا
- As the **arterioles enter a tissue**, they branch into numerous tiny vessels called **capillaries.** The thin walls of capillaries allow the **exchange** of substances between the blood and body tissues. **Groups of capillaries** within a tissue reunite to form small veins called **venules.** These in turn merge to form progressively larger blood vessels called **veins.** Veins are the blood vessels that convey blood from the tissues back to the heart.

BASIC STRUCTURE OF A BLOOD VESSEL

The three structural layers of a generalized blood vessel from innermost to outermost are the tunica interna (intima), tunica media, and tunica externa (adventitia).



TUNICA INTERNA (INTIMA)

- ❖ The tunica interna (intima) forms the inner lining of a blood vessel and is in direct contact with the blood as it flows through the lumen, or interior opening, of the vessel. Although this layer has multiple parts, these tissue components contribute minimally to the thickness of the vessel wall.
- ❖ Its innermost layer is called endothelium, is a thin layer of flattened cells that lines the inner surface of the entire cardiovascular system (heart and blood vessels). The endothelial cells are active participants in a variety of vessel-related activities, including physical influences on blood flow, secretion of locally acting chemical mediators that influence the contractile state of the vessel's overlying smooth muscle, and assistance with capillary permeability. In addition, their smooth luminal surface facilitates efficient blood flow by reducing surface friction. تساعد في النفاذية

وظائف طبقة endothelium



(1) تعمل على Smooth blood flow و تقلل من الاحتكاك friction

(2) تحافظ على اشي اسمه Vascular tone فهي التي تحافظ على autoregulation أي تنظيم تدفق الدم بشكل ذاتي حسب حاجة العضو و توازن و افراز Vasodilation و Vasoconstriction و وهي عبارة عن معبر في بين Exocytosis و Endocytosis

(3) تقلل من حدوث الالتهاب Inflammation عن طريق انها بتعمل توازن بين المواد المحفزة لحدوث Inflammation التي تسمى Pro-inflammatory mediator مع المواد التي تمنع حدوث Inflammation التي تسمى Anti-inflammatory mediator

(4) تقلل من حدوث التخثر Coagulation و كمان بتعمل توازن بين العوامل التي تساعد على Coagulation التي تسمى Pro-coagulatory factor مع العوامل التي تمنع على Coagulation التي تسمى Anti-coagulatory factor

TUNICA INTERNA (INTIMA)

- ❖ The **second component** of the tunica interna is a **basement membrane** ^{الداعم} deep to the endothelium. It provides a **physical support** base for the epithelial layer. It appears to play an important role in **guiding cell movements during tissue repair of blood vessel walls.**
توجيه حركات الخلايا أثناء إصلاح أنسجة جدران الأوعية الدموية
- ❖ The **outermost part of the tunica interna**, which forms the boundary between the tunica interna and tunica media, is the **internal elastic lamina**, is a **thin sheet of elastic fibers** with a variable number of windowlike openings that facilitate **diffusion** ^{تسهيل الانتشار} of materials through the tunica interna to the thicker tunica media.

TUNICA MEDIA

الطبقة التي تظهر أكبر اختلاف بين أنواع الأوعية الدموية المختلفة.

يعني إذا قارنت الشريان مع الأوردة مثلاً مع الشعيرات الدموية، هذه الطبقة تختلف كثير من نوع لآخر.

- ✓ Is the tissue layer that displays the **greatest variation among the different vessel types**. In most vessels, it is a relatively thick layer comprising mainly **smooth muscle cells** and **substantial amounts of elastic fibers**.
التحكم في قطر الوعاء الدموي
- ✓ An **increase in sympathetic stimulation** typically stimulates the **smooth muscle to contract**, squeezing the vessel wall and narrowing the lumen. Such a **decrease in the diameter of the lumen of a blood vessel** is called **vasoconstriction**.
- ✓ In contrast, when **sympathetic stimulation decreases**, **smooth muscle fibers relax**. The resulting **increase in lumen diameter** is called **vasodilation**.

TUNICA EXTERNA

The outer covering of a blood vessel, the tunica externa, consists of elastic and collagen fibers.

In addition to the important role of supplying the vessel wall with **nerves** and **self-vessels**, the tunica externa **helps anchor** the vessels to surrounding tissues.

ARTERIES

Elastic arteries

Muscular arteries

تمدد جدرانها بسهولة أو تمدد دون أن تتمزق استجابةً لزيادة طفيفة في الضغط (بسبب أليافها المرنة الوفيرة).

Their walls stretch easily or expand without tearing in response to a small increase in pressure (due to their plentiful elastic fibers).

The wall of an artery has the three layers of a typical blood vessel.

Tunica
interna

Tunica
media

Tunica
externa

ELASTIC ARTERIES

- The largest arteries in the body.
- **TUNICA INTERNA:** Well-defined internal elastic lamina.
- **TUNICA MEDIA:** Thick and dominated by elastic fibers; well-defined external elastic lamina.
- **TUNICA EXTERNA:** Thinner than tunica media.
- Function: **Conduct blood from heart to muscular arteries.**

توصيل الدم من القلب إلى.

MUSCULAR ARTERIES

- **The Medium-sized arteries.**
- **TUNICA INTERNA:** Well-defined internal elastic lamina.
- **TUNICA MEDIA:** Thick and dominated by smooth muscle; thin external elastic lamina.
- **TUNICA EXTERNA:** Thicker than tunica media.
- **Function:** **Distribute blood to arterioles.** توزيع الدم إلى 

ARTERIOLES

- **Microscopic (15–300 micrometer in diameter).**
- **TUNICA INTERNA:** Thin with a fenestrated internal elastic lamina that disappears distally.
الاتجاه الدائري
- **TUNICA MEDIA:** One or two layers of circularly oriented smooth muscle; distalmost smooth muscle cell forms a precapillary sphincter.
- **TUNICA EXTERNA:** Loose collagenous connective tissue and sympathetic nerves.
تنظيم
- **Function:** Deliver blood to capillaries and help regulate blood flow from arteries to capillaries.

CAPILLARIES

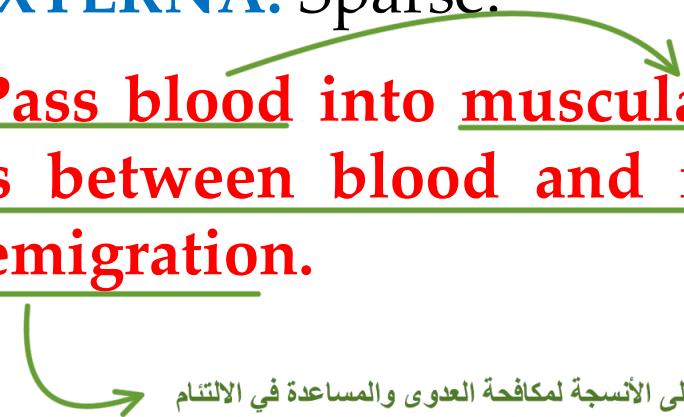
- **Microscopic; smallest blood vessels (5–10 micrometer in diameter).**
- **TUNICA INTERNA:** Endothelium and basement membrane.
- **TUNICA MEDIA:** None.
- **TUNICA EXTERNA:** None.
- **Function:** Permit exchange of nutrients and wastes between blood and interstitial fluid; distribute blood to postcapillary venules.

السماح بتبادل العناصر الغذائية والنفايات بين الدم و *interstitial fluid*

توزيع الدم إلى

POSTCAPILLARY VENULES

- **Microscopic (10–50 micrometer in diameter).**
- **TUNICA INTERNA:** Endothelium and basement membrane.
- **TUNICA MEDIA:** None.
- **TUNICA EXTERNA:** Sparse.
- **Function:** Pass blood into muscular venules; permit exchange of nutrients and wastes between blood and interstitial fluid and function in white blood cell emigration.



خروج خلايا الدم البيضاء من الأوعية إلى الأنسجة لمكافحة العدو و المساعدة في الالتام

MUSCULAR VENULES

- **Microscopic (50–200 micrometer in diameter).**
- **TUNICA INTERNA:** Endothelium and basement membrane.
- **TUNICA MEDIA:** One or two layers of circularly oriented smooth muscle.
- **TUNICA EXTERNA:** Sparse.
- **Function:** Pass blood into  **vein**; act as reservoirs for accumulating large volumes of blood (along with postcapillary venules).

والعمل كخزانات لتخزين كميات كبيرة من الدم

VEINS

- **Range from 0.5 mm to 3 cm in diameter.**
- **TUNICA INTERNA:** Endothelium and basement membrane; no internal elastic lamina; contain valves; lumen much larger than in accompanying artery.
- **TUNICA MEDIA:** Much thinner than in arteries; no external elastic lamina.
- **TUNICA EXTERNA:** Thickest of the three layers.
- **Function:** **Return blood to heart**, facilitated by valves in limb veins.

CAPILLARY EXCHANGE

التبادل

- Is the movement of substances between blood and interstitial fluid.

تدخل المواد وتنزح من capillaries من خلال ثلاثة آليات أساسية:

- Substances enter and leave capillaries by three basic mechanisms: diffusion, transcytosis, and bulk flow.

↓
Endocytosis + Exocytosis

DIFFUSION

- The most important method of capillary exchange is simple diffusion.
- Because O₂ and nutrients normally are present in higher concentrations in blood, they diffuse down their concentration gradients into interstitial fluid and then into body cells. CO₂ and other wastes released by body cells are present in higher concentrations in interstitial fluid, so they diffuse into blood.

TRANSCYTOSIS

- A small quantity of material crosses capillary walls by transcytosis.
- In this process, substances in blood plasma become enclosed within tiny pinocytic vesicles that first enter endothelial cells by endocytosis, then move across the cell and exit on the other side by exocytosis.

BULK FLOW: FILTRATION AND REABSORPTION

- Bulk flow is a passive process in which large numbers of ions, molecules, or particles in a fluid move together in the same direction.
- Bulk flow occurs from an area of higher pressure to an area of lower pressure, and it continues as long as a pressure difference exists.
- Diffusion is more important for solute exchange between blood and interstitial fluid, but bulk flow is more important for regulation of the relative volumes of blood and interstitial fluid.
- Pressure-driven movement of fluid and solutes from blood capillaries into interstitial fluid is called filtration. Pressure-driven movement from interstitial fluid into blood capillaries is called reabsorption.

في عمليه Bulk flow (حركة المواد من خلال capillaries) كيف بتعطي arterial capillaries الخلايا الغذاء ؟؟

بتيجي arterial capillaries وتعطي الغذاء إلى interstitial fluid وبعدين تدخل المواد إلى داخل الخلية وبعدين الزائد والفضلات بتطلع من الجهة الثانية وبرجع إلى venes capillaries وثم إلى interstitial fluid

انتقال السوائل والمواد من interstitial fluid إلى arterial capillaries يسمى: Filtration ترشيح السوائل الزائدة والفضلات تنتقل من venous capillaries إلى interstitial fluid تسمى: Reabsorption إعادة امتصاص

HEMODYNAMICS: FACTORS AFFECTING BLOOD FLOW

- **Blood flow** is the volume of blood that flows through any tissue in a given time period (in mL/min). **Total blood flow is cardiac output (CO)**, the volume of blood that circulates through systemic (or pulmonary) blood vessels each minute.
تعتمد كييفية توزيع .
فرق الضغط
- How the cardiac output becomes distributed into circulatory routes that serve various body tissues depends on two more factors:
- (1) **the pressure difference that drives the blood flow through a tissue.** علاقه طردية
القارمة
- (2) **the resistance to blood flow in specific blood vessels.** علاقه عكسيه
- Blood flows from regions of higher pressure to regions of lower pressure; **the greater the pressure difference, the greater the blood flow. But the higher the resistance, the smaller the blood flow.**

في **Blood flow** هي كمية الدم التي تدخل أو تمر عبر عضو كامل في فترة زمنية محددة
مثال: تدفق الدم الكلي للقلب، أو للرئة، أو للكلى

اما **Blood perfusion** هذا كمية الدم التي تصل لكل وحدة مساحة أو وزن **sub-section** من نسيج
العضو

علاقة **blood flow** و **blood pressure** كل ما كنت قريب من القلب علاقة طردية
عشان المقاومة

يعني كل ما كنت قريب من القلب **blood flow** عالي و **blood pressure** عالي بتكون المقاومة معروفة وكل
ما ابتعدت بضل **blood flow** عالي بس بقل **blood pressure** عشان المقاومة

BLOOD PRESSURE

- Contraction of the ventricles generates **blood pressure (BP)**, the hydrostatic pressure exerted by blood on the walls of a blood vessel.
- **BP is determined by cardiac output, blood volume, and vascular resistance.**
- BP is highest in the aorta and large systemic arteries; in a resting, young adult, BP rises to about 110 mmHg during systole (ventricular contraction) and drops to about 70 mmHg during diastole (ventricular relaxation).
- **Mean arterial pressure (MAP)**, the average blood pressure in arteries, is **roughly one-third of the way between the diastolic and systolic pressures. It can be estimated as follows:**

$$\text{MAP} = \text{diastolic BP} + \frac{1}{3} (\text{systolic BP} - \text{diastolic BP})$$



BLOOD PRESSURE

- We have already seen that cardiac output equals heart rate multiplied by stroke volume. Another way to calculate cardiac output is to divide mean arterial pressure (MAP) by **resistance (R)**: $CO = MAP/R$. By rearranging the terms of this equation, you can see that **MAP = CO * R**.
- Blood pressure also depends on the total volume of blood in the cardiovascular system. **The normal volume of blood in an adult is about 5 liters.** Any decrease in this volume, as from **hemorrhage**, **decreases the amount of blood that is circulated through the arteries each minute.**
يمكن تعويض الانخفاض الطفيف بآليات التوازن الداخلي التي تساعد على الحفاظ على ضغط الدم
النزيف
- **A modest decrease can be compensated for by homeostatic mechanisms that help maintain blood pressure**, but if the decrease in blood volume is greater than 10% of the total, blood pressure drops. **Conversely, anything that increases blood volume, such as water retention in the body, tends to increase blood pressure.**
في المقابل، فإن أي شيء يزيد من حجم الدم، مثل احتباس الماء في الجسم، يميل إلى رفع ضغط الدم.

VASCULAR RESISTANCE

- Vascular **resistance** is the opposition to blood flow due to friction between blood and the walls of blood vessels.
- Vascular resistance depends on (1) **size of the blood vessel lumen**, (2) **blood viscosity**, and (3) **total blood vessel length**.

SIZE OF THE LUMEN

- The smaller the lumen of a blood vessel, the greater its resistance to blood flow.
تناسب عكسي
- Resistance is **inversely proportional to the fourth power of the diameter (d) of the blood vessel's lumen.**

علاقة القطر للوعاء الدموي size of the blood vessel مع المقاومة علاقة عكسي كل ما كان اصغر كانت المقاومة اعلى

BLOOD VISCOSITY

- The viscosity of blood depends mostly on the ratio of red blood cells to plasma (fluid) volume, and to a smaller extent on the concentration of proteins in plasma.
- The higher the blood's viscosity, the higher the resistance.
- Any condition that increases the viscosity of blood, such as dehydration or polycythemia (an unusually high number of red blood cells), thus increases blood pressure.
- A depletion of plasma proteins or red blood cells, due to anemia or hemorrhage, decreases viscosity and thus decreases blood pressure.

الجاف

و blood viscosity هي الزوجة علاقة طردية كل ما كانت عدد الكريات الدم الحمراء اكبر كانت الزوجة اكبر

ولما يصير عنا جاف يعني عدد الكريات اكبر بتكون الزوجة اكبر

و اذا صار نزيف او معه انيميا يعني عدد الكريات اقل بيكون الزوجة اقل

SYSTEMIC VASCULAR RESISTANCE (SVR)

- Resistance to blood flow through a vessel is directly proportional to the length of the blood vessel.
- The longer a blood vessel, the greater the resistance.
- Systemic vascular resistance (SVR), also known as total peripheral resistance (TPR), refers to all of the vascular resistances offered by systemic blood vessels.
- The diameters of arteries and veins are large, so their resistance is very small because most of the blood does not come into physical contact with the walls of the blood vessel. The smallest vessels—arterioles, capillaries, and venules—contribute the most resistance.

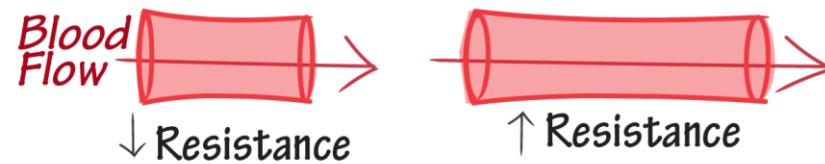
وهي طول الوعاء الدموي كل ما كان اكبر كانت المقاومة اكبر علاقة طردية vessel length

Determinants of Resistance:

Blood Viscosity (η) \propto Resistance



Vessel Length (l) \propto Resistance



Vessel Radius (r) \propto Resistance

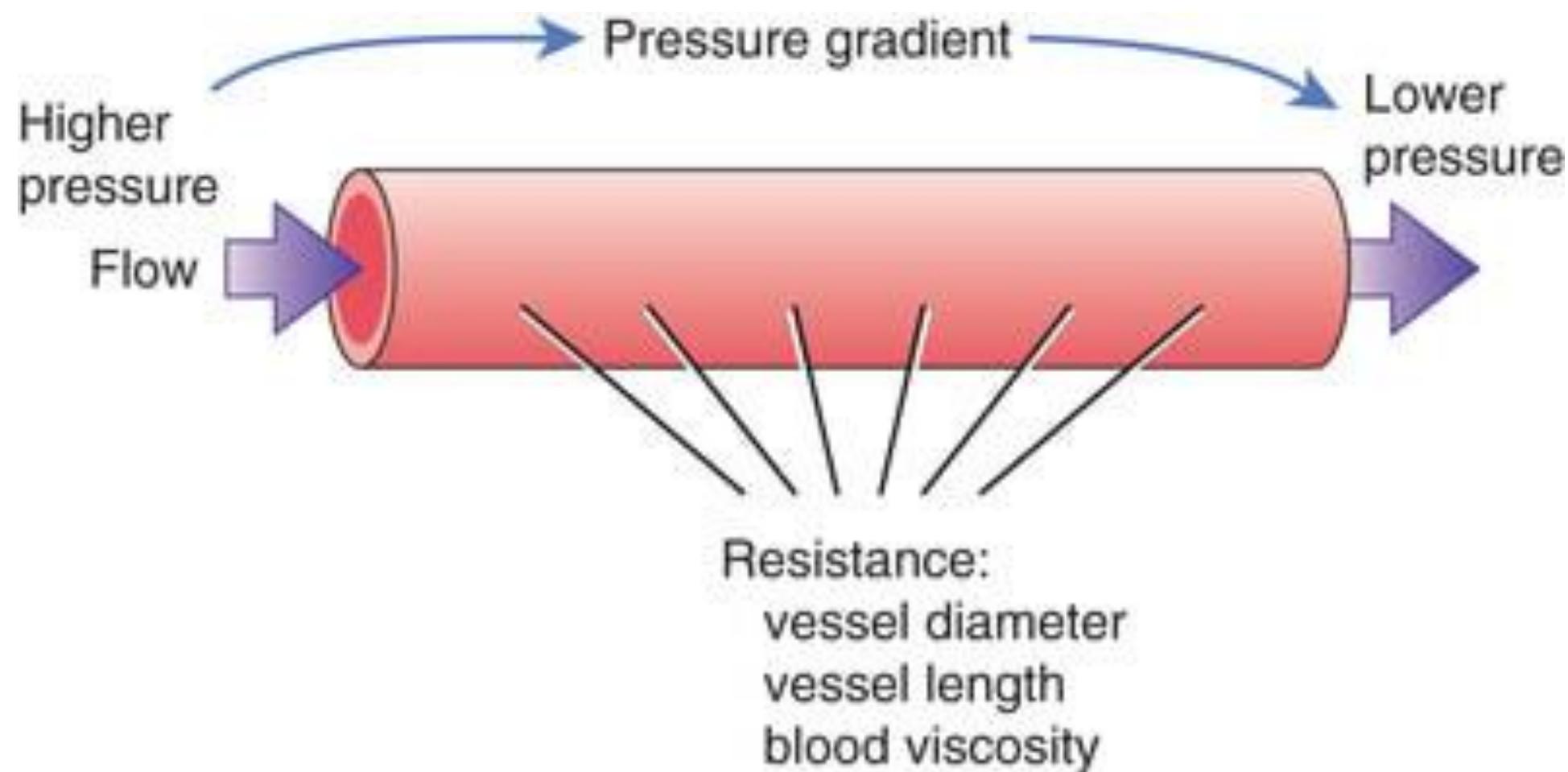


Factors Affecting Blood Flow

Pressure and resistance both affect blood flow to tissues, but they have opposing effects.

Blood flow and pressure are directly related: when pressure increases, flow increases.

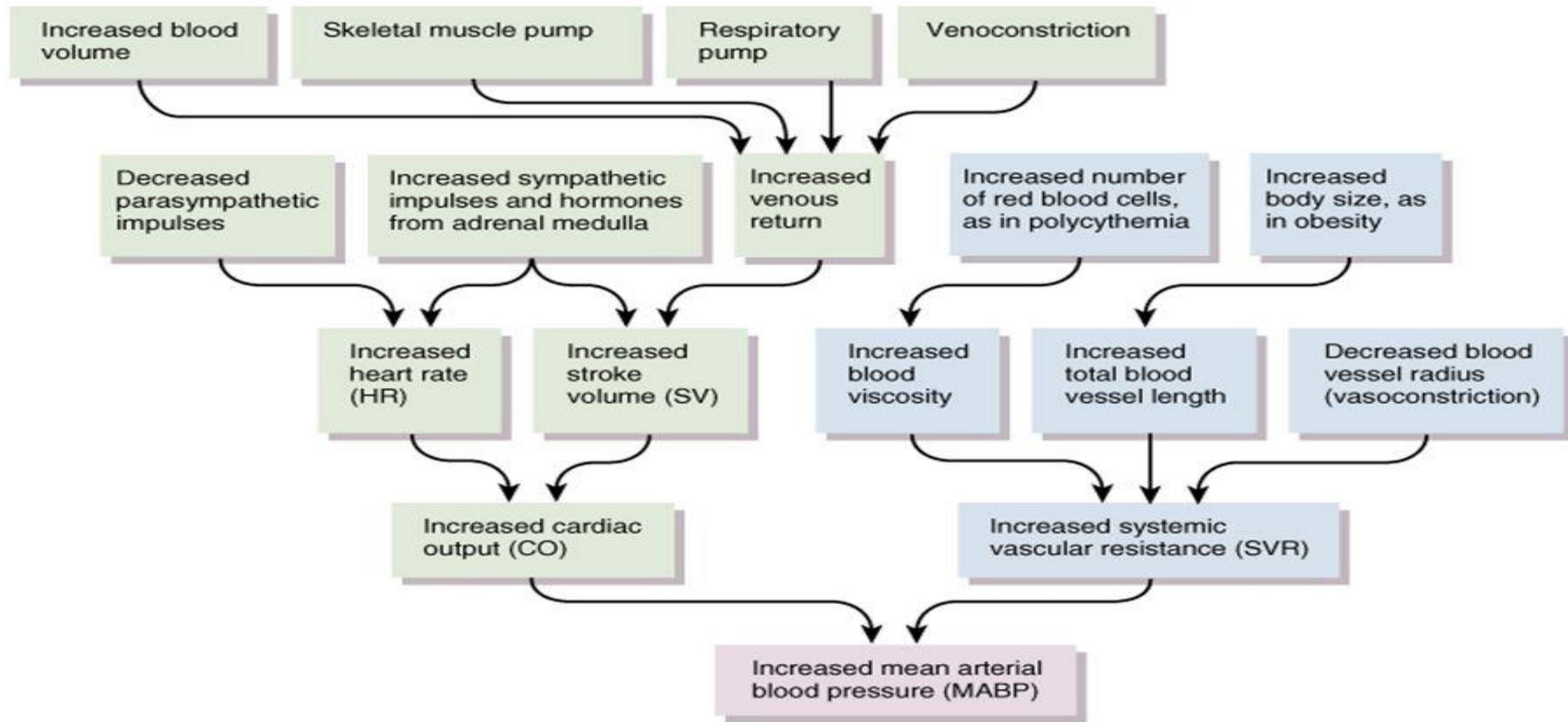
Blood flow and resistance are inversely related: when resistance increases, flow decreases.



VELOCITY OF BLOOD FLOW

- Earlier we saw that blood flow is the volume of blood that flows through any tissue in a given time period (in mL/min).
تناسب عكسي
سرعة تدفق الدم
- The speed or velocity of blood flow (in cm/sec) is inversely related to the cross-sectional area.
- Velocity is slowest where the total cross-sectional area is greatest.
- Each time an artery branches, the total cross-sectional area of all of its branches is greater than the cross-sectional area of the original vessel, so blood flow becomes slower and slower as blood moves further away from the heart, and is slowest in the capillaries.

Factors that Increase Blood Pressure



Physiological factors affecting blood pressure

Factor	Effect on blood pressure
The pumping action of the heart	The greater the cardiac output, the higher the arterial pressure
The blood volume	The greater the blood volume, the higher the arterial pressure
The viscosity of the blood	The more viscous the blood, the higher the arterial pressure
The condition of the blood vessels (resistance)	The greater the resistance, the higher the arterial pressure

CONTROL OF BLOOD PRESSURE AND BLOOD FLOW

- Several interconnected negative feedback systems control blood pressure by adjusting heart rate, stroke volume, systemic vascular resistance, and blood volume.
- Some systems allow rapid adjustments to cope with sudden changes, such as the drop in blood pressure in the brain that occurs when you get out of bed; others act more slowly to provide long-term regulation of blood pressure.

CONTROL OF BLOOD PRESSURE AND BLOOD FLOW

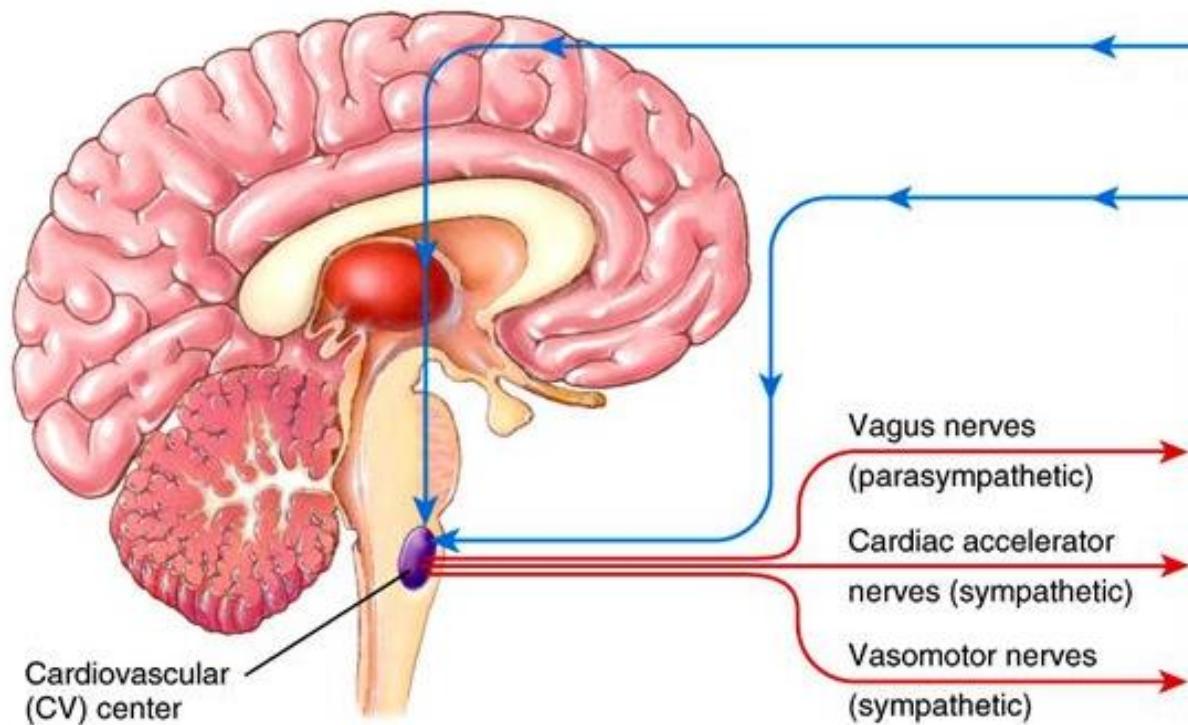
□ Role of the Cardiovascular Center in the medulla oblongata:

- ❖ 1- helps regulate heart rate and stroke volume.
- ❖ 2- controls neural, hormonal, and local negative feedback systems that regulate blood pressure and blood flow to specific tissues.
- ❖ Groups of neurons scattered within the CV center:
 - ❖ Some neurons stimulate the heart (cardiostimulatory center); others inhibit the heart (cardioinhibitory center).
 - ❖ Still others control blood vessel diameter by causing constriction (vasoconstrictor center) or dilation (vasodilator center).

1. ROLE OF THE CARDIOVASCULAR CENTER

- ❖ The cardiovascular center receives input both from higher brain regions and from sensory receptors. Nerve impulses descend from the cerebral cortex, limbic system, and hypothalamus to affect the cardiovascular center.
- ❖ The three main types of sensory receptors that provide input to the cardiovascular center are proprioceptors, baroreceptors, and chemoreceptors.
- ❖ Proprioceptors monitor movements of joints and muscles and provide input to the cardiovascular center during physical activity.
- ❖ Baroreceptors monitor changes in pressure and stretch in the walls of blood vessels.
- ❖ Chemoreceptors monitor the concentration of various chemicals in the blood.

CV Center



INPUT TO CARDIOVASCULAR CENTER (nerve impulses)

- From higher brain centers: cerebral cortex, limbic system, and hypothalamus
- From proprioceptors: monitor joint movements
- From baroreceptors: monitor blood pressure
- From chemoreceptors: monitor blood acidity (H^+), CO_2 , and O_2

OUTPUT TO EFFECTORS

(increased frequency of nerve impulses)

Heart: decreased rate

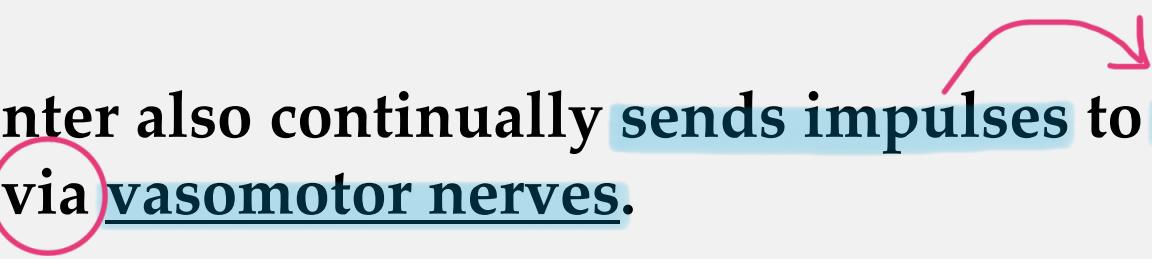
Heart: increased rate and contractility

Blood vessels: vasoconstriction

ROLE OF THE CARDIOVASCULAR CENTER

- ❖ Output from the cardiovascular center flows along sympathetic and parasympathetic neurons of the ANS.
- ✓ Sympathetic impulses reach the heart via the cardiac accelerator nerves. An increase in sympathetic stimulation increases heart rate and contractility.
- ✓ Parasympathetic stimulation, conveyed along the vagus (X) nerves, decreases heart rate.

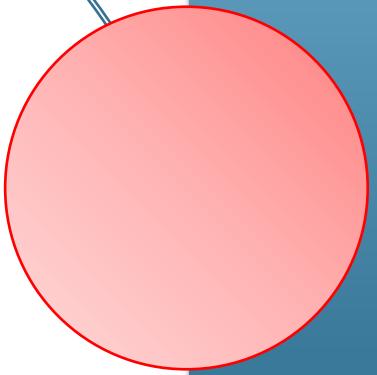
ROLE OF THE CARDIOVASCULAR CENTER

- ❖ The cardiovascular center also continually sends impulses to smooth muscle in blood vessel walls via vasomotor nerves.
- ✓ Impulses propagate along sympathetic neurons that innervate blood vessels in viscera and peripheral areas.
- ✓ The result is a moderate state of tonic contraction or vasoconstriction, called vasomotor tone, that sets the resting level of systemic vascular resistance. Sympathetic stimulation of most veins causes constriction that moves blood out of venous blood reservoirs and increases blood pressure.

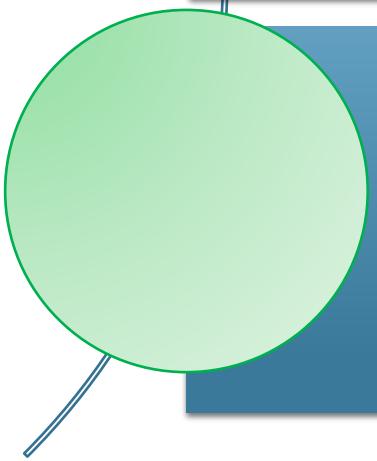
2. NEURAL REGULATION OF BLOOD PRESSURE

The nervous system regulates blood pressure via negative feedback loops that occur as two types of reflexes: **baroreceptor reflexes** and **chemoreceptor reflexes**.

BARORECEPTOR REFLEXES

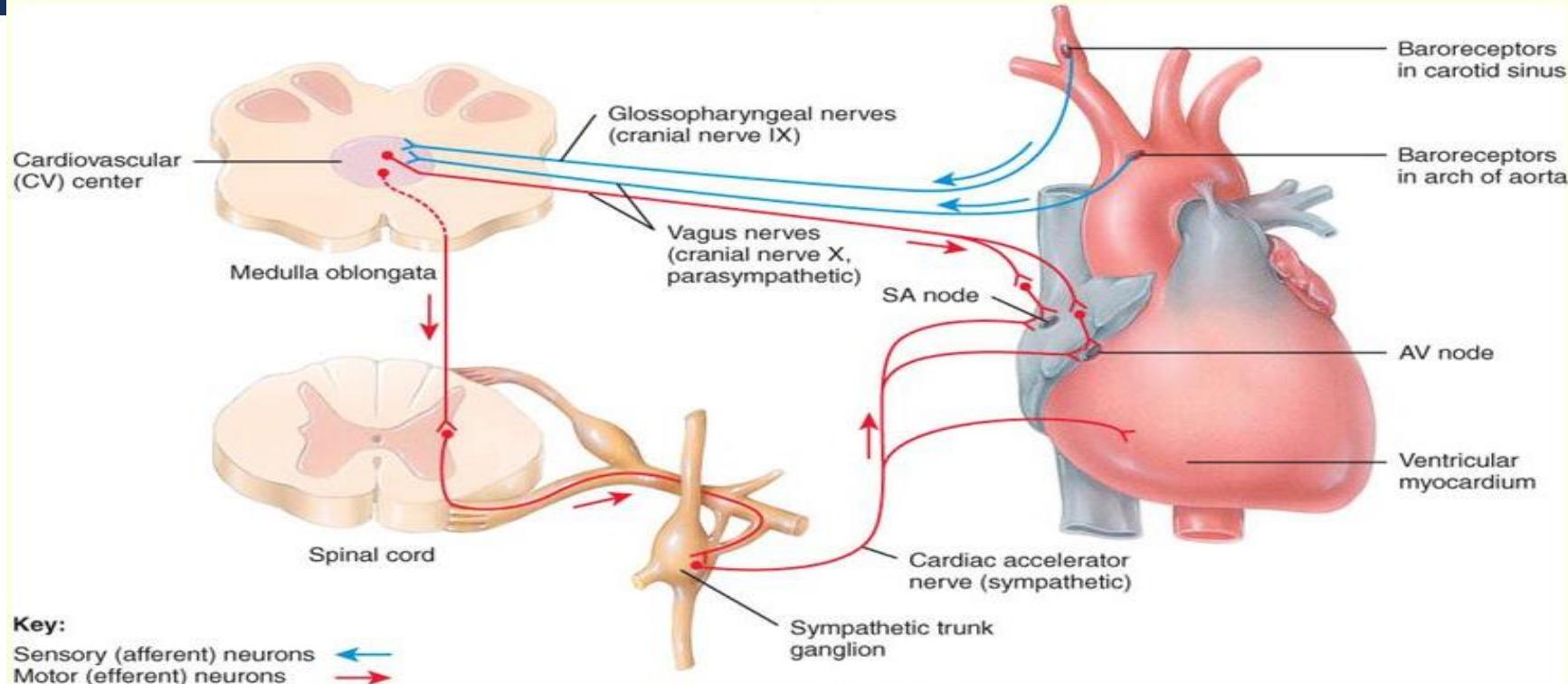


Baroreceptors are **pressure-sensitive sensory receptors**. They are **located in the aorta, internal carotid arteries** (arteries in the neck that supply blood to the brain), and other **large arteries in the neck and chest**.

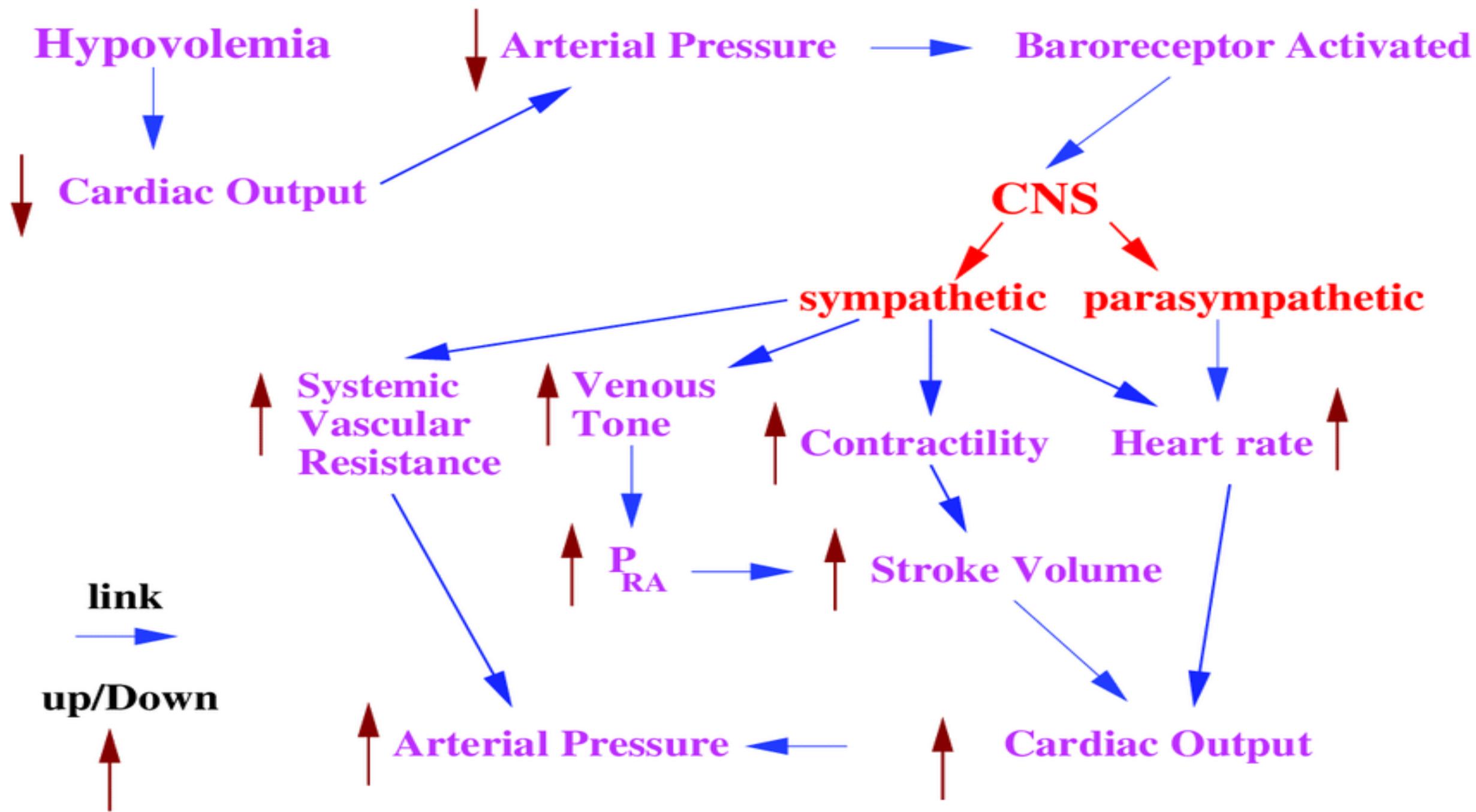


They **send impulses to the cardiovascular center to help regulate blood pressure**.

Innervation of the Heart



- Slow it down with parasympathetic stimulation (X)
- Sensory information from baroreceptors (IX)



BARORECEPTOR REFLEXES

- Baroreceptors are pressure-sensitive neurons that monitor stretching.
- When blood pressure falls, the baroreceptors are stretched less, and they send nerve impulses at a slower rate to the cardiovascular center. In response, the CV center decreases parasympathetic stimulation of the heart by way of motor axons of the vagus nerves and increases sympathetic stimulation of the heart via cardiac accelerator nerves.
- Moving from a prone (lying down) to an erect position decreases blood pressure and blood flow in the head and upper part of the body. The baroreceptor reflexes, however, quickly counteract the drop in pressure. Sometimes these reflexes operate more slowly than normal, especially in the elderly.

في عنا long-term وفي عنا short-term
في sensory receptor short-term regulation بشغل على
renin-angiotensin-aldosterone system long-term regulation بشغل على

Short-term

بصير regulation of blood pressure عن طريق ثلاثة أنواع من المستقبلات :
(1) في proprioceptors التي مسؤولة عن حركة العضلات
(2) chemoreceptore
(3) baroreceptore

وهذه ion channels تكونوا موجودين على carotid artery و Aortic arch baroreceptore و chemoreceptore و
والتي بعمل كشف detection للتحغير بشكل direct هو baroreceptore

في الدماغ وتحديدا في medulla oblongata مركز فيه ثلاثة مكاتب
(Cardiac stimulatory center) (Cardiac inhibitory center) (Vasomotor center)

لو واحد عنده انخفاض ضغط الدم Hypotension يعني كمية blood pressure التي طالعة من القلب قليلة بصير في activation ويعدين baroreceptore و بصير في generation action potential depolarization opening ion channel والي contraction Sympathetic accelerator nerves ينطلق عن طريق cardiac stimulatory center والتي بزيد heart rate ويزيد من cardiac output

لو واحد عنده ارتفاع ضغط الدم Hypertension يعني كمية blood pressure عاليه بصير في activation لـ ion channel هذا وبفتح Parasympathetic – Vagus nerve action potential وبروح عن cardiac output وبقل من heart rate inhibitory center

Cardiac stimulatory center مرتبط مع **Sympathetic accelerato nerve**
Cardiac inhibitory center مرتبط مع **Parasympathetic – Vagus nerve**

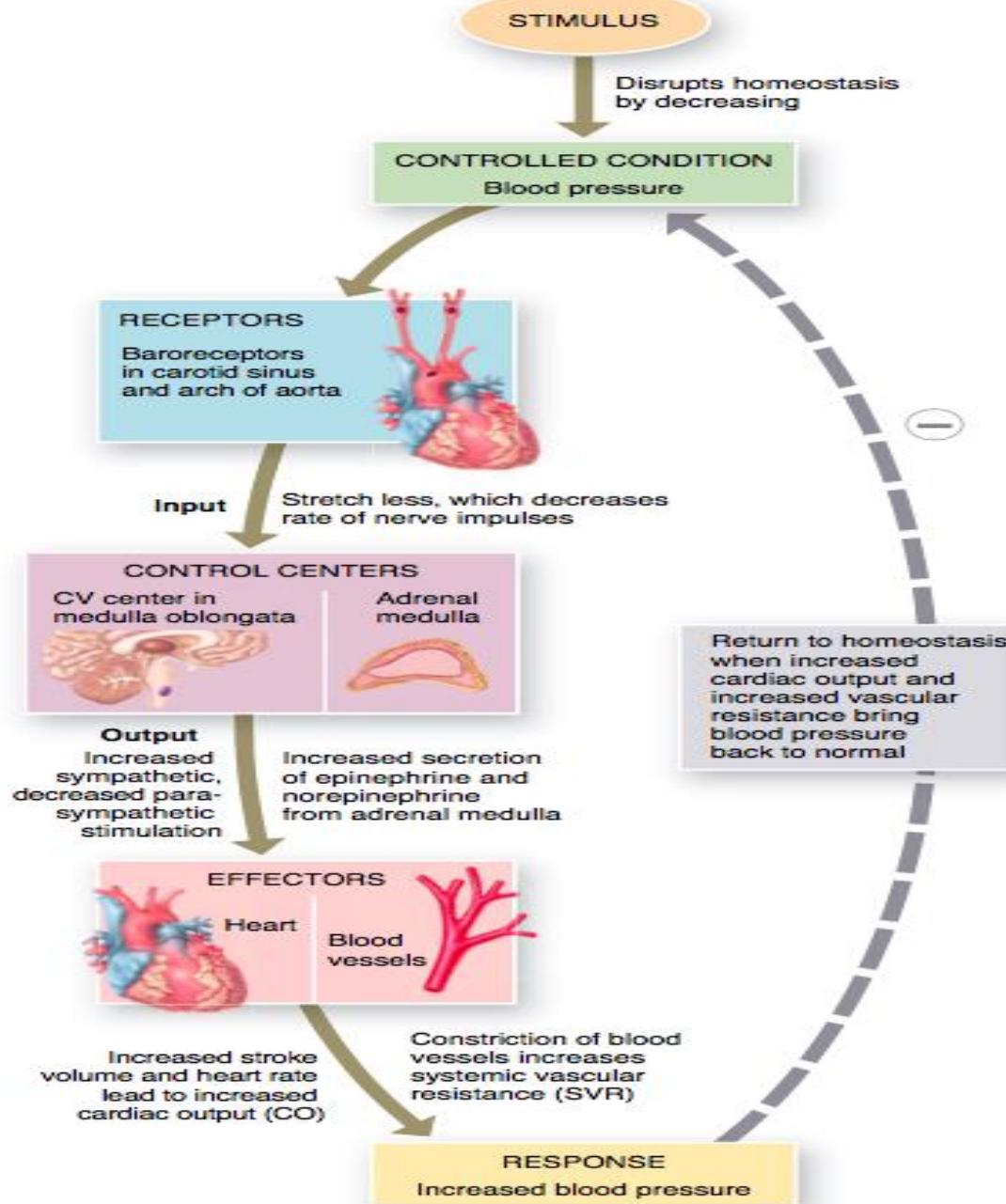
اما بالنسبة **Vasomotor center**

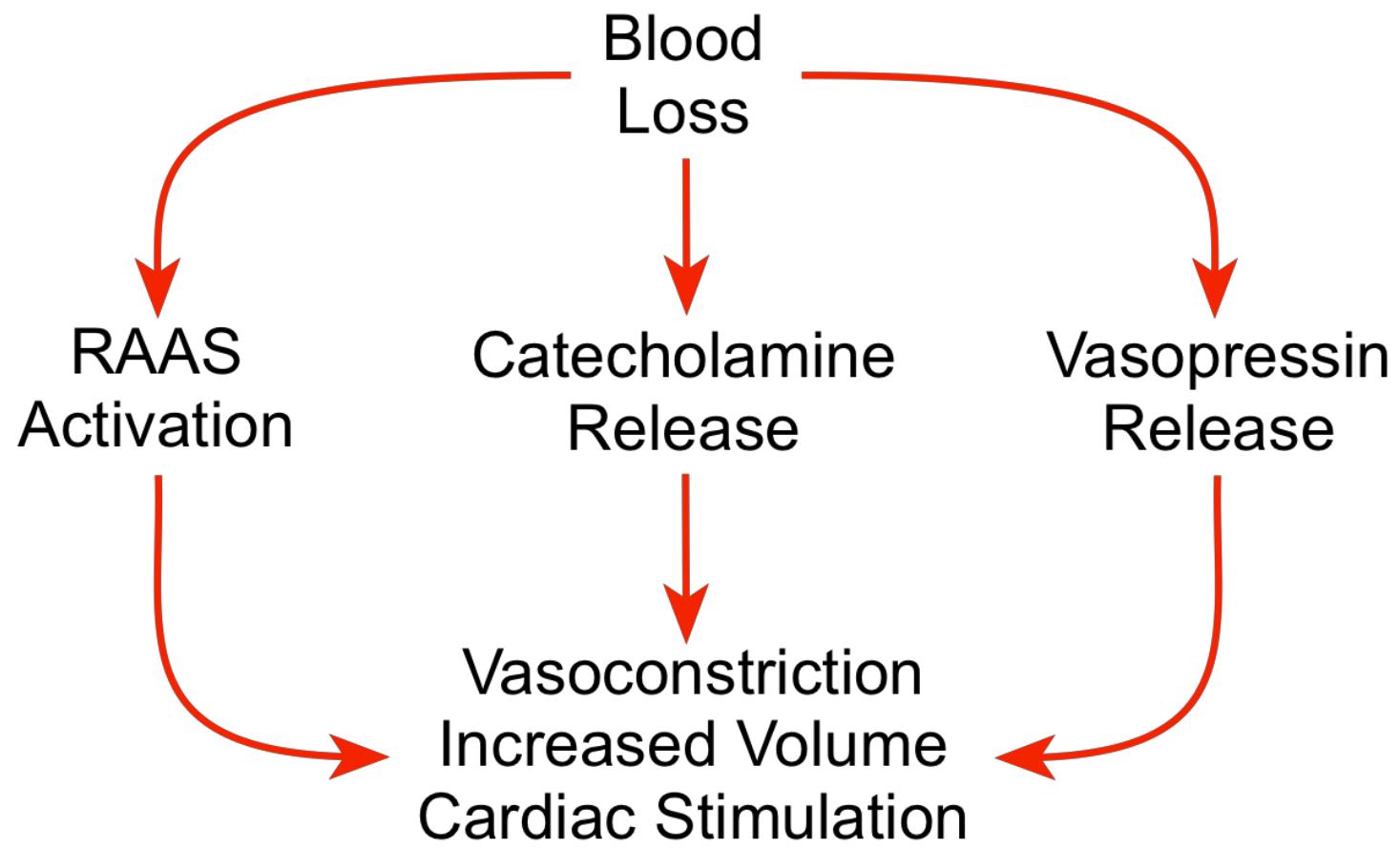
وظيفته تنظيم قطر الأوعية الدموية وبالتالي التحكم بضغط الدم وتوزيع الدم وفي داخله كمان مكاتب

مكتب مسؤول عن **Vasodilator center**

ومكتب مسؤول عن **Vasoconstrictor center**

ولما حكينا عن طبقات blood vessels حكينا في طبقة Tunica media تحتوي على smooth vasoconstriction & vasodilation هي الطبقة المسئولة عن mucels





CHEMORECEPTOR REFLEXES

- Chemoreceptors, sensory receptors that monitor the chemical composition of blood, are **located close to the baroreceptors** of the carotid sinus and arch of the aorta in small structures called **carotid bodies and aortic bodies**, respectively.
- These chemoreceptors **detect changes in blood level of O₂, CO₂, and H⁺**. **Hypoxia** (lowered O₂ availability), **acidosis** (an increase in H⁺ concentration), or **hypercapnia** (excess CO₂) stimulates the chemoreceptors to send impulses to the cardiovascular center. In response, the CV center increases sympathetic stimulation to arterioles and veins, producing vasoconstriction and an increase in blood pressure. These chemoreceptors also provide input to the respiratory center in the brain stem to adjust the rate of breathing.

اما PH chemoreceptore تستجيب لدرجة الحموضة
تستجيب لنقصان او لارتفاع ضغط الدم بطريقة غير مباشرة

لما يكون CO2 حدا عنده كمية الدم قليله يعني كمية الاكسجين O2 قليلة يعني بكون عندهم Hypoxia وكمية CO2 عاليه يعني Hypercapnia ، واحدة من الاشكال الي يتواجد عليها CO2 في الدم هي H2CO3 وهي ناتجة من تفاعل H2O مع CO2

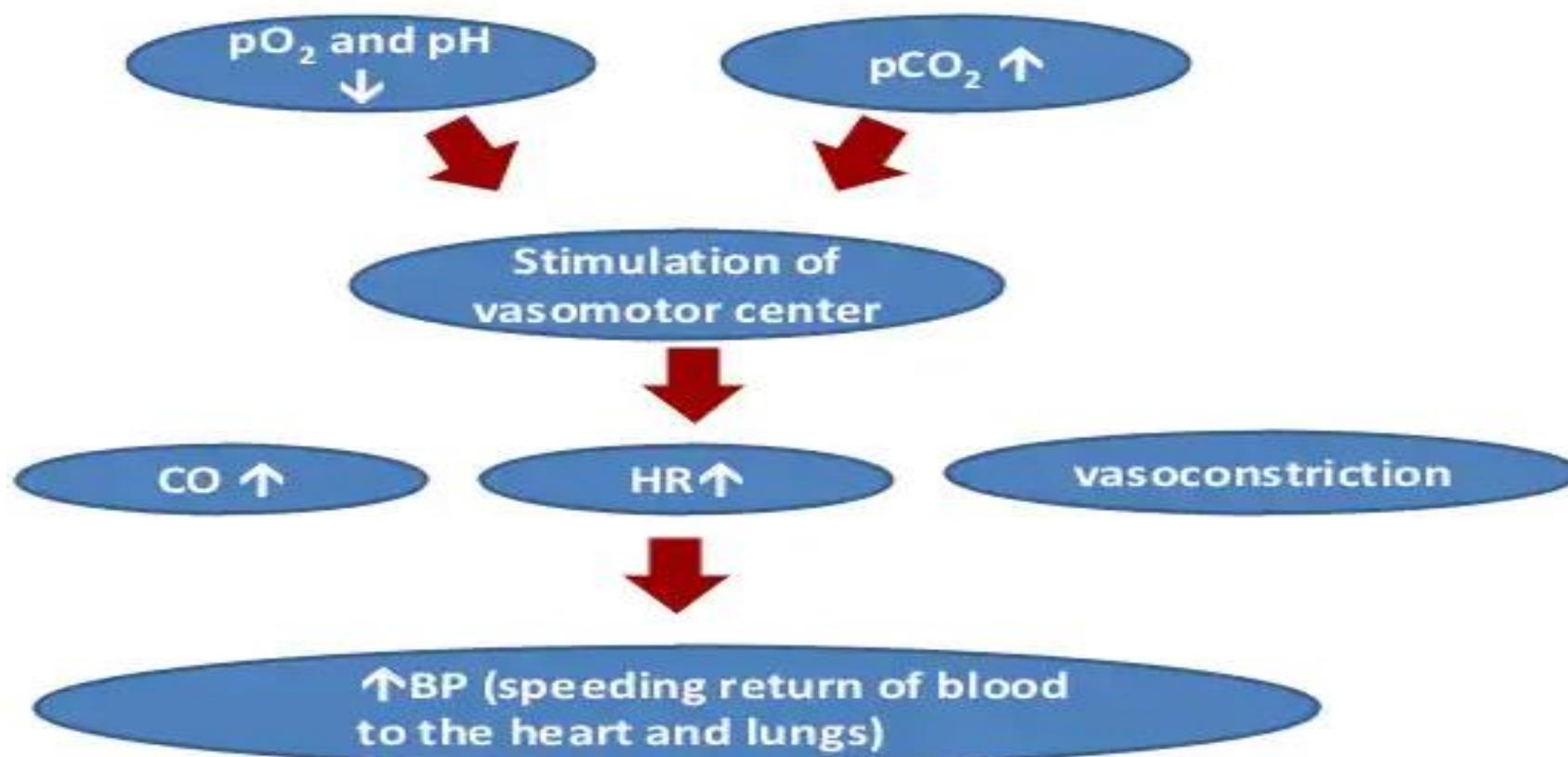
وبعدين هذا H2CO3 يرجع بتحلل الى H+ و HCO3- وهيك اذا CO2 عالي يعني H2CO3 عالي عن عالي H+ يعني الحموضة عاليه و PH قليله

بس لو واحد عنده Hypertension يعني نسبة الاكسجين عاليه ونسبة CO2 قليلة يعني نسبة CO2 الى رح تتفاعل مع H2O وتنتج H2CO3 قليله يعني H+ قليلة يعني الحموضة قليله و PH عاليه



Chemoreceptor

- Chemosensitive cells that respond to changes in pCO_2 and pO_2 and pH levels (Hydrogen ion).



3- HORMONAL REGULATION OF BLOOD PRESSURE

1- Renin–angiotensin–aldosterone (RAA) system:

- When blood volume falls or blood flow to the kidneys decreases, **juxtaglomerular cells in the kidneys secrete renin into the bloodstream.**
- In sequence, **renin and angiotensin-converting enzyme (ACE)** act on their substrates to produce the **active hormone angiotensin II**, which **raises blood pressure in two ways.**
- First**, **angiotensin II** is a potent vasoconstrictor; it **raises blood pressure by increasing systemic vascular resistance.**
- Second**, it **stimulates secretion of aldosterone**, which **increases reabsorption of sodium ions and water by the kidneys.** The water reabsorption increases total blood volume, which increases blood pressure.

Long-term renin-angiotensin-aldosterone system بشتغل على

لو في واحد عنده blood volume قليل يعني الدم الى رايج الى liver قليل والى kidneys قليل في ما يكون كمية الدم الى داخله عليها قليله في نوع من الخلايا اسمه juxtaglomerular يعمل على انتاج هرمون يسمى Renin kidney لما تكون كمية الدم الى داخله عليه قليله ي العمل على افراز هرمون يسمى Angiotensinogen liver لما تكون كمية الدم الى داخله عليه قليله ي العمل على افراز هرمون يسمى

يبحي Renin وبمسك Angiotensinogen وبحوله الى I ولما تكون كمية الدم الى داخله على lung كمان قليله تعمل على افراز ACE (Angiotensin-Converting Enzyme) وتحول الى Angiotensin II والي يعمل على اربع اشياء:

(1) بعمل Peripheraly في Vasoconstriction of arterie للي بيفوت الدم الى kidney عشان نقلل كمية blood الى اعضاء ونزيد كمية الدم الى راجعة على Systemic circulation وبيزيد cardiac output (2) يقلل من Bradykinin واحد منهم vasodilator بيقل

(3) اعادة امتصاص Proximal convoluted tubule للصوديوم والماء ، بشتغل على اول قناع في الكلية تسمى Reabsorption Systemic circulation الى PCT

(4) بيزيid من هرمون Aldosterone الى بيزيid من امتصاص الماء والصوديوم من distal convoluted tubule duct

3- HORMONAL REGULATION OF BLOOD PRESSURE

2- Epinephrine and norepinephrine:

- In response to sympathetic stimulation, the adrenal medulla releases epinephrine and norepinephrine.
- These hormones increase cardiac output by increasing the rate and force of heart contractions.



يُثبط ادرار البول Diuresis بصير له activation لما يوم blood volume قليل وبصير تحفيز مراكز العطش الموجودة في hypothalamus والتي تعمل انتقال action potential الى الغدة النخامية الخلفية Thirst center التي تعمل على افراز Antidiuretic hormone الي بساعد على اعادة امتصاص للصوديوم والماء من Late distal convoluted tubule و Collecting duct

3- Antidiuretic hormone (ADH):

- It is produced by the hypothalamus and released from the posterior pituitary in response to dehydration or decreased blood volume.
- It causes in an increase in blood volume and a decrease in urine output.

3- HORMONAL REGULATION OF BLOOD PRESSURE

4- Atrial natriuretic peptide (ANP):

- Released by cells in the atria of the heart, atrial natriuretic peptide (ANP) **lowers blood pressure by causing vasodilation and by promoting the loss of salt and water in the urine, which reduces blood volume.**

هذا بـشـتـغـل عـكـس الـكـل

4- AUTOREGULATION OF BLOOD FLOW

- In each capillary bed, local changes can regulate vasomotion.
- When **vasodilators** produce local dilation of arterioles and relaxation of precapillary sphincters, blood flow into capillary networks is increased, which increases O₂ level.
- Vasoconstrictors have the opposite effect.
- **The ability of a tissue to automatically adjust its blood flow to match its metabolic demands is called autoregulation.**

وفي اشي اسمه Autoregulation يعني برجع الحالة الجسم من حالة عدم التوازن الى حالة التوازن balance Imbalance

4- AUTOREGULATION OF BLOOD FLOW

- **Autoregulation** also controls regional blood flow in the brain; blood distribution to various parts of the brain changes dramatically for different mental and physical activities.
- During a conversation, for example, blood flow increases to your motor speech areas when you are talking and increases to the auditory areas when you are listening.

4- AUTOREGULATION OF BLOOD FLOW

- Two general types of stimuli cause autoregulatory changes in blood flow:
 1. **Physical changes.** Warming promotes vasodilation, and cooling causes vasoconstriction. In addition, smooth muscle in arteriole walls exhibits a myogenic response— it contracts more forcefully when it is stretched and relaxes when stretching lessens.
 2. **Vasodilating and vasoconstricting chemicals.** Several types of cells—including white blood cells, platelets, smooth muscle fibers, macrophages, and endothelial cells—release a wide variety of chemicals that alter blood-vessel diameter.

4- AUTOREGULATION OF BLOOD FLOW

- An important difference between the pulmonary and systemic circulations is their autoregulatory response to changes in O_2 level.
 - The walls of blood vessels in the systemic circulation dilate in response to low O_2 . With vasodilation, O_2 delivery increases, which restores the normal O_2 level.
 - By contrast, the walls of blood vessels in the pulmonary circulation constrict in response to low levels of O_2 . This response ensures that blood mostly bypasses those alveoli (air sacs) in the lungs that are poorly ventilated by fresh air. Thus, most blood flows to better-ventilated areas of the lung.

Pulmonary Circulation

الدورة التي يذهب فيها الدم إلى الرئتين ليأخذ الأكسجين
الشريان Artery سيكون محملاً بثاني أكسيد الكربون
الوريد Vein سيكون محملاً بالاكسجين

Systemic Circulation

الدورة التي توصل الأكسجين إلى كل خلايا الجسم
الشريان Artery سيكون محملاً بالاكسجين
الوريد Vein سيكون محملاً بثاني أكسيد الكربون

CHECKING CIRCULATION

1. Pulse:

- The alternate ^{التمدد}expansion and recoil of elastic arteries after each systole of the left ventricle creates a traveling pressure wave that is called the pulse.
- The pulse is strongest in the arteries closest to the heart, becomes weaker in the arterioles, and disappears altogether in the capillaries.
- The pulse rate normally is the same as the heart rate, about 70 to 80 beats per minute at rest. **Tachycardia** is a rapid resting heart or pulse rate over 100 beats/min. **Bradycardia** is a slow resting heart or pulse rate under 50 beats/min.

CHECKING CIRCULATION

2. Measuring Blood Pressure:

- The term **blood pressure** usually refers to the pressure in arteries generated by the left ventricle during systole and the pressure remaining in the arteries when the ventricle is in diastole. Blood pressure is usually measured in the brachial artery in the left arm.
- The device used to measure blood pressure is a **sphygmomanometer**.
- The normal blood pressure of an adult male is less than 120 mmHg systolic and less than 80 mmHg diastolic. For example, “110 over 70” (written as 110/70) is a normal blood pressure.

CHECKING CIRCULATION

2. Measuring Blood Pressure:

(systolic BP - diastolic BP)

- The difference between systolic and diastolic pressure is called **pulse pressure**. This pressure, normally about 40 mmHg, provides information about the condition of the cardiovascular system. For example, conditions such as atherosclerosis greatly increase pulse pressure. **The normal ratio of systolic pressure to diastolic pressure to pulse pressure is about 3:2:1.**

The normal blood pressure of an adult male is less than 120 mmHg systolic and less than 80 mmHg diastolic

Pulse pressure = Systolic BP – Diastolic

Systolic = 120 mmHg

Diastolic = 80 mmHg

Pulse pressure = 40 mmHg

لما نقسمهم على 40 :

120 → 3

80 → 2

40 → 1

Systolic : Diastolic : Pulse \approx 3 : 2 : 1

The normal ratio of systolic pressure to diastolic pressure to pulse pressure is about 3:2:1.

SHOCK AND HOMEOSTASIS

في فرق بين shock و Hypoxia
في Hypoxia نقصان الاكسجين فقط
واما shock هي نقصان الاكسجين والعناصر الغذائية nutrients

- Shock is a failure of the cardiovascular system to deliver enough O₂ and nutrients to meet cellular metabolic needs.

كلهم في عدم كفاية تدفق الدم إلى أنسجة الجسم

- The causes of shock are many and varied, but all are characterized by inadequate blood flow to body tissues. With inadequate oxygen delivery, cells switch from aerobic to anaerobic production of ATP, and lactic acid accumulates in body fluids. If shock persists, cells and organs become damaged, and cells may die unless proper treatment begins quickly.

TYPES OF SHOCK

➤ Shock can be of four different types:

- (1) Hypovolemic shock due to decreased blood volume
- (2) Cardiogenic shock due to poor heart function.
- (3) Vascular shock due to inappropriate vasodilation.
- (4) Obstructive shock due to obstruction of blood flow.

TYPES OF SHOCK

منقول
حكت الدكتور هذا الجدول مش مهم

Cause	Pathophysiology*	Patterns of abnormalities		
		Filling status	Cardiac function	Systemic resistance
Hypovolemic	Loss of volume	low	low	high
Vasogenic	Vasodilation	low	high	low
Cardiogenic	Pump failure	high	low	high
Obstructive	Obstruction to flow	Variable**	low	high

*primary problem mentioned in BOLD ; **depending on site of obstruction

HYPOVOLEMIC SHOCK

- ✓ It is due to decreased blood volume (i.e. **blood loss** as acute (sudden) **hemorrhage** and **loss of body fluids** i.e. through excessive sweating).
- ✓ Whatever the cause, when the volume of body fluids falls, venous return to the heart declines, filling of the heart lessens, stroke volume decreases, and cardiac output decreases. Replacing fluid volume as quickly as possible is essential in managing hypovolemic shock.

يعني نقصان blood volume ولو ما زبط بسرعة رح تموت الخلايا

CARDIOGENIC SHOCK

يعني مضخة القلب بطلت تشتعل كوييس ، يعني مثلا واحد عنده Myocardial infarction او Angina او Ischemia يعني جلطات بس بختلفوا عن بعض بعدين بنوخذهم

- ✓ The heart fails to pump adequately, most often because of a myocardial infarction (heart attack).
- ✓ Other causes of cardiogenic shock include poor perfusion of the heart (ischemia), heart valve problems, excessive preload or afterload, impaired contractility of heart muscle fibers, and arrhythmias.

عدم انتظام ضربات القلب

VASCULAR SHOCK

ب يكون مشكلة blood vessels بصير عكس كل انواع shocks ، ما بتكون الاعراض تبعتهم زي كل shocks انهم بردانين وجسمهم تكون مزرق ، لا هون العكس بيكونوا جسمهم احمر

- ✓ A variety of conditions can cause inappropriate dilation of arterioles or venules.

رد فعل تحسسي

قرصنة النحله

- ✓ In **anaphylactic shock**, a severe allergic reaction—for example, to a bee sting—releases histamine and other mediators that cause vasodilation.

صدمة عصبية

صدمة الرأس

- ✓ In **neurogenic shock**, vasodilation may occur following trauma to the head that causes malfunction of the cardiovascular center in the medulla.

سموم بكتيرية

- ✓ Shock stemming from certain bacterial toxins that produce vasodilation is termed **septic shock**.

OBSTRUCTIVE SHOCK

- ✓ It occurs when blood flow through a portion of the circulation is blocked.
- ✓ The most common cause is pulmonary embolism, a blood clot lodged in a blood vessel of the lungs.

السبب الأكثر شيوعاً هو الانصمام الرئوي، وهو عبارة عن جلطة دموية تستقر في أحد الأوعية الدموية في الرئتين

HOMEOSTATIC RESPONSES TO SHOCK

الآليات الرئيسية للتعويض في حالة الصدمة

- The major mechanisms of compensation in shock are negative feedback systems that work to return cardiac output and arterial blood pressure to normal.
- ❖ Activation of the renin–angiotensin–aldosterone system: angiotensin II causes vasoconstriction and stimulates the adrenal cortex to secrete aldosterone, a hormone that increases reabsorption of sodium ions and water by the kidneys.
- ❖ Secretion of antidiuretic hormone: the posterior pituitary releases more antidiuretic hormone (ADH). ADH enhances water reabsorption by the kidneys, which conserves remaining blood volume.

HOMEOSTATIC RESPONSES TO SHOCK

- ❖ **Activation of the sympathetic division of the ANS:** aortic and carotid baroreceptors initiate powerful sympathetic responses throughout the body. One result is marked vasoconstriction of arterioles and veins of the skin, kidneys, and other abdominal viscera. (Vasoconstriction does not occur in the brain or heart.) Constriction of arterioles increases systemic vascular resistance, and constriction of veins increases venous return.
- ❖ **Release of local vasodilators:** In response to hypoxia, cells liberate vasodilators—including potassium ions, hydrogen ions, lactic acid, adenosine, and nitric oxide—that dilate arterioles and relax precapillary sphincters. Such vasodilation increases local blood flow and may restore O₂ level to normal in part of the body.

HOMEOSTATIC RESPONSES TO SHOCK

- ❖ If blood volume drops more than 10–20%, or if the heart cannot bring blood pressure up sufficiently, compensatory mechanisms may fail to maintain adequate blood flow to tissues. At this point, shock becomes life-threatening as damaged cells start to die.

SIGNS AND SYMPTOMS OF SHOCK

و هذه كمان الاعراض مش كثیر مهمه عشان هى اعراض shock بشكل عام احنا بهمنا اعراض كل نوع shock لحاله

- **Systolic blood pressure is lower than 90 mmHg.**
- **Resting heart rate is rapid** due to sympathetic stimulation and increased blood levels of epinephrine and norepinephrine.
- **Pulse is weak and rapid** due to reduced cardiac output and fast heart rate.
- **Skin is cool, pale, and clammy** due to sympathetic constriction of skin blood vessels and sympathetic stimulation of sweating.
- **Mental state is altered** due to reduced oxygen supply to the brain.
- **Urine formation is reduced** due to increased levels of aldosterone and antidiuretic hormone (ADH).
- **The person is thirsty** due to loss of extracellular fluid.
- **The pH of blood is low (acidosis)** due to buildup of lactic acid.
- **The person may have nausea** because of impaired blood flow to the digestive organs from sympathetic vasoconstriction.



THANK YOU

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