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Physiology sheet

Doctor 2021 -mercy- I medicine I MU

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Regulation of cardiac output

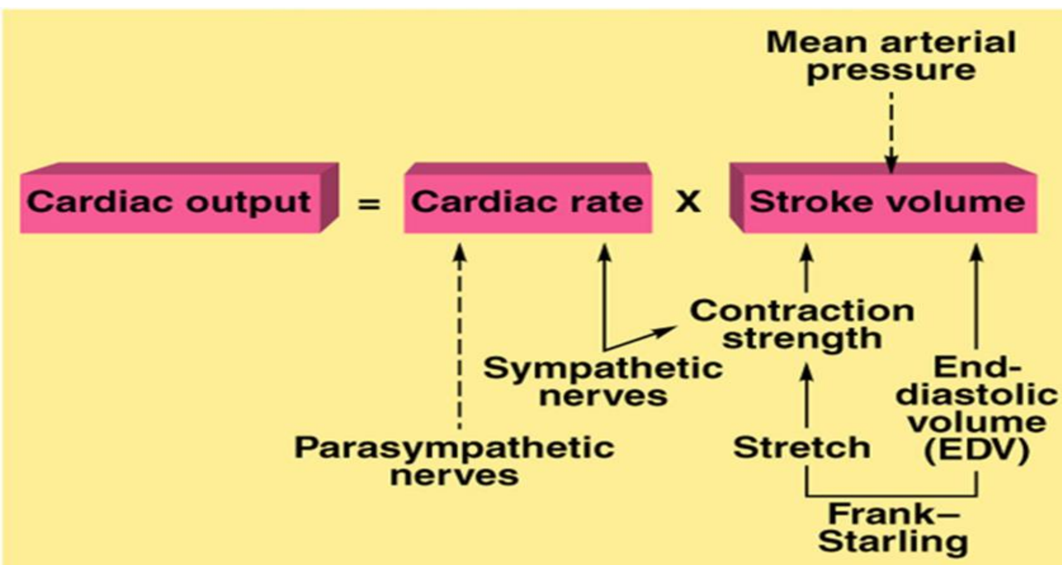
(implication of frank- starling law)

- **Nervous system modifies the cardiac rate**

-sympathetic and parasympathetic only regulate the action potential and do not generate A , regulate a pressure

- **Pacemakers trigger the action potential**
- **Positive inotropes (increase the contractility)** drugs, physiological, ex: sympathetic or Ca+2 & agonist
- **Negative inotropes (decrease the cardiac contractility)** **ex:** parasympathetic & antagonist

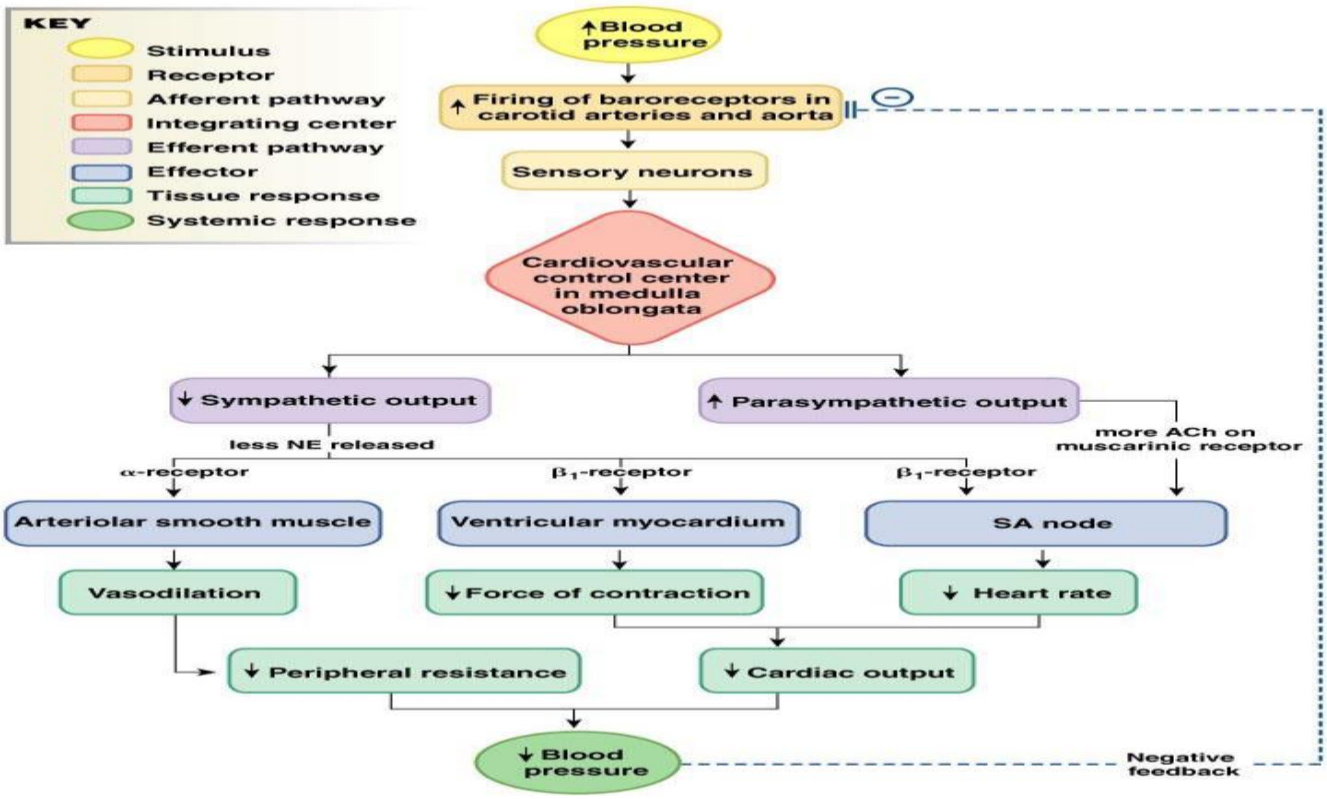
★ Cardiac output ↑ ,Cardiac rate ↑,Stroke volume ↑



على الرسمة:

★ parasympathetic to relax, ↓ BP

★ sympathetic fight or flight (stress condition)↑heat rate ,↑ stroke volume↑ contraction strength so cardiac output increase in normal state



- ★ ↑**blood pressure** = perfusion ↑ ,mean arterial BP↑
- ★ **Baroreceptors** are sensory receptor located in the carotid arteries & aorta they sense any simple alteration of blood pressure . type of receptor category is mechanical
- ★ **sensory neuron** {conduction ,link baroreceptor with upper CNS that is medulla oblongata (in hind brain) {make sensation there is something wrong increase BP}
- ★ decreasing sensitivity of sympathetic
- ★ SA Node starting point of decreasing the heart rate

- ➢ ↑BP= ↑MAP=↑Perfusion
- ➢ stimulation of baroreceptor ➡ conduction of these sensation by sensory neuron
- ➢ medulla oblongata sense that there somethings wrong

(↑BP) ➡ (BP ⬇)

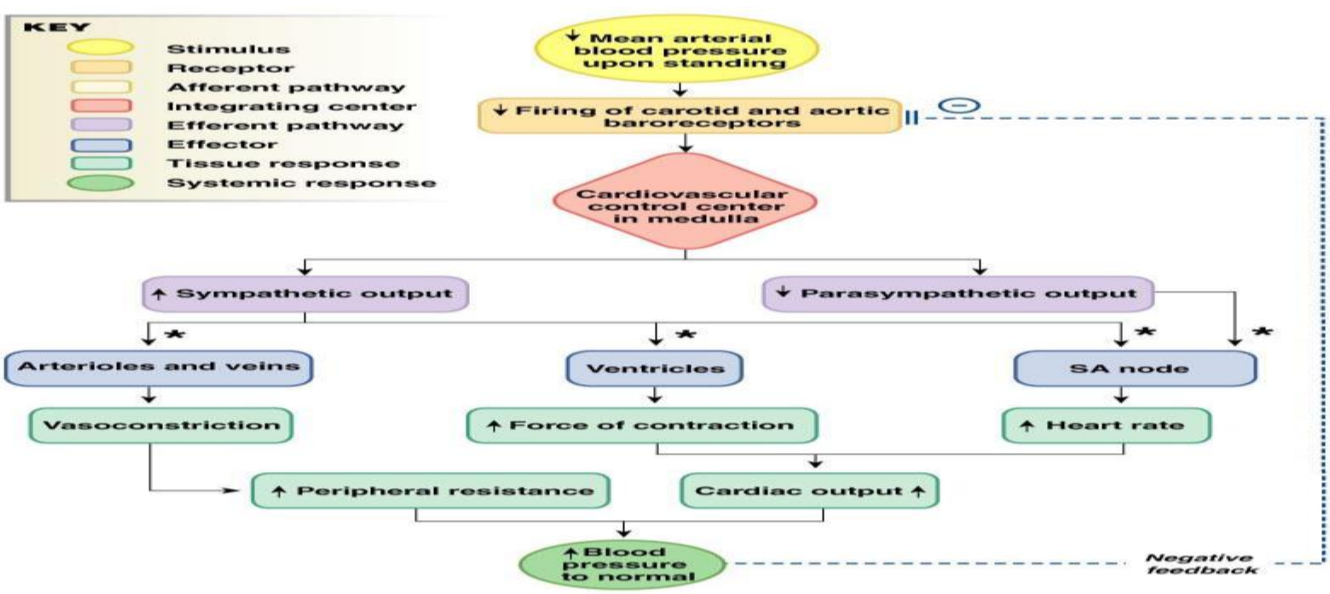
➢ Response \sensation will go to sympathetic {decrease sensitivity } \parasympathetic {increase sensitivity } output

➢ HOW ↓ sensitivity of sympathetic occur ?

1. decrease sensitivity of NE leads to vasodilation in arterial smooth muscle
2. ↓ force of contraction because the NE ↓
3. the regulation from first point lead to ,less contractility → less stretching relaxation → ↓heart rate
4. vasodilation → ↓resistance {why?} ↑diameter of smooth muscle → ↓BP
5. ↓heart rate + ↓force of contraction →↓cardiac output
6. resistance ↓,so according to ohm's law →↓BP = ↓resistance x↓CO

لما ال ↓ BPنعكس الرسمة

★ **NOTE:** NE usually link in α-receptors {adrenergic receptors }so vasoconstriction. Less releasing of NE causes vasodilation of arterial smooth muscle. when NE link in β-receptors {located in ventricle myocardium muscle } increase the contraction , when link in β1 usually increase the heart rate, but less releasing of NE lead to decrease heart rate



Adrenergic Receptors

- Located throughout the body
- Are 2 receptors for the sympathetic neurotransmitters
- Alpha-adrenergic receptors: respond to NE
- Beta-adrenergic receptors: respond to EPI

What do the receptors do?

- Activation of 〈 receptors leads to smooth muscle contraction
  positive
- Activation of ®2 receptors leads to smooth muscle relaxation {bronchi}
- Activation of ®1 receptors leads to smooth muscle contraction (especially in heart)

Clinical Utility of drugs which affect the adrenergic nervous system:

a.Agonists of the ®$_2$ receptors are used in the treatment of asthma (relaxation of the smooth muscles of the bronchi)

b.Antagonists of the ®$_1$ receptors are used in the treatment of hypertension and angina (slow heart and reduce force of contraction)

c.Antagonists {negative inotropes}of the 〈$_1$ receptors are known to cause lowering of the blood pressure (relaxation of smooth muscle and dilation of the blood vessels)

{agonist of the α1 receptor lead to contraction of smooth muscle & vasoconstriction positive inotropes }

agonist is a drug, which binds to a certain receptor and has the same effect of the origin neurotransmitter (a chemical that activates a receptor to give a response). However, antagonist binds to a receptor and stops its function.

Ventricular Compliance {changing of volume /pressure } to the heart

As the ventricle fills with blood, the pressure and volume that result from filling are determined by the compliance of the ventricle. Normally, compliance curves are plotted as the change in volume (ΔV) over the change in pressure (ΔP). Therefore, the slope of the relationship is the reciprocal of the compliance, which is sometimes referred to as ventricular "stiffness.“

- As the ventricle fills with blood and its volume increases, the pressure within the ventricular chamber passively increases (see the Normal filling curve in the figure). The relationship is not linear, particularly at higher volumes, because the compliance of the ventricular wall decreases ("stiffness" increases) the more the ventricular wall is stretched. This occurs in most biological tissues.
- in ventricular hypertrophy the ventricular compliance is decreased (i.e., the ventricle is "stiffer") because the thickness of the ventricular wall increases (tension↑ ,pressure↑); therefore, ventricular end-diastolic pressure (EDP) is higher at any given end-diastolic volume (EDV)

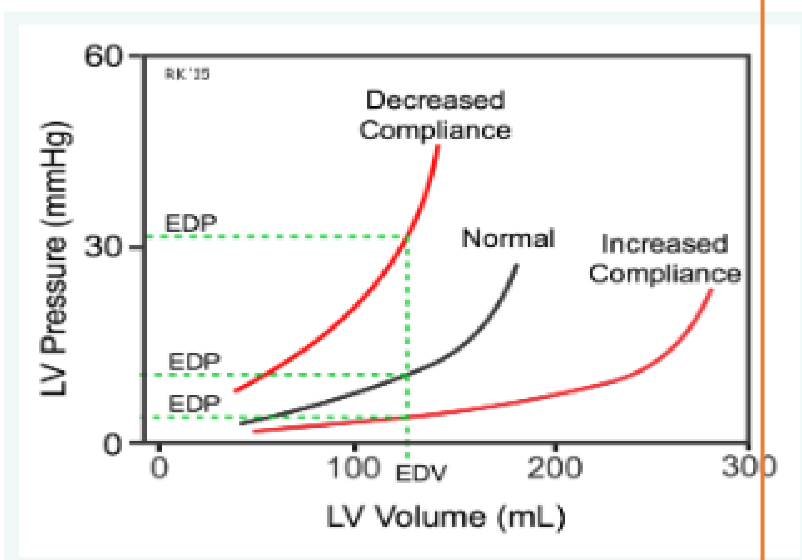
- In a disease state such as dilated cardiomyopathy, the ventricle becomes very dilated without appreciable thickening of the wall. This dilated ventricle will have increased compliance as shown in the figure; therefore, although the EDV may be very high, the EDP may not be greatly elevated.

NORMAL :{ linear }↑ volume , ↑ Preesure

most stretching point ➞ myosin move away from actin so myosin can't bind with any actin with filaments to reach max stretching ➞

لذلك مهما زاد الحجم الضغط ثابت

the pressure fixed after max stretching



“Conductance” of blood in a vessel and Its relation to resistance { to blood vessels }

Conductance (CL) is a measure of the blood flow through a vessel for a given pressure difference. .

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

This is generally expressed in terms of milliliters per second per millimeter of mercury pressure, but it can also be expressed in terms of liters per second per millimeter of mercury or in any other units of blood flow and pressure.

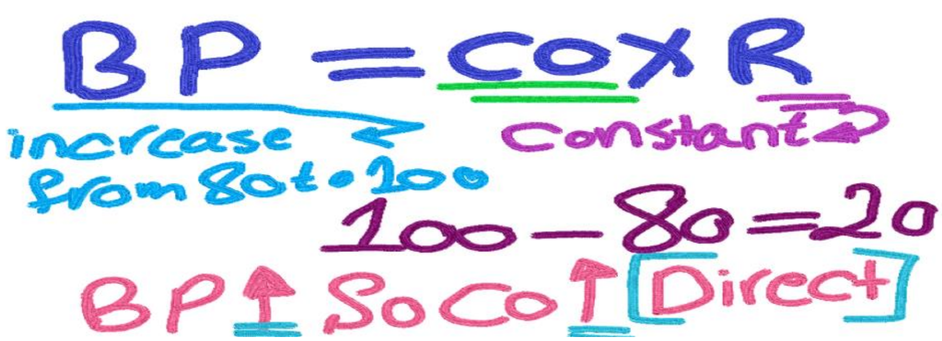
It is evident that conductance is the exact reciprocal of resistance in accord with the following equation:

Conductance= 1/Resistance indirect

The vascular compliance is proportional to the vascular distensibility and vascular volume of any given segment of the circulation. The compliance of a systemic vein is 24 times that of its corresponding artery because it is about 8 times as distensible, and it has a volume about 3 times as great.

اسئلة من الدكتورة خلال المحاضرة:

(1 If the arterial blood pressure is increased from 80 mm Hg to 100 mm Hg, and if total peripheral resistance is held constant, one could calculate that the cardiac output?



2) If we decrease heart rate what happens in stroke volume ?

answer:decrease heart rate increase stroke volume {indirect relationship}

note :

The average resting heart rate is usually between 60 and 80 bpm. But some athletes have resting heart rates as low as 30 to 40 bpm (beats per minute) **{why?}**

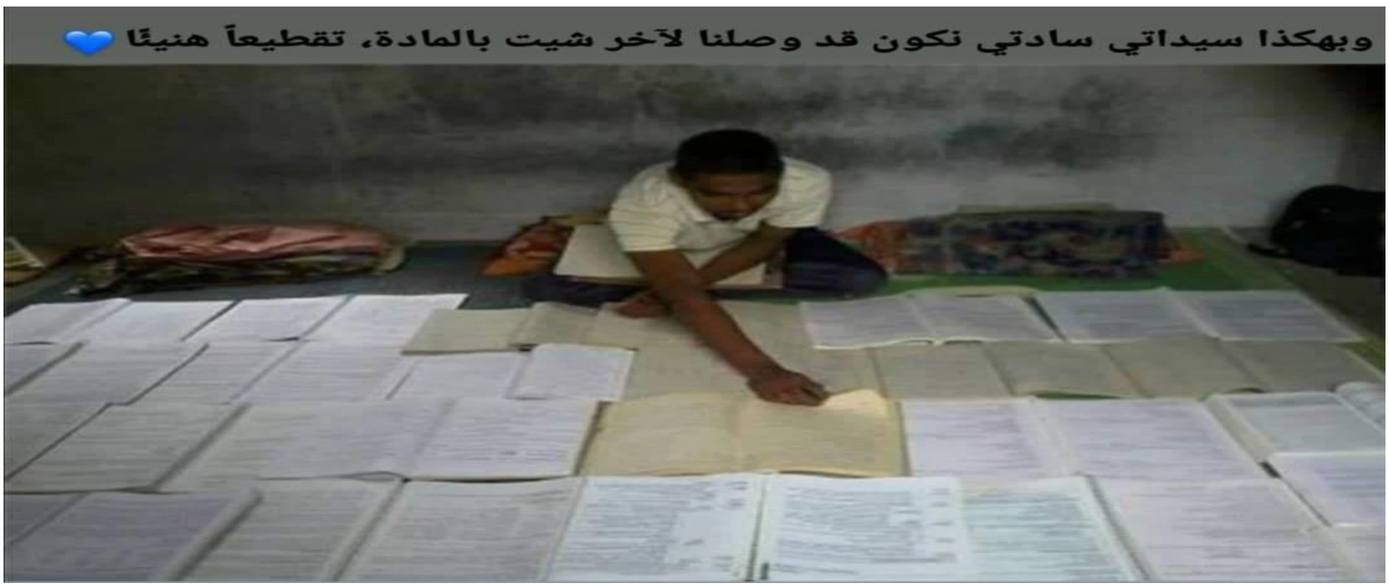
The muscles in the heart wall thicken, and the heart pumps more blood with each beat. so it is physiological (not pathological) case

3) compare between arteries & veins according to the conductance ?

answer : veins reserving the blood need large diameter , not need higher pulsation

artery pumping blood not need large diameter ,need higher pulsation

SO the veins have higher conductance



لجنة الطب والجراحة