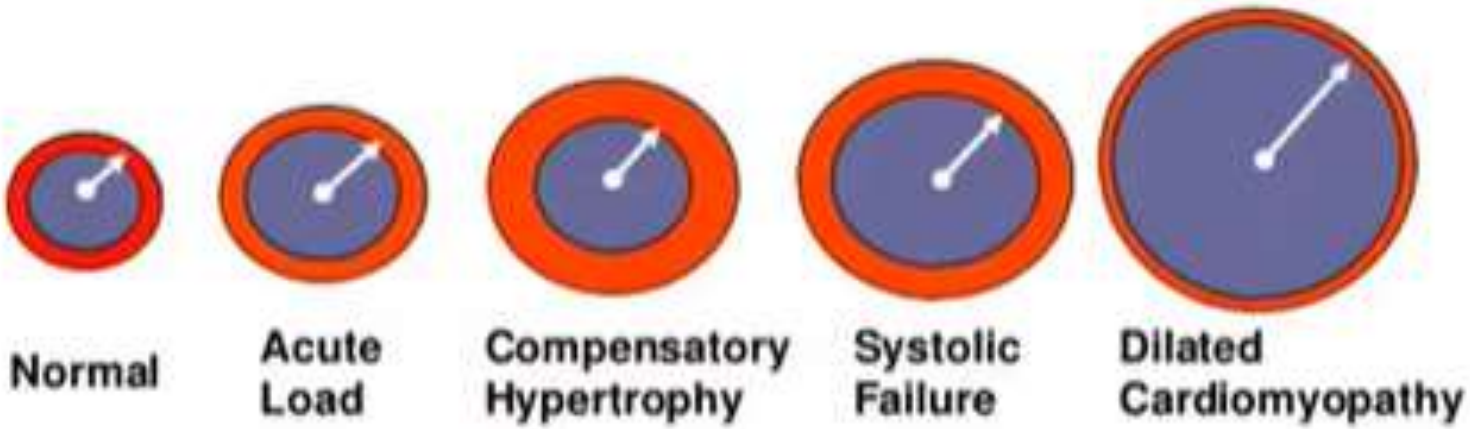
# Blood Pressure

Dr. Arwa Rawashdeh

# La Place law of the heart

## Pressure and Volume Govern Cardiac Function




La Place law for myocardial $O_2$ demand

$VO_2 \propto$ wall tension

Primary Target of Heart Failure Therapy: Reduce LV Wall Stress

$$\text{Laplace's Law: Wall stress} = \frac{\text{Pressure} \times \text{Radius}}{2 \times \text{Wall Thickness}} = \frac{\text{Pressure} \times \text{Volume}}{\text{LV Mass}}$$

Wall Stress

# What is blood pressure and Factors determining blood pressure

- Blood pressure is the pressure exerted by circulating blood on the wall of arteries
- One of the most physiological parameters of the body which is why including in the five vital signs along with temperature, heart rate, respiratory rate, oxygen saturation

- Factors affecting blood pressure
  - Heart rate
  - Myocardia contractility ; refers to how hard the heart is squeezing
  - Vascular tone; which refers to how much the arteries are constricted or relaxed
  - Blood volume
  - Blood viscosity
  - Arterial compliance; refers how much give or elasticity the arteries have

# Blood flow

- ***Laminar flow : normal blood flow in the blood vessels (physiological)***

❑ *As you go toward the edges the velocity the blood is going to be slower and the velocity in the middle is highest*

❑ *So imagine you are looking to blood vessels as a circle, and you are looking at the flow from the back you are going to notice that is flow is very concentric and this type of flow is silent*

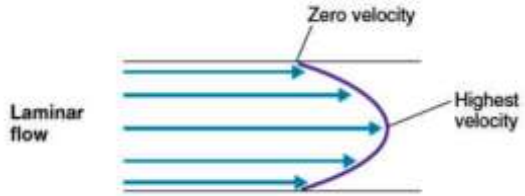
***Turbulent flow : pathological and physiological one***

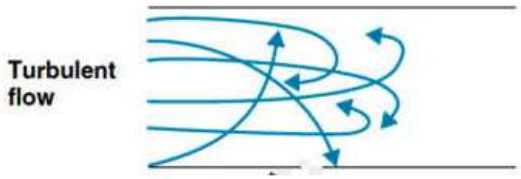
❑ *Inside our heart you have a valves mitral valve and aortic valve whenever blood is being pumped upward right it can hit mitral valve as it hits mitral valve it can develop turbulent flow*

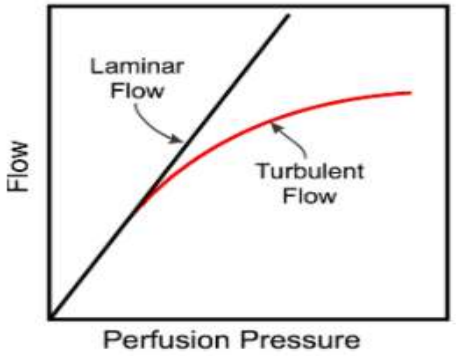
❑ *Imagine a blood vessels and plaques inside ; as the normal flow gets to the occlusion it start developing a turbulence and that gives a lot of heat and changes the action of perfusion pressure and produce what called brutes and can be heard at carotid artery so if you take a stethoscope and put it over carotid artery you can hear it is actual sounds that caused by turbulent flow. It also can produce murmurs*

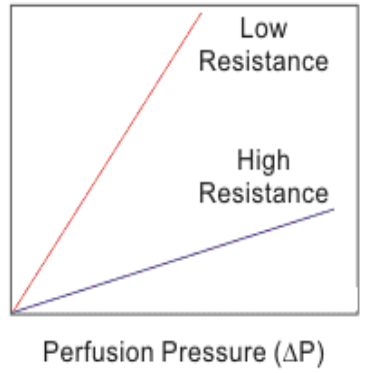
***If you look at the graph here ; as you increase the pressure the flow is increasing in normal or laminar flow, but you get to the point where the flow veers off and the flow start decreasing as the perfusion pressure start increasing***

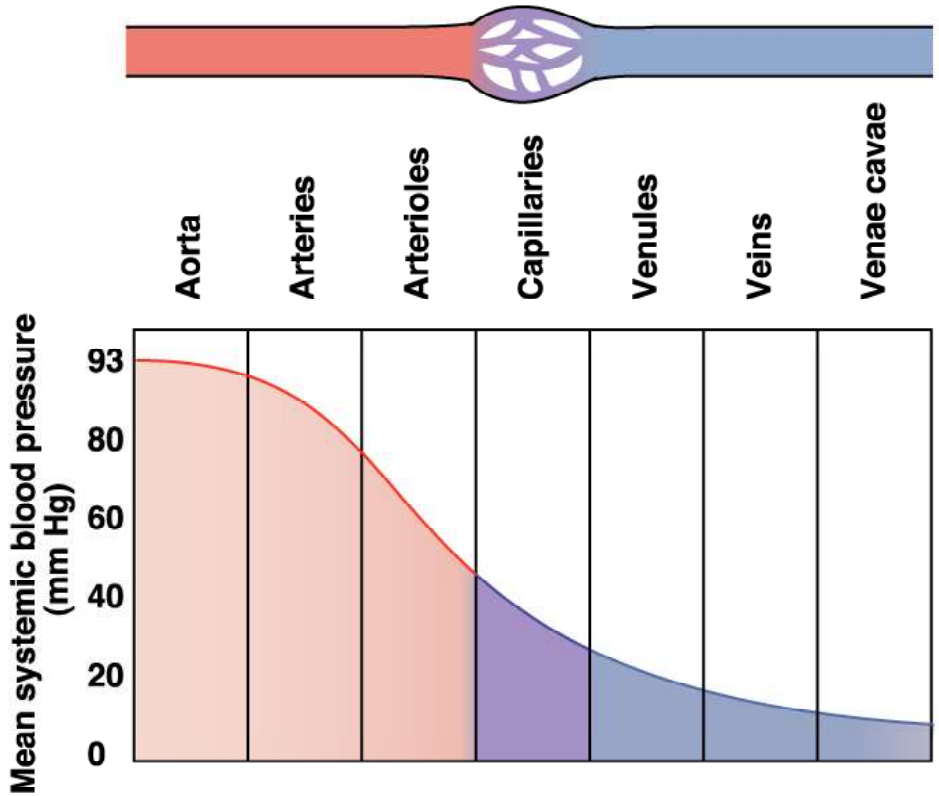
***If there is a turbulent flow it decreases the actual flow the volume of blood that circulating through an area of blood vessel per a minute and increase the perfusion pressure and the resistance is going to be very high***

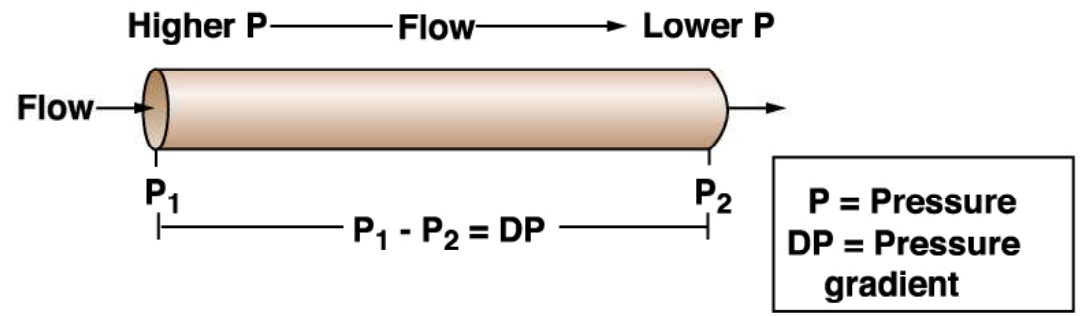



Aorta
Arteries
Arterioles
Capillaries
Venules
Veins
Venae cavae
Mean systemic blood pressure (mm Hg)
93
80
60
40
20
0


Higher P
Flow
Lower P
Flow
$P_1$
$P_2$
$P_1 - P_2 = DP$
P = Pressure
DP = Pressure gradient

# Perfusion pressure

- **Perfusion pressure (Δp) = Mean arterial pressure (MAP) – the central venous pressure(CVP)**
- *The central venous pressure (CVP) determines the right atrial pressure (RAP)*
- *The volume of blood pumped toward heart is your central venous pressure and the venous pressure affect your right atrium pressure and it is about 3-8mmHg; it is small we don't even consider it often*
- *So what we say that the*
- *(**Δp**) = Mean arterial pressure (MAP) what does that mean???*
- ***Systolic pressure***
- *When ever the heart contracting it pumping the blood outside the heart ; the force at which we are trying to push the blood out of the heart and into the actual major arteries is the systolic pressure (left ventricles to aorta ) and on average it is a bout 120mmHg*
- *When ever the blood comes into the aorta it stretches the wall of the aorta so the wall of the aorta is going to be stretched now this is not that is stretching the walls is the systolic pressure but what happens is eventually; the actual aorta is very elastic and wants to recoil and squeeze the blood downwards or upwards to the head and the neck*
- ***Diastolic blood pressure***
- *Whenever the aorta is coming back to it is natural size the point when is relaxing and going back to its normal size original size ; this is called the diastolic blood pressure and on average it is about 80mmHg*

# Mean arterial blood pressure

- $\boldsymbol{MAP = diastolic\ pressure + 1/3\ pulse\ pressure = 93mmHg}$

- ***Pulse pressure***
- *The difference between systolic and diastolic pressure which is 40mmHg on average*

❑ *To calculate a mean arterial pressure, double the diastolic blood pressure and add the sum to the systolic blood pressure. Then divide by 3. For example, if a patient's blood pressure is 83 mm Hg/50 mm Hg, his MAP would be 61 mm Hg. Here are the steps for this calculation:*

- $MAP = \frac{SBP + 2\ (DBP)}{3}$

*the ventricles spend approximately one-third (1/3) of their time in systole, and two-thirds (2/3) in diastole*

- ***It is so important because it determines the actual pressure by which will propel the substances out of the capillary beds into the tissues***
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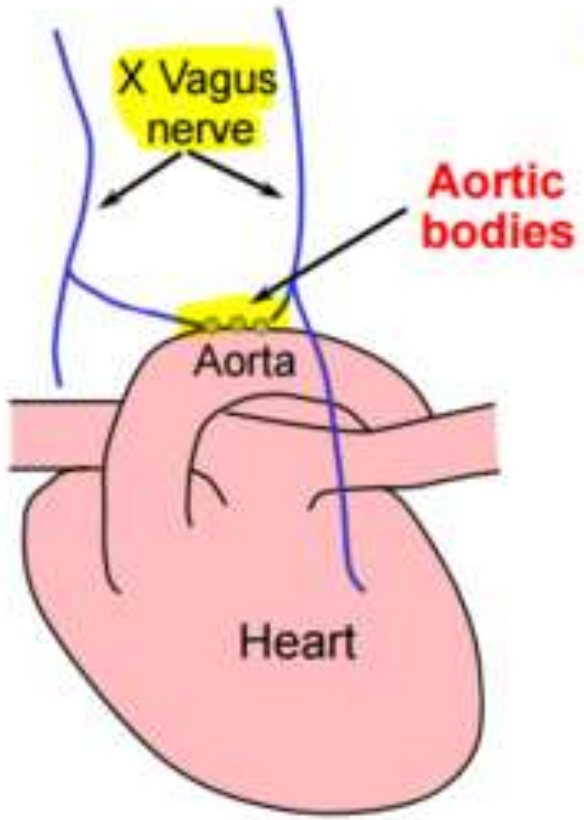
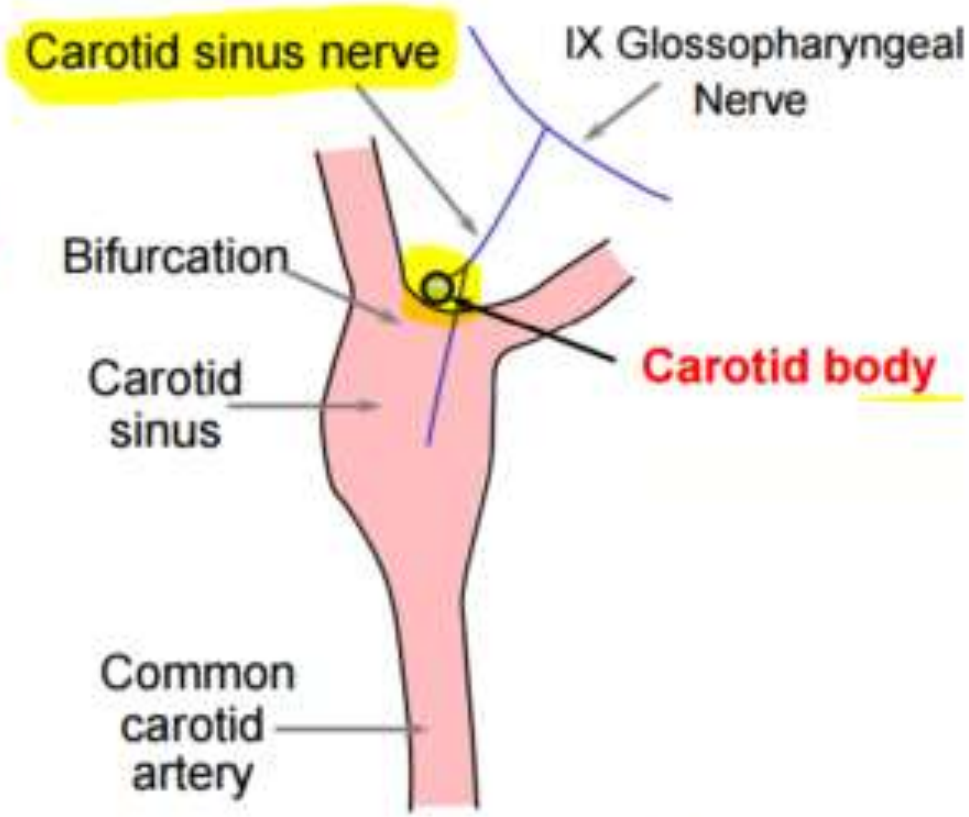
# Korotkoff sound

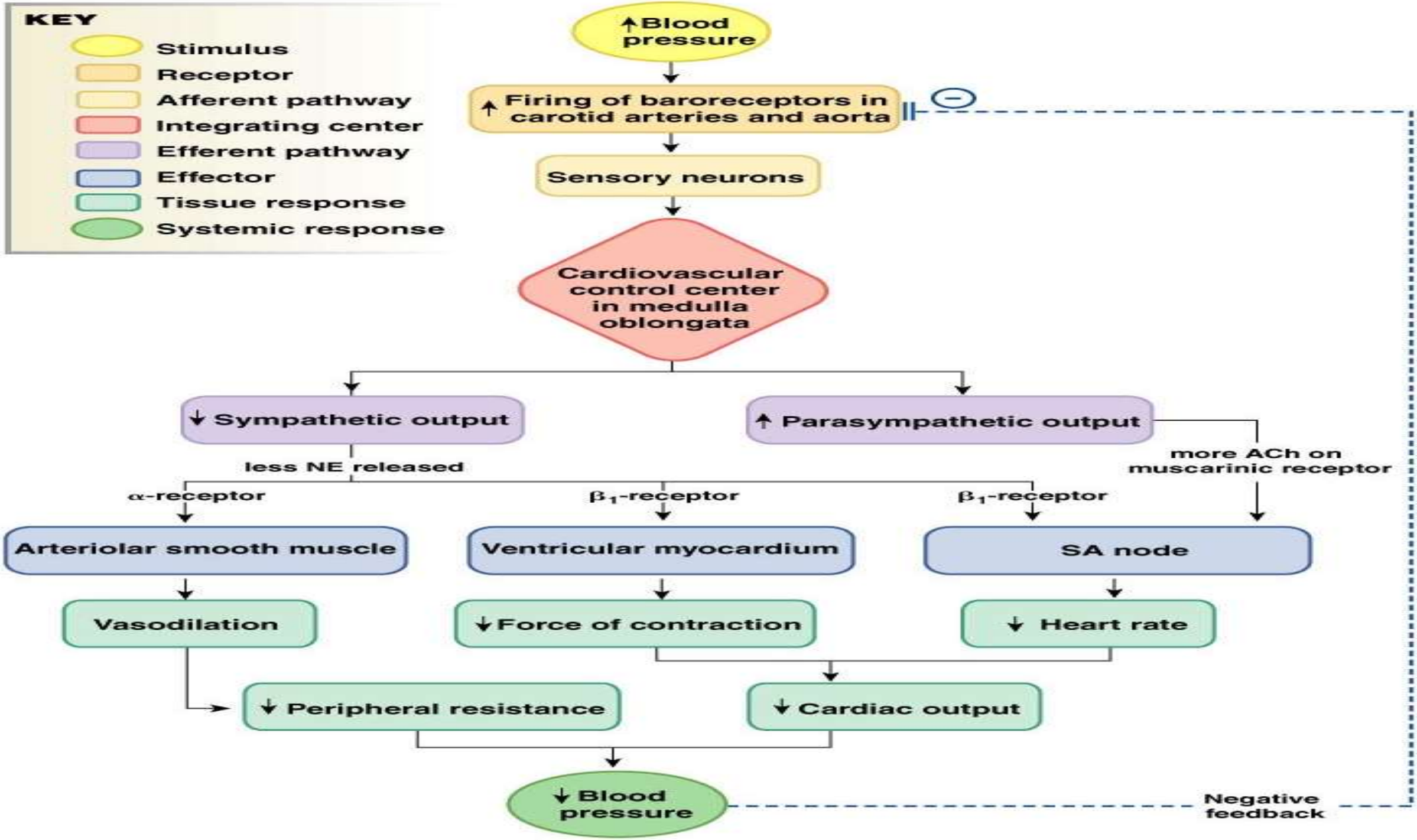
- *Put the blood pressure cuff on you start pumping the blood pressure cuff*
- *As you start pumping the cuff usually put around the brachial area, so you are compressing the  brachial artery as you compressing the brachial area you are going to decreasing and slowing the blood flow to that area*
- *Keep pumping it until you hear no sounds like hit it 30-50mmhg above*
- *Once you get to a decently high point Then start slowly letting go and you going to hearing tapping sound and it is like swishing sound and this Korotkoff sound*
- *After those sounds go away it leads into the  first sound is the systolic pressure*
- *Those sounds of systolic pressure is going to continue and continue until the sound completely dissipate that last point at which the sounds disappear is called the diastolic pressure*

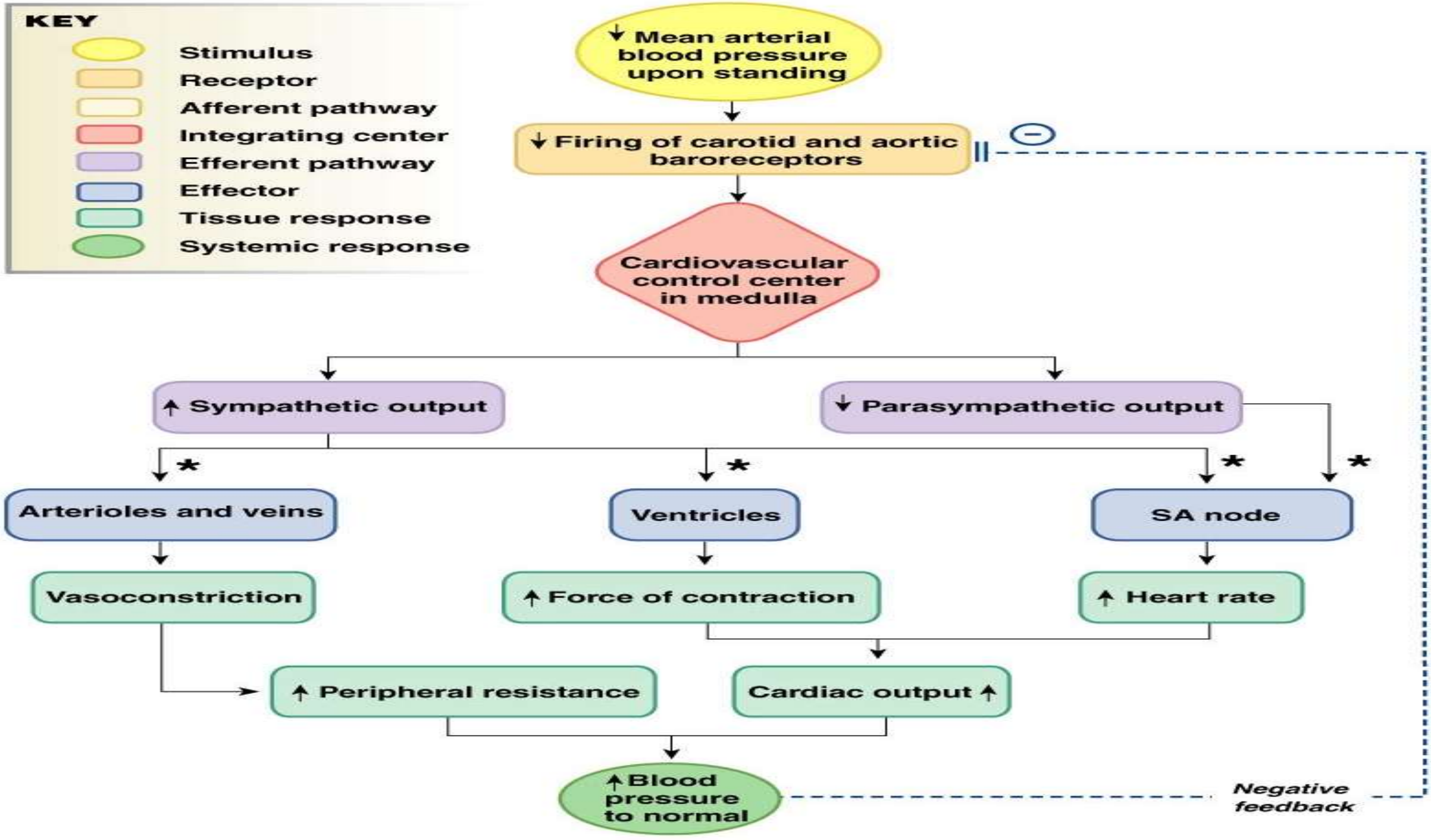



Aortic bodies present on upper part of the aortic arch and innervated by the vagus




Carotid body present at the top of the bifurcation of the common carotid artery, innervated by the carotid sinus nerve. Most important in humans


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
α-receptor
β1-receptor
β1-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
Afferent pathway
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