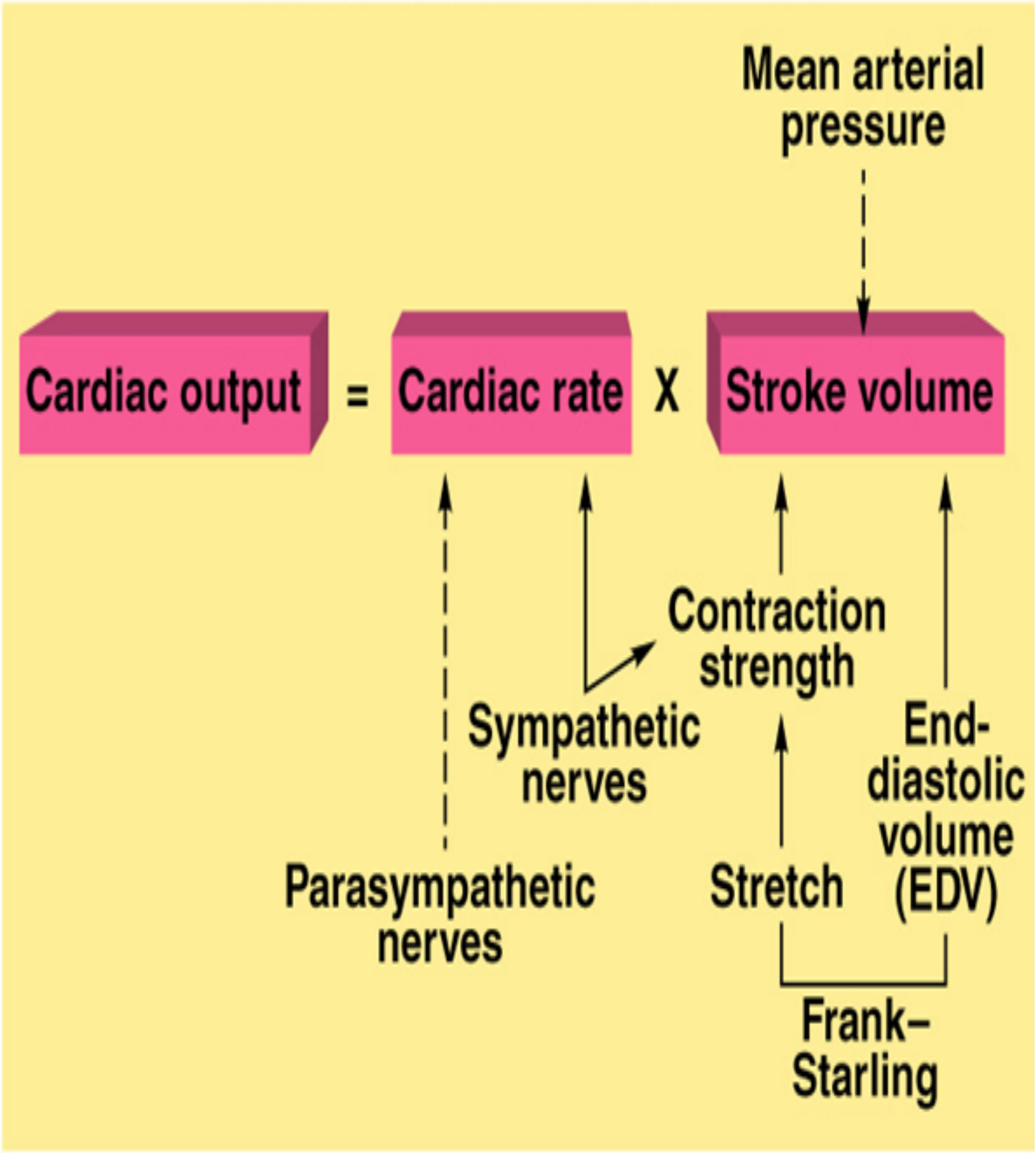
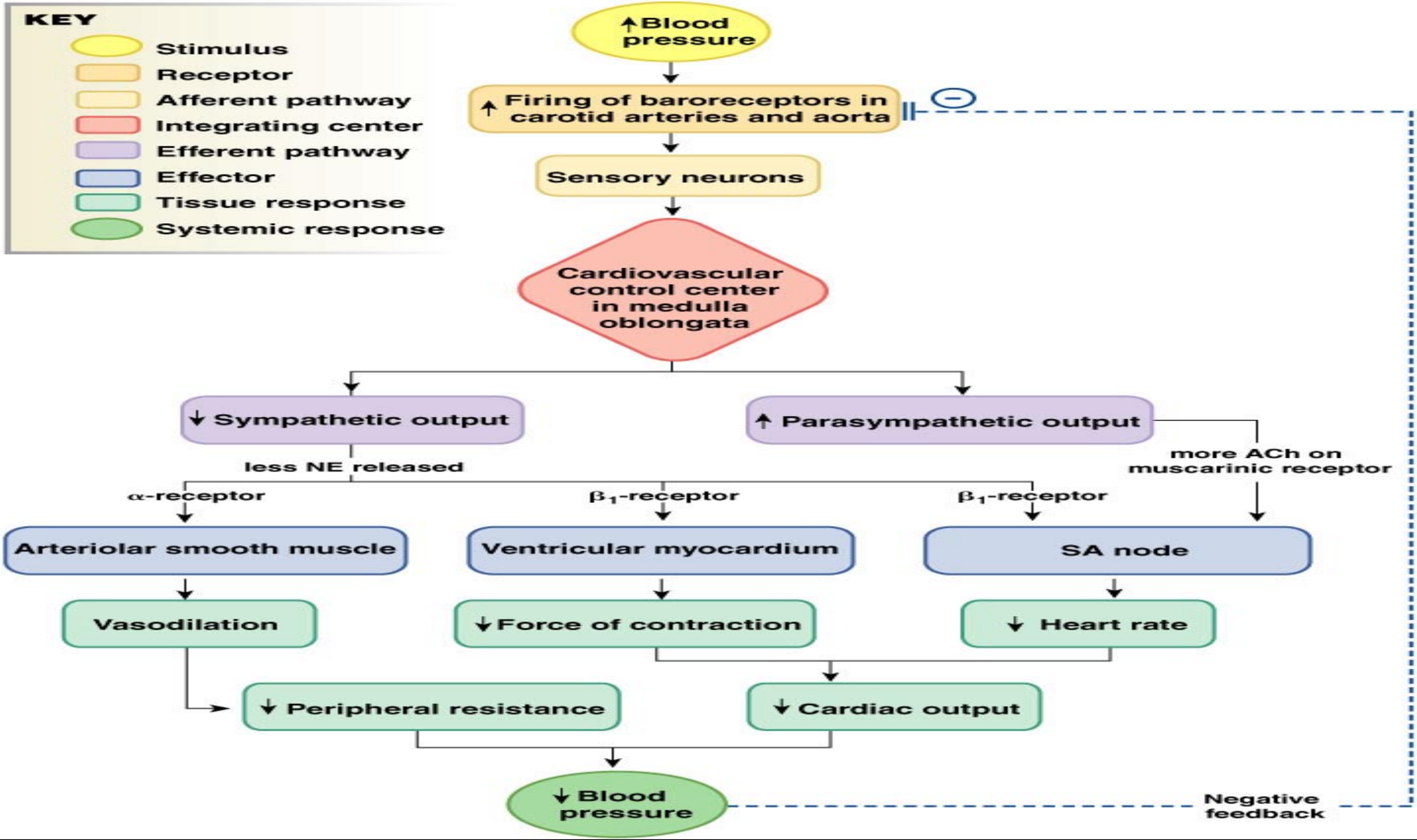
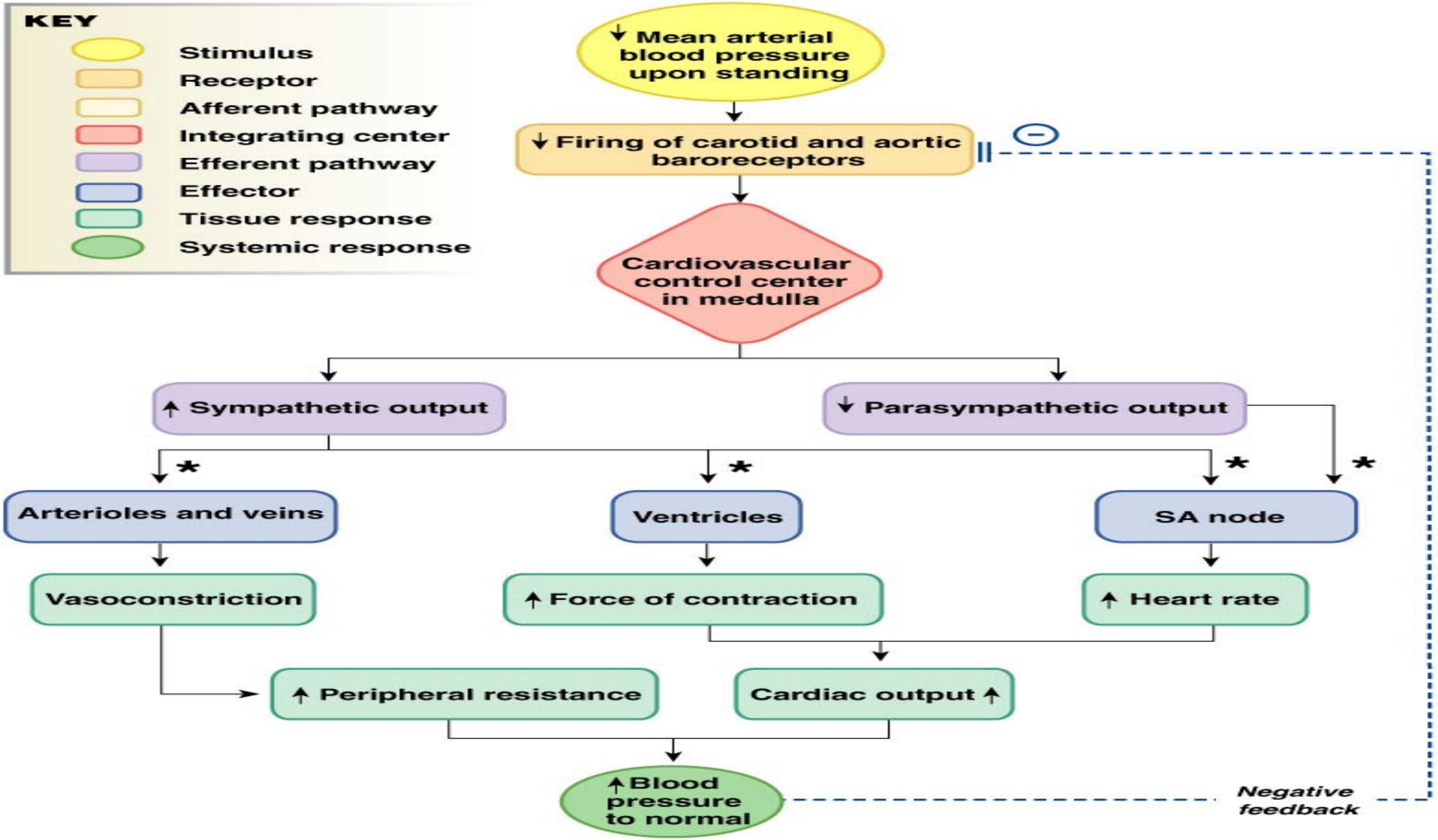
Regulation of cardiac output (implication of frank- starling law)

- Nervous system modifies the cardiac rate

- Pacemakers trigger the action potential
- Positive inotropes (increase the contractility)
- Negative inotropes (decrease the cardiac contractility)




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
β_1-receptor
β_1-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

Adrenergic Receptors

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

What do the receptors do?

Activation of **α receptors** leads to smooth muscle contraction

Activation of **β2 receptors** leads to smooth muscle relaxation

Activation of **β1 receptors** leads to smooth muscle contraction (especially in heart)

Clinical Utility of drugs which affect the adrenergic nervous system:

a. **Agonists** of the **β_2 receptors** are used in the treatment of asthma (<u>relaxation</u> of the smooth muscles of the bronchi)

b. **Antagonists** of the **β_1 receptors** are used in the treatment of hypertension and angina (<u>slow</u> heart and reduce force of contraction)

c. **Antagonists** of the **α_1 receptors** are known to cause lowering of the blood pressure (relaxation of smooth muscle and dilation of the blood vessels)

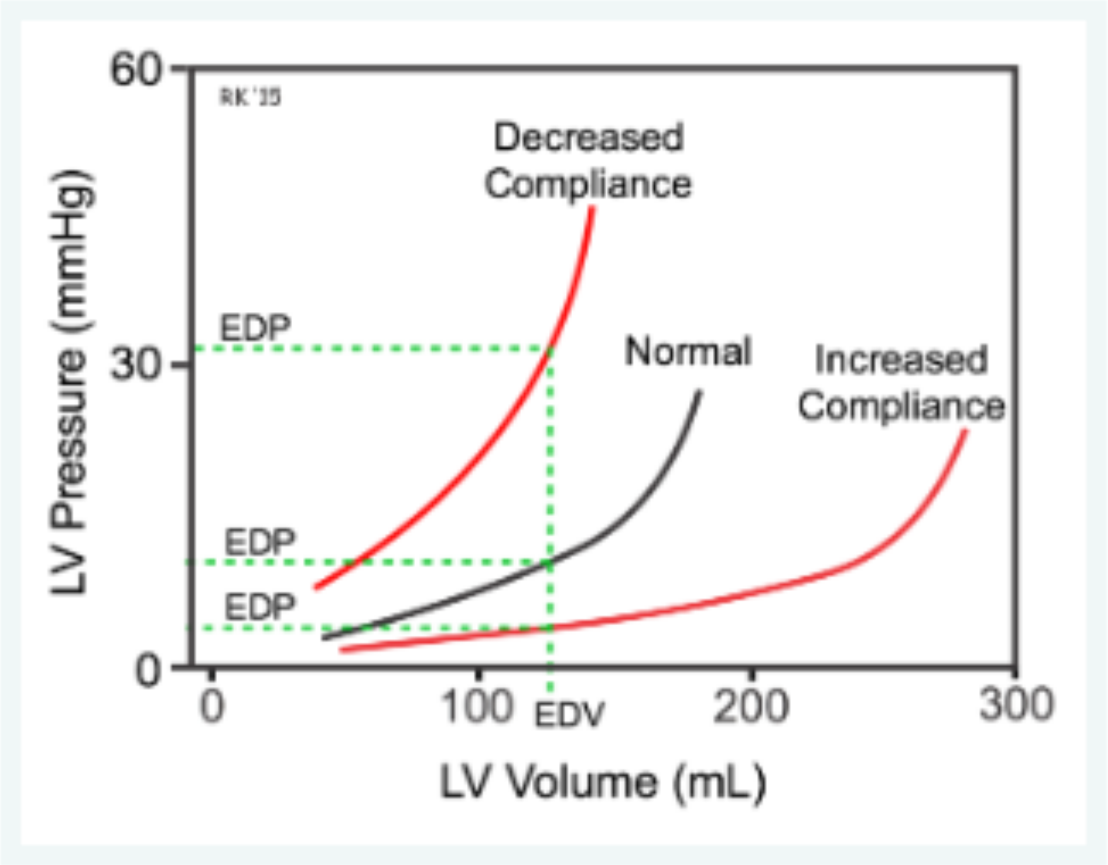
Ventricular Compliance

- 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; 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.



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

Conductance (C_L) 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

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.