### The pacemaker and automatic control of the heart

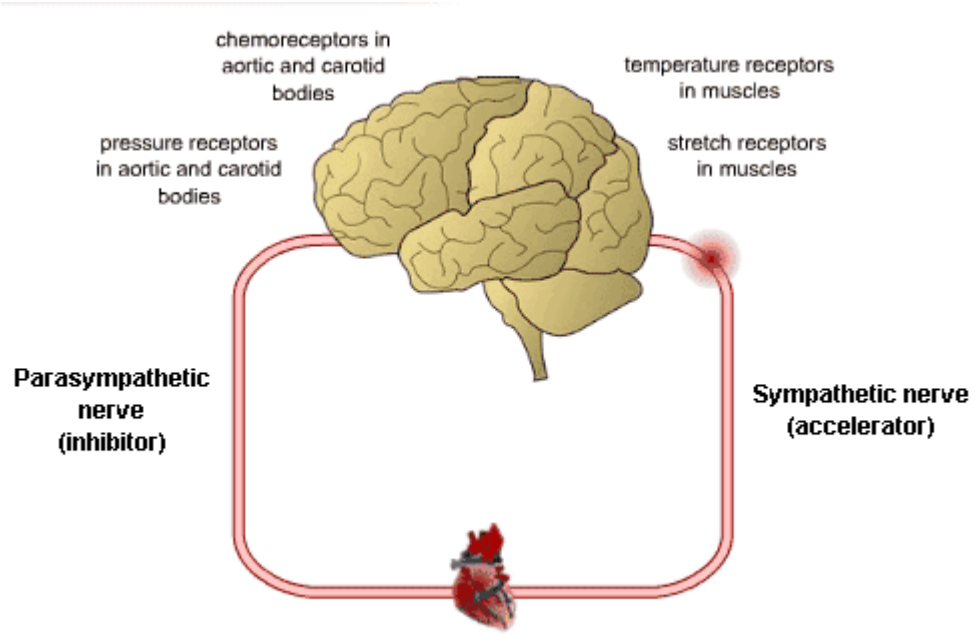
The specialized muscle fibres in the sinoatrial (SA) node initiate action potentials at a rate of 90 to 100 times per minute. This is faster than action potentials that may be initiated from other areas, so the SA node stimulates other areas of the conduction system first so that they do not create their own slower electrical signal. The electrical message from the SA node is therefore the pacemaker, although if these fibres become damaged, cells in the AV node (the secondary pacemaker) take over and usually create 40-60 beats per minute. However, heart rate is constantly modified by sympathetic and parasympathetic nerve fibres, and the average resting heart rate in adult humans is approximately 70 beats per minute.

## The heart beat and heart rate

The cardiovascular centre in the **medulla oblongata**, located in the brain stem, receives information from other areas of the brain and body, and conveys the relevant nervous output to the heart via the sympathetic and parasympathetic branches of the autonomic nervous system (ANS).

The sympathetic nervous system increases the heart rate and stroke volume in response to a number of different messages from other parts of the body. The sympathetic nervous system is stimulated during exercise, stress, anger, fear or emotion, with an end result of increased cardiovascular output.

During exercise, chemoreceptors register the increased amount of carbon dioxide ($CO_2$) and reduced blood pH, and send this information to the cardiovascular centre in the brain. Sympathetic nerve fibres send a message on to the SA node and myocardium, increasing cardiac output through increased depolarization in the SA and AV nodes (increasing heart rate) and increasing atrial and ventricular contractility (increasing stroke volume). This pumps more blood to the lungs so the $CO_2$ can be exhaled and blood pH returns to normal.




During Exercise

UHI / CC0

(Click image to toggle animation on/off)

**Text**

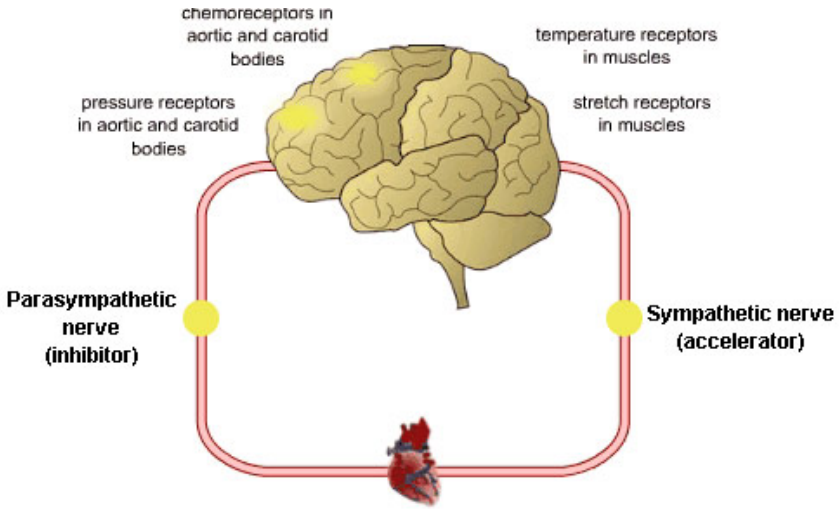
Parasympathetic nerve (inhibitor), pressure receptors in aortic and carotid bodies, chemoreceptors in aortic and carotid bodies, temperature receptors in muscles, stretch receptors in muscles, Sympathetic nerve (accelerator).

### How the nervous system affects our heart rate

**Sympathetic impulses** cause an increase in heart rate through release of a neurotransmitter called noradrenalin.

**Parasympathetic impulses** cause a decrease in heart rate through the release of a neurotransmitter called acetyl choline.

Hormones such as **adrenaline** (released during stress from the adrenal medulla) and thyroid hormones from the **thyroid gland** also accelerate the heart rate.




(files/images/how-nervous-system-affects-heart-rate.jpg?1612287030719)

UHI / CC0

**Text**

Parasympathetic nerve (inhibitor), pressure receptors in aortic and carotid bodies, chemoreceptors in aortic and carotid bodies, temperature receptors in muscles, stretch receptors in muscles, Sympathetic nerve (accelerator).

## Quiz

Embedded content: https://edu-dev.wp.uhi.ac.uk/wp-admin/admin-ajax.php?action=h5p_embed&id=60 (https://edu-dev.wp.uhi.ac.uk/wp-admin/admin-ajax.php?action=h5p_embed&id=60)

## Blood pressure

Blood pressure is simply a measurement of the pressure exerted by the blood upon the walls of the blood vessels.