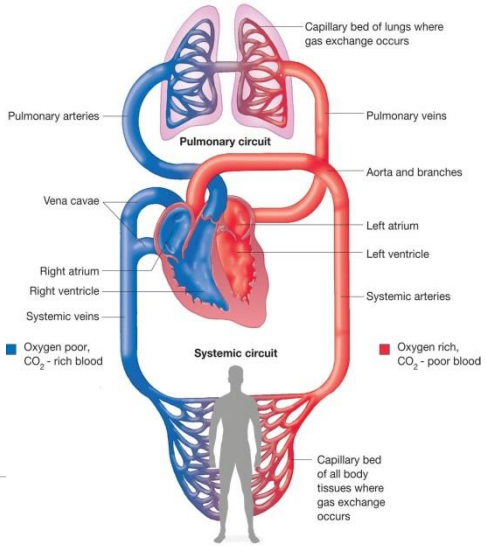
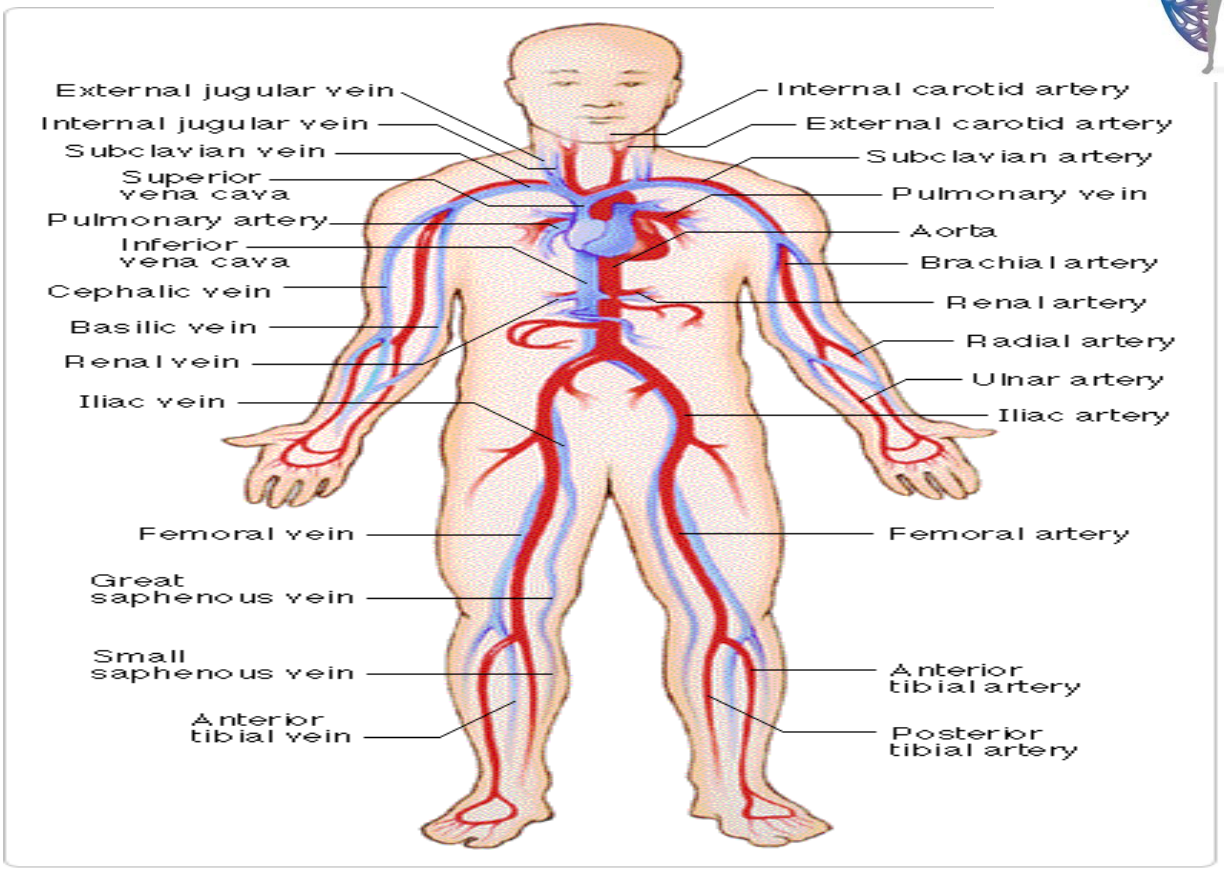
Structure & Function of the Cardiovascular System Exercise Physiology

2.2.5 Outline the relationship between the pulmonary and systemic circulation



- **Pulmonary circulation** is the portion of the cardiovascular system which carries oxygen-depleted blood away from the heart, to the lungs, and returns oxygenated blood back to the heart.
- **Systemic circulation** is the portion of the cardiovascular system which **carries oxygenated blood** away from the heart, to the body, and **returns deoxygenated blood** back to the heart.

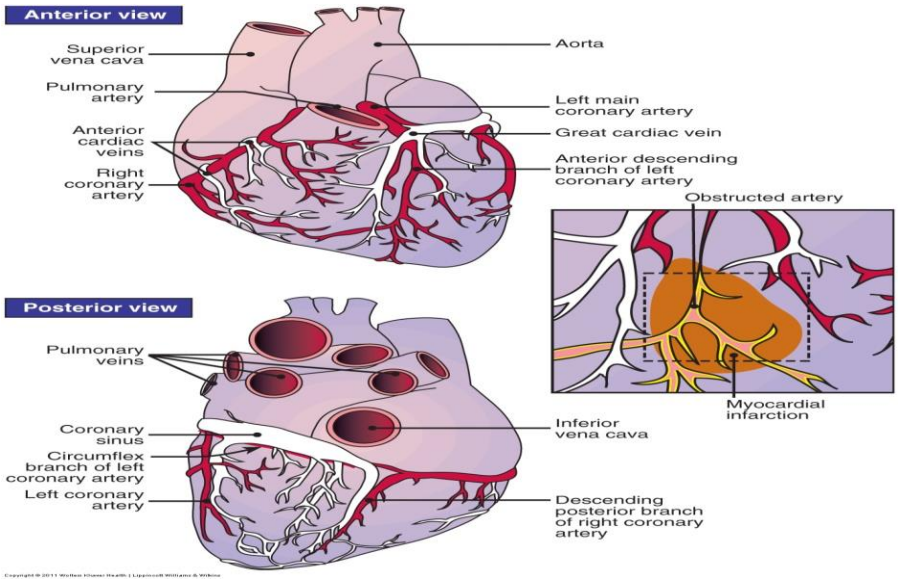
2.2.3 Describe the anatomy of the heart with reference to the heart chambers, valves and major blood vessels



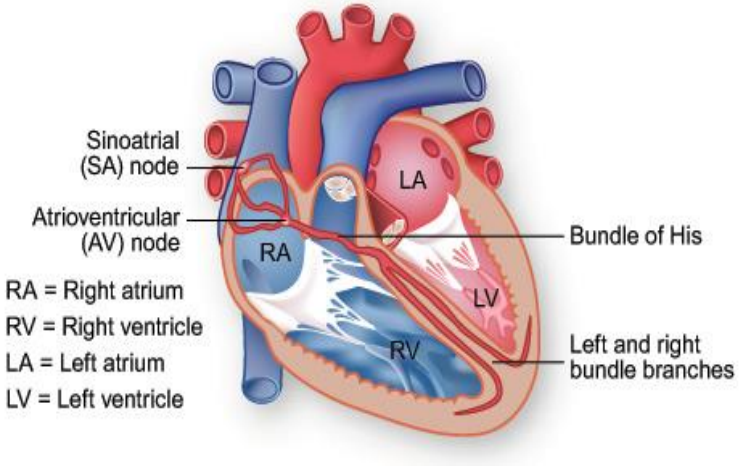
2.2.4 Describe the intrinsic and extrinsic regulation of heart rate and the sequence of excitation in the heart muscle

- The heart is able to beat after being separated from the body of its owner (as seen in horror films/etc) is not totally a product of overactive imaginations.
- The heart can actually continue to beat for a number of hours if supplied with appropriate nutrients and salts.
- This is because the heart has its own specialized conduction system and can beat independently of its nerve supply.

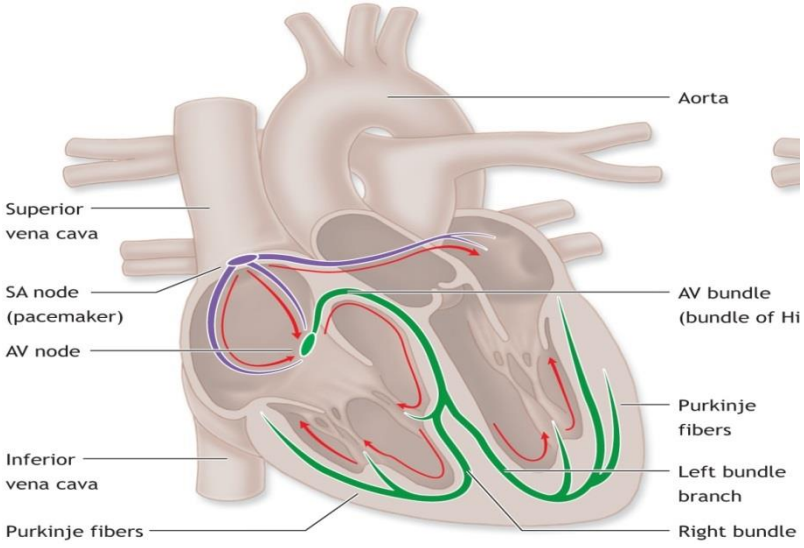
- **Coronary circulation – circulating the blood the heart muscle needs**
    - **Right coronary artery:** Supplies predominantly the right atrium and ventricle
    - **Left coronary artery:** Supplies the left atrium and ventricle, and a small portion of the right ventricle



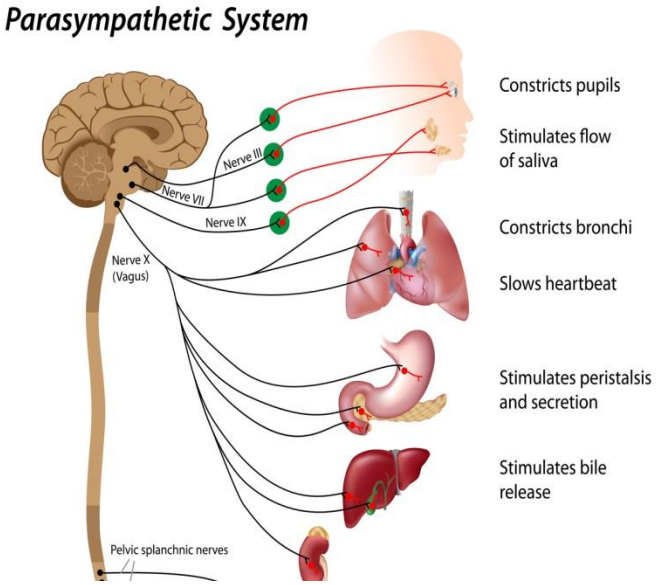
- **<u>The sinoatrial (SA) node</u>** - a small mass of specialized muscle in the posterior wall of the right atrium.
- Because automatic self-excitation of the SA node initiates each heartbeat, setting the basic pace for the heart rate, the SA node is known as the **<u>pace maker.</u>**
    - The end of the fibers of the SA node fuse with surrounding atrial muscle fibers so that the contraction spreads, producing atrial contraction.
    - Several groups of atrial muscle fibers conduct the contraction to the atrioventricular (AV) node, which spreads action potential (impulse) throughout the rest of the heart via specialized muscle fibers called <u>Purkinje fibers</u>.
        - These form the atrioventricular (AV) bundle OR <u>bundle of his</u>.



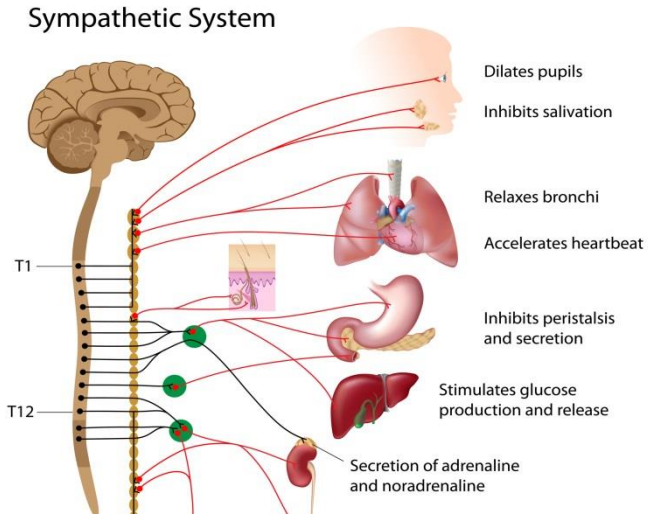
- **The heart rate that is produced solely by the SA node, with no other neural control or hormonal control, is known as intrinsic heart rate regulation.**
- Although the heart is capable of beating independently of body control systems**, in order to adapt its rate to the changing needs of the body** it is carefully regulated by the nervous system.
- A number of other factors**, including hormones, blood chemistry and change in body temperature** can influence heart rate.

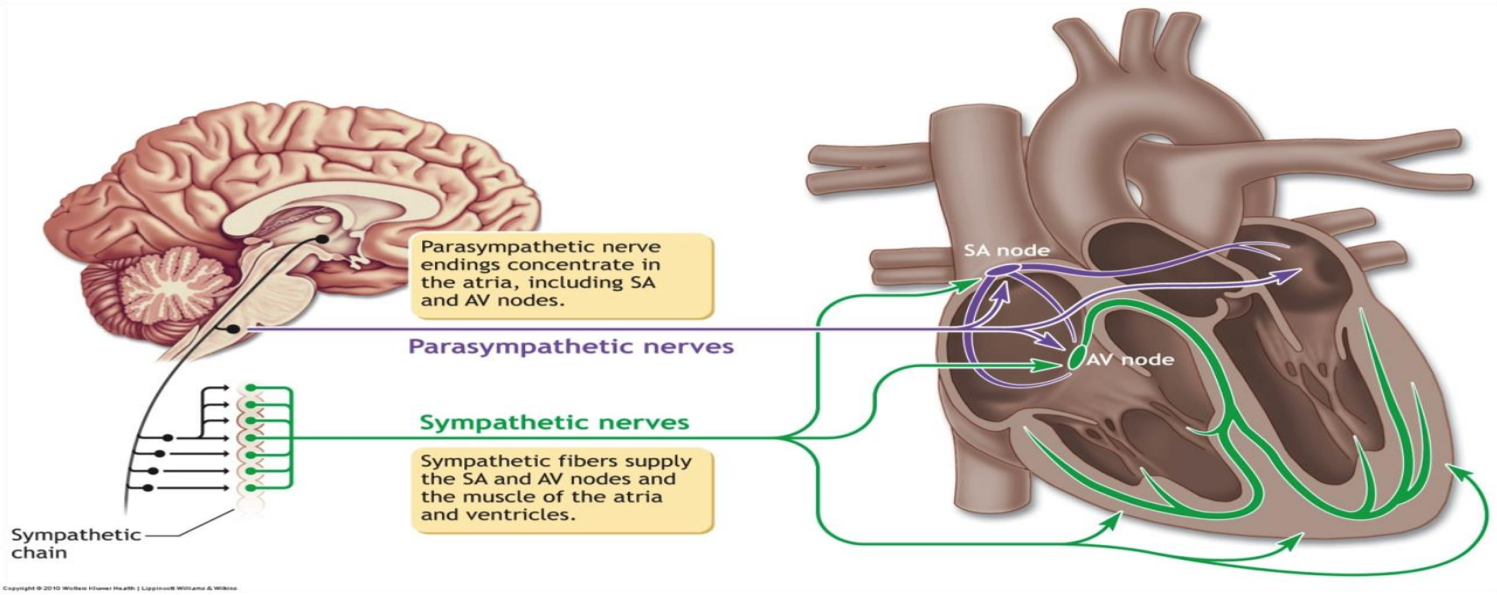


- **The heart is innervated (supplied with nerves) by:**
    - **<u>Parasympathetic</u> nerves that slow it's rate,**
        - **<u>Parasympathetic innervation</u> originates in the cardiac centers <u>in the medulla</u> and passes to the heart by way of the vagus nerves.**
        - **Vagus nerve fibers supply the SA (sinoatrial) and AV (atrioventricular) nodes.**
        - **When stimulated, these parasympathetic nerves release <u>acetylcholine</u>, which slows the heart.**
        - **This slowing of the heart is called <u>Bradycardia</u>**

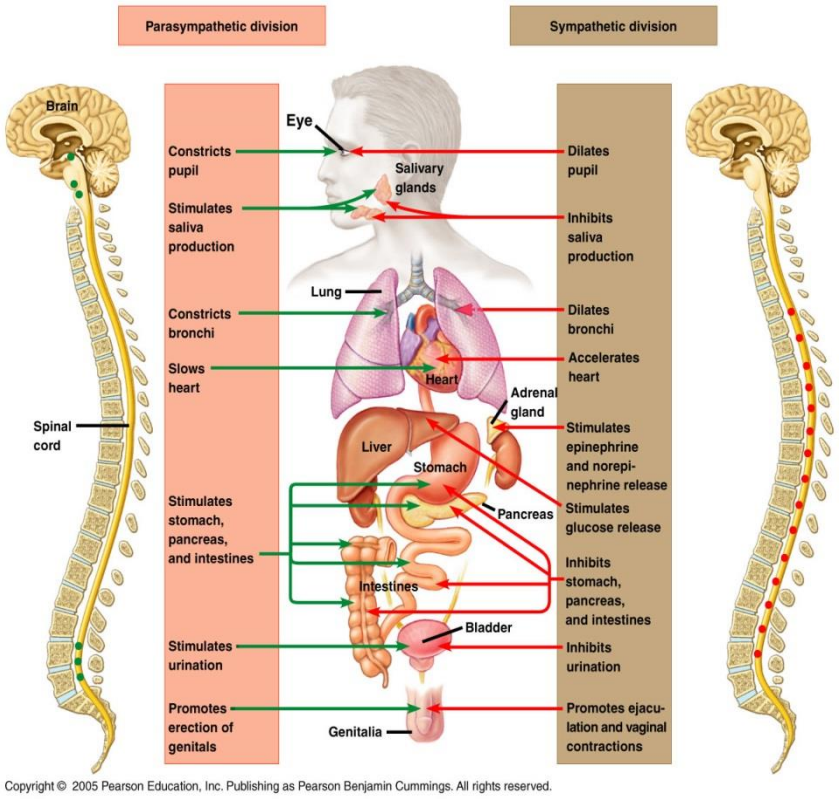


    - **<u>Sympathetic</u> nerves that speed it up.**
        - The change of heart rate the sympathetic and parasympathetic nerves/nervous systems can produce is an example of **<u>extrinsic heart rate regulation.</u>**
        - Sympathetic nerves that serve the heart originate in the **<u>upper thoracic spinal cord</u>** and reach the myocardium by way of several nerves sometimes called accelerator nerves.
        - These nerves supply the nodes and also the muscle fibers themselves.





- When Sympathetic nerves are stimulated, they release **norepinephrine or noradrenaline**, which increases the heart rate as well as the strength of ventricular contraction (heart beat)
    - **This speeding up of the heart rate is called Tachycardia**
    - Noradrenaline is released from the adrenal medulla of the adrenal glands as a <u>hormone</u> into the blood
        - It is also a <u>neurotransmitter</u> in the central nervous system and sympathetic nervous system where it is released from **noradrenergic neurons** during synaptic transmission
            - **Noradrenergic neurons**: neurons in the brain that form a <u>neurotransmitter system</u>. When activated, exerts effects on large areas of the brain. The effects are manifested in alertness, <u>arousal</u>, and readiness for action.



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2.2.6 Describe the relationship between heart rate, cardiac output and stroke volume at rest and during exercise

- <u>Heart Rate</u> = the speed of the heartbeat measured by the number of contractions of the heart per minute (bpm)
- <u>Cardiac Output</u> = the amount of blood pumped from the heart in one minute. This measured in liters per minute.
- <u>Stroke Volume</u> = the amount of blood pumped by each ventricle in each contraction. The average volume is about 0.07 liters of blood per beat.
    - All of the previous increase as a result of exercise
    - One response to exercise of the cardiovascular system is the increase in cardiac output from around 5 liters at rest to between 20 and 30 liters during maximal exercise.
        - The response is due to an increase in stroke volume in the rest to exercise transition, and an increase in heart rate.
    - Heart rate can reach 200bpm or more in some individuals. **Maximal <u>cardiac output</u> differs between people primarily due to differences in body size and the extent to which they might be endurance trained.**