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COURSE NAME: PHYSIOLOGY

COURSE CODE: PHY 201

CLASS: 200 LEVEL

ASSIGNMENT QUESTIONS:

1. **Discuss the long term regulation of mean arterial blood pressure**
2. **Write short notes on the following:**

a. **Pulmonary circulation**

b. **Circle of willis**

c. **Splanchnic circulation**

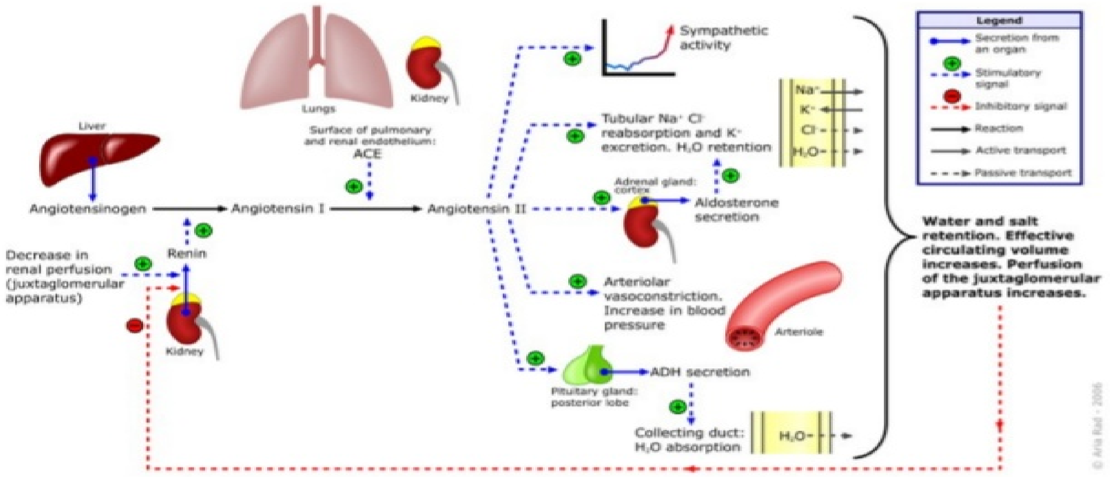
d. **Coronary circulation**

e. **Cutaneous circulation**

3. **Discuss the cardiovascular adjustment that occurs during exercise.**

1. **<u>THE LONG TERM REGULATIONS OF MEAN ARTERIAL BLOOD PRESSURE</u>**

Renin-angiotensin-aldosterone system.



RENIN-ANGIOTENSIN-ALDOSTERONE SYSTEM (RAAS)

Renin is a peptide hormone released by the granular cells of the juxtaglomerular apparatus in the kidney, it is released in response to:

- Sympathetic stimulation
- Reduced sodium-chloride delivery to the distal convoluted tubule
- Decreased blood flow to the kidney

Renin facilitates the conversion of angiotensinogen to angiotensin I which is then converted to angiotensin II using angiotensin-converting enzyme (ACE). Angiotensin II is a potent vasoconstrictor. It acts directly on the kidney to increase sodium reabsorption in the proximal convoluted tubule, Sodium is reabsorbed via the sodium-hydrogen exchanger. Angiotensin II also promotes release of aldosterone. Angiotensin-converting enzyme also breaks down a substance called bradykinin which is a potent vasodilator. Therefore, the breakdown of bradykinin potentiates the overall constricting effect.

Aldosterone promotes salt and water retention by acting at the distal convoluted tubule to increase expression of epithelial sodium channels. Furthermore, aldosterone increases the activity of the basolateral sodium-potassium ATP-ase, thus increasing the electrochemical gradient for movement of sodium ions. More sodium collects in the kidney tissues and water flows by osmosis. This results in decreased water excretion and therefore increased blood volume and thus blood pressure.

CLINICAL RELEVANCE- HYPERTENSION

Hypertension is defined as a sustained increase in blood pressure. It may be primary (of an unknown cause) or secondary to another condition such as chronic renal disease or Cushing's syndrome.

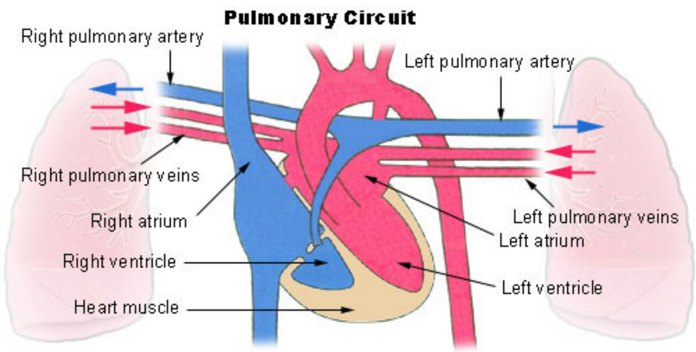
Hypertension causes damage to the walls of blood vessels, making them weaker. This leads to a number of pathologies including atherosclerosis, thromboembolism (progressing to MI or stroke) and aneurysms.

Hypertension also damages the heart itself by increasing the afterload of the heart. The heart is pumping against greater resistance, leading to left ventricular hypertrophy. This increases the risk of heart failure in the future.

Hypertrophy of the cardiac muscles also increases the heart's oxygen demand, predisposing to myocardial ischaemia and ultimately angina.

2a. PULMONARY CIRCULATION

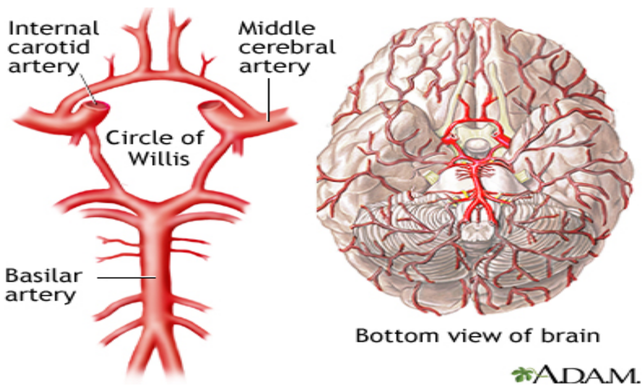
The **pulmonary circulation** is the portion of the circulatory system which carries deoxygenated blood away from the right ventricle, to the lungs, and returns oxygenated blood to the left atrium and ventricle of the heart. The term pulmonary circulation is readily paired and contrasted with the systemic circulation. The vessels of the pulmonary circulation are the pulmonary arteries and the pulmonary veins.



Human pulmonary circulation. Oxygen-rich is shown in red; Oxygen-depleted blood in blue.

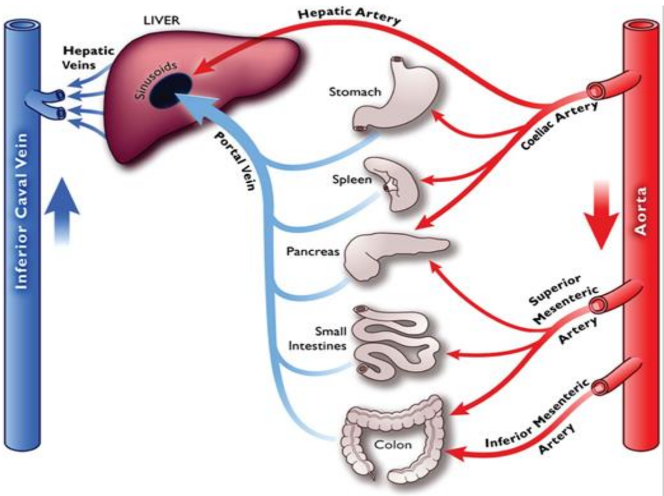
b. CIRCLE OF WILLIS

The Circle of Willis (also called **Willis' circle**, **loop of Willis**, **cerebral arterial circle**, and **Willis polygon**) is a circulatory anastomosis that supplies blood to the brain and surrounding structures and also the joining area of several arteries at the bottom (inferior) side of the brain. At the Circle of Willis, the internal carotid arteries branch into smaller arteries that supply oxygenated blood to over 80% of the cerebrum.



c. <u>SPLANCHNIC CIRCULATION</u>

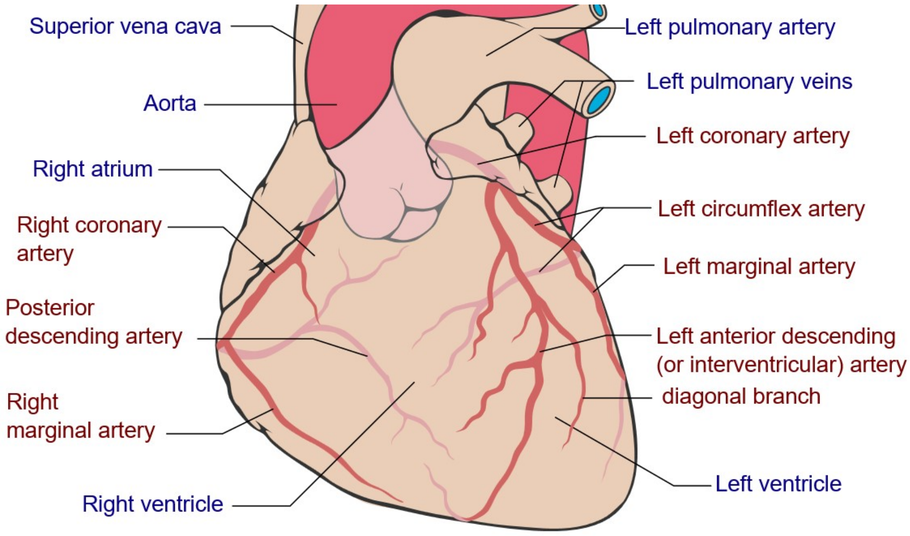
The term 'splanchnic circulation' describes the blood flow to the abdominal gastrointestinal organs including the stomach, liver, spleen, pancreas, small intestine, and large intestine. It comprises three major branches of the abdominal aorta; the coeliac artery; superior mesenteric artery (SMA); and inferior mesenteric artery (IMA). The hepatic portal circulation delivers the majority of the blood flow to the liver.



Schematic representation of the splanchnic circulation.

d. <u>CORONARY CIRCULATION</u>

Coronary circulation is the movement of blood in the blood vessels that supply the heart muscle (myocardium). Coronary arteries supply oxygenated blood to the heart muscle, and cardiac veins drain away the blood once it has been deoxygenated. Because the rest of the body, and most especially the brain, needs a steady supply of oxygenated blood that is free of all but the slightest interruptions, the heart is required to function continuously. Therefore its circulation is of major importance not only to its own tissues but to the entire body and even the level of consciousness of the brain from moment to moment. Interruptions of coronary circulation quickly cause heart attacks (myocardial infarctions), in which the heart muscle is damaged by oxygen starvation. Such interruptions are usually caused by ischemic heart disease (coronary artery disease) and sometimes by embolism from other causes like obstruction in blood flow through vessels.



Coronary arteries labeled in red text and other landmarks in blue text.

e . <u>CUTANEOUS CIRCULATION</u>

The cutaneous circulation is the circulation and blood supply of the skin. The skin is not a very metabolically active tissue and has relatively small energy requirements, so its blood supply is different to that of other tissues.

Some of the circulating blood volume in the skin will flow through will flow through arteriovenous anastomoses (AVAs) instead of capillaries. AVAs serve a role in temperature regulation. In this article we shall consider the different adaptations of the cutaneous circulation, and its role in body temperature control.

3. <u>DISCUSS THE CARDIOVASCULAR ADJUSTMENTS THAT OCCUR DURING EXERCISE</u>

Adjustments in the cardiovascular system are critical when engaging in aerobic activities but they are also required for strength training as well. The three major adjustments made by the cardiovascular system during exercise include;

1. An increase in cardiac output or the pumping capacity of the heart, designed to enhance the delivery of oxygen and fuel to the working muscles.
2. An increase in local blood flow to the working muscles.
3. A decrease in blood flow to other organs such as the kidneys, liver and stomach, thereby redirecting blood flow to the working muscles.

Cardiac output is the amount of blood pumped from the heart in one minute, generally measured in liters per minute. It's simply calculated by heart rate, in beats per minute, times stroke volume, or the amount of blood ejected by the heart with each beat. Thus in order to increase cardiac output we can increase heart rate, stroke volume, or as it is the case during exercise, we increase both. Let's examine the basic ways in which we can increase heart rate during exercise.

1. There is a reduction or withdrawal of the parasympathetic nerve activity to the heart. As parasympathetic nerve activity causes a lowering of heart rate, its withdrawal will actually result in an increase in heart rate.
2. An increase in sympathetic nerve activity to the heart will directly cause an increase in heart rate. This increase in sympathetic nerve activity will be a function of the exercise intensity.
3. An increase in the hormone epinephrine or adrenaline circulating in the blood will also stimulate an increase in heart rate.

These adjustments are also part of the fight or flight response which you experience when nervous or frightened. You may actually feel your heart pounding in your chest. This response is preparing the body for movement. This figure demonstrates how densely the heart is innervated with sympathetic nerve fibers. Thus, heart rate can be rapidly increased during exercise as a result of an increase in sympathetic nerve activity.

Heart rate increases linearly until approaching one's maximal heart rate. This will contribute to an increase in cardiac output during the course of the test. Notice that endurance training results in lower, resting, and submaximal heart rates with no change in maximal heart rate. An increase in stroke volume also contributes to an increase in cardiac output during exercise. A more forceful contraction of the ventricles of the heart, resulting in more blood being pumped per beat, can be accomplished by both increasing sympathetic nerve activity and circulating epinephrine.

There is the clear effect that an increase in sympathetic nerve stimulation has on stroke volume. For a given amount of blood in the ventricles, sympathetic stimulation results in a more forceful contraction, you'll get a significant increase in stroke volume. Stroke volume increases linearly at the onset of the test, but can plateau at submaximal workloads. Again, please notice that endurance training produces significantly greater stroke volumes both at rest and throughout the duration of the test. Including a large increase in maximal stroke volume. The heart becomes a more forceful pump after endurance training. Taken together, the increases in both heart rate and stroke volume result in a linear increase in cardiac output during the course of a graded exercise test to exhausture. oxygen consumption increases linearly during a graded exercise test until VO2 max is reached.