ARIEJA FORTUNE JESUTEKEVWE

MEDICINE AND HEALTH SCIENCE

MEDICINE AND SURGERY

18/MHS01/085

200 LEVEL

ASSIGNMENT ON CARDIOVASCULAR PHYSIOLOGY

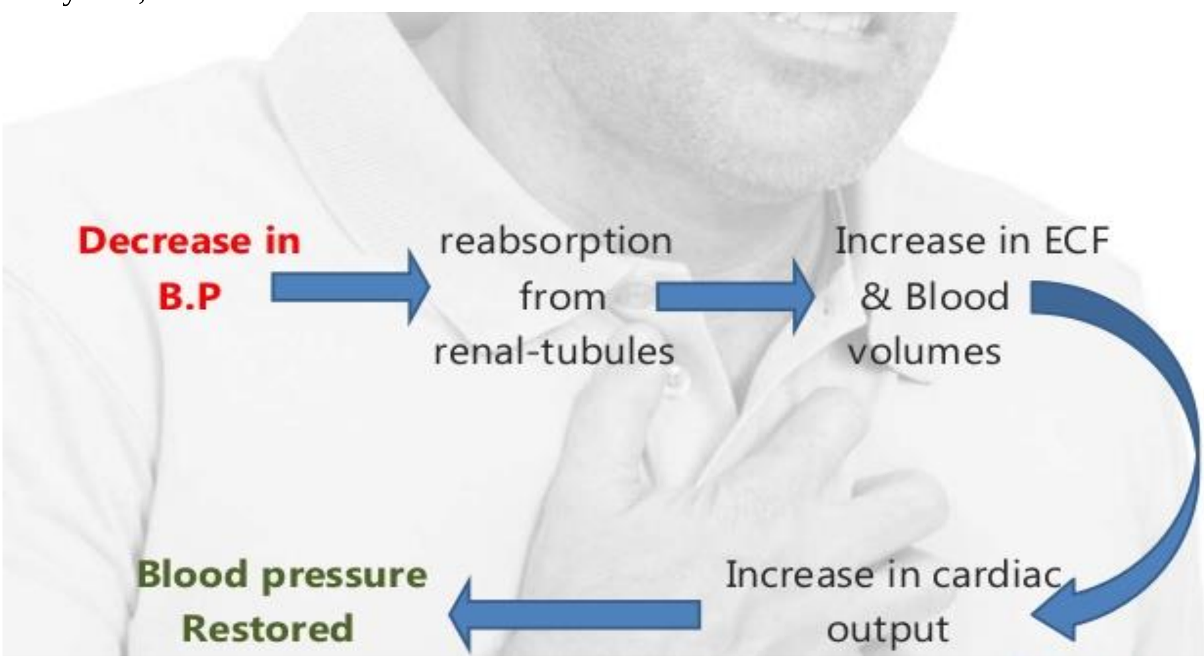
Question: Discuss the long-term regulation of mean arterial blood pressure

The definition of mean arterial pressure (MAP) of blood is the average arterial pressure throughout one cardiac cycle, systole, and diastole. MAP is influenced by cardiac output and systemic vascular resistance, each of which is under the influence of several variables.

Kidneys play an important role in the long-term regulation of arterial blood pressure. When blood pressure alters slowly in several days/months/years, the nervous mechanism adapts to the altered pressure and loses the sensitivity for the changes. It cannot regulate the pressure any more. In such conditions, the renal mechanism operates efficiently to regulate the blood pressure. Therefore, it is called 'long-term regulation'. It is noteworthy to say that renal mechanism for regulation of blood pressure or long term regulation works even when nervous mechanism adapts to new blood pressure. There are two ways through which the kidney regulates arterial blood pressure;

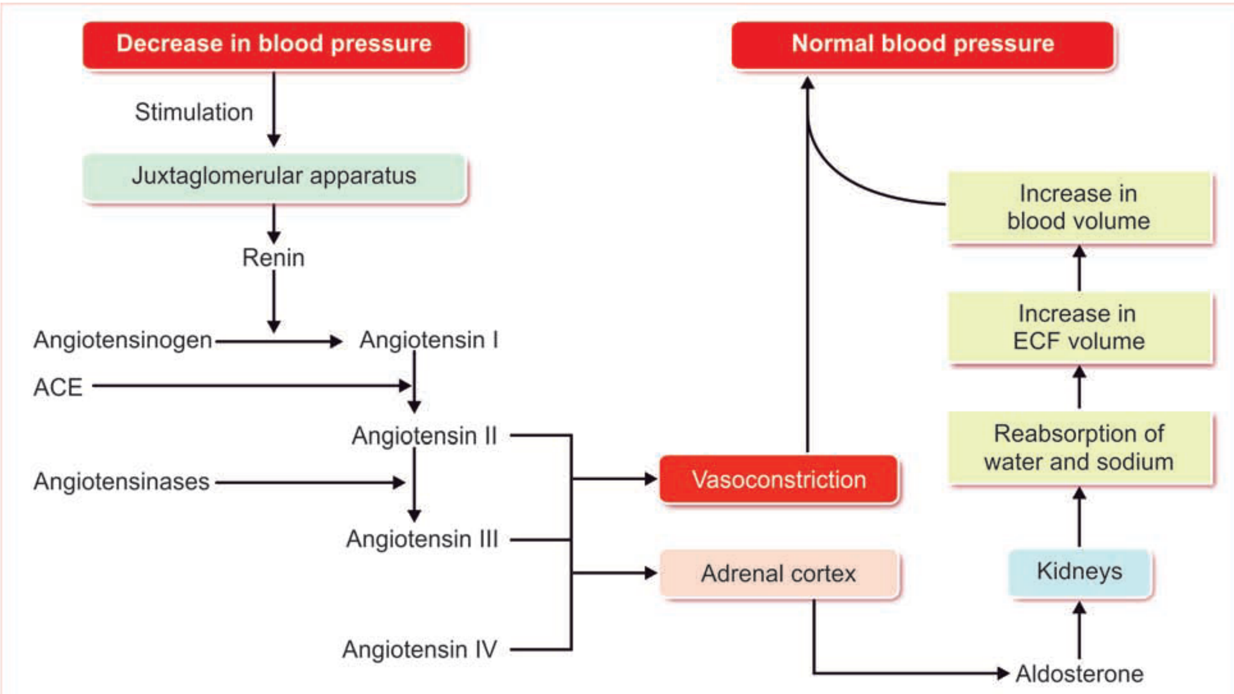
- By regulation of ECF volume

The kidneys control renal output by changing the extracellular fluid volume. An increase in extracellular fluid increases blood volume and ultimately cardiac output, which increases arterial pressure. This increase in arterial pressure is accomplished by controlling the amount of salt in the system, which is the main determinant of the amount of extracellular fluid.



- Through renin angiotensin mechanism.

As part of the endocrine system, the kidneys have an additional means of controlling arterial pressure. The renin-angiotensin system is a more powerful and complex mechanism than the one previously described. After a drop in blood pressure, the kidneys release renin, which enzymatically causes the release of angiotensin I. Within seconds, angiotensin I



is converted by an enzyme in the lungs to angiotensin II. The latter produces systemic vasoconstriction and decreased excretion of salt and water by the kidney. Angiotensin can secondarily cause fluid retention by stimulating the adrenal gland to secrete aldosterone. The renin-angiotensin system maintains normal arterial blood pressure despite wide fluctuations in salt intake. The system takes about 20 minutes to become fully active.

Therefore, it can be surmised that he long-term level of arterial pressure is dependent on the relationship between arterial pressure and the urinary output of salt and water, which, in turn, is affected by a number of factors, including renal sympathetic nerve activity (RSNA).

Question: Write short notes on the following:

- Pulmonary circulation
- Circle of Willis
- Splanchnic circulation
- Coronary circulation
- Cutaneous circulation

PULMONARY CIRCULATION:

Pulmonary circulation (otherwise known as lesser 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 vessels of the pulmonary circulation are the pulmonary arteries and the pulmonary veins. Deoxygenated blood leaves the heart, goes to the lungs, and then re-enters the heart; Deoxygenated blood leaves through the right ventricle through the pulmonary artery. From the right atrium, the blood is pumped through the tricuspid valve (or right atrioventricular valve), into the right ventricle. Blood is then pumped from the right ventricle through the pulmonary valve and into the main pulmonary artery.

The pulmonary arteries carry deoxygenated blood to the lungs, where carbon dioxide is released and oxygen is picked up during respiration. Arteries are further divided into very fine capillaries which are extremely thin-walled. The pulmonary vein returns oxygenated blood to the left atrium of the heart. The oxygenated blood then leaves the lungs through pulmonary veins, which return it to the left part of the heart, completing the pulmonary cycle. This blood then enters the left atrium, which pumps it through the mitral valve into the left ventricle. From the left ventricle, the blood passes through the aortic valve to the aorta. The blood is then distributed to the body through the systemic circulation before returning again to the pulmonary circulation. From the right ventricle, blood is pumped through the semilunar pulmonary valve into the left and right main pulmonary arteries (one for each lung), which branch into smaller pulmonary arteries that spread throughout the lungs.

CIRCLE OF WILLIS:

The circle of Willis is a circulatory anastomosis that supplies blood to the brain and surrounding structures. It is named after Thomas Willis (1621–1675), an English physician. The circle of Willis is a part of the cerebral circulation and is composed of the following arteries:

- Anterior cerebral artery (left and right)
- Anterior communicating artery

- Internal carotid artery (left and right)
- Posterior cerebral artery (left and right)
- Posterior communicating artery (left and right)

The left and right internal carotid arteries arise from the left and right common carotid arteries. The posterior communicating artery is given off as a branch of the internal carotid artery just before it divides into its terminal branches - the anterior and middle cerebral arteries. The anterior cerebral artery forms the anterolateral portion of the circle of Willis, while the middle cerebral artery does not contribute to the circle. The right and left posterior cerebral arteries arise from the basilar artery, which is formed by the left and right vertebral arteries. The vertebral arteries arise from the subclavian arteries. The anterior communicating artery connects the two anterior cerebral arteries and could be said to arise from either the left or right side.

The arrangement of the brain's arteries into the circle of Willis creates redundancy for collateral circulation in the cerebral circulation. If one part of the circle becomes blocked or narrowed or one of the arteries supplying the circle is blocked or narrowed, blood flow from the other blood vessels can often preserve the cerebral perfusion well enough to avoid the symptoms of ischemia.

SPLANCHNIC CIRCULATION

The Splanchnic circulation is composed of the blood flow originating from the celiac, superior mesenteric and inferior mesenteric arteries and is distributed to all abdominal viscera. The Splanchnic circulation receives over 25% of the cardiac output and contains a similar percentage of the total blood volume under normal conditions. Thus, the Splanchnic circulation can act as a site of regulation of distribution of cardiac output and also as a blood reservoir. Multiple regulatory pathways are involved in the distribution of the Splanchnic circulation. The Splanchnic circulation comprises the gastric, small intestinal, colonic, pancreatic, hepatic and splenic circulations. They are arranged in parallel and fed by the celiac artery and the superior and inferior mesenteric arteries. The resistance arterioles are the primary determinant of vascular resistance in the Splanchnic circulation. Neuronal control of the mesenteric circulation is almost entirely sympathetic in origin. The parasympathetic fibers from the vagi have little effect on blood flow. Overall Splanchnic blood flow requires about 25% of cardiac output. The Splanchnic venous capacitance reservoir contains about one-third of the body's total blood volume. The sympathetic postganglionic fibers cause arteriolar vasoconstriction and decrease Splanchnic perfusion. Sympathetic stimulation also contracts the smooth muscle of the capacitance veins in the Splanchnic circulation, and may expel a large volume of pooled blood from the Splanchnic into the systemic circulation.

CORONARY CIRCULATION

Coronary circulation is the circulation 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 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 ischemia heart disease (coronary artery disease) and sometimes by embolism from other causes like obstruction in blood flow through vessels.

CUTANEOUS CIRCULATION

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 from that of other tissues. Some of the circulating blood volume in the skin will flow through arteriovenous anastomoses (AVAs) instead of capillaries. AVAs serve a role in temperature regulation.

- Arteriovenous Anastomoses

AVAs are low-resistance connections between the small arteries and small veins that supply and drain the skin. These allow the shunt of blood directly into the venous plexus of the skin, without it passing through capillaries. Since AVAs contain no capillary section, they are not involved in transport of nutrients to/from the tissues, but instead play a major role in temperature regulation.

- Temperature Regulation

The skin is the body's main heat dissipating surface: the amount of blood flow to the skin determines the degree of heat loss and therefore the core body temperature. The blood flow through AVAs is heavily influenced by the sympathetic nervous system. At rest, the sympathetic nervous system dominates and acts to constrict AVAs. Any changes in core temperature are detected by the thermoregulatory center in the hypothalamus. It regulates temperature by altering the level of sympathetic outflow to the cutaneous vessels, to return temperature to its normal range.

Question: Discuss the cardiovascular adjustment that occurs during exercise

The integrated response to severe exercise involves fourfold to fivefold increases in cardiac output, which are due primarily to increases in heart rate and to a lesser extent to augmentation of stroke volume. In other words, cardiac output increases in a linear fashion to increases in the intensity of exercise, up to the point of exhaustion. This happens as a direct consequence of the heart rate and stroke volume responses to the intensity of exercise. The increase in stroke volume is partly due to an increase in end-diastolic cardiac size and secondarily due to a reduction in end-systolic cardiac size. The enhanced cardiac output is distributed preferentially to the exercising muscles including the heart. Blood flow to the heart increases fourfold to fivefold as well, mainly reflecting the augmented metabolic requirements of the myocardium due to near maximal increases in cardiac rate and contractility. Despite the great changes in cardiac output, increases in blood pressure during exercise are maintained within relatively smaller limits, as both pulmonary and systemic vascular resistance to blood flow is reduced.

Heart rate increases in a linear fashion to increases in the intensity of exercise. It is also worth noting that heart rates start to rise prior to any type of exercise – just the thought of exercise is enough to trigger a heart rate response. This initial response serves simply to prepare the body for activity and is controlled by the sympathetic division of the autonomic (involuntary) nervous system.

The cardiovascular system provides the link between pulmonary ventilation and oxygen usage at the cellular level. During exercise, efficient delivery of oxygen to working skeletal and cardiac muscles is vital for maintenance of ATP production by aerobic mechanisms. The equine cardiovascular response to increased demand for oxygen delivery during exercise contributes largely to the over 35-fold increases in oxygen uptake that occur during submaximal exercise. Redistribution of blood flow to the working muscles during exercise also contributes greatly to the efficient delivery of oxygen to sites of greatest need. Higher work rates and oxygen uptake at submaximal heart rates after training imply an adaptation due to training that enables more efficient oxygen delivery to working muscle. Such an adaptation could be in either blood flow or arteriovenous oxygen content difference. Also, Improvements in hemoglobin concentrations in blood during exercise after training are recognized, but at maximal exercise, hypoxemia may reduce arterial oxygen content.

In summary, these are the cardiovascular responses to exercise

- Increase in cardiac output, as a result of increase in heart rate and substantial increase in stroke volume.
- Increased pumping capacity of heart enhancing delivery of oxygen and fuel to working muscles.

- Increased muscle blood flow; blood vessels in muscles dilate increasing local blood flow.
- Increase in oxygen intake
- Although not mentioned above, there is decreased bloodflow to kidneys, liver and intestines as a result of blood being redirected to working muscles.