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COURSE: PHYSIOLOGY

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LEVEL: 200 LEVEL

1.

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. Kidneys regulate arterial blood pressure by two ways:
By regulation of extracellular fluid (ECF) volume. When the blood pressure increases, kidneys excrete
large amounts of water and salt, particularly sodium, by means of pressure diuresis and pressure natriuresis. Pressure diuresis is the excretion of large quantity of water in urine because of increased blood pressure. Even a slight increase in blood pressure doubles the water excretion. Pressure natriuresis is the excretion of large quantity of sodium in urine. Because of diuresis and natriuresis, there is a decrease in ECF volume and blood volume, which in turn brings the arterial blood pressure back to normal level. When blood pressure decreases, the reabsorption of water from renal tubules is increased. This in turn, increases ECF volume, blood volume and cardiac output, resulting in restoration of blood pressure.

The second way is through renin-angiotensin mechanism. When there is a fall in the blood pressure and ECF volume, renin secretion from kidneys is increased. Renin converts Angiotensinogen into angiotensin I, which is then converted into Angiotensin II by Angiotensin Converting Enzyme (ACE). Angiotensin II restores the blood pressure in two ways; by causing constriction of arterioles in the body so that the peripheral resistance is increased and blood pressure rises, and by causing constriction of afferent arterioles in kidneys, so that glomerular filtration reduces. This results in retention of water and salts, increases ECF volume to normal level. This in turn increases the blood pressure to normal level. Simultaneously, angiotensin II stimulates the adrenal cortex to secrete aldosterone, which increases reabsorption of sodium from renal tubules. Sodium reabsorption is followed by water reabsorption, resulting in increased ECF volume and blood volume. It increases the blood pressure to normal level. Like angiotensin II, the angiotensins III and IV also increase the blood pressure and stimulate adrenal cortex to secrete aldosterone.

2.

a. ***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 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.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.

b. ***Circle of willis***: The brain receives blood from the basilar artery and internal carotid artery. Branches of these arteries form circle of Willis. The Circle of Willis is the joining area of several arteries at the inferior side of the brain. At the Circle of Willis, the internal carotid arteries branch into smaller arteries that supply oxygenated blood to a large portion of the cerebrum. The circle of Willis is formed when the right and left internal carotid artery enters the cranial cavity and divide into two main branches: the anterior cerebral artery) and middle cerebral artery. The anterior cerebral arteries are then united and blood cross flows. The circle of Willis ensures that there is proper blood flow from the arteries to both hemispheres of the brain. It also acts as a safety mechanism for blood flow. In the case of blockage or narrowing of vessels, it prevents the blood flow in a connected artery, and the change in pressure causes blood to flow forward or backward in the circle of Willis to compensate. In an emergency, such as a stroke, this may reduce the damage or aftereffects of the event. The circle of Willis does not actively carry out the function. Instead, its shape of the circle and the pressure acting in the area allows for bidirectional blood flow when necessary.

c. ***Splanchnic circulation***: The splanchnic circulation consists of the blood supply to the gastrointestinal tract, liver, spleen, and pancreas. It consists of two large capillary beds partially in series. The small splanchnic arterial branches supply the capillary beds, and then the efferent venous blood flows into the PV. The PV and hepatic artery supply blood flow to the liver.
Unique feature of splanchnic circulation is that the
blood from mesenteric bed and spleen forms a major amount of blood flowing to liver. Blood flows to liver from GI tract and spleen through portal system
Splanchnic or visceral circulation constitutes three portions;
i. Mesenteric circulation supplying blood to GI tract
ii. Splenic circulation supplying blood to spleen
iii. Hepatic circulation supplying blood to liver.

d. ***Coronary circulation:*** Coronary circulation is the circulation of blood that supplies the myocardium. Coronary arteries supply oxygenated blood to the heart muscle, and cardiac veins drain away the blood once it has been deoxygenated. This 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. Interruptions of coronary circulation leads to myocardial infarctions, in which the heart muscle is damaged by oxygen starvation. Such interruptions are usually caused by ischemic heart disease (coronary artery disease) or by embolism from other causes like obstruction in blood flow through vessels. The coronary arteries are the vessels involved in coronary circulation and are the only vessels that branch from the ascending aorta. They have several smaller branches which run all along the surface of the heart. These smaller branches are called epicardiac arteries and give rise to further smaller branches known as final arteries or intramural vessels. Final arteries run at right angles through the heart muscle, near the inner aspect of wall of the heart. Coronary arteries supply blood to the heart muscle. Like all other tissues in the body, the heart muscle needs oxygen-rich blood to function. Also, they transport deoxygenated blood from the heart.

e. ***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 unique unlike that of other tissues. Some of the circulating blood in the skin flow through will flow through arteriovenous anastomoses (AVAs) instead of capillaries. The AVAs are involved in temperature regulation. Arterioles arising from the smaller arteries reach the base of papillae of dermis. Then, these arterioles turn horizontally and give rise to meta-arterioles. From meta-arterioles, hairpin-shaped capillary loops arise. Arterial limb of the loop ascends vertically in the papillae and turns to form a venous limb, which descends down. After reaching the base of papillae, few venous limbs of neighboring papillae unite to form the collecting venule. Collecting venules anastomose with one another to form the sub-papillary venous plexus. Sub-papillary plexus runs horizontally beneath the bases of papillae and drain into deeper veins. Cutaneous blood flow performs two main functions; Supply of nutrition to skin and regulation of body temperature by heat loss.

3. Discuss the cardiovascular adjustment that occurs during exercise

There are a few changes that occur in the heart during exercise. Some of those changes are;
Increase in heart rate: Heart rate increases during exercise. This is due to impulses from cerebral cortex to medullary centers, which reduces vagal tone. During moderate exercise, the heart rate increases to 180 beats/minute, and during severe muscular exercise, it reaches 240 to 260 beats/minute.
There is increased cardiac output during exercise. the cardiac output increases because of increase in heart rate and stroke volume. Heart rate increases because of vagal withdrawal. Stroke volume increases due to increased force of contraction which contributes to vasodilation of the arteries, thereby increasing the blood flow. Because of vagal withdrawal, sympathetic activity increases leading to increase in rate and force of contraction. Increase in cardiac output is directly proportional to the increase in the amount of oxygen consumed during exercise.