18/MHS01/203 Lawal Ayobami Amirah Physiology

1.) Discuss the long-term regulation of the mean arterial blood pressure

The mean arterial blood pressure is the average pressure existing in the arteries and it is not the arithmetic mean of systolic and diastolic pressures. It is the diastolic pressure (DP) plus one third of pulse pressure (PP). Formula to calculate mean arterial blood pressure: Mean arterial blood pressure = DP + 1/3PP. The normal range is between 70 and 100 mmHg. In the long-term regulatory or renal mechanism the kidney plays an important role. This involves mainly the regulation of extracellular fluid volume (ECF) by pressure natriuresis mechanisms residing in the kidney and by widespread actions of angiotensin II. It is referred to as the long-term regulation because when the blood pressure slowly changes over several days, months or years the nervous mechanism adapts to the altered pressure, loses the sensitivity for the changes and can no longer regulate the pressure. When this happens the renal mechanism operates efficiently to regulate the blood pressure.

When the kidney regulates arterial blood pressure by regulation of ECF volume, when there is an increase in the blood pressure the kidneys excrete large amounts of water and salt specifically sodium because of pressure diuresis (when the kidney filters too much bodily fluid leading to excessive production of urine) and pressure natriuresis (when there is excessive excretion of sodium in the urine). These two pressures cause a decrease in both ECF volume and blood volume making the arterial blood pressure to go back to normal. Then when there is a decrease in the blood pressure there is an increase in the water reabsorbed from the renal tubules. This will lead to an increase in ECF volume, blood volume and cardiac output causing the blood pressure to be restored to what it originally was.

So when regulated through renin angiotensin mechanism when the blood pressure and ECF volume both decrease the kidney increases the secretion of renin which converts angiotensinogen into angiotensin I then into angiotensin II by angiotensin converting enzyme (ACE). The angiotensin II then causes the contraction of arterioles in the body making the peripheral resistance to increase and a rise in blood pressure. It also causes constriction of afferent arterioles in kidneys causing glomerular filtration to reduce. This leads to the maintenance of water and salts, increases ECF volume to normal level and increases the blood pressure to be what it normally was. Angiotensin II can also restore the blood pressure by stimulating the adrenal cortex to secrete aldosterone which causes reabsorption of water and salt from the renal tubules. This leads to an increase in ECF volume and blood volume resulting in an increase in blood pressure.

2.) Short notes:

Pulmonary circulation

This is the part of the circulatory system that carries deoxygenated blood away from the right ventricle, the lungs, and then brings back oxygenated blood to the left atrium and ventricle of the heart. The pulmonary blood vessels are the pulmonary arteries and the pulmonary vein. The pulmonary artery carries deoxygenated blood to alveoli of lungs from the right ventricle and has a thin wall while the pulmonary veins transfer oxygenated blood from the lungs to the heart. These vessels are highly elastic and more distensible. This circulation can be affected by a number of conditions such as pulmonary hypertension which is when there is an increase in resistance in the pulmonary arteries.

Circle of Willis

This is also known as “the polygon of Willis” an arterial ring found at the base of the brain around the eye level and is completed by the anterior communicating artery (ACoA) and two posterior communicating arteries (PCoAs). It arterial network allows the arterial blood flow exchange between the anterior and posterior circulation and between the left and right hemisphere. The middle cerebral arteries that supply the brain are not considered part of the circle of Willis.

It is part of the cerebral circulation and is made up 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)

Splanchnic circulation

This is the flow of blood to the abdominal gastrointestinal organs including the stomach, liver, spleen, pancreas, small intestine and the large intestine.it is also known as the visceral circulation. This contains a fifth of the total blood volume and receives a quarter of the cardiac output at rest. The three major arteries involved are branches of the abdominal aorta. They are the coeliac artery, superior mesenteric artery (SMA) and inferior mesenteric artery. This circulation is made up of three parts. They are:

- Mesenteric circulation supplying blood to gastrointestinal (GI) tract
- Splenic circulation supplying blood to spleen
- Hepatic circulation supplying blood to liver

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. The hepatic portal circulation delivers the majority of the blood flow to the liver.

The splenic circulation is important because the spleen is the main reservoir of blood. So because of the dilatation of blood vessels, large amounts of blood are stored in spleen then the constriction of blood vessels by sympathetic stimulation releases blood into circulation.

Coronary circulation

This is the circulation of blood in the blood vessels the supply the heart muscle. They supply oxygenated blood to the muscle of the heart and the deoxygenated blood is then drained away by the cardiac veins. The heart muscle is supplied by two coronary arteries. They are the right and left coronary arteries. The right coronary artery supplies the right ventricle and posterior portion of the left ventricle. The left supplies mainly the anterior and lateral parts of left ventricle. These arteries divide and subdivide into smaller branches that run all along the surface of the heart. The smaller branches are called epicardiac arteries and then they give rise to further smaller branches known as final arteries or intramural vessels. This circulation is important because the body most especially the brain need a steady flow of oxygenated blood supply therefore the heart has to work continuously. An interruption will quickly cause a heart attack which can be as a result of ischemic heart disease and sometimes by embolism from other causes such as obstruction in blood flow through vessels.

Cutaneous circulation

This is the circulation and blood supply of the skin. The cutaneous circulation supplies nutrition to the skin and also regulates the body temperature through loss of heat. The cutaneous blood flow is regulated mainly by body temperature. Hypothalamus plays an important role in regulating cutaneous blood flow. When the temperature of the body increases and the hypothalamus is activated causing cutaneous vasodilatation by acting through medullary vasomotor center increasing blood flow in skin. An increase in the cutaneous blood flow causes loss of heat from the body through sweat. When the body temperature is low vasoconstriction occurs in the skin decreasing blood flow to the skin and also prevents heat loss from the skin.

3.) Discuss the cardiovascular adjustment that occurs during exercise

During exercise, there is an increase in metabolic needs of body tissues, particularly the muscles. This increases the cardiac output which is distributed preferentially to the exercising muscles including the heart. The increased cardiac output is coupled with a transient increase in systemic vascular resistance, elevate mean arterial blood pressure. The blood flow to the heart increases four-fold to fivefold mainly reflecting the augmented metabolic requirements of the myocardium due to near maximal increases in cardiac rate and contractility. Therefore various adjustments in the body during exercise need to be made. These adjustments include: supplying various metabolic requisites like nutrients and oxygen to muscles and other tissues involved in the exercise, and preventing the increase of the body temperature. These adjustments also depend on the severity of the exercise. When the exercise is a mild exercise little or no change will occur in the cardiovascular system. Such exercise includes slow walking. The moderate exercise does not involve the use of strenuous muscular activity and can be performed for a longer period of time. Exhaustion does not occur at the end of moderate exercise, examples are fast walking and slow running. The severe exercise which involves strenuous muscular activity that can only be maintained for a short period of time. There is complete exhaustion at the end of severe exercise. An example is fat running for a distance of like 100 or 400 meters. During exercise more heat is produced and the thermoregulatory system is activated. This causes secretion of large amount of sweat leading to fluid loss, reduced blood volume, hemoconcentration and sometimes severe exercise leads to even dehydration. Mild hypoxia is also developed during exercise and it stimulates the juxtaglomerular apparatus to secrete erythropoietin. This then stimulates the bone marrow causing release of red blood cells. Increased carbon dioxide content in blood decreases the pH of blood. Also the venous return increases remarkably during exercise because of muscle pump, respiratory pump and splanchnic vasoconstriction