NAME: EBIMOGHAN EBIEKIYE BENEDICT

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COURSE: PHYSIOLOGY

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ASSIGNMENT ON CARDIOVASCULAR PHYSIOLOGY

QUESTION 1: DISSCUSS THE LONG-TERM REGULATION OF MEAN ARTERIAL BLOOD PRESSURE

In the regulation of Mean Arterial Blood Pressure (MAP), there are various physiological mechanisms involved for the long-term. They include:

- **Renin-Angiotensin-Aldosterone System (RAAS):** Renin is a peptide hormone released by the glandular cells of the juxtaglomerular apparatus in the kidney (nephron). Renin is responsible for the conversion of angiotensinogen to angiotensinogen I. Angiotensinogen I is then converted to angiotensinogen II by angiotensin-converting enzyme(ACE). Angiotensinogen II is an active vasoconstrictor which acts on the kidney to increase sodium reabsorption in the convoluted tubule. It increases total peripheral resistance (TPR), Blood pressure and sympathetic activity thereby increasing heart rate.
  Angiotensinogen II stimulates the release of Aldosterone from the adrenal gland to enable electrolyte(salt) and water retention, resulting in decreased water excretion and therefore increased blood volume, venous return and cardiac output thereby increasing blood pressure.
- **Anti-Diuretic hormone**: Anti-Diuretic hormone is released from the OVLT of the hypothalamus in response to thirst or increased plasma osmolarity. It increases water reabsorption from the collecting duct resulting in increasing plasma volume and decreasing osmolarity

QUESTION 2: WRITE SHORT NOTES ON THE FOLLOWING

(A) **Pulmonary circulation**: Pulmonary circulation is the part of the circulatory system which carries deoxygenated blood away from the heart through the right ventricle, to the lungs, and returns to the oxygenated blood to the heart through the left atrium. It is the first stage in the double circulation of the human circulatory system. The pulmonary trunks splits into the right and left pulmonary arteries. These arteries transport the de-oxygenated blood to arterioles and capillary beds in the lungs.

There, carbon dioxide is released and oxygen is absorbed. The oxygenated blood then passes from the capillary beds through venules into the pulmonary veins. Pulmonary circulation begins on the right ventricle and ends on the left atrium. It is responsible for re-saturating the blood with oxygen before it is dispersed into the systemic circulation.

(B) **Circle of Willis**: The circle of Willis is 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. It helps blood flow from both the front and back sections of the brain. It gets its name from the physician "Thomas Wilson" who described this part of the anatomy in 1664. The Circle of Willis acts to provide collateral blood flow between the anterior and posterior circulations of the brain, protecting against ischemia in the event of vessel disease or damage in one or more areas.

(C) **Splanchnic circulation**: The splanchnic circulation consists of blood supply to the gastrointestinal tract, liver, spleen and pancreas arranged in parallel with one another. There are three major arteries that supply the splanchnic organs: Celiac artery, Superior mesenteric artery and Inferior mesenteric artery which all give rise to smaller arteries that anastomose extensively. It consists of large capillary beds partially in series. The small splanchnic arteries branches supply the capillary beds, and then the efferent venous blood flows into the PV. The splanchnic circulation powerfully influences systemic arterial pressure via two distinct mechanisms: (i) Widespread contraction of arteries in the splanchnic organs allows for a very large reduction in blood flow without producing ischemia. (ii) Active constriction of veins in the splanchnic organs reduces regional blood volume, with little effect on TPR but raises cardiac output and arterial pressure by increasing central blood volume and thus cardiac preload.

(D) **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. The two main coronary arteries are the:

- Left main coronary artery (LMCA): supplies blood to the left side of the heart muscle(left ventricle and atrium), it divides into two branches: (i) the left anterior descending artery which supplies blood to the front of the left side of the heart (ii) the circumflex artery which encircles the heart muscle and supplies blood to the outer side and back of the heart.
- Right coronary artery (RCA): supplies blood to the right ventricle, atrium, Sino atrial node(SA) and atrioventricular node(AV). It divides into smaller branches: (i) Right posterior descending artery (ii) Acute marginal artery
  Other smaller branches include: Obtuse marginal(OM), Septal perforator(SP) and Diagonalis.

The coronary circulation is very important because it delivers blood to the heart muscle and any disorder or disease of the coronary arteries will result to serious complications by reducing the flow of oxygen and nutrients to the heart muscle. This can lead to heart attack and possibly death.

(E) **Cutaneous circulation**: This 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 and organs. Therefore under normal conditions, circulation to the skin makes up about 4% of the total cardiac output. However, cutaneous circulation plays and important role in the regulation of core body temperature. It involves the transport of oxygenated blood through the arteries to the capillaries, where it nourishes the tissues, and the return of oxygen-depleted blood through the veins to the heart, where the cycle is renewed. Control of the cutaneous circulation by reflexes aimed at body temperature regulation, blood pressure regulation and the reflexes attending muscular exercise, as were the similarities and differences between control of cutaneous arterioles and arteriovenous anastomoses.

QUESTION 3: DISCUSS THE CARDIOVASCULAR ADJUSTMENT THAT OCCURS DURING EXERCISE

There are three major adjustments the cardiovascular system makes in response to exercise:

- **Increased cardiac output**: Increased pumping capacity of the heart enhancing delivery of oxygen and fuel to working muscles. This is achieved in the following steps:
  (i) Chemoreceptors/baroreceptors detect the new demand for energy and oxygen
  (ii) Stimulates Cardiac Accelerating Centre (CAC)
  (iii) Initiates the Sympathetic nervous system via CAC
  (iv) Increased impulse at Sino atrial node (SA node)
  (v) Increased Heart stroke and Stroke volume resulting in Increased Cardiac Output HR/SV=increased Q

- **Increased muscle blood flow**: Blood vessels in muscles dilates, increasing local blood flow
- **Decreased blood flow to kidneys, liver and gut**: Redirects or shuts blood flow from other organs to working muscles

The integrated response to severe exercise involves increases in cardiac output, which are primarily to increases in cardiac rate and to a lesser extent to augmentation of stroke volume. The enhanced cardiac output is distributed preferentially to the

exercising muscles including the heart due to the augmented metabolic requirement of the myocardium due to near maximal increases in cardiac rate and contractility. The cardiovascular system provides the link between pulmonary ventilation and oxygen usage at cellular level. An increase in the release of Epinephrine/Adrenaline would also increase heart rate which in turn increases cardiac output.