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**Discuss the long-term regulation of mean arterial blood pressure?**

Blood pressure is a measure of the pressures within the cardiovascular system during the pumping cycle of the heart. It is influenced by a vast number of variables, and can alter in either direction for various reasons. Blood pressure has two values (eg 120/80mmHg) measured in ‘millimetres of mercury (mmHg)’;

Systolic Pressure – the first number (12ommHg in the example) is the pressure of the blood during heart contraction.

Diastolic Pressure – the second number (80mmHg in the example0 is the pressure of the blood after one contraction but before the next contraction.

There are several physiological mechanisms that regulate blood pressure in the long term, the first of which is the 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**.

ACE 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**i**ncreasing the electrochemical gradien**t** for movement of sodium ions. More sodium collects in the kidney tissue and water then follows by osmosis. This results in decreased water excretion and therefore increased blood volume and thus blood pressure.

Other factors that can affect long-term regulation of blood pressure are natriuretic peptides. These include:

* Atrial natriuretic peptide**(ANP)** is synthesised and stored in cardiac myocytes. It is released when the atria are stretched, indicating of high blood pressure.
* ANP acts to promote sodium excretion. It dilates the **afferent arteriole** of the glomerulus, increasing blood flow (GFR). Moreover, ANP inhibits sodium reabsorption along the nephron. Conversely, ANP secretion is low when blood pressure is low.
* **Prostaglandins** act as local vasodilators to increase GFR and reduce sodium reabsorption. They also act to prevent excessive vasoconstriction triggered by the sympathetic nervous and renin-angiotensin-aldosterone systems.

**Write short notes on the following:**

**Pulmonary circulation;** System of blood vessels that forms a closed circuit between the heart and lungs, it involves transportation that shunts de-oxygenated blood from the heart to the lungs to be re-saturated with oxygen before being dispersed into systemic circulation. Deoxygenated blood from the lower half of the body enters the heart from the inferior vena cava while deoxygenated blood from the upper body is delivered to the heart via the superior vena cava. Both the superior vena cava and inferior vena cava empty blood into the right atrium. Blood flows through the tricuspid valve into the right ventricle. It then flows through the pulmonic valve into the pulmonary artery before being delivered to the lungs. While in the lungs, blood diverges into the numerous pulmonary capillaries where it releases carbon dioxide and is replenished with oxygen. Once fully saturated with oxygen, the blood is transported via the pulmonary vein into the left atrium which pumps blood through the mitral valve and into the left ventricle. With a powerful contraction, the left ventricle expels oxygen-rich blood through the aortic valve and into the aorta: This is the beginning of systemic circulation.

**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. 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 gastric, small intestinal, colonic, pancreatic, hepatic, and splenic circulations, arranged in parallel with one another. The three major arteries that supply the splanchnic organs, cellac and superior and inferior mesenteric, give rise to smaller arteries that anastomose extensively. Numerous extrinsic and intrinsic factors influence the splanchnic circulation. Extrinsic factors include general hemodynamic conditions of the cardiovascular system, autonomic nervous system, and circulating neurohumoral agents. Intrinsic mechanisms include special properties of the vasculature, local metabolites, intrinsic nerves, paracrine substances, and local hormones. The existence of a multiplicity of regulatory mechanisms provides overlapping controls and restricts radical changes in tissue perfusion.

**Coronary circulation;** Coronary circulation is the circulation of blood in the blood vessels that supply the heart muscle (myocardium). The major vessels of the coronary circulation are the left main coronary that divides into **left anterior descending** and **circumflex** branches, and the right main coronary artery. Coronary arteries supply oxygenated blood to the heart muscle, and cardiac veins drain away the blood once it has been deoxygenated. Obstruction of a coronary artery, depriving the heart tissue of oxygen-rich blood, leads to death of part of the heart muscle (myocardial infarction) in severe cases, and total heart failure and death may ensue.

**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 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. 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.

**Discuss the cardiovascular adjustment that occurs during exercise?**

 The autonomic nervous system provides for acceleration of the heart at the onset of exercise, but a slow increase in heart rate is established even without central command, neural feedback from working muscles, or autonomic influence on the heart. Yet an intact autonomic nervous system is a prerequisite for a large rise in cardiac output and in turn leg blood flow during exercise. Thus, when the sympathetic nervous system is injured at a level where it influences the heart, vasodilatation in working muscles challenges blood pressure.

During exercise, cardiac output (CO) increases to provide the flow needed to serve the contracting skeletal muscles. Yet, by resetting the operating point for the arterial baroreceptors, vasodilatation is regulated to make blood pressure stable or to increase during exercise.Such a balance between CO and total peripheral resistance would be considered to be governed by an interplay between the autonomic influence on the heart, vasodilatory substances released from the working muscles, and sympathetic mediated vasoconstriction, including active skeletal muscles. The central nervous system (CNS),and especially neural feedback from contracting muscles, are important for the blood pressure response to exercise. Acceleration of the heart is governed by central command, whereas a blood-borne substance may contribute to the maintained elevation of heart rate (HR). Even in the absence of influence from CNS and neural feedback from working muscles, a tight coupling between CO and whole body oxygen uptake (V̇o2) is maintained. 1. Increased cardiac output because increased pumping capacity of the heart enhances delivery of oxygen and fuel to working muscles. 2. Increased muscle blood flow because blood vessels in the muscles dilate increasing local blood flow. 3. Decreased blood flow to kidney, liver and guts due to the redirection of blood flow to working muscles. The following three are the summary of the cardiovascular adjustments that occur during exercise.