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ASSIGNMENT

1. Discuss the long-term regulation of mean arterial blood pressure
2. Write short notes on the following
   a) Pulmonary circulation
   b) Circle of Willis
   c) Splanchnic circulation
   d) Coronary circulation
   e) Cutaneous circulation
3. Discuss the cardiovascular adjustment that occurs during exercise.

1.

LONG TERM REGULATION OF MEAN ARTERIAL BLOOD PRESSURE

The body's blood pressure is a measure of the pressures within the cardiovascular system during the pumping cycle of the heart. There are several physiological mechanisms that regulate blood pressure in the long term, the first of which is the renin-angiotensin-aldosterone system (RAAS). Long-term arterial blood pressure control is usually concerned with the ECF and blood volume on the one hand and renal mechanisms controlling urine output on the other hand.

Renin-Angiotensin-Aldosterone System (RAAS)

Renin is a peptide hormone released by the glandular 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 the 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.

The long-term regulation of BP is believed to be dependent mainly on the blood volume –urine output balance which in turn is mainly influenced by the renin –angiotensin –aldosterone system. For instance, an increase in arterial BP causes fluid output through the kidneys and a reduction in the ECF volume, blood volume and venous return. This will lead to a decrease in C.O which will result in BP decrease. It should be noted that blood volume itself depends on a balance between fluid intake and fluid losses and that only very small changes in fluid volume are required to produce marked changes arterial BP. Thus 2% increase in blood volume can result in an increase in arterial BP of as much as 5%. Although the rapidly acting control system will serve to reduce this change, the long –term adjustment will be by increased fluid loss by the kidneys. By reabsorbing 99% of the water and sodium filtered in the glomerulus per day, the kidneys help in conserving body water and therefore maintaining blood volume. By so doing, it ensures a long-term maintenance of normal blood pressure.

2.

a. PULMONARY CIRCULATION

Pulmonary circulation is otherwise called lesser circulation. Blood is pumped from right ventricle to lungs through pulmonary artery. Exchange of gases occurs between blood and alveoli of the lungs at pulmonary capillaries. Oxygenated blood returns to left atrium through the pulmonary veins. Thus, left side of the heart contains oxygenated or arterial blood and the right side of the heart contains deoxygenated or venous blood.

b. CIRCLE OF WILLIS

It is an anatomical structure that provides an anastomotic connection between the anterior and posterior circulations, providing collateral flow to affected brain regions in the event of arterial incompetency. The vertebral arteries unite to form the basilar artery, and the basilar artery and the carotids form the circle of Willis below the hypothalamus. The circle of Willis is the origin of the six large vessels supplying the cerebral cortex.

c. SPLANCHNIC CIRCULATION

The blood vessels of the gastrointestinal system are part of a more extensive system called the splanchnic circulation. The splanchnic circulation includes the gut, pancreas, liver and spleen. Splanchnic blood flow courses through the gut, spleen and pancreas and then flows immediately into the hepatic circulation by way of the portal vein. Blood then flows through minute liver sinusoids and reenters the systemic circulation via the hepatic veins. This complex secondary flow of blood allows the reticuloendothelial system of the sinusoids to remove harmful bacterial and other substances that could potentially enter the systemic circulation. Maintenance of an adequate blood supply to the intestines is important in insuring normal intestinal homeostasis. Maintenance of normal splanchnic blood flow is important in preserving intestinal motility, absorption of nutrients and immune function.

d. CORONARY CIRCULATION

This is the circulation of blood in the blood vessels of the heart muscle (myocardium),the vessels that deliver oxygen-rich blood to the myocardium are known as coronary arteries while the vessel that remove the deoxygenated blood from the heart muscle are known as cardiac veins, these include the great cardiac veins, the middle cardiac veins, the small and the anterior cardiac veins. As the left and right coronary arteries run on the surface of the heart, they can be called epicardial coronary arteries. These relatively narrow vessels are commonly affected by atherosclerosis (due to the presence of cholesterol around the vessel causing an occlusion) and can become blocked, causing angina or a heart attack. The coronary arteries that run deep within the myocardium are referred to as subendocardial. The coronary arteries are classified as end circulation, since they represent the only source of blood supply to the myocardium. There is very little redundant blood supply which is why blockage of these vessels can be so critical.

e. CUTANEOUS CIRCULATION

This is the circulation of blood through the skin. The primary function of the skin circulation is to help maintain body temperature. Blood vessels constrict to prevent heat loss and dilate to facilitate transfer of heat from the body core to the body surface. The skin comprises 4% to 5% of the total body weight and receives about 2% of the cardiac output. The arterio-venous oxygen difference is small (3%vol), indicating that most of the blood flow is non nutrient flow. Veins draining these vascular beds comprise large venous plexuses with slow blood flow in the forearm, legs and thigh. These plexuses provide a large surface area for heat exchange with the environment. The second type of vessel is composed almost exclusively of smooth muscle. These provide a direct connection between arteries and the venous plexuses described above.

3.

CARDIOVASCULAR ADJUSTMENTS THAT OCCUR DURING EXERCISE

Muscular exercise constitutes the strongest physiologic stress on the human CVS. It demands a huge increase in the supply of O_2 and nutrients to the exercising muscles and a proportionate increase in the removal of metabolic waste products and excess heat generated during the exercise. Certain cardiovascular adjustments are made to enable the body cope with the above increased demands.

- Changes in cardiac function

The cardiac function changes include; increase in stroke volume, heart rate and cardiac output.

- Changes in arterial blood pressure

The increase can be as little as 20mmHg or as great as 80mmHg depending on the type of exercise and condition under which the exercise is performed.

- Redistribution of cardiac output
- Increased O_2 delivery to the tissues
- Temperature regulation.

This is achieved through increased heat loss via the lungs (due to increased pulmonary ventilation) and the skin.