Name: Okonkwo Amarachukwu Divine

Matric No: 18/MHS02/135

Department: medicine and surgery.

Level: 200level

Course: Cardiovascular System Physiology

Lecturer: Dr. Oniyide

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.

Blood pressure can be calculated as: Flow*Resistance

Mean arterial blood pressure= cardiac output* total peripheral resistance.

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:

a. by regulation of ECF volume
b. through renin-angiotensin-aldosterone system (RAAS)

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.

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:

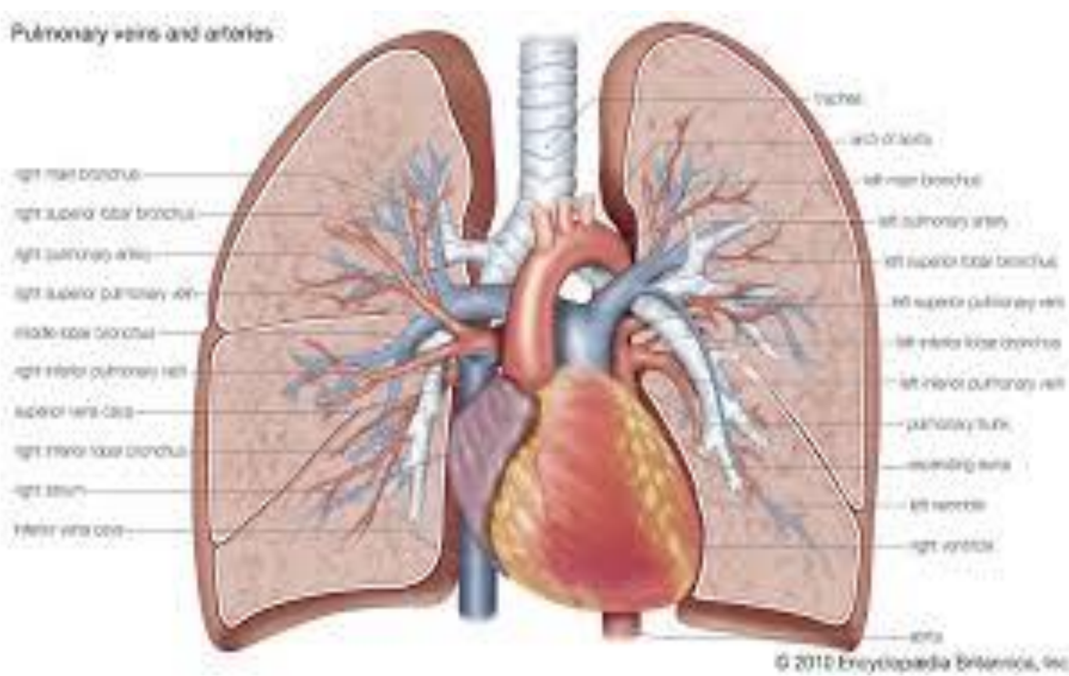
- Sympathetic Stimulation
- Reduced sodium-chloride delivery to the distal convoluted tubule.
- Decreased blood flow to the kidney.

Renin facilitates the conversion of angiotensinogen to angiotensin I which is then converted to angiotensin II using angiotensin-converting enzyme (ACE).

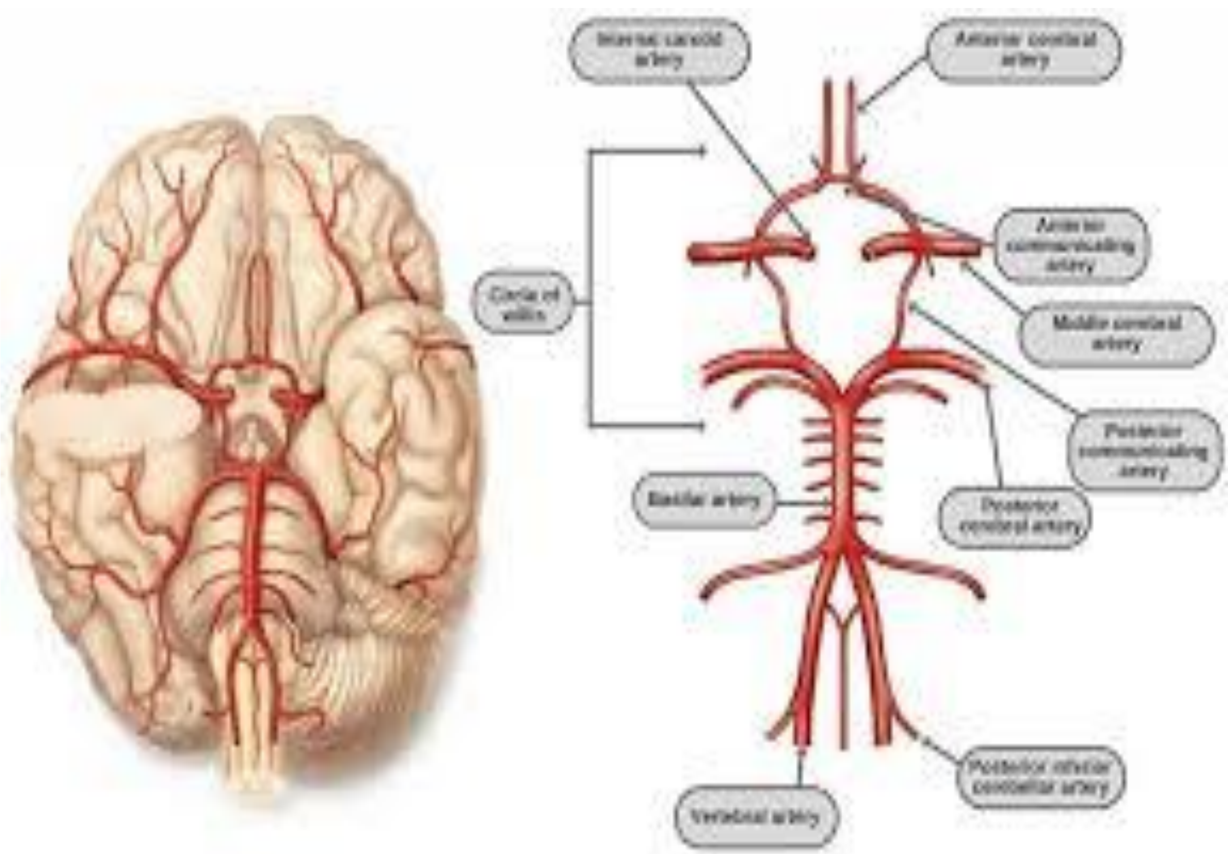
Another mechanism by which blood pressure is regulated is release of Anti Diuretic Hormone (ADH) from the OVLT of the hypothalamus in response to thirst or an increased plasma osmolarity. ADH acts to increase the permeability of the collecting duct to water by inserting aquaporin channels (AQP2) into the apical membrane. It also stimulates reabsorption from the thick ascending limb of the loop of Henle. This increases water reabsorption thus increasing plasma volume and decreasing osmolarity.

2.

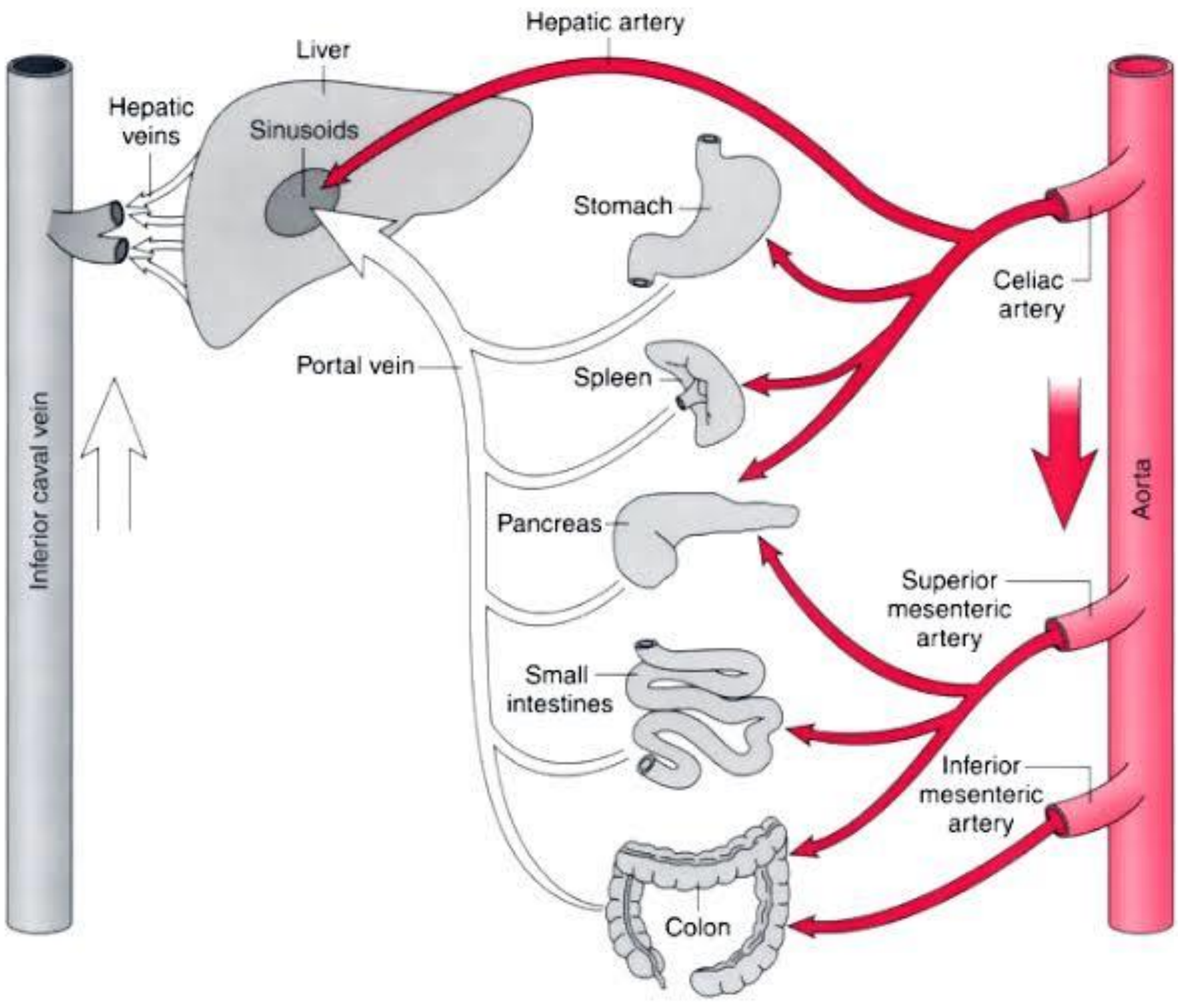
a) **PULMONARY CIRCULATION**: It is the system of transportation that shunts deoxygenated blood from the heart to the lungs to be re-saturated with oxygen before being dispersed into the systematic circulation. The pulmonary circuit begins with the right ventricle, which pumps deoxygenated blood through the pulmonary artery. This artery divides above the heart into two branches, to the right and left lung, where the further subdivide into smaller and smaller branches until the capillaries in the pulmonary air sacs (alveoli) are reached. In the capillaries the blood takes up oxygen from the air inspired into the air sacs and releases carbon dioxide. It then flows into larger and larger vessels until the pulmonary veins (usually four in number, each serving a whole lobe of lung) are reached. The pulmonary veins open into the left atrium of the heart.



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 80% of the cerebrum. The circle of Willis (CoW) 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. It acts to provide collateral blood flow between the anterior and posterior circulations of the brain of the brain, protecting against ischemia in the event of vessel disease or damage in one or more areas.



c) **SPLANCHNIC CIRCULATION**: Splanchnic circulation describes the blood flow to the abdominal gastrointestinal organs including the stomach, liver, spleen, pancreas, small intestine, and large intestine. It is composed essentially of the flow of blood originating from the celiac, superior mesenteric, and inferior 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 act as a site of regulation of distribution of cardiac output and also as a blood reservoir. Multiple regulatory pathways are involved in the distribution of the splanchnic circulation.



d) **CORONARY CIRCULATION**: Coronary circulation is a part of systemic circulatory system that supplies blood to and provides drainage from the tissues of the heart. In human heart, two coronary arteries arise from the aorta just beyond the semilunar valves: during diastole, the increased aortic pressure above the valves forces blood into the coronary arteries and thence into the musculature of the hear. Deoxygenated blood is returned to the chambers of the heart via coronary veins: most of these converge to form the coronary veins; most of these converge to form the coronary venous sinus, which drains into the right atrium. The heart normally extracts 70% to 75% of the available oxygen from the blood in coronary circulation, which is much more than the amount extracted by other organs from their circulations e.g. 40% by resting skeletal muscle and 20% by the liver. Obstruction of a coronary artery, depriving the heart tissue of oxygen-rich blood, leads to death of the heart muscle (myocardial infarction) in severe cases, and total heart failure and death may ensue.

e) **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 arteriovenous anastomoses (AVAs) instead of capillaries. Arteriovenous anastomoses serve a role in temperature regulation.

3. Discuss the cardiovascular adjustment that occurs during exercise.

The three major adjustments made by the cardiovascular system during exercise are

1. An increase cardiac output: Cardiac output increases up to 20 L/minute in moderate exercise and up to 35 L/minute during severe exercise. Increase in cardiac output is directly proportional to the increase in the amount of oxygen consumed during exercise. During exercise, the cardiac output increases because of increase in heart rate and stroke volume. Increased pumping capacity of heart enhancing delivery of oxygen and fuel to working muscles:

How to increase heart rate during exercise because it helps increase cardiac output.

- Reduction of parasympathetic nervous system activity: it causes a lowering of heart rate which withdraw the result in an increase in heart rate
- Increase in sympathetic nervous system activity to the heart will directly cause an increase in heart rate.
- Increase in the circulating hormone epinephrine in the blood

An increased Stroke volume increases with exercise intensity but may plateau before reaching maximum which causes the ventricles to contract resulting in more blood been pumped out per beat can be accomplished by:

- Increasing sympathetic activity which results in a more forceful contraction resulting in an increase in stroke volume.

- Increasing circulating epinephrine.

2. Increased muscle blood flow: There is a great increase in the amount of blood flowing to skeletal muscles during exercise. In resting condition, the blood supply to the skeletal muscles is 3 to 4 mL/100 g of the muscle/minute. It increases up to 60 to 80 mL in moderate exercise and up to 90 to 120 mL in severe exercise. During the muscular activity, stoppage of blood flow occurs when the muscles contract. It is because of compression of blood vessels during contraction. And in between the contractions, the blood flow increases. Sometimes the blood supply to muscles starts increasing even during the preparation for exercise. Blood vessels in muscles dilate, increasing local blood flow. A decrease in blood flow to other organs like kidneys, liver and gut thereby redirects or shunts blood flow to working muscles. Mild hypoxia developed during exercise stimulates the juxtaglomerular apparatus to secrete erythropoietin. It stimulates the bone marrow and causes release of red blood cells. Increased carbon dioxide content in blood decreases the pH of blood.
3. Increased heart rate: Impulses from cerebral cortex to medullary centers, which reduces vagal tone increases heart rate. In moderate exercise, the heart rate increases to 180 beats/minute. In severe muscular exercise, it reaches 240 to 260 beats/minute. Increased heart rate during exercise is mainly because of vagal withdrawal. Increase in sympathetic tone also plays some role.
   i. Impulses from proprioceptors, which are present in the exercising muscles; these impulses act through higher centers and increase the heart rate
   ii. Increased carbon dioxide tension, which acts through medullary centers
   iii. Rise in body temperature, which acts on cardiac centers via hypothalamus, increased temperature also stimulates SA node directly
   iv. Circulating catecholamines, which are secreted in large quantities during exercise.