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LONG TERM REGULATION OF ARTERIAL BLOOD PRESSURE

The RENIN ANGIOTENSIN ALDOSTERONE SYSTEM is a method used for the long term regulation of arterial blood pressure. The key cell in the renin angiotensin aldosterone system is a cell called the juxtaglomerular apparatus located in the blood vessels of the kidney.

Whenever blood pressure in the arteries drop, the juxtaglomerular cells release a particular hormone called **RENIN.** Renin is released by the juxtaglomerular cells for a number of reasons which are

- A drop in blood pressure
- When sympathetic nerve (cardio accelerators) fire
- Drop in sodium or salt levels in blood.

Simultaneously, hepatocytes in the liver release an inactive hormone called **ANGIOTENSINOGEN.** Renin is already secreted by the kidney and is already in blood. The angiotensinogen also circulated through blood on release. when these two meet, **ANGIOTENSIN I** which is a more active from of angiotensinogen. The angiotensin I circulates ib blood and when it gets to the lungs, with the help of an enzyme called **ANGIOTENSIN CONVERTING ENZYME,** it is converted to **ANGIOTENSIN II.** This angiotensin II is a way more active enzyme than angiotensin I. The angiotensin II circulates in blood and acts on a variety of cells to increase the blood pressure.

- Angiotensin II acts on the smooth muscle cells in blood vessels (endothelium) all over the body, making them to contract, thereby increasing resistance, causing vasoconstriction.
- Angiotensin II acts on the kidney, causing the kidney to conserve more water, thereby increasing stroke volume.
- Angiotensin II acts on the pituitary gland to secrete Anti-Diuretic Hormone (ADH), the function of ADH is to conserve more water and they also act on smooth muscle cells, causing vasoconstriction.
- Angiotensin II acts on the Adrenal Gland at the top of the kidney to secrete Aldosterone which mainly causes the kidney to reabsorb salt.

All these streams of events occur in order to raise blood pressure, force of contraction and stroke volume. Also, as the kidney conserves more water and more salt, more potassium ions are being excreted, therefore, there is low potassium, fostering increase in heart rate.

PULMONARY CIRCULATION

Pulmonary circulation is a kind of circulation in which the blood is taken to the lungs for oxygenation. It is also referred to as **Lesser Circulation.**

To understand pulmonary circulation, we'll have to briefly explain the anatomy of the heart. The heart has two sides i.e. the left and right sides. The right side consists of the right atrium and right ventricle, separated by a Tricuspid valve while for the left side, it consists of the left atrium and left ventricle which is separated by the mitral or bicuspid valve. From the ventricles, there are the pulmonary artery and the aorta, which contains the pulmonary valve and aortic valves respectively. The pulmonary artery brings blood back to the left atrium.

Pulmonary circulation occurs thus;

Blood flowing in from the vena cava into the heart is usually deoxygenated. And the heart would need oxygenated blood to pump to the rest of the body. The blood flows into the right atrium, and then into the right ventricles. From the ventricles, the blood is moved into the pulmonary artery. This pulmonary artery is what carries the deoxygenated blood to the lungs where they become oxygenated. The new oxygenated blood is brought back to the heart by the pulmonary vein to be pumped into circulation.

CIRCLE OF WILLIS

Cerebral circulation refers to the flow of blood through the blood vessels of the brain. Stoppage of blood to the brain for just 5 seconds would lead to unconsciousness and for 5 minutes would lead to irreversible brain damage.

The **Circle of Willis** is formed by anastomosis of various blood vessels. These includes the **basiliar artery,** the **internal carotid artery** and the **vertebral arteries.** Branches from these arteries form the Circle of Willis.

The brain receives about 15-16% of the cardiac output, which is about 750 to 800ml of blood per liter.

Blood flow to the brain is regulated through the following ways

- Autoregulation e.g. Cushing's Reflex
- Chemical factors
- Neural factors

Autoregulation means when an organ is able to regulate its own blood supply on its own.

Cushing's Reflex

Cushings reflex usually occurs due to Cerebral Vascular Resistance. Cerebral vascular resistance occurs as a result of **increased intracranial pressure** and **increased cerebrospinal fluid pressure.** As a result, blood flow to the brain through the circle of Willis is reduced, a state which can lead to ischemia. There is low blood flow of the vasomotor area of the brain and as a result of hypoxia (low oxygen tension) and hypercapnia (high CO2), the vasomotor center is stimulated and streams of cardio acceleratory signals are sent to constrict blood vessels and increase peripheral arterial blood pressure. This causes increased blood flow to the brain and therefore, the Cushing's reflex has restored blood flow to the brain.

Chemical factors

- High co2
- Low oxygen
- High H+

Neuronal factors

The cerebral circulation is usually regulated by sympathetic fibers but they do not play any important role until in cases of pathological conditions such as hypertension. In the case of hypertension, the sympathetic fibers send impulses, causing the blood vessels to constrict, thereby reducing blood flow just in order to prevent the risk of Cerebral Embolism and Stroke.

SPLANCHNIC CIRCULATION

Splanchnic circulation refers to the circulation around the abdominal area. It consists of three portions namely;

- **Mesenteric circulation -** circulation to the GIT and pancreas.
- **Splenic circulation –** circulation to the spleen.
- **Hepatic circulation -** circulation to the liver.

Mesenteric circulation

The blood flow to the gastro intestinal tract is by a group of arteries called the **mesenteric arteries.**

Regulation is by autoregulation, contraction and relaxation activities of the gastrointestinal tract, nervous regulation is by sympathetic fibers and chemical factors include **hyperemia-** increase in mesenteric blood flow due to food and water intake

Splenic circulation

The arteries that supply the spleen are known as **splenic arteries.** The spleen is a reservoir for storing large amounts of blood. The two structures involved in storing blood in the spleen are **splenic venous sinuses** and **splenic pulp.** Nerve regulation of the splenic circulation id=s by sympathetic nerves.

Hepatic circulation

This is the supply of blood by the liver. The liver is supplied by the **hepatic artery** and the **hepatic portal vein.** The liver is the organ of the body that receives maximum amount of blood supply. This is because the liver performs most of the metabolic processes in the body. The blood flow to the liver is about 30% of cardiac output. Regulation of hepatic circulation is by systemic blood pressure, splenic contraction, movement of the intestines, some chemical factors and sympathetic fibers.

CORONARY CIRCULATION

This is the circulation of blood in the blood vessels that supply the heart. It is responsible for the functional blood supply of the heart muscle itself.

The heart is mainly supplied by the **Coronary Arteries**. These coronary arteries are divided into two. They are the;

- **Right coronary artery** which mainly supplies the right ventricle and posterior portion of the left ventricle
- **Left coronary artery** which mainly supplies the anterior and lateral parts of the left ventricle.

The coronary arteries are divided into smaller branches which are referred to as **epicardial arteries.** The epicardial arteries are further divided into **final** or **intramural arteries.**

Venous drainage

The venous drainage of the heart is by three principal veins

- **Coronary sinus** which drains about 75% of the blood to the heart. It drains blood from the left side of the heart into the right auricle.
- **Anterior coronary vein** which drains blood from the right side of the heart onto the right atrium.
- **Thebesian veins** which drains deoxygenated blood from the myocardium into any associated chambers.

The thebesian veins are able to serve as a physiological shunt i.e. deoxygenated blood is able to mix with oxygenated blood. It is also referred to as waste blood. Another similar shunt is when deoxygenated blood from bronchial vessels flow directly into the heart from the pulmonary vein.

Regulation of coronary hear flow is by autoregulation which is triggered by

- Need for oxygen
- Metabolic factors
- Coronary perfusion pressure
- Nervous factors i.e. sympathetic and parasympathetic nerves.

Problems of the coronary circulation include **CORONARY ARTERY OCCLUSION.** This occurrence could be as a result atherosclerosis, thrombus and embolus formation in blood vessels.

All these could result in **myocardial infarction** which would ultimately lead to ischemia. This would result in necrosis of hear cells if not treated fast.

CUTANEOUS CIRCULATION

This is the supply of blood to the skin. The architecture of the cutaneous supply goes as thus

- Small arteries go into the thin papillary layer of the skin to become the **arterioles.**
- These arterioles move horizontally to give rise to **meta arterioles.**
- The meta arterioles are then joined with the veins via capillary loops. The capillary loops have the arterial part which is the **arterial limbs of the loop** and the venous part which is the **venous limb of the loop.**
- The venous loops go beneath the papillary layer and join together to form **venules**.
- The venules anastomose with one another to form the **subcutaneous venous plexus**
- The subcutaneous venous plexus leaves to papillary layer, goes downwards horizontally to join larger deeper veins.

Body temperature is a key regulator of cutaneous circulation.

3.)

CARDIOVASCULAR ADJUSTMENT THAT OCCURS DURING EXERCISE

During exercise the body's metabolic needs are suddenly increased due to increased overall body and muscle activity that the body needs to compensate for. Various adjustments of the body during exercise include the supply of various metabolic requisites like nutrients and oxygen to muscles and other tissues involved, and the increase in body temperature.

On the cardiovascular system, there are a lot of adjusrments that need to be done in order for the body tobe able to compensate for the use of oxygen and energy.

On the Heart

When a person starts to exercise, cardiac output increases. This occurs because the body needs oxygen just as fast as the oxygen is being utilized for muscular activity. The nervous involvement is that there is vagal nerve withdrawal. As a result, there is increased sympathetic activity which increases heart rate and force of contraction. Some of the factors that play an increase in heart rate include

- Proprioceptors present in the exercising muscle send impulses tto the vasomotor center
- Increased carbon dioxide tensions
- Circulating catecholamine's (neurotransmitter that regulates heart beat)

On the Blood Vessels and Skeletal Muscle

During exercise, the skeletal muscles are going to be receiving a lot of blood flow due to their increased activity. During muscular activity, blood flow is increased to the muscle. This is because, as the muscle contract, the blood vessel is also constricted but in-between contractions, a large amount of blood flows into the muscle cells. Another factor responsible for increased blood flow to the muscle is **splanchnic vasoconstriction.** This occurs so that splanchnic supple is reduced and increases blood flows into the muscles.

On Blood Pressure

During exercise, blood pressure in increased. But however, it is only systolic pressure that increases and diastolic pressure is not altered. This is as a result of peripheral resistance isn't altered during moderate exercises.

In the case of more strenuous exercise, the systolic pressure increases at a very high rate, and diastolic pressure decreases. This occurs because peripheral resistance is decreased due to vasodilation.

On venous return

Venous return is increased during strenuous exercise due to increased intrathoracic pressure as as a result of heavy breathing, increased muscle contraction because of increased muscular activity and splanchnic vasoconstriction.

On Blood

As a result of constant use of oxygen during exercise, mild hypoxia is induced. This hypocia stimulates erythropoietin to be released by the juxtaglomerular apparatus in the kidney.

On Blood Volume

During exercise, there is fluid loss through sweating as a result of vasodilation. As a result, water and salts are lost from the body, reducing blood volume. Hemoconcentration also occurs because of loss of plasma components in blood. Dehydration may also occur.