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MAT NO;18/MHS01/150

LEVEL; 200LEVEL

COURSE; CARDIOVASCULAR PHYSIOLOGY

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

Long-Term Regulation of Blood Pressure

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-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 increasing the electrochemical gradient 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.

Anti-Diuretic Hormone (ADH)

The second 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 sodium reabsorption from the thick ascending limb of the loop of Henle. This increases water reabsorption thus increasing plasma volume and decreasing osmolarity.

Further Control of 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.

Clinical Relevance - Hypertension

Hypertension is defined as a sustained increase in blood pressure. It may be **primary** (of an unknown cause) or secondary to another condition such as chronic renal disease or Cushing's syndrome.

Hypertension causes damage to the walls of blood vessels, making them weaker. This leads to a number of pathologies including **atherosclerosis,** thromboembolism (progressing to MI or stroke) and aneurysms.

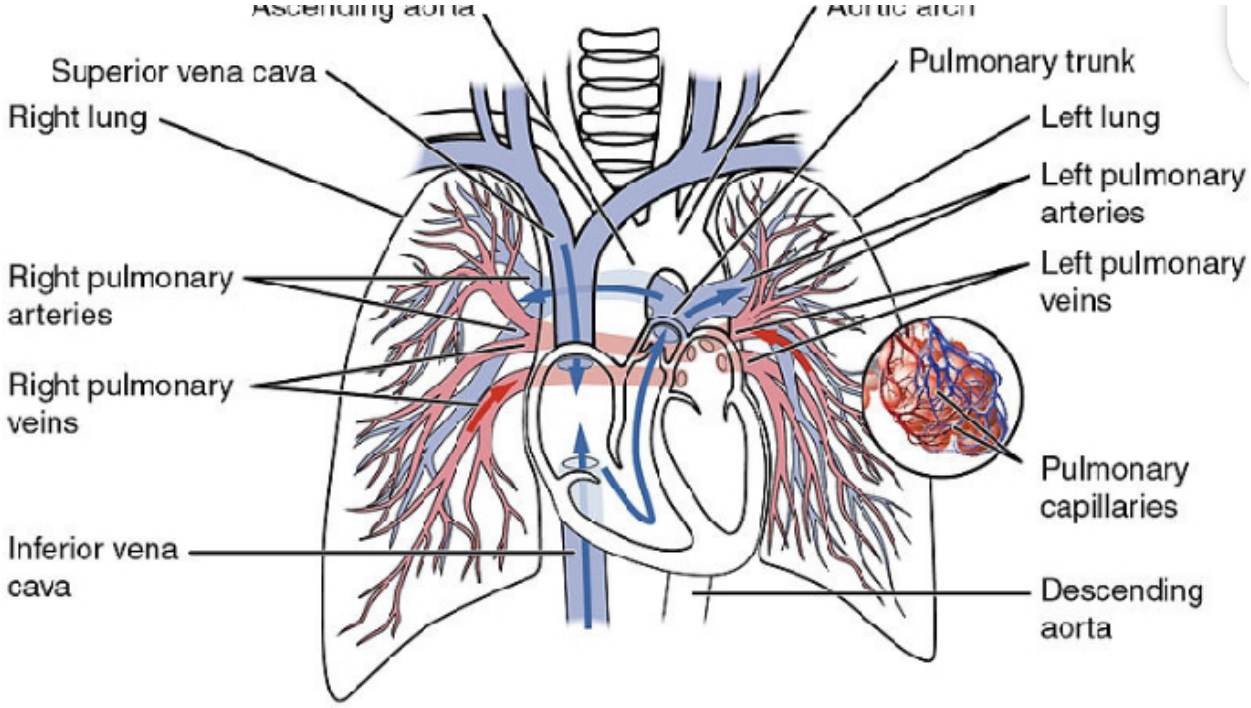
Hypertension also damages the heart itself by increasing the **afterload** of the heart. The heart is pumping against greater resistance, leading to left ventricular hypertrophy. This increases the risk of heart failure in the future. Hypertrophy of the cardiac muscle also increases the heart's oxygen demand, predisposing to myocardial ischaemia and ultimately angina.

Hypertension is classified using the BHS thresholds for treatment:

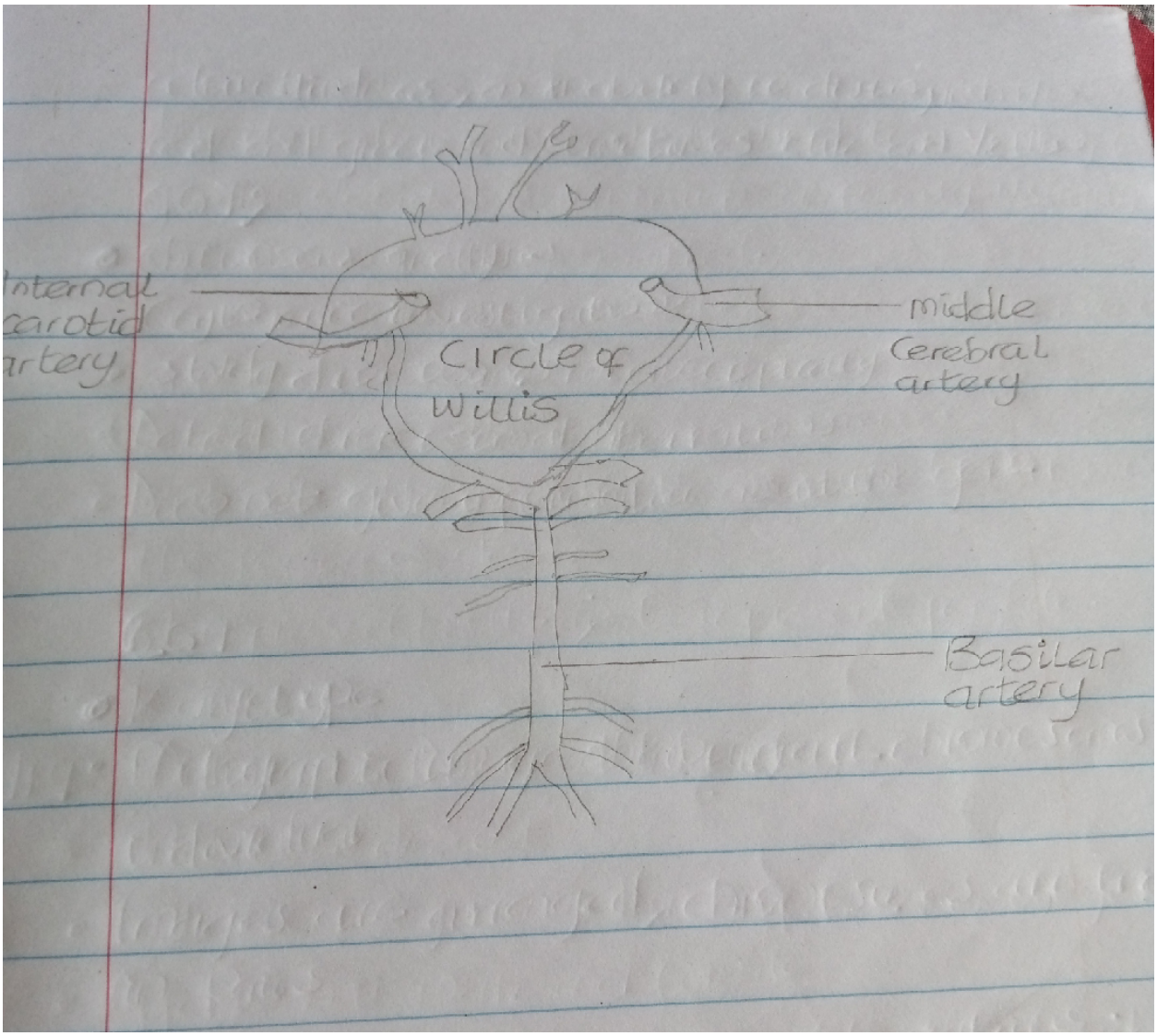
	Systolic BP (mmHg)	Diastolic BP (mmHg)
Optimal	<120	<80
Grade 1 (mild hypertension)	140-159	90-99
Grade 2 (moderate)	160-179	100-109
Grade 3 (severe)	>180	>110

2. WRITE SHORT NOTES ON THE FOLLOWING

a. pulmonary circulation; this is the portion of the circulatory system which carries deoxygenated blood away from the right ventricle, to the lungs, and returns oxygenated blood to the left atrium and ventricle of the heart. The vessels of the pulmonary circulation are the pulmonary arteries and the pulmonary veins



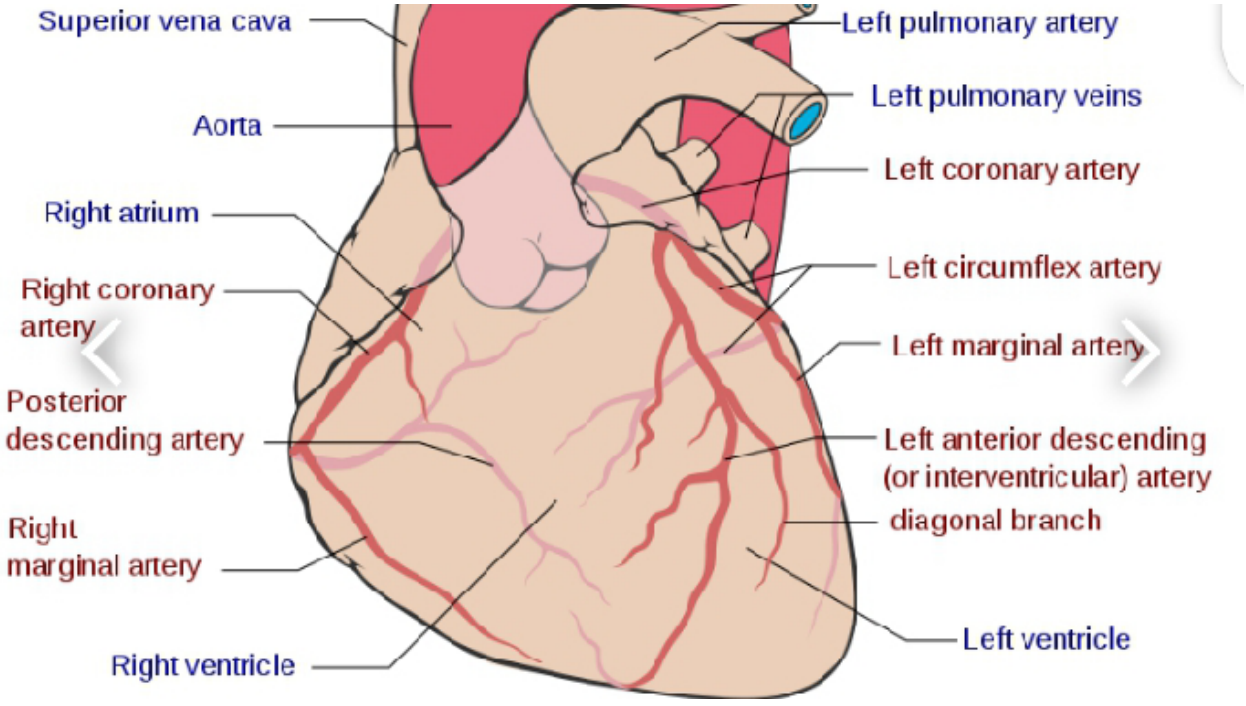
b. circle of willis; the circle of willis is the joining area of several arteries at the inferior side of the brain. At the circle of willis, theninternal carotid arteries branch into smaller arteries that supply oxygenated blood to over 80% of the cerebrum



c. splanchnic circulation; also called mesenteric circulation. The splanchnic circulation is composed of blood flow originating from the celiac, superior mesenteric, and inferior arteries and is distributed to all abdominal viscera. It consists of the blood supply to the gastro intestinal tract, liver, spleen, and pancreas. It consists of two large capillary beds partially, and then the efferent venous blood flows into the PV. The splanchnic circulation can act as a site of regulation of distribution of cardiac output and also as a blood reservoir.

d.coronary circulation; this is the circulation of 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 heart is

required to function continuously. Its function is not only to its tissues but to the entire body and even the level of consciousness from time to time. Interruptions of coronary circulation causes heart attack in which the heart is damaged by oxygen starvation



e.cutaneous circulation; this is the circulation and blood supply of the skin. The blood supply the skin is different from other tissues because of its low metabolically active tissue and relatively small energy requirement. Some of the circulating blood volume in the skin will flow through arteriovenous anastomoses instead of capillaries. AVAs serve a role in temperature regulation.

ARTERIOVENOUS **ANASTOMOSES**

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.

Temperature Regulation

The skin is the body's main heat dissipating surface: the amount of blood flow to the skin determines the degree of heat loss and therefore the core body temperature. The blood flow through AVAs is heavily influenced by the **sympathetic nervous system.** At rest, the sympathetic nervous system dominates and acts to constrict AVAs.

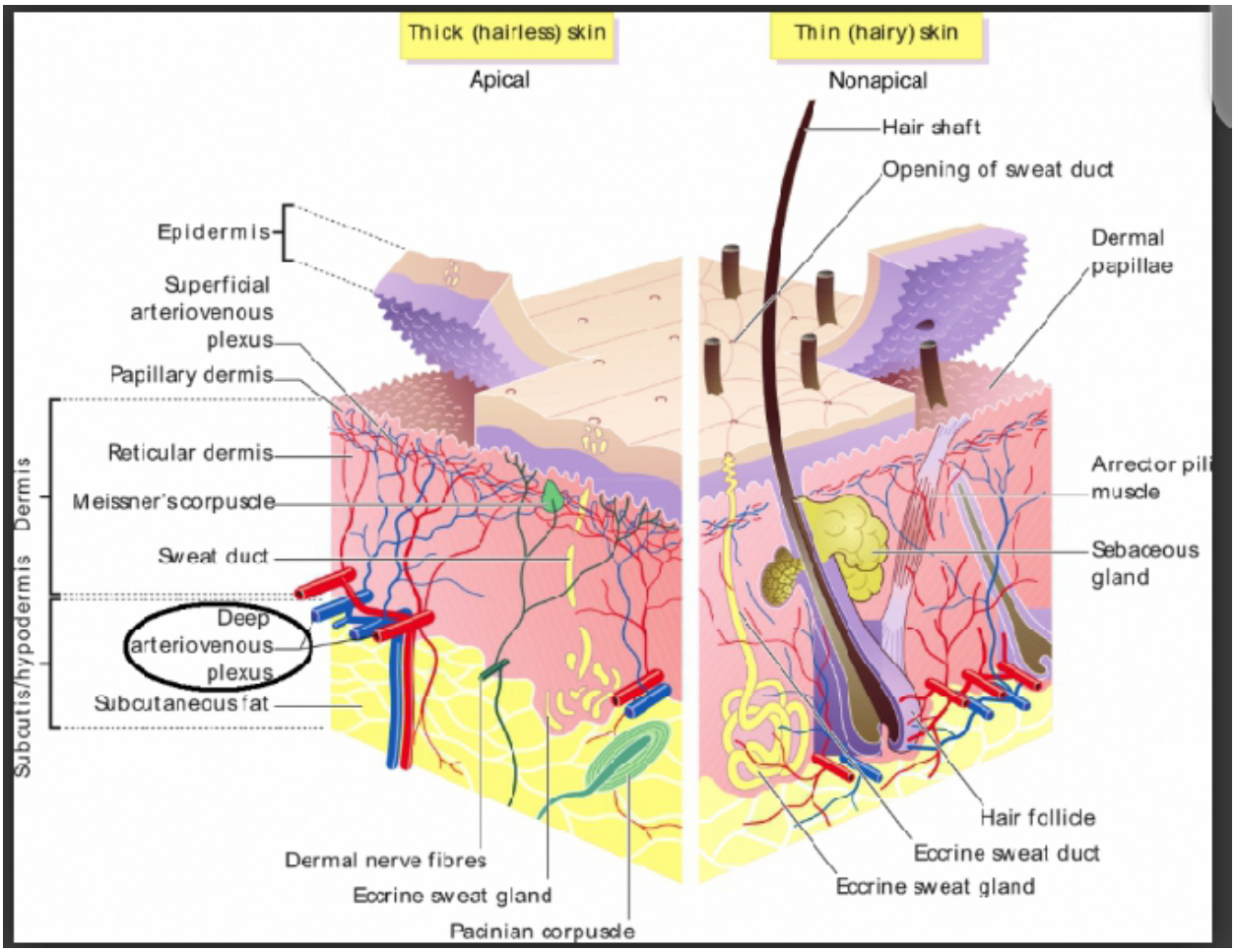
Any changes in core temperature are detected by the thermoregulatory centre in the **hypothalamus**. It regulates temperature by altering the level of sympathetic outflow to the cutaneous vessels, to return temperature to its normal range:

In high core temperatures:

- Sympathetic innervation is decreased, reducing the vasomotor tone in the AVAs.
- More blood flows through the AVAs and reaches the venous plexus (close to the surface of the skin), increasing heat loss to reduce core temperature.

In low core temperatures:

- Sympathetic innervation is increased, increasing the vasomotor tone in the AVAs.
- Less blood flows to the apical skin (of nose, lips, ears, hands and feet), reducing heat loss to increase the core temperature.



3. DISCUSS THE CARDIOVASCULAR ADJUSTMENT THAT OCCURS DURING EXERCISE.

Cardiovascular system responses to exercise is directly proportion to the skeletal muscle demands for any given rate of work and oxygen take up. The adjustments of cardiovascular system undergo during exercise include;

i. Increase in cardiac output or pumping capacity of the heart; designed to enhance oxygen delivery and fuel to working muscles.

ii. During exercise, more blood is sent to the active skeletal muscles, and, as body temperature increases, more blood is sent to the skin. This process is accomplishes both by the increase in cardiac output and by the redistribution of blood flow away from areas of low demand, such as splanchnic organs.

During exercise, cardiac output increases to provide the flow needed to serve the contracting skeletal muscles. Yet, by resetting the operating point for the arterial baroreceptors, vasodilation is regulated to make blood pressure stable or to increase during exercise. Such a balance between cardiac output and total peripheral resistance would be considered to be governed by an interplay between autonomic influence on the heart, vasodilatory substances released from the working muscles, and sympathetic mediated vasoconstriction, including active skeletal muscles. The central nervous system 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. Even in the absence of influence from the CNS and neural feedback from working muscles, a tight coupling between cardiac output and whole body oxygen uptake is maintained.