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DEPARTMENT: MEDICINE AND SURGERY

COURSE: PHYSIOLOGY

ASSIGNMENT:

1) DISSCUSS THE LONG TERM REGULATION OF MEAN ARTERIAL BLOOD PRESSURE

2) WRITE SHORT NOTES ON
A) PULMONARY CIRCULATION
B) CIRCLE OF WILLIS
C) SPLANCHNIC CIRCULATION
D) CORONARY CIRCULATIOM
E) CUTANEOUS CIRCULATION

3) DISCUSS THE CARDIOVASCULAR ADJUSTMENT THAT OCCURS DURING EXERCISE

1) DISCUSS THE LONG-TERM REGULATION OF MEAN ARTERIAL BLOOD RESSURE

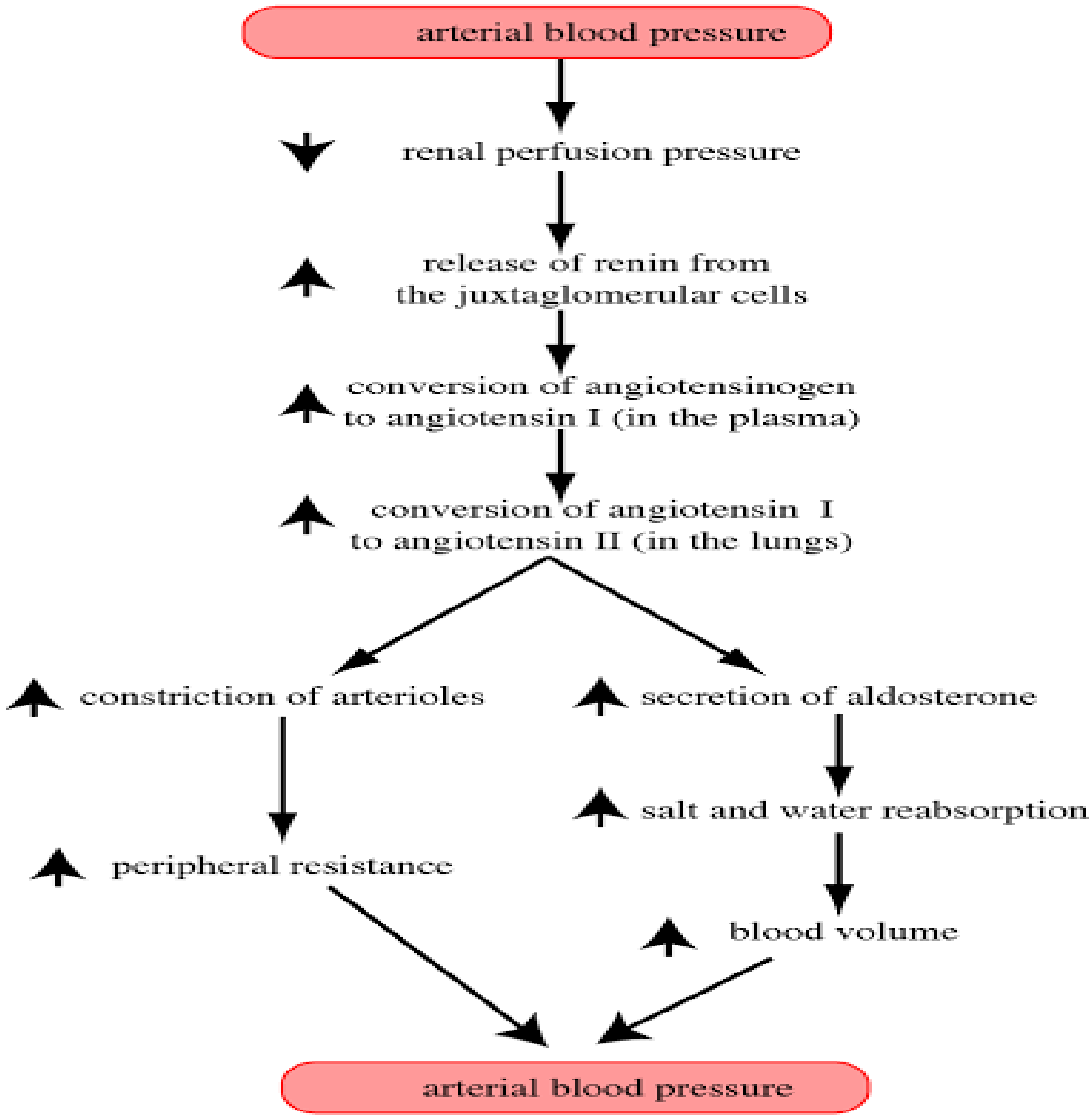
Arterial blood pressure varies even under physiological conditions. However, it's immediately brought back to normal level because of the presence of well-organized regulatory mechanisms in the body. One of those mechanisms is the **long term regulatory mechanism (renal mechanism).**

LONG TERM REGULATORY MECHANISM (RENAL MECHANISM)

Consistent and long term control of blood-pressure is determined by the renin-angiotensin system. Along with vessel morphology, blood viscosity is one of the key main factors influencing resistance and hence blood pressure**.** A key modulator of blood pressure is the **Renin-Angiotensin System (RAS)** or the renin **Angiotensin-Aldosterone System (RAAS),** a hormone system that regulates blood pressure and water balance.

- When the volume of blood is low, juxtaglomerular cells in the kidney secrete renin directly into circulation.
- Plasma renin then carries out the conversion of angiotensinogen released by the liver to angiotensin I.
- Angiotensin I is subsequently converted to angiotensin II by the enzyme found in the lungs.
- Angiotensin II is a potent vasoactive peptide that causes blood vessels to constrict, resulting in increased blood pressure. Angiotensin II also stimulates the secretion of the hormone aldosterone from the adrenal cortex.
- Aldosterone causes the tubules of the kidneys to increase the reabsorption of sodium and water into the blood. This increases the volume of fluid in the body, which also increases blood pressure. If the renin-angiotensin-aldosterone is too active, blood pressure will be too high. .
- It is believed that angiotensin I may have minor activity, but angiotensin II is the major bioactive product. Angiotensin II has a variety of effects on the body; throughout the body. **IT IS A POTENT VASOCONSTRICTOR OF ARTERIOLES.**

Function diagram of the renin-angiotensin-aldosterone system



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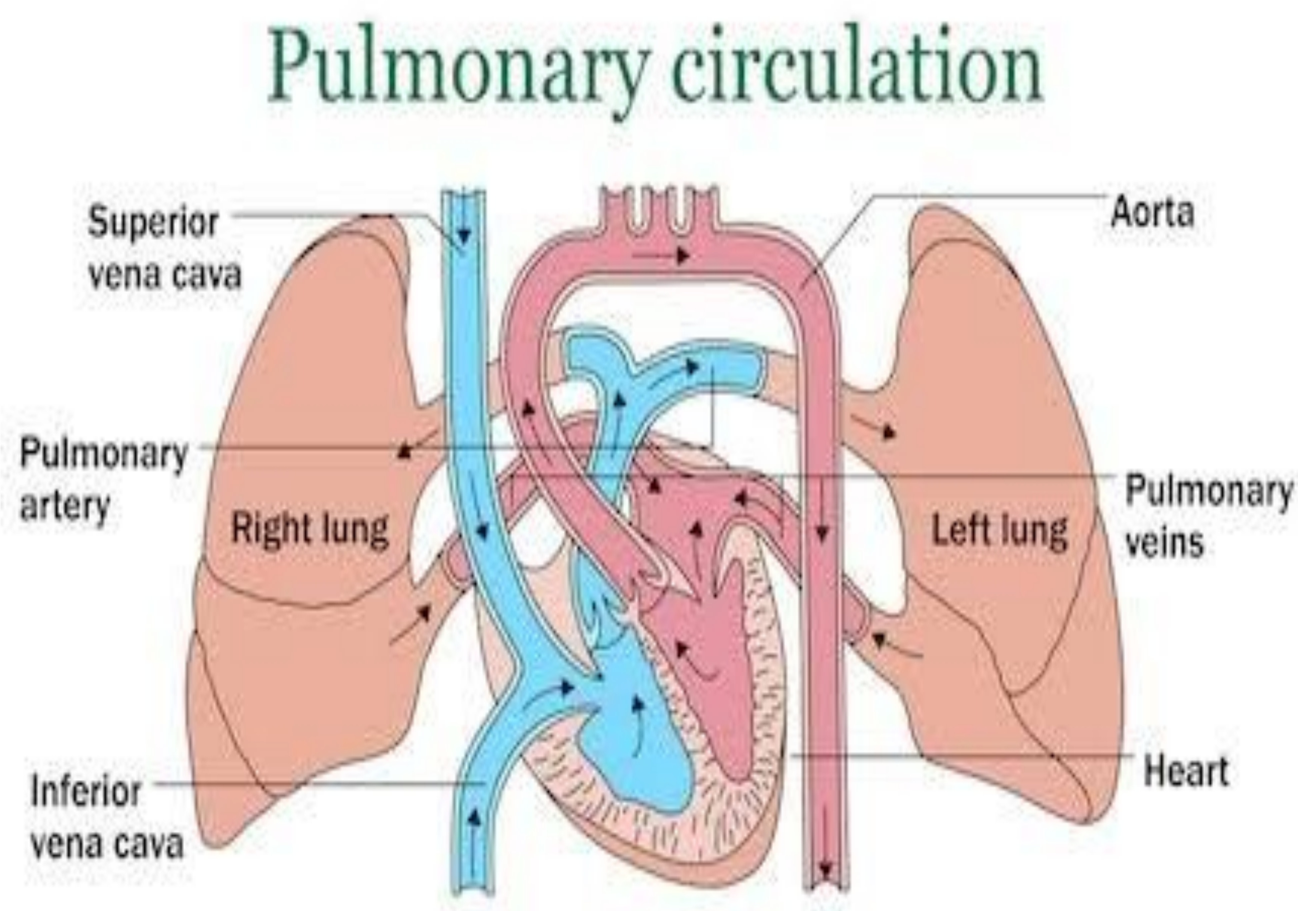
2) WRITE SHORT NOTES ON

A) PULMONARY CIRCULATION:

Pulmonary circulation is a type of circulation that forms a closed circuit between the heart and the lungs, as distinguished from the systemic circulation between the heart and all other body tissue. It is otherwise called lesser circulation. The mammalian is four-chambered. The pulmonary circuit beings with the right ventricles, which pumps blood through the pulmonary artery. The artery divides into smaller and smaller branches until the capillaries in the pulmonary air sacs (alveoli) are reached. There's exchange of gases between the blood and alveoli of the lungs at the pulmonary capillaries. Then the oxygenated blood from into the pulmonary vein. The pulmonary veins open into the left atrium of the heart.

<u>Diagrammatic representation of the pulmonary circulation</u>



B) CIRCLE_OF_WILLIS

The circle of Willis is a circulatory anastomosis that supplies blood to the brain and surrounding structures. It is named after Thomas Willis. The circle of Willis is formed by two groups of arteries.

Location

It is a ring of interconnecting arteries located at the base of the brain around the optic chiasma (partial crossing of the optic nerve –important for binocular vision), infundibulum of the pituitary stalk and the hypothalamus.

Structure

The two arteries called the carotid arteries, supply blood to the brain. They run along either side of the neck and lead directly to the circle of Willis.

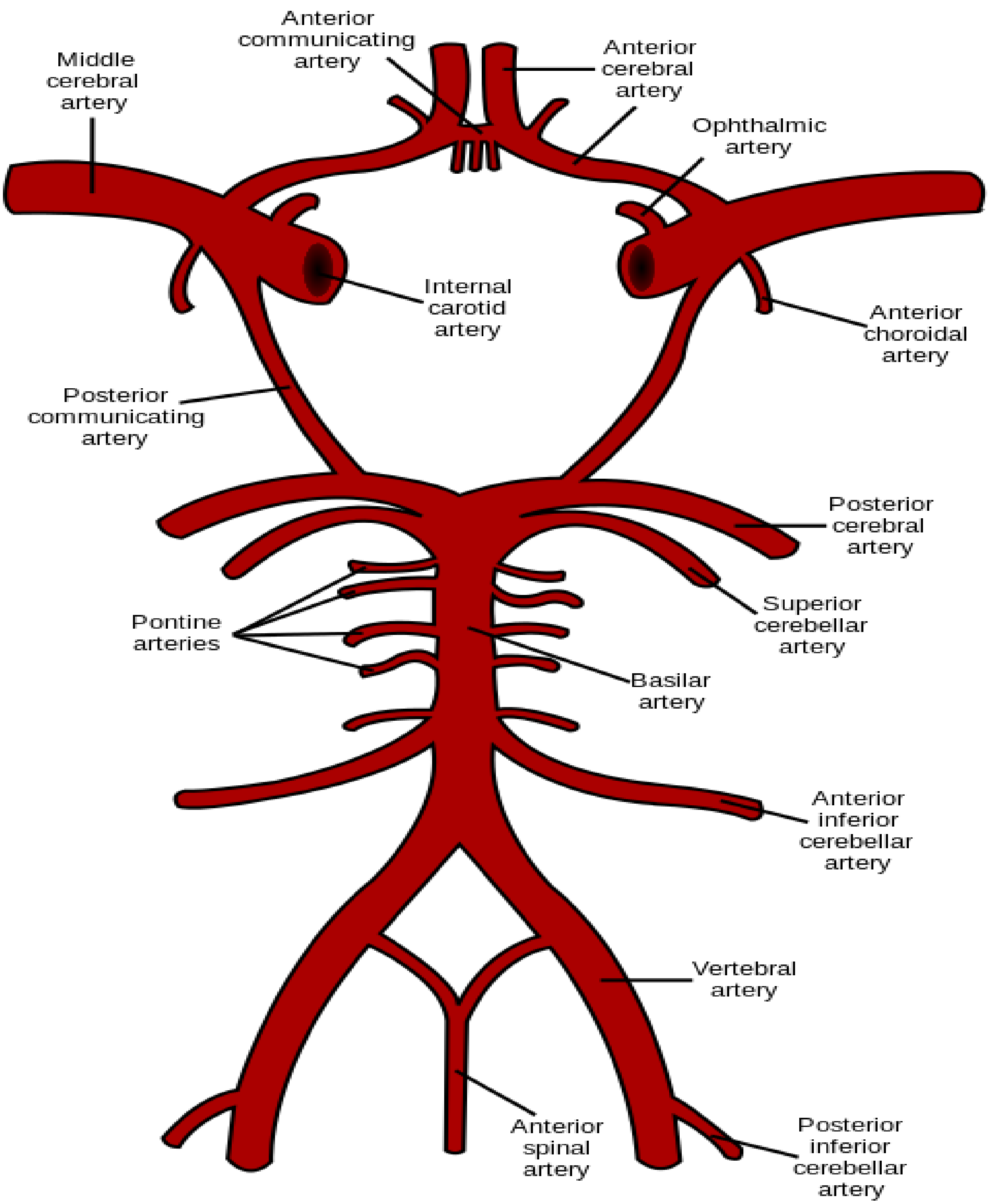
The structure of the circle of Willis includes

- left and right internal carotid arteries
- Left and right anterior cerebra arteries
- Left and right posterior cerebral arteries
- Left and right posterior communicating arteries.
- Basal artery and anterior communicating arteries

Function

- The circle of Willis plays an important role, as it allows for proper blood flow from the arteries to both the front and the back hemispheres of the brain. The arteries that stem off from the circle of Willis supply much of the blood to the brain.
- The circle of Willis also serve as a sort of safety mechanism when it comes to blood flow in a connected artery, the change in pressure can cause blood to flow forward or backwards in the circle of Willis to compensate
- The natural shape of the circle and the way that pressure acts in the area simply allow for bidirectional blood flow when necessary.

Diagrammatic explanation of the circle of Willis



C) SPLANCHNIC CIRCULATON

The splanchnic circulation is a complex system. It's composed of gastric, small, intestinal, colonic, pancreatic, hepatic, and splanchnic circulations, arranged in parallel with one another.

Splanchnic circulation consists of three portions

- Mesenteric circulation supplying blood to the GI tract.
- Splenic circulation supplying blood to the spleen.
- Hepatic circulation supplying blood to the liver.

NOTE: Unique feature of splanchnic circulation is that the blood from mesenteric bed and spleen forms a major amount of blood flowing to the liver. Blood flows to liver from GI tract and spleen through portal system.

MESENTERIC CIRCULATION

Mesenteric circulation refers to the vasculature of the intestines. Small mesenteric arteries form an extensive vascular network in the intestinal submucosa. The arterial branches penetrate the longitudinal and circular muscle layers of the intestine and give rise to arterioles.

SPLENIC CIRCULATION

Spleen is the main reservoir for blood. Due to the dilation of blood vessels, a large amount of blood is stored in spleen. And the constriction of blood vessels by sympathetic stimulation releases blood into the circulation. Blood flow to the spleen is regulated by sympathetic nerve fibres.

HEPATIC CIRCULATION

Liver receives blood from two sources

- Hepatic artery
- Portal vein

Liver receives maximum amount of blood as compared to other organs of the body, since most of the metabolic activities are carried out by the liver. Blood flow to the liver is 1,500Ml/min, which forms about 30% of cardiac output. Portal vein carries about 25% of blood to the liver and hepatic vein carries about 75%

FACTORS INFLUENCING THE SPLNCHNIC CIRCULATION

The circulation of some splanchnic organs is complicated by the existence of intramural circulation. Numerous intrinsic and extrinsic factors influence the splanchnic circulation.

Extrinsic factors

- General hemodynamic conditions of the cardiovascular system
- Autonomic nervous system
- Circulating neurohumoral agents.

Intrinsic factors

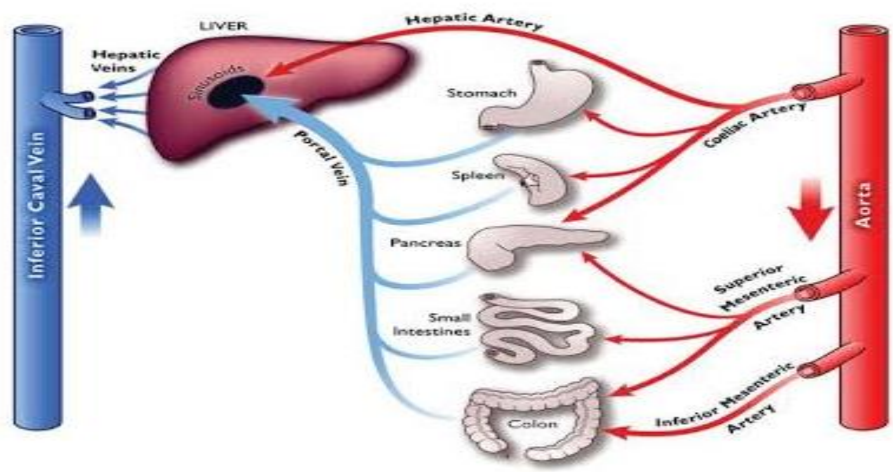
- Special properties of the vasculature
- Local metabolites
- Intrinsic nerves
- Paracrine substances and local hormones

The existence of a multiplicity of regulatory mechanisms provides overlapping controls and restricts radical changes in tissue perforation.

A number of important functions depends on its normal operation, including;

- Digestion and absorption within the gut
- Maintenance of the mucosa barrier
- Successful healing of surgical anastomosis**.**

<u>Diagrammatic representation of splanchnic circulation</u>



D) CORONARY CIRCULATION

Coronary circulation is the circulation of blood through blood vessels of the heart muscle (myocardium). It is responsible for functional blood supply to heart muscle itself. Blood flowing through the chambers of the heart does not nourish the myocardium. When functioning normally, blood in coronary blood vessels supply adequate oxygen to myocardium. Like systemic circulation and pulmonary circulation, coronary circulation is also made up of arteries, arterioles, capillaries, venules and veins.

Normal coronary blood flow

Normal blood flow through coronary circulation is about 200mL/min. It forms 4% of cardiac output.

Factors regulating coronary blood flow

Auto-regulation

Like any other organ, heart also has the capacity to regulate its own blood flow by auto regulation. Coronary blood flow is not affected when mean arterial pressure varies between 60 and 150mmhg. Several factors are involved in the auto regulation mechanism. Coronary blood flow is regulated mainly by **local vascular response to the needs of cardiac muscle.**

Factors regulating coronary blood flow include:

- **Need for oxygen**: The amount of blood passing through the coronary circulation is directly proportional to the consumption of oxygen by cardiac muscle.
- **Metabolic factors**: Coronary vasodilation during hypoxic conditions occurs because of some metabolic products, which increases the coronary blood flow by vasodilation. Metabolic products which increase blood flow are adenosine, potassium, hydrogen, carbon dioxide, adenosine phosphate compounds.
- **Coronary perfusion pressure:** Pressure balance between mean arterial blood pressure and venous pressure.

- **Nervous factors:** Coronary blood vessels are innervated by the both by parasympathetic and sympathetic divisions of autonomic nervous system. These nerves influence the coronary blood flow by acting on the musculature of heart.

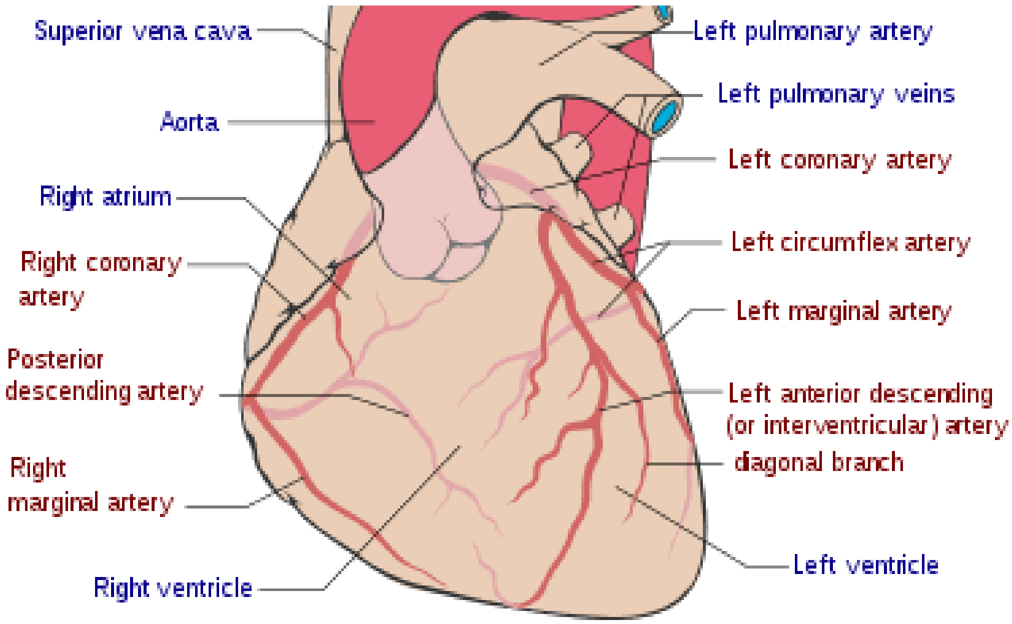
APPLIED PHYSIOLOGY OF CORONARY CIRCULATION

Coronary artery disease (CAD)

Coronary artery disease (CAD) is the heart disease that is caused by inadequate blood supply to cardiac muscle due to occlusion of coronary artery. It is also called coronary heart disease.

- **Coronary Occlusion-** Partial or incomplete obstruction of the coronary artery.
- **Myocardial Ischemia and Necrosis-** Myocardial ischemia is the reaction of a part of the myocardium in response to hypoxia. Ischemia leads to necrosis of myocardium if a large part of myocardium is involved.
- **Myocardial Infarction- Heart attack-** This is the necrosis of myocardium caused by insufficient blood flow due to embolus, thrombus or vascular spasm
- **Cardiac Pain- Angina Pectoris-** Cardiac pain is the chest pain that’s caused by myocardial ischemia.

Diagrammatic representation of coronary circulation.



E) CUTANEOUS CIRCULATION

The cutaneous circulation is the circulation and blood supply to the skin. The skin is not a very metabolically active tissue and has relatively small energy requirements, so its blood supply is different tot that of other tissues.

Cutaneous blood vessels

- Cutaneous arterioles
- Meta arteriole
- Cutaneous capillaries
- Venules-extensive sub papillary venous plexus
- Arteriovenous anastomosis – in distal parts of extremities (hands, feet, nose, lips and ear lobules)

Functions of cutaneous circulation

- Supply of nutrition to the skin
- Regulation of body temperature by heat loss

Normal blood flow to the skin

Under normal conditions, the blood flow to the skin is about 250mL/sq. m/min. when the body temperature increases, cutaneous blood flow increases up to 2,8000mL/sq. m/min. because of cutaneous vasodilation.

Regulation of cutaneous circulation

Cutaneous blood flow is regulated mainly by blood temperature. Hypothalamus plays an important role in regulating cutaneous blood flow.

- Temperature regulation centre of hypothalamus mediate thermoregulation by increase and decrease of sympathetic discharge to cutaneous vessels
- When body temperature increases the hypothalamus is activated.
- Hypothalamus in turn causes AVAs cutaneous vessels to dilate (vasodilation) by acting through medullary vasomotor centre.
- Now blood flow increases in skin. Increases in blood flow causes the loss of heat from the body through sweat.

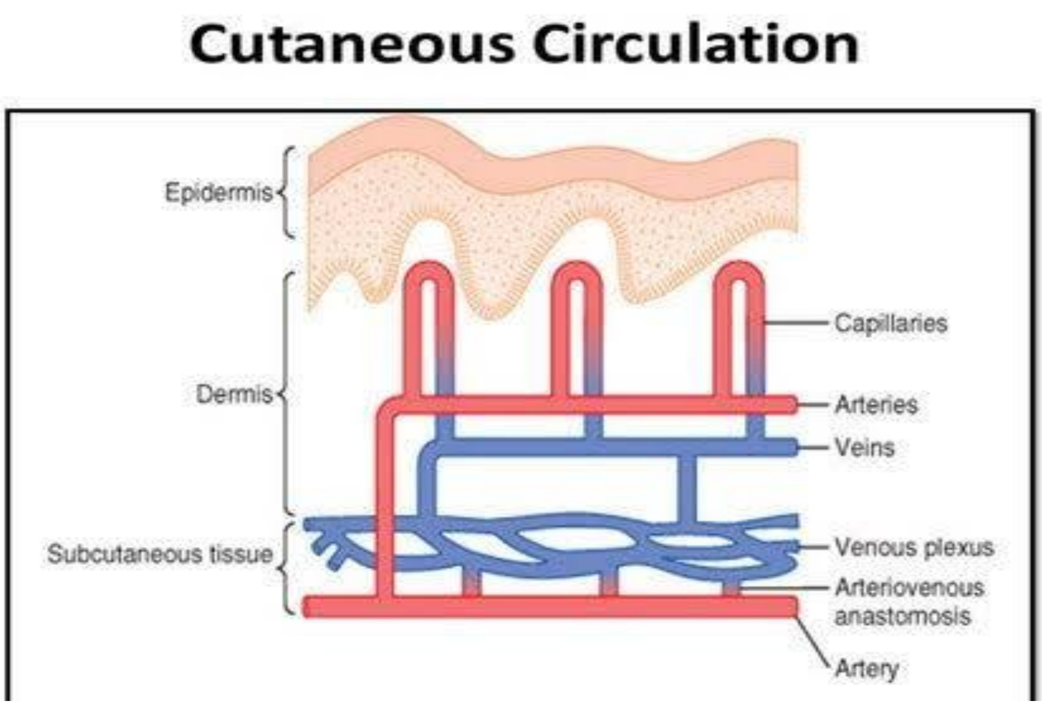
- When body temperature is low, vasoconstriction occurs in the skin. Therefore, the blood flow to skin decreases and prevents the heat loss from skin.

Applied physiology-- vascular responses of skin to mechanical stimulus

Vascular responses of skin are the reactions developed in blood vessels of skin when some mechanical stimuli are applied over the surface of it. It is of two types

- **White reaction-** response of the skin blood vessels to mechanical stimulus. White reaction is due to constriction of the cutaneous capillaries because of local stimulation and exertion of tension upon capillary walls.
- **Lewis triple response-** This is the vascular response of skin that includes three consecutive reactions of blood vessels of skin to a mechanical stimulus; the red, flare and wheal responses.

Diagrammatic representation of cutaneous circulation



3) CARDIOVASCULAR ADJUSTMENT THAT OCCURS DURING EXERCISE

During exercise, there is an increase in the metabolic needs of body tissues, particularly the muscles. Various adjustments in the body during exercise are aimed at supplying various metabolic requirements like nutrients and oxygen to muscles and other tissues involved in exercise.

The following are the adjustment that takes place on the cardiovascular system.

- 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.**
- More heat is produced during exercise and the t**hermoregulatory system is activated**. This in turn, causes section of large amount of sweat leading to;
  - Fluid loss
  - **Reduced blood volume**
  - Hemoconcentration
  - Dehydration if exercise is severe.
- Because of vagal withdrawal, **sympathetic activity increases**.
- The sympathetic nervous system stimulates the S.A node, leading to an **increase in heart rate, force of contraction, and blood pressure.**
- **Stroke volume increases** due to increased force of contraction.
- **Venous return also increases remarkably** because of muscle pump, respiratory pump and splanchnic vasoconstriction.
- **Cardiac output increases** because of increase in heart rate and increase in stroke volume. Cardiac output increases up to 20 L/min during severe exercise. Increase in the cardiac output is directly proportional in **increase in the amount of oxygen consumed during exercise**.