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COURSE: PHYSIOLOGY; CARDIO VASCULAR PHYSIOLOGY

ASSIGNMENT

1) Discuss the long term regulation of mean arterial pressure.

Answer:

Mean arterial pressure is regulated by changes in cardiac output and systemic vascular resistance. Mean arterial pressure is maintained within a narrow range.

In Systemic Arterial Pressure - Long-term Regulation, While changes to the Systemic Vascular Resistance (SVR) can transiently affect the systemic arterial pressure, arterial pressures tend to return to their original baseline within hours even if the changes to SVR are maintained. A variety of empirical studies have demonstrated that **long-term control of the systemic arterial pressure** over timescales of days, weeks, and months is principally regulated by the **kidneys** and is not dependent on changes to the systemic vasculature. The capacity of the kidneys to control arterial pressure depends on their ability to modify the extracellular fluid (ECF) volume which in a healthy individual determines the total blood volume.

The kidneys respond to changes in systemic arterial pressure by modifying their urinary excretion of sodium and water. When arterial pressures are elevated, renal urinary excretion of sodium and water increases; conversely, when arterial pressures are deficient, renal urinary excretion of sodium and water decreases. The mechanisms which connect changes in arterial pressures to renal urinary excretion of salt and water are described more fully in ECF volume regulation and principally rely on mechanisms pressure natriuresis and the RAAS System. Nevertheless, **this relationship between systemic arterial pressures and renal urinary excretion is largely independent of the SVR**; consequently, whether or not the SVR is high or low, the kidneys will respond as described above by matching their urinary excretion to the effective systemic arterial pressure

The capacity of the kidneys to regulate urinary salt and water excretion allows these organs to regulate the total ECF volume which, as discussed below, is a major determinant of systemic arterial pressure in healthy individuals. Taken together, the relationship between arterial pressure, renal salt and water excretion, and ECF volume resembles a **negative feedback control circuit** in which changes to arterial pressure modulate renal sodium and water excretion which in turn affect ECF volume and thus modulate arterial pressure. Once again, this negative feedback appears to act completely independently of the SVR and explains why changes to the SVR can only affect arterial pressures transiently.

While a rapid increase in SVR will immediately boost the blood pressure, the kidneys will respond by progressively excreting salt and water, thus reducing the ECF volume and thus causing a slow decline in arterial pressure. Conversely, while a rapid decrease in SVR will immediately reduce the blood pressure, the kidneys will respond by retaining more salt and water than that ingested, thus increasing the ECF volume and thus causing a slow increase in the arterial pressure.

2) Write short note on the following.

a) pulmonary circulation

Answer:

Pulmonary circulation is the system of transportation that shunts de-oxygenated blood from the heart to the lungs to be re-saturated with oxygen before being dispersed into systemic circulation. Deoxygenated blood from the lower half of the body enters the heart from the inferior vena cava while deoxygenated blood from the upper body is delivered to the heart via the superior vena cava. Both the superior vena cava and inferior vena cava empty blood into the right atrium. Blood flows through the tricuspid valve into the right ventricle. It then flows through the pulmonic valve into the pulmonary artery before being delivered to the lungs. While in the lungs, blood diverges into the numerous pulmonary capillaries where it releases carbon dioxide and is replenished with oxygen. Once fully saturated with oxygen, the blood is transported via the pulmonary vein into the left atrium which pumps blood through the mitral valve and into the left ventricle. With a powerful contraction, the left ventricle expels oxygen-rich blood through the aortic valve and into the aorta: This is the beginning of systemic circulation.

b) Circle of Willis

Answer:

The circle of Willis is an important junction of arteries at the base of the brain. The structure encircles the middle area of the brain, including the stalk of the pituitary gland and other important structures. 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.

Each carotid artery branches into an internal and external carotid artery. The internal carotid artery then branches into the cerebral arteries. This structure allows all of the blood from the two internal carotid arteries to pass through the circle of Willis.

The structure of the circle of Willis includes:

- left and right internal carotid arteries

- left and right anterior cerebral arteries
- left and right posterior cerebral arteries
- left and right posterior communicating arteries
- basilar artery
- anterior communicating artery

The circle of Willis is critical, as it is the meeting point of many important arteries supplying blood to the brain. The internal carotid arteries branch off from here into smaller arteries, which deliver much of the brain's blood supply.

c) Splanchnic circulation

Answer:

The splanchnic circulation is composed of gastric, small intestinal, colonic, pancreatic, hepatic, and splenic circulations, arranged in parallel with one another. The three major arteries that supply the splanchnic organs, celiac and superior and inferior mesenteric, give rise to smaller arteries that anastomose extensively. The circulation of some splanchnic organs is complicated by the existence of an intramural circulation. Redistribution of total blood flow between intramural vascular circuits may be as important as total blood flow. Numerous extrinsic and intrinsic factors influence the splanchnic circulation. Extrinsic factors include general hemodynamic conditions of the cardiovascular system, autonomic nervous system, and circulating neurohumoral agents. Intrinsic mechanisms include 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 perfusion.

d) coronary circulation

Answer:

Coronary circulation is part of the systemic circulatory system that supplies blood to and provides drainage from the tissues of the heart. In the 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 heart. Deoxygenated blood is returned to the chambers of the heart via coronary veins; most of these converge to form the coronary venous sinus, which drains into the right atrium.

e) Cutaneous circulation

Answer:

The 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 will flow through arteriovenous anastomoses (AVAs) instead of capillaries. AVAs serve a role in temperature regulation.

3) discuss the cardiovascular adjustment that occurs during exercise.

Answer:

During exercise, increases in cardiac stroke volume and heart rate raise cardiac output, which coupled with a transient increase in systemic vascular resistance, elevate mean arterial blood pressure (60). However, long-term exercise can promote a net reduction in blood pressure at rest. The cardiac output increase is due to a large increase in heart rate and a small increase in stroke volume.

The integrated response to severe exercise involves fourfold to fivefold increases in cardiac output, which are due primarily to increases in cardiac rate and to a lesser extent to augmentation of stroke volume. The increase in stroke volume is partly due to an increase in end-diastolic cardiac size (Frank-Starling mechanism) and secondarily due to a reduction in end-systolic cardiac size. The full role of the Frank-Starling mechanism is masked by the concomitant tachycardia. The reduction in end-systolic dimensions can be related to increased contractility, mediated by beta adrenergic stimulation. Beta adrenergic blockade prevents the inotropic response, the decrease in end-systolic dimensions, and approximately 50% of the tachycardia of exercise. The enhanced cardiac output is distributed preferentially to the exercising muscles including the heart. Blood flow to the heart increases fourfold to fivefold as well, mainly reflecting the augmented metabolic requirements of the myocardium due to near maximal increases in cardiac rate and contractility.