

Introduction to Physiology

BMHP5003_BIRM

Assignment one

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CARDIOVASCULAR SYSTEM

STRUCTURE &FUNCTIONS

The human cardiovascular system is an organ system responsible for transporting blood through vessels to and from all parts of the body, carrying nutrients and oxygen to tissues and removing carbon dioxide and other wastes. It is a closed tubular system in which the blood is propelled by a muscular heart (Entman, 1998).

MAIN COMPONENTS OF THE CARDIOVASCULAR SYSTEM

- Heart
- Veins
- Capillaries
- Arteries (Moore, 2017).

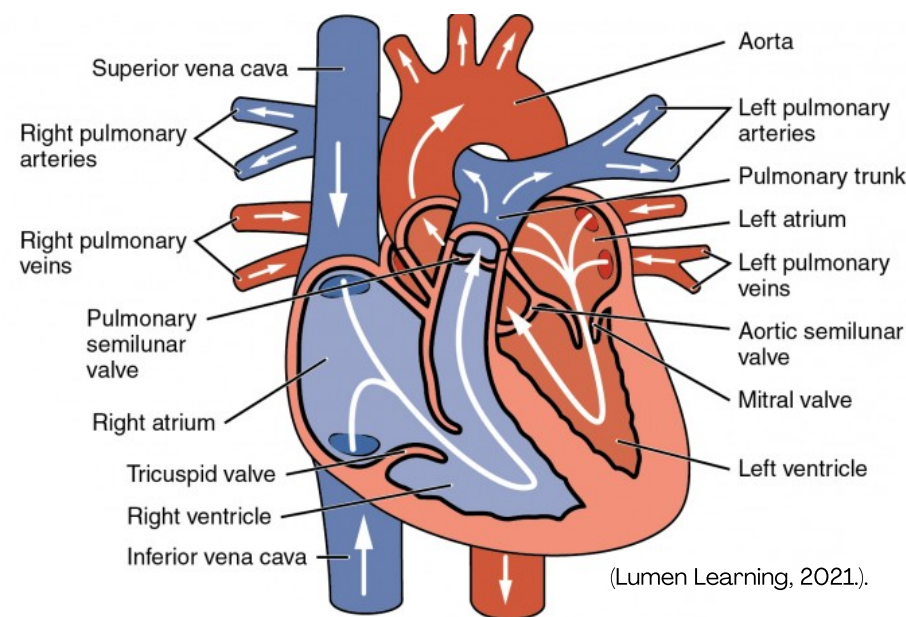
THE FUNCTION- TRANSPORTATION

- Gases
- Nutrients
- Waste
- Hormones
- Electrolytes (Gorman Msc, 2021).

TWO DISTINCT CIRCULATORY PATHS

Pulmonary circulation transports deoxygenated blood between the heart and the lungs. Deoxygenated blood travels to the lungs to absorb oxygen and release carbon dioxide with oxygenated blood flowing back to the heart.

Systemic circulation transports blood between the heart and the rest of the body. Oxygenated blood is sent out to cells with deoxygenated blood returning to the heart (Visible Body, 2021).



HEART COMPONENTS

- Three Layers – myocardium, endocardium, epicardium
- Four Chambers – left and right atria left and right ventricles
- Blood vessels – arteries (oxygenated blood), veins (deoxygenated blood) (Gorman Msc, 2021).

BLOOD - PLASMA WITH CELLULAR COMPONENTS:

- **Erythrocytes** (red blood cells) – contain haemoglobin and carry oxygen throughout the blood vessels
- **Leukocytes** (white blood cells) – immune system cells
- **Thrombocytes** (platelets) – coagulation cells (Gorman Msc, 2021).

THREE LAYERS OF THE HEART

- **Epicardium** – refers to the outer and inner layer of the heart wall. It is a thin layer of elastic connective tissue and fat that offers an additional layer of protection for the heart.
- **Myocardium** – refers to the thick, muscular tissue located in the middle of the heart wall made up of Cardiomyocytes. Cardiomyocytes are specialised muscle cells which, due to their continuous rhythmic contractions, require a dedicated blood supply to deliver oxygen and nutrients and removing waste products such as carbon dioxide from the cardiac muscle tissue. The blood supplying the cells originates from coronary arteries.
- **Endocardium** – refers to the smooth, elastic inner layer of the heart made up of Endothelial cells designed to pump and collect blood. The Endocardium may at times regulate the removal of waste from the heart's tissue and act as a barrier between blood and the heart's muscle. Infective Endocarditis is an inflammatory condition affecting the Endocardium, damaging the heart's valves and impairing normal blood flow through the heart (LibreTexts, 2020).

ATRIA

The two upper chambers of the heart are called the atria. They are cube-shaped with an ear-shaped opening called an auricle. Blood low in oxygen and high in carbon dioxide is received by the right atrium and transferred to the right lower Ventricle which is then pumped to the lungs. The left atrium receives oxygen-rich blood, low in carbon dioxide, allowing its flow into the left ventricle where it is then pumped through the arteries to the tissues. The openings into the left atrium are the entry points of the pulmonary veins, bringing oxygenated blood from the lungs, and the opening into the left ventricle. The openings into the right atrium are the points of entry for the superior and inferior venae cavae, and for the coronary sinus carrying deoxygenated blood from the heart muscle itself. It is also the opening into the right ventricle (Britannica, 1998).

VENTRICLES

The two lower chambers of the heart are called ventricles. The walls of the chamber are more muscular than the walls of the atria due to the forces exerted when pumping blood to the lungs and tissues.

There are two openings into the ventricles. They are the opening from the right ventricle into the pulmonary artery, which transports blood to the lungs and the opening from the left ventricle into the aorta, where oxygen-rich blood begins its journey to the tissues. Each opening, in and out, is guarded by a valve (Britannica, 1999).

TYPE OF ARTERIES

- **Pulmonary arteries** transport blood that has a low oxygen content from the right ventricle to the lungs.
- **Systemic arteries** transport oxygenated blood from the left ventricle to the body tissues.
- **Arterioles** are microscopic arteries that are key in regulating blood flow into the tissue capillaries
- **Muscular arteries** are distributing arteries.
- **Large elastic arteries** are the conducting arteries carrying blood at high pressure from the heart to smaller conducting arteries (Gorman Msc, 2021).

CAPILLARIES

Capillaries are tiny blood vessels that supply tissues such as muscles, liver and kidneys. The more metabolically active the tissue, the more capillaries it contains. The exchange of oxygen, nutrients, and waste between your blood and tissues also happens in your capillaries. This happens through two processes:

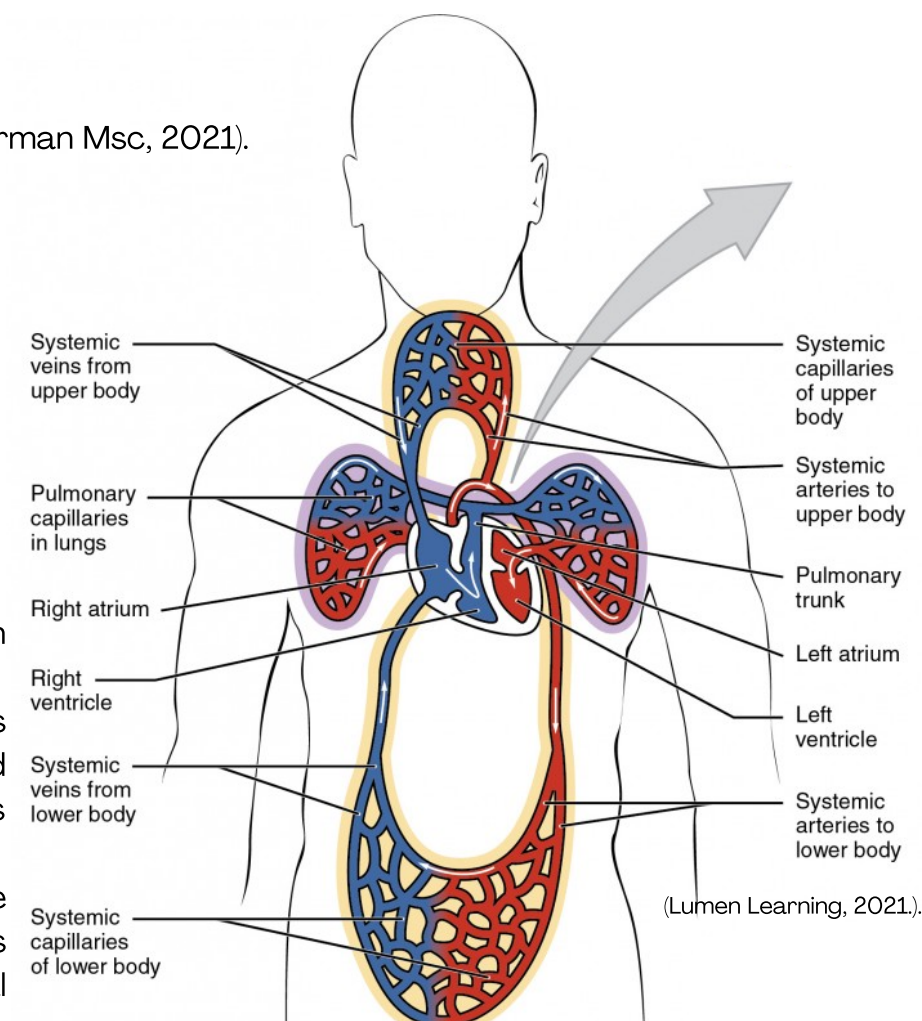
- **Passive diffusion** is the movement of a substance from an area of higher concentration to an area of lower concentration.
- **Pinocytosis** refers to the process through which your body's cells actively take in small molecules, such as fats and proteins.

There are three types of capillary. They are:

- **Continuous Capillaries** are the most common type of capillaries containing small gaps in their walls allowing gases, water, sugars and select hormones to pass through. Continuous capillaries are the only exception as they create a blood-brain barrier which only allows the most essential nutrients to enter.
- **Fenestrated capillaries** contain small pores as well as small gaps in their walls that allow for the exchange of larger molecules. They are typically found in areas of high exchange between blood and tissues such as in the small intestine, where nutrients are absorbed from food or in the kidneys where waste is filtered out of the blood.
- **Sinusoid Capillaries** are the rarest which allow for large molecule or cell exchange with numerous large gaps as well as pores and small gaps. They are found in a select few tissues. Bone marrow, alongside the liver and spleen, is one of those tissues. In bone marrow, these capillaries allow new, fresh blood to enter the bloodstream and circulate (Seladi-Schulman, 2019).

ARTERIOLES

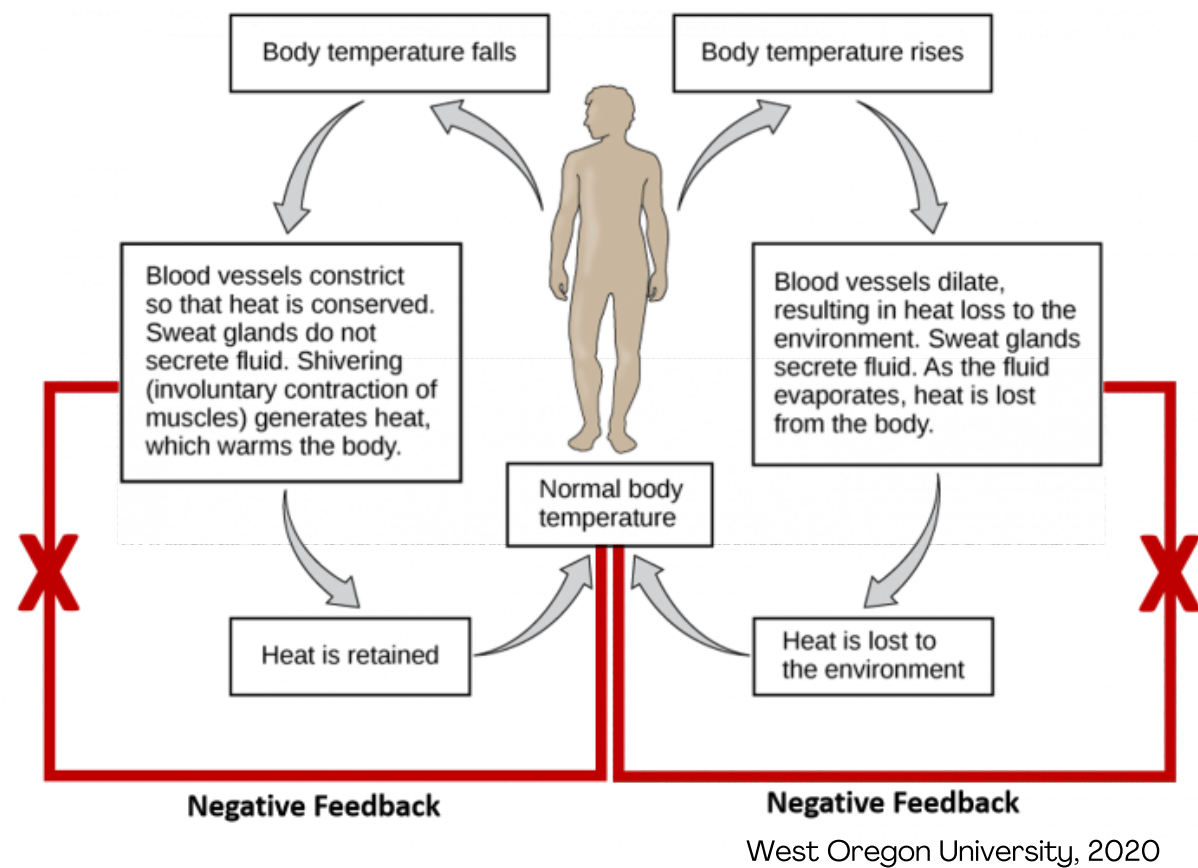
Arterioles are minute, thinly walled arteries that lead to a capillary. They are tasked with carrying oxygenated blood from the heart to the rest of the body. The further they are from the heart, the smaller they get. The major organs are serviced by arteries as they require a large amount of blood and are closest to the heart (Biology Online, 2021).



CARDIOVASCULAR SYSTEM

HOMEOSTATIS & DISORDERS

Homeostasis refers to any process that living things use to actively maintain stable conditions in order to survive (Scientific America, 2000).



MAINTAINING HOMEOSTASIS

Homeostasis refers to the body's physiological ability to regulate its inner environment to ensure stability in response to changes in its internal or external conditions. The liver, the pancreas, the kidneys, and the brain (hypothalamus, the autonomic nervous system and the endocrine system) help maintain homeostasis. The liver is responsible for metabolizing toxic substances and with signalling from the pancreas maintains carbohydrate metabolism. The liver also helps to regulate lipid metabolism and is the primary site of cholesterol production. The kidneys are responsible for regulating blood water levels, re-absorption of substances into the blood, maintenance of salt and ion levels in the blood, regulation of blood pH, and excretion of urea and other waste products. The hypothalamus is involved in the regulation of body temperature, heart rate, blood pressure, and circadian rhythm. Internal or existing conditions and external or environmental conditions influence homeostasis. Regardless of the mechanism, homeostasis controls have at least three components. They are:

- **Sensor/Receptor** - Detecting changes in the environment whether it be internal and external.
- **The integrating centre/control centre** - Receiving information from the sensors/receptors and initiates the required response to maintain homeostasis.
- **Effector** - Any organ or tissue that receives information from the integrating centre/control centre and assists to make changes to maintain homeostasis (West Oregon University, 2020).

Cardiovascular disease or CVD is the term used to describe the conditions affecting the heart or blood vessels.

It is usually associated with the build up of fatty tissue inside the arteries with an increased risk of blood clots.

CVD is one of the main causes of death and disabilities in the UK and can be associated with damage to arteries in organs such as the heart, kidney, eyes and brain.

Although a major cause of death and disability CVD can mostly be prevented by a healthy, balanced lifestyle (NHS, 2018).

FOUR MAIN TYPES OF CARDIOVASCULAR DISEASE

- Coronary heart disease
- Strokes and TIAs (A transient ischaemic attack (also called a TIA or "mini-stroke")
- Peripheral arterial disease
- Aortic disease (NHS, 2018).

STROKES

A stroke occurs when blood supplying the brain is cut off. Strokes are time-critical with greater damage occurring the longer treatment is sought. The brain relies on the oxygen and nutrients the blood provides and without this constant flow, this can lead to brain cells dying which in turn can lead to brain injury, disability and possibly death.

There are 2 main causes of a stroke. They are:

- **Ischaemic** – where the blood supply is stopped because of a blood clot.
- **Haemorrhagic** – where a weakened blood vessel supplying the brain bursts.

Stroke survivors often suffer long term issues caused by the injury to their brains. This leads some to have long periods of rehabilitation before returning to their previous level of independence. Many unfortunately will never recover and need ongoing assistance throughout their lives (NHS, 2019).

TIAS

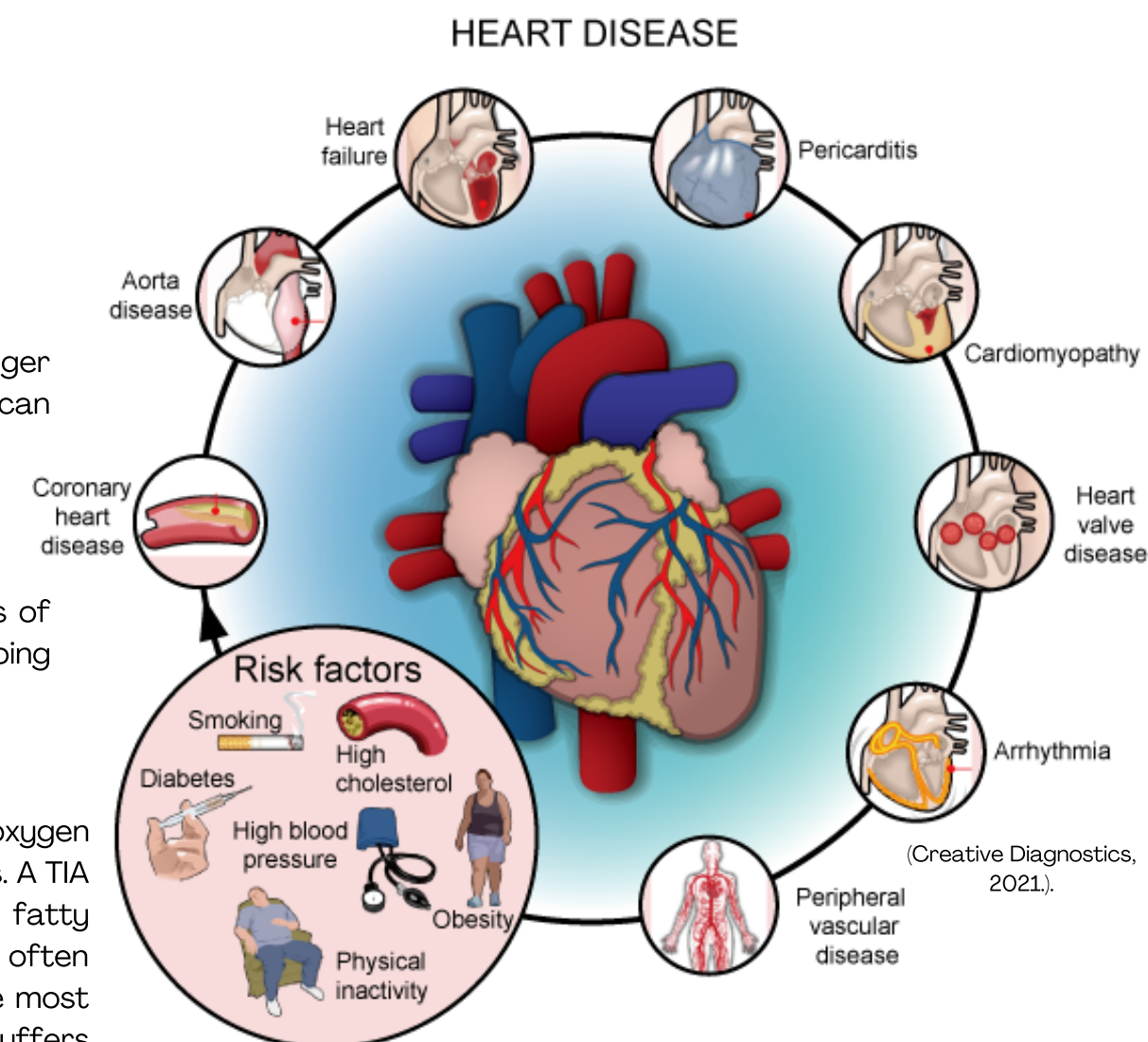
TIA's or mini-strokes are caused by a temporary loss of blood supply to the brain. The lack of blood results in a lack of oxygen bringing about stroke-like symptoms. TIA's usually last a few minutes to a few hours and usually come to an end within 24hrs. A TIA is brought about by a blockage in 1 of the vessels that supply oxygen-rich blood to the brain. Usually, these blood clots, fatty materials and air bubbles that have formed in other parts of the body travel to blood vessels supplying the brain. TIA's often signal a full stroke will occur soon with those aged over 55, of African, Asian or Caribbean heritage being amongst those most likely to suffer a TIA. The likely hood of suffering a TIA is heightened when an individual smokes, has high blood pressure, suffers from obesity, is a regular drinker, has diabetes and has an elevated cholesterol level (NHS, 2020)

SYMPTOMS OF A STROKE OR TIA - FAST

- **Face** – The face may drop on one side with the individual unable to smile or move their mouth. The eyes might also have drooped.
- **Arms** – Individuals may not be able to lift either or both arms and keep them there.
- **Speech** – Speech may become slurred and in extreme cases they may not be able to talk at all despite being conscious, They may have problems conversating or understanding what is being said to them.
- **Time** – Time, emergency services be contacted to offer specialist support (NHS, 2019).

PREVENTING CARDIOVASCULAR DISEASE

1. **Healthy Diet** – Basing meals on higher fibre starchy carbohydrates, eating fruit and veg, eating more fish, especially oily fish. Removing sugar, salt and saturated fats. Always eat breakfast and drink plenty of water (NHS, 2019).
 2. **Exercise** – brisk walking, water aerobics, riding a bike, dancing, tennis, pushing a lawnmower, hiking and rollerblading (NHS, 2021).
 3. **Managing your weight (BMI)** – BMI stands for body mass index. You will need to use a BMI calculator entering your height to work out your ideal weight. A BMI between 18.5 and 24.9 is within the healthy range (NHS, 2018).
 4. **Reducing Stress Levels** – The NHS recommend the following for reducing stress. They are being active, taking control, connecting with people, having some 'me time', avoiding unhealthy habits, challenging yourself and trying to be positive (NHS, 2021).
 5. **Stopping the use of alcohol** – will leave people feeling better in the mornings, being less tired, having better-looking skin, feeling more energetic and having better weight management. There will be improvements in heart, behaviour, sleep patterns, immune system and mood (NHS, 2018).
 6. **Stopping the use of tobacco** – Engage with free local stop smoking services. They will offer services such as one-to-one and group stop smoking sessions, nicotine replacement therapy (NRT) such as patches and gum and medication such as Varenicline (Champix) and Bupropion (Zyban) (NHS, 2018).
- (Tri-City Cardiology, 2016).



RISK FACTORS

- High blood pressure
- Smoking
- High cholesterol
- Diabetes
- Inactivity
- Being overweight or obese
- Family history of CVD
- Ethnic background
- Age
- Gender
- Diet
- Alcohol (NHS, 2018)

CARDIOVASCULAR DISEASES

- Abnormal heart rhythms, or arrhythmias
- Aorta disease and Marfan syndrome
- Congenital heart disease
- Coronary artery disease (narrowing of the arteries)
- Deep vein thrombosis and pulmonary embolism
- Heart attack
- Heart failure
- Heart muscle disease (cardiomyopathy)
- Heart valve disease
- Pericardial disease
- Peripheral vascular disease
- Rheumatic heart disease
- Stroke
- Vascular disease (blood vessel disease) (Steinbaum, 2019).

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