Structure of mammalian heart

Pericardium

It is the membrane that surrounds and protects the heart. It confines the heart to its position while allowing sufficient freedom for rapid contractions.

Pericardium has two layers:

1. Fibrous pericardium: superficial, composed of tough, inelastic, dense, irregular connective tissue. It rests on and attaches to the diaphragm and prevents stretching of heart while providing protection and anchorage.

2. Serous Pericardium: deeper, thinner and more delicate. Forms a double layer around the heart:

~ Outer Parietal Layer: Fused to fibrous pericardium.

~ Inner Visceral Layer: Adhered ti the surface of the heart.

Between parietal and visceral layers, pericardial cavity filled with pericardial fluid is present.

Layers of Heart Wall

Epicardium: visceral layer of serous pericardium. Composed of mesothelium and delicate connective tissue.

Myocardium: cardiac muscle tissue responsible for pumping action of the heart.

Endocardium: composed of thin layer of endothelium overlying a thin layer of connective tissue.

Chambers of heart

2 superior atria, 2 inferior ventricles.

On anterior region of both atria, **auricles** are present. Auricles are large wrinkled pouches that increases capacity of the atria.

Series of grooves on the surface of heart that contain blood vessels and variable amount of fat are called**Sulci**. Sulci are of three types: coronary sulcus, anterior intraventricular sulcus, posterior intraventricular sulcus.

Right Atrium:

Receives blood from superior vena cava, inferior vena cava and coronary sinus.

Average thickness of wall: 2-3 mm (atria pumps blood to adjacent ventricles, hence pressure of pumping is less and walls are thin).

Anterior wall is rough due to muscular ridges called pectinate muscles.

Right and Left atria are divided by interatrial septum.

Blood from RA --> Tricuspid Valve (Right AV Valve) --> RV

Right Ventricle:

Receives blood from right atrium.

Average thickness of wall: 4-5 mm (RV pumps blood relatively short distance to the lungs)

Contains a series of ridges formed by raised bundles of cardiac muscle fibres called trabeculae carnae.

RV and LV are separated by interventricular septum.

Blood from RV --> Pulmonary Semilunar Valve --> Pulmonary Trunk --> Right and Left Pulmonary Arteries

Left Atrium:

Receives blood from 4 pulmonary veins.

Average thickness: 2-3 mm

Blood from LA --> Bicuspid Valve (Left AV Valve) --> LV

Left Ventricle:

Receives blood from left atrium.

Structure of mammalian heart (cont)

Average thickness: 10-15mm (blood is pumped a great distance to all cells of the body hence LV contract with great force)

Contains trabeculae carnae.

During foetal life, a temporary blood vessel called ductus arteriosus shunts blood from pulmonary trunk to aorta. Hence, only small amount of blood enters non functioning foetal lungs. Remnant of ductus arteriosus is the ligamentum arteriosum, which connects the arch of aorta and the pulmonary trunk.

Blood from LV --> Aortic Semilunar Valve --> Ascending Aorta --> Coronary Arteries, Arch of Aorta/ Thoracic Aorta, Descending Aorta/ Abdominal Aorta

Valves of Heart

Operation of Atrioventricular Valves:

When AV valves are open, rounded end of the cusps project into the ventricle. When the ventricles are relaxed, papillary muscles are relaxed, chordae tendinae are slack and blood flows from higher pressure in atria to lower pressure in ventricles.

When the ventricles contract, pressure of blood drives the cusps up till their edges meet and close the opening. Papillary muscles contract, causing chordae tendinae to tighten

Operation of Semilunar Valves:

Each cusp attaches to the arterial wall by its convex outer margin. Free borders of the cusp project into the lumen of the artery.

When ventricles contract, pressure builds up within the chamber. Semilunar valves open when the pressure within the chamber exceeds the pressure in the arteries, permitting ejection of blood from the ventricles into the pulmonary trunk or aorta.

Systemic and Pulmonary Circulation

Systemic Circulation

Left side of the heart is a pump for systemic circulation.

LA receives oxygen rich blood from the lungs.

LA --> LV --> Aorta --> Systemic Arteries --> Systemic Arterioles --> Systemic Capillaries

In capillaries, blood unloads O2 and picks ups CO2.

Systemic capillaries --deoxygenated blood--> systemic venules --> veins --> RA

Pulmonary Circulation

Right Side of the heart is pumped for pulmonary circulation.

RA receives deoxygenated blood from systemic circulation.

RA --> RV --> pulmonary trunk --> pulmonary arteries --> left and right lungs

In pulmonary capillaries, blood unloads CO2 and picks up O2.

Pulmonary capillaries --oxygenated blood--> pulmonary veins --> LA

Coronary Circulation

Nutrients are not able to diffuse from the blood in the chambers to all the layers of cells in the heart wall.

Hence, heart has its own system of circulation called Coronary/ Cardiac Circulation.

Coronary arteries branch from ascending aorta and encircle the heart.

When heart is relaxed, high blood pressure of blood in the aorta propels the blood through the coronary arteries, into the coronary capillaries and then into the coronary veins.

Coronary Arteries

1. Left Coronary Artery:

~ *Anterior Intraventricular:* also called left anterior descending artery, it is in the anterior intraventricular sulcus and supplies oxygenated blood to both the ventricles.

~ *Circumflex:* lies in the coronary sulcus, supplies oxygenated blood to left side of the heart

2. Right Coronary Artery:

~ *Posterior Intraventricular:* lies in the posterior intraventricular sulcus, supplies oxygenated blood to both ventricles.

~ *Marginal:* lies in the coronary sulcus and supplies oxygenated blood to RV.

Coronary Veins

~ *Great Cardiac Vein*

~ *Middle Cardiac Vein*

~ *Small Cardiac Vein*

~ *Anterior Cardiac Vein*

Cardiac Muscle Tissue

Cardiac muscle fibres have centrally located nucleus.

Gap junctions between the muscle fibres allow the entire myocardium of the atrium/ ventricles to contract as a large unit.

Large mitochondria, take up about 25% of cytosolic space.

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