Processes in the blood and cardiovascular system

Describe the formation of blood cells.

The formation, or haematopoiesis of both red and white blood cells occurs in the hematopoietic tissue contained in the red bone marrow which is found in the epiphyses (Rounded ends) of long bones and is also found in flat bones such as the pelvis, ribs and vertebrae. During pregnancy, the foetus forms blood in the liver. As age takes effect, blood is produced less in the long bones and more in the flat bones. Cell differentiation occurs and different cells are produced dependent on the body's requirement. Erythropoiesis the formation of Red blood cells and begins with the creation of Proerythroblasts from hematopoietic stem cells. These cells originally have a nucleus. During a period of 3 to 5 days, ribosome's and Haemoglobin synthesise and the nucleus is ejected and the production of the reticulocyte (Immature Erythrocyte) cell is complete. These reticulocytes are larger than normal Erythrocytes. After a day or two in the blood stream, the reticulocyte becomes a mature fully formed Erythrocyte. The lifespan of a red blood cell is approximately 120 days.

Leucocytes develop into differentiated cells that perform functions within the body's defence mechanism. They are fewer in number than Erythrocytes, (approximately 1: 7000). Leucocytes are split into two groups, Granulocytes, (Neutrophils, Eosinophil's and Basophils), so called due to the granular appearance of the cytoplasm and are formed from Myoblasts. The second group is Agranulocytes (Lymphocytes (T and B), and monocytes). Monocytes, Neutrophil's and Eosinophil's are phagocytic. They engulf bacteria and destroy this from within the cell. Basophils produce antihistamines, heparin and serotonin. The heparin prevents the unnecessary clotting of blood and

the Serotonin helps to make the capillaries porous to allow Phagacytes to exit the blood and enter infectious areas where bacteria are located. The lifespan of white blood cells (Leucocytes) is dependent on the bodies needs due to their unique role in defending the body.

Explain the structure and function of erythrocytes.

Erythrocytes are red blood cells. They are a biconcave disc shaped often described as “ doughnut” shaped. They are approximately 7µm in diameter and 2 µm thick. During Erythropoiesis a reticulocyte is formed from the stem cell in the marrow. These Reticulocytes have a nucleus which upon maturity to a fully formed Erythrocyte, the nucleus is expelled to allow for more haemoglobin and oxygen to be carried during the cell lifespan. Haemoglobin is the clotting function of blood and is the reason for the red colour. The disc shape is to give the cell more surface area to allow diffusion of the oxygen into the cells more quickly. Although the erythrocyte is larger than some capillaries, the cell is able to distort and enter the narrow passages returning to its original shape afterwards. Erythrocyte cells main function is to transport oxygen through body but they also release carbonic anhydrase that allows H2O in the blood to carry CO2 back to the lungs for expulsion. They also play a part in controlling the bodies Ph balance and homeostasis.

Explain the function of haemoglobin.

When the compound Haem and Globin synthesise it forms haemoglobin. Haemoglobin allows Oxygen and Carbon dioxide to be transported by the Erythrocytes. Oxyhaemoglobin is haemoglobin saturated with oxygen molecules that have attached to the Haem molecule attracted by the Iron

(Fe) in the compound, allowing the oxygen to be carried around the blood to be diffused where required.

De-saturated haemoglobin (DeoxyHaemoglobin) occurs when the oxygen molecules have left the protein and this is what gives the Haemoglobin its bluish tint. CO2 also bonds with the Haemoglobin molecule allowing the blood returning to the lungs to transport this for expulsion through exhaling.

Explain the function of leucocytes in relation to the body’s defences and immune responses.

Produce a two-sided leaflet explaining the above to a group of young mothers – clearly explain what leucocytes are and the importance they play. Describe clearly and concisely and use visual images where applicable

Explain platelet function.

You are working for the Red Cross and explaining to “ new recruits” what platelets are and their function. Briefly explain how platelets ensure clotting takes place.

Platelets are small fragments megakaryocyte Cells. These cells are found in the bone marrow. These small platelets are essential in the function of Haemostasis which is the function of stopping blood loss, (Blood clotting). They secrete vasoconstrictors that close the openings of blood vessels during vascular spasm, form platelet plugs to stem the flow of blood, secrete clotting factors (proteins), to assist in the clotting of blood. These functions are the important factors of haemostasis which platelets are vital for during

bleeding and the catalysts for vascular spasms, platelet plug creation and blood clotting (coagulation).

Explain the process by which the body maintains haemostasis.

Haemostasis is the body’s reaction to stop the loss of blood exiting the body from damaged blood vessels. There are three main steps to haemostasis, vascular spasm, Platelet Plug and coagulation:

1. Vascular spasm

When a broken blood vessel occurs, the first reaction in Haemostasis to stem the flow of blood is a vascular spasm. Pain receptors stimulate platelets to secrete vasoconstrictor “ Serotonin” which cause the blood vessels to constrict reducing the blood flow this allows for time for the next stage of the haemostasis process.

- Platelet Plug

Platelets in their normal state flow freely in the blood plasma as the lining of the blood vessel is smooth and coated with a platelet repellent prostacyclin. When the blood vessel is damaged, or broken, platelets are exposed to collagen fibres that are present in the walls of the arterioles, platelets become tacky and start sticking together and react with proteins in the blood plasma to form a temporary “ plug” until a more permanent fix occurs in the form of coagulation.

- Coagulation

Thromboplastin protein reacts with vitamin K and Ca2+ Ions. The Thromboplastin then activates with the inactive prothrombin protein. The

protein fibrinogen that is normally inactive becomes fibrin which is a fibrous compound. The fibrin starts to form a “ net” across the damages vessel and platelets become trapped in the net to form permanent “ glue” fixing the damages vessel to prevent blood loss and bacteria from entering the wound.

Explain the different blood groups A, B, O and Rhesus

State which groups are compatible, and explain why.

Your “ new recruits” now require an explanation of the above. Present this to them in a clear brief manner. Group compatibility may be best shown by use of a table. Ensure that your explanation is written in your own words and give an example of the consequences of group incompatibility.

- Blood Groups:

Blood groups were first identifies in 1900 by Karl Landsteiner at the university of Vienna to ascertain why deaths occurred after blood transfusions. The blood groups most widely known are A, B, AB and O.

Two antigens (an antigen is a substance that an antibody fixes to), one type of antigen attaches to one type of antibody similar to a lock and key. These two antigens and antibodies identify the A, B and O blood groups. The antibodies are called Anti A and Anti B

These antigens form on the surface of the red blood cells. A type blood cells will have the A blood antigen attached, and the body would not produce A blood antibodies. The reason for this is that if A blood antibodies were present, then these would attach and destroy the blood cells. However, should type B blood be inserted, B type antibodies are present. These

antibodies would then attach to the antigens of the B blood and destroy the cell. The blood cells start to clump together that can cause a blockage in the blood vessel. This is called “ agglutination”.

O type blood do not produce any antigens for type A, B or O which makes this group universally accepted by any blood group therefor it is known as the “ Universal Donor”. AB Blood types have both Anti A and Anti B antibodies and therefore can receive blood from all groups safely. AB blood groups are known the “ universal receiver”.

- Rhesus:

There are many other antigens on the red blood cell. The “ Rhesus” antigen is another important factor. It was named rhesus after finding the antigen during research injecting Rhesus monkeys with rabbit’s blood.

Not all blood has the antigen. Blood that does have the antigen is defined as RH+ and the Blood that does not is defined as RH-. There is rhesus negative (RH-) and rhesus positive (RH+). RH- does not already contain the RH antibodies and should RH+ blood come into contact with RH- blood, RH- then starts to produce the anti RH antibodies. This does not cause too much of a problem in the first instance as the process of producing the antibodies takes almost a week and the donated blood cells would have died. The major problem occurs should the RH- receives a further dose of RH+ blood as this causes the reaction much quicker due to the presence of the RH antibodies. This causes “ Agglutination” and can be fatal. This is especially serious in pregnancy. Should a mother that is RH- has a foetus that is RH+. The mother receives the RH+ blood from the foetus and then starts to produce RH

antibodies. These antibodies are then transferred back to the foetus via the placenta and into the foetus’s circulation. In the first child, this is not generally a problem as the antibodies will not have been produced in sufficient numbers to do any damage. The huge issue is any subsequent pregnancy. If a following foetus is RH+ the RH- antibodies from the mother will transfer across to the unborn foetus causing a mass destruction of blood cells. This condition is known as “ Haemolytic disease of the new born”.

Explain the function of the heart

The heart is the most vital organ in the body. Its function is to “ pump” blood through the circulatory system via arteries and veins. It has what is known as a “ double circulatory” system. The first system pumps blood to and from the lungs to expel waste gasses (CO2) and other waste products and to collect the vital oxygen needed to sustain life, provision on nutrients that are essential for growth and repair.

The second system pumps blood to the whole body. Oxygenated blood is pumped into the left atrium via the Pulmonary veins from the lungs. The flow is controlled by the mitral valve as it is passed through to the left ventricle where the heart muscle contraction pushes the oxygenated blood with its thick walls at high pressure through the aorta and into the body. Deoxygenated blood is returned to the heart via the inferior and superior vena cava into the right atrium where it is passed through the tricuspid valve into the right ventricle. Here, at low pressure, it is pumped through the pulmonary artery back into the lungs to expel the waste and to collect oxygen to be pumped around the body again. This function takes place

continuously and the heart pumps approximately 7200 litres per 24 hours (based on an average heart rate of 72 bpm).

Explain coronary circulation

The heart muscle (Myocardium) requires a blood supply to enable it to function correctly. This supply allows the heart to be provided with the oxygen required along with the extraction of waste products, (CO_2 etc). Coronary Circulation is the supply of this blood to the myocardium. The oxygenated blood is provided by the coronary Arteries which can either be epicardial (run along the surface of the heart) or Subendocardial which are the arteries that run deep within the myocardium. Epicardial arteries are self regulating providing a constant level of supply to the heart muscle. They are very narrow and are prone to blockage which can cause serious heart damage such as angina or a heart attack due to the arteries being the only source of blood to the myocardium. Deoxygenated blood is removed by the cardiac veins.