

## Q11 Outline the formation, structure and function of the adult red blood cell (March 2014)

Erythrocytes (red blood cells) play a vital role in oxygen and carbon dioxide transport through the body.

They make up 40-50% of the blood volume, usual value  $4-5 \times 10^{12}/L$

Biconcave disc shaped

Lifespan 120 days

### ERYTHROCYTES – PRODUCTION

- Myeloid progenitor → differentiates into erythroid line
- The erythroid line begins with the proerythroblast, a nucleated cell. As it differentiates into a reticulocyte it decreases in size, gradually losing cytoplasmic organelles and increasing its haemoglobin content
- Reticulocytes then lose their ribosomes to become mature erythrocytes
- The differentiation from stem cell to erythrocyte takes 7-10 days.
- Erythropoietin increases the rate of differentiation of the stem cell. EPO is produced in the corticomedullary cells of the kidney in response to low local oxygen tension
- Haemoglobin (MW 65,000Da) is synthesized in erythroid cells from the proerythroblast stage. It consists of four globin chains, each covalently linked to a haem molecule. Haem is an iron chelated porphyrin ring structure synthesized in the mitochondria from glycine, succinyl CoA and  $Fe^{2+}$ .

### ERYTHROCYTES - FATE

- RBCs are destroyed after 120 days (this may be due to continual loss of membrane components, accumulation of oxidative products, decreased deformability of the aging cell, leaving it unable to pass through minute fenestrations in the microvasculature)
- 90% are removed by phagocytosis in the liver, spleen and lymph nodes
- 10% hemolyse in the circulation and are then engulfed by circulating macrophages
- Lysosomes within the macrophage breakdown the chemical components of the RBC. Globin is metabolized to amino acids which can be used for protein synthesis
- Iron is removed from haem molecules and either stored in the macrophage or released into the bloodstream where it binds to transferrin and delivered to the bone marrow where it is used to synthesise new hemoglobin

### ERYTHROCYTES - FUNCTION

- Gas carriage (oxygen bound to Hb,  $CO_2$  in carbamino compounds and as  $HCO_3^-$ ). The lack of intracellular organelles provides more room for Hb
- Contain carbonic anhydrase to catalyse the reaction between  $CO_2$  and  $H_2O$ , increasing the amount of  $CO_2$  that can be transported in the form of  $HCO_3^-$  in the plasma
- Biconcave disc shape allows for distensibility through small vessels and increases the surface area for gas exchange, optimizing diffusion
- Buffering capacity (via  $HCO_3^-$  production and Hb)