المحاضرة الثانية مدرس المادة د.نوران جميلHematology

**Red Blood Cell Structure**

Red blood cells have a unique structure responsible for oxygen transport. Their flexible disc shape helps increase the surface area-to-volume ratio of these extremely small [cells](http://biology.about.com/od/cellbiology/a/cells-facts.htm). This enables oxygen and carbon dioxide to [diffuse](http://biology.about.com/od/cellularprocesses/ss/diffusion.htm) across the red blood cell's [plasma membrane](http://biology.about.com/od/cellanatomy/ss/cell-membrane.htm) more readily. Red cells in peripheral blood smears appear as rounded bright pink-stained cells, they are 6.5-8.5 µm in diameter and have a biconcave shape, appearing paler in the center and darker at the periphery. Red blood cells contain enormous amounts of a [protein](http://biology.about.com/od/molecularbiology/ss/protein-structure.htm) called **hemoglobin**. This iron containing molecule binds oxygen as oxygen molecules enter blood vessels in the lungs. Unlike other [cells](http://biology.about.com/od/cellbiology/ss/animal_cells.htm) of the body, mature red blood cells do not contain a [nucleus](http://biology.about.com/od/cellanatomy/p/nucleus.htm), [mitochondria](http://biology.about.com/od/cellanatomy/ss/mitochondria.htm), or [ribosomes](http://biology.about.com/od/cellanatomy/p/ribosomes.htm). The absence of these cell structures leaves room for the hundreds of millions of hemoglobin molecules found in red blood cells.

A [mutation](http://biology.about.com/od/basicgenetics/ss/gene-mutation.htm) in the hemoglobin [gene](http://biology.about.com/od/geneticsglossary/g/Genes.htm) can result in the development of [sickle-shaped cells](http://biology.about.com/od/genetics/ss/Genetic-Dominance.htm) and lead to sickle cell disorder.

The blood's red color is due to the spectral properties of the [hemic](https://en.wikipedia.org/wiki/Heme) [iron](https://en.wikipedia.org/wiki/Iron) [ions](https://en.wikipedia.org/wiki/Ion) in [hemoglobin](https://en.wikipedia.org/wiki/Hemoglobin). Each human red blood cell contains approximately 270 million of these [hemoglobin](https://en.wikipedia.org/wiki/Hemoglobin) molecules. Each hemoglobin molecule carries four hem groups; hemoglobin comprises about a third of the total cell volume. Hemoglobin is responsible for the transport of more than 98% of the oxygen in the body (the remaining oxygen is carried dissolved in the [blood plasma](https://en.wikipedia.org/wiki/Blood_plasma))..

**Red Blood Cell Production**

Red blood cells are derived from [stem cells](http://biology.about.com/od/biotechnologycloning/ss/stem-cells.htm) in red [bone marrow](http://biology.about.com/od/anatomy/ss/bone-marrow.htm). New red blood cell production, also called **erythropoiesis**, is triggered by low levels of oxygen in the [blood](http://biology.about.com/od/bloodcells/ss/12-Facts-About-Blood.htm). Low oxygen levels can occur for various reasons, including blood loss, presence in high altitude, exercise, bone marrow damage, and low hemoglobin levels. When the [kidneys](http://biology.about.com/od/anatomy/ss/kidney.htm) detect low oxygen levels, they produce and release a [hormone](http://biology.about.com/od/molecularbiology/ss/hormones.htm) called erythropoietin..

Red blood cells circulate on average for about 4 months. Due to their lack of a nucleus and other [organelles](http://biology.about.com/od/cellanatomy/ss/organelles.htm), adult red blood cells cannot undergo [mitosis](http://biology.about.com/od/mitosis/ss/mitosis-animation.htm) to divide or generate new cell structures. When they become old or damaged, the vast majority of red blood cells are removed from circulation by the [spleen](http://biology.about.com/od/anatomy/ss/spleen.htm), liver, and [lymph nodes](http://biology.about.com/od/anatomy/ss/lymph-nodes.htm). These body structures contain [white blood cells](http://biology.about.com/od/cellbiology/ss/white-blood-cell.htm) called [macrophages](http://biology.about.com/od/bloodcells/fl/Macrophages.htm) that engulf and digest damaged or dying blood cells. Red blood cell degradation and erythropoiesis typically occur at the same rate to ensure [homeostasis](http://biology.about.com/od/biologydictionary/g/homeostasis.htm) in red blood cell circulation, Though this process red blood cells are continuously produced in the red [bone marrow](https://en.wikipedia.org/wiki/Bone_marrow) of large bones, (In the [embryo](https://en.wikipedia.org/wiki/Embryo), the [liver](https://en.wikipedia.org/wiki/Liver) is the main site of red blood cell production.) Just before and after leaving the bone marrow, the developing cells are known as [reticulocytes](https://en.wikipedia.org/wiki/Reticulocyte); these comprise about 1% of circulating red blood cells.

Hemopoiesis

The process of formation and development of the various types of blood

 cells and other formed elements. Blood cells do not originate in the bloodstream itself but in specific blood-forming organs, notably the marrow of certain bones. In the human adult, the [bone marrow](https://www.britannica.com/science/bone-marrow) produces all of the red blood cells, 60–70 percent of the white cells (*i.e.,* the [granulocytes](https://www.britannica.com/science/granulocyte)), and all of the [platelets](https://www.britannica.com/science/platelet). The lymphatic tissues, particularly the [thymus](https://www.britannica.com/science/thymus), the [spleen](https://www.britannica.com/science/spleen-anatomy), and the [lymph](https://www.britannica.com/science/lymph) nodes, produce the [lymphocytes](https://www.britannica.com/science/lymphocyte) (comprising 20–30 percent of the white cells). The reticuloendothelial tissues of the spleen, liver, lymph nodes, and other organs produce the [monocytes](https://www.britannica.com/science/monocyte) (4–8 percent of the white cells). The platelets, which are small cellular fragments rather than complete cells, are formed from bits of the cytoplasm of the giant cells (megakaryocytes) of the bone marrow. In the human embryo, the first site of blood formation is the [yolk sac](https://www.britannica.com/science/yolk-sac). Later in embryonic life, the [liver](https://www.britannica.com/science/liver) becomes the most important red blood cell-forming [organ](https://www.britannica.com/science/organ-biology), but it is soon succeeded by the bone marrow. Both the red and white blood cells arise through a series of complex, gradual, and successive transformations from primitive [stem cells](https://www.britannica.com/science/stem-cell), which have the ability to form any of the [precursors](https://www.merriam-webster.com/dictionary/precursors) of a blood cell. [Precursor cells](https://www.britannica.com/science/precursor-cell) are stem cells that have developed to the stage where they are committed to forming a particular kind of new blood cell.

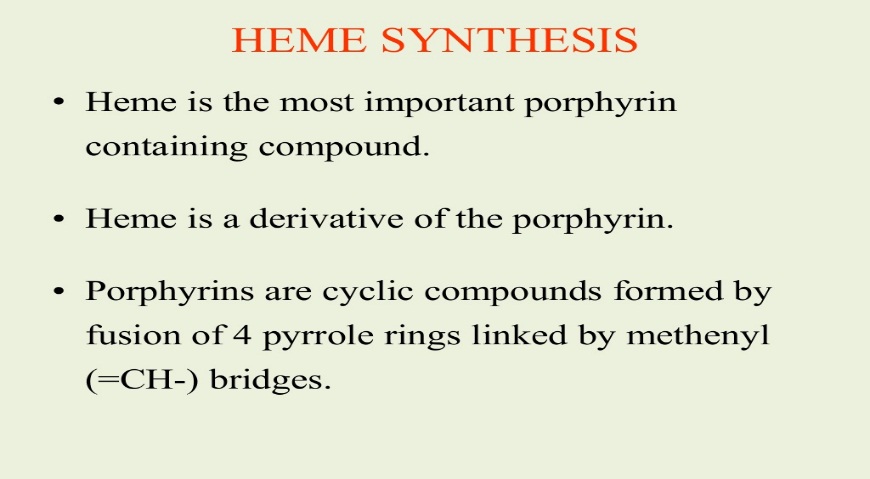
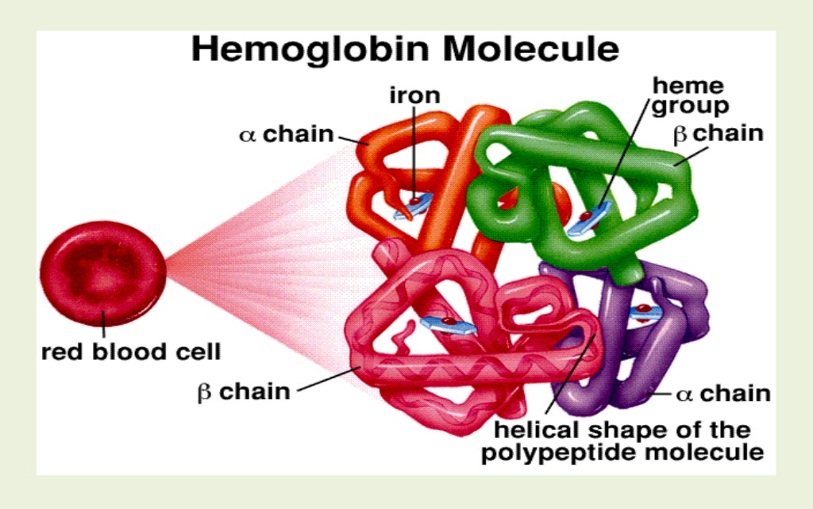
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**Myoglobin and Hemoglobin - the Oxygen Carriers**

Hemoglobin (or haemoglobin, frequently abbreviated as Hb), which is contained in red blood cells, serves as the oxygen carrier in blood. The name hemoglobin comes from ***heme*** and ***globin***, since each subunit of hemoglobin is a globular protein with an embedded heme (or haem) group. Each heme group contains an iron atom, and this is responsible for the binding of oxygen. The presence of hemoglobin in blood increases the oxygen carrying ability of a liter of blood from 5 to 250 ml. Hemoglobin also plays a major role in the transport of carbon dioxide from the tissues back to the lungs. Myoglobin, on the other hand, is located in muscle, and serves as a reserve supply of oxygen and also facilitates the movement of O2 within muscle.Hemoglobin consists of four subunits, each with a cofactor called a heme group that has an iron atom center. The iron is the main component that actually binds to oxygen, thus each hemoglobin molecule is able to carry four molecules of O2. Cooperation among the four subunits of the hemoglobin molecule is necessary for the efficient transportation of O2. The four subunits of hemoglobin actually bind to oxygen cooperatively, the binding of oxygen to one site of the four subunits will increase the likelihood of the remaining sites to bind with oxygen as well.

**The Heme Porphyrin**

Although the hemoglobin and myoglobin molecules are very large, complex proteins, the active site is actually a non-protein group called heme. The heme consists of a flat organic ring surrounding an iron atom. The organic part is a porphyrin ring based on porphin (a tetrapyrrole ring), and is the basis of a number of other important biological molecules, such as [chlorophyll](http://www.chm.bris.ac.uk/motm/chlorophyll/chlorophyll_h.htm) and cytochrome. The ring contains a large number of conjugated double bonds, which allows the molecule to absorb light in the visible part of the spectrum. The iron atom and the attached protein chain modify the wavelength of the absorption and gives hemoglobin its characteristic color.

**Heme Synthesis**

