Red Blood Cells (Erythrocytes)

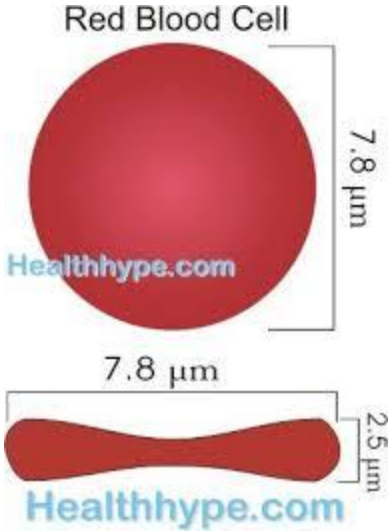
Lecture-2

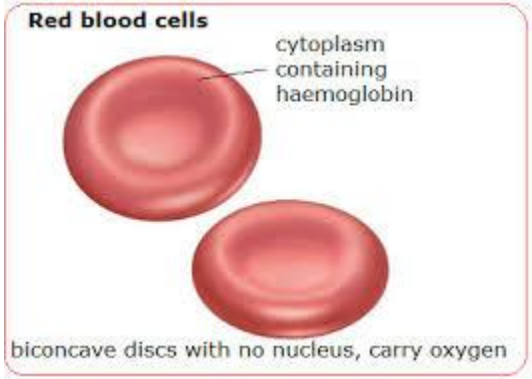
Functions

- Transport *hemoglobin, which in turn carries oxygen from the lungs to the tissues.*
- RBCs contain a large quantity of *carbonic anhydrase, an enzyme* that catalyzes the reversible reaction between carbon dioxide (CO2) and water to form carbonic acid (H2CO3), increasing the rate of this reaction several thousand fold.
- The rapidity of this reaction makes it possible for the water of the blood to transport enormous quantities of CO2 in the form of bicarbonate ion (HCO3 –) from the tissues to the lungs, where it is reconverted to CO2 and expelled into the atmosphere as a body waste product.
- The hemoglobin in the cells is an excellent *acid-base buffer.*

Shape and Size of Red Blood Cells

- Normal red blood cells, are biconcave discs having a mean diameter of about 7.8 micrometers and a thickness of 2.5 micrometers at the thickest point and 1 micrometer or less in the center.





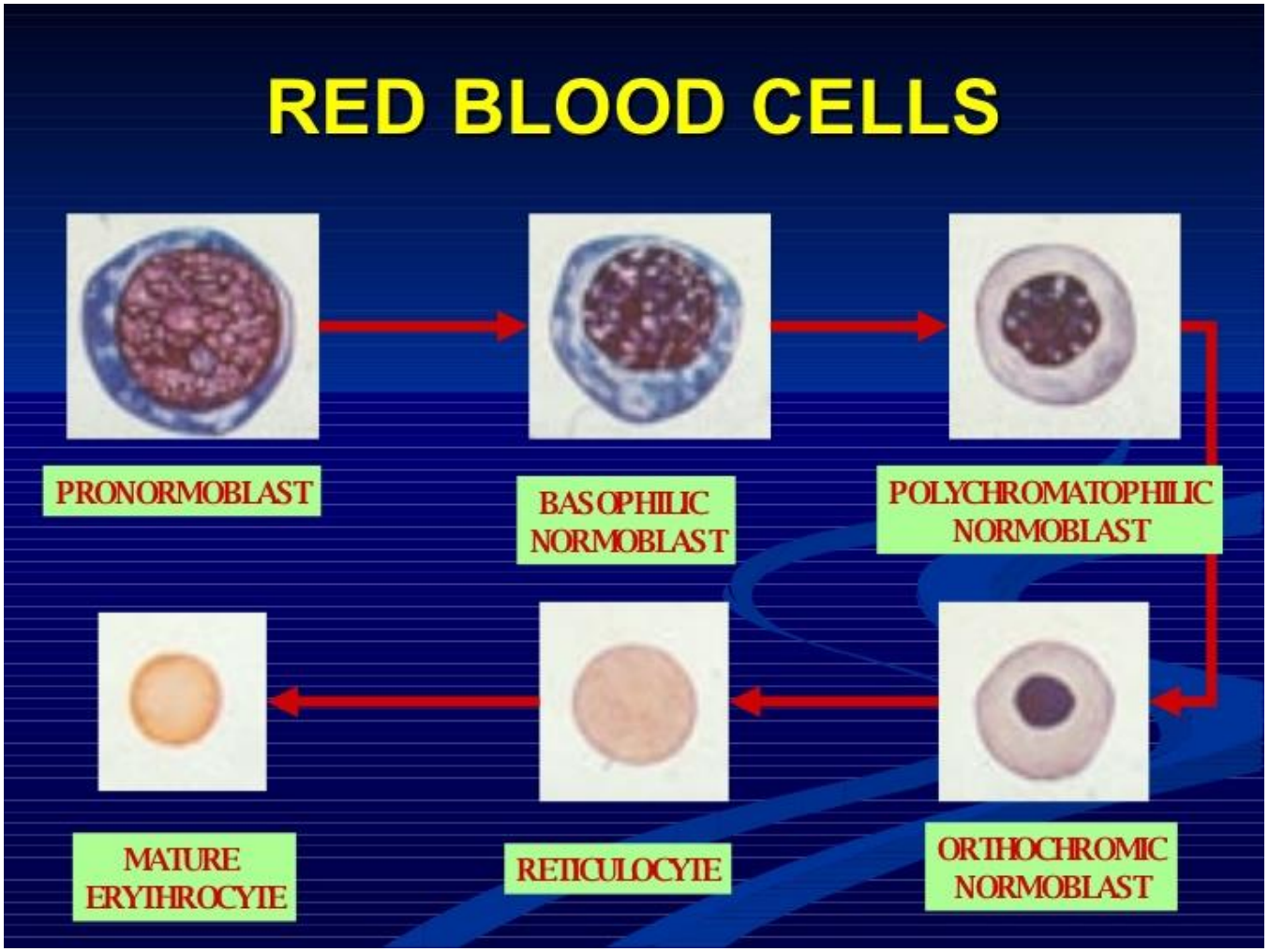
QUANTITY OF HEMOGLOBIN IN THE CELLS

- Average: 14-15 grams/dL
- Maximum: 34 grams per dL (100 ml)
- No nucleus
- Whole cell filled with Hb.

Production

- In the early weeks of embryonic life, primitive, nucleated red blood cells are produced in the *yolk sac*.
- *During the middle* trimester of gestation, the *liver is the main organ for* production of red blood cells, but reasonable numbers are also produced in the *spleen and lymph nodes*.
- *Then*, during the last month or so of gestation and after birth, red blood cells are produced exclusively in the *bone marrow*.

- This process of developing from erythropoietic bone marrow cells to mature red blood cells takes about 7 days.


RED BLOOD CELLS
PRONORMOBLAST
BASOPHILIC NORMOBLAST
POLYCHROMATOPHILIC NORMOBLAST
ORTHOCHROMIC NORMOBLAST
RETICULOCYTE
MATURE ERYTHROCYTE

Regulation of production

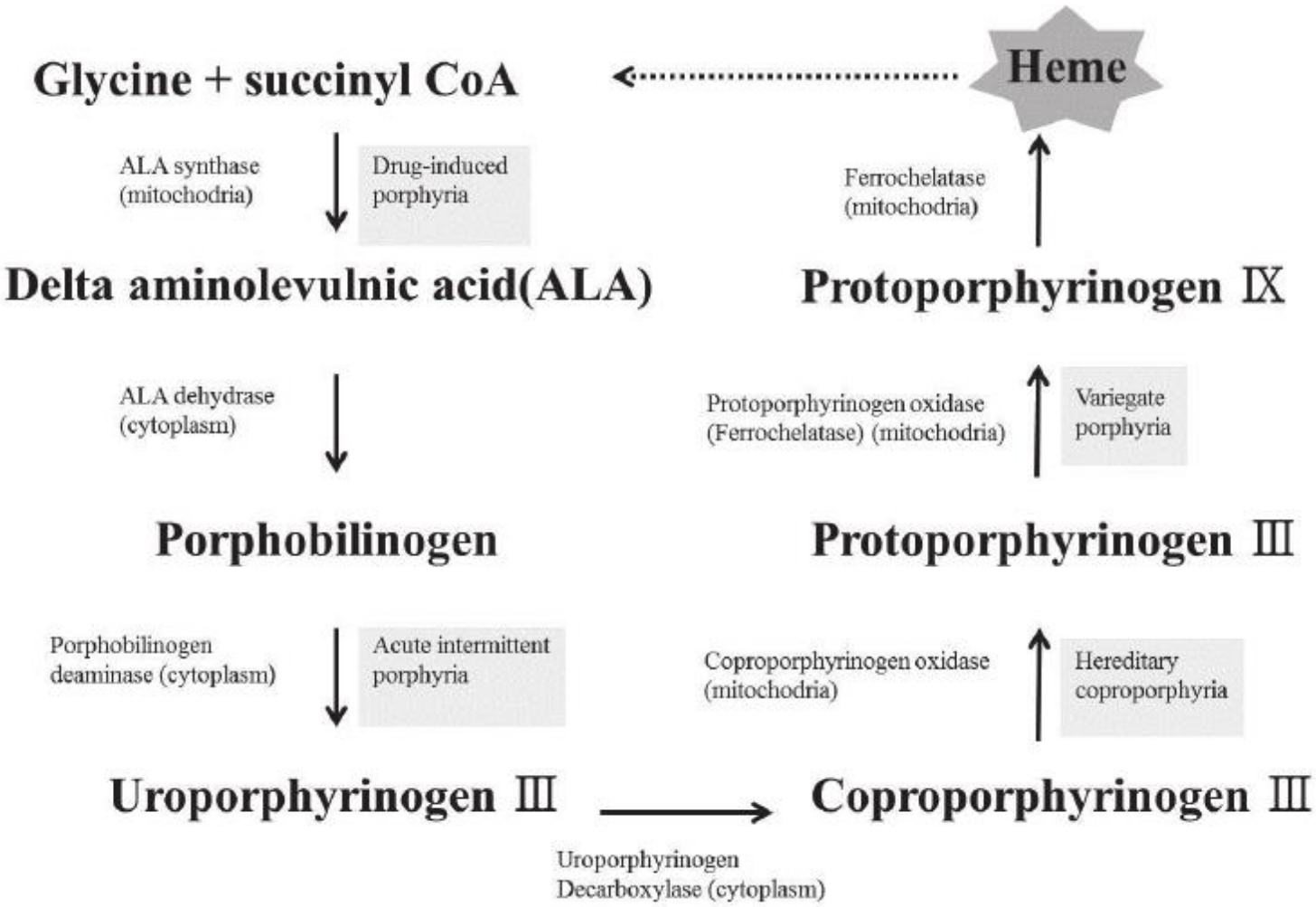
1. Tissue oxygenation – most important regulator eg., anemias, people living at high altitudes.
2. Erythropoietin – Principal stimulus for RBC production.

- Increased in hypoxia
- 90% formed in the kidneys

Formation of haemoglobin

- Begins in proerythroblast.
- Starting molecule: succinyl CoA with glycine forms a pyrrole.
- Four pyrroles form protoporphyrin IX.
- Protoporphyrin IX combines with iron to form haeme.
- Each haeme combines with globin to form haemoglobin.

Heme biosynthesis



THE HEMOGLOBINS

Hemoglobin	Polypeptides
Hemoglobin A1 (Adult)	$2\alpha\,2\beta$
Hemoglobin A2	$2\alpha\,2\delta$
Hemoglobin F (Fetal)	$2\alpha\,2\gamma$

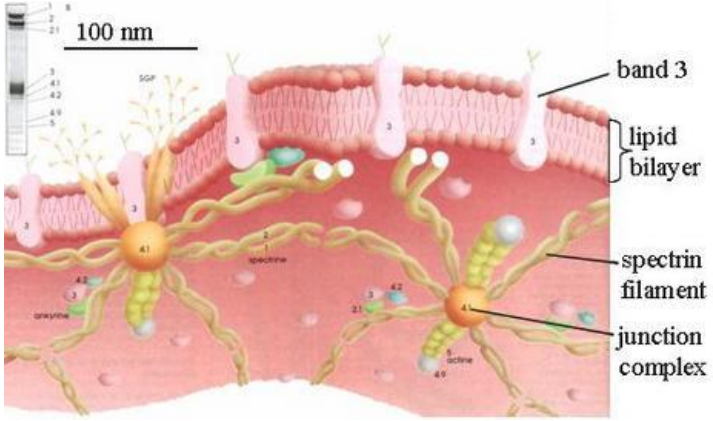
Life span and destruction

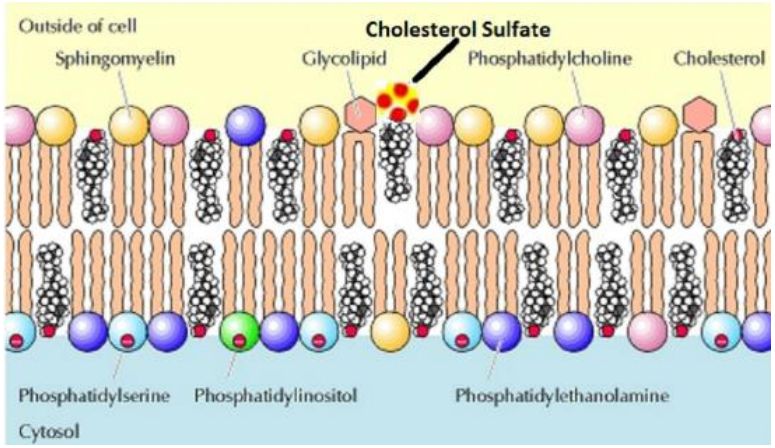
- 120 days.
- The RBCs rupture when they pass through spleen.
- Haemoglobin is phagocytosed by macrophages in spleen, liver and bone marrow.
- Iron is released into the blood.
- Porphyrin is converted to bilirubin.

- Red Blood Cells have an unusual structure compared to other cells in the human body.
- It lacks a nucleus, mitochondria or endoplasmic reticulum.
- However enzymes within the red blood cells allow it to produce small amounts of energy (ATP from glucose).
- The most important part of a red blood cell is hemoglobin, which is essentially the functional component of the cell.

- Have no nucleus can fit more Hb inside the cytoplasm.
- Have a special biconcave disc shape increases the surface area and makes the diffusion of oxygen into & out of the cell easier.

RBC membrane





RBC membrane

- Protein 50%
- Phospholipid 20%
- Cholesterol 20%
- Carbohydrate 10%

Components of RBC membrane

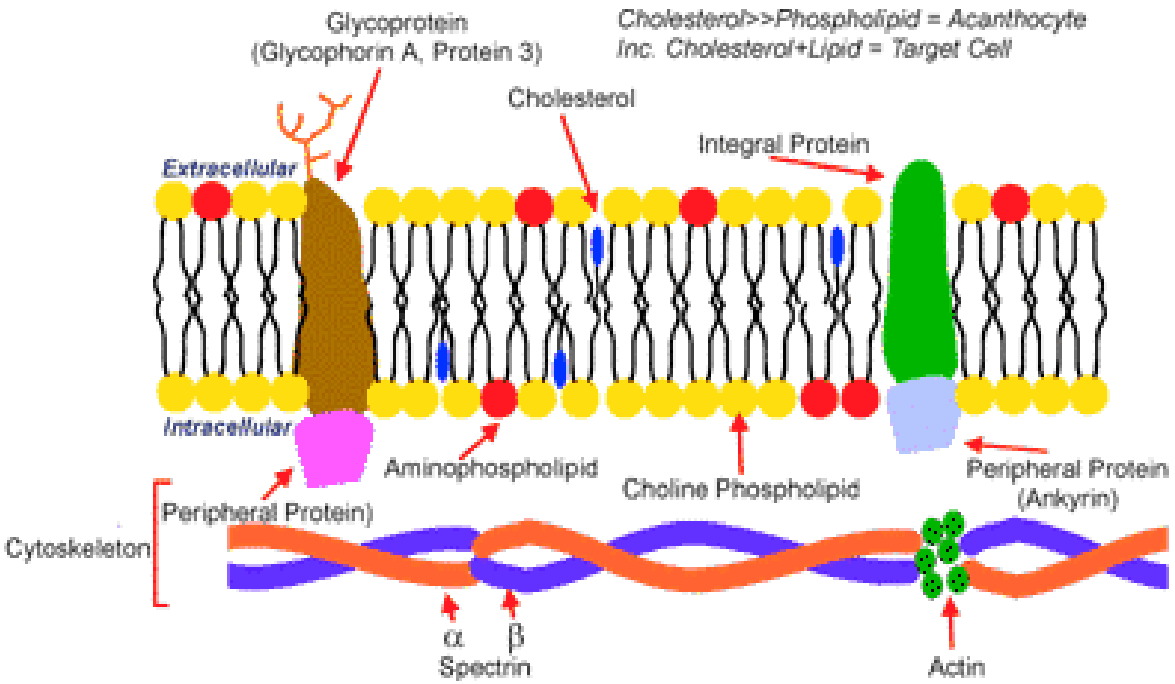
- Lipid bilayer
- Integral membrane protein
- Membrane cytoskeleton

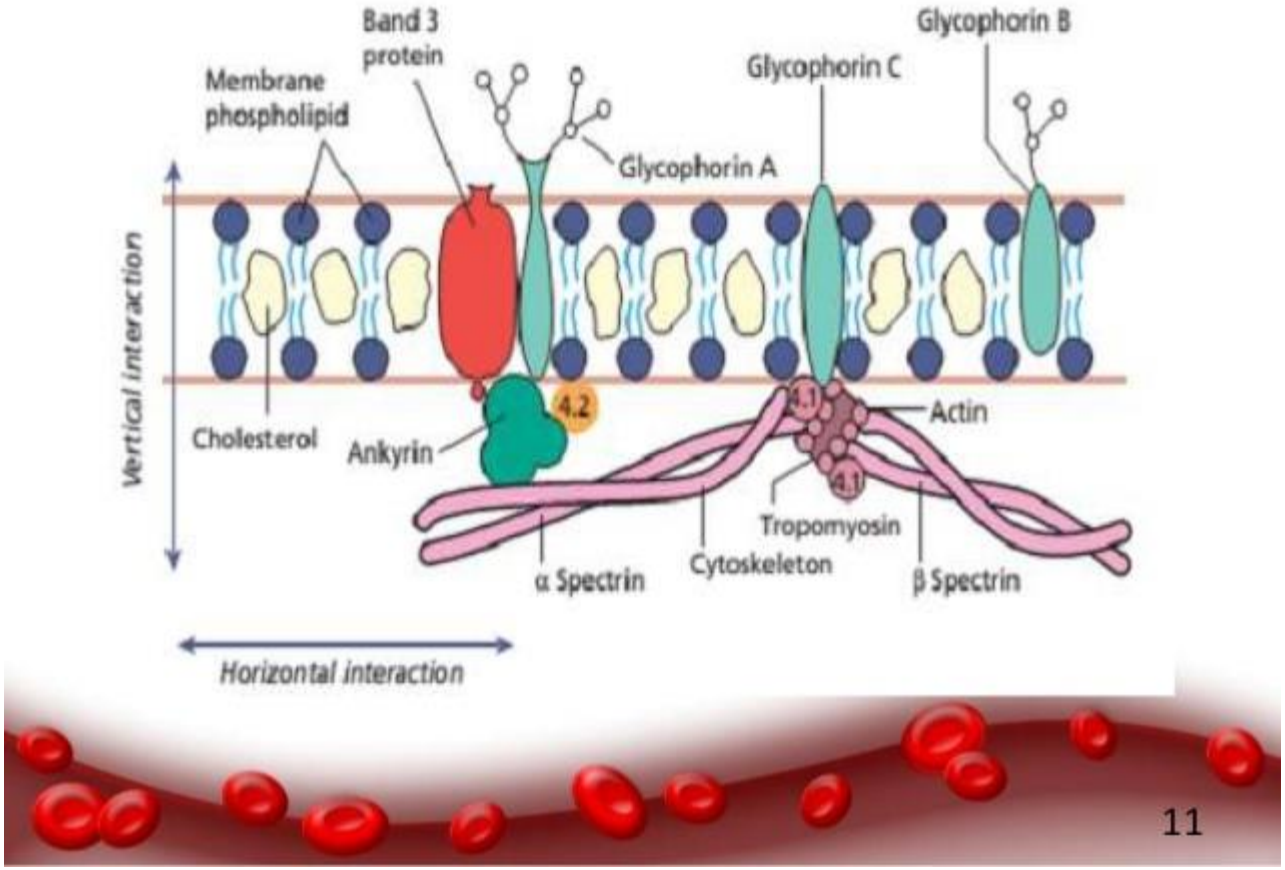
Lipid bilayer

- Phospholipid
- Cholesterol
- Glycolipid
- Integral protein
- Peripheral protein

CYTOSKELETON

1. Formed by structural protein
2. Basic unit : hexagonal lattice with 6 spectrin molecules.
3. Tail end: tetramers linked to actin and protein 4.1.
4. Head end: ß spectrin linked to ankyrin


Glycoprotein
(Glycophorin A, Protein 3)
Cholesterol>>Phospholipid = Acanthocyte
Inc. Cholesterol+Lipid = Target Cell
Cholesterol
Integral Protein
Extracellular
Intracellular
Aminophospholipid
Choline Phospholipid
Peripheral Protein
(Ankyrin)
Peripheral Protein)
Cytoskeleton
α β
Spectrin
Actin


Band 3
protein
Membrane
phospholipid
Glycophorin C
Glycophorin B
Glycophorin A
Vertical interaction
Cholesterol
Ankyrin
4.2
4.1
Actin
4.1
Tropomyosin
α Spectrin
Cytoskeleton
β Spectrin
Horizontal interaction


THE END