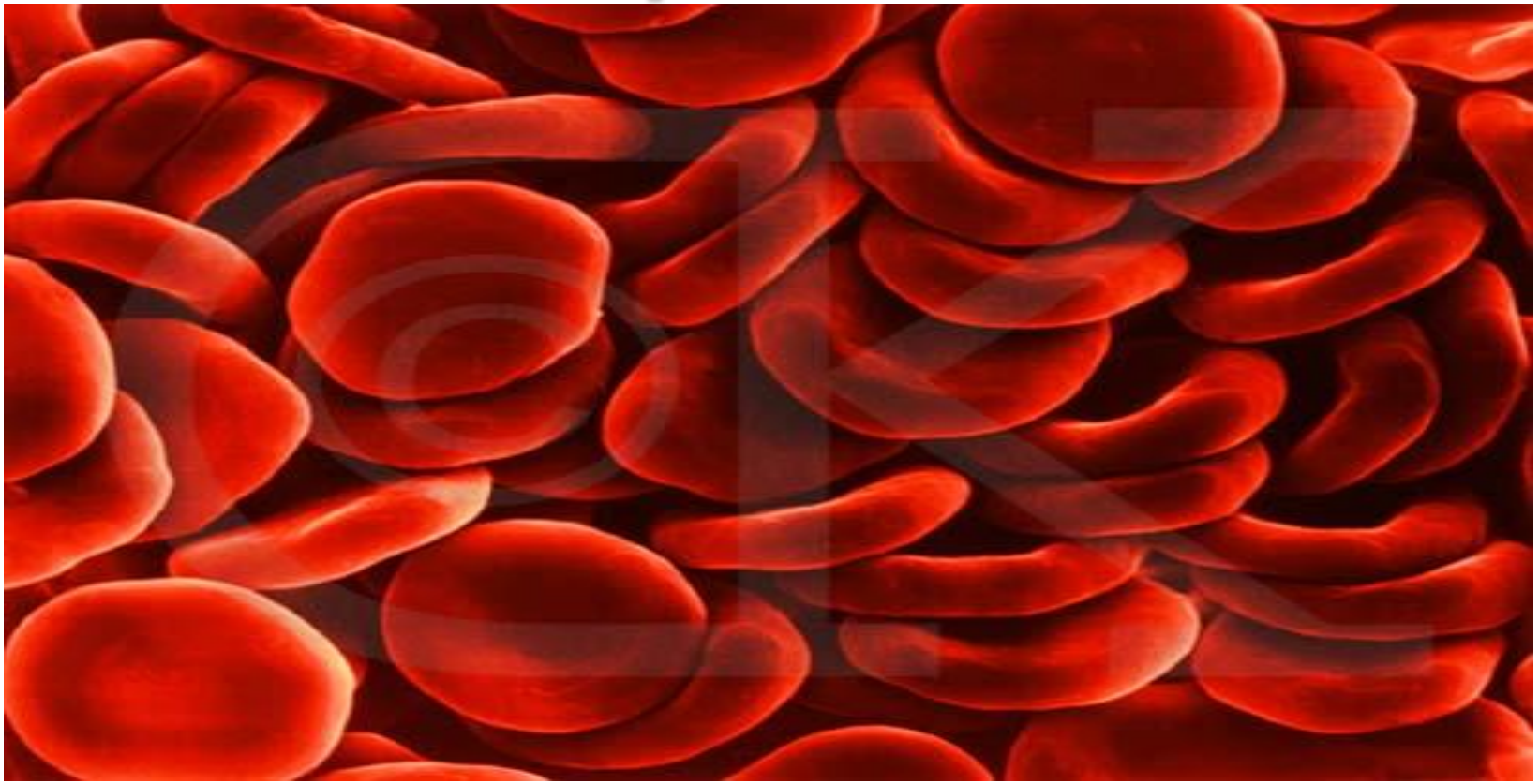
Bone Marrow & Bone Marrow Transplantation



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Prof. of Physiology

STUDY OBJECTIVES

By the end of the lecture the student will able to:

1. Name the types of bone marrow and give their functions.
2. Name the sites of hemopoiesis in different age groups.
3. List the indications of bone marrow biopsy.
4. List the indications of bone marrow transplantation.

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Types of Bone Marrow

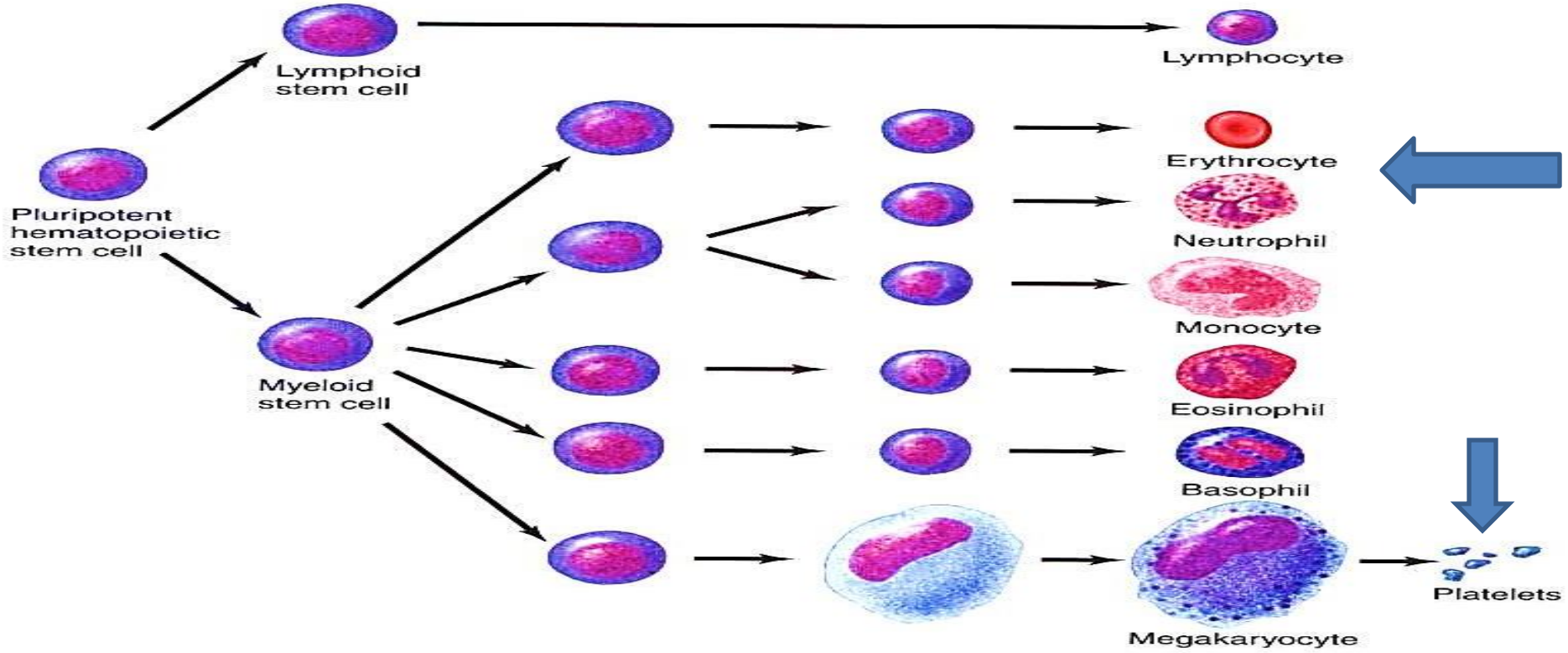
3 types	Red	Yellow
Color	Red	Yellow
Activity	active	Inactive
Cellularity	Highly cellular; (hemopoietic cells)	Contains fat cells
Sites	**In adults**, it is only in membranous bone (skull, sternum, ribs, pelvis, vertebral column, scapula and clavicle) and ends of hummers and femurs.	is present in all long bones (except ends of humors and femur),

3- White: In very old age (> 70 y), a gelatinous transformation of fat to **a mucoid material** occurs in bone marrow.

FUNCTIONS OF BONE MARROW

1. Haematopoietic (haemopoietic) function

(production and release of all types of blood cells): **pluripotent hematopoietic stem cells** are differentiated into lymphoid and myeloid stem cells.



Site of Hematopoiesis

1- In fetus:

First trimester of pregnancy from yolk sac.

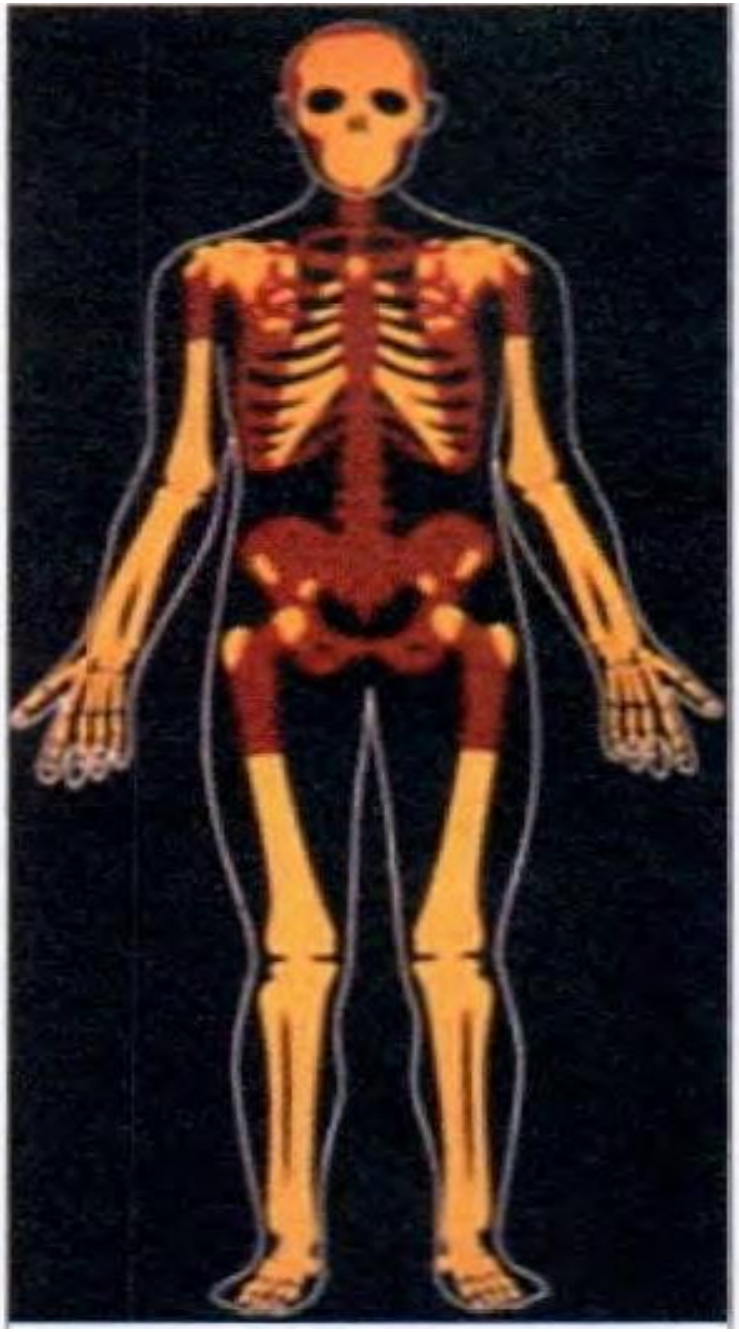
Middle trimester from reticuloendothelial system (RES).

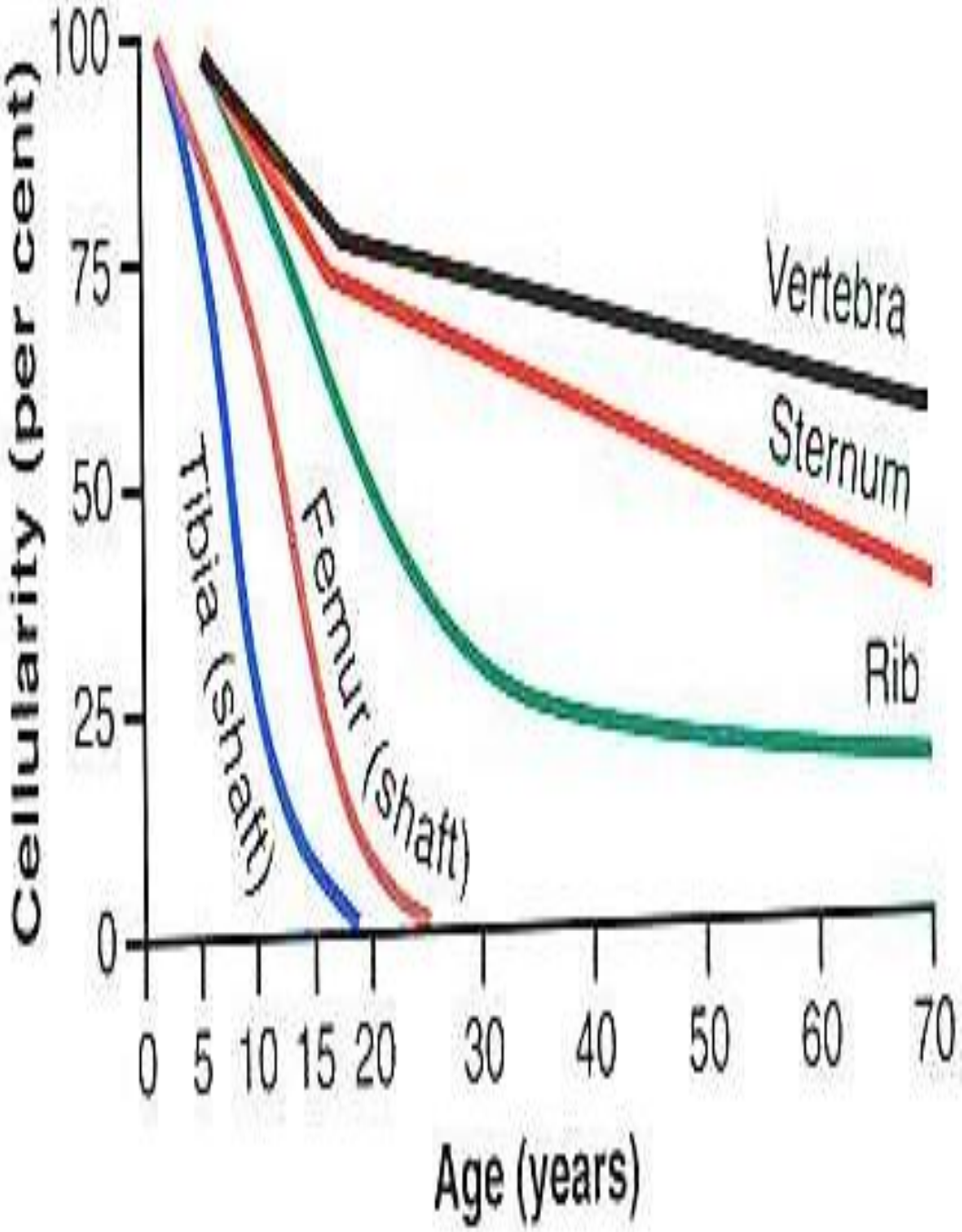
Last trimester and after birth up to the age of 20 years from bone marrow.

2-In adult (>20 years) from bone marrow.

**In fetus the all bone marrow are red bone marrows but in adult (≥20 years), they are differentiated into red and yellow bone marrow.

- The yellow bone marrow is not produced blood cells except in stress conditions e.g. bone marrow destruction or fibrosis (in this conditions not only yellow bone marrow produced blood cells but RES also produced).




Cellularity (per cent)
100
75
50
25
0
Vertebra
Sternum
Rib
Tibia (shaft)
Femur (shaft)
0 5 10 15 20 30 40 50 60 70
Age (years)

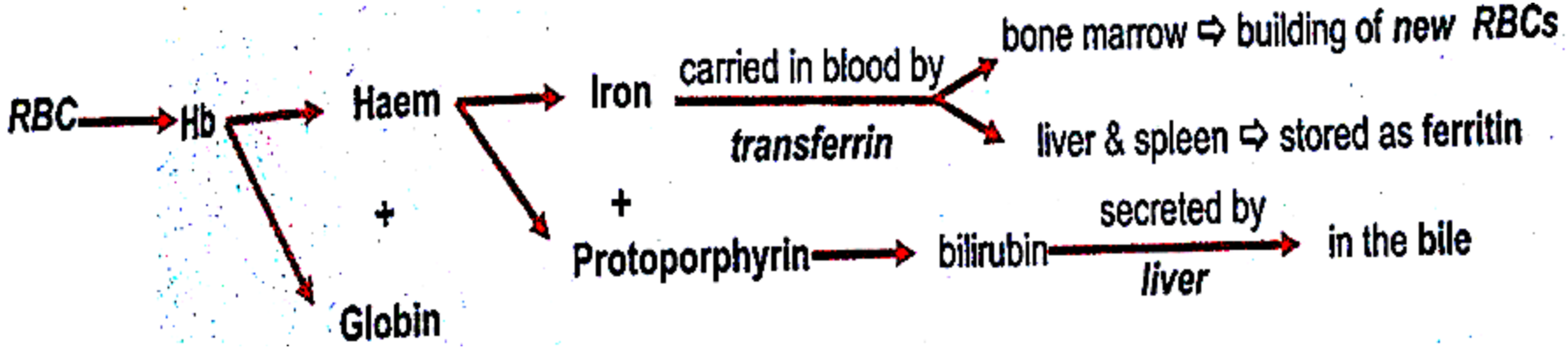
N.B.

-The bone marrow is actually one of the largest organs in the body (= the size and weight of the liver). Normally it is about 5% of total body mass (=3.65 kg in a man weighing 73 kg).

- Normally 75% of the bone marrow cells are white blood cells, and only 25% are RBCs. While in circulation 500 times more in RBCs numbers than WBCs this due to the average life span of WBCs is shorter than RBCs.

FUNCTIONS OF BONE MARROW

2. **Destruction of RBC:** After 120 days **(life span)** (due to loss of flexibility), RBCs are sequestered or trapped and phagocytised in the macrophages of the bone marrow & RES.



3. **Storage functions:** Bone marrow is an important site for storage of iron (for later use in the synthesis of haemoglobin).

FUNCTIONS OF BONE MARROW

3- **Immunological function:** it is the part of reticuloendothelial system so, it plays an important role in defense by:

A-Formation of antibodies.

B- Phagocytosis.

C- Repair of damaged tissues.

4- **Osteogenic function:** The osteoclast, osteoblast & osteocyte are formed within the marrow.

Bone Marrow Examination

Indications

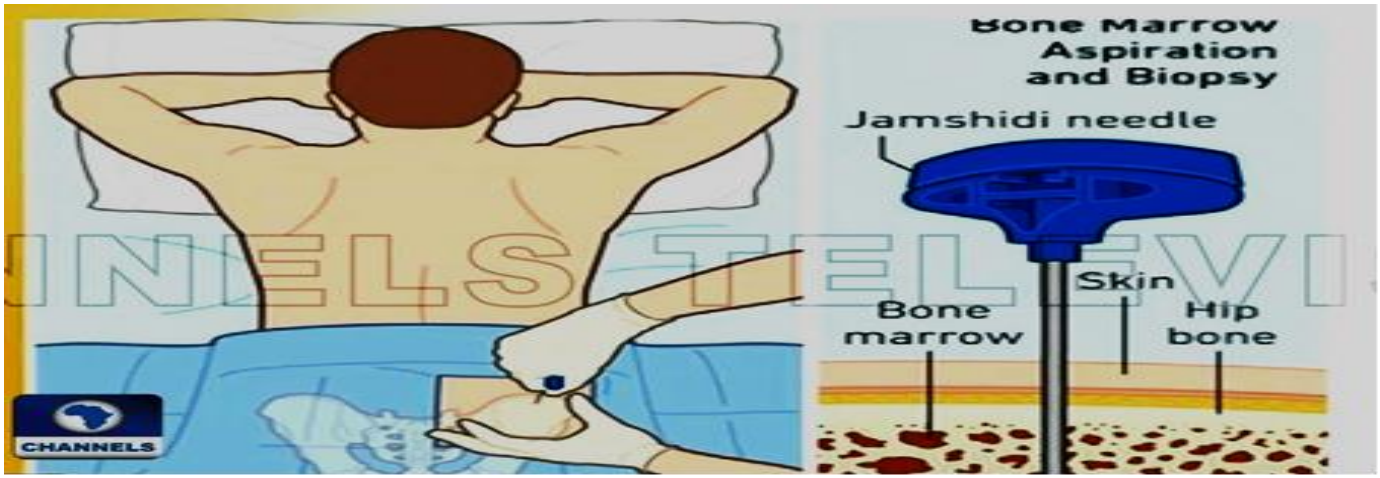
1. Anemias: Aplastic anemia or megaloblastic anemia.
2. Thrombocytopenic purpura (platlates less than 50,000/ mm3)
3. A granulocytosis (Stoppage of WBCs production).
4. Leukemia (↑ immature WBCs production).

3. Multiple myeloma (↑ plasma cells production)

6. Therapeutic (Bone marrow transplant)

Bone Marrow Transplantation

- Bone marrow transplantation is the process of collection and infusion of hematopoietic stem cells from the patient or from other individuals.
- Bone marrow cells can be stimulated to form any cell in the body. They are also capable of completely replacing the bone marrow when injected into a host whose own bone marrow has been completely destroyed.



Bone Marrow Transplantation

Indications

-Cancerous conditions:

- Leukemia
- Lymphoma
- Multiple myeloma
- Myelodysplasia.

-Non cancerous conditions:

- Aplastic anemia
- Hemoglobinopathies
- Immunodeficiency disorders

Dr. Donnall Thomas received Nobel Prize in Physiology and Medicine in 1990,

TEST YOUR SELF

1-Breakdown of erythrocytes in the body:

A. occurs when they are 6-8 weeks old;

B. is named erythropoiesis;

C. yields iron, most of which is excreted in the urine;

D. yields bilirubin which is carried by plasma protein to the liver;

2-During the last month of pregnancy, red blood cells of the fetus are produced mainly by:

a) Liver

b) Spleen

c) Bone marrow

d) Yolk sac

e) Lymph nodes

3-Cells in the red bone marrow that give rise to all the formed elements of the blood are called

A. Fibrinogens.
B. Megakaryocyte.
C. Myeloid stem cells
D. Lymphoid stem cells.

4-Concerning aplastic anemia :

a) caused by erythroblastosis fetalis.

b) caused by lack of vitamin B12.

c) caused by failure of the bone marrow function.

d) only B & C are correct.

5-During the second trimester of pregnancy, where is the predominant site of blood cells production in the embryo?

A) Yolk sac

B) Bone marrow

C) RES

D) All of the above

6-The shafts of long bones do not contain red bone marrow after:

a) Birth

b) One year

c) 10 years

d) 20 years

e) 70 years

7-Normally, 75% of the cells in the marrow belong to the white blood cell–producing stem cells because they are:

A. large blood cell count
B. large sized blood cell
C. Small sized blood cell
D. Small life span cell
E. for phagocytosis

8-In a two-month old foetus the RBC are produced in:

A. Bone marrow
B. Liver
C. Spleen
D. Yolk sac

9-Which of these areas does NOT contain red marrow in the adult?

A. sternum
B. ribs
C. pelvis
D. distal femur

10-Life span of RBC is

A. 120 hours.
B. 120 days.
C. 12 days.
D. 12 hours.

11-Severe depression of the bone marrow may result in :

a) microcytic hypochromic anemia.

b) increased number of granulocytes.

c) aplastic anemia.

d) increased of blood cell formation

12-Normally, erythrocytes:

A. Are formed by white bone marrow.

B. Are formed by yellow bone marrow.

C. Are removed from the circulation after about 120 days by macrophages in the bone marrow

D. Are removed from the circulation after about 120 days by Hematopoietic stem cells

13-Red bone marrow is absent in:

A. Pernicious anaemia

B. Sickle cell anaemia

C. Aplastic anaemia

D. Megaloblastic anaemia

14-Bone marrow plays an important role in:

A- platelete formation

B- phagocytosis

C- formation of immunoglobin.

D-all of the above

E- a & b

15-From indications for bone marrow transplantation is :

A. Sickle cell anaemia
B. Iron deficience anaemia
C. Megaloblastic anaemia
D. Thrombocytopenic purpura
E. Lymphoma

16-Which organ synthesizes new erythrocytes in adult?

a) Liver

b) Spleen

c) Red bone Marrow

d) Yellow bone Marrow

e) All of the above

17-Which of the following is a function of the bone marrow?

A. Haemostasis

B. Peristalsis

C. Glycogenolysis

D. Osteogenesis

18-Haemopoietic function means:

A. Blood cell formation in bone marrow

B. The process of blood clotting

C. The crenation of red blood cells in a hypotonic solution

D. An excessively large proportion of red blood cells to plasma

19-A survivor of the Hiroshima blast during the Second World War presented to hospital with pale look and purplish patches on the thin skin area. His hemoglobin is below normal. He is most likely suffering from:

A. iron deficiency anemia
B. sickle cell anemia
C. megaloblastic anemia
D. aplastic anemia

20-Where can red marrow be found in the adult?

A. In the pelvis, sternum and ribs

B. At the epiphyseal ends of long bones such as the radius, ulna and tibia

C. In the pelvis, sternum, ribs and the ends of the humerus and femur

D. In the medullary cavity of long bones

21- Complications of bone marrow destruction generally include:

A. Suppressed immunity
B. Impaired formation of all blood cells
C. osteogenesis deficiencies
D. All of the above

Answers

1-D 2. C 3. C 4.C

5-C 6-D 7-D 8-D

9-D 10- B 11- C 12- C

13 –C 14-D 15-E 16- C

17-D 18-A 19-D 20-C

21-D