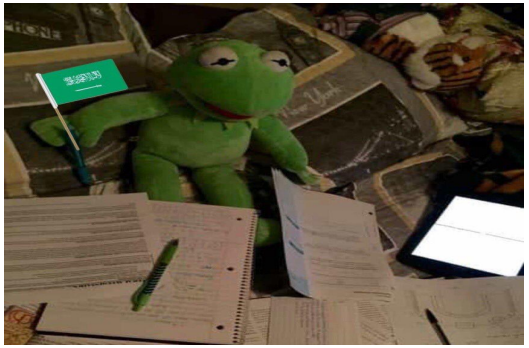
Blood physiology 1



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Red: Important
Black: In Male & Female slides
Blue: In male slides
Pink: In female slides
Green: Notes & extra information

Objectives

- Describe the physical characteristics & composition of blood
- List the common functions of blood.
- Define the process of erythropoiesis, Discuss its sites and stages.
- Describe the functions of red blood cells.
- Enumerate the factors affecting erythropoiesis.
- The role of hypoxia & erythropoietin hormone in the process of erythropoiesis.

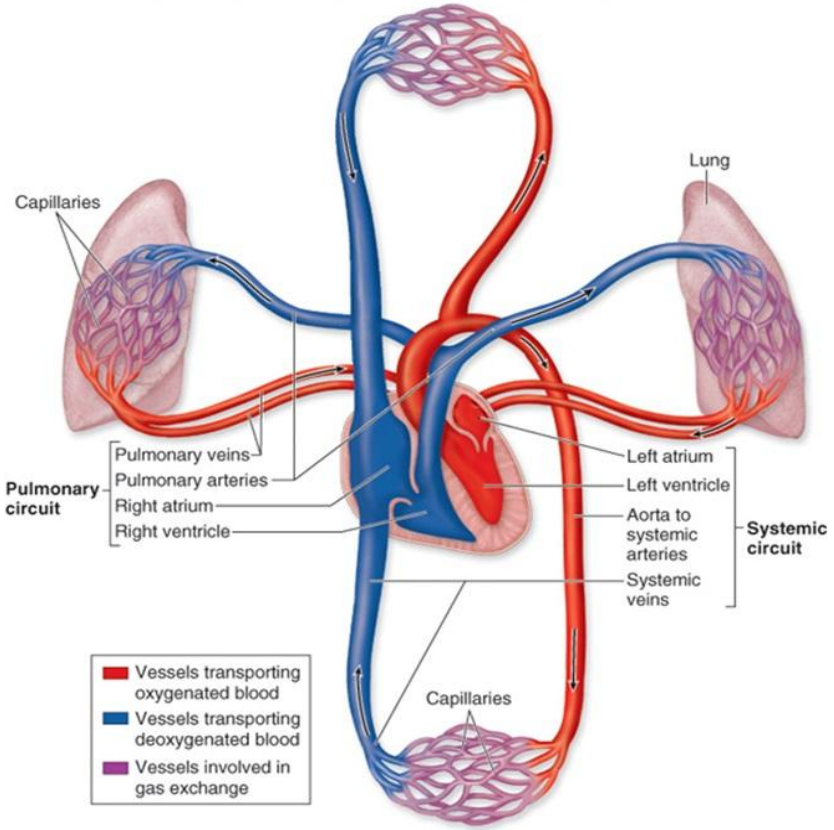
Major Components of the Circulatory System

1- Heart

2- Blood vessels

3- Blood

- Cellular composition
  - RBCs
  - WBCs
  - Platelets
- Plasma
  - 98% water+ions+plasma protein (Albumin,Globulin,Fibrinogen)
  - Same Ionic composition as interstitial fluid.



Blood

Physical Characteristics

Volume:
5-6L males, 4-5L females
7-9 % of body weight

Viscosity:
Thicker and slower
Plasma: 1.8 times of water
Blood: 4.5-5.5 times of water

pH = 7.35-7.45

Color:
Bright red = O2 rich
Dull red = O2 poor

Osmolarity:
300 mOsmol/L & 0.9% NaCl

Osmotic pressure:
=5540 mmHg

Function

Transport:
O2 , nutrients, wastes product & hormones

Maintains:
Temperature, ECF pH & fluid volume

Protection from infection by:
Antibodies & Activating WBCs

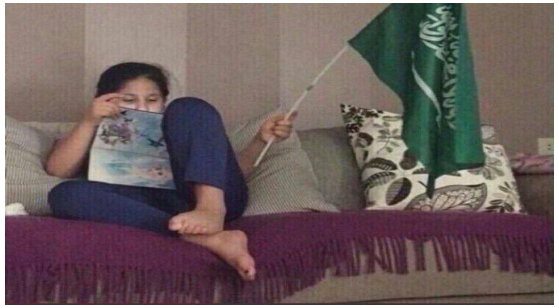
Prevent blood loss by:
Activating plasma proteins and platelets & clot formation when a vessel is broken

Composition

1- **Formed elements;**
45% of blood:
- RBCs = 99%
-WBCs & platelets= 1%

WBCs are:
a) **granular**: neutrophils, eosinophils & basophils
b) **agranular**:
- Lymphocytes,
T,B cells & macrophages

2- **Plasma (matrix);**
55% of blood



Plasma = 55% of whole blood

"Buffy coat"
<1%

Platelets

White blood cells

Packed cell volume, or hematocrit

Red blood cells =
45% of whole blood

RBCs:

Lack a nucleus and most of organelles

		CONTAINS:	
Shape	Flat,Biconcave discs,flexible		
Diameter	7.5 µm		
Thickness	2 µm	Carbonic anhydrase enzyme (CA):	For buffer function.
Volume	90 – 95 μm^3	2-3 DPG enzyme:	For anaerobic glucose metabolism & controls of O_2 affinity binding
RBC's N°	$4.7\text{-}5x10^6$	Haemoglobin:	14-16 g/dl (For Gas transport).

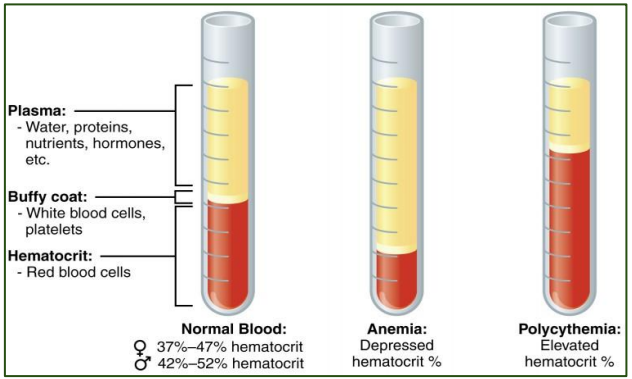
Functions of RBCs (by Haemoglobin):

1- O2 & CO2 transport.

2- Buffer function: responsible of 85% of the buffering

Hematocrit; Hct (PCV)

the ratio of the volume of red blood cells to the total volume of blood as determined by separation of red blood cells from the plasma usually by centrifugation.



Formation of blood cells terms:

Erythrocytes (RBCs) = **Erythropoiesis**

Leukocyte (WBCs) = Leukopoiesis

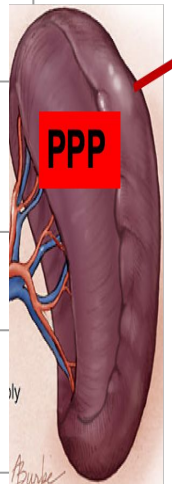
Thrombocytes (Platelets)= Thrombopoiesis

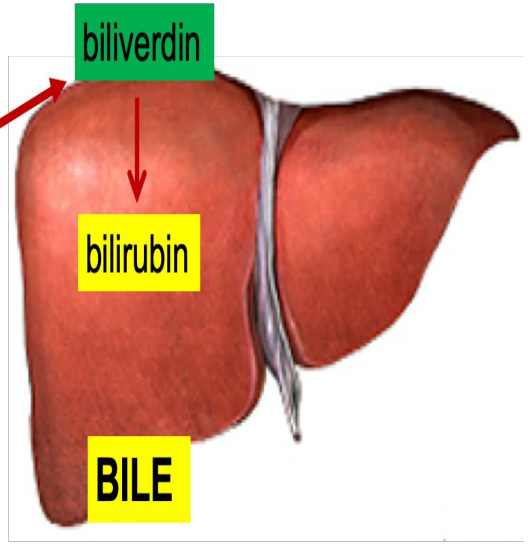
*all occurs in the bone marrow

This slide was found only in male slides

RBCs life cycle & fate:

- RBCs live only 120 days
- Cells rupture during passage into tight capillaries due to loss of membrane flexibility.
- Repair is not possible due to lack of organelles.
- damaged cells are removed by macrophages in the spleen and liver.
- products (Iron & vitamins) are recycled.
- Hemoglobin -> biliverdin -> bilirubin -> secreted into bile (by liver)





RBCs Erythropoiesis
Formation of new RBC

Sites:
Bone marrow,(3 situations)

1-During intrauterine life:
A) Early few weeks of embryo formed in yolk sac.
B) Middle trimester in liver & spleen & lymph nodes.
C) Last months formed in bone marrow of all bones

2-Before age of 20 years:
Bone marrow of all bones.

3- After age of 20 years:
Bone marrow of membranous bones only

After Birth:
-Bone marrow of flat bone(sternum,ribs) continue to produce RBCs into adult life
-Shaft of long bone stop to produce RBCs at puberty while epiphysis continued.

RBCs Erythropoiesis Factors:

1- Oxygen supply to the tissues (Hypoxia).

2- Dietary requirements (Vitamins – Iron – Copper – Cobalt – Zinc – Other elements).

3- Healthy organs (Bone marrow – Liver – Kidney).

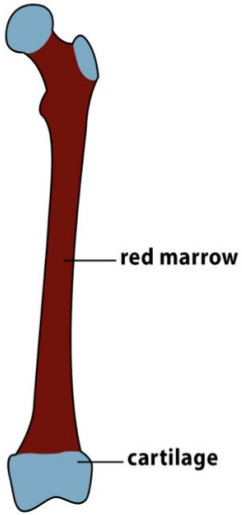
4- Hormones (Erythropoietin – Androgens – Thyroxine – Cortisol)

RBCs development is characterized by:
-Decrease in cell size
-Disappearance of nucleus
-Appearance of hemoglobin

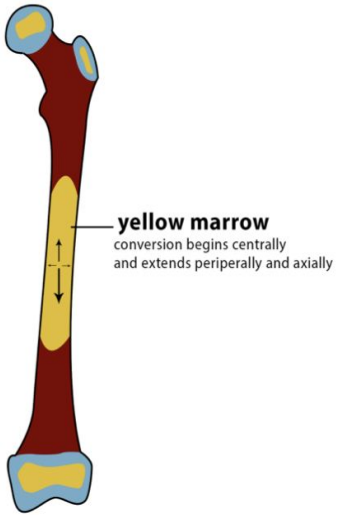
In case of rapid RBC production, high concentration of reticulocytes in the circulation

Regulation of RBC production:
Erythropoiesis is stimulated by erythropoietin hormone produced by the kidney in response to hypoxia (low oxygen in the blood)

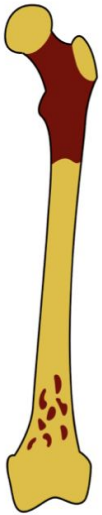
Normal bone marrow conversion



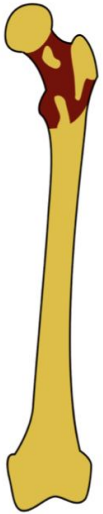
Infant
<1 year



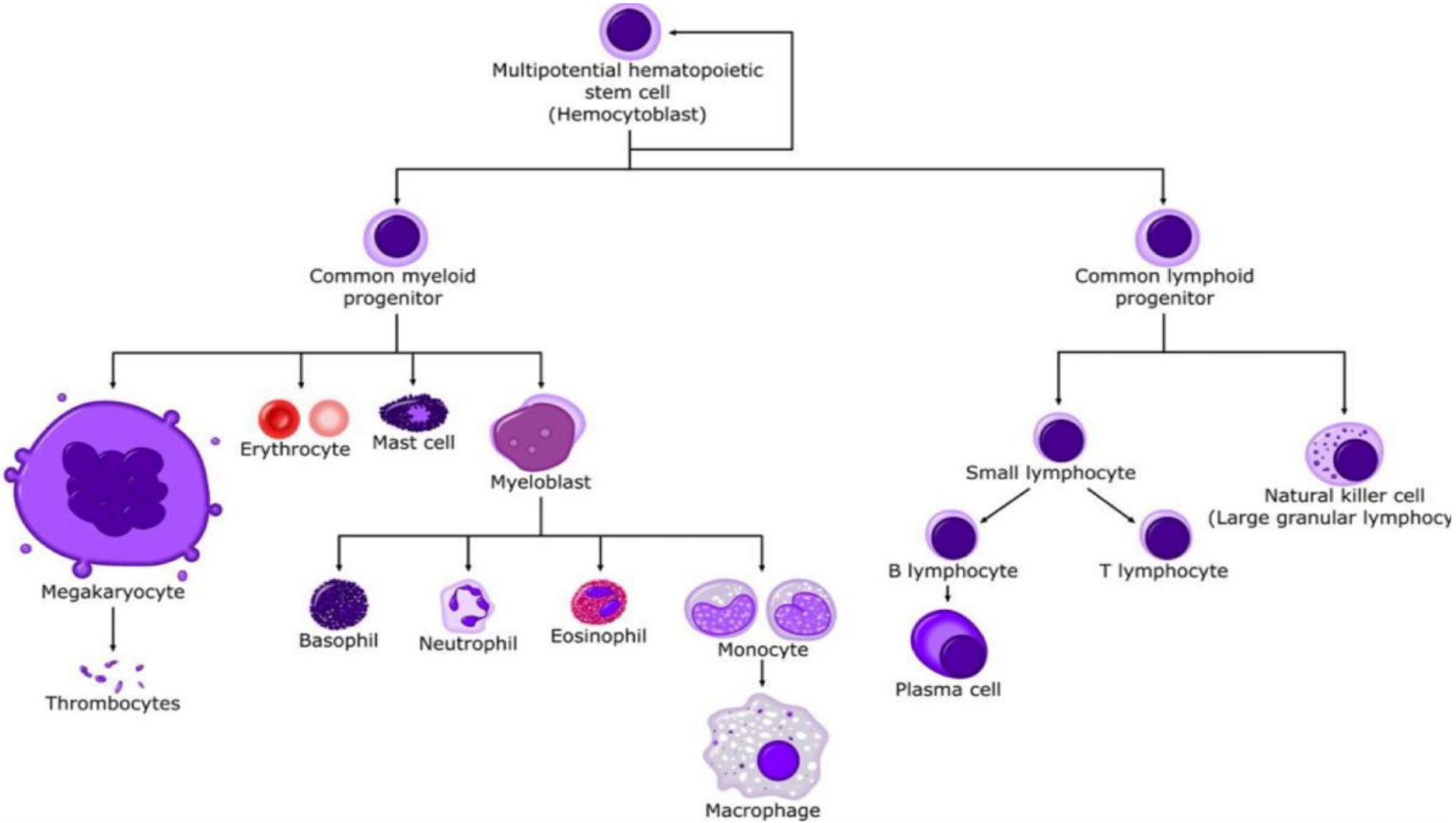
Childhood
1-10 years



Adolescent
10-20 years



Adult
>25 years


Multipotential hematopoietic stem cell (Hemocytoblast)
Common myeloid progenitor
Common lymphoid progenitor
Megakaryocyte
Thrombocytes
Erythrocyte
Mast cell
Myeloblast
Basophil
Neutrophil
Eosinophil
Monocyte
Macrophage
Small lymphocyte
B lymphocyte
Plasma cell
T lymphocyte
Natural killer cell
(Large granular lymphocy

Erythropoietin effect:

Importance	Tissue oxygenation is the most essential regulator of RBCs production. The mechanism is via the stimulatory effect of hypoxia on the release of erythropoietin hormone (stimulate the growth of early stem cells)
Nature	Glycoprotein with a molecular weight =34,000
Site of release	Mainly from the kidney(renal cortex)(90%), 10% from the liver
Site of action	Bone marrow.
Action	Stimulate the growth and differentiation of early hematopoietic stem cells

Clinical correlation:

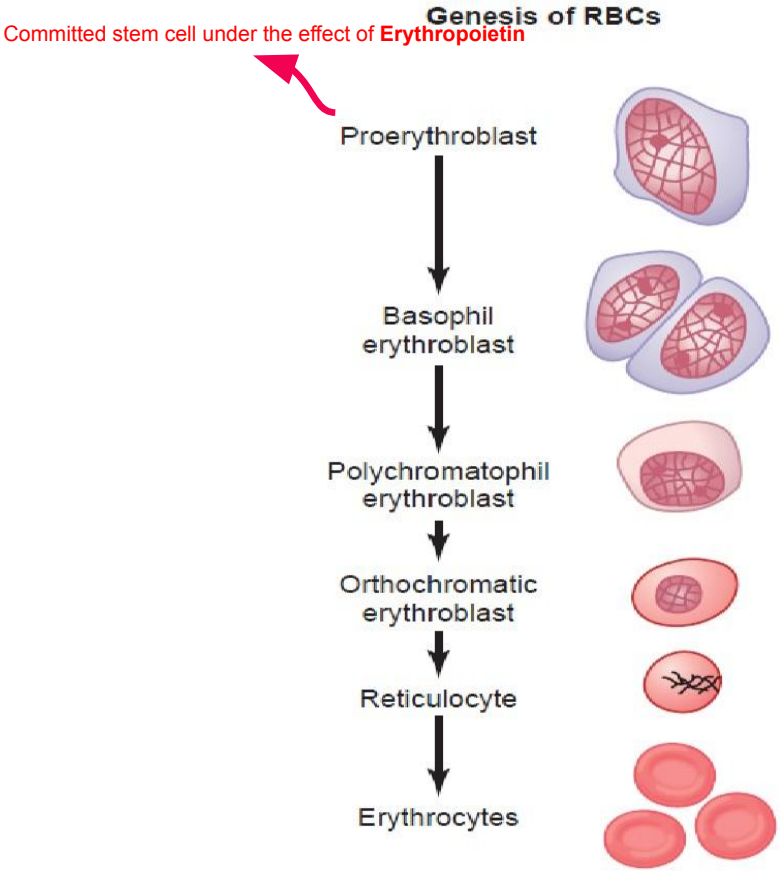
In case of renal disease, the person becomes anemic, and the liver can NOT compensate the role of kidneys in releasing erythropoietin.

Anemia of renal disease is treated with erythropoietin

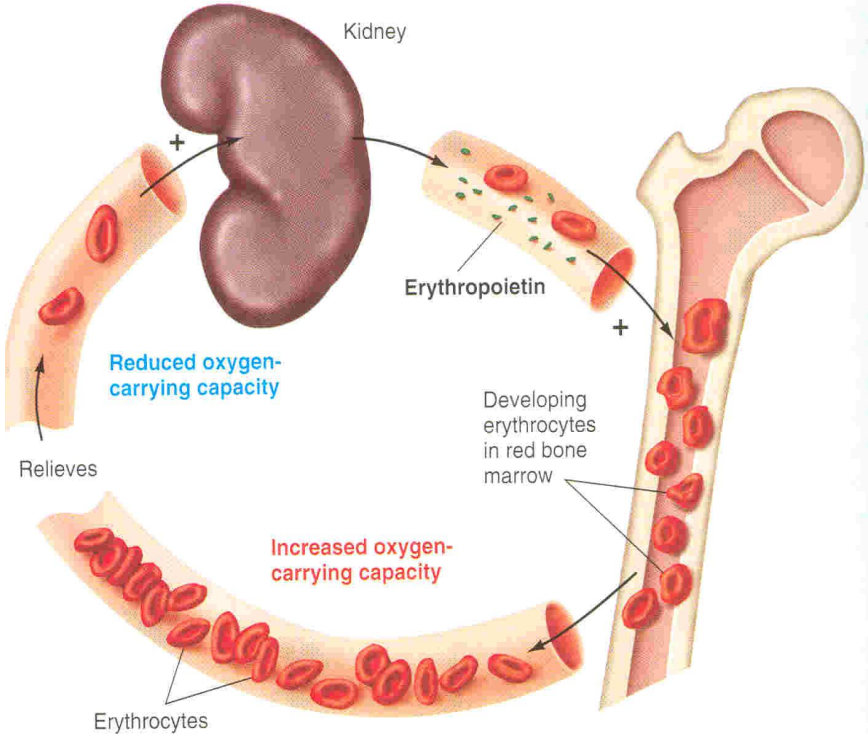
Erythropoietin
does not affect maturation process.
can massacred in plasma & urine .
conditions like : anemia,high altitude, heart failure, lung disease.
result in high erythropoietin levels and polycythemia.

Stages of RBCs development:

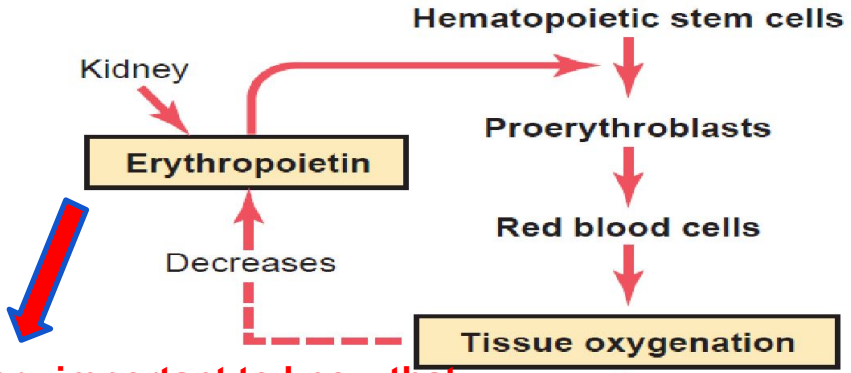
*All blood cells are formed from Pluripotential hematopoietic stem cells



Role of the kidneys in RBCs formation



RBCs Erythropoiesis Factors: Oxygen supply to the tissues (Hypoxia)



***It's very important to know that the "Erythropoietin" is released from the kidney (NOT bone marrow)**

Females slides:
Hypoxia caused by:
1- Hemorrhage
2- High altitude
3- Prolong heart failure
4- Lung disease

males slides:

Factors that decrease oxygenation
1. Low blood volume
2. Anemia
3. Low hemoglobin
4. Poor blood flow
5. Pulmonary disease

QUIZ!

MCQs

Q1: after the age of 20, which bone is NOT responsible for RBCs erythropoiesis:			
A) vertebra	B) sternum	C) ribs	D) ulna
Q2: Macrophages that remove damaged cells are found in:			
A) spleen kidney	B) liver lungs	C) spleen & liver	D) kidney & lungs
Q3: In which situation that the liver, spleen & lymph nodes erythropoiesis RBCs :			
A) middle trimester of intrauterine	B) last month of intrauterine	C) first few weeks of intrauterine	D) first month after birth
Q4 : Erythropoietin is released from:			
A) bone marrow	B) kidney	C) lungs	D) liver

SAQ

Q1: How can anemia for renal disease treated by?

Q2: What is the benefit of carbonic anhydrase enzyme?

MCQs key answer :
1) D
2) C
3) A
4) B

SAQ answer key :
1) by erythropoietin.
2) buffering.

Thank You

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