

PHYSIOLOGICAL REVIEW & NORMAL HEMATOLOGICAL VALUES



**Diyala University – collage of medicine
Hematology -5th stage
Dr.zahraa najah alzuhairi
Lec 1**

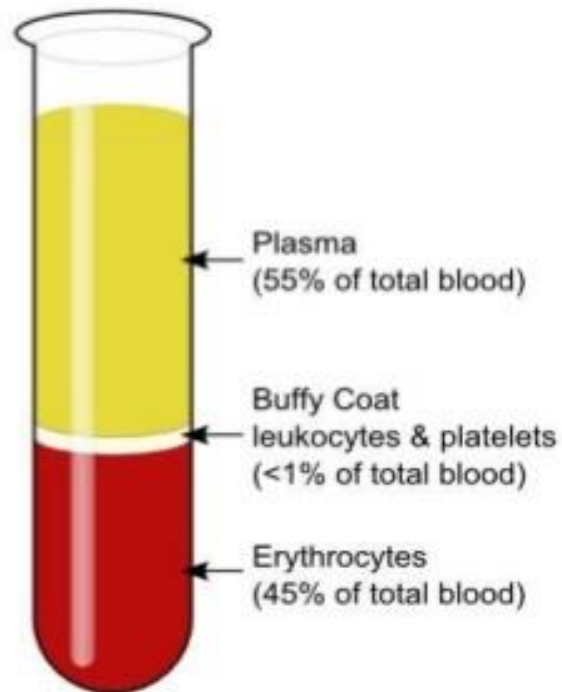
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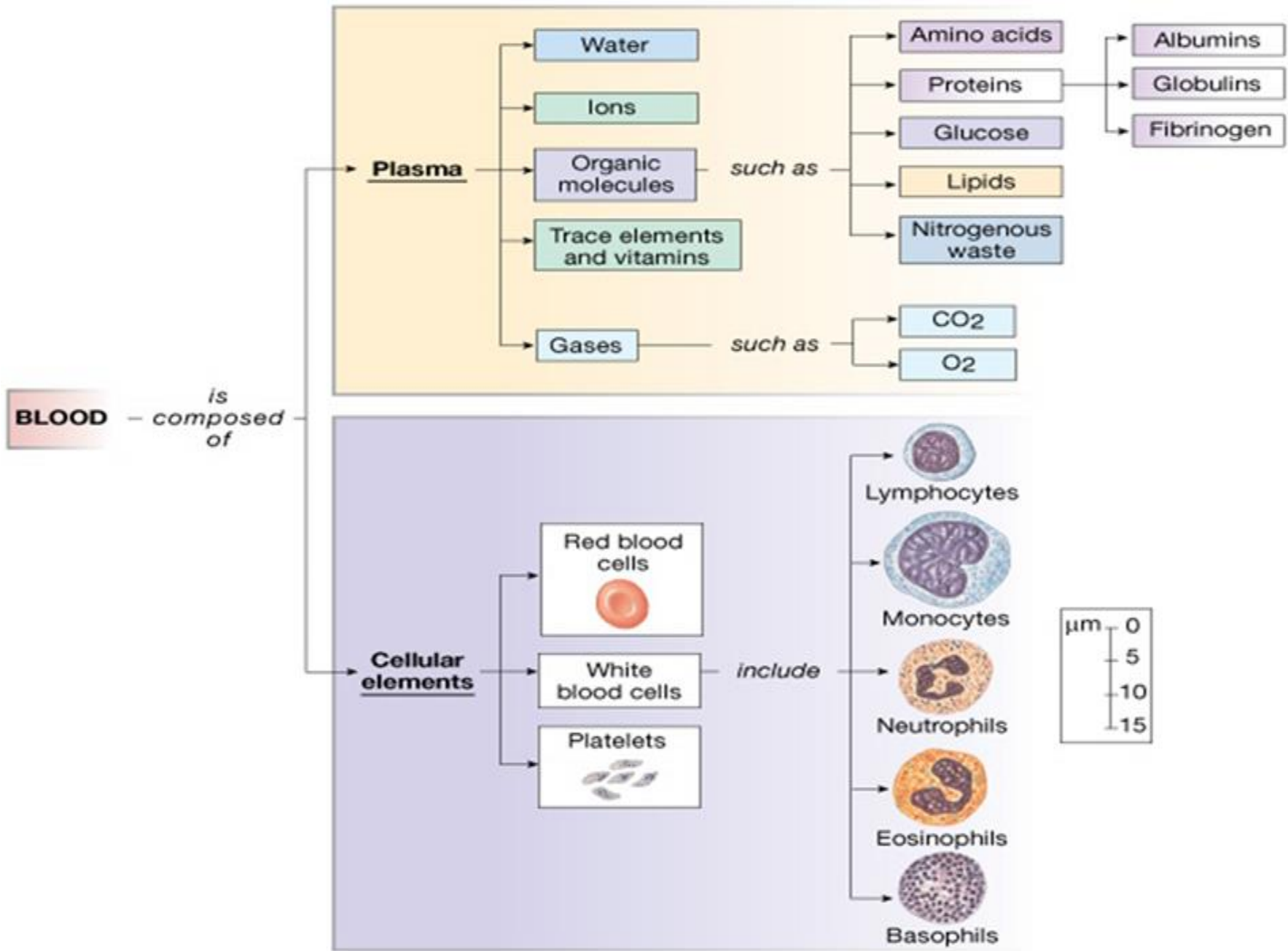
- ❑ Haemopoiesis
- ❑ Haemopoietic growth factors
- ❑ Sites of Haemopoiesis
- ❑ Erythropoiesis
- ❑ Control of erythropoiesis
- ❑ Myelopoiesis
- ❑ Hematological parameters




- ❑ **Haemopoiesis:** is the process of blood formation
- ❑ **Blood:** is a suspension of non-dividing end-stage cells in suspending fluid (Plasma), three types of cells namely:
 - ✓ RBC Red blood cell: 120 days life span
 - ✓ WBC White cells (leucocytes): ~ 1day life span
 - ✓ Platelets(thrombocytes) : 7-10 days

BUFFY COAT:





- Haemopoiesis starts with a pluripotential stem cell, Haemopoietic stem cell (HSC) that can give rise to the separate cell lineages.
 - Stem cells are cells from which all haemopoietic elements originate. They are characterized by their ability of Self-renewal & Differentiation.
 - **Stem cells** → **progenitor cells** → **Precursors cell**
End-stage cells
 - **Progenitor cells:**
 - Early and late type.
 - Multi-lineage or uni-lineage.
 - Increase differentiation over the proliferation.
 - **Precursor cells:**
 - Specific for single line.
 - Unable to proliferation.
 - Morphologically recognizable.
- 

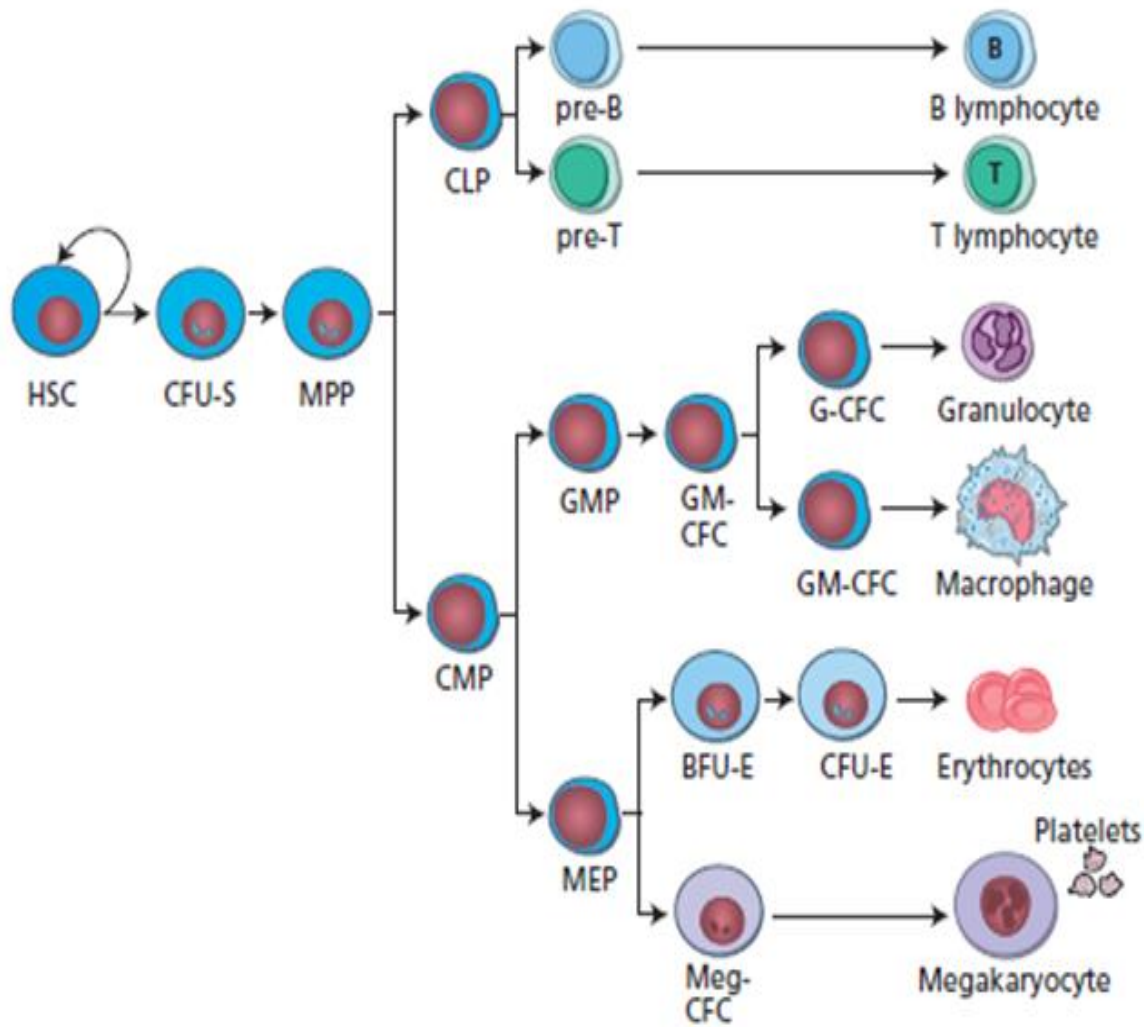


Figure 1.1 The adult haemopoietic hierarchy. Haemopoietic stem cells are at the foundation of the hierarchy. Through a series of progressive proliferation and differentiation steps the mature blood cell lineages are produced. Haemopoietic stem cells have the greatest proliferative and multilineage differentiation potential, while the mature blood cells are not proliferative and are lineage restricted. While large numbers of mature cells are found in the blood and turn over rapidly, the bone marrow contains long-lived quiescent haemopoietic stem cells at a very low frequency.

Proliferative potential

Frequency and turnover rate

Stem cells

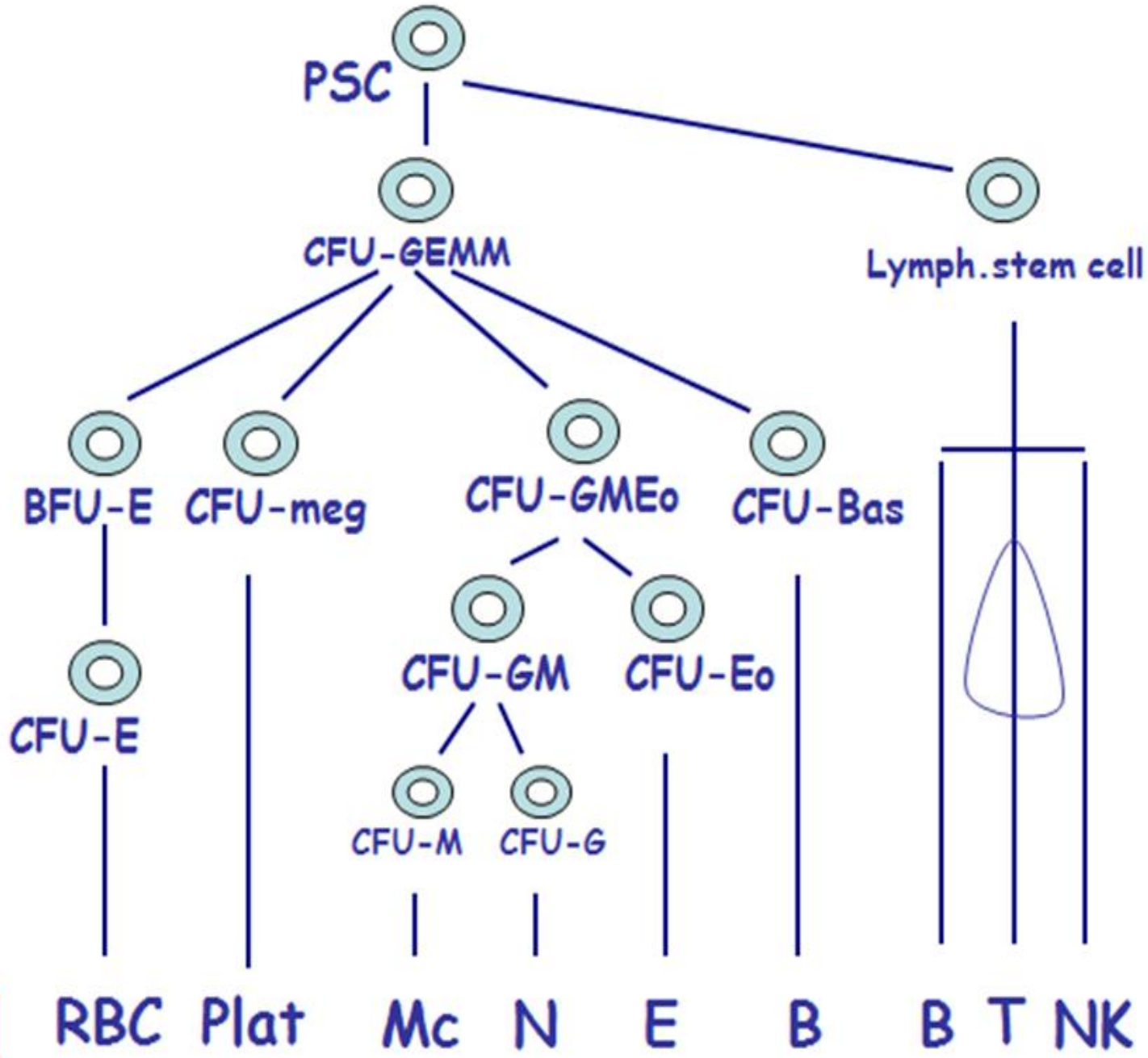
Progenitor cells

Multilineage

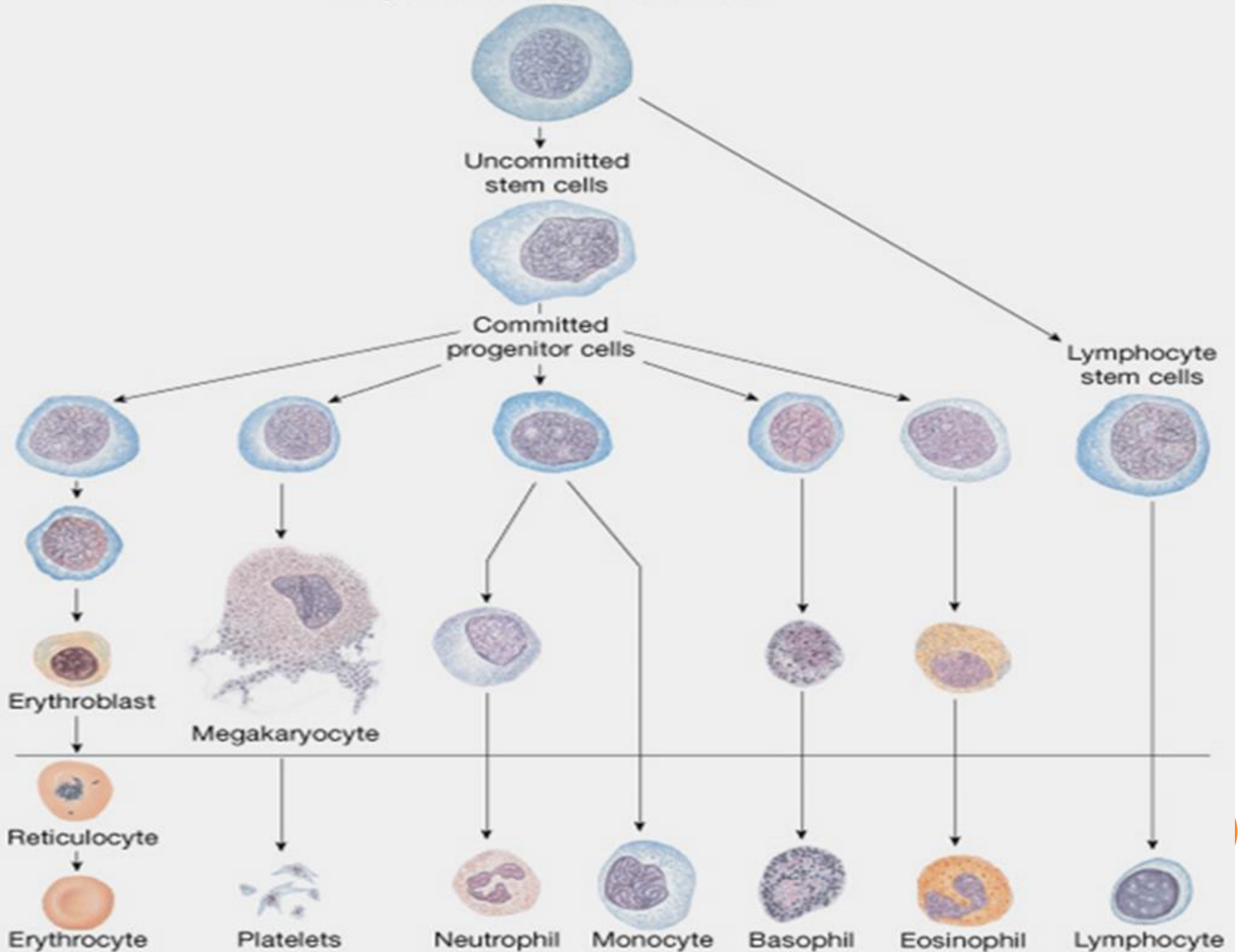
Single line

Precursor

Mature cells



Pluripotent hematopoietic stem cell



HAEMOPOIETIC GROWTH FACTORS

- Glycoproteins act at very low concentration
- Produce by many cells
- Usually of more than one action
- Important Examples:

Act on stromal cells

IL-1

TNF

Act on pluripotential stem cells

SCF

Flt-L

Act on multipotential progenitor cells

IL-3

GM-CSF

IL-6

G-CSF

Thrombopoietin

Act on committed progenitor cells

G-CSF*

M-CSF

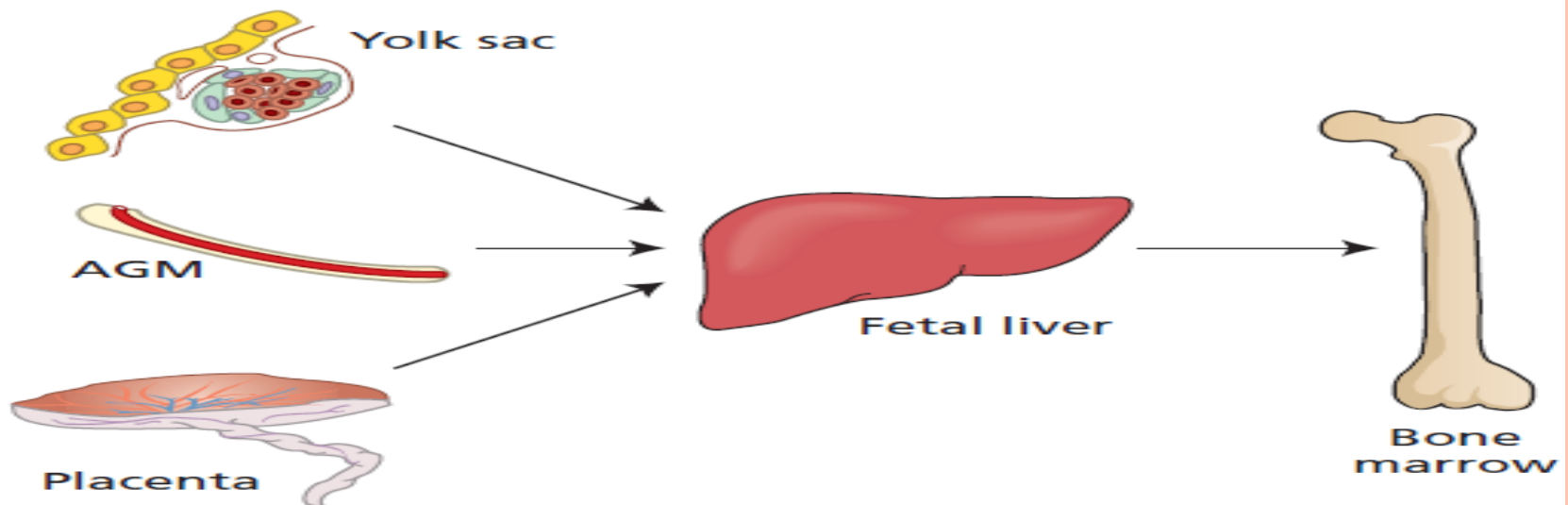
IL-5 (eosinophil-CSF)

Erythropoietin

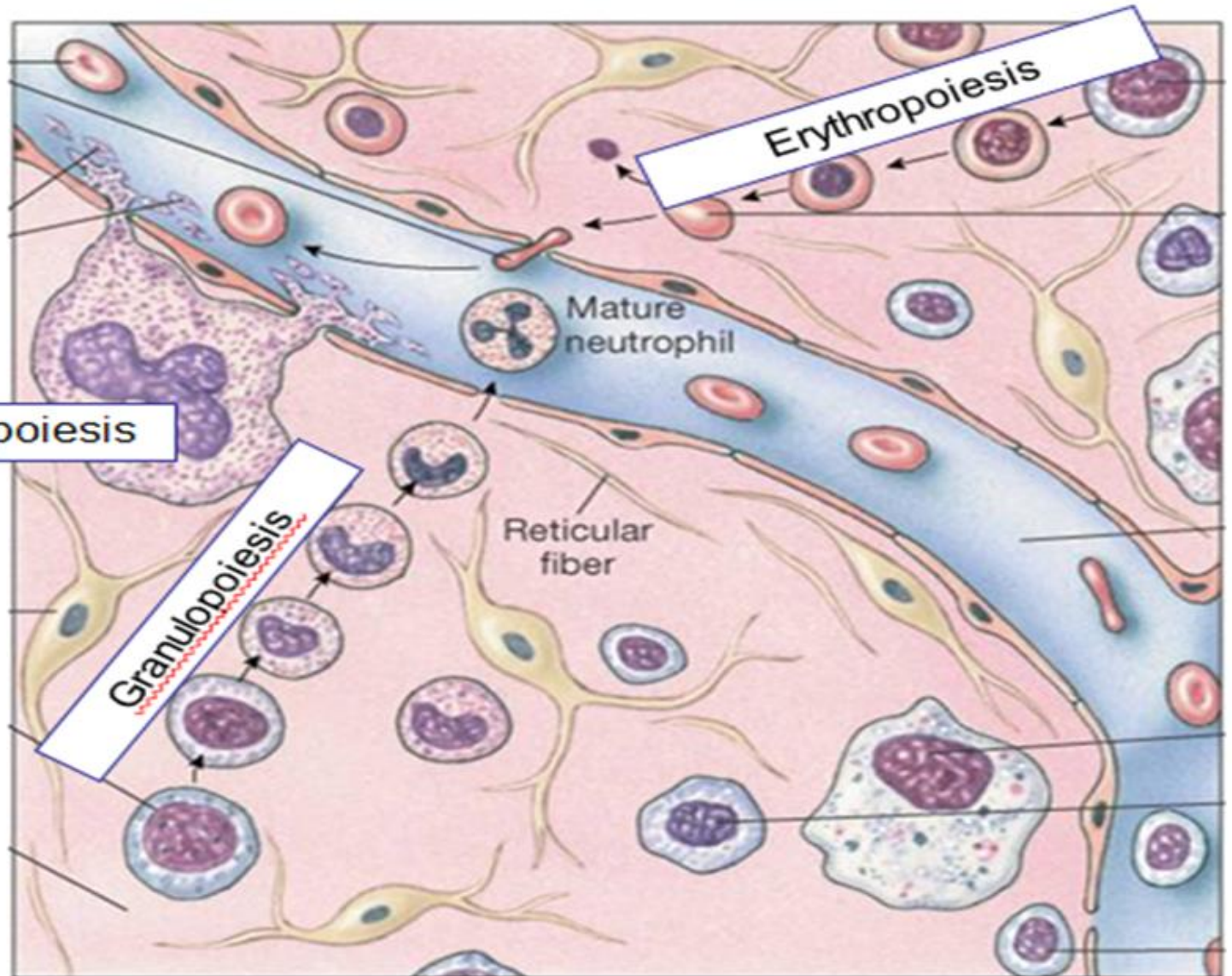
Thrombopoietin*

SITES OF HAEMOPOIESIS

- **Fetus** 0-2 m (yolk sac)
2-7 m (liver, spleen)
5-9m (Bone marrow)
- **Infant** Bone marrow (all bones)
- **Adult** Bone marrow (Axial skeleton and proximal end of large bones)
- **Extramedullary Haemopoiesis** mean hemopoiesis occur outside the BM (mainly in liver and spleen)



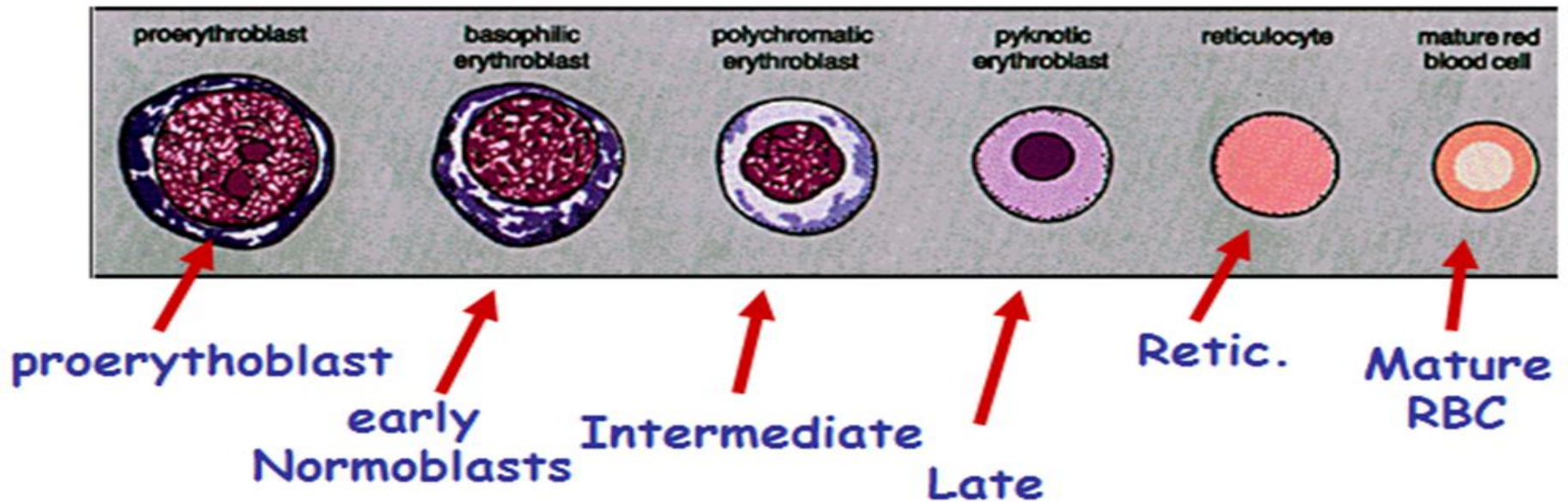
HAEMOPOIESIS INCLUDING:



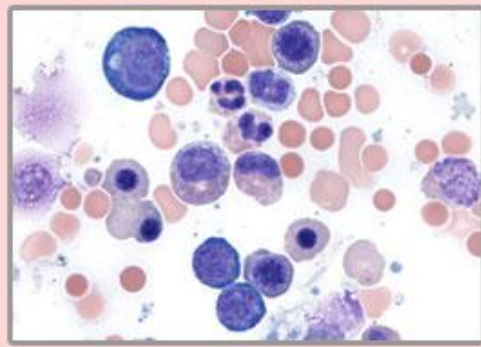
ERYTHROPOIESIS

- Around 10^{12} new RBC per day.
- 7 days required for RBC formation in Erythropoiesis.
- Erythropoiesis passes through stem cells, CFUGEMM, BFUE, CFUE, and then precursor cells for RBC.

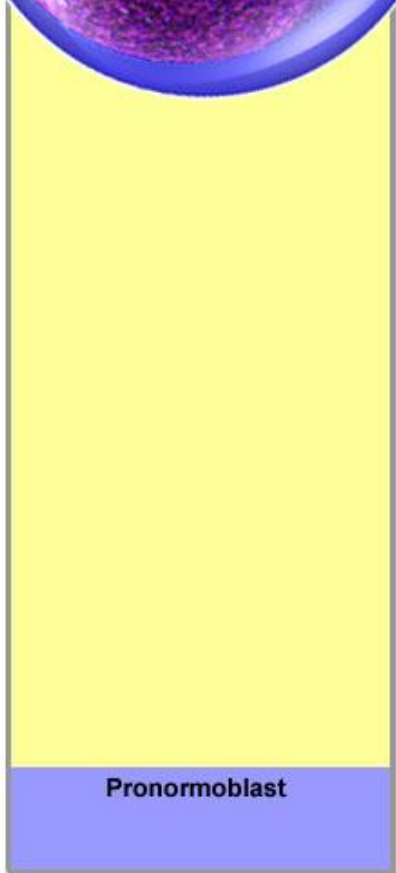
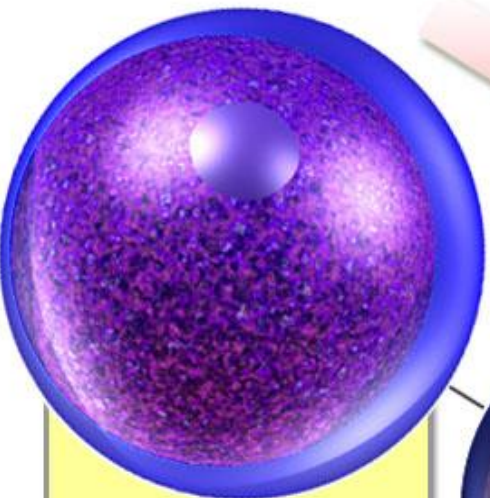
Red Cell precursors (in marrow)



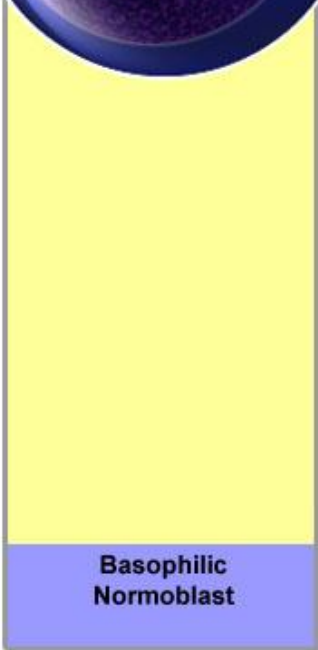
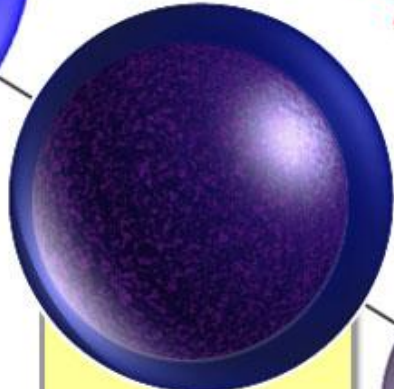
ERYTHROID (RBC) MATURATION DIAGRAM



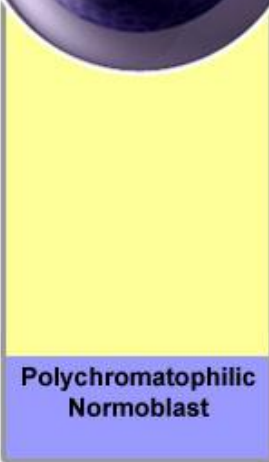
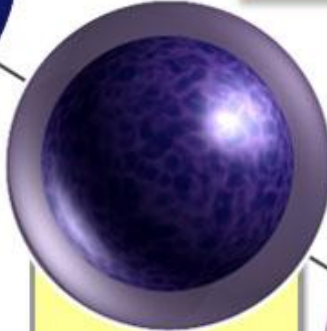
- Cell size decreases
- Cytoplasm ratio increases
- Nuclear size decreases and disappears
- Cytoplasm staining changes from blue to pinkish red
- Chromatin pattern matures and disappears with nucleus



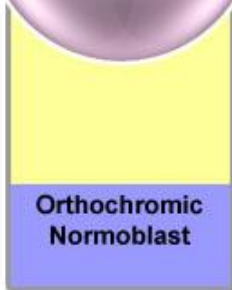
Pronormoblast



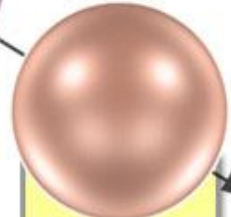
Basophilic Normoblast



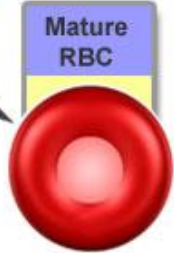
Polychromatophilic Normoblast



Orthochromic Normoblast

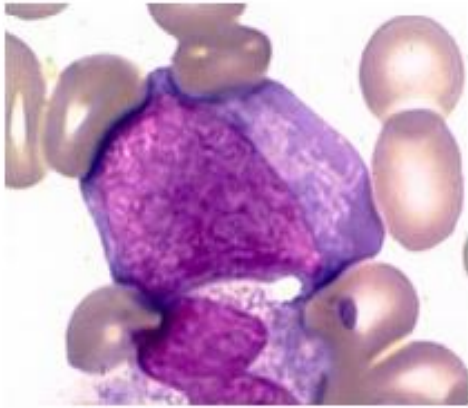


Polychromatophilic RBC (Reticulocyte)

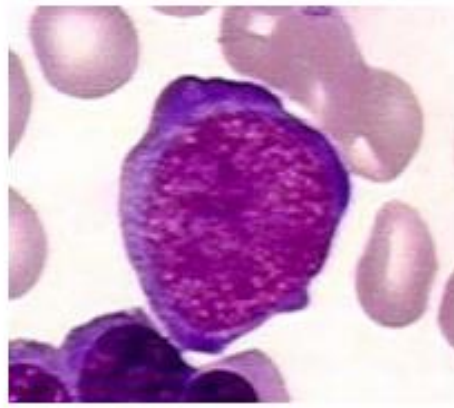


Mature RBC

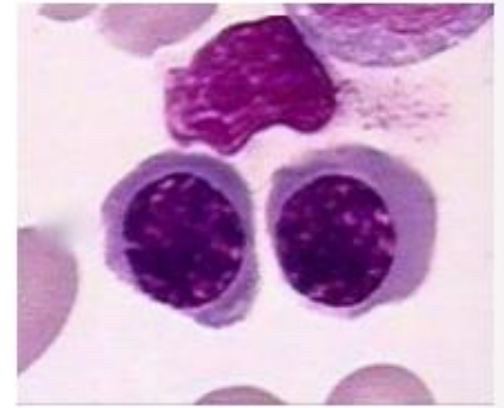




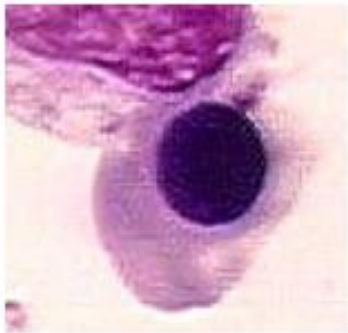
A. Proerythroblast



B. Basophilic Erythroblast



C. Polychromatophilic Erythroblast



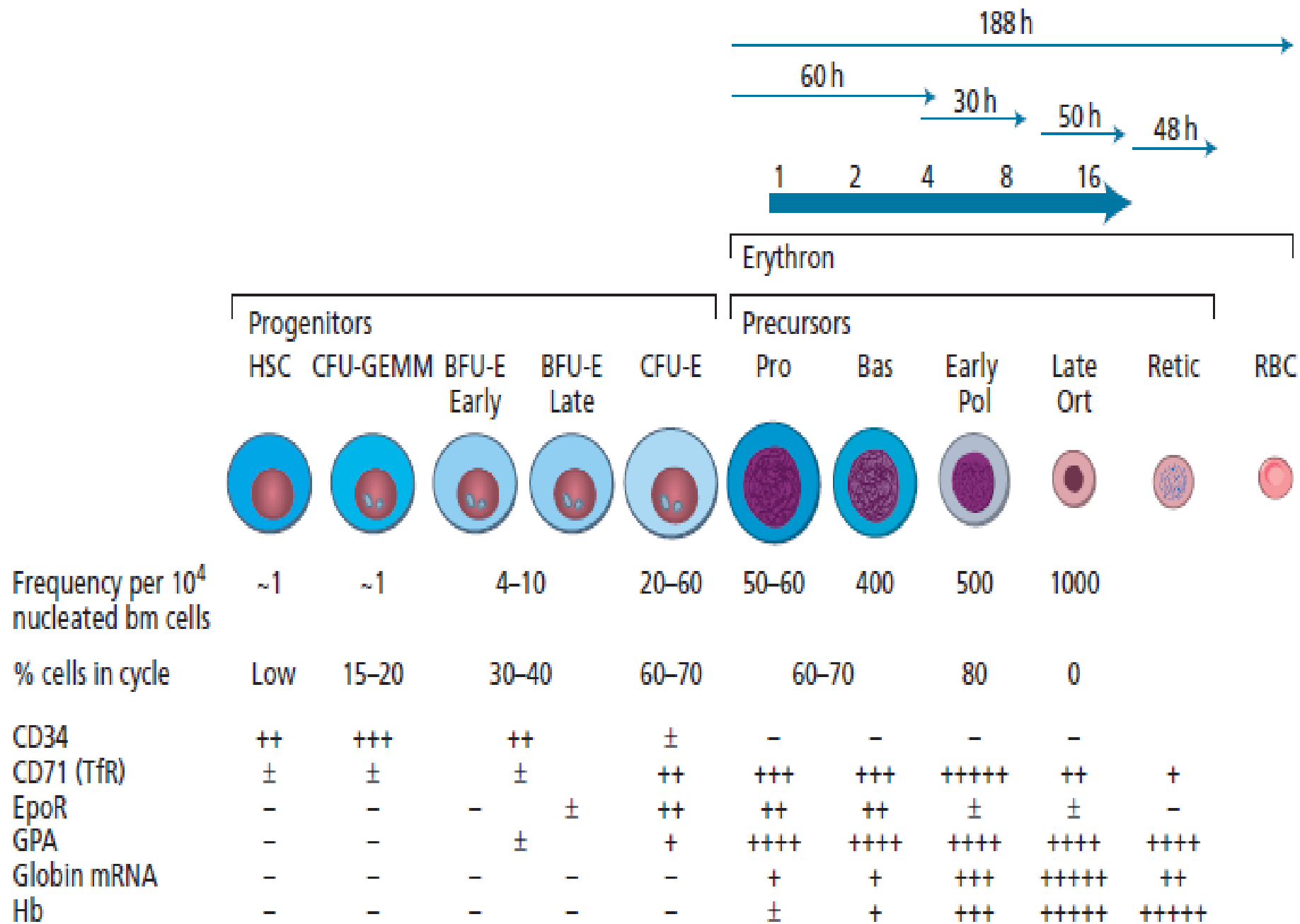
D. Orthochromatophilic Erythroblast

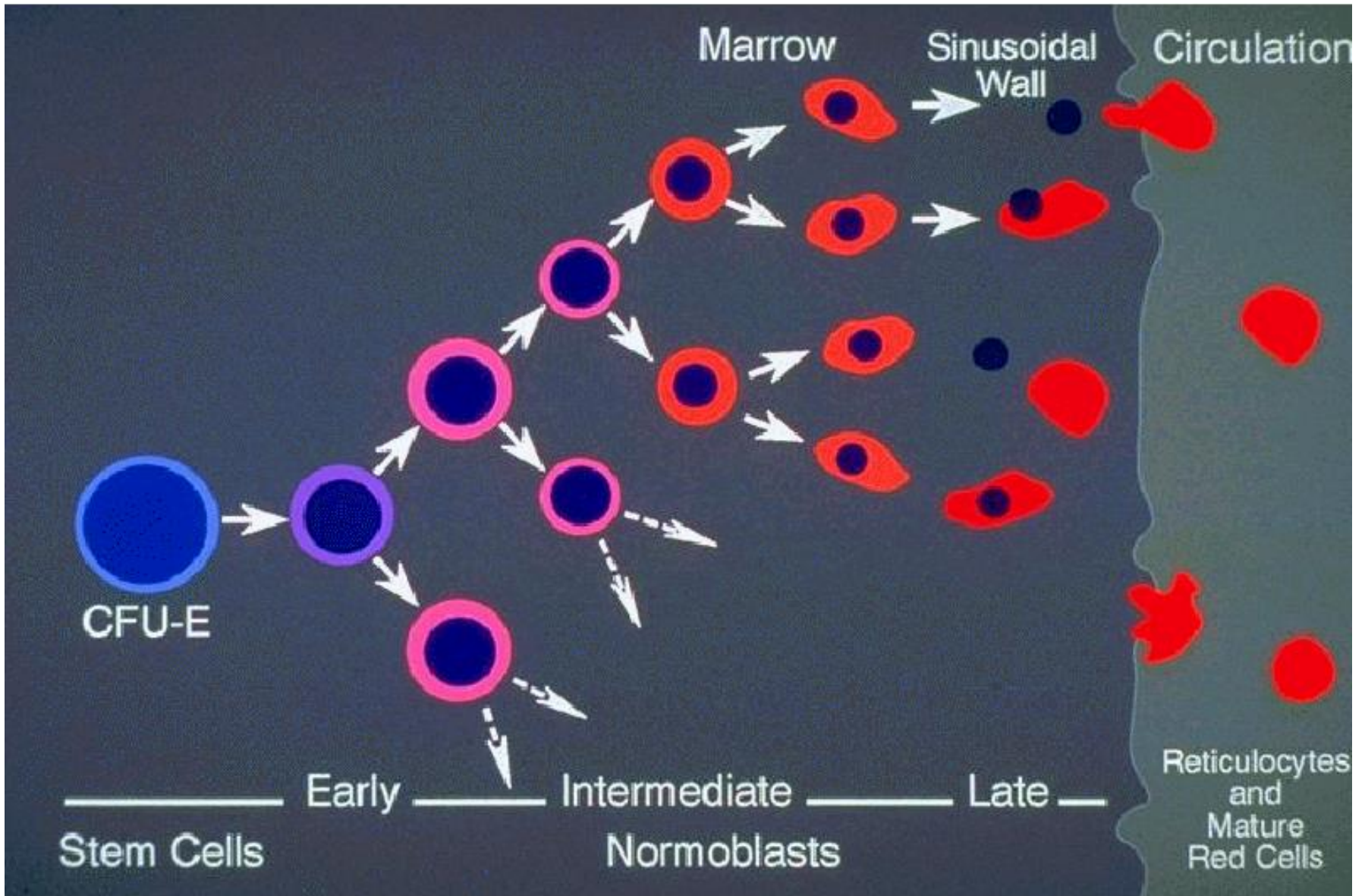


E. Reticulocyte



F. Erythrocyte

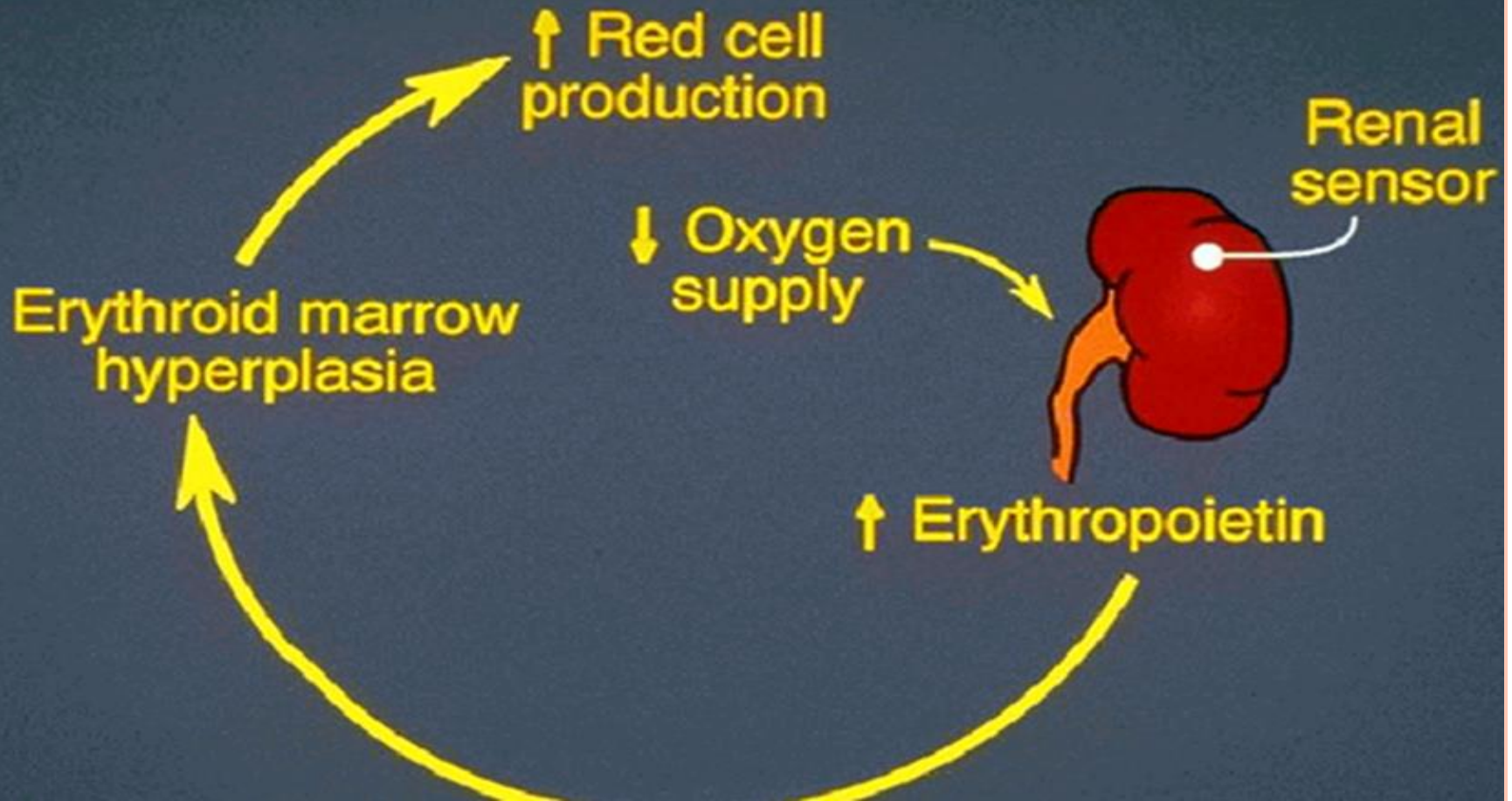




~ 7 days

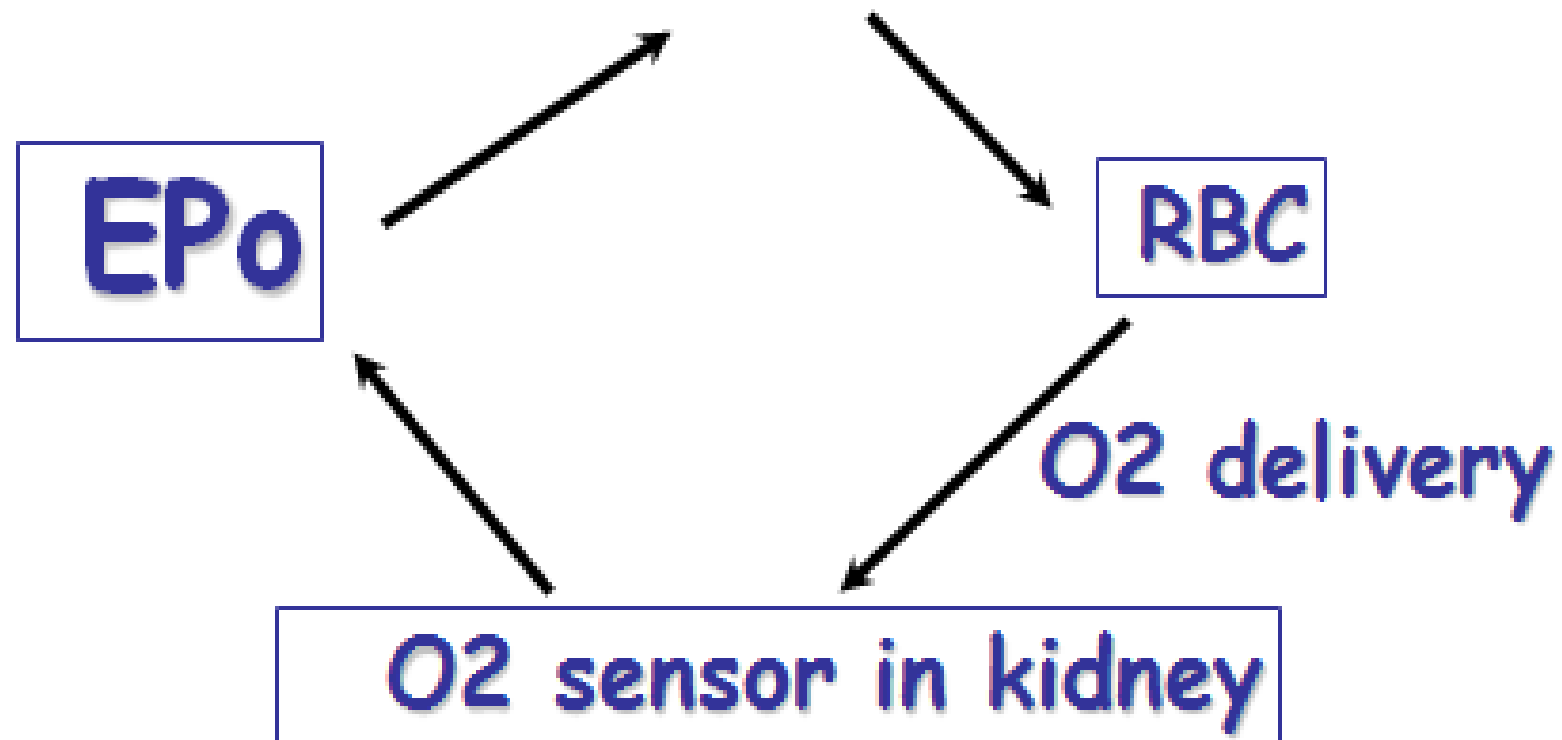
CONTROL OF ERYTHROPOIESIS

1. Functional feedback
2. Certain hormones
3. Nutritional factors



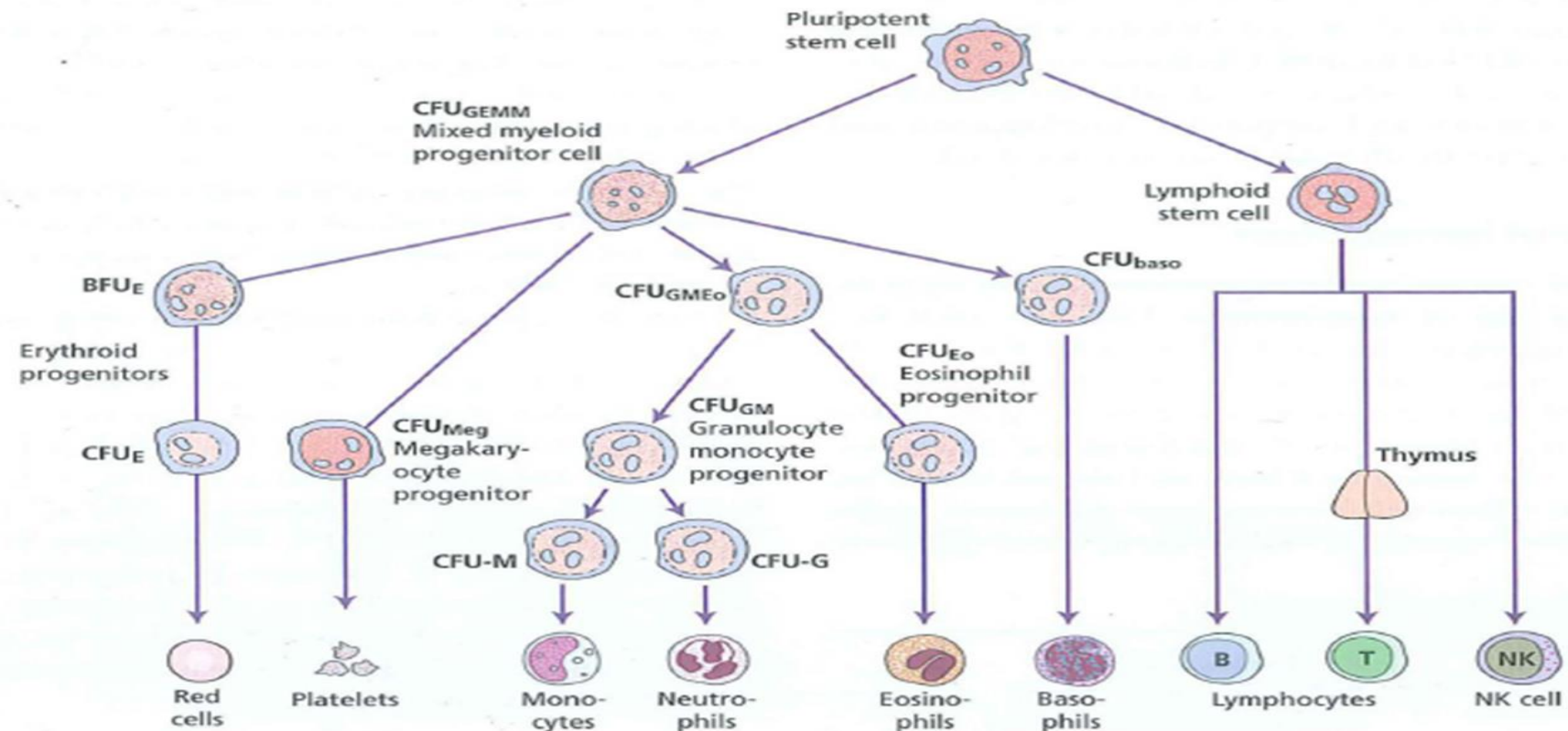
Control of erythropoiesis

BM: late BFUe, CFUe, pronormoblast

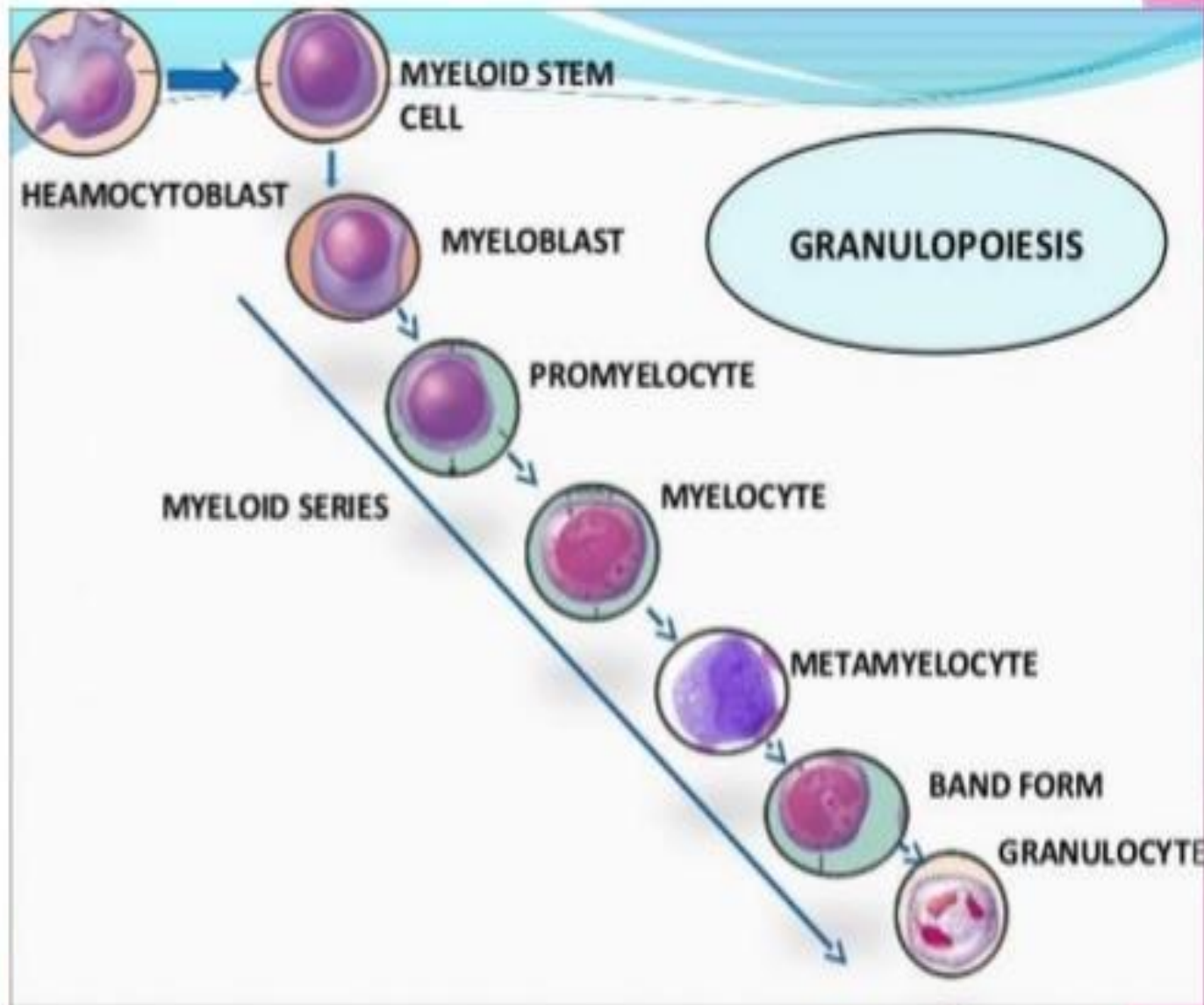


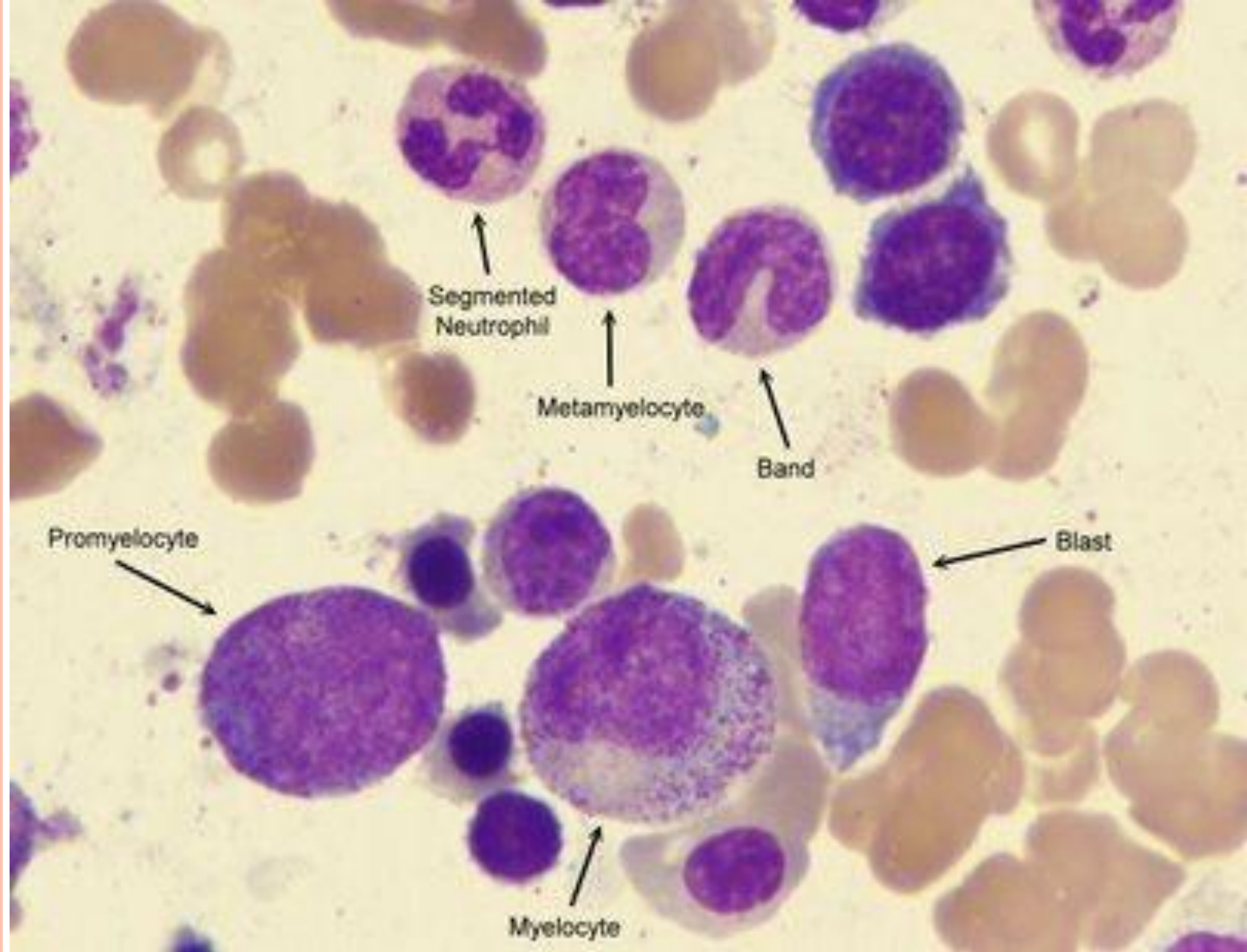
MYELOPOIESIS

- It starts from the CFU-GEMM, which is a multilineage progenitor and will be committed to tri- then to bipotential progenitor CFU-GMEo & CFU-GM and further differentiated to unipotential progenitor ex. CFU-Eo; CFU-G; CFU-M; CFU-baso

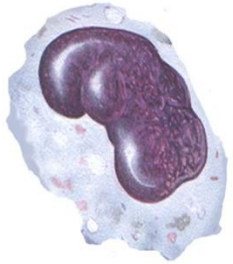


STAGES OF GRANULOPOIESIS





Blood Cells



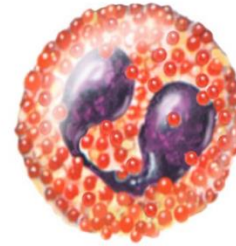
Monocyte



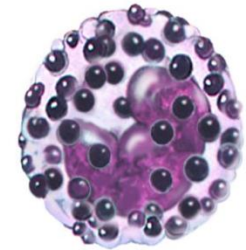
Lymphocyte



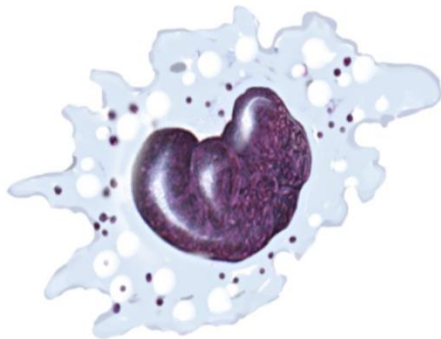
Neutrophil



Eosinophil



Basophil



Macrophage



Erythrocyte



Platelets

NORMAL HEMATOLOGICAL PARAMETERS

1. Complete blood count

| PARAMETER | NORMAL ADULT | COMMENTS |
|------------------------------|--|--|
| HB - Hemoglobin | Male= 15.5 +/- 2mg/dl Female = 13.5 +/- 2 | Low = Anemia High = Polycythemia |
| HCT - Hematocrit | Male= 46.0 +/- 6% Female= 41.0 +/- 6% | = = |
| RBC-Red Blood cell count | Male = 4.3-5.9 Million/uL Cell Count Female= 4.0 - 5.2 | = = |
| WBC - White Blood Cell Count | 4.5-11K/uL | Low = Leukopenia High = Leukocytosis |
| Platelet Count | 150 - 400 K cell/uL | Low =Thrombocytopenia High = Thrombocytosis |
| Retic - Reticulocyte Count | 0.5 - 1.5 % 25 - 85 K cell/ul | Low in anemia = low High = RBC loss |

2.Red cell indices

| | <i>At birth</i> | <i>Men</i> | <i>Women</i> |
|-------------------------|-----------------|-------------|--------------|
| Red cell indices | | | |
| MCV | 100-120 fL | 82-100 fL | 82-100 fL |
| MCH | 31-37 pg | 27-32 pg | 27-32 pg |
| MCHC | 30-36 gm/dL | 31-35 gm/dL | 31-35 gm/dL |
| RDW | 13-18% | 11.5-14.0% | 11.5-14.0% |



| Test Name | Result | Reference value |
|----------------------|----------|----------------------------------|
| Hematology | | |
| RBC (Erythrocytes) | * H 6.26 | 4.06 - 5.30 10 ⁶ /uL |
| HCT(Haematocrit) | 38.9 | 38 - 52 % |
| HGB (Hemoglobin) | 12.3 | 12.0 - 16.0 g/dL |
| MCV | * L 62.1 | 76 - 96 fL |
| MCH | * L 19.6 | 26 - 32 pg |
| MCHC | * L 31.6 | 32 - 36 g/dL |
| RDW-SD | * L 31.6 | 37 - 54 fL |
| RDW-CV | * H 15.6 | 11.5 - 14.5 % |
| WBC (Leukocyte) | 7.50 | 3.70 - 11.00 10 ³ /uL |
| NEU% | 66.4 | 39.3 - 73.7 % |
| NEU# | 4.98 | 1.63 - 6.96 10 ³ /uL |
| LYM% | 22.3 | 18 - 45.3 % |
| LYM# | 1.67 | 1.09 - 2.99 10 ³ /uL |
| MON% | * H 9.3 | 2 - 8 % |
| MON# | 0.70 | 0.240 - 0.79 10 ³ /uL |
| EOS% | 1.7 | .7 - 6 % |
| EOS# | 0.13 | .03 - .44 10 ³ /uL |
| BASO% | 0.3 | 0.0 - 1.70 % |
| BASO# | 0.02 | 0.0 - 1 10 ³ /uL |
| PLT (Platelet Count) | 325 | 155 - 450 10 ³ /uL |
| MPV | 10.4 | 6.9 - 10.6 fL |
| PDW | 12.5 | 9 - 17 fL |
| PCT | 0.34 | 0.17 - 0.35 % |
| P-LCR | 29.6 | 13 - 43 % |

