BLOOD INDICES

① Mean corpuscular volume (MCV)
avg vol of single RBC.

$$MCV = \frac{PCV \text{ in } 100mL \text{ blood} \times 10}{RBC \text{ count}}$$

normally, $\frac{45 \times 10}{5} = 90fL$

Normal value : 78 - 96 fL → NORMOCYTE
< 78 : microcyte
> 100 : macrocyte

② Mean corpuscular ~~Vol~~ Haemoglobin (MCH).
Avg wt of Hb contained in each RBC

$$MCH = \frac{Hb\ (g/dL) \times 10}{RBC}$$

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Normal rate : 27-33 pg

< 25 → hypochromic

eg Iron deficiency anaemia

→ increased in Megaloblastic anaemia and spherocytosis.

(3) Mean corpuscular Haemoglobin conc (MCHC)

amnt of Hb expressed as % of vol of RBC

% conc of Hb in single cell

$$MCHC = \frac{Hb\ g\% \times 100}{PCV\ in\ 100mL}$$

normal value

: 33-37 %

decreased - called hypochromia

osmotic pressure.

VVIMP

* ERYTHROPOESIS ** 10 mark

HAEMATOPOESIS / HAEMOPOESIS

formation of blood cells

RBC - erythropoeisis

WBC - leucopoesis

platelets - thrombopoesis.

10 marks : exp, site, stage, diagram, R

ERYTHROPOESIS

Entire process by which RBC are formed in body

SITE :

In the intra Uterine life :

from 3rd week to 8 months : 1st trimester

i) Mesoplastic phase - takes place in mesoderm of ~~[illegible]~~ yolk sac
Intra vascular erythropoesis.

ii) Hepatic phase
2nd trimester : takes place in liver and spleen

iii) last trimester in the bone marrow called Myeloid phase
- Medullary erythropoesis.

After birth : In red bone marrow only

upto 5 years of age - all marrow is red
after 5 years red marrow decrease and yellow marrow increase.
after 20, restricted to axial skeleton which include sternum, ribs, pectoral girdl skull, vertebrae and also proxima end of long bones. like humerus and femur.

STAGES

① Pleuripotent Hematopoetic stem cell (PHSC)
→ self renewed
→ can differentiate into progenital c
→ uncommited stem cells → differentiate to form committed ste cells / progental cells

2) Committed stem cells / Progenital
a) lymphoid progenital cells form lymphocytes.
b) Myeloid cells form RBCs & rest of WBCs: also called colony forming unit stem cells. again differentiate to form colony forming unit erythrocyte

PHSC
↓
Progenital
↓
CFU-E
↓
Blast cell

Promonomoblast / Proerythroblast
early normo-blast / erythrophilic
intermediate normoblast / poly chromatic erythroblast

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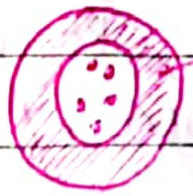
Last → late normoblast / ortho chromatic erythroblast

Blast cell form mature cell - two type

① reticulocyte
② Mature RBC

PRONORMOBLAST

1st identifiable cell of erythrocyte
large round cell ~~650~~ 15-20μm
large nucleus with multiple nucleoli
a thin ring of basophilic cytoplasm
haemoglobin is absent
Mitosis is present



2) EARLY NORMOBLAST / BASOPHILIC ERYTHROBLAST

12-16 µm

→ Nucleus is slightly smaller
→ nucleoli is absent
→ scant basophilic cytoplasm.
→ Hb is absent
→ Mitosis is present

3) INTERMEDIATE NORMOBLAST / POLY CHROMATIC ERYTHROBLAST

size : 10-14 µm

Nucleus is cart wheel appearance

cytoplasm is both basophilic & eosinic both blue & pink hence called poly chromatic erythroblast.

* Haemoglobin ist appears in intermediate normoblast

x Mitosis absent.

LATE NORMOBLAST / ORTHO CHROMATIC ERYTHROBLAST

Size : 8-12 μm size.

Nucleus is very small shrunken (pyknotic), eccentric and sometimes may be excluded out.

* cytoplasm is acidophilic (pink)
* Hb content increases.
* Mitosis is absent

last nucleated cell of erythroid series

RETICULOCYTE

flat disc shaped cells.

slightly larger than mature RBC

size 8 μm

immediate precursor of RBC

cytoplasm shows small amount of RNA

Nucleus is absent Hb content increases

On supra vital staining with brilliant cresyl blue - it shows deep blue reticulum of RNA.
Remnants of disintegrated Organelles.

1mark

MATURATION OF RETICULOCYTE

After forming the reticulocyte it remains in the bone marrow for one day and then it enters into peripheral blood
total maturation of reticulocyte takes 2 days.
only RBC precursor found in the peripheral blood normally.
reticulocyte count: 0.5-2 % of RBC count.
~~MATURE RBC~~ infants: 2-6 %.

Causes of reticulocytosis - increase in reticulocyte count

- haemolytic anaemia
- treatment of deficiency anaemia
- high altitude

reticulocytopenia - decrease in count
- aplastic anaemia.

MATURE ERYTHROCYTE

Biconcave disc shaped cell with central pallor
size : 7.3 - 7.5 µm
colour of cytoplasm - deeply acidophilic

duration of erythropoesis → 7 days
5 days till reticulocyte [1 day in bone marrow 7 two days to convert to mature RBC.

SA QN

Short

REGULATION OF ERYTHROPOESIS

A) Hormonal factors:

a) Erythropoetin
b) Interleukins of GM-CSF
c) Androgens
d) Oestrogens
e) thysoxinsine, cortisol, growth hormone

B) Dietary factors

a) Iron
b) Vitamin B12
c) Folic acid
d) Protein
e) Copper, cobalt, Vit C.

C) OTHER FACTORS

a) Intrinsic factor of castle
b) hypoxia (envt. factors - high altitude)

A) Hormonal factor

*+ a) Erythro Poetin

It's a glycoprotein

→ 85% of erythropoitin produced from interstitial cells of peritubular capillaries of kidney & from JG cells

→ 15% produced from liver.

IMP:- [MOST POTENT STIMULUS FOR ERYTHROPOETIN SECRETION is HYPOXIA]

Mechanism of action.

* stimulates conversion of haematopoitic
* stem cells to promormoblast
* Incease Hb synthesis
* promote every stage of maturation
* Stimulates release of RBC frm bone marrow to circulation.

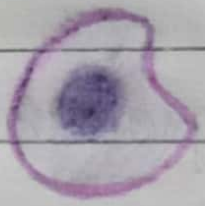
FACTORS INCREASING ERYTHROPOETIN SYNTHESIS :

1. Degree of tissue oxygenation & RBC circulation.
2. Androgens, thyroxin, growth hormone, ACTH
3. Products of RBC breakdown
4. Nucleotides : Cyclic AMP, NAD
5. Vasoconstrictor drugs

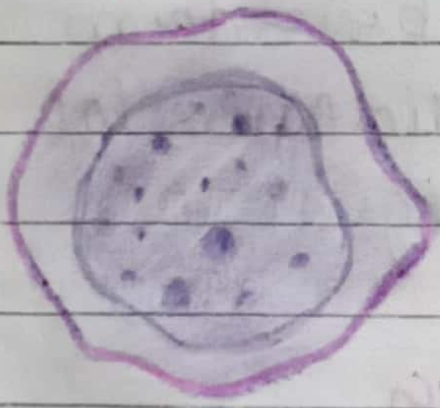
FACTORS DECREASING

1. Estrogen
2. Liver failure, renal failure

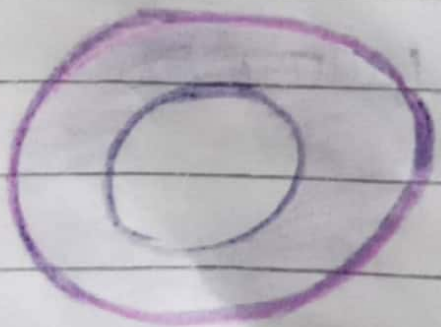
HEMATOPOETIC STEM CELL



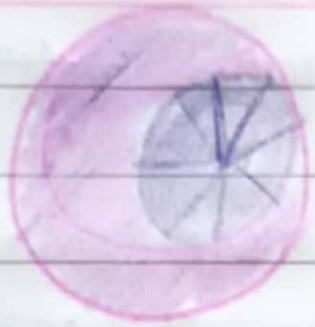
COMMITTED STEM CELL



PRONORMOBLAST (15-20 Mm)

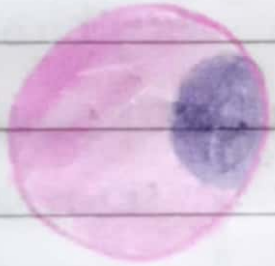


EARLY NORMOBLAST
(12-16 Mm)



INTERMEDIATE NORMOBLAST
[10-15 Mm]

↓



LATE NORMOBLAST
8-12 Mm .

↓

RETICULOCYTE
8Mm

↓

MATURE RBC
7.3-7.5 Mm

Other hormonal factors ~~& GMCSF stimulates~~

→ Interleukins & GM CSF stimulate production of committed stem cells

→ Androgens → stimulate erythropoesis
estrogen → inhibit erythropoesis
thyroxine, cortesol & GH → stimulate erythropoesis.
∴, females have low RBC count & Hb

DIETARY FACTOR

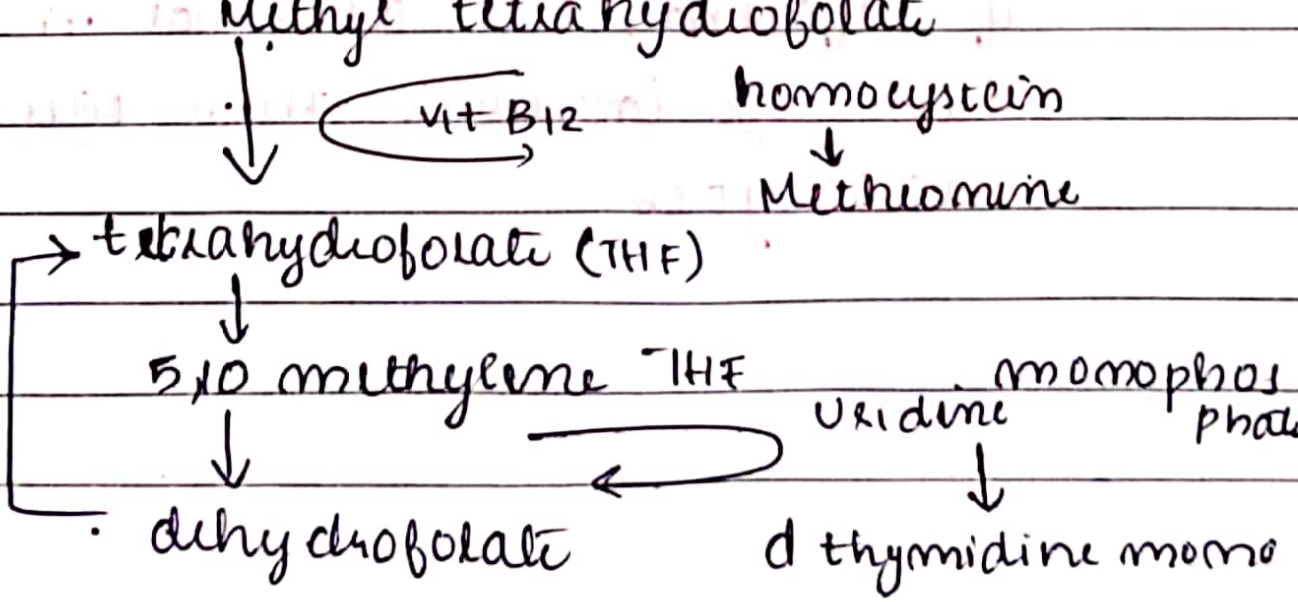
- IRON : raw material for haem part of Hb
- Vit B_{12} (Cyanocobalamin)
  sources : milk, meat, animal liver, bacterial flora of intestine
- Absorption : from terminal ileum using intrinsic factor of castle

secreted by parietal cells of stomach
transported by transcobalamin II
actions: DNA synthesis, cell & nucleus maturation.
deficiency: perinicious / megaloblastic anaemia

perinicious anaemia is a type of megaloblastic due to intrinsic factor deficiency

- Folic acid :

Sources: leafy vegetable, yeast, pulses, liver
actions: DNA synthesis, RBC maturation
plasma form - methyl tetrahydrofolate
deficiency: megaloblastic anaemia.



- Proteins : for synthesis of globin part of Hb
- Vit C - helps in absorption of iron
- copper & cobalt - influence Hb formation

* Megaloblastic anaemia is usually seen in vegetarian. due to Vit B_{12} has mainly non veg components as sources.
(clinical case)

* Vit B_{12} is required for cell maturation if deficient, cell does not mature, then size increases then cause macrocytes.

HAEMOGLOBIN

* Red coloured O_2 binding pigment
conjugated protein with MW 65000
Normal Hb count : Male : 14-18 g/dL of blood
female : 12-16 g/dL of blood
infant - 16-22 g/dL blood.

Heme
iron porphyrin complex - IRON ~~PORP~~
PROTOP.
iron present in form of ferrous.

GLOBIN
1 mark
2 pairs of poly peptide chain
$\alpha, \beta, \gamma, \Delta$ chains
Normal adult (HbA)

VARIANTS OF Hb

1mark Fetal Haemoglobin has 2α 2γ chain
Special feature: higher affinity to oxygen:

FATE OF RBC

1mark Life span of RBC - 120days
1mark graveyard of RBC - spleen

By

ANAEMIA (CLINICAL SA)

VVIMP defined as a condition in which Hb concentration of blood or the RBC count is below the normal range for the age & sex of the subject
Male - <13g/dL
Female - <12g/dL
Newborn - <15g/dL

depending on level of Hb

Mild - 9-11 g/dL

Moderate - 7-9 g/dL

Severe - < 7 g/dL

CLINICAL

→ pallor skin & mucous membrane - palpebral conjunctiva

→ tissue hypoxia → tiredness, easy fatiguability, muscle weakness

→ CVS : palpitation, tachycardia, cardiac murmurs

→ Respiratory : breathlessness, tachypnoea

→ CNS : lethargy, headache, confusion drowsiness.

→ Ocular : visual disturbance, cotton wool spot

→ GI : anorexia, constipation

↓

No hunger.

→ Reproductive system : amenorrhea

CLASSIFICATION

Etiological classification (Whitbys)

Morphological classification (Wintrobe

ETIOLOGICAL CLASSIFICATION.

1. Increased destruction of RBCs - Haemolytic anaemia
2. Defective formation of RBC
3. Blood loss - Hemorrhagic anemia.

HAEMOLYTIC ANEMIA.

Intracorpuscular defects :

1. RBC membrane defect - Spherocytosis
2. Disorders of glycolysis - G6PD deficiency
3. Globin chain defects - sickle cell anemia, Thalassemia

Extracorpuscular defects:
Incompatible transfusion., malaria, snake venom, drugs, Autoimmune hemolytic anemia.

2 Defective formation of RBC
- deficiency anemias: iron; folic acid, B12, B6, Cu, Co
- defective absorption: intrinsic factor, Vit C difiiency
- APlastic anemia: bone marrow atropy - drugs, cancers, radiation
- Anaemia due to chronic disorder Chronic renal disease.

3 Hemorrhagic anemia
Acute: RTA, childbirth
Chronic: hookworm ~~flatu~~

infestation, bleeding ulcer etc

MORPHOLOGICAL CLASSIFICATION

- Normocytic normochromic
  acute hemorrhage, aplastic anemia
- Microcytic hypochromic
  iron deficiency anemia, thalassemia, chronic hemorrhagic anemia.
- Macrocytic normochromic
  Megaloblastic anaemia
  (B12, folate deficiency