

In the name of God

Presenting by F .Malek
Assistant Professor of Mofid children's Hospital

Scope of Pediatric Hematology

- Introduction (1)
- Red Cells
 - Anemias of Inadequate Production (2)
 - Hemolytic anemia (3)
 - Thalassaemia (4)
- Platelets (5) and Coagulation (5)
- White cells and other topics (6)
- Pediatric oncology (7)

THE COMPLETE BLOOD COUNT

WBC
RBC
Hb
Hct
MCV
MCH
MCHC
RDW
Platelet

(1)

- Hb = Hct/3 45/3 = 15
- MCV ?
- Hct/RBC X10 = fl 45/5X10 = 90 fl
- MCH ?
- Hb/RBCX10 = pg 15/5X10 = 30pg
- MCHC ?
- Hb/Hct X100 = g% 15/45 X100 = 33 g%

(1)

- **MCV :**
- Embryonic period = 180fl
- Newborn = 110 ± 10 fl
- 3M = 90fl
- 6M - 6y = 70 – 75 fl
- 6y - 12y = 75 – 80 fl
- >12y = 80 – 100fl

(1)

- **MCH**
- (27 – 32) pg
- **MCHC**
- (32 – 36) g%

(2)

6y girl

- WBC 15000 / μ l (PMN 40% , Band 5% ,lymph 30% , Eos 15% ,mono 10%)
 - RBC 4200000
 - Hgb 13.2g%
 - Hct 40%
 - MCV 78fl
 - MCH 29pg
 - MCHC 33g%
 - RDW 14 %
 - Platelet count 450000 / μ l
- ANC = ?
- AEC = ?

(2)

- ANC
- $(\text{PMN} + \text{band}) \times \text{WBC} / 100$
- $(40 + 5) \times 15000 / 100 = 6750$
- AEC
- $15 \times 15000 / 100 = 2250$
- ALC
- $30 \times 15000 / 100 = 4500$

(2)

- leukocytosis
- Leukopenia
- Neutrophilia
- Neutopenia
- Eosinophilia(%Ref. Range 0.0 - 8.0,AEC 30 – 600)
- Lymphocytosis (adults, ALC>4000 in older children >7000 infants >9000)
- Lymphopenia (adults<1500 , children<3000)
- Monocytosis(Ref. Range 0.0 - 13.0,AMC 40-900)
- Basophilia(%Ref. Range 0.0 - 2.0, ABC Range 40 – 900)

Hematologic Values During infancy and Childhood

Age	Hb Gr/dl	HCT	Retic %	MCV	WBC /mm ³	N %	L %
Cord	16.8	55	5	110	18 000	61	31
2 wk	16.5	50	1		12 000	40	63
3 mo	12 (9.5 – 14.5)	36	1		12 000	30	48
½ – 6 yr	12 (10.5 – 14)	37	1	70-74	10 000	45	48
7-12 yr	13	38	1	76-80	8 000	55	38
Adult female	14	42	1.6	80	7 500	55 (35- 70)	35
Adult male	16	47		80			

Definition of Anaemia

Hemoglobin level below the normal range for
the age and sex

- Neonate < 14 gr/dl
 - 1-12 months < 10 gr/dl
 - 1-12 years < 11gr/dl
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- Hemoglobin at birth – cord blood = 16-18 gr/dl
 - 24-48 hour of age – Increase due to hemoconcentration
 - 3 months of age - Drop up to 9.5 – 11 gr/dl

Causes of Anemia

- Impaired Production of RBC
 - Red Cell Aplasia
 - Ineffective erythropoiesis
- Increased Destruction of RBC
 - Intra corpuscular
 - Extra corpuscular
- Blood Loss (overt or apparent)
 - Internal
 - External

Increased Destruction of RBC

- Intra corpuscular

- Membrane
- Enzyme
- Hemoglobin

- Extra corpuscular

- Autoimmune
- Fragmentation
- Hyper spleenism
- Plasma factors

Causes of Blood Loss

- Intra uterine
 - Feto-maternal bleeding
 - Feto-fetal bleeding
- Chronic gastrointestinal blood loss
 - Meckel's diverticulum,
 - GOR
 - Peptic ulcer disease
 - Hook worm manifestation
- Inherited bleeding disorders - von Willebrand's disease
- Chronic hematuria

Clinical approach to a child with anemia

1. History and Examination
2. First Line Investigations
3. Second Line Investigations

Clinical approach to a child with anemia – History and Examination

- Family History
- Evidence bleeding (overt and hook worm, urine)
- Evidence of hemolysis (Jaundice, pallor)
- Involvement of other cell line (petechia, infections)
- Dysmorphic features

HPLC – High Performance Liquid Chromatography (Hb electrophoresis can be used)

1. Beta Thalassaemia major – Only Hb F present
2. Alpha Thalassaemia – HPLC normal
3. Beta Thalassaemia trait – Increased HbA₂
4. Sickle disease – HbS – No HbA present

Anemia of Inadequate Production

- Congenital Hypoplastic Anemia (Diamond - Blackfan)
- Pearson Marrow – Pancrease syndrome
- Acquired Pure Red Blood Cell Anemia
- Anemia of chronic Disorders and renal disease
- Congenital Dyserythropoietic Anemias
- Physiologic anemia of infancy
- Megaloblastic anemia
- Iron deficiency anemia

Clinical feature in history	Relevance
Family history of inherited anaemia	Consider Thalassemia, Hereditary Spherocytosis
Birth weight maturity, iron supplement	Anaemia of prematurity . Iron deficiency anaemia
Dark urine	Intra vascular Hemolysis , hematuria
History of bleeding rectal , vomiting, hematuria	Anaemia due to blood loss
Dietetic history	Nutritional anaemia
Jaundice	Hemolytic anemia
Bruises and echymosis	Evidence of low platelets
Recurrent infections	Involvement of white cell line
Drinking drugs	Bone marrow suppression
General ill health, bone pain and fever	Leukemia

Investigation	Relevance
Hb	Establish base line Hb, consider need for transfusion
Reticulocyte count	Low count – bone marrow failure High count – Hemolysis or treated iron deficiency Normal count – deficiency anaemia
Full blood count	Involvement of other cell lines - Aplastic anaemia Abnormal cells - leukemia
Serum bilirubin	Increase – Hemolysis
Blood picture	Leukemia, Categorize Microcytic, Normocytic and Macrocytic Red cell morphology
HPLC or Hb Electrophoresis	To establish diagnosis in Thalassaemia
Bone marrow biopsy	Aplastic anaemia, leukemia
G-6-PD assay	
Osmotic fragility test	

switch from HbF to HbA

— switch from HbF to HbA

- HbF decreases about 3% per week
- at 6 mo. HbF represents only 2% of total Hb
- switch to HbA provides for greater **unloading of oxygen to tissues** d/t lower oxygen affinity of HbA relative to HbF.

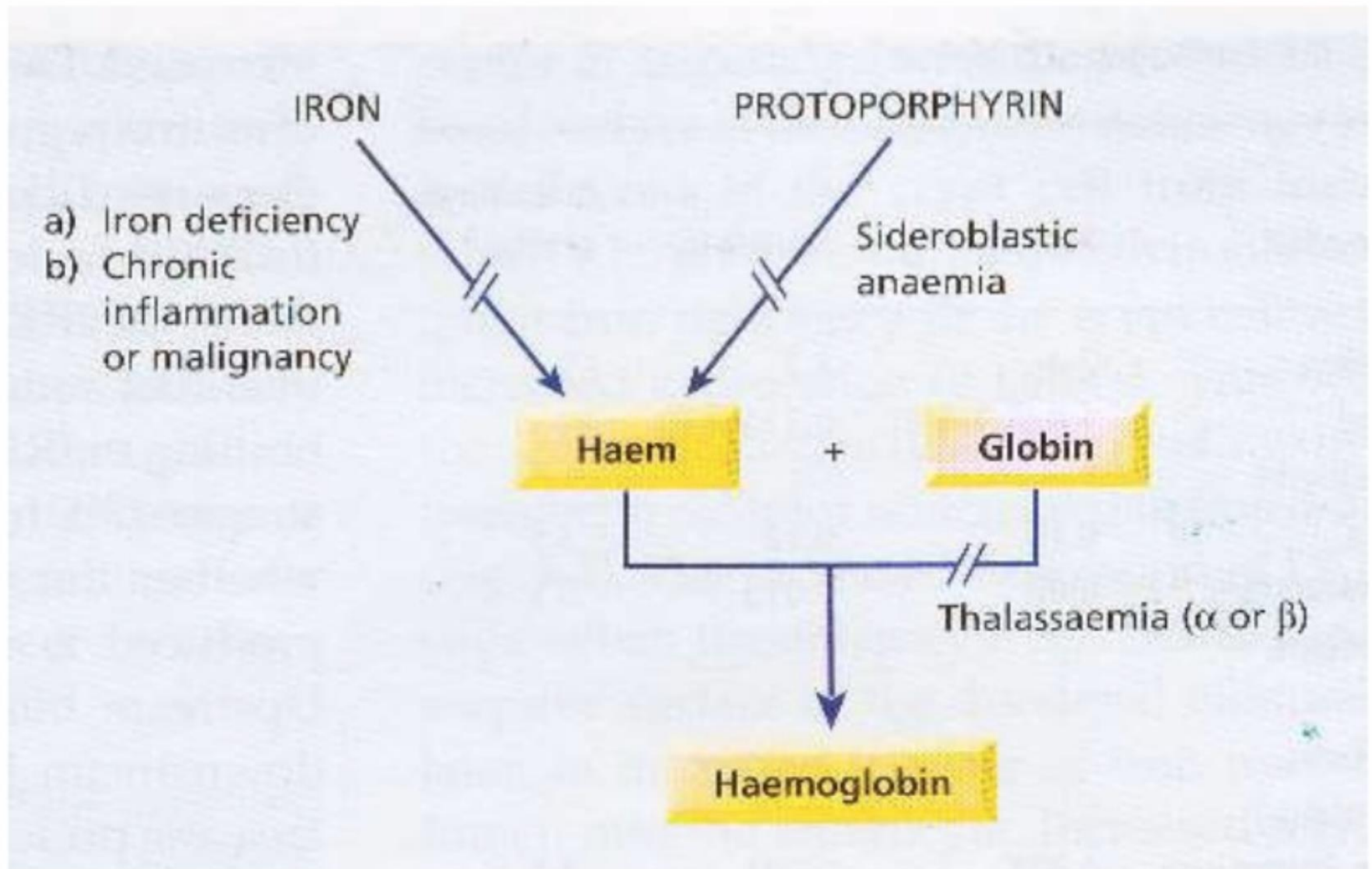
— seldom produces symptoms

— not altered by nutritional supplements.

FACTORS REGULATING HEMOPOIESIS

- **(RBCs).**
IRON ,“TISSUE O₂” & ERYTHROPOIETIN.
- **Thrombopoietin → (platelets) .**
- **. Cytokines → WBCs:-**
e,g (G- CSF: granulocyte colony-stimulating factor).
- **B12&folic acide for all cells .**

The causes of a hypochromic microcytic anaemia.



Juvenile red cells

Reticulocyte Count

- Reticulocytes are young or juvenile red cells released from the bone marrow into the bloodstream .
- Reticulocyte count is performed to assess erythropoietic activity of the bone marrow .

-REFERENCE RANGES

- Reticulocyte percentage: 0.5-2.5%
- Absolute reticulocyte count: 50,000-85,000 / cmm .

In the Neonates, Count is 2 – 6/Cu.mm.

Falls to <1 in the first week of life.

corrected reticulocyte count or Reticulocyte Production

Index (RPI)

- Maturation of reticulocytes to erythrocytes takes 24-48 hours.
- indicates whether the bone marrow is responding appropriately to the anemia.
- The corrected “retic count” should be elevated if the bone marrow is working properly and has all the right nutrients for making RBCs, including iron, folate, and vitamin B12.
 - an **RPI > 3** suggests increased production and implies either hemolysis or blood loss.
 - an **RPI < 2** suggests decreased production or ineffective production for the degree of anemia.

$$\text{Corrected Retic Percentage} = \text{Retic Percentage} * \frac{\text{Hematocrit}}{\text{Normal Hematocrit}}$$

