

# Definition of anaemia

- ▶ The condition of having too few red blood cells.
- ▶ It is a reduction of the red cell volume or hemoglobin concentration below  $-2SD$  for age, race and sex.
- ▶ Microscopic:

normocytic, microcytic, normochromic  
macrocytic or specific abnormalities  
(spherocyte, sickle cell, target cell)

# Functional Anemia:

No Anemia (with definition of anemia)

Oxygen delivery to tissues are decreased

CHD , Mutant Hemoglobins

# Symptoms of Anemia

**Nonspecific and reflect tissue hypoxia:**

Fatigue

Dyspnea on exertion

Palpitations

Headache

Confusion, decreased mental acuity

Skin pallor



# Age:

**Neonate:** Recent blood loss , Isoimmunisation , Congenital infection, Congenital hemolytic anemia

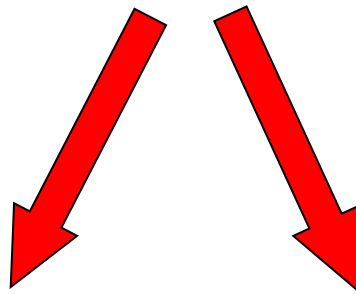
**3–6 months:** Hb synthesis or structure

**4–7 months:** Folate deficiency

**9–24 months:** IDA

Nutritional IDA never in term infant prior to 6 months

# Anemia?



**Production?**

**Survival/Destruction?**

**The key test is the .....**

# The First Laboratory Examination for Approach to Anemia:

CBC(RBC indices)

PBS(Peripheral Blood Smear)

Reticulocyte Count



# COMPLETE BLOOD COUNT

- ▶ Hb Conc (g/dl)
- ▶ H e m a t o c r i t ( P C V )
- ▶ MCV (fl)
- ▶ MCH (pg)
- ▶ MCHC (detects red cell dehydration)
- ▶ RBC Count (...x10 )
- ▶ WbC Count (...x10 )
- ▶ Platelet Count (...x10 )
- ▶ Reticulocyte Count ( % )



# Normal values

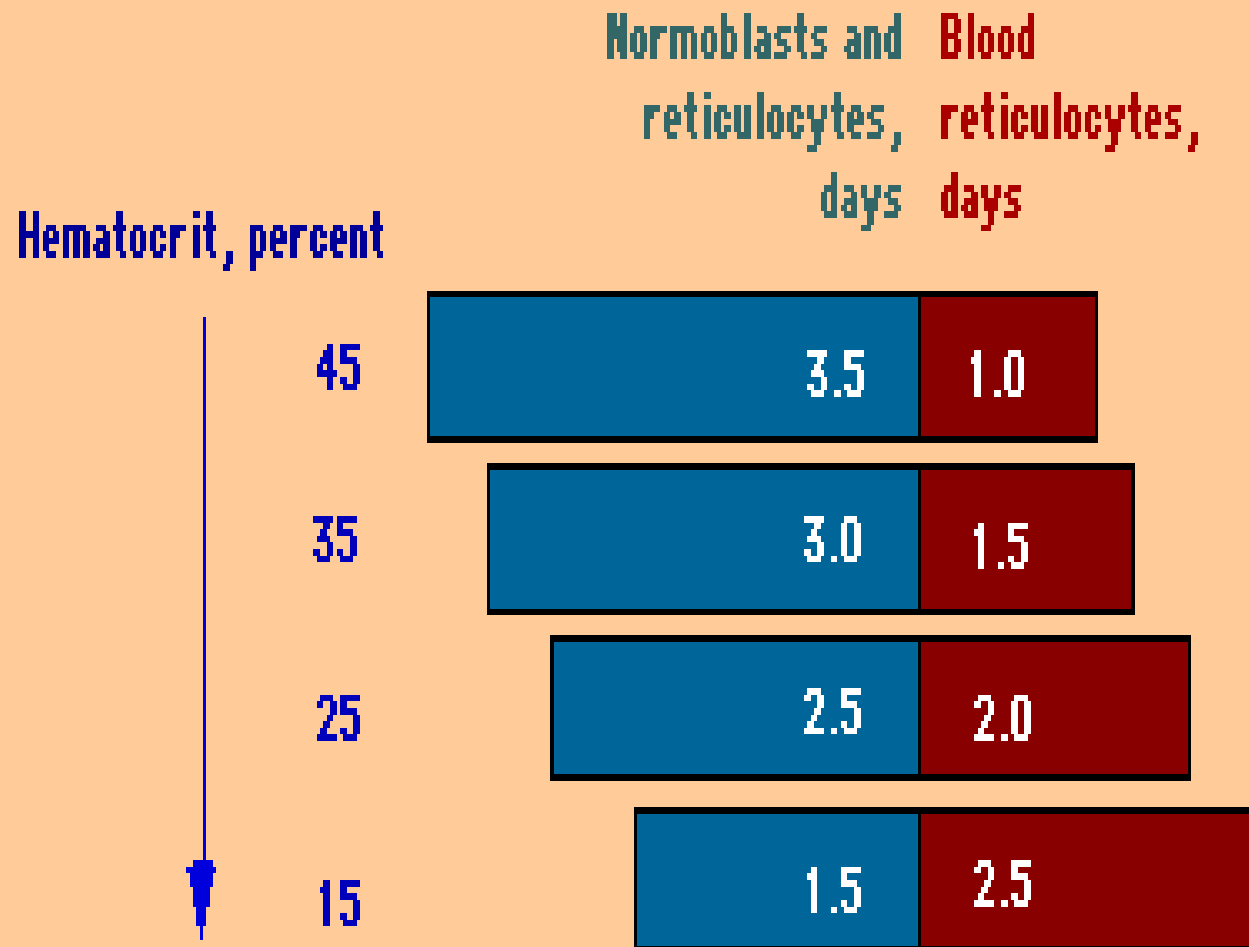
<b>AGE</b>	<b>Hgb Mean/ (-2SD)</b>	<b>HCT% Mean/ (-2SD)</b>	<b>MCV Mean/ (-2SD)</b>
<b>Newborn</b>	16.5 (13.5)	51 (42)	108 (96)
<b>1 Month</b>	13.9 (10.7)	44 (33)	101 (91)
<b>2 Months</b>	11.2 (9.4)	35 (28)	95 (84)
<b>6 Months</b>	12.6 (11.0)	36 (31)	76 (68)
<b>&gt; 6 Months</b>	12.5 (11.0)	36 (33)	81 (70+ age per yr)
<b>Adult</b>	15.5 (13.5)	47 (40)	90 (80)
<b>Male</b>	14.0 (12.0)	41 (36)	90 (80)
<b>Female</b>			

# The reticulocyte count (kinetic approach)

- ▶ Increased reticulocytes (greater than 2–3% or 100,000/mm<sup>3</sup> total) are seen in blood loss and hemolytic processes, although up to 25% of hemolytic anemias will present with a normal reticulocyte count due to immune destruction of red cell precursors.
- ▶ Retic counts are most helpful if extremely low (<0.1%) or greater than 3% (100,000/mm<sup>3</sup> total).

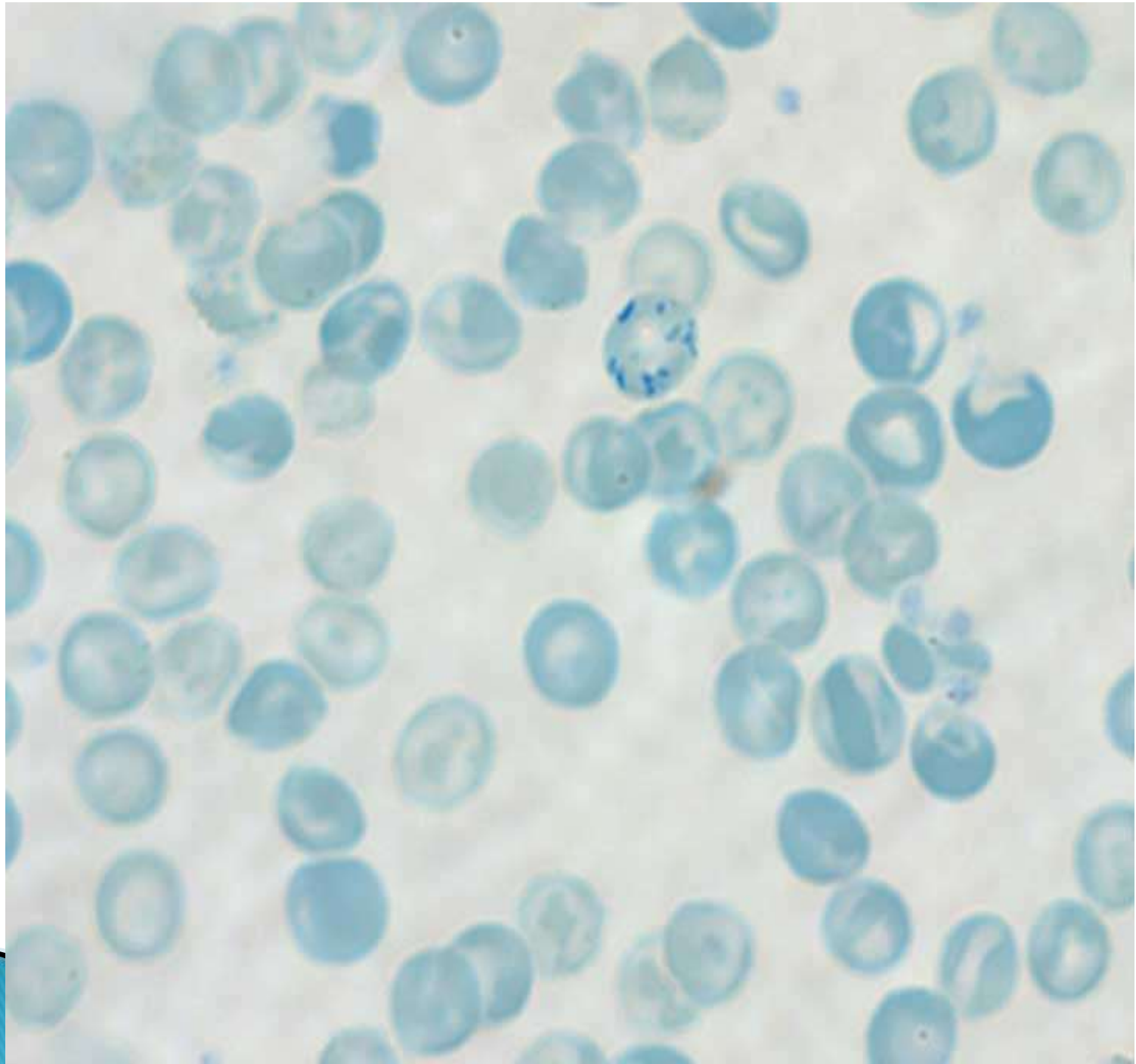
# The reticulocyte count

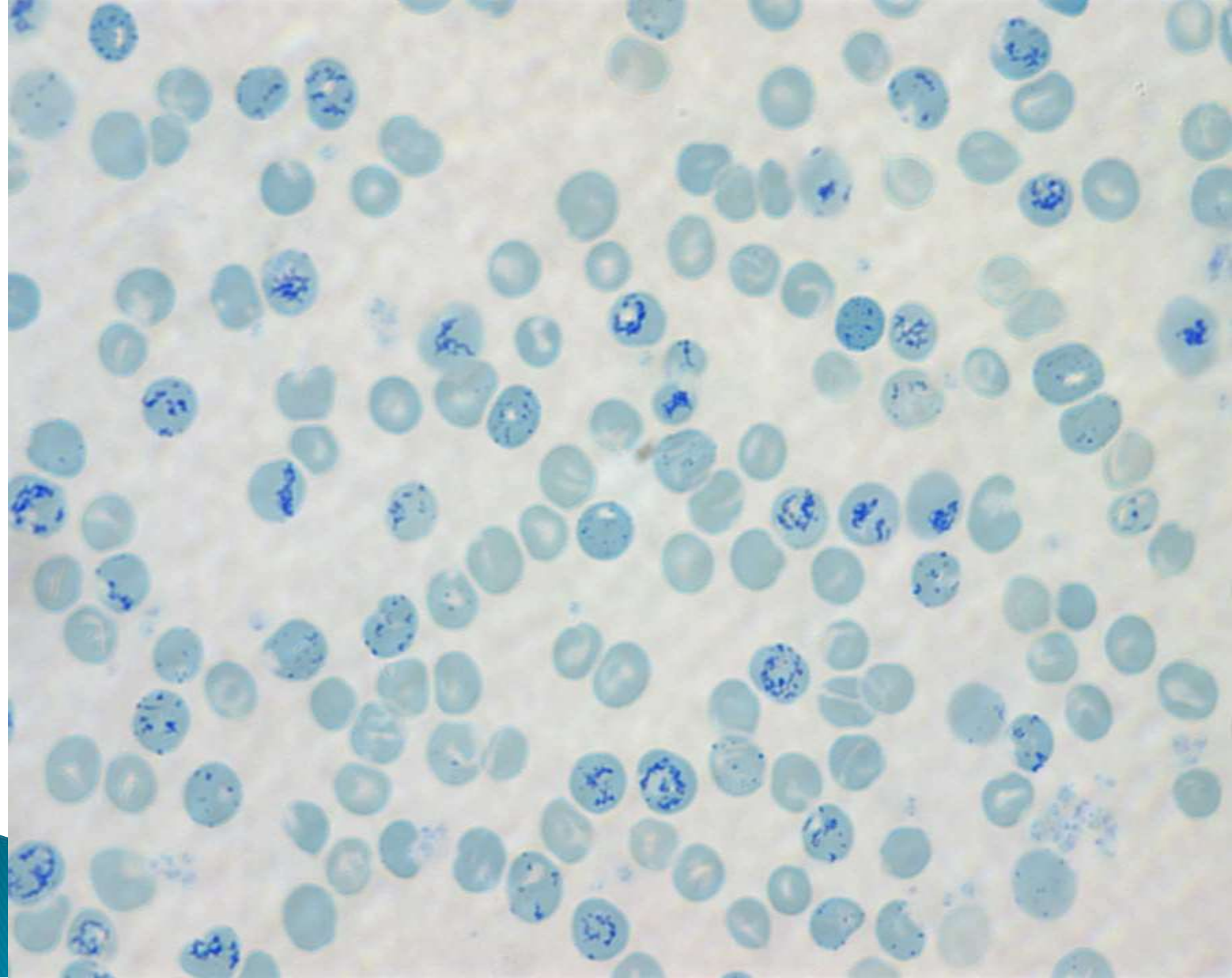
- ▶ To be useful the reticulocyte count must be adjusted for the patient's hematocrit. Also when the hematocrit is lower reticulocytes are released earlier from the marrow so one can adjust for this phenomenon. Thus:
- ▶  $\text{Corrected retic.} = \text{Patients retic.} \times (\text{Patients Hct} / 45)$
- ▶  $\text{Reticulocyte index (RPI)} = \text{corrected retic. count} / \text{Maturation time}$   
(Maturation time = 1 for Hct=45%, 1.5 for 35%, 2 for 25%, and 2.5 for 15%.)
- ▶  $\text{Absolute reticulocyte count} = \text{retic} \times \text{RBC number.}$



# Reticulocyte Production Index

- ▶ RPI corrects the retics for the degree of anaemia
- ▶ RPI indicates whether bone marrow is responding appropriately to anaemia
- ▶  $RPI = \text{Retic} \times \text{Hb(o)} \times \text{divided by Hb(n)} \times 1 / \mu$
- ▶  $RPI > 3$  increased production (hemolysis or blood loss)
- ▶  $RPI < 2$  decreased production or ineffective production for the degree of anaemia
- ▶ Reticulocytopenia—acute onset of anaemia, antibody mediated destruction, BM disease

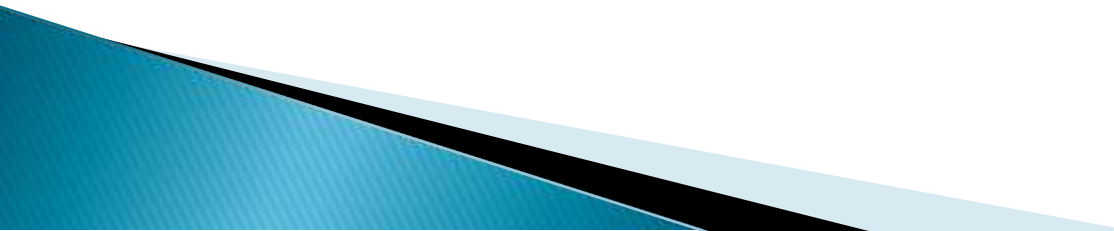






# Classification of Anemia:

Morphologic classification  
Physiologic classification  
Both category

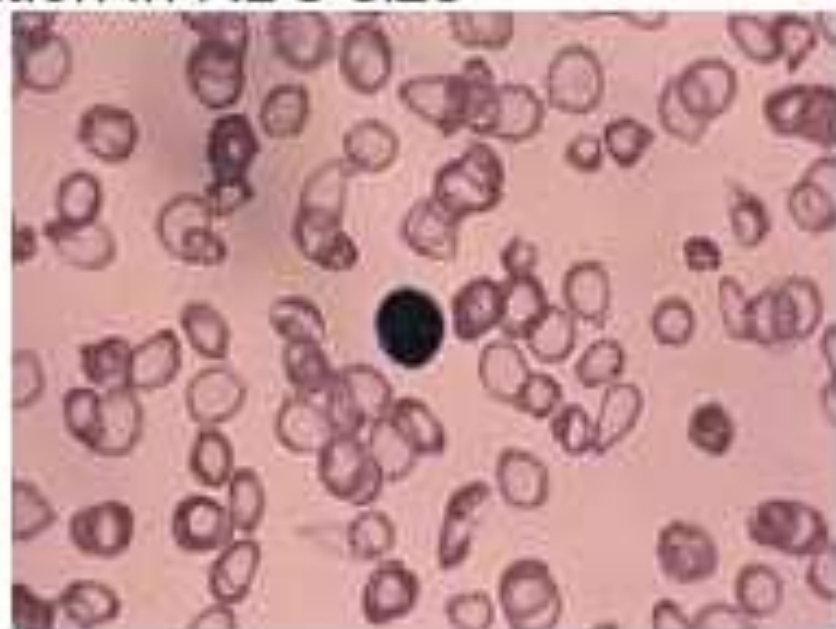




# Red Cell Indices MCV - RDW

MCV - Mean Corpuscular Volume 80 - 94 fl  
Low = Microcytosis High = Macrocytosis

RDW - Red Cell Distribution Width 11.5 - 14.5  
Variation in RBC size



Microcyte



Normal



Macrocytosis



Normal  
lymphocyte

# **Morphological Approach (big versus little)**

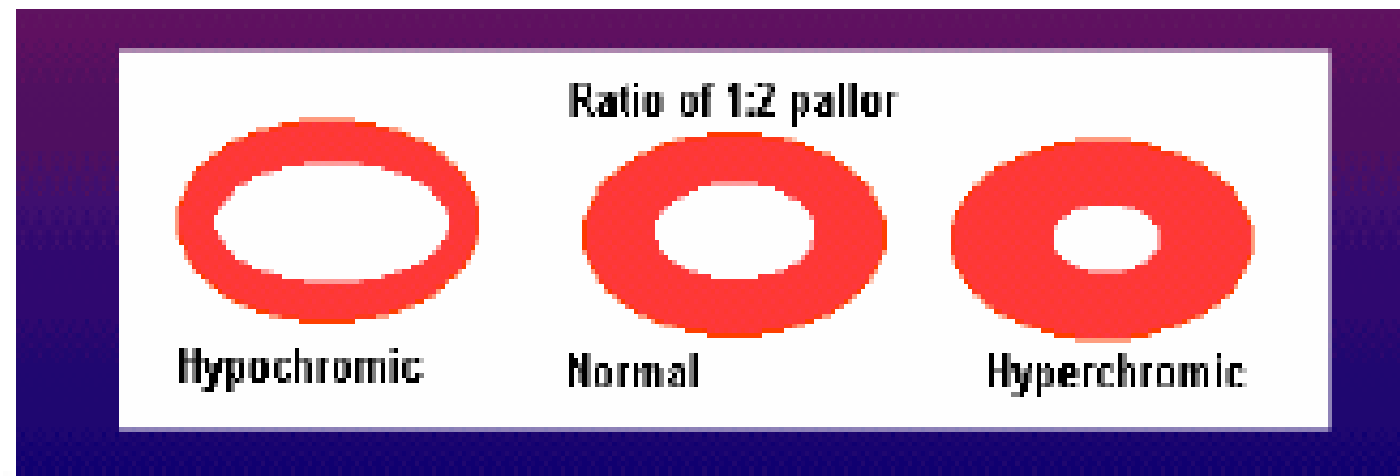
**First, measure the size of the RBCs:**

- **Use of volume-sensitive automated blood cell counters, such as the Coulter counter. The red cells pass through a small aperture and generate a signal directly proportional to their volume.**
- **Other automated counters measure red blood cell volume by means of techniques that measure refracted, diffracted, or scattered light**
- **By calculation from an independently-measured red blood cell count and hematocrit:**

$$\text{MCV (femtoliters)} = 10 \times \text{HCT(percent)} \div \text{RBC (millions}/\mu\text{L)}$$

# Red Cell Indices MCH, MCHC

MCH - Mean Corpuscular Hemoglobin	27 -32 pg	Low = Hypochromic High = Hyperchromic
MCHC - Mean Corpuscular Hemoglobin Concentration	30 - 36 gm/dl	Low = R/O Fe def. High = Spherocytosis



# Anemia Algorithm

- ▶ Patient with anemia and decreased reticulocyte count–

What is the MCV ??

Microcytic

Fe def. Thal

ther: sideroblastic anemia (meds, ID, alcohol excess, Cu def)

Normocytic

Systemic Diseases

Renal vs. Liver vs. Endocrine  
vs. Anemia of Inflammation

Diseases in Bone Marrow

- MDS
- Solid Tumor
- Myeloma
- Aplastic anemia

Macrocytic:

- Vitamin-related

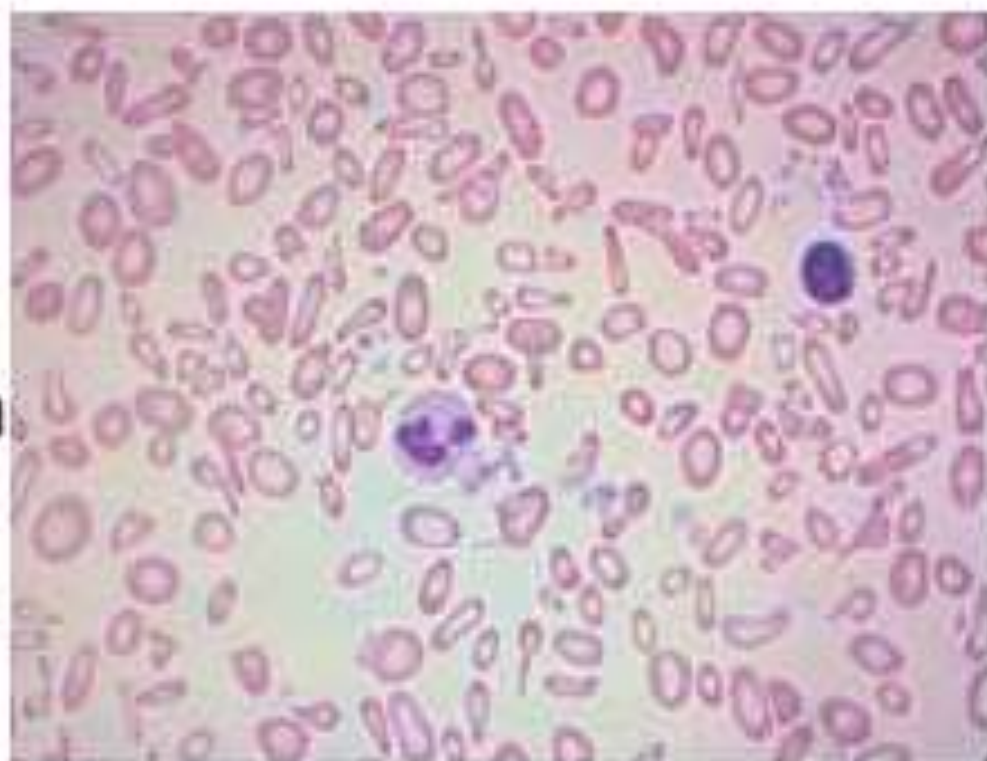
B<sub>12</sub>, Folate

- Non-vitamin:

- MDS
- EtOH/Liver Disease
- Hypothyroidism

# Microcytic

- MICROCYTIC = "TICS"
- T-Thalassemias
- I-Iron Deficiency
- C-Chronic Inflammation
- S-Sideroblastic - lead, drug, or hereditary





A. DISORDERS OF RED CELL PRODUCTION IN WHICH THE RATE OF RED CELL PRODUCTION IS LESS THAN EXPECTED FOR THE DEGREE OF ANEMIA:

1. Marrow failure:

a. Aplastic anemia:

Congenital

Acquired

b. Pure red cell aplasia:

Congenital:

Diamond-Blackfan syndrome

Aase's syndrome

Acquired:

Transient erythroblastopenia of childhood

Other

c. Marrow replacement:

Malignancies

Osteopetrosis

Myelofibrosis<sup>20</sup>:

Chronic renal disease<sup>21</sup>

Vitamin D deficiency<sup>22</sup>

d. Pancreatic insufficiency-marrow hypoplasia syndrome

2. Impaired erythropoietin production:

a. Chronic renal disease

b. Hypothyroidism, hypopituitarism

c. Chronic inflammation

d. Protein malnutrition

e. Hemoglobin mutants with decreased affinity for oxygen

## B. DISORDERS OF ERYTHROID MATURATION AND INEFFECTIVE ERYTHROPOIESIS:

1. Abnormalities of cytoplasmic maturation:
    - a. Iron deficiency
    - b. Thalassemia syndromes
    - c. Sideroblastic anemias
    - d. Lead poisoning
  2. Abnormalities of nuclear maturation
    - a. Vitamin B<sub>12</sub> deficiency
    - b. Folic acid deficiency
    - c. Thiamine-responsive megaloblastic anemia
    - d. Hereditary abnormalities in folate metabolism
    - e. Orotic aciduria
  3. Primary dyserythropoietic anemias (types I, II, III, IV)
  4. Erythropoietic protoporphyria
  5. Refractory sideroblastic anemia with vacuolization of marrow precursors and pancreatic dysfunction
- deficiency



## C. HEMOLYTIC ANEMIAS:

1. Defects of hemoglobin:
  - a. Structural mutants
  - b. Synthetic mutants (thalassemia syndromes)
2. Defects of the red cell membrane
3. Defects of red cell metabolism
4. Antibody-mediated
5. Mechanical injury to the erythrocyte
6. Thermal injury to the erythrocyte
7. Oxidant-induced red cell injury
8. Infectious agent-induced red cell injury
9. Paroxysmal nocturnal hemoglobinuria
10. Plasma-lipid-induced abnormalities of the red cell membrane



# Iron Deficiency Anemia (IDA)

# Introduction

**Most common hematologic disease of infancy and childhood**

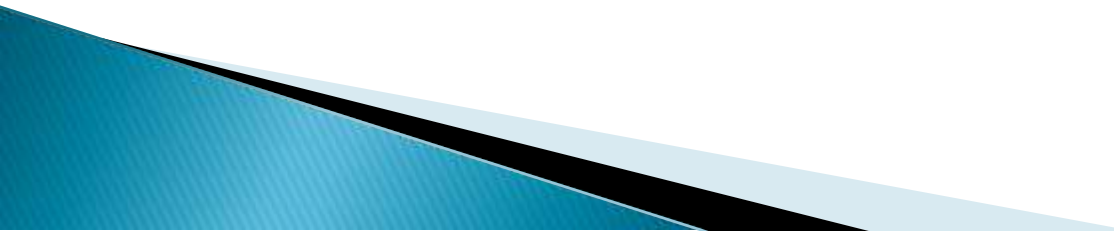
**Infants body contains 0.5 gr iron**

**Adult body contains 5 gr iron**

**4.5 gr iron should be absorbed during the first 15 yrs of life ▶**



# Susceptibility to IDA

- ▶ **Permaternity**
  - ▶ **Growth catch-up**
  - ▶ **Females**
  - ▶ **Blood loss**
  - ▶ **Infestation**
  - ▶ **Dialysis**
  - ▶ **Frequent blood sampling**
- 

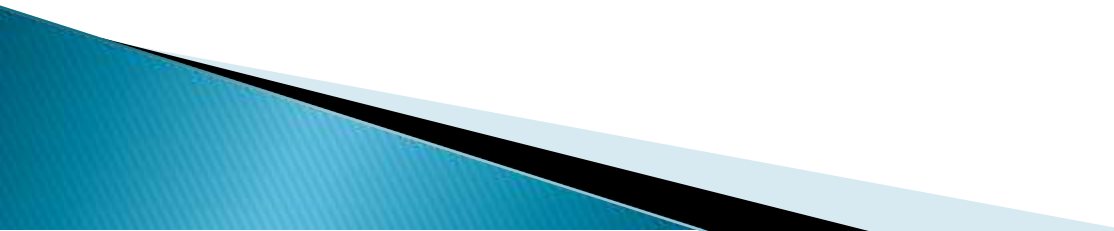
# Distribution of Iron in Body

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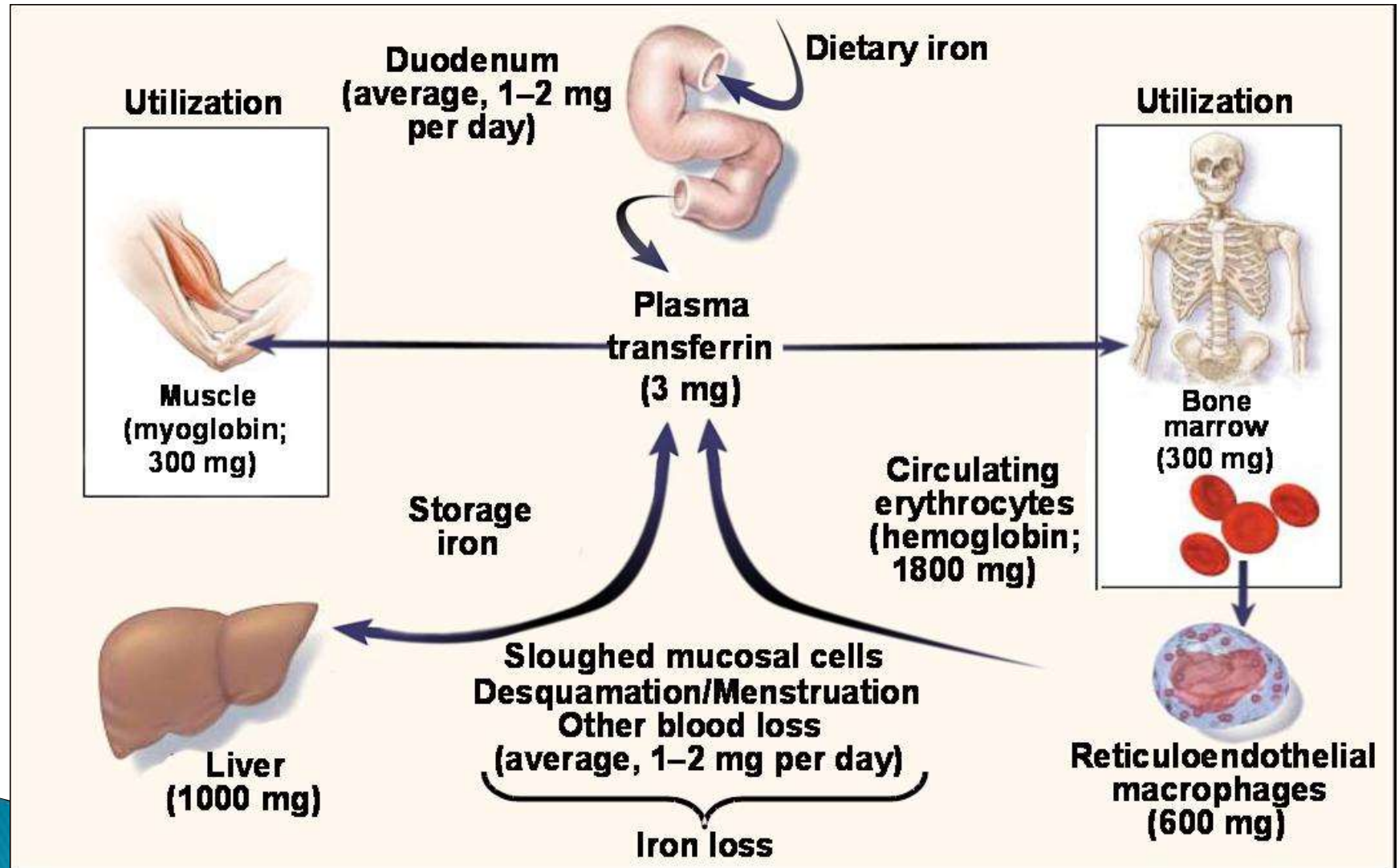
<b>Haemoglobin</b>	<b>2000 mg</b>
<b>Storage iron</b>	<b>1000 mg</b>
<b>Myoglobin iron</b>	<b>130 mg</b>
<b>Labile pool</b>	<b>80 mg</b>
<b>Other tissue iron</b>	<b>8 mg</b>
<b>Transport iron</b>	<b>3 mg</b>

**Iron deficiency is a common form of malnutrition that affects more than 2 billion people globally.**

- Project IDEA (Iron Deficiency Elimination Action)®, CDC



# Body Iron Distribution and Storage

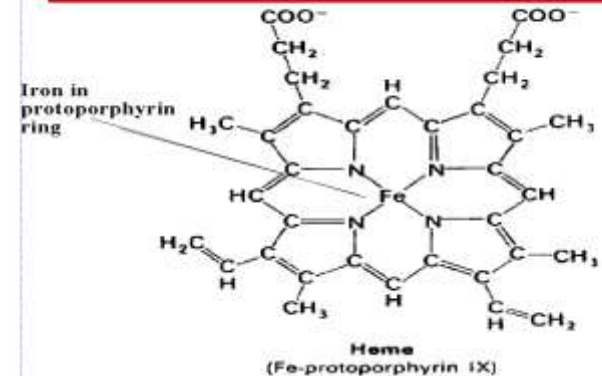


# BODY IRON COMPARTMENTS

## ■ A. *Metabolically Active Iron*

- haemoglobin
- transport compartment - bound to a protein called transferrin in the blood
- tissue iron: part of many functional compounds including enzymes
- myoglobin

The Haem Moiety of Haemoglobin



# IRON COMPARTMENTS

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## **B. *Metabolically Inactive Iron***

**storage compartment:**

- **ferritin - (all cells of body and tissue fluids)**
- **haemosiderin - (macrophages of marrow, liver, spleen)**



# IRON COMPARTMENTS

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## **B. *Metabolically Inactive Iron***

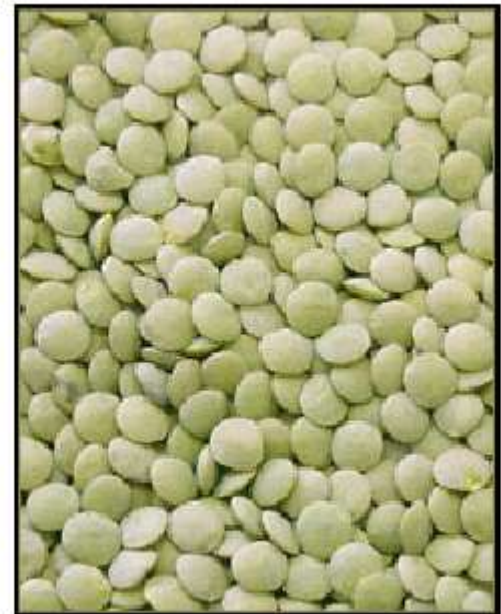
**storage compartment:**

- **ferritin - (all cells of body and tissue fluids)**
- **haemosiderin - (macrophages of marrow, liver, spleen)**

# DIETARY SOURCES OF IRON

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- Haem iron in meat
- Non haem iron in dairy products, eggs, some vegetables (legumes)



# **DAILY REQUIREMENT OF IRON**

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- **10-15 mg/per day (5-10% absorbed)**

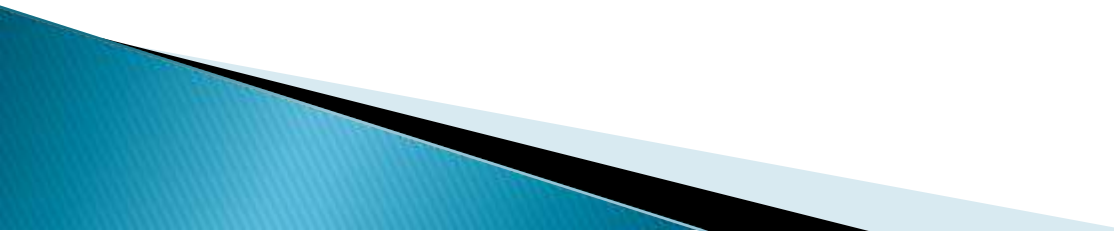
# IRON DEFICIENCY

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- **A cause of chronic ill health**
- **Commonest cause of anaemia worldwide**
- **May indicate presence of important underlying disease, e.g. blood loss from tumour**



# Clinical Presentation

- ▶ Pallor
  - ▶ Pica
  - ▶ Irritability
  - ▶ Attention deficit
  - ▶ Tachycardia
  - ▶ Cardiac failure
- 

# CLINICAL FEATURES OF IRON DEFICIENCY

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- Symptoms - fatigue, alteration in mentation, sore tongue, pica, rarely dysphagia
- Signs - pallor, smooth tongue, angular cheilosis, koilonychia, Plummer Vinson syndrome



**LOOK FOR  
THE CAUSE  
OF IRON  
DEFICIENCY**

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# Iron Deficiency

## ▶ Increased Need

- Early childhood and adolescence (growth spurts)
- Pregnancy (extra 3.8 mg/day over baseline)
- Lactation

## ▶ Poor Intake/Absorption

- Milk baby
- Achlorhydria
- Inflammatory bowel disease



# Iron Deficiency

## ▶ Increased Loss

- Menorrhagia
- GI blood loss
- Urinary blood loss
- Pulmonary blood loss

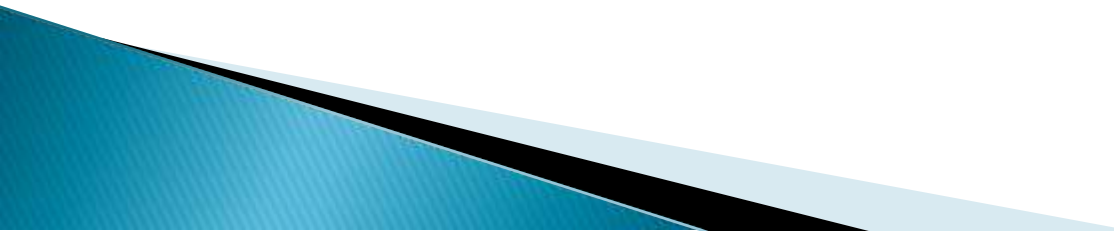
# **EVOLUTION OF IRON DEFICIENCY ANAEMIA**

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- **Earliest stage depletion of body iron stores only. No anaemia**
- **Iron deficiency without anaemia**
- **Iron deficiency anaemia**

# Stages of Iron Deficiency Anemia

## 1. Iron Depletion

- Negative iron balance
  - Iron is mobilized from stores
  - Serum ferritin decreases
  - Iron absorption increases
  - Serum transferrin increases
- 

# Stages of Iron Deficiency Anemia

## 2. Iron Deficient Erythropoiesis

- Iron stores depleted, but not yet anemic
- Serum iron decreases
- Iron saturation  $< 15\%$
- Percentage of sideroblasts decreases in marrow
- Increases in RBC protoporphyrin  
also good test for lead poisoning

# Stages of Iron Deficiency Anemia

## 3. **Iron Deficient Anemia**

- Normochromic/ Normocytic at start
- Marrow then produces microcytic cells
- Hypochromic/ Microcytic anemia

# MEASUREMENT OF BODY IRON STATUS

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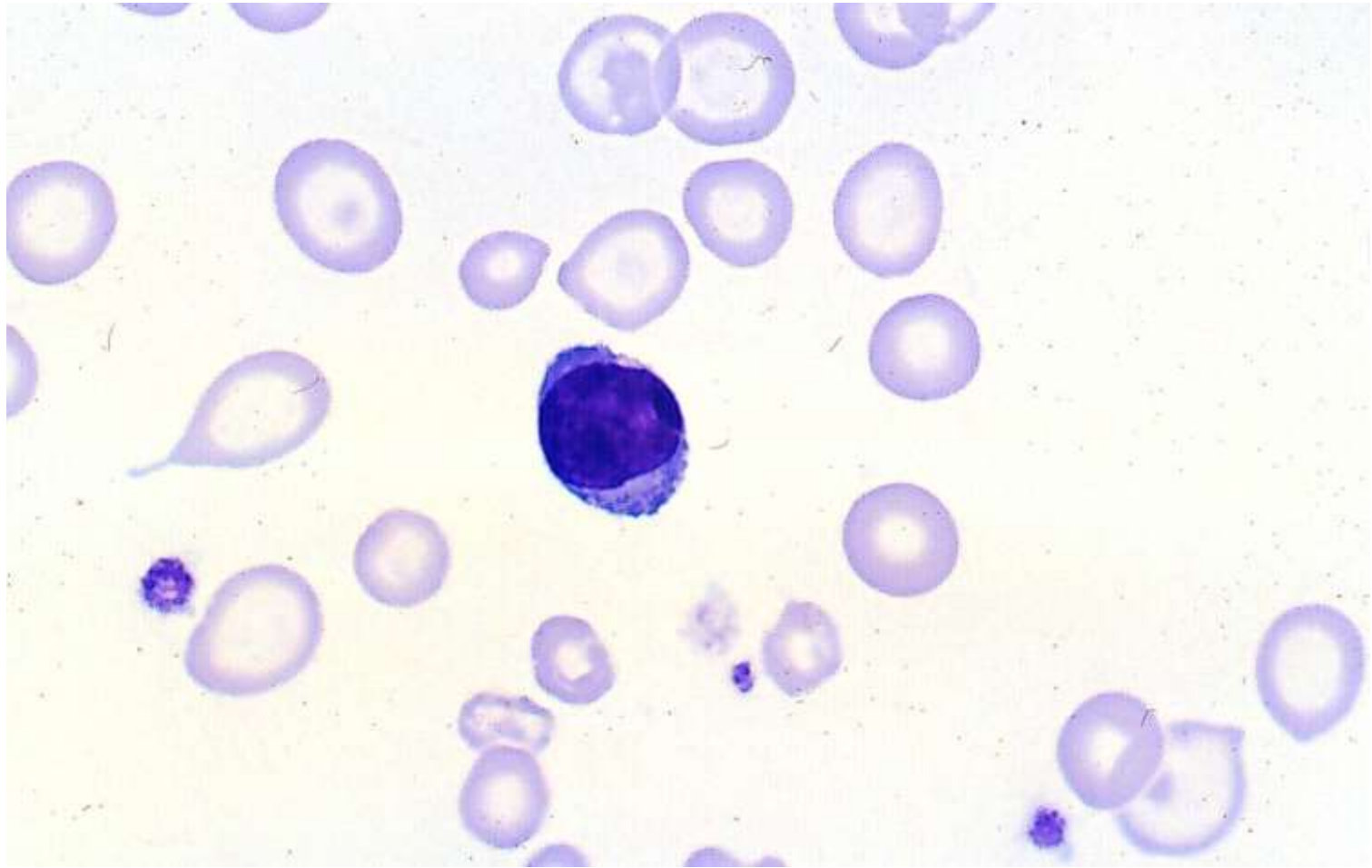
- **Serum iron level** (Transferrin bound ferric iron)
- **Total iron binding capacity** (Measure of transferrin protein)
- **Percentage transferrin saturation** ( $\text{Serum iron/TIBC} \times 100$ )
- **Serum ferritin** (Water soluble complex of iron and a protein. Level correlates with total body iron stores.)
- **Bone marrow iron stores**
- **Plasma transferrin receptor**

# **LABORATORY DIAGNOSIS**

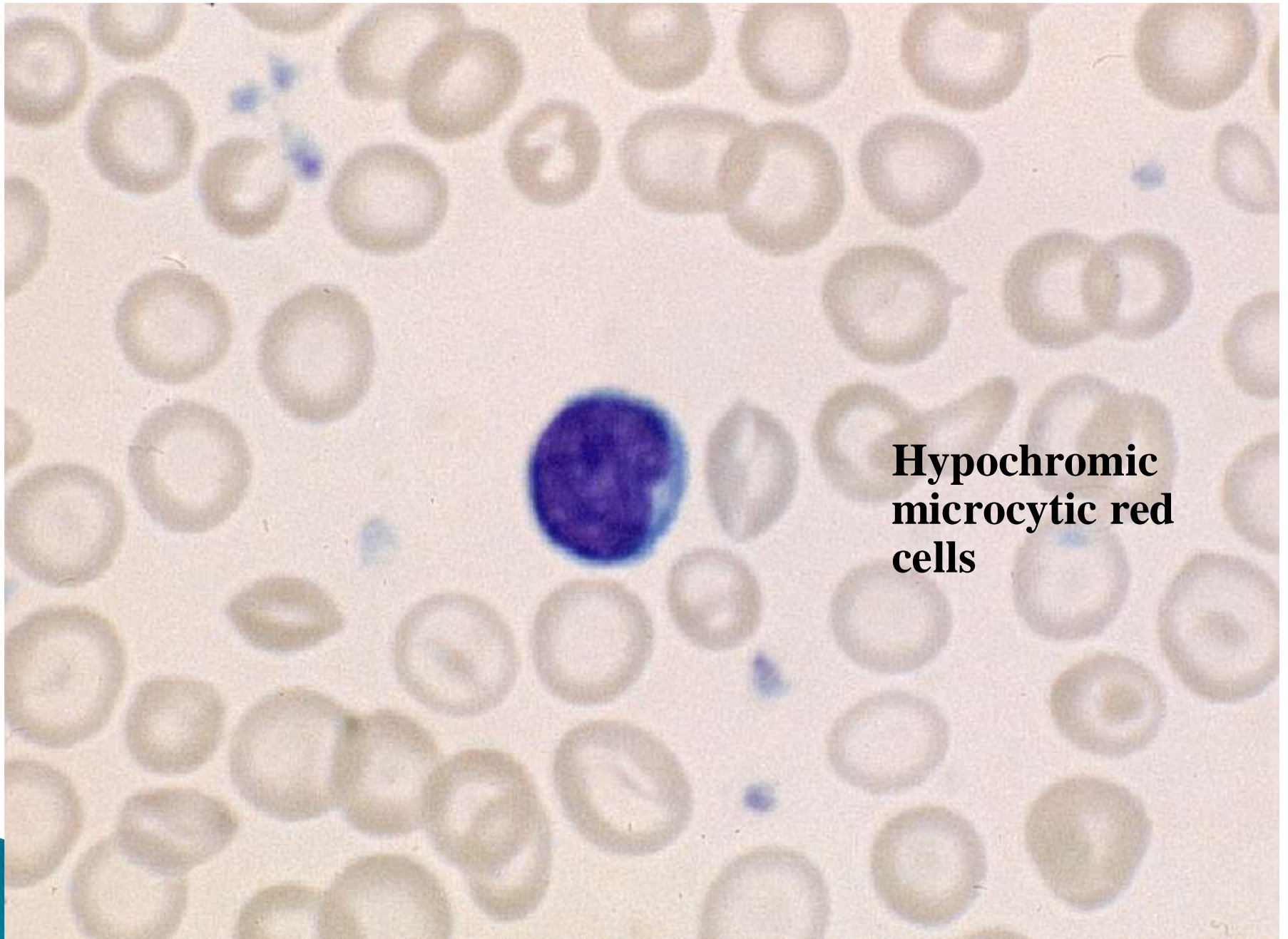
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- **Microcytic hypochromic anaemia**
- **Serum iron decreased**
- **TIBC increased**
- **Percentage transferrin saturation decreased**
- **Serum ferritin decreased**
- **Absent bone marrow haemosiderin (rarely required for diagnosis in uncomplicated cases)**

# Iron Deficiency Anemia







**Hypochromic  
microcytic red  
cells**

# DIFFERENTIAL DIAGNOSIS

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*MCV*

*Serum  
Iron*

*TIBC*

*% Saturation*

*Ferritin*

*Iron  
Deficiency*

Decreased

Low

High

Low

Low

*Anaemia  
Of Chronic  
Disease*

Normal to  
Decreased

Low

Low

Low

Normal to  
Increased

*Thalassemia*

Decreased

Normal  
To High

Normal

Normal or  
High

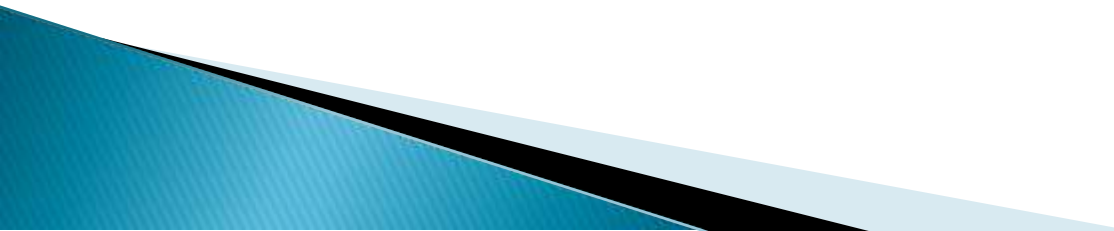
Normal or  
Increased

# Laboratory Tests

Table 1

- Tests used in diagnosing iron deficiency anemia (IDA) (Test Limitations)\*
    - Blood smear hypochromia Subjectivity
  - \*MCV insensitivity
  - RDW Non-specificity
  - Serum iron Markedly lowered by fever or inflammation
  - Iron binding capacity (IBC Moderately lowered by fever; increased by pregnancy Iron/IBC
  - (% saturation (Like serum iron, lowered by fever\*
  - Ferritin raised by fever or inflammation
  - Stool for occult blood Bleeding may be intermittent
  - Endoscopy: EGD and colonoscopy Expensive and invasive; appropriate after iron deficiency is diagnosed
  - Bone marrow for iron stores Expensive and invasive;
  - iron depletion does not prove IDA
  - Treatment with oral iron, followed by hemoglobin and hematocrit surveillance (1 month (Effect is slow; Hb may rise for other reasons
- \*probably the best tests, currently

# Evaluation of Anemia

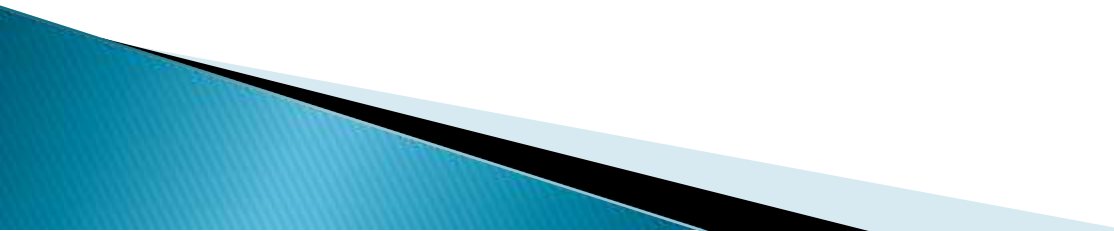
- ▶ Depends mostly on elements of iron metabolism
  - ▶ Can measure
    - Serum Fe
    - Ferritin
    - TIBC
    - Transferrin saturation
    - Soluble serum transferrin receptor
- 

# LABORATORY DIAGNOSIS

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- **Microcytic hypochromic anaemia**
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- **Serum ferritin decreased**
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# Laboratory Diagnosis

- ▶ **Screening**
  - ▶ **Diagnostic**
  - ▶ **Specialized**
- 

# Screening

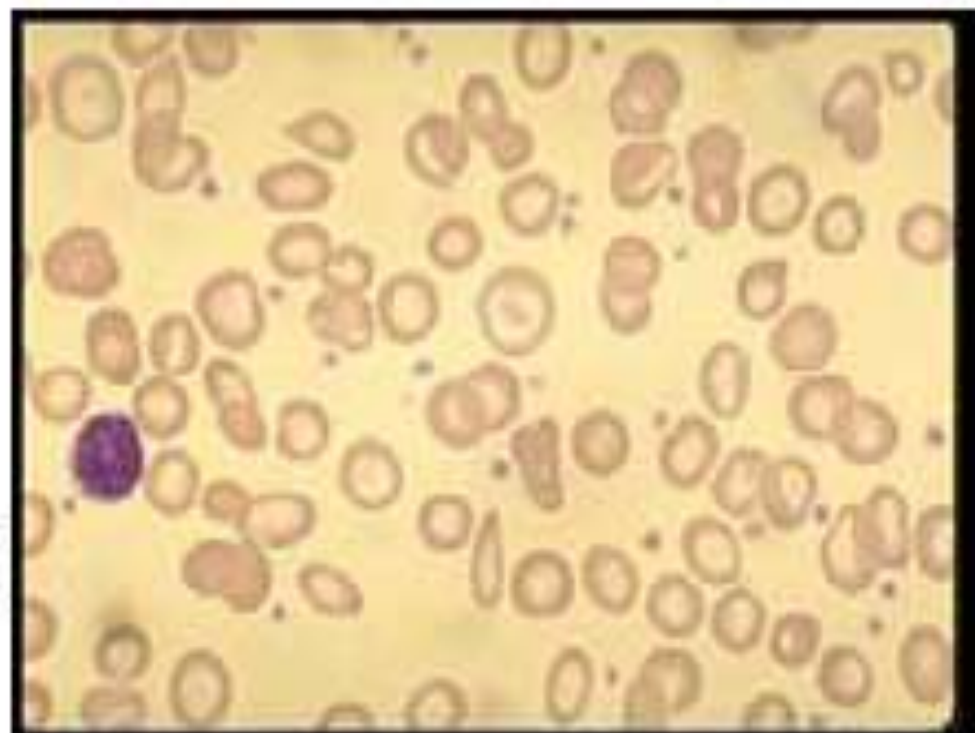
CBC ►

- RDW ↑
- Hb ↓
- MCV ↓
- MCHC ↓
- RBC count ↓
- Thrombocytosis
- Anisocytosis
- Poikilocytosis

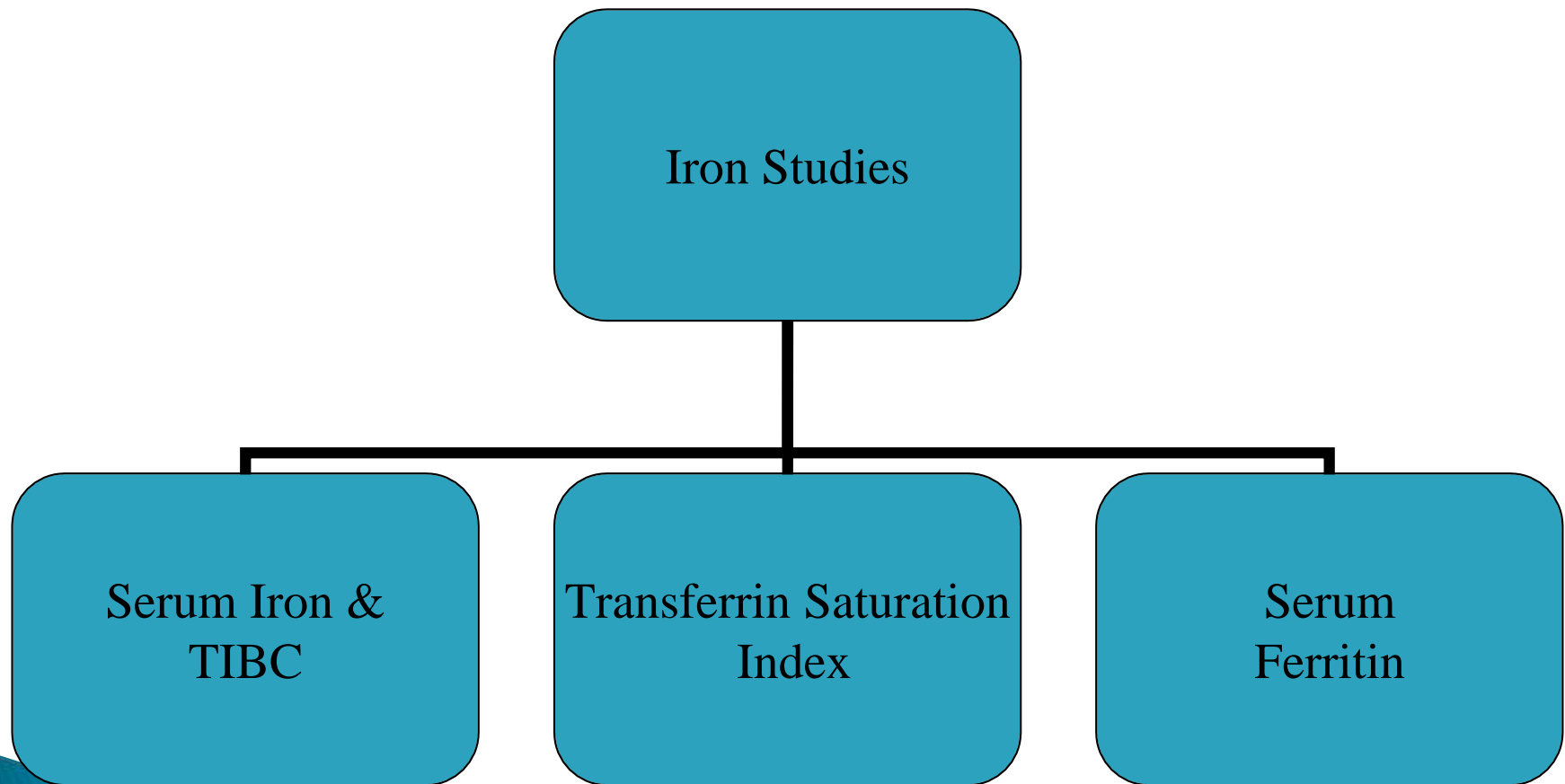


# Iron deficiency

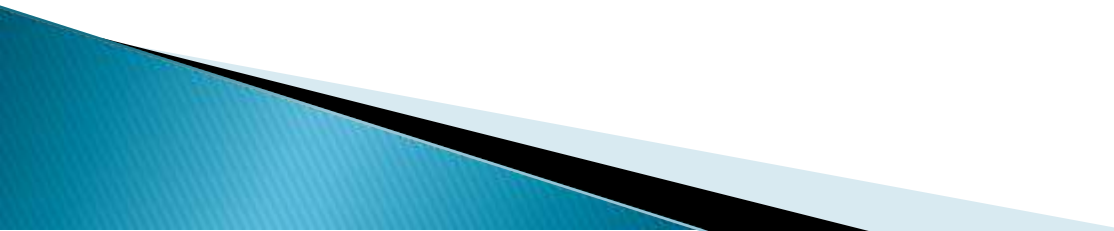
- Low Serum iron, Low Ferritin, High TIBC
- Find out why –GI bleed, menses, diet
- Treat  $\text{FeSO}_4$  300mg tid



# Diagnostic Test



# Specialized Tests

- ▶ **FEP/zpp (Fluorometry)**
  - ▶ **sTFR (Immunoassay)**
  - ▶ **BM Aspiration & Biopsy**
- 

# Differential Diagnosis of Anemia

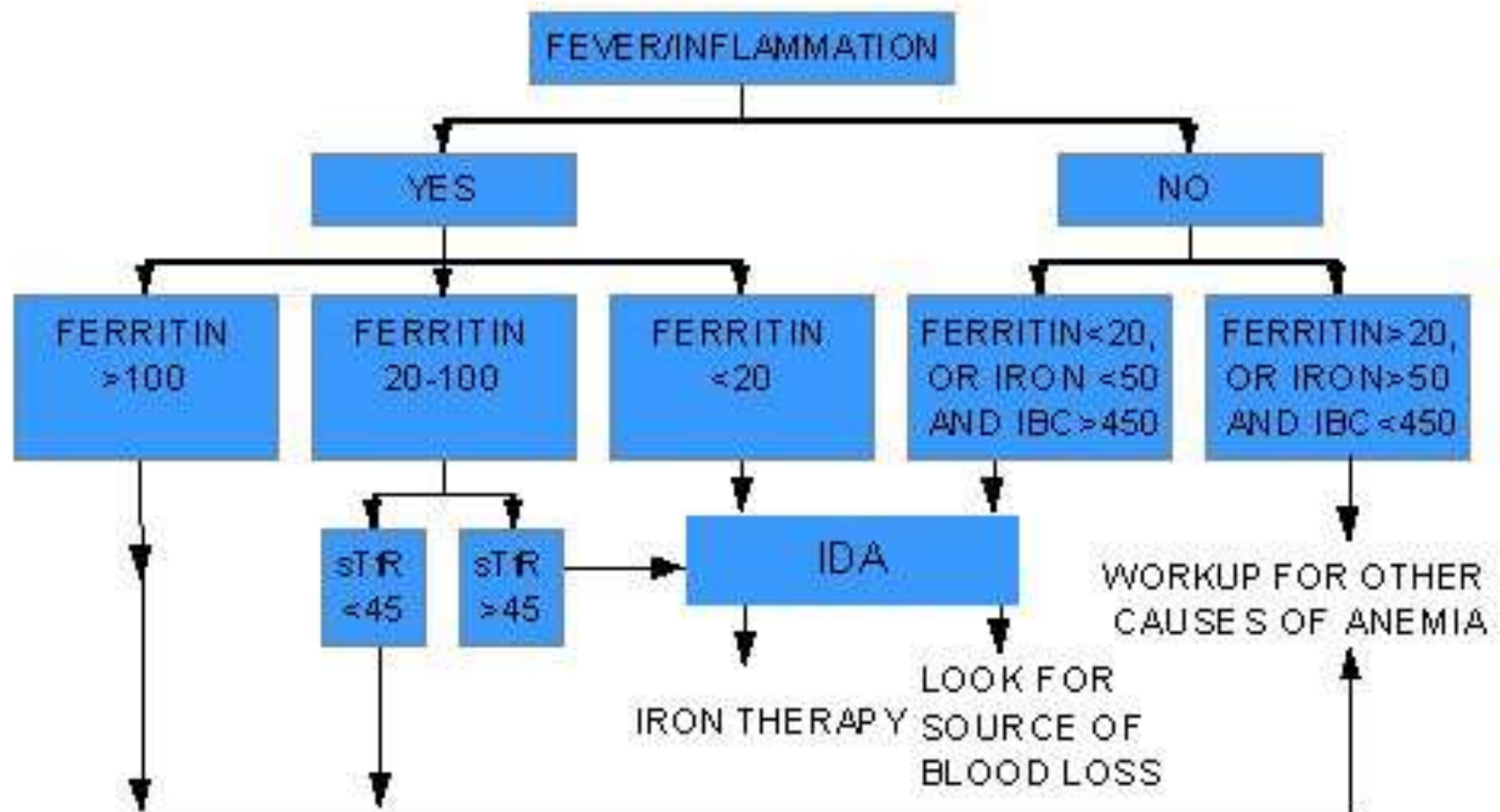
## ▶ Poor production

- Fe deficiency
- Anemia of chronic disease
- Thalassemia
- Chronic renal disease
- Bone marrow infiltration (neoplasia or hemophagocytic syndrome)

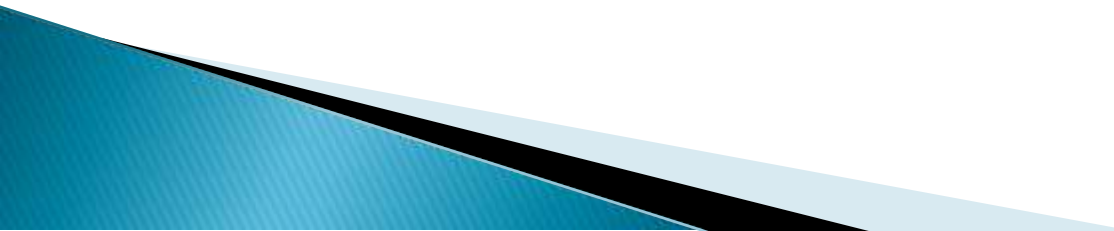
## ▶ Increased loss

- Hemolysis
  - Hypersplenism
  - (occult bleeding)
- 

# LAB TESTING ALGORITHM FOR IRON DEFICIENCY ANEMIA (IDA)



# Treatment

- ▶ **First Step:** Treat underlying condition
  - ▶ **Second Step:** Nutritional supplement
  - ▶ **Third Step:** Iron therapy
- 

# Iron in Food

- ▶ Good Sources :  
liver  
organ meats  
beef  
cooked beans  
cooked oysters  
fortified cereals



# TREATMENT

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- **Oral iron - not enteric coated preparation**
- **Replace iron deficit in total**  
**Correct anaemia and MCV**  
**Replenish iron stores**

# Iron Therapy

- ▶ **Ferrous Sulfate:**
  - Prophylaxis
  - On empty stomach
  - Side effect: nausea, constipation
  - Duration: 4–6 months

# Different Iron Products

- ▶ **Hematinic Capsules**

- (115 mg elemental iron + vitamin B12 + vitamin C + folic acid)

- ▶ **Ferfolic**

- (60 mg iron + folic acid)

- ▶ **Fer Iron**

- (50 mg iron)

- ▶ **FeFol**

- (45 mg iron)

- ▶ **Ferrous Sulfate Syrup**

- (41 mg iron in each 5 cc)

- ▶ **Ferrous Sulfate Drop**

- (25 mg iron in 1 cc = 1mg per 1 drop)

# Iron deficiency Anemia

- ▶ Treatment: Response to oral iron includes
  - 24–48hr  
subjective improvement in CNS
  - 48–72hr  
reticulocytosis
  - 4–30days  
increase in Hb
  - 1–3 mo  
repletion of iron stores

▶ .

Therapeutic dose: **3–6 mg/Kg/day** of elemental iron:

Induces an increase in Hb of **0.25–0.4 g/dl per day**

Or

**1%/day** rise in hematocrit.

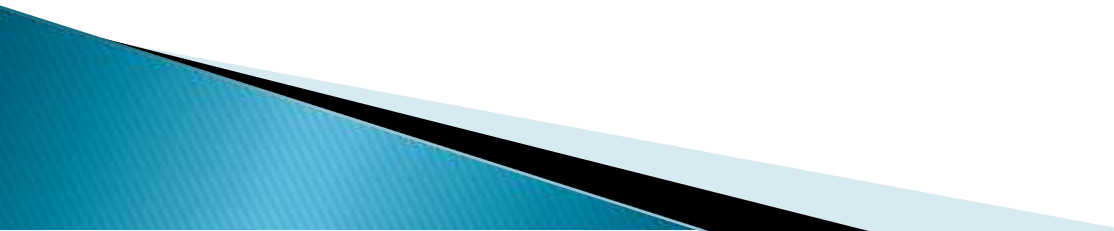


# Failure of response

► Failure of response after 2 weeks of oral iron requires reevaluation for :

1. Ongoing blood losses
  2. Infection
  3. Poor compliance
  4. Other causes of micro- anaemia
- 

# Oral iron failure?

- ▶ **Incorrect diagnosis (eg, thalassemia)**
  - ▶ **anemia of chronic disease?**
  - ▶ **Patient is not taking the medication**
  - ▶ **Not absorbed (enteric coated?)**
  - ▶ **Rapid iron loss?**
- 



Remember:

Iron deficiency anemia is a manifestation of an underlying process.

Look for and treat the cause of the iron deficiency.

# Thalassemia

Sanjiv Kumar Sahi  
Hemodialysis Unit, Kidney Unit, IISG  
Pune, India

# Thalassemia

- defective production of globin portion of hemoglobin molecule.
- Globin chains structurally normal but have imbalance in production of two different types of chains.
- May be either homozygous defect or heterozygous defect.
- Two major types of thalassemia:
  - Alpha ( $\alpha$ ) - Caused by defect in rate of synthesis of alpha chains.
  - Beta ( $\beta$ ) - Caused by defect in rate of synthesis in beta chains.

# BETA THALASSEMIA

Beta thalassemia usually  
caused by genes mutation on  
chromosome 11

## CLASSICAL SYNDROMES OF BETA THALASSEMIA

- **Silent carrier state** = heterogenous beta mutations , no hematologic abnormalities
- **Beta thalassemia minor**
- **Beta thalassemia major**

# Beta Thalassemia Minor

- Only has one copy of the beta thalassemia gene
- Caused by heterogenous mutations
- Usually presents as mild, asymptomatic hemolytic anemia .
- Hemoglobin level in 10-13 g/dL range with normal or slightly elevated RBC count.
- Normally require no treatment.

# Beta Thalassemia Major 1 of 3

- child born with thalassemia major has two genes for beta thalassemia.
- Characterized by severe microcytic, hypochromic anemia.
- Detected early in childhood:
  - Infants fail to thrive.
  - Have pallor, variable degree of jaundice, abdominal enlargement, and hepatosplenomegaly.
- Hemoglobin level between 4 and 8 gm/dL.



## Beta Thalassemia Major 2 of 3

- Severe anemia causes marked bone changes in skull, long bones, and hand bones due to expansion of marrow space for increased erythropoiesis.
- Physical growth and development delayed.
- Peripheral blood shows markedly hypochromic, microcytic erythrocytes with extreme poikilocytosis, such as target cells, teardrop cells.
- MCV in range of 50 to 60 fL.
- Low retic count seen (2-8%).

# Beta Thalassemia Major 3 of 3

- Regular transfusions usually begin around one year of age and continue throughout life.
- Danger in continuous transfusion therapy:
  - Development of iron overload.
  - Development of alloimmunization (developing antibodies to transfused RBCs).
  - Risk of transfusion-transmitted diseases.

## management

- regular blood transfusions. The aim is to maintain the haemoglobin concentration above 10 g/dl.
- iron chelation with subcutaneous desferrioxamine, or with an oral iron chelator drug ( deferasirox) starting from 2 to 3 years of age = treat iron overload.
- Alternative treatment for  $\beta$ -thalassaemia major = bone marrow transplantation

# ALPHA THALASSEMIA

Alpha thalassemia usually caused by gene mutation on chromosome 16

Normally, people have **four (4) genes for alpha globin** with two (2) genes on each chromosome ( $\alpha\alpha/\alpha\alpha$ ).

# Alpha Thalassemia

- cause = gene deletions in the alpha-globin gene.
- Absence of alpha chains result in increase of gamma globin (fetal life) / excess beta chains later in life; Causes molecules like Bart's Hemoglobin ( $\gamma_4$ ) or Hemoglobin H ( $\beta_4$ )
- Are four clinical syndromes present in alpha thalassemia:
  - Silent Carrier State
  - Alpha Thalassemia Trait (Alpha Thalassemia Minor)
  - Hemoglobin H Disease
  - Bart's Hydrops Fetalis Syndrome

## Silent Carrier State

- Deletion of one alpha gene, leaving three functional alpha genes.
- Alpha/Beta chain ratio nearly normal.
- No hematologic abnormalities present.

## Alpha Thalassemia Trait (Alpha Thalassemia Minor)

- Deletion of one or two  $\alpha$ -globin genes.
- Exhibits mild microcytic, hypochromic anemia (MCV = 70-75 fL)
- May be confused with iron deficiency anemia.





# Hemoglobin H Disease 1 of 2

- Second most severe form alpha thalassemia.
- three of the  $\alpha$ -globin genes are deleted
- RBCs are microcytic, hypochromic with marked poikilocytosis. Numerous target cells.
- Hb H vulnerable to oxidation. Gradually precipitate in vivo to form Heinz-like bodies of denatured hemoglobin. Cells been described has having "golf ball" appearance, especially when stained with brilliant cresyl blue.
- Blood transfusion dependent



# Bart's Hydrops Fetalis Syndrome

- deletion of all four  $\alpha$ -globin genes
- Sign= edema and ascites caused by accumulation serous fluid in fetal tissues as result of severe anemia. Also hepatosplenomegaly and cardiomegaly.
- Hemoglobin Bart's has high oxygen affinity so cannot carry oxygen to tissues. Fetus dies in utero or shortly after birth. At birth, see severe hypochromic, microcytic anemia.
- Pregnancies dangerous to mother. Increased risk of toxemia and severe postpartum hemorrhage.

- long-term survivors =those who have received monthly intrauterine transfusions until delivery followed by lifelong monthly transfusions after birth.

# Laboratory Diagnosis of Thalassemia

## Laboratory Diagnosis of Thalassemia

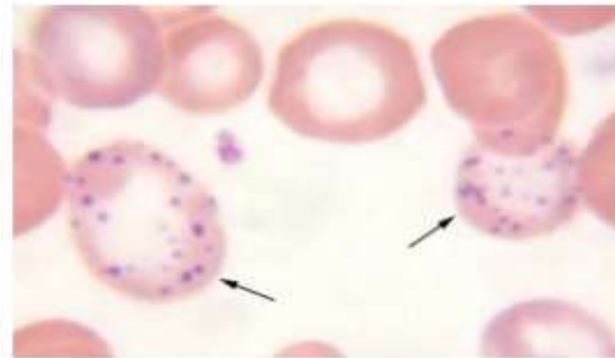
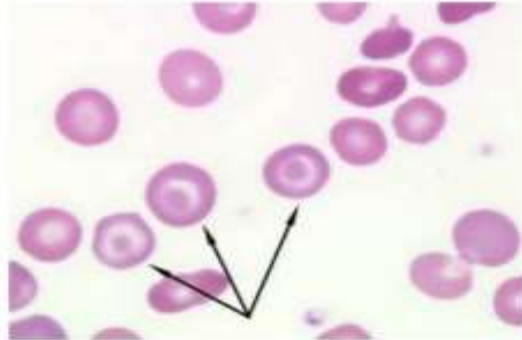
- Need to start with patient's individual history and family history.
- physical examination:
  - Pallor indicating anemia.
  - Jaundice indicating hemolysis.
  - Splenomegaly due to pooling of abnormal cells.
  - Skeletal deformity, especially in beta thalassemia major.

# Complete Blood Count

- decrease in hemoglobin, hematocrit, mean corpuscular volume (MCV), and mean corpuscular hemoglobin (MCH).
- normal to slightly decreased Mean Corpuscular Hemoglobin Concentration (MCHC).
- normal or elevated RBC count with a normal red cell volume distribution (RDW).

## CBC 2 of 2

- On differential, see microcytic, hypochromic RBCs (except in carrier states). See mild to moderate poikilocytosis. In more severe cases, see marked number of target cells and elliptocytes, basophilic stippling (spontaneous aggregation of ribosomal RNA), and NRBCs.

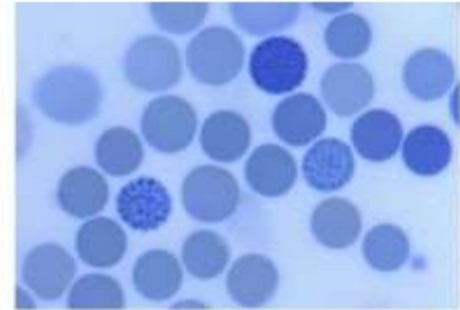


# Reticulocyte Count

- Usually elevated. Degree of elevation depends upon severity of thalassemia.



## Brilliant Cresyl Blue Stain



- Incubation with brilliant cresyl blue stain causes Hemoglobin H to precipitate. Results in characteristic appearance of multiple discrete inclusions -golf ball appearance of RBCs. Inclusions are evenly distributed throughout cell.

# Hemoglobin Electrophoresis

- Important role in diagnosing and differentiating various forms of thalassemias.
- Can differentiate among Hb A, Hb A<sub>2</sub>, and Hb F, as well as detect presence of abnormal hemoglobins such as hemoglobin Bart's.

# Routine Chemistry Tests

- Indirect bilirubin elevated in thalassemia major
- Assessment of iron status, total iron binding capacity, and ferritin level important in differentiating thalassemia from iron deficiency anemia.

# TREATMENT

- Blood transfusion
- splenectomy