Anemia

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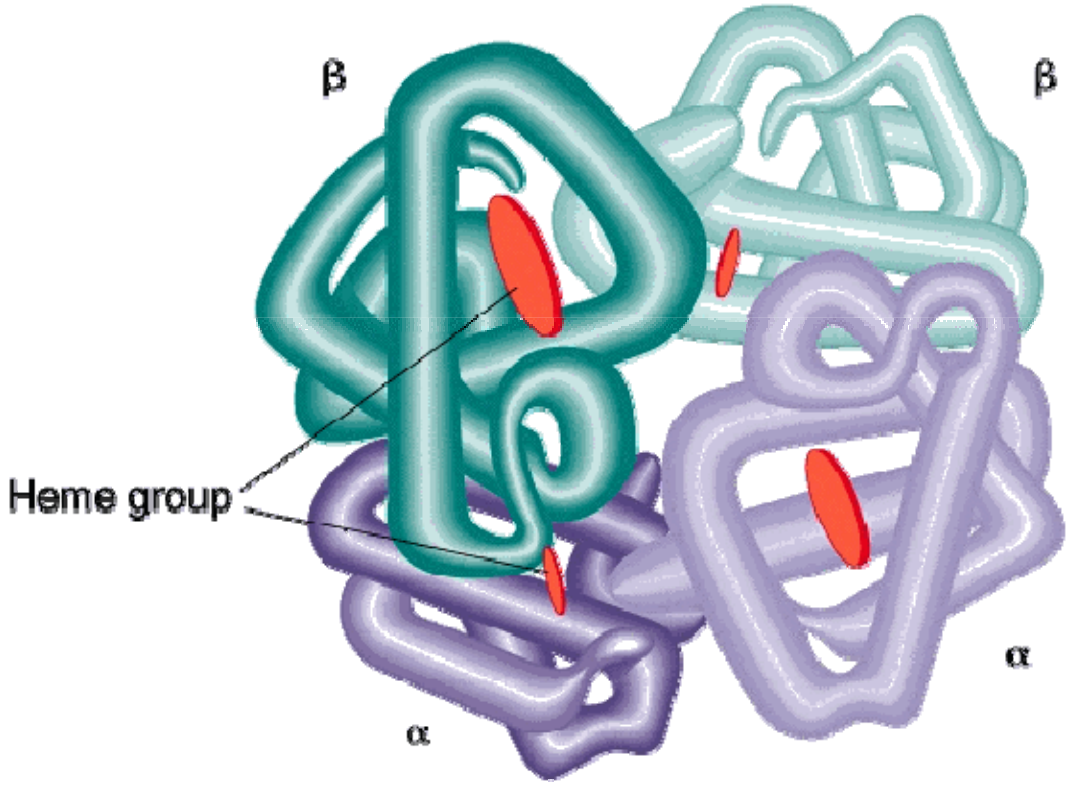
Terms

- RBC = red blood cells
- Hgb = hemoglobin
- MCV = mean cell volume
- Fe = iron
- SD = standard deviation
- TIBC = total iron binding capacity
- RDW = red cell distribution width

Hemoglobin

- Tetramer of 4 globin chains (proteins)
- Each with a heme group containing iron
- Can be distinguished by electrophoresis
- Chain types
  - Alpha
  - Beta
  - Gamma
  - Delta
  - Zeta and epsilon are embryonic

The Hemoglobin Molecule



Fetal and Neonatal Hemoglobins

Hemoglobin type	Designation	Amount %	
		Birth	> 1 year
Fetal	Hgb F (alpha2 gamma2)	60-85	0-2
Adult (major)	Hgb A (alpha2 beta2)	15-40	96-98
Adult (minor)	Hgb A2 (alpha2 delta2)	1	1-3

About Hemoglobin

- Hemoglobin binds oxygen and carries it to tissues
- Erythrocytes (red blood cells) consist mainly of hemoglobin
- Function of red blood cell dependent on:
  - Hemoglobin type and content
  - Membrane stability
  - Energy production

Survival and Production of RBC

- Formed in bone marrow
- Life span is 120 days (+/- 20 days)
- Cleared in spleen
- Reticulocytes are newly formed RBC in circulation
- If no new production, Hgb drops 1 gm/week

Definition of Anemia

- Hgb > 2 standard deviations below the mean for age

(see chart)

Age and Sex Adjusted Hgb and MCV Values

Age and Sex	Hgb Mean (-2 SD)	MCV Mean (-2 SD)
Birth	16.5 (13.5)	108 (98)
1-3 days	18.5 (14.5)	108 (95)
2 weeks	16.6 (13.4)	105 (88)
1 month	13.9 (10.7)	101 (91)
2 months	11.2 (9.4)	95 (84)
6 months	12.6 (11.1)	76 (68)
6-24 months	12.0 (10.5)	78 (70)
2-6 years	12.5 (11.5)	81 (75)
6-12 years	13.5 (11.5)	86 (77)
12-18 year male	14.5 (13)	88 (78)
12-18 year female	14.0 (12)	90 (78)
Adult male	15.5 (13.5)	90 (80)
Adult female	14.0 (12)	90 (80)

Anemia

- Physiologic: hgb below the level needed to deliver adequate oxygen to cells
- Clinical features:

Mild	Mild dyspnea on exertion, palpitation
Moderate	As with MILD ANEMIA, may also have excessive fatigue
Severe	Dyspnea at rest, tachycardia with pounding pulse, weakness, dizziness, syncope, headache, insomnia

Anemia

- General mechanisms
  - Increased hgb loss (usually bleeding)
  - Decreased hgb production
  - Increased destruction of RBC

Workup for Anemia

- History
  - Diet
  - Blood loss
  - Family history
  - Recent illness or immunization
  - History of anemia and cause

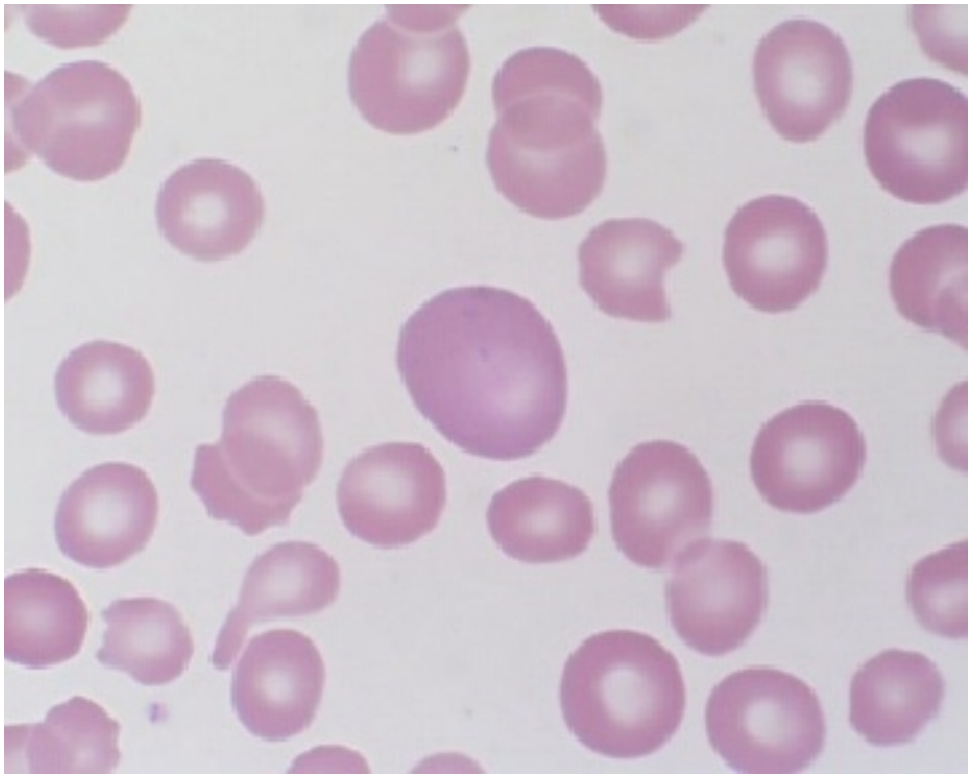
Workup of Anemia

- Physical Examination
  - Evaluate conjunctiva and mucous membranes for paleness
  - Cardiovascular system for murmur
  - Liver
  - Spleen
  - Nodes
  - Look for jaundice or purpura

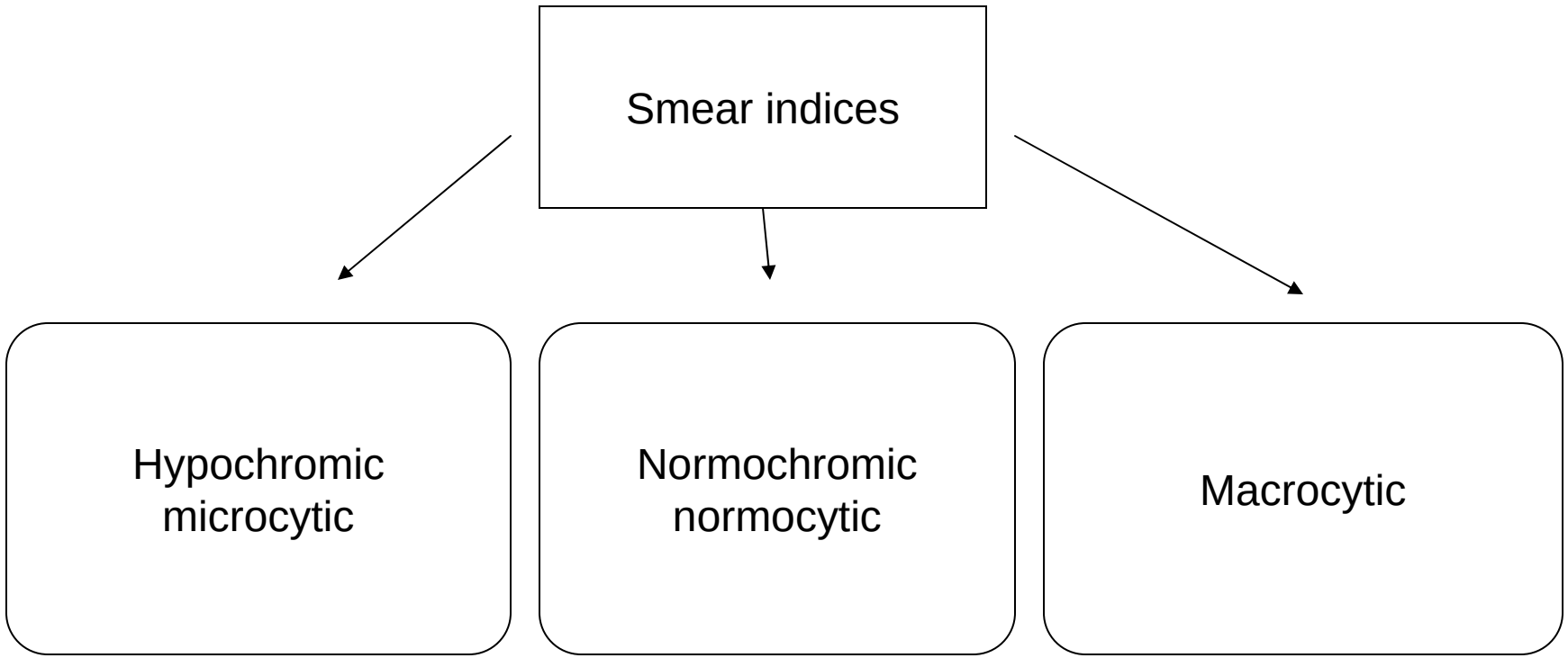
Workup of Anemia

- Labs
  - Complete blood count with differential and platelets
  - Evaluation of smear with red cell indices
  - Reticulocyte count
- Other tests
  - Serum bilirubin, LDH, urinary hemosiderin, hgb electrophoresis, quantitative hgb A2 and F

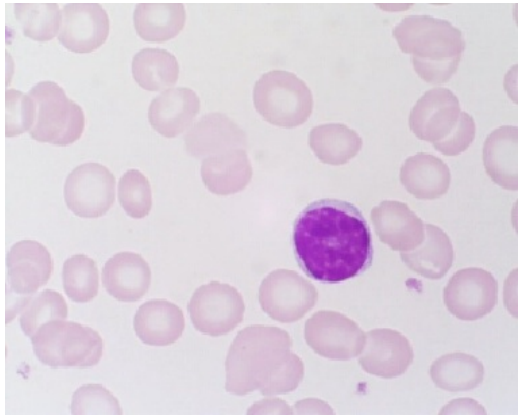
Reticulocytes

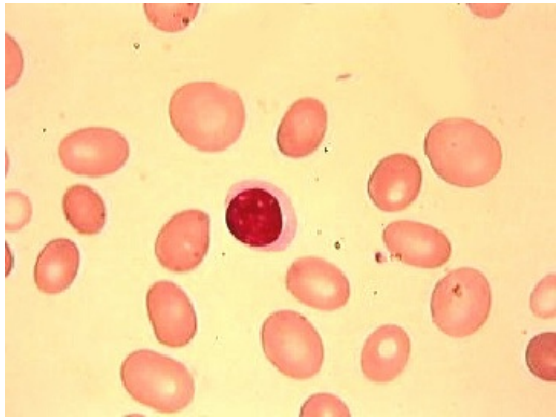


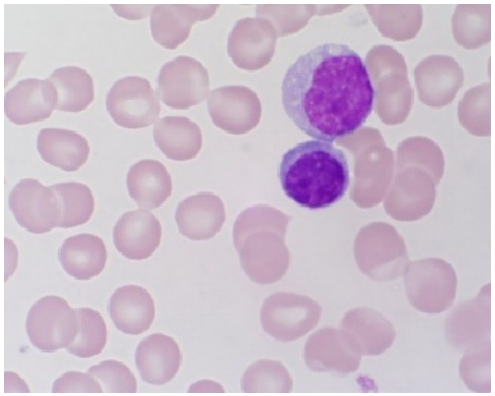
Approach to Anemia



Anemias







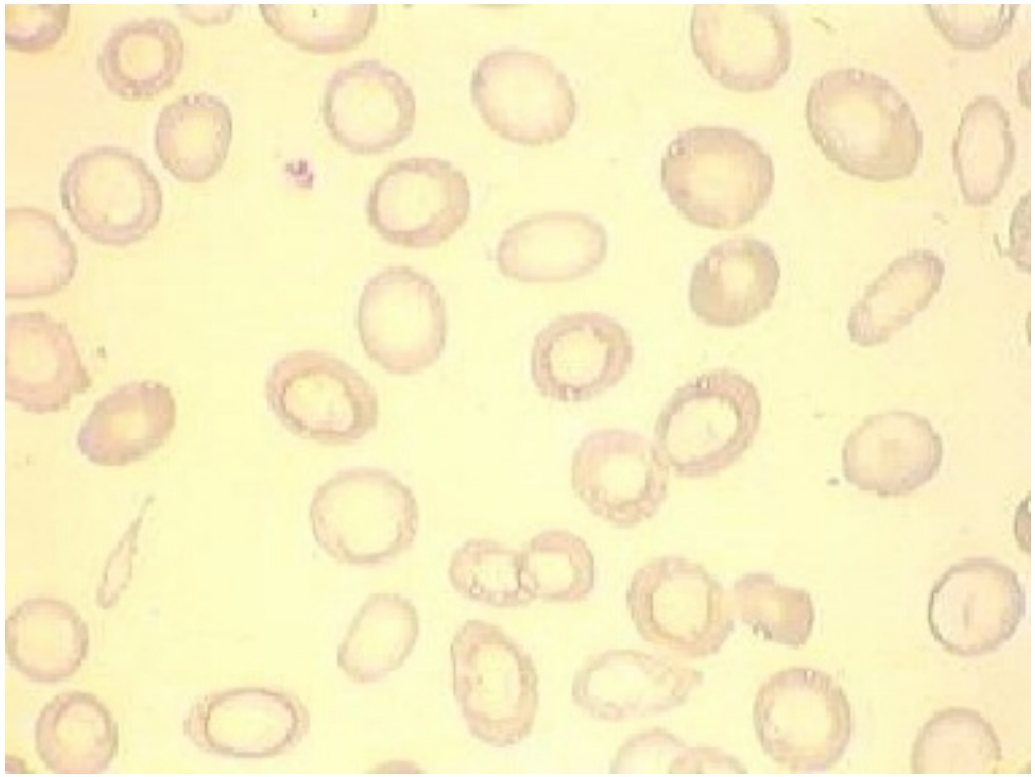
Hypochromic Microcytic Anemia

- Appearance:
  - Weakly staining, small in size
- Mechanism:
  - Decreased hgb synthesis secondary to decreased heme synthesis
- Causes:
  - Iron deficiency
  - Thalassemia
  - Lead poisoning

Hypochromic, Microcytic Anemia: Iron Deficiency

- Mechanism
  - Decreased hgb synthesis secondary to decreased heme synthesis
- Major differential diagnosis
  - Beta thalassemia minor
- Incidence
  - 3-24% of children age 6-24 months

Iron Deficiency Anemia



Iron Deficiency Anemia: Causes

- Lack of adequate iron at birth
  - Low birth weight
  - Low hgb at birth
- Poor iron intake
- Loss of iron (GI bleeding)

Iron Deficiency Anemia

- Symptoms
  - Irritability
  - Anorexia with poor weight gain
  - Behavioral changes

  **Some of these changes may not be readily reversible with Fe treatment*
- Diagnostic tests
  - Hgb and MCV are decreased
  - Ferritin decreased
  - TIBC increased

Iron Deficiency Anemia: Treatment

Elemental iron 4-6 mg/kg/day

- In a 1-2 year old with a poor diet, therapy may consist of empiric course of oral iron without a full workup
- Reticulocyte count will rise in 4-5 days
- Hgb starts to rise at 1 week
- Once normalized, continue Fe therapy 1-2 months to replace Fe stores in marrow

Iron Deficiency Anemia: Note

- Make sure there is no source of GI bleeding
- Consider malignancy if there is GI bleeding

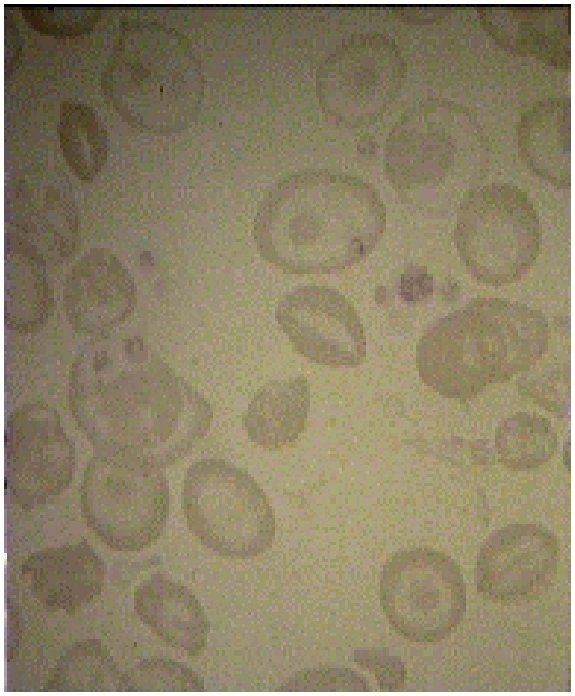
Lead Poisoning

- Blocks placement of Fe into heme
- May cause neurological damage and anemia
- Usually related to lead-based paints and industrial exposures
- Test for a SERUM LEAD LEVEL
- Treatment – chelation with deferoxamine

Thalassemia

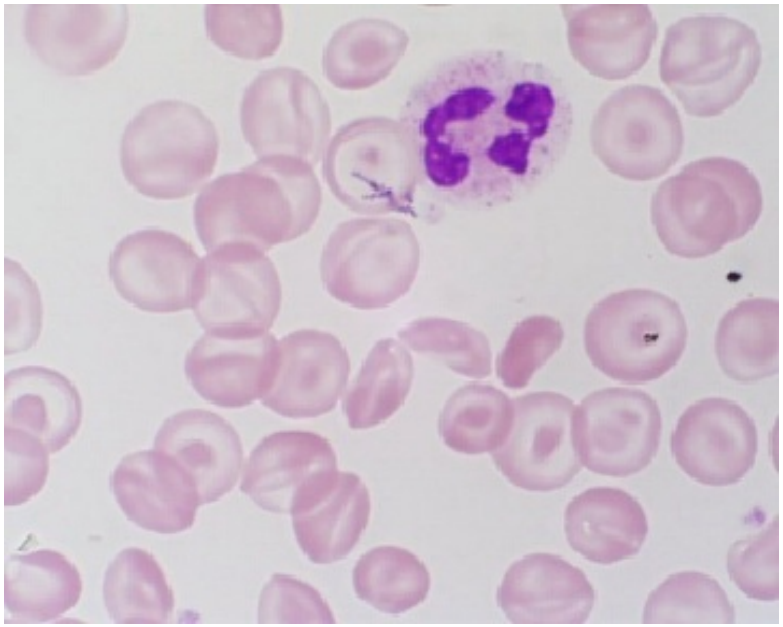
- Genetically determined, often familial defects in the production of Hgb
- Two processes involved
  - Decreased production of Hgb
  - Imbalance of globin chain production

THALASSEMIA



Victims of this hereditary anemia produce very little functional hemoglobin. The cells are also prone to rupture. The result is a severe form of anemia. This disease affects persons from the lands surrounding the Mediterranean Sea.

Thalassemia



Beta-Thalassemia

- Due to deficiency of one or both Beta-globin genes
- Heterozygotes
  - Defect in one chain
  - Mild hypochromic microcytic anemia
  - Normal life expectancy
  - Potential for homozygous children
  - Confirmed by electrophoresis

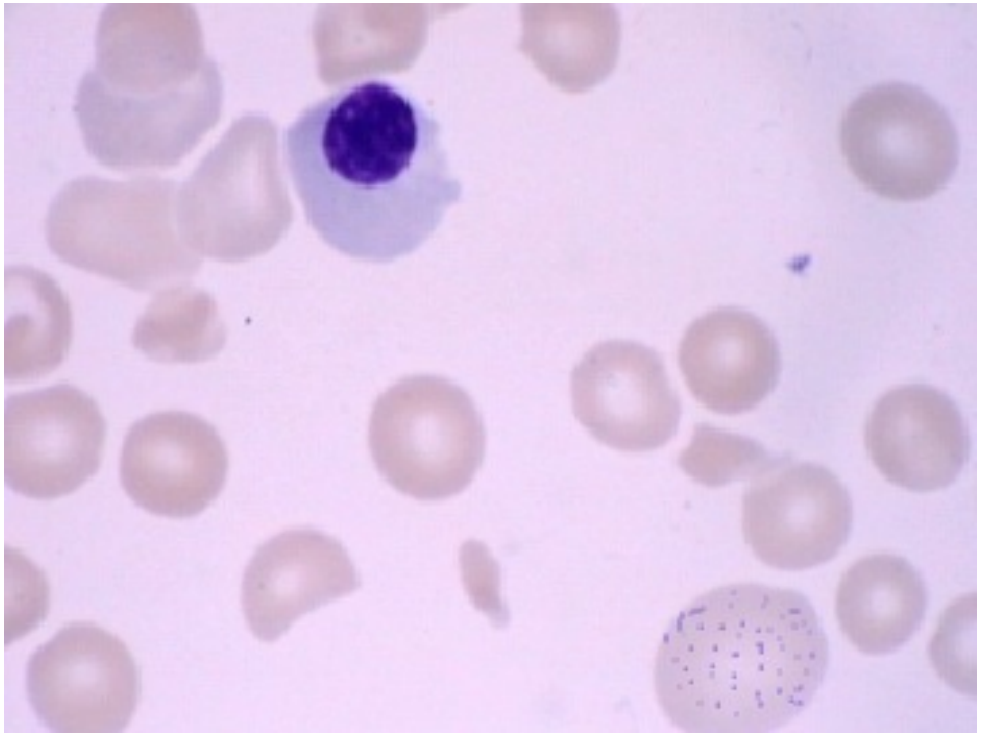
Beta-Thalassemia

- Homozygotes
  - Beta-Thalassemia major
  - Defect in *both* beta chains
  - Decreased or no production of Hgb A
  - Hgb F 60-90%
- Clinical
  - Presents with severe anemia at 4-6 months
- Treatment
  - Transfusions

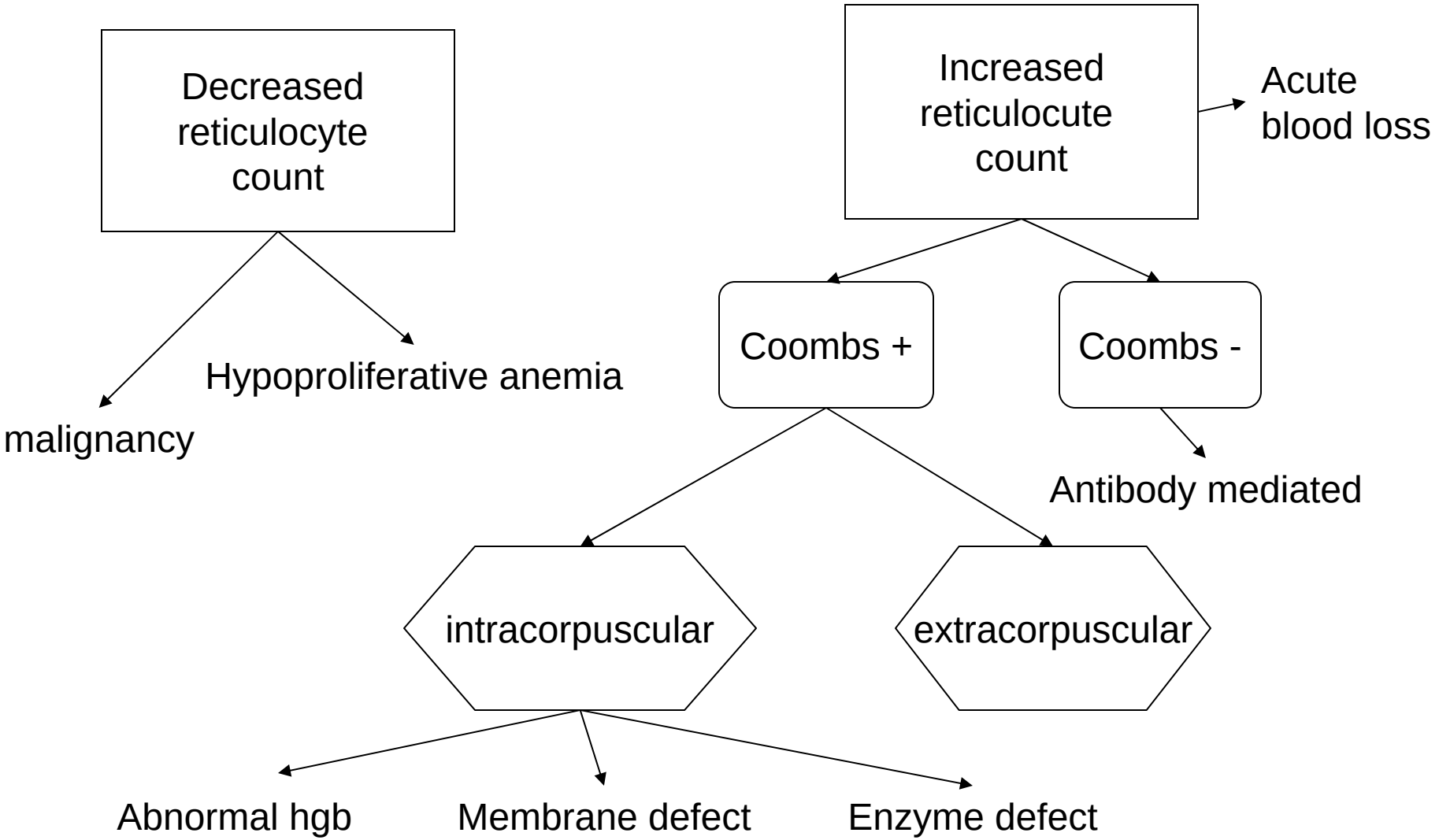
Differentiating Between Iron Deficiency and Beta-Thalessmia Trait

Test/Finding	Beta-Thal trait	Iron Deficiency
Serum Fe/ferritin	Normal	Decreased
TIBC	Normal	Increased
Fe/TIBC	Normal	Decreased
Hgb A2	Increased	Decreased
Hgb F	Increased	Normal
MCV/RBC	< 13	> 13
FEP	Normal	Increased
RDW	Normal (13.4 +/- 1.2)	Higher
RBC morphology	Abnormal Basophilic stippling	Slightly abnormal

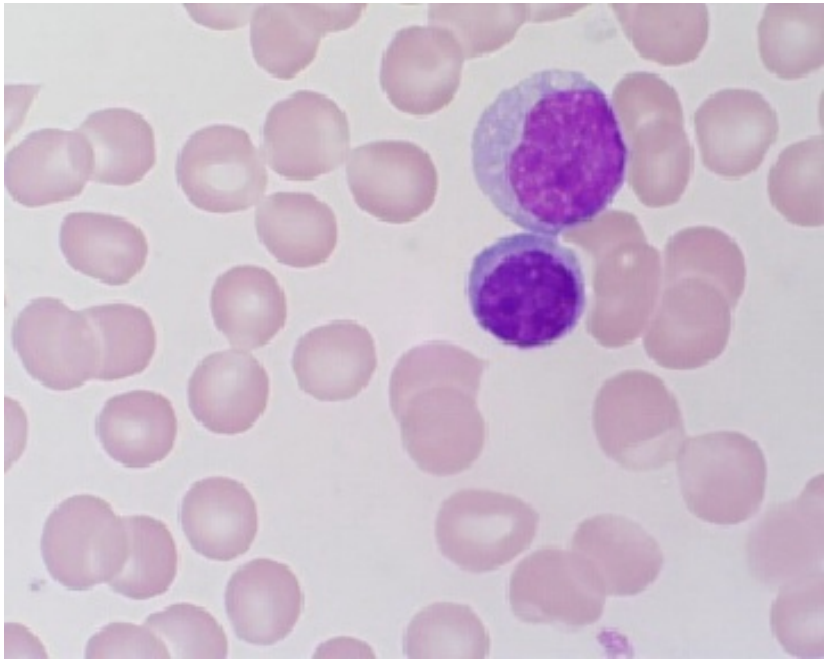
Basophilic Stippling



Normochromic, Normocytic Anemia



Normochromic, Normocytic Anemia



Macrocytic Anemia

- Appearance:
  - Large cells
- Causes:
  - Vitamin B12 deficiency
  - Folate deficiency

Macrocytic Anemia