Anemia ([Hgb] < 120g/L)

(Average MCV, CBC, and reticulocyte count assists with diagnosis!)

**Microcytic** (MCV < 80fL)

(↓ heme or globin synthesis)

- Anemia of Chronic disease/inflammation
  - Ferritin high, Fe low, TIBC low, Fe/TIBC >18% (low-normal)
  - Early Fe deficiency
  - ↓ EPO (Hypothyroid ↓ TSH), renal failure
  - Cancer (i.e. multiple myeloma)
  - Pregnancy (RBC dilution)

- Low/high WBCs

- Reticulocytes: Low/inappropriately normal

- High reticulocytes (Polychromatophilic macrocytes) (marrow is fine)
  - Look at blood smear!

- Low/normal reticulocytes

**Normocytic** (MCV 80-100fL)

(RBCs lost, or less RBCs produced)

- Normal/high WBCs

- High reticulocytes (marrow is fine)

- Low/normal reticulocytes

**Macrocytic** (MCV > 100fL)

(↓ DNA synthesis, ↓ cell division)

- Rule out Reticulocytosis
  - ↑ #s of reticulocytes in blood, due to hemolysis or acute bleeding, may ↑ MCV

- Low WBCs

- Reticulocytes: Low/inappropriately normal

- Low/normal reticulocytes

- High reticulocytes (marrow is fine)

- High reticulocytes: (polychromatophilic macrocytes) (marrow is fine)

**Thalassemia**

- MCV <73fl (very low!)

- Ferritin/Fe/TIBC all normal, Mediterranean/African/SE Asian

- Abnormal Hb
  - ↑ HbA2, Normal HbA
    - β-thal minor
  - ↑ HbH (γ4), HbH bodies, worse anemia
    - HbH disease (3 α-globin gene deletions)
  - ↑ HbH (γ4), HbH bodies, worse anemia
    - HbH bodies (3 α-globin gene deletions)

- Normal RBCs: Acute bleed → hemolysis

**RBC spheroctyes/schistocytes**: Autoimmune or Hereditary spheroctysis → Microangiopathic hemolytic anemia (MAHA): DIC, TTP, HUS

- Abnormal RBCs: Infarct spleen → Sickle cells, target cells, howell-jolly bodies → Hemoglobinopathy (HbS, HbE, HbC) (HbE can be macrocytic)

**Lead poisoning**

(basophilic stippling, sideroblasts)

- Low stomach acid (esp in elderly)

- Ferritin low, Fe low, TIBC high, Fe/TIBC <18%
  - Low retics - ↑ w/ Tx, hypochromic RBCs, spoon nails, pica, stomatitis, glossry tongue
  - Assoc w/ celiac

- Iron deficiency

- ↑ HbA2, Normal HbA
  - β-thal minor

- ↑ HbF, NO HbA,
  - Hemolysis triad, erythroid bone expansion → β-thal major

- ↑ Hbh (γ4), HbH bodies, worse anemia
  - Hbh disease (3 α-globin gene deletions)

- 4 α-globin gene deletions = hydrops fetalis: Hb Barts (γ4)!

- In >50yr old with normocytic/macrocytic anemia, high calcium, bone pain, renal issues/low albumin → multiple myeloma

- Low RBC folate, High Hcy only (alcoholic?)
  - Folate deficiency, ↑ need, malabsorption

- Low Serum B12, High Hcy, high MMA, (red tongue)
  - B12 deficiency, malabsorption, ↑ need

- Corrected w/ IF (pernicious anemia: antibodies against IF/parietal cells)

- Not corrected w/ IF

- Parasites

- RBCs in Rouleaux formation (multiple myeloma) – false ↑ in MCV due to RBC agglutination

- Target cells, normal WBCs
  - Liver disease (more lipids in RBC membrane)

- Low RBCs

- ↑ HbA2, ↑ HbF, NO HbA,
  - Hemolysis triad, erythroid bone expansion → β-thal major

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- In >50yr old with normocytic/macrocytic anemia, high calcium, bone pain, renal issues/low albumin → multiple myeloma

- No terminal ileum (Crohn’s, celiac, resections)
  - Deficiency, ↑ need
  - Pancreatic disease (no proteases)

- Low stomach acid (esp in elderly)

- Dysplasia (i.e. Myelodyplasia – bi-lobed neutrophils)

- RBCs in Rouleaux formation (multiple myeloma) – false ↑ in MCV due to RBC agglutination

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- Low stomach acid (esp in elderly)
Anemia ([Hgb] < 120g/L)

**Treatments**

- **Microcytic** (MCV < 80fL)
  - Rule out Reticulocytosis
  - Dysplastic (i.e. Myelodysplasia)
  - Normal blood smear → remove offending drug

- **Normocytic** (MCV 80-100fL)
  - Low WBCs (pancytopenia)
  - Low/normal retics
  - High retics (polychromasia)

- **Macrocytic** (MCV > 100fL)
  - Normal WBCs
  - Low/normal retics

- **Lead poisoning** (lead chelation)
- **Iron deficiency** → oral iron (high dose, low compliance)
- **IM/IV iron** (for low oral tolerance, permanent iron malabsorption)

- **Thalassemia**
  - Dx: Ethnicity, family Hx, blood smear (HbH bodies), HPLC, Hgb electrophoresis
  - **β-thalassemia** → seen only after 6 mon of life (after γ-globins stop being made)
  - → High HbA2, HbF
  - **α-thal trait** → No Tx
  - **HbE**

- **Sickle-cell Anemia (HbSS):**
  - Sx: 1) vaso-occlusion of spleen, hands/feet, liver, brain, bones...; 2) hemolysis – RBCs abnormal; 1+2 → 3) end-organ damage
  - Dx: HPLC, Hgb electrophoresis
  - Tx: prevent infection w/ abx, hydration, pain control, O2 (↓ sickling), transfusion, avoid hypoxia, immunization re encapsulated bacteria.

- **B12-deficiency**
  - Not corrected w/ IF
  - IM B12 injections (replenish stores)
  - Oral B12 (high dose, 1000ug)
  - (1% not absorbed through IF pathway)

- **Folate Deficiency**
  - oral supplement
  - rarely parenteral

- **Normal RBCs:** Acute bleed, hemolysis
- **RBC spherocytes/ schistocytes:**
  - Autoimmune or Hereditary spherocytosis
  - Microangiopathic hemolytic anemia (MAHA)

- **β-thal major**
  - smear: target cells, nucleated RBCs
  - Tx: lifelong transfusion w/ iron chelation (IV or oral)
- **β-thal Minor** → B/B0 or B/B+ → no Tx

- **Infiltrative (acute leukemia)** → chemo/hormonal cancer tx

- **β-thal trait**
  - B/B0 or B/B+
  - No Tx

- **HbH disease**
  - No Tx

- **Normal/high WBCs**
- **Low WBCs** (pancytopenia)
- **Low/normal retics**
  - **High retics** (polychromasia)

- **HbE**

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- **Thalassemia**
  - Dx: Ethnicity, family Hx, blood smear (HbH bodies), HPLC, Hgb electrophoresis

- **Normal blood smear**

- **Aplastic anemia**
  - → stop causative agents & supplement B12/Folate.
  - → Supress T-Cells w/ Antithymocyte Globulin, steroids, cyclosporin
  - → Stem cell transplant
  - → supportive care (transfuse, antibiotics, etc)

- **Macrocytic (MCV > 100fL)**
  - Normal blood smear
  - Rule out Reticulocytosis

- **Thalassemia**
  - Dx: Ethnicity, family Hx, blood smear (HbH bodies), HPLC, Hgb electrophoresis

- **HbE**

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