ANEMIAS
Anemia is usually a symptom, that is associated with another disease, e.g. with chronic inflammation or with malignancy.

**Definition:**
Red Blood Cell Count (**RBC**), or other laboratory parameters (**HGB**, **PCV**) are lower than normal.

**Male:**
- **RBC**: < 4.4 T/l
- **HGB**: < 135 g/l
- **PCV**: < 0.40 l/l

**Female:**
- **RBC**: < 3.8 T/l
- **HGB**: < 120 g/l
- **PCV**: < 0.37 l/l
Classification of Anemias

I. BLOOD LOSS:
   a. acute: traumatic shock,
   b. chronic: gynecological or gastrointestinal diseases.

II. HEMOLYTIC ANEMIAS:
   a. intrinsic (intracorpuscular) abnormalities:
      1. abnormalities of cytoskeleton,
      2. enzyme deficiencies,
      3. disturbances of hemoglobin synthesis.
   b. extrinsic (extracorpuscular) abnormalities:
      1. antibody mediated,
      2. mechanic traumas of RBCs,
      3. infections.

III. ABNORMAL RBC DEVELOPMENT
Thalassemia Peripheral Blood
## Classification of Anemias

<table>
<thead>
<tr>
<th>Size of RBC (MCV)</th>
<th>Hb Content of RBC (MCH)</th>
<th>Hypo-Aregenerative Anemias</th>
<th>Regenerative Anemias</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Normocytic</strong></td>
<td>Normochromic</td>
<td>Aplastic Anemias</td>
<td>Hemolytic anemias</td>
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<td></td>
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<td></td>
<td>Anemia due to Acute Blood Loss</td>
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<tr>
<td><strong>Microcytic</strong></td>
<td>Hypochromic</td>
<td>Iron deficiency Anemia</td>
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</tr>
<tr>
<td><strong>Macrocytic</strong></td>
<td>Hyperchromic</td>
<td>Megaloblastic Anemias</td>
<td></td>
</tr>
</tbody>
</table>
Laboratory Diagnosis of Anemias

**RBC**: 3.8-5.5 T/l  
**WBC**: 4-10 G/l  
**MCV**: 80-95 fl  
**PLT**: 150-400 G/l  
**MCH**: 28-33 pg  
**MCHC**: 320-360 g/l  
**HGB**: 120-180 g/l  
**PCV**: 0.37-0.52 l/l  

**Reticulocyte count (relative to RBC)**: 0.5-2.0 %
Blood Chemistry

Serum Iron: 10-36 μmol/l
TIBC: 45-80 μmol/l
Transferrin saturation: 0.2-0.5
   (Quotient of serum iron and TIBC)
Haptoglobin concentration: 6-28 μmol/l
   (its level decreases during hemolysis)
Examinations

Medical history, Symptoms and Findings:

a. Medical History: nutritional habits, dyscoloration of urine and stool, gynecological history, previous diseases: chronic inflammation, malignancy.

b. Symptoms: weakness, fatigue, short of breath, palpitation, angina pectoris, headache, sleeping problems, flattened nails, dry skin, hair loss, digestive disorders, motivelessness (DD: depression).

c. Findings: pallor (conjunctiva, nail bed), systolic murmur, tachycardia, jaundice, splenomegaly, paresthesia, glossitis.

Symptoms and findings depend on the type of anemia and its duration.
Laboratory examinations I.

**Basic:**
- Blood test, thrombocyte- and reticulocyte count, BSR,
- Urine test,
- Serum: creatinine, bilirubin, LDH, iron, ferritin, haptoglobin, hemopexin,
- Blood in stools.

**If cause of anemia is not clear:**
- Gastroscopy, colonoscopy, gynecological examination,
- Special laboratory tests: Schilling-test, direct and indirect Coombs test, Hgb-electrophoresis in thalassemia and sickle cell anemia,
- Bone marrow smear.
Laboratory examinations II.

*In vivo examinations:*
1.) Schilling test,
2.) Life span of RBCs.

*In vitro examinations:*
1.) serum ferritin level,
2.) serum vitamin $B_{12}$ level,
3.) serum and RBC folic acid level,
4.) erythropoietin level.
## Laboratory Diagnosis of Hypochromic Anemia

<table>
<thead>
<tr>
<th></th>
<th><strong>Iron deficiency Anemia</strong></th>
<th><strong>Anemia due to Chronic Inflammation or Malignancy</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MCV</strong></td>
<td>Decreased, depending on the severity of anemia</td>
<td>At the lowest level of the normal range or decreased</td>
</tr>
<tr>
<td><strong>MCH</strong></td>
<td></td>
<td></td>
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<tr>
<td><strong>MCHC</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Serum iron</strong></td>
<td>decreased</td>
<td>decreased</td>
</tr>
<tr>
<td><strong>TIBC</strong></td>
<td>elevated</td>
<td>decreased</td>
</tr>
<tr>
<td><strong>Bone marrow iron storages</strong></td>
<td>empty</td>
<td>normal</td>
</tr>
</tbody>
</table>
Iron Deficiency Anemia Peripheral Blood
Causes of Iron Deficiency Anemia

1. Chronic Blood Loss
   - gynecological bleeding,
   - gastrointestinal bleeding
   - rarely hematuria, hemoglobinuria.

6. Increased Needs
   - preterm neonates,
   - puberty,
   - pregnancy.

11. Nutritional Habits

13. Malabsorption
   - gastrectomy, celiac disease.
Causes of Vitamin $\text{B}_{12}$ Deficiency

1. Nutritional:
   vegetarianism

2. Malabsorption:
   a. Gastric origin:
      lack of IF, pernicious anemia, gastrectomy.
   b. Bowel origin:
      diverticulosis, blind loop syndrome, bowel resection, inflammatory bowel diseases.
Folic acid deficiency

1. **Nutritional:**
   - alcoholism, starvation, elderly patients, nutritional habits.

2. **Malabsorption:**
   - gastrectomy, bowel resection, inflammatory bowel diseases, celiac disease.

3. **Increased consumption:**
   - pregnancy, breast feeding, preterm neonates,
     inflammatory diseases: rheumatoid arthritis, psoriasis,
     hematological diseases,
     malignant diseases.

4. **Medical treatment**
   - antiepileptics,

5. **Others:**
   - active liver disease,
   - heart failure.
Megaloblastic Anemia  Peripheral Blood
Megaloblastic Anemia Bone Marrow