

## BLI Class 1 Notes

Blood -liquid connective tissue

1. Blood is made of formed elements and plasma

Complete Blood Count (CBC)

1. RBC count
2. Hemoglobin
3. Hematocrit
4. RBC indices
  - a. MCV
  - b. MCH
  - c. MCHC
  - d. RDW
5. WBC/with differential
  - a. Neutrophils
  - b. Eosinophils
  - c. Basophils
  - d. Monocytes
  - e. Lymphocytes
6. Platelet count

Any value – normal, low, high

Red blood cell count (**Erythrocyte** count)/RBC count

1. Reticulocyte (new circulating RBC)
2. Biconcave – spectrin of cytoskeleton
3. Life span 120 days – spleen
4. Male has more RBC.
5. Increased (Erythrocytosis)
  - a. Sever COPD (emphysema, chronic bronchitis)
  - b. High altitude (secondary polycythemia)
  - c. Primary polycythemia (Polycythemia vera)

- d. Congenital heart disease
- e. Severe dehydration
- 6. Decreased = anemia (**decrease of RBC and/or decrease of Hg**)
  - a. Hemorrhage
  - b. Bone marrow failure
  - c. Kidney disease – erythropoietin (EPO)
  - d. Hemolytic anemias (premature destruction of RBC, less than 120 days)
  - e. Hemoglobinopathies (Thalassemia, Sickle cell anemia)
  - f. Malignancies – leukemia, lymphoma, multiple myeloma
  - g. Dietary deficiencies – **Fe def**, B12 def, Folate def
  - h. Normal pregnancy

Hemoglobin (Hg) – (Hemoglobin A =  $\alpha_2\beta_2$ )

- 1. Increased
  - a. Polycythemia
  - b. Dehydration
  - c. Extreme physical exercise
  - d. Burns
- 2. Decreased = anemia (even if the RBC count is normal)

Hematocrit (Hct)

- 1. The percentage volume of RBC in given volume of blood (measures percentage of formed elements). Formed elements 45% and 55% plasma
- 2. (Male 40-54%, F 37-47%)
- 3. Increased
  - a. Same as RBC
- 4. Decreased = anemia

**Patient presents with fatigue, palpitations, pallor. Blood work shows low RBC, Hg, Hct = anemia.** Have look at more blood tests. Which is next test you would like to see?

RBC indices (measured and calculated studies)

- 1. **MCV (Mean corpuscular volume) – size of single RBC (80-100)**
  - a. Normal = Normocytic anemia – Acute blood loss, hemolytic anemia, bone marrow failure

- b. Decreased (<80) = Microcytic anemia – Fe (iron) deficiency anemia, thalassemia, anemia of chronic disease
- c. Increased (>100) = Macrocytic anemia – Vitamin B12 def (Pernicious anemia), Folate (folic acid) def, chronic liver disease, hypothyroidism
- 2. MCH (Mean corpuscular hemoglobin) – amount of Hg per RBC
  - a. Normal: normochromic (Acute bleeding – Normocytic normochromic anemia)
  - b. Decreased – hypochromic: Fe def, thalassemia, **lead poisoning**, sideroblastic anemia, anemia of chronic disease I
    - Microcytic hypochromic anemia – Fe def (Low RBC, Low Hg, Low Hct, low MCV and low MCH)
  - c. Increased – hyperchromic – Vitamin B12 def, Folate def
    - **Macrocytic Hyperchromic anemia**
- 3. MCHC (Mean corpuscular hemoglobin concentration) -measures average amount of hemoglobin in a single RBC
- 4. RDW (Red blood cell distribution width) – normal variation 11.5 -16.9%
  - a. Increased – Fe def, B12 def, Folate def, hemoglobinopathies, hemolytic anemia
    - Low RBC, Low Hg, Low Hct, **low MCV** and low MCH, **Increased RDW**

Patient 1 presents with fatigue, palpitation, pallor. Blood test shows following

- 1. RBC low
- 2. Hg low
- 3. Hct low
- 4. MCV normal (Normocytic)
- 5. MCH normal (Normochromic)
- 6. RDW normal

What is possible cause of this presentation? What is the most likely type of anemia?

Normocytic normochromic anemia – acute blood loss, hemolysis and bone marrow failure

BP is falling in this patient (acute bleeding)

Patient starts to look yellow (jaundice) = hemolysis

Patient 2 presents with fatigue, palpitation, pallor. Blood test shows following

1. RBC low
2. Hg low
3. Hct low
4. MCV low (Microcytic)
5. MCH low (Hypochromic)
6. RDW increased

Microcytic hypochromic anemia – Fe deficiency (Dif dg: thalassemia, anemia of chronic disease)

What would you like to see next? Iron (Fe) in blood and related tests.

1. Iron (Blood)
  - a. Normal – that it is not iron def
  - b. **Low – chronic blood loss** (menstruation, males- GI ulcer)
  - c. High – Supplements, hemochromatosis. Blood transfusion
2. **Ferritin – iron storage molecule – low (iron is in low amount in red bone marrow)**
3. TIBC - total iron binding capacity, indirectly measures transferrin levels
4. Transferrin – protein that carries iron
5. Transferrin saturation – how much serum iron is bound to the protein

Patient 2 presents with fatigue, palpitation, pallor. Continued

6. RBC low
7. Hg low
8. Hct low
9. MCV low (Microcytic)
10. MCH low (Hypochromic)
11. RDW increased
12. Iron – low
13. TIBC – high
14. Transferrin – low

15. Transferrin saturation – low

16. Ferritin – low (if normal or high – not Fe def)

Why does this patient have Fe def. (most common reason in US **chronic blood loss**)

Symptoms of iron poisoning – severe vomiting, abdominal pain, bloody vomit and stool, cyanosis, rapid weak pulse, lethargy, coma

Iron deficiency – desire to eat peculiar thing (ice), swollen spleen, swollen tongue, brittle nails, pale skin and pale nail beds.

### **Total WBC count**

1. Increased - leukocytosis
  - a. **Infection**
  - b. **Severe inflammation (systemic)**
  - c. Malignancy
  - d. Trauma
  - e. Stress
  - f. Hemorrhage
  - g. Dehydration
2. Decreases – leukopenia
  - a. Bone marrow failure
  - b. Bone marrow infiltration
  - c. Severe overwhelming infection
  - d. Dietary deficiencies
  - e. Hypersplenism

Total WBC/with differential – total amount of WBC per mm<sup>3</sup> and percentage of each type WBC in this amount

1. Neutrophils (50-70%) – bacteria, acute inflammation
2. Eosinophils – allergies or parasites
3. Basophils (0-1%) – allergic reaction
4. Monocytes
5. Lymphocytes (20-40%) (T cell and B cell) – viral infection

WBC – cancer (**leukemia**, lymphoma), inflammation, infection

**Platelet count (thrombocytes) – (fragments of megakaryocytes) – 150,000-400,000**

1. Platelet function = stop bleeding by creating platelet plug. Low – bleeding, High – clot
2. Decreased
  - a. Bone marrow suppression – bleeds, infections, anemia
  - b. Bone marrow failure
  - c. Bone marrow infiltration
  - d. Chemotherapy
  - e. Platelet **autoantibodies**
  - f. Hypersplenism
  - g. Drugs – aspirin
  - h. Infection
    - HIV: decreased number and decreased function, and survival
  - i. <20,000
3. Increased
  - a. Acute blood loss
  - b. Infection
  - c. Inflammation
  - d. Leukemia
  - e. **Iron deficiency anemia**
  - f. Malignancies

Patient 3 presents with frequent nose bleeds. CBC – low platelets (can be normal platelets and still be platelet issue)

**Coagulation panel**

1. Platelet count (Screening test in CBC)
2. Platelet antibody test – looks autoantibodies against platelets
3. Platelet aggregation test – this test looks at the platelet function (useful if platelets are normal amount, but presents as deficiency)
4. **Bleeding time** – creating small cuts in patients skin and looking how quickly it stops bleeding
  - a. Bleeding time is increased (prolonged) if low platelet count or low functional capacity

b. 2-7 minutes

Which test would show the function of platelets? Bleeding time or platelet aggregation test

Coagulation cascade – Screening test – PT and PTT

1. Prothrombin time (PT)
  - a. Examines **extrinsic pathway** and common pathway clotting factors **-I, II, V, VII, X**
  - b. Vitamin K dependent coagulation factors
  - c. Can be used to assess the adequacy of Warfarin (Coumadin)
  - d. Prothrombin is produced in liver
  - e. Increased time – liver disease, coumadin therapy, alcohol use, salicylate intoxication, DIC (disseminated intravascular coagulation), vitamin K deficiency
  - f. Decreased time – diet high in fat or green leafy vegetable (contain vitamin K)
2. Partial thromboplastin time (PTT, aPTT )
  - a. Examines **intrinsic** and common pathway factors I, II, V, VIII, IX, X, XI, **XII**
  - b. Can be used to assess the adequacy of **heparin therapy**
  - c. Increased time – Heparin, liver disease, DIC, hemophilia, Sepsis, autoantibodies against factors
  - d. Decreased time – DIC, extensive cancers
3. Thrombin time (TT)
  - a. To see how well fibrinogen is working
  - b. Prolonged by heparin
4. Coagulation factor concentration (Clotting factor assay)
  - a. Factor VIII (Hemophilia A), Factor IX (Hemophilia B)
5. Fibrinogen (Fibrinogen is converted to fibrin that secures platelet plug)
6. **Plasminogen (Active form is Plasmin)** – enzyme that breaks down proteins including fibrin (erases or dissolves clots) (tPA medication to dissolve clots)
  - a. Decreased PLG levels – DIC, liver disease, Hyperthyroidism, Thrombolytic therapy
  - b. Increased PLG levels – anabolic steroids, hypothyroidism, hormonal contraceptives

Screening test for bleeding disorders – Platelets, bleeding time, PT, PTT

INR = international normalized ration (Patient PT/Normal mean PT)

Warfarin therapy – Keep INR between 2.0-3.0