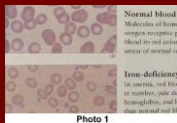


ERYTHOCYTE DISORDERS



ANEMIA

- Decreased Ability to Carry O₂ to Tissues
 - Erythrocyte Loss
 - Impaired Production
- Steady State = Production x Survival

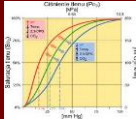


VOLUME CHANGES

- Hypervolemia – Increase in Plasma, RBC Steady
 - Pregnancy, Oliguria, Renal Failure, Congestive Heart Failure, Congested Splenomegaly, Chronic Disease, Hypoalbuminemia, Recumbent Posture
- Hypovolemia – Decrease in Plasma, RBC Steady
 - Dehydration, Stress, Diabetic Acidosis, Intestinal Malfunction

ADAPTIVE MEASURES

- Increase Oxygenated Blood Flow to Tissues
 - Increase Cardiac Output and Rate
 - Increase Circulation Rate
 - Increase Circulation to Vital Organs
- Increase Oxygen Utilization by Tissues
 - Increase 2,3-DPG
 - Decrease Affinity of Hemoglobin due to Bohr Effect



DIAGNOSIS

- Patient History
- Physical Exam
- Laboratory Investigation



LABORATORY TESTS

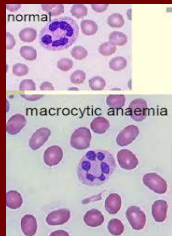
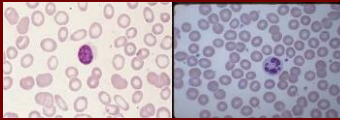
- RBC Counts
- Hgb
- HCT
- Effects of Age, Altitude, and Smoking

ERYTHOCYTE INDICES

- Mean Cell Volume - MCV
- Mean Corpuscular Hemoglobin - MCH
- Mean Corpuscular Hemoglobin Concentration - MCHC
- Red Cell Distribution Width - RDW

MCV

- $MCV (fL) = HCT (L/L) / RBC (x10^9) \times 1000$
- Normocytic = 80-100 fL
- Microcytic = <80 fL
- Macrocytic = >100 fL



MCH

- $MCH (pg) = Hgb (g/dl) \times 10 / RBC (X 10^9)$
- MCH does not take into account of the size of the cell. Use MCV to interpret results.
- 26-34 pg

MCHC

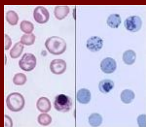
- $MCHC (g/dL) = Hgb (g/dl) / HCT (L/L)$
- Normochromic = 32-36 g/dL
- Hypochromic = <32 g/dL
- Hyperchromic = >36 g/dL

RED CELL DISTRIBUTION WIDTH

- $SD \text{ of } MCV \times 100 / \text{mean } MCV = RDW$
- Reference Range 11.5-14.5%

RETICULOCYTE COUNT

- Reference Range 0.8-4% or $18-158 \times 10^9$
- Absolute Count = $RBC \times \text{Reticulocyte Count}$
- Corrected Reticulocyte Count = $\text{Patient HCT} / \text{Normal HCT} \times \% \text{ Reticulocyte}$



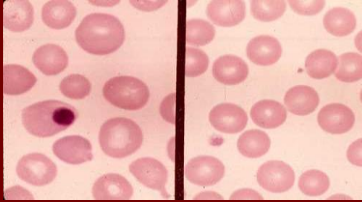
RETICULOCYTE PRODUCTION INDEX

- RPI =
Patient HCT/ 0.45 L/L x
Retic %/Retic Maturation Time

RPI > 2 = Appropriate Response
RPI < 2 = Inadequate or Ineffective Response

BLOOD SMEAR EVALUATION

- 7 μ m Biconcave Discocyte
- Anisocytosis = Variation in Size
 - Slight, Moderate, Marked 1-4+

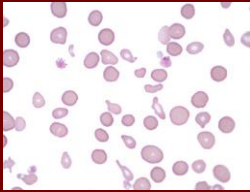


ANISOCYTOSIS

- Macrocytes = >8 μ m, MCV >100 fL
 - Vitamin B12 or Folate Deficiency, Hemolytic Anemia, Liver Disease, Asplenia, Aplastic Anemia, Myelodysplasia, Endocrinopathies
- Microcytes = <7 μ m, MCV <80 fL, can be hypochromic or normochromic
 - Iron Deficiency Anemia, Thalassemia, Sideroblastic Anemia

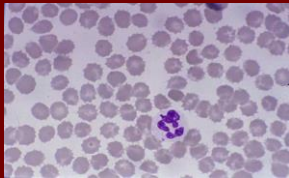
BLOOD SMEAR EVALUATION

- Poikilocytosis – Variation in Shape
 - Slight, moderate, marked 1-4+



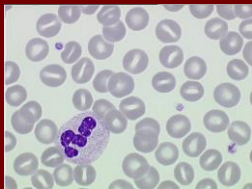
ECHINOCYTES

- Burr cells, Crenated Cells
 - Artifact, Liver Disease, PKU, Peptic Ulcers, Ca of Stomach, Heparin Therapy



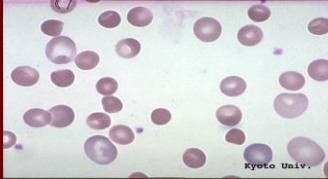
STOMATOCYTES

- Cup-shaped, Mouth Cell, Mushroom Cap, Uniconcave Disc
 - Hereditary Stomatocytosis, Spherocytosis, Alcoholic Cirrhosis, Lead Intoxication, Neoplasms



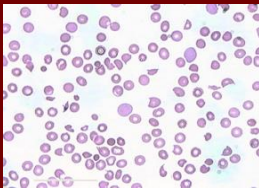
SPHEROCYTOSIS

- No Biconcavity, no central pallor, Increased Osmotic Fragility
 - Hereditary Spherocytosis, Immune Hemolytic Anemia, Severe Burns, ABO Incompatibility, Heinz Body Anemia



SHISTOCYTES

- Fragmented Cells
 - Microangiopathic Hemolytic Anemia, Heart Valve Hemolysis, DIC, Severe Burns, Uremia



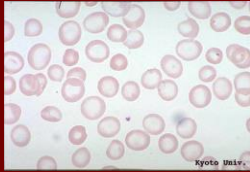
ACANTHOCYTOSIS

- Spur Cell, irregular thorn like projections
 - Abetalipoproteinemia, Alcoholic Liver Disease, Disorders of Lipid Metabolism, Post Splenectomy, Fat Malabsorption, Retinitis Pigmentosis



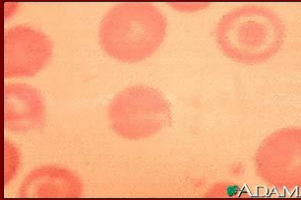
LEPTOCYTOSIS

- Thin Cell
 - Thalassemia, Iron Deficiency Anemia, Hemoglobinopathies, Liver Disease



CODOCYTES

- Target cells, Mexican Hat Cells
 - Thalassemia, Hemoglobinopathies, Obstructive Liver Disease, Iron Deficiency Anemia, Splenectomy, Renal Disease, LCAT Deficiency



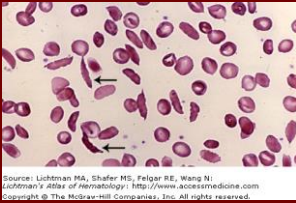
DACRYCYTES

- Teardrop, elongated at one end, Pear Shaped
 - Thalassemia, Myelofibrosis, Metastatic Cancer to Bone Marrow



DREPANOCYTES

- Sickle Cells, Elongated Crescent Shaped with Pointed Ends
 - Sickle Cell Anemia



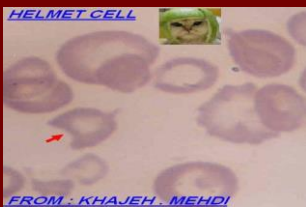
ELLIPTOCYTES

- Pencil Cells, Cigar Cells, Elongated or Rod Like
 - Hereditary Elliptocytosis, Iron Deficiency Anemia, Thalassemia, Anemia Associated with Leukemia



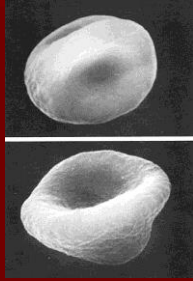
KERATOCYTE

- Helmet Cells, Concavity on one side and 2 hornlike projections on either end
 - Microangiopathic Hemolytic Anemia



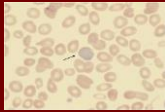
KNIZOCYTE

- 2 Concavities
– Associated with Spherocytosis



VARIATION IN HEMOGLOBIN

- Normal = MCH 30 pg
- Hypochromic = Central Pallor > 1/3 cell
- Polychromatophilic = Bluish Tinge larger than normal (Reticulocytes)
- Hyperchromic = Not usually Used



ERYTHROCYTE INCLUSIONS

- Particulate Matter found in RBC can mean certain disease states

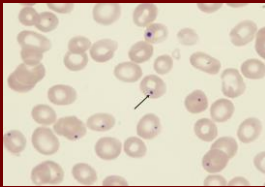
BASOPHILIC STIPPLING

- Bluish Black Granular Inclusions
 - Artifact, Lead Poisoning, Thalassemia



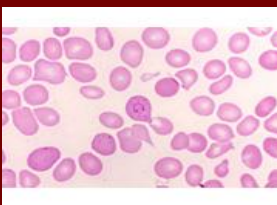
HOWELL-JOLLY BODIES

- Dark Purple or Violet Spherical Granules
 - Post Splenectomy, Megaloblastic Anemia, Some Hemolytic Anemia, Severe Anemia



CABOT RINGS

- Figure Eight, Ring or Incomplete Ring
 - Severe Anemia, Dyserythropoiesis



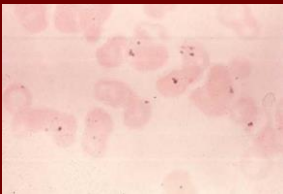
HEINZ BODIES

- Purple bodies not seen with Wright's Stain
 - G6PD Deficiency, Unstable Hemoglobin Disorders, Oxidizing Drugs or Toxins, Post Splenectomy



SIDEROBLASTS AND SIDEROCYTES

- RBC with Iron Granules, use Prussian Blue or Iron Stain
 - Iron Stores and some Disease States



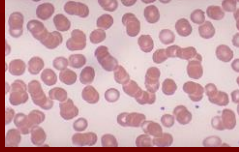
PAPPENHEIMER BODIES

- Iron Containing Granules at Periphery of Cell, Visible with Wright's and Prussian Blue Stain
 - Sideroblastic Anemia, Thalassemia, Other Severe Anemia



VARIATION IN RBC DISTRIBUTION

- Rouloux = Erythrocytes stacking, resembles coins
 - Multiple Myeloma, Other Gammopathies
- Agglutination = RBC sticking together
 - Cold Agglutination, Autoimmune Hemolytic Anemia



CLASSIFICATION OF ANEMIA

- Morphological – Size and Hgb Concentration Using RBC Indices
- Functional –
 - Proliferative
 - Maturation
 - Survival
