Human Physiology

Lecture 2 – Monday 15/2/2016

"Composition and function of plasma & function of plasma proteins" with Dr. Khalid Talafih

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PharmaGlory 15

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Note: The book is "Essentials of Physiology"/"Fundamentals of Physiology" by Sherwood.

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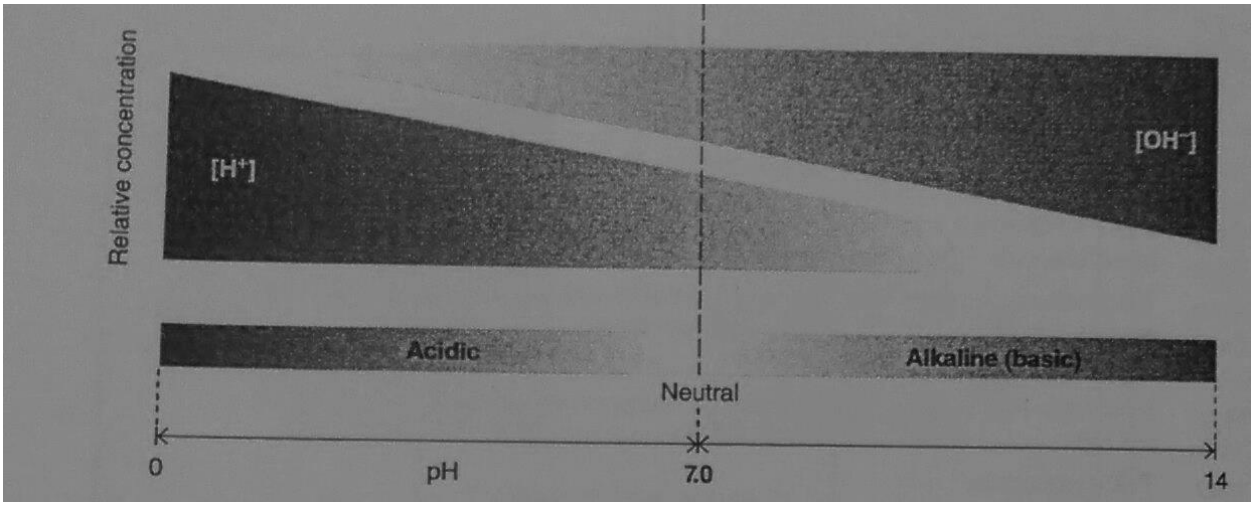
Note: RBC= Red Blood Cell, ECF= Extracellular Fluid

- **Blood** is a type of connective tissue – and one of its major function is to transport Oxygen from the lungs to the tissues by Hemoglobin & transport of CO_2 (waste product) from the tissue to the lungs by plasma as Bicarbonate. Blood is composed is of a fluid part called plasma, and formed elements (like RBCs). It is about 3-4 times thicker than water.
- The **pH** of a solution is the **concentration of H^+ ions** in it.



  - H_2O/pure water has a pH of 7.
  - A pH less than 7 is considered **acidic**, and anything greater than 7 is considered **alkaline/basic**.
  - An increase in H^+ concentration makes the solution more acidic, with a lower pH.
  - A decrease in H^+ concentration makes the solution more basic, with a higher pH.

- The pH of blood in our body:
  - The pH of blood in **artery** systems (**oxygenated**): 7.45
  - The pH of blood in **vein** systems (**deoxygenated**): 7.35
  - The pH of capillary systems: 7.35 – 7.45 (because of the exchange of O_2 and CO_2)
  - Therefore blood is considered "slightly alkaline" or "slightly basic".
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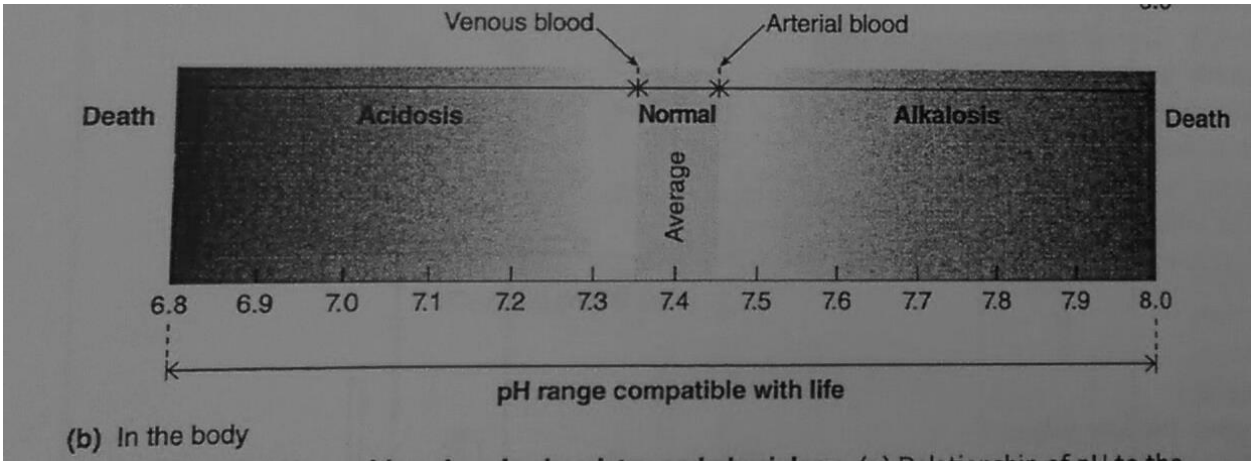
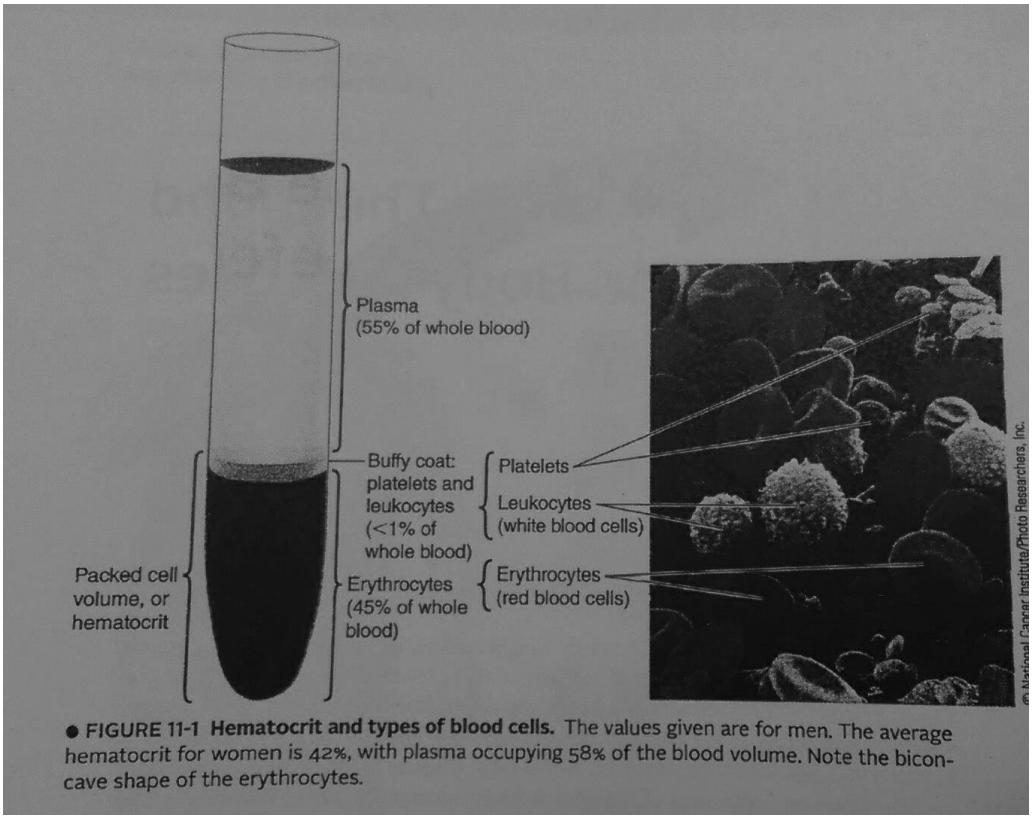


Acidosis occurs when blood pH falls below 7.35.

Alkalosis occurs when blood pH rises above 7.45.

- Extreme alkalosis (8.0) or extreme acidosis (6.8) can cause death.
- Experiments to obtain plasma/serum:
  - Take 2 test tubes & add the same amount of blood to them.
  - To the first test tube, add **anticoagulant** (anticoagulant: prevents blood clotting = مضاد للتخثر).
  - Do not add anything to the second tube & leave it in the room for a few minutes for it to clot.
  - Then put them in a centrifuge to get their components separated.

- First tube: We will obtain plasma & hematocrit (RBCs), separated by a small buffy coat (that contains white blood cells and platelets).



● FIGURE 11-1 **Hematocrit and types of blood cells.** The values given are for men. The average hematocrit for women is 42%, with plasma occupying 58% of the blood volume. Note the biconcave shape of the erythrocytes.

  Blood is 45% RBCs, <1% WBCs & platelets, and 55% plasma (the fluid).

- Second tube: We will obtain **serum** (the same composition of plasma but without the protein fibrinogen, and clotting factors II, V, VIII… and serotonin is present in higher concentration in serum)

- **Hematocrit** is the percentage of RBCs in whole blood.

  Its normal values are:

  40-50% for male adults

  35-45% for female adults

  45-60% for newborns.

- The reason for the difference in hematocrit between adults and newborns:
  In placentas, the amount of Oxygen is less than the outside atmosphere… this results in production of more RBCs. 1-3 days after birth, this percentage (45-60%) starts to drop as the extra RBCs are destructed.

  [عندما يكون الطفل داخل الرحم، كمية الاوكسجين الموجودة أقل من الكمية الطبيعية، و هذا يؤدي إلى إنتاج المزيد من خلايا الدم الحمراء]
- Plasma is 7-9% protein.
- The major function of plasma proteins is transport.
- The major plasma protein is Albumin (4.5g/100mL), with 45-60% of total plasma proteins being Albumin.
  Albumin works to regulate blood volume.
  (Note: ECF = plasma and tissue fluid – tissue fluid has the same composition of plasma EXCEPT no proteins in tissue fluid.)
- During starvation (المجاعة)/liver disease/kidney disease, the amount of plasma proteins decrease. This is because most of the proteins are formed in the liver, and because kidney disease causes proteins to escape from the Bowman's capsule.
  After the amount of plasma proteins start to decrease, H_2O starts to diffuse from blood plasma to tissue fluid.
  Albumin works to prevent all the diffusion of H_2O from plasma to tissue fluid.
  [عندما يصاب الإنسان بالمجاعة أو مرض في الكلية/الكبد، تقل كمية البروتينات في البلازما. سبب ذلك هو أن معظم البروتينات تتكون في الكبد... و مرض الكلية يسبب تسرب البروتينات من الدم. قلّة كمية البروتينات تسمح لخروج المياه من البلازما.]

- **Globulin** is the second major plasma protein (40% of total plasma proteins). It has 3 types, alpha/beta/gamma globulin.
- Alpha Globulin: transports lipid/cortisol (hormone).
  Beta Globulin: transports irons, cholesterol hormones, etc.
  Gamma Globulin: produces antibodies (or "immunoglobulin").
- **Fibrinogen** is the third major plasma protein. It takes part in the clotting mechanism (التخثر).
- RBCs are formed from red bone marrow. The diameter of a RBC is about 8 micrometers (μm). Its major function is transport of O_2 by hemoglobin from the lungs to the tissues.
  The membrane of RBCs contains antigens, and these antigens determine our blood groups (A/B/AB/O).
  RBCs have no nucleus, and are full of hemoglobin. A decrease in the amount of hemoglobin leads to **anemia** [فقر الدم] (specifically, "iron-deficiency anemia").
- A decrease in the amount of Oxygen in the body leads to **Hypoxia**.
  Hypoxia leads to more production of RBCs.

Note: The material here is from Chapter 11 ("Blood and Body Defenses", pages 316 to 318) & Chapter 14 ("Fluid and Acid-Base Balance", pages 452 to 454)