Math 29
Worksheet 2
Blood Cells

Background and Definitions. Polycythemia vera is an abnormal increase in the number of blood cells (primarily red blood cells) resulting from excess production by the bone marrow. It is a rare disease that occurs more frequently in men than women, and rarely in patients under 40 years of age. Some people with polycythemia vera also have an increased tendency to form blood clots that can result in strokes or heart attacks. That is why a common treatment for patients with polycythemia vera is to reduce the high blood viscosity (thickness of the blood) due to the increased red blood cell mass. This is done through phlebotomy; that is, drawing blood from the patient until the red blood cell (RBC) count is within the normal range.

1. The number of red blood cells per volume of blood (known as the RBC count) in healthy, human adults ranges from 4.7 to 6.1 million cells per microliter for males, and from 4.2 to 5.4 million cells per microliter in females. Assume that, on average, the volume of a red blood cell is about 8.5×10^{-11} cm^3. Estimate the range for the percent of blood volume that is comprised of red blood cells in human adults (both male and female separately); this percent is known as the hematocrit (HCT).

2. A 150–pound, male patient is found to have a hematocrit value of 55.8%. What is his RBC?

3. Suppose that it is determined (for example, by means of a bone marrow biopsy) that the patient from Problem 2 does have polycythemia and phlebotomy is recommended. Assume that the blood withdrawn from the patient is replenished by the body with an equal volume of mostly plasma material with very few red blood cells; that is, the number of RBCs produced by the body of the patient shortly after the phlebotomy is negligible. If one pint of blood is removed from the patient, estimate the HCT level of the patient after the blood has been replenished by the body. Is this HCT within the expected range? (It is estimated that the blood content in the body of an adult male is about 71 milliliters per kilogram of body weight).

4. Estimate the minimum volume of blood that needs to be drained from the patient in order to bring the RBC count to within the normal range.

5. Blood banks consider that 7–9% of whole blood volume can be removed safely on a single occasion in a person in good health and with a hematocrit

level not less than 38%. Is the minimum amount of blood that needs to be drawn from the patient within this safety margin?