the average adult man and 4.4 million per cubic millimeter in the average adult woman.

Under the microscope, red blood cells appear as thin, round or slightly oval discs. They have an average diameter of 7.5 microns and measure at least 1 micron thick at the center. (One micron equals about 1/25,000 of an inch.) Each cell has a volume of about 90 cubic microns.

The outer membrane of a red blood cell is very elastic, allowing the cell to change its shape as it squeezes through narrow capillaries. Although mature red blood cells do not contain a nucleus, they are still considered living cells, because they contain enzymes that enable them to metabolize glucose and products broken down from glucose.

About 1% of the red blood cells in the blood contain a thin reticulum, or network. These red blood cells, called reticulocytes, have just entered the bloodstream from the bone marrow, where they have been formed by cells known as erythroblasts. Red blood cells have a life span of about 120 days. As they become old and worn out, they are captured and destroyed by macrophages in the spleen and other organs.

The process of red blood cell destruction is called hemolysis. Most of the materials from the destroyed cells are used again for the formation of new cells.

**Hemoglobin.** Each red blood cell contains a large amount of hemoglobin, a protein pigment that is able to bind oxygen molecules in a loosely bound combination. When carrying a full load of oxygen, the hemoglobin, also called oxyhemoglobin, gives the blood its bright red color. In a person of average size there are about 750 grams (26 oz) of hemoglobin, with each gram carrying 1.35 milliliters (0.04 oz) of oxygen. Thus, the total amount of oxygen carried by the blood is about 1,100 milliliters (36.3 oz); this is about the amount that would be consumed in a minute of exercise.

After hemoglobin has delivered its oxygen to the tissues, the blood becomes darker and slightly bluish. On its return trip to the heart, the hemoglobin picks up a small portion of the carbon dioxide that is produced by the cells as a waste product of metabolism. As the red blood cells pass through the capillaries of the lungs, the carbon dioxide is released and oxygen is picked up.

Hemoglobin contains two kinds of components: heme, a red protoporphyrin pigment containing iron, and globin, a colorless protein. Each hemoglobin molecule contains a single molecule of globin bound to four heme groups, with each heme group containing one atom of iron in a bivalent state. Because each gram of hemoglobin contains 3.35 milligrams (1/30,000 of an ounce) of iron, the circulating hemoglobin holds a large portion of the body's iron.

At birth, the blood of a baby has larger red blood cells and contains slightly more hemoglobin than the blood of an adult. In the first month of life, the amount of hemoglobin decreases sharply and the body manufactures smaller, younger red blood cells. The hemoglobin content remains low for about a year. Then a rise begins, and adult values of 14 or 15 grams (0.5 to 0.52 oz) per 100 milliliters (3.5 oz) are reached in the early teens.

**White Blood Cells.** The white blood cells, or leukocytes, differ from the red blood cells in several important ways. Unlike red cells, they are complete cells, possessing a nucleus and varying amounts of granules in their cytoplasm. They are also larger than red cells, measuring from 10 to 20 microns in diameter. In addition, white blood cells are capable of moving about independently and are not merely carried by the bloodstream. They can also move out of the bloodstream, squirming between the cells that line the walls of the blood vessels. Their method of locomotion is similar to that of one-celled organisms known as amebas. There are many forms of white blood cells, red cells, although the normal number of white cells varies according to age. In normal adults there are about 7,000 white blood cells per cubic millimeter of blood. In a newborn infant, there are more than 15,000 and often from 25,000 to 30,000. However, the white blood cell count drops quickly on the third or fourth day of life and then fluctuates from 5,000 to 14,000, until it returns to adult levels by puberty.

The most important members of the white cell family are the granulocytes, lymphocytes, and monocytes. The granulocytes, which are formed in the bone marrow, are classified into three groups—neutrophils, eosinophils, and basophils—on the basis of their affinity for certain dyes. The lymphocytes and monocytes are formed mostly in the lymph nodes and spleen. The approximate distribution of the white cells is as follows: granulocytes, 70%; lymphocytes, 20%; and monocytes, 10%.

The white blood cells serve to protect the body against infection by two methods. In phagocytosis (literally meaning "cell eating"), the cells engulf and digest bacteria, cellular debris, old cells, and other foreign substances. They are also performed by the mobile white blood cells—the neutrophils, eosinophils, and the monocytes. The second method of defense is the production of antibodies. The lymphocytes and plasma cells (cells that enter the blood only when infection occurs) lead in this function.

Whenever infective matter penetrates the body tissue, for example, when a boil develops on the neck, the granulocytes move swiftly into the area, collecting around the bacteria and destroying them. During this process many of the granulocytes degenerate, and their remnants appear in the pus draining from the infection. At the second line of defense, the monocytes attack. These white blood cells have the ability to engulf particles other than bacteria. The monocytes are activated by contact with the infective agent, and they promote the production of antibodies that later attack and destroy the bacteria. In acute infections, such as appendicitis, pneumonia, and meningitis, the granulocytes play the strongest defense role. In indolent infections (ones that progress slowly) such as tuberculosis and malaria, the monocytes dominate the defense. In other infections, including infectious mononucleosis, German measles, and other virus infections, the lymphocytes are active. In all infections, however, the variable activities of the white blood cells are never self-limited. Once the infective agent is gone, the reaction gradually subsides.

**Platelets.** Platelets, or thrombocytes ("clot cells"), are the smallest blood cells, measuring only from 1 to 2 microns in diameter. They are round or oval and named for their plate-like shape and like red blood cells they have a nucleus. Unlike red blood cells, however, contain a few granules and are formed in the central part of the bone marrow. They have a very active life span. After being formed, they circulate in the blood for about a year before dying. The white blood cells, proteins, and carbohydrates contain many platelets. Platelets have the properties of substances that clot and carry substances that are particular chemicals, including substances that cause reactions such as blood, and certain others that aid in blood clotting. They adhere to the surfaces of blood vessels that have injured, the aggregate of platelets can form in stopping the bleeding in the body continuously.

**blood** for blood-forming purposes in the bone marrow. The bone marrow manufactures...