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L7

How fast dose your blood flow

As the blood moves away from the heart, the arteries branch and rebranch many times to carry blood to the various tissues.

The blood goes from the aorta into the smaller arteries and arterioles with greater total-cross-sectional areas the velocity of the blood decreases

Velocity = blood flow/ area

V=Q/A

Q=VA

The average velocity in the aorta 30cm/s; that in a capillary is only about 1mm/s, this low velocity allows time for diffusion of gases to occur

We can calculate the average kinetic energy per volume of (1gm)(1cm^3)of blood as leaves the heart.

KE=1/2mv^2 since average velocity=30cm/s

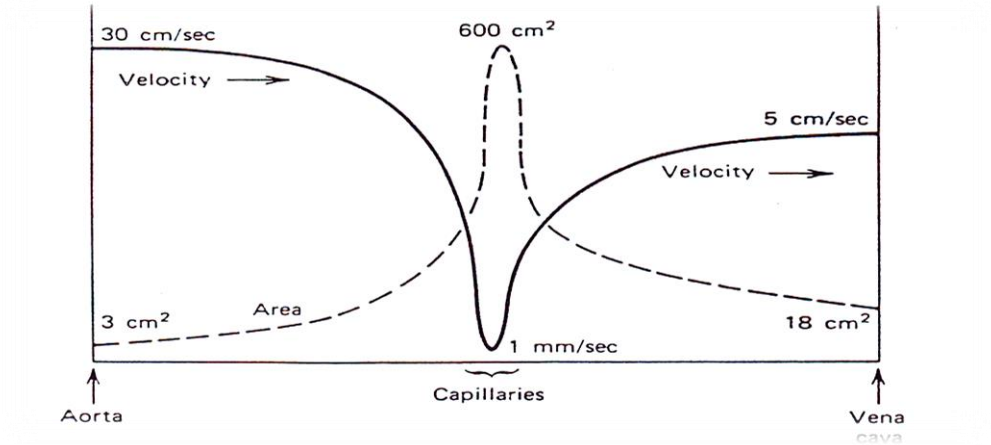
KE= 1/2 x 30^2 = 450 ergs/cm^3 or 450 ergs

This kinetic energy is equivalent to a potential energy 450 dyne/cm^2,

since a pressure of 1mmHg corresponds to 1330 dyne/cm^2, this potential energy amounts to less than 0.4mmHg

The smallest blood vessels are the capillaries(~20µm in diameter)and there are millions of them, the total cross-sectional area=30 cm in diameter.

V in the aorta=30 cm/sec , V in a capillary =1 mm/sec (exchange of O_2 and CO_2).

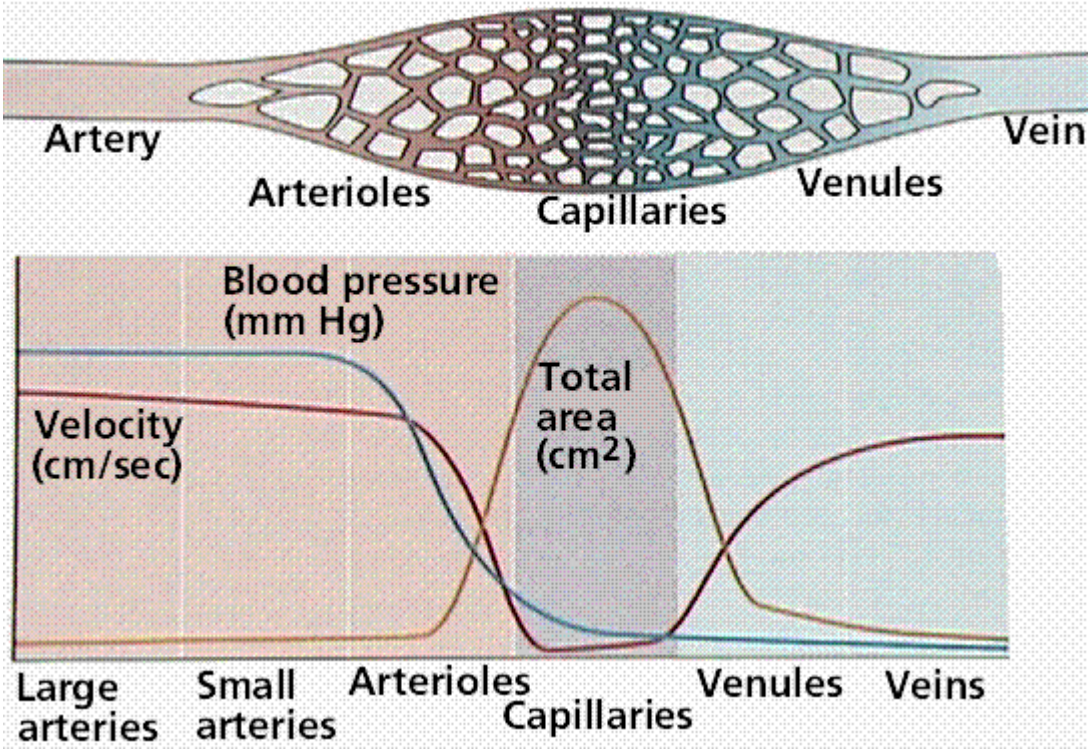


Blood flow through any single capillary is very slow because its diameter is so small (resistance to flow increases inversely with the 4th power of the vessel radius).

However, if you add up all the capillaries in all the vascular beds of the body, the aggregate flow through all of them is exactly the same as it is anywhere else in the vascular system.

Capillaries are a main site of gaseous and nutrient exchange. The blood flow is slow to allow adequate diffusion and osmosis of water, oxygen, carbon dioxide, nutrients and

other waste products.



Viscosity and the physics of some cardiovascular diseases

Viscosity

Viscosity: **is a property of fluid related to the internal friction of adjacent fluid and the wall of the vessel.**

Blood viscosity is a measure of the resistance of blood to flow. It can also be described as the thickness and stickiness of blood.

The viscosity of plasma ≈ 1.8 ×viscosity of water at 37℃ (relative viscosity) and is related to the protein composition of the plasma

Whole blood has a relative viscosity of 3-4 depending on hematocrit, temperature, and flow rate.

1-Hematocrit :(the percentage of red blood cell in the blood) is an important factor effect in viscosity of blood. Is an important factor effect in viscosity of blood .As hematocrit increases, there is a disproportionate increase in viscosity.

The relative viscosity at 0% hematocrit (plasma without cells) is about 1.8 As hematocrit increases, there is a disproportionate increase in viscosity.

At a hematocrit of 40%, the relative viscosity is 4.

At a hematocrit of 60%, the relative viscosity is 8.

Therefore, a 50% increase in hematocrit from a normal value increase in blood viscosity by about 100% .

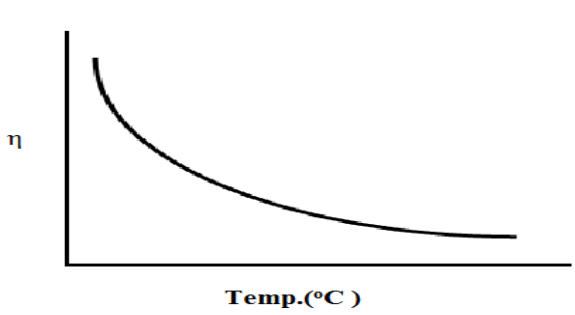
Such changes in hematocrit and blood viscosity occur in patients with an abnormal elevation in red cell hematocrit (polycythemia) have much higher blood viscosities.

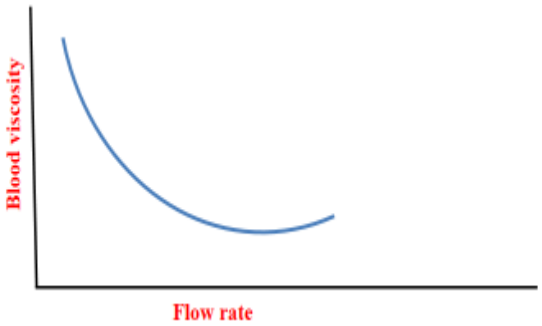
Increased viscosity increases the resistance to blood flow and thereby increases the work of the heart and impairs organ perfusion.

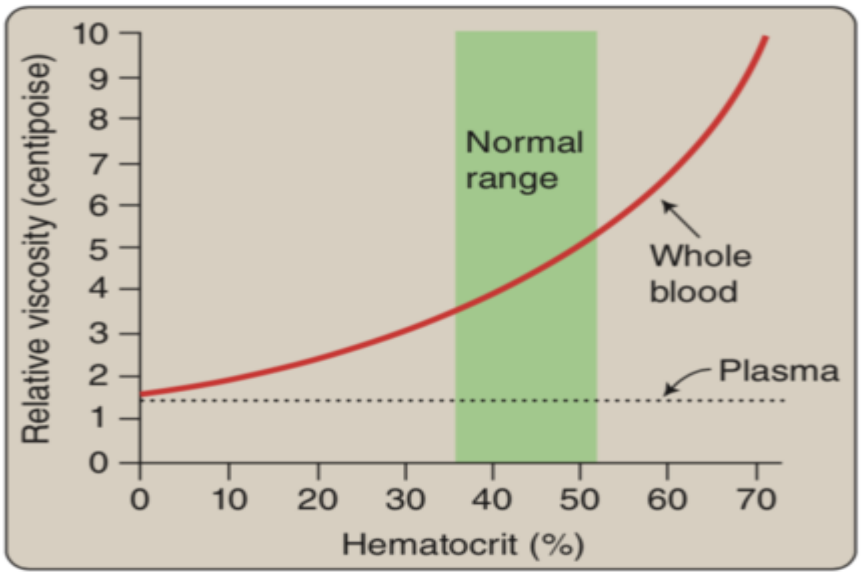
Some patients with anemia have low hematocrits, and therefore reduced blood viscosities.

2- Temperature: when blood gets cold, it becomes "thicker" and flows more slowly. Therefore, there is an inverse relationship between temperature and viscosity. Viscosity increases about 2% for each degree centigrade decrease in temperature.

Normally, blood temperature does not change much in the body. However, if a person's hand is exposed to a cold environment and the fingers become cold, the blood temperature in the fingers falls and viscosity increases. When whole body hypothermia is induced in critical care or surgical situations, this leads to an increase in blood viscosity and impaired organ blood flow.







3-The Flow rate : at very low flow states in the microcirculation ,as occur during circulatory shock , the blood viscosity can increase .This occurs because at low flow states there are increased cell-to-cell and protein –to –cell adhesive interactions that cause erythrocytes to adhere to one another and increase the blood viscosity.