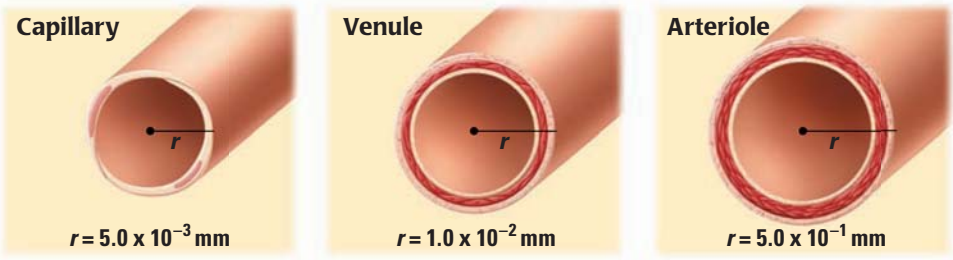
EXAMPLE 5 TAKS REASONING: Multi-Step Problem

BLOOD VESSELS Blood flow is partially controlled by the cross-sectional area of the blood vessel through which the blood is traveling. Three types of blood vessels are venules, capillaries, and arterioles.



a. Let r_1 be the radius of a venule, and let r_2 be the radius of a capillary. Find the ratio of r_1 to r_2. What does the ratio tell you?

b. Let A_1 be the cross-sectional area of a venule, and let A_2 be the cross-sectional area of a capillary. Find the ratio of A_1 to A_2. What does the ratio tell you?

c. What is the relationship between the ratio of the radii of the blood vessels and the ratio of their cross-sectional areas?

Solution

a. From the diagram, you can see that the radius of the venule r_1 is 1.0×10^{-2} millimeter and the radius of the capillary r_2 is 5.0×10^{-3} millimeter.

$$\frac{r_1}{r_2} = \frac{1.0 \times 10^{-2}}{5.0 \times 10^{-3}} = \frac{1.0}{5.0} \times \frac{10^{-2}}{10^{-3}} = 0.2 \times 10^{1} = 2$$

The ratio tells you that the radius of the venule is twice the radius of the capillary.

ANOTHER WAY
You can also find the ratio of the cross-sectional areas by finding the areas using the values for r_1 and r_2, setting up a ratio, and then simplifying.

b. To find the cross-sectional areas, use the formula for the area of a circle.

$$\frac{A_1}{A_2} = \frac{\pi r_1^2}{\pi r_2^2} \qquad \text{Write ratio.}$$

$$= \frac{r_1^2}{r_2^2} \qquad \text{Divide numerator and denominator by } \pi.$$

$$= \left(\frac{r_1}{r_2}\right)^2 \qquad \text{Power of a quotient property}$$

$$= 2^2 = 4 \qquad \text{Substitute and simplify.}$$

The ratio tells you that the cross-sectional area of the venule is four times the cross-sectional area of the capillary.

c. The ratio of the cross-sectional areas of the blood vessels is the square of the ratio of the radii of the blood vessels.

GUIDED PRACTICE for Example 5

6. WHAT IF? *Compare* the radius and cross-sectional area of an arteriole with the radius and cross-sectional area of a capillary.