

Mass = volume x density

Surface Area = total area of the surface of a structure or organism

Volume = total internal space surrounded by a surface

$$\frac{S}{V} = \frac{\text{surface area}}{\text{volume}}$$

$$\frac{S}{M} = \frac{\text{surface area}}{\text{mass}}$$

ratios can be used to compare objects of different sizes

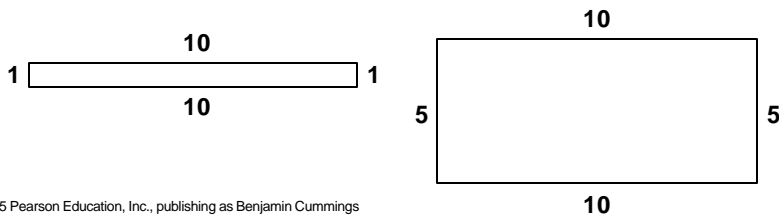
organelles

cells

organs

individual organisms

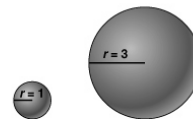
transport of gases, heat, solutes, waste products diffusion



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Surface Area to Volume Ratio

- As organisms grow larger, their ratio of surface area to volume decreases
- This limits the area available for diffusion and increases the diffusion distance



Sphere A

Sphere B

$$\text{Volume} = \frac{4}{3} \pi r^3$$

$$\text{Surface area} = 4\pi r^2$$

$$\frac{\text{Surface area}}{\text{Volume}} = \frac{3(4\pi r^2)}{4\pi r^3} = \frac{3}{r}$$

$$\frac{\text{Surface area}}{\text{Volume}} \text{ for sphere A} = 3$$

$$\frac{\text{Surface area}}{\text{Volume}} \text{ for sphere B} = 1$$

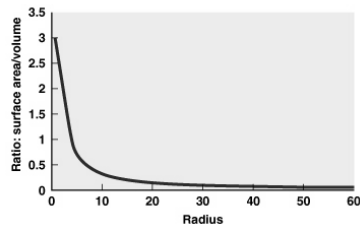


Figure 10.4

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Overview, Cont.

- Unicellular and small multicellular organisms rely on diffusion for gas exchange
- Larger organisms must rely on a combination of bulk flow and diffusion for gas exchange, i.e., they need a respiratory system

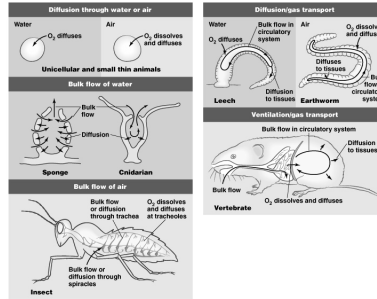


Figure 10.1

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Overview, Cont.

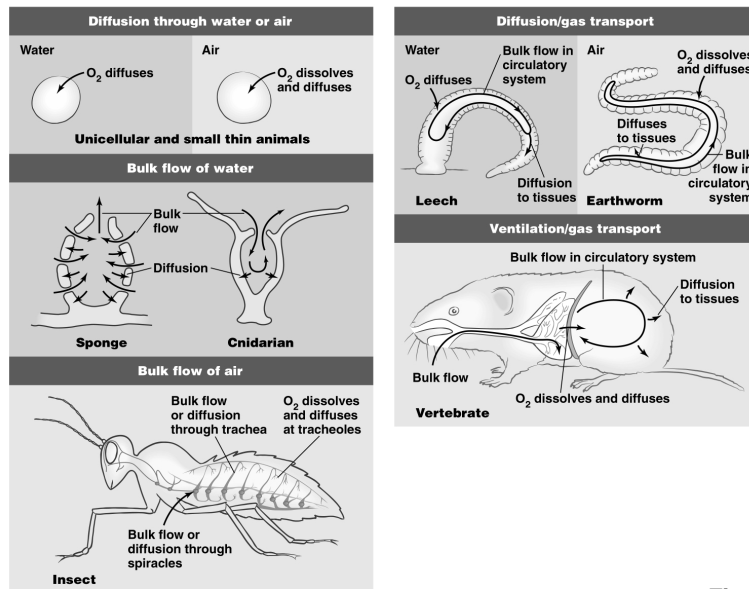


Figure 10.1

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