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Importance of Surface Area to Volume Ratio

Why are cells so small? Think about this: even though a whale is much larger than a

human and a human is much larger than a tulip, their cells are all roughly the same size.

Whales don't have larger cells than humans, just more of them.

There is a very specific reason why cells are the size they are. Anytime a cell

interacts with its environment, it does so at its membrane. The more membrane a cell

has, the more exchange it can perform with its environment. (This exchange can include

activities such as obtaining nutrients or getting rid of wastes.) We refer to the amount of

surface that an object has as its surface area (SA).

Once materials get inside the cell, they move via diffusion. Diffusion is the random

movement of particles that results in their dispersion in the cytoplasm. A drop of food

coloring in a beaker of water will diffuse until the entire beaker is the same color. This

type of movement occurs inside cells as a way of dispersing molecules. Diffusion works

best over short distances. Imagine how long it would take food coloring molecules to

diffuse in a water glass vs. in a swimming pool. Because the water glass has less

volume (V), diffusion is more efficient.

Cells try to **maximize** their surface area (in order to improve exchange) and **minimize**

their volume (to make diffusion more efficient). A basketball-sized cell would have lots of

surface area (good), but also lots of volume (bad). Think about how long it would take

molecules to diffuse from the outer portion of the ball to the center. A ping-pong ball or a

marble would be better choices. When we discuss the interplay of these two quantities,

we use the ratio of surface area to volume (abbreviated SA/V). Ideal cells have large

SA values, but small V values.

Consider these two cells below. Imagine they are long nerve cells in your body, like the

ones that extend from your spinal cord to your foot. They are both the same length, but

which one do you think is more realistic, based on the physical limitations of surface area and volume? Circle your answer below.

