Discussion points and extension activities

Maths with fruit

We can encourage students to look around and discover real-world examples that demonstrate the mathematical concepts they have explored.

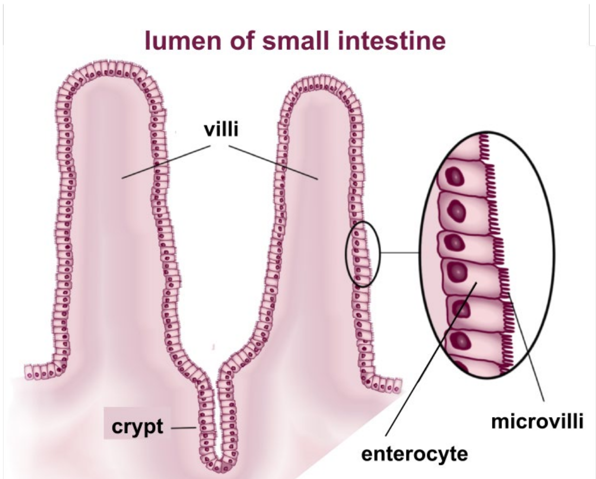
In particular, there are many chemical and physical properties and processes that depend on the relationship between surface area and volume. Some examples are described below.

Biological structures

Many biological structures are shaped to increase the area of contact surface. For example:

Digestion: During the digestive process, food comes into contact with gastric juices. If we chew a volume of food well, the amount of surface exposed to the gastric juices increases, and this makes digestion faster. We can model the increase in surface area by taking apart the larger cubes constructed for activity 3 in the main article: the volume of the unit cubes is the same, but their combined surface area is much larger than that of the large cube they were used to build.

Food absorption: In the small intestine, structures called villi line the inside and greatly increase the area available for the absorption of nutrients, because of their protruding folded surface.



BallenaBlanca, CC BY-SA 4.0, via Wikimedia Commons

You can make a model of the small intestine lining the inside of a cardboard tube (e.g. a toilet roll) with a sheet of paper folded many times, simulating the villi. Work out the area of the inside of the tube, and compare this to the area folded sheet: the sheet area is much larger (figure 1).

Figure 1: A model of a small intestine and villi

Image Courtesy of Maria Teresa Gallo

Heat flow

The flow of heat also depends on the amount of surface area relative to volume: the greater the surface for a given volume, the greater the flow of heat.

We can use this principle to our advantage when cooking food. For example, which cooks faster: a whole potato, or one that has been cut into smaller pieces? But it can also be inconvenient, for example, which cools faster: soup in a cup or in a large plate?

Many machines and devices need to disperse heat quickly so that they don't overheat. They use structures called heat sinks, which use an array of narrow pins or fins to disperse heat faster by increasing the surface area exposed to the surroundings. Radiators also have fins, again to increase the rate of heat transfer to the surroundings.

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Pressure

Pressure is the ratio between a force and the surface it acts on. When we stand on the ground, our weight exerts a force on the supporting surface. So here, the pressure exerted (*P*) is the weight (*W*) divided by the surface area in contact with the ground (*A*).

$$P = \frac{W}{A}$$

So the pressure we exert on the ground depends not only on our weight, but also on the area in contact with the ground. We can see this when we compare the depth of an impression left on sand by a shoe with a wide sole and low heel with that of a shoe with a high heel.

If we know our own mass, we can calculate the pressure exerted by drawing two different footprints on squared paper and measuring the areas (figure 2).

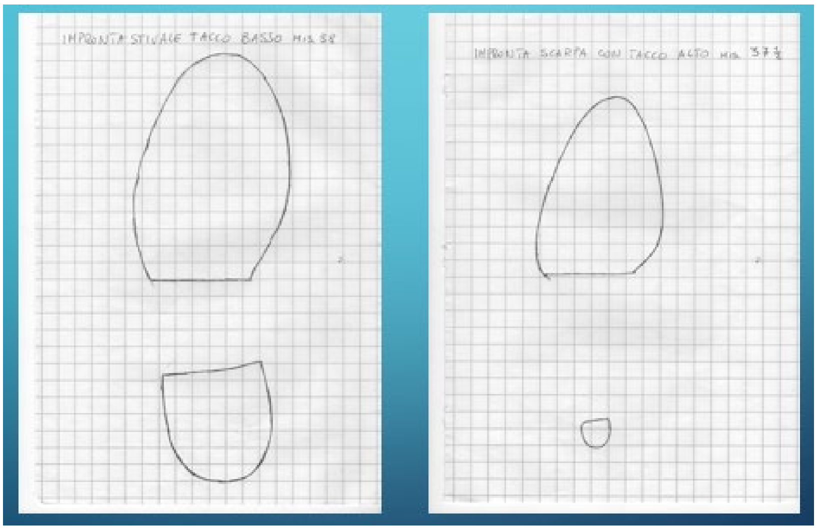

Figure 2: Boot footprint (left) and high-heeled footprint (right)
Image courtesy of Maria Teresa Gallo

For example, for someone (like the author) with a mass of 55 kg: $W = m \times g$ (where m = mass, g = acceleration due to gravity = 9.8 m/s^2) A (boot) = 136 cm^2

A (high heel) = 60 cm^2

$$P\text{ (boot)} = \frac{55 \times 9.8}{136} \times 2 = 7.9\ \text{N/cm}^2$$

$$P\text{ (high heel)} = \frac{55 \times 9.8}{60} \times 2 = 18.0\ \text{N/cm}^2$$

So if you are going for a muddy walk, this is another reason not to wear your best shoes!