4 The dominant form of life on Earth

Biomass is the term given to the total mass of living material in a particular species or habitat. Let's consider the relative biomass of humans and bacteria on Earth.

With 6 billion people on Earth, with an average mass of 50 kg, the biomass of humans is

$$6 \times 10^9 \text{ people} \times 50 \text{ kg/person} = 3 \times 10^{11}\text{kg}.$$

What about bacteria? Let's consider bacteria in oceans. A rough estimate, which certainly varies with location and depth, is 1 billion per liter, i.e. 10^9 bacteria Lt^{-1} or 10^{12} bactera m^{-3}.

The total volume of the Earth's oceans is 1.4×10^{18} m^3. The total number of bacteria is therefore

$$10^{12}\text{bacteria}\,\text{m}^{-3} \times 1.4 \times 10^{18}\text{m}^3 = 1.4 \times 10^{30}\text{bacteria}.$$

What is the mass of a single bacterium? A typical bacterium is 1μm (10^{-6}m) in size or $1\mu\text{m}^3$ (10^{-18}m^3) in volume. Being made mostly of water, the mass of a bacterium is equal to its volume multiplied by the density of water

$$\text{Mass (bacterium)} = 10^{-18}\text{m}^3 \times 1000 \text{ kg}\,\text{m}^{-3} = 10^{-15}\text{kg}.$$

The total mass of bacteria is therefore equal to

$$\begin{aligned} &= 1.4 \times 10^{30} \text{ bacteria} \times 10^{-15} \text{ kg/bacterium} \\ &= 1.4 \times 10^{15}\text{kg}. \end{aligned} \tag{1}$$

The ratio of bacterial biomass to human biomass is then

$$\frac{1.4 \times 10^{15}\text{kg}}{3 \times 10^{11}\text{kg}} = \frac{1.4}{3} \times 10^4 \approx 5 \times 10^3.$$