EXPLORE THE WORLD OF THE SMALL

Measuring in Nanometers

Target Population:
Students, ages 12+

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Smithsonian
Science Education Center

Explore the World of the Small: Measuring in Nanometers is part of the STEM²D Student Activity Series. The content and layout were both developed by the Smithsonian Science Education Center as part of Johnson & Johnson's WiSTEM²D initiative (Women in Science, Technology, Engineering, Mathematics, Manufacturing, and Design), using a template provided by FHI 360 and JA Worldwide. This series includes a suite of interactive and fun, hands-on activities for girls (and boys), ages 5-18, globally.

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Explore the World of the Small:
MEASURING IN NANOMETERS

Challenge:
Can you arrange the images on these 8 cards from largest to smallest?

Target Population: Students, ages 12+

ACTIVITY DESCRIPTION

Students learn that nanometers are units of length that are essential for measuring objects of the extremely small nano-world. They become aware of the relative size of a nanometer and discover some objects that are measured in this small unit.

Materials

For 100 students:

- 1 Metric ruler
- Four sets of 8 cards with images of the following:
  - *Hair*
  - *Red blood cell*
  - *Bacterium*
  - *Dust particle*
  - *Wavelength of red light*
  - *Nanowire*
  - *DNA helix*
  - *Gold atom*
- 100 Chart handouts, which serve as takeaways

Instructions: Open Engineering

1. Show students a centimeter on the ruler and the Small Metric Measurement Scale from a centimeter to a picometer. Explain that all the images they will be looking at are measured nanometers.

2. Hand a student or pair of students a set of the 8 image cards.

3. If there is space, have them place the cards on a surface in the order they think they should be, from largest to smallest.

4. Listen to the discussion between the students as they make their selections.

5. On a Small Sequencing Chart, have them write their best guess for the order next to the approximate size of the images in nanometers.

6. Show them the answers, guiding their thinking using the background information.

Correct Sequence

Object	Approximate Size
Width of a dust particle	100–100,000 nm
Width of a hair	75,000 nm
Width of a red blood cell	7,000 nm
Length of a typical bacterium	1,000 nm
Wavelength of red light	620–750 nm
Width of a nanowire	50 nm
Width across the helix of DNA	2 nm
Width of a gold atom	0.1–0.3 nm

Background Information/Resources

A **nanometer** is used **to measure** things that are very small. Atoms and molecules, the smallest pieces of everything around us, are measured in nanometers. For example, a water molecule is less than 1 **nanometer**. A typical germ is about 1,000 **nanometers**.

The **wavelength** is the distance over which a a wave's shape repeats. Examples of waves include sound waves, light, and water waves. Light is electromagnetic radiation and moves in a wave pattern that has different lengths. Different types of light have different wavelengths.

Visible light has wavelengths ranging from 400 to 700 nm. The exact wavelength determines the color we see. Other animals can see wavelengths that we cannot.

Infrared, radio waves, X-rays, and gamma rays, are all wavelengths outside of the visible spectrum of colors we can see.

SI prefixes are standardized for use in the **International System of Units (SI)** by the International Bureau of Weights and Measures (BIPM) in resolutions dating from 1960 to 1991. Since 2009, they have formed part of the International System of Quantities. The prefix "nano" means 10^{-9}, so a billion times less than a meter.

Reflection:

1. What did you learn that you didn't know before?

2. What careers do you think might have a connection to the nanoworld?

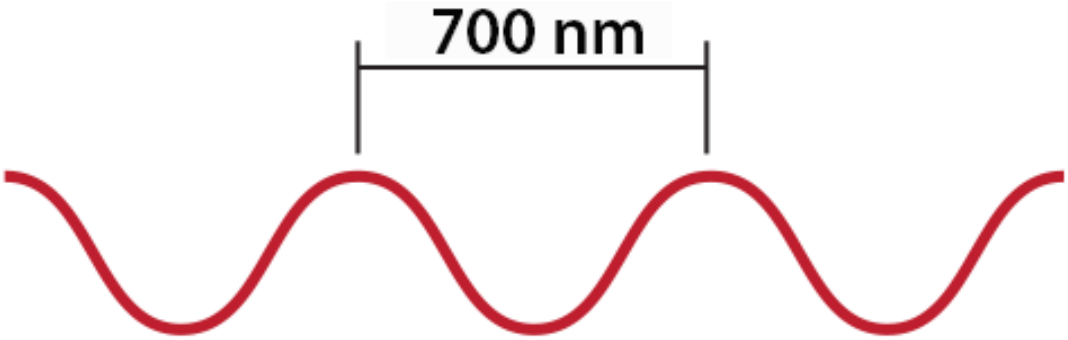
Charts

Small Metric Measurement Scale
International System of Units (SI)

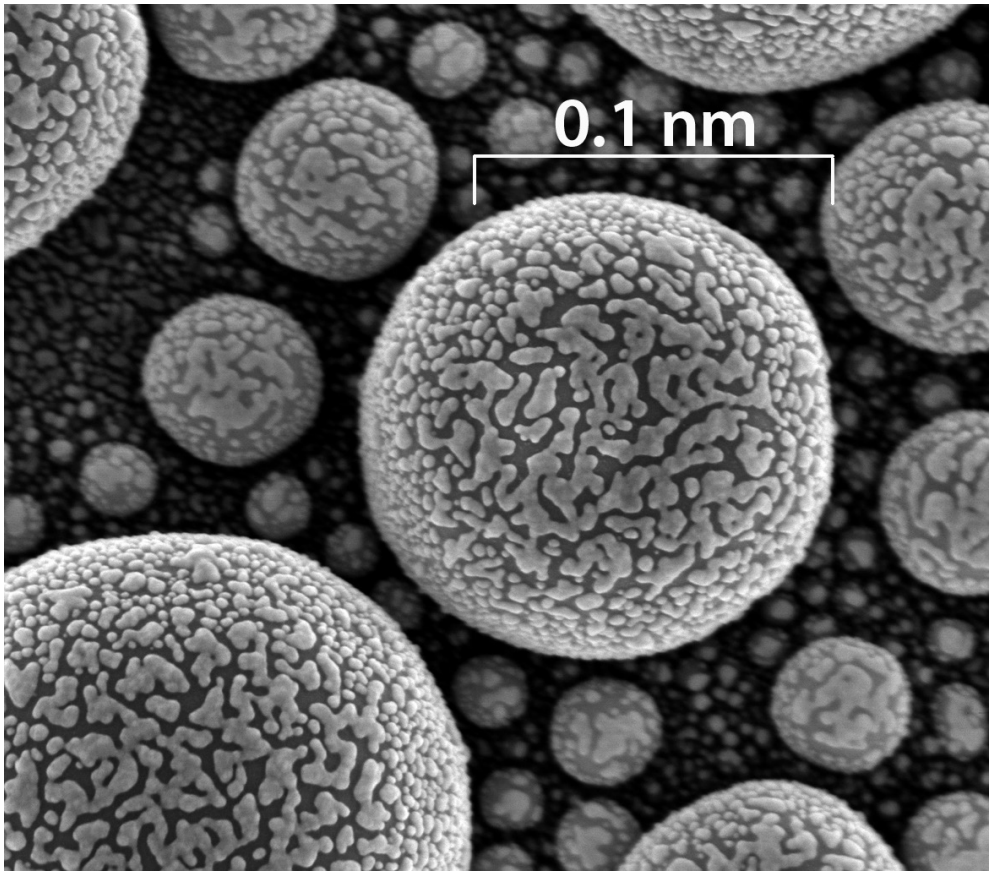
Multiplication Factor	Prefix	Symbol
0.01	centi/10^{-2}	c
0.001	milli/10^{-3}	m
0.000,001	micro/10^{-6}	µ
0.000,000,001	nano/10^{-9}	n
0.000,000,000,001	pico/10^{-12}	p

Name of Object (My best guess)	Approximate Size
1.	100–100,000 nm
2.	75,000 nm
3.	7,000 nm
4.	1,000 nm
5.	620–750 nm
6.	50 nm
7.	2 nm
8.	0.1-0.3 nm

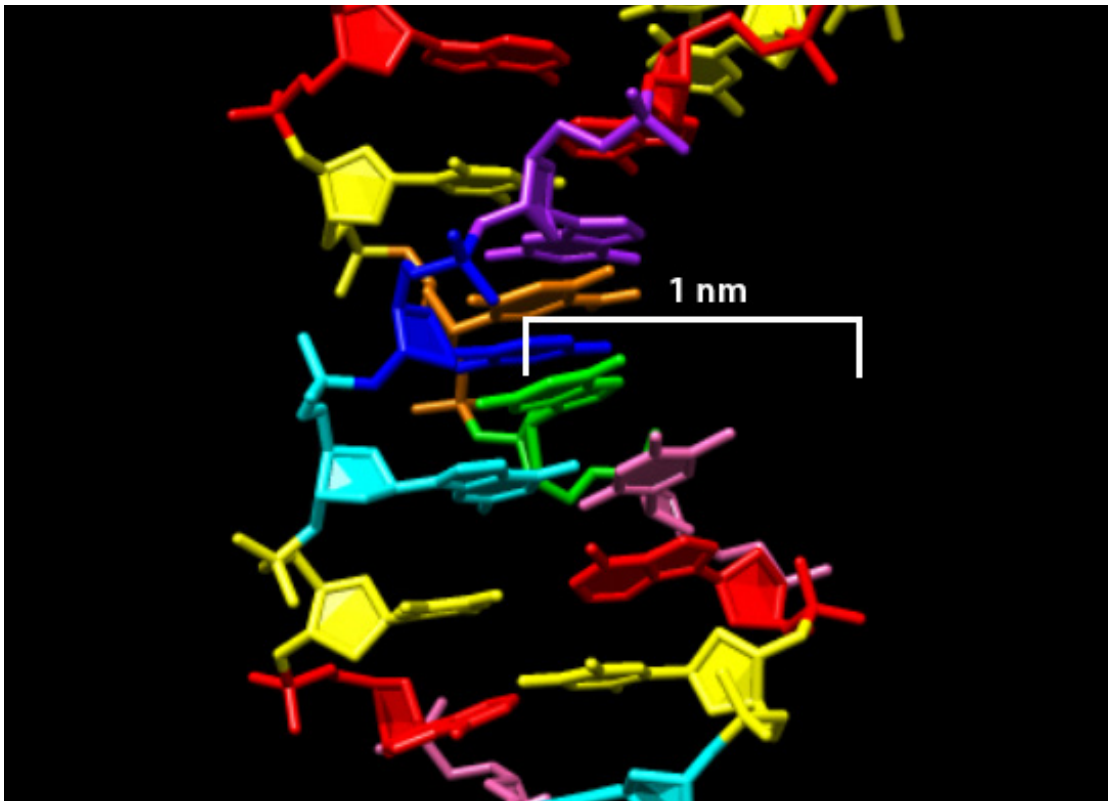
Wavelength of Red Light



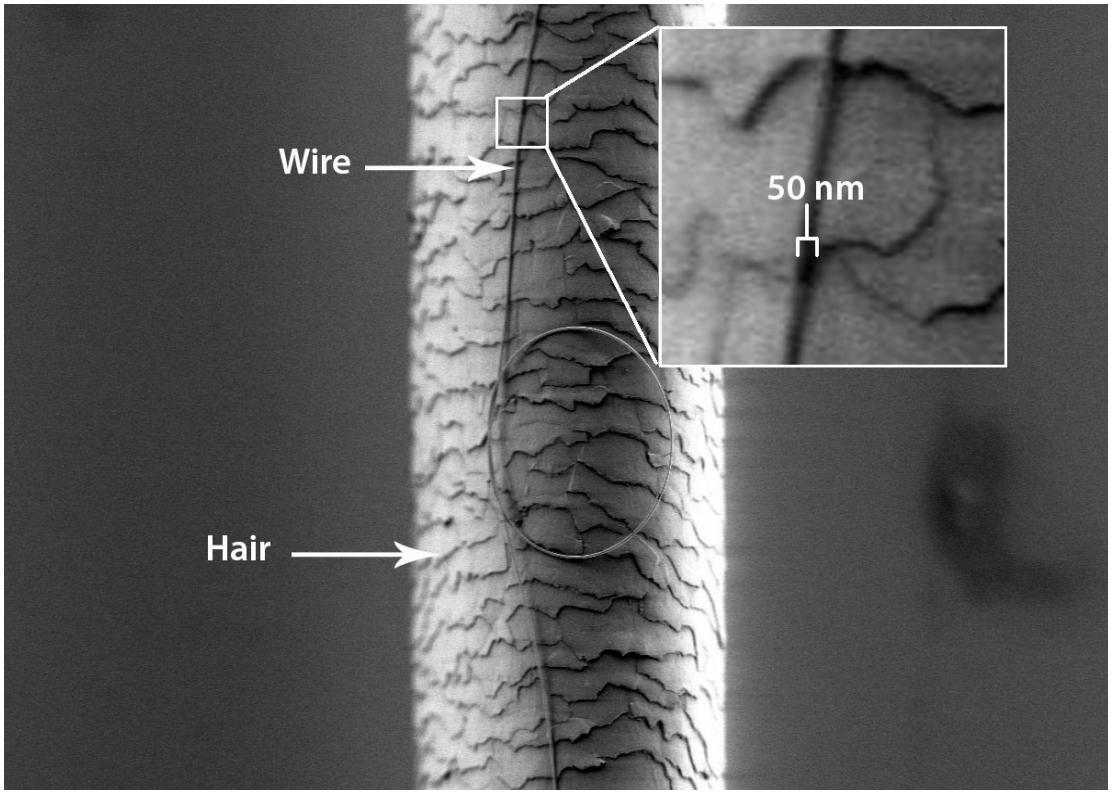
Gold Atom



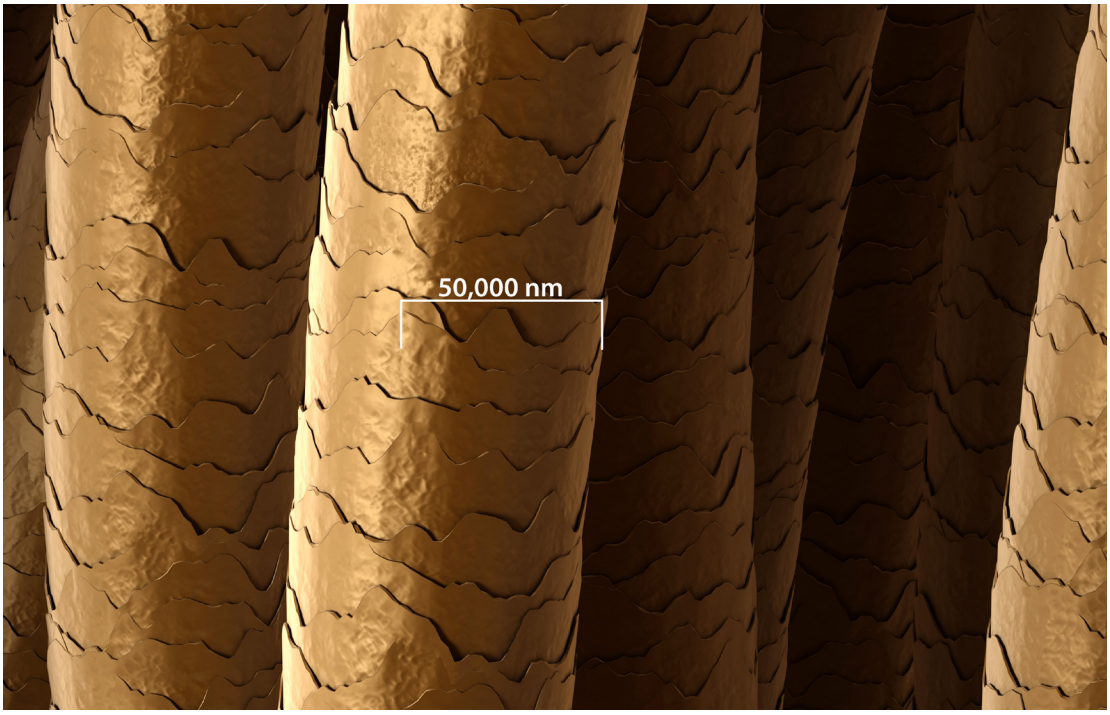
DNA Helix



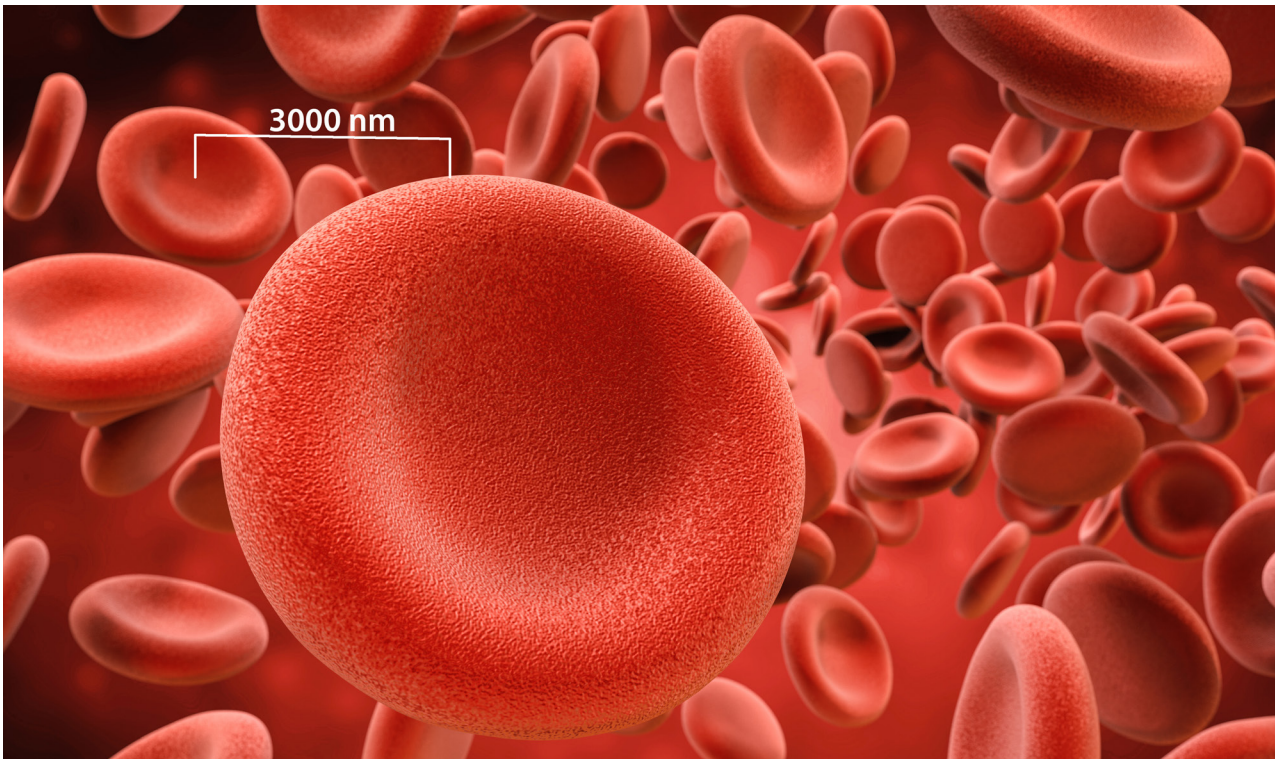
Nanowire



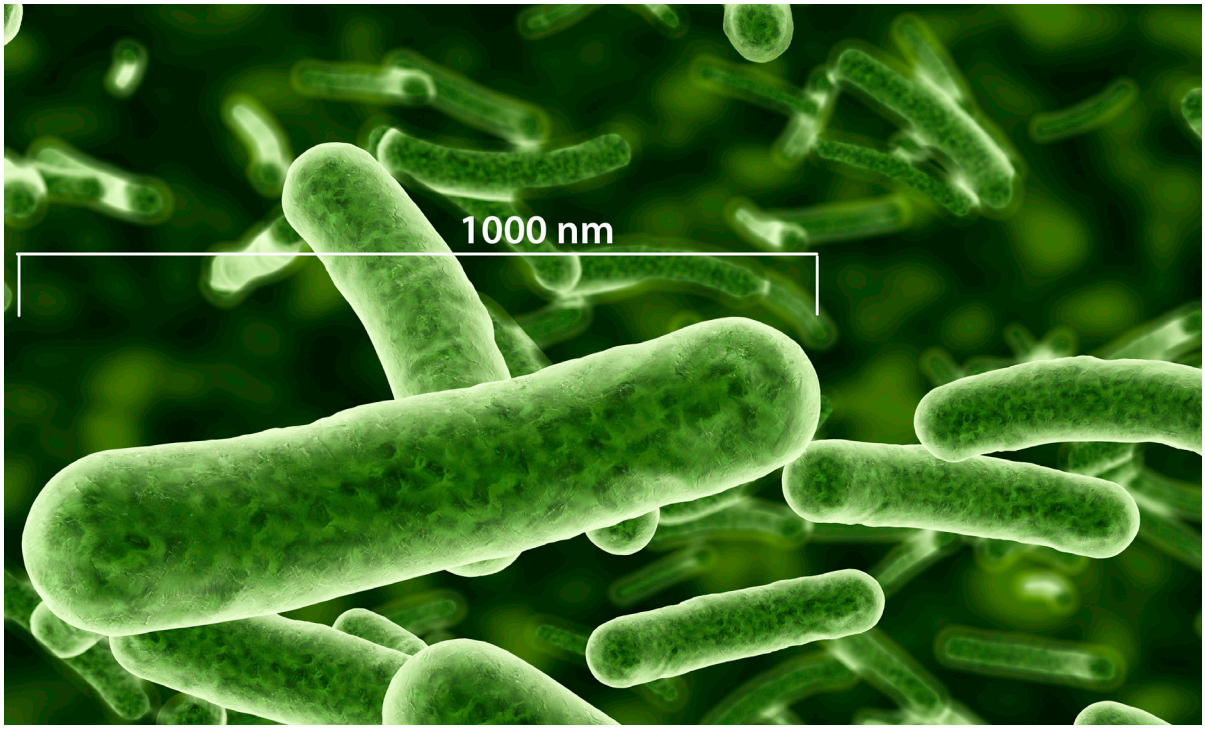
Hair



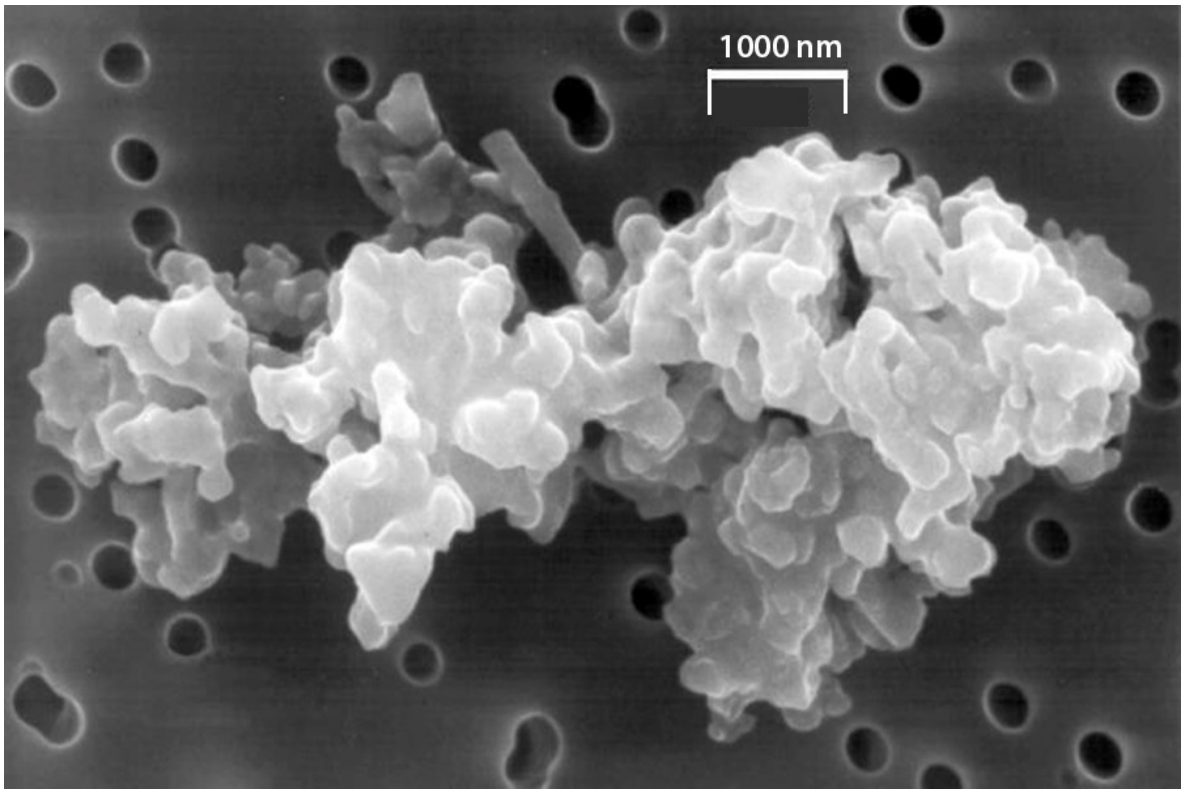
Red Blood Cells



Bacterium



Dust Particle



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