

Introduction to Nanotechnology

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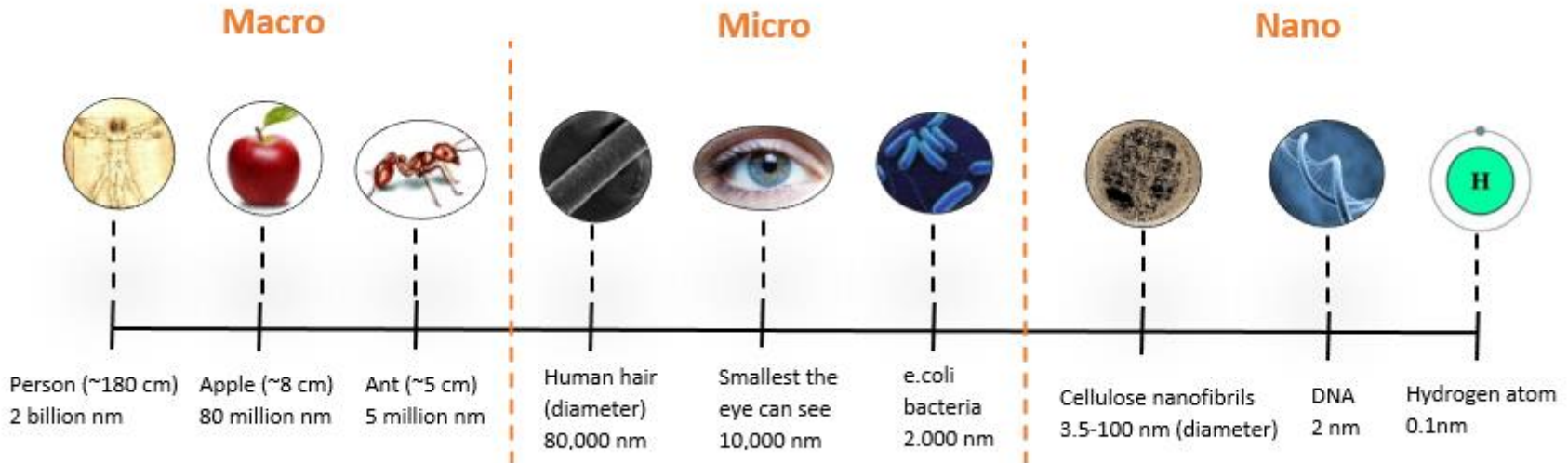
What is nanotechnology?

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Nanotechnology is technology on the nanoscale, involving the manipulation of molecules and atoms.

The Nanoscale

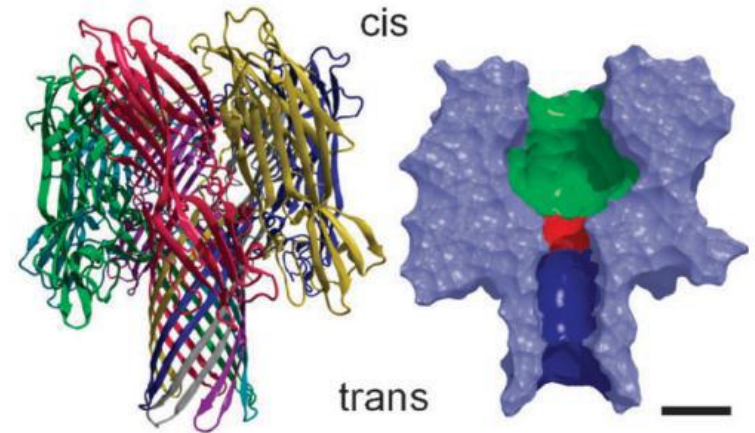
- A nanometer is 10^{-9} meters
- For reference:
 - Width of an adult human nail is about 2×10^7
 - Width of a single hair human is about 10^5 nanometers
 - Width of double-stranded DNA is about 2 nanometers
 - Diameter of an atom ranges from 0.1-0.5 nanometers



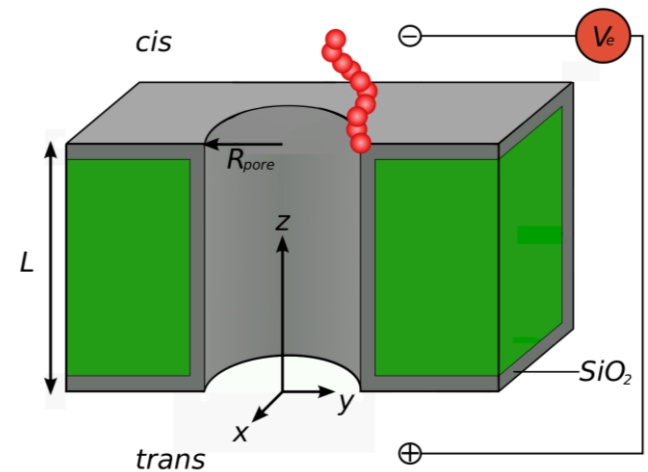
**We work with computational
models of nanopores.**

Nanopores

- Nanopores, pores on the nanoscale, can be biological or artificial
- Biological nanopores, or pore-forming proteins, are compatible with specific molecules and environment
- Artificial membranes, made from solid-state material, can be constructed for a specific task by having a particular geometry and environment



α -hemolysin pore
(biological nanopore) [1]



Silicon dioxide pore
(artificial nanopore) [2]

**What was required to study this
branch of nanotechnology?**

Studying nanopore technology

In order to

- Biology of:
 - Biological polymers, such as DNA
 - Biological molecules, such as insulin
- Physics of:
 - Modeling the motion of nano-sized particles
 - Energy and forces on a polymer
 - Modeling the electrical environment of an electrolyte solution
- Computational programming abilities including:
 - Coding biological environments
 - Coding models of particle motion

**What are some applications of
this nanotechnology?**

What are some applications of this nanotechnology?

- Biosensing, or identifying/characterizing molecules
- Rapid sequencing of polymers, such as DNA

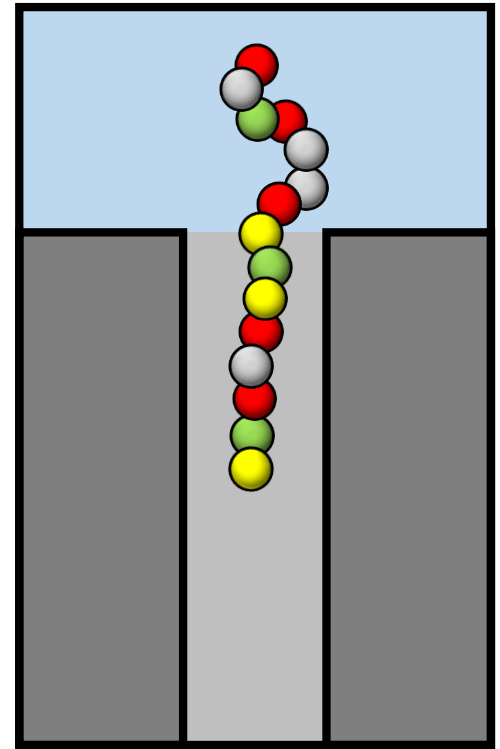
With a rapid, simple, and mobile way of sequencing a DNA polymer, whole new technologies that rely on your own unique DNA can be developed. This includes:

 - Medical advances, such as identifying potential predisposition to infection or genetic diseases
 - Security technologies, such as using your own DNA as a password rather than text
- Filtering proteins



Biosensing/Sequencing

- Molecules can be forced through a nanopore using an applied electric bias or fluid flow
- Identifying and characterizing various biomolecules is possible by measuring ionic current blockage in the nanopore
- Fast and cheap DNA sequencing may be developed utilizing a nanopore



Single-stranded DNA translocating nanopore. Each differently colored bead represents a different nucleotide.

Other Nanotechnologies

- Nanopore functionalities and applications
 - Membrane surface modifications
 - Polymer/protein modifications
 - Protein filtering
- Developing nanoparticles