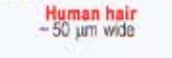




Cat
~0.3 m



Dust mite
300 μ m



Human hair
~50 μ m wide



Magnetic domains garnet film
11 μ m wide stripes



Schematic, central core
10 nm



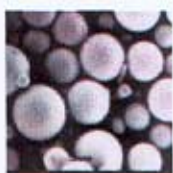
DNA
~2 nm wide



Monarch butterfly
~0.1 m



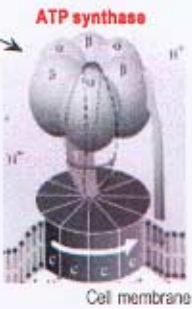
Bee
~15 mm



Fly ash
~10-20 μ m



Red blood cells with white cell
~2-5 μ m



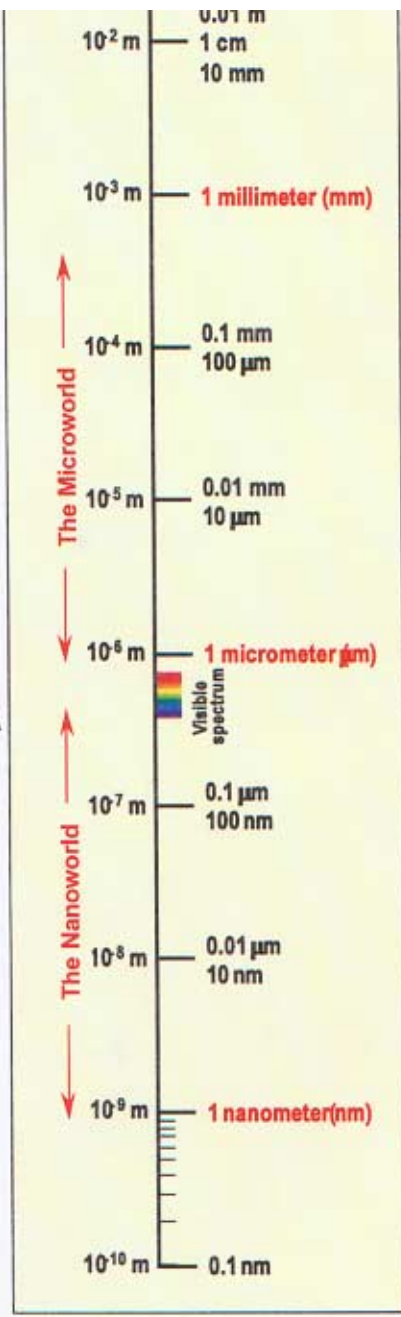
ATP synthase

Cell membrane

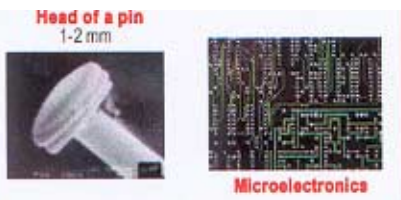


Atoms of silicon
spacing ~tenths of nm

Progress in atomic-level understanding



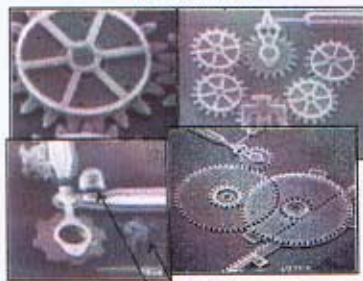
Progress in microtechnology



Head of a pin
1-2 mm

Microelectronics

MEMS (MicroElectroMechanicalSystems) Devices
10 -100 μ m wide



Red blood cells
Pollen



Indium arsenide quantum dot



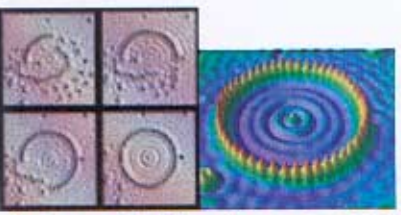
Quantum dot array -- germanium dots on silicon



Biomotor using ATP

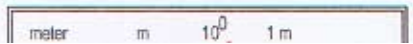


Self-assembled "mushroom"

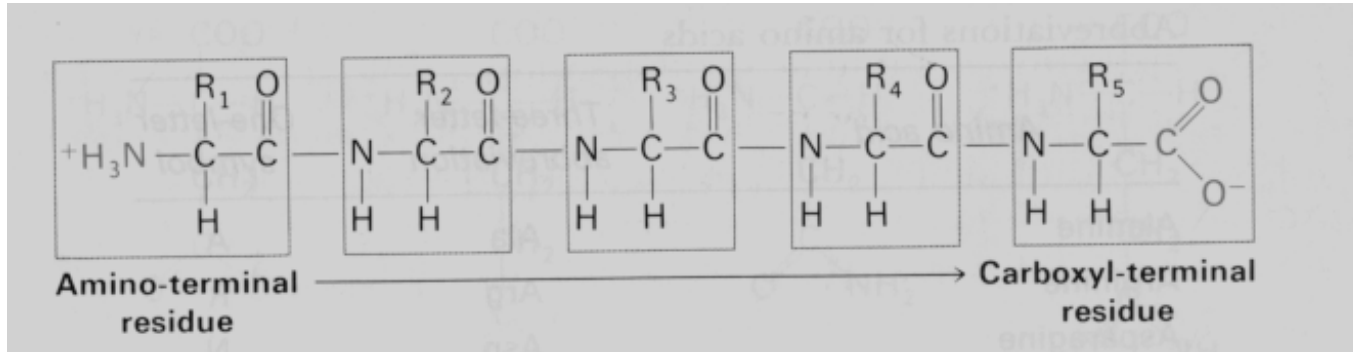


Quantum corral of 48 Iron atoms on copper surface
positioned one at a time with an STM tip
Corral diameter 14 nm

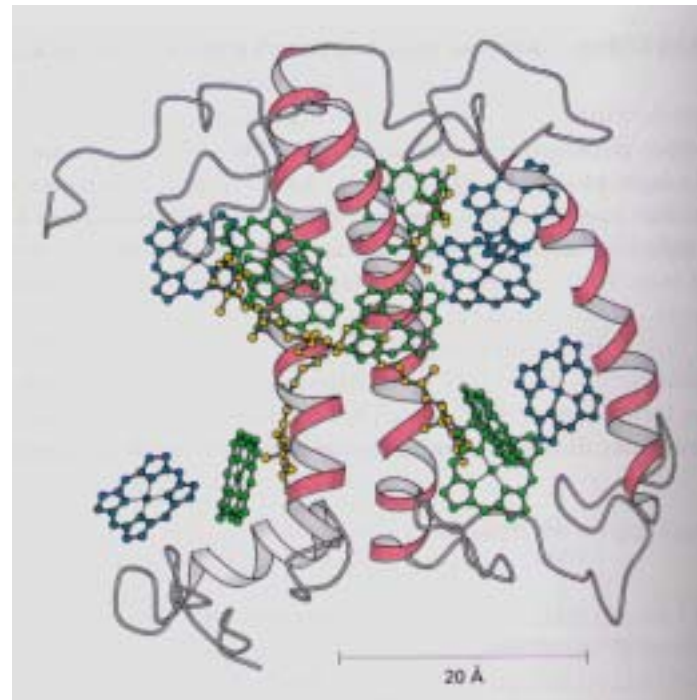
The 21st century challenge -- Fashion materials at nanoscale with desired properties and functions



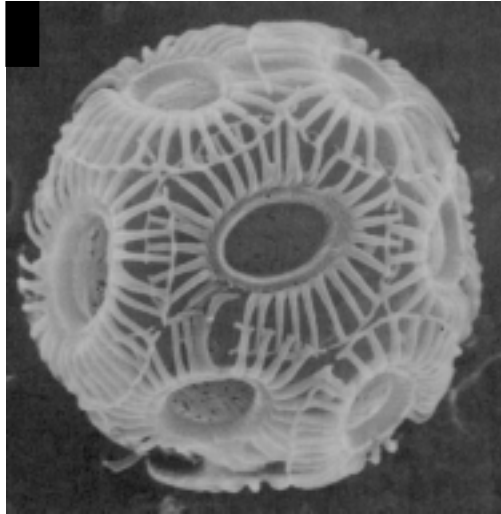
Proteins



- Proteins are natural polymers made up from a collection of 20 different amino acids.
- They self-assemble into complex 3D shapes that can have a variety of advanced functions.



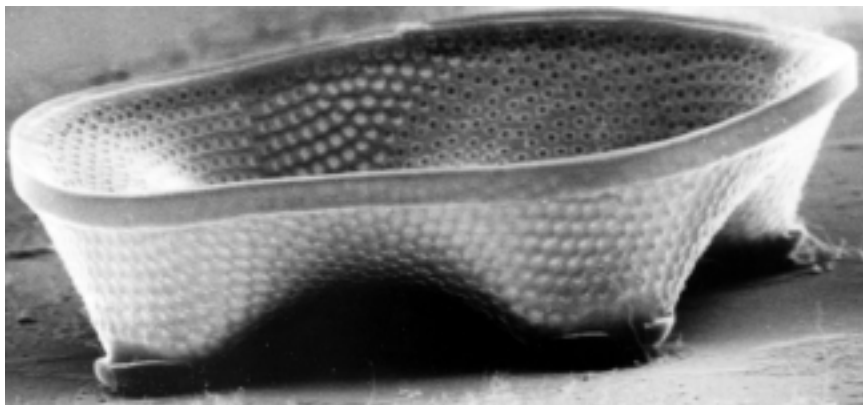
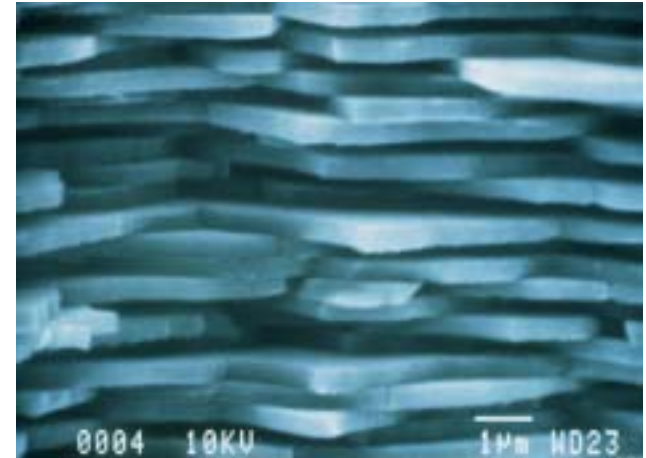
Biomimetics



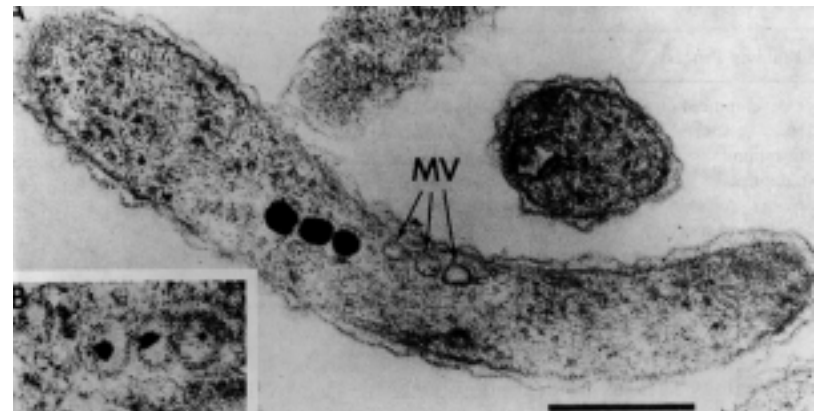
**Coccosphere
(CaCO_3)**



Abalone shell (CaCO_3)



Diatom (SiO_2)



Magnetotactic bacterium (Fe_3O_4)

Organic materials can self-assemble on the nanometer length scale to make highly advanced materials

