

Nanotechnology: What's All the Buzz About

Nanotechnology is the science and technology of small things – in particular things that are less than 100nm in size. One nanometer is 10^{-9} or one billionth of a meter. Scientists have discovered that materials at small dimensions-small particles, thin films, etc., can have significantly different properties than the same materials at larger scale. There are endless possibilities for improved devices, structures, and materials if we can understand these differences, and learn how to control materials and structures at the nanoscale. There are different views of what is included in nanotechnology but most agree that three things are important: 1) Small size – 1 to 100 nanometers or less, 2) Unique properties because of the small size, and 3) Ability to control the structure and composition in order to control these properties.

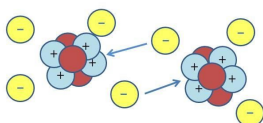
Examples of How Properties Change at the Nanoscale

Optical Properties: Bulk gold appears yellow in color- Nanosized gold appears as different colors depending on particle size. Many other materials behave similarly. The ability to change the optical properties of materials is a powerful tool in the development of nanotechnology products

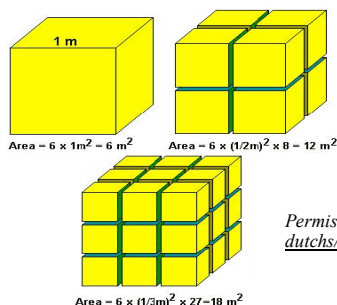


Douma, M., curator. (2008). Gold. In Cause of Color. Retrieved 1/30/2012, <http://www.webexhibits.org/causesofcolor/3.html>.

Forces: gravitational forces become negligible and electromagnetic forces dominate.



Surface Area to Volume Ratio: For smaller particles, a greater proportion of material is exposed on the surface. This becomes even more important in the nanoscale, where a large fraction of the atoms become “surface atoms” where they are more accessible to chemical reactions



Permission granted by S. Dutch; <http://www.uwgb.edu/dutchs/EarthSC202Notes/ROCKCYCL.HTM>

More Nanotechnology Resources
www.nnci.net/learn
Learn more about Nanotechnology
www.nanooze.org

Allotropes of Carbon

Graphite – atomic planes slide easily over each other making it a natural lubricant.

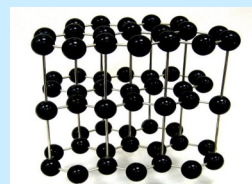


Image courtesy
Cochise College

of R.Weller/

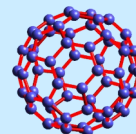
Diamond –
rally occur-
stance



hardest natu-
ring sub-

Image courtesy of R.Weller/Cochise College

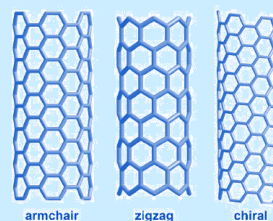
**Buckminster-
nicknamed
“bucky ball”**



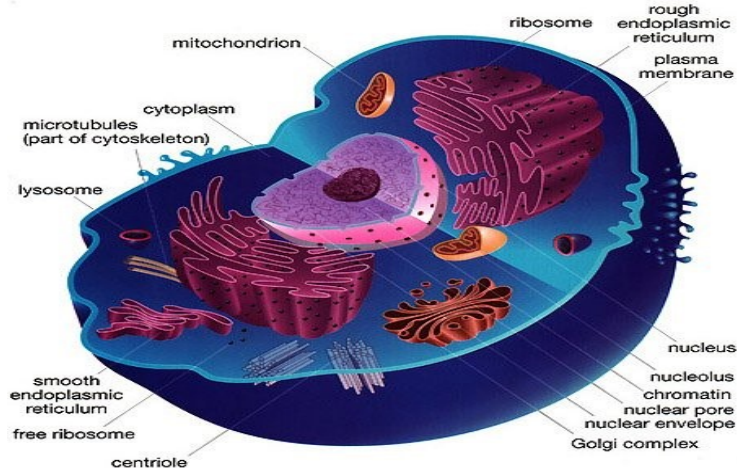
fullerene C₆₀ –

Image at US DOE: <http://www.osti.gov/accomplishments/smalley.html>

**Carbon
100
er
than steel**

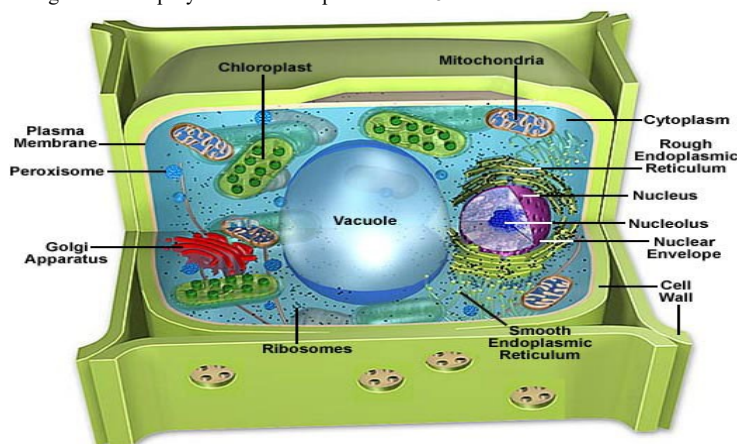


**nanotubes –
times strong-**



Cross section of animal cell (top) and plant cell (bottom)

Images from: <http://year12bio.wikispaces.com/2.8+Cells>



10^n	Prefix	Symbol	Decimal
10^{24}	yotta-	Y	1 000 000 000 000 000 000 000 000
10^{21}	zetta-	Z	1 000 000 000 000 000 000 000
10^{18}	exa-	E	1 000 000 000 000 000 000
10^{15}	peta-	P	1 000 000 000 000 000
10^{12}	tera-	T	1 000 000 000 000
10^9	giga-	G	1 000 000 000
10^6	mega-	M	1 000 000
10^3	kilo-	k	1 000
10^2	hecto-	h	100
10^1	deca-	da	10
10^0	(none)	(none)	1
10^{-1}	deci-	d	0.1
10^{-2}	centi-	c	0.01
10^{-3}	milli-	m	0.001
10^{-6}	micro-	μ	0.000 001
10^{-9}	nano-	n	0.000 000 001
10^{-12}	pico-	p	0.000 000 000 001
10^{-15}	femto-	f	0.000 000 000 000 001
10^{-18}	atto-	a	0.000 000 000 000 000 001
10^{-21}	zepto-	z	0.000 000 000 000 000 000 001
10^{-24}	yocto-	y	0.000 000 000 000 000 000 000 001

Six Kingdoms

Eubacteria
Archaeobacteria
Protists
Fungi
Plants
Animals

Levels of Classification

Kingdom
Phylum
Class
Order
Family
Genus
Species

Diffusion: the movement of substances across the cell membrane from an area of high concentration to an area of lower concentration

Osmosis: the diffusion of water molecules through a selectively permeable membrane from an area of high concentration to an area of lower water concentration

Facilitated transport (facilitated diffusion): occurs when a carrier molecule embedded in the cell membrane transports a substance across the membrane by means of diffusion

Prokaryotes:

Single-celled organisms that lack internal structures surrounded by membranes. They lack a true nucleus.

Examples:

Bacteria
Archaea

Eukaryotes:

Single-celled and multi-cellular organisms that have cells containing internal membrane-bound structures. They have a true nucleus containing the cell's DNA

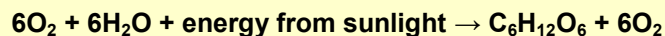
Examples:

Plants
Animals
Mushrooms (fungi)
Amoebas (protists)

Cellular Respiration



Photosynthesis



Some examples of Environmental Factors

Biotic

Plants
Animals
Bacteria

Abiotic

Climate
Light
Soil
Water

Active Transport: a process that drives large molecules across the cell membrane from a region of lower concentration to a region of higher concentration

Endocytosis: a process in which a cell surrounds and takes in material from its environment

Exocytosis: a process by which a cell surrounds and removes materials from inside the cell