

# 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.

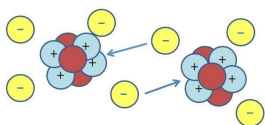
## Examples of How Properties Change at the Nanoscale

**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

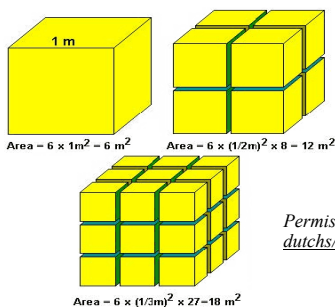


Douma, M., curator. (2008). Gold. In Cause of Color. Retrieved 1/30/2012, <http://www.webexhibits.org/causesofcolor/3.html>.

**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](http://www.nnci.net/learn)  
**Learn more about Nanotechnology**  
[www.nanooze.org](http://www.nanooze.org)

## Allotropes of Carbon

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

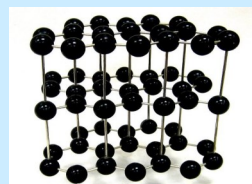


Image courtesy  
Cochise College

of R.Weller/

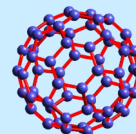
**Diamond** –  
rally occur-  
stance



hardest natu-  
ring sub-

Image courtesy of R.Weller/Cochise College

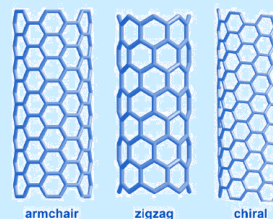
**Buckminster-  
nicknamed  
"bucky ball"**



**fullerene C<sub>60</sub> –**

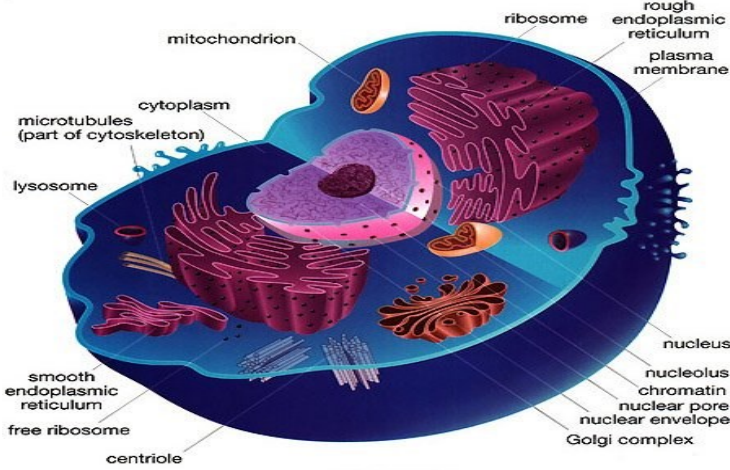
Image at US DOE: <http://www.osti.gov/accomplishments/smalley.html>

**Carbon  
100  
er  
than steel**



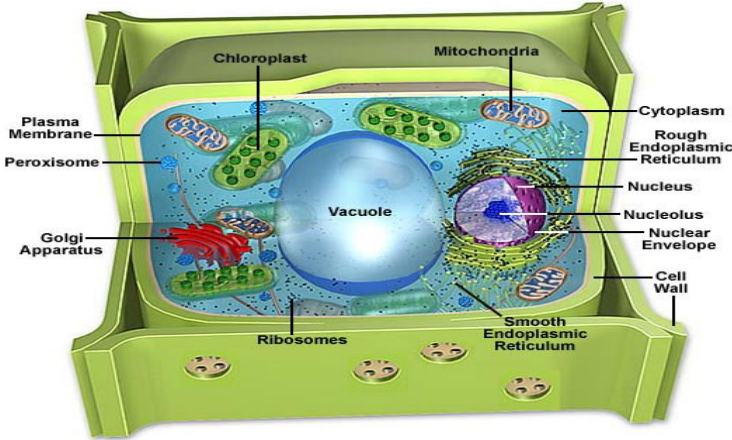
**nanotubes –  
times strong-**

# Reference ♦ BIOLOGY ♦ Information



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

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



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

## Six Kingdoms

Eubacteria (Monera)  
 Archaeobacteria  
 Protista  
 Fungi  
 Plantae  
 Animalia

## Levels of Classification

Domain  
 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 a distinct nucleus bound by a membrane nor other specialized organelles. Prokaryotes reproduce without fusion of gametes.

Examples:  
 Bacteria  
 Archaea

### Eukaryotes:

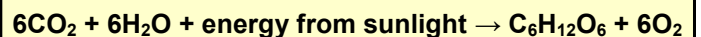
Single-celled and multi-cellular organisms that have cells containing internal membrane-bound structures. They have a true nucleus containing the cell's DNA

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