

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.

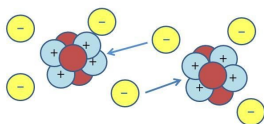
Examples of How Properties Change at the Nanoscale

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

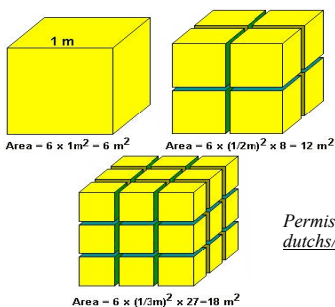


Douma, M., curator. (2008). Gold. In Cause of Color. Retrieved 1/30/2012, <http://www.webexhibits.org/causesofcolor/3.html>.

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.nnin.org/education-training
Learn more about Nanotechnology
www.nanooze.org



Allotropes of Carbon

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

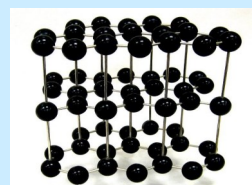


Image courtesy
Cochise College

of R.Weller/

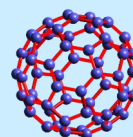
Diamond – hardest naturally occurring substance



hardest naturally occurring substance

Image courtesy of R.Weller/Cochise College

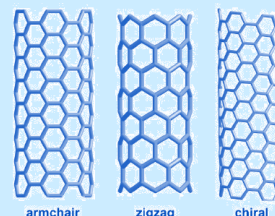
Buckminsterfullerene – nicknamed "bucky ball"



fullerene C_{60} –

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

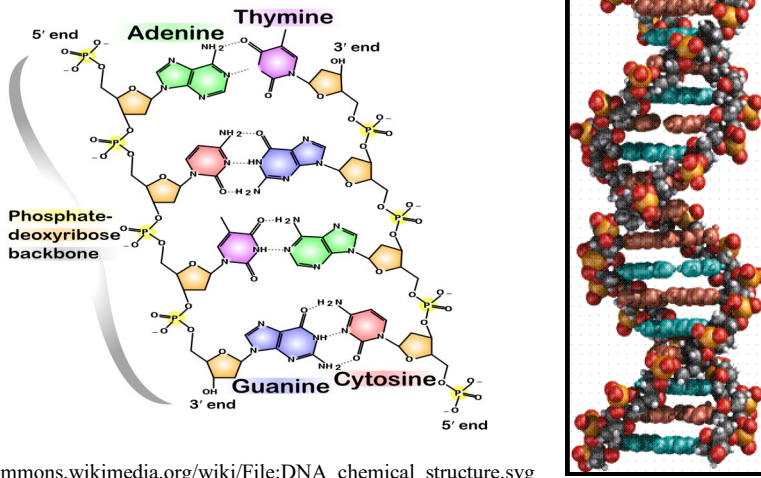
Carbon nanotubes – 100 times stronger than steel



nanotubes – 100 times stronger than steel

DNA is a nanoscale structure with a diameter of 1-2 nm

DNA Molecule



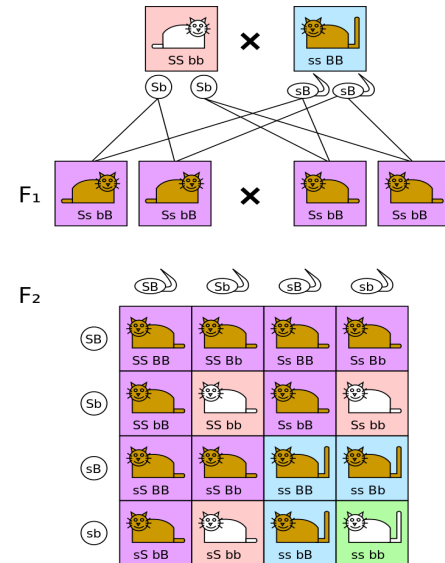
https://commons.wikimedia.org/wiki/File:DNA_chemical_structure.svg

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

Genetic Code for Amino Acids

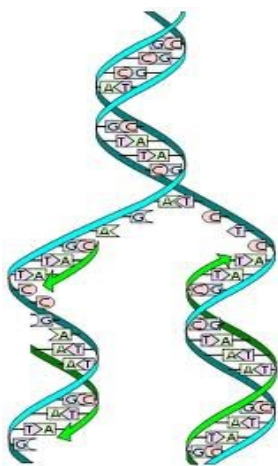
	U	C	A	G	
U	UUU Phenyl-alanine UUC UUG Leucine UUA	UCU Serine UCC UCA UCG	UAU Tyrosine UAC UAA Stop UAG	UGU Cysteine UGC UGA Stop UGG Tryptophan	U C A G
C	CUU Leucine CUC CUA CUG	CCU Proline CCC CCA CCG	CAU Histidine CAC CAA Glutamine CAG	CGU Arginine CGC CGA CGG	U C A G
A	AUU Iso-leucine AUC AUA AUG Methionine	ACU Threonine ACC ACA ACG	AAU Asparagine AAC AAA Lysine AAG	AGU Serine AGC AGA Arginine AGG	U C A G
G	GUU Valine GUC GUA GUG	GCU Alanine GCC GCA GCG	GAU Aspartic acid GAC GAA Glutamic acid GAG	GGU Glycine GGC GGA GGG	U C A G

Dihybrid Cross



https://en.m.wikipedia.org/wiki/File:Dihybrid_cross.svg

DNA Replication



- A = Adenine
- G = Guanine
- T = Thymine
- C = Cytosine

Creation of mRNA

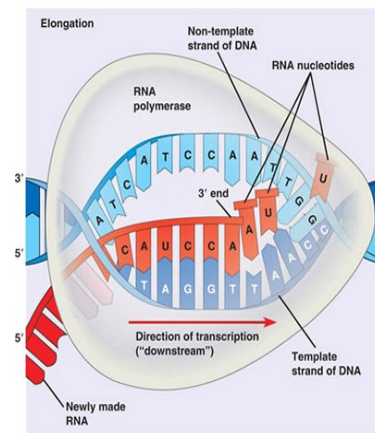
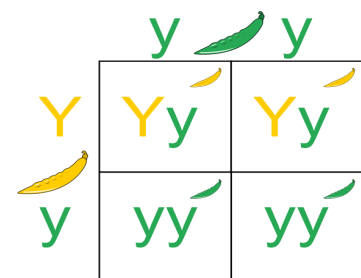


Image courtesy of DynamicScience.com.au

http://en.wikipedia.org/wiki/DNA_replication

Monohybrid Cross



https://en.wikipedia.org/wiki/Punnett_square