

تقنية النانو واستعمالاتها في الجلدية

The use of Nanotechnology in Dermatology

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تقنية النانو واستعمالاتها في الجلدية

ماذا تعني كلمة نانو ؟

تعني كلمة نانو باللغة اليونانية "قزم"
(Nano stands for one billionth) وهي مشتقة من
نانومتر (Nanometer) وهي وحدة قياس.

كيف يمكننا أن نتصور حجم النانو (المادة المتناهية الصغر)؟

هي واحد على البليون من المتر (one billionth of meter) أو
واحد على المليون من المليمتر (one millionth of millimeter).

تقنية النانو واستعمالاتها في الجلدية

• تعريف علم (تقنية النانو):

القدرة في التحكم التام والدقيق في انتاج المواد (المتناهية الصغر) من خلال التحكم في تفاعل الجزيئات الداخلة في التفاعل وتوجيهها للحصول أو انتاج مادة معينة لتصبح أكثر دقة ونقاوة من الطرق التقليدية.

هذا النوع من التفاعل يعرف بالإنتاج أو التصنيع الجزيئي .

Nanotechnology

- Shortened to "**Nanotech**", is the study of the control of matter on atomic and molecular scale.
- A sophisticated field that requires a well established Institutes
- Nanoscience is the study of phenomena and manipulation of materials at atomic, molecular and macromolecular scales, where the properties differ significantly from those at a larger scale

Nanotechnology

- Generally nanotechnology is dealing with functional systems based on the use of sub-units, with structures of the size 100 nanometers or smaller, and involves developing materials or devices by controlling shape and size within that scale.
- Particles of materials at nanoscale change their properties due to their tiny size and large surface area to volume ratio thus, possess unique feature. e.g.

Nanotechnology

Nanoscale: 1/50000 the diameter of human hair, or the width of 10 hydrogen atoms.

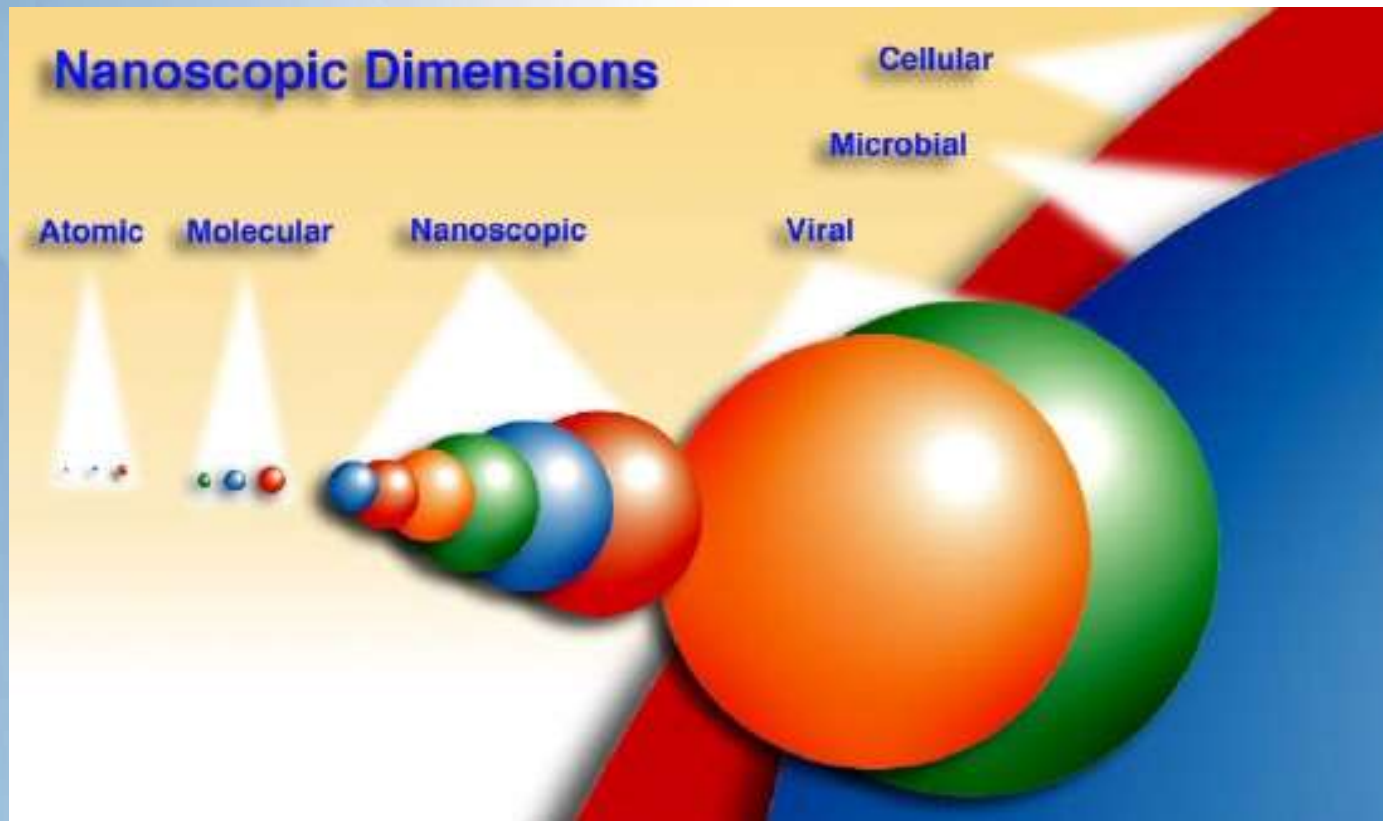
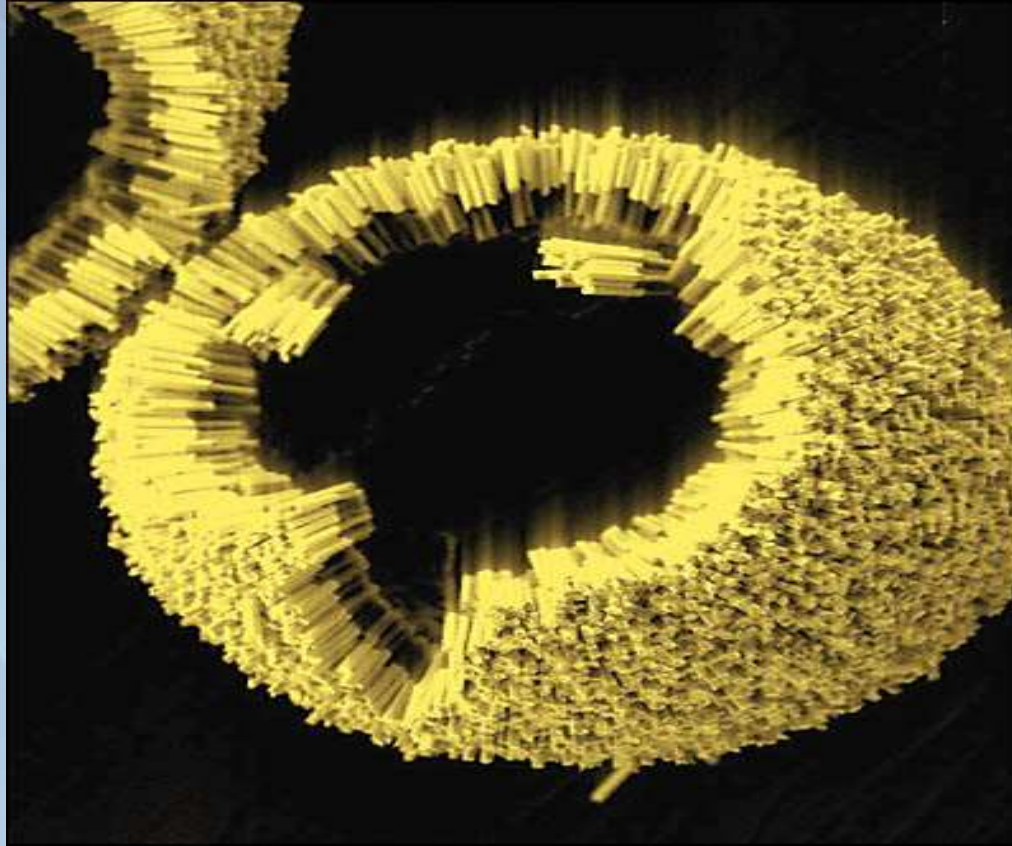


Image courtesy University of Michigan-Ann Arbor

Nanotechnology



Novel Nano Material that have at least one dimension that does not exceed 100 nanometers in size. Science. 2004;303:348-352.

Nanotechnology

- Carbon particles at nanoscale are 100 times stronger than steel and have lighter weight and higher conductivity than copper and can be used safely as drug delivery system.
- Opaque substances become transparent (Copper), inert material become catalysts (platinum), solid turn into liquid at room temperature (gold), insulators become conductor.

History of Nanotechnology

- December 29, 1959. Feynman described in his talk There's Plenty of Room at the Bottom a process by which the ability to manipulate individual atoms and molecules might be developed, using one set of precise tools to build and operate another proportionally smaller set, so on down to the needed scale.
- Later The term "nanotechnology" was defined by Tokyo Science University Professor Norio Taniguchi in a 1974.

History of Nanotechnology

- Then in more depth In the 1980s by Dr. K. Eric Drexler
- This lead both Heirrich Rohrer and Gerd Binning, for their invention the scanning tunneling microscope in 1981 and eventually winning of Nobel prize,
- Then lead scientists to the discovery of fullerenes in 1985 and carbon nanotubes a few years later, and in year 2000 the Atomic force microscope was invented.

History of Nanotechnology

The Magic of Nanotechnology

Any science sufficiently advanced, is indistinguishable from magic”

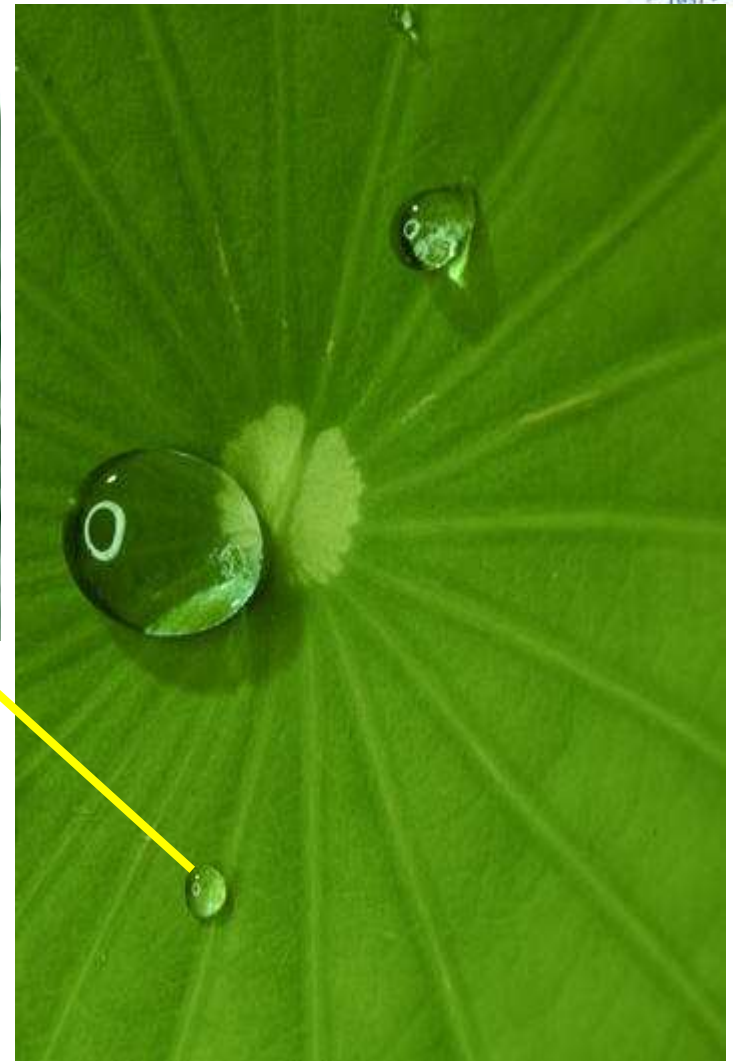
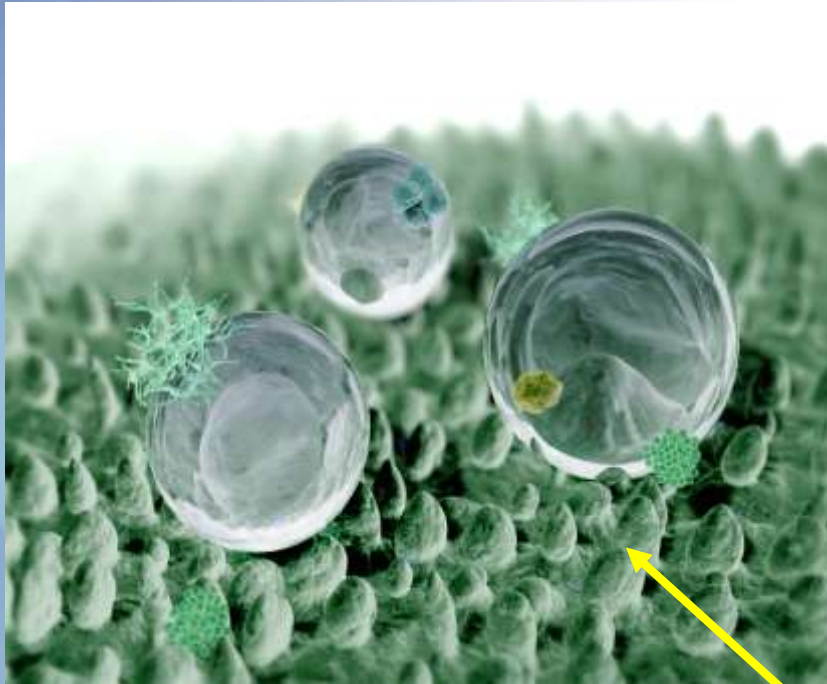
Clarke’s Law

Nature : self cleaning surfaces the “lotus effect”



In 1982 botanist Wilhelm Barthlott of the University of Bonn in Germany discovered in the lotus leaf a naturally self-cleaning, water-repellent surface

How dose it work?



The secret lies in waxy microstructures and nanostructures that, by their contact angle with water, cause it to bead and roll away like mercury, gathering dirt as it goes. Barthlott patented his discovery, calling it the Lotus Effect

History of Nanotechnology

Cotton fibers, when coupled to certain nanoscale molecule moieties creates a barrier to liquid and stain



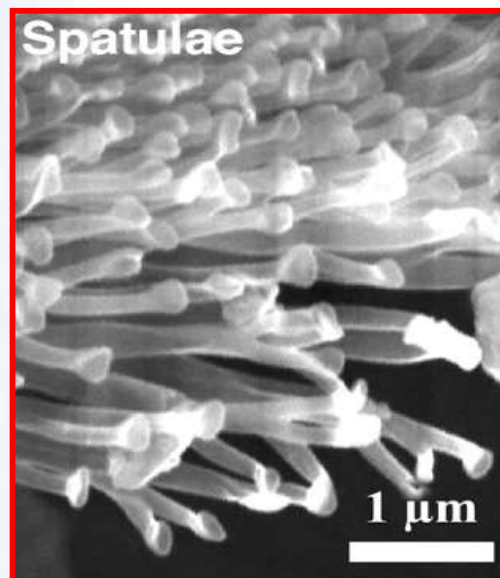
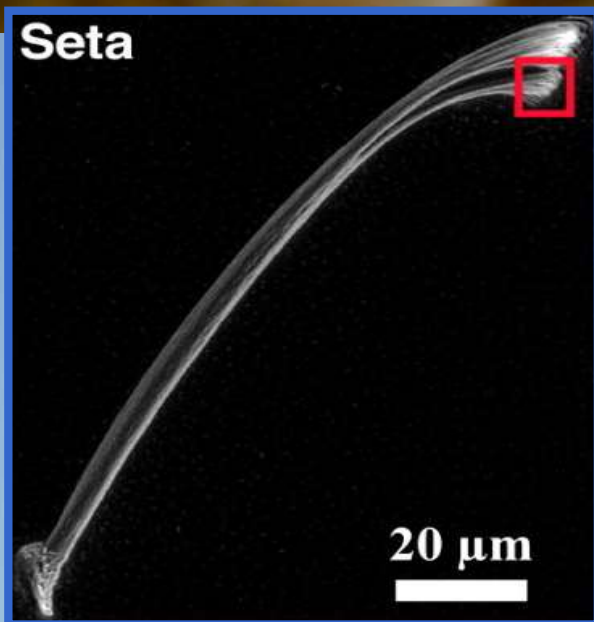
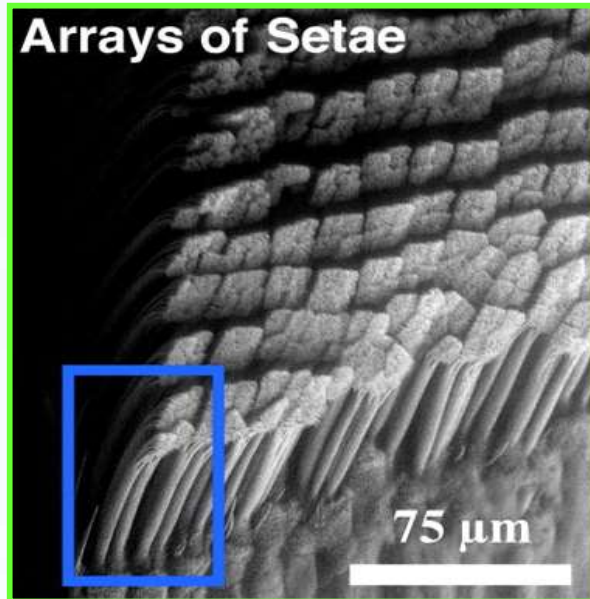
Fabric made in the fashion similar to lotus cause hydrophilic and hydrophobic liquid to bead and roll off.

History of Nanotechnology

The Gecko effect, can climb vertical surfaces

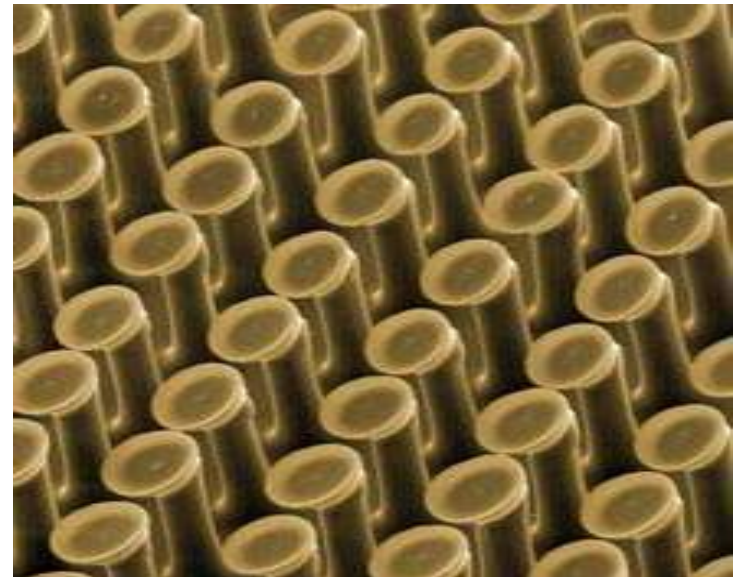
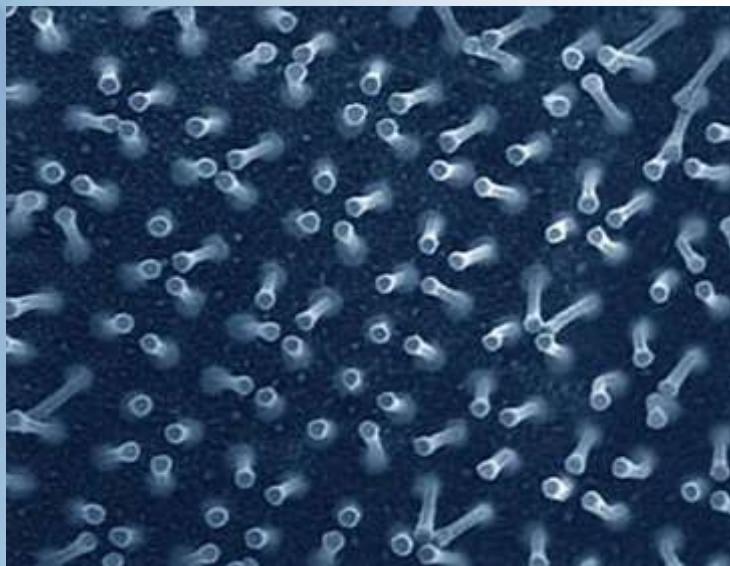


Due to the nano structures called setae and spatula that causes short lived dipoles which are the basis of Van der Waals force that causes contact



History of Nanotechnology

By Nanotechnology now a Gecko tapes have a practical application and may contribute to the reduction of skin irritation and allergy caused by old fashion tapes



History of Nanotechnology

Another example from nature



The Australian Thorny Devil

History of Nanotechnology

How does it drink water??



Sipping through a foot, the thorny devil lizard of the arid Australian desert demonstrates its ability to wick water to its mouth

History of Nanotechnology



via nanoscopic channels between its scales.
Scientists hope to mimic the mechanism to develop
water-capture technologies for dry regions.

Types of Nanotechnology

1. Nanomaterials (Important in the field of dermatology)
 - Nanostructured fluid
 - Nanocomposites
 - Nanostructured solids
 2. Nanocomputers
 3. Nanomachines.
- This is beyond the scope of this talk

Nanomaterials & Nanoscale Particles

- Variety of nanomaterials have been incorporated into consumer products, like antibacterial cleansers, makeup, fabric or surfaces as self cleaning in food e.g. ice creams, in automobiles, in military, in electronics and in skin care and dermatological products

تقنية النانو واستعمالاتها في الجلدية

الجدول أدناه يوضح أمثلة لتطبيقات النانو في المجال الطبي ومجالات أخرى:

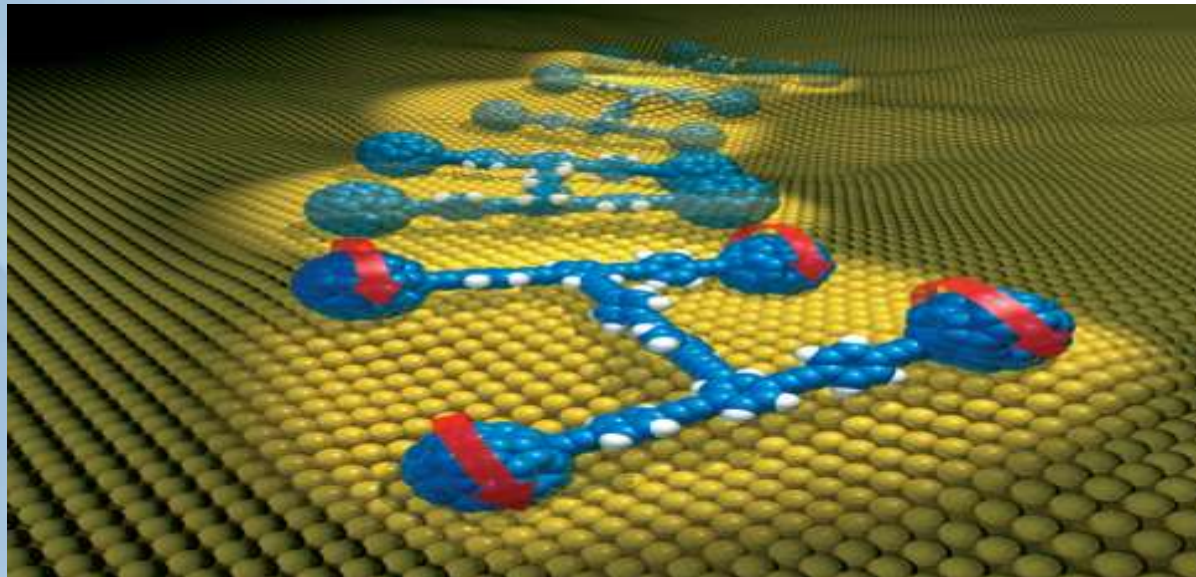
Current Nanotechnology Product	
Skin care	Sunscreens, anti-wrinkle cream, camouflage, antibacterial cleansers, makeup, toothpaste, shampoo, lipsticks, face powder, blush,, eye shadow, perfume, aftershave lotion, appliances, self-cleaning surfaces.
Food	Ice cream, nano-nutraceuticals
Household	Paints, antibacterial cleansers
Clothing	Sporting goods, shoe inserts
Automotive	Tires, engines
Military	Armor, camouflage, radioprotection
Electronics	OLED (organic light emitting diode) screens on digital cameras

Nanostructures

- There are 2 types of nanostructures A- Nanocomposite (where nanoscale particles incorporated into substance) B- free nanoparticles.
- Nanostructures developed through four projected phases:
 1. Passive nanostructure : a nanomaterials that perform one task for example sunscreen, coating polymers, ceramics
 1. Active nanostructure: a multitasking Devices, eg; drug delivery device

Nanostructures

3. Nanosystems: Robotic or large number of interacting components e.g nanocomputers
4. Molecular nanosystem or integrated nanosystems i.e. system within systems independent Nanomachines



A Rice University laboratory in Houston, where chemist James Tour and his colleagues have built one trillion nanoscopic cars

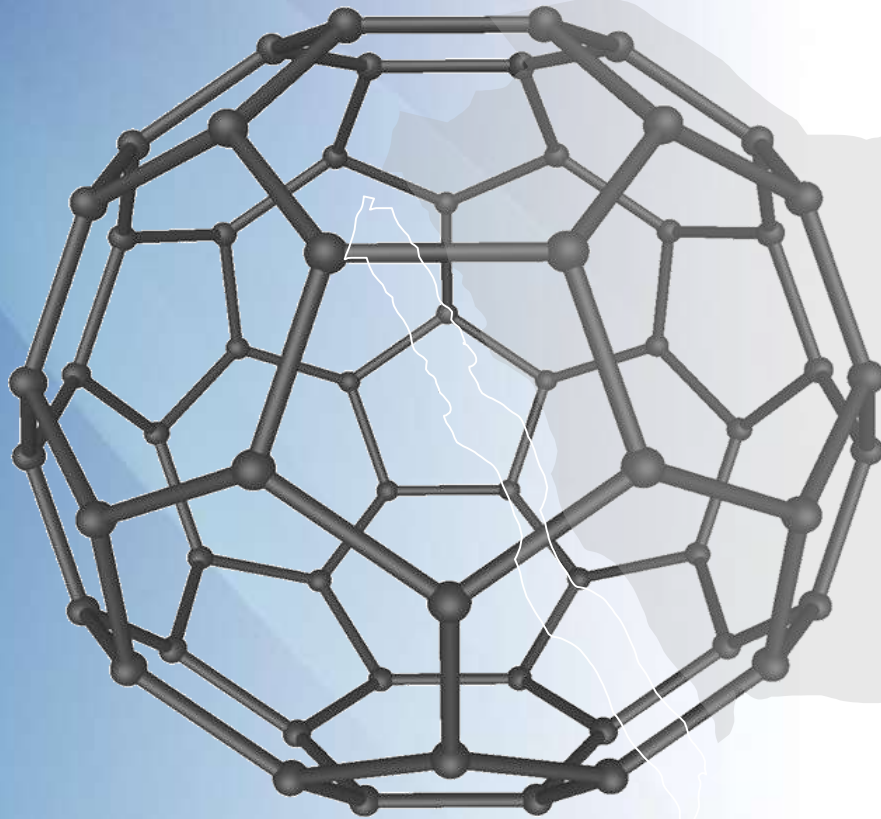
Nanotechnology in Medicine

- Nanomedicine from science fiction in 1966 “Fantastic voyage” by the Author Isaac Asimov to reality,
- Nanomedicine is an interdisciplinary research field incorporating biology, chemistry, engineering and medicine with the intention to improve disease prevention, diagnosis, and treatment.

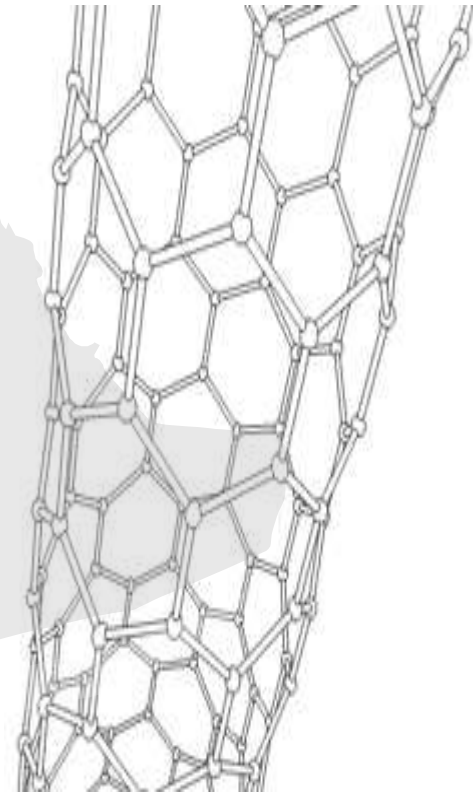
Nanotechnology in Medicine

- The field of nanotechnology is under constant and rapid growth, here are some classes of nanoparticles used in biotechnology and particularly nanomedicine:
- Fullerenes: Buckyballa and carbon tubes
- Carbon tubes found use in biomedicine as carriers for vaccines, drugs and other molecules.

Nanotechnology in Medicine



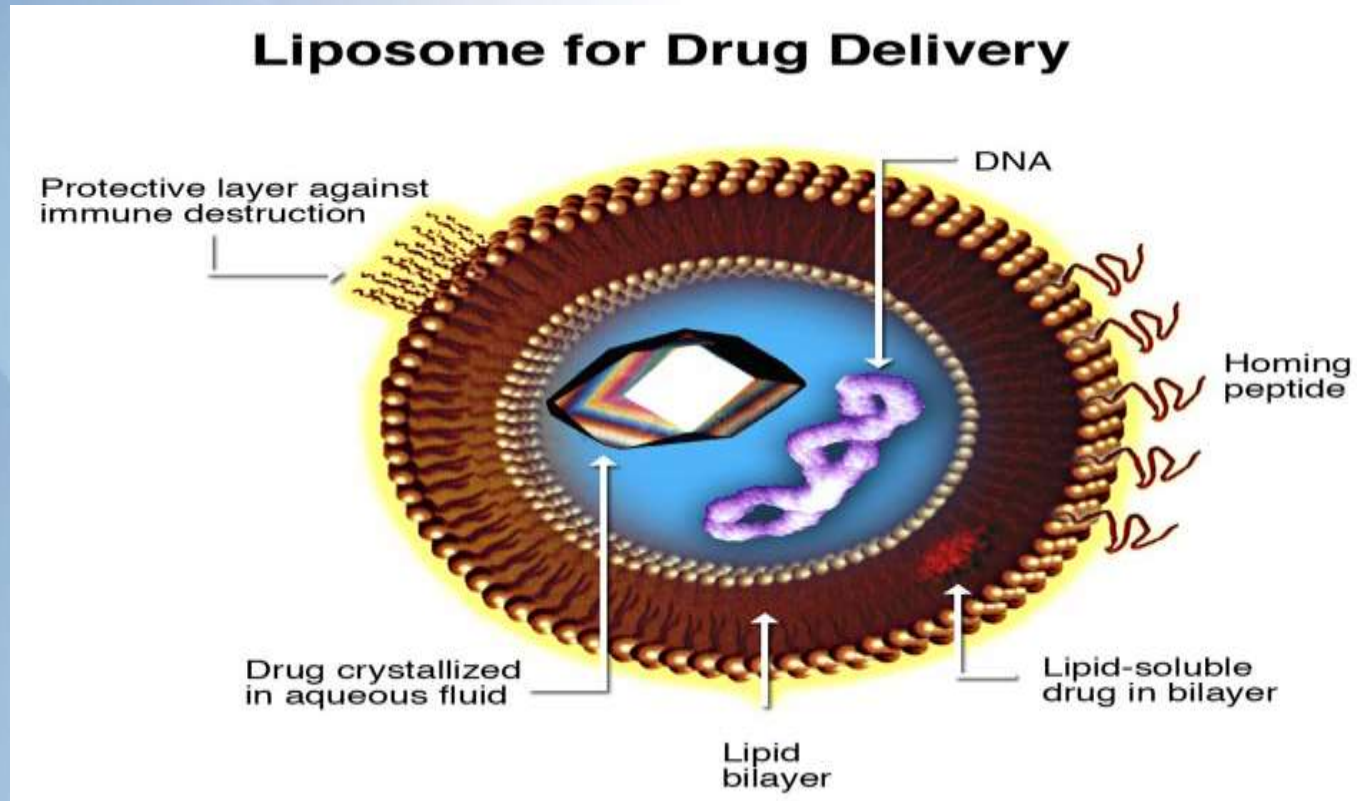
C60a
buckyball



Carbon nanotube

Nanotechnology in Medicine

Liposomes: Lipid based nanoparticles used extensively in pharmaceuticals and cosmetic industries.



In industry, they have been replaced by other nanoparticle Due to their propensity to fuse together in aqueous environment and release of their payload

Nanotechnology in Medicine

- Similar concept Nanospheres of Gold can be coupled to antibody, that when attached to cancer cells the gold absorb laser light and allows for selective tumour photothermolysis.
- Although It is generally known that, Skin care companies are notoriously tight-lipped about their research budgets, we know that the sixth largest patent holder of nanotechnology in the united states is cosmetic companies.

Nanotechnology and Stem Cell Research



“The marriage of nanotechnology and stem cell will dramatically advance our ability to understand and control stem cell-fate decision and develop novel stem cell technologies, which will eventually lead to stem cell-based therapeutics for the prevention, diagnosis and treatment of human diseases” Yubing Xie

Three main categories can be assigned to the use of nanotechnology in stem cell research

- 1- tracking or labeling (Qdots, SPIO/ MRI)
- 2-delivery
- 3-scaffold platforms e.g (Nanofibers).

- Nanofibers would eventually become the foundation of scaffold for stem cell culture and transplantation.
- Now researches are ongoing in the application of nanomaterials to regenerate numerous organs (including, as specific examples, bone, neural, and bladder tissues) will be presented with necessary future directions highlighted for the field of nanomedicine to progress
- The fact that particles of materials at nanoscale change their properties interests cosmetic and pharmaceutical companies lead to the following and many more:

Nanotechnology in Cosmetic & Dermatology



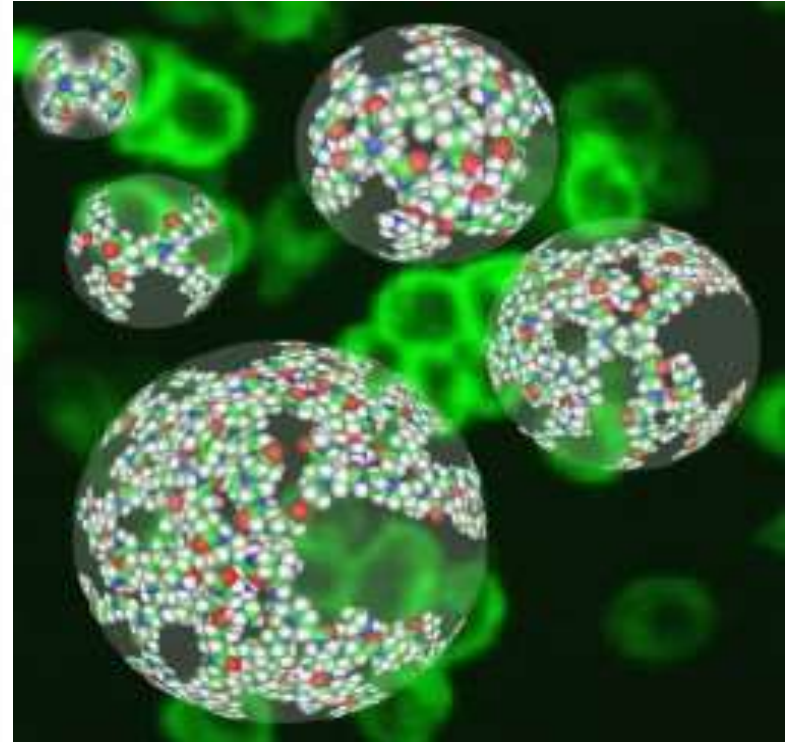
- The total over the counter skin care market is estimated to be \$12 Billion treatment of face alone account for 7\$ Billion in USA with about 5% annual growth.
- Cosmetic companies like L'Oréal devotes about \$600 million of its annual \$17 billion revenues to research, is the industry leader on nanopatents.
- Some believe a coming boom in nanotechnology stocks with estimates floating around of about 1-2 trillion-dollar industry in all field within 10 years.

Nanotechnology in Cosmetic & Dermatology



The Nano products are not new

L'Oréal researchers have been tinkering with nanotech since the 1980s. Its first nanoproducts, introduced about 19 years ago, were nanosomes, tiny capsule-like structures that transport active ingredients, such as vitamins, into the skin's outer layer, and then release them.



Computer-generated images of nanoparticles. Image courtesy Center for Biologic Nanotechnology, University of Michigan-Ann Arbor

Nanotechnology in Cosmetic & Dermatology



Sunscreen

- Nanosized zinc oxide, Zinc oxide particle normally opaque and greasy when broken down to nanoparticles they become invisible and have elegant feel.

Nanopigments:

- Titanium and Titanium oxide, another physical UV blocker with whitening properties at nanoscale it retains its ability to block UV light, but does not scatter visible light thus less noticeable when applied topically, they also pack more densely and evenly on the skin and leave fewer gaps for UV light to penetrate in comparison to larger particles.

Nanotechnology in Cosmetic & Dermatology



Nanoemulsion

- particles range 50-1000 nm (widely used in parenteral nutrition), at this size nanoemulsions become invisible, they also develop good sensory texture with light non greasy feel.
- Due to their hydrophilic exterior they penetrate rapidly to the outer layer of the skin and Hair. And with their hydrophobic interior they can transport hydrophobic substance in aqueous environment, and sprayable form could be used.
- Nasal nanoemulsion vaccines for influenza have been developed and now in the same way vaccine against HIV and Smallpox is underway.

Nanotechnology in Cosmetic & Dermatology



- Nanoemulsion can be used as Drug delivery system in creams to pass the lipophilic skin barrier in administering fat soluble vitamin like Vit E, K
- Topical containing GABA used in cosmetic and has been studied for wrinkle reduction.
- Some can be used to stabilize bioactive enzymes e.g.(transglutaminase) or deliver molecular particles (filaggrin), given a potential to treat difficult skin conditions e.g. (Atopic Eczema Ichthyosis, palmoplantar keratoderma)

Nanotechnology in Cosmetic & Dermatology



Soyabean oil Nanoemulsion at 400-600nm is able to kill many pathogen including bacteria (MRSA) and viruses due to their surface, on the other hand it might disrupt erythrocyte and spermatocyte membranes thus might not be safe for systemic use.

Nanotechnology in Cosmetic & Dermatology



Silver

- Is highly toxic to wide range of bacteria, its nanoparticles are more effective because of their high surface/volume ratio, which allows greater proportion of silver atoms to come into direct contact with a pathogen and at 10 nm size or less they can pass through bacterial outer cell wall. e.g.
- In treatment of MRSA
- *Pseudomonas aeruginosa*
- Lately was found to prevent HIV from binding to host cell surface.

Proposed Research to Utilize Nanotechnology at King Saud University (Dermatology Dept.)

- Research studies submitted by Dermatology research group in the field of Nano-biotechnology includes:
 1. Development of Self-cleaning surface.

This aim to initialize Nano-Engineering to develop surface that prevent adherence and accumulation of dust, dirt and microbes
- In the field of Allergy Diagnosis
 2. Comparison of Nano-prepared allergen extracts with conventional extracts in diagnosis of type I allergy by the skin prick test.

This aim to utilize the high specification and penetration of nano-prepared extracts.

In preparation:

Prof. Mohamed Osman Gad El Rab

Omar Abdulaziz Al-Sheikh, MD

Dr. Sohaib Mukhtar Agouba

Dr. Hind Al Otaibi

The Risks of Nanotechnology

Some Facts to remember;

- The adverse effect of engineered nanoparticles cannot be predicted or derived from the known toxicity of the bulk material.
- Larger nanoparticles might have different properties than smaller ones, nanoparticles have tendency to aggregate due to their atomic force, such aggregate often behave differently from individual nanoparticles.

The Risks of Nanotechnology

Facts

- In nanotechnology nothing much is known about the risk of a rather relatively new technology.
- Anticipation is of that; we are going to be faced by a boom of Nanoproducts,
- To date studies of nanotechnology toxicity have produced conflicting results.
- Reporting of side effects should be the responsibility of all professionals handling this technology including dermatologist.

The Risks of Nanotechnology

Some Recommendations given to European Centre for Ecotoxicology and Toxicology of Chemicals (ECETOC) :

- Measure/Calculate exposure of the skin to Nanomaterials and especially NP for workers handling powder like Nanomaterials such as Carbon Black or Titanium dioxide.
- Develop a method to reproducibly assess personal exposure to NP and their agglomerates.
- measurements in working areas and estimate personal exposure levels to derive an overview on possible exposure levels.

The Risks of Nanotechnology

Dermatologists are at the front line

- The skin is at the front line, Nanoparticle can penetrate the skin, and the smaller a particle the further it can travel through tissue, along airways or in blood vessels and might threaten organs
- (If nanoparticle are indestructible, they can accumulate and cause end organ damage, or might cause biochemical disturbances, penetrate cell membrane causing cell death. Lodge in DNA, generate O₂ free radicals, inflammation or allergic reactions, granuloma or even cancer).

The Risks of Nanotechnology

Nanoparticles Parameters that determine toxicity.

Nanoparticle can enter the body through many routes, respiratory (the most important route) Cutaneous, GIT Parenteral or reproductive, and toxicity can be determined by:

- Small size (in skin which is diseased larger nanoparticles might penetrate 7000nm)
- Size distribution
- Chemical composition
- Surface structure
- Shape
- Aggregation
- dispersal

The Risks of Nanotechnology

Reporting Has Began

- Nanoparticles can damage DNA, increase cancer risk April 17th, 2007 www.Physiorg.com
- Craig A. Poland¹, Rodger Duffin¹, Ian Kinloch², Andrew Maynard³, William A. H. Wallace¹, Anthony Seaton⁴, Vicki Stone⁵, Simon Brown¹, William MacNee¹ & Ken Donaldson¹ Carbon nanotubes introduced into the abdominal cavity of mice show asbestos-like pathogenicity in a pilot study *Nature Nanotechnology* 3, 423 - 428 (2008)

Conclusion

- Our young generation should learn about Nanotechnology in early school years.
- We should increase our scientific research on Nanotechnology and it's applications (Medicine, Agriculture, Engineering, etc.)
- Build sophisticated infrastructure and Institutes for Nanotechnology
- Despite the evident and appealing qualities of Nano-engineered products, and the numerous Nano materials manufactured over the past few years, very little is known about the safety aspects of such materials, thus caution and reporting of side effects should be the responsibility of all professionals handling Nanotechnology.

الخلاصة

- ثقافة تقنية النانو يجب التركيز عليها في المؤسسات العلمية بشكل عام ابتدا من المراحل الاولى في التعليم.
- التركيز وبشكل اكبر على البحث العلمى فى مجال تقنية النانو وعلاقتها بالعلوم التطبيقية) طب؛ زراعة؛ صناعة.(...)
- الاهتمام وتوسيع البنى التحتية لتقنية النانو.
- على الرغم من الفوائد الكثيرة فى تقنية النانو فى الطب؛الا انه يجب التركيز وبشكل لا يقل اهمية على متابعة الاعراض الجانبية والمخاطر المحتملة على الجلد وجميع اعضاء الجسم البشرى.

References

<http://www.wikipedia.org/>

Yubing Xie, The Application of Nanotechnology in Stem Cell Research Nanotechnology Now January 22nd, 2008

Chun YW, Webster TJ. The Role of Nanomedicine in Growing Tissues. Ann Biomed Eng. 2009 Jun 5

Biomimetic design by nature DECEMBER 12, 2005

<http://www.core.form-ula.com/2008/04/15/biomimetics-design-by-nature/>

W.R Hansen, and K Autumn. Evidence for self-cleaning in gecko setae

Communicated by Jacob Israelachvili, University of California, Santa Barbara, CA, November 8, 2004 (received for review July 26, 2004)

EUROPEAN BUSINESS December, 12 2005 Nano, Nano, On The Wall...
L'Oréal and others are betting big on products with microparticles

Cosmetics Break the Skin Barrier

By CLAUDIA H. DEUTSCH January 8th 2009

Examining the Viability of Patent Pools to the Growing Nanotechnology Patent Thicket

By: Alexander Lee¹

Adnan Nasir, MD, PhD, FAAD. Nanotechnology and dermatology, presentation at the American Academy of Dermatology, San Antonio, Texas, February 2008.

السلامة المترتبة من تطبيقات تقنية النانو، مقال علمي
د. عبد الوهاب بن صادق استاذ التلوث الميكروبي البيئي، كلية العلوم ج.س

تقنيات النانو تفتح آفاقا واعدة في قطاعات الطب والاقتصاد ومختلف مناحي الحياة ز
جريدة الشرق الاوسط الاربعاء 13 صفر 1426 هـ 23 مارس 2005 العدد 9612

علوم وتقنيات النانو تطبيقاتها، اثارها واستراتيجية تطويعها في الوطن العربي
د. فتحي حمد بن شتوان، المنظمة العربية للتنمية والتعدين

References

Adnan Nasir, MD Nanomaterial may pose health risk, science news, Dec 4 2008.

Theresa Phillips. Nan particles used in biotechnology www.about.com Biotech/Biomedical 2009.

Michael Berger Nanotechnology structure of materials with atomic precision, Nanowerk LLC June 18 2009.

Optimizing the benefit of nanotechnology while minimizing and controlling the risk an insider report. Nanoriskrisk, issue 1 volume 1 June 2006.

0.1117/2.1200602.0094 Quantum-dot diodes provide sources for optical coherence tomography the international society for optic engineering.

[Gold Nanotechnology: Past and Future](#) PaulTech Network, AUG 22, 2008

Nanoscale Materials from the EML / Gold nano rod cir1 UC Berkeley Electron Microscope Lab 12/9/2004
gvrldolja@nature.berkeley.edu

Nanoemulsion vaccines effective against HIV?
Chris Jablonski February 28th, 2008 ,

Paul JA Borm¹ , David Robbins² , Stephan Haubold³ , Thomas Kuhlbusch⁴ , Heinz Fissan⁴ , Ken Donaldson⁵ , Roel Schins⁶ , Vicki Stone⁷ , Wolfgang Kreyling⁸ , Jurgen Lademann⁹ , Jean Krutmann⁶ , David Warheit¹⁰ and Eva Oberdorster¹¹ the potential risks of nanomaterials: a review carried out for ECETOC. *Particle and Fiber Toxicology* 2006, 3:11doi:10.1186/1743-8977-3-11.

Nanobiotechnology: From Stem Cell, Tissue Engineering To Cancer Research Yubing Xie
CNSE Assistant Professor of Nanobioscience
College of Nanoscale Science & Engineering

Size-Dependent Proinflammatory Effects of Ultra fine Polystyrene Particles: A Role for Surface Area and Oxidative Stress in the Enhanced Activity of Ultra fines 2000

Nanoparticles can damage DNA, increase cancer risk April 17th, 2007 www.Physiorg.com

Nanoparticle lung threat blocked <http://news.bbc.co.uk/2/hi/health/8091141.stm> a research, by the Chinese Academy of Medical Sciences, appears in the Journal of Molecular Cell Biology links polyamidoamine dendrimers used in medicine to lung cancer.

Craig A. Poland¹, Rodger Duffin¹, Ian Kinloch², Andrew Maynard³, William A. H. Wallace¹, Anthony Seaton⁴, Vicki Stone⁵, Simon Brown¹, William MacNee¹ & Ken Donaldson¹ Carbon nanotubes introduced into the abdominal cavity of mice show asbestos-like pathogenicity in a pilot study *Nature Nanotechnology* 3, 423 - 428 (2008)

Standard Researchers Develop New Nanoscale Cancer Detection System for the Human Body