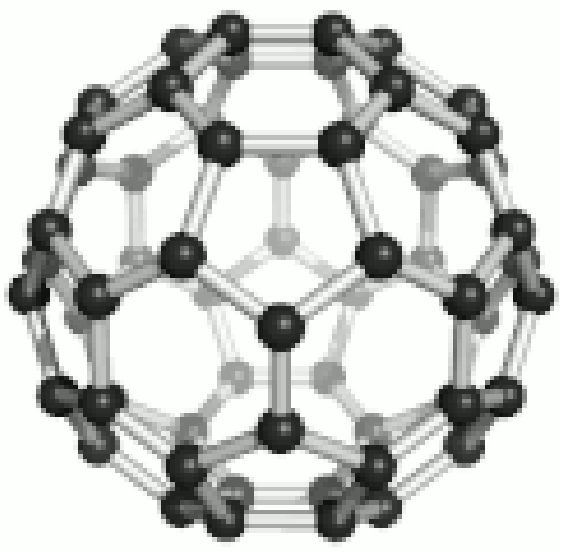
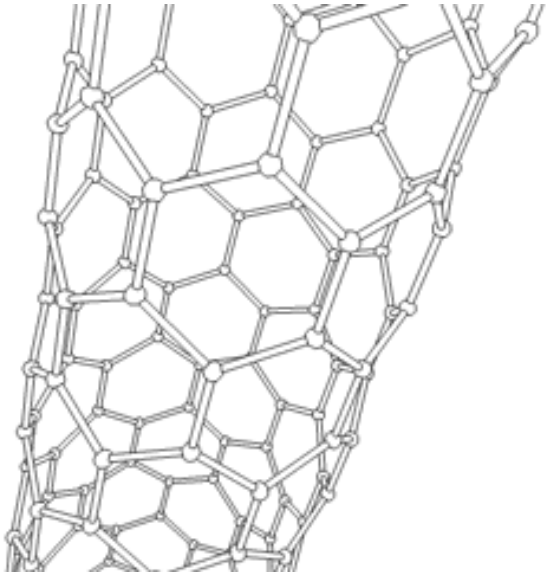
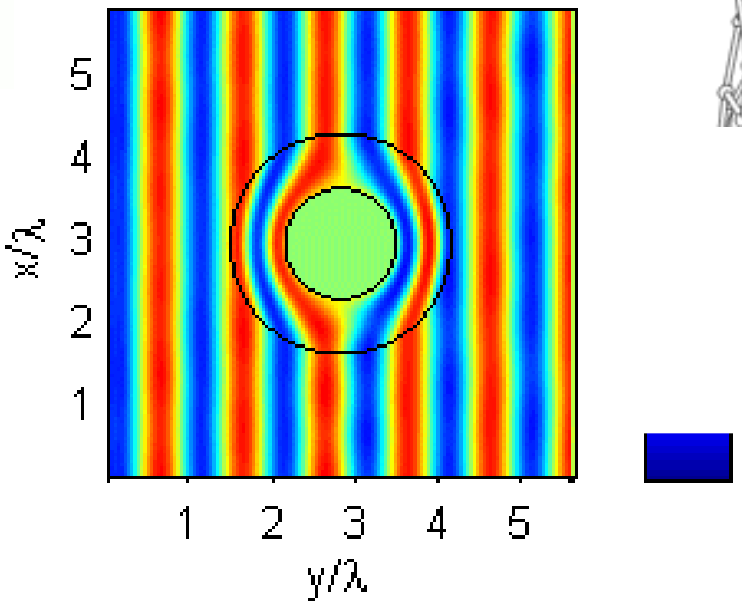
NANOTECHNOLOGY. METAMATERIALS, AND THEIR APPLICATIONS



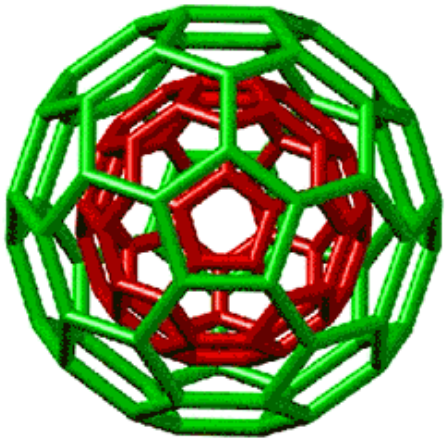




COMPILED BY HOWIE BAUM

PRESENTATION ABOUT NANOTECHNOLOGY

- WHAT IS IT ?
- HOW SMALL ARE NANO PARTICLES?
- WHAT ARE THE DIFFERENT TYPES OF NANO PARTICLES ?
- WHAT ARE THE APPLICATIONS OF NANOMATERIALS ?
- SAFETY CONCERNS ABOUT NANOMATERIALS



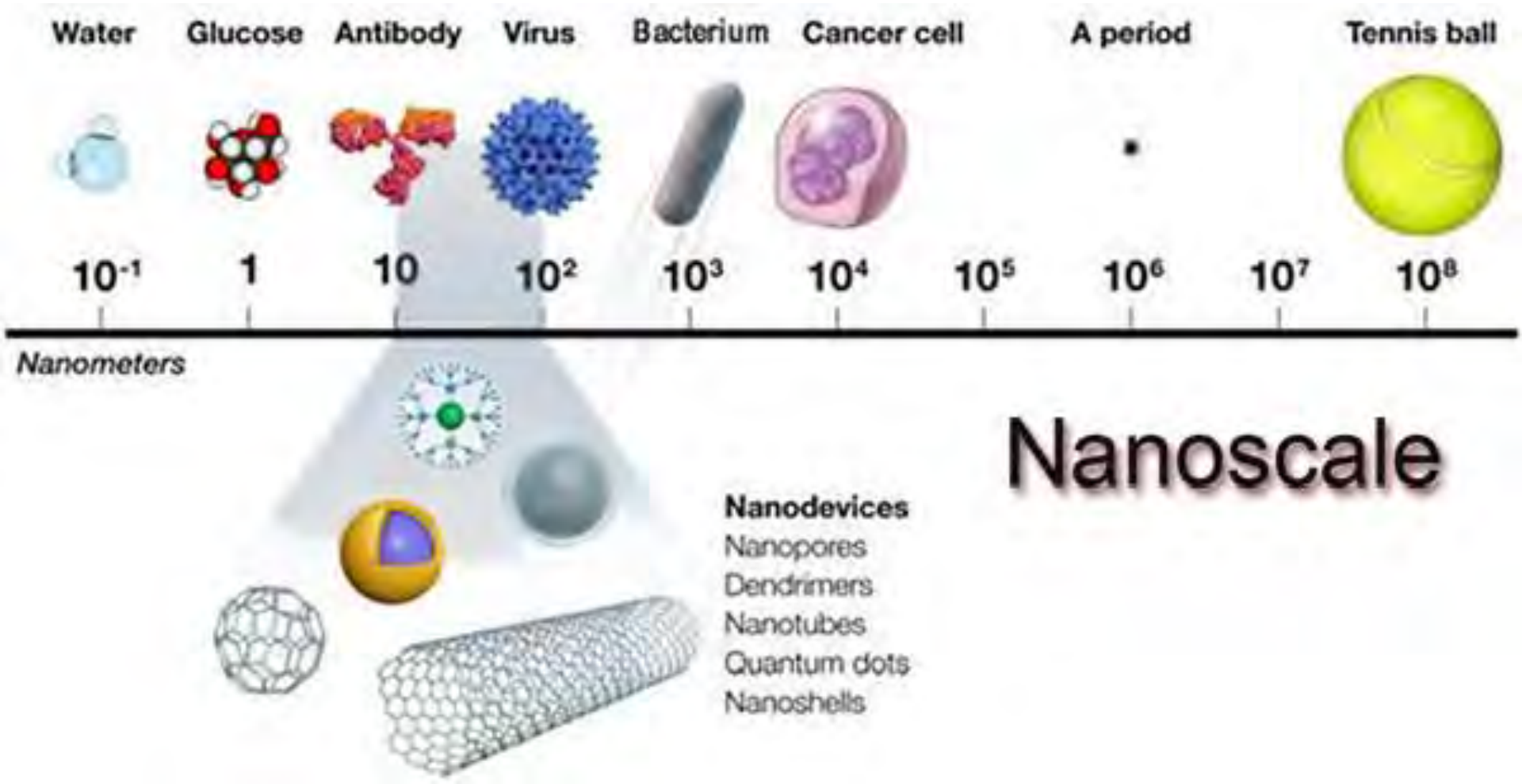
NANOMATERIALS - materials of which a section is between 1 and 100 nanometers long. (a billionth of a meter !)

Materials with structure at the nanoscale often have unique optical, electronic, thermal (heat), or mechanical properties.

Examples of biological materials that are nanomaterials are:

- The overlapping scales on the wing of the Blue Morpho Butterfly contain nanoscale structures that reflect light to create iridescent colors.

- Chalk
- Viruses
- Wax crystals covering a lotus leaf
- Spider and spider-mite silk
- "Spatulae" on the bottom of a Gecko lizard's feet
- Milk and blood



HOW SMALL IS NANO ?

https://www.youtube.com/watch?v=5AAR7bNSM_s

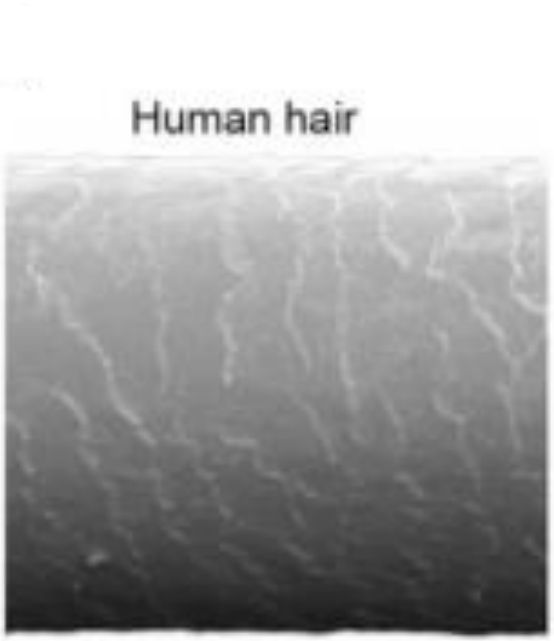
go to 55 sec

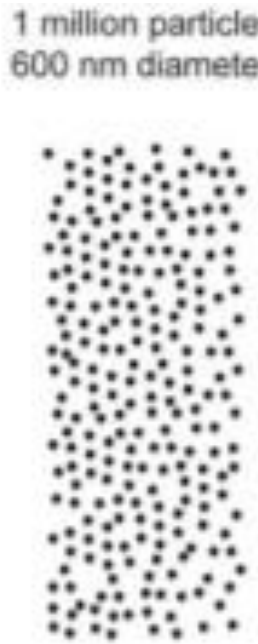
µm = a millionth of a meter

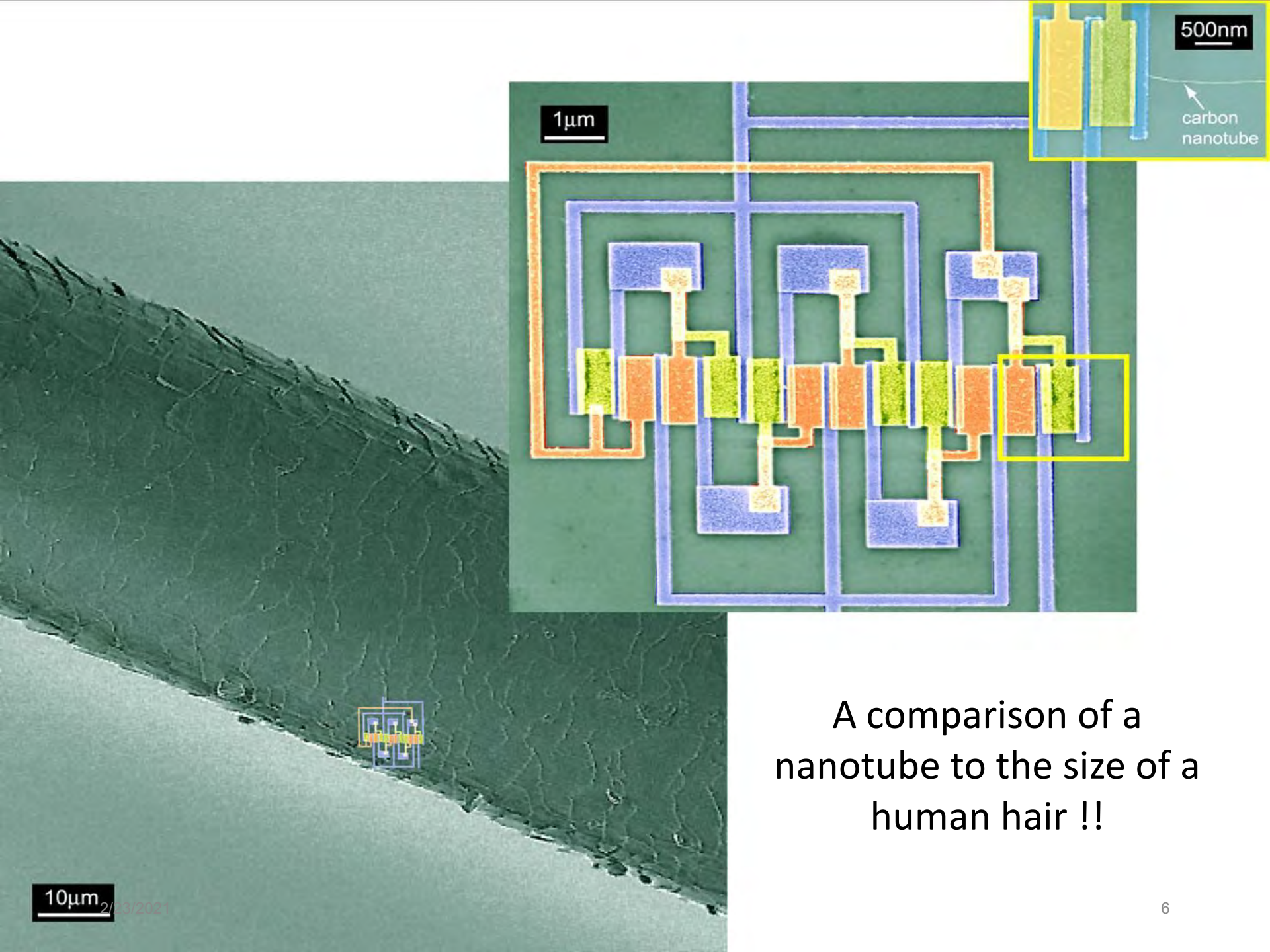
.000001 meter

nm = a billionth of a meter

.000000001 meter







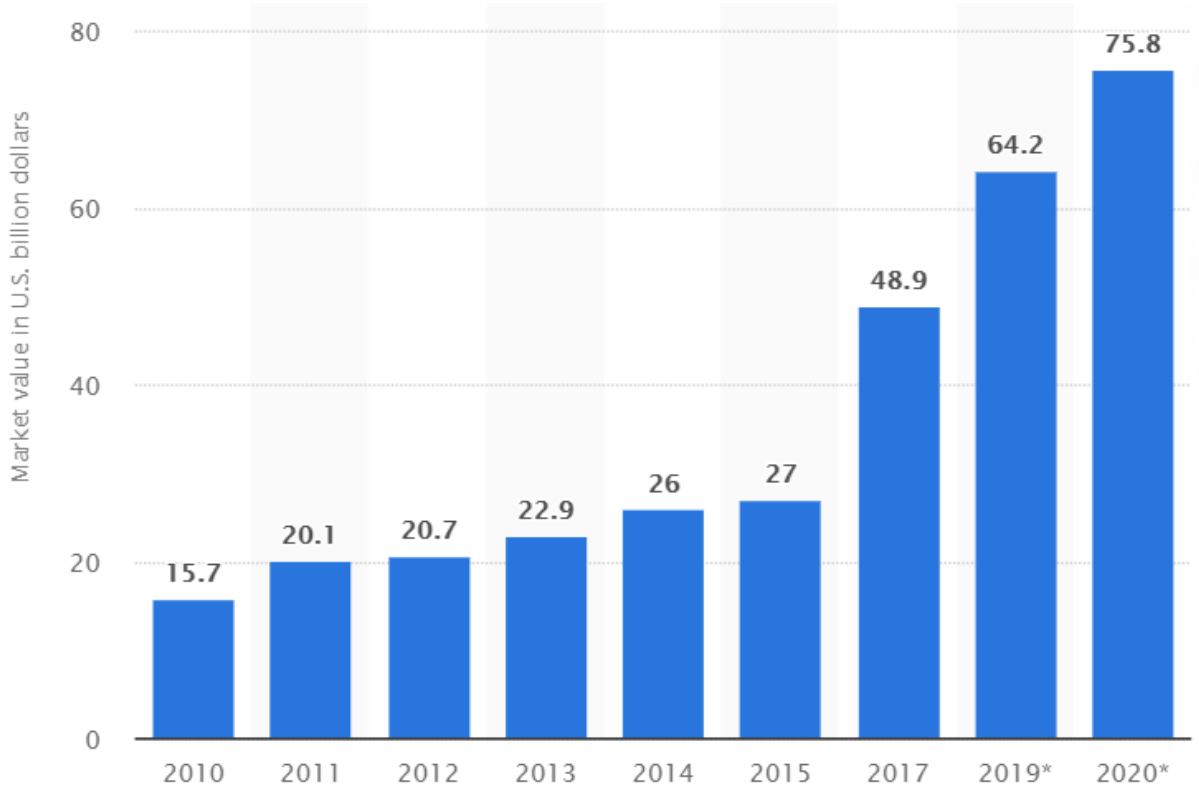
A comparison of a nanotube to the size of a human hair !!

SIZE OF THE MARKET FOR NANOMATERIALS

The global nanomaterials market size was valued at 8.5 billion in US dollars in 2019.

Aerospace applications are expected to drive the market.

Rapid developments in healthcare technology, growth in the medical diagnostics industry, and various advantages of medicinal imaging applications are anticipated.

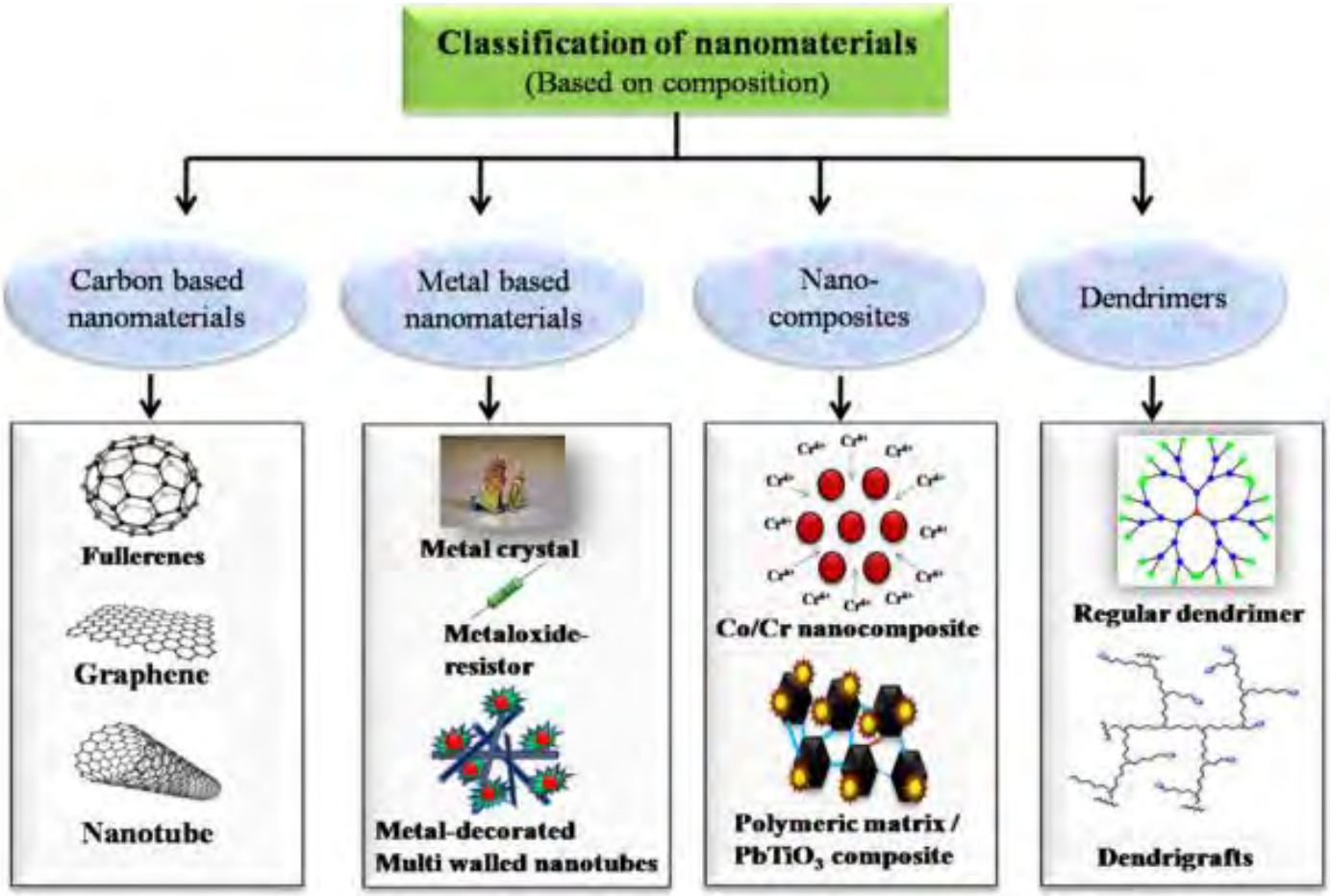


https://www.youtube.com/watch?reload=9&v=dQhhcgn8YZo 3.5 minutes

DIFFERENT TYPES OF NANOMATERIALS

NANOMATERIALS CAN BE DIVIDED INTO 4 TYPES:

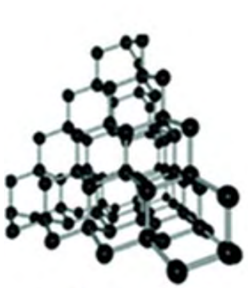
1) CARBON-BASED
2) METAL-BASED
3) DENDRIMERS
4) COMPOSITES



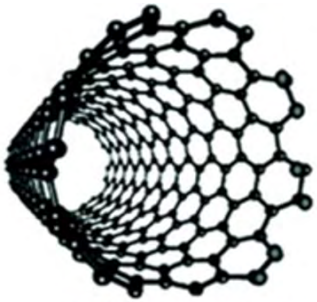
1) CARBON BASED MATERIALS

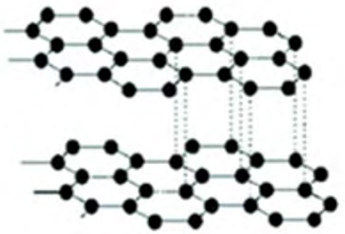
These nanomaterials are composed mostly of carbon atoms, most commonly taking the form of a hollow spheres, ellipsoids, or tubes.

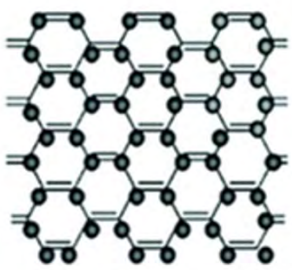
Spherical and ellipsoidal carbon nanomaterials are referred to as fullerenes, while cylindrical ones are called nanotubes.

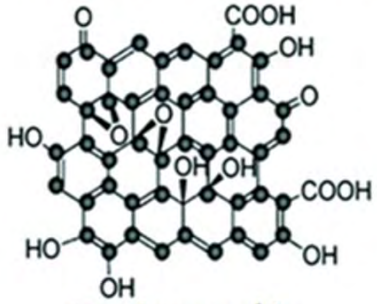

Diamond


Fullerene

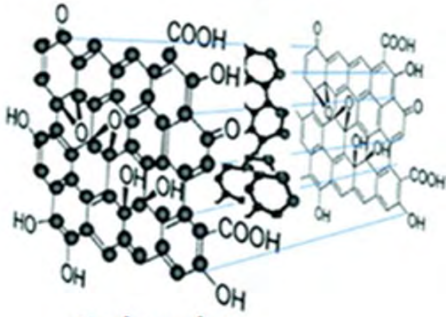

Carbon nanotube


Graphite


Graphene



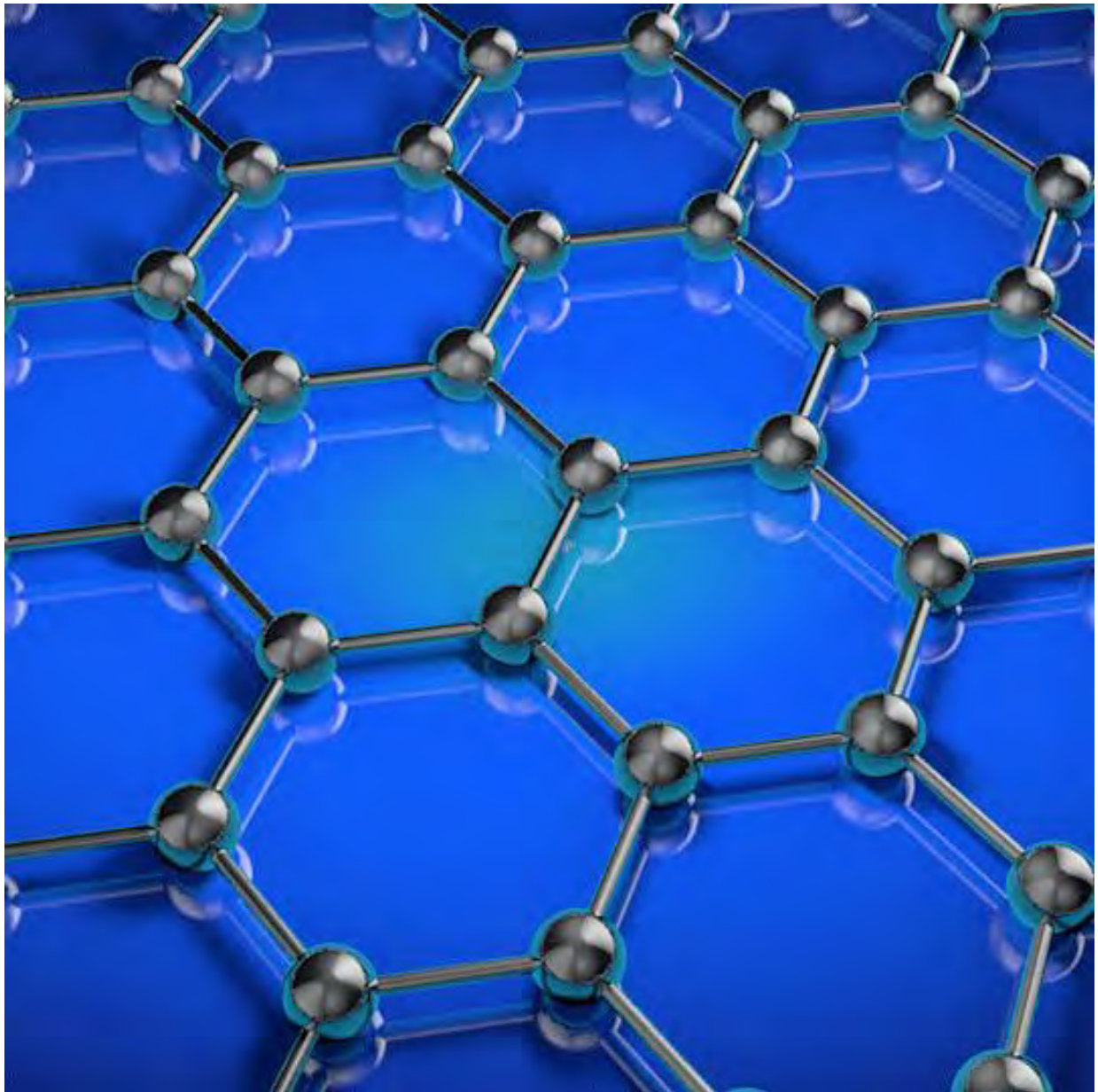
Graphene oxide



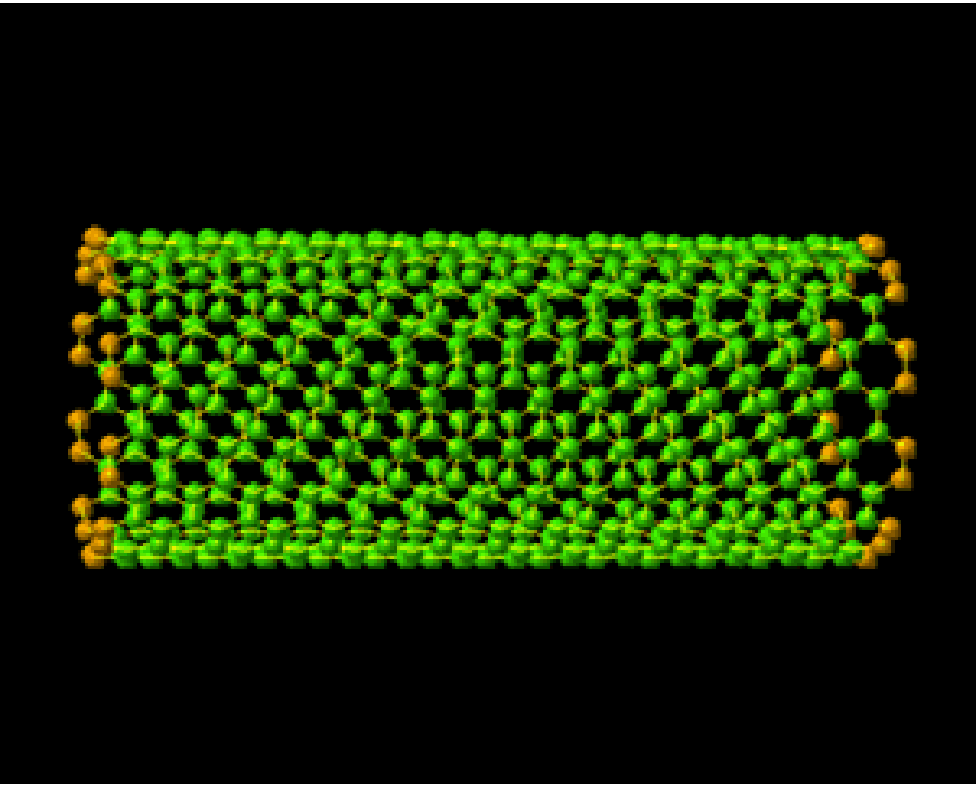
Carbon dot

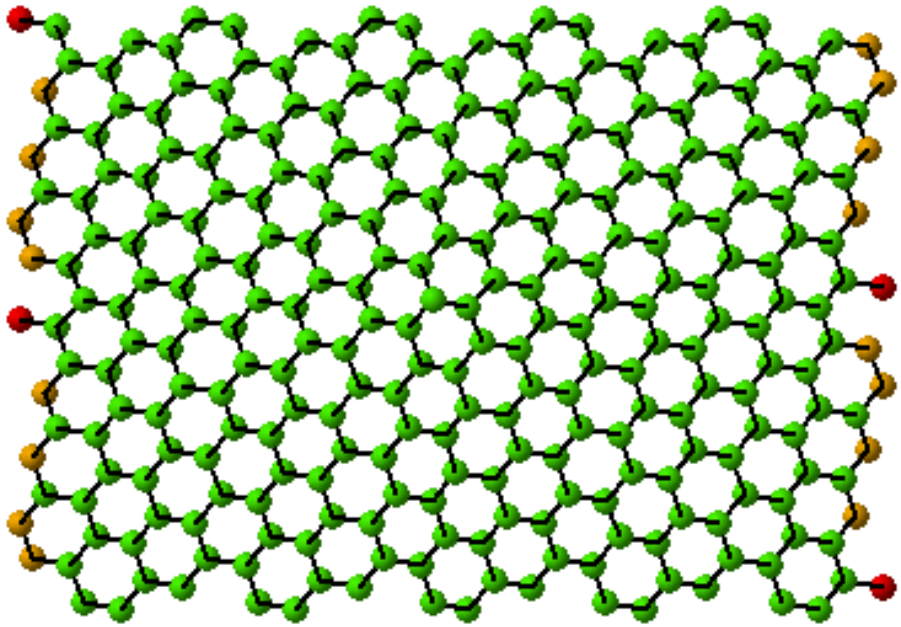
These particles have many potential applications, including improved films and coatings, stronger and lighter materials, and applications in electronics.

GRAPHENE – HEXAGON-SHAPED PLANE OF CARBON ATOMS IN SHEET FORM



NANOTUBES ARE FLAT AREAS OF GRAPHENE THAT IS ROLLED UP INTO A TUBE





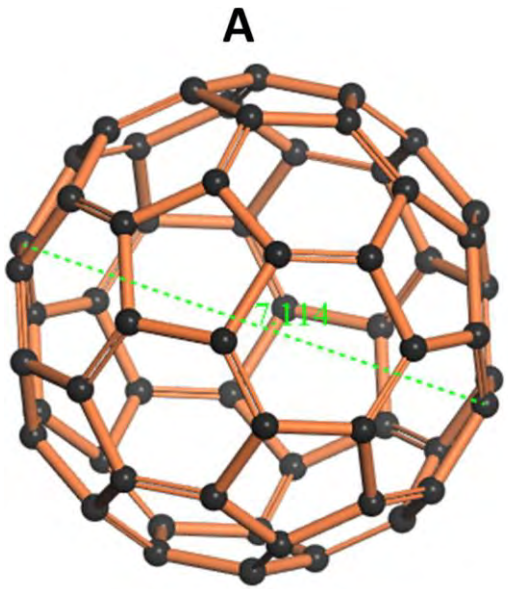
CARBON-BASED FULLERENES (ALSO CALLED BUCKYBALLS)

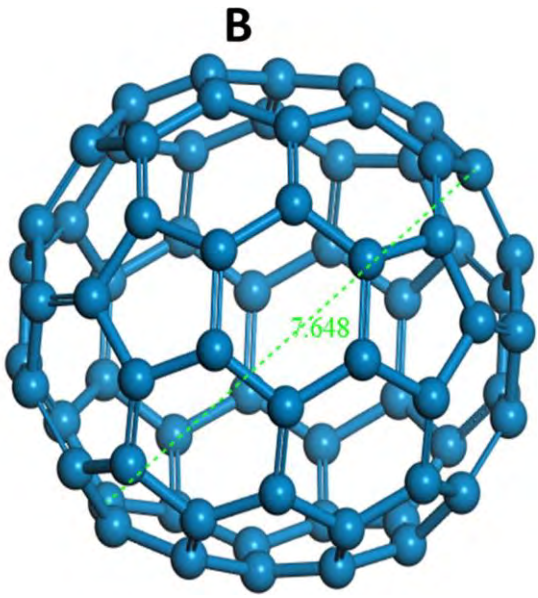
Fullerenes are nanomaterials that are made of round hollow cages and have high electrical conductivity and strength.

They are named after Buckminster Fuller who designed the Geodesic dome.

The illustration shows some of the well-known fullerenes consisting of C60 (A) and C70 atoms (B) of carbon.

The number of Carbon atoms can range from 20 to 90.



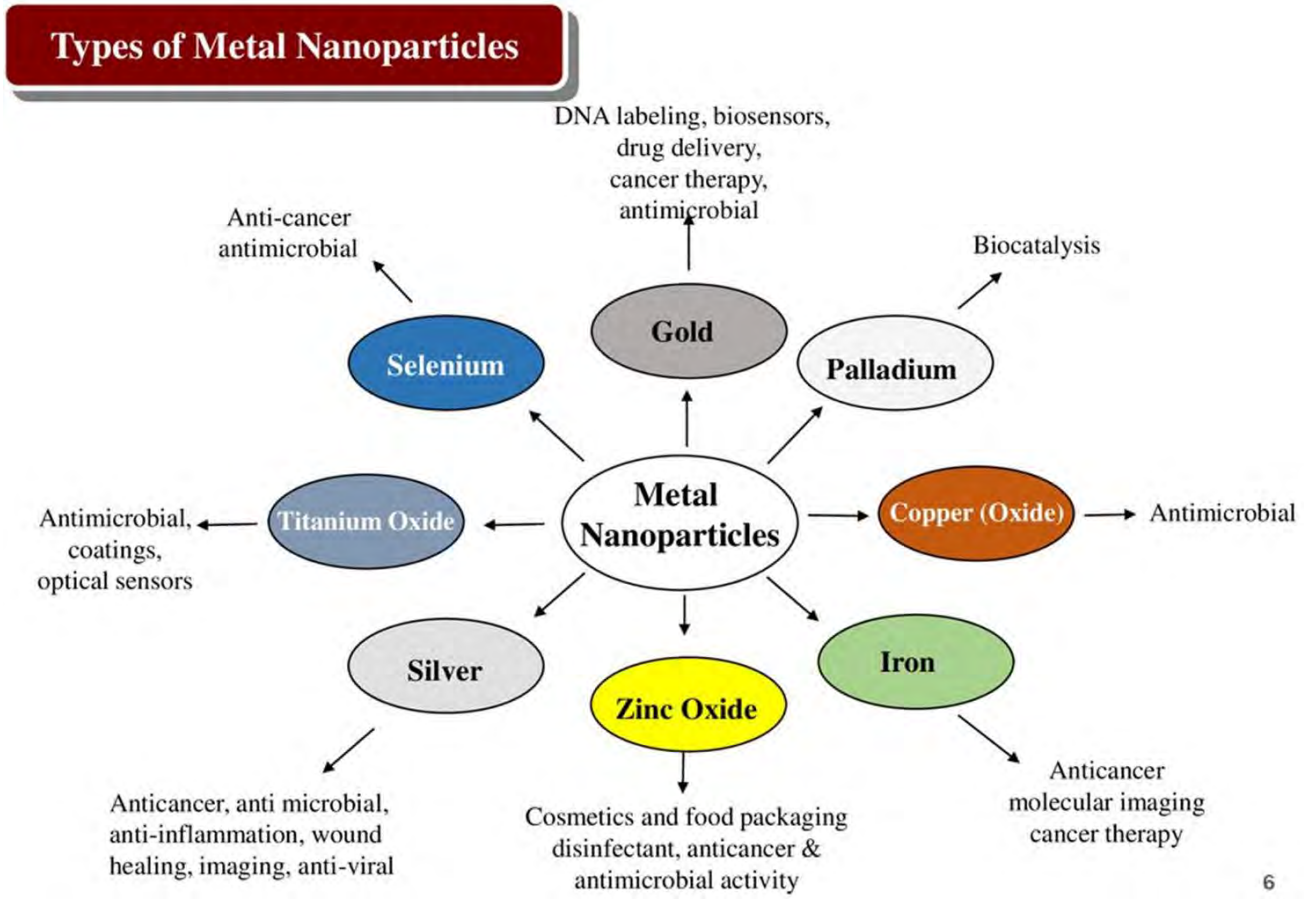


2) METAL BASED NANOMATERIALS

These nanomaterials include quantum dots, nanogold, nanosilver and metal oxides, such as titanium dioxide.

A quantum dot is a closely packed semiconductor crystal comprised of hundreds or thousands of atoms, and whose size is on the order of a few nanometers to a few hundred nanometers.

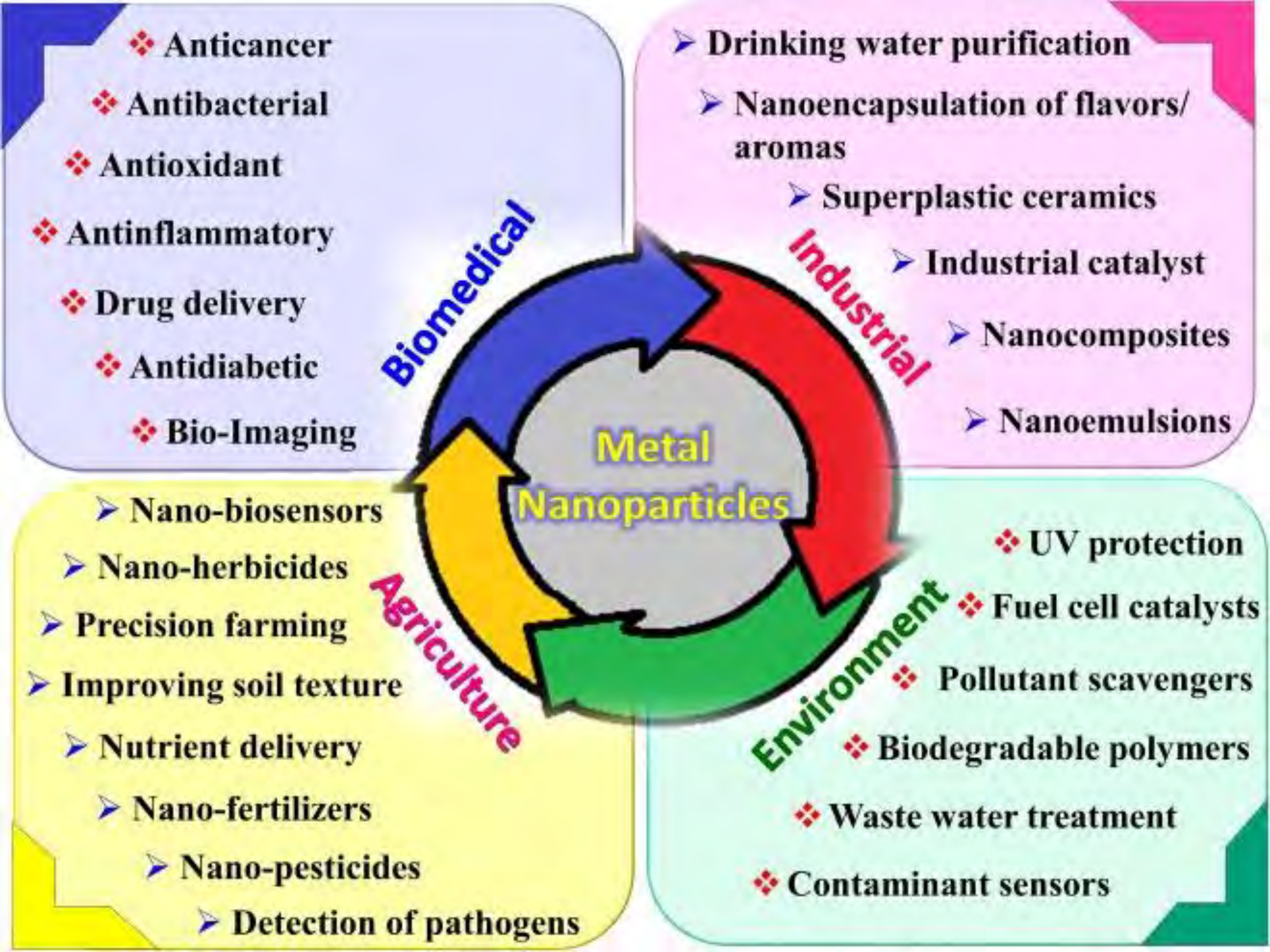
Changing the size of quantum dots changes their optical properties.



Infrormation obtained from MLi, Xiangqian, et al. "Biosynthesis of nanoparticles by microorganisms and their applications." *Journal of Nanomaterials* 2011 (2011): 8.

- Nanoparticles exhibit unique optical properties.

- A change in optical absorption with reduced sizes cause them to glow when exposed to UV light.


Anticancer
Antibacterial
Antioxidant
Antinflammatory
Drug delivery
Antidiabetic
Bio-Imaging
Biomedical
Drinking water purification
Nanoencapsulation of flavors/ aromas
Superplastic ceramics
Industrial catalyst
Nanocomposites
Nanoemulsions
Industrial
Metal Nanoparticles
Nano-biosensors
Nano-herbicides
Precision farming
Improving soil texture
Nutrient delivery
Nano-fertilizers
Nano-pesticides
Detection of pathogens
Agriculture
UV protection
Fuel cell catalysts
Pollutant scavengers
Biodegradable polymers
Waste water treatment
Contaminant sensors
Environment

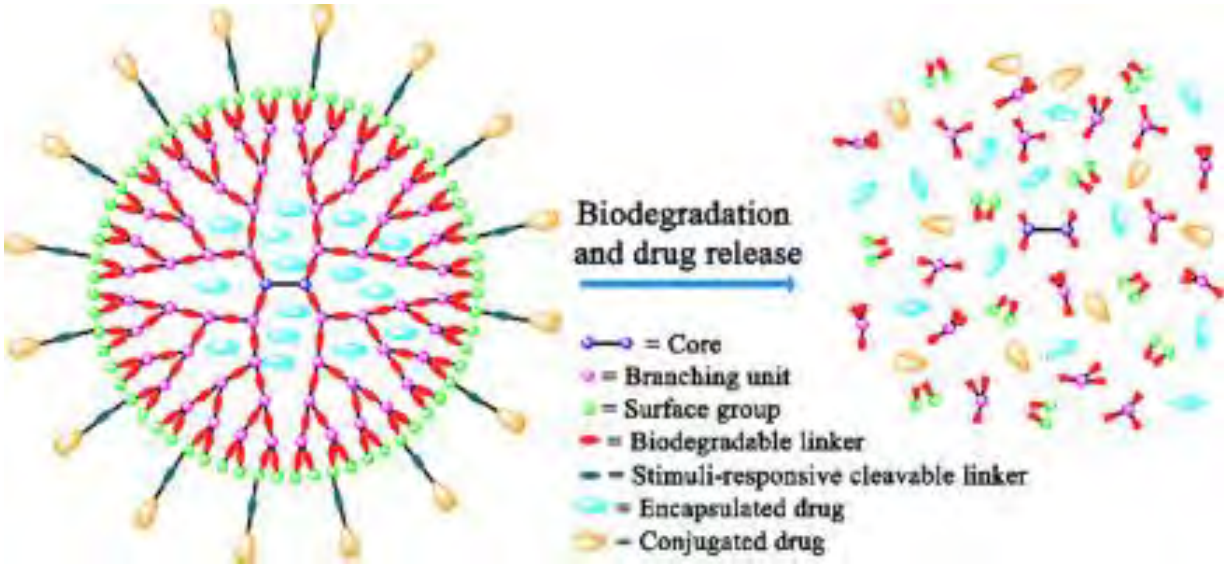
3) DENDRIMERS

These nanomaterials are nanosized polymers built from branched units.

The surface of a dendrimer has numerous chain ends, which can be tailored to perform specific chemical functions.

This property could also be useful for catalysts, to help with chemical reactions.

Also, because three-dimensional dendrimers contain interior cavities into which other molecules could be placed, they may be useful for drug delivery.



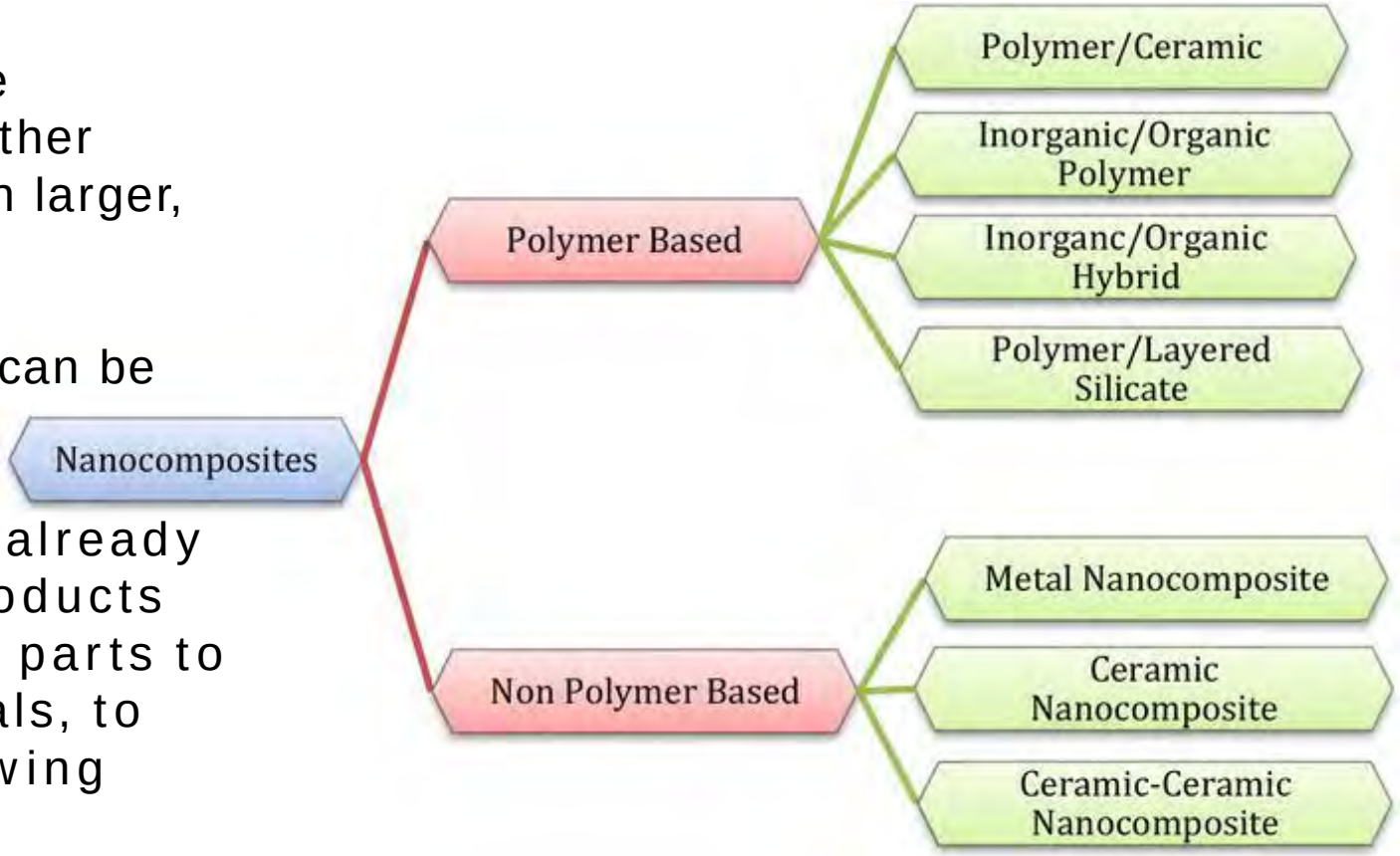
4) COMPOSITES

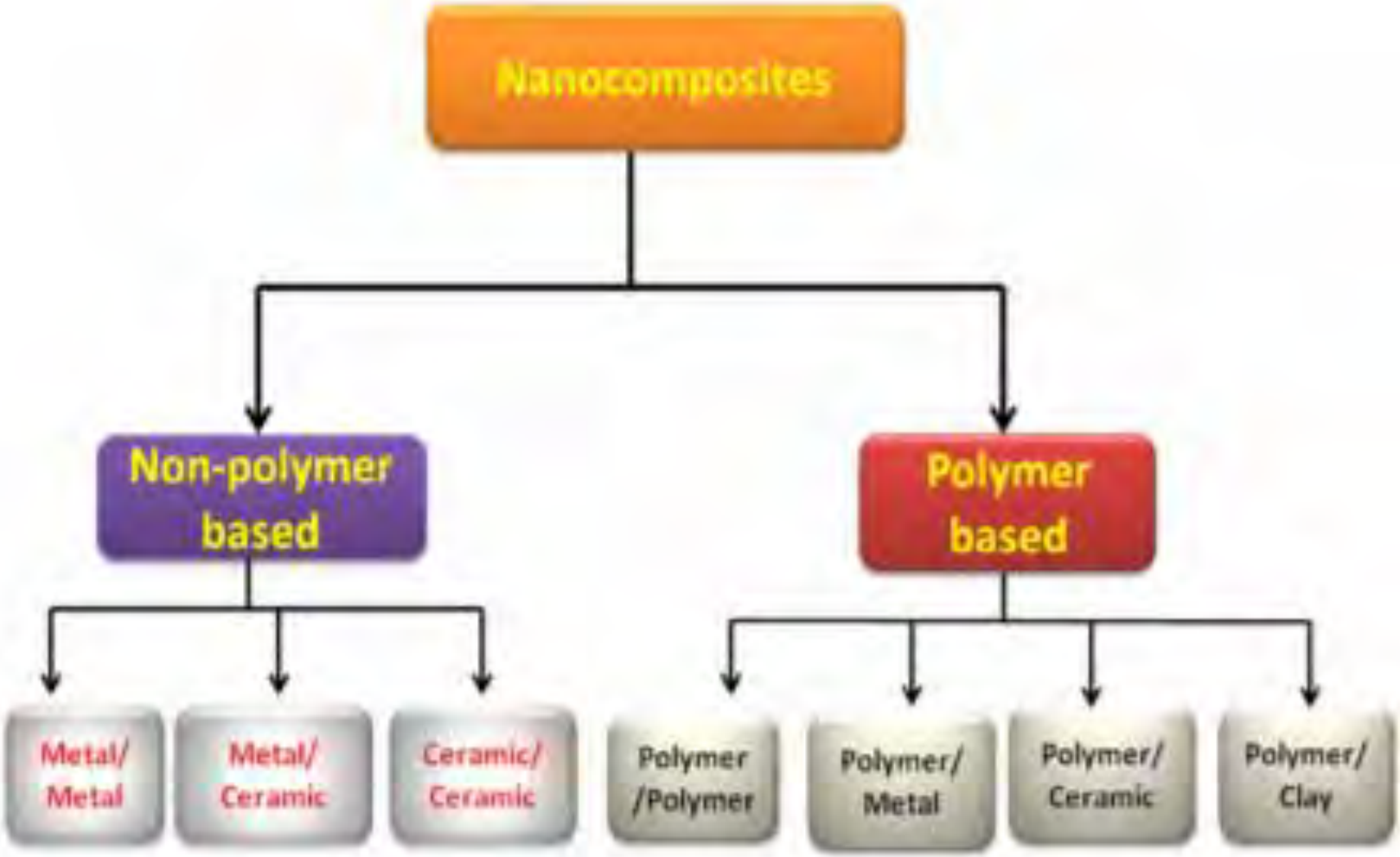
Composites combine nanoparticles with other nanoparticles or with larger, bulk-type materials.

Clays and Polymers can be used to make them.

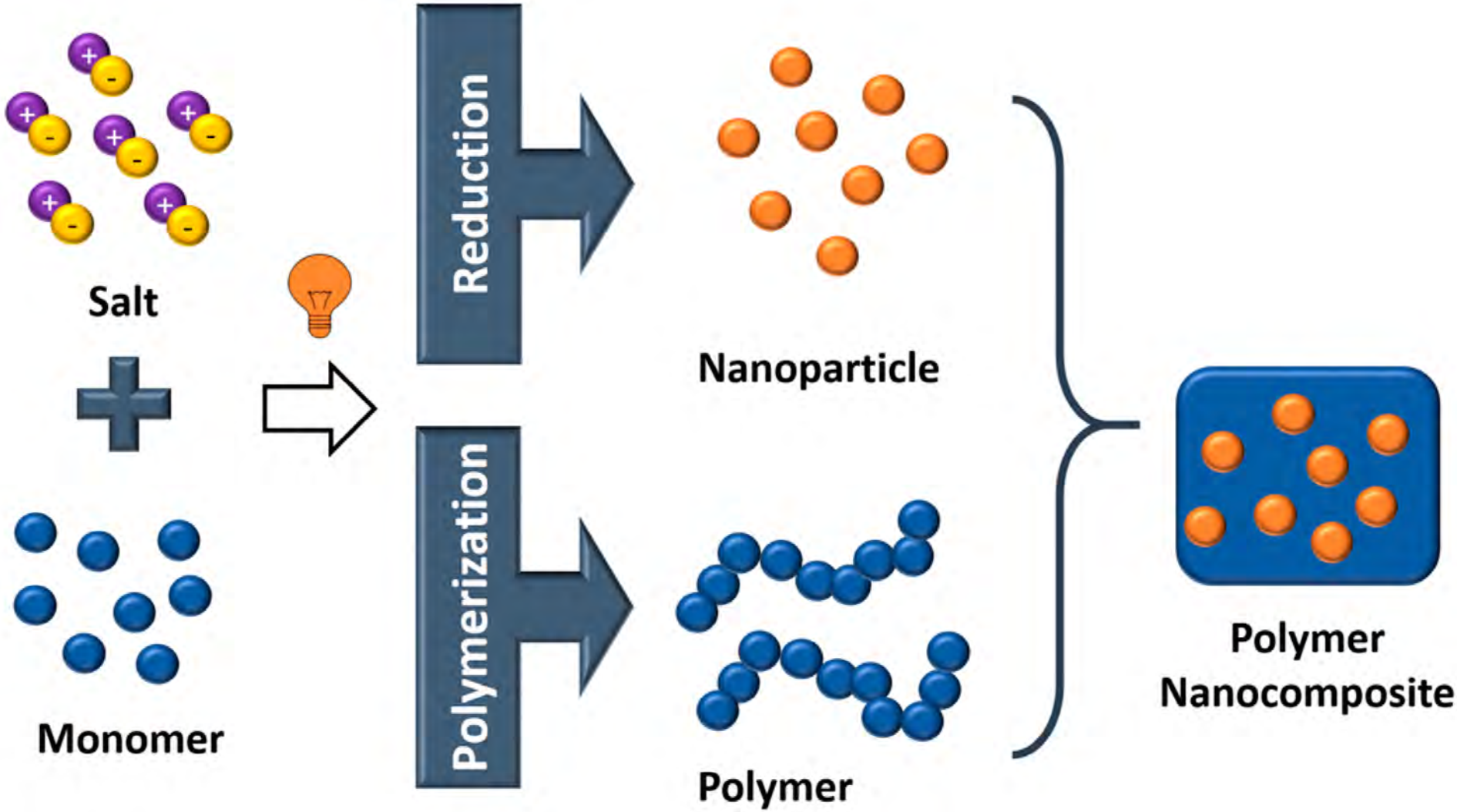
Nanoparticles are already being added to products ranging from auto parts to packaging materials, to enhance the following properties:

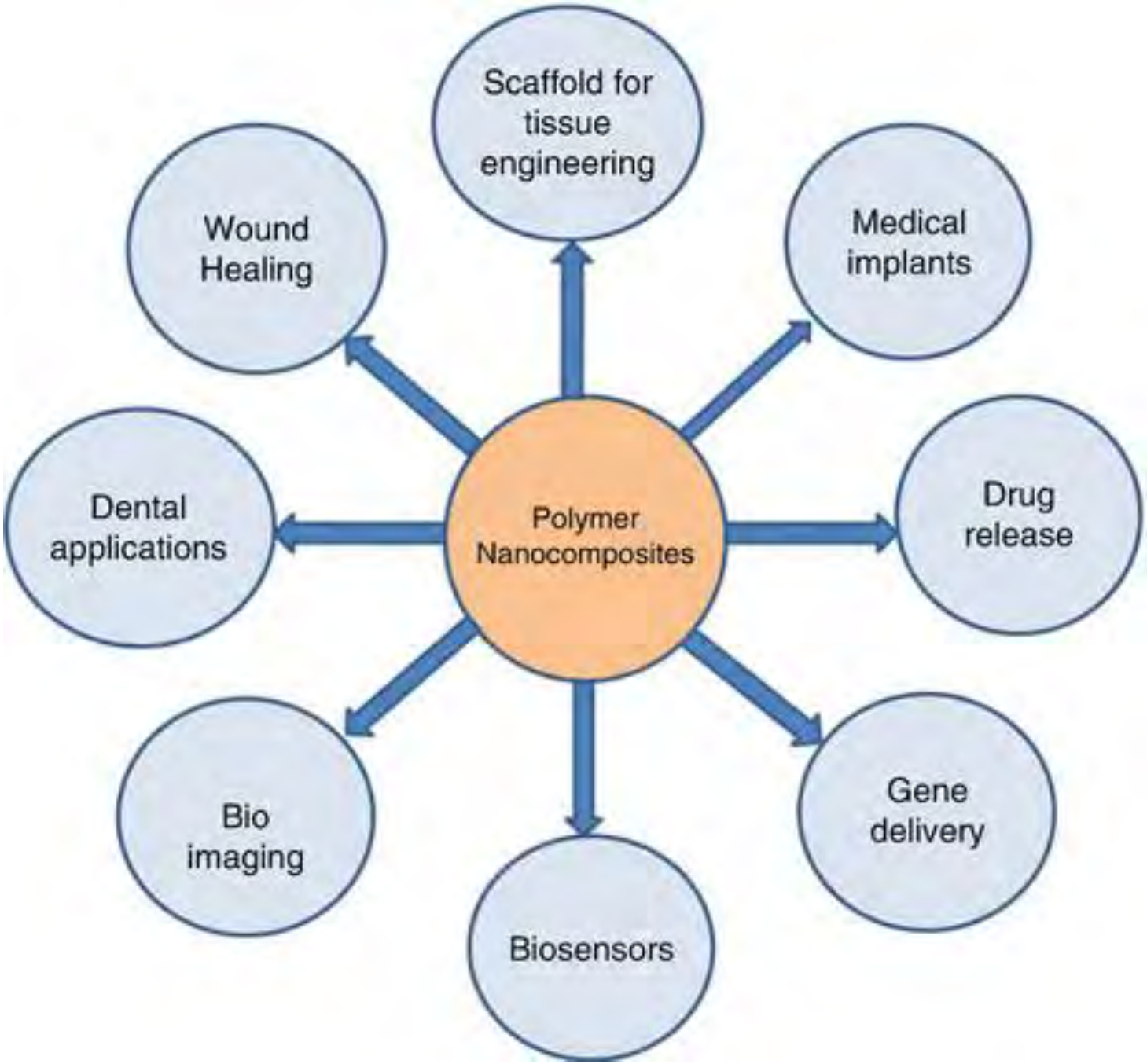
- Mechanical
- Thermal
- Barrier
- Flame-retardance

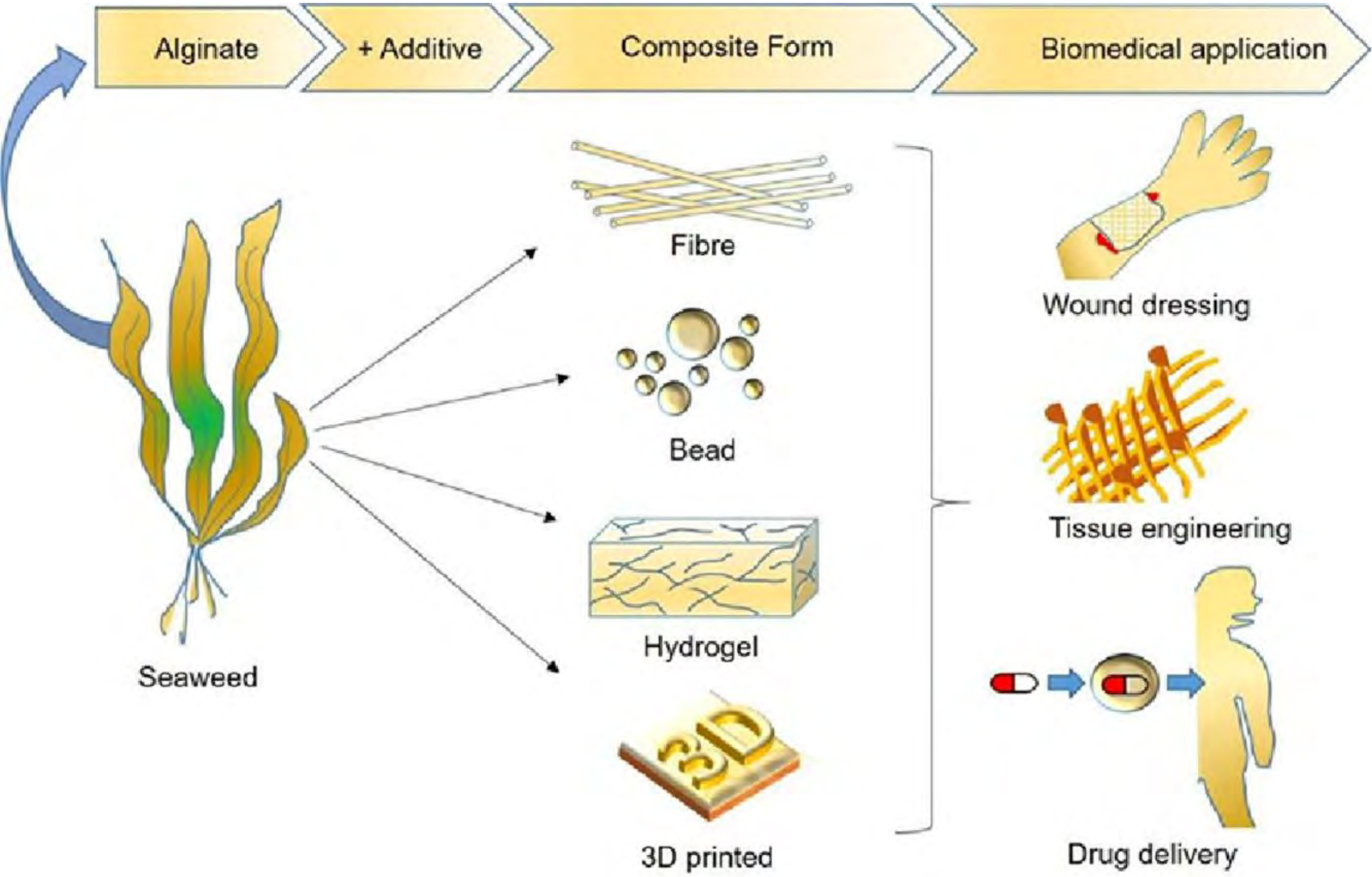




Classification of nanocomposites


Salt
Monomer
Reduction
Polymerization
Nanoparticle
Polymer
Polymer
Nanocomposite

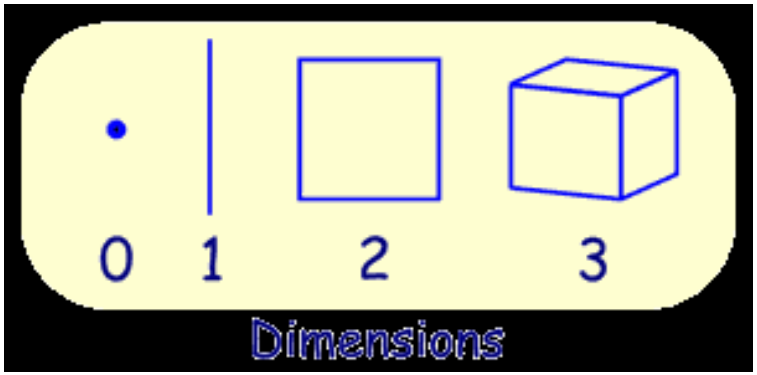

Scaffold for tissue engineering
Wound Healing
Medical implants
Dental applications
Polymer Nanocomposites
Drug release
Bio imaging
Biosensors
Gene delivery

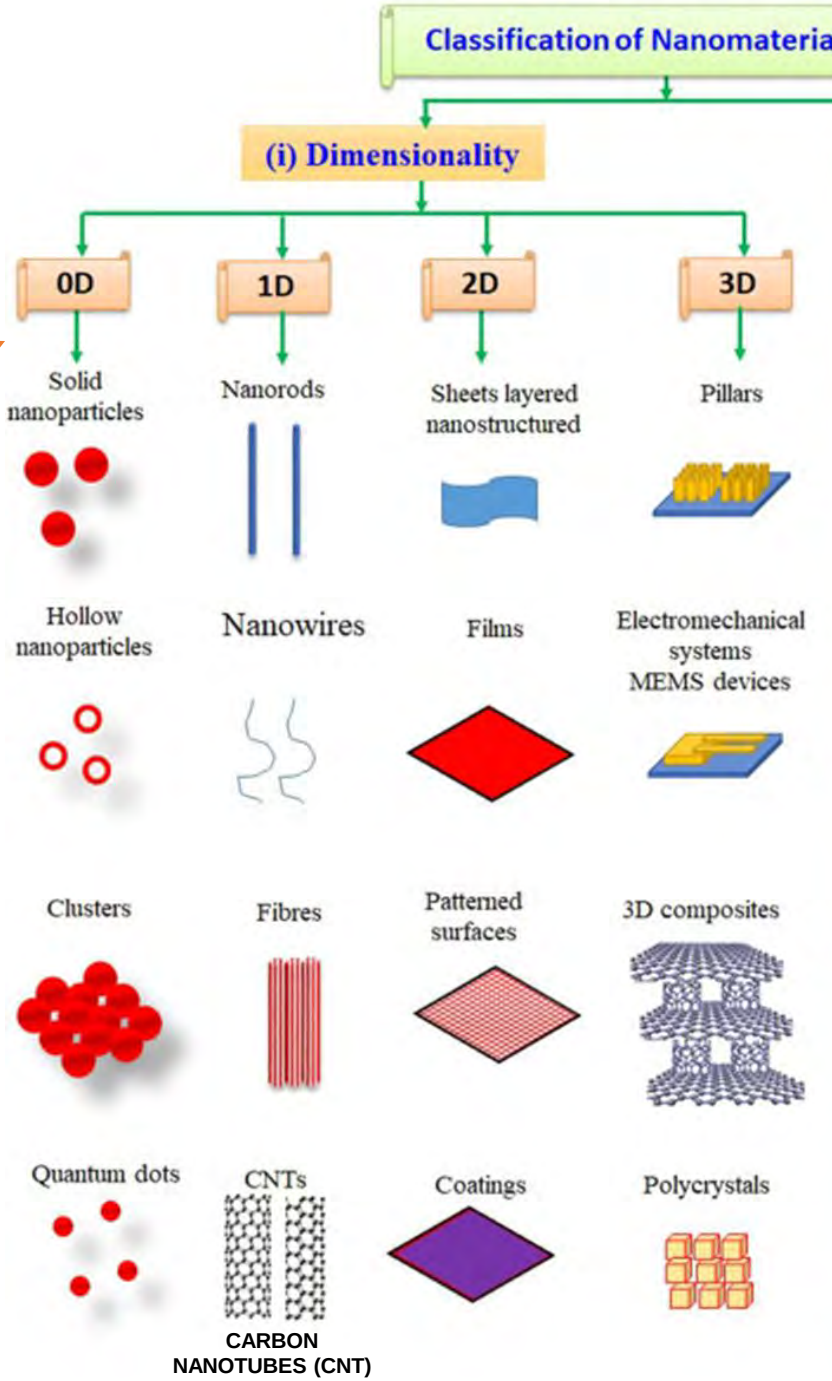

Alginate
+ Additive
Composite Form
Biomedical application
Seaweed
Fibre
Bead
Hydrogel
3D
3D printed
Wound dressing
Tissue engineering
Drug delivery

NANOMATERIAL CLASSIFICATION

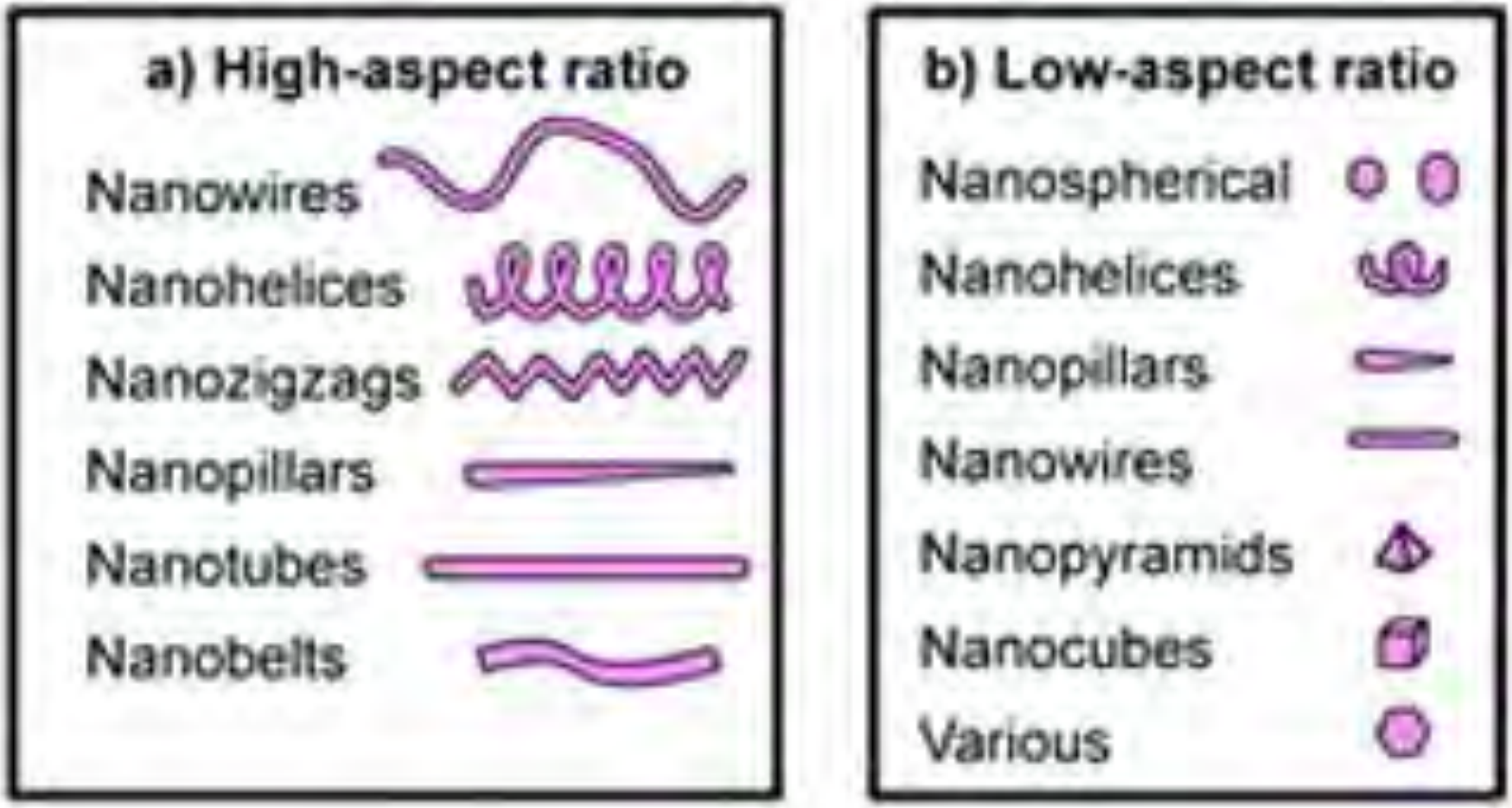
Another way to classify Nanomaterials is based on their dimensions.

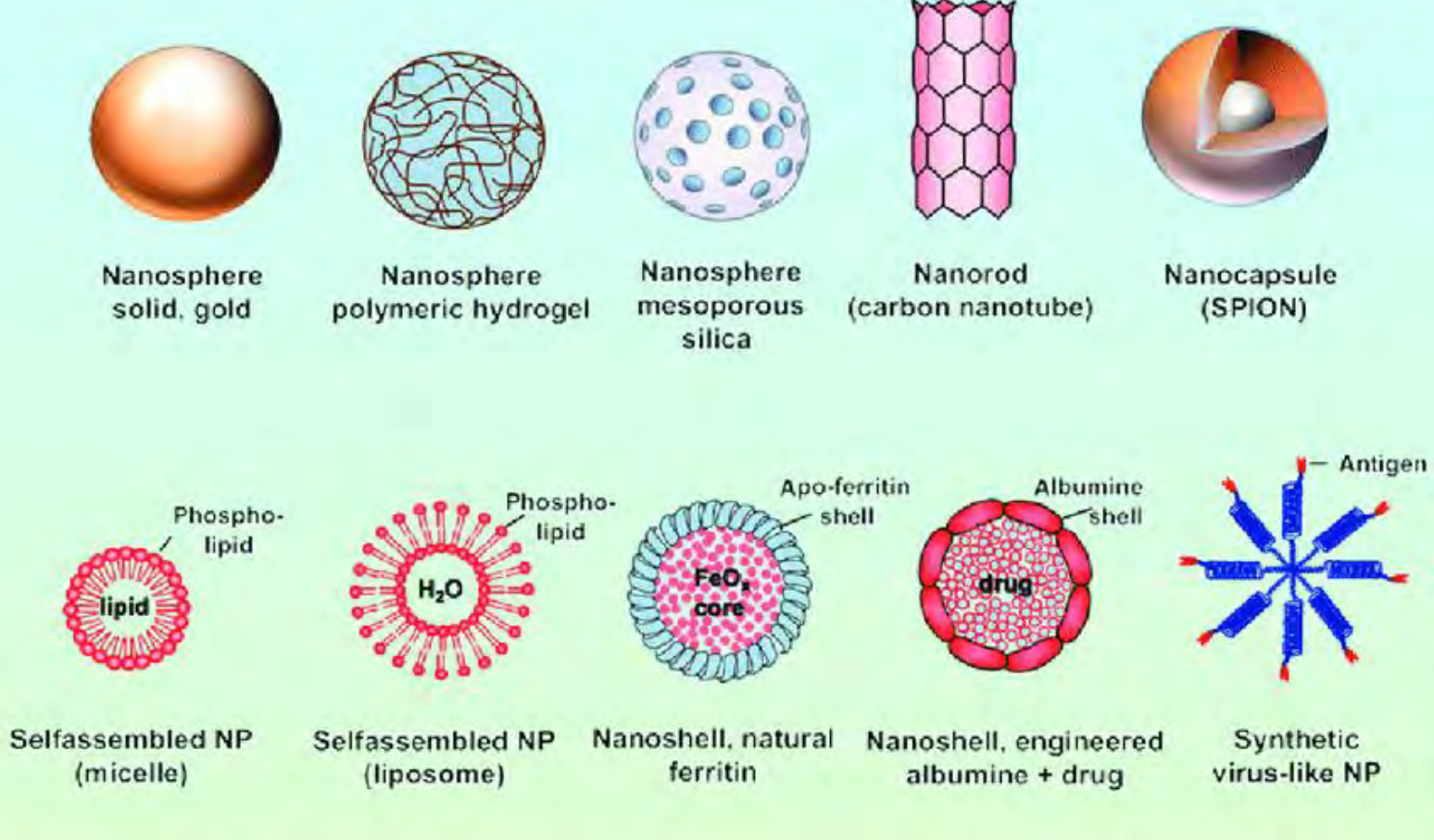
This diagram shows the different types, depending if they are 0, 1, 2, or 3 dimensional.





THEY CAN ALSO BE DESCRIBED BY THEIR DIFFERENT SHAPES





SCHEMATIC ILLUSTRATION OF DIFFERENT ARCHITECTURES OF ENGINEERED NANOMATERIALS.

Micelles are a group of molecules in a solution, such as those formed by detergents.

A **Liposome** is a minute spherical sac of molecules enclosing a water droplet, especially formed artificially to carry drugs or other substances into the tissues.

NANOWIRES

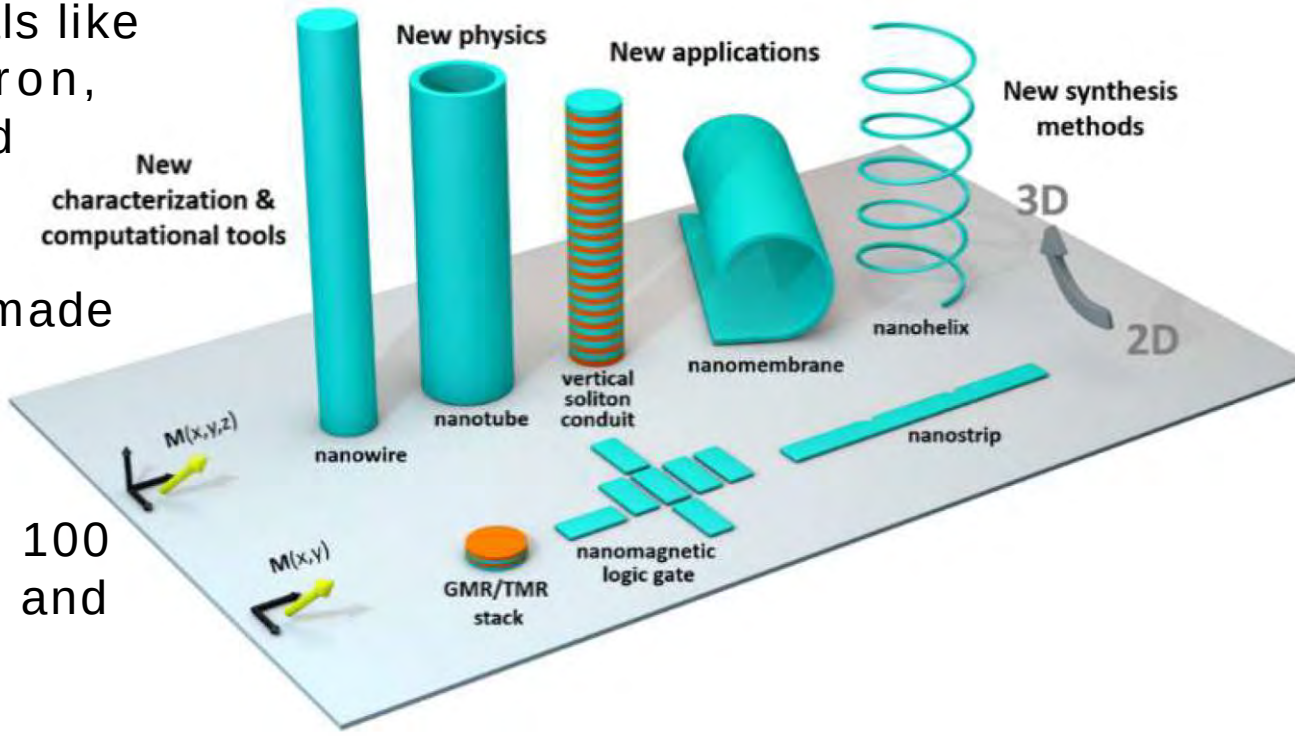
Background

Nanowires are just like normal electrical wires other than the fact that they are extremely small. Like conventional wires, nanowires can be made from a variety of conducting and semiconducting materials like copper, silver, gold, iron, silicon, zinc oxide and germanium.

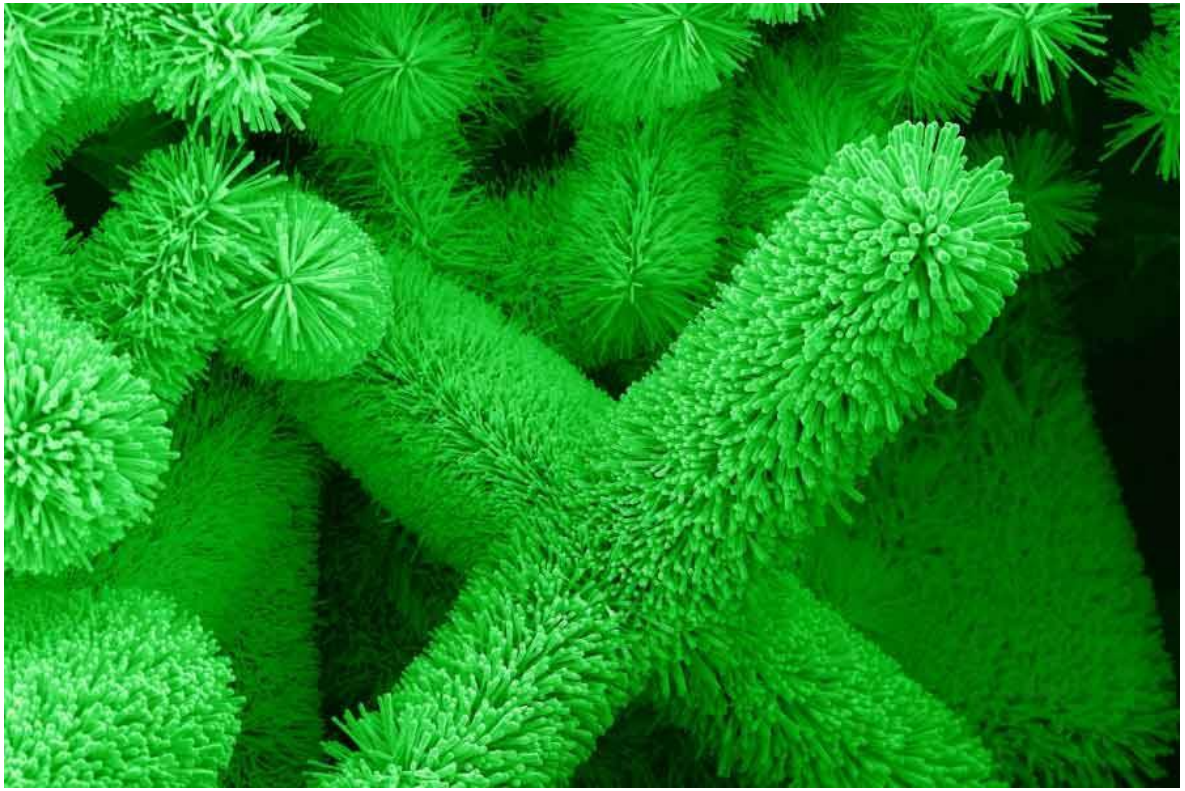
Nanowires can also be made from carbon nanotubes.

Nanowire Size

Nanowires are less than 100 nanometers in diameter and can be as small as 3 nanometers. Typically nanowires are more than 1000 times longer than their diameter.



Sensor test chips containing thousands of nanowires, able to detect proteins and other biomarkers left behind by cancer cells, could enable the detection and diagnosis of cancer in the early stages from a few drops of a patient's blood.



Researchers at the Emory/Georgia Tech Center of Cancer Nanotechnology Excellence synthesize, by vapor-solid process, aligned Zinc Oxide nanowire arrays as shown in the scanning electron microscopy (SEM) image.

NANORODS

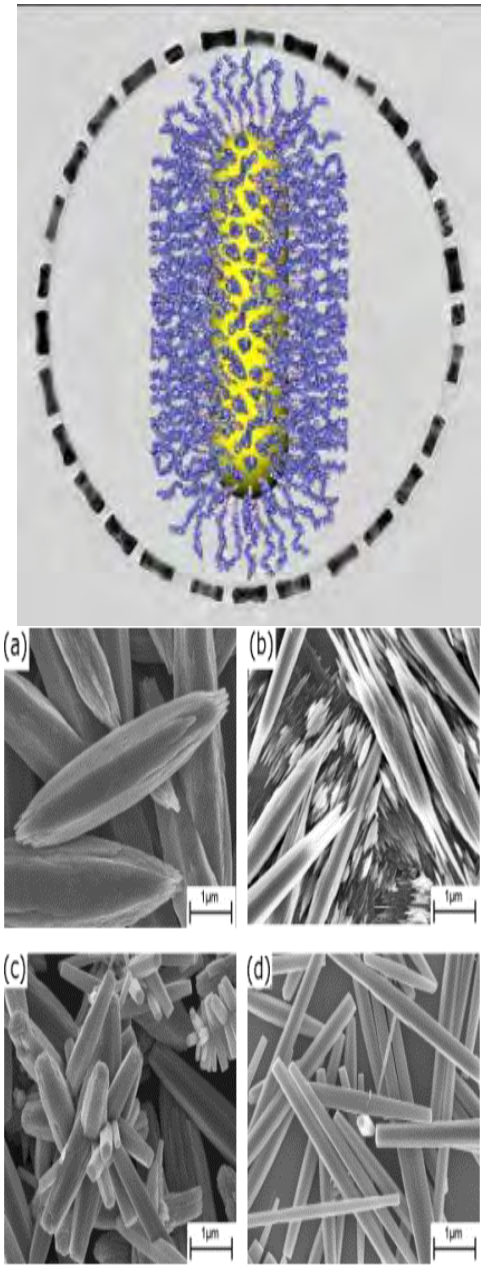
Nanorods are one form of nanoscale objects with dimensions ranging from 1–100 nm.

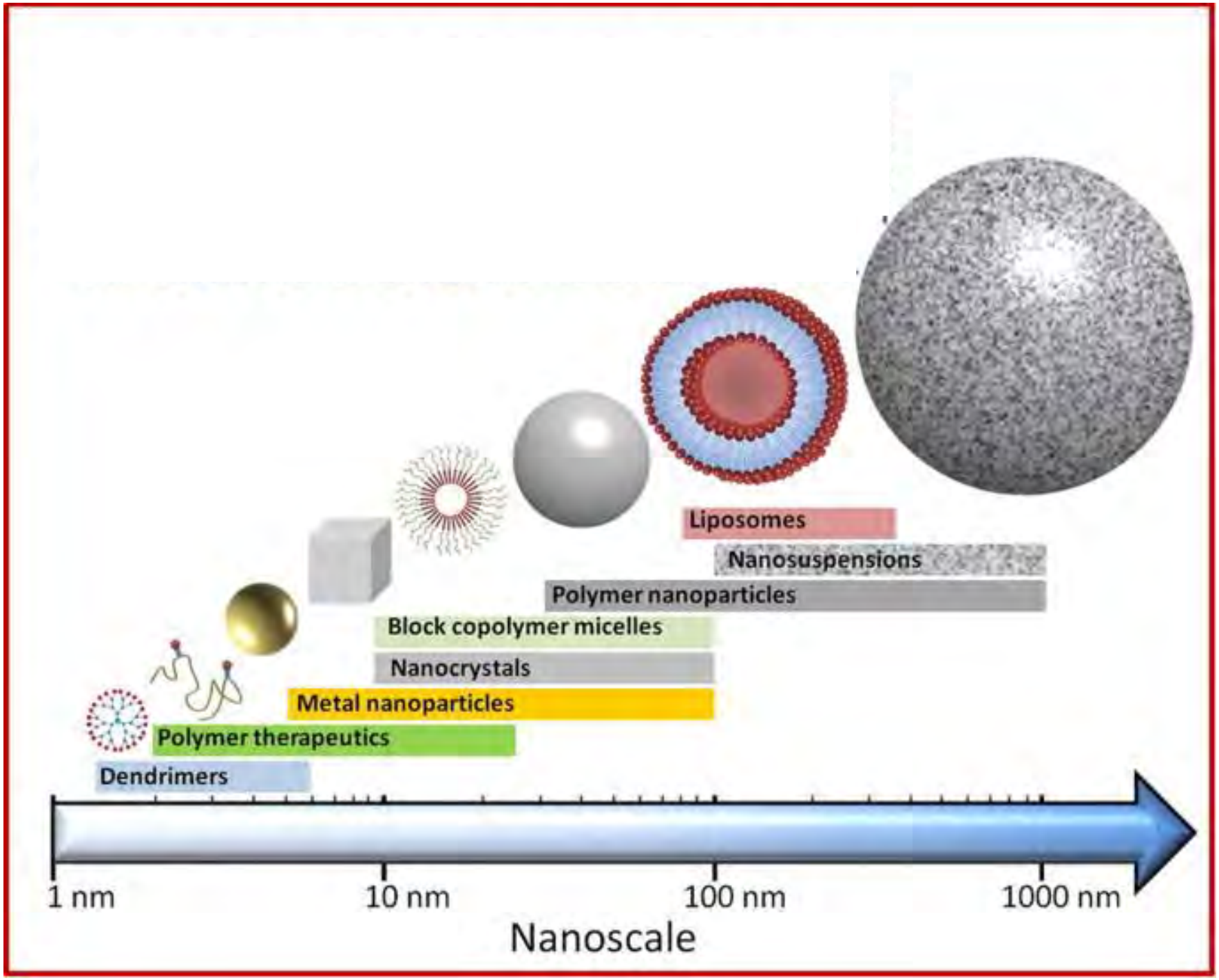
A combination of ligands act as shape control agents and bond to different facets of the nanorod with different strengths.

This allows different faces of the nanorod to grow at different rates, producing an elongated object.

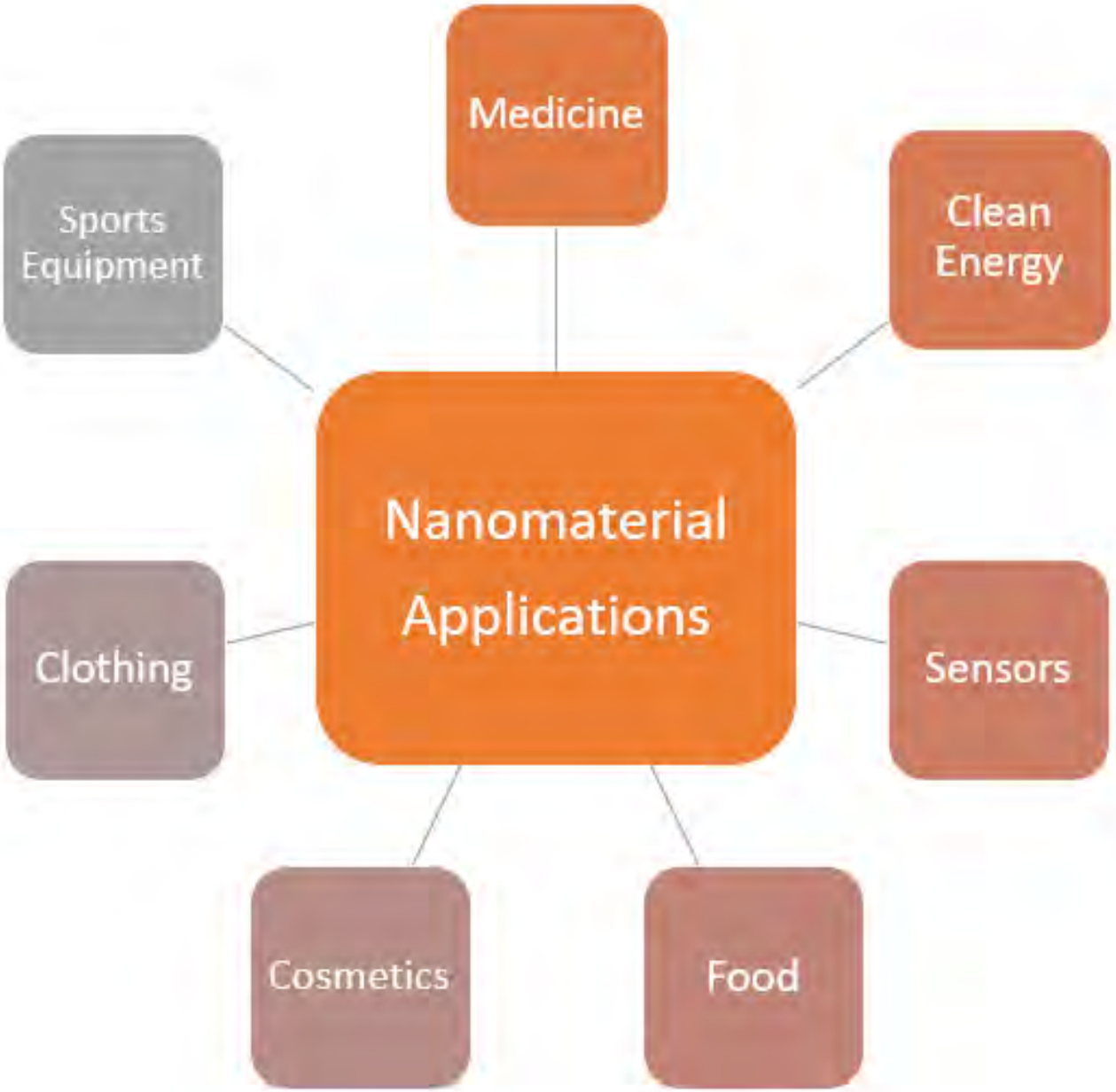
USES:

- In display technologies, because the reflectivity of the rods can be changed by changing their orientation with an applied electric field.
- In micro-electro-mechanical systems (MEMS).
- In cancer therapeutics.




Liposomes
Nanosuspensions
Polymer nanoparticles
Block copolymer micelles
Nanocrystals
Metal nanoparticles
Polymer therapeutics
Dendrimers
1 nm
10 nm
100 nm
1000 nm
Nanoscale

USES OF NANOTECHNOLOGY



Cleaner environment through new water and air purification methods as well as removal of pollutants from groundwater and soil

Energy innovations, including more efficient solar panels, alternative methods for producing hydrogen fuel and tools for enhanced renewable energy applications in developing countries

Better detection and treatment of cancer, including improved tumor imaging, drug delivery and specialized, targeted chemotherapy

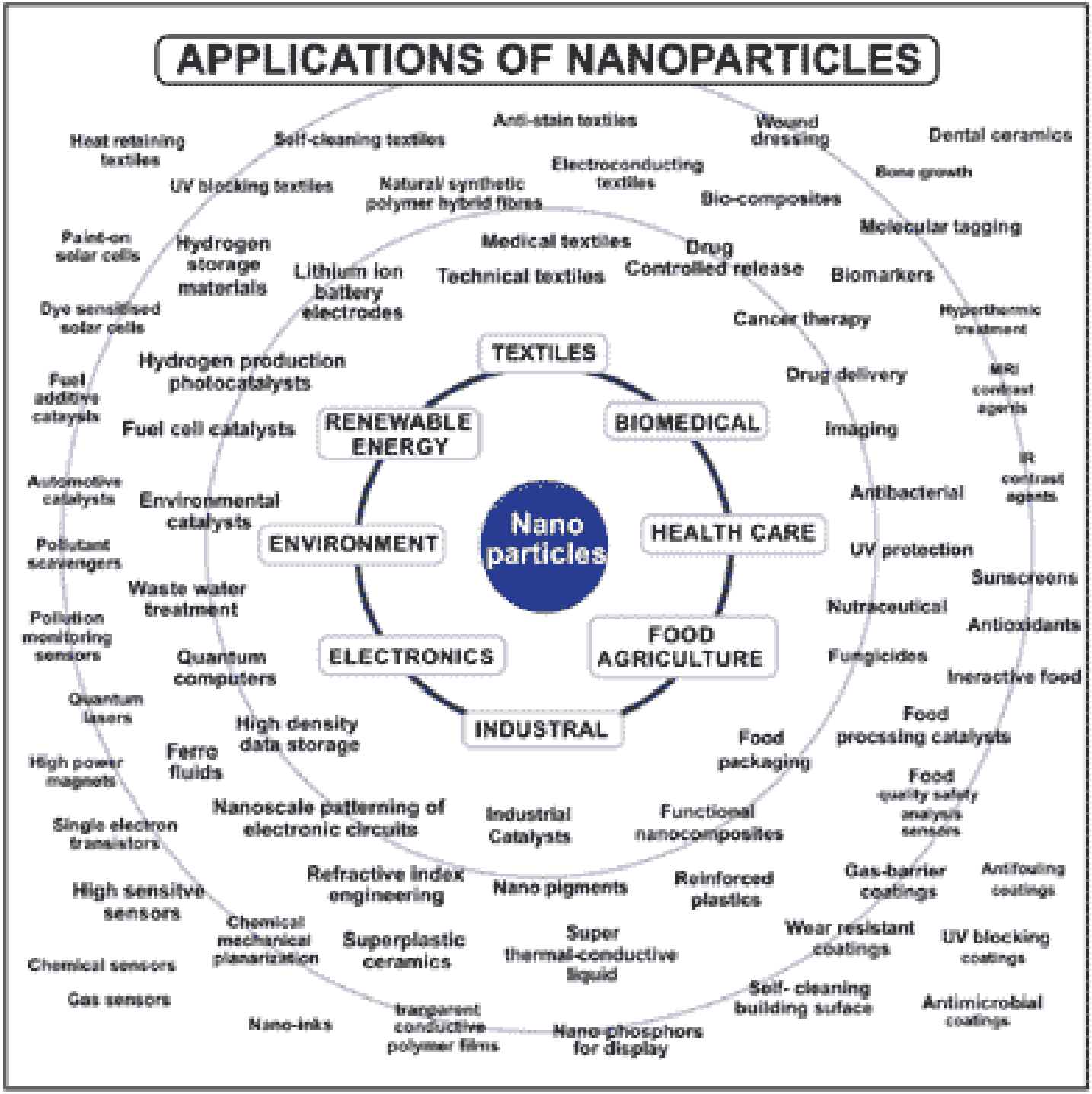
Automotive innovations like smart tires, anti-fog window coatings, improved fuel efficiency and stronger, lighter car parts

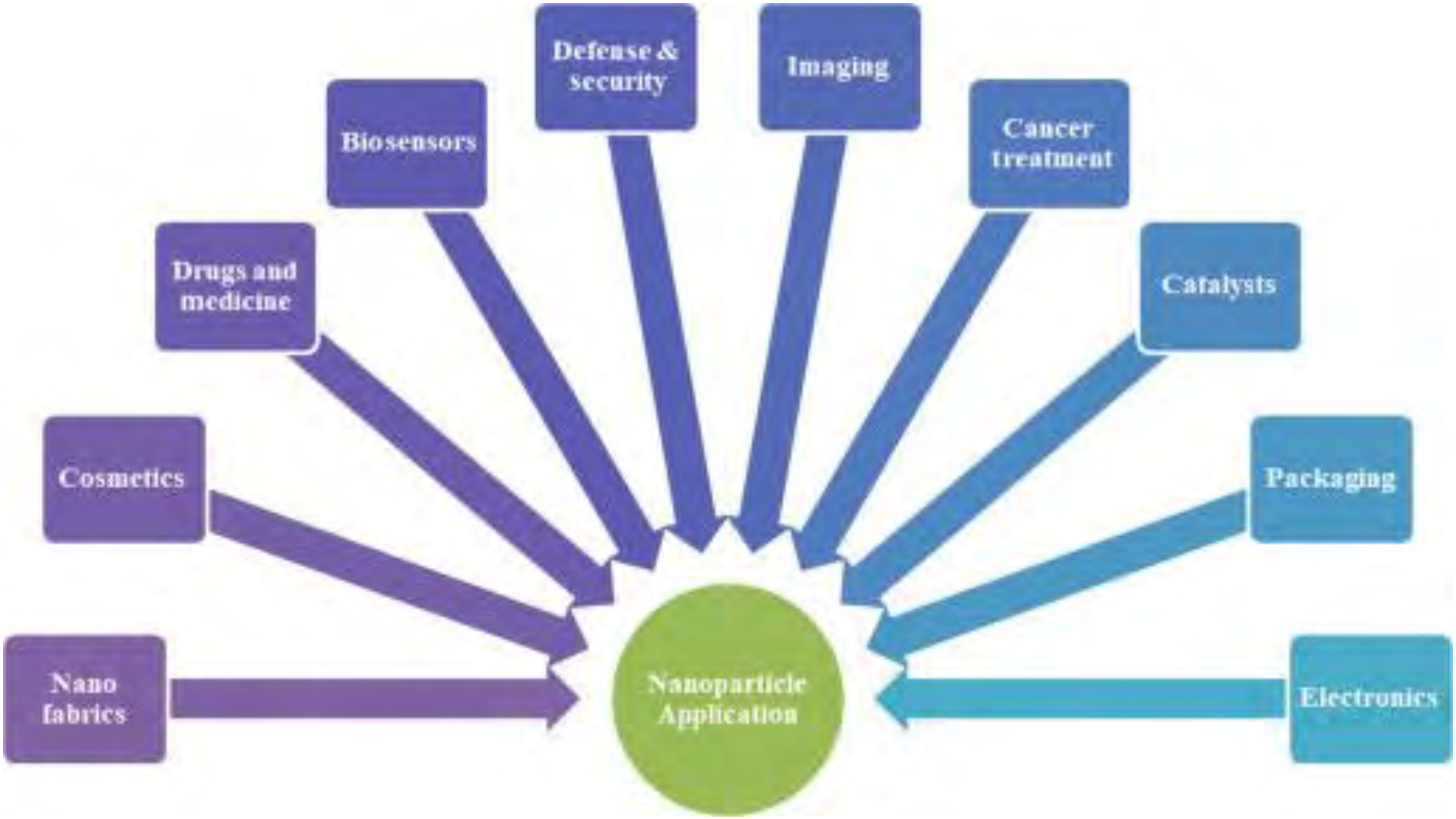
Defense innovations like state-of-the-art drones and artificial intelligence that allow for remote operation and autonomous platforms

Improved healthy lifestyle products like wearable fitness devices, sweat-resistant workout clothing and stronger, yet lighter sports equipment

Electronics that are faster, smaller, carry more information and can also be biodegradable, helping to limit e-waste

Healthcare innovations like more precise targeting of cancer tumors, microscopic surgeries and nanorobots that doctors may one day use inside the body to aid disease diagnosis and treatment

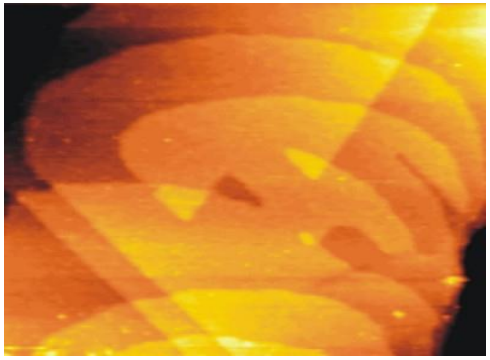

APPLICATIONS OF NANOPARTICLES
Nano particles
TEXTILES
BIOMEDICAL
HEALTH CARE
FOOD AGRICULTURE
INDUSTRAL
ELECTRONICS
ENVIRONMENT
RENEWABLE ENERGY
Anti-stain textiles
Wound dressing
Dental ceramics
Heat retaining textiles
Self-cleaning textiles
Electroconducting textiles
Bone growth
UV blocking textiles
Natural/ synthetic polymer hybrid fibres
Bio-composites
Molecular tagging
Paint-on solar cells
Hydrogen storage materials
Medical textiles
Drug Controlled release
Lithium ion battery electrodes
Technical textiles
Biomarkers
Dye sensitised solar cells
Cancer therapy
Hyperthermic treatment
Hydrogen production photocatalysts
Drug delivery
MRI contrast agents
Fuel additive catalysts
Fuel cell catalysts
Imaging
IR contrast agents
Automotive catalysts
Environmental catalysts
Antibacterial
Pollutant scavengers
UV protection
Sunscreens
Waste water treatment
Nutraceutical
Antioxidants
Pollution monitoring sensors
Quantum computers
Fungicides
Interactive food
Quantum lasers
High density data storage
Food processing catalysts
Ferro fluids
Food packaging
High power magnets
Food quality safety analysis sensors
Nanoscale patterning of electronic circuits
Industrial Catalysts
Functional nanocomposites
Single electron transistors
Refractive index engineering
Nano pigments
Reinforced plastics
Gas-barrier coatings
Antifouling coatings
High sensitive sensors
Chemical mechanical planarization
Superplastic ceramics
Super thermal-conductive liquid
Wear resistant coatings
UV blocking coatings
Chemical sensors
Self- cleaning building suface
Gas sensors
Antimicrobial coatings
Nano-inks
transparent conductive polymer films
Nano-phosphors for display


Defense & security
Imaging
Biosensors
Cancer treatment
Drugs and medicine
Catalysts
Cosmetics
Packaging
Nano fabrics
Nanoparticle Application
Electronics

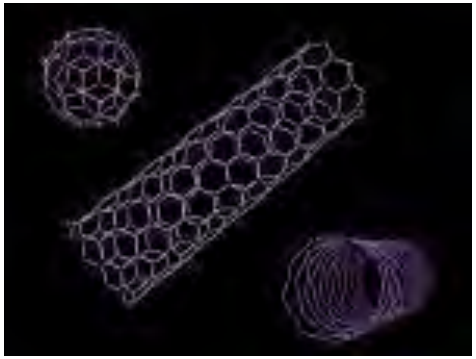
Railway industry	• Foam (sandwich) structures • Protective coatings	• Mechanical properties enhancement (e.g. compression strength) • Flame retardancy
Electronics	• NEMS, RF-MEMS • LCD Displays, • Conductive tubes/parts • Sensors	• Increase in the operation power • Thermal transmission properties • Partial or total replacement of conventional electrically costly conductive additives • Increase in electrical conductivity
Energy	• Photovoltaics • Wind turbines • Batteries • Fuel cells	• Lightweight structures • Reduced mechanical stress during operation • Higher capacity retention and higher performance electrodes in batteries
Environment	• Membranes for water purification & gas separation • Absorbent materials	• Environmentally friendly cleanup techniques • Removal of heavy metals from wastewater • Oil spills remediation
Sporting goods	• Tennis racquets • Cricket bats • Hockey sticks & accessories • Golf clubs • Heated uniforms for winter sports (e.g. ski)	• Lightweight parts • Durability • Hydrophobicity

POTENTIAL IMPACTS OF NANOTECHNOLOGY

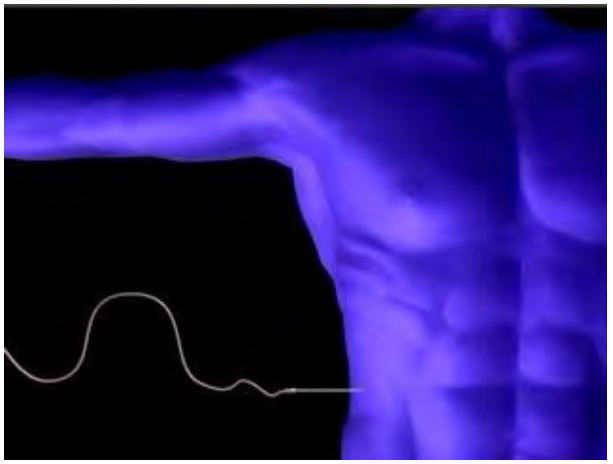
- Materials
  - Waterproof and stain-resistant clothes
- Health Care
  - Chemical and biological sensors, drugs and delivery devices
- Technology
  - Better data storage and computation
- Environment
  - Clean energy, clean air



Thin layers of gold are used in tiny medical devices



Carbon nanotubes can be used for Hydrogen fuel storage



Possible entry point for nanomedical device

Commercial Products Containing Nanomaterials

cosmetics

toothpaste

supplements

beer bottles

drugs

sunscreen

coatings

wound dressings

Nanomaterials in Consumer Products

The Future is Now

NANOMATERIALS IN CONSUMER PRODUCTS: THE PERSONAL CARE INDUSTRY IS LEADING THE WAY

BIONOVA

NANO SKIN TECH

NANOMATERIALS IN COSMETICS

Shampoos

Conditioners

Toothpastes

Anti-wrinkle creams

Anti-cellulite creams

Skin moisturizers

Face powders

Aftershave lotions

Deodorants

Soaps

Sunscreens

Make up

Perfumes

Nail polishes

Current Reported Uses of Nanotechnology in Cosmetics

- Excellent dispersability
- Alter optical properties
- Deliver water or lipid soluble ingredients
- Protect light or oxygen sensitive ingredients
- Improve stability of chemically unstable ingredients
- Controlled release of ingredients
- Improve skin hydration
- Transparent on skin
- Increase protection against both UVA and UVB rays


Nanocosmeceutical
Hair care
Nail care
Skin care
Lip care
Hair serum
Shampoo
Conditioner
Hair growth stimulators
Hair styling gel
Hair color
Nail lacquer
Moisturizer
Sun screen
Antiaging products
Skin cleanser
Antiacne products
Eye cream
Lipstick
Lip balm
Lip gloss
Lip volumizer

NANOTECHNOLOGY IN COSMETICS: *NANOCOSMETICS*

Nanotechnology in cosmetics means the use of microscopic *nanoparticles* in *cosmetics*. Nanoparticles are smaller than 100 nanometers, which is smaller than tip of a needle.

Nanotechnology is used in sunscreen products to protect skin from sun's UV rays such as nanosized Titanium Dioxide. Nanogold is used in anti-aging and nanosilver is added in anti-bacterial products.

Cosmetics with nanotechnology:
Moisturizer
Soap
Deodorant
Toothpaste
Shampoo
Sunscreen
Hair Conditioner
Perfume and Aftershave
Aftershave Lotion
Anti-Wrinkle Creams
Nail Polish
Lipstick
Eye Shadow
Foundation
Blush
and many more…

The use of nanocosmetics has been under intense debate due to their risk to penetrate through skin into other organs and altering the immune system responses which may cause unwanted side effects.

Some of the companies using Nanocosmetics include:
-Estee Lauder -Avon
-L'Oreal -Chantecaille
-Johnson & Johnson
-La Prairie

SUNSCREENS

Zinc oxide and Titanium dioxide have been used in sunscreens because of their powerful UV blocking properties but they leave a white coating on the skin, which most people find unpleasant.

Many sunscreens and moisturizers available now use these nanoparticles, including products from;

Boots

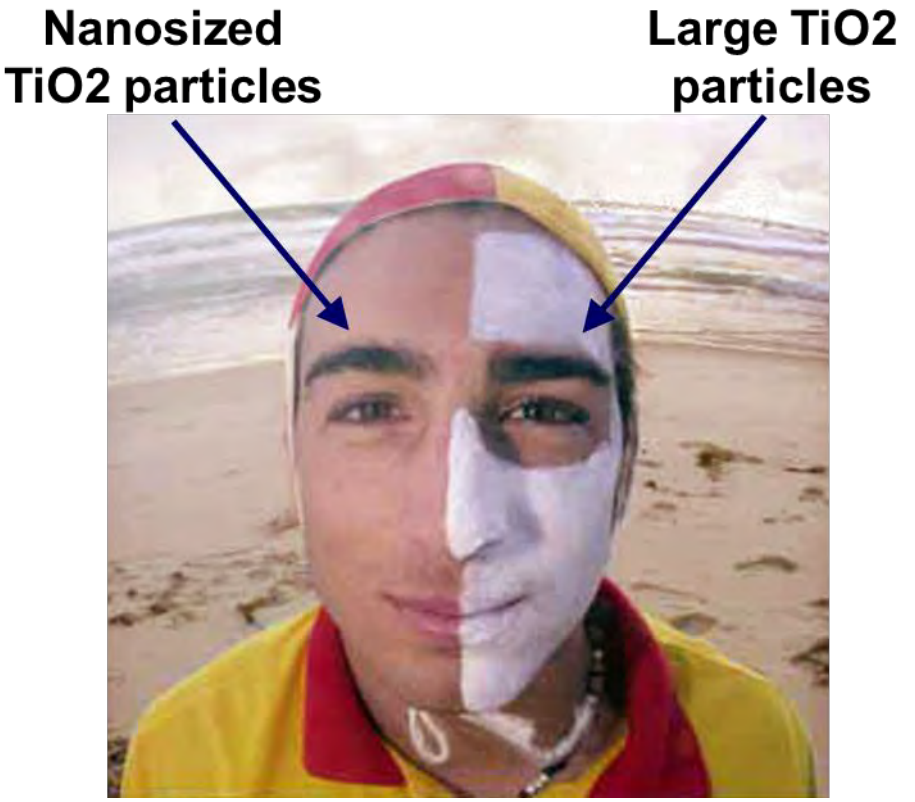
Avon

The Body Shop

L'Oreal

Nivea

Unilever



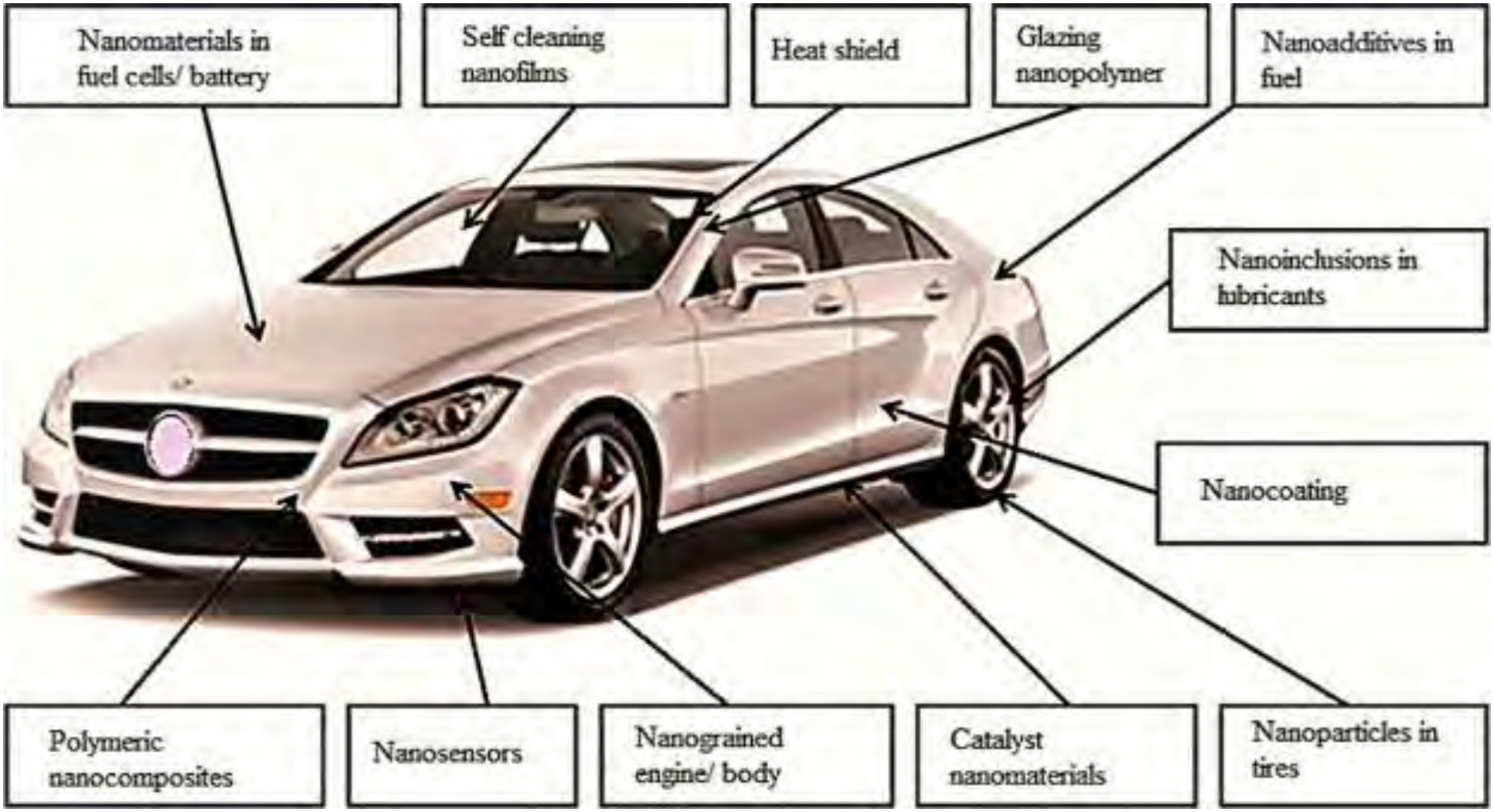
THESE SUNSCREEN PRODUCTS DO HAVE NANO MATERIALS IN THEM.

MODERN NANOTECHNOLOGY – ANTIMICROBIAL FABRICS

Nanohorizons, a company in Pennsylvania, has started producing a silver nanoparticle material as both a dye and use in polyester and nylon.

The silver nanoparticles are toxic to microbes, and so colonies will never form, and clothes using this material will not have odors.

USES FOR CARS



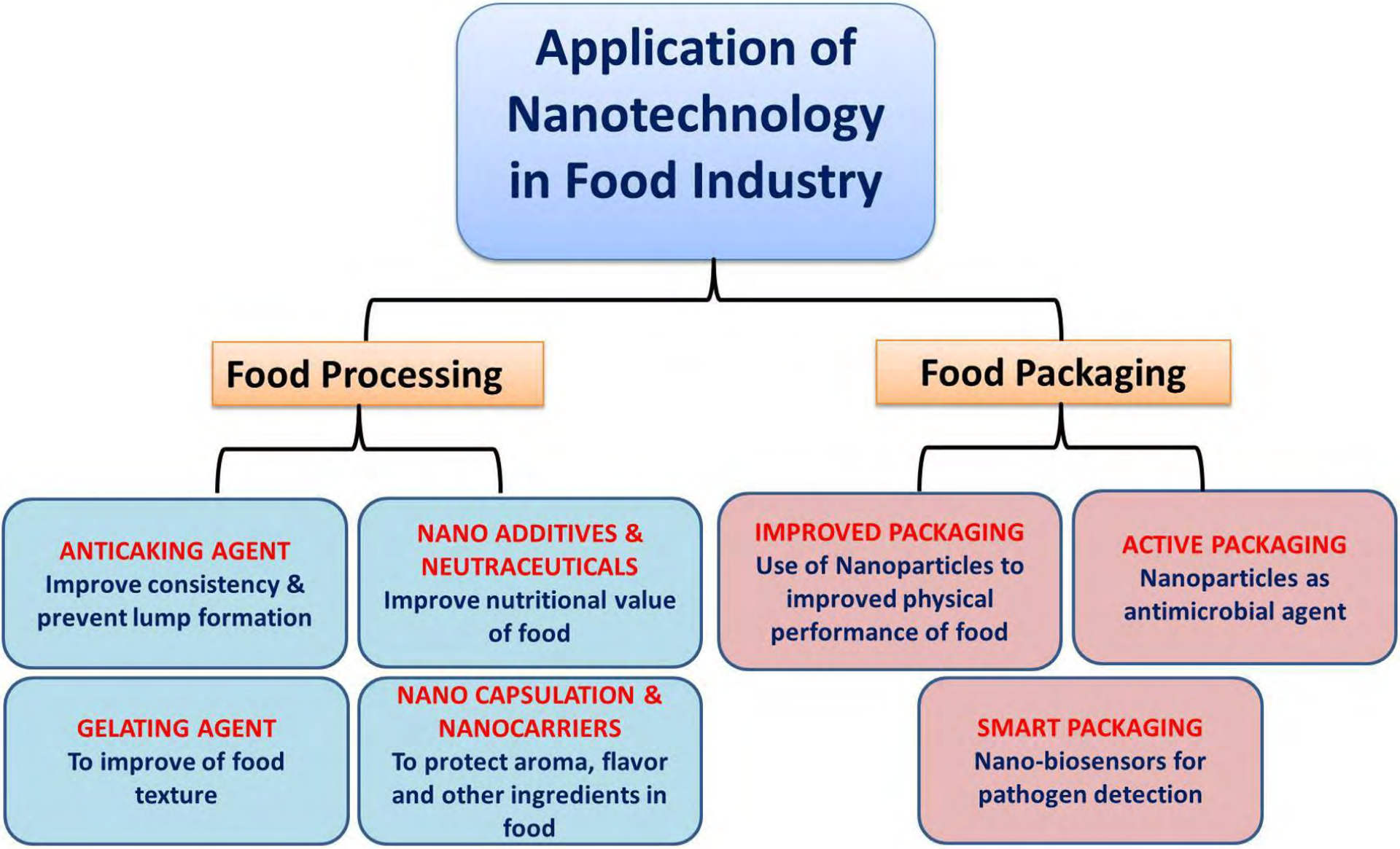
Some clothing manufacturers are making water and stain repellent clothing using nano-sized whiskers in the fabric that cause water to bead up on the surface.

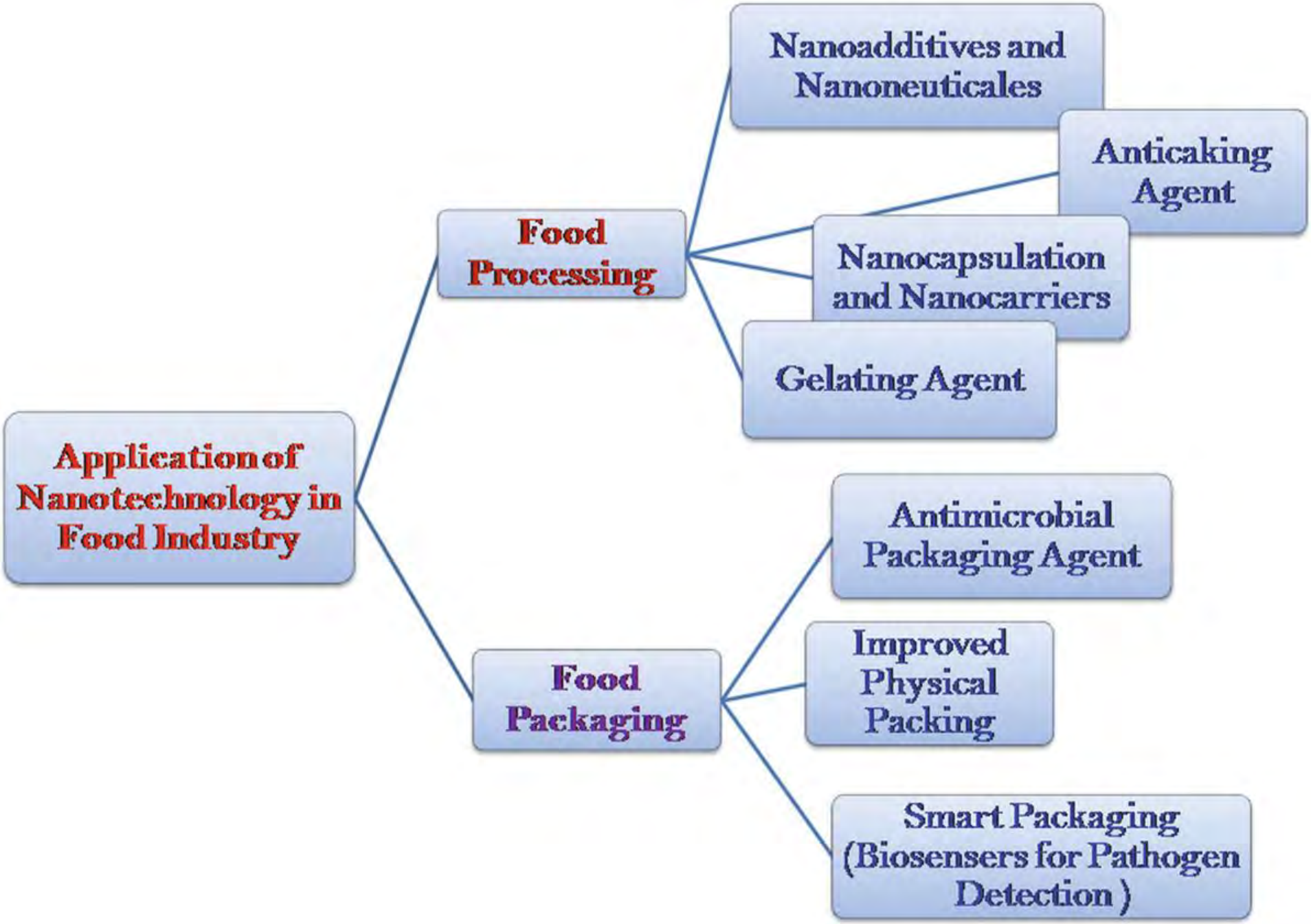
TITANIUM DIOXIDE PARTICLES IN OUR FOODS

Candies, sweets and chewing gum have been found to contain the highest levels of titanium dioxide.

Powdered doughnuts, candies and gums with hard shells, products with white icing and even bread, mayonnaise, yogurt and other dairy products may also contain titanium dioxide.

According to research published in Environmental Science and Technology, up to 36 percent of the titanium dioxide found in nearly 90 food products was in the nanoparticle sizes.


Application of Nanotechnology in Food Industry
Food Processing
Food Packaging
ANTICAKING AGENT
Improve consistency & prevent lump formation
NANO ADDITIVES & NEUTRACEUTICALS
Improve nutritional value of food
GELATING AGENT
To improve of food texture
NANO CAPSULATION & NANOCARRIERS
To protect aroma, flavor and other ingredients in food
IMPROVED PACKAGING
Use of Nanoparticles to improved physical performance of food
ACTIVE PACKAGING
Nanoparticles as antimicrobial agent
SMART PACKAGING
Nano-biosensors for pathogen detection


Application of Nanotechnology in Food Industry
Food Processing
Nanoadditives and Nanoneuticales
Anticaking Agent
Nanocapsulation and Nanocarriers
Gelating Agent
Food Packaging
Antimicrobial Packaging Agent
Improved Physical Packing
Smart Packaging (Biosensers for Pathogen Detection)

Titanium Dioxide Applications

Candies, sweets and chewing gum have been found to contain the highest levels of titanium dioxide.

Powdered doughnuts, candies and gums with hard shells, products with white icing and even bread, mayonnaise, yogurt and other dairy products may also contain titanium dioxide.

According to research published in Environmental Science and Technology, up to 36 percent of the titanium dioxide found in nearly 90 food products was in the nanoparticle sizes.

Titanium (µgTi / mg food)

DrJockers.com
SUPERCHARGE YOUR HEALTH

DrJockers.com
SUPERCHARGE YOUR HEALTH!

Titanium Dioxide Levels in Popular Doughnuts

Product	TiO_2 Listed as Ingredient	Total Ti PPM
Conchitas - Fine Pastry		Not Detected
Dolly Madison - Donut Gems	●	58
Dunkin' Donuts - Powdered Cake Donut	●	19
Entenmann's - Pop'ems Donuts		73
Hostess Brand - Donettes	●	75
Kroger - Sugared Cake Donut Holes	●	43
Little Debbie - Mini Powdered Donuts	●	43
Walmart The Bakery - Powdered Mini Donuts		63
Van de Kamp's - Donuts	●	43
Sunnyside Farms - Mini Powdered Donuts	●	71

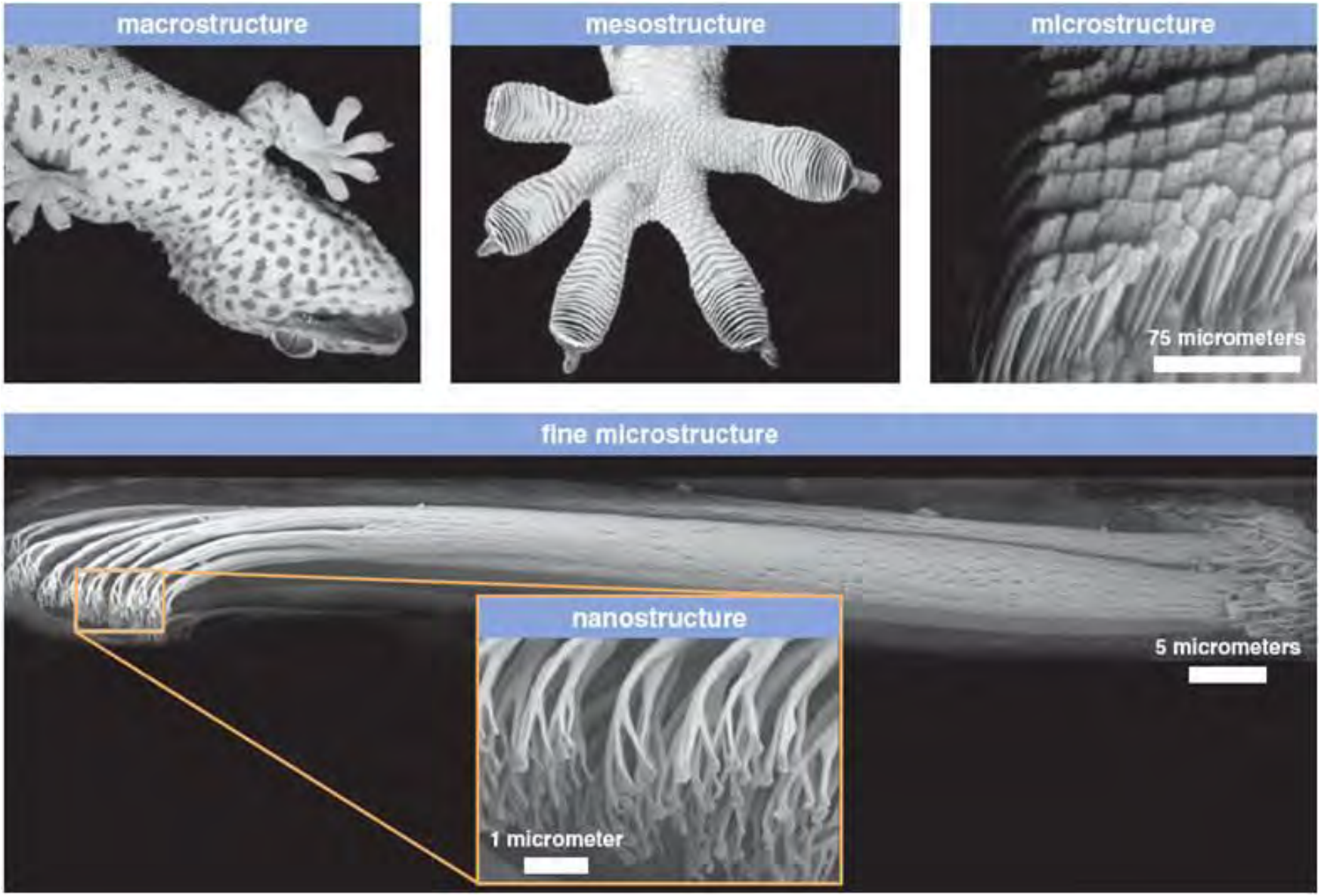
GECKO NANOSCALE FOOT PADS

Animals that cling to walls and walk on ceilings owe this ability to micro-and nanoscale hairs on their feet.

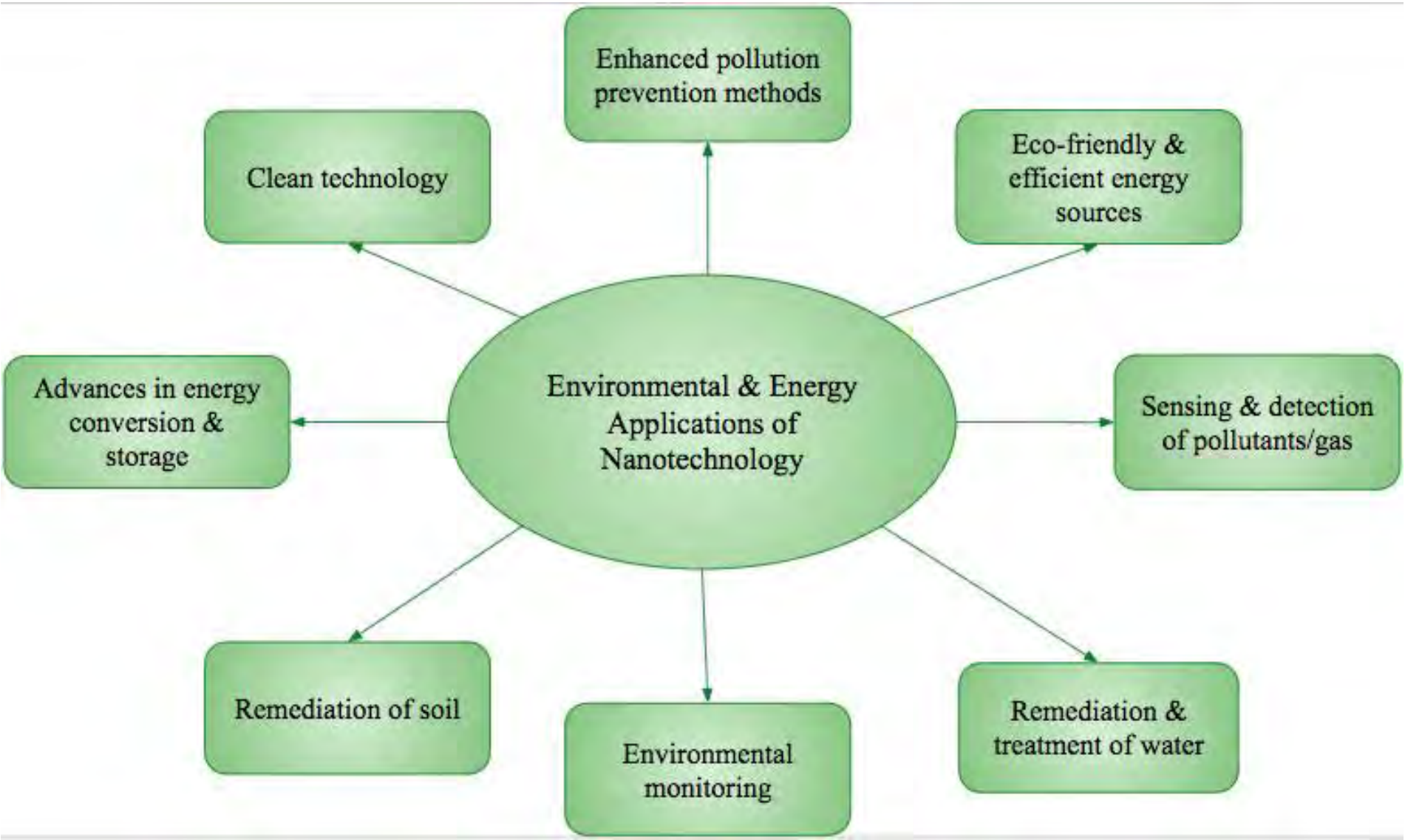
The highest adhesion forces are encountered in lizards called geckos.

On the sole of a gecko's toes there are some one billion tiny adhesive hairs, about 200 nanometers in both width and length that have spatula-shaped ends on them for strong adhesion to flat surfaces.

GECKO NANO-SCALE FOOT-HAIRS FOR WALKING ANYWHERE




Stickybot
Climbing Smooth Vertical
Surfaces with Directional Adhesion
MakeAGIF.com


Enhanced pollution prevention methods
Clean technology
Eco-friendly & efficient energy sources
Advances in energy conversion & storage
Environmental & Energy Applications of Nanotechnology
Sensing & detection of pollutants/gas
Remediation of soil
Environmental monitoring
Remediation & treatment of water

SMART NANOMATERIALS

They are materials which can respond to Stimuli (forces) from the surrounding environment.

Stimuli agents are further classified as:

Light

Temperature

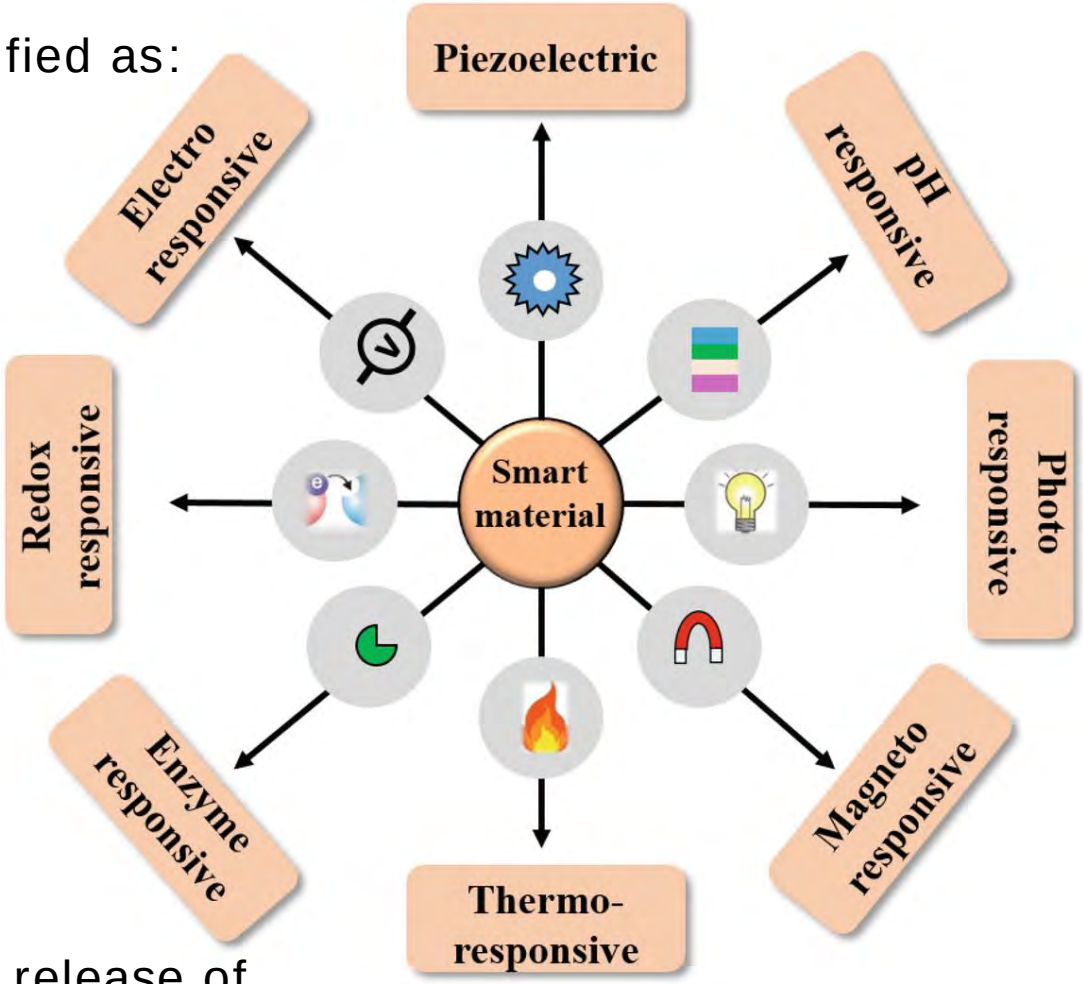
Electricity

Magnetic fields

Stress

Pressure

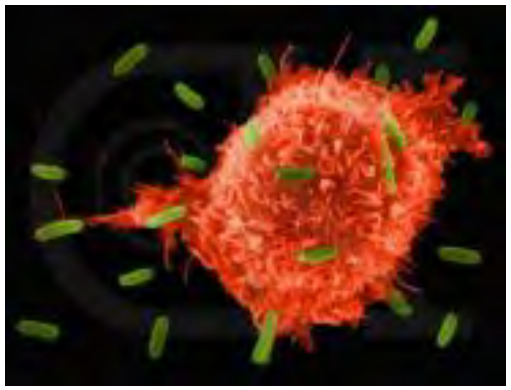
pH

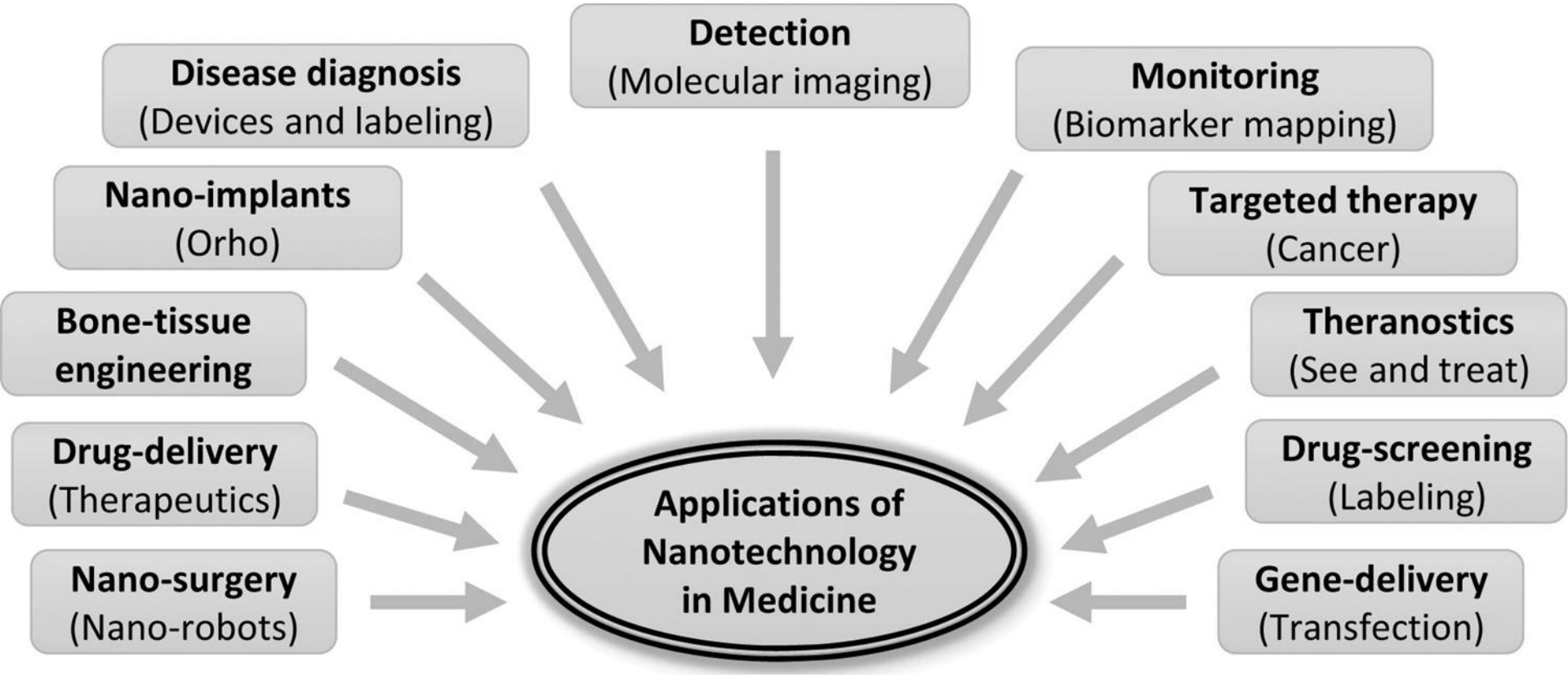


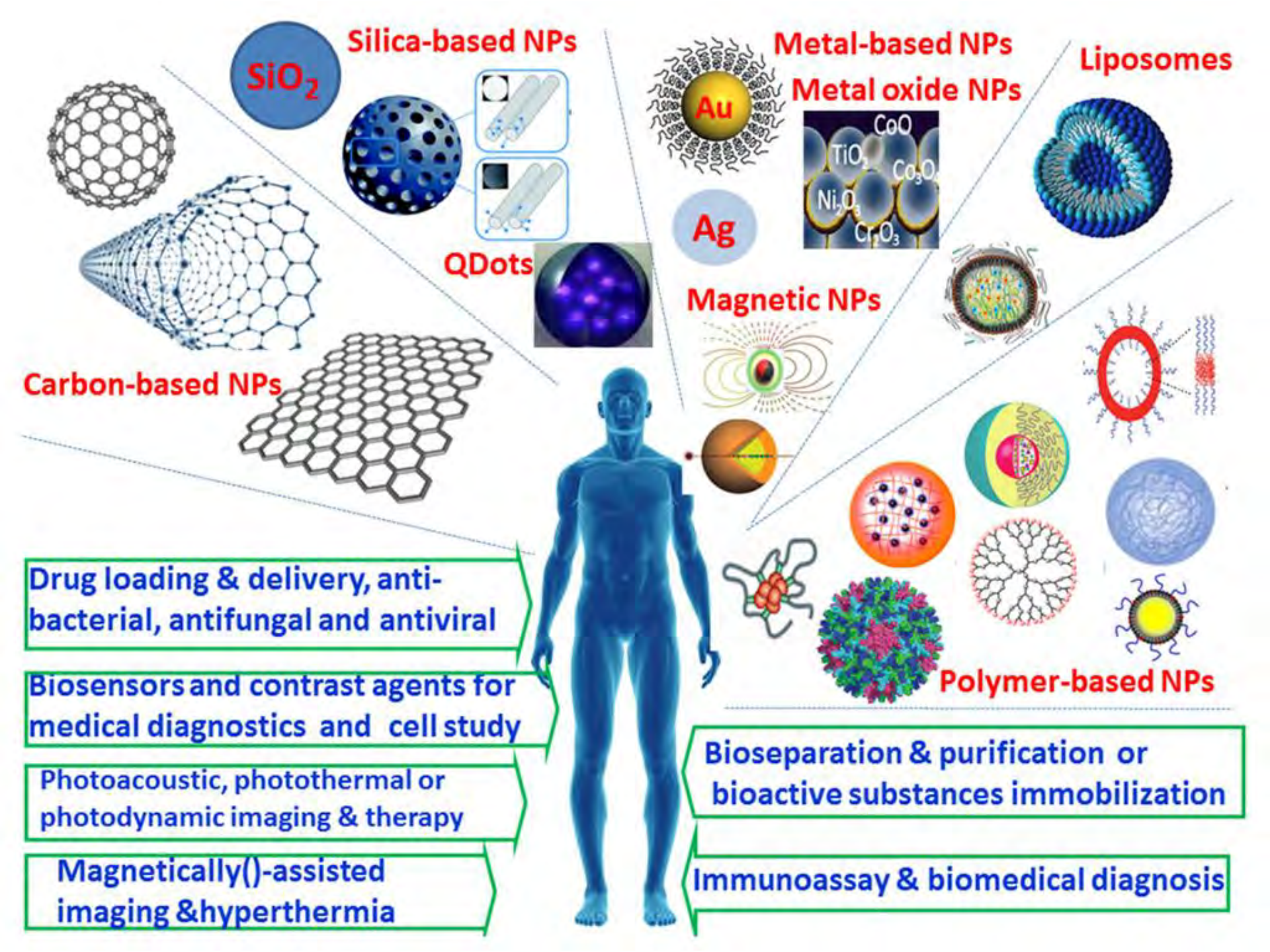
They can be used for controlled release of drugs, treatment of various diseases, biosensors, etc.

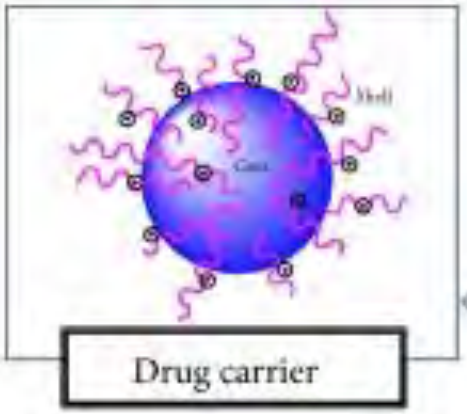
Medical Applications

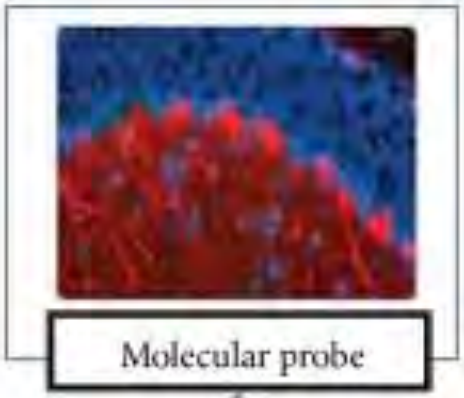
- Cancer treatment
- Bone treatment
- Drug delivery
- Appetite control
- Drug development
- Medical tools
- Diagnostic tests
- Imaging




Detection
(Molecular imaging)
Disease diagnosis
(Devices and labeling)
Monitoring
(Biomarker mapping)
Nano-implants
(Orho)
Targeted therapy
(Cancer)
Bone-tissue
engineering
Theranostics
(See and treat)
Drug-delivery
(Therapeutics)
Drug-screening
(Labeling)
Applications of
Nanotechnology
in Medicine
Nano-surgery
(Nano-robots)
Gene-delivery
(Transfection)

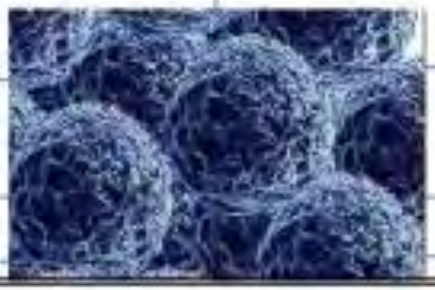

Silica-based NPs
SiO_2
Metal-based NPs
Metal oxide NPs
Au
Ag
CoO
TiO_2
Co_3O_4
Ni_2O_3
Cr_2O_3
Liposomes
QDots
Magnetic NPs
Carbon-based NPs
Polymer-based NPs
Drug loading & delivery, anti-bacterial, antifungal and antiviral
Biosensors and contrast agents for medical diagnostics and cell study
Photoacoustic, photothermal or photodynamic imaging & therapy
Magnetically()-assisted imaging &hyperthermia
Bioseparation & purification or bioactive substances immobilization
Immunoassay & biomedical diagnosis


Drug carrier


Molecular probe


Catalyst


Antibiotics


Potential application of
engineered nanomaterials


Cosmetic


Opacifier

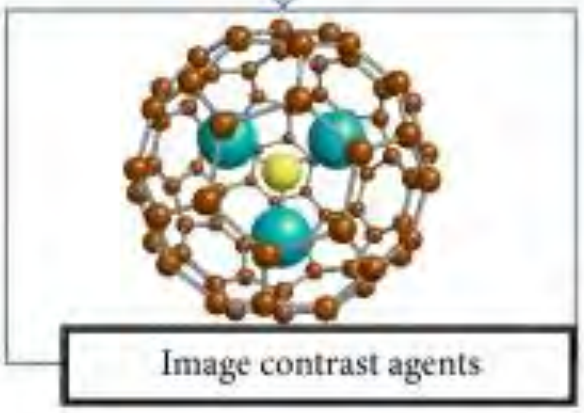
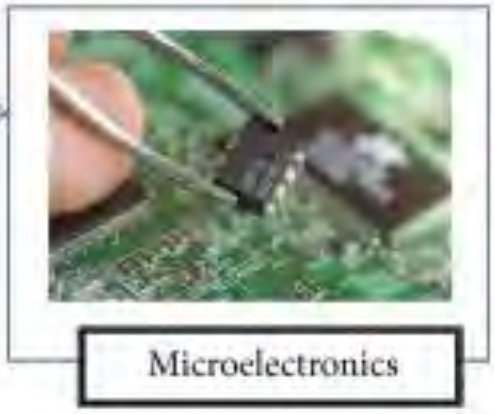


Image contrast agents


Microelectronics

COVID-19 DISEASE MANAGEMENT

Uses include:

- Nano-based disinfectants
- Personal protective equipment
- Diagnostic systems
- Treatments and vaccine development

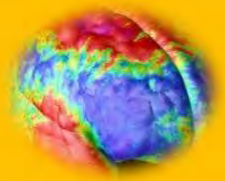
MEDICAL USES OF NANO TECHNOLOGY

Diagnostics

In vitro
& In vivo

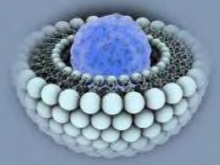
Medical Imaging

In vivo



Nano-therapeutics

Systems &
Devices



Vaccines

Regenerative Medicine

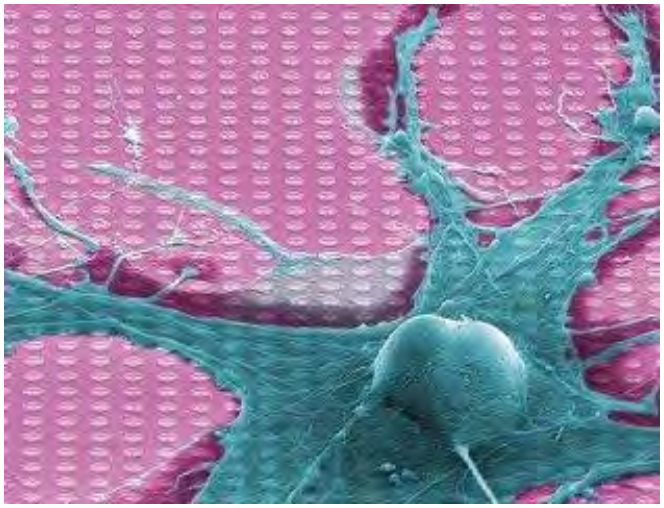
Biomaterials
Functionalisation

HEALTH CARE

NERVE TISSUE TALKING TO COMPUTERS

- Neuro-electronic networks interface nerve cells with semiconductors

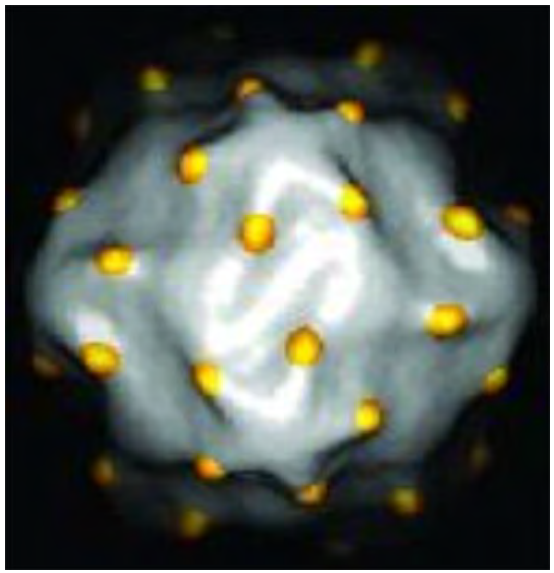
  - Possible applications in brain research, neuro-computation, prosthetics, and biosensors



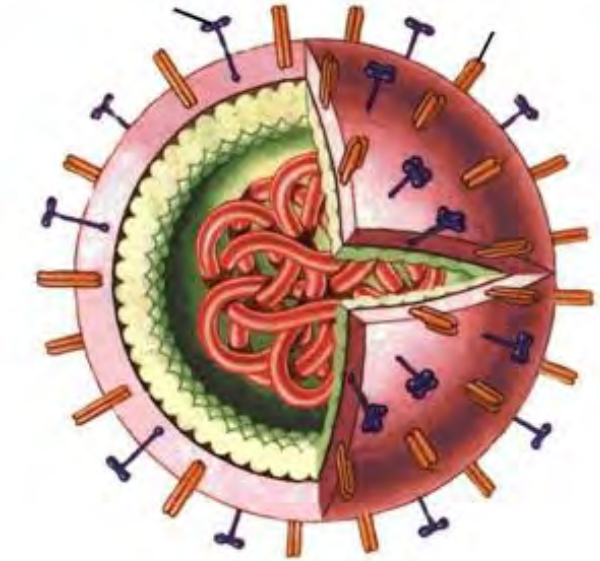
Snail neuron grown on a chip that records the neuron’s electrical activity

Health Care: Preventing Viruses from Infecting Us

- Applying nano-coatings over proteins on viruses
  - Could stop viruses from binding to cells
  - Never get another cold or flu?



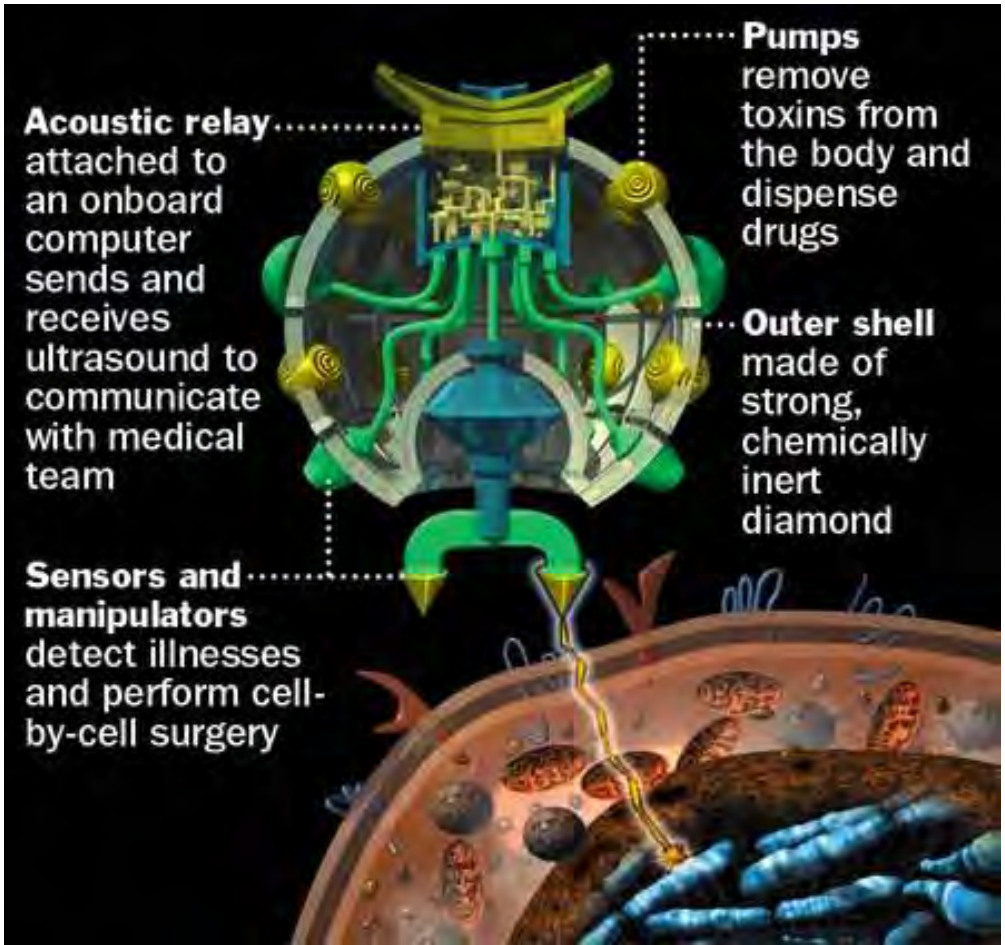
Gold tethered to the protein shell of a virus



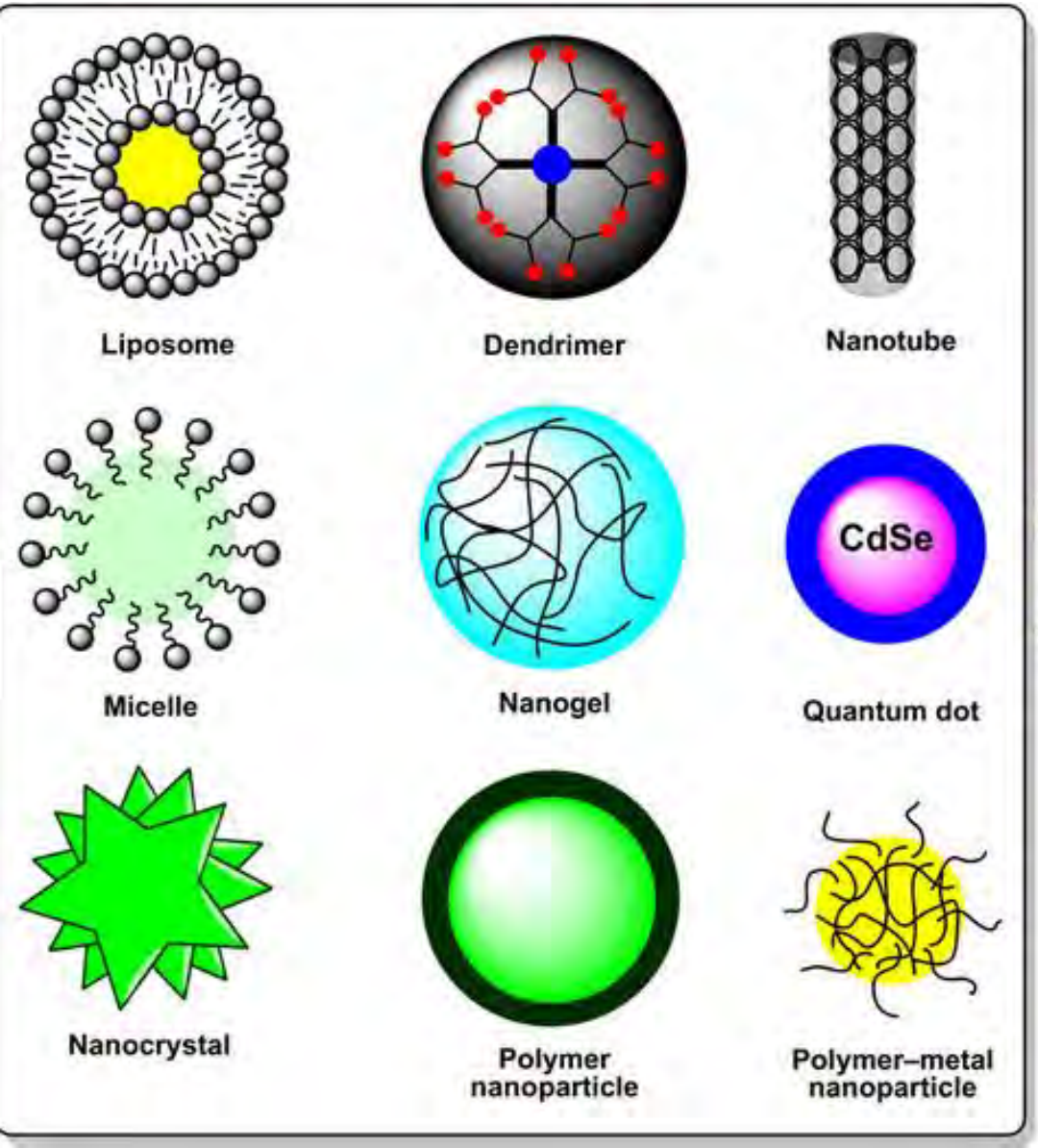
Influenza virus: Note proteins on outside that bind to cells

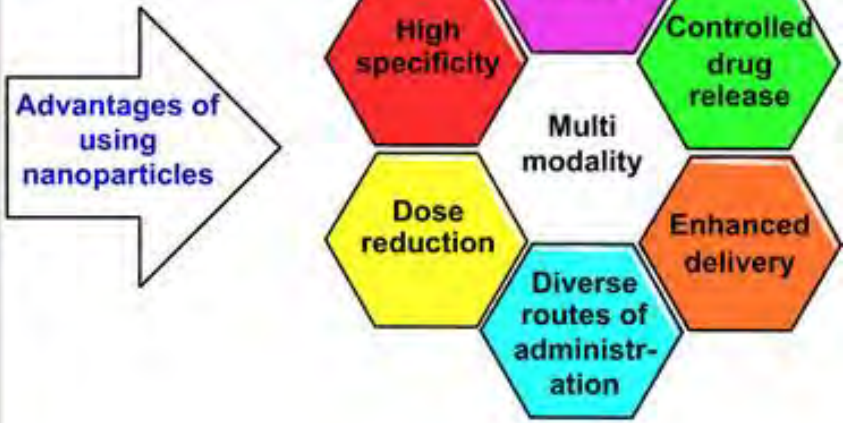
HEALTH CARE: MAKING REPAIRS TO THE BODY

- Nanorobots are imaginary, but nano-sized delivery systems could…
  - Break apart kidney stones, clear plaque from blood vessels, and ferry drugs to tumor cells



VARIOUS TYPES OF NANO MEDICINES

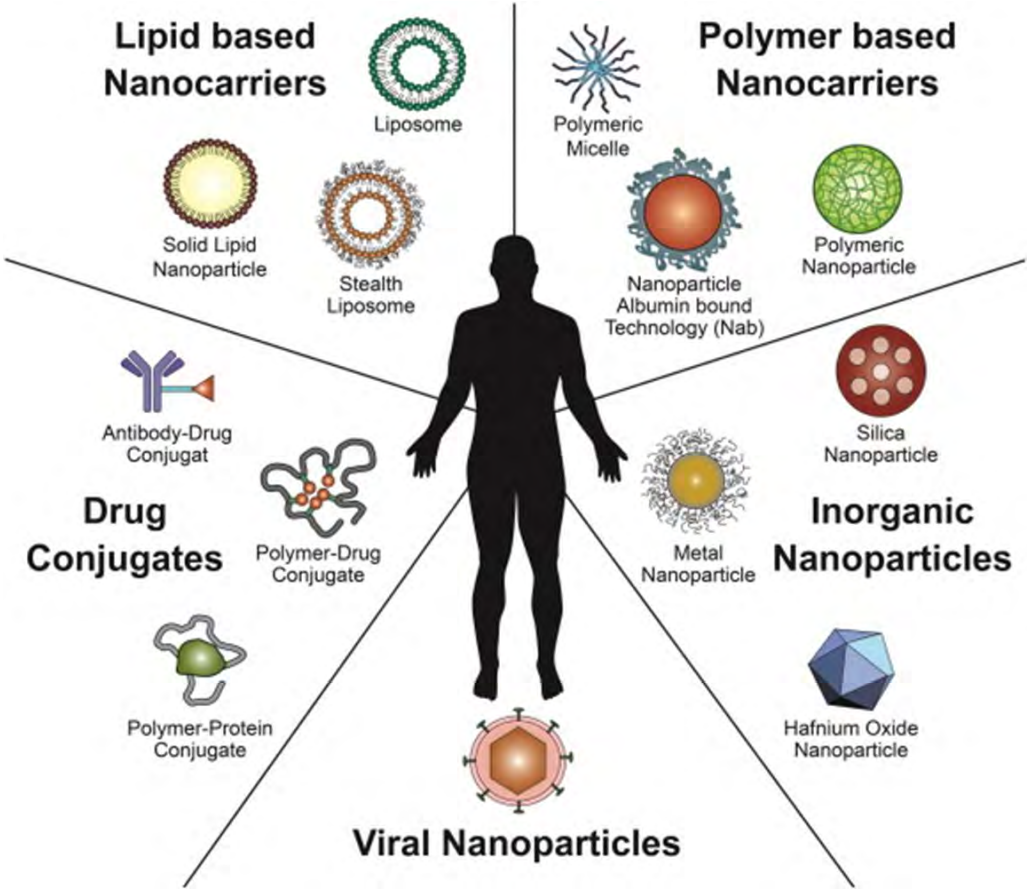


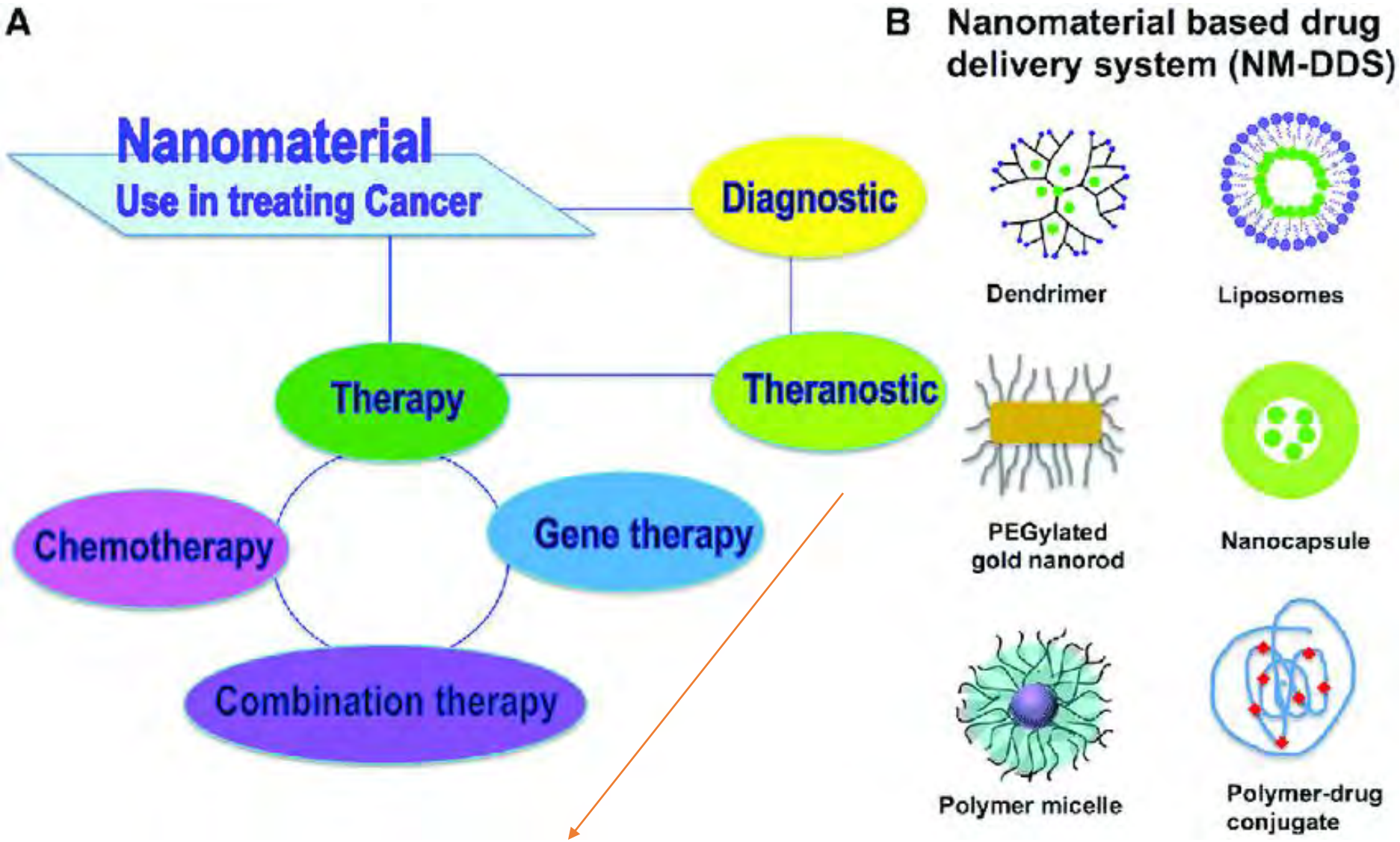


Cancer is a leading cause of death worldwide.

Currently available therapies are inadequate and spur demand for improved technologies.

Rapid growth in nanotechnology towards the development of nanomedicine products holds great promise to improve therapeutic strategies against cancer.





Theranostic nanoparticles are designed for combining diagnostic and therapeutic capabilities into one single biocompatible and biodegradable nanoparticle.

SOME NANOTECHNOLOGY-BASED DRUGS THAT ARE COMMERCIALLY AVAILABLE OR IN HUMAN CLINICAL TRIALS

Abraxane, approved by the U.S. Food and Drug Administration (FDA) is used to treat breast cancer, non-small-cell lung cancer, and pancreatic cancer.

Doxil was originally approved by the FDA for the use on HIV-related Kaposi's sarcoma. It is now being used to also treat ovarian cancer and multiple myeloma.

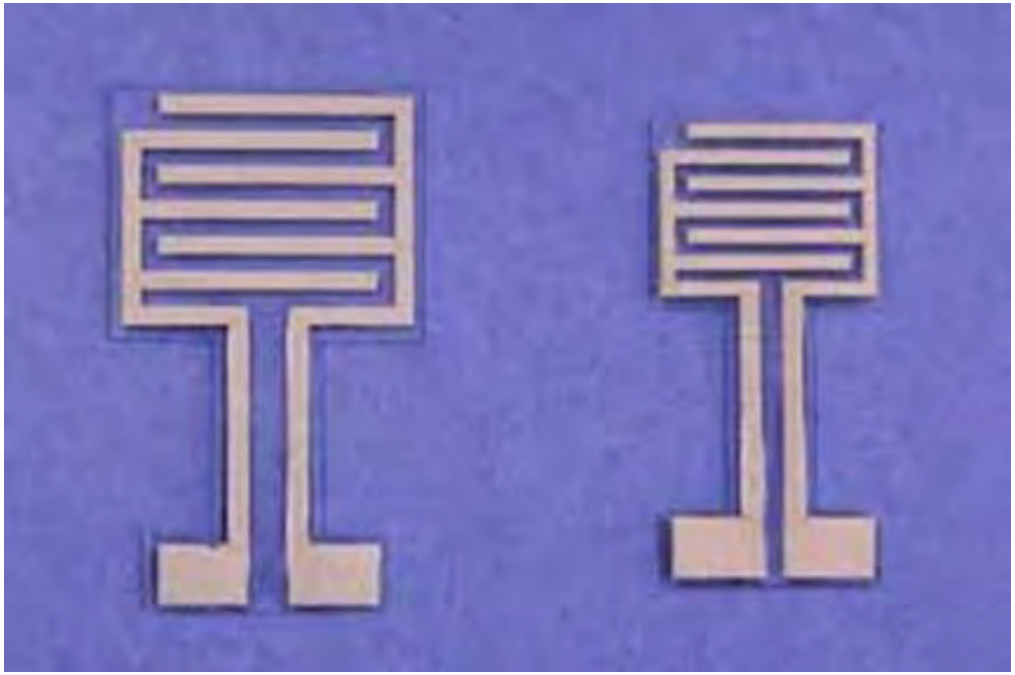
Onivyde, liposome encapsulated irinotecan to treat metastatic pancreatic cancer, was approved by FDA in October 2015.

Rapamune is a nanocrystal-based drug that was approved by the FDA in 2000 to prevent organ rejection after transplantation.

Researchers from North Carolina State University have developed a wearable, wireless sensor that can monitor a person's skin hydration for use in applications that need to detect dehydration before it poses a health problem.

It is made of made of conductive silver nanowires inlaid in a silicone matrix.

The device is lightweight, flexible and stretchable and has already been incorporated into prototype devices that can be worn on the wrist or as a chest patch.



LAB-ON-SKIN

Stretchable and flexible electronic devices as biosensors for measuring (clockwise from top right)

skin modulus stiffness)

Electro-cardiology

Hydration

Blood oxygen

Wound-healing rate

Sweat content

Skin surface temperature

Blood pressure,

Electromyography

Electroencephalography. (© ACS)

Nanotechnology materials are going to open new realms of possibility for flexible and stretchable monitoring gadgets that are wearable directly on the skin

Graphene-based Sensors in Health Monitoring

Invasive Applications

Nervous System

- ECoG
- Nerual stimulation

Cardiovascular System

- ECG
- Blood glucose

Digestive System

- Gastrointestinal diagnosis

Locomotor System

- EMG
- Muscle stimulation

Non-invasive Applications

Biophysical

Electrophysiological

- EEG
- EOG
- ECG
- EMG

Kinematic

- Pulse/heart rates
- Respiration
- Phonation
- Facial expressions
- Blood pressure
- Joints movements
- Gesture
- Muscle movements

Thermometer

- Body temperature

Environmental

- Light
- Gases
- Heavy Metal

Bio-chemical

- Volatile gases
- Electrolyte
- Metabolite
- Bacteria
- Drug
- Dopamine
- Tumor markers
- Others

INJECTED INTO A HEALTHY MOUSE, NANOPARTICLES OF CADMIUM SELENIDE GLOW WHEN EXPOSED TO ULTRA-VIOLET LIGHT.

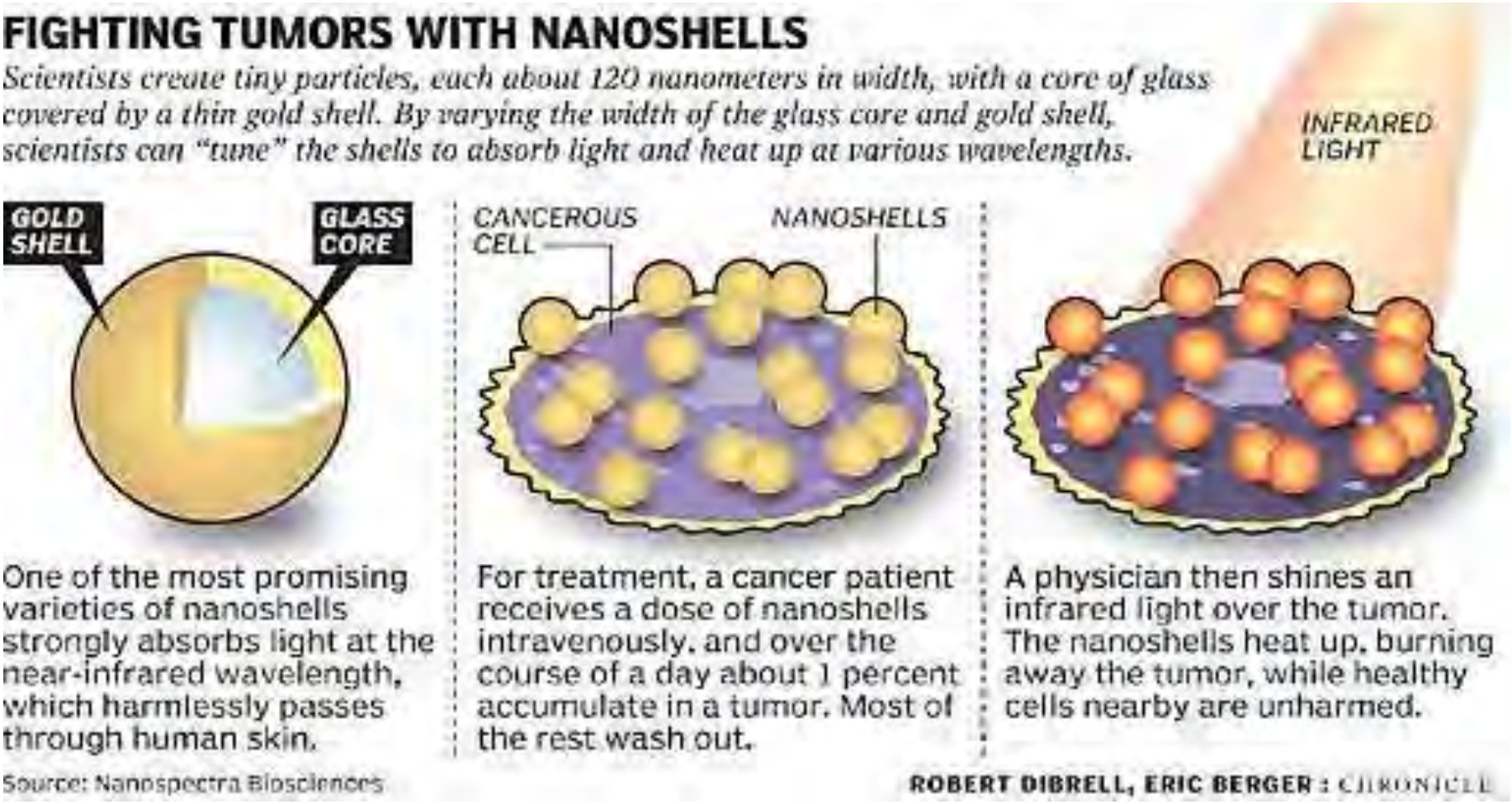
SUCH QUANTUM DOTS CAN SEEP INTO CANCEROUS TUMORS TO HELP SURGEONS FIND AND REMOVE SICK CELLS WITHOUT DISTURBING HEALTHY ONES.

Killing cancer cells

While cancer treatments such as chemotherapy, radiation, and surgery are invasive or debilitating, nanotechnology promises treatment with barely a touch. Researchers, including Naomi Halas of Rice University, have engineered spheres of silica coated with a thin layer of gold that are about 120 nanometers in diameter (right). Injected into the bloodstream, they can infiltrate tumors. When an infrared laser is then focused on the tumor, as illustrated above, the intense light passes harmlessly through healthy tissue but heats up the nanoshells, which kill the malignant cells while leaving adjacent tissue unharmed. In laboratory tests, mice have remained healthy and tumor free more than 90 days after such treatments.

150 nanometers (nm)

Nanoshells

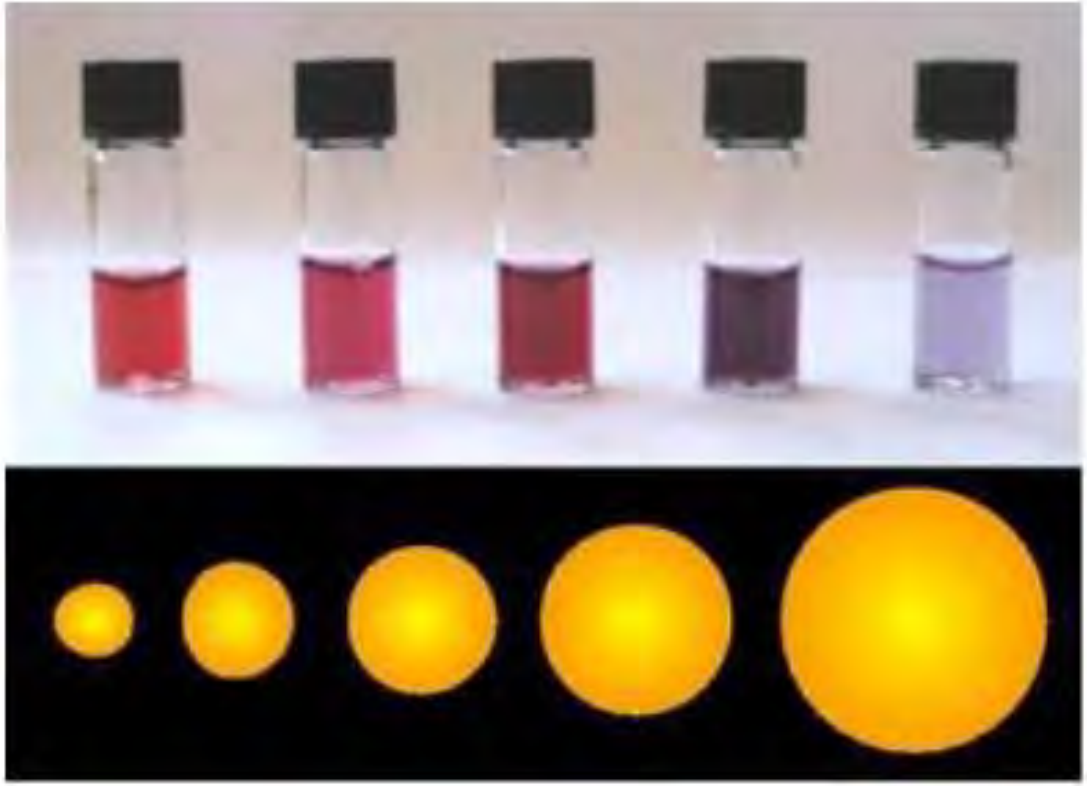

FIGHTING TUMORS WITH NANOSHELLS
Scientists create tiny particles, each about 120 nanometers in width, with a core of glass covered by a thin gold shell. By varying the width of the glass core and gold shell, scientists can "tune" the shells to absorb light and heat up at various wavelengths.
GOLD SHELL
GLASS CORE
One of the most promising varieties of nanoshells strongly absorbs light at the near-infrared wavelength, which harmlessly passes through human skin.
CANCEROUS CELL
NANOSHELLS
For treatment, a cancer patient receives a dose of nanoshells intravenously, and over the course of a day about 1 percent accumulate in a tumor. Most of the rest wash out.
INFRARED LIGHT
A physician then shines an infrared light over the tumor. The nanoshells heat up, burning away the tumor, while healthy cells nearby are unharmed.
Source: Nanospectra Biosciences
ROBERT DIBRELL, ERIC BERGER : CHRONICLE

Size

Which of these is Gold?

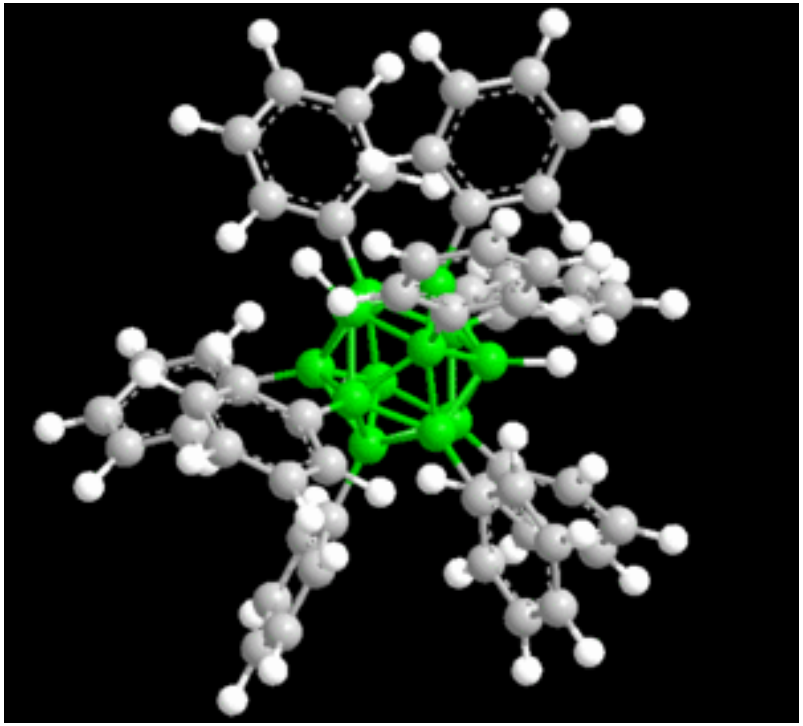
The colour of gold can range from purple to red depending on the size of the atom clusters.

Different sizes of particles reflect and absorb light differently.



NANO BORANES FOR CANCER AND OTHER DISEASE TREATMENT

Polyhedral Boranes, or clusters of boron atoms bound to hydrogen atoms, are transforming the biomedical industry.



These man-made materials have become the basis for the creation of cancer therapies, enhanced drug delivery and new contrast agents needed for radio-imaging and diagnosis.

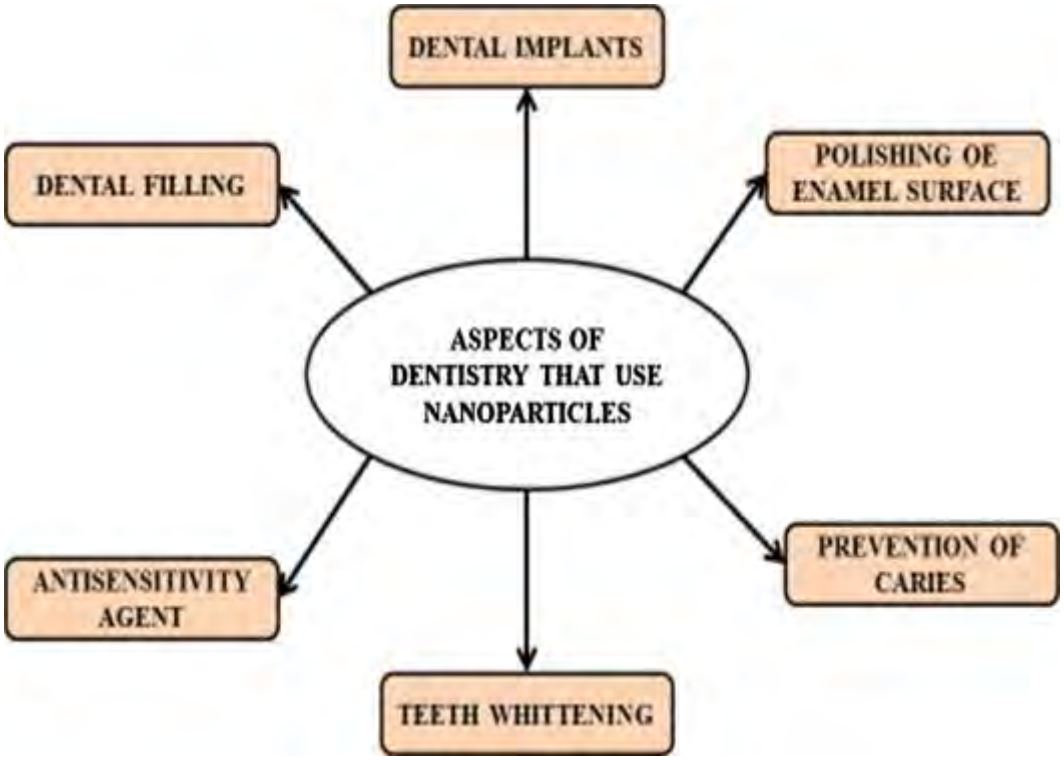
They also can be improved diagnostic tools for cancer and other diseases as well as low-cost solar energy cells

NANODENTRISTY

Nanotechnology used in the dental field is called nanodentistry.

Nanoparticles are used for:

- Prevention of oral diseases
- Cavity preventive drugs
- Prostheses for teeth implantation
- Maintaining oral health

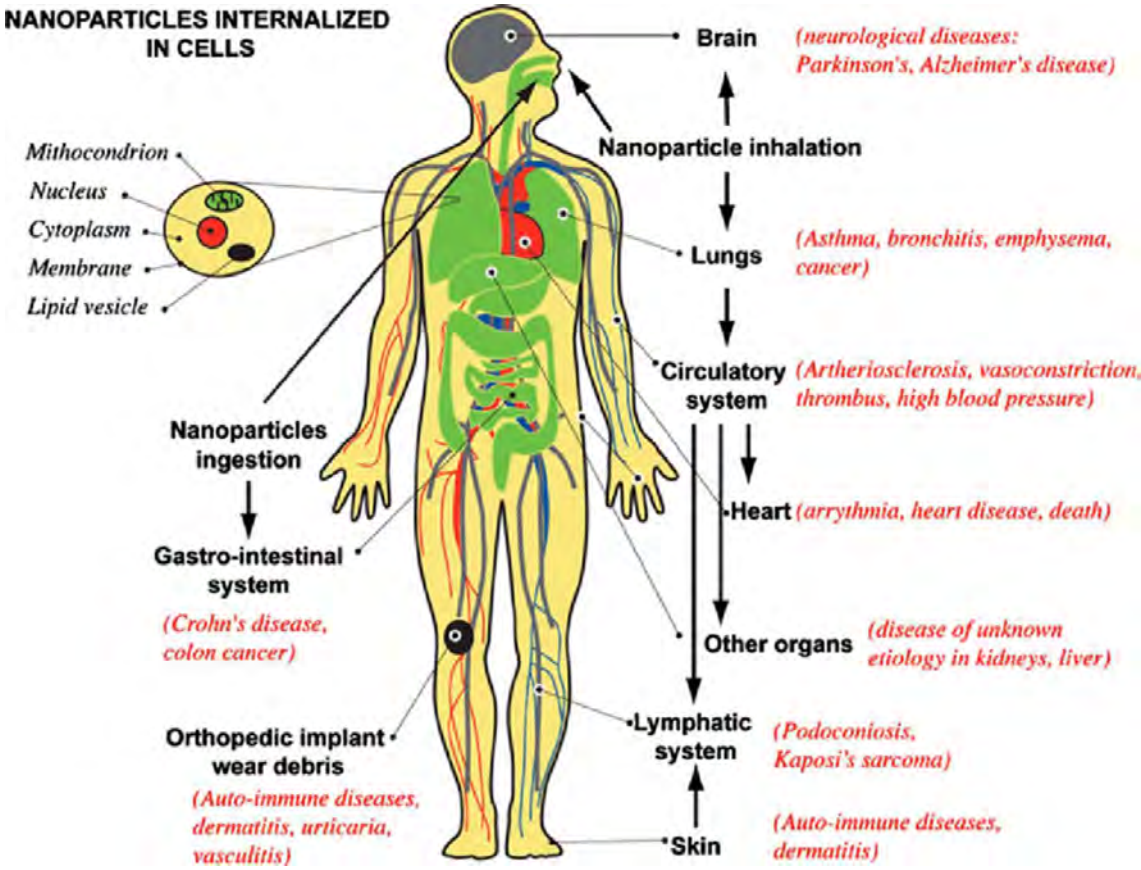


SAFETY ASPECTS OF NANOMATERIALS

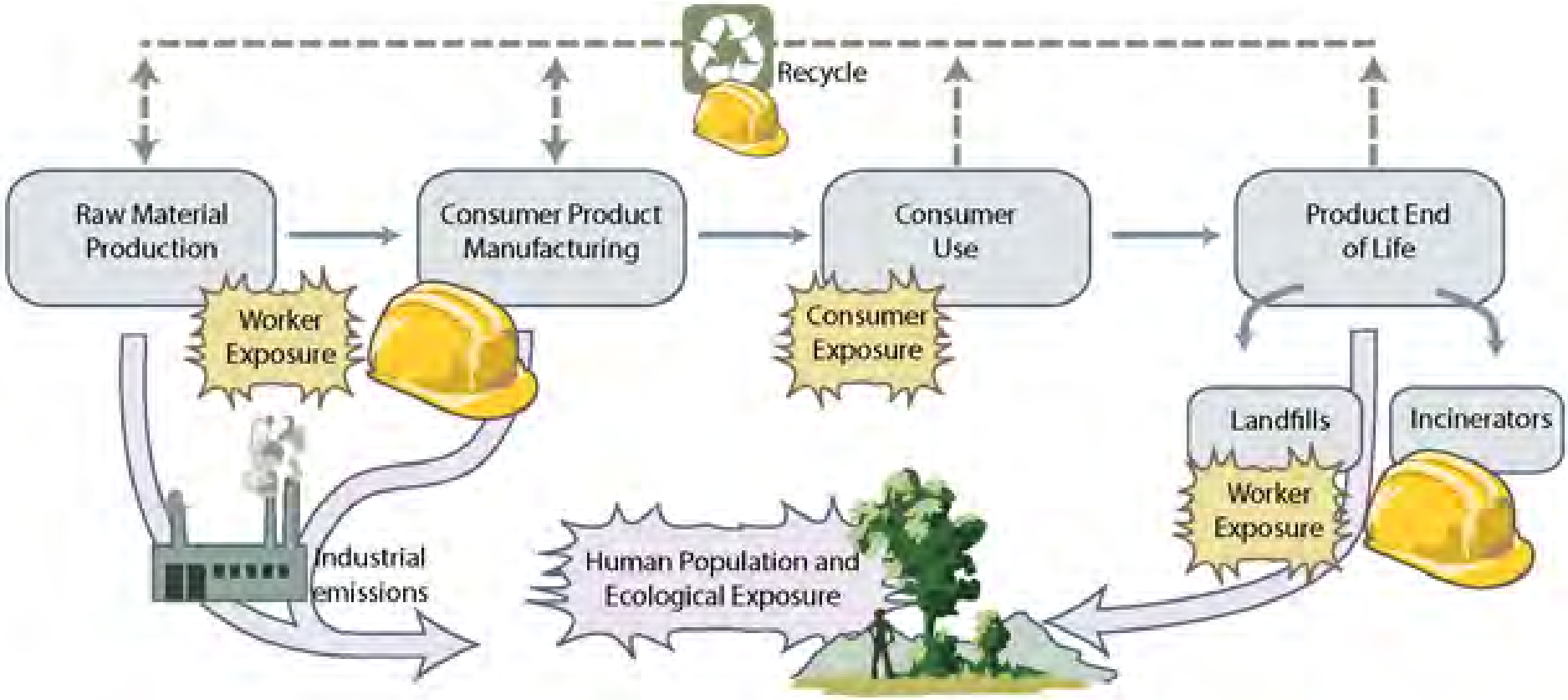
Nanopollutants could be a risk to the general population, but especially to workers in nanotechnology research and those in manufacturing of buildings.

They are very small nanoparticles which can let them enter the skin and be absorbed by the lungs, which can cause severe health problems.

If the nanopollutants enter the bloodstream, they may be able to cross the blood-brain barrier, therefore opening up the possibility that these nanoparticles could severely damage the brain.



Product life cycle showing different points for EHS evaluation.



Consumer Products Inventory
An inventory of nanotechnology-based consumer products introduced on the market.

After more than twenty years of basic and applied research, nanotechnologies are gaining in commercial use.

But it has been difficult to find out how many “nano” consumer products are on the market and which merchandise could be called “nano.”

This inventory gives the public the best available look at the 5,003 ! manufacturer-identified nanotechnology-based consumer products introduced to the market.

This "living" inventory is a resource for consumers, citizens, policymakers, and others who are interested in learning about how nanotechnology is entering the marketplace.

https://www.nanodb.dk/

THE END

BIBLIOGRAPHY

https://arxiv.org/ftp/arxiv/papers/0801/0801.3280.pdf