

# The field of Nanotechnology

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NANOTECHNOLOGY



# Agenda

- ▶ Introduction
  - ▶ My personal background and journey
- ▶ What is Nanotechnology?
  - ▶ The science of nanotechnology
- ▶ Real world applications of nanotechnology
  - ▶ History and applications
- ▶ Skills required for a nanotechnologist
  - ▶ Education
  - ▶ Continued learning
- ▶ Career paths of a nanotechnologist
  - ▶ Diverse career tracks
- ▶ Future of nanotechnology
  - ▶ Where is this heading?

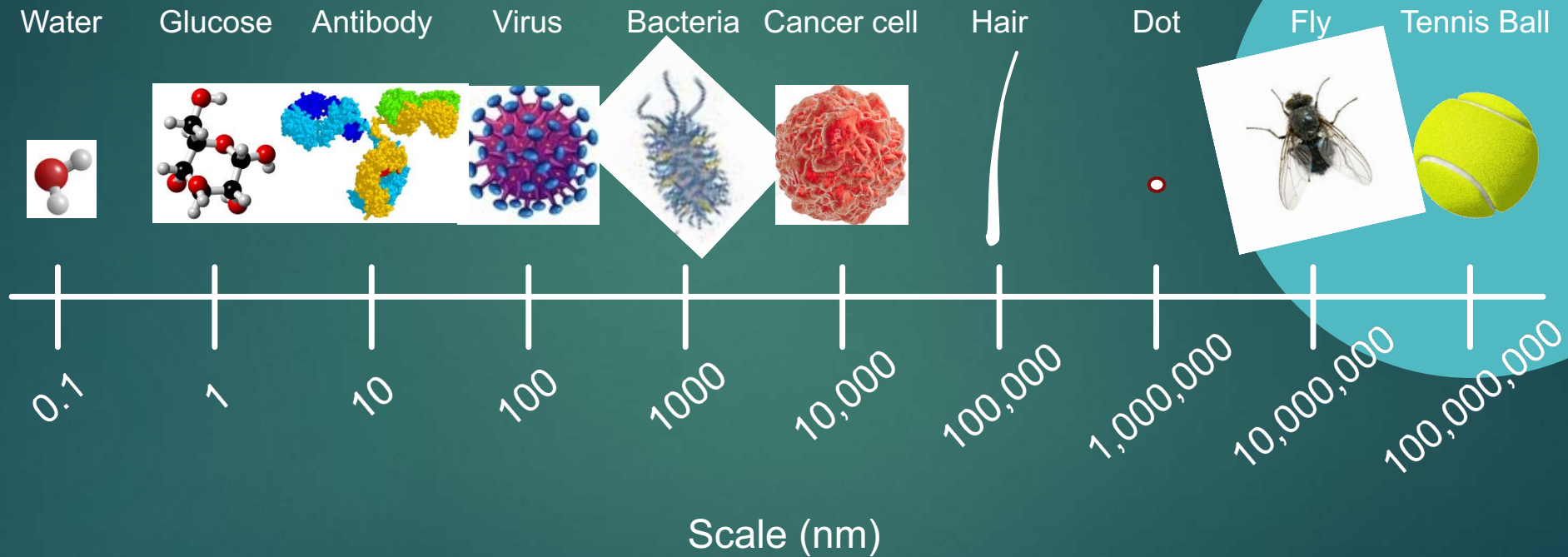


# Journey into the world of nanotechnology

- ▶ Bachelors in Computer Science and Economics – Mount Holyoke College
- ▶ Ph.D in Nanomaterials Chemistry – Rice University
- ▶ Postdoctoral Fellowship – Rice University
- ▶ Founder and CEO - NanoInnovations



# The Nanoscale



Angstrom =  $10^{-10}$  m

# Top down vs. Bottom up approach in making nanostructures



**Bottoms up**  
approach  
using  
chemical  
methods



nanoparticles



Atoms and  
Molecules



Bulk material

**Top down**  
approach using  
mechanical,  
optical, thermal  
and etching  
processes



nanoparticles



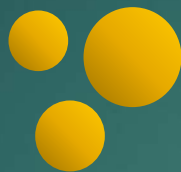
Plasma ion etcher



# Property changes at the nanoscale



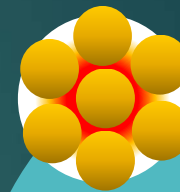
Size



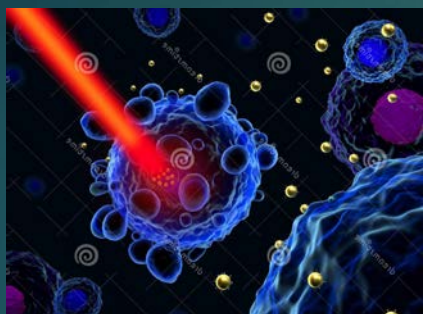
Geometry



Coupling

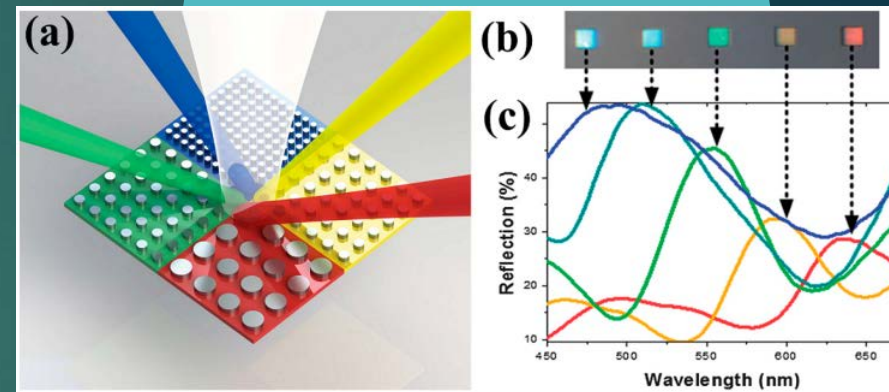
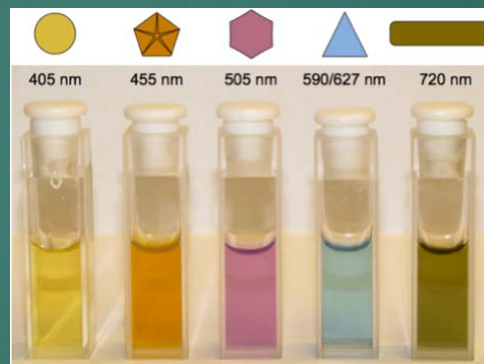


R&D for Copper NPs for COVID19



Gold NPs in cancer tumor destruction

Gold nanoparticles



Silver nanoparticles



Silver antibacterial socks

# Successful examples

Better electricity/heat providers



Self-cleaning/ De-coloration resistance/ Anti-graffiti properties



Improve radiation shielding



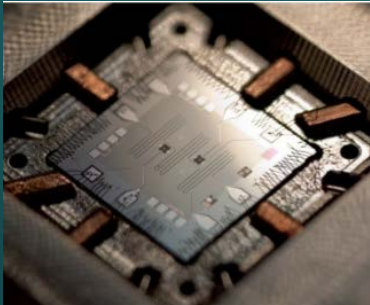
Lighter/flexible/stronger Material for protection



Flexible digital screen



Quantum computer chip



Spray coated batteries



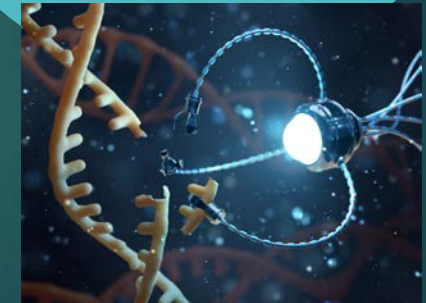
Light emitting diode display



Nano-sensor



Nano-medicine



Lighter

Faster

Sensitive

Powerful

Ubiquitous

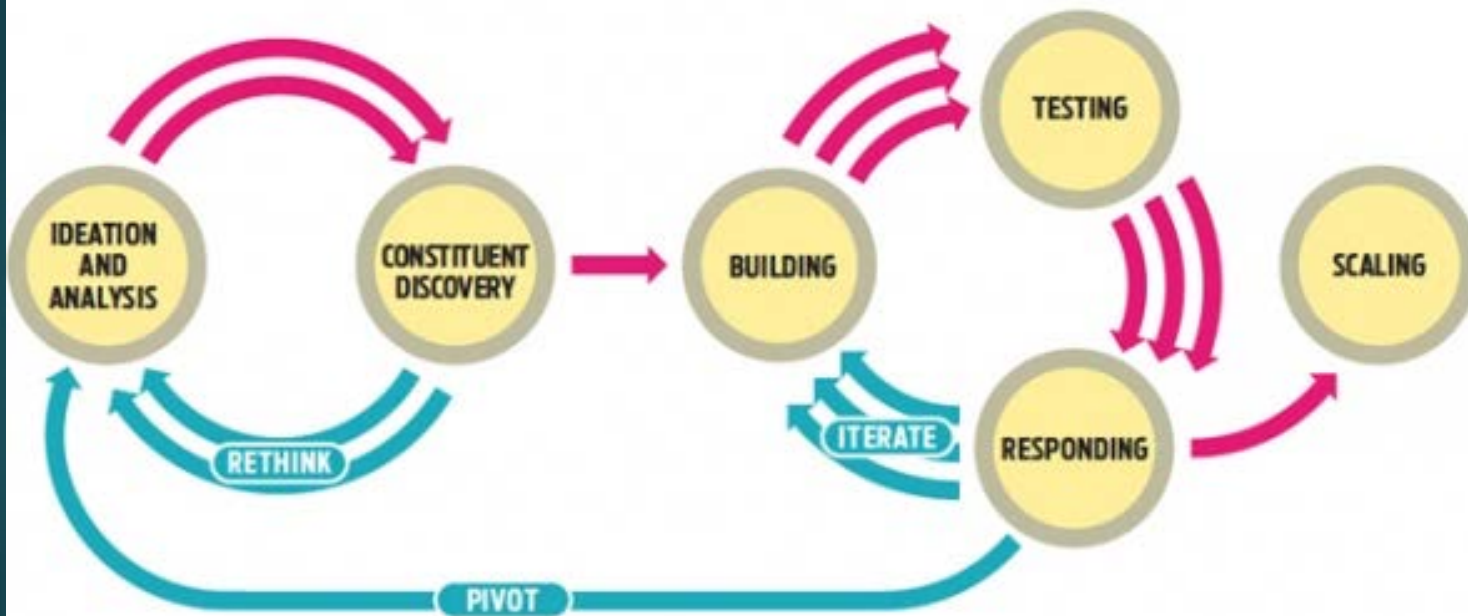
# Education/Skills required for a nanotechnologist

- ▶ Platform technology
  - ▶ STEM related undergraduate degree (**Physics, Chemistry, Biology, Biochemistry, Material Science, Environmental Science, Math**)
  - ▶ **Research work – critical!**
    - ▶ Research Experience for Undergraduates (REU)
    - ▶ With an undergraduate professor/advisor – great for recommendations
    - ▶ READING – Science, Nature, MIT Technology Review, nanotechmag.com, Harvard Business Review, Wired
    - ▶ Summer internships – industry
    - ▶ Conferences/Hackathons
  - ▶ A lot of curiosity
  - ▶ Grit and knowing failure is part of the process – experiments almost certainly don't go as planned the 1<sup>st</sup> time!
  - ▶ Almost always requires a graduate school degree (Ph.D) ~5 years



# A day in the life of a nanotechnologist

## The Lean Experimentation Process



Showing of the waterless toilet – Bill and Melina Gates Foundation – Toilet Expo

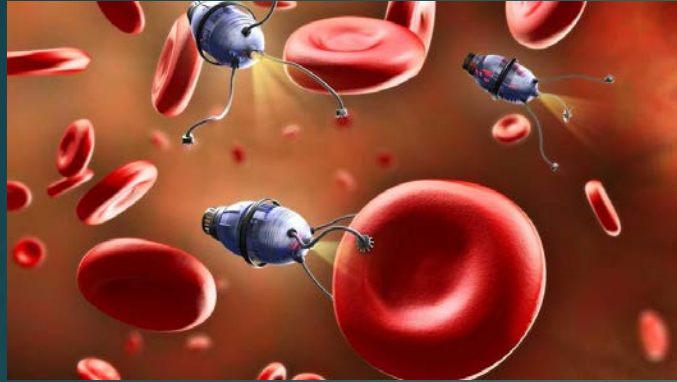
# Career tracks as a nanotechnologist

- ▶ Research Scientist
  - ▶ University/Hospital/National Labs
  - ▶ Industry
    - ▶ Renewable energy
    - ▶ Oil and Gas
    - ▶ Microprocessor chips
    - ▶ Batteries
    - ▶ Bio and life sciences / pharmaceutical
    - ▶ Medical devices
    - ▶ Manufacturing
    - ▶ Sporting goods
    - ▶ Space
    - ▶ Food safety
    - ▶ Environment
- ▶ Law
  - ▶ IP attorney
  - ▶ Patent agents
- ▶ Venture Capital/Private equity
- ▶ Start-up route
- ▶ Government – special task force





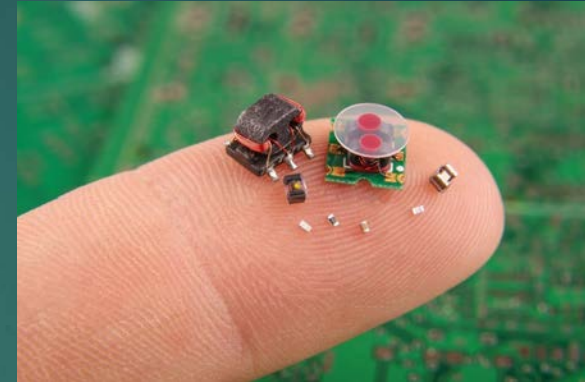
# Future of nanotechnology



Doctors inside your body



Self-healing structures



Sensors everywhere



Big Data/Quantum computing -  
Nanostructured 5D glass ultra-  
dense memory 360 TB/disc



Climate change – wallpaper  
to convert sunlight and heat  
into energy



Nano-particle paint to prevent corrosion

Thermo-chromic glass to regulate the influx of light

Organic Light Emitting Diodes (OLEDs) for displays

LEDs are now powerful enough to compete with light bulbs

Photovoltaic film that converts light into electricity

Scratchproof, coated windowpanes using the lotus effect

Menu card made of electronic cardboard

Piezo mats prevent annoying vibrations

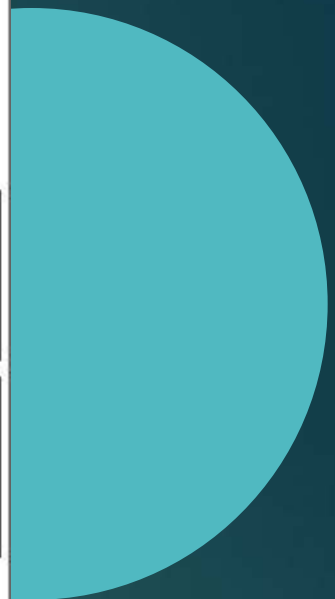
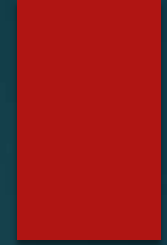
Intelligent clothing measure pulse and respiration

The Bucky-tube frame is as light as a feather, yet strong

Fuel cells provide power for mobile phones and vehicles

Fabrics coated to resist stains

Nanotubes for new notebook displays





Questions?

