Nanotechnology

- The manipulation and manufacture of materials and devices on the scale of atoms or small groups of atoms.
- The **"nanoscale"** is typically measured in nanometers, or billionths of a meter (**nanos, the Greek word for "dwarf**", being the source of the prefix), and materials built at this scale often exhibit distinctive physical and chemical properties due to quantum mechanical effects.
- Nanotechnology holds promise for significant advances in a wide variety of applications, from devices that clean the Earth's atmosphere to new means of conquering disease and the aging process.

Richard Feynman

- Idea of working at this super **miniature level** as early as **1959**
- **American Physicist**

Norio Taniguchi

- Introduced the term **"Nanotechnology"** in **1970s**
- **Researcher** in **Japan**

Carbon Nanotubes

- Discovered by **Sumio Iijima**
- **Japan** in **1991**
- Use in **"jumbotron" lamps** installed in many sports stadiums

Other practical applications of nanoscale technology include materials used in computer disk drives, automotive sensors, tires, land-mine detectors, and solid-state compasses. The technology is used in the manufacture of dressings for burns and wounds, water filtration, catalytic converters, and sunscreens.

Gerd Binnig

- Born **July 20, 1947**
- **German Physicist**
- Won the **Nobel Prize in Physics** with **Heinrich Rohrer** in **1986** for the invention of the **scanning tunneling microscope**

Heinrich Rohrer

- Born **June 6, 1933** at **Buchs, Switzerland**
- Died **May 16, 2013** at **Wollerau**
- **Swiss Physicist**
- Received half of the 1986 Nobel Prize for Physics for their joint invention of the scanning tunneling microscope
- **Ernst Ruska** received the other half of the prize

Carbon Nanotubes (CNTs)

- Cylindrical molecules that consist of rolled-up sheets of **single-layer carbon atoms (graphene)**
- **Single-walled (SWCNT)** with a diameter of **less than 1 nanometer (nm)**
- **Multi-walled (MWCNT)**, consisting of several concentrically interlinked nanotubes, with diameters reaching **more than 100 nm**
- Their length can reach several micrometers or even millimeters
- Like their building block graphene, **CNTs are chemically bonded with sp2 bonds**, an extremely strong form of molecular interaction
- This feature combined with carbon nanotubes' natural inclination to rope together via Van der Waals forces, provide the opportunity to develop ultra-high strength, low-weight materials

that possess highly conductive electrical and thermal properties
- This makes them highly attractive for numerous applications

Dr. Eric Drexler

- widely known for his seminal studies of **advanced nanosystems** and **scalable atomically precise manufacturing (APM)**, a prospective technology using arrays of nanoscale devices to guide chemically-reactive molecular encounters, thereby structuring matter from the bottom up
- His 1981 paper in the ***Proceedings of the National Academy of Sciences*** established the fundamental principles of APM, and his 1992 book, ***Nanosystems: Molecular Machinery, Manufacturing, and Computation****,* presented a deeper analysis of key physical principles, devices, and systems for implementing APM (atomically precise manufacturing) capabilities

Techniques for working at the nanoscale have become essential to electronic engineering and nanoengineered materials have begun to appear in consumer products.

Example, billions of microscopic **"nanowhiskers,"** each about 10 nanometres in length, have been molecularly hooked onto natural and synthetic fibres to impart **stain resistance** to clothing and other fabrics

Zinc oxide nanocrystals have been used to create invisible **sunscreens** that block ultraviolet light

And **silver nanocrystals** have been embedded in **bandages** to kill bacteria and prevent infection

Nanotechnology may make it possible to manufacture lighter, stronger, and programmable materials that require less energy to produce than conventional materials, that produce less waste than with conventional manufacturing, and that promise greater fuel efficiency in land transportation, ships, aircraft, and space vehicles.

Nanocoatings for both opaque and translucent surfaces may render them **resistant to corrosion**, **scratches**, and **radiation**.

Nanoscale electronic, magnetic, and mechanical devices and systems with unprecedented levels of information processing may be fabricated, as may chemical, photochemical, and biological sensors for protection, health care, manufacturing, and the environment; new photoelectric materials that will enable the manufacture of cost-efficient solar-energy panels; and molecular-semiconductor hybrid devices that may become engines for the next revolution in the information age.

The potential for improvements in health, safety, quality of life, and conservation of the environment are vast.

At the same time, significant challenges must be overcome for the benefits of nanotechnology to be realized.

Scientists must learn how to **manipulate** and **characterize individual atoms** and **small groups of atoms** reliably. New and improved tools are needed to control the properties and structure of materials at the nanoscale; significant improvements in computer simulations of atomic and molecular structures are essential to the understanding of this realm.

Next, new tools and approaches are needed for assembling atoms and molecules into nanoscale systems and for the further assembly of small systems into more-complex objects.

Furthermore, nanotechnology products must provide not only improved performance but also lower cost.

Finally, without integration of nanoscale objects with systems at the micro- and macroscale (that is, from millionths of a metre up to the millimetre scale), it will be very difficult to exploit many of the unique properties found at the nanoscale.

An example of nanoscale devices already at work are the carbon nanotubes, discovered by Sumiko Ijma in Japan in 1991, in use in “jumbotron” lamps installed in many sports stadiums.

Other practical applications of nanoscale technology include materials used in **computer disk drives, automotive sensors, tires, land-mine detectors,** and **solid-state compasses.**

The technology is used in the manufacture of **dressings for burns and wounds, water filtration, catalytic converters**, and **sunscreens**.

Bellevue, **Washington-based Innovega** with its **iOptik** platform embedded a center filter and display lens at the center of a contact lens. The optical elements are smaller than the eye's pupil and therefore do not interfere with vision. A projector can hit those tiny optical elements that guide images to the retina. The retina is still getting the overall normal vision provided through the entire pupil. The brain ends up viewing the projected images and the overall normal field of vision as one.

Renewable Energy

- **Energy from sources that are naturally replenishing but flow-limited**

Renewable Resources

- **Virtually inexhaustible in duration but limited in the amount of energy that is available per unit of time.**

Biomass

- **Renewable organic material that comes from plants and animals**
- Continues to be an important fuel in many countries, especially for cooking and heating in developing countries
- Use for fuels for transportation and for electricity generation
- A means of avoiding carbon dioxide emissions from fossil fuel use

Biomass sources for energy include:

- **Wood and wood processing wastes –** firewood, wood pellets, and wood chips, lumber and furniture mill sawdust and waste, and black liquor from pulp and paper mills
- **Agricultural crops and waste materials –** corn, soybeans, sugar cane, switchgrass, woody plants, and algae, and crop and food processing residues
- **Biogenic materials in municipal solid waste –** paper, cotton, and wool products, and food, yard, and wood wastes
- **Animal manure and human sewage**
- **Biodiesel and Renewable Diesel –** are biomass-based biofuels
- **Biomass-based Diesel Fuels –** used as petroleum distillate fuel oil (diesel fuel and heating oil) include biodiesel and renewable diesel. They are both called **biomass-based diesel fuels** because they are mostly produced for use in diesel engines, but they can also be used as heating fuels
- **Ethanol** - made from biomass. It is clear, colorless alcohol made from a variety of biomass materials called **feedstocks** (the raw materials used to make a product). U.S. fuel ethanol producers mostly use food grains and crops with high starch and sugar content as feedstocks for making ethanol such as corn, sorghum, barley, sugar cane, and sugar beets. Can also be made from grasses, trees, and agricultural and forestry residues such as corn cobs and stocks, rice straw, sawdust, and wood chips.

Geothermal Energy

- **Heat within the earth**
- Comes from Greek words **geo** (earth) and **therme** (heat)
- A renewable energy source because heat is continuously produced inside the earth
- People use geothermal heat for bathing to heat buildings, and to generate electricity

Geothermal reservoirs

- Are **naturally occurring areas of hydrothermal resources**
- Reservoirs are deep underground and are largely undetectable above ground

Geothermal Energy finds its way to the earth's surface in three ways:

- **Volcanoes** and **fumaroles** (holes in the earth where volcanic gases are released)
- **Hot springs**
- **Geysers**

The environment effects of geothermal energy depend on how geothermal energy is use or how it is converted to useful energy.

Direct use application and geothermal heat pumps have almost no negative effects on the environment

- Can have a positive effect by reducing the use of energy sources that may have negative effects on the environment

How turbines work?

- Wind turbines use blades to collect the wind's kinetic energy
- Wind flows over the blades creating lift (similar to the effect on airplane wings), which causes the blades to turn
- The blades are connected to a drive shaft that turns an electric generator, which produces (generates) electricity

Ocean Energy

- Refers to all forms of renewable energy derived from the sea

Three main types of ocean technology:

- **Wave**
- **Tidal**
- **Ocean Thermal**

How does wave energy work?

- Wave energy is generated by converting the energy within ocean waves (swells) into electricity
- There are many different wave energy technologies being developed and trialled to convert wave energy into electricity

Tidal energy comes in two forms, both of which generate electricity:

- **Tidal range technologies** harvest the potential energy created by the height difference between high and low tides. Barrages (dams) harvest tidal energy from different ranges
- **Tidal streams (or current) technologies** capture the kinetic energy of currents flowing in and out of tidal areas (such as seashores). Tidal stream devices operate in arrays, similar to wind turbines

Ocean Thermal Energy

- Generated by converting the temperature difference between the ocean's surface water and deeper water into energy
- **Ocean thermal energy conversion (OTEC)** plants may be land-based as well as floating or grazing

Hydrogen Energy

- Hydrogen is the most common chemical in the universe.
- It can be produced as a gas or liquid, or made part of other materials, and has many uses such as fuel for transport or heating, a way to store electricity, or a raw material in industrial processes.
- When it is produced using renewable energy or processes, hydrogen becomes a way of

storing renewable energy for use at a later time when it is needed.

- Hydrogen energy can be stored as a gas and even delivered through existing natural gas pipelines.
- When converted to a liquid or another suitable material, hydrogen can also be transported on trucks and in ships.

Genetically Modified Organism (GMO)

- **Organism whose genome has been engineered in the laboratory in order to favor the expression of desired physiological traits or the generation of desired biological products**

In conventional:

- **Livestock production**
- **Crop farming**, and even
- **Pet breeding**

In genetic modification, recombinant genetic technologies are employed to produce organisms whose genomes have been precisely altered at the molecular level, usually by the inclusion of genes from unrelated species of organisms that code for traits that would not be obtained easily through conventional selective breeding

Genetically modified organisms (GMOs) provide certain advantages to producers and consumers. Modified plants, for example, can at least initially help protect crops by providing resistance to a specific disease or insect, ensuring greater food production. GMOs are also important sources of medicine.

Genetically modified (GM) foods were first approved for human consumption in the United States in 1994, and by 2014-15 about 90 percent of the corn, cotton, and soybeans planted in the United States were GM. By the end of 2014, GM crops covered nearly 1.8 million square kilometers (685,00 square miles) of land in more than two dozen countries worldwide. The majority of GM crops were grown in the Americas.

Engineered crops can dramatically increase per area crop yields and, in some cases, reduce the use of chemical insecticides. For example, the application of wide-spectrum insecticides declined in many areas growing plants, such as potatoes, cotton, and corn, that were endowed with a gene from the bacterium **Bacillus Thuringiensis,** which produces a natural insecticide called **BT Toxin**.

Field studies conducted in India in which BT Cotton was compared with non-BT Cotton demonstrated a 30-80 percent increase in yield from the GM crop.

This increase was attributed to marked improvement in the GM plants' ability to overcome bollworm infestation, which was otherwise common.

Studies of BT Cotton production in Arizona, US, demonstrated only small gains in yield – about 5 percent – with an estimated cost reduction of $25-$65 (USD) per acre owing to decreased pesticide applications.

In China, where farmers first gained access to BT Cotton in 1997, the GM crop was initially successful.

Farmers who had planted BT Cotton reduced their pesticide use by 50-80 percent and increased their earnings by as much as 36 percent. By 2004, however, farmers who had been growing BT Cotton for several years found that the benefits of the crop eroded as populations of secondary insect pests, such as mirids, increased. Farmers once again were forced to spray broad-spectrum pesticides throughout the growing season, such that the average revenue for BT growers was 8 percent lower than that of farmers who grew conventional cotton.

Assessing the environmental safety of genetically modified organisms (GMOs) is challenging.

- While modified crops that are resistant to herbicides can reduce mechanical tillage and hence soil erosion

- Engineered genes from GMOs can potentially enter into wild populations
- Genetically modified crops may encourage increased use of agricultural chemicals, and there are concerns that GMOs may cause inadvertent losses in biodiversity

Coronavirus disease (COVID-19) is an infectious disease cause by a newly discovered coronavirus

Most people infected with the COVID-19 virus will experience mild to moderate respiratory illness and recover without requiring special treatment. Older people, and those with underlying medical problems like cardiovascular disease, diabetes, chronic respiratory disease, and cancer are more likely to develop serious illness.

The best way to prevent and slow down transmission is being well informed about the COVID-19 virus, the disease it causes and how it spreads. Protect yourself and others from infection by washing your hands or using an alcohol-based rub frequently and not touching your face.

The COVID-19 virus spreads primarily through droplets of saliva or discharge from the nose when an infected person coughs or sneezes, so it is important that you also practice respiratory etiquette (for example, by coughing into a flexed elbow).

COVID-19 affects different people in different ways. Most infected people will develop mild to moderate illness and recover without hospitalization.

Symptoms

Most common symptoms: fever, dry cough, tiredness

Less common symptoms: aches and pains, sore throat, diarrhea, conjunctivitis, headache, loss of taste or smell, a rash on skin, or discoloration of fingers or toes.

Serious symptoms: difficulty breathing or shortness of breath, chest pain or pressure, loss of speech or movement. Seek immediate medical attention if you have serious symptoms. Always call before visiting your doctor or health facility. People with mild symptoms who are otherwise healthy should manage their symptoms at home. On average it takes 5–6 days from when someone is infected with the virus for symptoms to show, however it can take up to 14 days.

Preventions

To prevent infection and to slow transmission of COVID-19, do the following:

1. Wash your hands regularly with soap and water or clean them with alcohol-based hand rub.
2. Maintain at least 1-meter distance between you and people coughing or sneezing.
3. Avoid touching your face.
4. Cover your mouth and nose when coughing or sneezing.
5. Stay home if you feel unwell.
6. Refrain from smoking and other activities that weaken the lungs.
7. Practice physical distancing by avoiding unnecessary travel and staying away from large groups of people.

COVID-19 Mutations

It appears to be behind a recent spike in local COVID-19 cases. In fact, it might be linked to a faster spread of disease. (December 14, 2020)

Evidence to support this has emerged. It prompted officials to tighten public health measures. They include restricting gatherings of people who don't live in the same household.

The new variant is called B.1.1.7. It does not seem to affect disease severity. And for now, experts expect vaccines should still protect against this version of the COVID-19 virus.

Viruses are always changing. Our cells use a virus that infects us to make new copies. But cells are prone to copying errors. Over time, such errors naturally change a virus's genetic instructions. Known as mutations, most changes won't alter how a virus behaves, notes Stephen Goldstein. He's an evolutionary virologist who works at the University of Utah in Salt Lake City. But those changes do serve to fingerprint viruses and their spread.

Compared to its closest relative, the U.K. variant has 17 mutations that alter or remove amino acids, the building blocks of proteins. Six of those changes affect just one protein. Two missing amino acids do, too. They affect the spike protein that allows the virus to break into cells.

Compared to people with other versions of the new coronavirus, those infected with B.1.1.7 tend to pass the virus on to more people. They also tend to have higher amounts of the virus's genetic material in their bodies. That's the finding of a new reports. It comes from researchers in the U.K. New and Emerging Respiratory Virus Threats Advisory Group.

Coronavirus variants in South Africa and other countries also have the N501Y mutation. The U.K. and South African variants each developed N501Y on their own. When variants in different places evolve the same mutation, that change may offer some benefit, says Goldstein at Utah. The rapid spread of B.1.1.7 in the United Kingdom and of its distant relative in South Africa hint that N501Y might help the virus spread.

That should limit copying mistakes — those mutations. And that should mean these viruses change more slowly than others that also use RNA as their genetic blueprint (such as flu viruses). The surprise was that B.1.1.7 had so many more mutations than had been expected.

It could mean the variant emerged in someone with a weak immune system. If that allowed the virus to copy itself in their body for much longer than usual, Katzourakis says, it could have collected lots of mutations. Such a circumstance, he argues, could have given "evolution a helping hand."

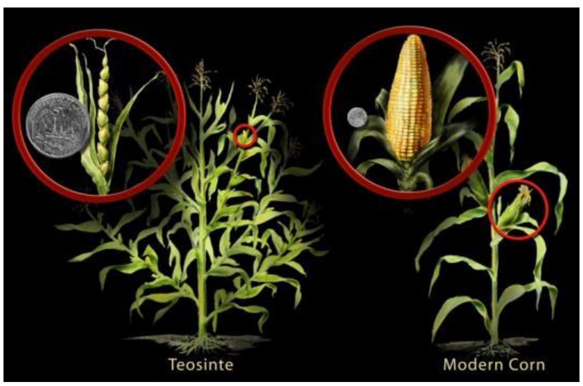
Wearing masks, handwashing and social distancing are still going to be important to curbing spread of the new coronavirus. Officials "may have to think about introducing additional measures," Katzourakis says. But they will "be the same kind of measures," he adds, just "potentially more often and more stringent."

Another mutation emerged in this past spring, called D614G, there are signs it is more contagious than variants without it. It prevented countries like Vietnam or Taiwan or South Korea or New Zealand from being able to contain the virus.

Scientists originally never used the term genetically modified organisms or GMOs to describe genetic engineering. This term seems to have come from the popular media. The term has become so common that even scientists often use the term now. For many the terms genetically modified organisms are synonymous with genetically engineered organisms.

Most scientists would say that almost all the food we eat has been "genetically modified" by man and that genetic modification includes not only conventional breeding, but simple selections man has made over millennia.

Picture 1 teosinte to modern corn – 7000 years, Picture 2 on right - wild carrot vs modern carrots, orange carrots were developed in 1700's, Picture 3 The exact date of domestication of tomato is unknown: by 500 BC, it was already being cultivated in southern Mexico and probably other areas.



What is GMO?

- GMO from Dictionary.com: **genetically modified organism: an organism or microorganis m whose genetic material has been altered by mean of genetic engineering.**
- Genetic engineering, also called **genetic modification**, is the direct manipulation of an organism's genome using biotec hnology.

Transgenic - a gene is moved from one non-closely related species to another

Cisgenic/intragenic - a gene is moved within the same species or a closely related species.

RNAi - is a biological process in which RNA molecules inhibit gene expression

Subgenic - a gene is edited to amplify, delete, insert, silence or repress the gene.

CRISPR

GE Crop Traits

Herbicide tolerance - crop can withstand herbicide applications

Insect tolerance - plant produces toxin to kill pest

Improved nutrition – plant produces a substance of nutritive value or is changed to not produce an anti-nutrient

Disease resistant – crop is resistant to certain disease

Stress Tolerance – crop is tolerant of stress, low nutrient levels or excess nutrients

Increased Storage – crop can be stored longer to avoid spoilage losses

Medicinal uses – crops that produce medicines or vaccines

Industrial uses – crops to make more efficient industries

Both apples (Arctic apples) and potatoes (first generation Innate potatoes) have been genetically engineered so that they do not brown when cut open and reduce losses due to bruising. Both are examples of RNAi, which uses genes from the same species, for gene silencing. The potato also reduces acrylamide in potatoes. Acrylamide has been linked to some cancers. Both products could benefit consumers by reducing food waste. The small company that produced Arctic apples hopes the ability to serve sliced apples that do not brown will increase apple comsumption by children.

The second generation of Innate potatoes entered the USDA process on the heels of the recent deregulation of its first generation. The potatoes will also undergo FDA review and must be registered by the US EPA. The second generation of Innate contains the same traits as the first generation (low black spot bruise and low acrylamide), plus two additional traits consisting of resistance to late blight disease (regulated by the US EPA) and lowered reducing sugars. Late blight disease is what caused the Irish potato famine and is still a problem that often requires multiple pesticide applications)

Rennet is a complex of enzymes produced in stomachs of ruminant mammals which is used in the production of most cheeses. **Chymosin,** its key component, is a protease enzyme that curdles the casein in milk, helping young mammals digest their mothers' milk.

Traditionally, rennet is obtained from the fourth stomach lining of an unweaned calf. Calves have a higher amount of rennet in their stomachs compared to adults as they use it to digest milk, their main source of food. The rennet extracted from the stomach linings is usually a mixture of chymosin, pepsin (another enzyme) and other proteins.

Beginning in the 1960s, the price of rennet, a byproduct of the veal industry, rose and became less stable as the animal rights movement grew. Demand for cheese also soared, and cheese-makers began looking for alternative sources of rennet from plants and microbes.

Some plants and microbes naturally produce enzymes that have coagulating properties like rennet. However, rennet from these sources tend to produce other side reactions in cheese production, leading to undesirable results in taste.

So how did biotechnology come to play a role? In the late 1980s, scientists figured out how to transfer a single gene from bovine cells that codes for chymosin into microbes, giving microbes the ability to produce chymosin. These genetically modified microbes are allowed to multiply and cultivated in a fermentation process while they produce and release chymosin into the culture liquid. The chymosin can then be separated and purified. Chymosin produced using this method is termed fermentation-produced chymosin, or FPC.