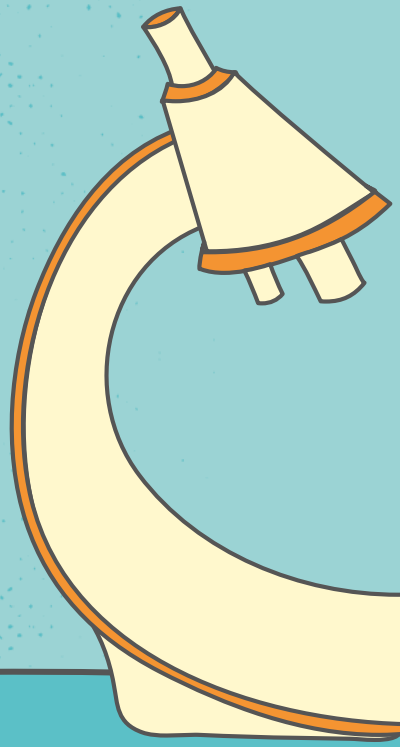
CHAPTER 3: Specific Issues in Science, Technology, and Society



LESSON 1:

Gene Therapy

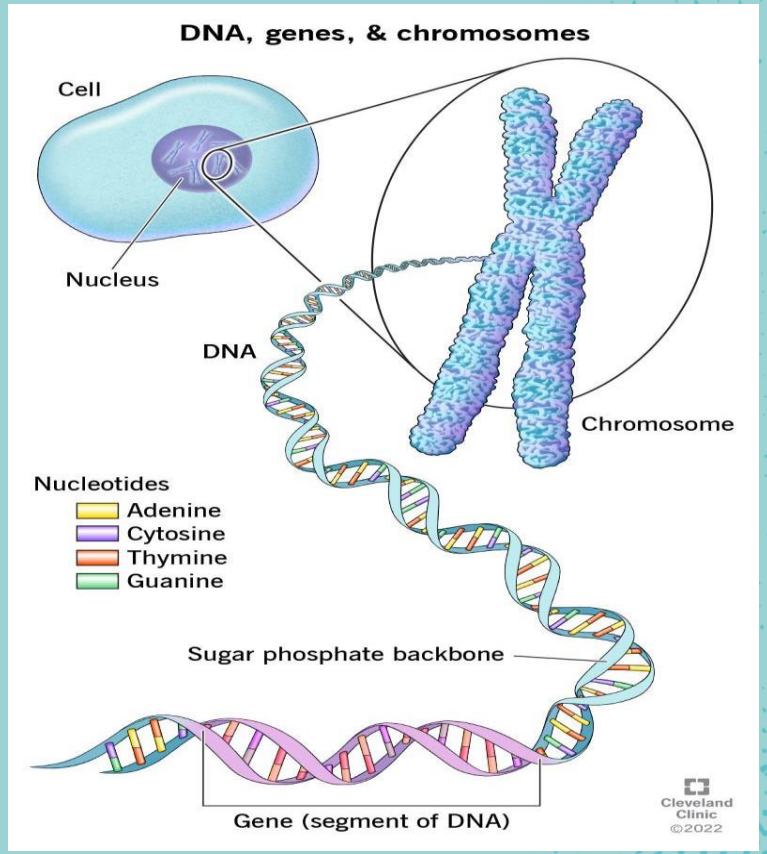
Gene Therapy

Genes

- is the basic unit of heredity

Chromosome

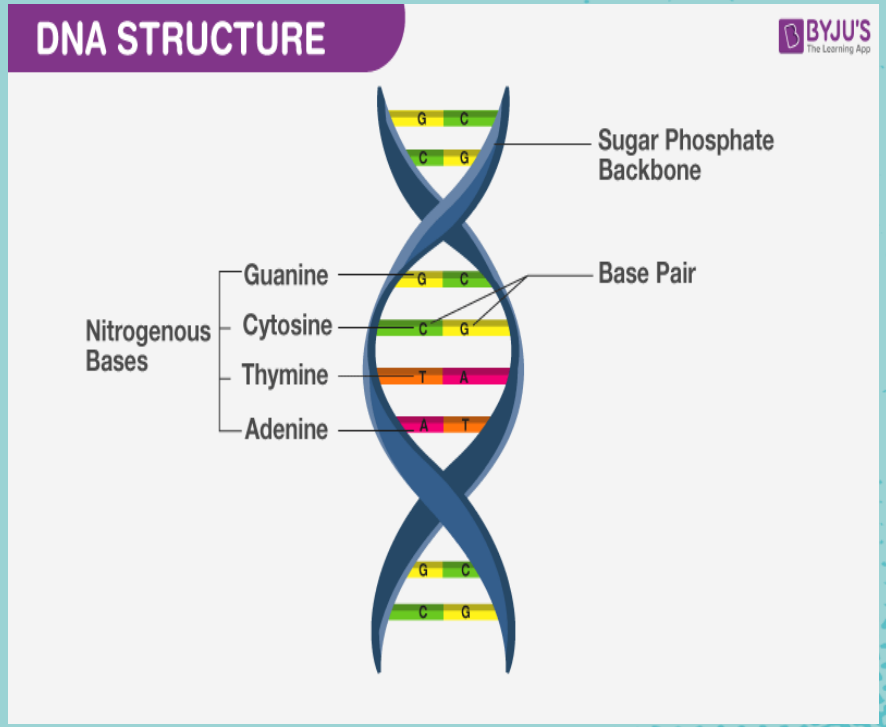
- is a DNA molecule with part or all of the genetic material of an organism



Gene Therapy

Deoxyribonucleic acid (DNA)

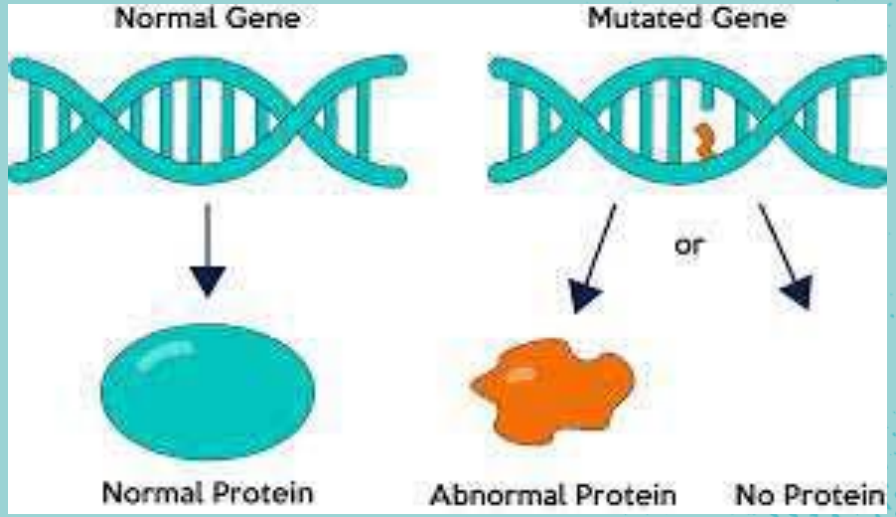
- is the molecule that carries genetic information for the development and functioning of an organism. DNA is made of two linked strands that wind around each other to resemble a twisted ladder — a shape known as a double helix.



Gene Therapy

Genetic Mutation

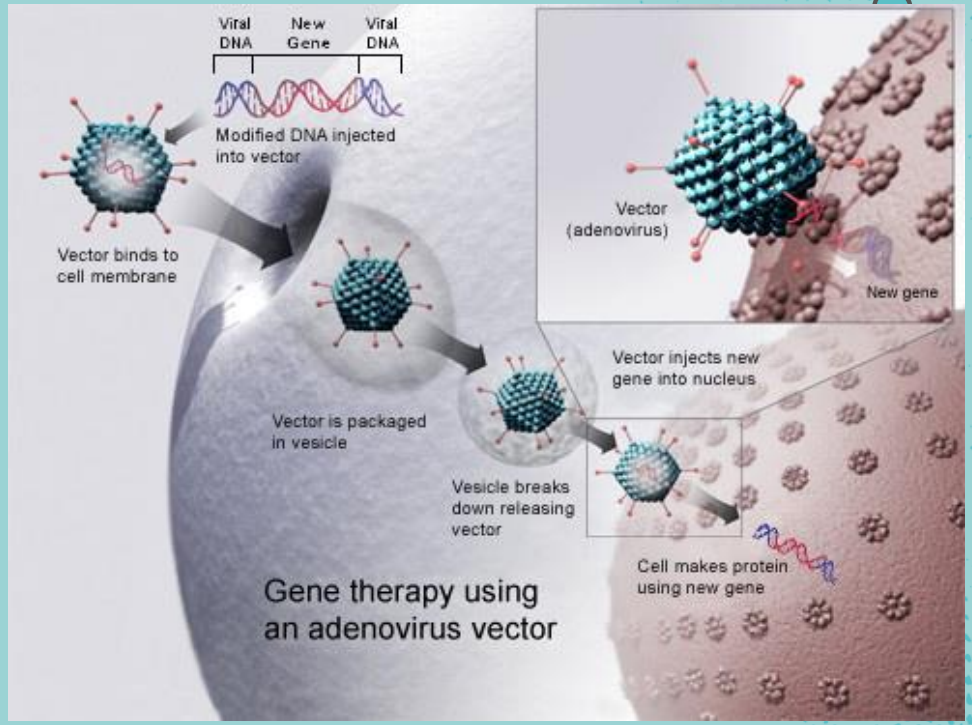
- is a change to a gene's DNA sequence to produce something different. It creates a permanent change to that gene's DNA sequence.



Gene Therapy

Gene Therapy

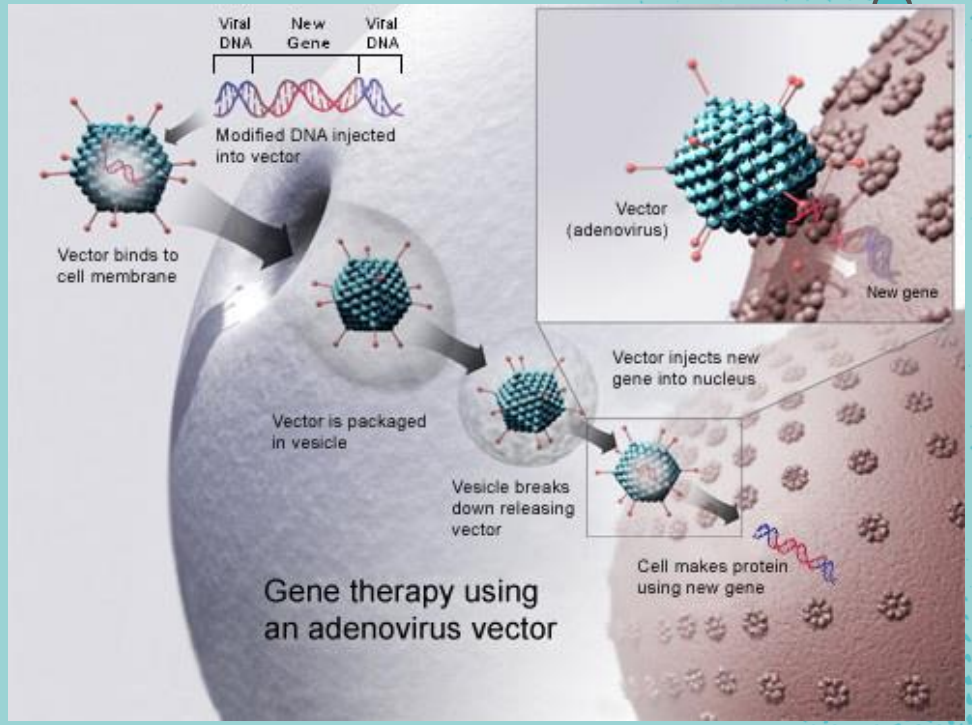
- seeks to alter genes to correct genetic defects in order to prevent or cure genetic diseases.



Gene Therapy

How it started….

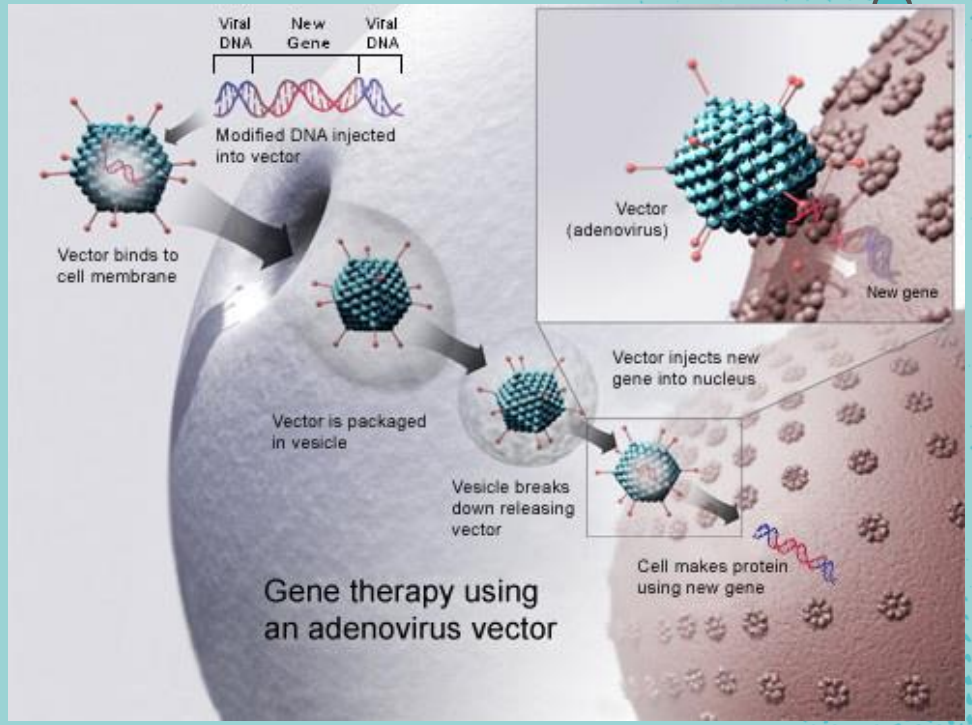
In the 1980s, Scientists began to look into gene therapy. They would insert human genes into a bacteria cell. Then the bacteria cell would transcribe and translate the information into a protein Then they would introduce the protein into human cells



Gene Therapy

The First Case….

- performed on September 14th, 1990
- Ashanti De Silva was treated for SCID (Sever Combined Immuno Deficiency)



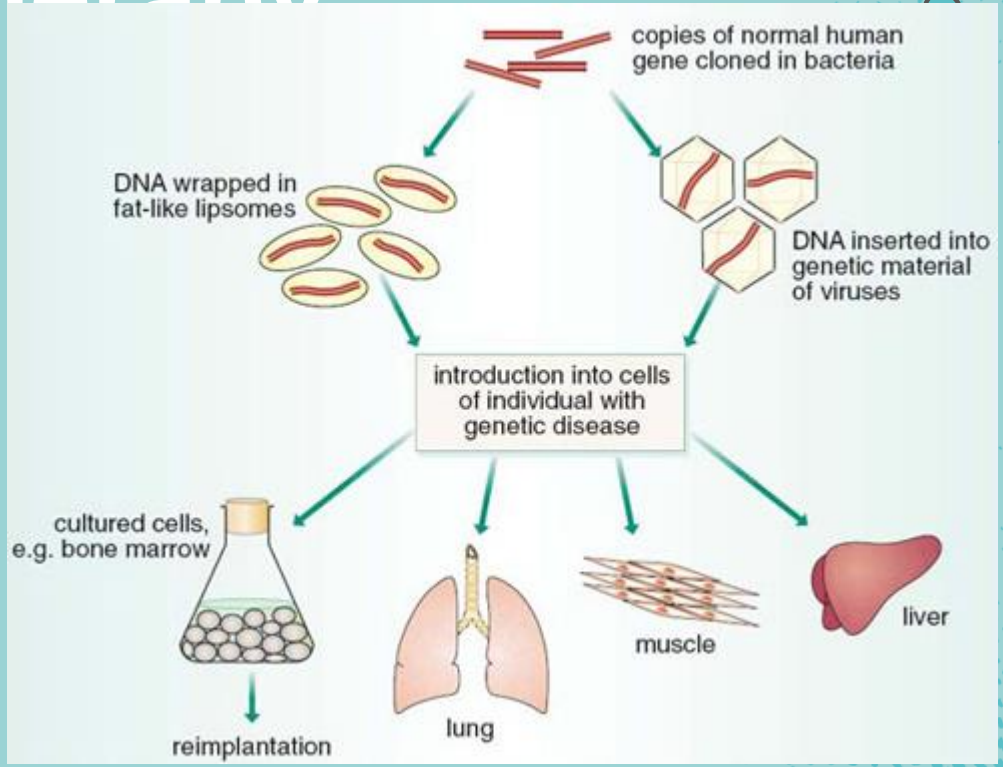
Two Basic Types of Gene Therapy

1. **Somatic Cell Gene Therapy**

❖ It involves the placement of a human gene into a living person's somatic cells

Somatic Cell

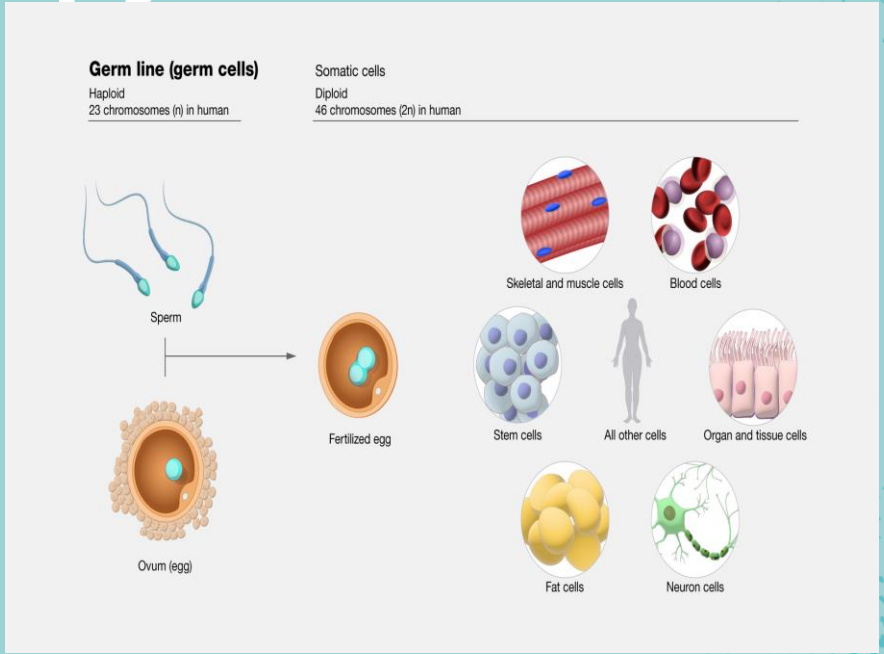
➢ cells that do not produce the eggs and sperm that in turn produce the next generation



Two Basic Types of Gene Therapy

2. Germline Gene Therapy

- is when DNA is transferred into the cells that produce reproductive cells, eggs or sperm, in the body.
- This type of therapy allows for the correction of disease-causing gene variants that are certain to be passed down from generation to generation



Two Approaches of Gene Therapy

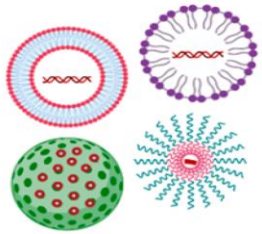
1. In the **in vivo gene**/cell **therapy** means that **therapy** is administered directly the patient. The targeted cells remain **in** the body of the patient.

2. In the **ex vivo gene**/cell **therapy** the targeted cells are removed from the patient and **gene therapy** is administered to the cells **in vitro** before they are returned to the patient's body.

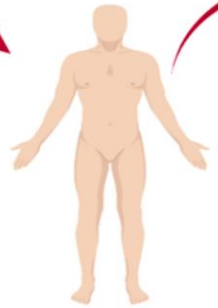
In vivo gene therapy

Ex vivo gene therapy

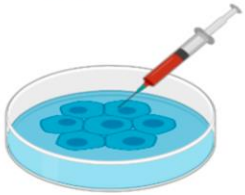
Non-viral delivery system



Nanoparticles that can potentially be used for HCC gene therapy



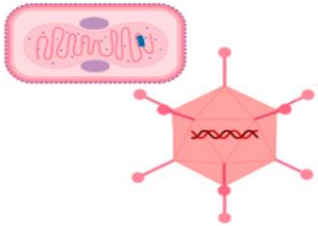
cells isolated from patient



cells modified *in vitro*

Modified cells injected back into the patient

Viral delivery systems

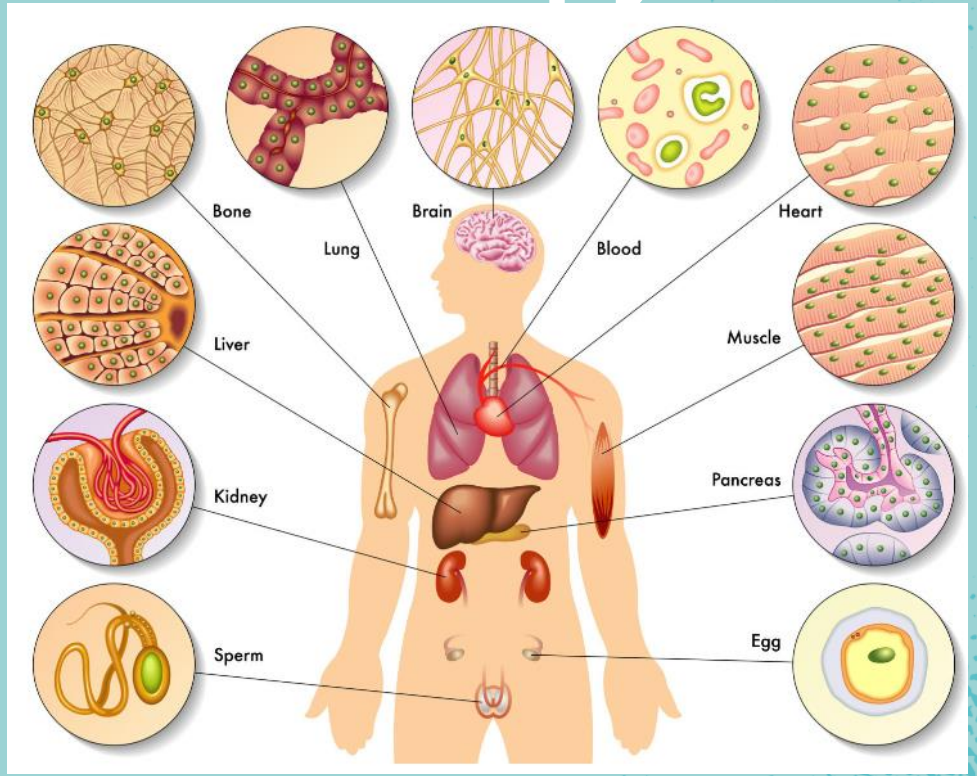


Viruses currently being used for HCC gene therapy

Stem Cell Gene Therapy

Stem Cell

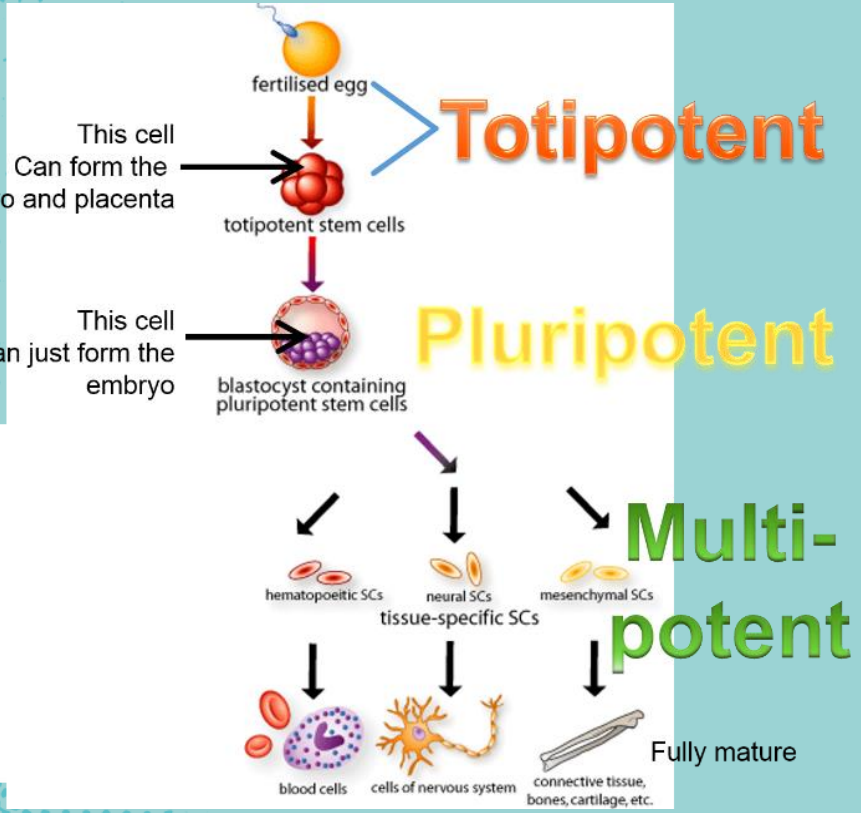
- is cell that can continuously divide and differentiate (develop) into various other kind(s) of cells/tissues. This is usually used in this kind of therapy.
- are referred to as ‘Blank cells’ (unspecialized).



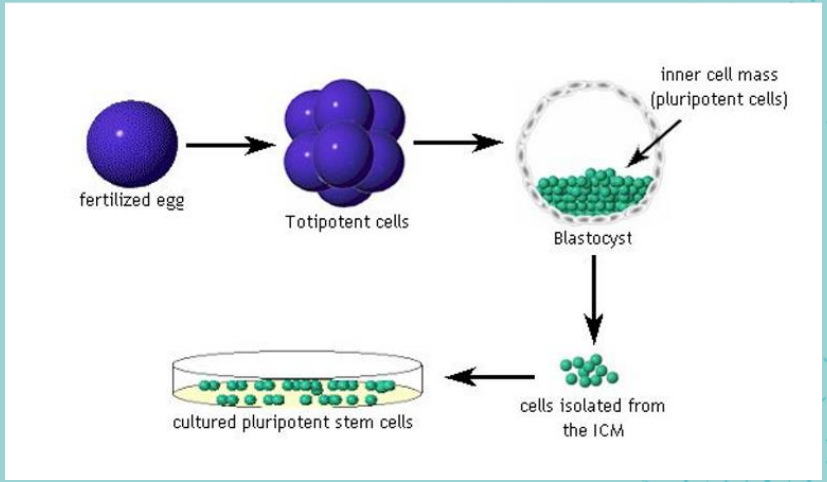
Classification of Stem Cells

Stem cell type	Description	Examples
Totipotent	Each cell can develop into a new individual	Cells from early (1-3 days) embryos
Pluripotent	Cells can form any (over 200) cell types	Some cells of blastocyst (5 to 14 days)
Multipotent	Cells differentiated, but can form a number of other tissues	Fetal tissue, cord blood, and adult stem cells

Classification of Stem Cells



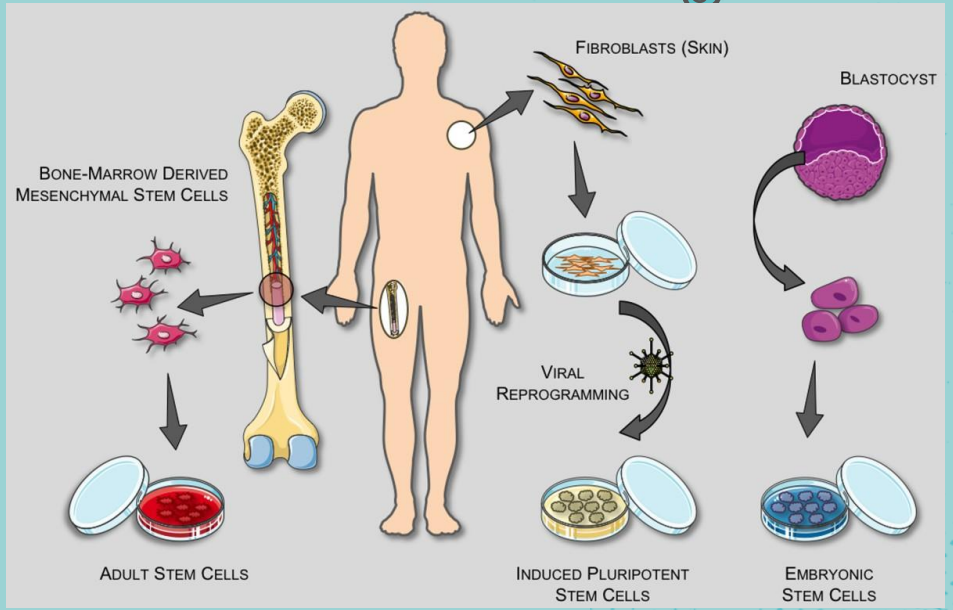
Blastocyst Diagram



Two main sources of stem cells:

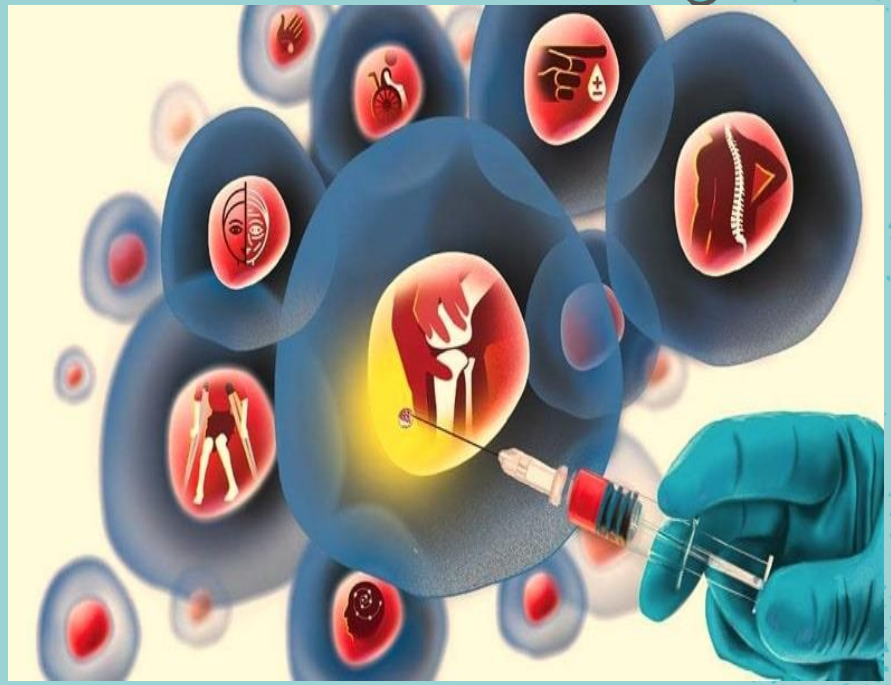
1. Embryonic Stem cells which are derived from a four- or five-day-old human embryo that is in the blastocyst phase of development.

2. Adult Stem Cells which are found in tissues such as the brain, bone marrow, blood, blood vessels, skeletal muscles, skin, liver and umbilical cord.



Stem Cell Applications

This could be for tissue repair for nerve, heart, muscle, organ, skin, treatment for Cancers and Autoimmune diseases such as diabetes, rheumatoid arthritis, multiple sclerosis.



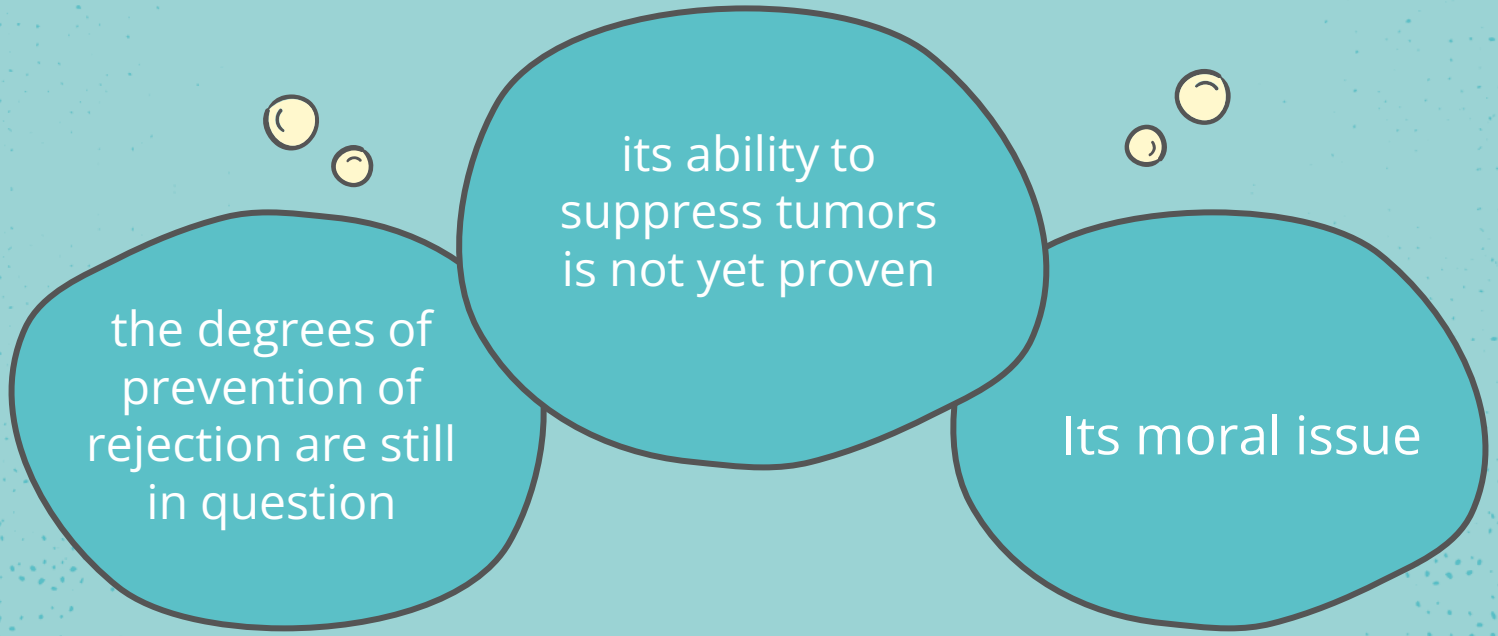
Technical Challenges

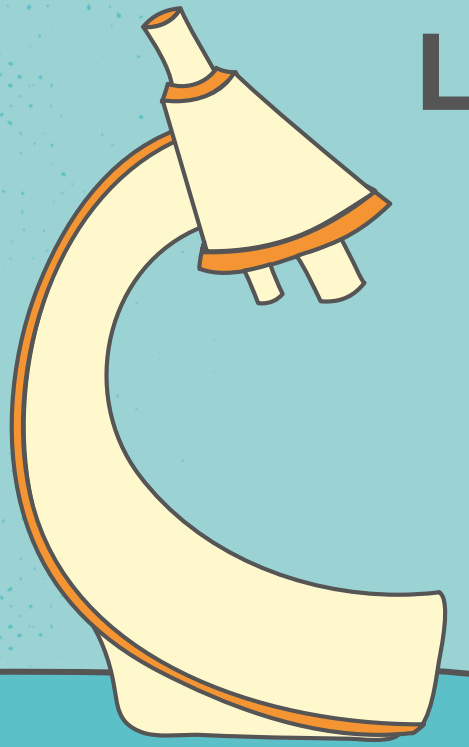
the source because cell lines may have mutations

the delivery to target areas could be lost since there may be hundreds of cells around

the carrier may be misled during the process

Technical Challenges





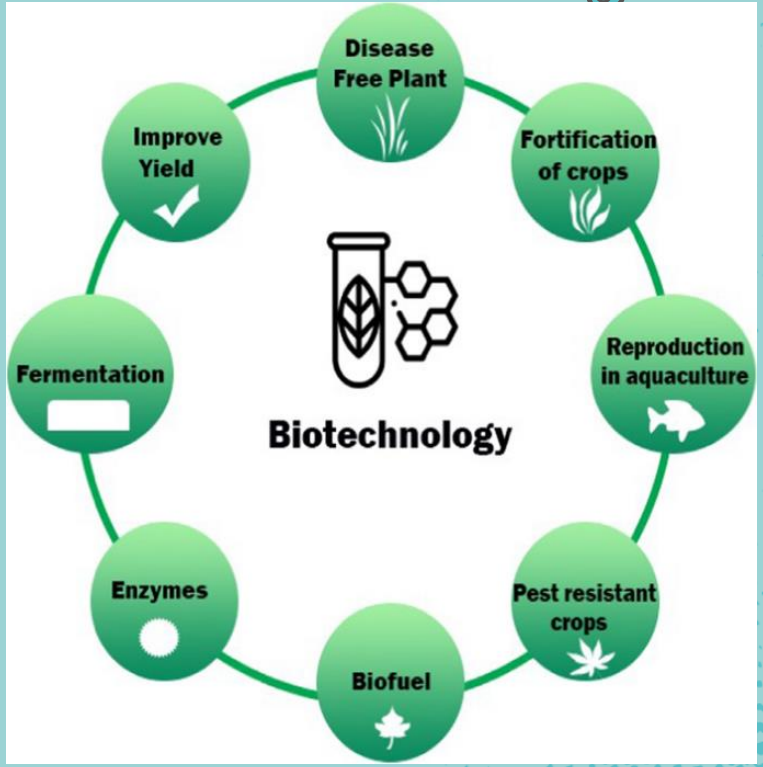
LESSON 2:

Genetically-Modified Organisms

Genetically-Modified Organisms

Biotechnology

- Use of biological systems, living organisms or derivatives thereof, to make or modify products or processes for a specific use



Genetically-Modified Organisms

Genetic engineering

- technique that allows genes and DNA to be transferred from one source to another, leading to the production of living modified organisms (LMOs) or genetically-modified organisms (GMOs)

Genetically-Modified Organisms

Genetically-Modified Organism (GMO)

- Plant, animal, microorganism, or other organism whose genetic makeup has been modified using recombinant DNA methods

Example of GMO

GMO	Description	Picture
Golden Rice	Rice modified with daffodil genes to have more beta-carotene, which the body converts to Vitamin A	
Flavr Savr Tomatoes	Tomatoes modified by the removal of genes responsible for the softening of fruit, meaning the tomatoes spoil more slowly	
Bt Corn	Corn modified with a bacterial insecticide gene so that it produces insect toxins within its cells, protecting it from pest species	
Aqua Advantage Salmon	Salmon modified with growth hormone regulating genes in order to grow to market sizes in significantly less time	
Glow in the Dark Animals	Animals modified with genes for fluorescent proteins will glow in the dark – this novel feature serves no practical purpose	

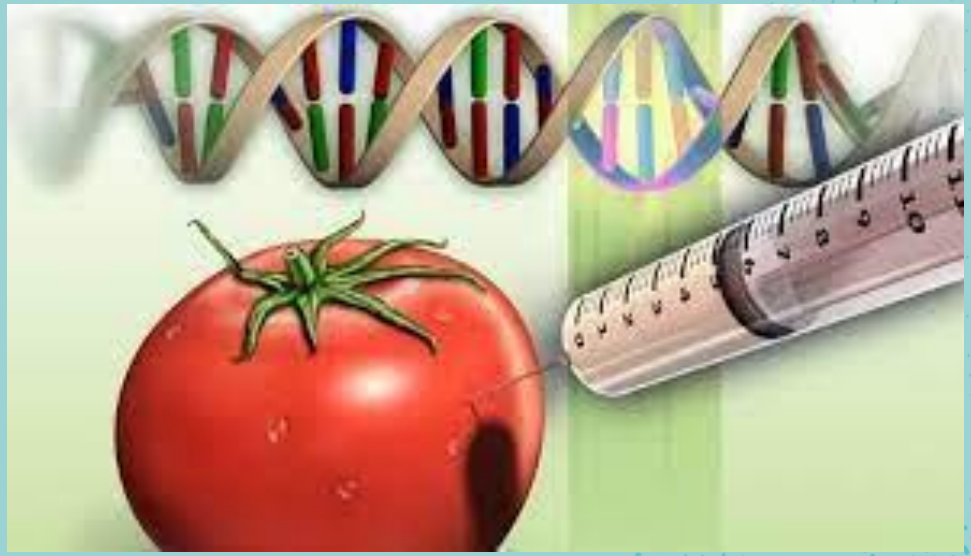
Benefits of GMO

1. Higher efficiency in farming
2. Increase in harvest
3. Control in fertility
4. Increase in food processing
5. Improvement of desirable characteristics
6. Nutritional and pharmaceutical enhancement

Potential Risks of GMO

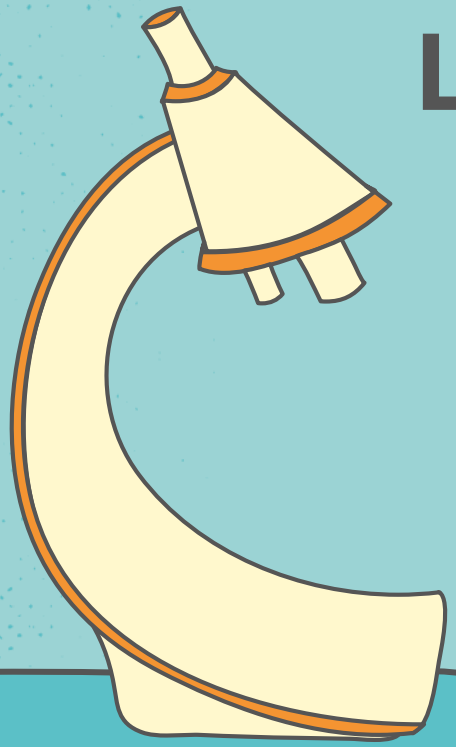
1. Inadequate studies on the effects of GMO to humans and the environment
2. Promotes mutation in organisms, which the long-term effects are still unknown
3. Human consumption might have the following effects:

- More allergic reactions
- Gene mutation
- Antibiotic resistance
- Change in nutritional value



“Take care of your body, it's the only place you have to live.”

—Jim Rohn

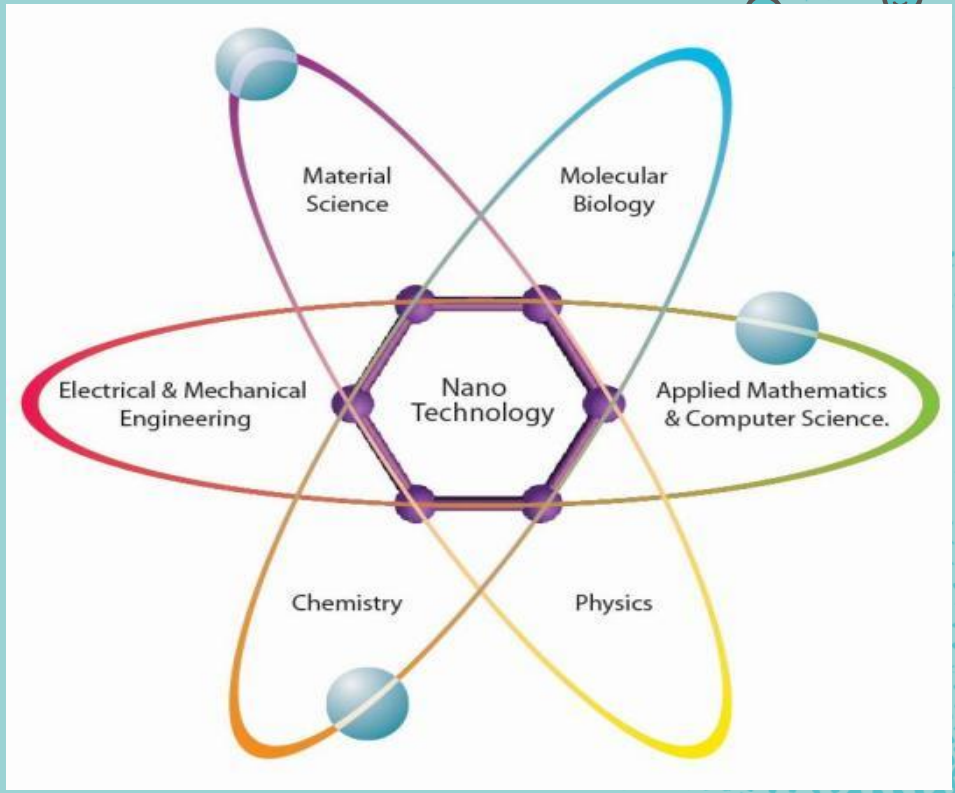


LESSON 3:

The Nano World

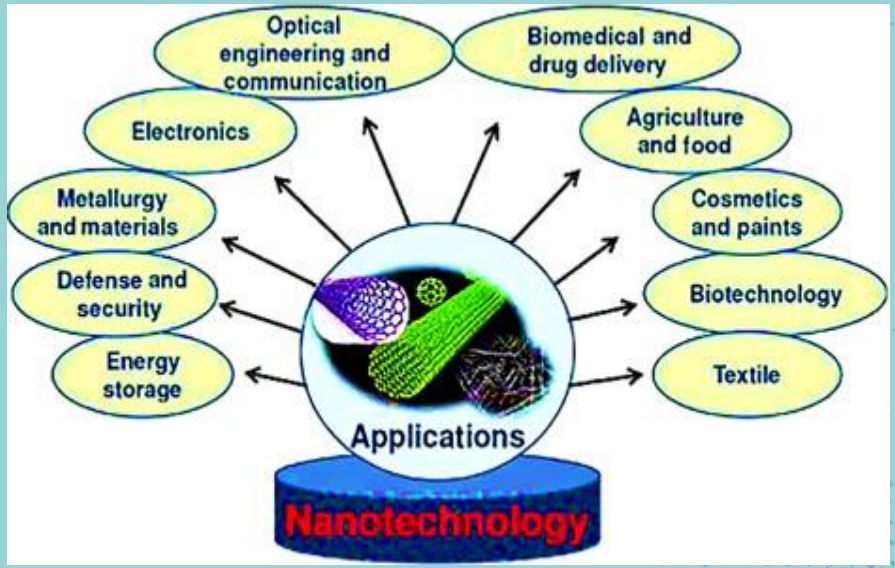
Nanotechnology

- refers to the branch of science and engineering devoted to designing, producing, and using structures, devices, and systems by manipulating atoms and molecules at nanoscale, i.e. having one or more dimensions of the order of 100 nanometres (100 millionth of a millimetre) or less
- size is about 1 to 100 nm (1 nm = 1 x 10^{-9}m)



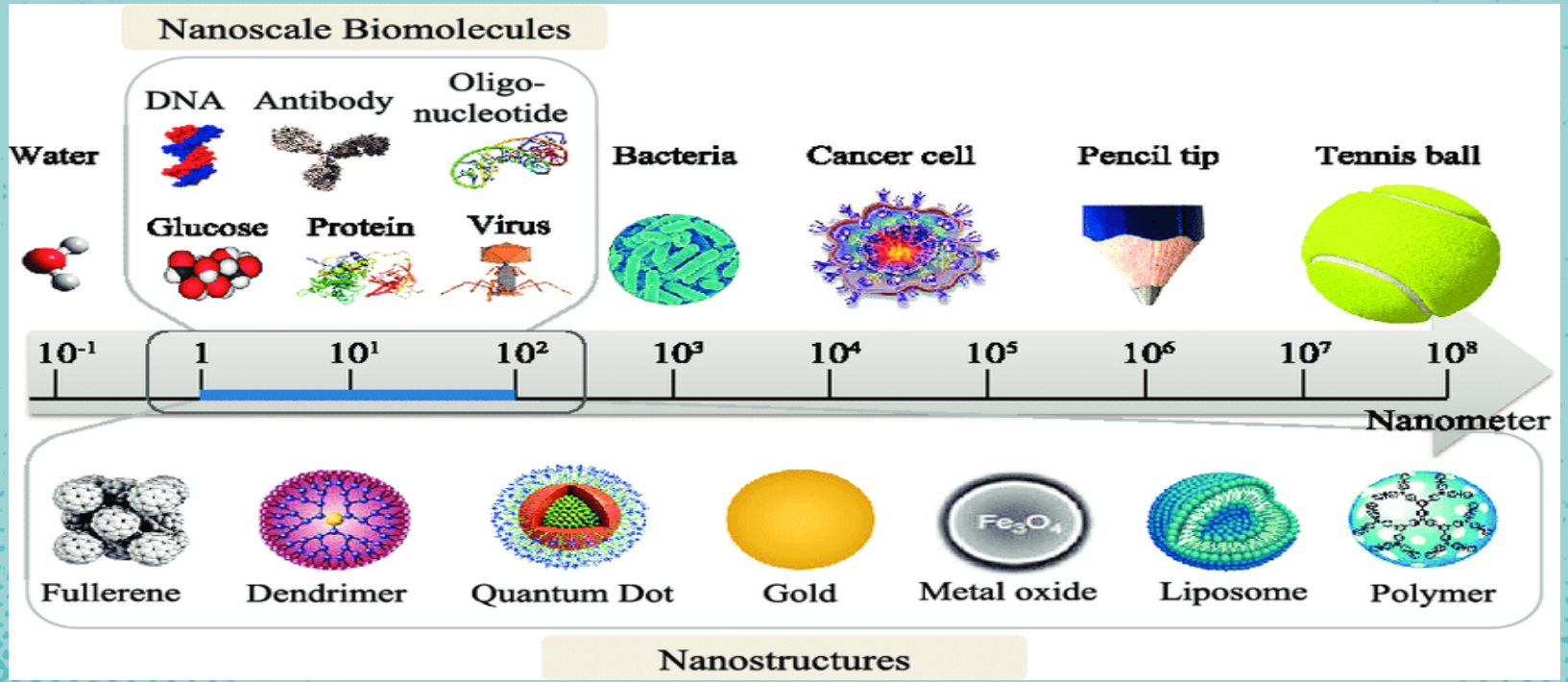
Nanotechnology

- its concept started in December 29, 1959 when Physicist **Richard Feynman** discussed a method in which scientist can direct and control individual atoms and molcules in hid talk "*There's Plenty of Room at the Bottom"* during the American Physical Society Meeting at the California Institute of Technology
- coined by **Prof. Norio Taniguchi**



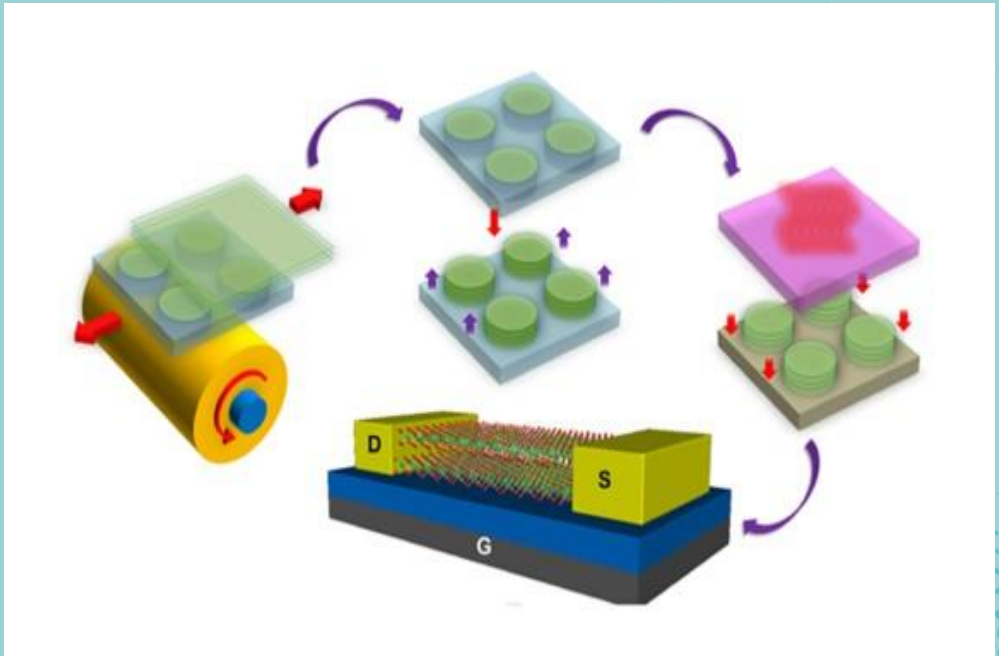
Nanoscale

- is the size range between approximately 1 and 100 nm.



Nanomanufacturing

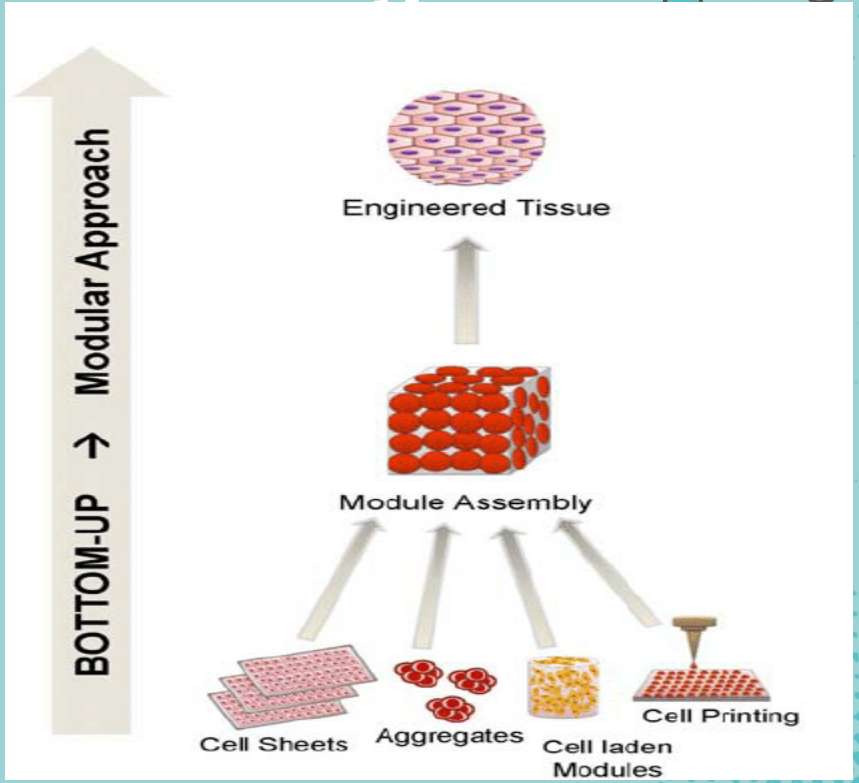
- refers to a scaled, reliable, and cost-effective manufacturing of nanoscale materials, structures, devices, and systems
- also involves research, improvement, and incorporation of processes for the construction of materials
- lead to the development of new products and improved materials



Two Fundamental Approaches of Nanomanufacturing:

1. Bottom-up Approach/Fabrication

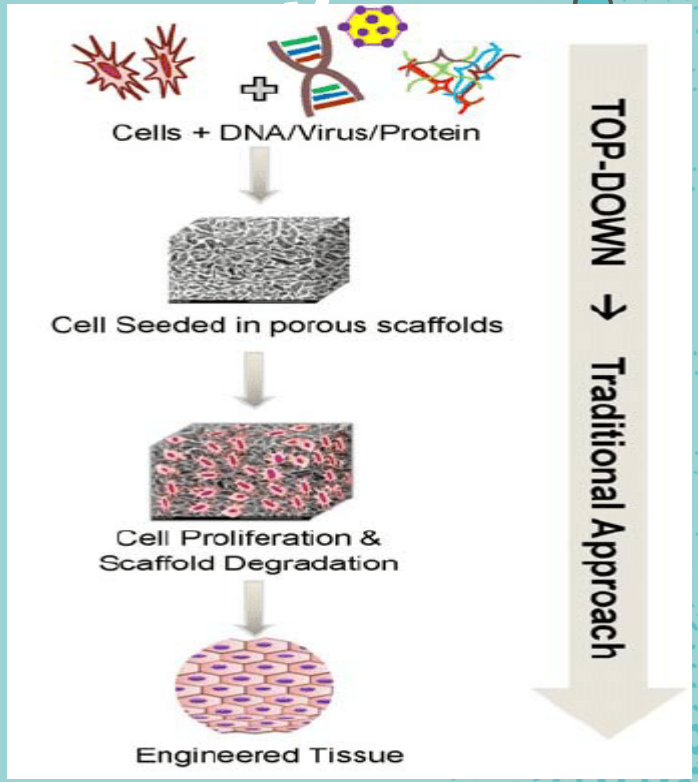
- are created by building them up from atomic- and molecular-scale components, which provides engineers with more building options.



Two Fundamental Approaches of Nanomanufacturing:

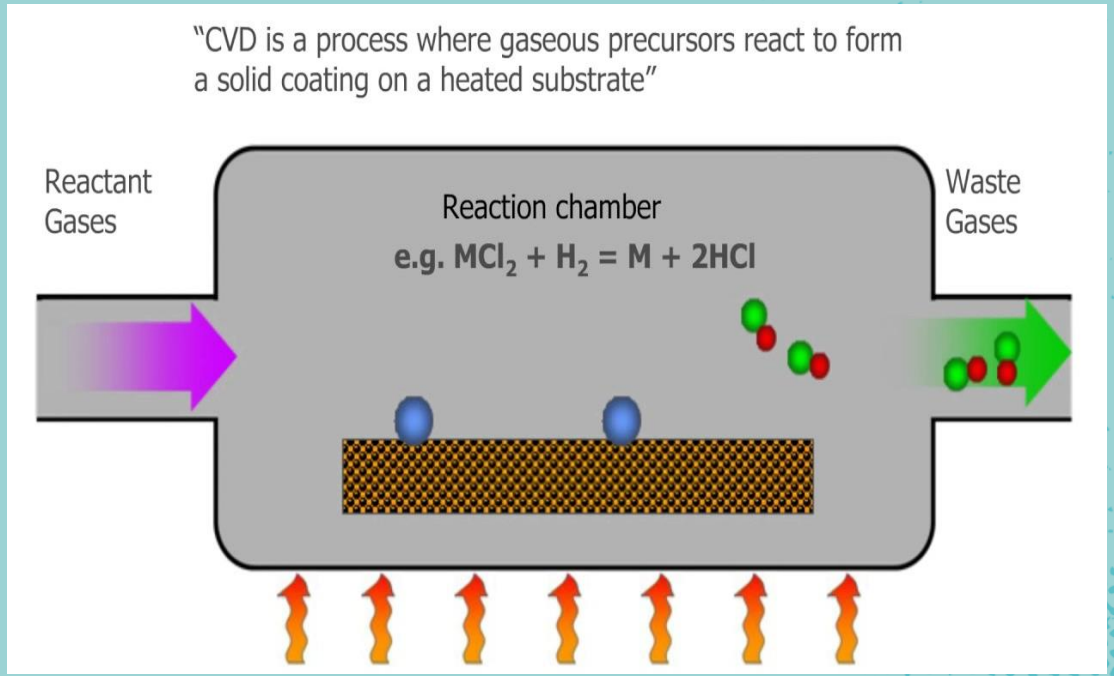
2. Top-down Approach/Fabrication

- starts with a block of original material and systematically carves it away, down to the final nanoscale product.



There are New Approaches to the Assembly of Nanomaterials these Includes:

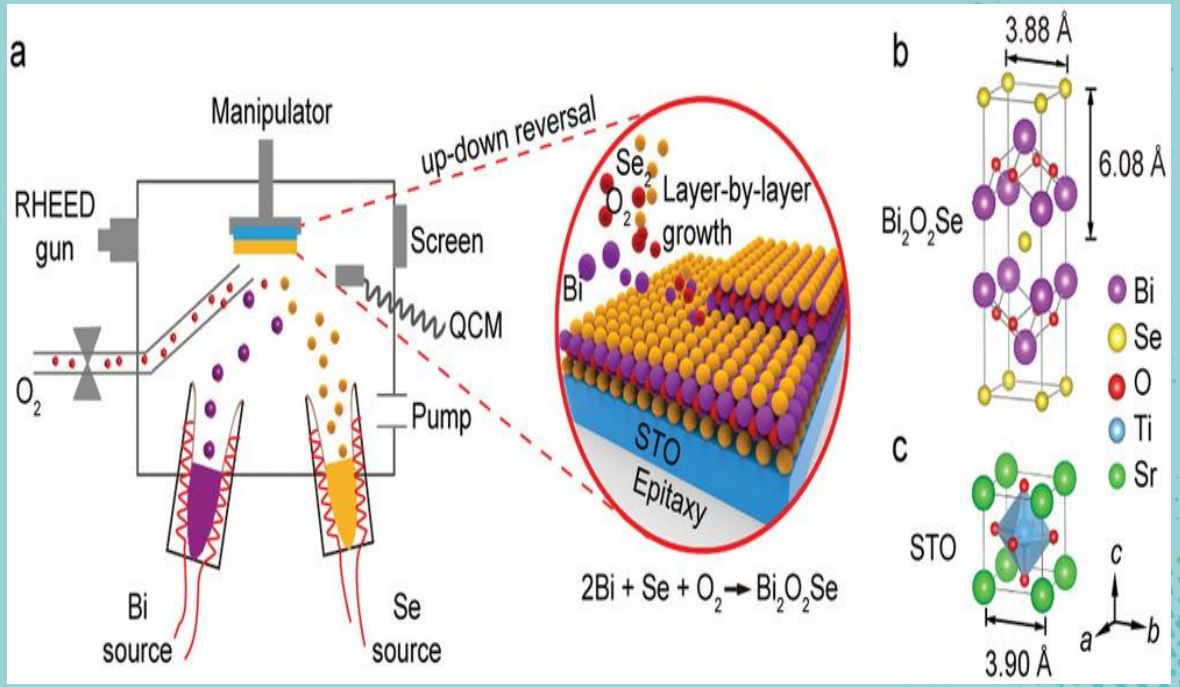
1. Chemical vapor deposition
   - ➢ chemicals are combined to react and produce very pure, high-performance films



There are New Approaches to the Assembly of Nanomaterials these Includes:

2. Molecular beam epitaxy

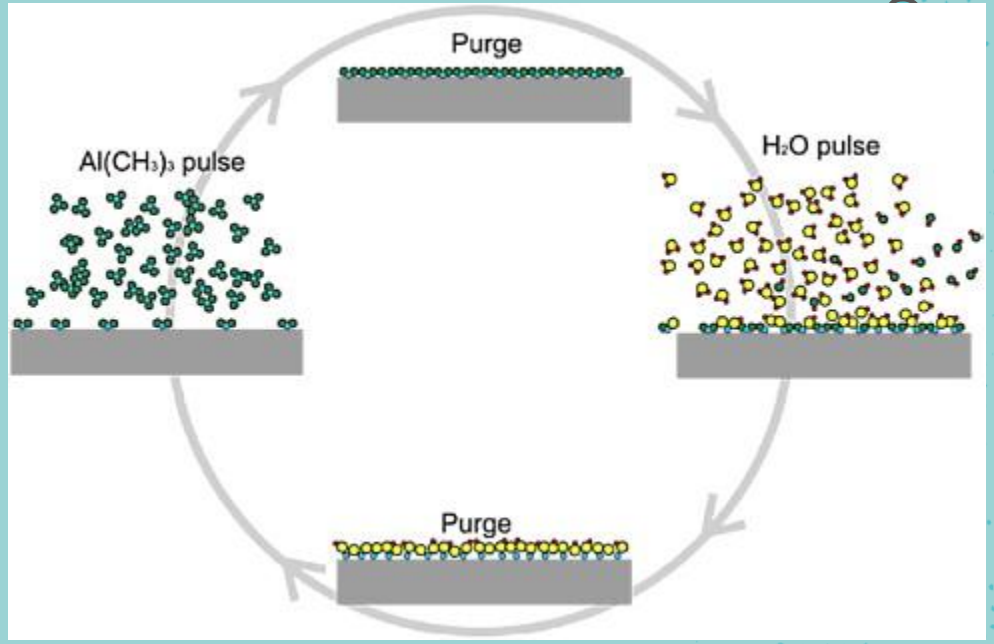
- a method of depositing single crystals, especially useful in semiconductor manufacturing



There are New Approaches to the Assembly of Nanomaterials these Includes:

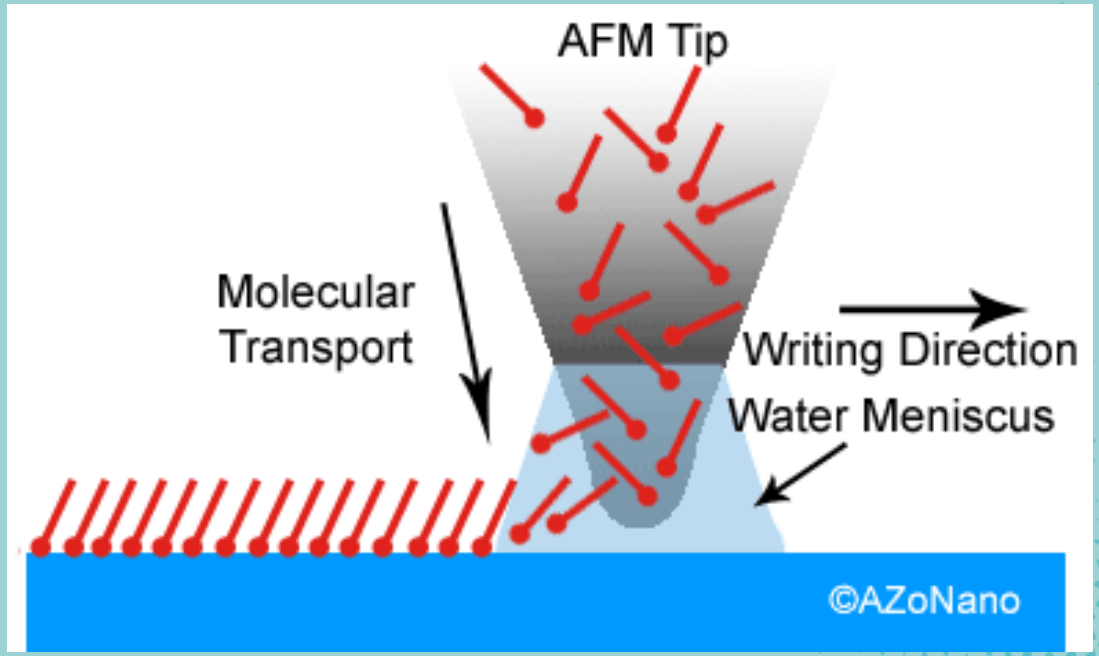
3. Atomic layer epitaxy

- a process for depositing one-atom-thick layers on a surface



There are New Approaches to the Assembly of Nanomaterials these Includes:

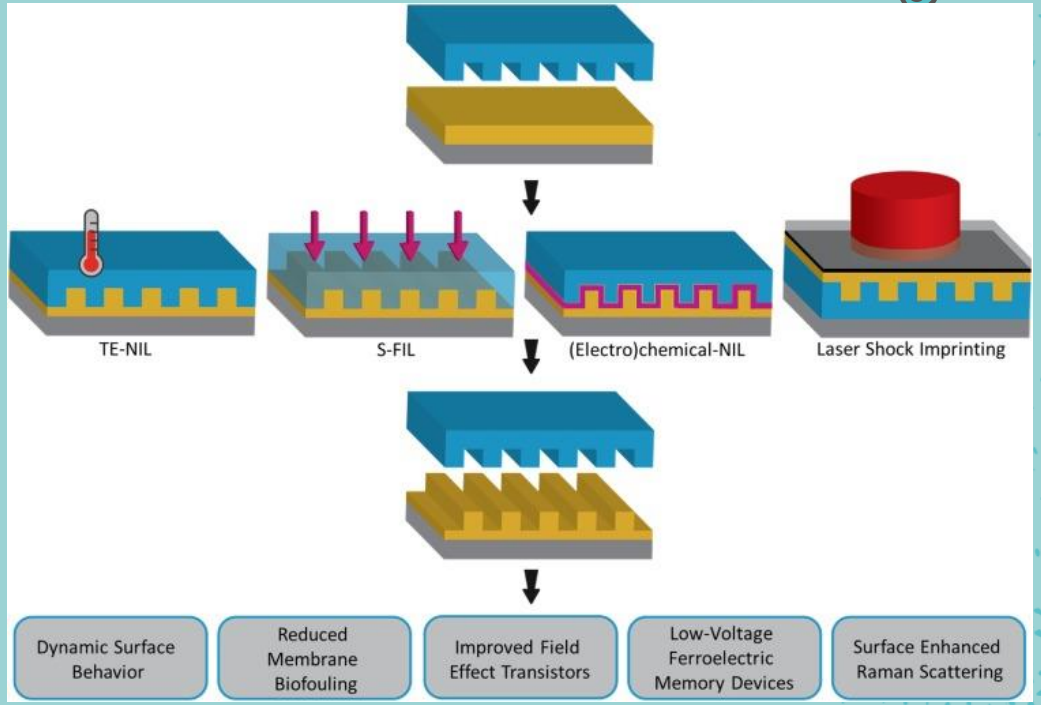
4. “Dip pen” lithography
   - dips the tip of an atomic force microscope into a chemical fluid, which then "writes" on a substrate surface



There are New Approaches to the Assembly of Nanomaterials these Includes:

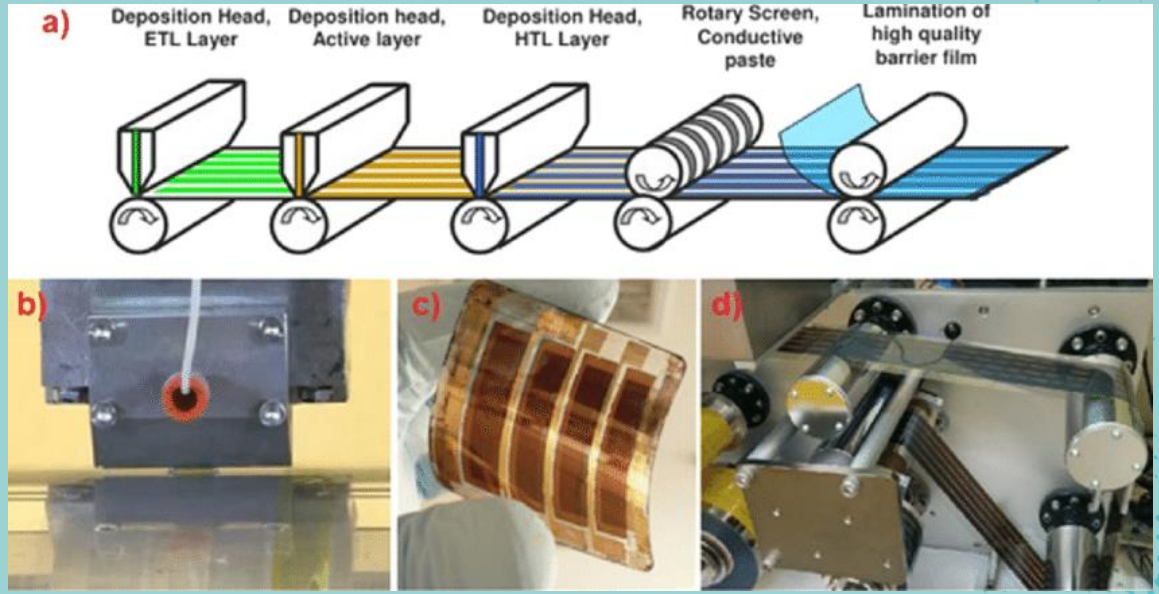
5. Nanoimprint lithography

- creates nanoscale features by stamping or printing them onto a surface



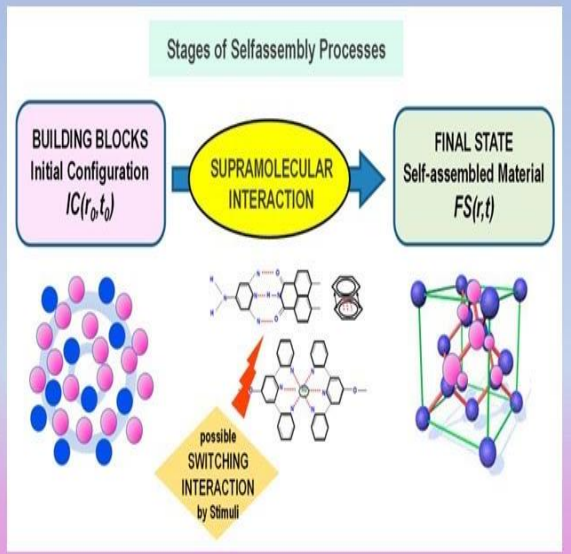
There are New Approaches to the Assembly of Nanomaterials these Includes:

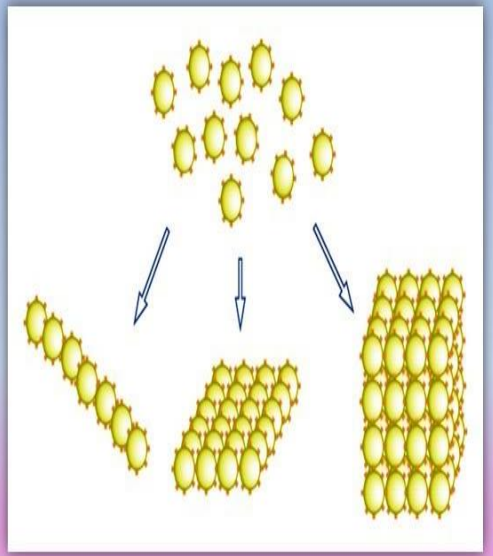
6. Roll-to-roll processing
   - ➢ produces nanoscale devices on a roll of ultrathin plastic or metal in high volumes



There are New Approaches to the Assembly of Nanomaterials these Includes:

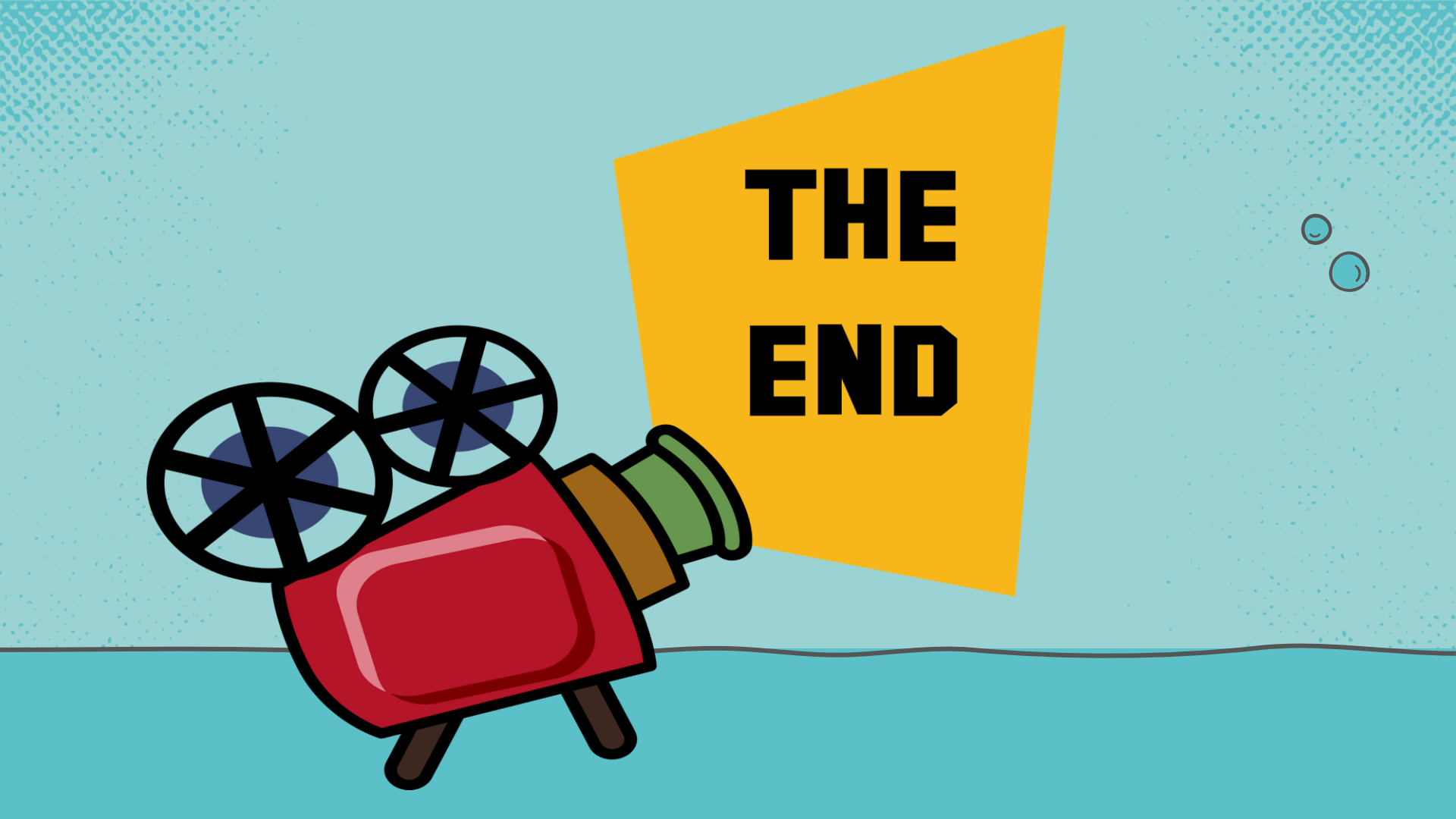
7. Self-assembly
- a process by which individual chemical or biological molecular structures group themselves together naturally to form an ordered structure, without outside direction





Benefit and Concern of the Application of NanoTechnology in Different Areas

Example of Areas Affected by Nanotechnology	Possible Benefits	Concerns
Environment	➢ improved detection and removal of contaminants ➢ development of benign industrial processes and materials	➢ high reactivity and toxicity ➢ pervasive distribution in the environment ➢ no nano-specific EPA regulation
Health	➢ improved medicine	➢ ability to cross cell membranes and translocate in the body ➢ no FDA approval needed for cosmetics or supplements
Economy	➢ better products ➢ new jobs	➢ redistribution of wealth ➢ potential cost of cleanups and healthcare ➢ accessibility to all income levels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