ENVIRONMENTAL STUDIES & LIFE SCIENCES

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Basic Concepts of Ecosystems

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Ecology

- The meaning of the word ecology was given by German Biologist Ernst Haeckel in 1869.
- The term ‘Ecology’ was derived from two Greek words, OIKOS (means house) and LOGUS (means study of) to denote the relationship between the organisms and their environment.
- **Definition:** The living community of plants and animals in any area together with the non-living components of the environment such as soil, air and water, constitute the ecosystem.

Concept of an Ecosystem

- Ecosystems are divided into terrestrial or land based ecosystems, and aquatic ecosystems in water.
- These form the two major habitat conditions for the Earth's living organisms:
    - At a global level the thin skin of the earth on the land, the sea and the air, forms the biosphere.
    - At a sub-global level, this is divided into biogeographical realms

Concept of an Ecosystem

At a national or state level, this forms biogeographic regions.

Eg. There are several distinctive geographical regions in India- the Himalayas, the Gangetic Plains, the Highlands of Central India, he Western and Eastern Ghats, the semi-arid desert in the West, the Deccan Plateau, the Coastal Belts, and the Andaman and Nicobar Islands.

https://www.iucn.org/news/india/202003/iucn-himalayan-adaptation-network

Concept of an Ecosystem

At an even more local level, each area has several structurally and functionally identifiable ecosystems such as different types of forests, grasslands, river catchments, mangrove swamps in deltas, seashores, islands, etc.

https://www.unenvironment.org/explore-topics/resource-efficiency/what-we-do/cities/biodiversity-and-ecosystems

Classification of Ecology

Based on study area:

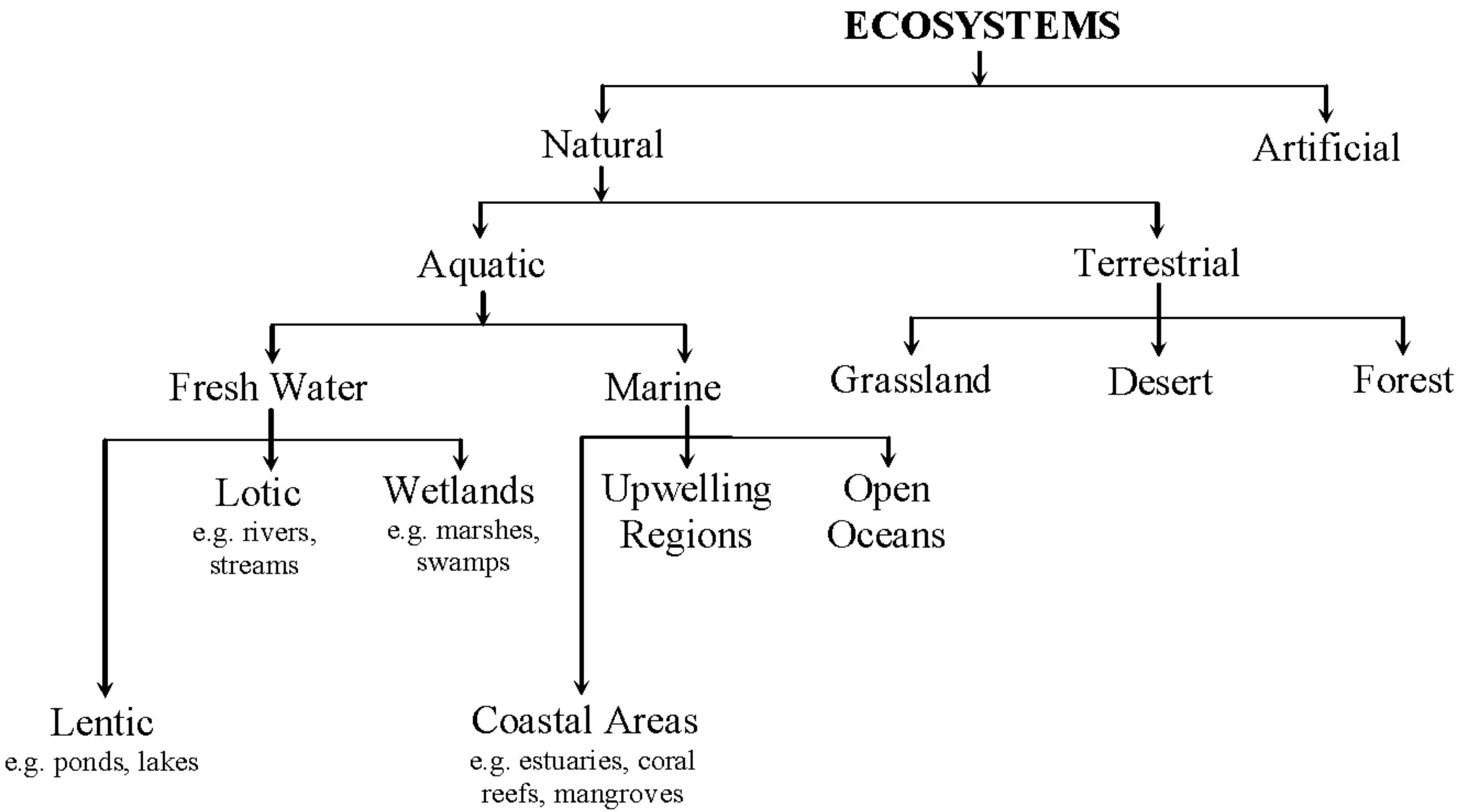
1. Autecology : It deals with the study of an individual species of organisms and it's population. It is also called the Species ecology.
2. Synecology : It deals with the study of communities, their composition, their behaviour and relation with the environment. It is further divided into 3 types:
    a) Population Ecology
    b) Community Ecology
    c) Ecosystem Ecology

Classification of Ecology

Autecology	Synecology
It is the study of individual organism or individual species or a population in relation to their environment	It is the study of group of organisms or many species or communities in relation to their environment
It is also called as population ecology	It is also called as community ecology
The study is at the level of an individual, a population or an entire species	Synecology is concerned with study of the highest level of biological organization; many populations in an area (called as community) interacting with each other and also with the environment. It can even be the study of an ecosystem
Autecology is comparatively simple experimental and inductive.	Synecology is complex, philosophical and deductive. (Refer: Inductive vs Deductive)
Autecology studies can be accommodated in a laboratory setup and data is interpreted using conventional mathematical tools**	Synecology studies refers to the interaction of a whole system and that cannot be accommodated in a laboratory setup as the system is naturally formed after interactions of hundreds of years such as a forest ecosystem
Example: Study of Zebra population in relation to its environment (may be factors like rainfall, hunting, lion population etc in a grassland ecosystem) see the figure (in dotted black lines)	Example: Study of entire grassland ecosystem (including all the species or communities) see the figure (in green thick border)

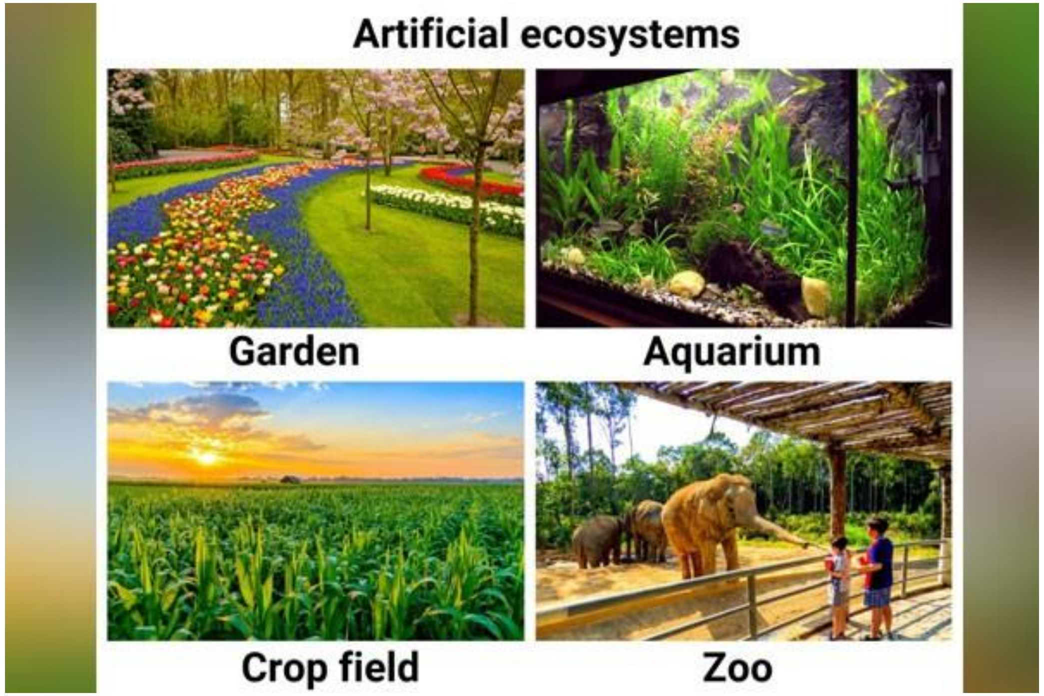
https://www.majordifferences.com/2016/08/difference-between-autecology-and-synecology.html#.X-A7H9gzbIU

Types of Ecosystem



Types of Ecosystem

- **Artificial (Man Engineered) Ecosystems:** These are maintained artificially by man where by addition of energy and planned manipulation, natural balance is disturbed regularly e.g., crop land ecosystem.



Ecosystem Degradation

- Ecosystems are however frequently disrupted by human actions which lead to the extinction of species of plants and animals.
- Extinction occurs due to changes in land use, pollution from industry in urban areas. Forests are deforested for timber, wetlands are drained to create more agricultural land and semi arid grasslands that are used as pastures are changed into irrigated fields.
- Some species if eliminated seriously affect the ecosystem. These are called ‘Keystone species’.

Ecosystem Degradation

- In the 1960s, renowned ecologist Robert Paine disrupted a patch of Washington State coastline—and made a huge environmental breakthrough.
- In an effort to understand the food web in a tidal ecosystem in Makaw Bay, he removed all of a single starfish species in one area.
- Rapidly the entire ecosystem changed, leading him to the realization that certain species play outsize roles in the overall structure and function of their environment.

Ecosystem Degradation

- While some creatures exert little influence on their ecosystem, others can topple a whole community of plants and animals with their absence.
- Paine coined a term for these critical organisms: keystone species.
- They are nearly always a critical component of the local food web. One of the defining characteristics of a keystone species is that it fills a critical ecological role that no other species can.

- EXAMPLES OF KEYSTONE SPECIES:
- Star fish- By keeping populations of mussels and barnacles in check, this sea star helps ensure healthy populations of seaweeds and the communities that feed on them.
- Sea otters- Role as a top predator in the nearshore marine ecosystem.
- Beavers- Builds well-maintained dams. These dams turn small streams into ponds and lakes which provide excellent areas for other animals to use and thrive.

Ecosystem Degradation

- Wolves- By regulating prey populations, wolves enable many other species of plants and animals to flourish.
- Bees- It is predicted that if honey bees disappear, more than 50% of plant species will become extinct. Honey bees do not only produce cross-pollination which assists with genetic diversity of plants and possibly other animal species and accordingly biodiversity relates to healthy ecosystems.

- Humming birds- Key agents of pollination and by doing so, aid in the growth and spread of certain plant species.
- American alligators- high level predators, it modifies their surroundings by their food consumption alone.
- Tiger sharks- control the populations of primary consumers, it is a top predator in the ocean.

Functional aspects

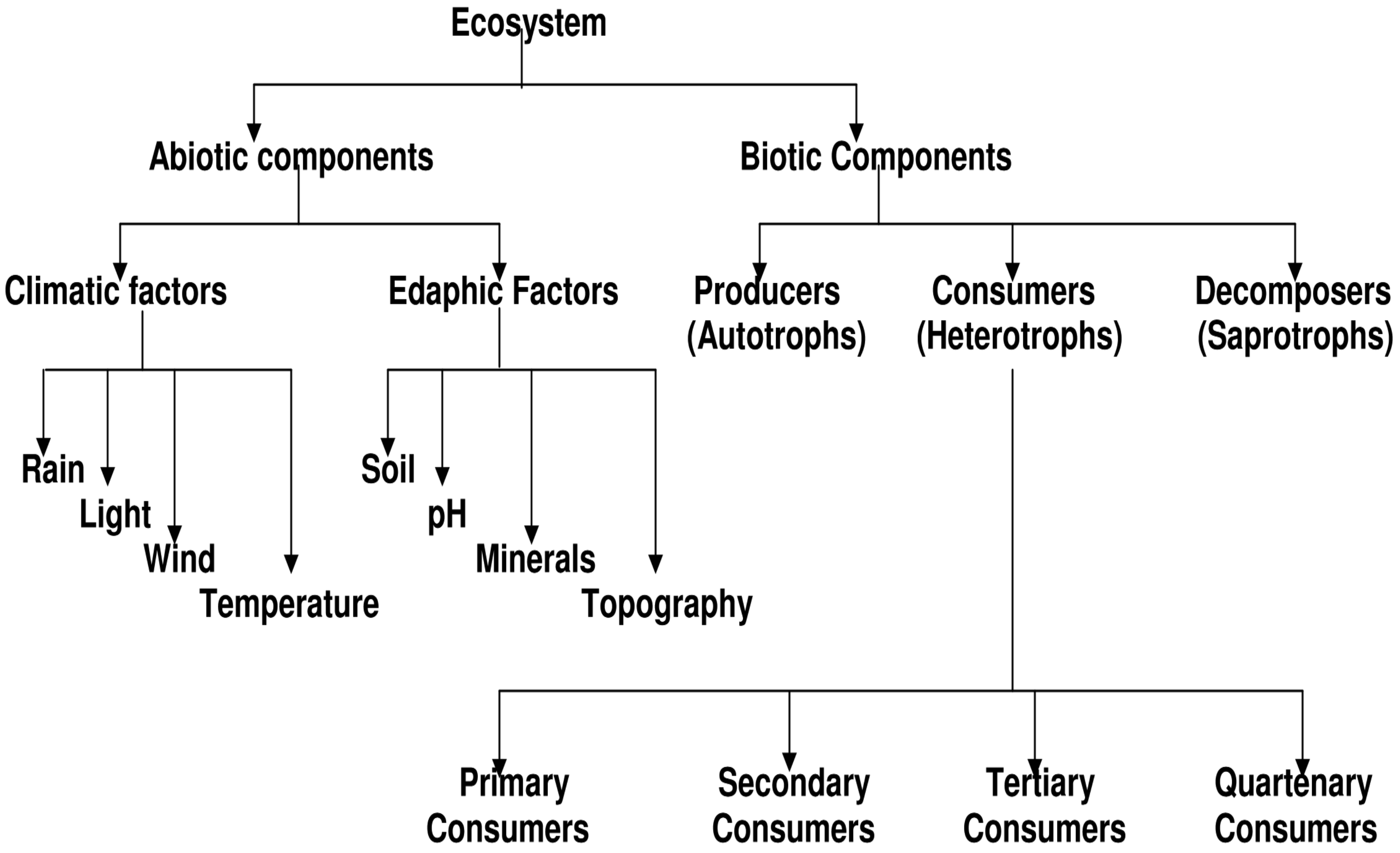
- The non-living components of an ecosystem are the amount of water, the various inorganic and organic compounds, and climatic conditions such as rainfall and temperature, which depend on geographical conditions and location which is also related to the amount of sunlight.
- The living organisms in an ecosystem are inseparable from their habitat.

Structural aspects

Components that make up the structural aspects of an ecosystem include:

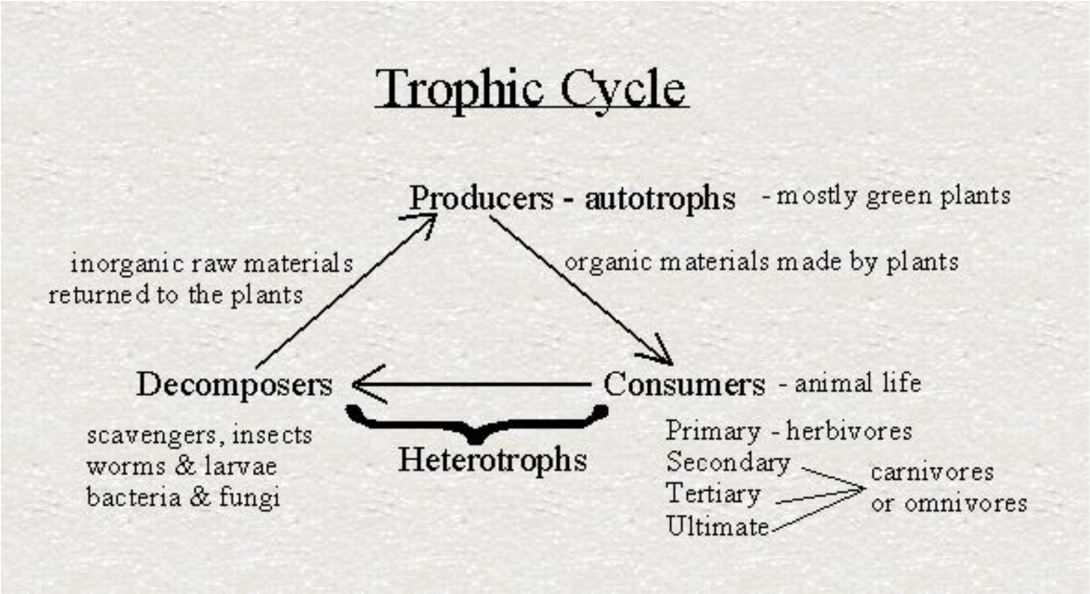
1) **Inorganic aspects** – C, N, CO_2, H_2O
2) **Organic compounds** – Protein, Carbohydrates, Lipids – link abiotic to biotic aspects.
3) **Climatic regimes** – Temperature, Moisture, Light & Topography.
4) **Producers** – Plants.
5) **Macro consumers** – Phagotrophs – Large animals.
6) **Micro consumers** – Saprotrophs, absorbers– fungi.

Components of Ecosystem



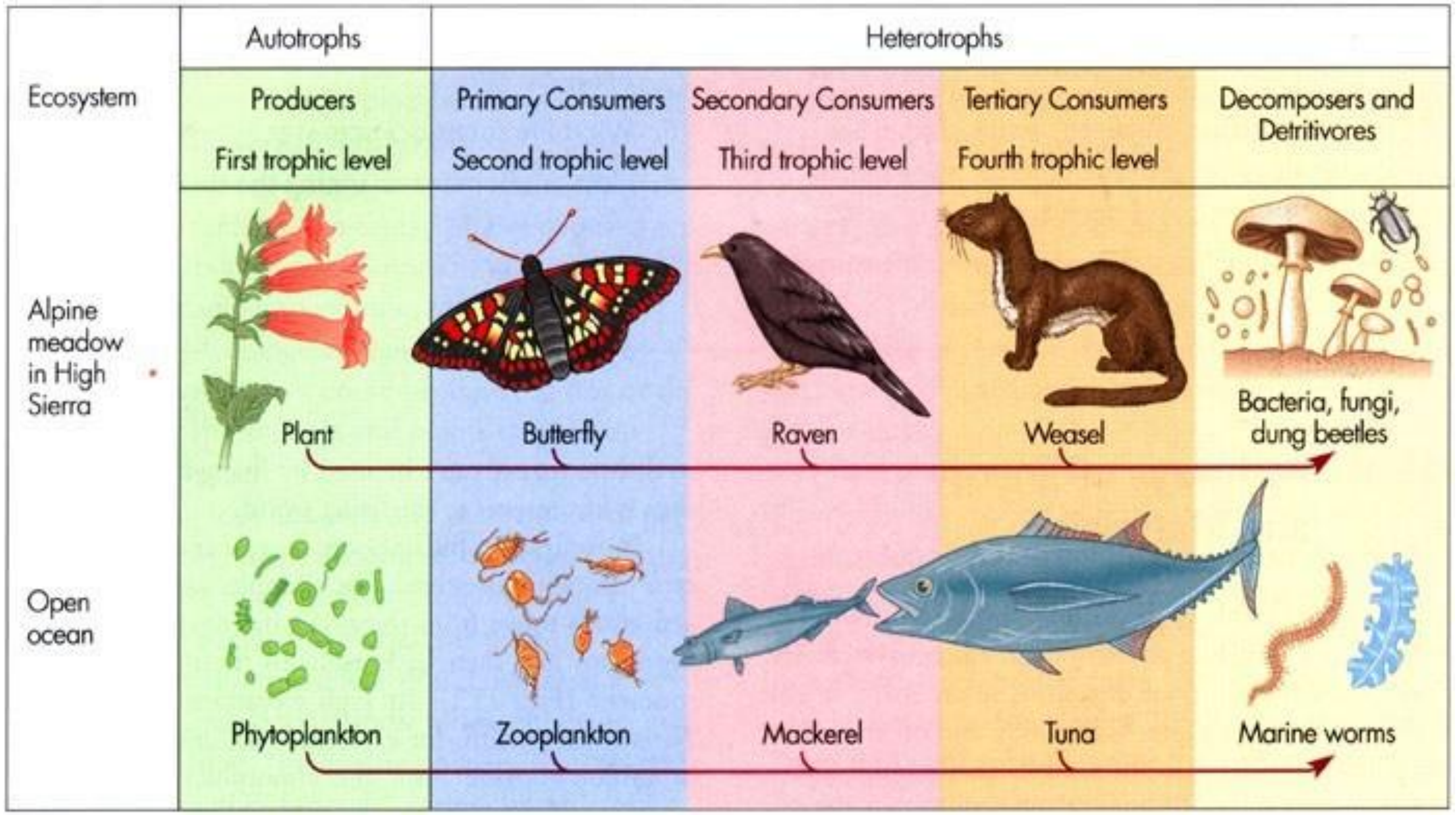
Producers, Consumers & Decomposers

- Every living organism is in some way dependent on other organisms.
- Plants are food for herbivorous animals which are in turn food for carnivorous animals.
- Thus there are different trophic levels in the ecosystem.
- Some organisms such as fungi live only on dead material and inorganic matter.



Food Chain

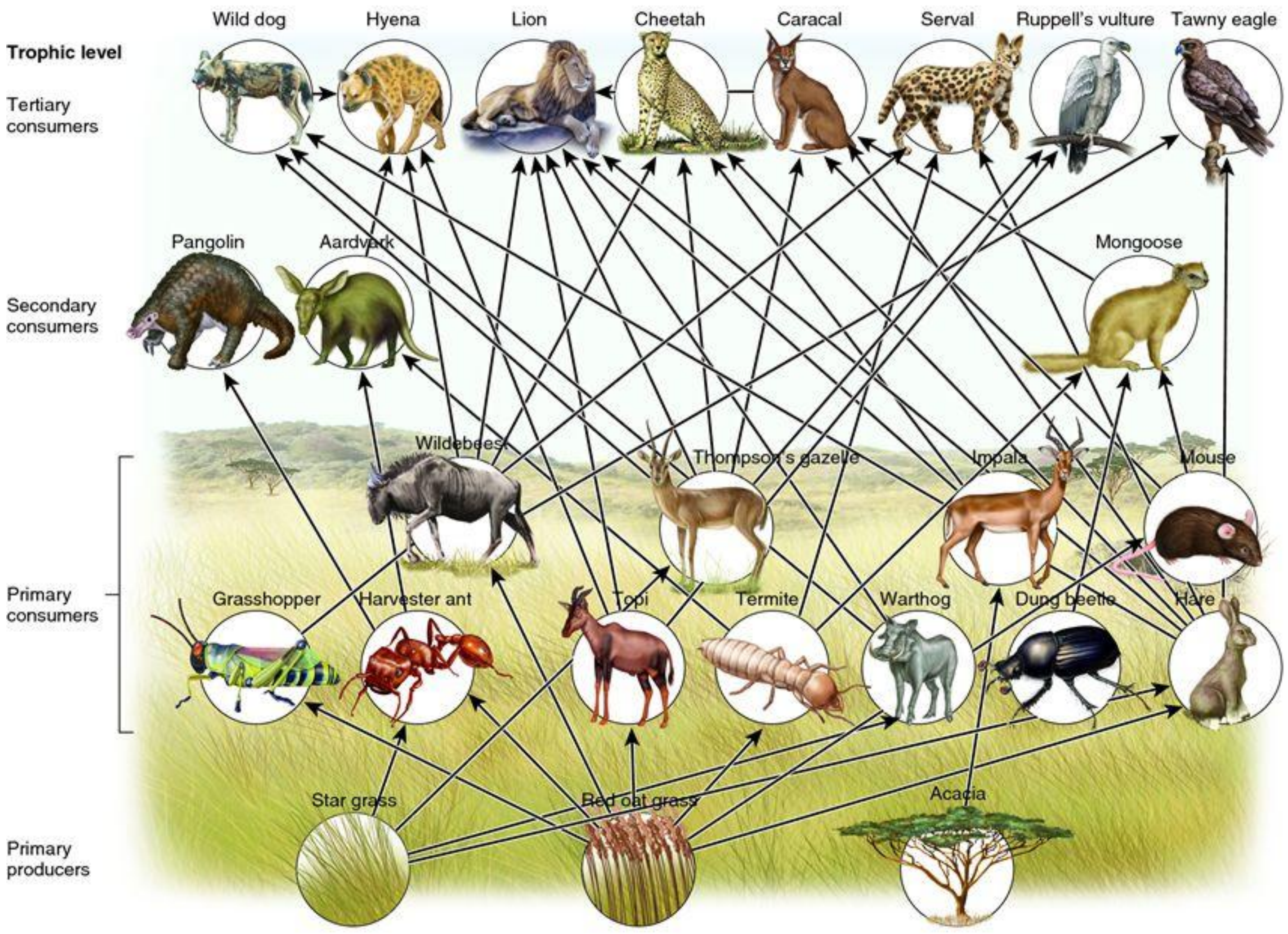
- A **food chain** is the sequence of who eats whom in a biological community (an ecosystem) to obtain nutrition.



Food Web

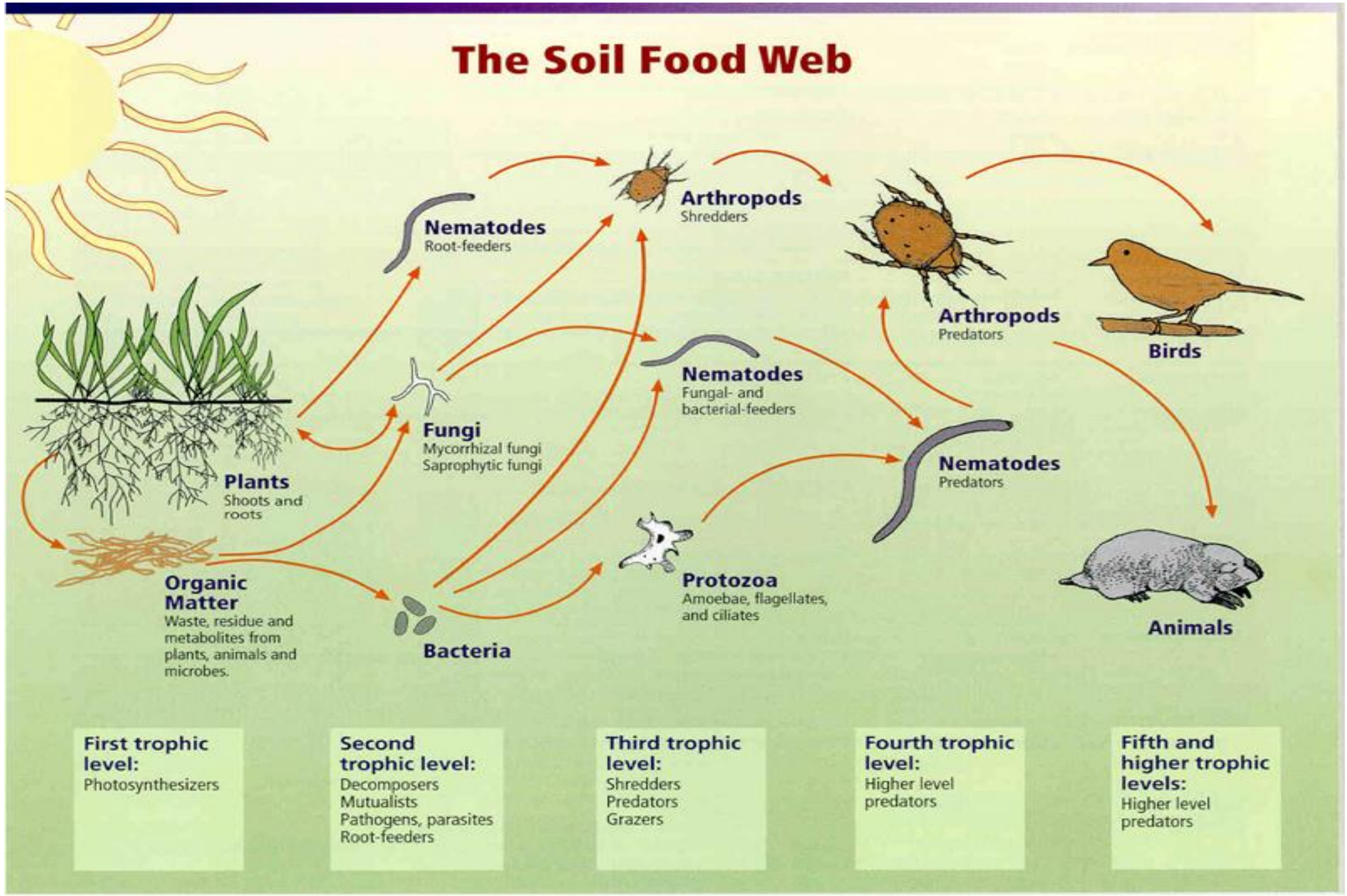
- A **food web** (or **food cycle**) depicts feeding connections (what-eats-what) in an ecological community and hence is also referred to as a consumer- resource system.
- The food web is a simplified illustration of the various methods of feeding that links an ecosystem into a unified system of exchange.
- Various food chains are often interlinked at different trophic levels to form a complex interaction between different species from the point of view of food.
- Food Web provides more than one alternatives of food to most of the organisms in an ecosystem and thus increases their chances of survival.

Food Web



https://savannabiomeassignment.weebly.com/food-web.html

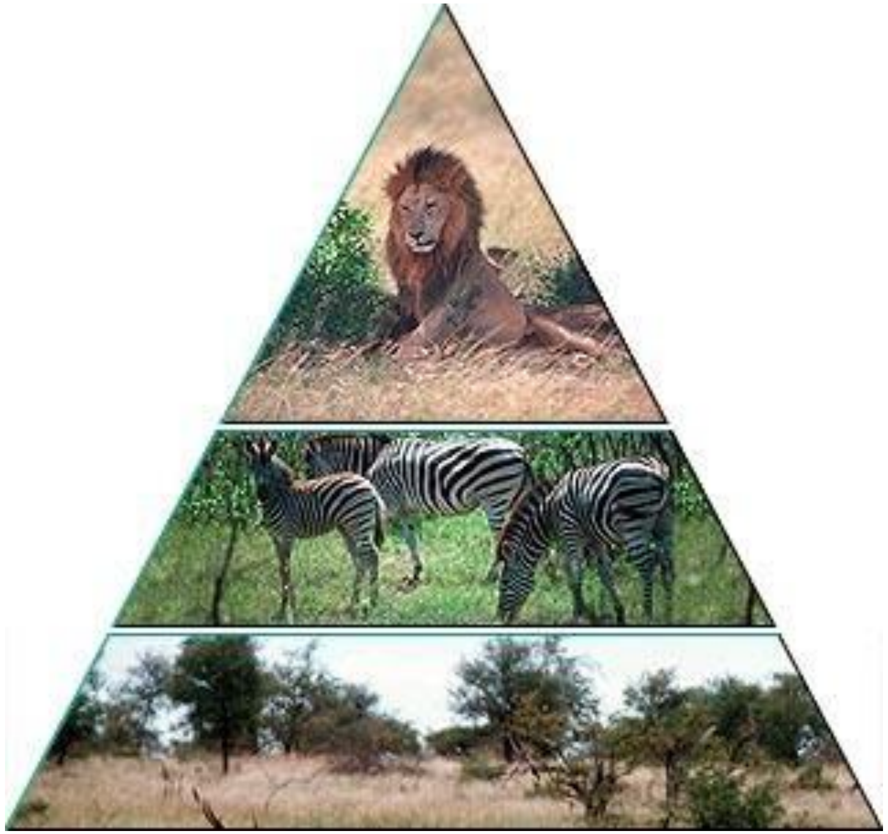
Food Web



Relationships between soil food web, plants, organic matter, and birds and mammals
Image courtesy of USDA Natural Resources Conservation Service
http://soils.usda.gov/sqi/soil_quality/soil_biology/soil_food_web.html.

Ecological Pyramids

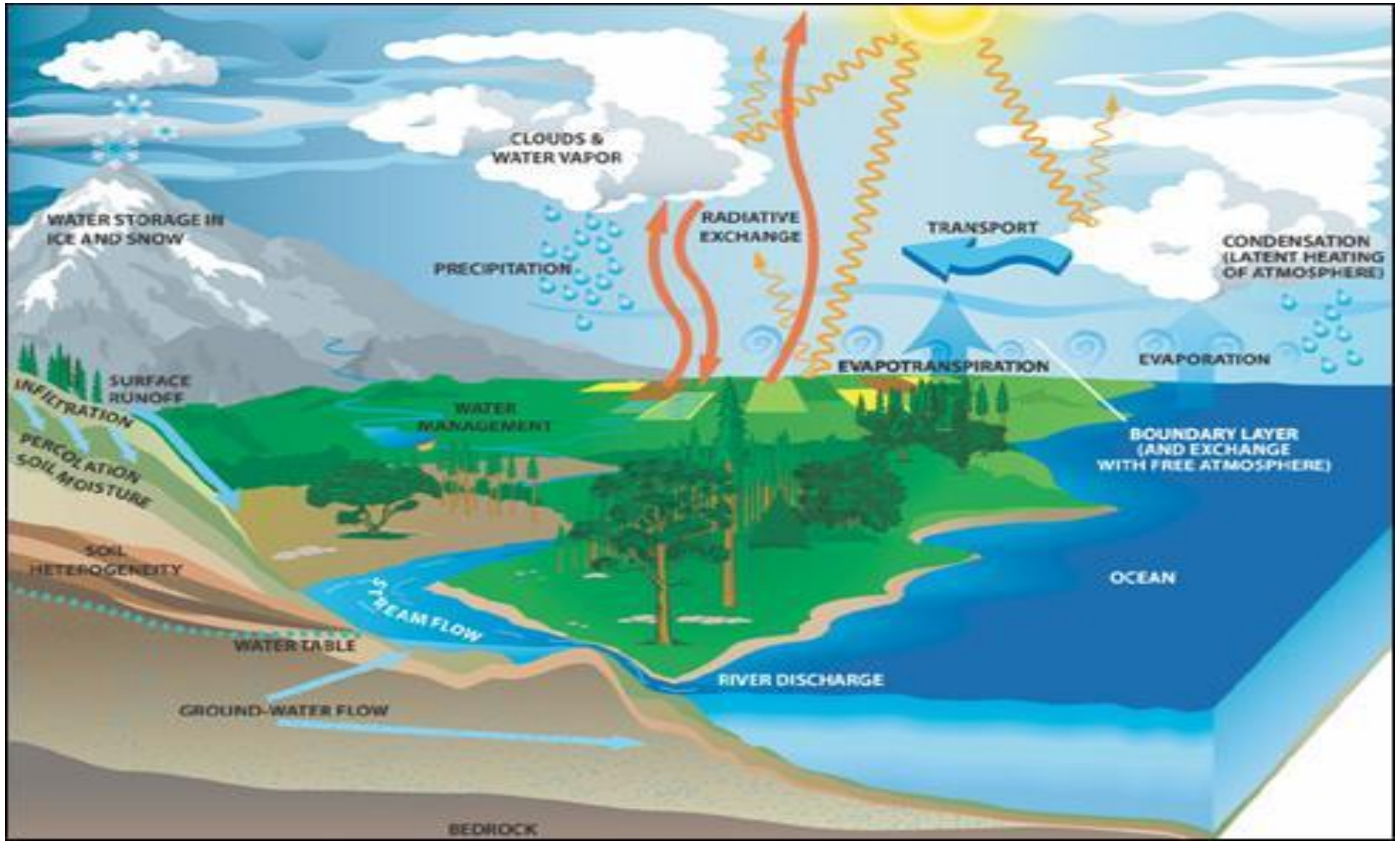
- Graphical representation of trophic structure & functioning of ecosystem starting with producers at the base & successive trophic levels forming the apex



https://www.ugc.ac.in/oldpdf/modelcurriculum/env.pdf

Energy flow in the Ecosystem

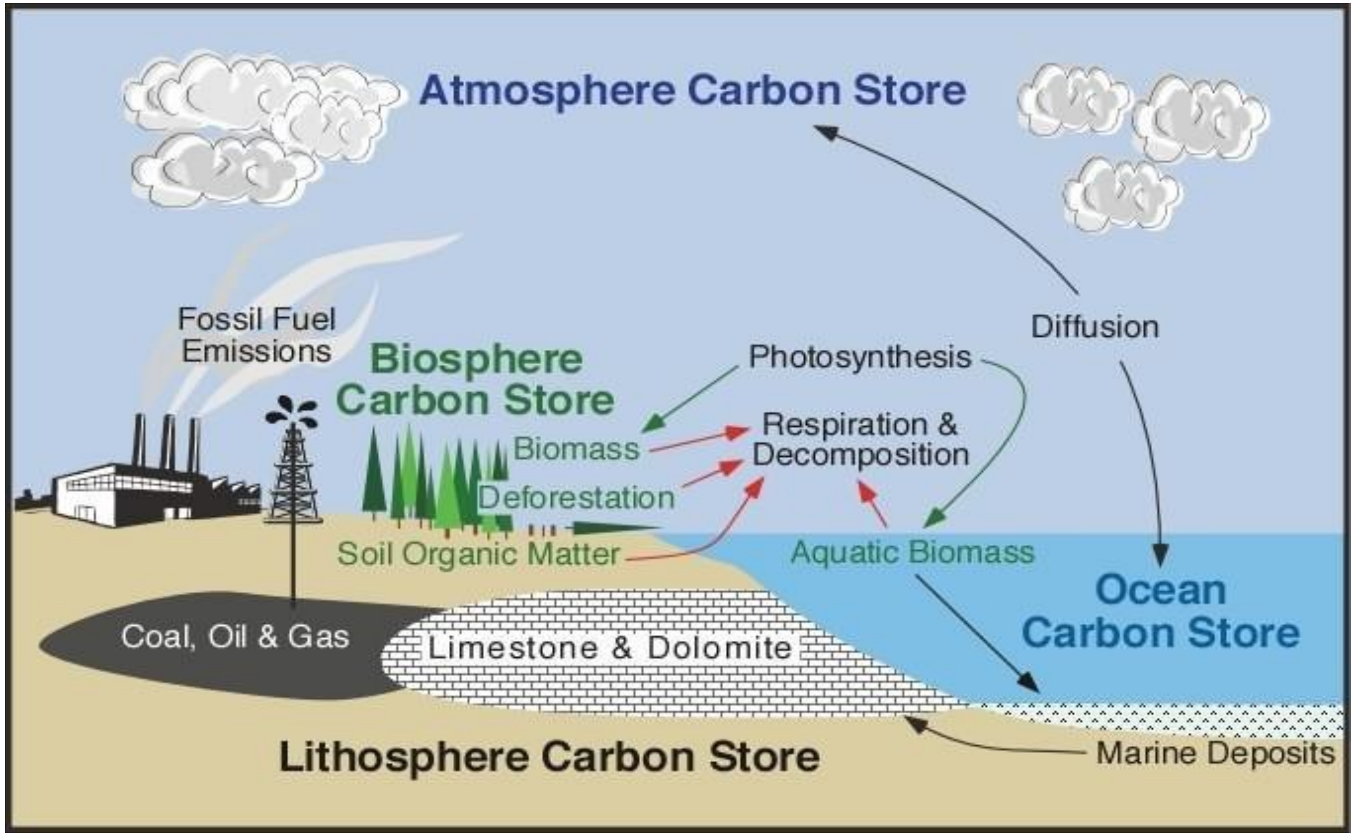
Every ecosystem has several interrelated mechanisms that affect human life. These are the water cycle, the carbon cycle, the oxygen cycle, the nitrogen cycle and the energy cycle.



https://science.nasa.gov/earth-science/oceanography/ocean-earth-system/ocean-water-cycle

Carbon cycle

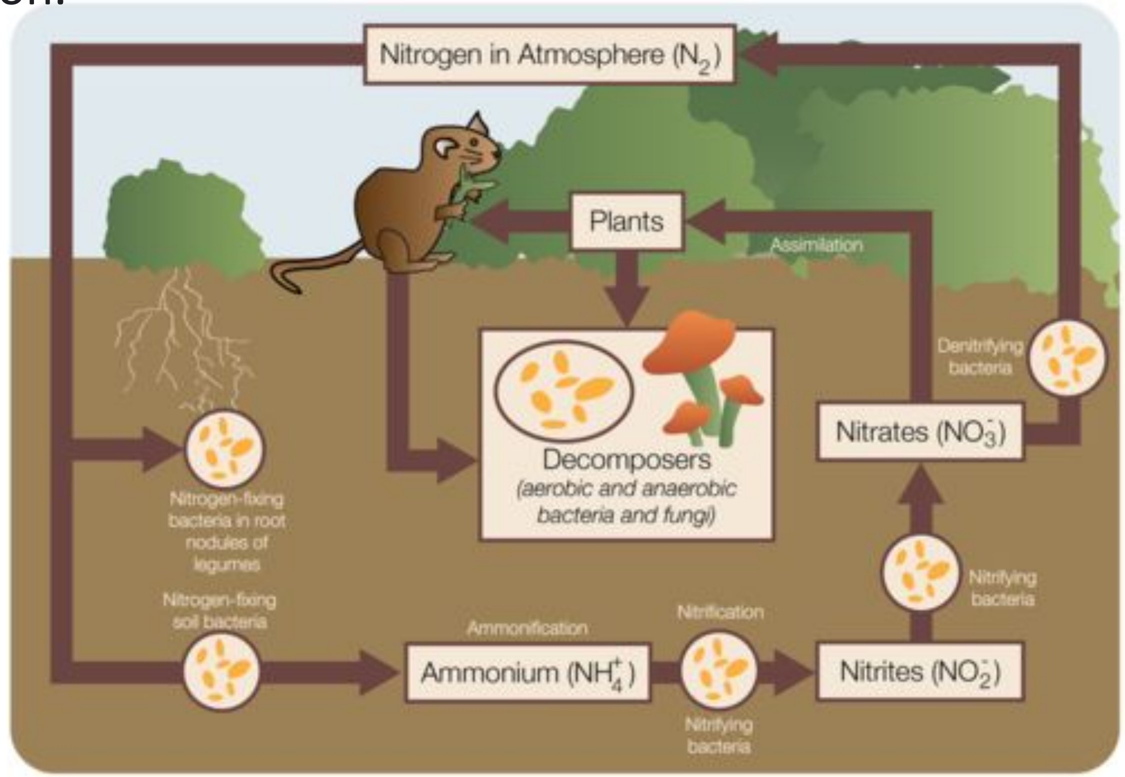
The **carbon cycle** is the biogeochemical cycle by which carbon is exchanged among the biosphere, pedosphere, geosphere, hydrosphere, and atmosphere of the Earth.



http://www.calforestfoundation.org/materials/the-carbon-cycle-diagramdownload-only

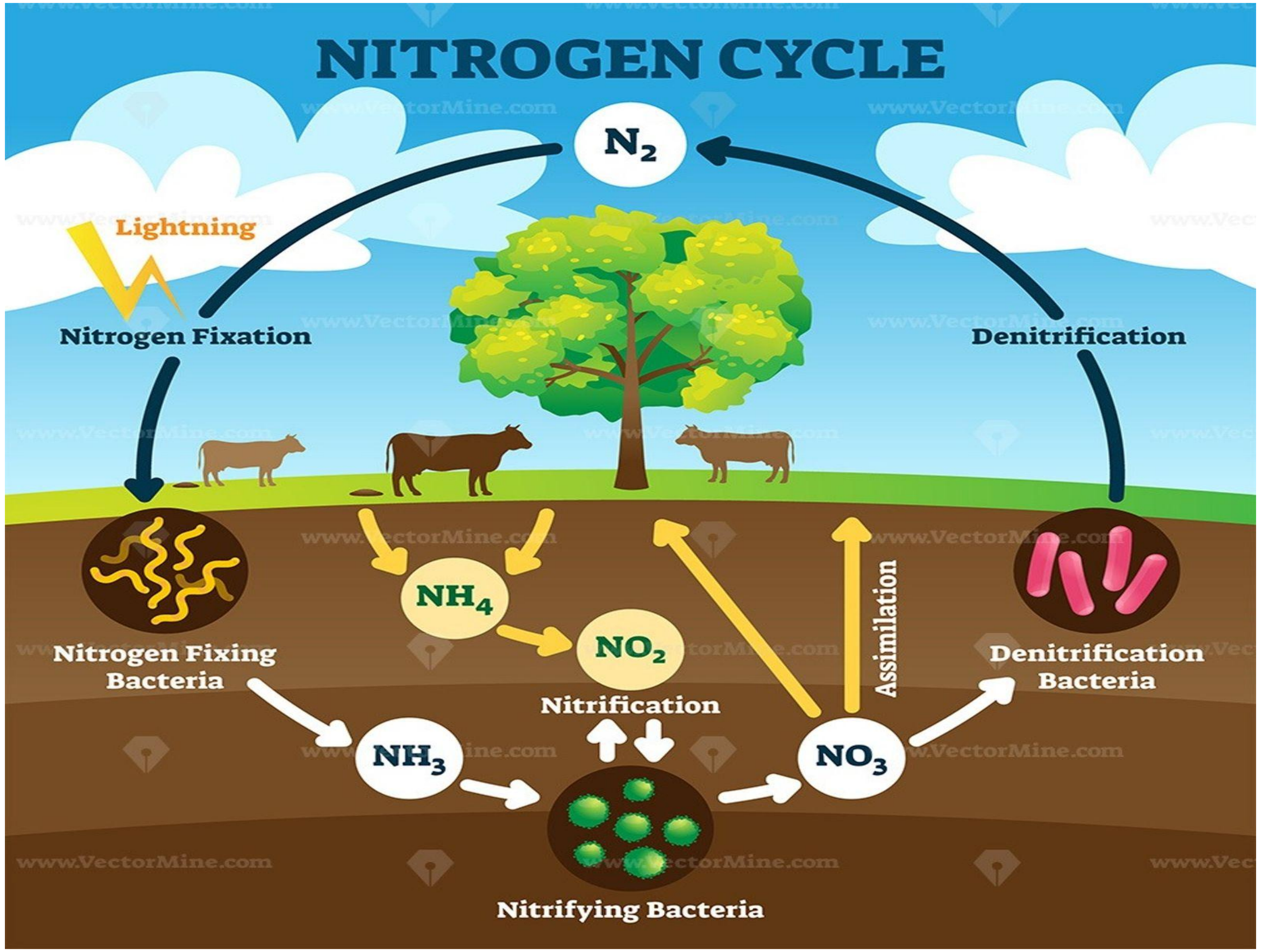
Nitrogen cycle

Nitrogen Cycle is a biogeochemical process through which nitrogen is converted into many forms, consecutively passing from the atmosphere to the soil to organism and back into the atmosphere. It involves several processes such as nitrogen fixation, nitrification, denitrification, decay and putrefaction.



https://courses.lumenlearning.com/sanjac-earthscience/chapter/the-carbon-cycle-and-the-nitrogen-cycle/

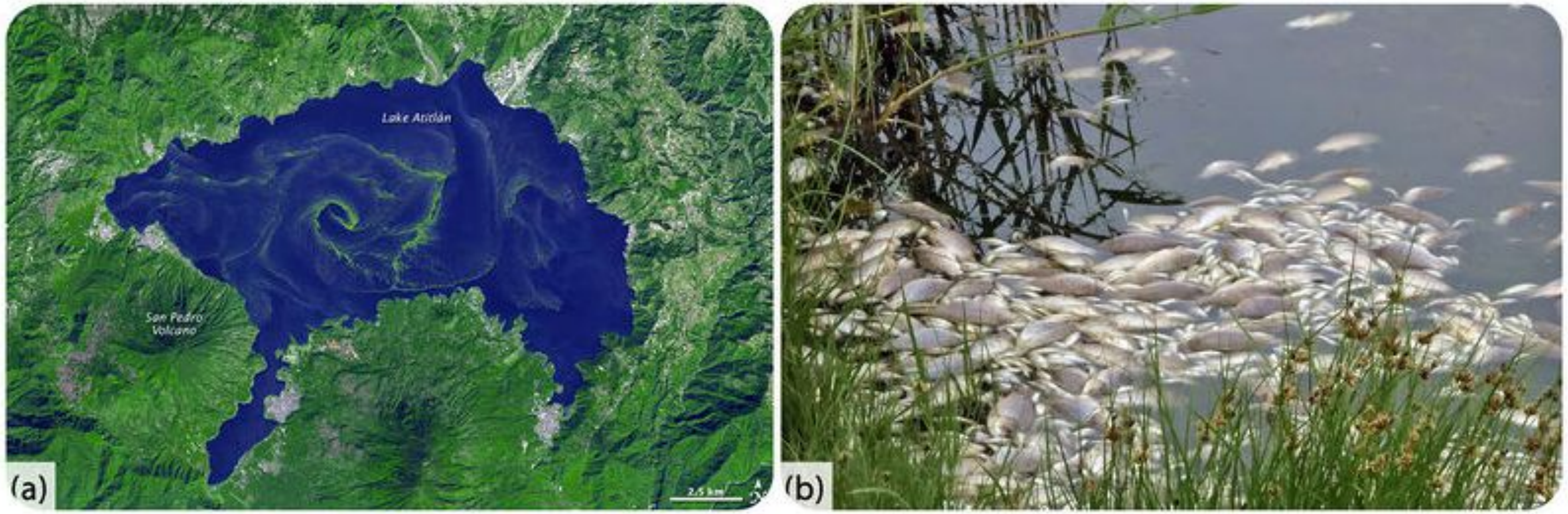
Nitrogen cycle



https://in.pinterest.com/pin/732538695628001656/

Nitrogen cycle

Excess nitrogen and phosphorus cause an overgrowth of algae in a short period of time, also called algae blooms. The overgrowth of algae consumes oxygen and blocks sunlight from underwater plants. When the algae eventually dies, the oxygen in the water is consumed.



(a) Nitrogen runoff into Lake Atitlán, Guatemala, caused an algae bloom in the normally clear blue mountain lake. (b) Fish killed by a lack of oxygen in the water.

https://courses.lumenlearning.com/sanjac-earthscience/chapter/the-carbon-cycle-and-the-nitrogen-cycle/

Oxygen cycle

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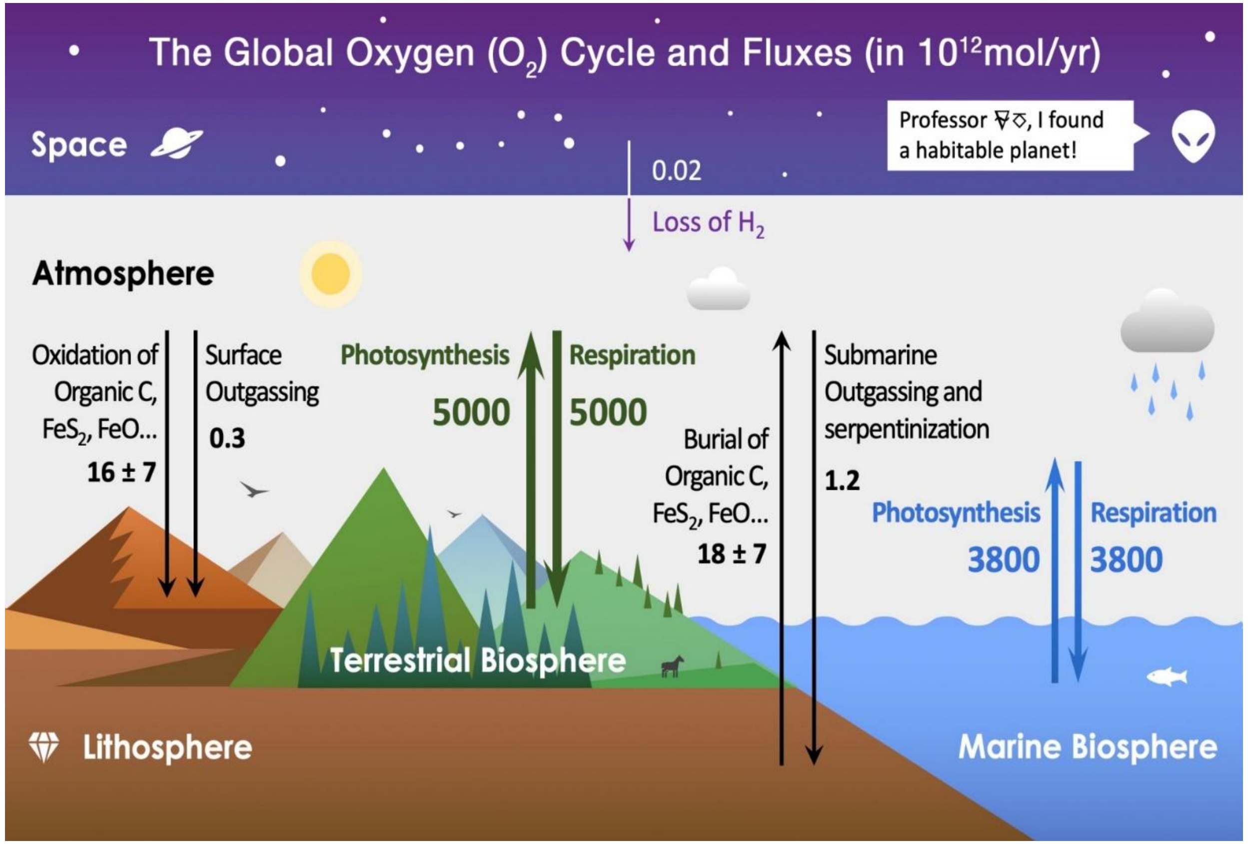
Oxygen cycle refers to the movement of oxygen through the atmosphere (air), biosphere (plants and animals) and the lithosphere (the Earth's crust).



https://en.wikipedia.org/wiki/Oxygen_cycle

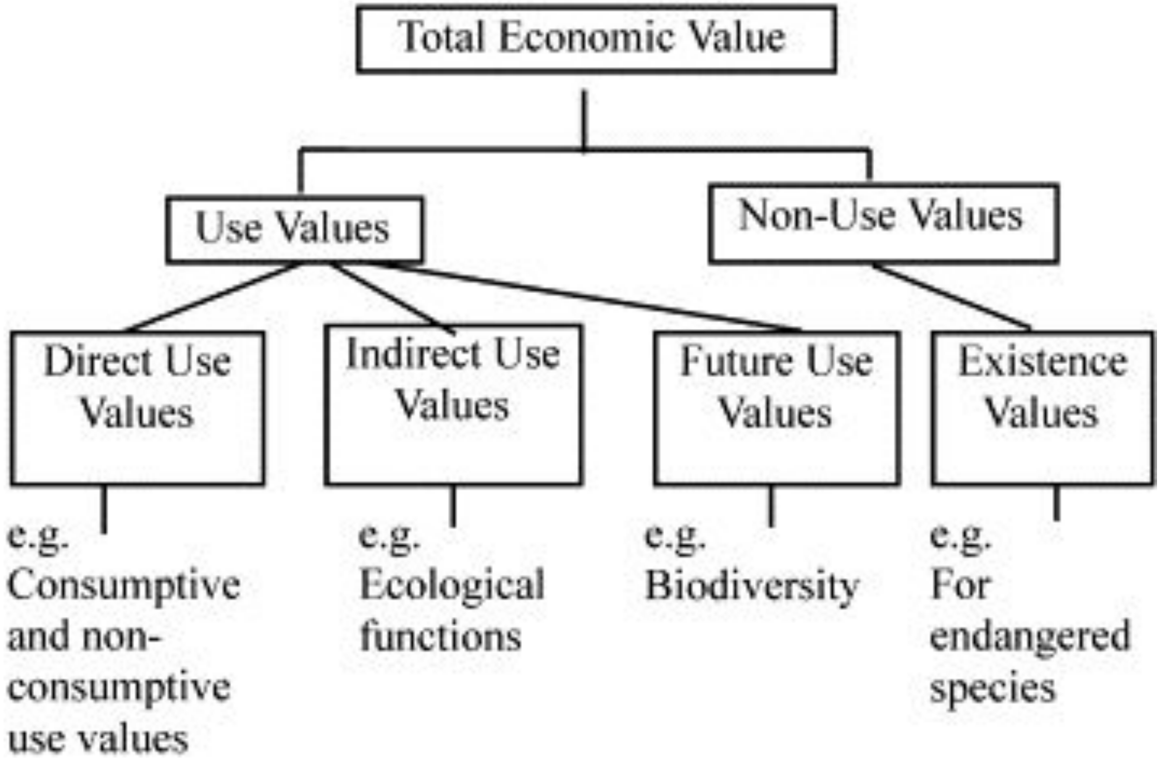
Direct/Indirect values

- **Direct and indirect use value of biodiversity**
- Direct values: Direct values can be consumptive or productive values. Plants provide an instant incentive towards sustainable development as they're the primary source of food that could be picked and spent legally. Direct use values include the economic advantages derived from directly forest wood, fuelwood, edible plants, and so on.

Direct/Indirect values

- Indirect values: The indirect values are the social and cultural values, ethical values, aesthetic values, optional and environmental values. Aesthetic qualities are an unusual motivator for biodiversity because unique views in undisturbed areas are fascinating to see and give possibilities for leisure activities that promote the eco-travel sector.

Direct/Indirect uses



https://www.sciencedirect.com/science/article/abs/pii/S0006320702003981

THANK YOU

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Energy Resources

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Energy Resources

- A natural resource that can be converted by humans into other forms of energy in order to do useful work
- ***Natural resource-*** any natural substance, organism, or energy form, living things use
    - The sun is our most important energy resource
- Energy has always been closely linked to man's economic growth and development

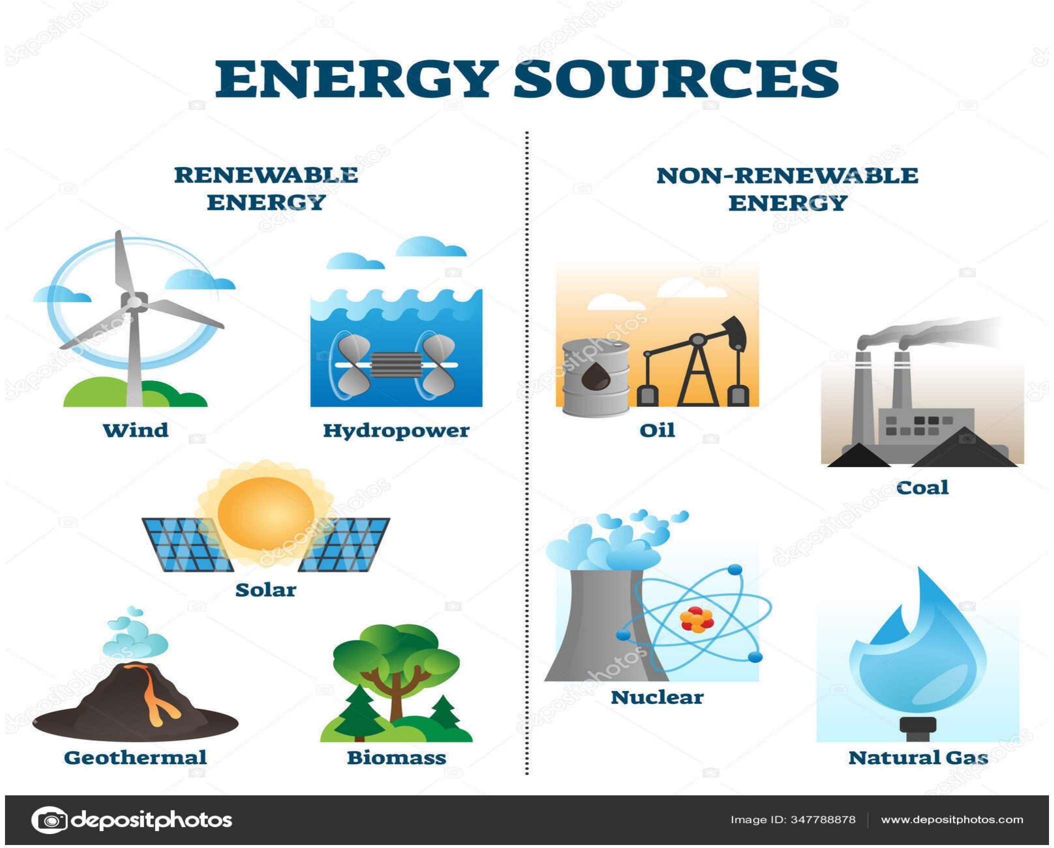
Types of Energy

There are three main types of energy; those classified as

a) ***Non-renewable***

b) ***Renewable***

c) ***Nuclear energy***



Non renewable energy

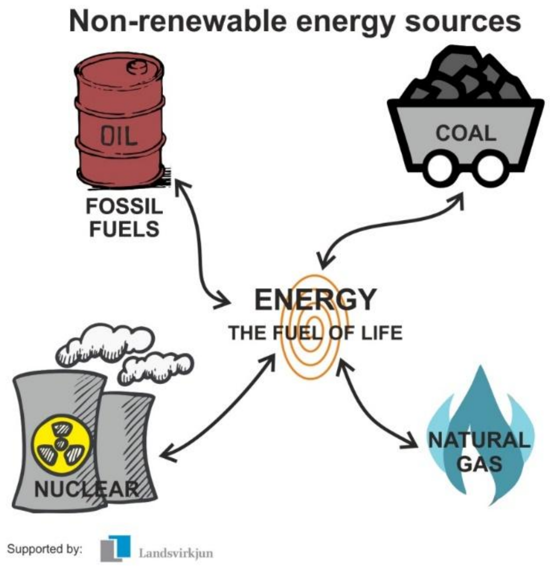
- Energy resources that cannot be replaced after they are used or can be replaced only over thousands or millions of years.
- The fuel is placed in a well contained area and set on fire. The heat generated turns water to steam, which moves through pipes, to turn the blades of a turbine. This coupled with electromagnetism, is used as energy resource.

  Example- Fossil fuels

  - These consist of the mineral based hydrocarbon fuels coal, oil and natural gas, that were formed from ancient prehistoric forests

Non renewable energy

- When these fuels are burnt, they produce waste products that are released into the atmosphere as gases such as carbon dioxide, oxides of sulphur, nitrogen, and carbon monoxide, all causes of air pollution.



Obtaining Fossil Fuels

1. **Coal** is obtained either by mining deep beneath the Earth's surface or by strip mining.

   – Strip mining- a process in which rock and soil are stripped from the Earth's surface to expose the underlying materials to be mined.

2. **Petroleum and natural gas** are removed from the Earth by drilling wells into rock that contain these resources.

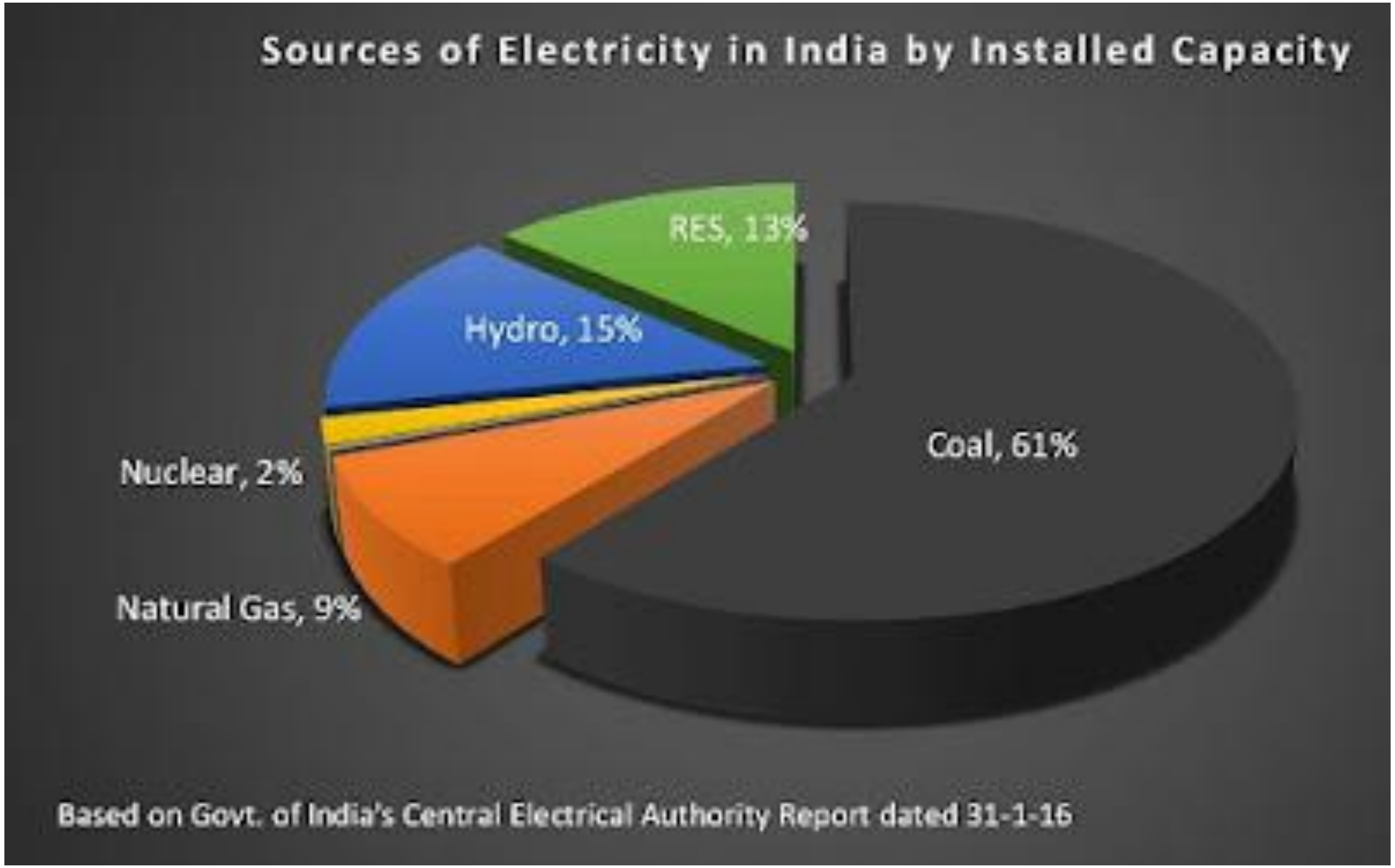
   – Oil wells exist on land and in the ocean.

Strip mining

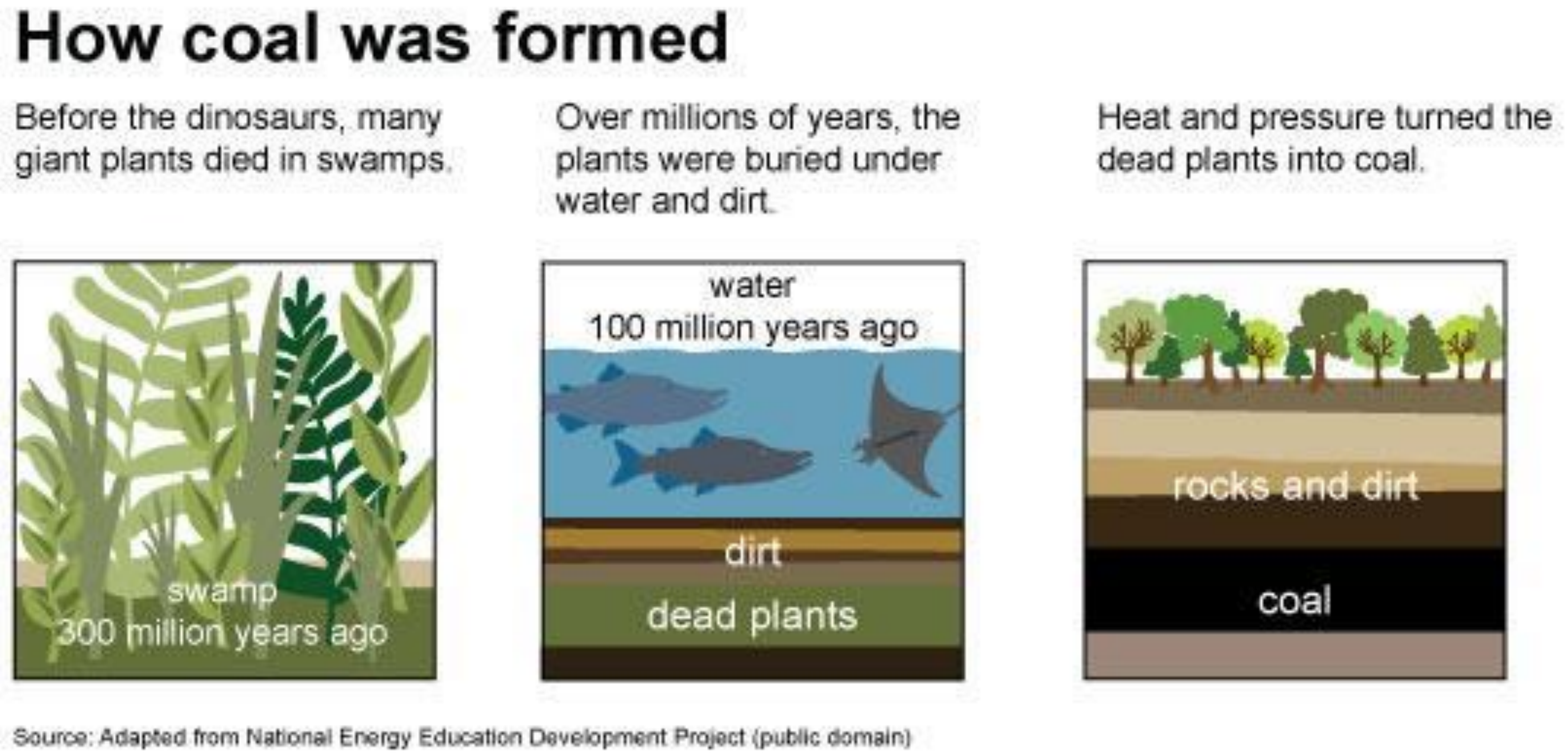
Fossil Fuels

- Energy resources that formed from the buried remains of plants and animals that lived in swamps millions of years ago – Coal, petroleum, and natural gas. Originally received their energy from the sun.
- The United States' primary source of electrical energy is generated by burning fossil fuels
- For almost 200 years, coal was the primary energy source fuelling the industrial revolution in the 19th century

Solid Fossil Fuels- Coal



Solid Fossil Fuels- Coal



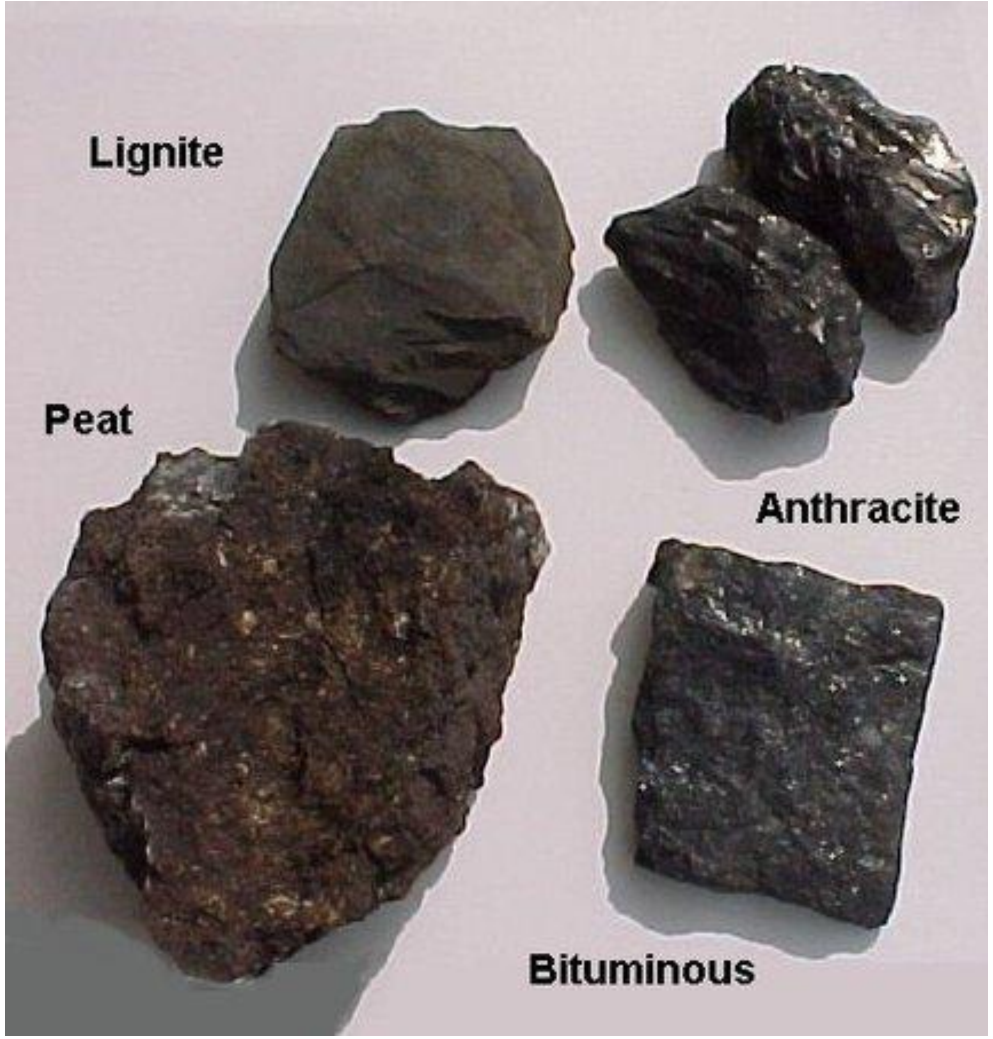
Solid Fossil Fuels- Coal

Coal – the remains of wetland plants that have been compressed over millions of years

Different types –

1. **Peat** – about 50% carbon. The rest is water and contaminants.
2. **Lignite** (brown coal) – about 70% carbon.
3. **Bituminous** (soft coal) – about 85% carbon.
4. **Anthracite** (hard coal) – greatly than 90% carbon. This is the cleanest burning and least abundant.

Solid Fossil Fuels- Coal

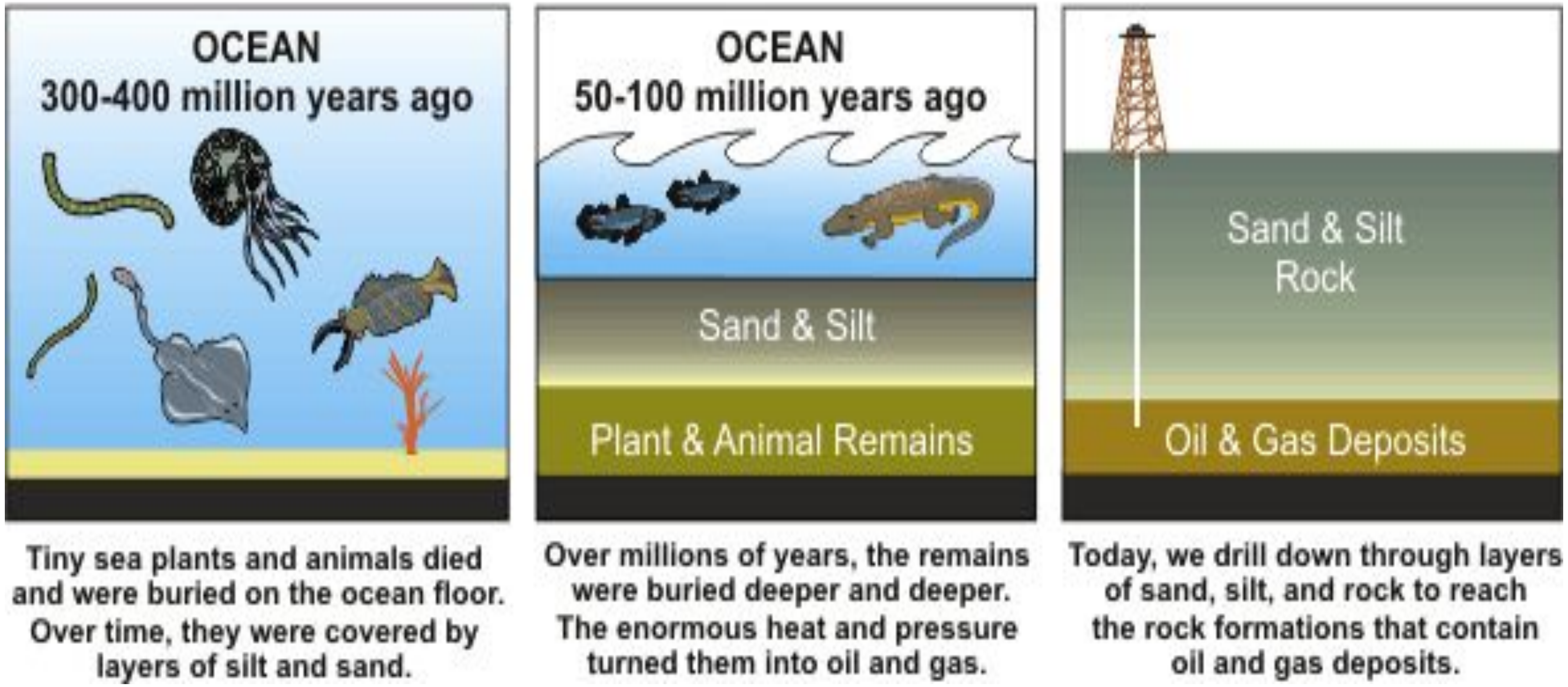


Liquid Fossil Fuels- Petroleum

- Can be called **crude oil**
- An oily mixture of flammable organic compounds from which liquid fossil fuels and other products, such as asphalt, are separated
  - Gasoline, plastics, and petrochemicals (which are used to make synthetic fibers, such as rayon) are some of the products
  - Formed from the remains of organisms that were in shallow prehistoric lakes and seas

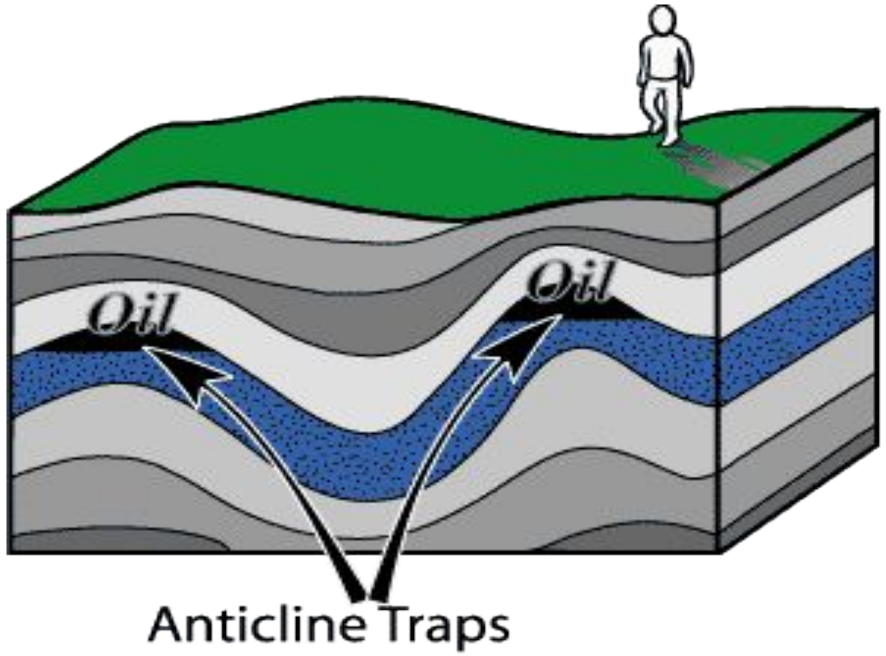
Liquid Fossil Fuels- Petroleum

How are liquid fossil fuel formed?



Liquid Fossil Fuels- Petroleum

How is oil formed?



In developing countries, the fossil fuels are fossilized wood, charcoal, and peat

In developed countries, the fossil fuels are mainly coal, natural gas, and oil

Gaseous Fossil Fuels- Natural Gas

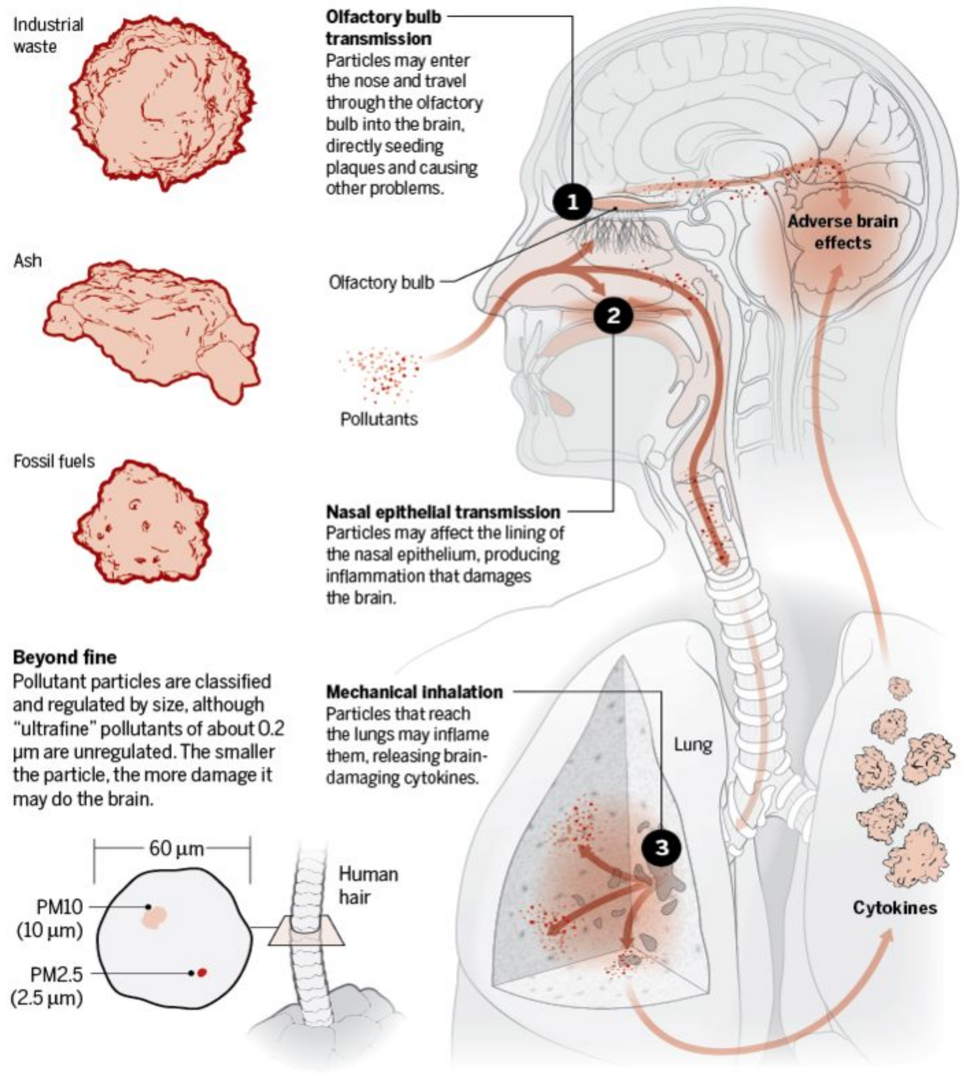
- Used the most to heat in businesses and at homes as well as generating electricity;
- Stoves, ovens, and in vehicles as an alternative to gasoline
- Cleanest burning fossil fuel

Problems With Fossil Fuels

We use them for energy because they provide a large amount of thermal energy per unit of mass

1. Acid precipitation from the burning of coal
2. Burning petroleum produces smog
3. Obtaining Coal: – Strip mining causes environmental damage
4. Coal mines can be hazardous for men and women working in them
5. Pollute water supplies, and cause the overlying Earth to collapse
6. Obtaining petroleum: – Oil spills can kill hundreds of thousands of animals and wildlife as well as damage the fishing industry

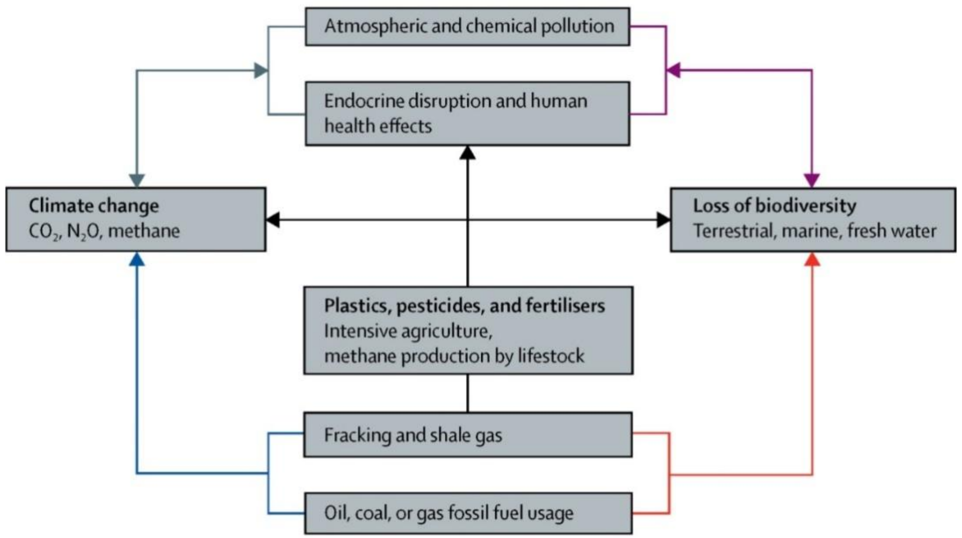
Problems With Fossil Fuels



https://auroushealthcare.wordpress.com/2017/02/01/new-evidence-shows-that-air-pollution-causes-alzheimers-and-dementia/

Problems With Fossil Fuels

A



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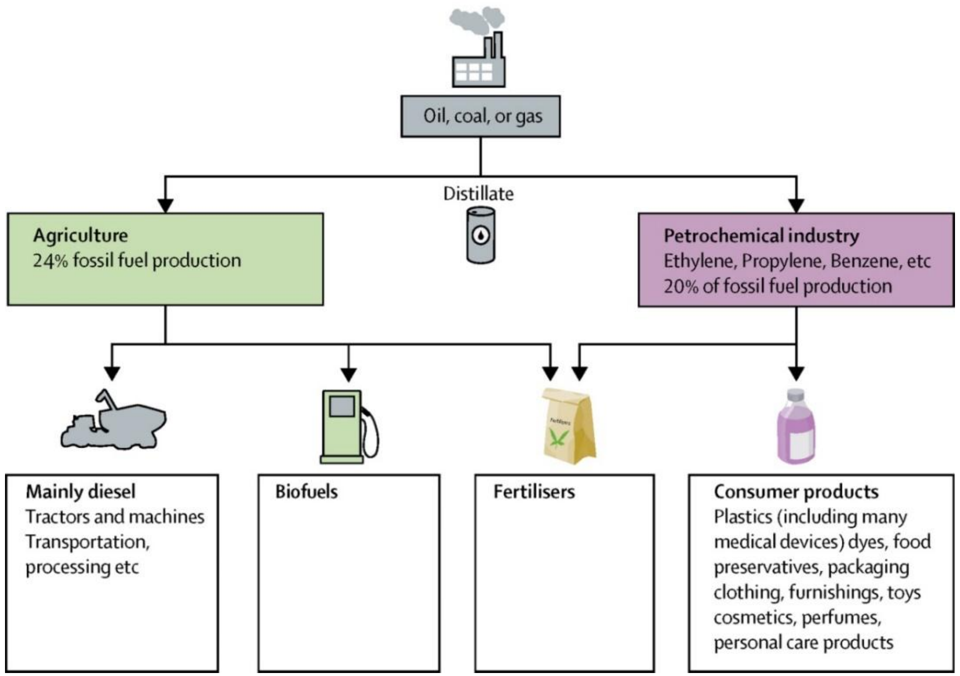
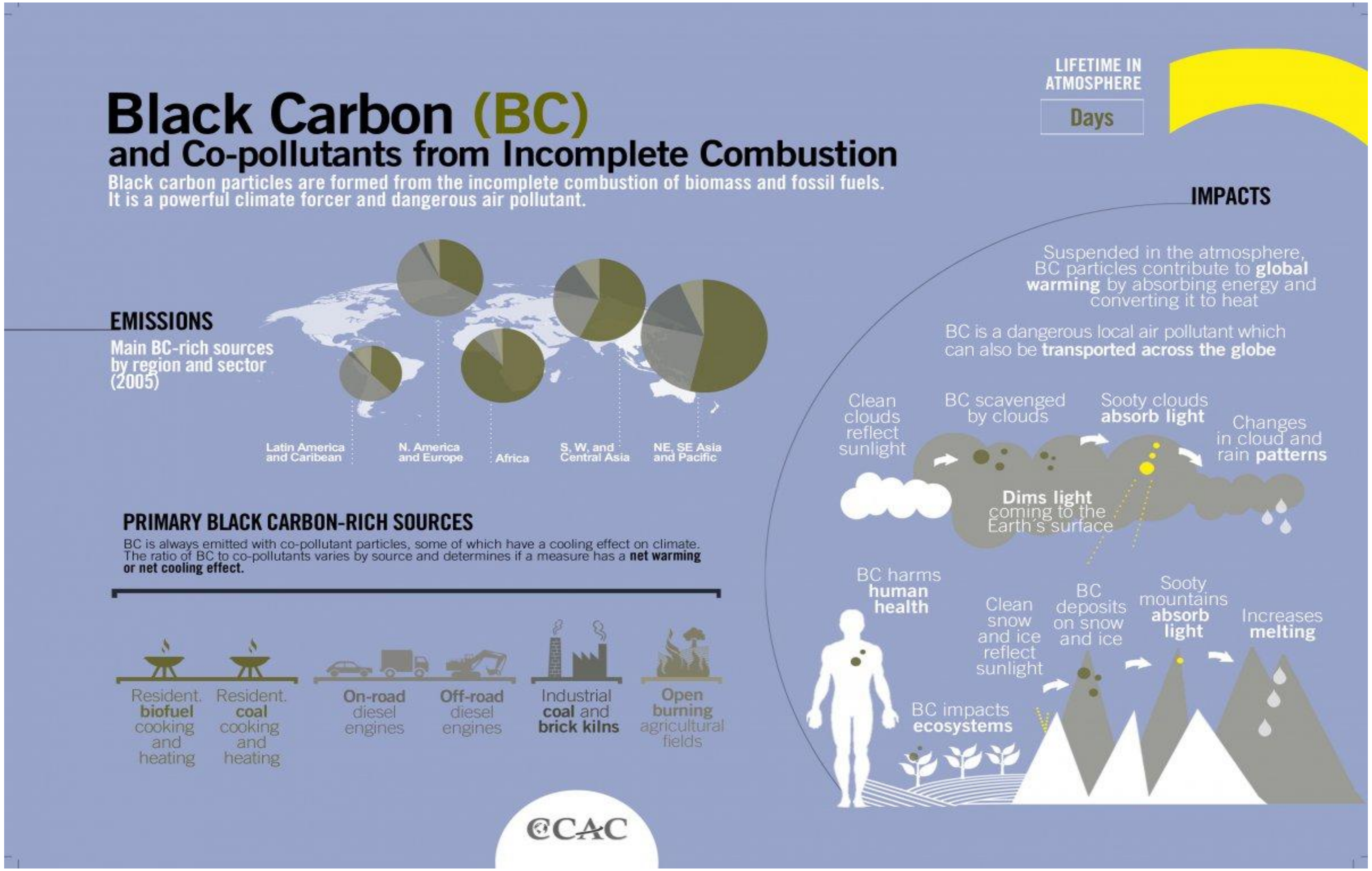


https://www.thelancet.com/journals/landia/article/PIIS2213-8587(20)30116-9/fulltext

Problems With Fossil Fuels



https://www.ccacoalition.org/ru/slcps/black-carbon

Renewable Resources

- A natural resource that can be used and replaced over a relatively short time

https://www.freepik.com/free-vector/people-with-renewable-energy-resources-illustration_3460385.htm

Biomass – Organic matter that contains stored energy or energy produced by heat within the Earth's crust

Ex: plants, wood, and waste

– Non-industrialized countries rely heavily on biomass for energy.

– Gasohol- Plant material that is changed into liquid fuel

Ex: Plants containing sugar or starch can be made into alcohol. The alcohol is burned as a fuel or mixed with gasoline to form the gasohol.

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Geothermal energy

– Harness heat from the Earth

– Ground water that seeps into hot spots near the surface of the Earth can form geysers. (Natural vents in which steam and water escape)

- Example: Old Faithful (geyser) in Yellowstone National Park
- The steam is used in power plants to generate electricity

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Solar energy

– Energy from the sun
– 2 common ways (indirectly or directly):

Sunlight can be changed into electricity by the use of solar cells.

Example: solar calculator, solar panels (large panels made up of many solar cells wired together)

1. Solar collectors- dark-colored boxes with glass or plastic tops used to directly heat
2. Solar mirrors- mirrors that use sunlight to produce electricity for large-scale solar power

Hydroelectric energy

– Electricity produced by falling water

– Recycled through the water cycle

– Example: dams

Wind energy

– The energy in wind

– Uses wind turbines to convert kinetic energy into electrical energy by rotating a generator

Advantages of Renewable Resources

1. Reduces fossil fuels usage
2. Solar – Almost limitless source of energy – Does not produce pollution
3. Water – Renewable – Does not produce air pollution – Dams produce no hazardous wastes.
4. Wind – Relatively inexpensive to generate – Does not produce air pollution
5. Geothermal – Almost limitless source of energy – Power plants land
6. Biomass – Renewable

Disadvantages of Alternative Resources

1. Solar: – Expensive to use for large-scale energy production – Only practical in sunny areas
2. Water: – Dams disrupt a river's ecosystem. – Available only in areas that have rivers
3. Wind: – Only practical in windy areas (require strong, steady breezes to be effective), so there are limited locations for wind farms
4. Geothermal – Only practical in locations near hot spots (Hot spots are volcanic regions with a hotter mantle than most places.) – Waste water can damage soil
5. Biomass – Requires large areas of farmland – Produces smoke

Conserving Natural Resources

- Whether the natural resources we use are renewable or nonrenewable, we should be careful on how we use them
- Only use them when necessary
- Recycle! The process by which used or discarded materials are treated for reuse.

Nuclear Energy

- An alternative source of energy that comes from the use of nuclear reactions
- A nuclear power plant generates thermal energy that boils water to produce steam.
  - Fossil fuel and nuclear power plants use steam to turn a turbine, which rotates a generator that converts kinetic energy into electrical energy.
  - Nuclear power plants provide alternative sources of energy without the problems that come with fossil fuels, but produce dangerous, radioactive wastes.

https://en.wikipedia.org/wiki/Energy_flow_(ecology)

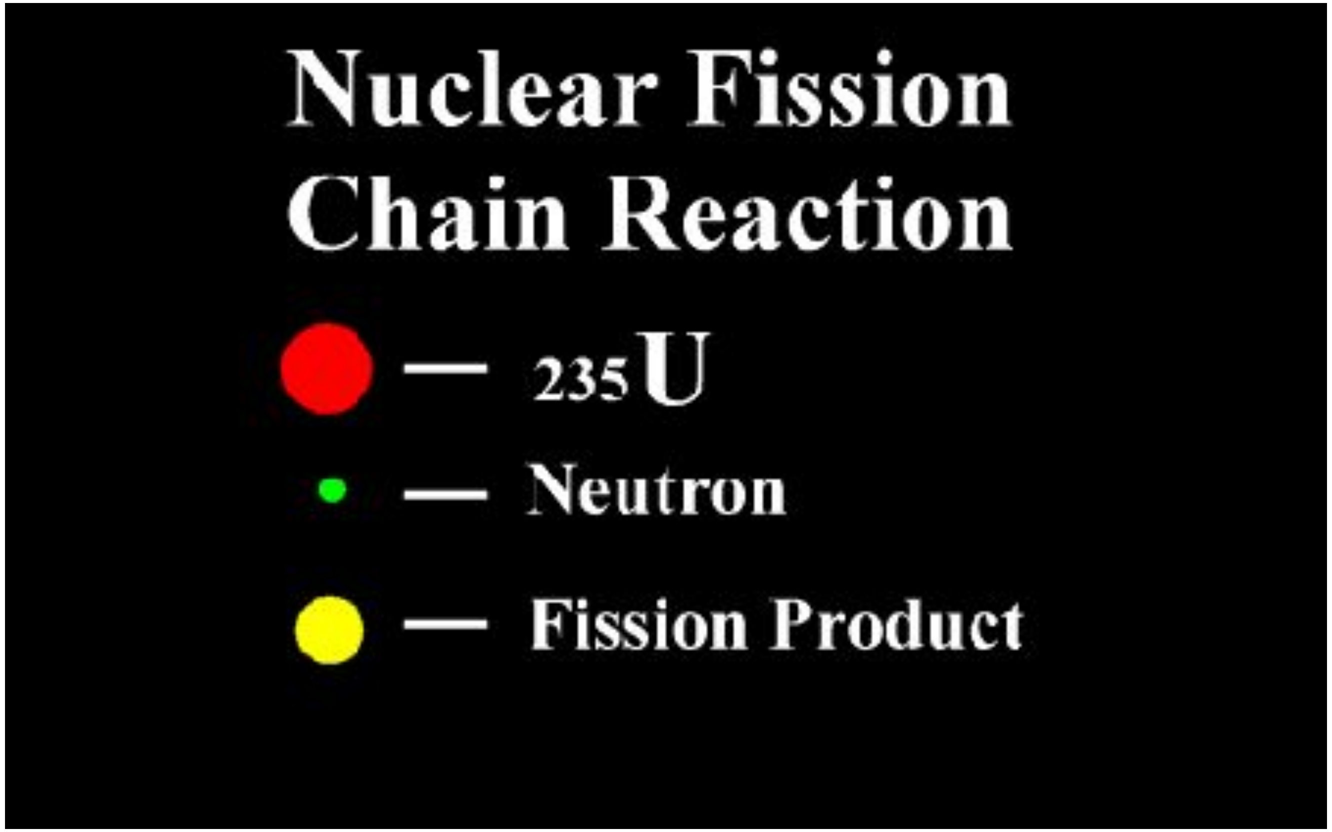
Nuclear Energy

- Nuclear power can be obtained from nuclear fission, nuclear decay and nuclear fusion reactions.
- **Nuclear fission-** a process when the nucleus of a uranium atom is split into two smaller nuclei, releasing nuclear energy
- **Nuclear fusion-** the joining of nuclei of small atoms to form larger atoms
  – Produces few dangerous wastes, but very high temperatures are required for the reaction to take place

Nuclear Fission

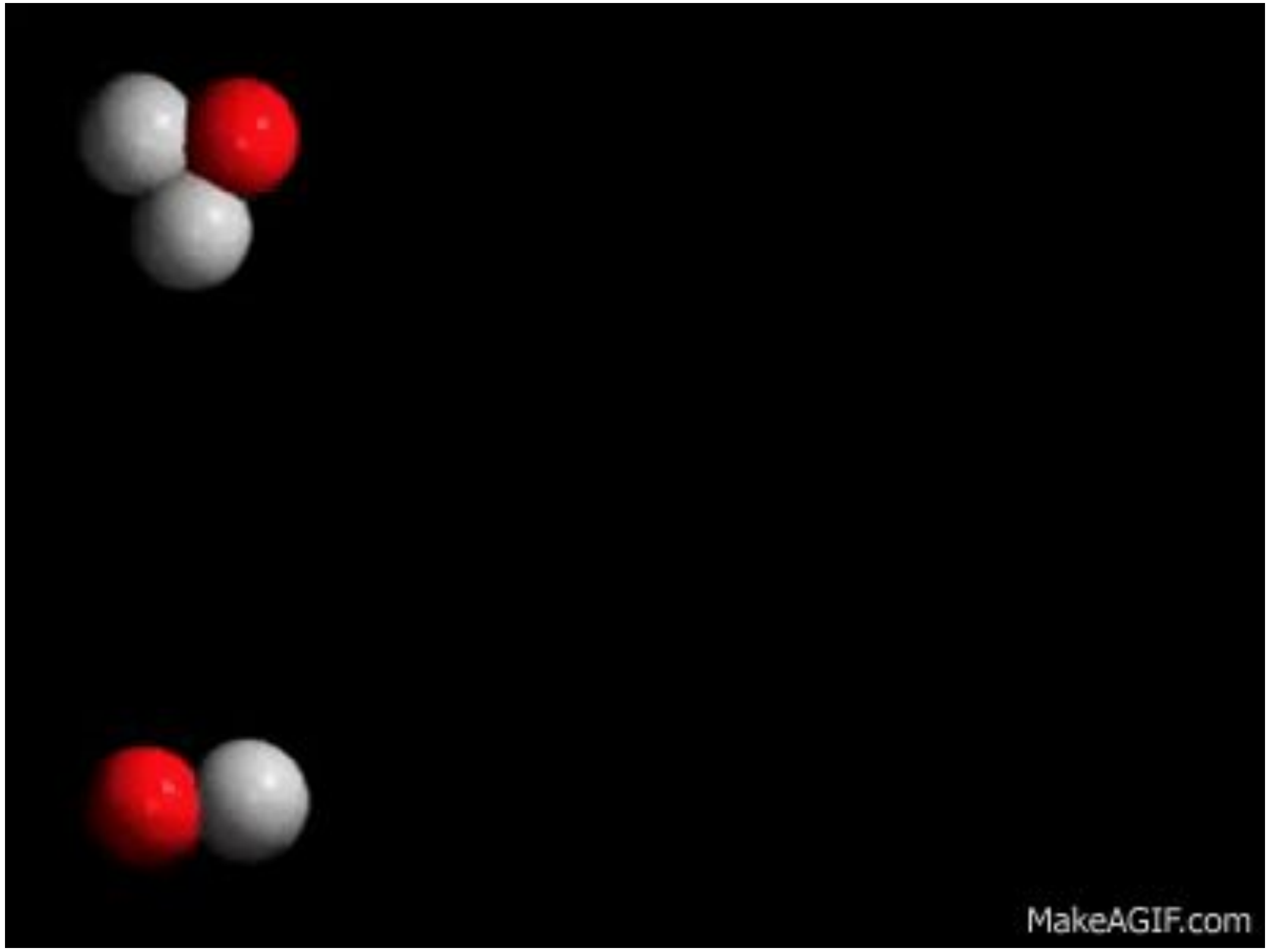
https://atomicpsa.wordpress.com/what-is-nuclear-fission-and-fusion/

Nuclear Fission



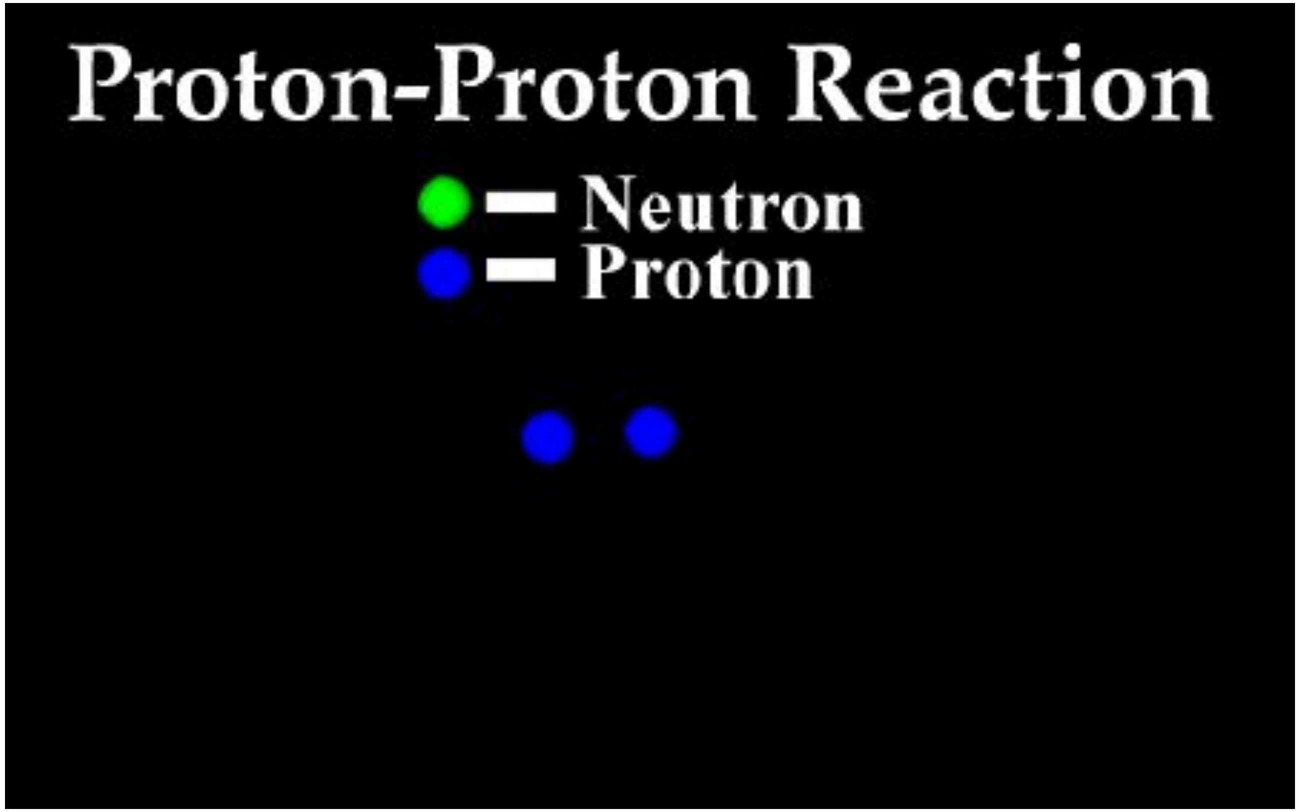
https://atomicpsa.wordpress.com/what-is-nuclear-fission-and-fusion/

Nuclear Fusion



https://makeagif.com/gif/nuclear-fusion-animation-mcQMHk

Nuclear Fusion



https://atomicpsa.wordpress.com/what-is-nuclear-fission-and-fusion/

Nuclear Energy

- As of March 2018, twenty two nuclear reactors are operational in 7 nuclear power plants that generate nearly 20 percent of the nation’s electricity, all without carbon emissions because reactors use uranium, not fossil fuels.
- These plants are always: well-operated to avoid interruptions and built to withstand extreme weather, supporting the grid 24/7.
- All that power and potential from a tiny atom.

How do nuclear reactors work?

Three steps that reactors use to make clean electricity:

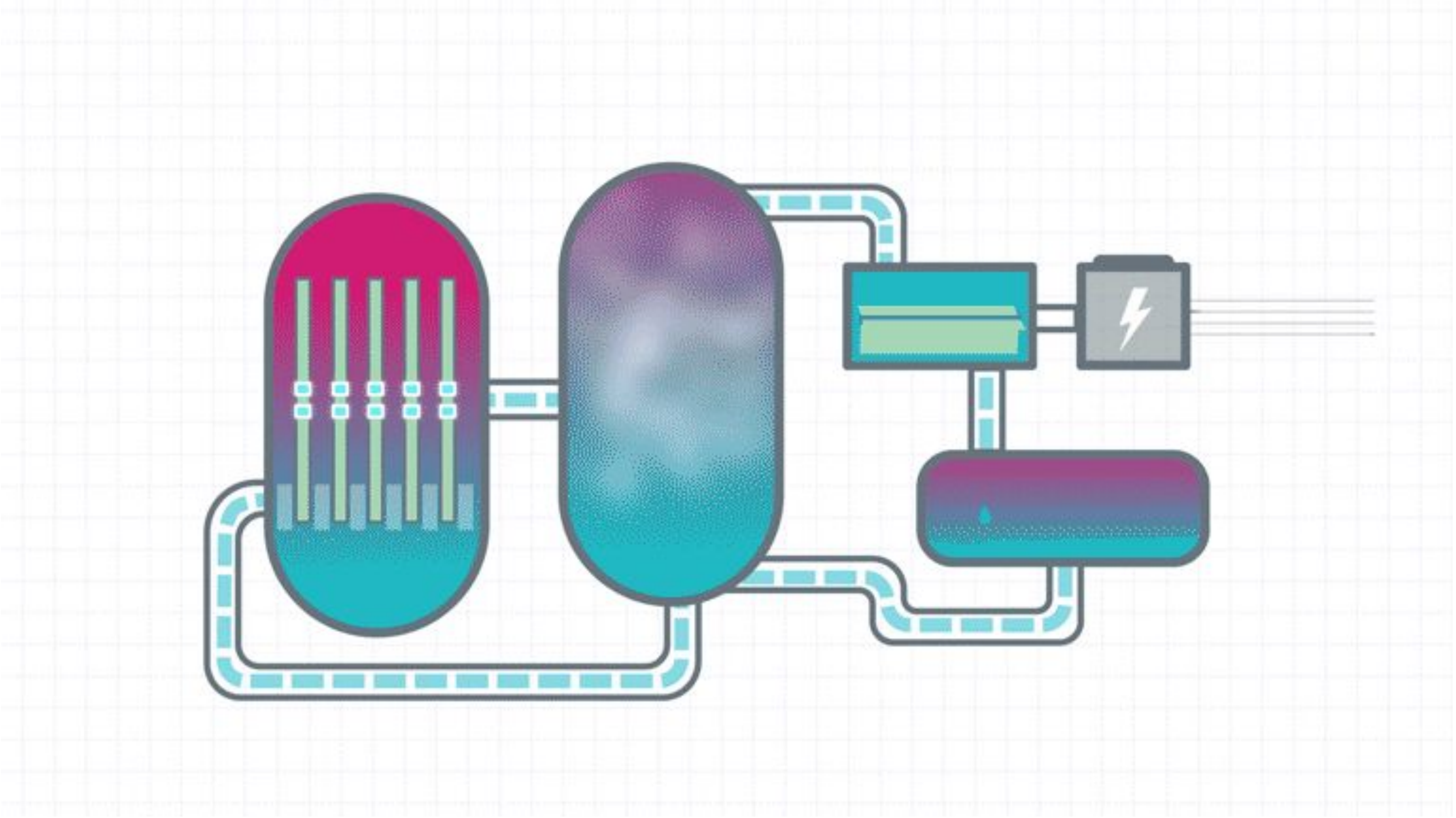
Step 1: Split Atoms to Create Heat

https://www.nei.org/news/2019/how-reactor-actually-works

How do nuclear reactors work?

Step 2: Use the Heat to Make Steam

Step 3: Use the Steam to Turn a Turbine

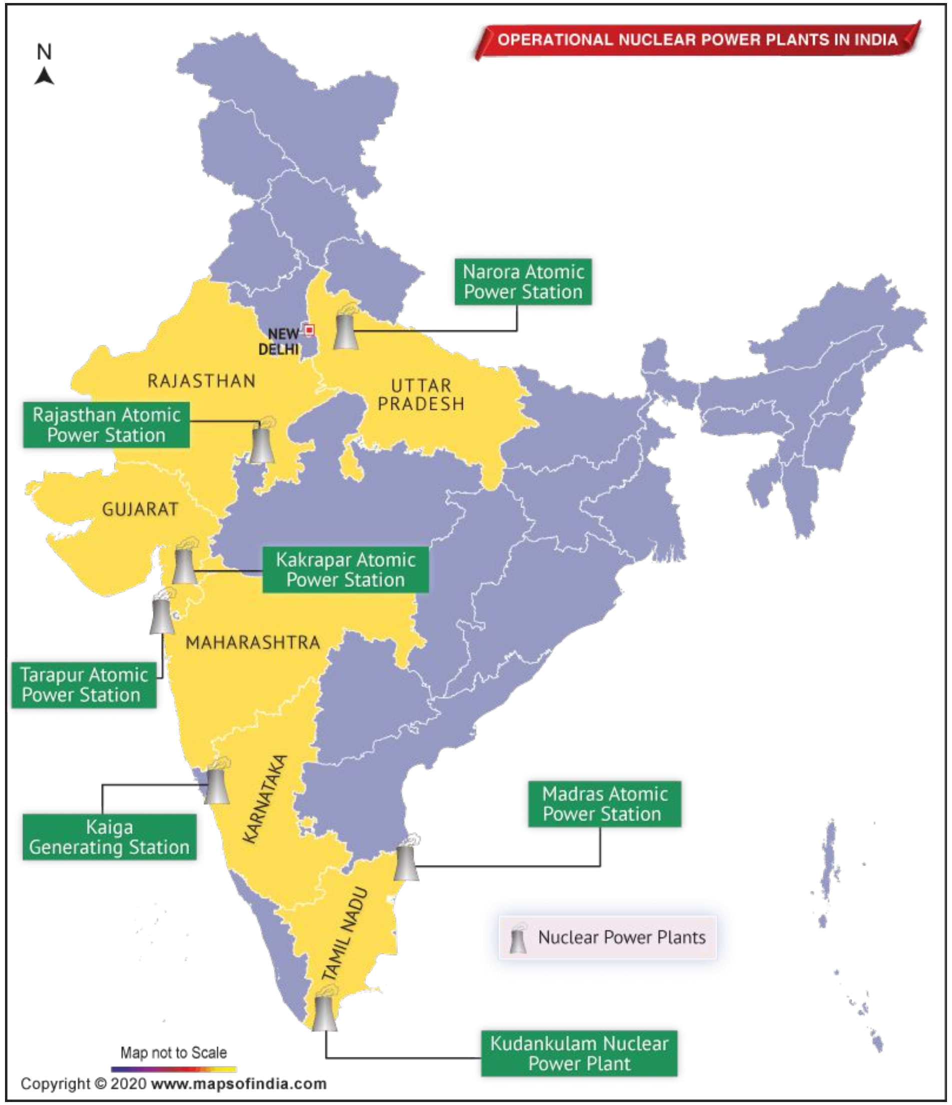


https://www.nei.org/news/2019/how-reactor-actually-works

Benefits of Nuclear Energy

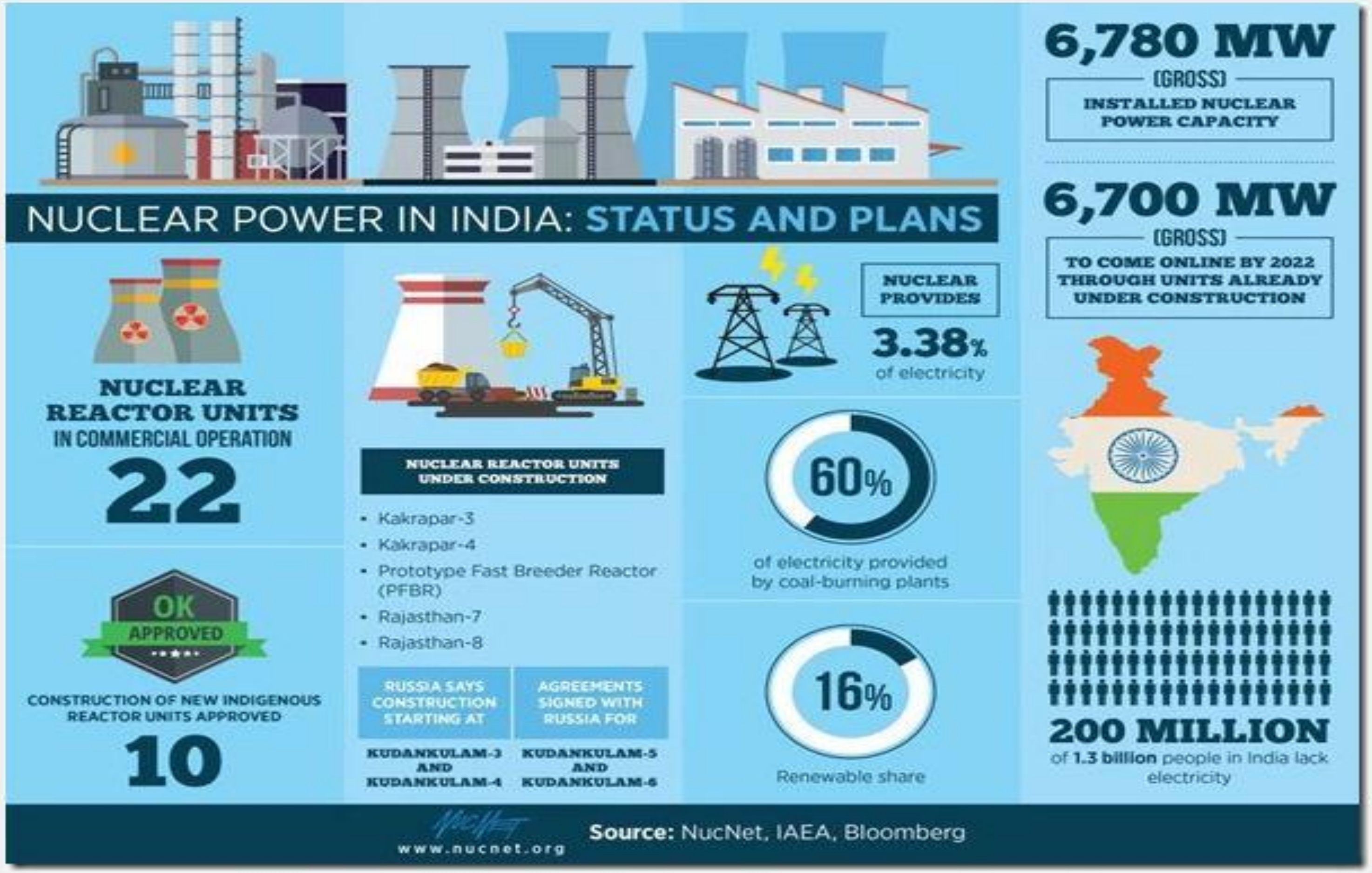
1. Nuclear fights climate change-provides large amounts of 24/7 carbon-free electricity now, which is irreplaceable in protecting the environment
2. Nuclear protects our air-No trace elements like Nitrogen oxide, sulfur dioxide, particulate matter and mercury
3. Nuclear boosts international development- Nuclear energy helps developing nations meet sustainable development goals.
4. Nuclear powers electric vehicles- Electrified transportation promises to reduce carbon emissions.

Nuclear Energy



https://www.mapsofindia.com/my-india/technology/operational-nuclear-power-plants-in-india

Nuclear Power in India



Current Status of India's Nuclear Energy Program. Image courtesy of NucNet

https://energypost.eu/17408-2/

Nuclear Power in India- 4th Kudankulam Nuclear Power Plant

https://www.newindianexpress.com/states/tamil-nadu/2019/dec/21/equipment-for-4th-kudankulam-nuclear-power-plant-unit-shipped-2079007.html

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ENVIRONMENTAL STUDIES & LIFE SCIENCES

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ENVIRONMENTAL STUDIES & LIFE SCIENCES

Natural and Man-made Disasters

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Disaster

- A Disaster is a serious disruption of the functioning of a society involving widespread human, material, economic or environmental losses & impacts which exceeds the ability of the affected community or society to cope using it's own resources

Natural Disasters

- Earthquake/ Floods/ Landslides/ Avalanche/ Cyclone/ Tsunami/ Heat waves/ Drought

Man-made Disasters

- Nuclear Disasters/ Chemical Disasters/ Biological Disasters/ Accidental or Ignorance Disasters

Natural Disasters

- A Natural Disaster is a major adverse event resulting from natural processes of the Earth such as floods, volcanic-eruptions, earthquakes, tsunamis & other geological processes, such events lead to loss of life & property.

- The severity of such events depends on the affected population's ability to recover.

Earthquakes

- An earthquake is the result of a **sudden release of energy** in Earth's crust that creates seismic waves.
- At the Earth's surface, earthquakes manifest themselves by shaking & sometimes displacement of the ground.
- **Seismic activity** of an area refers to the frequency, type & size of earthquakes experienced over a period of time & are measured using **seismometers**.
- Earthquakes are measured using observations from seismometer and moment magnitude is expressed in terms of **Richter scale**.

Floods

- A flood is an overflow of water that submerges land, may occur as an overflow of water from water bodies, such as a river or lake, in which the water overtops, resulting in some of that water escaping it's usual boundaries or it may occur due to accumulation of rainwater on saturated ground in an areal flood.
- Flash floods can develop within hours of heavy rainfall.
- Deserts are vulnerable to flash floods. Wadis (Arroyos) are dry river beds that only flow during heavy rains.

Floods

https://www.npr.org/2019/02/05/691585812/australian-residents-return-home-after-flash-floods-amid-warnings-of-another-sto

Landslide

- A landslide is a geological phenomenon that includes a wide range of ground movements, such as rock falls, deep failure of slopes & shallow debris flows.
- Landslides can occur in offshore, coastal & onshore environments.
- Landslides are caused by rain, earthquakes, volcanoes, or other factors that make the slope unstable.

Landslide

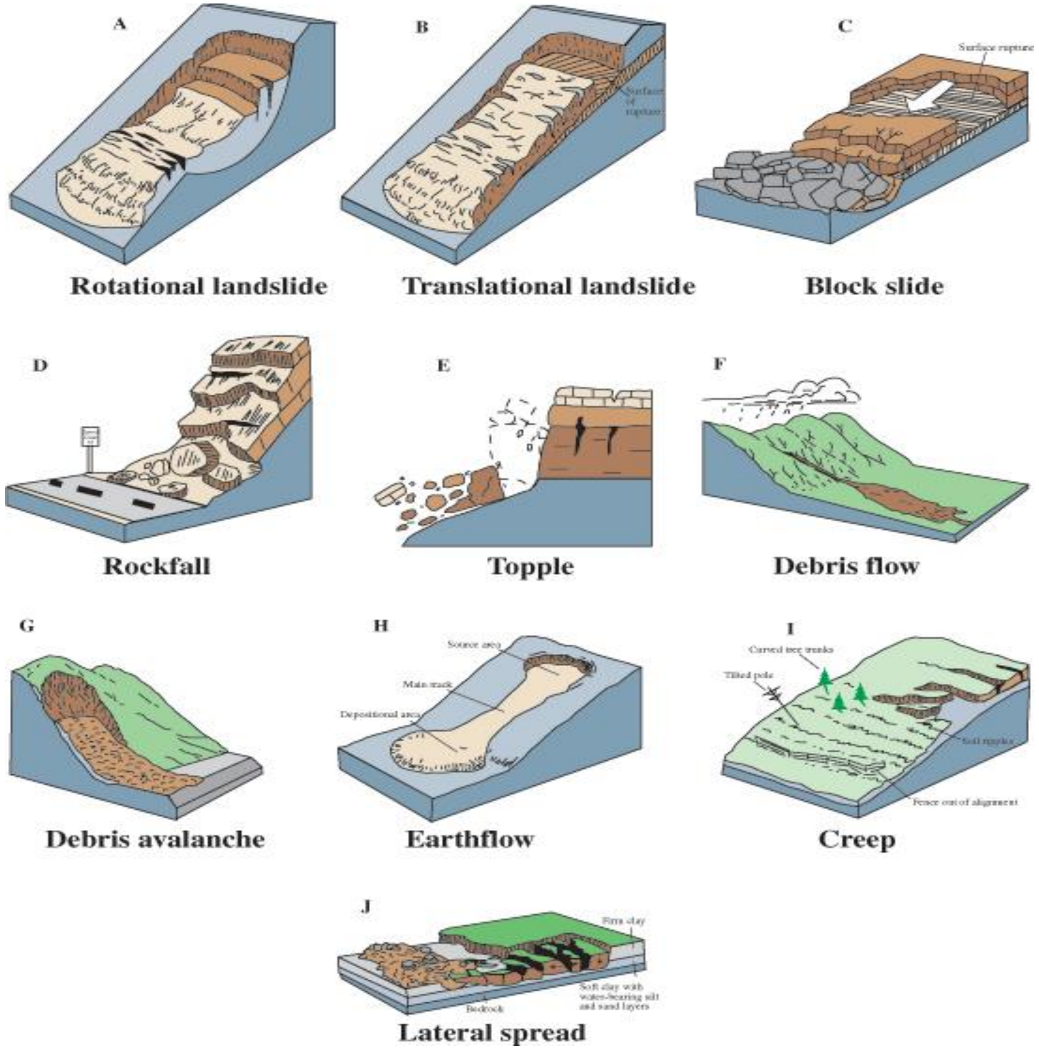
A landslide near Cusco, Peru in 2018.

https://en.wikipedia.org/wiki/Landslide

Landslide Movement

- There are several ways of describing how a landslide moves. These include falls, topples, translational slides, lateral spreads, and flows.
- Falls & topples-heavy blocks of material fall after separating from a very steep slope or cliff.
- In translational slides, surface material is separated from the more stable underlying layer of a slope.
- A lateral spread or flow is the movement of material sideways, or laterally.

Landslide Movement

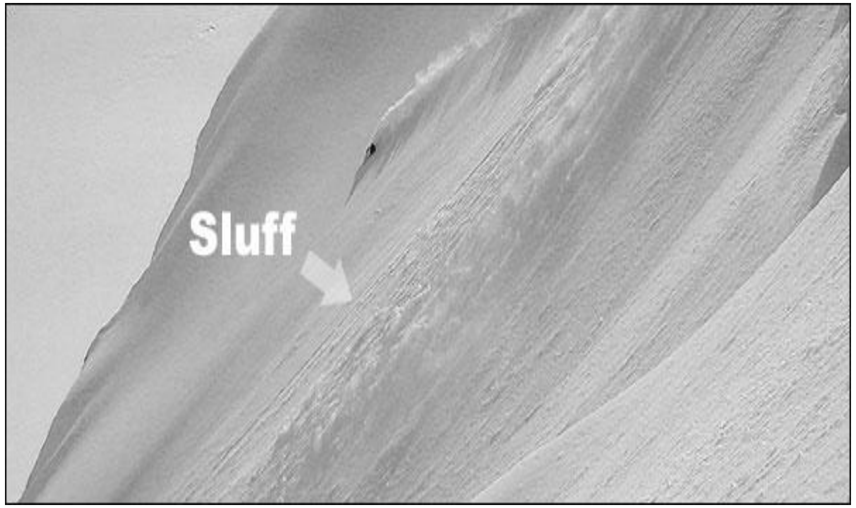


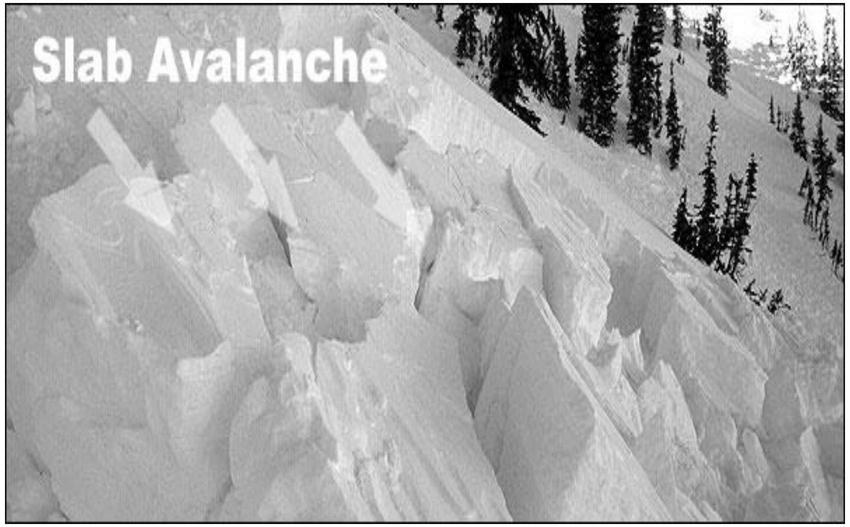
https://pubs.usgs.gov/fs/2004/3072/fs-2004-3072.html

Avalanche

- An avalanche is a rapid flow of snow down a sloping surface. During an avalanche, a mass of snow, rock, ice, soil, and other material slides swiftly down a mountainside.
- There are two main types of snow avalanches—sluffs and slabs.
- Sluff avalanches occur when the weak layer of a snowpack is on the top. A sluff is a small slide of dry, powdery snow that moves as a formless mass
- A slab avalanche occurs when the weak layer lies lower down in a snowpack. This layer is covered with other layers of compressed snow. When the avalanche is triggered, the weak layer breaks off, pulling all the layers on top of it down the slope.

Avalanche





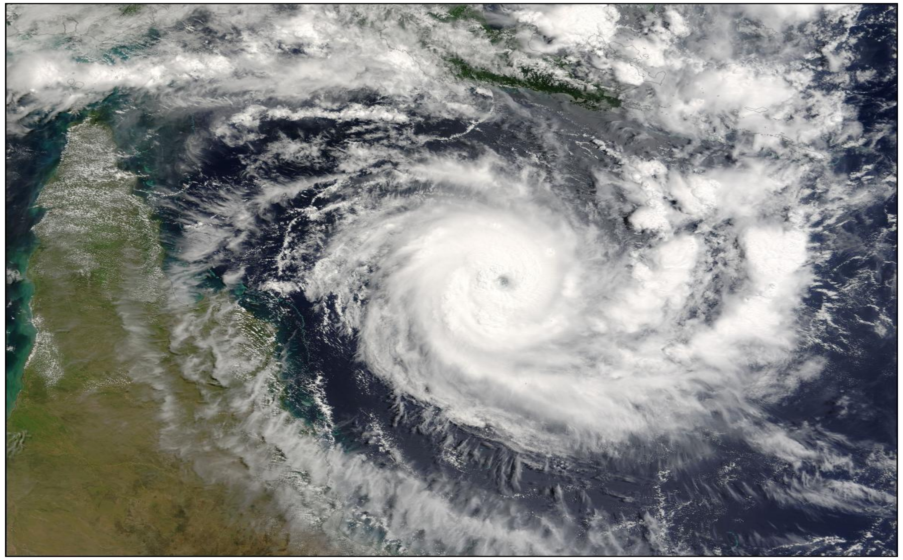
https://avalanche.org/avalanche-encyclopedia/avalanche/

Cyclone

- A cyclone is an area of closed, circular fluid motion rotating in the same direction as the Earth.
- This is usually characterized by inward circular winds that rotate anti-clockwise in the Northern Hemisphere & clockwise in the Southern Hemisphere of the Earth.
- An anticyclone is the opposite of a cyclone. An anticyclone's winds rotate clockwise in the Northern Hemisphere around a center of high pressure. Air comes in from above and sinks to the ground.

Cyclone

- Most large-scale cyclonic circulations are centered on areas of low atmospheric pressure.
- There are two types of cyclones:
- Mid-latitude cyclones are the main cause of winter storms in the middle latitudes. Tropical cyclones are also known as hurricanes.



https://www.scoop.co.nz/stories/HL0503/S00056/super-cylone-ingrid-heads-for-queensland-coast.htm

Tsunami

- In Japanese, *tsunami* means "harbor wave."
- A Tsunami also known as seismic sea wave, it is a series of water waves caused by displacement of a large volume of a body of water, generally an ocean or a large lake.
- Tsunamis race across the sea at up to 500 miles (805 kilometers) an hour—about as fast as a jet airplane. At that pace, they can cross the entire expanse of the Pacific Ocean in less than a day.

Tsunami

https://www.youtube.com/watch?v=Z-2khcTHIgs

Drought

- Drought is an extended period when a region receives a deficiency in it’s water supply, whether atmospheric, surface or ground water.
- A drought can last for months or years, or may be declared after as few as 15 days, this occurs when a region receives consistently below average precipitation.
- A Drought can have a substantial impact on the ecosystem & agriculture of the affected region.

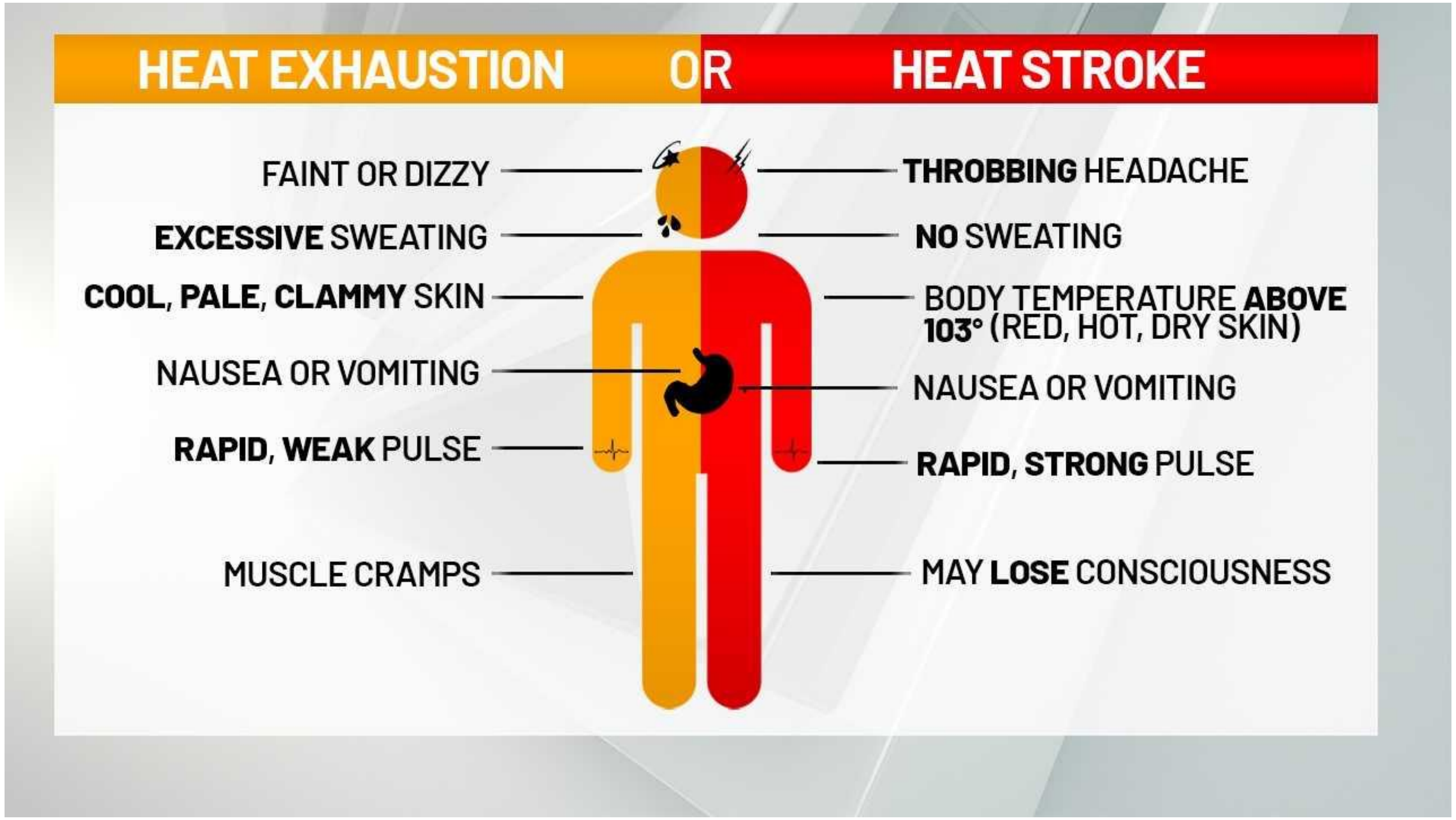
Drought

https://www.outlookindia.com/website/story/nine-districts-of-odisha-declared-as-drought-hit/319411

Heat Wave

- A heat wave is a prolonged period of excessively hot weather accompanied by high humidity, especially in oceanic climate countries.
- It occurs during the summer season in the North-Western parts of India.
- The extreme temperatures and resultant atmospheric conditions adversely affect people living in these regions as they cause physiological stress, sometimes resulting in death.

Health Impacts of Heat Waves



https://www.news10.com/news/heat-exhaustion-vs-heat-stroke-heres-how-to-know-the-difference-2/

Man-made Disasters

- Disasters having elements of human intent, negligence, error, failure of human-made systems.
- Such events result in huge losses of life & property along with damage to people's mental, physical & social well-being.
- Such man-made disasters are Nuclear disaster, biological/chemical threat, accidental, terrorism, etc.
- The causes of man made disasters are: Ignorance, unawareness, illiteracy, carelessness

- Nuclear and Radiological Emergency/Disaster Scenarios:

1. An accident taking place in any nuclear facility of the nuclear fuel cycle including the nuclear reactor, or in a facility using radioactive sources, leading to a large-scale release of radioactivity in the environment.
2. A 'criticality' accident in a nuclear fuel cycle facility where an uncontrolled nuclear chain reaction takes place inadvertently leading to bursts of neutrons and gamma radiation (as had happened at Tokaimura, Japan).

Nuclear Disaster

3. An accident during the transportation of radioactive material.

4. The malevolent use of radioactive material as Radiological Dispersal Device (RDD) by terrorists for dispersing radioactive material in the environment.

5. A large-scale nuclear disaster resulting from a nuclear weapon attack (as had happened at Hiroshima and Nagasaki in Japan) which would lead to mass casualties and destruction of large areas and properties.

Nuclear Disaster

https://sites.suffolk.edu/jstraka/2015/10/30/fukushima-daiichi-nuclear-disaster/

https://www.businessinsider.in/science/chernobyl

Chemical Disaster

- Chemical, being at the core of modern industrial systems, has attained a very serious concern for disaster management.

- Chemical disasters may be traumatic in their impacts on human beings and have resulted in the casualties and also damages nature and property.

- The elements which are at highest risks due to chemical disaster primarily include the industrial plant, its employees & workers, hazardous chemicals vehicles, the residents of nearby settlements, adjacent buildings, occupants and surrounding community.

Chemical Disaster

Chemical disasters may arise in number of ways, such as:-

1. Process and safety systems failures
   - Human errors
   - Technical errors
   - Management errors
2. Induced effect of natural calamities
3. Accidents during the transportation
4. Hazardous waste processing/ disposal
5. Terrorist attack/ unrest leading to sabotage

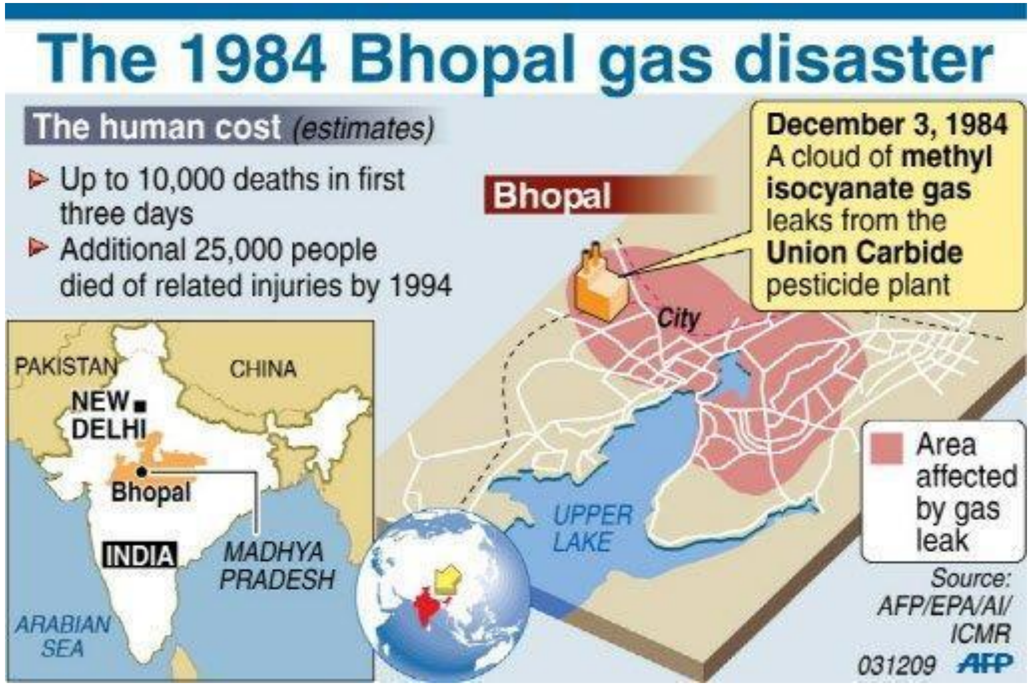
Status of Chemical Disaster Risk in India

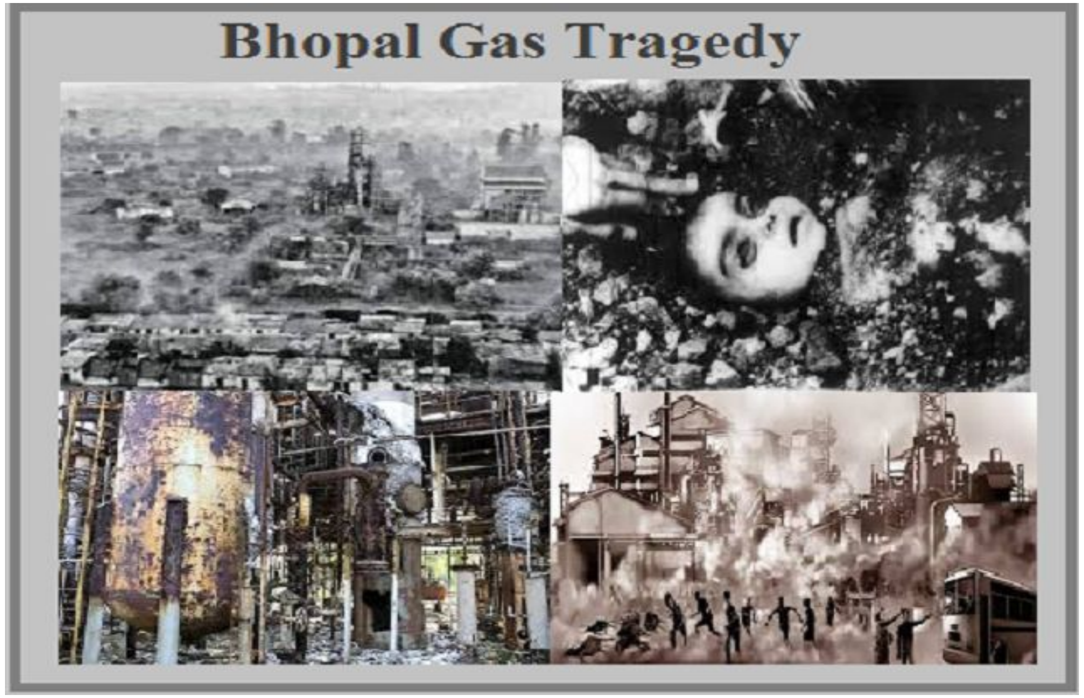
- India has witnessed the world's worst chemical (industrial) disaster "Bhopal Gas Tragedy" in the year 1984.

- The Bhopal Gas tragedy was most devastating chemical accident in history, where over 2500 people died due to accidental release of toxic gas **Methyl Iso Cyanate** (MIC).

- India continued to witness a series of chemical accidents even after Bhopal had demonstrated the vulnerability of the country. Only in last decade, 130 significant chemical accidents reported in India, which resulted into 259 deaths and 563 number of major injured.

Status of Chemical Disaster Risk in India

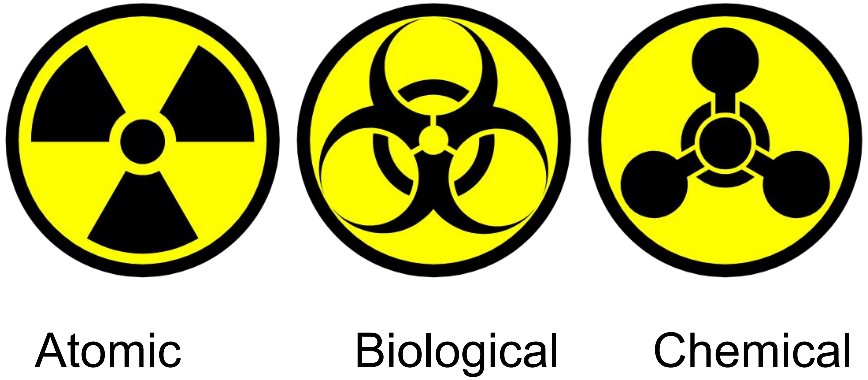




Source: https://prevencontrol.com/prevenblog/lessons-learned-30-years-bhopal-disaster-new-safety-culture/

Biological Disaster-Natural or Human-made?

- Charles Baldwin developed the symbol for biohazard in 1966.
- Biological disasters are natural scenarios involving disease, disability, or death on a large scale among humans, animals, and plants due to micro-organisms like bacteria, or viruses, or toxins.



Biological Disaster-Natural or Human-made?

- The US Center for Disease Control classifies biohazards into four biosafety levels as follows:

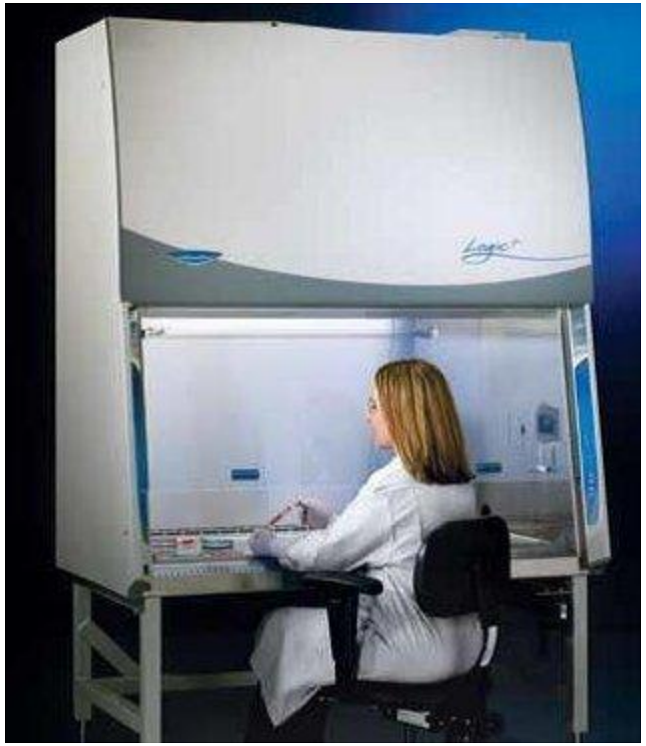
  - BSL-1: Bacteria and Viruses including *Bacillus subtilis*, some cell cultures, canine hepatitis, and non-infectious bacteria. Protection is only facial protection and gloves.

  - BSL-2: Bacteria and viruses that cause only mild disease to humans, or are difficult to contract via aerosol in a lab setting such as hepatitis A, B, C, mumps, measles, HIV, etc. Protection – use of autoclaves for sterilizing and biological safety cabinets.

Biological Disaster-Natural or Human-made?

- BSL-3: Bacteria and viruses causing severe to fatal disease in humans. Example: West Nile virus, anthrax, MERS coronavirus. Protection – Stringent safety protocols such as the use of respirators to prevent airborne infection.
- BSL-4: Potentially fatal (to human beings) viruses like Ebola virus, Marburg virus, Lassa fever virus, etc. Protection – use of a positive pressure personnel suit, with a segregated air supply.

Biological Disaster-Natural or Human-made?



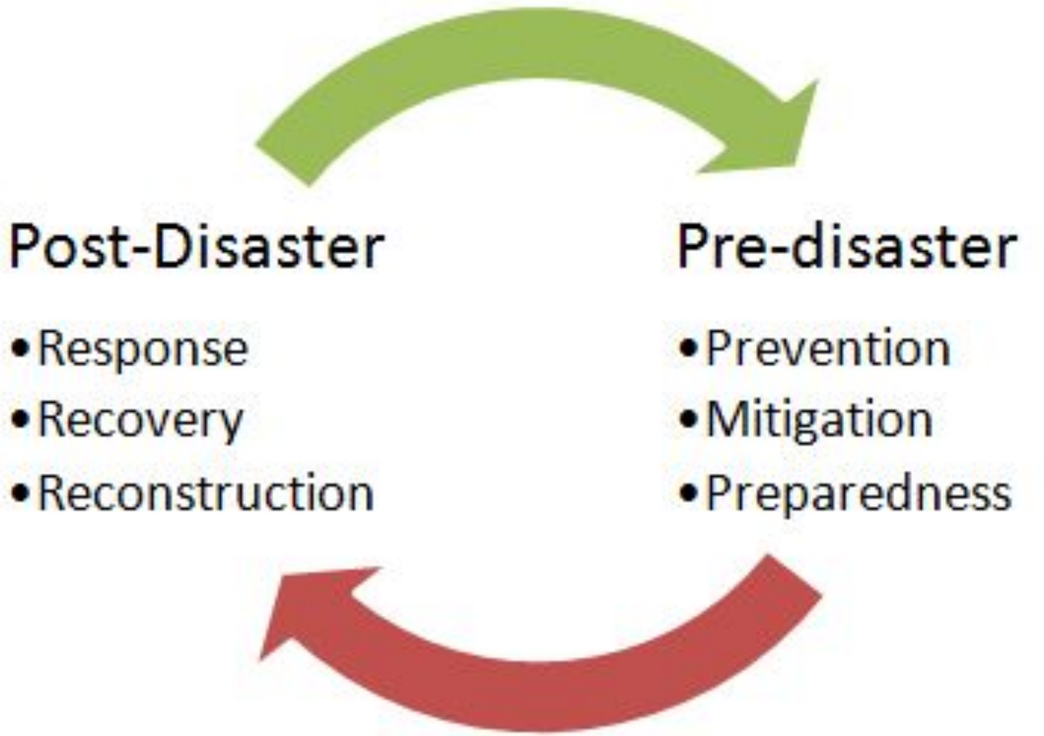
Biological safety cabinet BSL - 2

BSL - 3

BSL - 4

Source: https://absa.org/event/bsl-3-laboratory-training-2/

Pre & post disaster management



Pre disaster management

- Disaster **prevention and mitigation** refers to the activities which are undertaken to prevent or mitigate the adverse effects of a disaster in short and long term.
- On the one hand they include political, legal, administrative and infrastructural measures; while on the other hand it includes educating vulnerable communities influencing their lifestyle and behaviour in order to reduce their disaster risk.

Pre disaster management

- **Disaster Preparedness**
- The intention of Disaster preparedness is to prevent or minimize the losses and damage in case of a disaster.
- This would include the preparedness of all civic bodies such as civil administration, fire-brigade, hospitals, police etc. Preparedness denotes the third phase of emergency management.

- **Response, Recovery and Reconstruction**
- The response phase includes the search and rescue; fulfilling basic humanitarian needs of victims ; assistance by regional, national and international bodies etc. Recovery phase starts after the immediate threat to human life has subsided.
- The immediate goal of the recovery phase is to bring the affected area back to some degree of normalcy. During reconstruction, the location or construction material of the property is considered.

Bioterrorism

- A biological attack, or **bioterrorism**, is the intentional release of viruses, bacteria, or other germs that can sicken or kill people, livestock, or crops.
- **Biological warfare:** intentional use of microorganisms and toxins usually of microbial, plant or animal origin to produce disease and death among humans, live stock and crops.

Bioterrorism

- World War 1: Germany sent infected horses and mules into the Allied forces
- World War 2 : Japanese military unit 731 killed Chinese in the regions of Ping Fan, Manchuria using various agents including anthrax
- In September 2001, the American public was exposed to anthrax spores as a bioweapon delivered through the US postal system, called the case of the 'anthrax letters' in the aftermath of the World Trade Center attack.

- **Ideal features of a Bioterrorist agent:**
- Should consistently produce a given effect, death or disease, at low concentrations.
- Should be highly contagious,
- Have a short and predictable incubation period.
- The target population should have little or no immunity against the organism.
- Little or no prophylaxis or treatment should be available with the native population.

- The bioterrorist agents with highest priority are
- Anthrax (*Bacillus anthracis*),
- Botulism (*Clostridium botulinum*),
- Plague (*Yersinia pestis*),
- Smallpox (*Variola major*),
- Tularaemia (*Francisella tularensis*) and
- Viral haemorrhagic fevers (Filoviruses and Arena viruses).

Bioterrorism

	CRITERIA	EXAMPLES
Category A	High mortality, disseminate easily, needs special action	*Bacillus. anthracis*, *Yersinia pestis*, *Variola major*, *Francisella tularensis*, Filoviruses & Arenaviruses family
Category B	Moderately easy to disseminate, moderate morbidity	*Brucella* species, *Salmonella* species, *Escherichia coli* O157:H7, *Vibrio cholerae* Alphaviruses family
Category C	Easily produced, potential for high morbidity and mortality	*Mycobacterium tuberculosis** Nipah virus, Hantavirus,

https://www.researchgate.net/publication/303403193_CLASSIFICATION_CAUSES_CONTROL_MEASURES_AND_ACTS_OF_BIOTERRORISM/figures

Delivery Mechanisms

1) **Aerosol spray** : easiest method of dispersal. Highest number of people victimized
2) **Food & Water contamination** : more cumbersome. People victimized are less & large quantities of agent required
3) **Spores** : Through envelops (Anthrax) easy dispersal.
4) **Infected People/ Animals :** People or animals in the prodromal or latent illness where the organism can't be identified. Very difficult and very few people will be infected.

Bioterrorism Indicators

Clinicians to identify a bioterrorism attack :

1) Clustering of cases,
2) Disease in no-risk individuals
3) Atypical conditions like unusual age groups, or seasons

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ENVIRONMENTAL STUDIES & LIFE SCIENCES

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ENVIRONMENTAL STUDIES & LIFE SCIENCES

Environmental Pollution and its types

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Pollution – Introduction

The term *pollution* can refer to both artificial and natural materials that are created, consumed, and discarded in an unsustainable manner.

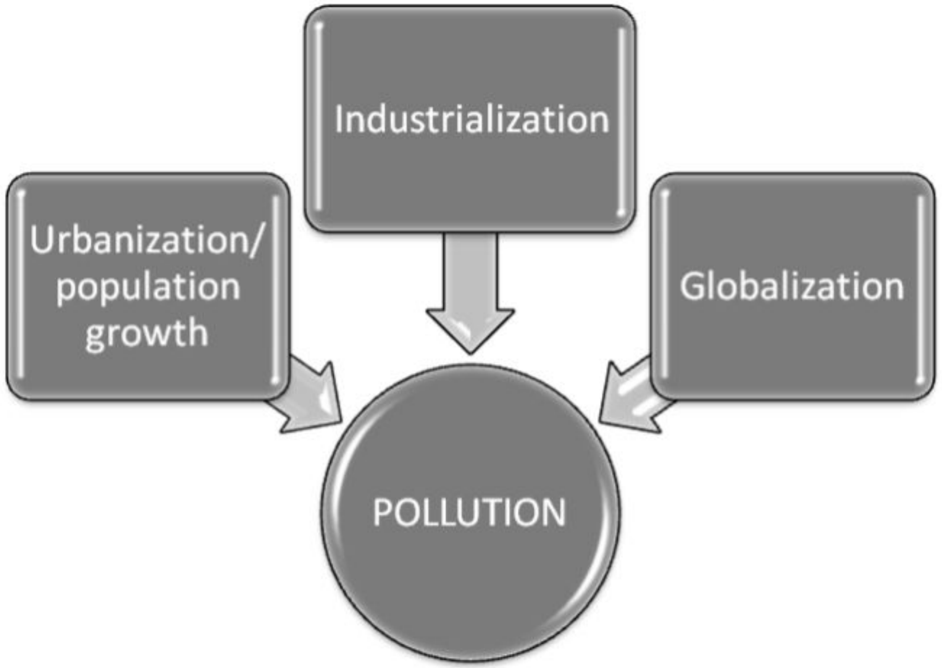
Pollutant

Pollutant is defined as harmful material released into the environment that causes undesirable effects in the environment.

Pollutants are the elements, molecules and particles involved in pollution - life can be harmed when exposed to these materials, and the effects of them on humans and plants are well known.

Environmental Pollution and its impacts

Environmental pollution may destabilize development process and competitiveness of developing nations whose economies depends on natural resources.



The Fundamental Drivers of Pollution
https://www.pide.org.pk/pdf/PDR/2016/Volume4/589-604.pdf

Types of Environmental Pollution

- Industrialisation is the first fundamental cause of pollution.
- Among other things, industrialization set in motion the widespread use of fossil fuels (oil, gas and coal) which are now the main sources of pollution.
- Industrial pollution contribute majorly in emitting waste gases like carbon monoxide, sulphur oxides, and nitrogen oxides which are the waste products of industry and end up in the air as well as dumping of industrial waste into water, endangering human life

Types of Environmental Pollution

Overview on Pollution

- Any form of pollution that can trace its immediate source to industrial practices is known as industrial pollution.
- Most of the pollution on the planet can be traced back to industries of some kind.

https://www.conserve-energy-future.com/causes-effects-of-industrial-pollution.php

Types of pollution

The term "pollution" refers to any substance that negatively impacts the environment or organisms that live within the affected environment.

The five major types of pollution include:

- **Air pollution,**
- **Water pollution,**
- **Soil pollution,**
- **Light pollution,**
- **Thermal Pollution**
- **Radioactive Pollution and**
- **Noise pollution**.

Types of Environmental Pollution

https://www.trackpollution.com/

Air pollution

Sources: Urbanization/ Manmade- Outdoor pollution sources and Indoor pollution sources

- **Burning of fossil fuels** : The burning of fossil fuels contributes to the formation of smog, a dense layer of particulate matter that hangs like a cloud over many major cities and industrial zones.

- **Vehicle and factory emissions** : Carbon monoxide, sulfur dioxide and lead are typically released directly into the atmosphere from industrial activity and vehicles.
  Ozone, is usually created from the chemical decomposition of nitrogen oxides released from automobiles. Nitrogen dioxide is the product of the oxidation of nitrogen oxides.

Indoor include carbon monoxide, methane, particulate matter (PM), polyaromatic hydrocarbons (PAH) and volatile organic compounds (VOC).
SPM is usually caused by dust, combustion,

Air pollution and its effects

- Air pollution is the introduction of harmful chemicals into the atmosphere.
- The exhaust from vehicles for instance, is polluting the air with toxic chemicals such as carbon monoxide and formaldehyde.

https://www.nationalgeographic.org/encyclopedia/pollution

Air pollution

Sources:

Natural sources: Volcanic eruption, dust storm, forest fire, Carbon dioxide from humans during respiration, Methane from cattle during digestion, Oxygen from plants during Photosynthesis

Manmade

natural

https://www.conserve-energy-future.com/causes-effects-solutions-of-air-pollution.php

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Major Pollutants of air:

- Ozone
- particulate matter
- carbon monoxide
- nitrogen dioxide
- sulfur dioxide and
- lead
- Volatile organic compounds (VOCs)
- Chlorofluorocarbons (CFCs)
- Mercury (Hg)
- Peroxyacyl nitrates (PANs)

Air pollution and its Environmental effect

Types of air pollutants:

It can be further divided into **Primarily and Secondary air pollutants** if we go deep.

Primarily air pollutants can be caused by primary sources or secondary sources. The pollutants that are a direct result of the process can be called Primary pollutants. Eg. sulfur-dioxide emitted from factories.

Secondary pollutants are the ones that are caused by the intermingling and reactions of primary pollutants. Smog created by the interactions of several primary pollutants is known as a secondary pollutant.

Classification of Air Pollution

Air pollution can be classified into two sections –

Visible air pollution, like smog over a city is an example of visible pollution.

Invisible air pollutants are less noticeable, but they can be more deadly. Good examples of invisible air pollutants are sulfur dioxide, carbon monoxide and nitrogen oxides

Effects of Air pollution

1. Respiratory and Heart Problems- Asthma, chronic bronchitis, emphysema, heart attacks and strokes along with cancer

2. Child Health Problems- Exposure to high air pollution levels during pregnancy causes miscarriages as well as premature birth, autism, asthma and spectrum disorder in young children. Brain development and pneumonia

3. Global Warming - With increased temperatures worldwide, an increase in sea levels and melting of ice from colder regions and icebergs, displacement, and loss of habitat have already signaled an impending disaster if actions for preservation and normalization aren’t undertaken soon.

Environmental effects of air pollution

4. Acid Rain

Harmful gases like nitrogen oxides and sulfur oxides are released into the atmosphere during the burning of fossil fuels. When it rains, the water droplets combine with these air pollutants, becomes acidic and then falls on the ground in the form of acid rain. Acid rain can cause great damage to humans, animals, and crops.

5. Depletion of the Ozone Layer

Ozone exists in the Earth's stratosphere and is responsible for protecting humans from harmful ultraviolet (UV) rays. Earth's ozone layer is depleting due to the presence of chlorofluorocarbons, hydrochlorofluorocarbons in the atmosphere.

Effects of Air pollution on Environment

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Smog

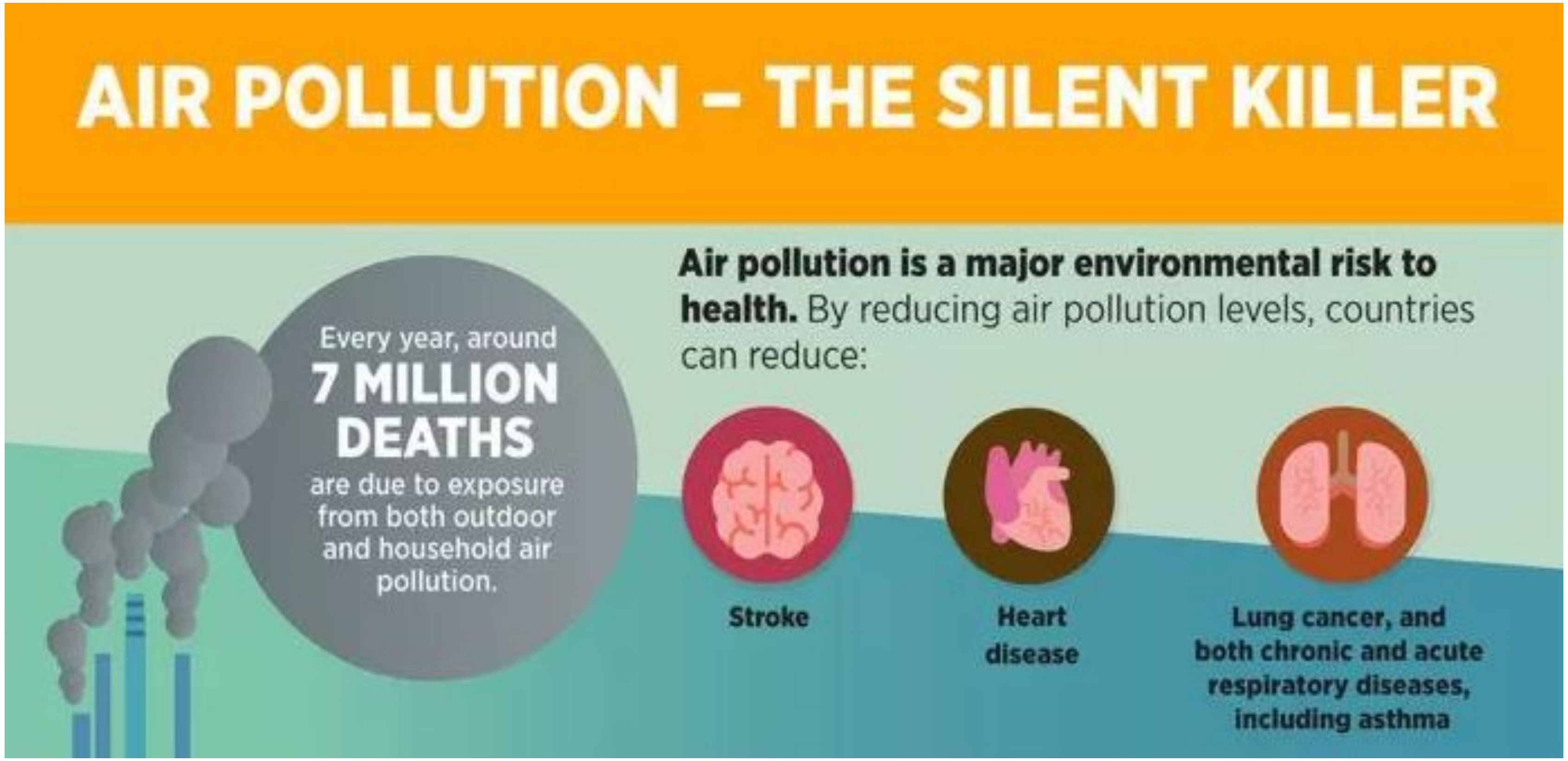
- **Smog** is air pollution that reduces visibility.
- Ex: New Delhi 2019.
- Shanghai smog, The great smog of London (1952)
- Higher levels of smog are associated with a wide range of diseases such as chronic obstructive pulmonary disorder, heart disease, stroke and lung cancer.

https://www.insider.com/new-delhi-smog-air-pollution-photos-2019-11

Solutions To Air Pollution

1. Use the Public Mode of Transportation
2. Better Household Practices
3. Conserve Energy
4. Understand the Concept of Reduce, Reuse and Recycle
5. Use Energy-Efficient Devices

Health effect of air pollution



https://www.conserve-energy-future.com/causes-effects-solutions-of-air-pollution

Water pollution

- Water pollution happens when toxic substances enter water bodies such as lakes, rivers, oceans and so on, getting dissolved in them, lying suspended in the water or depositing on the bed.

- This degrades the quality of water.

https://www.britannica.com/explore/savingearth/water-pollution

Environmental Pollution and its effect- WATER

Pollutants or contaminants which enter a body of water can be further divided into:

Degradable (non-conservative) pollutants: impurities which eventually decompose into harmless substances or which may be removed by treatment methods; that is, certain organic materials and chemicals, domestic sewage, heat, plant nutrients, most bacteria and viruses, certain sediments

Non-degradable (conservative) pollutants: impurities which persist in the water environment and do not reduce in concentration unless diluted or removed through treatment; that is, certain organic and inorganic chemicals, salts, colloidal suspensions

Hazardous waterborne pollutants: complex forms of deleterious wastes including toxic trace metals, certain inorganic and organic compounds

Radionuclide pollutants: materials which have been subjected to a radioactive source.

Water pollution and its Environmental effect

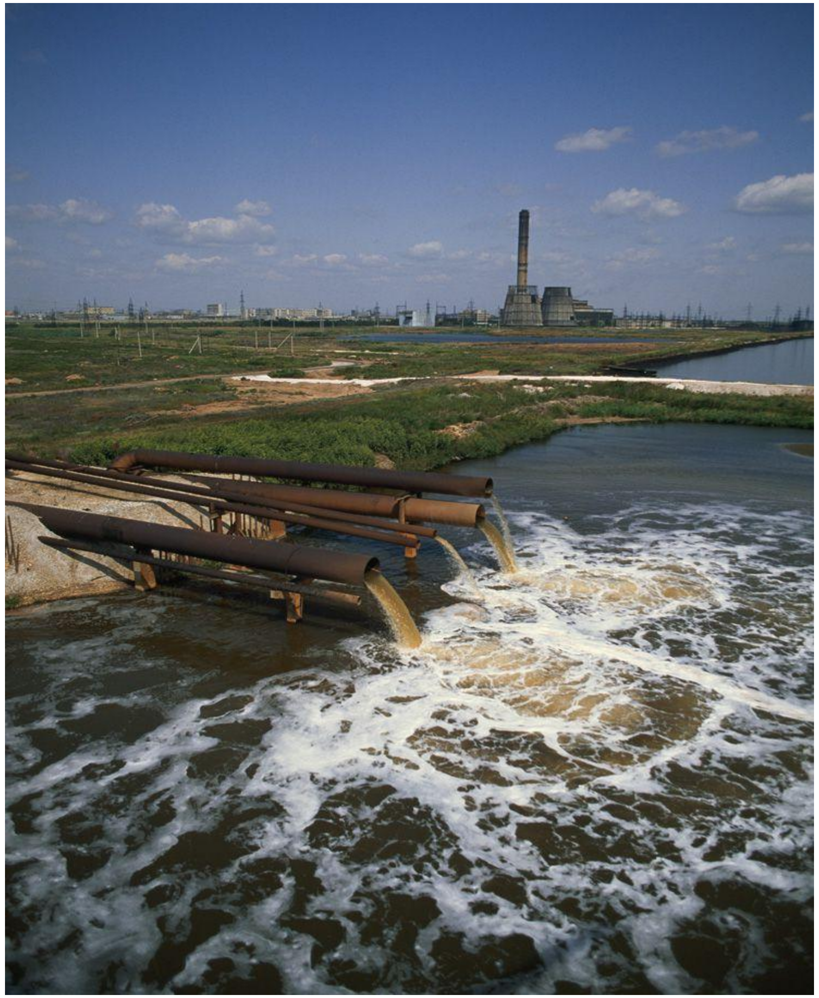
- Not only does this spell disaster for aquatic ecosystems, the pollutants also seep through and reach the groundwater, which might end up in our households as contaminated water we use in our daily activities, including drinking.

https://indianexpress.com/article/cities/

Water pollution and its Environmental effect

Industrial Runoff

- Stormwater and **industrial runoff** is a leading cause for water pollution.
- Industrial runoff typically contains high concentrations of pollutants such as heavy metals and petroleum hydrocarbons.



https://www.nationalgeographic.org/encyclopedia/pollution

Water pollution and its Environmental effect

Oil Spill

- An **oil spill** refers to any uncontrolled release of crude oil, gasoline, fuels, or other oil by-products into the environment.

https://www.orfonline.org/expert-speak/mauritius-oil-spill

Oil Spill

- The **Deepwater Horizon oil spill** was an industrial disaster that began on April 20, 2010, in the Gulf of Mexico on the BP-operated Macondo Prospect, considered to be the largest marine **oil spill** in the history of the **petroleum** industry

https://www.orfonline.org/expert-speak/mauritius-oil-spill

Types of pollution – Water Pollution

Sources of Water Pollution

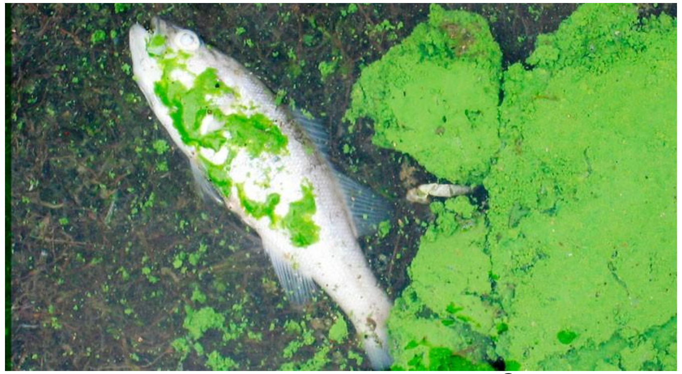
- Water pollution comes from point sources or non-point sources.
- **Point sources** include factories, sewage pipes and specific spills from pipelines or containers.

- **Non-point sources**, however, do not have a specific point of origin. Runoff from storms and melting snow carry fertilizers, pesticides, oil and gasoline, litter such as plastic bags and animal faeces into storm drains, creeks, rivers, lakes and, ultimately, the ocean.

Water pollution and its Environmental effect

Major water pollutants

- Runoff from agricultural fields, industrial sites, or urban areas . Agricultural runoff typically includes fertilizer or toxic chemicals. Fertilizer can cause algal blooms .
- Raw sewage
- Trash such as plastic bags, fishing line, and other material
- oil spills



https://www.conserve-energy-future.com/causes-effects-solutions-of-air-pollution

Types of pollution – Water Pollution

Major pollutant types

Major types of water pollution around the world is caused by

- microbial pathogens (mostly disease-causing bacteria and viruses)
- nutrients from fertilizers and faeces
- heavy metals such as arsenic and mercury
- chemicals from roads and industry and
- litte
- Heat pollution, especially near power plants, can severely impact local ecosystems.

Types of pollution – Water Pollution

Effects of Water Contamination

- Diarrhea, skin diseases and other infections
- Bioaccumulation occurs as heavy metals like mercury move up through the food chain contaminate shellfish and fish like mackerel, tuna and sharks, exposing consumers to these toxic chemicals.
- Mercury poses higher health risks to children under 6 and to child-bearing women because it interferes with brain development.
- Oil floats on water, cutting off oxygen for plankton. Oil causes tissue damage in coral and coral larvae, causes heart defects in bluefin tuna larvae and other fish and even small amounts of oil impairs the ability of seabirds to fly, swim and dive for food.

Types of Pollution-Land Pollution

Land Pollution refers to the deterioration of the earth's land surfaces.

It is a result of indirect and direct effects of human activities.
It is a global issue that needs to be fixed immediately.

Soil pollution as part of land degradation is caused by the presence of Xenobiotics (human-made) chemicals or other alteration in the natural soil environment. It is typically caused by industrial activity, agricultural chemicals or improper disposal of waste

EPA (Environmental Protection Agency) estimates the pollution

Soil Pollution

The presence of substances in soil that are not naturally produced by biological species is of great public concern.

Xenobiotic

- Xenobiotics are defined as chemicals to which an organism is exposed that are extrinsic to the normal metabolism of that organism.
    - Ex: poly aromatic hydrocarbons (PAHs), persistent organic pollutants (POPs)

Environmental effect of soil Pollution

Recalcitrants:

- **Recalcitrants** are pollutants that persist in the environment, they are capable of long range transportation, bioaccumulation, in human and animals, and biomagnifications in food chain.
- The **term** "**long-range transport**" refers to the **transport** by the wind of air pollutants or their precursors from the areas where they were emitted to other locations at downwind distances of 100 km or more.
    - Ex: most phenols (especially chloro- and nitro-derivatives) and fungicides.

Environmental effect of soil Pollution

Landfills

- Landfills are well-engineered facilities designed to receive specific kinds of waste, including municipal solid waste, construction and demolition debris and hazardous waste.

https://www.nationalgeographic.org/encyclopedia/pollution

Land pollution and its Environmental effect

Causes of Land Pollution

various substances that spill on the land cause land pollution.

Similarly, these substances have different sources of origin.

The most common ones are:

Garbage

Factories

Farming

Mining

Environmental effect of soil Pollution

Garbage: wet and dry waste , e waste generated at household gets dumped onto land which is referred to as a landfill. landfills release toxic gases that harm living beings as well as the ozone layer.

Factories

Factories produce toxic waste products and chemical which prove very damaging to land.

Farming : fulfil our food demands but may be harmful sometimes. Clearing of forests for land area in order to farm and use of insecticides and fertilizers sprayed on crops also damage the land.

Mining

Is done in order to obtain coal and minerals, we dig holes into the land. This results in land erosion and aswell produces harmful gases and toxins which results in contaminated land as well as the air.

Environmental effect of soil Pollution

Effects of Land Pollution

- Cancer and skin infections.
- landfills also release methane gas which increases the effect of Global warming; Leachate contaminating ground water

Prevention of Land Pollution

- Reducing the usage of chemicals and pesticides
- Reforestation
- Recovering and Recycling Material
- Limit use of disposable products

Environmental effect of Noise Pollution

Types of pollution : Noise pollution-

Unpleasant sound is noise

- **Noise pollution** is generally defined as regular exposure to elevated sound levels that may lead to adverse effects in humans or other living organisms.

  According to the World Health Organization, sound levels less than 70 dB are not damaging to living organisms, regardless of how long or consistent the exposure is.

https://en.wikipedia.org/wiki/Noise_pollution

Environmental effect of Noise Pollution

Effects of Noise pollution :

- **Noise pollution** is an invisible danger.
- It causes is **Noise** Induced Hearing Loss (NIHL).
- Exposure to loud **noise** can also cause high blood pressure, heart disease, sleep disturbances, and stress.
- These health problems can **affect** all age groups, especially children.

Prevention of Noise Pollution:

- Upgrade Insulation.
- Noise Cancelling Headphones and Earplugs.
- Turn Off Electrical Appliances.
- Place Furniture Strategically in Your Property.

Environmental effect of thermal pollution

Types of Pollution - Thermal pollution

Thermal pollution is sudden increase or decrease in temperature of a natural body of water, that may be ocean, lake, river or pond by human influence.

Causes:

This normally occurs when a plant or facility takes in water from a natural resource and puts it back with an altered temperature.

It is from hot water or cold water being dumped into a body of water

https://en.wikipedia.org/wiki/Thermal_pollution

Environmental effect of thermal pollution

Effects of thermal pollution

- It decrease the amount of dissolved oxygen in the water
- aquatic life like fishes, their larvae and eggs gets damaged .
- Kills some species of fish and macroinvertibrates that have a limited tolerance for temperature change, and migration of living entities
- Contributes to global warming

Environmental effect of Radioactive pollution t

Types of Pollution- Radioactive pollution

The radioactive pollution is the physical pollution resulting due to of release of radioactive substances into the environment during nuclear explosions and testing of nuclear weapons, nuclear weapon production and decommissioning, mining of radioactive ores

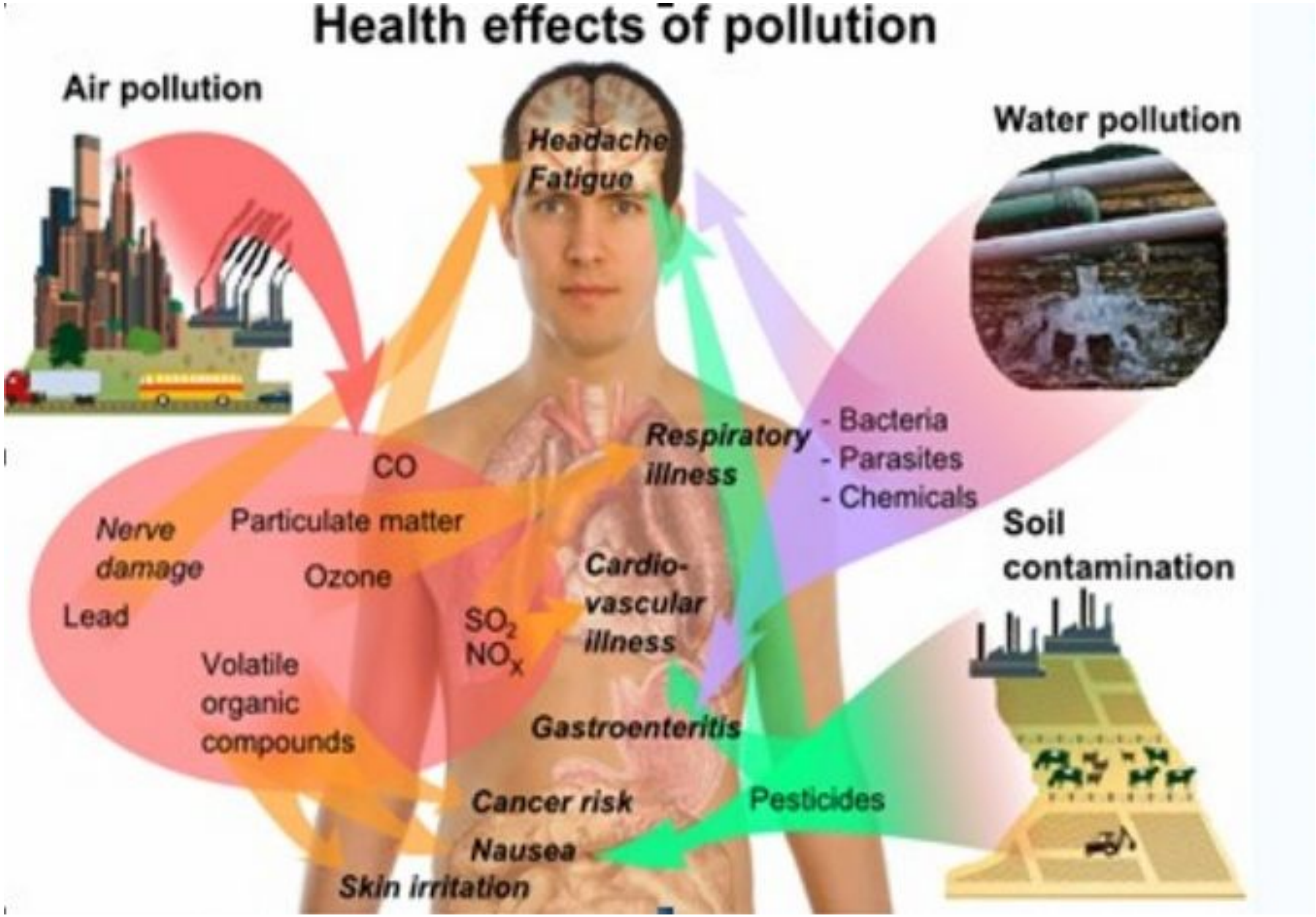
https://sites.google.com/site/iibismevs/air-pollution/sources-of-air pollution/home/radiation-pollution

Effects of Radiation :

Exposure to very high levels of radiation, such as being close to an atomic blast, can cause acute health effects such as

- skin burns
- acute radiation syndrome ("radiation sickness").
- Skin cancer
- cardiovascular disease.
- chronic respiratory disease,
- lung cancer

Effects of Environmental Pollution on human



https://www.toppr.com/guides/chemistry/environmental-chemistry/land-pollutio

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ENVIRONMENTAL STUDIES & LIFE SCIENCES

Environmental Pollution and management

Dr. Sasmita Sabat
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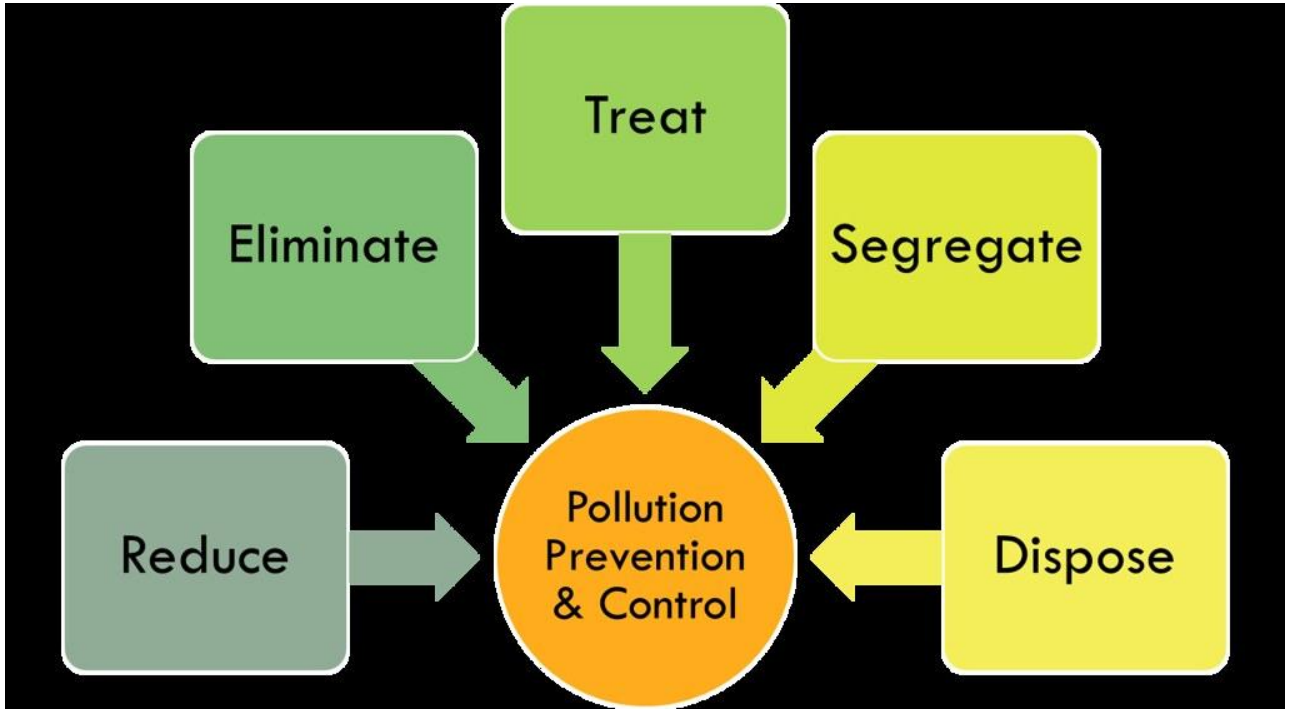
INTRODUCTION

- Around the world, people and governments are making efforts to combat pollution.
- **Pollution** control is the process of reducing or eliminating the release of pollutants into the **environment** .
- It is regulated by various environmental agencies which establish pollutant **discharge** limits for air, water, and land.
- Recycling, for instance, is becoming more common.
- In recycling, trash is processed so its useful materials can be used again.
- Glass, aluminum cans, and many types of plastic can be melted and reused.
- Paper can be broken down and turned into new paper.

Pollution control



https://www.lanl.gov/environment/sustainability/pollution-prevention.php

International agencies

World Health Organization (WHO),
World Meteorological Organization (WMO) and
United Nations Environment Programme (UNEP) have instituted monitoring and research projects in order to clarify the issues involved in air pollution and to promote measures to prevent further deterioration of public health and environmental and climatic conditions.

The Global Environmental Monitoring System GEMS/Air (WHO/ UNEP 1993) is organized and sponsored by WHO and UNEP and has developed a comprehensive programme for providing the instruments of rational air pollution management

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Growing recognition of the environmental and public health impacts associated with anthropogenic activities has prompted the development and application of methods and technologies to reduce the effects of pollution.

Governments have adopted regulatory and other policy measures to minimize negative effects and ensure that environmental quality standards are achieved.

Best Ways to Reduce Air Pollution

1. Using public transports.
2. Turn off the lights when not in use.
3. Recycle and Reuse.
4. No to plastic bags.
5. Reduction of forest fires and smoking.
6. Use of fans instead of Air Conditioner.
7. Use filters for chimneys.
8. Avoid usage of crackers.
9. Avoid using of products with chemicals
10. Implement Afforestation

Under the pollution control approach, attempts to protect the environment have especially relied on isolating contaminants from the environment and using end-of-pipe filters and scrubbers.

These solutions have tended to focus on media-specific environmental quality objectives or emission limits, and have been primarily directed at point source discharges into specific environmental media (air, water, soil).

Factor Coordination :
Industrial development, city planning, water resources development and transportation policies

Environmental pollution Management:

- Environmental pollution controls often include the management of land development and the design of transportation systems so as to reduce pollution.
- Environmental planning, the management of land development, and the design of transportation systems are key components of environmental pollution control.

Stages of the pollution management model:

Strategies for reducing these impacts can be directed at three different levels in the process:

1. Altering the human activity,
2. Regulating and reducing quantities of pollutant released at the point of emission, and
3. Cleaning up the pollutant and restoring ecosystems after pollution has occurred.

Control Measures

Controls can be divided into two basic types of controls - technological and administrative.

Technological:

Gaseous- Condensation, adsorption, absorption, incinerator

Particulate- wet scrubbers, electrostatic precipitators, Filters

WATER POLLUTION CONTROL

water pollution problems

- Surface Water Pollution Control
- Groundwater Pollution Control

Water pollution refers to the qualitative state of impurity or uncleanliness in hydrologic waters of a certain region, such as a watershed.

It results from an occurrence or process which causes a reduction in the utility of the earth's waters, especially as related to human health and environmental effects.

Pollution occurring within these drainage systems originates from the following sources:
Point sources: waste discharges into a receiving water body at a specific location, at a point such as a sewer pipe

Non-point (dispersed) sources: pollution entering a receiving water body from dispersed sources in the watershed; uncollected rainfall runoff water drainage into a stream is typical. Non-point sources are also sometimes referred to as "diffuse" waters.

Intermittent sources: from a point or source which discharges under certain circumstances, such as with overloaded conditions; combined sewer overflows during heavy rainfall runoff periods are typical.

Water pollution control regulations

- National and state (or province) levels,
- Environmental protection agencies (EPAs) and
- Ministries of health are usually charged with this responsibility

Water supplies include:

· **Public water supply**: waters which with conventional treatment will be suitable for human consumption

· **Agricultural supply**: waters suitable for irrigation and livestock watering without treatment

· **Industrial/commercial supply:** waters suitable for industrial and commercial uses with or without treatment.

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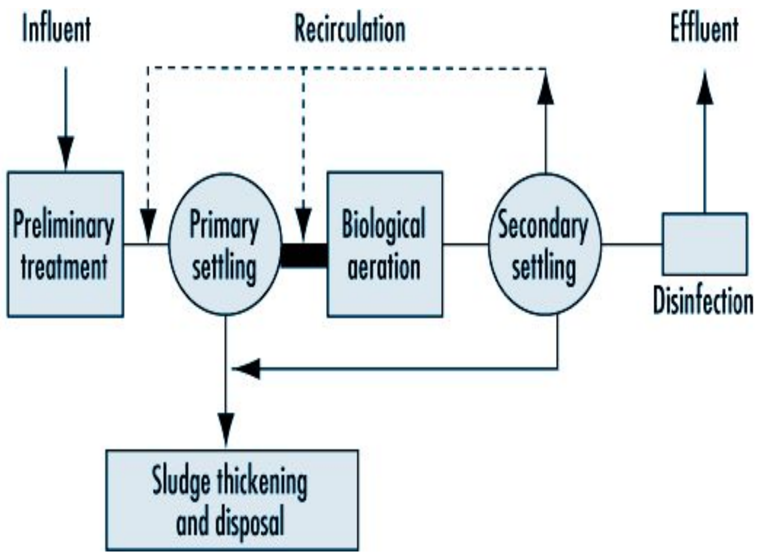
Soil Pollution control

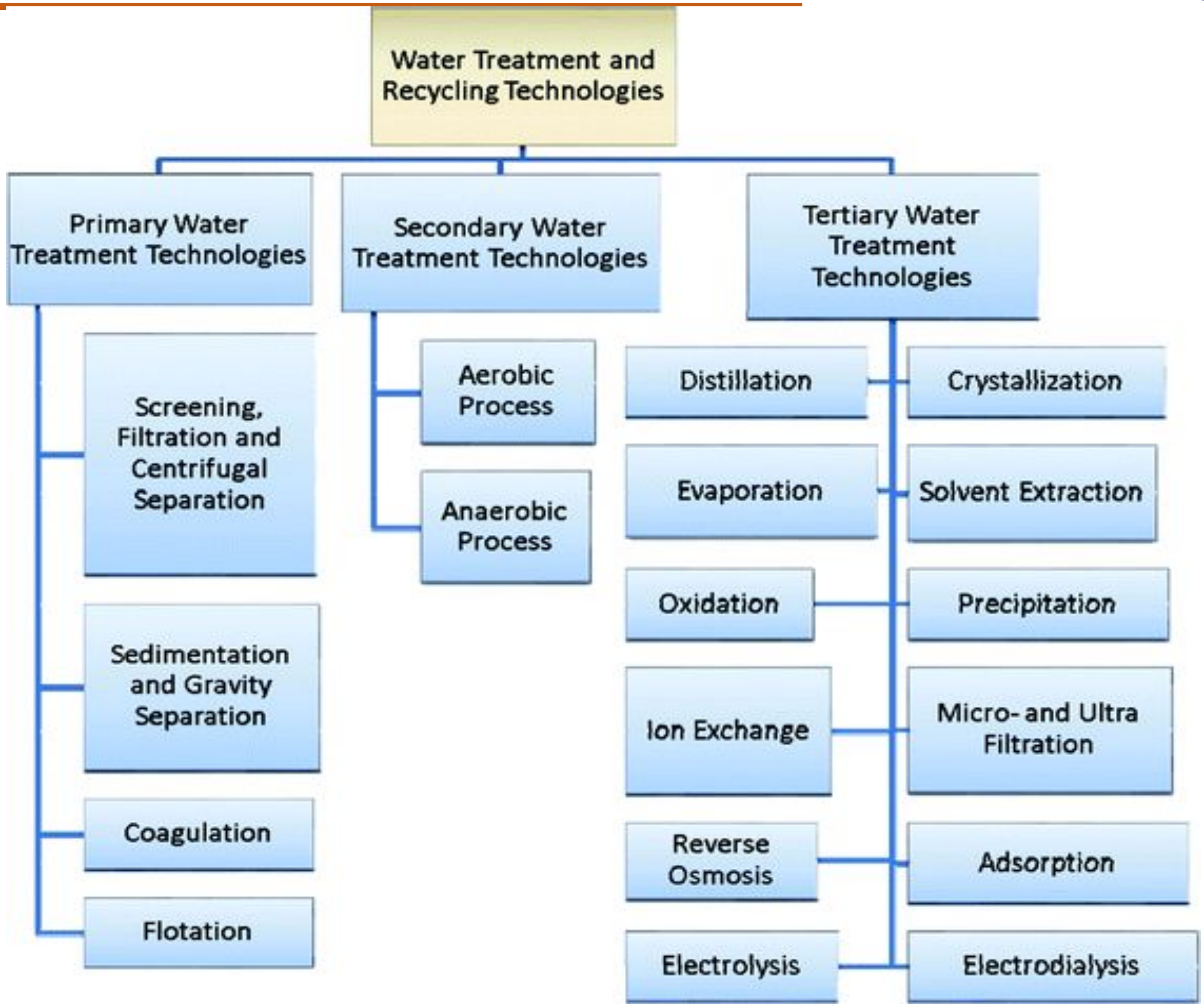
- Solid pollution control methods which are typically used include landfilling, composting , and incineration.

BIS GUIDELINES OF PARAMETERS

Parameters	UNITS	GUIDELINE VALUE
pH	-	4-12
Suspended solids	mg/l	24-5700
BOD5	mg/l	450-4,790
COD	mg/l	80 - 95000
Total nitrogen	mg/l	15-180
Total phosphorus	mg/l	11-160
Oil and grease	mg/l	10
Total coliform bacteria	Mpn/100ml	400
Magnesium	mg/l	25-49
Potassium	mg/l	11-160
Chloride	mg/l	48-469
Calcium	mg/l	57-112

Environmental Pollution and management- WATER





https://pubs.rsc.org/en/content/articlelanding/2012/ra/c2ra20340e#!divAbstract

SOLID WASTE MANAGEMENT:

Environmental awareness is leading to a rapid transformation of waste management practices.

Interpretation of this change is necessary before examining in more detail the methods that are applied to waste management and to the handling of residues.

Modern principles of waste management are based on the paradigm of a geared connection between the biosphere and the anthroposphere.

Waste Management Practices

Waste may be grouped into three major categories, depending on its production:

1. from the primary sector of production (mining, forestry, agriculture, animal breeding, fishery)
2. from the production and transformation industry (foods, equipment, products of all types)
3. from the consumption sector (households, enterprises, transportation, trade, construction, services, etc.).

Waste can be also classified by legislative point of view:

Municipal waste and mixed waste from enterprises which may be aggregated as municipal waste, since both consist of the same categories of waste and are of small size (vegetables, paper, metals, glass, plastics and so on), although in differing proportions.

Bulky urban waste (furniture, equipment, vehicles, construction and demolition waste other than inert material)

Waste subject to special legislation (e.g., hazardous, infectious, radioactive).

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Management of municipal and ordinary commercial waste:

Collected by trucks, these wastes can be transported (directly or by road-to-road, road-to-rail or road-to-waterway transfer stations and long-distance transportation means) to a landfill, or to a treatment plant for material recovery (mechanical sorting, composting, biomethanization), or for energy recovery (grid or kiln incinerator, pyrolysis).

SOLID WASTE MANAGEMENT AND RECYCLING

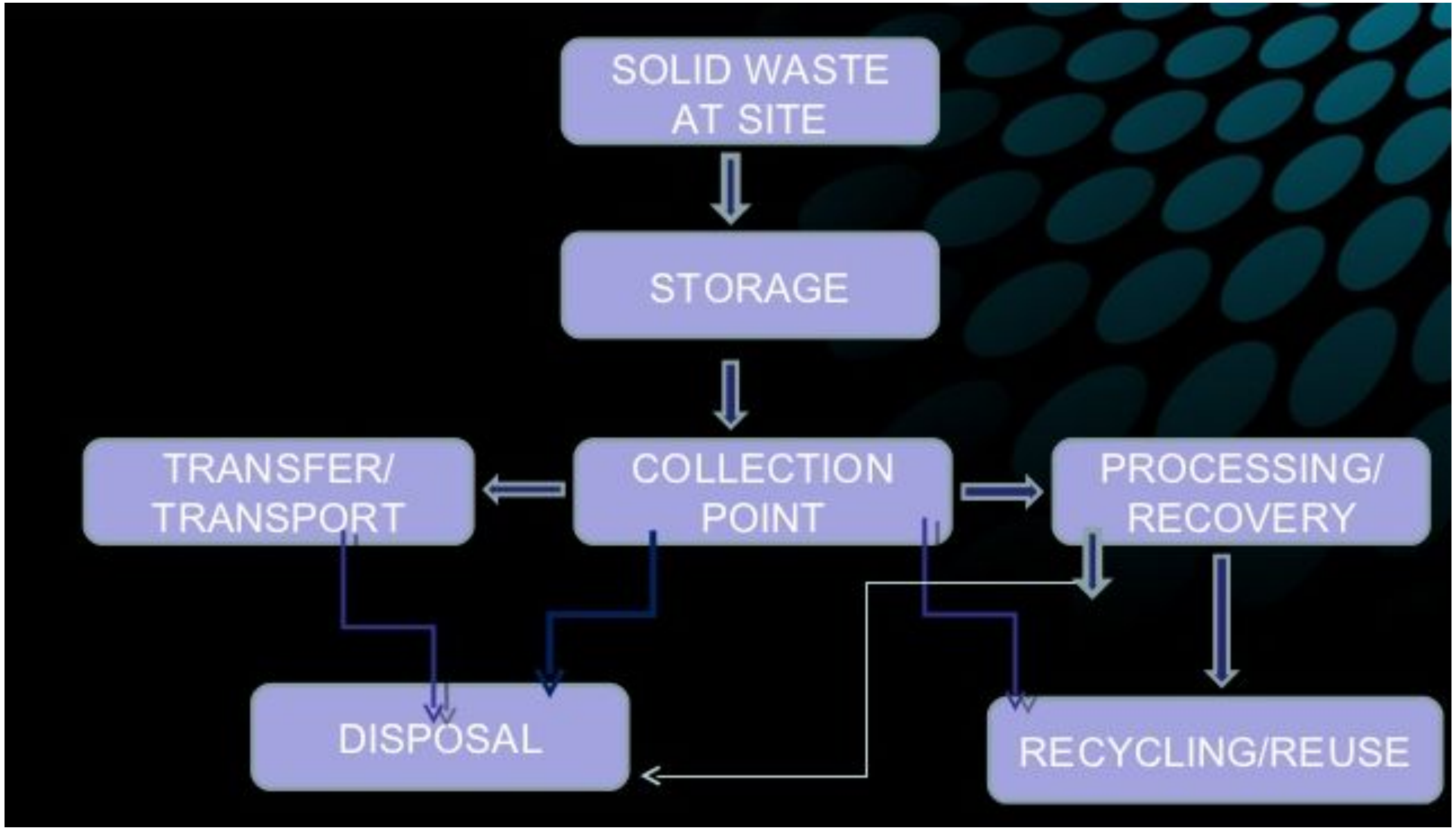
Solid wastes are traditionally described as residual products, which represent a cost when one has to resort to disposal.

Management of waste encompasses a complex set of potential impacts on human health and safety, and the environment.

The impacts, although the type of hazards may be similar, should be distinguished for three distinct types of operation:

- handling and storage at the waste producer
- collection and transportation
- sorting, processing and disposal.

Environmental Pollution and management-SOLID



Environmental Pollution and management-SOLID

Occupational health and safety authorities in the industrialized countries are focusing on working conditions which, a few years ago, passed off unnoticed with unspoken acceptance, such as:
improper heavy lifting and excessive amount of materials handled per working day

- · inappropriate exposure to dust of unknown composition
- · unnoticed impact by micro-organisms (bacteria, fungi) and endotoxins
- · unnoticed exposure to toxic chemicals.

Recycling

Recycling or salvaging is the word covering both reuse (use for the same purpose) and reclamation/recovery of materials or energy.

The reasons for implementing recycling may change depending on national and local conditions, and the key ideas in the arguments for recycling may be:

- detoxification of hazardous waste when high environmental standards are set by the authorities
- resource recovery in low income areas
- reduction of volume in areas where landfilling is predominant
- energy recovery in areas where conversion of waste to energy can replace fossil fuel (coal, natural gas, crude oil and so on) for energy production.

Environmental Pollution and management-NOISE

Noise is an unwanted sound in wrong place at wrong time

Sources: Equipment usage in anthropogenic activities in industry.

Effects: Human- Rise in BP, stress levels and violent behavior.
Hearing Damage- depends on intensity and duration of sound
Physiological and psychological changes in various parts of body

Noise level tolerance: Unit is decibels- Silence zone- 40-50 dB
Residential zone-45-50 dB
Commercial Zone-55-65 dB
Industrial Zone-70-75 dB

Solution: Sound proofing using fibrebglass core, enclosures, acoustic lining

Environmental Pollution and management- THERMAL

Presence of waste heat in water which can cause undesirable changes in the natural environment.

Sources: processes like evaporation, convection, radiation, use of dryers and evaporators.

Effects: decreases oxygen level in the atmosphere, leading to health effects of human beings.

Control: cooling ponds, spray ponds, cooling towers-dry/ wet

Environmental Pollution and management- RADIOACTIVE

Sources: Natural: cosmic rays,
Anthropogenic: Nuclear power plants, X rays, nuclear accidents.

Effects: Genetic damage affecting genes and chromosomes.
Somatic damage- Burns, miscarriages, eye cataract, thyroid and cancer of bone, breast , lung, skin

Control: Proper siting, disposal of waste and maintenance

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Prevention of Radiation :

- Select reagents and procedures that minimize the volume and toxicity of all wastes.
- Avoid ordering excess radioactive materials than requirement
- Non radioactive wastes must never be mixed with radioactive wastes.
- Promotion of Non-radioactive tracers and methods for many common assays, and procedures used in biomedical
- Substitute with Short-lived Radionuclides where feasible
- Reduce the activity and volumes of materials used in the experiment to achieve minimal waste generation
- Replace hazardous chemical solvents with formulations not regulated as hazardous or mixed wastes
- Limit the number of users of radioactive materials
- Limit the number of areas where radioactive materials are used

https://www.orf.od.nih.gov/EnvironmentalProtection/WasteDisposal/Pages/rad_procedures.aspx

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ENVIRONMENTAL STUDIES AND LIFE SCIENCES

BIOMIMETICS

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BIOMIMETICS

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- Biomimetics is the application of biological methods and systems found in nature to the study and design of engineering systems and modern technology.
- Also known as Bionics, biognosis, biomimicry or bionical creativity engineering.

BIOMIMETICS-Strategies and principles

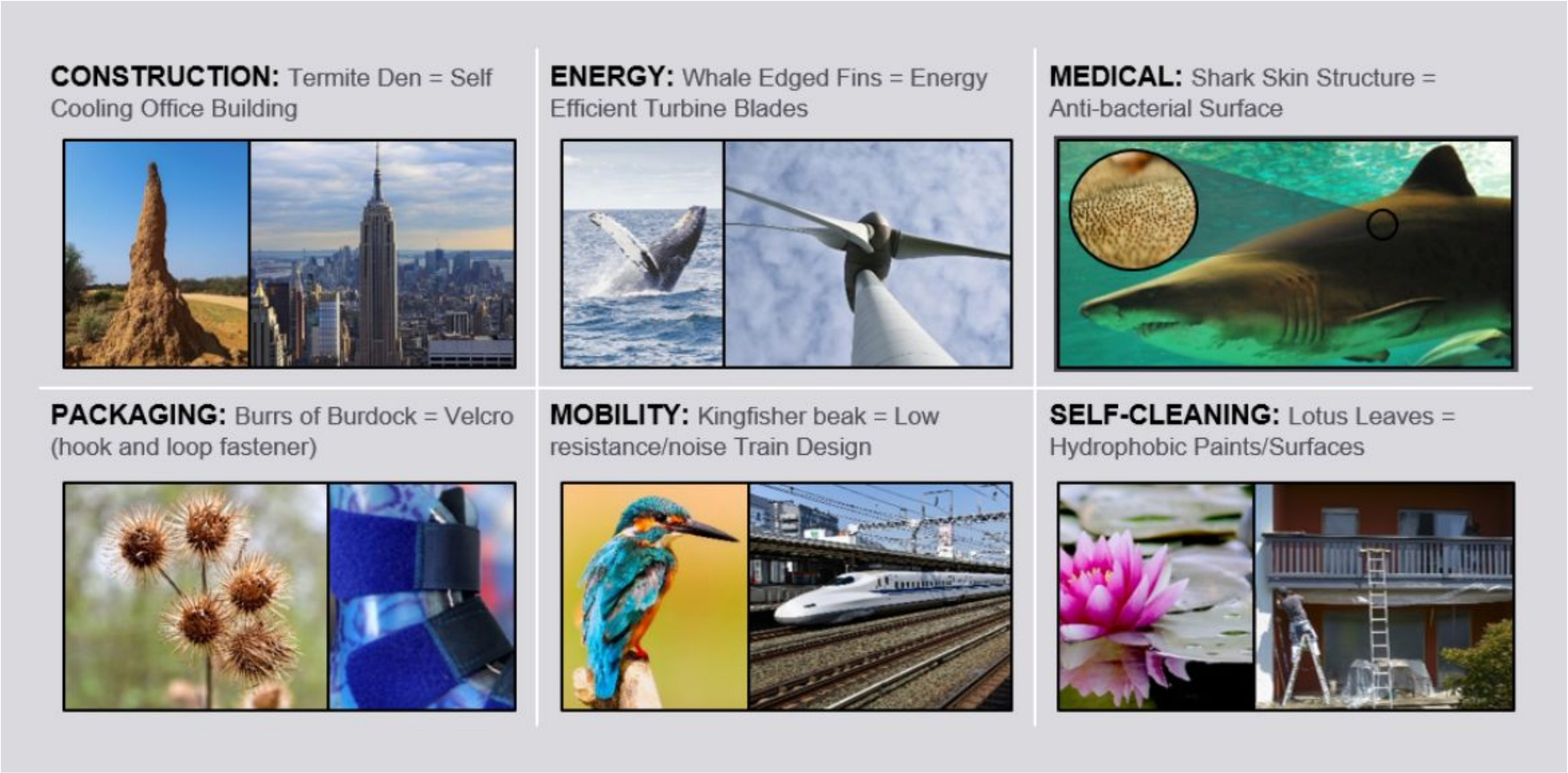
- Nature fits form to function, utilizes a variety of non orthogonal forms and design methods in its constructions to ensure maximization in terms of structural efficiency.
- It minimizes the required input of material.
- Nature recycles everything, Uses waste as a resource.
- Nature uses an ordered hierarchy of structures.
- Nature banks on diversity, constantly mutating and adapting in a flexible and dynamic flow of change.
- Nature self assembles and generates structural organization on all scales.
- Nature is resilient to changes and self healing.
- Nature optimizes rather than maximize, using the least materials for optimal structure and function.

In Europe, Japan, and the USA, biomimetics is being recognized as the technology of the future and there is increasing interest and funding.

In particular, global companies such as Ford, General Electric, Herman Miller, HP, IBM, and Nike are collaborating with scientists and designing laboratories to explore novel technologies.

ENVIRONMENTAL STUDIES AND LIFE SCIENCES

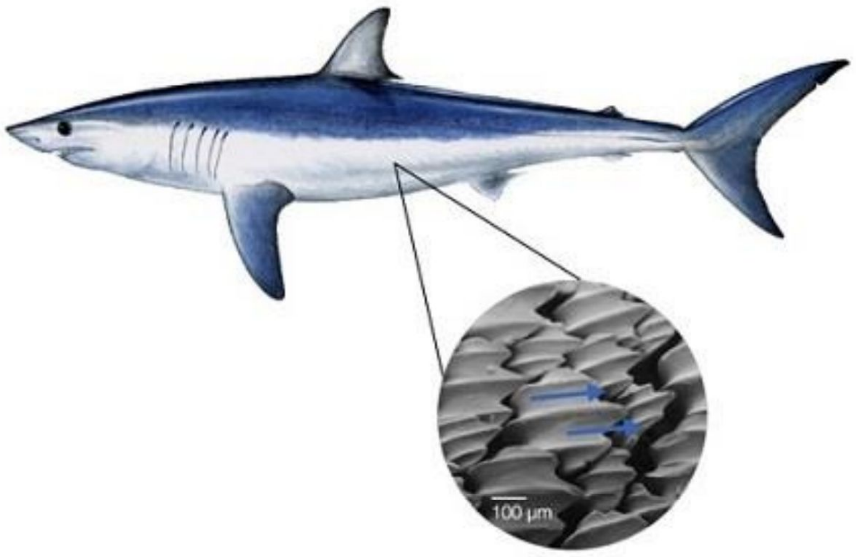
BIOMIMETICS- APPLICATION

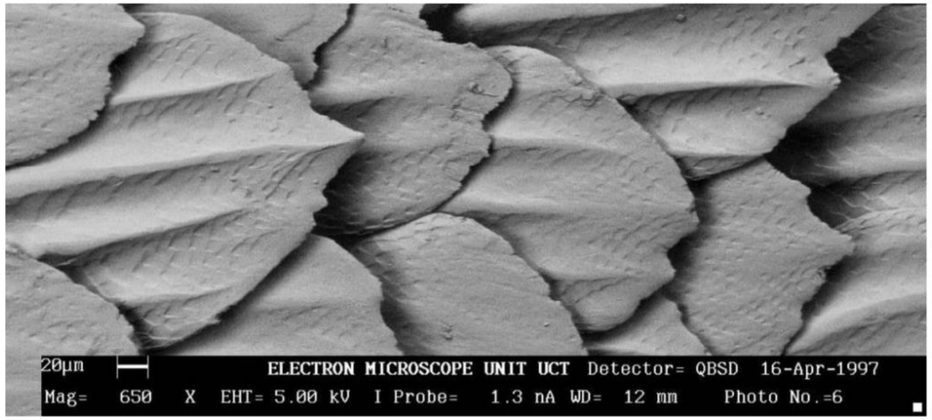


https://www.futurebridge.com/

BIOMIMETICS- APPLICATION

- Shark skin is constructed of overlapping scales.
- Nature through evolution, has ensured that water flows over the scales extremely efficiently, helping the shark to reach high speeds.





https://illumin.usc.edu/

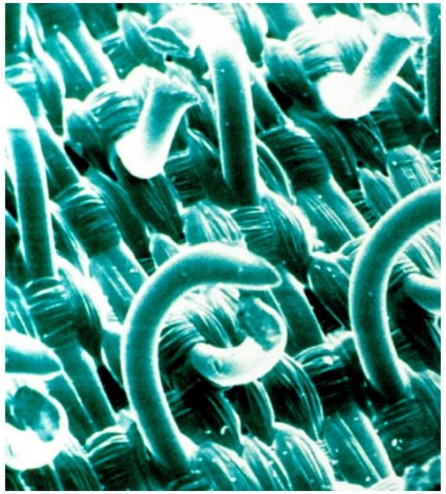
BIOMIMETICS- APPLICATION

- Special alignment and grooved structure of denticles embedded in shark skin decrease drag and thus greatly increase swimming proficiency.
- Airbus fuel consumption down 1.5% when “shark skin” coating applied to aircraft.
- It is possible to increase the efficiency of Air planes up to 4% by adjusting riblets.
- Brings increase of speed up to 1.56%.
- The results of the use of riblets are a – reduction of the total drag, – a higher glide ratio and – a better handling of the aircraft.

BIOMIMETICS- APPLICATION

- Small hooks enable seed-bearing burr to cling to tiny loops in fabric.
- Velcro fastening was invented in 1941 by Swiss engineer George de Mestral, who took the idea from the burrs that stuck to his dog's hair.
- Under the microscope he noted the tiny hooks on the end of the burr's spines that caught anything with a loop - such as clothing, hair or animal fur.
- The 2-part Velcro fastener system uses strips or patches of a hooked material opposite strips or patches of a loose- looped weave of nylon that holds the hooks

https://www.bloomberg.com/



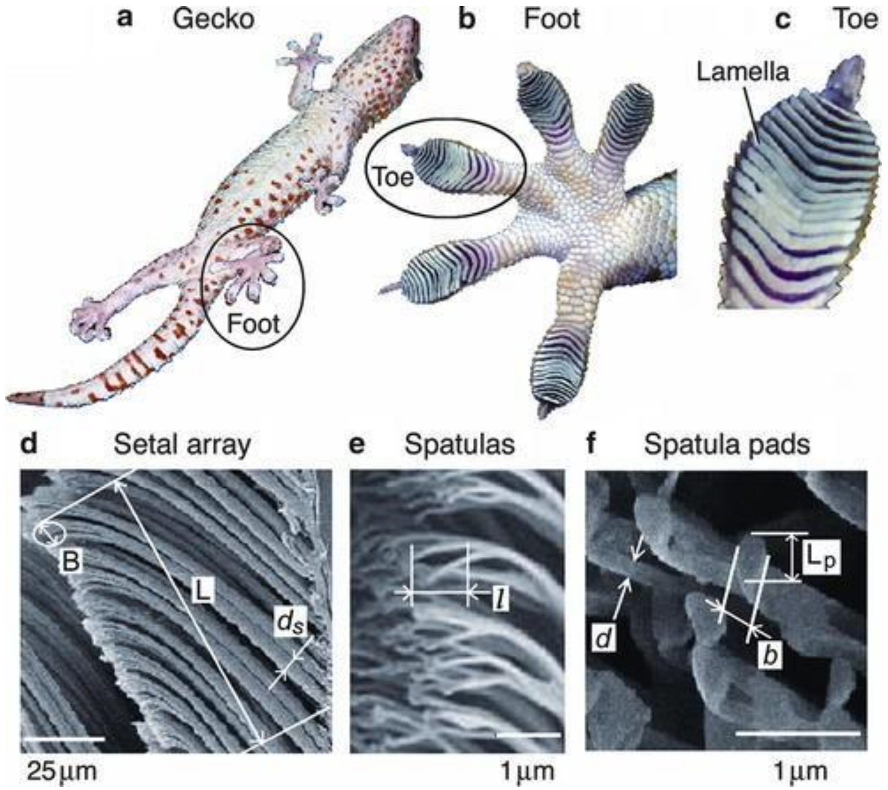
BIOMIMETICS- APPLICATION

BIOMIMETICS- APPLICATION

- The fastest train in the world at speeds of up to 200 miles per hour, Japan's Shinkansen Bullet Train was a marvel of modern technology.
- But there was one major problem after its initial debut: noise. Each time the train emerged from the tunnel, it caused a change in air pressure that caused thunder-like sounds that were a nuisance from a quarter of a mile away.
- The train's chief engineer, a bird-watcher, had an idea: taking inspiration from the shape of a bird's beak to make it more aerodynamic.
- The resulting design was based on the narrow profile of a kingfisher's beak, resulting in a quieter train that also consumes 15% less electricity and goes 10% faster than before.

BIOMIMETICS- APPLICATION

- Gecko is a nocturnal lizard which has adhesive pads on the feet to assist in climbing on smooth surfaces.
- Geckos hang single-toed from walls and walk along ceilings using fine hairs on feet.
- Gecko's feet comprise of lamellae. Lamellae are equipped with setae; each seta ends in a spatula-like structure.
- Nanoscale spatulae interact with wall atoms; generate Van der Waal's forces. The adhesive system demonstrates high friction.



https://link.springer.com/

BIOMIMETICS- APPLICATION

- Gecko Tape is a material covered with nanoscopic hairs that mimic those found on the feet of gecko lizards.
- These millions of tiny, flexible hairs exert van der Waals forces that provide a powerful adhesive effect. One square centimeter of gecko tape could support a weight of one kilogram.
- University of California - Berkeley created an array of synthetic micro-fibres using very high friction to support loads on smooth surfaces.
- Gecko-footed robots could climb to the roof and emplace permanent anchors for suspension of utilities, transportation, or even entire lunar bases.

TRAINING SHOES WITH GRIP

https://link.springer.com/

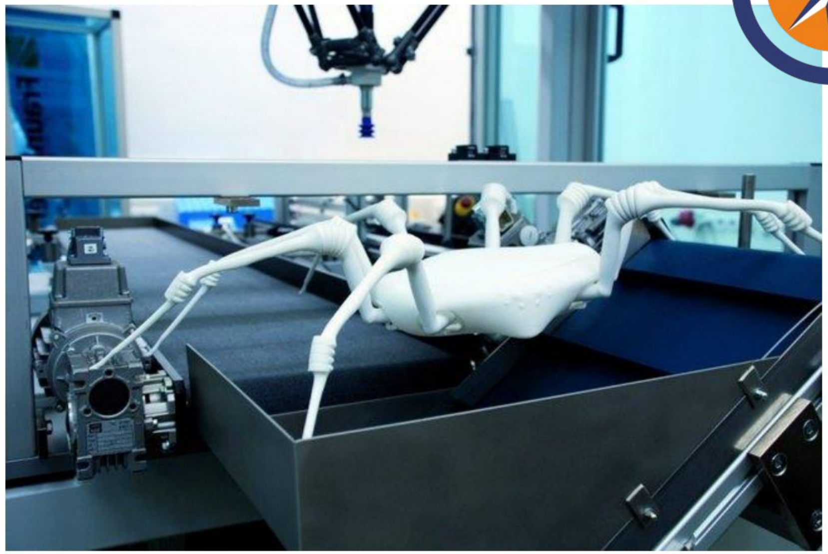
BIOMIMETICS- APPLICATION

- A butterfly's wings are one of nature's most remarkable materials.
- These tiny but complex structures reflect light in such a way that specific wavelengths interfere with each other to create intensely vivid colors one could only find in nature.
- By carefully studying this process, engineers at Qualcomm have been able to mimic this effect, allowing them to develop a system that produces colored electronic screens that are extremely efficient and can be viewed under any light conditions.

https://inhabitat.com/

BIOMIMETICS- APPLICATION

- The ability to squeeze through tight spaces and turn on a dime makes the spider an ideal model for lifesaving robots that could make their way through rubble after a disaster to locate survivors.
- Researchers at Germany's Frauenhofer Institute say this robot can be cheaply reproduced using 3D printers.
- After natural catastrophes and industrial or reactor accidents, or in fire department sorties, it can help responders, for instance by broadcasting live images or tracking down hazards or leaking gas.



https://www.theverge.com/

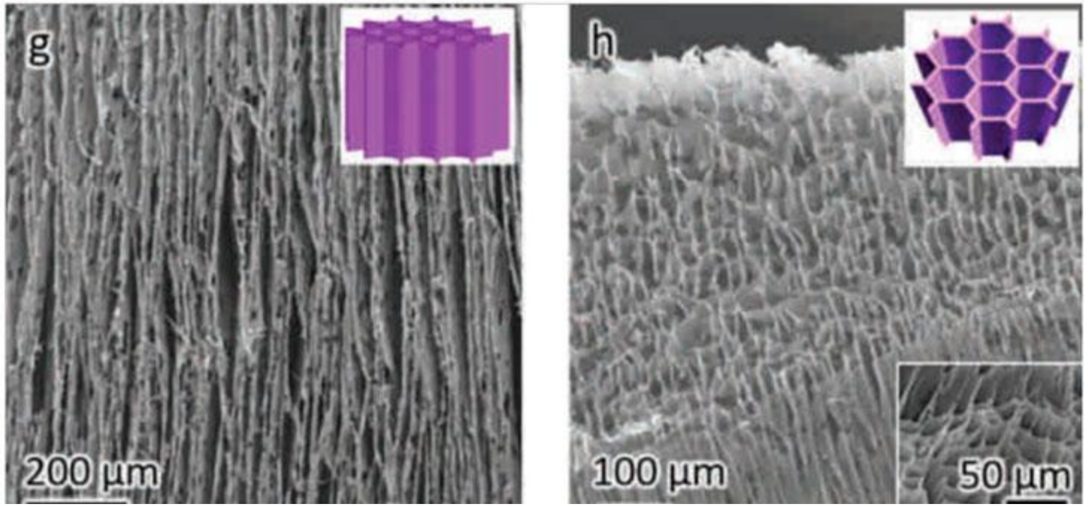
BIOMIMETICS FOR SPACE APPLICATIONS

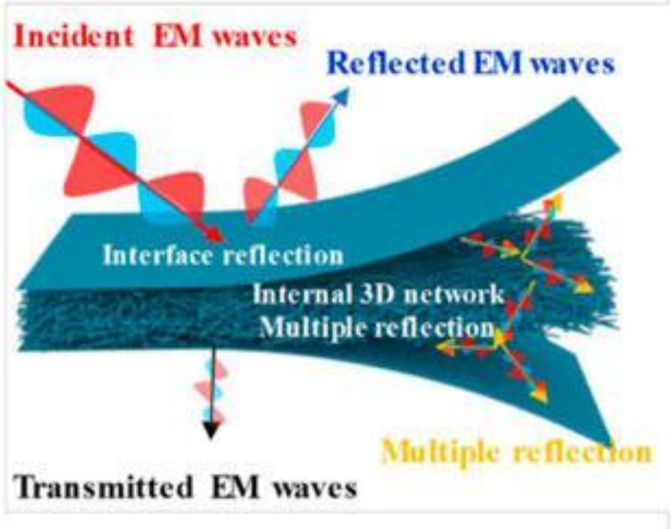
- Space environment, presents a challenging setting due to existing conditions of low to zero gravity, high temperature fluctuations, elevated levels of UV, electromagnetic and particulate radiation, reactive atomic oxygen, as well as natural micrometeoroids and space debris.
- There are recent advances in biomimetic research and developments within the space industry.
- Due to highly fluctuating temperatures within space environment enormous range of extremes, heat flow as well as temperature management and control are crucial steps to maintain the integrity of space systems.
- **Bio-inspired porous carbon** showed promising results regarding their thermal protection of spacecrafts during the re-entry process into planetary atmospheres.

doi.org/10.3389/frspt.2022.1000788

BIOMIMETICS FOR SPACE APPLICATIONS

- Recently, researchers have developed lightweight and flexible materials for the protection of structures and equipment against electromagnetic radiation.
- Experiments show that electromagnetic interference can be successfully shielded by substituting conventional metal shields with ones inspired by cellular architecture with tiny pores mimicking cell walls as aerogels.





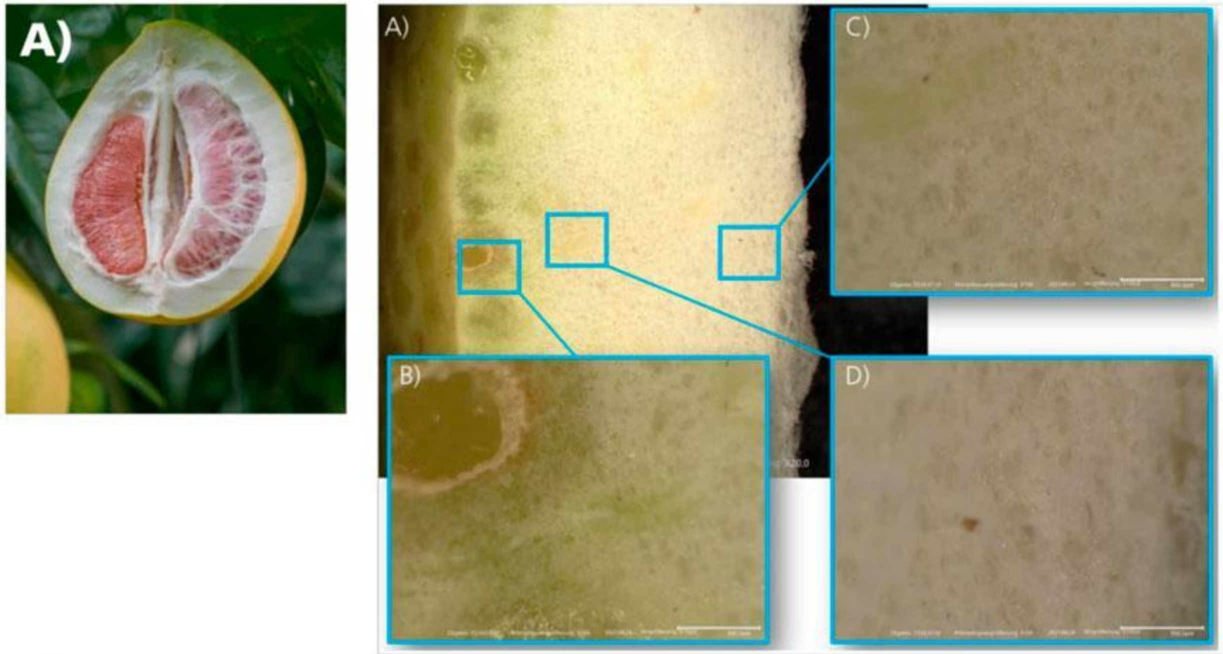
doi.org/10.3389/frspt.2022.1000788

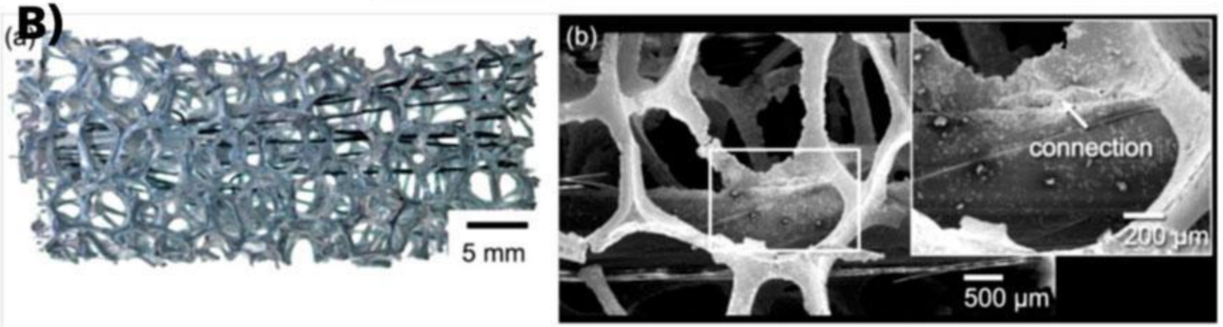
BIOMIMETICS FOR SPACE APPLICATIONS

- Landing of unmanned spacecrafts on surface of another planet is violent and associated with enormous impact forces.
- Several actions and measures have been taken to protect sensitive equipment and payloads against those forces.
- Option of dealing with high impact forces is demonstrated by the peel of the pomelo fruit.
- Peel of the pomelo fruit demonstrates a thick layer with open cell foam structure of varying pore size which protects the fruit inside from damage when falling from trees.
- This impact damping and energy dissipating capabilities are implemented in artificial versions of the foam to apply in space systems.

doi.org/10.3389/frspt.2022.1000788

ENVIRONMENTAL STUDIES AND LIFE SCIENCES
BIOMIMETICS FOR SPACE APPLICATIONS





Pomelo peel as dampener,

(A) Photographs of the honey pomelo's peel.

(B) Photograph of an Aluminium foam sample showing the connection between the fibre bundle and the foam matrix

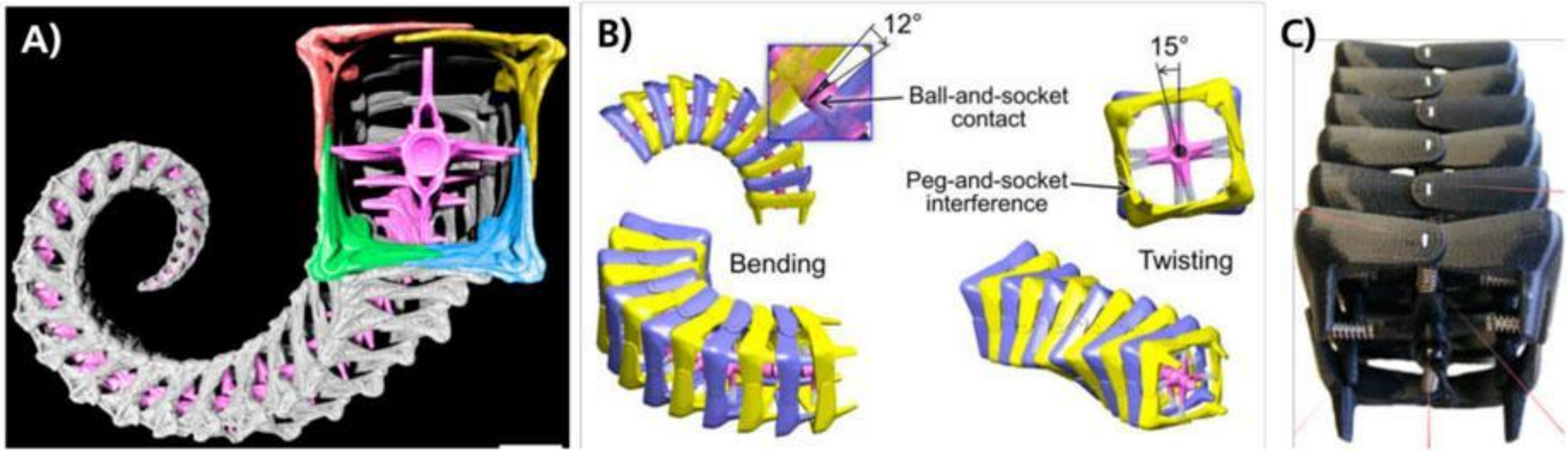
doi.org/10.3389/frspt.2022.1000788

BIOMIMETICS FOR SPACE APPLICATIONS

- As space debris has become a major topic of concern, recent efforts have concentrated on space debris removal and mitigation measures.
- Robotic systems inspired by octopi arms have already been proposed for space debris removal.
- Their great mobility, maneuverability and adaptability makes them very suitable to wrap around complex target shapes.
- Seahorses use their tail for grasping activities involving different diameter objects.
- Arrangement like continuously decreasing square cross-section in their tail made from four individual plates connected through special joints, provide great bending and torsion abilities for grasping, especially of a diverse range of shapes and sizes.
- In addition, due to specialized construction, their tails shows great fracture resistances under crushing and impact forces.

doi.org/10.3389/frspt.2022.1000788

BIOMIMETICS FOR SPACE APPLICATIONS



Seahorse tail inspired robotic arm

doi.org/10.3389/frspt.2022.1000788

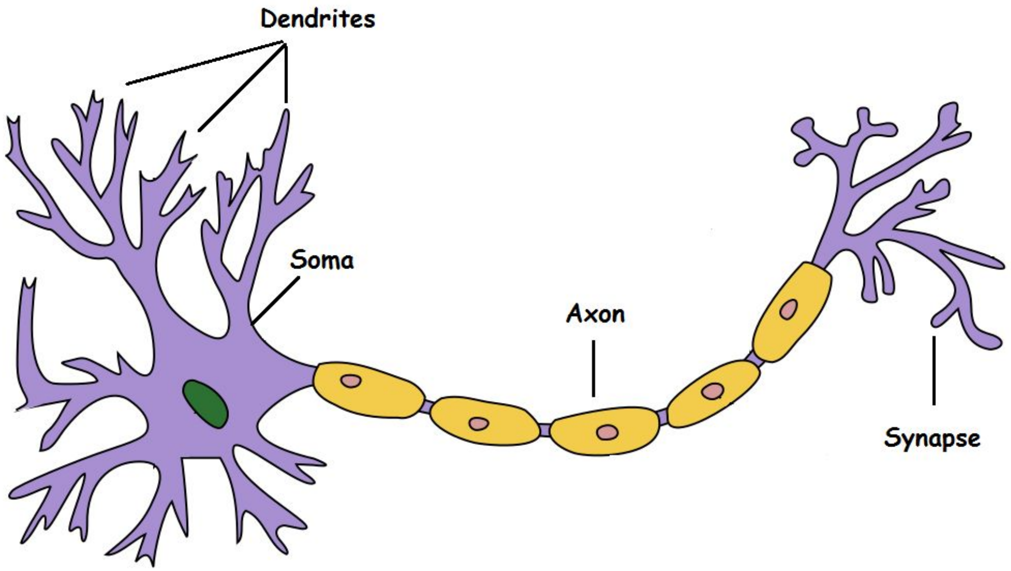
ENVIRONMENTAL STUDIES AND LIFE SCIENCES

BIOINSPIRED ANN

BIOINSPIRED ANN

- A biological neuron has three types of main components; dendrites, soma (or cell body) and axon.
- Dendrites receives signals from other neurons.
- The soma, sums the incoming signals. When sufficient input is received, the cell fires; that is it transmit a signal over its axon to other cells.

Human Biological Neuron



towardsdatascience.com

BIOINSPIRED ANN

- In the human brain, a typical neuron collects signals from others through a host of fine structures called *dendrites*.
- The neuron sends out spikes of electrical activity through a long, thin stand known as an *axon*, which splits into thousands of branches.
- At the end of each branch, a structure called a *synapse* converts the activity from the axon into electrical effects that inhibit or excite activity in the connected neurons.

BIOINSPIRED ANN

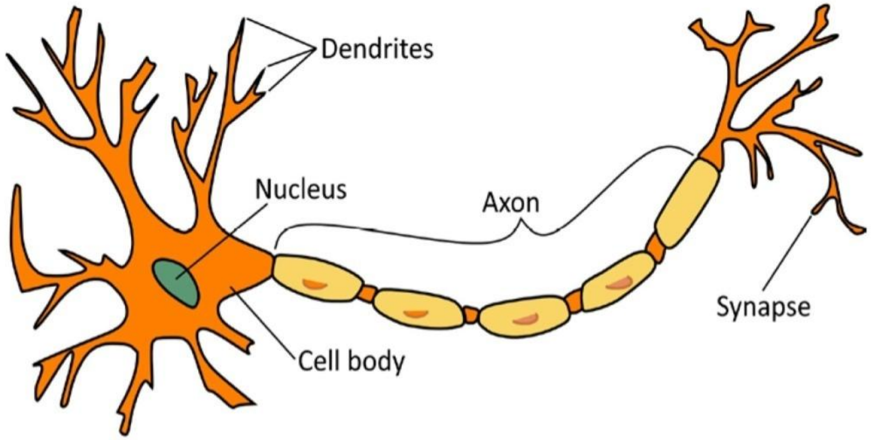
Artificial Neural Network-ANN is an information processing system that has certain performance characteristics in common with biological nets.

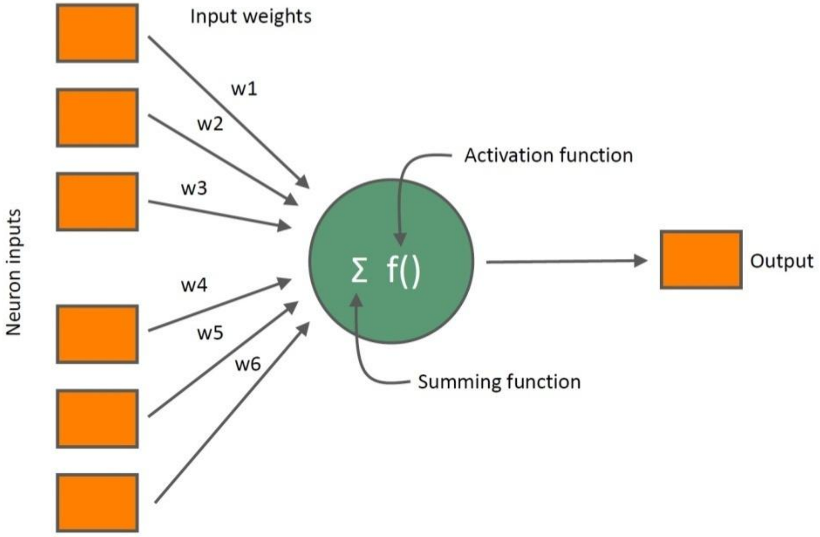
Several key features of the processing elements of ANN are suggested by the properties of biological neurons:

- The processing element receives many signals.
- Signals may be modified by a weight at the receiving synapse.
- The processing element sums the weighted inputs.
- Under appropriate circumstances (sufficient input), the neuron transmits a single output.
- The output from a particular neuron may go to many other neurons.

BIOINSPIRED ANN

- From experience: examples / training data
- Strength of connection between the neurons is stored as a weight-value for the specific connection.
- Learning the solution to a problem = changing the connection weights





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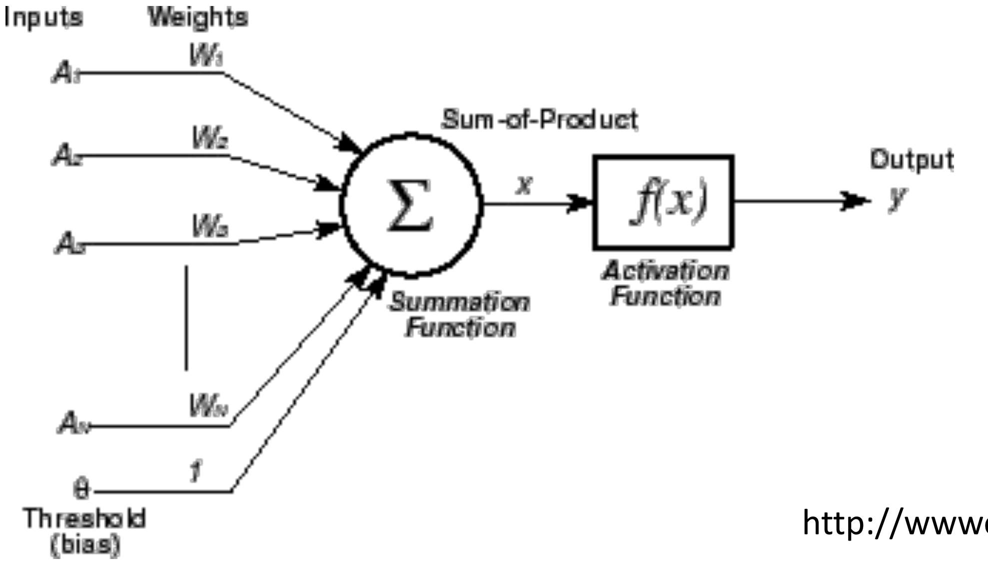
BIOINSPIRED ANN

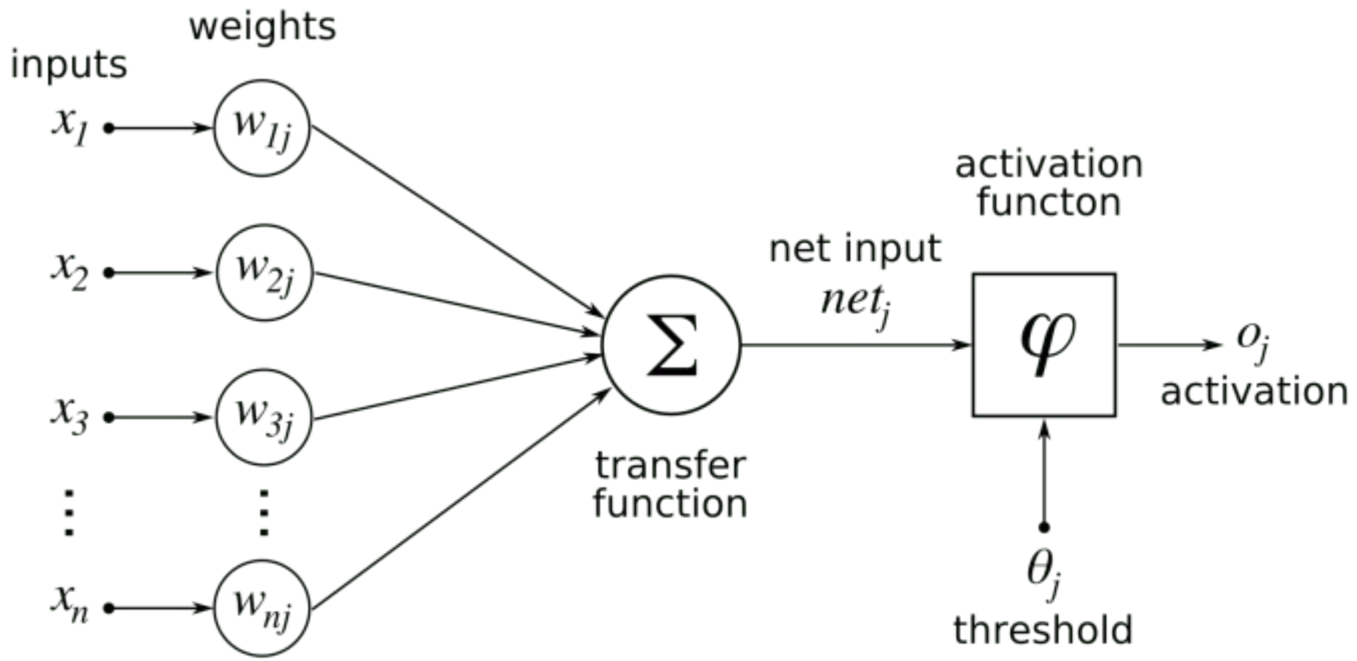
ANNs have been developed as generalizations of mathematical models of neural biology, based on the assumptions that:

- Information processing occurs at many simple elements called neurons.
- Signals are passed between neurons over connection links.
- Each connection link has an associated weight, which, in typical neural net, multiplies the signal transmitted.
- Each neuron applies an activation function to its net input to determine its output signal.



http://wwwold.ece.utep.edu/

Artificial Neural Network



-A neuron receives input, determines the strength or the weight of the input, calculates the total weighted input, and compares the total weighted with a value (threshold)
-The value is in the range of 0 and 1
- If the total weighted input greater than or equal the threshold value, the neuron will produce the output, and if the total weighted input less than the threshold value, no output will be produced

https://bdtechtalks.com/

Characterization

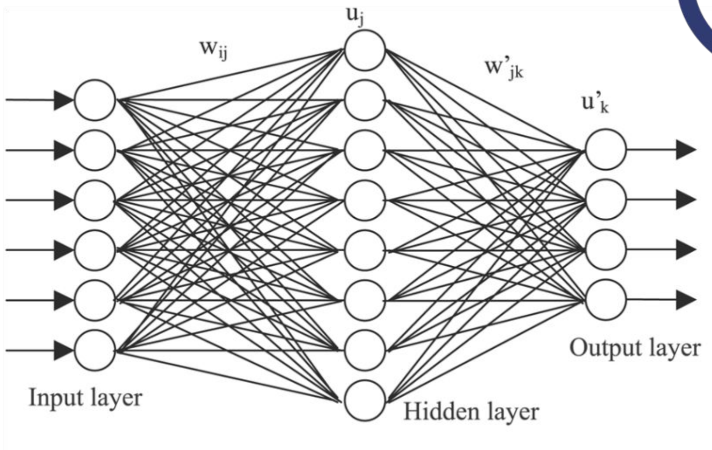
- Architecture
  - a pattern of connections between neurons
    - Single Layer Feedforward
    - Multilayer Feedforward
    - Recurrent
- Strategy / Learning Algorithm
  - a method of determining the connection weights
    - Supervised
    - Unsupervised
    - Reinforcement
- Activation Function
  - Function to compute output signal from input signal

Some Properties of Artificial Neural Networks

- Assembly of simple processors
- Information stored in connections
- Massively Parallel
- Massive connectivity
- Fault Tolerant
- Learning and Generalization Ability
- Robust
- Individual dynamics different from group dynamics
- All these properties may **not** be present in a particular network

BIOINSPIRED ANN

- Input Layer - The activity of the input units represents the raw information that is fed into the network.
- Hidden Layer - The activity of each hidden unit is determined by the activities of the input units and the weights on the connections between the input and the hidden units.
- Output Layer - The behavior of the output units depends on the activity of the hidden units and the weights between the hidden and output units.
- This simple type of network is interesting because the hidden units are free to construct their own representations of the input.
- The weights between the input and hidden units determine when each hidden unit is active, and so by modifying these weights, a hidden unit can choose what it represents.



https://www.extremetech.com/

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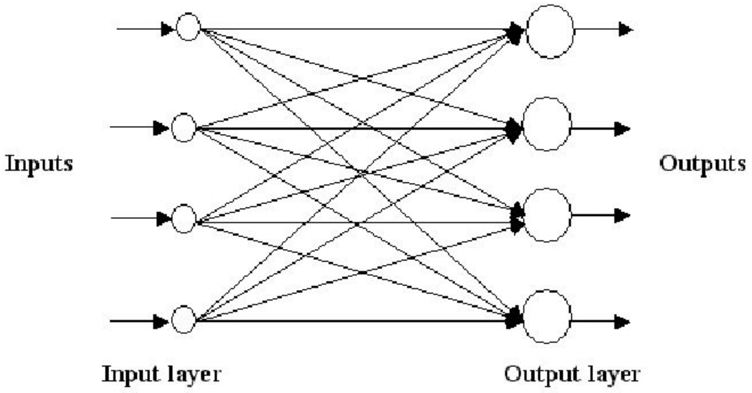
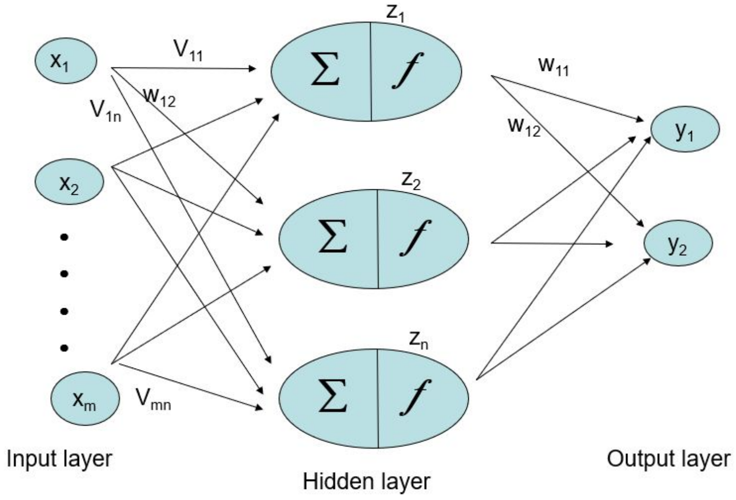
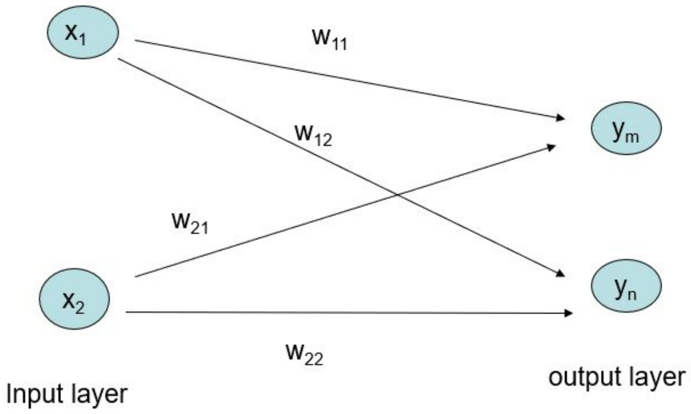
BIOINSPIRED ANN



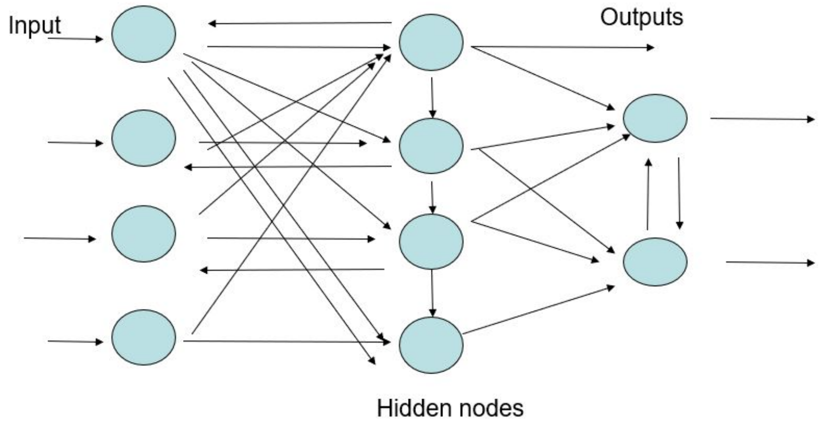
Multilayer Neural Network



Single Layer Feedforward NN



Recurrent NN



https://www.researchgate.net/

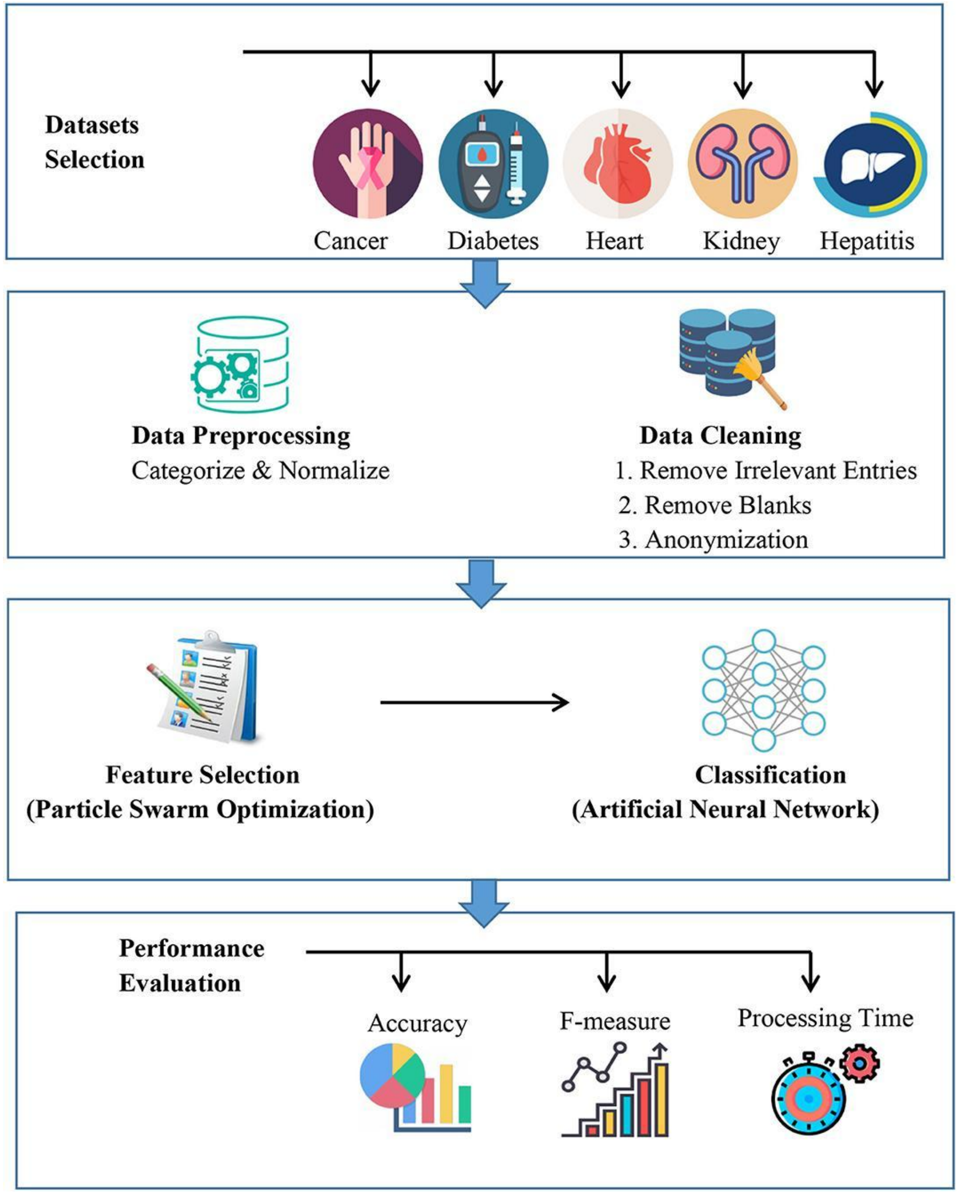
BIOINSPIRED ANN

- ANN is currently a 'hot' research area in medicine.
- Research is on modeling parts of the human body and recognizing diseases from various scans (e.g. cardiograms, CAT scans, ultrasonic scans, etc.).
- Neural Networks are used experimentally to model the human cardiovascular system.
- Diagnosis can be achieved by building a model of the cardiovascular system of an individual and comparing it with real time physiological measurements taken from the patient.

BIOINSPIRED ANN

- A model of an individual's cardiovascular system must mimic the relationship among physiological variables (i.e., heart rate, systolic and diastolic blood pressures, and breathing rate) at different physical activity levels.
- If a model is adapted to an individual, then it becomes a model of the physical condition of that individual.
- If this routine is carried out regularly, potential harmful medical conditions can be detected at an early stage and thus make the process of combating the disease much easier.

BIOINSPIRED ANN



www.frontiersin.org

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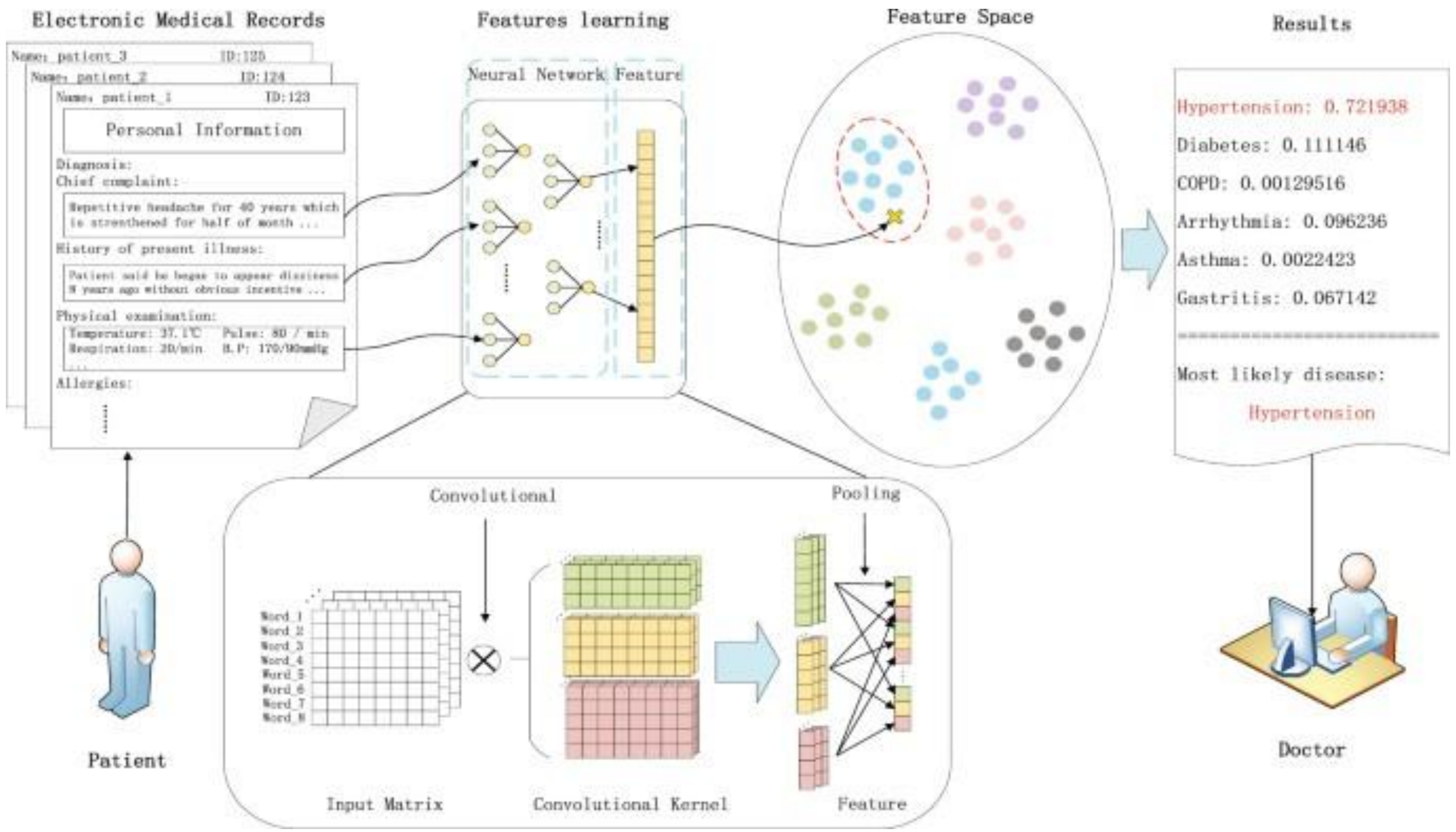
BIOINSPIRED ANN



Convolutional neural network extract semantic feature vectors of unstructured electronic medical records and map them to the feature space, finally classifier calculates probable probability of each disease and select highest probability of the disease .

www.nature.com

THANK YOU

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PES UNIVERSITY
CELEBRATING 50 YEARS

ENVIRONMENTAL STUDIES AND LIFE SCIENCES

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ENVIRONMENTAL STUDIES AND LIFE SCIENCES

BIOSENSORS

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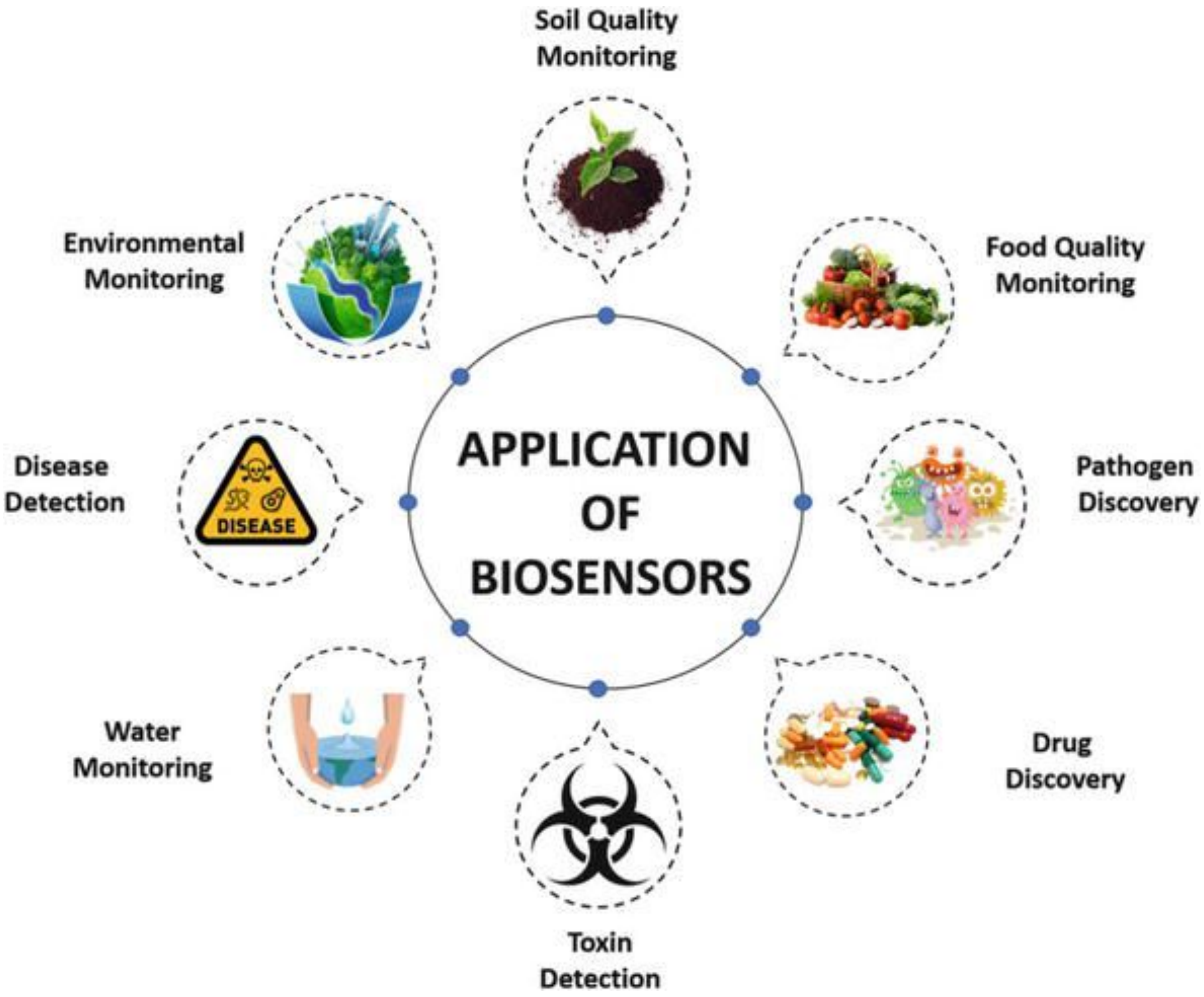
BIOSENSORS

- Biosensors can be defined as analytical devices which include a combination of biological detecting elements like sensor system and a transducer.
- The sensitive biological element, e.g. tissue, microorganisms, organelles, cell receptors, enzymes, antibodies, nucleic acids, etc., is a biologically derived material that interacts with, binds with, or recognizes the analyte under study.
- Biosensors are nowadays ubiquitous in biomedical diagnosis, point-of-care monitoring of treatment and disease progression, environmental monitoring, food control, drug discovery, forensics and biomedical research.
- A wide range of techniques can be used for the development of biosensors.
- Their coupling with high-affinity biomolecules allows the sensitive and selective detection of a range of analytes.

www.ncbi.nlm.nih.gov

APPLICATION AREAS



www.intechopen.com

A typical biosensor consists of the following components.

Analyte:

- A substance of interest that needs detection.
- For instance, glucose is an ‘analyte’ in a biosensor designed to detect glucose.

Bioreceptor:

- A molecule that specifically recognizes the analyte is known as a bioreceptor.
- Enzymes, cells, aptamers, deoxyribonucleic acid (DNA) and antibodies are some examples of bioreceptors.
- The process of signal generation (in the form of light, heat, pH, charge or mass change, etc.) upon interaction of the bioreceptor with the analyte is termed bio-recognition.

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Transducer:

- The transducer is an element that converts one form of energy into another.
- In a biosensor the role of the transducer is to convert the bio-recognition event into a measurable signal.
- This process of energy conversion is known as signalisation.
- Most transducers produce either optical or electrical signals that are usually proportional to the amount of analyte–bioreceptor interactions.
- The transducer works in a physicochemical way: optical, piezoelectric, electrochemical, electrochemiluminescence etc., resulting from the interaction of the analyte with the biological element, to easily measure and quantify.

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Electronics:

- This is the part of a biosensor that processes the transduced signal and prepares it for display.
- It consists of complex electronic circuitry that performs signal conditioning such as amplification and conversion of signals from analogue into the digital form.
- The processed signals are then quantified by the display unit of the biosensor.

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Display:

- The display consists of a user interpretation system such as the liquid crystal display of a computer or a direct printer that generates numbers or curves understandable by the user.
- This part often consists of a combination of hardware and software that generates results of the biosensor in a user-friendly manner.
- The output signal on the display can be numeric, graphic, tabular or an image, depending on the requirements of the end user.

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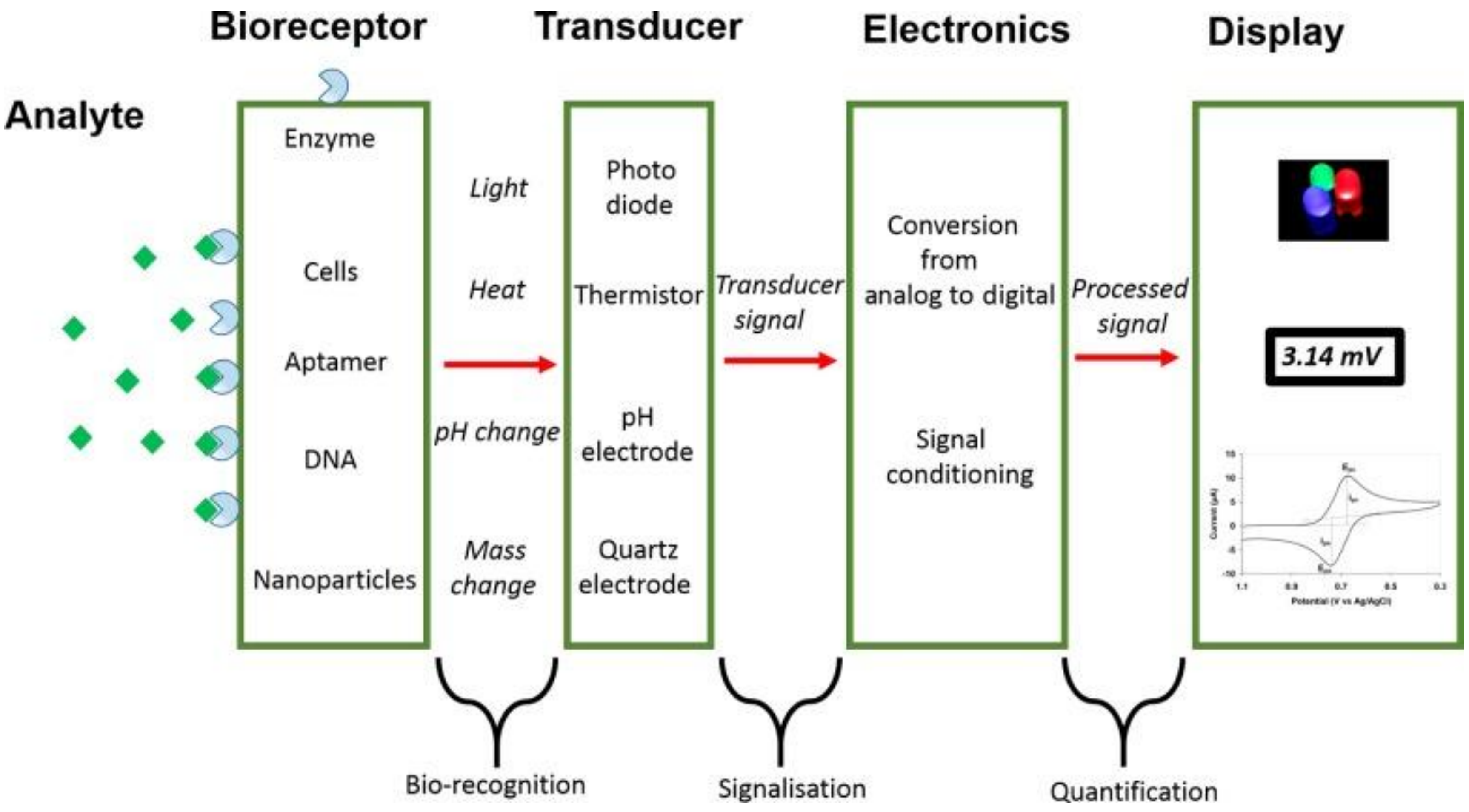
BIOSENSORS

- In a summary a biosensor typically consists of a bio-receptor (enzyme/antibody/cell/nucleic acid), transducer component (semi-conducting material/nanomaterial), and electronic system which includes a signal amplifier, processor & display
- In a biosensor, the bioreceptor is designed to interact with the specific analyte of interest to produce an effect measurable by the transducer.
- High selectivity for the analyte among a matrix of other chemical or biological components is a key requirement of the bioreceptor.

BIOSENSORS



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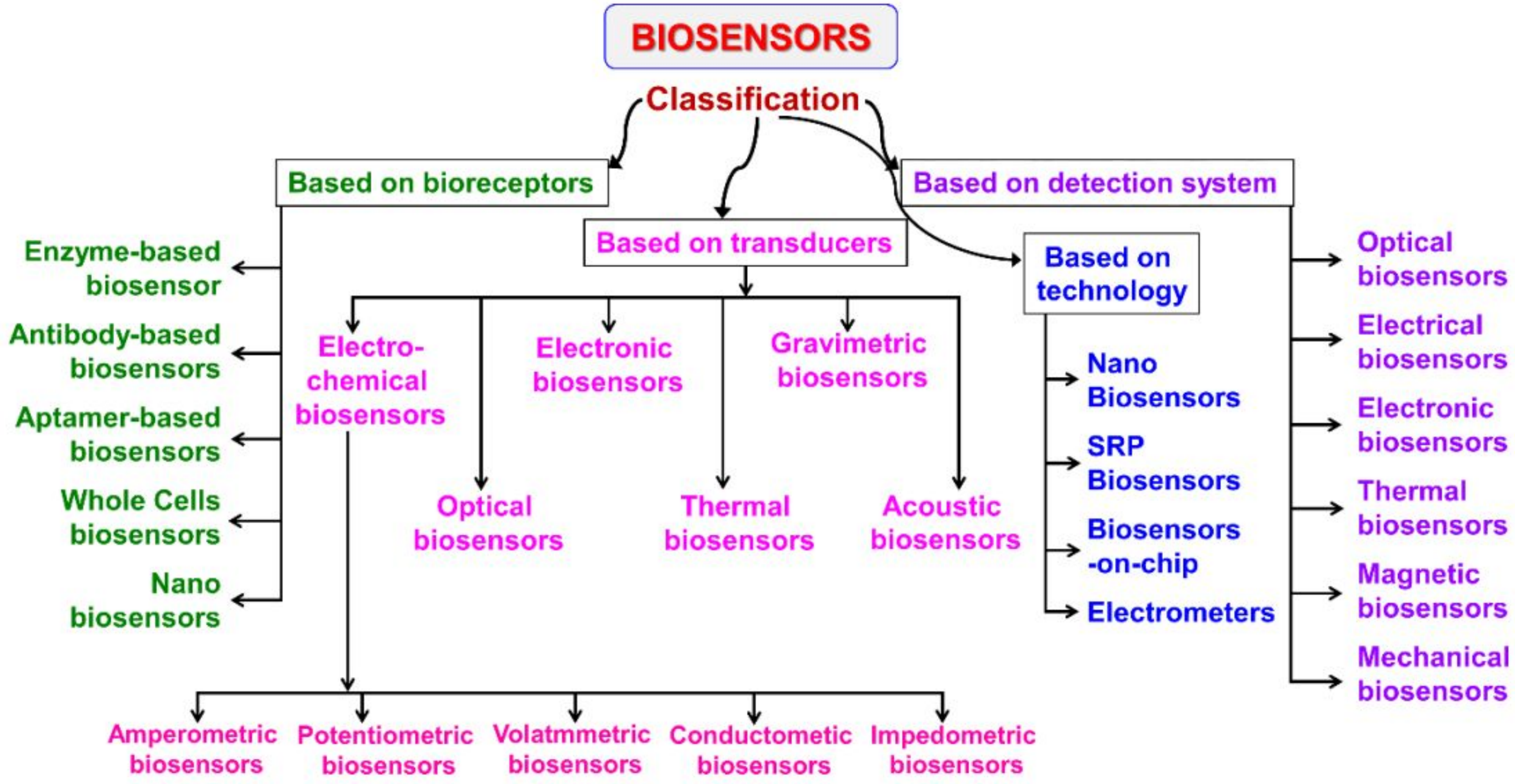
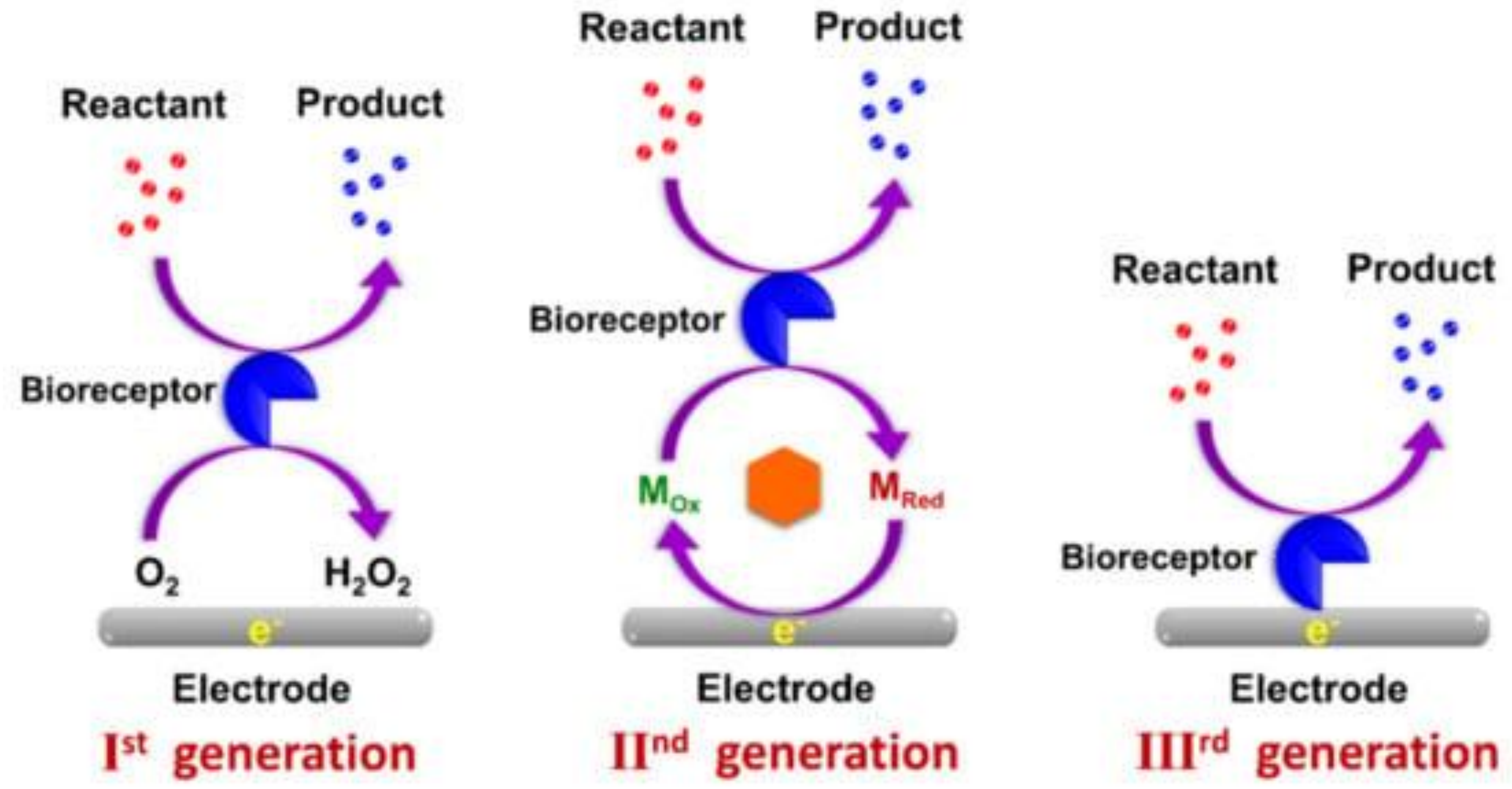
BIOSENSORS



www.mdpi.com

BIOSENSORS



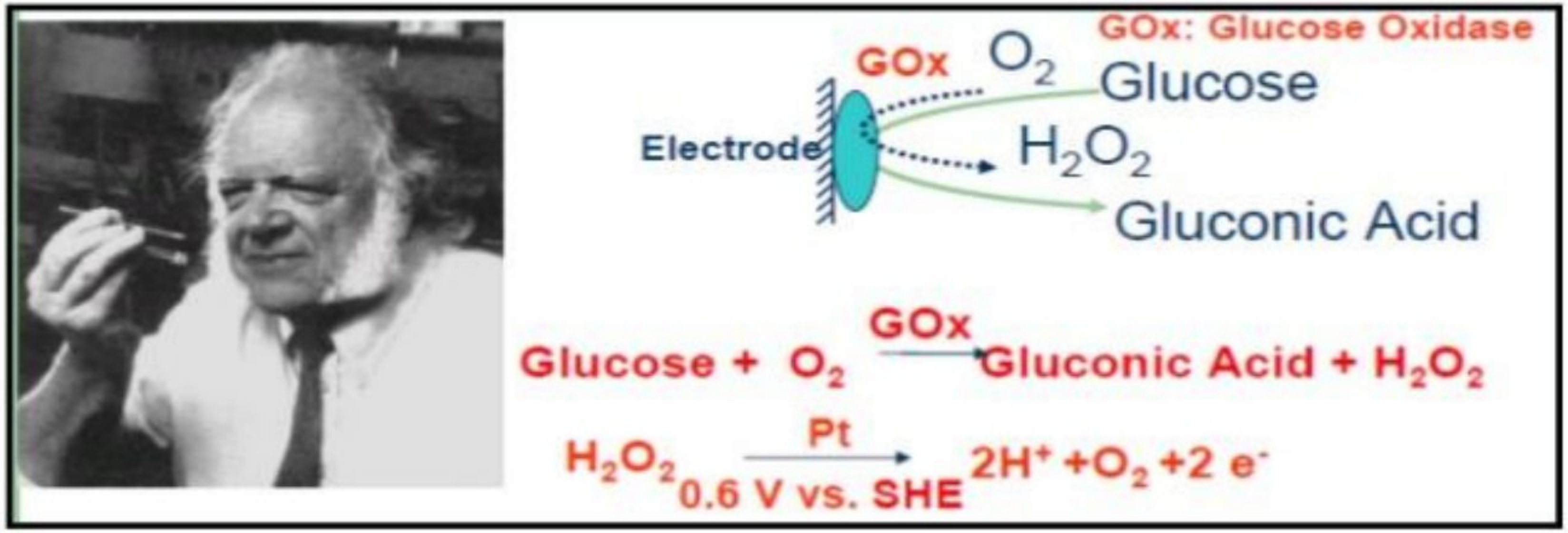
Three generations of the biosensor construction (M_{OX}: Oxidized mediator; M_{Red}: Reduced mediator).

www.mdpi.com

BIOSENSORS

- The first 'true' biosensor was developed by Leland C. Clark in 1956 for oxygen detection. He is known as the ‘Father of Biosensors' and his invention of the oxygen electrode bears his name: 'Clark electrode'

Professor Leland C Clark (1918–2005)



The first and the most widespreadly used commercial biosensor: the blood glucose biosensor – developed by *Leland C. Clark in 1962*

There are certain static and dynamic attributes that every biosensor possesses.

Selectivity

- Selectivity is the most important feature of a biosensor.
- Selectivity is the ability of a bioreceptor to detect a specific analyte in a sample containing other admixtures and contaminants.

Reproducibility

- Reproducibility is the ability of the biosensor to generate identical responses for a duplicated experimental set-up.
- Reproducibility is characterised by the precision and accuracy of the transducer and electronics in a biosensor.

Precision is the ability of the sensor to provide alike results every time a sample is measured and accuracy indicates the sensor's capacity to provide a mean value close to the true value when a sample is measured more than once.

Stability

- Stability is the degree of susceptibility to ambient disturbances in and around the biosensing system.
- These disturbances can cause a drift in the output signals of a biosensor under measurement causing an error in the measured concentration and can affect the precision and accuracy of the biosensor.

Sensitivity

- The minimum amount of analyte that can be detected by a biosensor defines its limit of detection (LOD) or sensitivity.
- In a number of medical and environmental monitoring applications, a biosensor is required to detect analyte concentration of as low as ng/ml or even fg/ml to confirm the presence of traces of analytes in a sample.

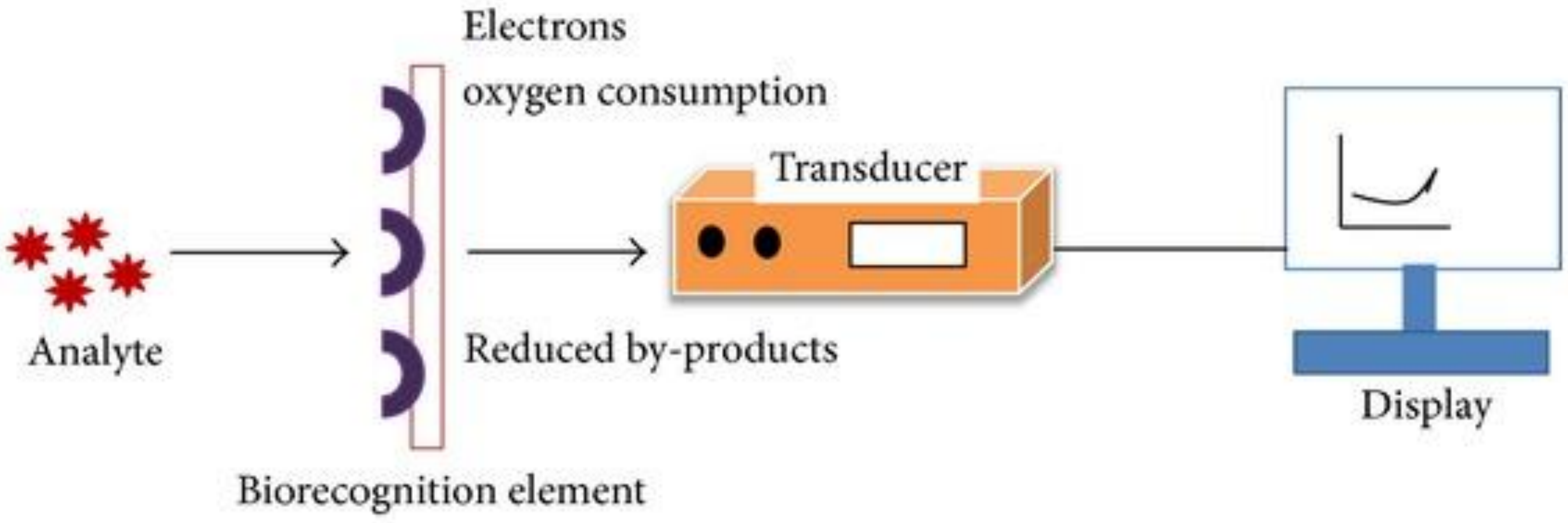
Linearity

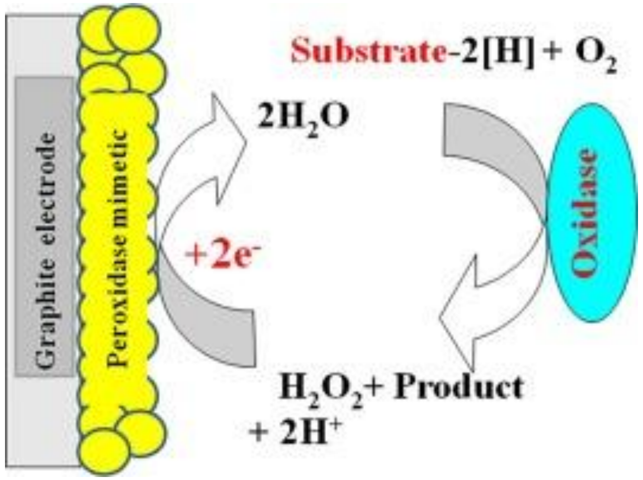
- Linearity is the attribute that shows the accuracy of the measured response (for a set of measurements with different concentrations of analyte) to a straight line, mathematically represented as $y=mc$, where c is the concentration of the analyte, y is the output signal, and m is the sensitivity of the biosensor.
- Linearity of the biosensor is associated with the resolution of the biosensor and range of analyte concentrations under test.
- The resolution of the biosensor is the smallest change in the concentration of an analyte that is required to bring a change in the response of the biosensor.

BIOSENSORS

- **Linearity**: Linearity of the sensor should be high for the detection of high substrate concentration.
- **Sensitivity**: Value of the electrode response per substrate concentration
- **Selectivity**: Chemical interference must be minimized for obtaining correct result
- **Response time**: Time necessary for having 95% of the response

ELECTROCHEMICAL BIOSENSORS





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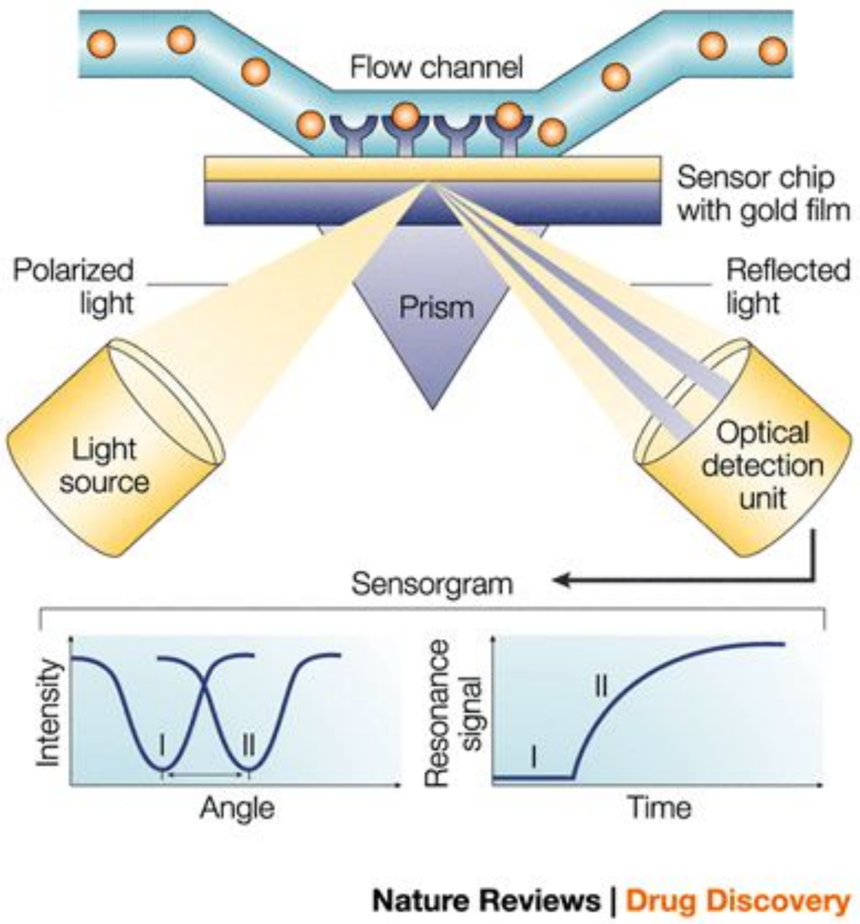
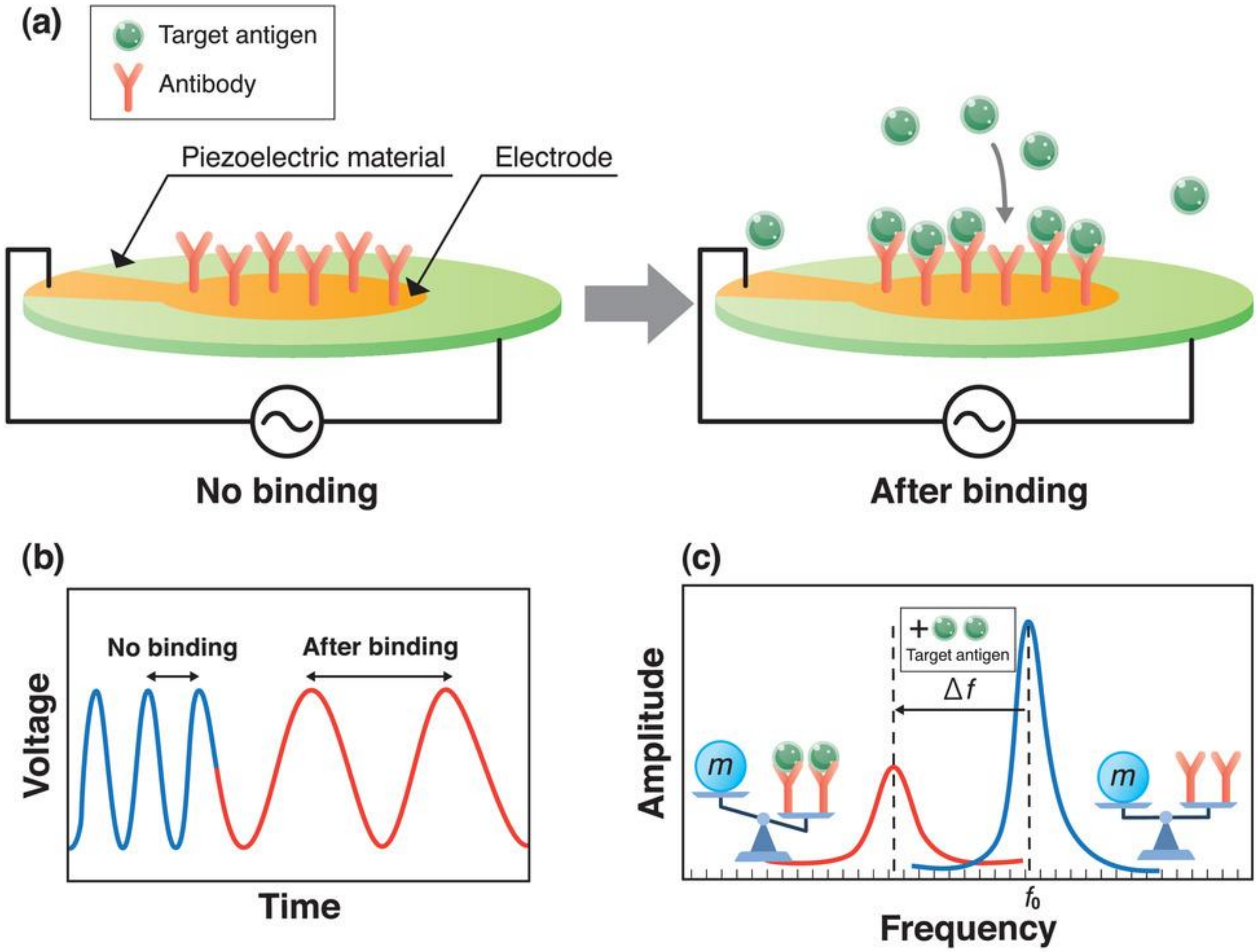
OPTICAL BIOSENSORS



PIEZOELECTRIC BIOSENSORS



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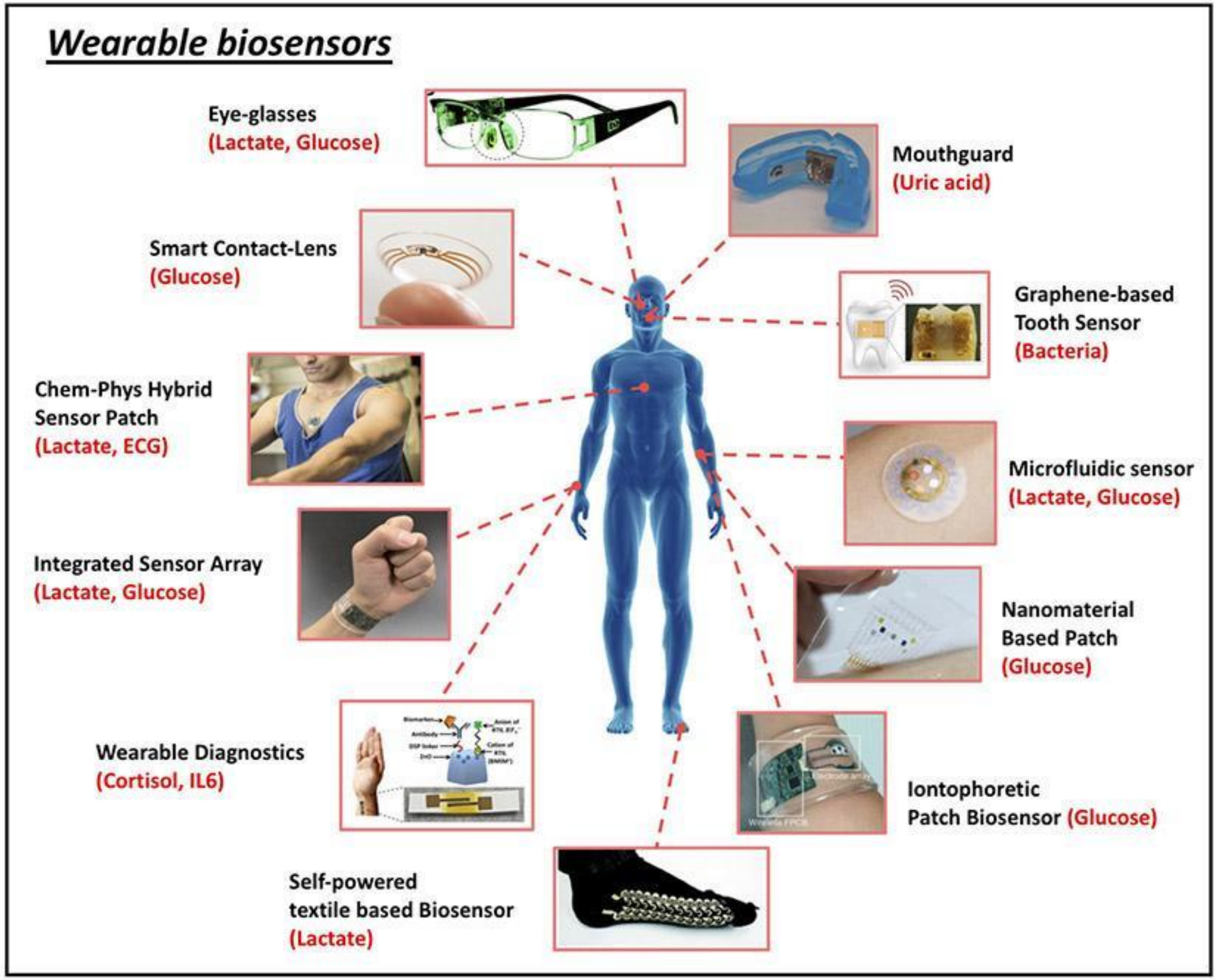

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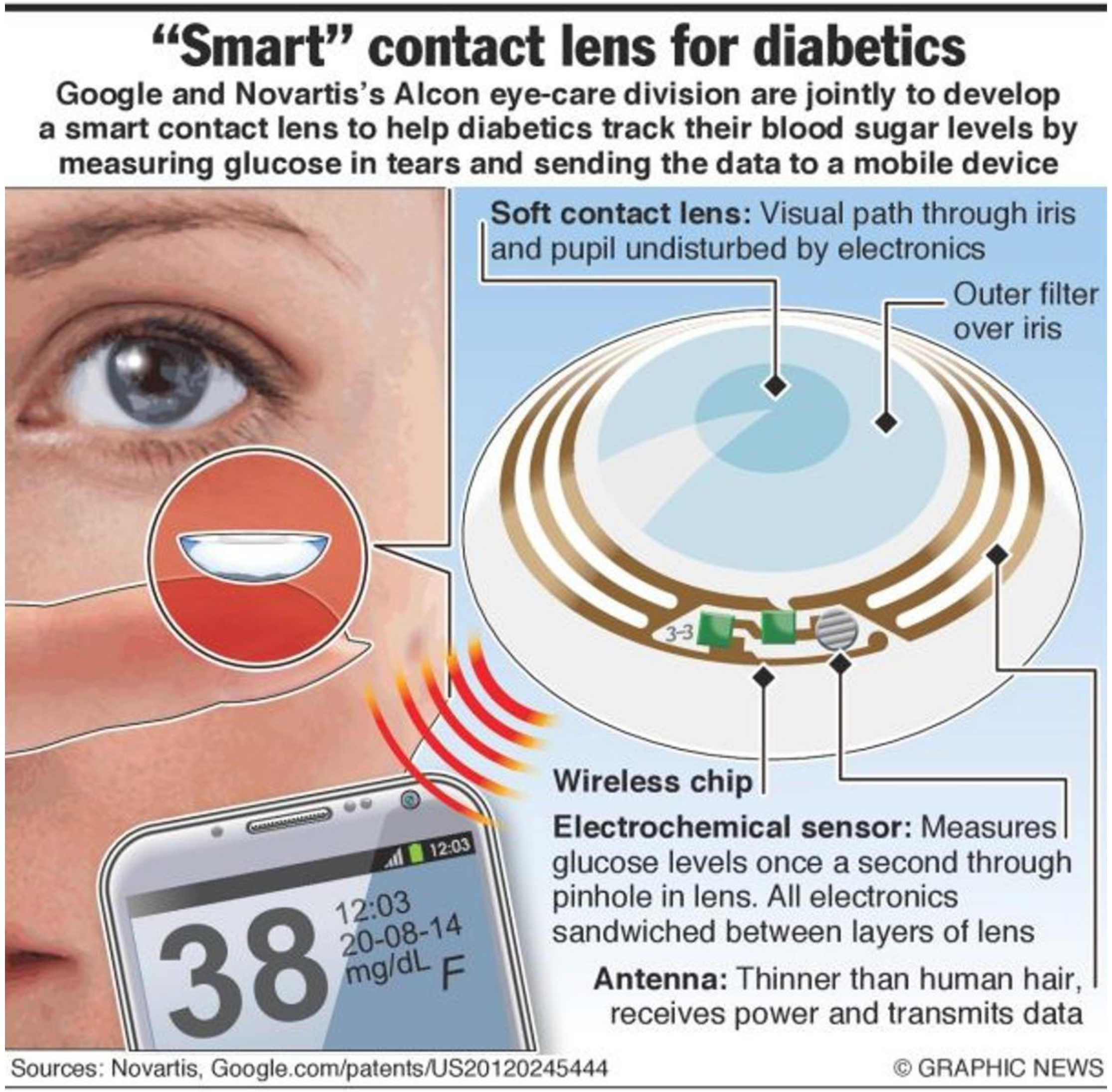
"Smart" contact lens for diabetics
Google and Novartis's Alcon eye-care division are jointly to develop a smart contact lens to help diabetics track their blood sugar levels by measuring glucose in tears and sending the data to a mobile device
Soft contact lens: Visual path through iris and pupil undisturbed by electronics
Outer filter over iris
Wireless chip
Electrochemical sensor: Measures glucose levels once a second through pinhole in lens. All electronics sandwiched between layers of lens
Antenna: Thinner than human hair, receives power and transmits data
12:03
38
12:03
20-08-14
mg/dL
F
Sources: Novartis, Google.com/patents/US20120245444
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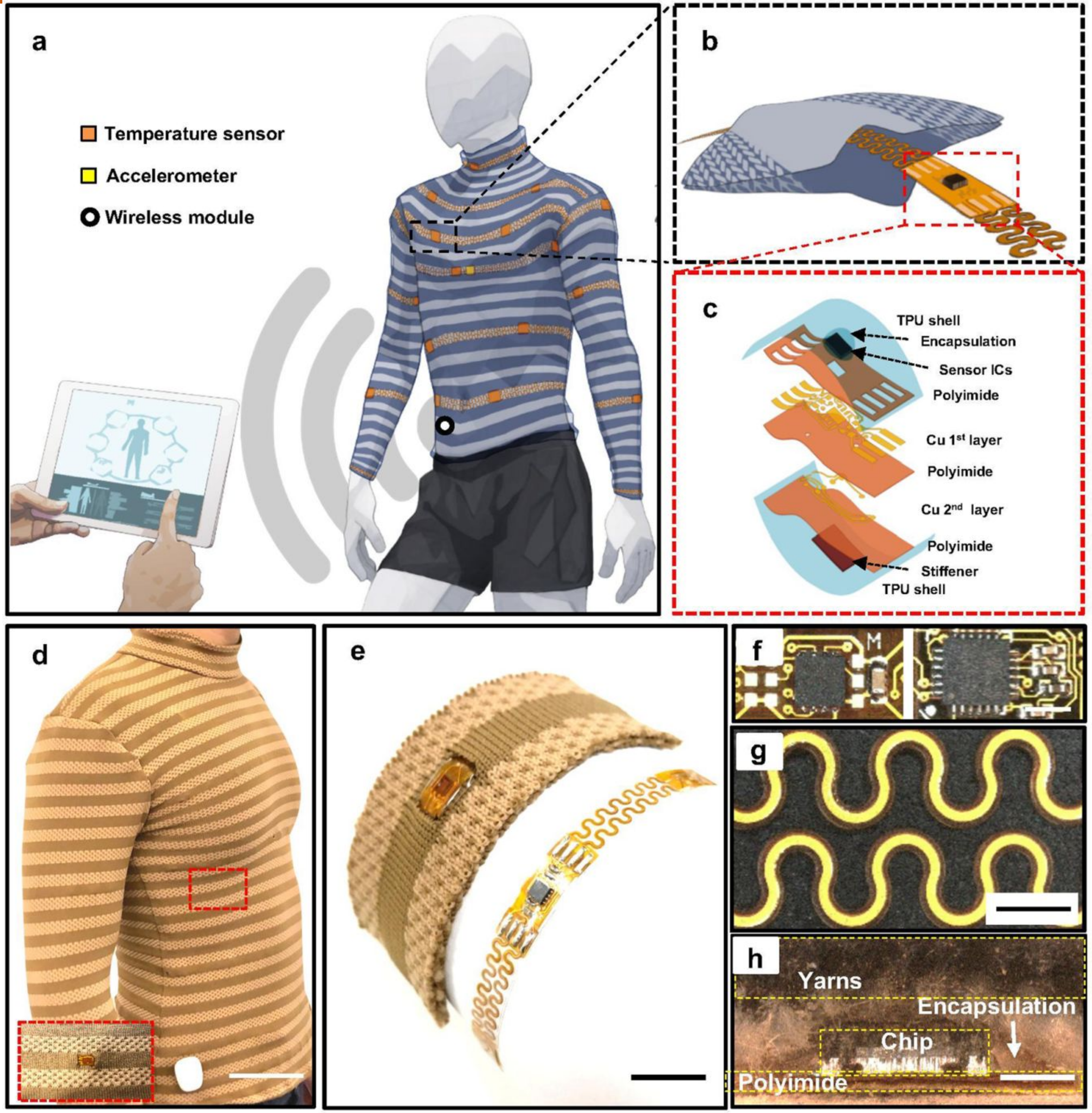
BIOSENSORS



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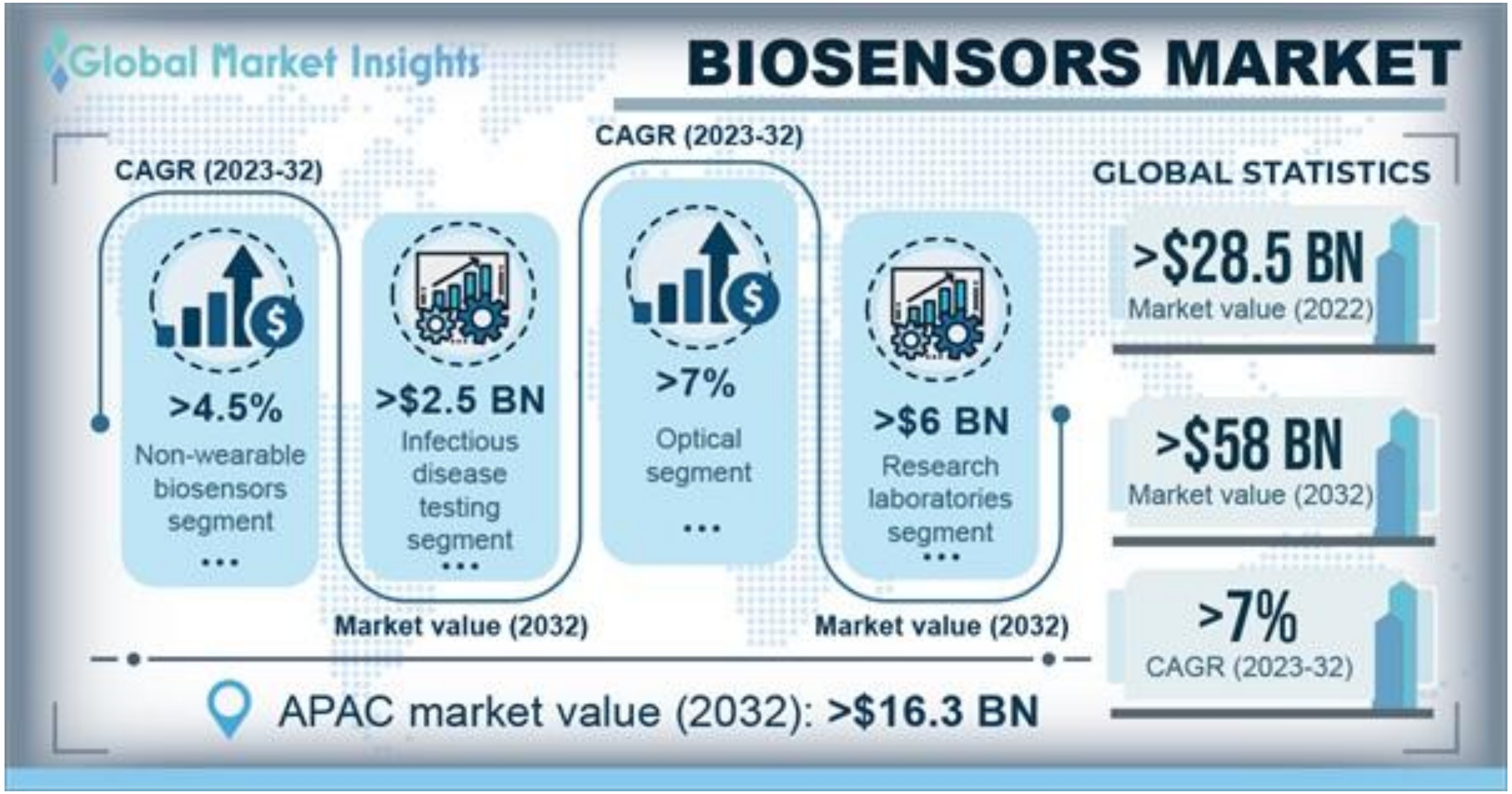

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ENVIRONMENTAL STUDIES AND LIFE SCIENCES

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ENVIRONMENTAL STUDIES AND LIFE SCIENCES

3D Bioprinting

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3D Bioprinting

- 3D printing, is driving major innovations in many areas, such as engineering, manufacturing, art, education and medicine.
- Recent advances have enabled 3D printing of biocompatible materials, cells and supporting components into complex 3D functional living tissues.
- 3D bioprinting is being applied to regenerative medicine to address the need for tissues and organs suitable for transplantation.
- 3D bioprinting involves additional complexities, such as the choice of materials, cell types, growth and differentiation factors, and technical challenges related to the construction of tissues.
- Addressing these complexities requires the integration of technologies from the fields of engineering, biomaterials science, cell biology, physics and medicine.
- 3D bioprinting has already been used for the generation and transplantation of several tissues, including multilayered skin, bone, vascular grafts, tracheal splints, heart tissue and cartilaginous structures.
- Other applications include developing high-throughput 3D-bioprinted tissue models for research, drug discovery and toxicology.

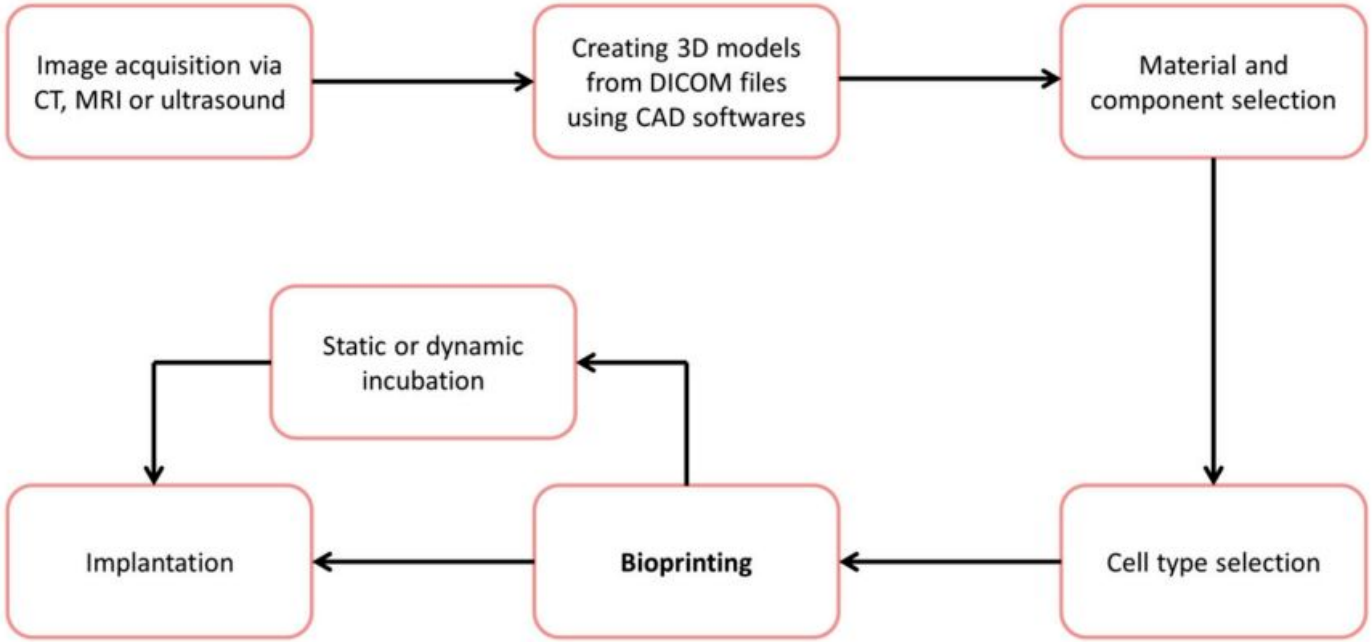
doi:10.1038/nbt.2958

3D Bioprinting

- 3D printing was first described in 1986 by Charles W. Hull. In his method, which he named ‘sterolithography’, thin layers of a material that can be cured with ultraviolet light were sequentially printed in layers to form a solid 3D structure.
- Development of solvent-free, aqueous based systems enabled the direct printing of biological materials into 3D scaffolds that could be used for transplantation.
- A related development was the application of 3D printing to produce medical devices such as stents and splints for use in the clinic.
- In a typical process for bioprinting 3D tissues imaging of the damaged tissue and its environment can be used to guide the design of bioprinted tissues.
- The choice of materials and cell source is essential and specific to the tissue form and function. These components have to integrate with bioprinting systems such as inkjet, microextrusion or laser-assisted printers.

doi:10.1038/nbt.2958

3D Bioprinting Process



Schematic of Bioprinting Scaffolds for clinical use. Digital 3D images obtained from CT, MRI or ultrasound, are used to design a suitable scaffold with 3D slicing and CAD software; materials from printing are chosen depending upon the application, and can consist of polymers, ceramics, and bioactive components; cells are selected dependent on the application, a bioink can consist of singular or multiple cell types.

doi:10.3390/ma11112199

3D Bioprinting - Bioprinters

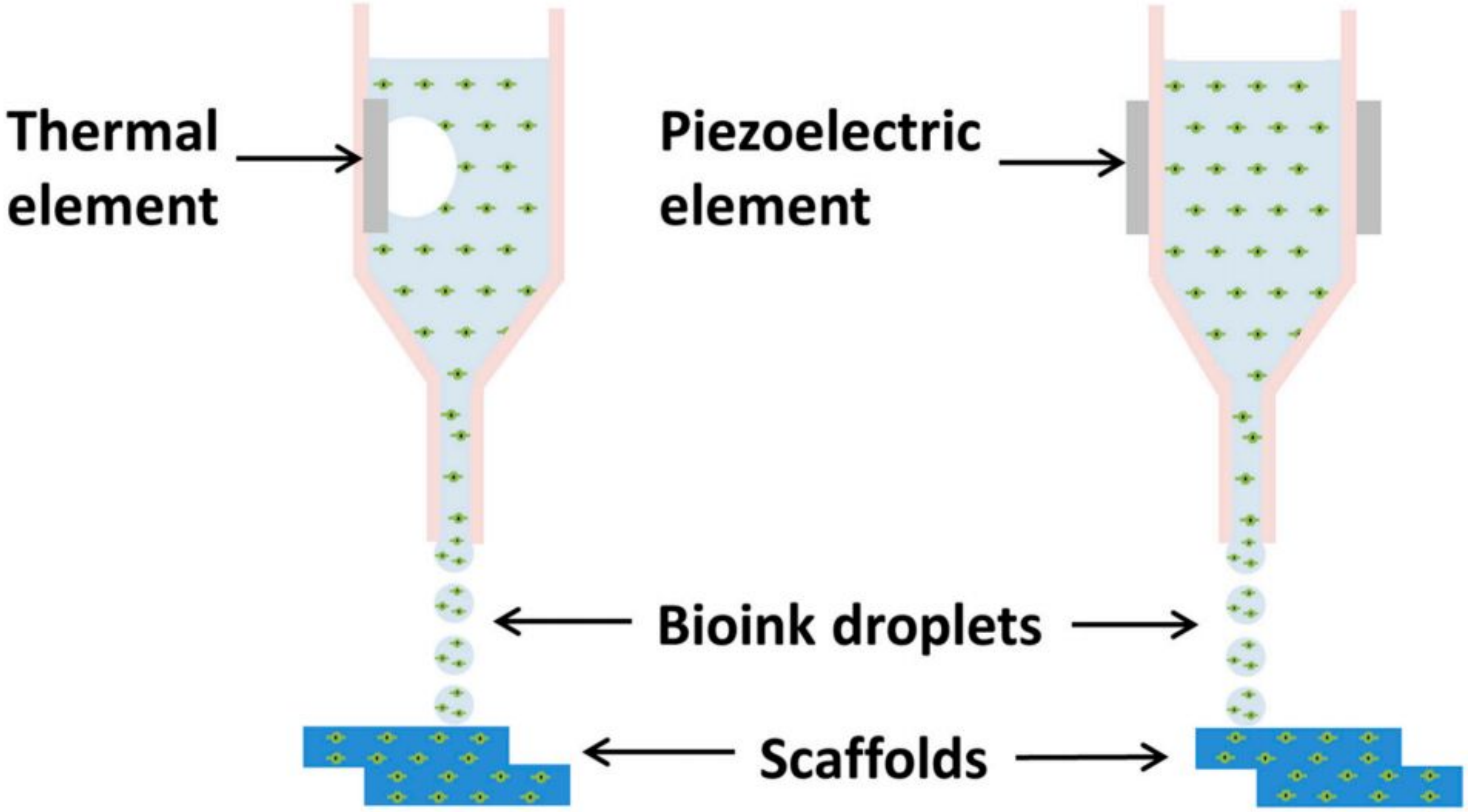


Figure 2. Schematic of Inkjet-based Bioprinting. Thermal inkjet uses heat-induced bubble nucleation that propels the bioink through the micro-nozzle. Piezoelectric actuator produces acoustic waves that propel the bioink through the micro-nozzle.

doi:10.3390/ma11112199

3D Bioprinting - Bioprinters

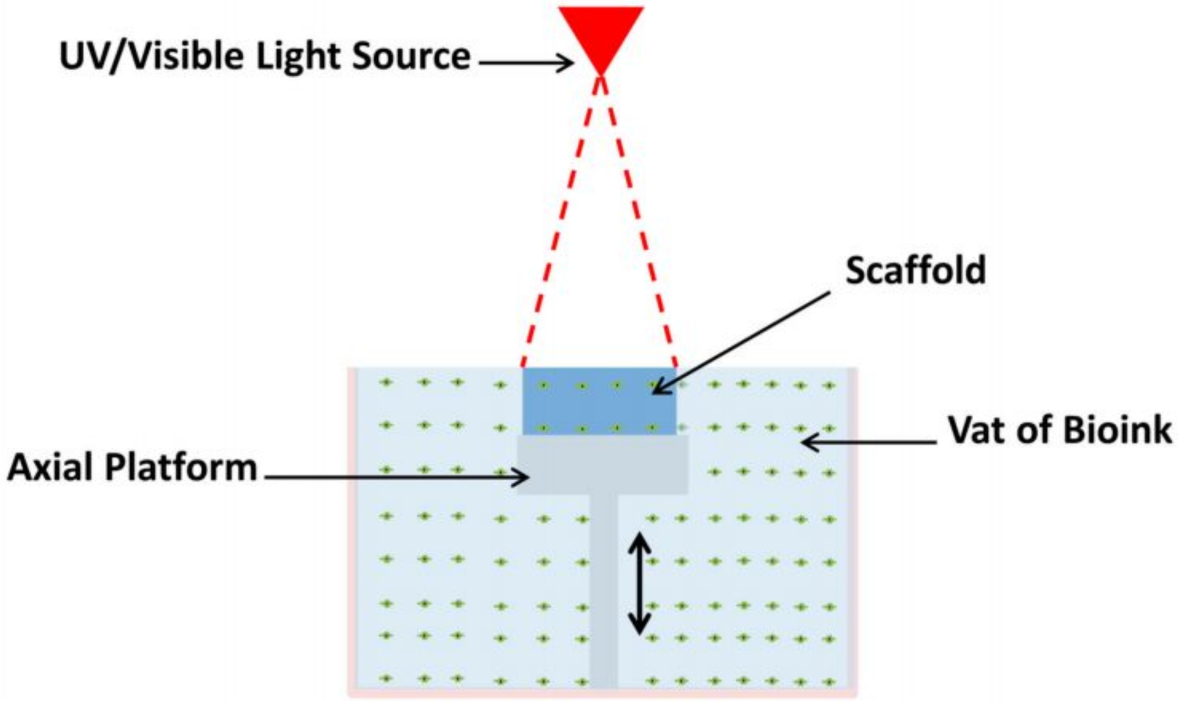


Figure 3. Schematic of Stereolithography Bioprinting. Photopolymerization occurs on the surface of the vat where the light-sensitive bioink is exposed to light energy. Axial platform moves downward the Z-axis during fabrication. This layer-by-layer technique does not depend on the complexity of the design, rather on its height.

doi:10.3390/ma11112199

3D Bioprinting - Bioprinters

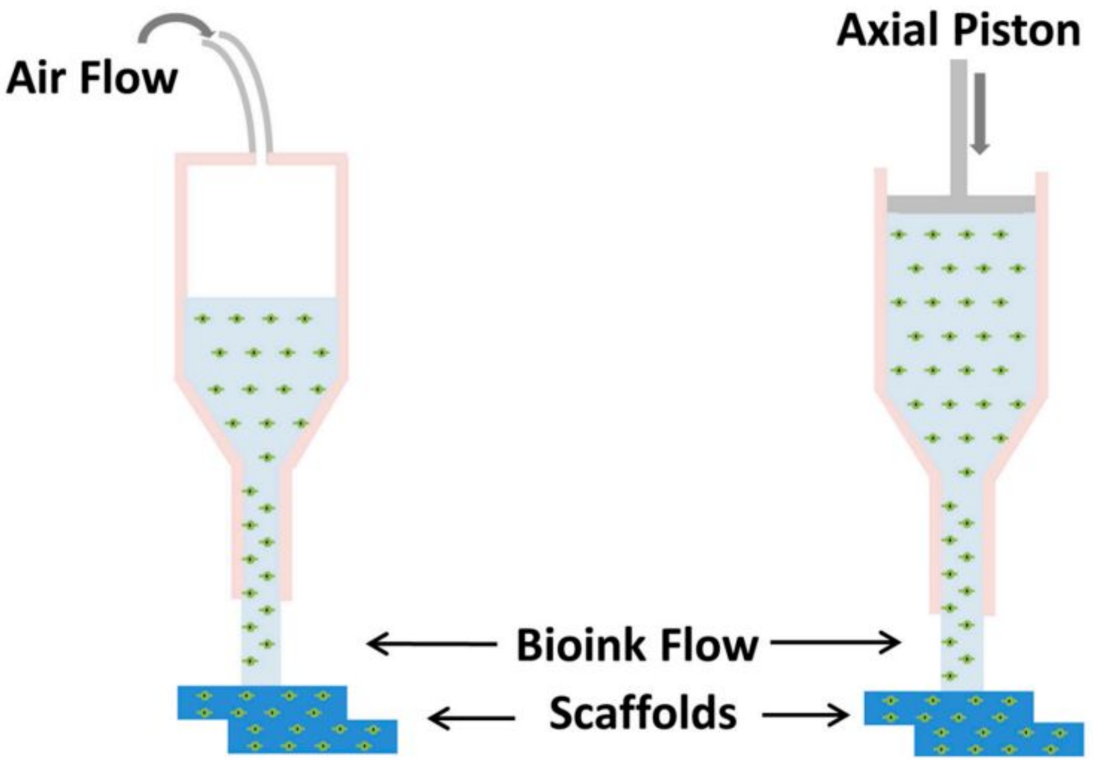
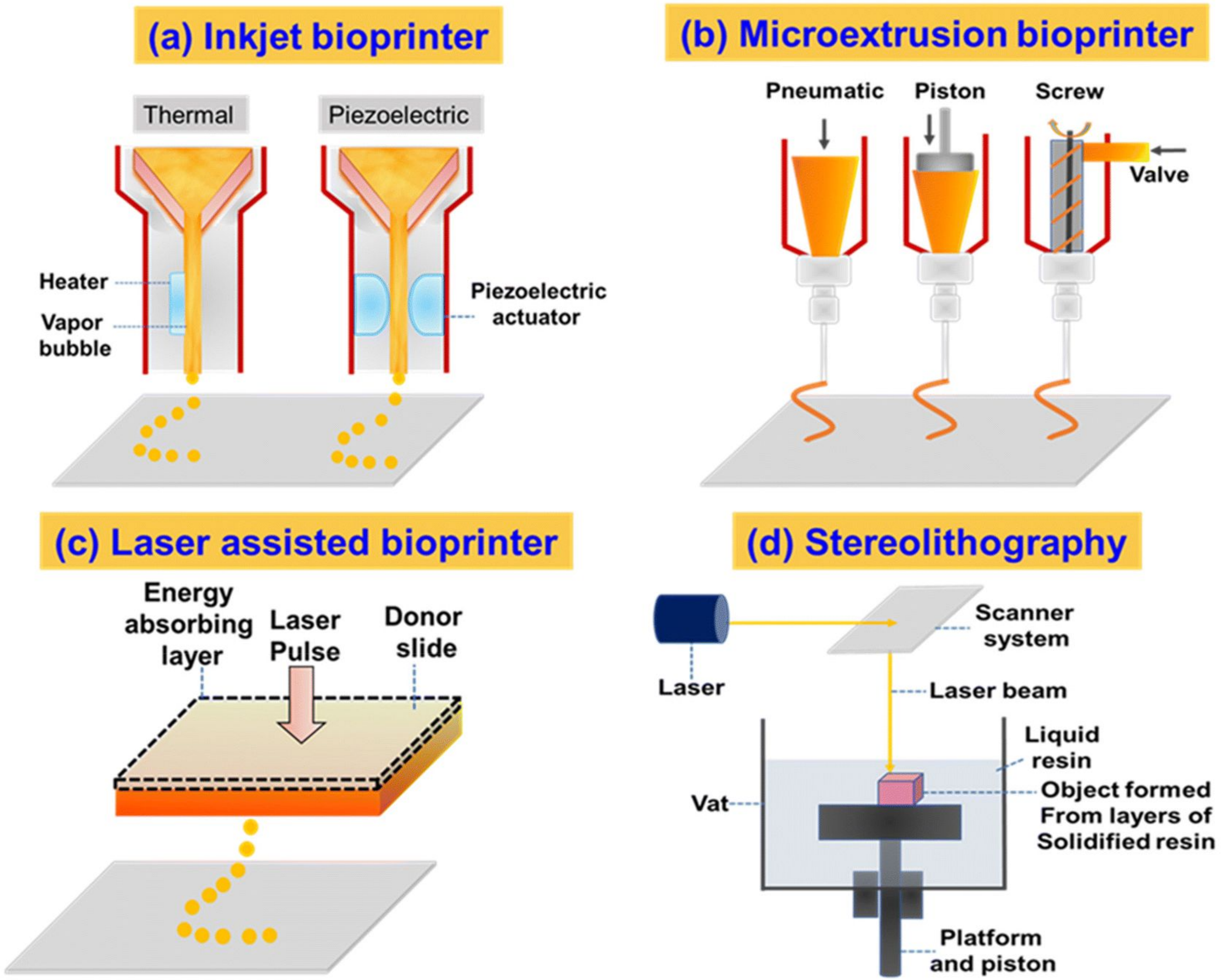


Figure 5. Schematic of Extrusion-based Bioprinting; from left, pneumatic-based and right, mechanical-based. Struts are extruded via pneumatic or mechanical pressure through micro-nozzles. Extrusion-based techniques can produce structures with great mechanical properties and print fidelity.

doi:10.3390/ma11112199

3D Bioprinting - Bioprinters



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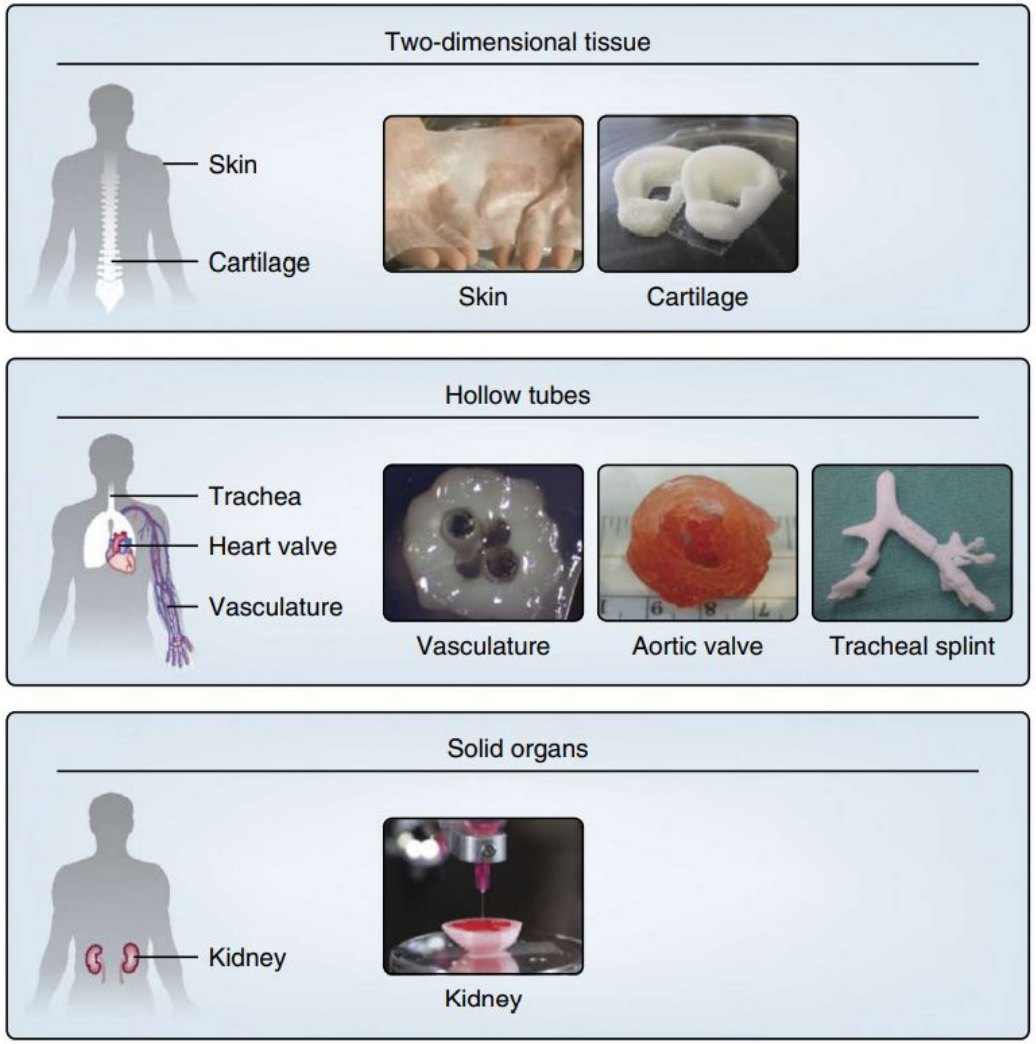
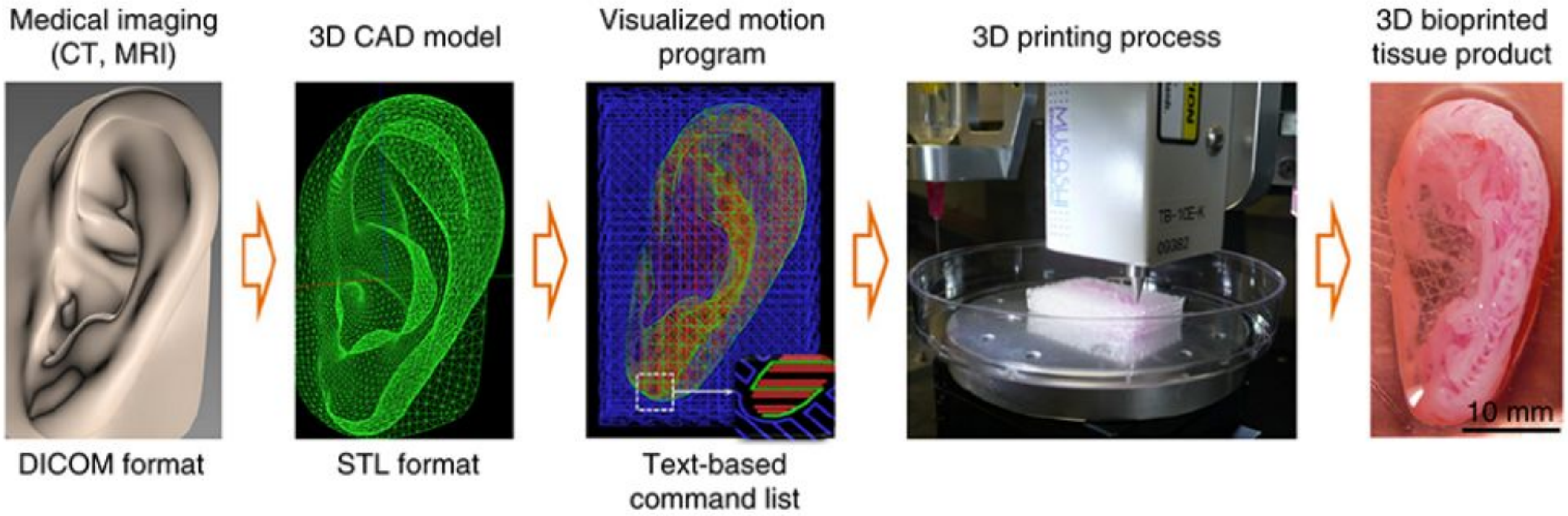
3D Bioprinting (Human scale bioprinted tissue)



doi:10.1038/nbt.2958

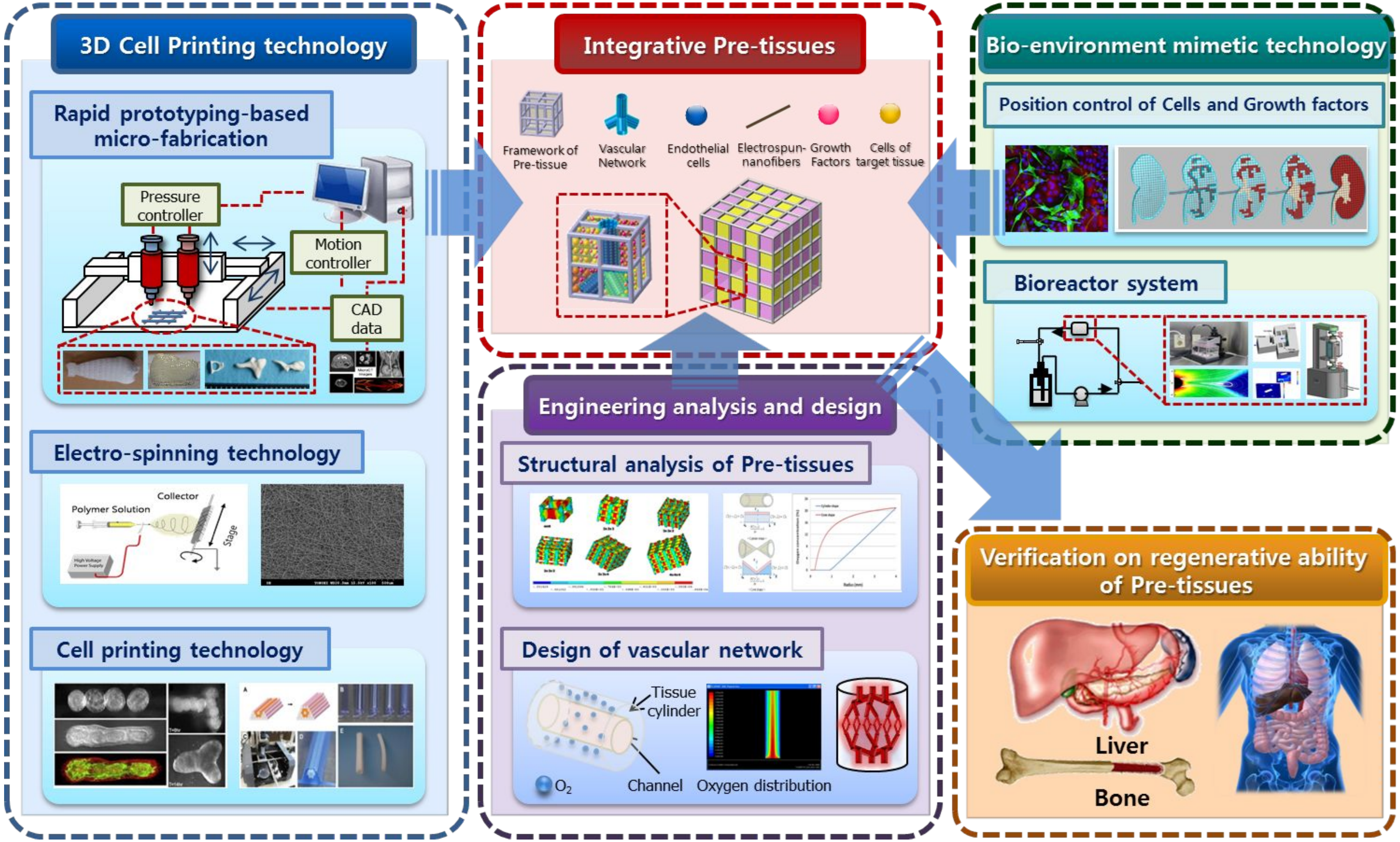
3D Bioprinting (Human scale bioprinted tissue)



The 3D bioprinting process. Image: Wake Forest, *Nature Biotechnology*

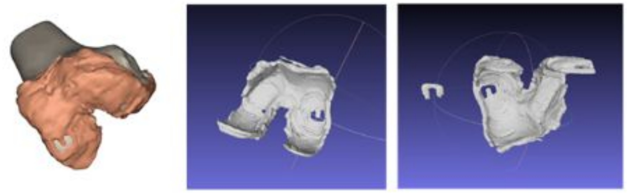
blog.cirm.ca.gov

3D Bioprinting

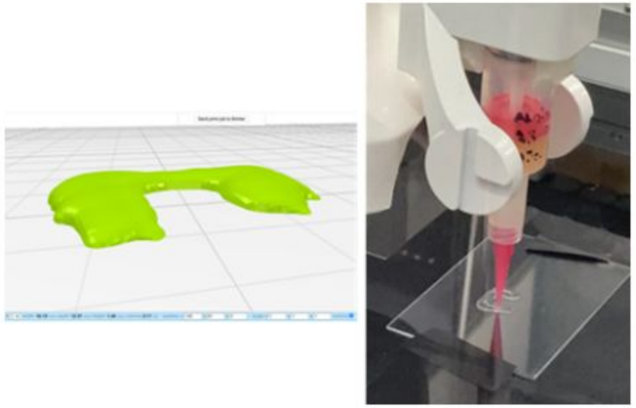


3dprintingindustry.com

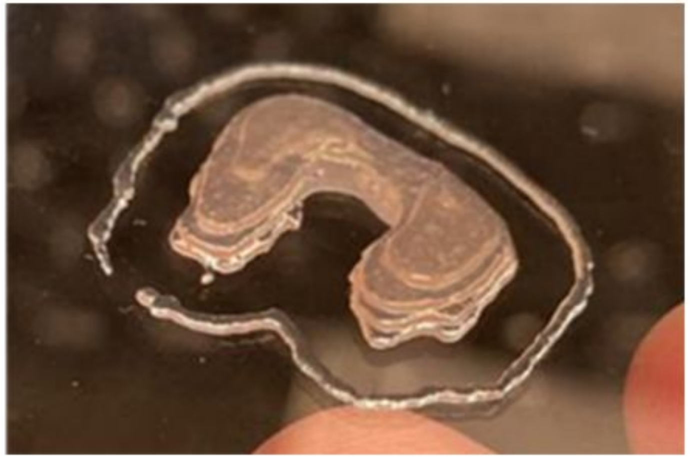
3D Bioprinting



A representative 3D reconstructed model of the osteoarthritic knee joint from the RESTORE Project's online database, together with STL models of the femoral cartilage with a horse-shoe-shaped cartilage patch designed to fit the lesion.



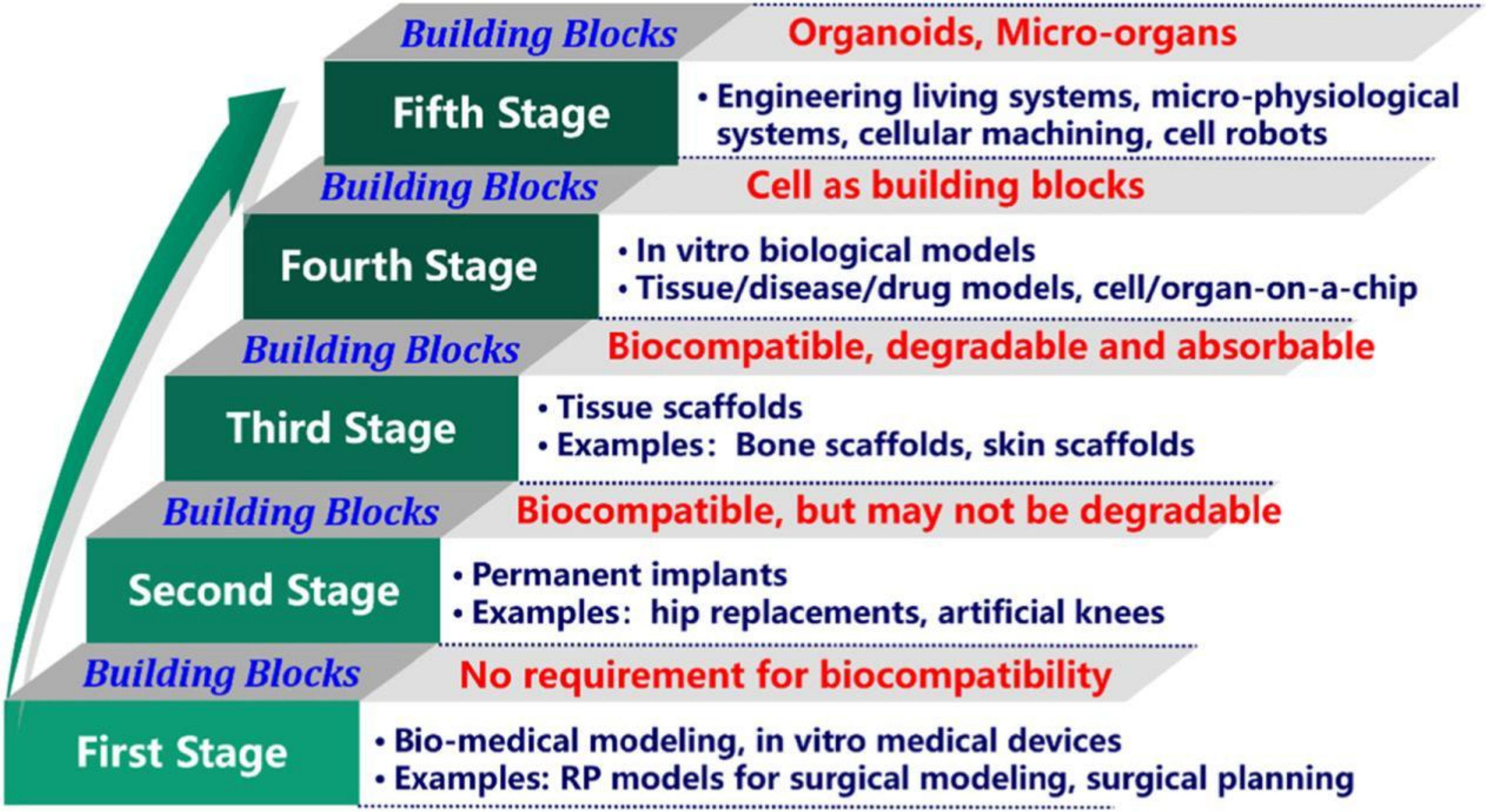
(Left): The horse-shoe-shaped cartilage patch model was created using various imaging techniques to unravel the 3D architecture of the tissues and control the positioning of print heads to place bioink in a 3D shape for a patient-specific match. (Right): 3D bioprinting process of the patch using Brinter® Rotary Tool print head and bioink material mixed with cells, spheroids or organoids.



The completed cartilage patch bioprinted using the Brinter® Rotary Tool print head.

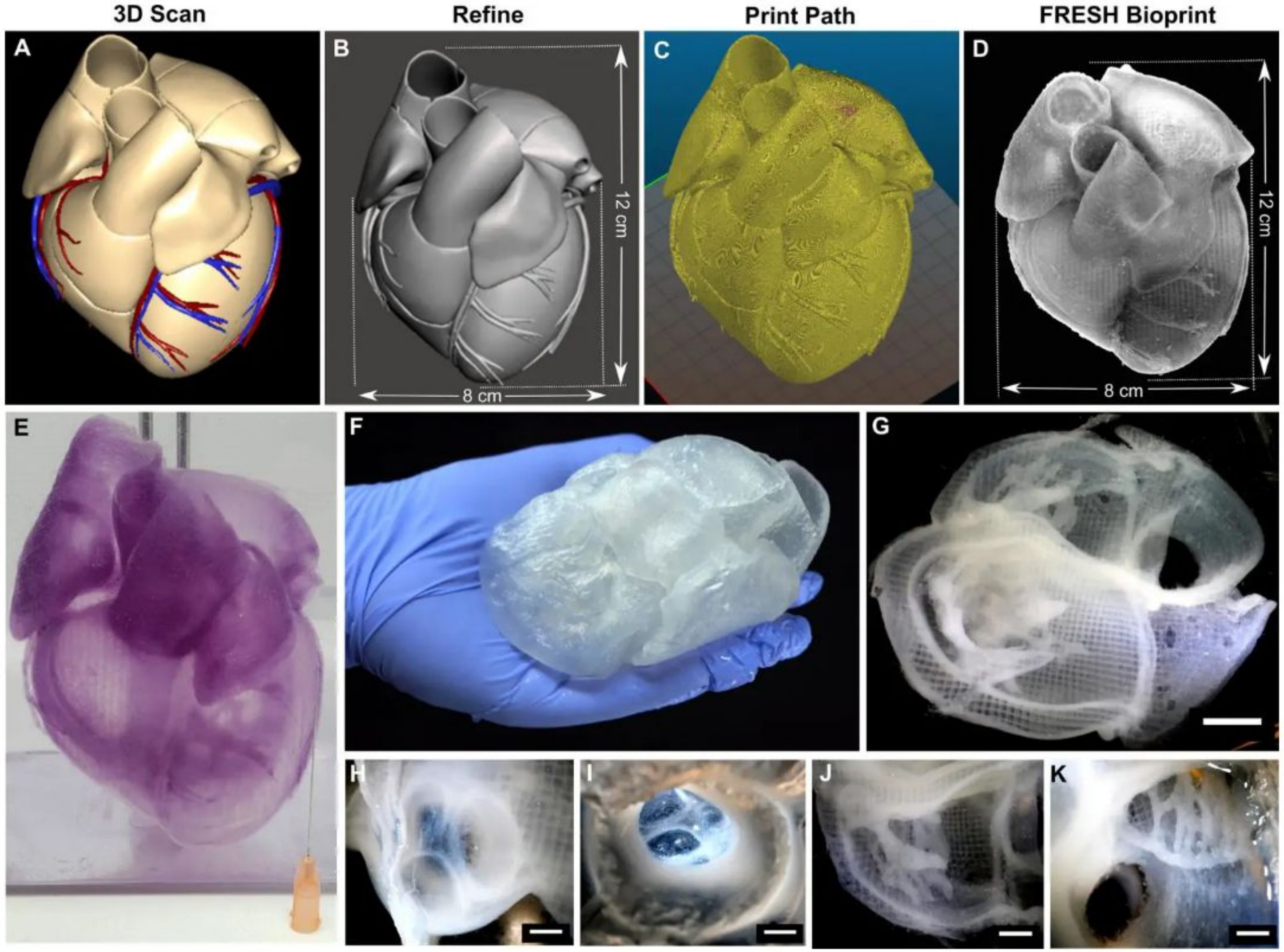
www.pharmaceutical-networking.com

3D Bioprinting



3dprintingindustry.com

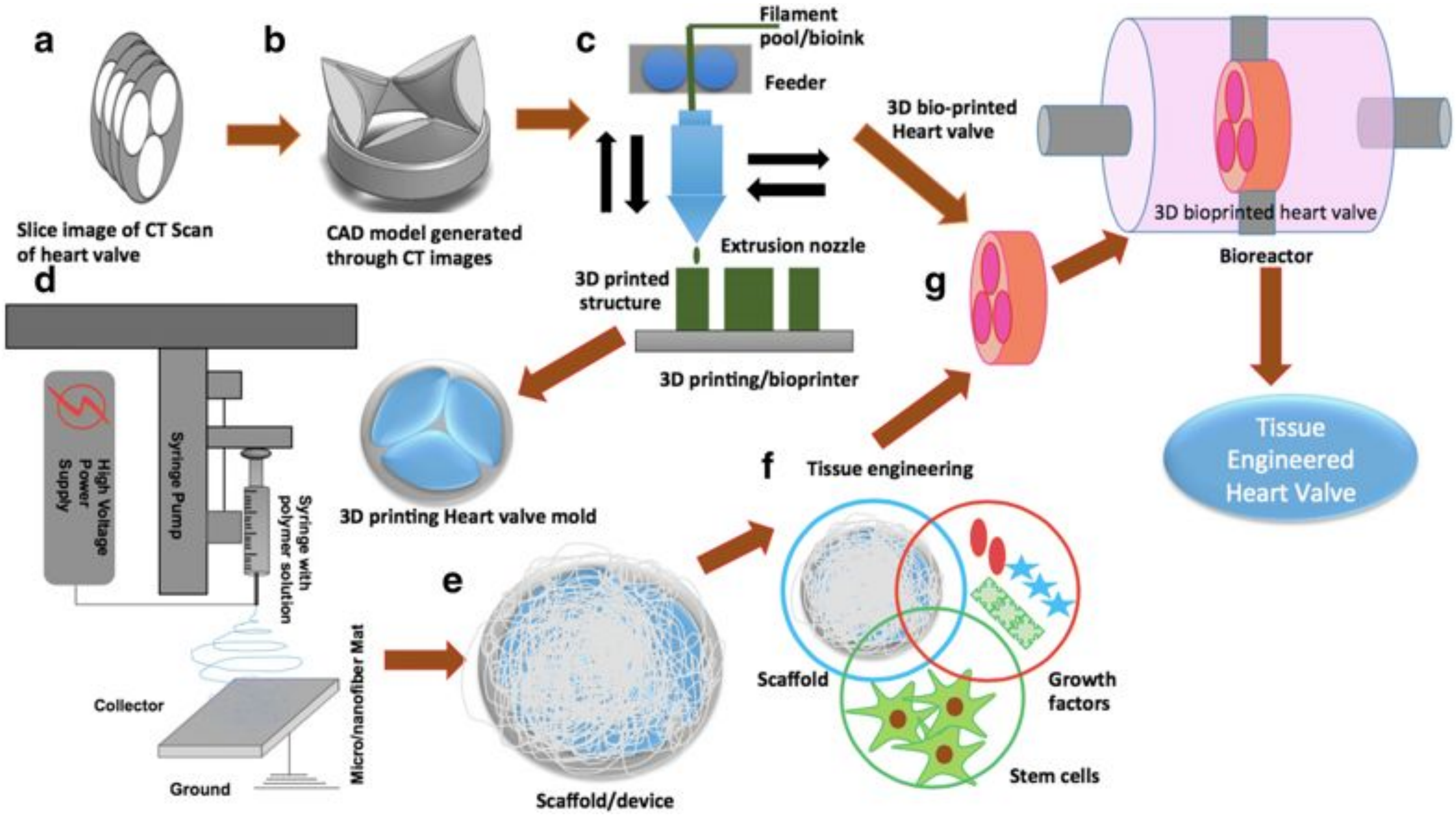
3D Bioprinting



Modeling incorporates imaging data into the final 3D printed object. Credit: Carnegie Mellon University College of Engineering

scitechdaily.com

3D Bioprinting



https://3dprint.com/

3D Bioprinting

Proposed process for the generation of 3D heart valves through bioprinting to arrive at functional tissue engineered heart valves

(a) slice of CT images,

(b)3D CAD model generation,

(c)3D bioprinting through bioink/ 3D printing through polymer scaffold,

(d)3D printed scaffold,

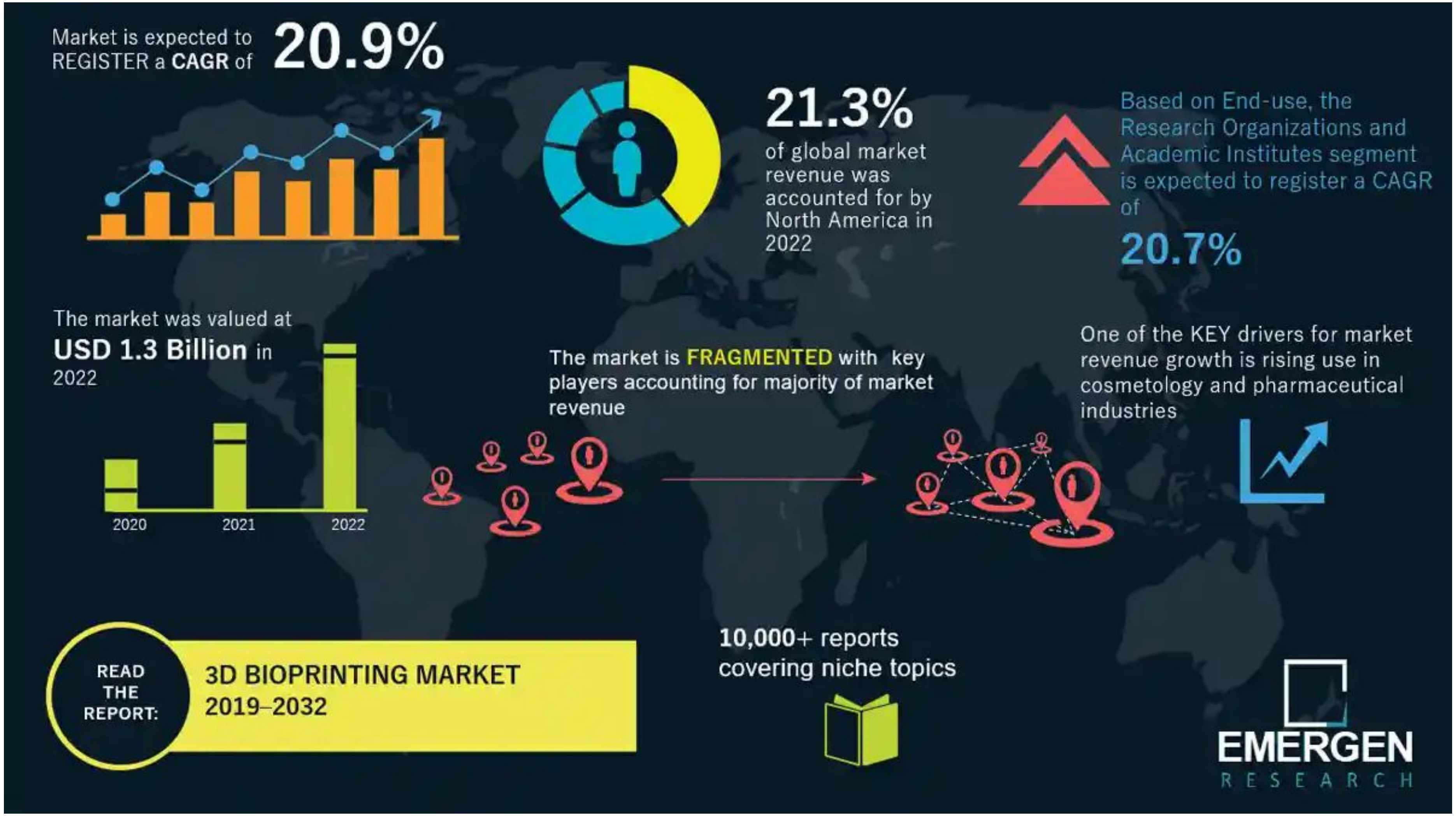
(e)scaffold ready

(f)Development of tissue through combining cells, growth factors and developed scaffold,

(g)Development and initial tissue remodeling in bioreactor

https://3dprint.com/

3D Bioprinting



www.emergenresearch.com

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ENVIRONMENTAL STUDIES & LIFE SCIENCES

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ENVIRONMENTAL STUDIES & LIFE SCIENCES

Organic Farming

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Organic Farming

- Organic farming is a method of crop and livestock production that involves choosing not to use pesticides, fertilizers, genetically modified organisms, antibiotics and growth hormones
- Holistic system designed to optimize the productivity and fitness of diverse communities within the agro-ecosystem, including soil organisms, plants and livestock

Organic Farming

Image source: agritech.ac.in

- The general principles of organic production, include the following:

1. protect the environment, minimize soil degradation and erosion, decrease pollution, optimize biological productivity
2. maintain long-term soil fertility by optimizing conditions for biological activity within the soil
3. recycle materials and resources to the greatest extent possible within the enterprise

4. prepare organic products, emphasizing careful processing, and handling methods in order to maintain the organic integrity and vital qualities of the products at all stages of production
5. rely on renewable resources in locally organized agricultural systems

Organic Farming

- In 1921 the founder and pioneer of the organic movement Albert Howard and his wife Gabrielle Howard, accomplished botanists, founded an Institute of Plant Industry to improve traditional farming methods in India

Organic Farming

- **Methods**
- Crop rotation
- Green manures and compost
- Biological pest control
- Nitrogen fixing organisms
- Natural insect predators

Organic Farming

- The science of agroecology has revealed the benefits of polyculture (multiple crops in the same space), which is often employed in organic farming
- Planting a variety of vegetable crops supports a wider range of beneficial insects, soil microorganisms, and other factors that add up to overall farm health

Organic Farming

- Biological process, driven by microorganisms such as mycorrhiza and earthworms allows the natural production of nutrients in the soil throughout the growing season
- Organic farmers use a number of traditional farm tools to minimize their reliance on fossil fuels

Organic Farming

- In India, in 2016, Sikkim achieved its goal of converting to 100% organic farming
- Kerala, Mizoram, Goa, Rajasthan and Meghalaya, have also declared their intentions to shift to fully organic cultivation
- Andhra Pradesh is promoting organic farming, especially Zero Budget Natural Farming (ZBNF) which is a form of regenerative agriculture

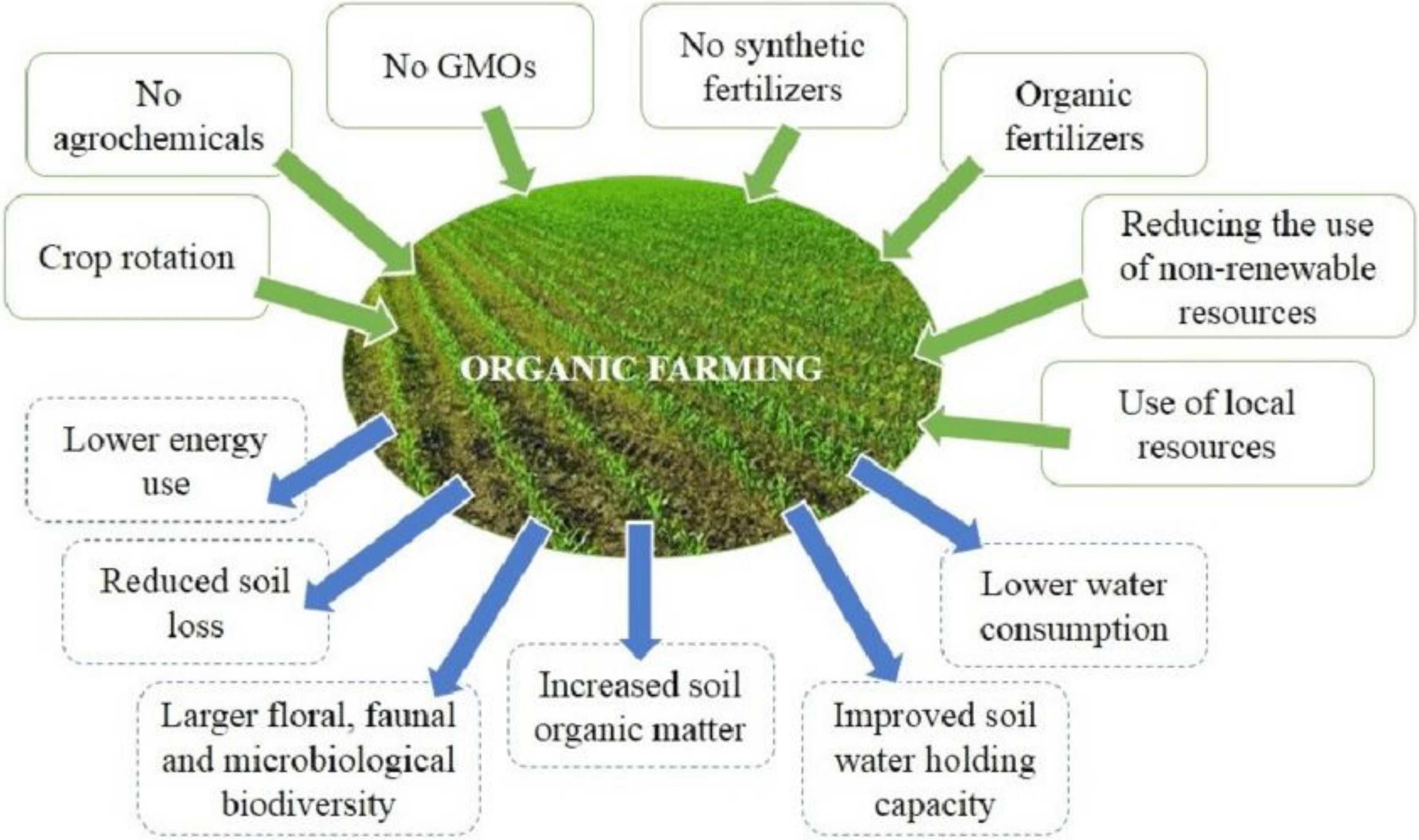
Organic Farming

- As of 2018, India has the largest number of organic farmers in the world and constitutes to more than 30% of the organic farmers globally
- India has 835,000 certified organic producers

Advantages of Organic Farming:

- Farmers can reduce their cost of production as they do not need to buy expensive chemicals and fertilizers.
- Healthier farmworkers as no pesticide is used.
- Organic farms save energy and protect the environment in the long term.
- Organic farming can slow down global warming.
- There are fewer residues in food.
- Biodiversity: More animals and plants can live in the same place in a natural way.
- Pollution of groundwater is stopped.
- Soil is built with natural fertilizers in order to grow crops.
- Soil conservation is done due to crop rotation.
- Organic farming creates new living areas for wasps, bugs, beetles and flies by giving them water and food.

Organic Farming



https://www.researchgate.net/figure/The-main-principles-and-effects-of-organic-farming_fig1_338066368

Key Highlights

• The central government had launched two dedicated programs in 2015 to provide a boost to natural, organic and chemical-free farming. The schemes include:
Mission Organic Value Chain Development for North East Region (MOVCD)
Paramparagat Krishi Vikas Yojana (PKVY)

• The two programmes were launched to assist farmers to adopt organic farming and improve remunerations due to premium prices.

• The Agri-export Policy 2018 also aims to help India emerge as a major player in global organic markets.

• India's major organic exports include flax seeds, sesame, soybean, tea, medicinal plants, rice and pulses. These exports were instrumental in driving an increase of nearly 50 percent in organic exports in 2018-19, touching Rs 5151 crore.

• The centre is further trying to strengthen the organic e-commerce platform www.jaivikkheti.in to directly link farmers with retail as well as bulk buyers. Infusion of digital technology in a much bigger way. This has been one of the major takeaways during the pandemic period.

Image source: © 2020 Organic Products India

Certification of Organic Products

The two central programmes PKVY and MOVCD promote certification under Participatory Guarantee System (PGS) and National Program for Organic Production (NPOP) respectively targeting domestic and export markets, as certification is an important element of organic produce to instill customer confidence.

The Food Safety and Standards (Organic Foods) Regulations, 2017 are also based on the PGS and NPOP standards. The consumer should look out for the logos of FSSAI, Jaivik Bharat / PGS Organic India on produce to establish its organic authenticity. PGS Green certification is given to chemical-free produce under transition to 'organic' which takes 3 years.

Image source: © 2020 Organic Products India

Techniques of organic farming

Image source: © 2020 Organic Products India

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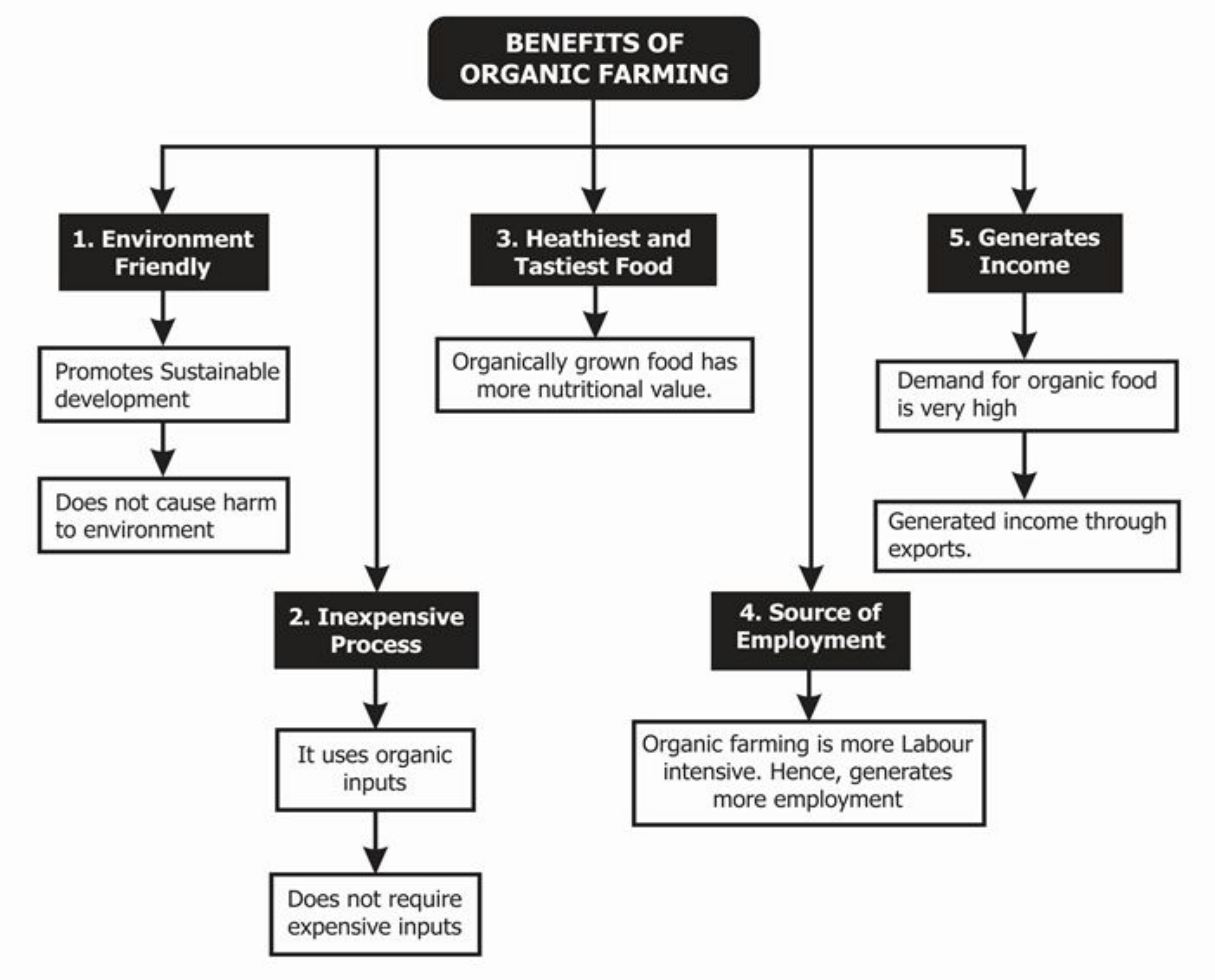
Types of organic farming

Image source: © 2020 Organic Products India

Benefits of organic farming



Organic Farming

Image source: © 2020 Organic Products India

ENVIRONMENTAL STUDIES & LIFE SCIENCES

Vermicomposting

Vermicomposting

- **Vermicomposting** is a type of composting in which certain species of earthworms are used to enhance the process of organic waste conversion and produce a better end-product
- It is a mesophilic process utilizing microorganisms and earthworms

Vermicomposting

- Vermicompost is the product of the decomposition process using various species of earthworms
- To create a mixture of decomposing vegetable or food waste, bedding materials etc.
- This process is called vermicomposting, while the rearing of worms for this purpose is called vermiculture

Vermicomposting

- Vermicomposting, or worm composting, turns kitchen scraps and other green waste into a rich, dark soil that smells like earth
- Made of almost pure worm castings, it’s a sort of super compost
- Not only is it rich in nutrients but it’s also loaded with the microorganisms that create and maintain healthy soil

Vermicomposting

Image source:
© 2020 - Center for American Progress

- Collection of Earthworm Species: Collected from the department of entomology, University of Agriculture Sciences, GKVK, Bangalore–65

1. *Eisenia fetida*

2. *Eudrilus euginiae*

3. *Perionyx excavatus*

Vermicomposting

- It provides a way to treat organic wastes more quickly
- The earthworm species most often used are red wigglers (*Eisenia fetida*), though European nightcrawlers (*Eisenia hortensis*) and red earthworm (*Lumbricus rubellus*) could also be used
- Red wigglers are recommended by most vermicomposting experts, as they have some of the best appetites and breed very quickly

Earthworm species

Image source: redwormcomposting.com

Vermicomposting

- Containing water-soluble nutrients, vermicompost is a nutrient-rich organic fertilizer and soil conditioner in a form that is relatively easy for plants to absorb
- Worm castings are sometimes used as an organic fertilizer
- Because the earthworms grind and uniformly mix minerals in simple forms, plants need only minimal effort to obtain them

Vermicomposting

- How to vermicompost at home?
- In addition to readily available kitchen scraps, worms, a container, and bedding are required
- One pound of worms, approximately 1,000 worms, to one pound of garbage (worms need to be added gradually)
- Since worms are quite sensitive to both light and noise, a dark corner works best

Vermicomposting

- They thrive at temperatures between about 13°-25°C
- Bedding should be about 75 percent water
- Bedding can be made out of strips of newspaper or shredded grocery bags, cardboard, or egg cartons, composted manure, old leaves, coconut coir, or a mixture of any of these substances
- The material must be clean and non-toxic

Vermicomposting

Image source: agritech.ac.in

Vermicomposting

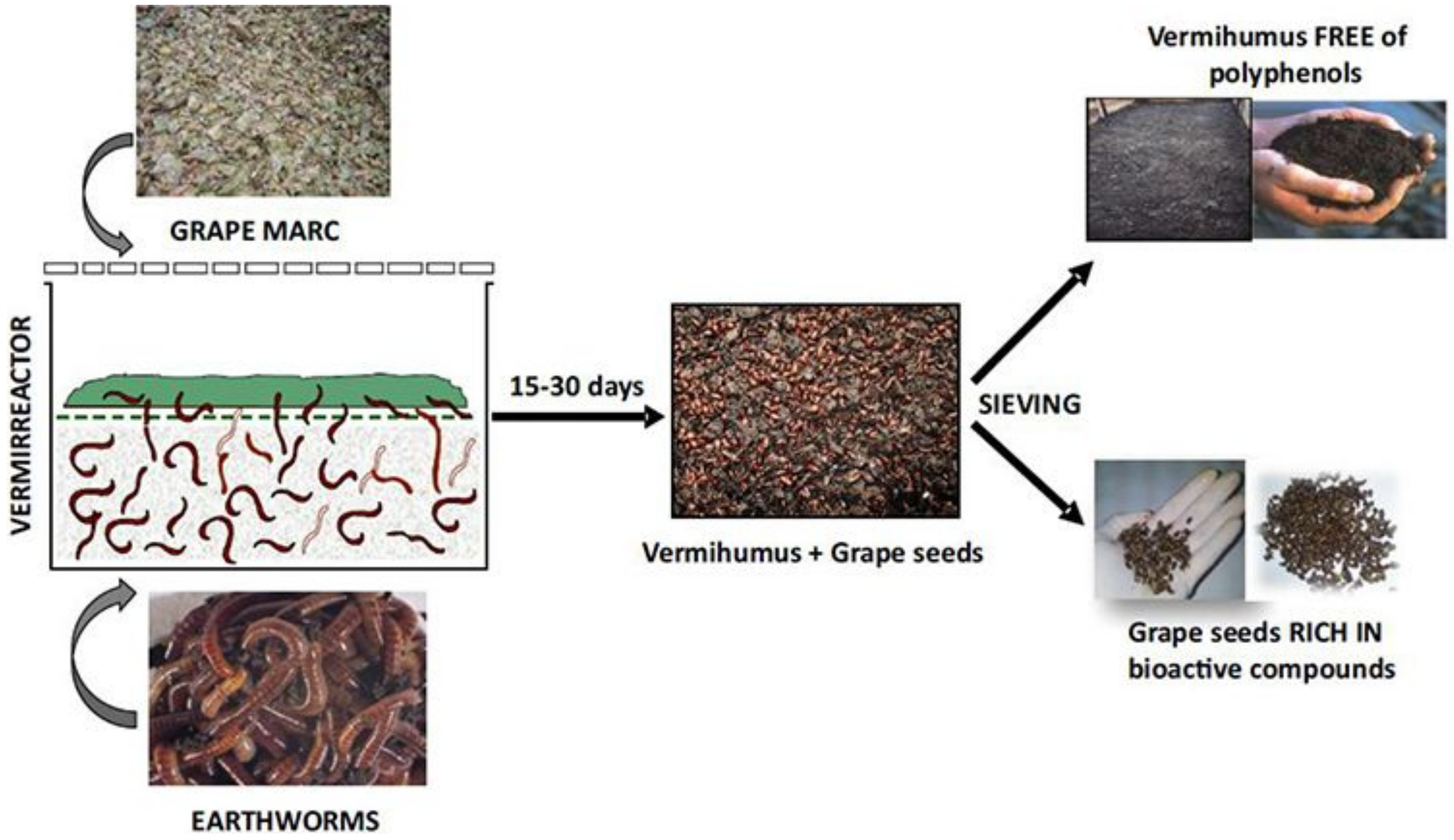


Image source: agritech.ac.in

Vermicomposting

Vermicomposting in large scale

Vermicompost pits in the farmer's field

Healthy worms from the compost pits

Vermicompost

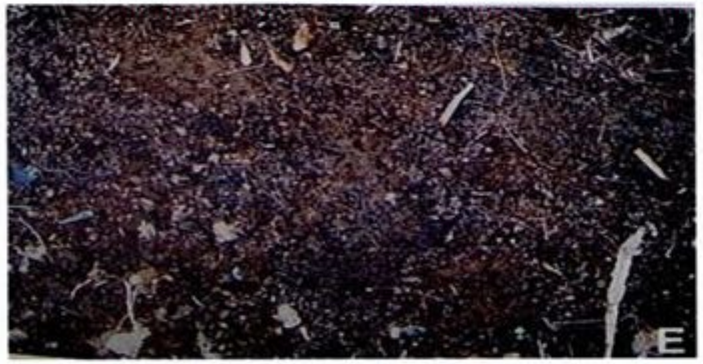
Image source: agritech.ac.in

Vermicomposting

Department of Biotechnology,
Vermicomposting unit

Vermiculture unit of kitchen waste recycling @ PES University

Eisenia fetida, Eudriluus euginiae, Perionyx excavatus



Shade drying of Vermicompost

Sieved Vermicompost

Vermicomposting

- **Benefits in plant growth**
- Enhances germination, plant growth, and crop yield
- Improves root growth and structure
- Enriches soil with micro-organisms (adding plant hormones such as auxins and gibberellic acid)

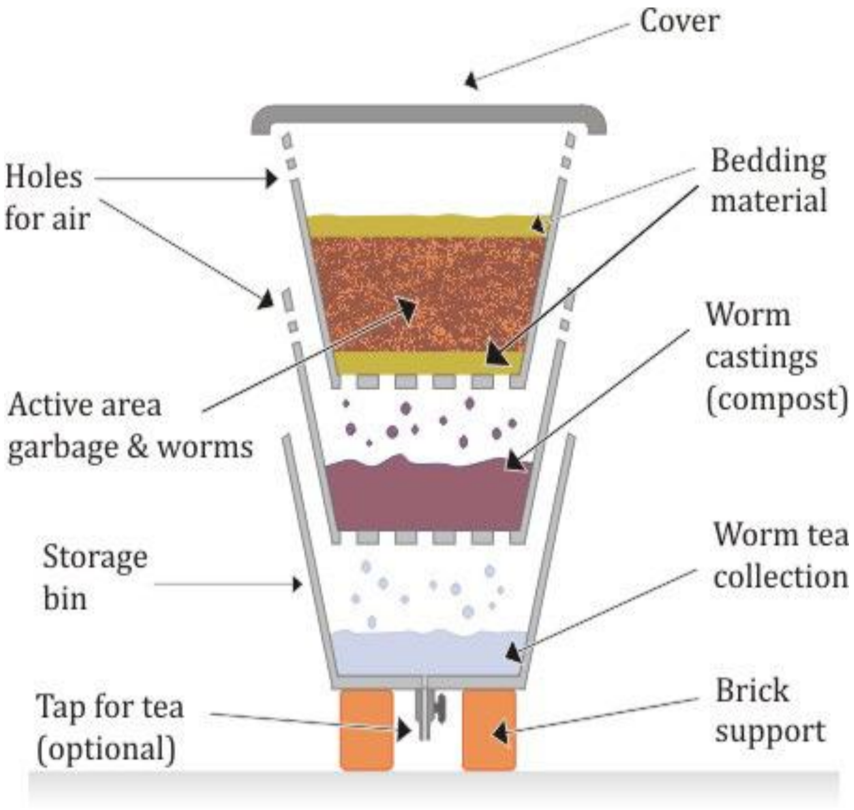
Vermicomposting

- **Benefits for environment**
- Biowastes conversion reduces waste flow to landfills
- Elimination of biowastes from the waste stream reduces contamination of other recyclables collected in a single bin
- Production reduces greenhouse gas emissions such as methane and nitric oxide

Vermicomposting

- **Uses**
- **Soil conditioner**
- Vermicompost can be mixed directly into the soil, or mixed with water to make a liquid fertilizer known as worm tea

Vermicomposting



Vermicomposting

PIT/BED method

Windrow method

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ENVIRONMENTAL STUDIES & LIFE SCIENCES

Biofuels

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Biofuels

- Biofuels are a renewable energy source, made from organic matter or wastes, that can play a valuable role in reducing carbon dioxide emissions
- Biofuels are one of the largest sources of renewable energy in use today
- In the transport sector, they are blended with existing fuels such as gasoline and diesel

Biofuels

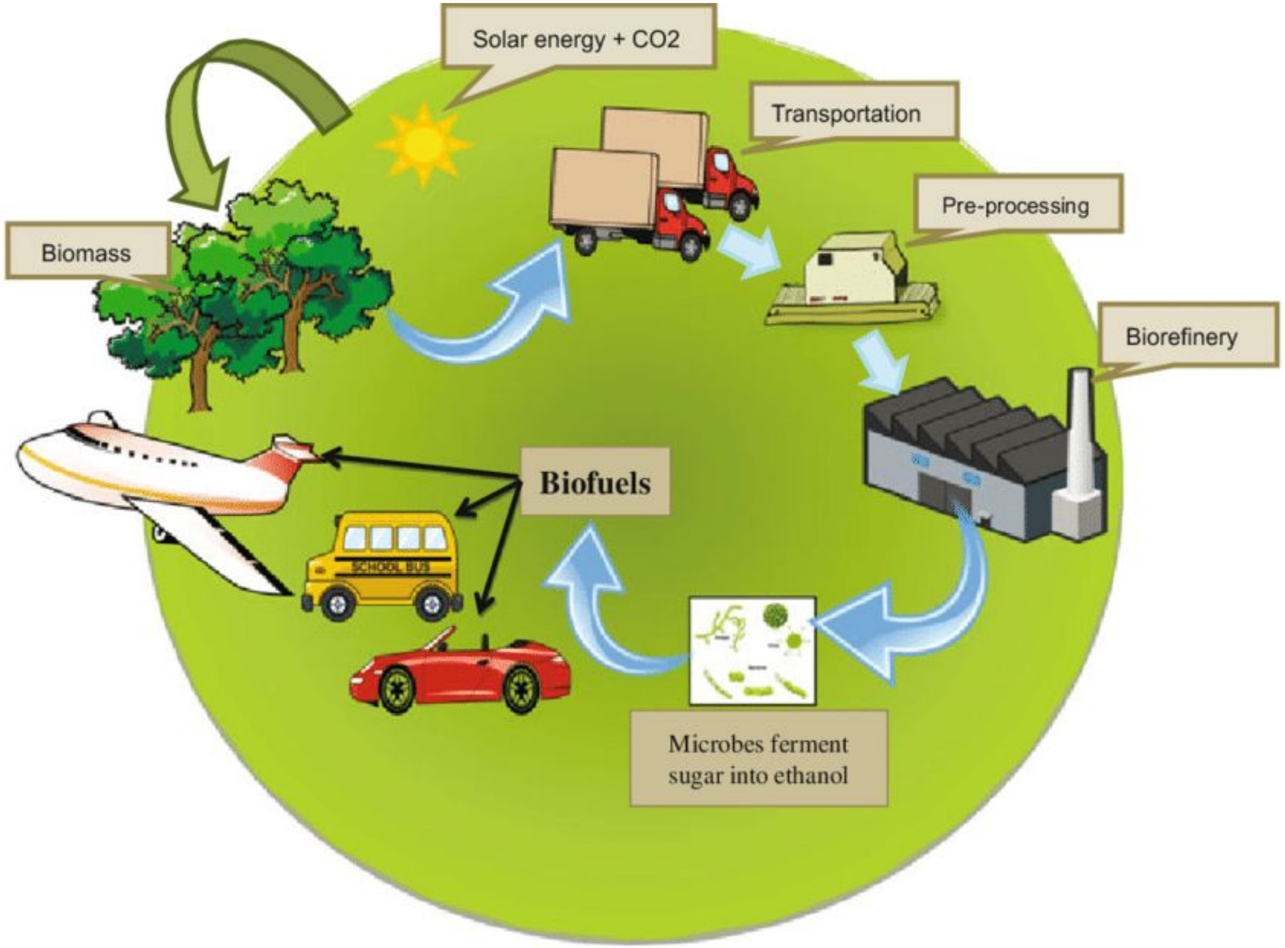


Image source: solarsurge.in

Biofuels

- Biofuels can be produced from plants (i.e. energy crops), or from agricultural, commercial, domestic, and/or industrial wastes (if the waste has a biological origin)
- The two most common types of biofuels in use today are bioethanol and biodiesel, both of which represent the first generation of biofuel technology

Biofuels

- First-generation or conventional biofuels are made from food crops grown on fertile land
- Second-generation biofuels are fuels manufactured from various types of biomass. Biomass means any source of organic carbon that is renewed rapidly as part of the carbon cycle. Biomass is derived from plant materials, but can also include animal materials.
- Third generation biofuels use algae as a source
- Fourth generation class of biofuels include electrofuels and photobiological solar fuels

Biofuels

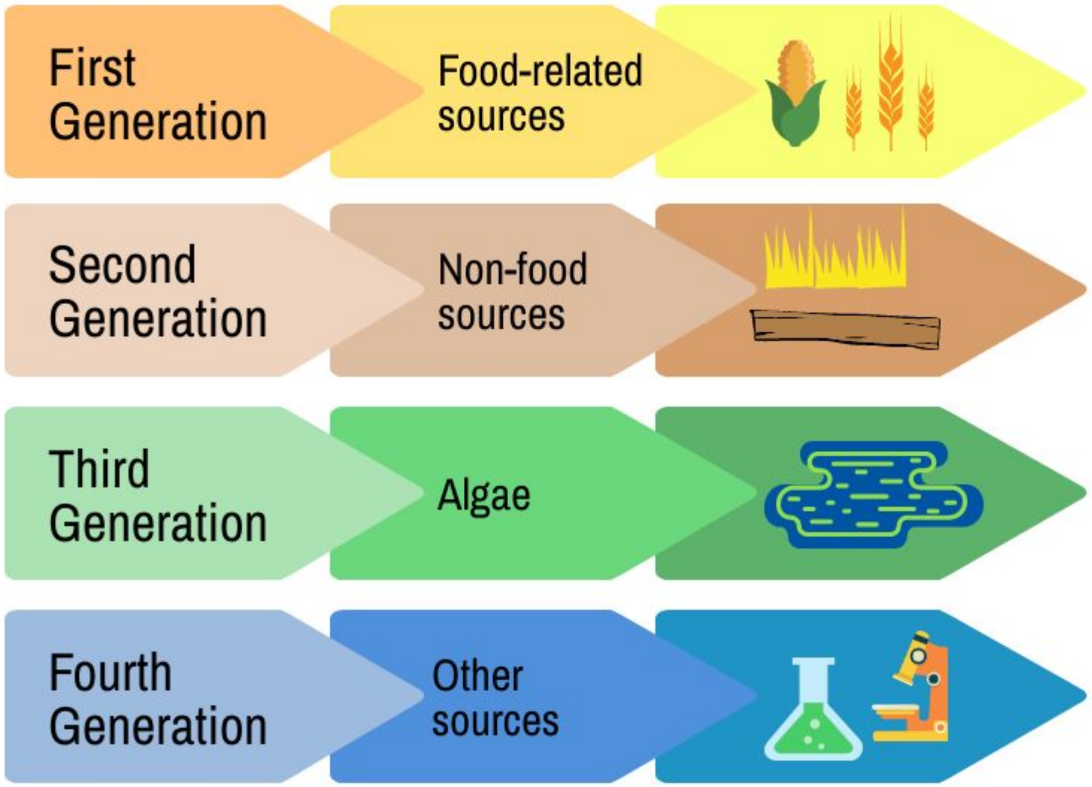


Image source: © 2019 letstalkscience

Biofuels

- The following fuels can be produced using first, second, third or fourth-generation biofuel production procedures:
- Biogas
- Syngas
- BioEthanol
- Biodiesel
- Green diesel
- Bioethers

Bioethanol:

- Most ethanol is made from plant starches and sugars, but scientists are continuing to develop technologies that would allow for the use of cellulose and hemicellulose
- The common method for converting biomass into ethanol is called fermentation when microorganisms (e.g., bacteria and yeast) metabolize plant sugars and produce ethanol

Biodiesel:

- Biodiesel is a liquid fuel produced from renewable sources, such as new and used vegetable oils and animal fats and is a cleaner-burning replacement for petroleum-based diesel fuel
- Biodiesel is nontoxic and biodegradable and is produced by combining alcohol with vegetable oil, animal fat, or recycled cooking grease

Advantages of biofuels

1. Efficient fuel
2. Non-dependency on fossil fuels
3. Durability of vehicles' engine
4. Easy to source
5. Renewable
6. Reduces greenhouse gases
7. Lower levels of pollution

Disadvantages of biofuels

1. High Cost of Production
2. Use of Fertilizers for the huge amount of crops used to produce biofuels
3. Water use
4. Land use
5. Dependent of weather

Biofuels

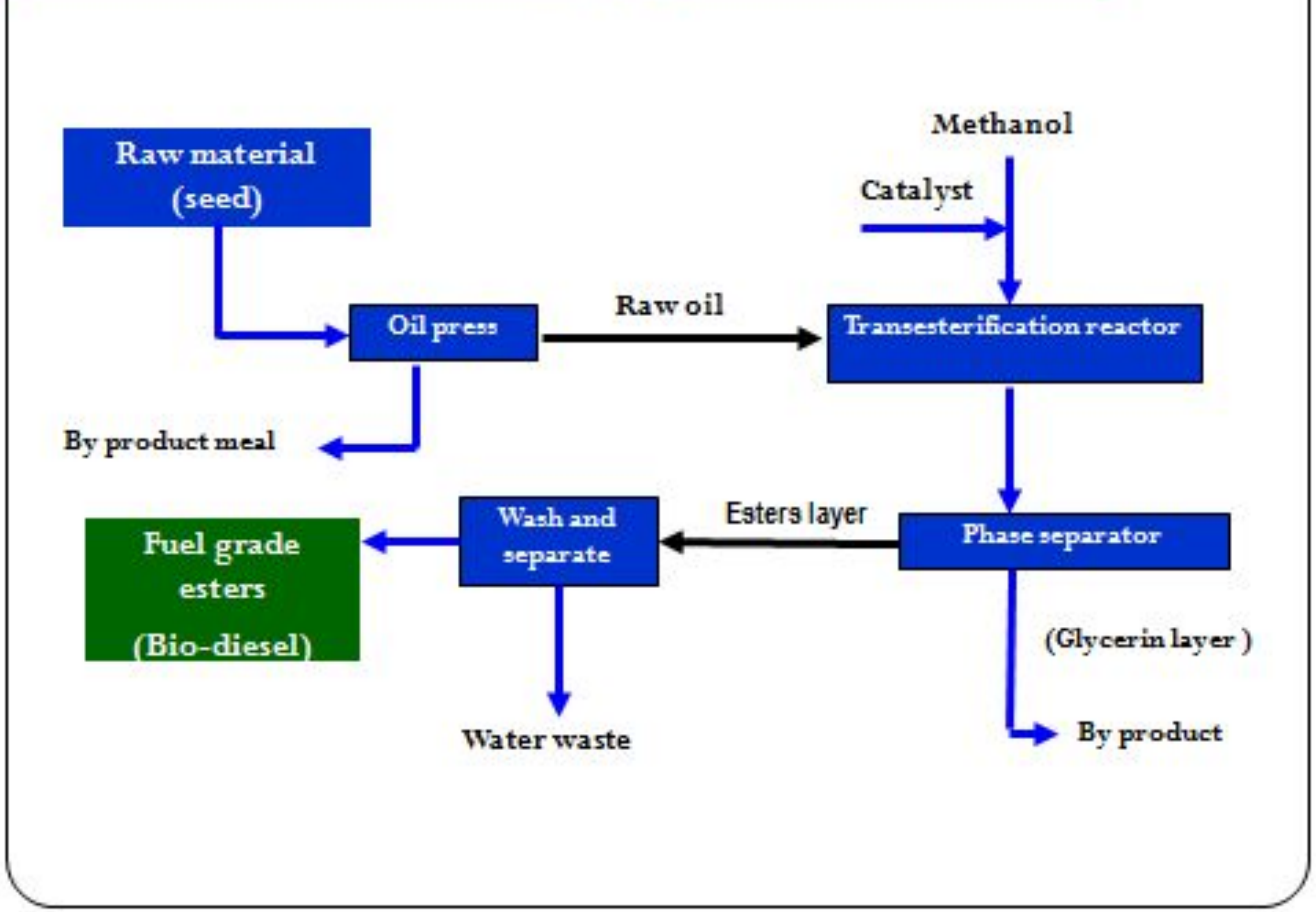
- India's biofuel production accounts for only 1% of the global production
- It is worth noticing that India is the second largest producer of sugarcane in the world but accounts for only about 1% of global ethanol production

Biofuels

- In India, jatropha seeds were used to produce biodiesel, but the production has not been consistent
- Farmers were encouraged to plant jatropha, but the yield was far below what was expected
- This led to the raw material cost becoming fairly expensive, making biodiesel even more expensive than petroleum based diesel

Biofuels

Bio-diesel manufacture from *Jatropha curcas* seeds



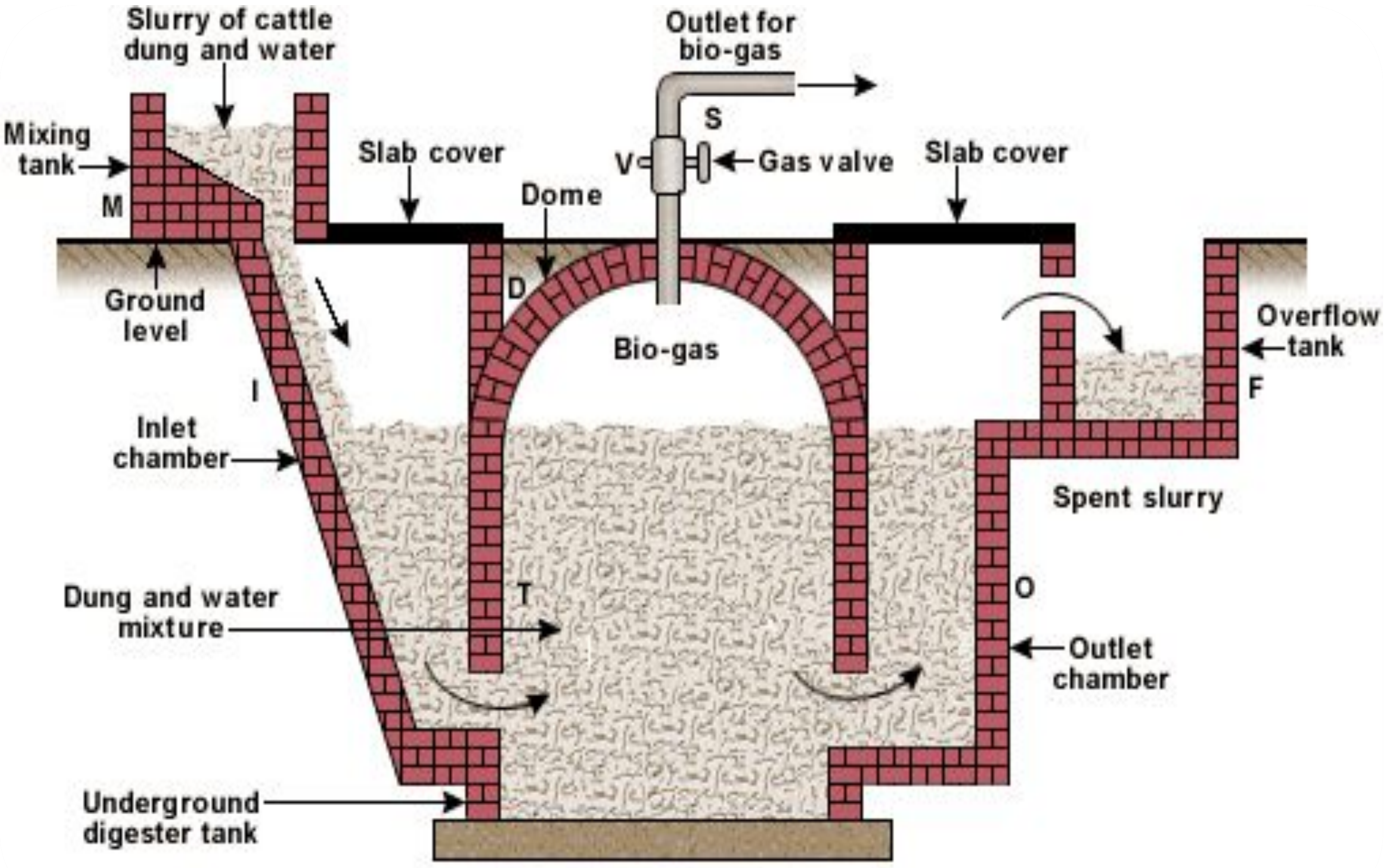
Biofuels

- Bioenergy consists of biomass (biological mass) used in the production of energy
- Phototrophs use light to survive and propagate (plants)

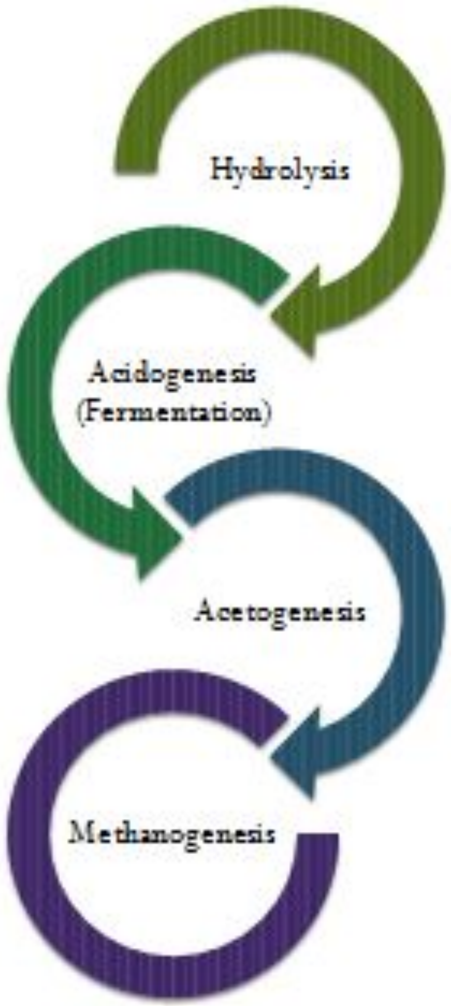
CO_2 + H_2O >--solar energy and ..>>CH_2O + O_2, or carbohydrate and oxygen

- Chemotrophs (like us) eat phototrophs (vegetables and salads)
- While biomass combustion releases CO_2 into the atmosphere, new plants require CO_2 to grow, balancing the process.

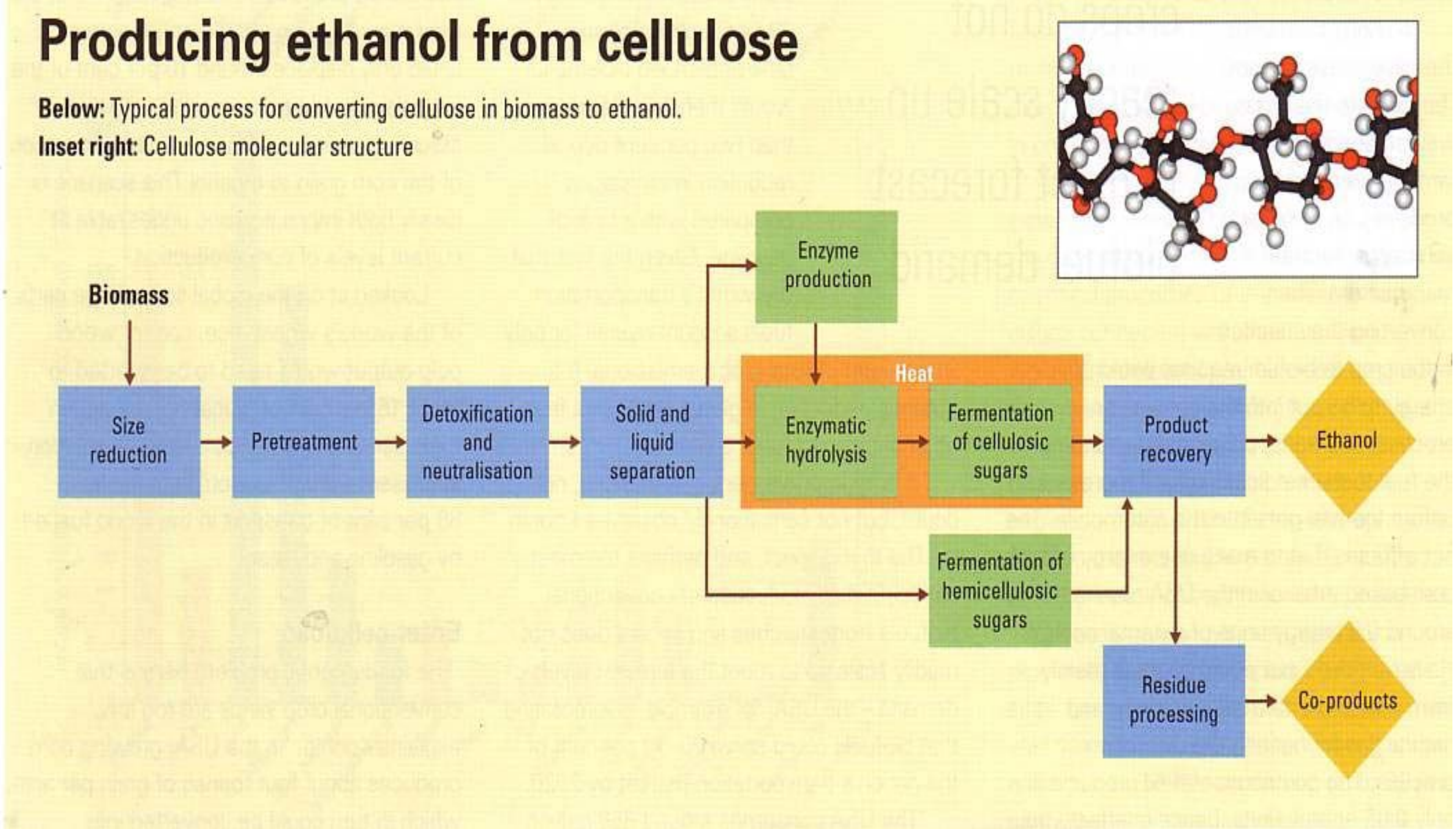
Biofuels- Biogas



Fixed-dome type bio-gas plant.



Biofuels


Producing ethanol from cellulose
Below: Typical process for converting cellulose in biomass to ethanol.
Inset right: Cellulose molecular structure
Biomass
Size reduction
Pretreatment
Detoxification and neutralisation
Solid and liquid separation
Enzyme production
Heat
Enzymatic hydrolysis
Fermentation of cellulosic sugars
Product recovery
Ethanol
Fermentation of hemicellulosic sugars
Residue processing
Co-products

Biofuels

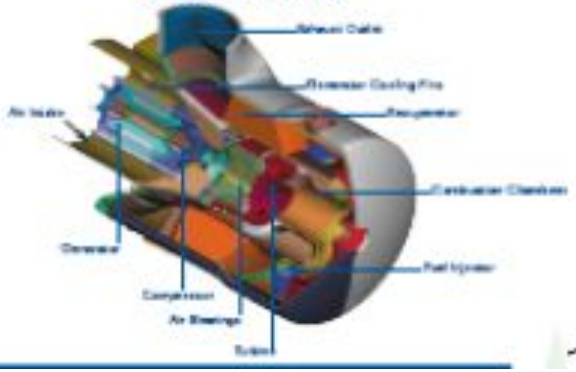
Methanol fuelled absorption cooling

Methanol fuelled lantern

APPLICATIONS

Methanol fuelled cook stove

Methanol fuelled microturbine



ENVIRONMENTAL STUDIES & LIFE SCIENCES

Biofuels

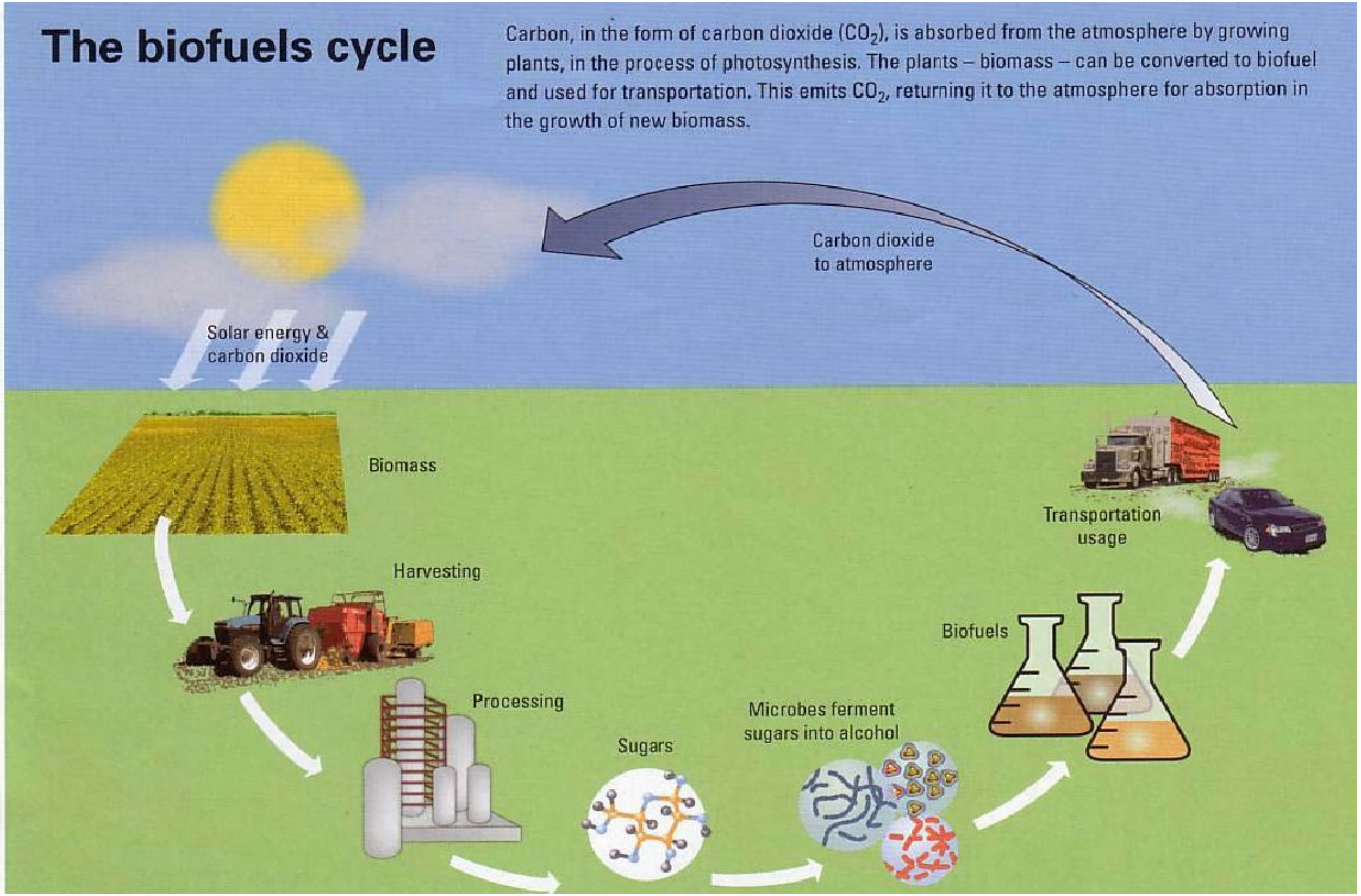
Biofuels

- Daimler-Benz, with Ballard, has produced their methanol-driven car, Necar.

Its features are:

- Top-speed: 120km/h
- Only weighs 1.7 tons
- Upto 400km for 38l of methanol

Biofuels

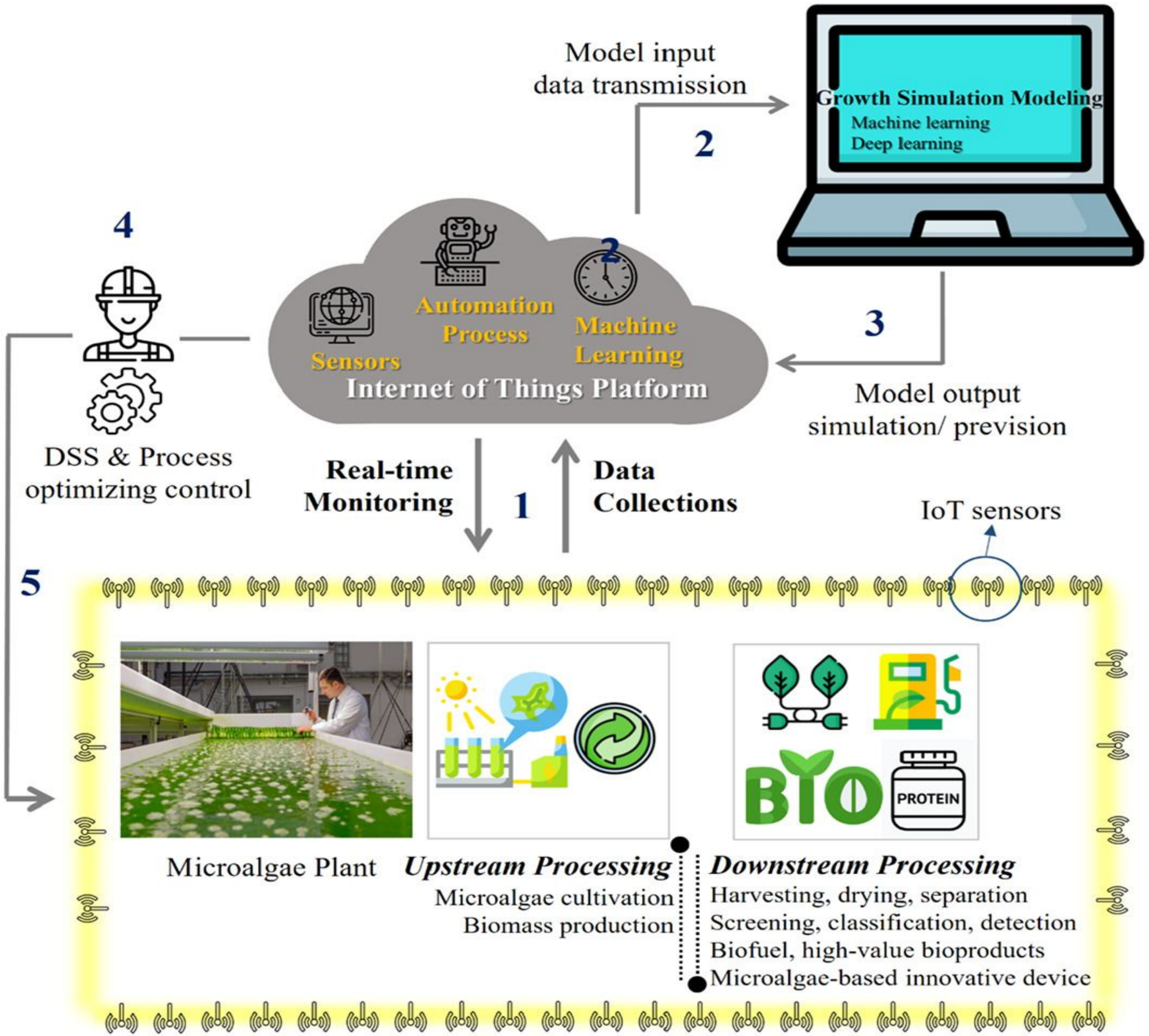

The biofuels cycle
Carbon, in the form of carbon dioxide (CO_2), is absorbed from the atmosphere by growing plants, in the process of photosynthesis. The plants – biomass – can be converted to biofuel and used for transportation. This emits CO_2, returning it to the atmosphere for absorption in the growth of new biomass.
Carbon dioxide to atmosphere
Solar energy & carbon dioxide
Biomass
Harvesting
Processing
Sugars
Microbes ferment sugars into alcohol
Biofuels
Transportation usage

IoT

- Microalgae biorefinery is a platform for the conversion of microalgal biomass into a variety of value-added products, such as biofuels, bio-based chemicals, biomaterials, and bioactive substances.
- Commercialization and industrialization of microalgae biorefinery heavily rely on the capability and efficiency of large-scale cultivation of microalgae.
- Thus, there is an urgent need for novel technologies that can be used to monitor, automatically control, and precisely predict microalgae production.

https://www.sciencedirect.com

IoT



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IoT

- IoT helps real-time monitoring of microalgae biorefinery process parameters.
- IoT assists in sufficient data collection to make smart prediction and decision.
- IoT promotes automation in microalgae biorefinery.
- IoT guides microalgal biorefinery towards low-cost and high efficiency.

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ENVIRONMENTAL STUDIES & LIFE SCIENCES

Bioremediation

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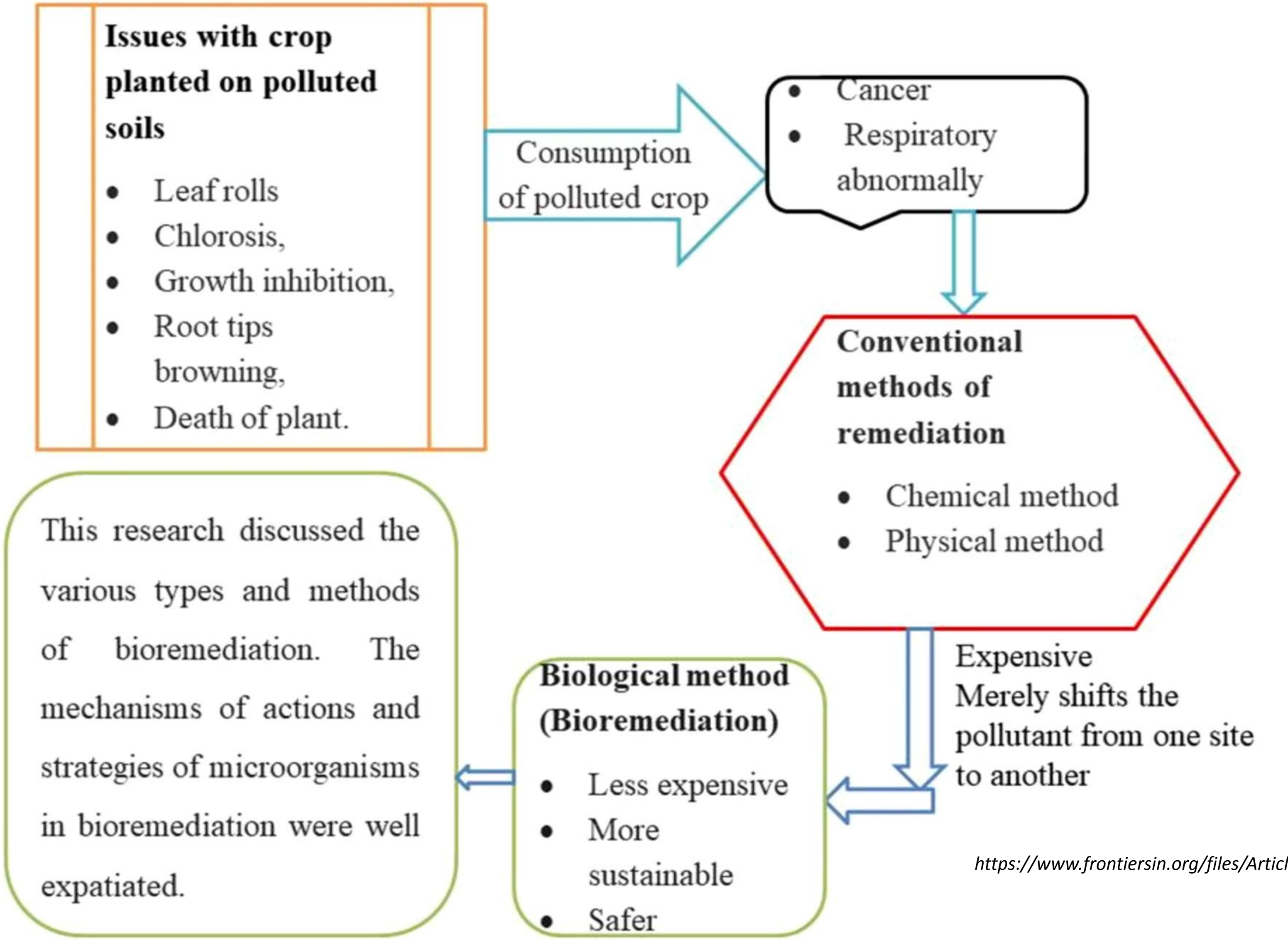
Bioremediation

- The use of either naturally occurring or deliberately introduced microorganisms to consume and break down environmental pollutants, in order to clean a polluted site
- Employs the microorganisms, to degrade the pollutants and convert them into less toxic or non-toxic form
- The suitable organisms can be bacteria, fungi, or plants, which have the physiological abilities to degrade, detoxify, or render the contaminants harmless.
- Biological method of remediation is an extremely attractive, important, and productive alternative for cleaning, debugging, managing, and rehabilitating and consequently ameliorating contaminated environments *via* judicious utilization of microbial activities

Bioremediation

- Bioremediation technologies can be classified into two general categories: ***ex situ* and *in situ***
- The *ex situ* techniques require the physical removal of the contaminated material and its transportation to another area for further treatment by bioreactors, land farming, or composting, whereas *in situ* technologies involve treatment of contaminated material in place

Bioremediation



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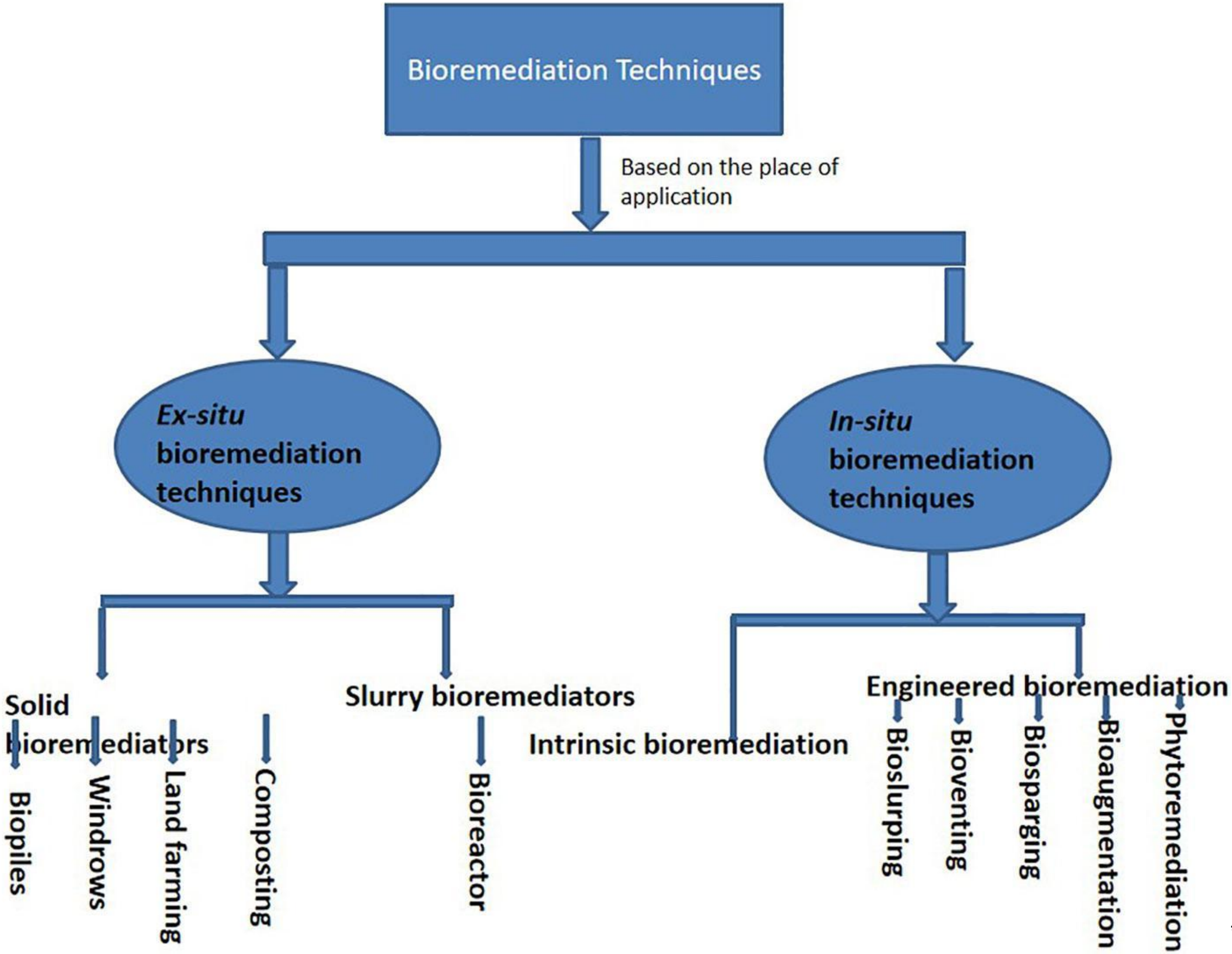
Bioremediation



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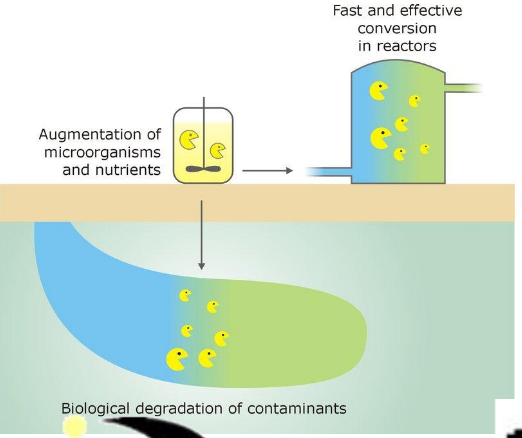
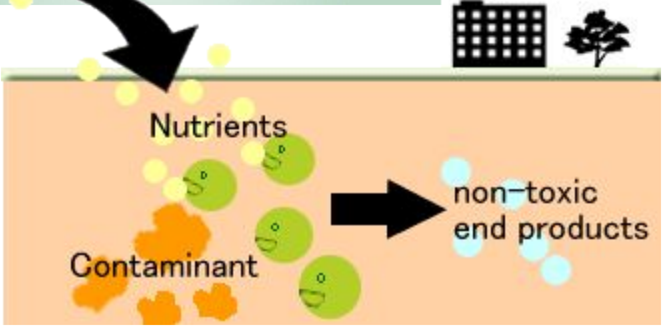
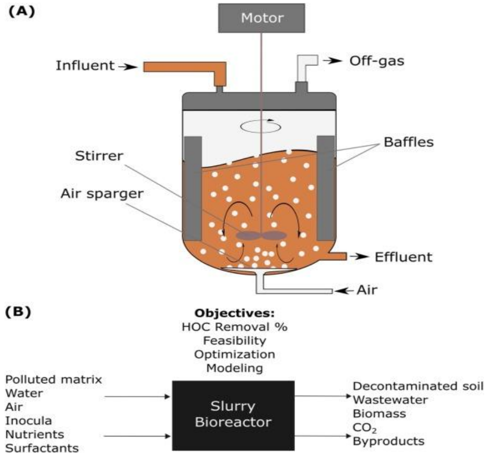
Bioremediation

Bioaugmentation	Addition of bacterial cultures to a contaminated medium; frequently used in bioreactors and *ex situ* systems
Biostimulation	Stimulation of indigenous microbial populations in soils or groundwater by adding nutrients to the existing bacteria; which can be performed either *in situ* or *ex situ*
Bioreactors	Biodegradation in a container or reactor; may be used to treat several liquid wastes or slurries but relatively high capital and operational cost

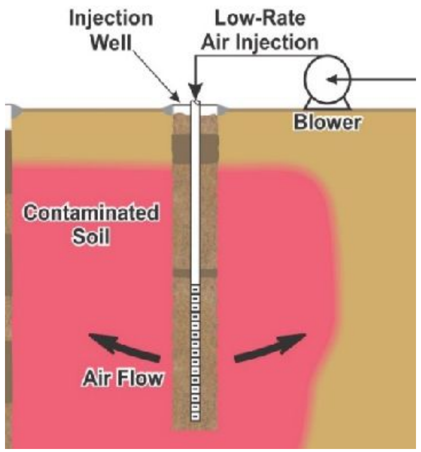


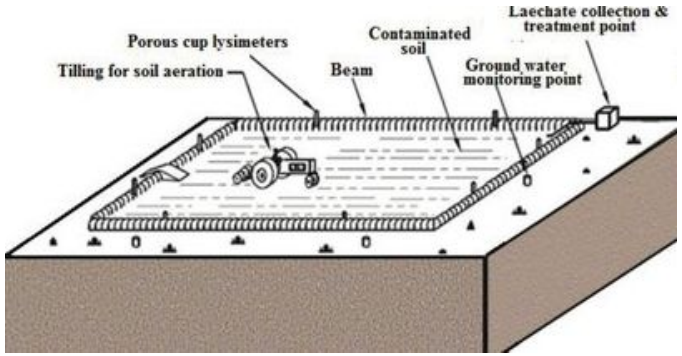




Bioremediation

Bioventing	Method of treating contaminated soils by drawing oxygen through the soil to stimulate microbial growth and activity
Composting	Aerobic, thermophilic treatment process; can be performed by using static piles, aerated piles, or continuously fed reactors; extended treatment time
Land farming	Solid-phase treatment system for contaminated soils; may be performed *in situ* or in a constructed soil treatment cell; cost-efficient





Bioremediation

- Most bioremediation systems operate under aerobic conditions; however, anaerobic conditions are also applicable, thus enabling the degradation of recalcitrant molecules by using specific microorganisms
- Mainly microorganisms, microbial or plants or its enzymes are used to detoxify contaminants in the soil and other environments

Bioremediation

- Bioremediation, as a technique, can offer several advantages over other more conventional treatment methods
- Firstly, bioremediation, as a natural process for the treatment of wastes, is usually acceptable
- Suitable microbial populations can degrade a wide range of contaminants, rendering a hazardous compound to a harmless one

Bioremediation

- Eventually, the residues of the treatment may include simpler compounds, such as carbon dioxide or water, but also cell biomass
- The potential threats to human health and to the environment are minimal
- Crime scene clean-up

Bioremediation

- Bioremediation, like any other technology, has certain disadvantages
- In particular, it is limited only to those compounds that are biodegradable
- The effectiveness of bioremediation is highly susceptible to the microbial growth and other environmental parameters of the site
- Bioremediation often requires more time than other treatment options

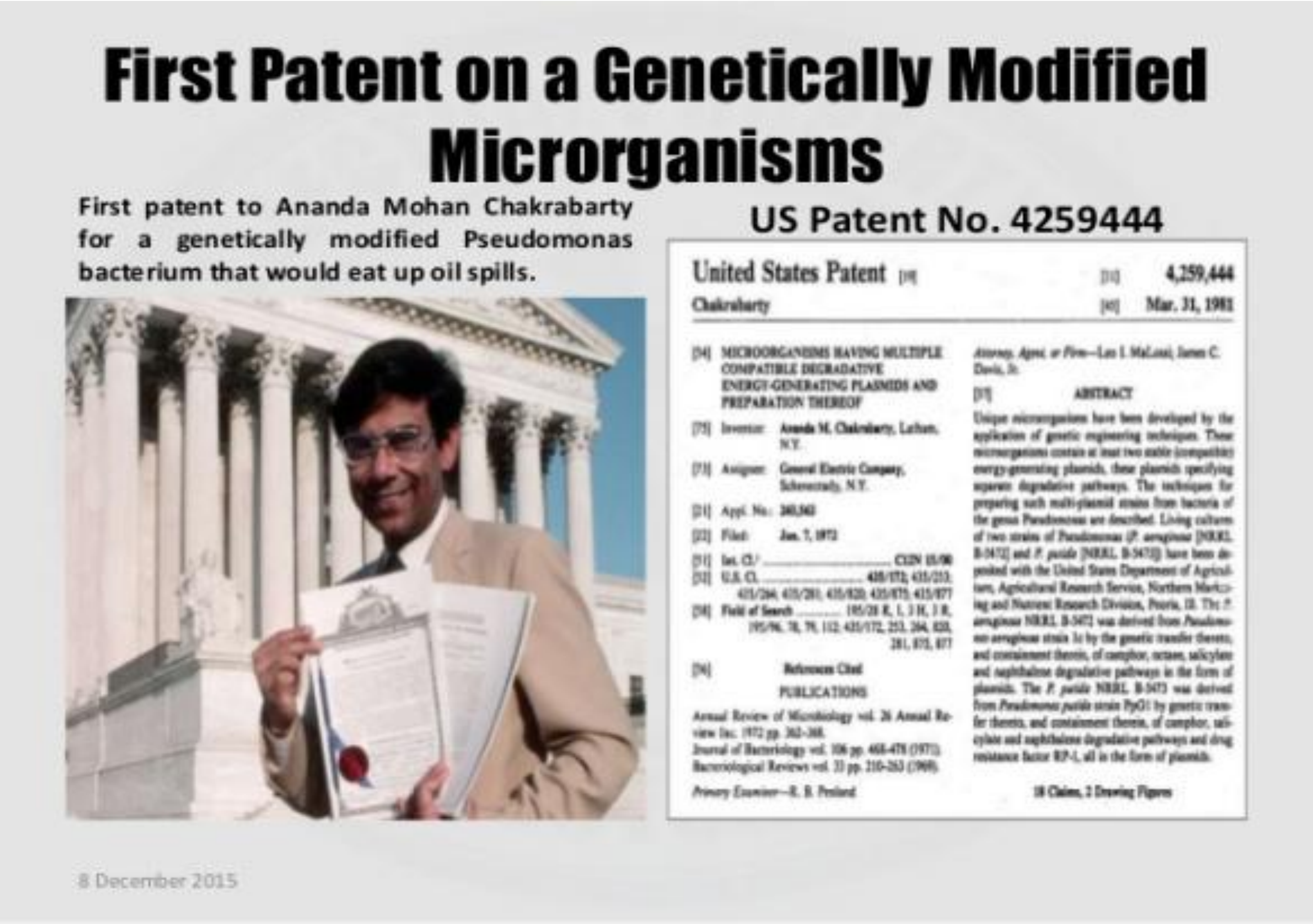
Bioremediation

- **Examples of bioremediation:**
- Exxon Valdez spill, Prince William Sound, Alaska, 1989
- Deepwater Horizon oil spill, Gulf of Mexico, 2010

Exxon Valdez spill

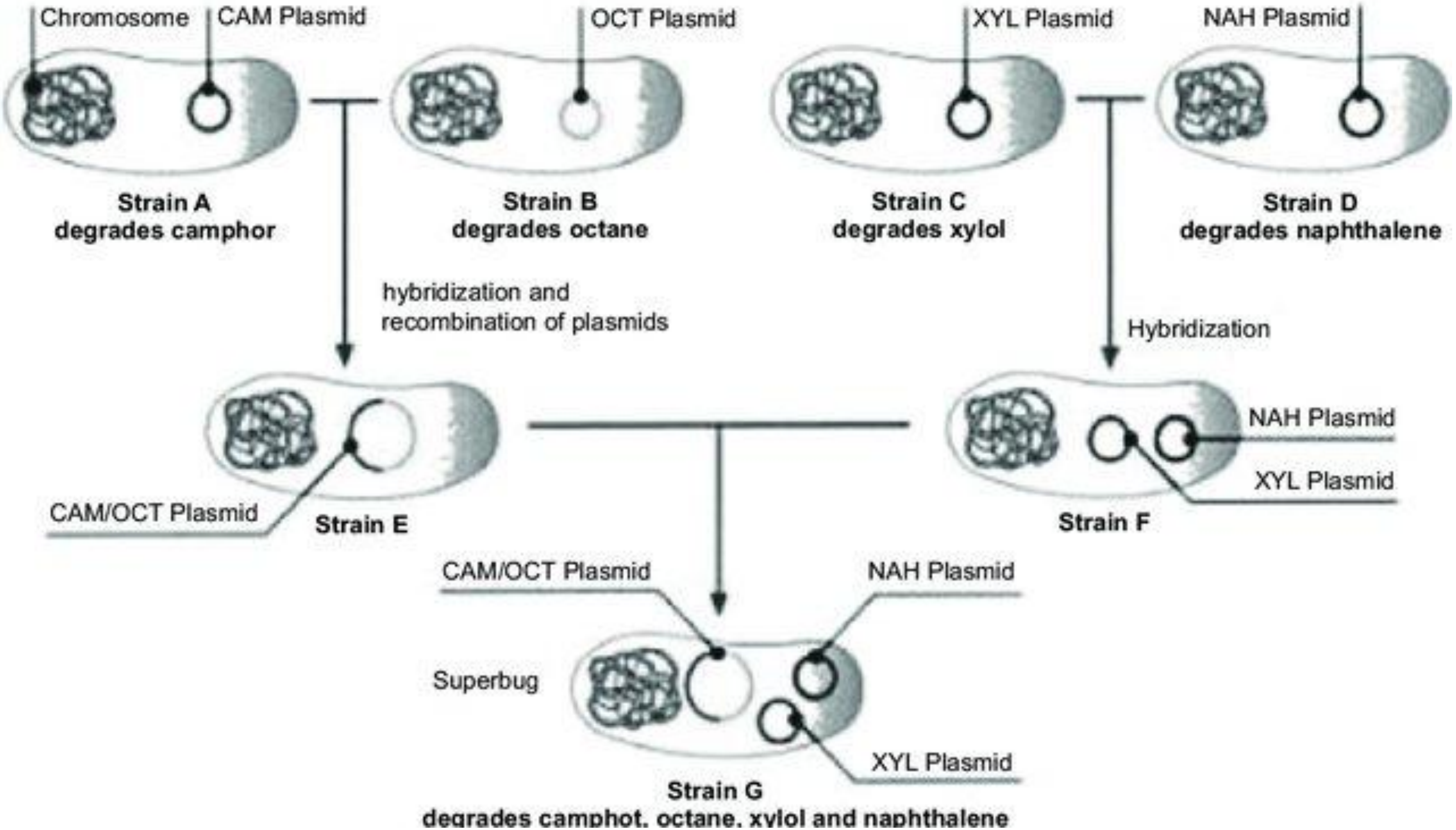
Image source: RGB Ventures

Exxon Valdez spill



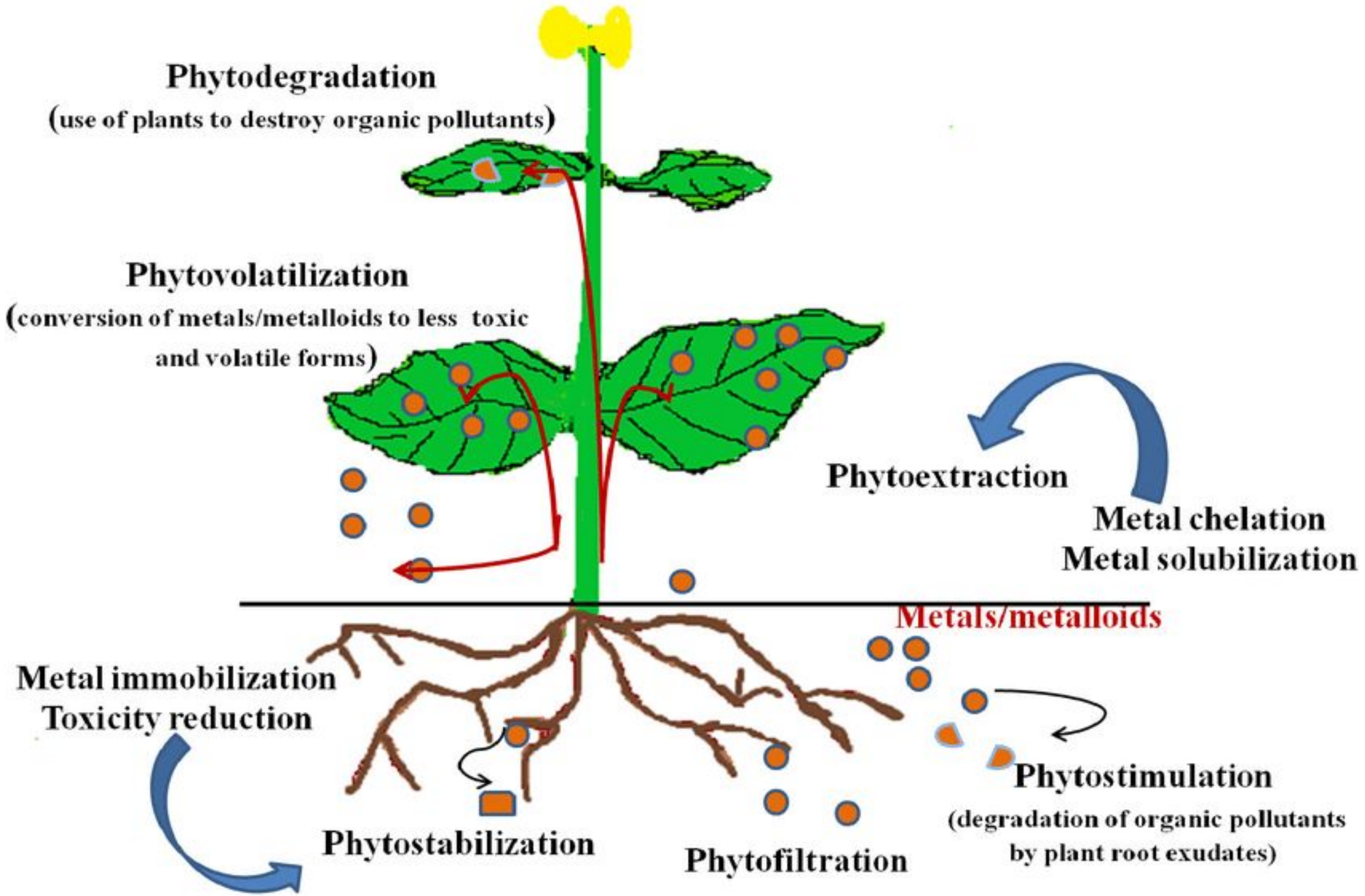
Prof. Chakrabarty genetically engineered a new species of *Pseudomonas* bacteria ("the oil("the oil-eating bacteria") in 1971 while working for the Research & Development("the oil-eating bacteria") in 1971 while working for the Research & Development Center at General Electric Company("the oil-eating bacteria") in 1971 while working for the Research & Development Center at General Electric

Bioremediation



Phytoremediation is a bioremediation process that uses various types of plants to remove, transfer, stabilize, and/or destroy contaminants in the soil and groundwater. There are several different types of **phytoremediation** mechanisms.

PHYTOREMEDIATION



PHYTOREMEDIATION

Phytotechnology	Mechanism	Pollutants	Plants
Phytoextraction	Hyperaccumulation in harvestable parts of plants	Inorganic: Co, Cr, Ni, Pb, Zn, Au, Hg, Mo, Ag, Cd Radionuclides: Sr, Cs, Pb, U	*Brassica juncea*, *Thalspi caerulescens*, *Helianthus annus*
Rhizofilteration	Rhizosphere accumulation though sorption, concentration and precipitation	Organics/Inorganics: Metals like Cd, Cu, Ni, Zn,Cr Radionuclides	*Brassica juncea*, *Helianthus annus*, Tobacco, Rye, Spinach and Corn
Phytovolatilization	Volatilization by leaves through transpiration	Organics/Inorganics: Chlorinated solvents, inorganics (Se, Hg, As)	*Arabidopsis thaliana*, Poplars, Alfalfa, *Brassica juncea*
Phytodegradation	Pollutant eradication	Organic compounds, Chlorinated solvents, Phenols, Herbicides, Munitions	Hybrid poplars, Stonewort, Black willow, Algae
Phytostabilization	Complexation, sorption and precipitation	Inorganics: As, Cd, Cu, Cr, Pb, Zn, Hs	*Brassica juncea*, Hybrid poplars, Grasses

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ENVIRONMENTAL STUDIES & LIFE SCIENCES

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ENVIRONMENTAL STUDIES & LIFE SCIENCES

Types of Infectious diseases

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Infectious diseases

Significantly contribute to the mortality in

- Elderly
- Immunosuppressed
- Chronic disease states

How microorganisms cause disease?

- Humans harbor a complex ecosystem of microflora.
- Attenuation of normal host- defense healthy” microbial flora to cause pathologic infections.
- Non-commensal organisms with a wide range of virulence.
- Highly infectious microbes produce disease in healthy individuals.

Types of Infectious diseases

Bloodborne Diseases:

- HIV/AIDS.
- Hepatitis B and C.

- Bacterial:
  - “Staph” skin infection.
  - Pneumonia.
  - Urinary tract infection.
  - Anthrax
  - Botulism
- Parasitic: Malaria
- Viral:
  - Influenza, or the flu.
  - Respiratory infections.
  - Diarrhea.
  - Chickenpox, measles, mumps.
- Fungi:
  - Candidiosis, Aspergillosis.

Infectious diseases: Definitions

- **Disease:** A pathological condition of body parts or tissues characterized by an identifiable group of signs and symptoms.
- **Infectious disease:** Disease caused by an infectious agent such as bacteria, virus, fungi, protozoa that can be passed on to others.
- **Infection:** Occurs when an infectious agent enters the body and begins to reproduce; may or may not lead to disease.
- **Pathogen:** An infectious agent that causes disease.
- **Host:** An organism infected by another organism.
- **Virulence:** The relative ability of an agent to cause rapid and severe disease in host.

Phases of infectious disease

1. **Incubation period:** time between infection and the appearance of signs and symptoms.
2. **Prodromal phase:** mild, nonspecific symptoms that signal onset of some diseases.
3. **Clinical phase:** a person experiences typical signs and symptoms of disease.
4. **Decline phase**: subsidence of symptoms.
5. **Recovery phase:** symptoms have disappeared, tissue heal and the body regains strength.

Types of Infectious diseases

Classification of disease

- **By duration**

*Acute: develop and runs its course rapidly

*Chronic: develops more slowly and it usually less severe may persist for a long, indefinite period of time.

*Latent: characterized by periods of no symptoms between outbreaks of illness.

- **By location**

*Local: confined to a specific area of the body

*Systemic: a generalized illness that infect most of the body

- **By timing**

*Primary: initial infection in the previously healthy person

*Secondary: infection that occurs in a person weakened by primary infection

Types of Infectious diseases

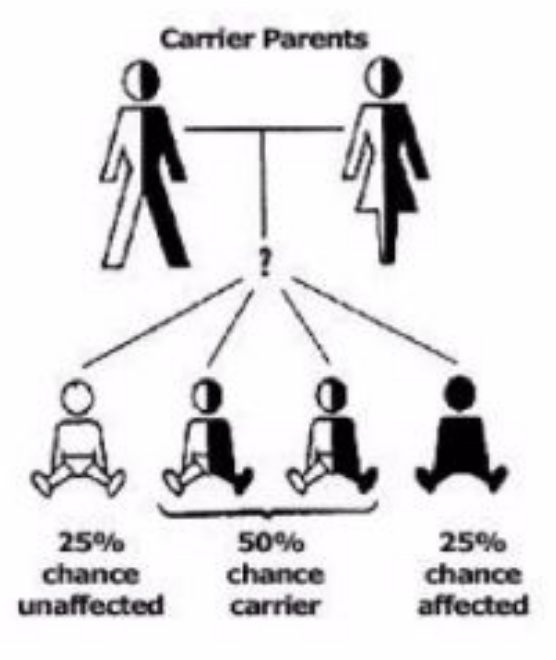
Table 14.10 Modes of Disease Transmission

Mode of Transmission	Diseases Spread Include:
Contact Transmission	
Direct Contact: e.g., handshaking, kissing, sexual intercourse, bites	Cutaneous anthrax, genital warts, gonorrhea, herpes, rabies, staphylococcal infections, syphilis
Indirect Contact: e.g., drinking glasses, toothbrushes, toys, punctures	Common cold, enterovirus infections, influenza, measles, Q fever, pneumonia, tetanus
Droplet transmission: e.g., droplets from sneezing (within 1 meter)	Whooping cough, streptococcal pharyngitis (strep throat)
Vehicle Transmission	
Airborne: e.g., dust particles	Chickenpox, coccidiomycosis, histoplasmosis, influenza, measles, pulmonary anthrax, tuberculosis
Waterborne: e.g., streams, swimming pools	*Campylobacter* infections, cholera, *Giardia* diarrhea
Foodborne: e.g., poultry, seafood, meat	Food poisoning (botulism, staphylococcal); hepatitis A, listeriosis, tapeworms, toxoplasmosis, typhoid fever
Vector Transmission	
Mechanical: e.g., (on insect bodies) flies, roaches	*E. coli* diarrhea, salmonellosis, trachoma
Biological: e.g., lice, mites, mosquitoes, ticks	Chagas' disease, Lyme disease, malaria, plague, Rocky Mountain spotted fever, typhus fever, yellow fever

Types of Infectious diseases

Diseases

- Genetic
- Biological
- Physical
- chemical



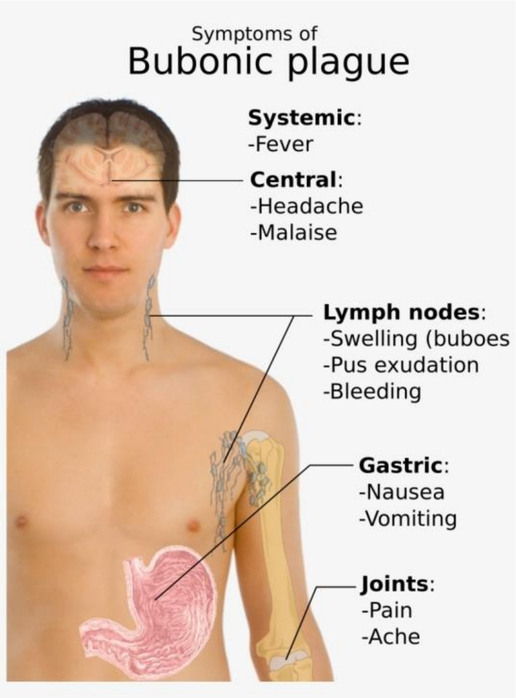
Types of Infectious diseases

Epidemics of

- Plague in India
- Avian (H5N1) influenza in Hong Kong
- Ebola haemorrhagic fever in central Africa
- Nipah virus (niv) infection in Malaysia and Singapore required national and international response.

Plaque: Also called as Black Death

- ***Yersinia pestis* causes plague. Transmitted from rodents to human by aerosols or fleabites.**
- There are two main clinical forms of plague infection: bubonic and pneumonic.
- Bubonic plague is the most common form and is characterized by painful swollen lymph nodes or 'buboes'.
- The lymph node then becomes inflamed, tense and painful, and is called a ‘bubo’.
- Inflamed lymph nodes can turn into open sores filled with pus.
- **Pneumonic** plague, or lung-based plague, is the most virulent form of plague.



Types of Infectious diseases-Biohazards

Anthrax

- *Bacillus anthracis* causes anthrax in human.
- These are prevalant in animals having contact with spore-contaminated soil.
- Human in contact through exposure to contaminated animal products or powdered spores (called as a biologic weapon) suffer from anthrax.
- 3 major syndromes:

-Cutaneous: painless, pruritic papules that become edematous vesicles (lymphadenopathy & lymphangitis) followed by a black eschar.

-Inhalation: flu like symptoms rapidly leads to sepsis, shock, and frequently death.

-GI: by eating contaminated meat, causes severe, bloody diarrhoea and often death.

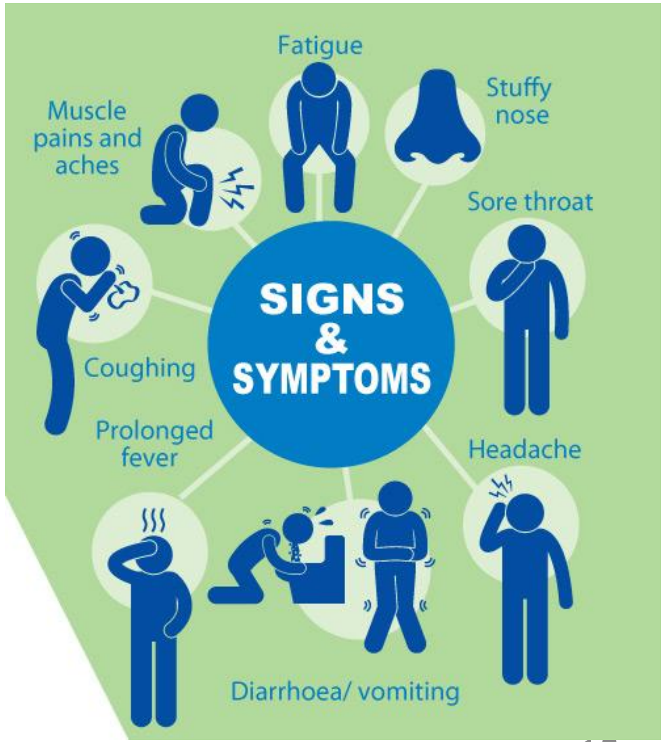
Small pox

- acute contagious disease caused by the ***Variola*** virus
- **high fever which may be recurrent.**
- **malaise** (general feeling of unwellness)
- **widespread skin rash** – flat spots which change into raised bumps then firm fluid filled blisters which then scab
- **severe headache.**
- **backache**.
- **abdominal pain.**
- **vomiting.**
- **diarrhoea.**

Types of Infectious diseases

Influenza

- Acute contagious disease caused by influenza virus.
- Causes respiratory tract infection but symptoms throughout the body.
- Seasonal causes epidemics with low fatality. More deadly during pandemics and occur several times.
- Rapid onset, chills, fever, malaise/fatigue, headache, sore throat , cough, nasal congestion, & GI symptoms



https://www.jagranjosh.com/general-knowledge/influenza-flu-viruses-types-symptoms-naming-and-vaccine-1585055168-1

Types of Infectious diseases

Viral Hemorrhagic Fever

- Viral hemorrhagic (hem-uh-RAJ-ik) fevers are infectious diseases. Cause severe, life-threatening illness.
- They can damage the walls of tiny blood vessels, making them leak, and can hamper the blood's ability to clot internal bleeding.

Early signs and symptoms can include:

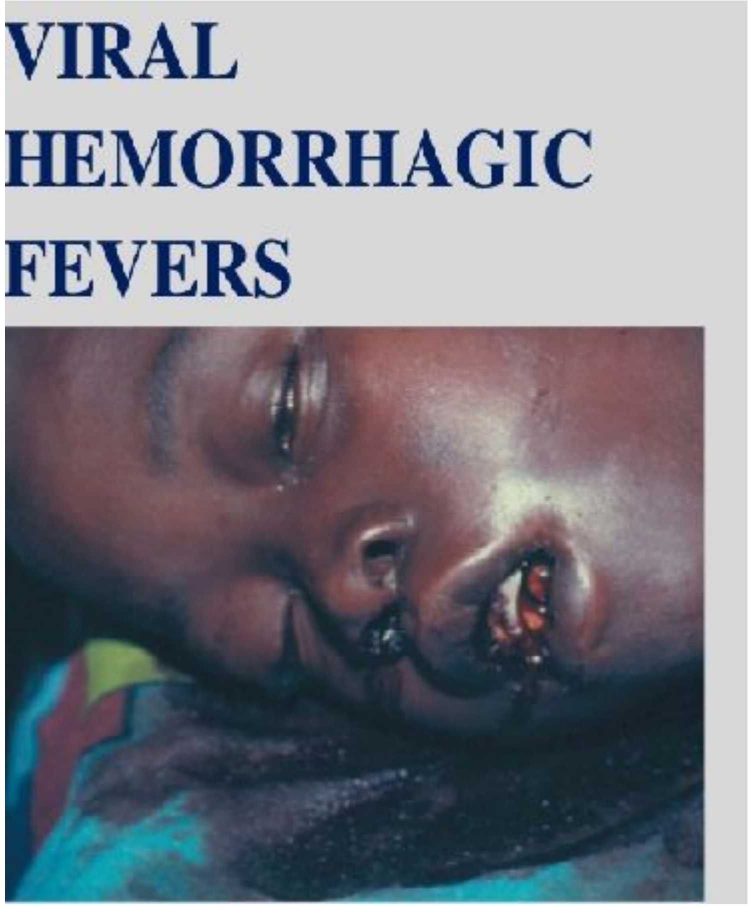
Fever, Fatigue, weakness or general feeling of being unwell, Dizziness, Muscle, bone or joint aches, Nausea and vomiting, Diarrhoea

Some viral hemorrhagic fevers include:

1. Dengue
2. Ebola
3. Lassa
4. Marburg
5. Yellow fever

Severe symptoms include:

Bleeding under the skin, in internal organs, or from the mouth, eyes or ears, Nervous system malfunctions, Coma, Delirium, major organ failure.



https://www.slideshare.net/ChristianAmarvi/viral-hemorrhagic-fever

Tularaemia

- Tularaemia, also known as “rabbit fever,” is a disease caused by the bacterium ***Francisella tularensis*.**
- Tularaemia is typically found in animals, especially rodents, rabbits, and hares. Tularaemia is usually a rural disease and has been reported in all U.S. states except Hawaii.
- Symptoms: Rapid onset, fever, dyspnoea , headache, malaise, cough, hemoptysis (coughing up blood).

https://www.nejm.org/doi/full/10.1056/NEJMicm1003352
https://www.msdmanuals.com/professional/infectious-diseases/gram-negative-bacilli/tularemia

Botulism

- ***Clostridium botulinum*** is a bacterium that produces dangerous toxins (botulinum toxins) under low-oxygen conditions.
- Botulinum toxins block nerve functions and can lead to respiratory and muscular paralysis.
- Foodborne botulism is a serious, potentially fatal disease.
- Improperly processed food, homemade canned, preserved or fermented foodstuffs are a common source of foodborne botulism.

Symptoms: fatigue, weakness, blurred vision, difficulty in swallowing and speaking, descending muscle paralysis and respiratory failure.

Malaria

- ***Plasmodium falciparum*** causes severe malaria.
- ***Plasmodium vivax, Plasmodium ovale, and Plasmodium malariae*** are the various types of disease causing vectors.
- Malaria infection begins when an infected f**emale *Anopheles* mosquito** bites a person, injecting *Plasmodium* parasites, in the form of sporozoites into the bloodstream.
- The **sporozoites** pass quickly into the **human liver.**
- The sporozoites multiply asexually in the liver cells over the next 7 to 10 days, causing no symptoms.
- In an animal model, the parasites, in the form of **merozoites** are released from the liver cells in vesicles, **passes through the heart, lungs, and settle within lung capillaries.**

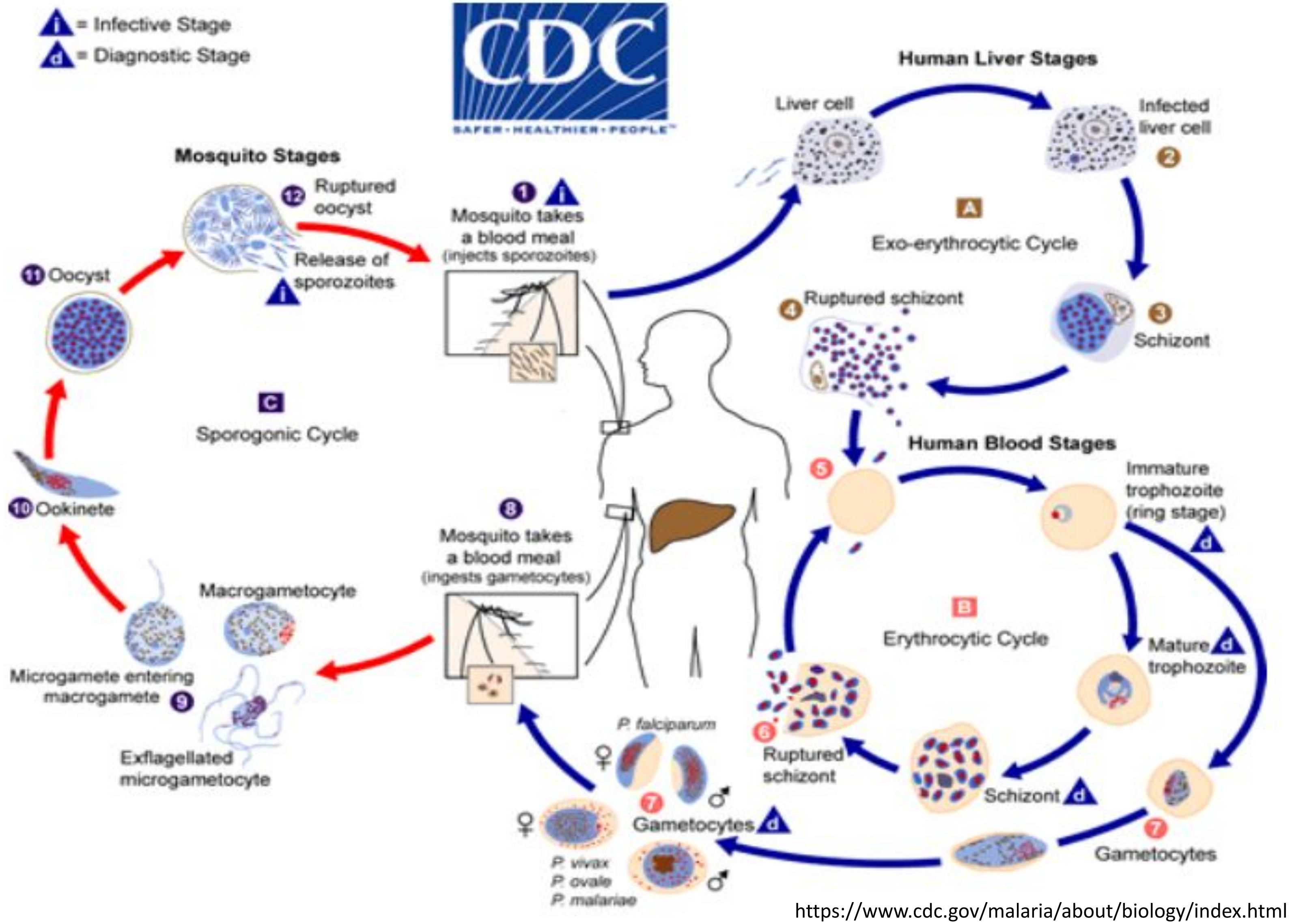
Types of Infectious diseases

- The vesicles disintegrate, free the merozoites to enter the blood phase of their development.
- In the bloodstream, the merozoites invade red blood cells **(erythroctes)** and multiply again until the cells burst. Then they invade more erythrocytes. This cycle is repeated, causing fever each time parasites break free and invade blood cells.
- Some of the infected blood cells leave the cycle of asexual multiplication. Instead of replicating, the merozoites in these cells develop into sexual forms of the parasite, called gametocytes that circulate in the blood stream.

Types of Infectious diseases

- When a mosquito bites an infected human, it ingests the gametocytes, which develop further into mature sex cells called gametes.
- The fertilized female gametes develop into actively moving ookinetes that burrow through the **mosquito's midgut wall and form oocytes on the exterior surface.**
- Inside the oocyst, thousands of active sporozoites develop. The oocyst eventually bursts, releasing sporozoites into the body cavity that **travel to the mosquito's salivary glands.**
- **The cycle of human infection begins again when the mosquito bites another person.**

Types of Infectious diseases



https://www.cdc.gov/malaria/about/biology/index.html

Types of Infectious diseases

Bioterrorism acts and their functions.

ACTS	COUNTRY	YEAR	FUNCTIONS
The Pandemic and All-Hazards Preparedness Act (PAHPA)	United States	2006	Improve the nation's public health, medical preparedness and response capabilities in emergencies.
Public Readiness and Emergency Preparedness Act (PREP Act)	United States	2005	Protects from liability claims arising from administration, vaccine manufacturers, distributors, program planners, and qualified persons involved in the administration.
Biodefense and Pandemic Vaccine and Drug Development Act	United States	2005	Provides incentives for domestic manufacturing of vaccines and broad liability protections to the companies.
The Project Bioshield Act	United States	2004	Provides permanent funding for the procurement of medical countermeasures during emergencies.
Public Health Security and Bioterrorism Preparedness and Response Act (Bioterrorism Act)	United States	2002	Issue regulations on enhancing controls on dangerous biological agents and toxins, protecting safety and security of food and drug supply, drinking water Security and safety.
Homeland Security Act	United States	2002	Create the Department of Homeland Security (DHS), that prevent or minimize damage and assist in recovery for terrorist attacks
USA Patriot Act	United States	2001	Uniting and strengthening America by providing appropriate tools required to intercept and obstruct terrorism
Chemical and Biological Weapons Control Act	United States	1991	Strengthen efforts to control chemical and biological agents, precursors, and equipment.

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ENVIRONMENTAL STUDIES & LIFE SCIENCES

Disease Management

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The condition of being sound in body, mind or spirit, especially freedom from physical disease or pain- **Health**

Factors influencing health:

1. **Genetic disorders**- deficiencies a child born with & deficiencies/ defect child inherit
2. **Infections**
3. **Life style-** food & water, rest & exercise, habits

Any condition which interferes with normal functioning of the body and impairs the health- Disease

Types of Diseases:

I. Congenital Disease- inborn disease & genetically inherited
II. Acquired Disease- after birth & non- inheritable

Congenital Disease:

1. Disease due to gene mutation. Eg.- Haemophilia, Color blindness
2. Disease due to chromosomal mutation Eg.- Down's syndrome, Klinefelter's syndrome

Acquired Disease:

1. Communicable or infectious diseases- air, water, food, physical contact or vectors (Bacteria, Virus, Protozoa, Helminth, Fungus etc.)
2. Non- communicable or non- infectious diseases- Deficiency disease (Diabetes), Degenerative (Arthritis), Cancerous & Allergic diseases (Asthma)

Disease Management

- **Disease management** is a system of coordinated heath care interventions and communications for defined patient populations with conditions where self-care efforts can be implemented.

- **Disease management** empowers individuals, working with other health care providers to **manage** their **disease** and prevent complications.

Improvements in quality of care and patient outcomes should be the primary indicator of successful **disease management**.

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Infectious diseases can be caused by:

- **Bacteria.** These one-cell organisms are responsible for illnesses such as strep throat, urinary tract infections and tuberculosis.
- **Viruses**. Even smaller than bacteria, viruses cause a multitude of diseases ranging from the common cold to AIDS.
- **Fungi.**
- **Parasites.**

Common Infectious Diseases

- Chickenpox.
- Common cold
- Diphtheria.
- Giardiasis.
- HIV/AIDS.
- Influenza (flu)

Lifestyle diseases are ailments that are primarily based on the day to day habits of people.

Lifestyle diseases include

- atherosclerosis
- heart disease
- stroke
- obesity
- type 2 diabetes
- hypertension
- diseases associated with smoking and alcohol and drug abuse
- colon cancer, and
- premature mortality

A **chronic disease** **affects** every aspect of a person's life.

This can include physical and mental health, family, social life, finances, and employment.

Chronic diseases can also shorten a person's life.

Conditions such as asthma and diabetes require regular monitoring to prevent the disorders from progressing to life-threatening levels.

Chronic disease management, therefore, is **essential** to both improving health outcomes of poor individuals and containing costs in health care system.

Diseases can be grouped as:

1. Food & water borne diseases
2. Air borne diseases
3. Vector borne diseases

Food & water borne diseases:

- Proper personal hygiene include keeping the body clean; consumption of clean drinking water, food, vegetables, fruits, etc.
- Proper public hygiene which includes proper disposal of waste and excreta; periodic cleaning and disinfection of water reservoirs, pools, cesspools and tanks and observing standard practices of hygiene in public catering.
- Eg.- Typhoid (*Salmonella typhii*), Amoebiasis (*Amoeba*) and Ascariasis (*Ascaris*)

Air borne diseases:

- Close contact with infected person & their belongings should be avoided
- Personal hygiene is also very important to prevent diseases
- Eg.- Pneumonia and Common cold

Vector borne diseases:

- Controlling or eliminating the vectors and their breeding places.
- Avoiding stagnation of water in and around residential areas, regular
cleaning of household coolers, use of mosquito nets
- Introducing fishes like *Gambusia* in ponds that feed on mosquito larvae, spraying of insecticides in ditches, drainage areas and swamps, etc.
- Doors and windows- wire mesh to prevent the entry of mosquitoes.
- *Aedes & Culex* mosquitoes, Houseflies
- Malaria, Filariasis, Dengue and Chikungunya

Prevention or control of Diseases

- Infectious diseases can be prevented through maintenance of personal and public hygiene

10 steps for coping with a chronic condition

- Get a prescription for information.
- Make your doctor a partner in care.
- Build a team.
- Coordinate your care.
- Make a healthy investment in yourself.
- Make it a family affair.
- Manage your medications.
- Beware of depression.

Prevent Chronic Diseases----contd….

- **Eat Healthy.** Eating healthy helps prevent, delay, and manage heart disease, type 2 diabetes, and other chronic diseases.

- **Get Regular Physical Activity**. Regular physical activity can help you prevent, delay, or manage chronic diseases.

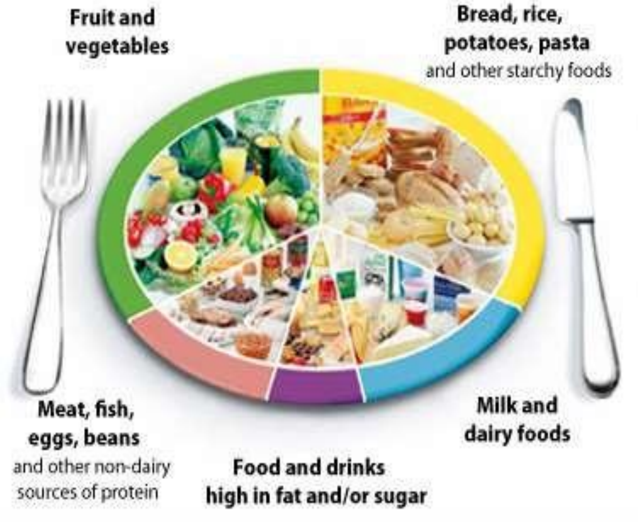
- **Avoid Alcohol.**

- **Get Screened.**

- **Get Enough Sleep.**

Disease Management

Disease Management



https://nutrivity.in/blog/super-nutrition-secrets

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Prevent Chronic Diseases----contd….

Vaccines and immunisation

- Diseases can be now prevented- vaccines and immunisation
- A **vaccine** is a biological preparation that provides active acquired immunity to a particular infectious disease.
- **Vaccines** - eradicate smallpox, polio, diphtheria, pneumonia and tetanus
- Through Biotechnology we can make available newer and safer vaccines.
- Discovery of antibiotics and various other drugs has also enabled us to effectively treat infectious diseases

Immunity

- The foreign agents could be pathogens or any foreign substance that could cause disease in host
- The overall ability of host to fight against disease causing organism-**Immunity**

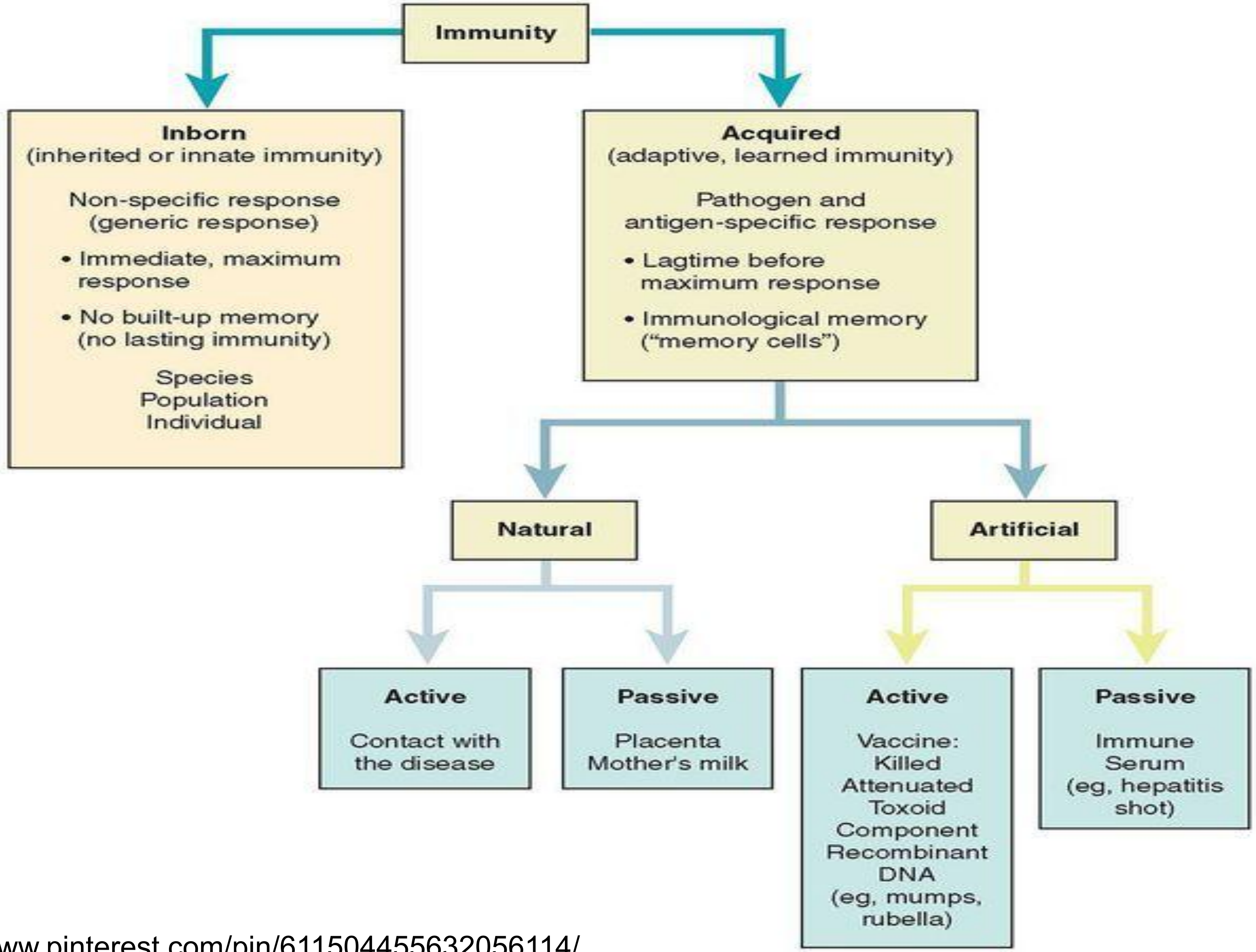
Types of Immunity

1. **Innate Immunity**
2. **Acquired Immunity**

- **Innate Immunity-** which is present from the time of birth & is not pathogen specific
- **Acquired Immunity-** not from time of birth & is pathogen specific; Immunity is conferred based on memory that immune system have for that pathogen

Disease Management

Disease Management



https://www.pinterest.com/pin/611504455632056114/

Principle- “property of ‘memory’ of the immune system”

<u>**Vaccination**</u>

- **Antigenic proteins** of pathogen or **activated/weakened pathogen** (vaccine) are introduced into the body.
- The antibodies produced in the body against these antigens would neutralise the pathogenic agents during actual infection.
- The vaccines also generate memory – B and T-cells that recognize the pathogen quickly on subsequent exposure and overwhelm the invaders with a massive production of antibodies.
- Recombinant DNA technology- antigenic polypeptides of pathogen are produced in bacteria or yeast.
- Vaccines produced using this approach allow large scale production and hence greater availability for immunisation, e.g., hepatitis B vaccine produced from yeast

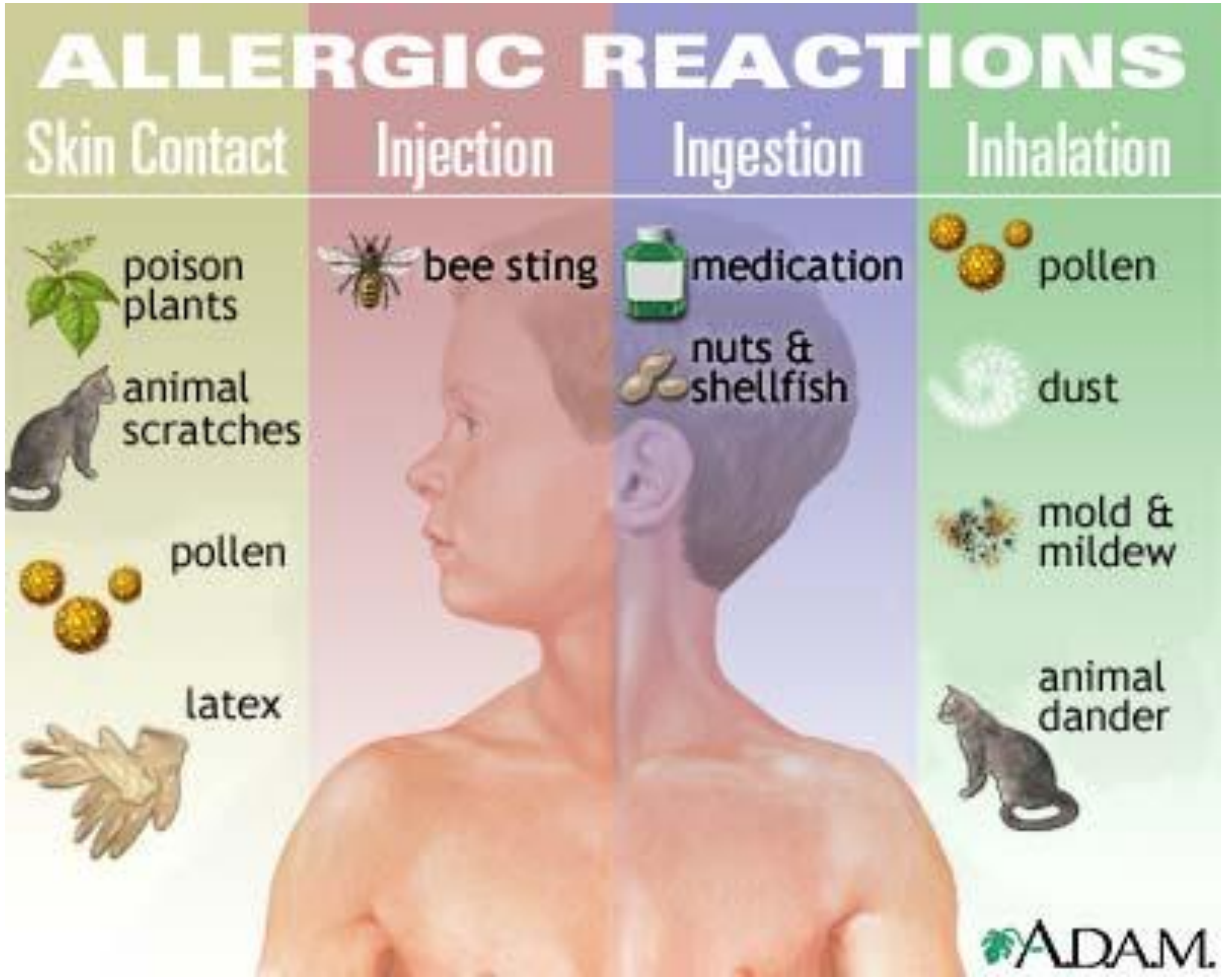
- Immunization is the process whereby a person is made immune or resistant to an infectious disease, typically by the administration of a vaccine. Vaccines stimulate the body's own immune system to protect the person against subsequent infection or disease.
- Two Types:

1. **Active Immunisation-** Slow immune response- infected from mild dosage of dead / pretreated live microbe. Eg.- Measles, Mumps, Rubella etc.
2. **Passive Immunisation-** Quick immune response

- Direct injection of preformed antibodies (Eg. Tetanus), or antitoxin- a preparation containing antibodies to the toxin (Eg. Snakebites)
- Snakebites, the injection which is given to the patients, contain preformed antibodies against the snake venom- Passive Immunisation

Allergy: Is hypersensitivity disorder of immune system in which exaggerated response of the immune takes place to certain antigens present in the environment

- Substance which induce allergy- **Allergen** (mites in dust, pollens, animal dander)
- Antibodies produced- IgE type etc.
- Symptoms: Sneezing, watery eyes, running nose and difficulty in breathing.
- Reason: Release of chemicals like **histamine** and **serotonin** from the mast cells
- Diagnosis: Injecting small dosage of possible allergens & reactions are observed
- Drugs **anti-histamine, adrenalin and steroids-** quickly reduce the symptoms of allergy
- Protected environment- lowered immunity thus more & more people are now sensitive to allergens



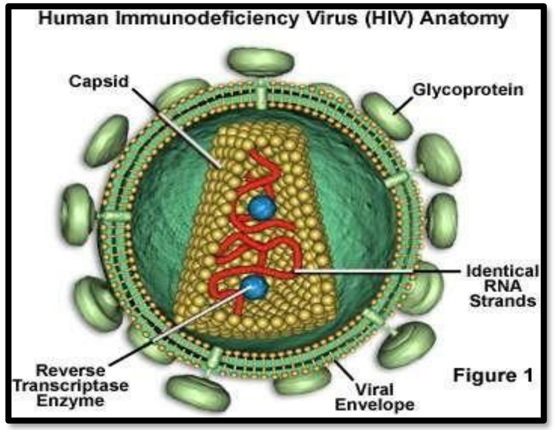
http://umr.adam.com/content.aspx?productid=117&pid=1&gid=000812

Acquired Immuno Deficiency Syndrome

- **Acquired Immuno Deficiency Syndrome-** disease caused due to deficiency of immune system
- Disease/ syndrome- acquired during the lifetime of an individual indicating that it is not a congenital disease
- First reported in 1981 & last twenty-five years- 25 million persons were killed

Causative organism:-

- **Human Immuno deficiency Virus (HIV)- retrovirus**, i.e RNA virus having RNA genome enclosed by protein coat



Modes of Transmission of HIV infection:

(a)sexual contact with infected person

(b)by transfusion of contaminated blood and blood products

(c)by sharing infected needles as in the case of intravenous drug abusers

(d)from infected mother to her child through placenta

- Individuals with multiple sexual partners, drug addicts who take drugs intravenously, individuals who require repeated blood transfusions and children born to an HIV infected mother- high chance of AIDS

It takes few months to few years (5- 10 years)- between infection & appearance of AIDS symptoms

Symptoms:

- HIV attacks Helper T lymphocyte- reduction of Helper T lymphocyte which cause severe **Cellular immuno- deficiency**
- Bouts of fever, Diarrhoea & Weight loss
- Highly susceptible to *Mycobacterium,* viruses, fungi, parasites like *Toxoplasma*
- Infected person becomes opportunistic to infections

Diagnosis & Treatment:

- Diagnostic test for AIDS- **enzyme linked immuno-sorbent assay**(ELISA)
- Treatment of AIDS with **anti-retroviral drugs-** partially effective
- Drugs can only prolong the life of the patient but cannot prevent death, which is inevitable.

Prevention of AIDS:

- Educating people to generate awareness among them
- National AIDS Control Organization (NACO) and
- other non-governmental organization (NGOs)
- WHO has started a number of programs to prevent the spreading of HIV infection which includes- Making blood (from blood banks) safe from HIV, ensuring the use of only disposable needles and syringes in public and private hospitals and clinics, free distribution of condoms, controlling drug abuse, advocating safe sex and promoting regular check-ups for HIV in susceptible populations
- Infection with HIV or having AIDS is something that should not be hidden – since then, the infection may spread to many more people

Cancer

- Cancer also known as a malignant tumor, is a group of diseases involving abnormal **cell growth** with the potential to invade or spread to other parts of the body

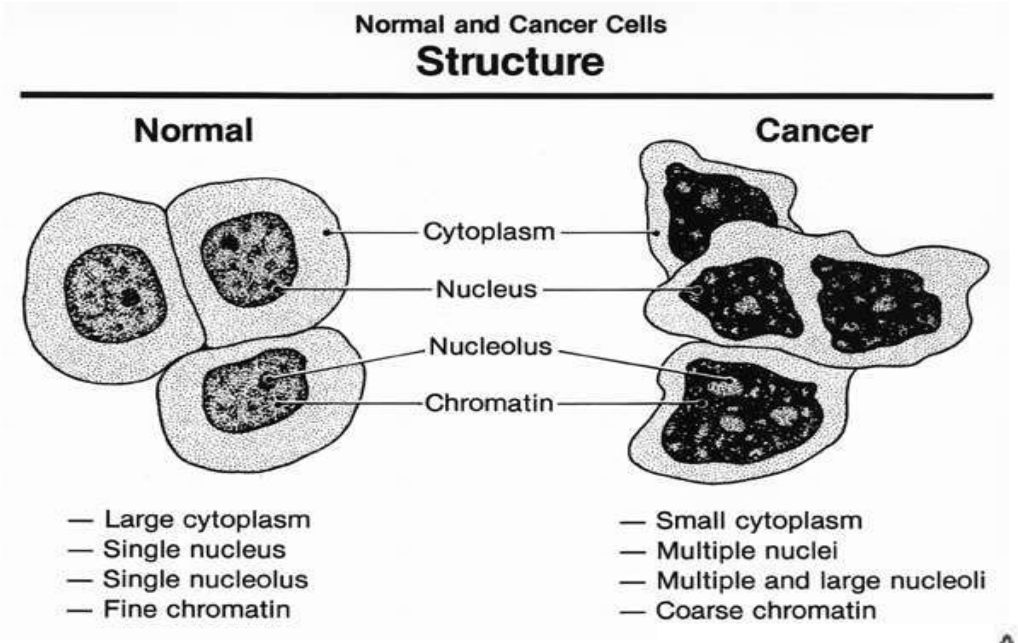
- Considered as one major cause of death all over world
- Due to its severity process of Oncogenic transformation of cells, its treatment and control requires most intense areas of research in biology and medicine

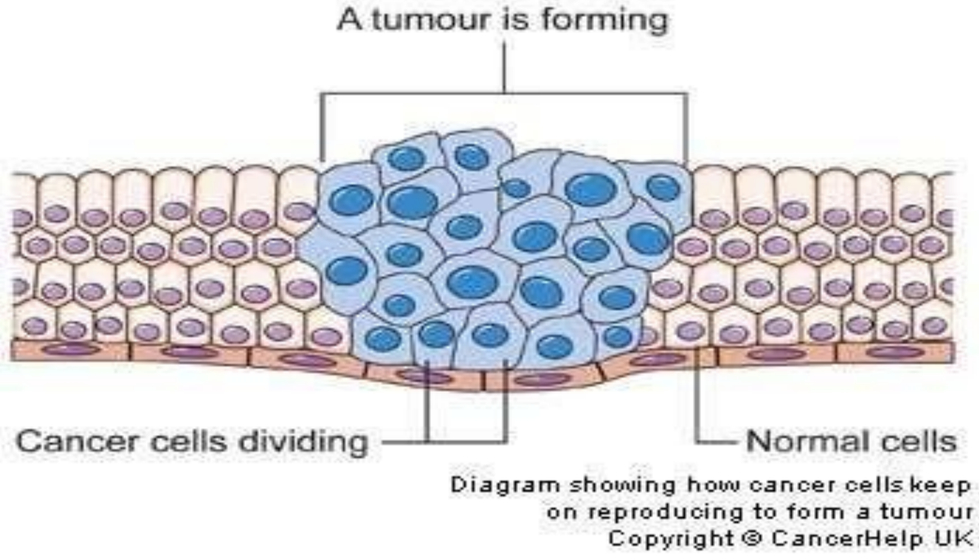
- Cancer can be induced by external factors- **Carcinogens**

Causes of Cancer:

Normal cells transformed into cancerous neoplastic cells by physical, chemical and biological agents. These agents are called **carcinogen.**

- **Physical agents:** ionizing radiation like X-rays, gamma rays non- ionizing radiations like UV-rays.
- **Chemical agents:** Tobacco smoke, sodium azaide, Methyl ethane sulphonate.
- **Biological agents:**
  - Cancer causing viruses called **oncogenic viruses** have a gene called **viral oncogenes,** induce transformation of neoplastic cells.
  - **Cellular oncogenes** (c-onc) or **proto oncogenes** in normal cells, when activated lead to oncogenic transformation of the normal cells


Normal and Cancer Cells
Structure
Normal
Cancer
Cytoplasm
Nucleus
Nucleolus
Chromatin
— Large cytoplasm
— Single nucleus
— Single nucleolus
— Fine chromatin
— Small cytoplasm
— Multiple nuclei
— Multiple and large nucleoli
— Coarse chromatin


A tumour is forming
Cancer cells dividing
Normal cells
Diagram showing how cancer cells keep on reproducing to form a tumour
Copyright © CancerHelp UK

Mechanism to transformation to cancerous cell:

- Cell growth and differentiation is highly controlled and regulated which is lacked in cancerous cell
- Normal cell show a property- **Contact inhibition-** inhibits uncontrolled growth
- Cancer cells appears to have lost this property. As a result of this, cancerous cells just continue to divide giving rise to masses of cells called **tumors**.

TYPES OF TUMOR

Benign tumors:

- Normally remain confined to their original location
- Do not spread to other location.
- Cause little damage

- **Malignant tumors:**
  - Mass of proliferating cells called **neoplastic** or tumor cells.
  - These cells grow very rapidly.
  - Invade and damage surrounding tissues.
  - These cells actively divide and grow; they also starve the normal cells.
  - Cancerous cells escape from the site of origin and moves to distant place by blood, wherever they get lodged make the normal cell cancerous. This property is called **metastasis.**

https://www.medicalnewstoday.com/articles/322551

Four main types of cancer are:

Carcinomas. A **carcinoma** begins in the skin or the tissue that covers the surface of internal organs and glands.

Sarcomas. A **sarcoma** begins in the tissues that support and connect the body.

Leukemias. **Leukemia** is a cancer of the blood.

Lymphomas and **Myelomas,** Cancer of immune system

Detection of Cancer:

Biopsy and histopathological study-

a)tissue and blood and bone marrow tests for increased cell counts (leukemias);

b)Biopsy of a piece of the suspected tissue cut into thin sections is stained and examined under microscope (histopathological studies) by a pathologist

Radiography like X-rays, CT (computerized tomography)

a)used to detect cancers of the internal organs

b)Computed tomography uses X-rays to generate a three- dimensional image of the internals of an object

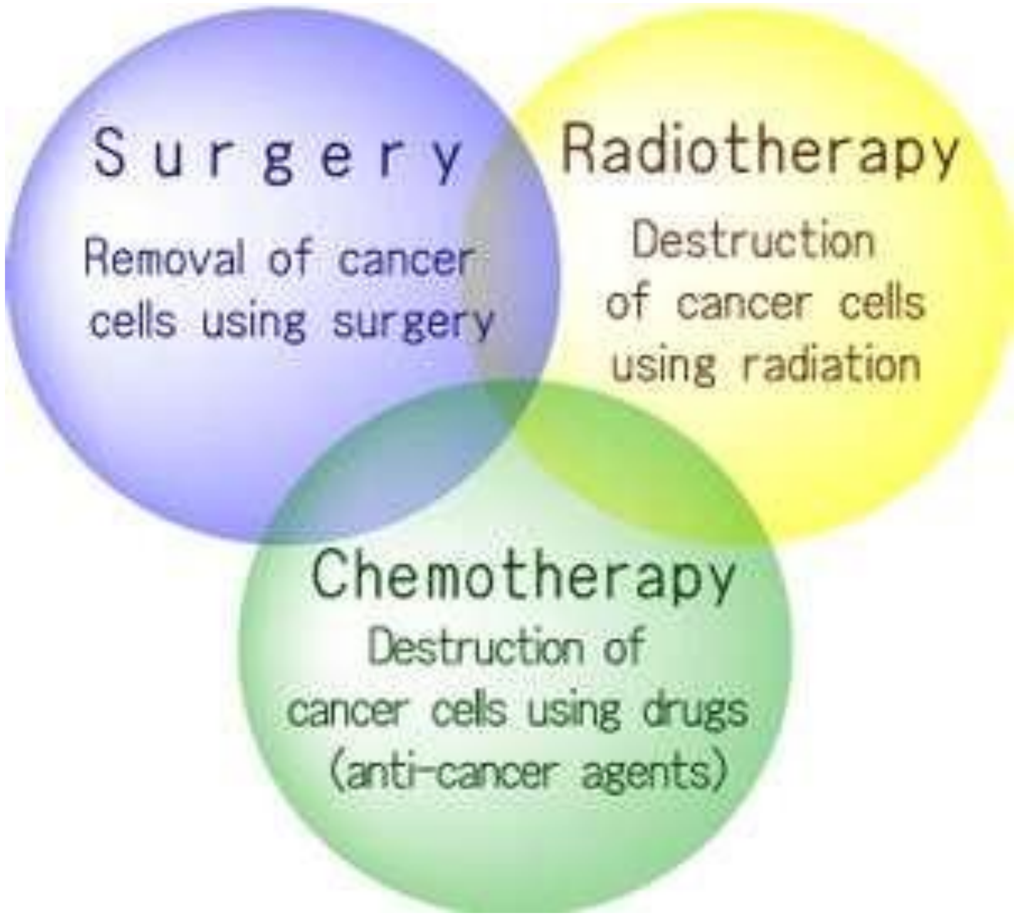
MRI (magnetic resonance Imaging):

a)uses strong magnetic fields and non-ionising radiations to accurately detect pathological and physiological changes in the living tissue

Antibodies against cancer-specific antigen:

a) Antibodies against cancer-specific antigens are used for detection of certain cancers genes- person is advised to prevent exposure

Treatment


Surgery
Removal of cancer cells using surgery
Radiotherapy
Destruction of cancer cells using radiation
Chemotherapy
Destruction of cancer cells using drugs (anti-cancer agents)

Pandemic Management Platform

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ENVIRONMENTAL STUDIES & LIFE SCIENCES

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ENVIRONMENTAL STUDIES & LIFE SCIENCES

Introduction to Telemedicine

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TELEMEDICINE

World Health Organization defines telemedicine as

'The delivery of health care services, where distance is a critical factor, by all health care professionals using information and communication technologies for the exchange of valid information for diagnosis, treatment and prevention of disease and injuries, research and evaluation, and for the continuing education of health care providers, all in the interests of advancing the health of individuals and their communities.'

TELEHEALTH

‘The delivery and facilitation of health and health-related services including medical care, provider and patient education, health information services, and self-care via telecommunications and digital communication technologies.’

Who can be associated with Telemedicine system ?

REGISTERED MEDICAL PRACTITIONER

‘A Registered Medical Practitioner [RMP] is a person who is enrolled in the State Medical Register or the Indian Medical Register under the Indian Medical Council Act 1956.’ [IMC Act, 1956].

Introduction to Telemedicine

- Patient management approach combining various information technologies for monitoring patients at distance.
- Information technology application domains in health care include telemedicine and home telecare.

Introduction to Telemedicine

- Chronic health conditions such as *pulmonary conditions, diabetes, hypertension, and cardiovascular diseases, which are preventable or highly treatable.*

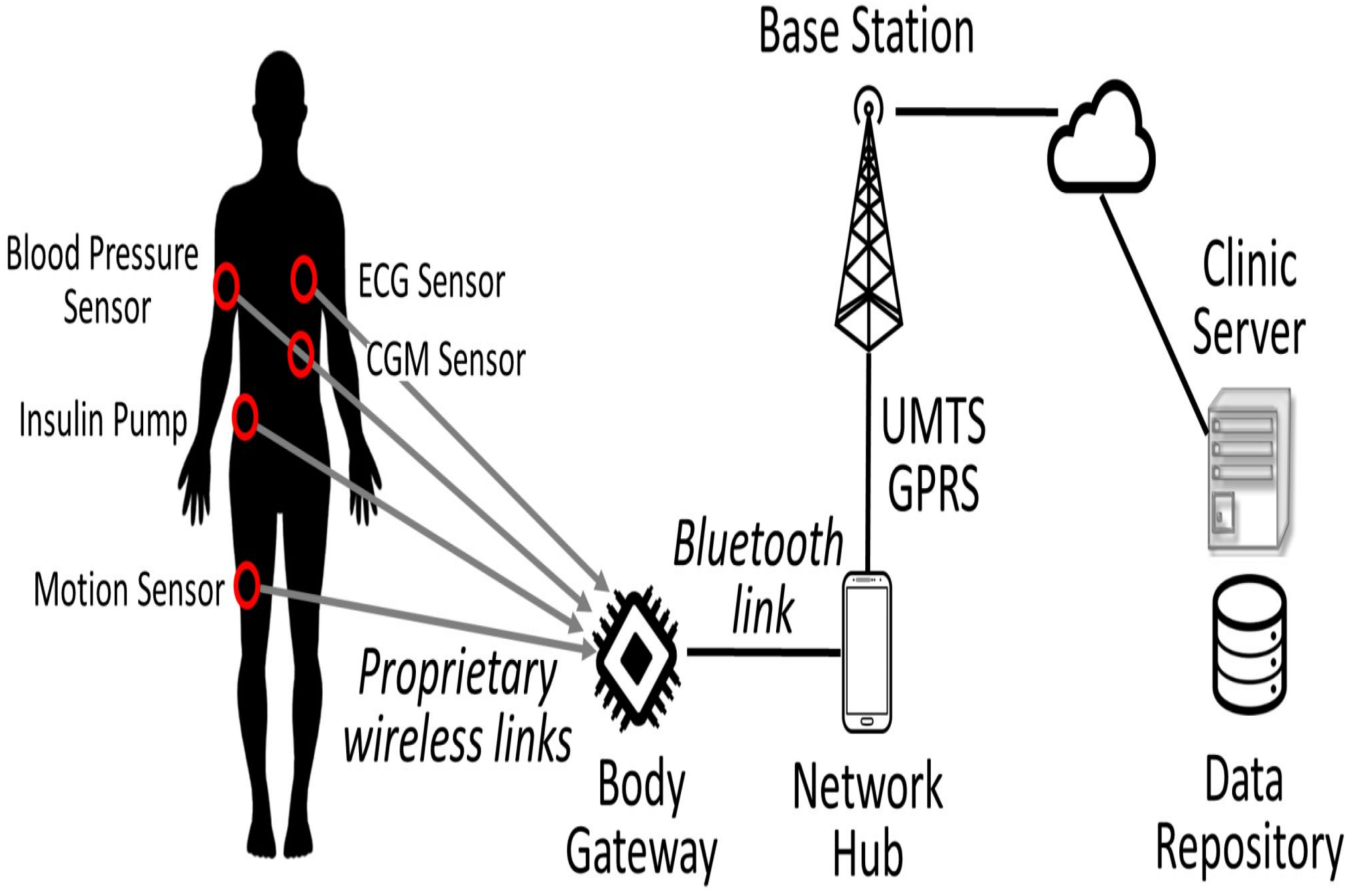
- These individuals account for the vast majority of all healthcare spending — funds that could be saved with better preventative care and disease management .
- *Telepsychiatry, teleradiology, teledermatology, and teleophthalmology.*
- Provides specialist consultation to distant communities, *rather than to provide a tool for self-management of chronic disease.*

- **Home telecare- focused on providing care in a home setting with the primary intent of supporting the patient rather than the health professionals.**

- Home telemonitoring is used in a more restrictive sense and encompasses the use of audio, video, and other telecommunication technologies to monitor patient status at a distance

Tools for Telemedicine

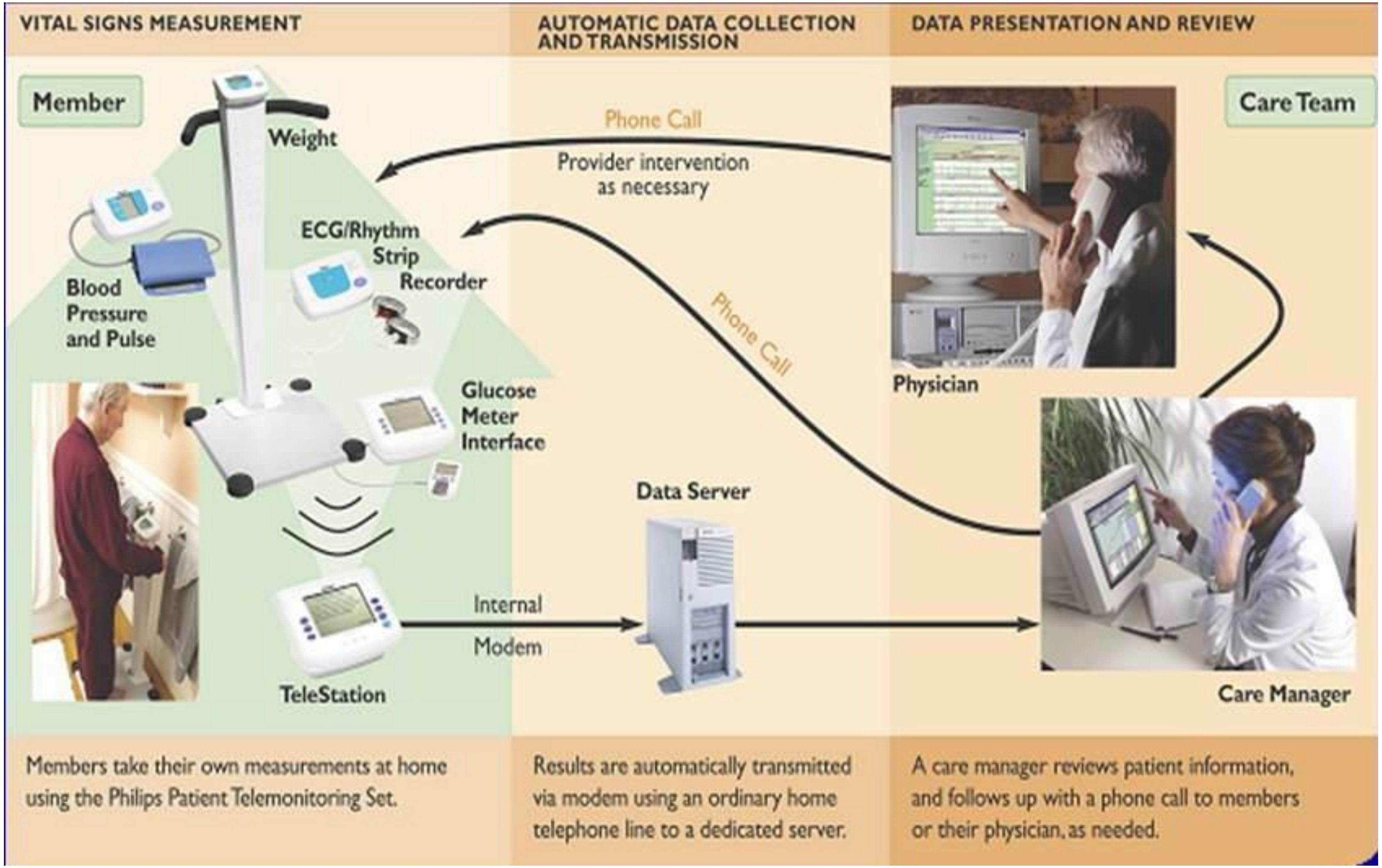
Telephone, video, devices connected over LAN, WAN, Internet, mobile or landline phones, Chat Platforms like WhatsApp, Facebook Messenger etc., or Mobile App or internet based digital platforms for telemedicine or data transmission systems like Skype/ email/ fax etc.



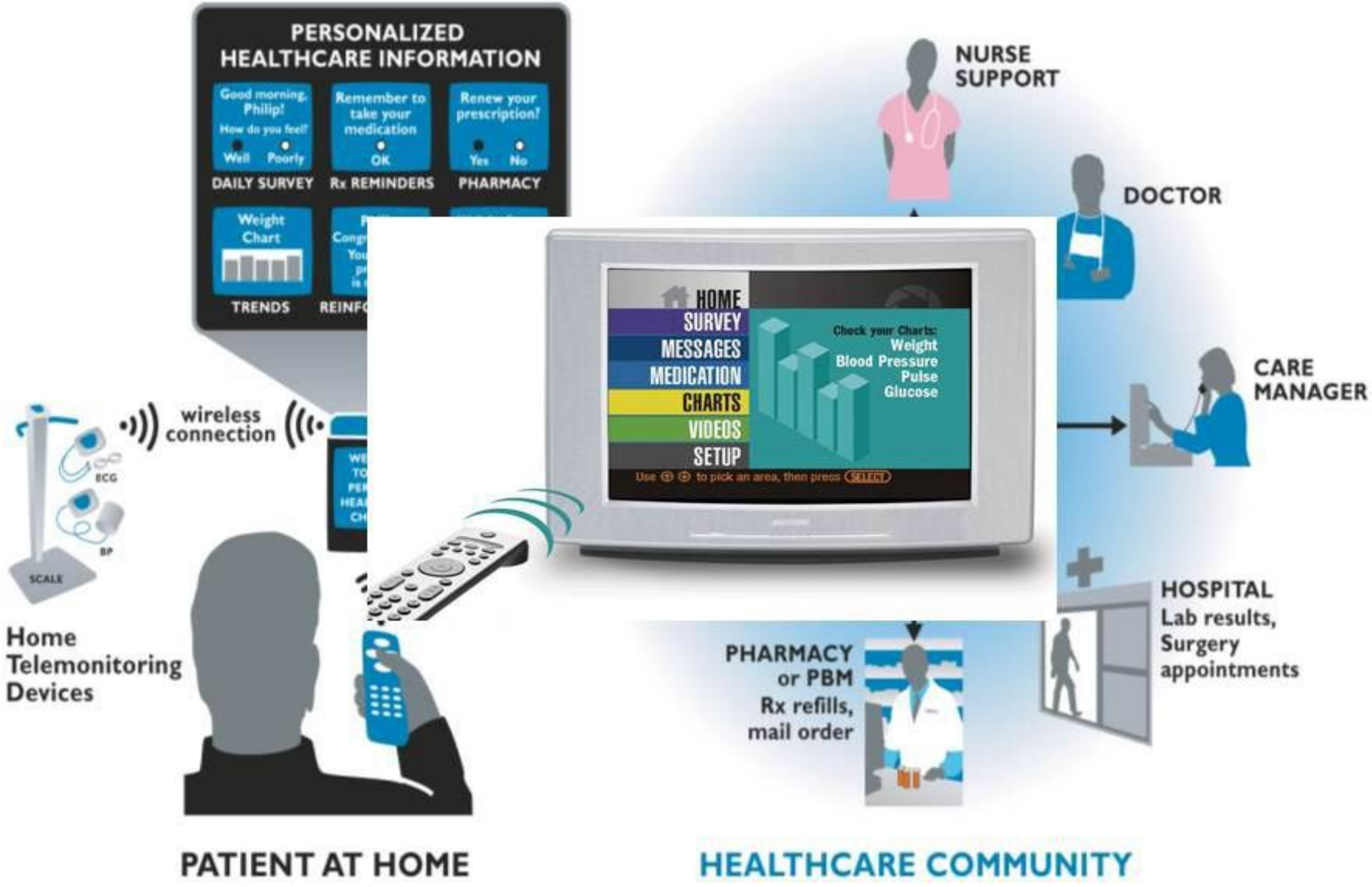
Telemedicine applications can be classified into four basic types

1. mode of communication
2. timing of the information transmitted
3. the purpose of the consultation and
4. the interaction between the individuals involved—be it RMP-to-patient / caregiver, or RMP to RMP.

Introduction to Telemedicine



Home monitoring with interactive television



Advantages

- Real-time data
- Decreased hospitalizations
- Actionable alerts
- Early identifications can be reported
- Client satisfaction

Disadvantages

- Reducing the number of complications remains inconsistent across chronic illnesses
- Very few have reported resulting changes in medication regimens and quality of life
- Clinical effects reported in several cardiac studies were often minimal and inconclusive

Telemedicine in Karnataka

- Karnataka introduced the Telemedicine Network Project in 2001 and the project was initiated by the Indian Space Research Organisation (ISRO).
- The first phase of the project was rolled out in the district hospitals of Mandya, Chitradurga, Chamarajnagar, Tumkur, Chikmagalur, Karwar, Shimoga, and Gadag.
- At the taluk level, hospitals offering telemedicine services during the first phase were Sagara, Maddur, and Yadgir.
- Expert medical advice was given by specialists from St. John's Medical College and Hospital, NIMHANS, Jayadeva Institute of Cardiology, Narayana Hrudayalaya, in Bangalore while from Mysore, it was JSS hospital that offered the service.

- The telemedicine project in Karnataka is coordinated by the Karnataka State Remote Sensing Applications Centre (KSRSAC) which uses the Indian Remote Sensing Satellite for monitoring and managing resources.
- Under the telemedicine project, hospitals in remote locations are connected to super-speciality hospitals from major cities via INSAT satellites thereby establishing a link between the patients and the specialised medical experts.
- The telemedicine system is a customised software that is integrated with the computer hardware and diagnostic instruments which in turn is joined to the Very Small Aperture Terminal (VSAT) at every location.

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ENVIRONMENTAL STUDIES & LIFE SCIENCES

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ENVIRONMENTAL STUDIES & LIFE SCIENCES

Intellectual Property Rights

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Intellectual Property Rights

- The word **property** is defined in the concise oxford dictionary as something owned, a possession, especially a house, land, etc. and the right to possession, use etc.
- In **Jurisprudence** the term **property** is a very complex term having different aspects which commonly includes all **legal rights, proprietary rights, and corporeal property.**
- Intellectual property means such rights recognized by law which result from **Intellectual creativity or Intellectual activity in the fields of literature, art, science and industry.**

Intellectual process

- Anything someone thinks through the application of his/her mind is collectively known as intellectual process which is the cause of creativity and inventions in this world.

Intellectual Property Rights

- Intellectual property rights are such rights which are given to persons **who are the authors or creators of the new and original literary and artistic works such as books, articles , other writings ,paintings , musical compositions, sculpture , films and computer programs by application of their creativity process and intellect**.

- WIPO (World Intellectual Property Organization) was established by the WIPO Convention in 1967
- The WIPO is a **specialized agency of** the United Nations.
- It **promote the protection of IP** throughout the world.
- Its headquarters are in Geneva, Switzerland

Types of property:

- Movable Property
  - Car, Pen, Furniture, Dress
- Immovable Property
  - Land, Building
- Intellectual Property
  - Literary works, inventions

IP as a property

- Can be sold
- Can be bought
- Can be lease or rent
- Can pass under a will
- Can be assigned

NECESSITY OF IPR PROTECTION

Intellectual property rights protection is necessary due to following reasons:

- Encouragement to creativity by ensuring its reward
- Innovations in technology
- Protection of users and consumers
- Transfer of technology to less developed nations and countries of the world
- IPR are given to such individuals to compensate for their efforts during such creative process and their investments.
- These rights are given for a certain period of time and after which general public have the right to get freely benefitted and use subsequently.

Intellectual Property Rights

- Encouragement to creativity by ensuring its reward
- All the creations are used by human beings for their enjoyment and benefit and due to that reason they have social applications in economic and social terms like financial gains and reputation.
- Pirates and imitators are not only depriving the intellectual property right- holders from their legal rights but also looting the users and consumers of such products and goods which are not original or produced by the real producers.

Intellectual Property Rights

The role of IP as intangible property provides:

- Economic rights of creators
- Commercial exploitation of owner of IP
- Capital expenditure
- Transfer of technology
- Cultural development

TYPES/TOOLs OF IPRs

- Patents.
- Trademarks.
- Copyrights and related rights.
- Geographical Indications.
- Industrial Designs.
- Trade Secrets.
- Layout Design for Integrated Circuits.
- Protection of New Plant Variety.

Intellectual Property Rights

Patent

The word *patent originates from the Latin* ***patere, which means "to*** lay open" (i.e., to make available for public inspection).

- A patent is an exclusive right granted for an invention, which is a product or a process that provides a new way of doing something, or offers a new technical solution to a problem.
- It provides protection for the invention to the owner of the patent.
- The protection is granted for a limited period, i.e., 20 years.
- Patent protection means that the invention cannot be commercially made, used, distributed or sold without the patent owner's consent.
- In principle, the patent owner has the exclusive right to prevent or stop others from commercially exploiting the patented invention.

Patent

- Patents are territorial rights. In general, the exclusive rights are only applicable in the country or region in which a patent has been filed and granted, in accordance with the law of that country or region.

What kinds of inventions can be protected?

- Patents may be granted for inventions in any field of technology, from an everyday kitchen utensil to a nanotechnology chip.
- An invention can be a product – such as a chemical compound, or a process, for example – or a process for producing a specific chemical compound.
- Many products in fact contain a number of inventions. For example, a laptop computer can involve hundreds of inventions, working together.

Intellectual Property Rights

Apple's 'rubber-banding' patent win stands – Samsung denied new trial

https://9to5mac.com/2013/08/23/

Trademarks

- A trademark is a distinctive sign that identifies certain goods or services as those produced or provided by a specific person or enterprise.
- It may be one or a combination of words, letters, and numerals.
- They may consist of drawings, symbols, 3D signs such as the shape and packaging of goods, audible signs such as music or vocal sounds, fragrances, or colours used as distinguishing features.
- The initial term of registration is for 10 years; thereafter it may be renewed from time to time.

Intellectual Property Rights

https://blog.ipleaders.in/trademark-law-in-india/

Intellectual Property Rights

Trade Mark:
Application No.: 3296219
Dated June 28, 2016 in Class 1

Trademarks

- In principle, a trademark registration will confer an exclusive right to the use of the registered trademark.
- This implies that the trademark can be exclusively used by its owner, or licensed to another party for use in return for payment.
- Registration provides legal certainty and reinforces the position of the right holder, for example, in case of litigation.

Trademarks

- A word or a combination of words, letters, and numerals can perfectly constitute a trademark.
- But trademarks may also consist of drawings, symbols, three-dimensional features such as the shape and packaging of goods, non-visible signs such as sounds or fragrances, or color shades used as distinguishing features – the possibilities are almost limitless
- Trademark rights are private rights and protection is enforced through court orders.

Copyrights and related rights

- Copyright is a legal term describing rights given to creators for their literary and artistic works.
- The kinds of works covered by copyright include:
  - literary works such as novels, poems, plays, reference works, newspapers and computer programs; databases; films, musical compositions, and choreography; artistic works such as paintings, drawings, photographs and sculpture; architecture; and advertisements, maps and technical drawings.

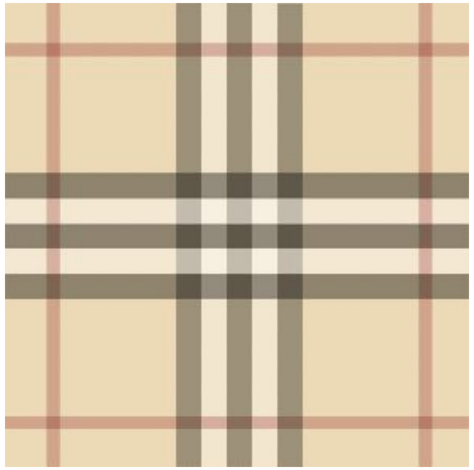
Geographical Indications (GI)

- GI are signs used on goods that have a specific geographical origin and possess qualities or a reputation that are due to that place of origin.
- Agricultural products typically have qualities that derive from their place of production and are influenced by specific local factors, such as climate and soil.
  - Ex: Basmati rice, Darjeeling tea

Industrial Designs

- Industrial designs refer to creative activity, which result in the ornamental or formal appearance of a product, and design right refers to a novel or original design that is accorded to the proprietor of a validly registered design.
- Industrial designs are an element of intellectual property.

- Three-dimensional product (Ex. Shape of a Coca-Cola bottle)
- Two-dimensional product (Ex. Check pattern of burberry)



•https://www.coca-colaindia.com/choices/getting-the-perfect-shape-every-time
•Commons.wikipedia.org

Trade Secrets

- It may be confidential business information that provides an enterprise a competitive edge may be considered a trade secret.
- Usually these are manufacturing or industrial secrets and commercial secrets.
- These include sales methods, distribution methods, consumer profiles, advertising strategies, lists of suppliers and clients, and manufacturing processes.
- Contrary to patents, trade secrets are protected without registration.


SECRET
INGREDIENTS.
That's the secret.
open happiness
Coca-Cola

Layout Design for Integrated Circuits

- Semiconductor Integrated Circuit means a product having transistors and other circuitry elements, which are inseparably formed on a semiconductor material or an insulating material or inside the semiconductor material and designed to perform an electronic circuitry function.
- The initial term of registration is for 10 years; thereafter it may be renewed from time to time.

Protection of New Plant Variety

- The objective of this act is to recognize the role of farmers as cultivators and conservers and the contribution of traditional, rural and tribal communities to the country's agro biodiversity by rewarding them for their contribution and to stimulate investment for R & D for the development new plant varieties to facilitate the growth of the seed industry.

IP Evolution

INTELLECT – PROPERTY – RIGHT

Idea → Expression → COPYRIGHT

Idea → Innovation → Invention → PATENT

Idea → Quality + Identity → TRADEMARK

Idea → Appearance → DESIGN

Idea → Keep Confidential / No Disclosure → TRADE SECRETS

Intellectual Property Rights

One product – many IP rights

Trademarks
- *NOKIA*
- *Product "225"*
- *Start-up tone*

Copyright
- *Software*
- *User manuals*
- *Ringtones*
- *Start-up tone*
- *Images*

Patents and utility models
- *Data processing methods*
- *Operating system*
- *Operation of user interface*

Designs
- *Form of overall phone*
- *Arrangements and shape of buttons*
- *Position and shape of screen*

Trade secrets
- *Part of technical know-how kept "in-house" and not published*

https://www.offshore-creation.biz/intellectual-property-services/

- Remedies for Infringement

❖ Administrative(copyright board)
❖ Civil Proceedings(starts from district court)
❖ Criminal remedies
❖ Penalties and Punishments
❖ First offence –six months imprisonment and Rs.50,000/-fine(Section 63)
❖ Second offence –one year imprisonment and Rs.1,00,000/-fine(Section 63 A)
❖ Maximum –three years imprisonment and Rs.2,00,000/-fine

Intellectual Property Rights

Nike has sued Wal-Mart for design patent infringement asserting infringement of Pat Nos. D498,914

Chart 1: Images Depicting Infringement of NIKE Design Patent D498,914 by the Wal-Mart Shoe

D498,914	Wal-Mart Shoe
 FIG. 4	

https://patentlyo.com/patent/2008/10/protecting-desi.html

Intellectual Property Rights

- "Infringement" of a patent occurs when a competitor makes, uses, sells, offers to sell or imports an embodiment of the invention **without the permission** of the patent owner.

https://patentlyo.com/patent/2008/10/protecting-desi.html

Intellectual Property Rights

First man jailed in web piracy case

Hong Kong, Nov. 7: A Hong Kong man on Monday was sentenced to three months in prison in what local officials said was the world's first successful prosecution of copyright violation using the popular file-sharing software BitTorrent. Chan Nai-ming, 38, was convicted of illegally uploading three Hollywood films, *Daredevil*, *Red Planet* and *Miss Congeniality*, onto a Web site so that others could obtain them, said Judiciary spokesman Mackenzie Mak.

Mr Chan is the first person in the world to be convicted and jailed for illegal online sharing of copyrighted material using the BitTorrent software, said customs spokeswoman Glenis Liong.

Pirated goods openly on sale at a shopping mall in Hong Kong. *(AFP)*

The software allows users share large chunks of data in a speedy way. But movie and music industries say the illegal online sharing of files causes them losses of millions of dollars a year. Mr Chan was found guilty last month of three counts of attempting to distribute copyrighted material without authorisation. The magistrate who convicted him said his act greatly hurt the interest of the copyrighted material's owner although h did not make any profit from uploading the movies onto the Internet. Because of its speed, BitTorrent steadily gained in popularity after the recording industry began cracking down on users of Kazaa and Morpheus, established file-sharing software. *(AP)*

Intellectual rights cases to get top priority, says CJI

By Dhananjay Mahapatra/TNN

New Delhi: Giving the first official recognition to the importance of intellectual property rights (IPR) cases in a fast developing economy like that of India, Chief Justice of India Y K Sabharwal on Saturday promised to put all such litigations in the fast track system for their early disposal.

This promise he dished out at the 51st Council meeting of Asian Patent Attorneys Association (APAA) here amidst applause from a large gathering of jurists from Asian countries.

Underlying the importance of intellectual property rights and protection of trade marks for foreign companies to venture into the domestic market, Justice Sabharwal promised to include IPR cases in his priority list, which he had unveiled as Chief Justice designate, to be put on fast track trial. The priority list was originally meant to include corruption cases against high and mighty and cases against old and infirm.

This was an impromptu promise by the CJI as his written speech did not contain any reference to the IPR cases. He said, "Any delay in deciding such cases would promote deceit and counterfeit and every attempt should be made to put these type of cases on fast track."

He said much before the world judiciary realised the importance of intellectual property rights, it was the Indian judiciary which took timely action in protecting

Y K Sabharwal

what was know then as Patents or Trade Marks. "Our judiciary has been proactive in protecting trade marks much before the TRIPS agreement took effect," the CJI said.

He reeled out statistics - patent application filing in India has gone up from 5000 in 1999 to 17,000 in 2004 and issuance of 2 lakh trademark certificates in last two years to lay stress on his view that India has kept pace with the dynamics of the field.

Jyoti Sagar, APAA Indian group president, narrated a joke to illustrate how important the trademarks have become. Two persons debating over a picture - whether it was a crocodile or alligator - went to a arbiter, who after having a look at the picture exclaimed "it looks like lacoste"!

APAA president Dato Kar dan said in today's world th struggle is for economic an technological superiority. Tec hnological supremacy come from creation, marketing an mastering a brand, which is in tellectual property.

THANK YOU

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