Contents

Xenobiotics

- ✓ Xenobiotics are foreign substances, originating from outside the body, that have an action when introduced within the body, and thus have a profound impact on metabolic/ hormonal balance.
- ✓ It means that Xenobiotics are chemicals found in an organism but which are not normally produced or expected to be present in it. Best example of Xenobiotics are antibiotics in humans because the human body does not produce them itself, nor are they part of a normal diet.
- ✓ Xenobiotics is very often used in the context of pollutants such as dioxins and polychlorinated biphenyls and chemicals derived from a petroleum sources.
- ✓ Since last 50 years, xenobiotic compounds are getting added to the environment, some being highly toxic, recalcitrant and having high Bio-accumulating and Biomagnification properties.
- ✓ Xenobiotic substances are becoming an increasingly large problem in Sewage Treatment systems, since they are relatively new substances and are very difficult to categorize. Antibiotics, for example, were derived from plants originally, and so mimic naturally occurring substances. This, along with the natural monopoly nature of municipal Waste Water Treatment Plants makes it nearly impossible to remove this new pollutant load.
- ✓ Some xenobiotics such as plastics and pesticides, or naturally occurring organic chemicals such as polyaromatic hydrocarbons (PAHs) and some fractions of crude oil and coal, are resistant to degradation. Many xenobiotics produce a variety of biological effects, which is used when they are characterized using bioassay.

The Early Xenobiotic Compounds

- ✓ It was not until the early 1960s that the first landmark episode of the toxic chemical pollution was widely reported.

- ✓ In 1962, Ms. Carson reported the effect of DDT residues on the bird population. It was later proved that the pesticide was also causing troubles to humans.
- ✓ Soon afterwards, mercury poisoning was discovered along the Minimata bay in Japan, where hundreds of cases of paralysis and sensory loss were reported.
- ✓ In late 1960s, there was a reported contamination of cooking oil with polychlorinated biphenyls (PCBs) in Japan and Taiwan.
- ✓ Chemical warfare in Vietnam which included the use of the Agent Orange as defoliating agent was proved to be catastrophic on environment.

Genetic Engineering and Environment

- ✓ All living organisms are made of cells which contain DNA. The Units of DNA molecules are called genes. The genes contain the information that is used by the cells as recipe for the organism.
- ✓ It has been discovered that DNA is interchangeable among animals, plants, bacteria and other organisms.
- ✓ In addition to using the traditional breeding methods, for improving the plant or animal species through cross breeding and selection, scientists in some cases now can transfer the genes that determine many desirable traits from one plant or animal to other.
- ✓ The transfer of DNA is done by various methods such as direct injection of cells with DNA or literally shooting cells with DNA Covered Particles from a special gun called gene gun.
- ✓ Another widely used method is to insert the DNA into specifically modified bacteria or viruses, that carry it into the cells they infect.
- ✓ Regardless of which method is used, the general purpose of the process of transferring DNA from one organism to another is called genetic engineering. Technically, almost any desirable trait found in nature can be transferred to any chosen organism. A plant or animal that is modified by genetic engineering to contain DNA from an external source is called transgenic organism. The uses are unlimited such as Pharma, gene therapy and the development of transgenic plants and animals such as Glofish which is the first commercially sold transgenic animal to be sold as a pet. These organisms are called GEM or genetically modified organisms.

Transgenic Plants & Animals

- ✓ Transgenic plants that can tolerate herbicides, insects or viruses, or produce modified fruit or flowers are being grown and tested in outdoor test plots since 1987.
- ✓ Copies of genes for these selected traits have been transferred to the plants by genetic engineering techniques from other unrelated plants, bacteria, or viruses.
- ✓ Corn plants that produce an insecticide protein to resist European corn borers and tomatoes that can ripen longer on the vine before shipping are examples of transgenic plants that have been developed.
- ✓ Another area of environmental protection is the application of biological controls for using biopesticides.

- ✓ ***Bacillus thuringiensis*** has been used to selectively control certain insect pests. In this case, the whole organism is marketed.
- ✓ Another biotechnology market is in **transgenic animals** are designed to help researchers diagnose and treat human disease. Several companies have designed and are testing transgenic mammals that produce important pharmaceuticals in their milk. Products such as insulin, growth hormone, and tissue plasminogen activator. Which are currently produed by fermentation of transgenic bacteria may soon be obtained from the milk of transgenic cows, sheep, or goats.

Comparison of Tissue Culture and DNA Technology

- ✓ The basic technologies used in different areas of biotechnology applications and are similar they could be grouped under the two general headings of tissue culture techniques and DNA technology.
- ✓ The former operates at above the cell level (with its components- membranes, chloroplasts, mitochondria , etc), and implies growing cells, tissues and organs in controlled conditions. The second involves the manipulation of genes that determine the cell (and therefore plant, animal or micro-organisms) characteristics, which mean working at the DNA level; the isolation of genes, their recombination and expression in new forms and their transfer into appropriate cells.

DNA Shuffling

- ✓ New and important biochemical activities are discovered and it is often of interest to modify a natural enzyme to achieve a desired substrate specificity, heat stability or high activity.
- ✓ Rational, protection design is still is very difficult task if one wishes to obtain improved enzyme. In this context, biologists are taking a cue from the chemists and expanding the use of combinatorial methods to modify enzymes.
- ✓ One example of this approach is generating genetic diversity by a process known as **DNA shuffling.**
- ✓ DNA shuffling produce many enzyme variants that can be screened or put through a biological selection procedure to obtain one or more desired traits. Recently, it has been found to be powerful to start the DNA shuffling process with natural genetic diversity. The idea is to use several natural variant genes because these divergent sequences have already been selected for their ability to produce proteins that have responsible enzyme activity, thus enhancing one's overall success in obtaining the improved enzyme.

BioFuels and fossil fuels

- ✓ Major progress in the prevention of pollution has been made in the field of biomining and bio-processing. The main advantages fro biotechnological methods are likely to be the replacement of environmentally harmful substances with biological ones and redesigning processes to minimize energy consumption and waste output.
- ✓ However, this will not be possible without adequate and economically viable monitoring devices. The current techniques are NOT economically viable, generally.
- ✓ The biotechnological impact on transport will be important for oil-importing countries. Biotechnology can have an impact on the environment by providing cleaner large-scale processes, perhaps no greater benefit could accrue than to make energy generation cleaner.

- ✓ The burning of fossil fuels causes pollution in several ways. The most problematic is the release of sulphur dioxide. Removing the sulphur from fossil fuels can prevent this. However, it is particularly difficult to remove the sulphur tied up in organic compounds while preserving a high thermal value of the fuel.
- ✓ In this context, there have been investigations aimed at removing sulphur from coal and oil by micro-organisms containing enzymes that selectively cleave the carbon-to-sulphur bonds in the fuel.

Biomining and Bioleaching

- ✓ In relation to bacterial leaching and biomining, micro-organisms are using and releasing minerals in the earth's crust since ancient times. Mining operations have long benefited from the activities of such naturally occurring micro-organisms, especially the ability of some bacteria to leach the metals from insoluble ores.
- ✓ Bacterial leaching is being used successfully in many countries throughout the world to recover metals from a wide variety of ores. The main metals recovered are copper and uranium, cobalt, nickel, zinc, lead and gold are also obtained.
- ✓ Bioleaching has received increasing attention because the technology has the potential to ease some of the problems experienced by the mining industry. A major problem is the greater depths.
- ✓ In many instances, it may be possible to use bacteria to leach the desired mineral out of deep or low-grade deposits without removing them from the ground, thus saving the costs of bringing vast tonnage of ore and waste rock to the surface.
- ✓ Additionally many conventional procedures consume large quantities of energy.
- ✓ The bioleaching of ores and concentrates may be an energy-saving alternative. Besides, biomining technology has potential environmental benefits.
- ✓ A long-standing problem in many mining operations has been the uncontrolled release of frequently occurring metals and acids. The controlled leaching of waste rock can result both in the recovery of valuable metals from the sites and the protection of environment pollution.

Biosensors in bio-processing

- ✓ Microbial biosensors are micro-organisms, which produce a reaction upon contact with the substance to be sensed.
- ✓ Most biosensors are a combination of biological and electronic devices- often built onto a microchip.
- ✓ The biological component might be simply an enzyme or antibody, or even a colony of bacteria, a membrane, neural receptor, or an entire organism.
- ✓ The sensor is immobilized on a substrate, its properties changing in response to some environmental effect in a way that is electronically or optically detectable.
- ✓ It is then possible to make quantitative measurements of pollutants with extreme precision or to very high sensitivities.

- ✓ **Immunoassays** use labelled antibodies (Complex proteins produced in biological response to specific agents) and enzymes to measure pollutant levels. If a pollutant is present, the antibody attaches itself to it the; the label making is detectable either through colour change, fluorescence or radio-activity.
- ✓ Immunoassays of various types have been developed for the continuous and automated monitoring of pesticides such as dieldrin and parathion. The nature of these techniques, the results of which can be as simple as a colour change, make them particularly suitable for highly sensitive field testing where traditional testing is impractical. Their use is however limited to pollutants, which can trigger can trigger biological antibodies.
- ✓ A range of biosensors and bioassays has been developed and applied to bio-processing systems and monitoring of pollutants in the environment. These devices can be based on catalytic elements such as enzymes, micro-organisms (e.g. using bioluminescence), and tissues, or on non-catalytic elements, such as receptages of biosensors, such as high specificity, lack of stability and short lifetime.
- ✓ Use of biosensors has considerable potential in pollution prevention, even though specificity presently makes them unsuitable for mass marketing.
- ✓ The development of living organism, such as larvae, molluscs, lichens and plants, as pollution indicators might be better suited for commercialization. Multi-purpose bioassays are also promising, for instance, in the development of multi-enzyme systems for the detection of toxic compounds in complex industrial effluents.

Heat Balance

- ✓ Since incoming radiation heats the atmosphere and the earth through absorption, these two regions should continue to get hotter and hotter. The reason for their not getting hotter is due to a complex system of re-radiation from the earth and clouds. Over a long period, the heat loss from the earth and atmosphere is equal to the heat gain.
- ✓ However, temporary imbalances exist at some points on earth. The system is complex because the water vapour in the atmosphere can absorb long-wave (terrestrial) radiation.
- ✓ Thus, the water vapour absorbs and re-radiates long-wave radiation to and from the earth. Because it absorbs long-wave radiation more effectively than sort waves, a green-house effect is created.

Urban Heat Island

- ✓ Urban heat island (UHI) is a urban area which is significantly warmer than its surrounding rural areas.
- ✓ The temperature difference usually is larger at night than during the day, and is most apparent when winds are weak.
- ✓ UHI is seen during both summer and winter. Due to their high heat capacities, urban surfaces act as a giant reservoir of heat energy. It has been shown that concrete can hold roughly 2,000 times as much heat as an equivalent volume of air.
- ✓ Latest studies show that UHI is one among the main reasons for Global warming.
- ✓ The rising columns of warm air in urban areas are commonly called as "**Urban Thermal Plume**".

Eutrophication

- ✓ Eutrophication derives from the Greek word *eutrophos*, meaning nourished or enriched.
- ✓ Eutrophication escalates rapidly when high nutrients from fertilizers, domestic and industrial wastes, urban drainage, detergents and animal, sediments enter water streams.
- ✓ Eutrophication is mainly divided into natural and cultural Eutrophication. In natural Eutrophication, a lake is characterized by nutrient enrichment. During this process an oligotrophic lake is converted into an eutrophic lake. It permits the production of phytoplankton, algal blooms and aquatic vegetation that in turn provide ample food for herbivorous zooplankton and fish.
- ✓ Cultural Eutrophication is caused by human activities. Which in turn are responsible for addition of 80% nitrogen and 75% phosphorus to lake and streams.
- ✓ Eutrophication causes several physical, chemical and biological changes, which considerably deteriorate the water quality.
- ✓ It creates algal bloom, releases toxic chemicals that kill fish, birds and other aquatic animals.
- ✓ Decomposition of algal bloom leads to the depletion of oxygen in water. Thus with a high CO_2 level and poor oxygen through reduction of nitrates.
- ✓ On complete exhaustion of nitrate, oxygen may as last resort be obtained by reduction of sulphate yielding hydrogen sulphide causing foul smell and putrefied taste of water. Many pathogenic microbes, viruses, protozoa and bacteria and grow on sewage products under anaerobic conditions. It results into the spread of fatal water-borne disease such as polio, dysentery, diarrhoea, typhoid and viral hepatitis.

Control of Eutrophication

- ✓ Several prevention and technical devices have been used to control Eutrophication. The wastewater must be treated before its discharge into water streams.
- ✓ Recycling of nutrients can be checked through harvest. Removing nitrogen and phosphorous at the source, division of nutrient-rich waters from the receiving bodies and dilution of these elements can minimize Eutrophication.
- ✓ Algal blood should be removed upon their death and decomposition. Limiting the dissolve nutrients can control algal growth. The most suitable, feasible and effective method involves the use of chemicals to precipitate additional phosphorus.
- ✓ Precipitants like alum, lime, iron and sodium aluminate may be used. Physicochemical methods can be adopted to remove nutrients. for example phosphorous can be removed by precipitation and nitrogen by nitrification or denitrification.
- ✓ Electrodialysis, reverse osmosis and ion exchange methods. Cooper-sulphate and sodium arsenite are employed for killing algae and rooted planet respectively.

Soil and solid waste pollution

- ✓ Soil pollution occurs when the thin layer of healthy and productive soil, which covers the earth's surface, is destroyed. Solid waste or rubbish is the most visible form of pollution. Every year, people dispose of billions of tonnes of solid waste.

- ✓ The solid waste produced in homes, schools, offices and shops is called municipal solid waste. It includes paper, plastic, bottles and cans and our left-over food.
- ✓ Other waste consists of scrap metal, leftover materials from agricultural processes, and mining wastes known as spoil. Soil pollutants, mainly results from the industrial wastes, urban wastes, radioactive pollutants, agriculture practices, chemical and metallic pollutants, biological agents, mining, objects and soil sediments.

Agriculture as source of Solid Waste

- ✓ The lignocellulosic biomass generated by agricultural activities is a primary source of solid waste.
- ✓ In addition, the use of fertilizers and pesticides in agricultural practices can limit the ability of soil organisms to process waste, which he turn makes the soil less productive or in the worst-case scenario, useless or every poisonous.
- ✓ Some pesticides can remain in the environment for many year and pass from one organism to another. When pesticides are present in a stream, small fish and other organisms build up even larger amounts of pesticides in their flesh and will eventually pass them on to us through the food chain. There are many other human activities, which can damage soil. The irrigation of soil in dry areas with poor drainage can leave fields flooded. When this standing water evaporates, it leave salt deposits behind, making the soil too salty for growing crops.

Industries as source of wastes

- ✓ Disposal of industrial waste is the major problem responsible for soil pollution. These industrial pollutants are mainly discharged from pulp and paper mills chemical industries, oil refineries, sugar factories, tanneries, textiles, steel, metal processing industries, drugs, glass, cement, petroleum and engineering industries.

Mining as source of wastes

- ✓ Mining operations can leave soil polluted with toxic heavy metals. Many scientists believe acid rain can also reduce soil fertility. In surface mining and strip mining top soil and sub-soil is removed. This leaves deep salt in the earth.
- ✓ The uncontrolled mine fires may also destroy the productivity of certain land areas permanently. Soil damage and environmental degradation during surface mining is inevitable as vegetation has to he removed and huge quantities of top soil and waste rocks are to be shifted to a new location, mining leads to loss of grazing and fertile land, soil erosion from waste dumps, sedimentation or silting, danger to aquatic life, flora and fauna as well as water and soil pollution.

Municipal and urban waste

- ✓ This waste comprises both commercial and domestic wastes consisting of dried sludge of sewage. All the urban solid wastes are commonly referred to as refuse.
- ✓ Solid wastes and refuse, particularly in urban area contribute to soil pollution. This refuse contains garbage and rubbish materials like plastics, glasses, metallic cans, fibres, rubbles, trash from the streets, fuel residues, leaves containers, abandoned vehicles and other discarded manufactured products.

- ✓ Municipal waste is largely categorized into three type; waste that can be incinerated (generally called "combustible waste") waste that is treated by non-incineration intermediate treatment measures (generally called "incombustibles") and materials that directly go to recycling or re-use procedures through separate collection or voluntary group collection.
- ✓ The waste generated from agriculture, municipal and commercial activities are putrid solid waste and is known as garbage. There are four broad categories of garbage.
    - o Organic waste : kitchen waste, vegetables, flowers, leaves and fruits.
    - o Toxic waste ; old medicines, paints, chemicals, bulbs, spray cans, fertilizer and pesticide containers, batteries and so on.
    - o Recyclable ; paper, glass, metals and plastics.
    - o Resistant objects; large resistant objects such as cans, plastic, tyres, polythenes, metallic junk, glasses or even old cars, refrigerators, washing machines destroys the beauty of landscape. In india, most of this is purchased by hawkers and resold. In industrialized countries, used vehicles are creating a serious threat to environment.

Soil sediments

- ✓ Soil sediments refer to the depositions of trace elements or metals such as Hg,As, Sb, Cd, Ni, Co, Mo, Cu and Cr.
- ✓ The process of sedimentation is a comprehensive natural geomorphologic process, which operates through the chain of erosion of soils, transportation of sediments (eroded material) and deposition of thee eroded material in different paths of water bodies.
- ✓ Sediments thus consist of soil and mineral particles washed away from land by storms and floodwaters, from geological process of denudation, which is both inevitable and universal. Eroded soil becomes a serious pollutant because of the absorbed chemicals that it carries to the particles surface.

Deforestation as soil pollutant

- ✓ The depletion of forest cover leads to increased run-off of rainwater and diminished storage in the soil.
- ✓ The structure of the soil is greatly influenced by lack of organic matter as a result of which run-off increases.

Destruction of pastures and overgrazing as soil pollutant

- ✓ A property managed, lightly grazed pasture might form a permanent protection to soil because it provides an efficient cover for preventing erosion and reducing run-off.

Environment issues with Shifting cultivation

- ✓ In Shifting cultivation, plots of land are cultivated temporarily, then abandoned. This system often involves clearing of a piece of land followed by several years of wood harvesting or farming, until the soil loses fertility. Once the land becomes inadequate for crop production, it is left to be reclaimed by natural vegetation, or sometimes converted to a different long-term cyclical farming

practice. Slash-and-burn is one element of their farming cycle. Land clearing without any burning is also used.

- ✓ The major characteristic of Shifting Cultivation is that the cultivated or cropped area is shifted regularly to allow soil properties to recover under conditions of natural successive stages of re-growth. It is known as Jhum Cultivation in India and Ladang in Malaysia.
- ✓ The longer a field is cropped, the greater the loss of soil organic matter, the reduction in the cation-exchange-capacity and in nitrogen and phosphorus, the greater the increase in acidity, the more likely soil porosity and infiltration capacity is reduced and the greater the loss of seeds of naturally occurring plant species from soil seed banks.
- ✓ The indiscriminate destruction of forest for shifting cultivation has also reduced the forest cover. Shifting or jumping cultivation is mainly practiced by the tribal communities for raising food.

Types of water erosion

There are **seven types of water erosion**.

1. **Raindrop erosion** is caused from so splash brought about by the impact of falling raindrops. Climate, rainfall and temperature, soil, topography, particularly steepness and length of slope, and the vegetative cover are responsible for raindrop erosion.
2. **Sheet erosion** is the removal of erosion is the removal of surface soil by running water, with the formation of normal cultivation.
3. **Fill erosion** is more apparent than sheet erosion.
4. **Gully erosion** is the removal of soil by running water, with the formation of channels that cannot be smoothened out completely by normal agricultural operation or cultivation.
5. **Gill erosion** is an advanced stage of Fill erosion.
6. **Stream channel erosion** is the scouring of material from the water channel and the cutting of banks by flowing or running water. This type of erosion occurs at the lower end of stream tributaries and to stream that have almost a continuous flow and relatively flat gradients. Landsides cause slip erosion with big masses of soil and rock bodies slipping down, damaging fields.
7. **Seashore erosion** is caused by the shrinking action of strong waves.

Erosion by Insolation

- ✓ In hot countries, the surface of rocks becomes very hot during the day because of intense heat and sun. the crust of the earth beneath the rocks consists of different minerals, which expand at different rates because of heat and sun.
- ✓ One mineral expanding more quickly than other, causes the rock to burst. This gives rise to cracks. During night, the rocks get cold, and thus contract. This process is repeated day after day, so that cracks increase in size and gradually the rocks break up into small pieces.
- ✓ The action of sun is called insolation and is important in hot and dry countries.

Is Ozone hole over only Antarctica?

Please note that it is incorrect to say that Ozone Hole is on only Antarctica. The Ozone depletion has been seen everywhere beyond tropics and there is a severe depletion in the Polar Regions due to some reasons which are explained here.

The Antarctic ozone hole is an area of the Antarctic stratosphere in which the recent (since about 1975) ozone levels have dropped to as low as 33% of their pre- 1975 values.

- ✓ The ozone hole o**ccurs during the Antarctic spring, from September to early December**; **as strong westerly winds start to circulate around the continent and create an atmospheric container.**
- ✓ In this container over 50% of the lower stratospheric ozone is destroyed.
- ✓ Announcement of polar ozone depletion over Antarctica in March 1985 prompted scientific initiatives to discover the ozone depletion processes, along with calls to freeze or diminish production of chlorinated fluorocarbons.
- ✓ A complex scenario of atmospheric dynamics, solar radiation, and chemical reactions was found to explain the anomalously low levels of ozone during the **polar springtime.**
- ✓ Recent expeditions to the arctic regions show that similar processes can occur in the northern hemisphere, but o a somewhat lesser degree due to warmer temperatures and erratic dynamics patterns. However, this ozone layer has been destroyed by chlorofluorocarbons and other factors, creating an ozone hole nearly twice the size of Antarctica in 1998.
- ✓ Every summer (December to January) the **hole repairs itself when stratospheric temperatures rise and the air above Antarctica mixes with the rest of the world's atmosphere.** This cycle of ozone hole formation and reparation is repeated every year.
- ✓ The ozone hole over Antarctica has been forming every year since the early 1970s. In recent years the hole has become both larger and deeper, in the sense that more and more ozone is being destroyed.
- ✓ Every March to April during the Northern Hemisphere springtime similar, but less pronounced ozone hole forms above the Arctic.
- ✓ The natural circulation of wind - the polar vortex - which isolates Antarctica from the rest of the world during the Southern Hemisphere winter and early spring, contributing to the ozone loss there, is much less developed in the Northern Hemisphere above the Arctic.
- ✓ In addition, stratospheric temperatures at Arctic, are not as low as in the Antarctic, and consequently the loss of ozone is not as severe. However, the formation of even a moderate ozone hole above the Arctic region can give cause for considerable concern due to the greater populations in the higher latitudes of the Northern Hemisphere.
- ✓ Many were worried that ozone holes might start to appear over other areas of the globe but to date the only other significant, localized depletion is much smaller **ozone dimple**, observed during the arctic spring over the North Pole.

- ✓ The Antarctic hole is a warning that if conditions become more Antarctic, i.e. cooler stratospheric temperatures, more stratospheric clouds, more active chlorine; and then ozone will decrease at a much greater pace.
- ✓ Some of the more popular scenario of global warming predict that these changes could occur in larger portions of the statrasphere. When the Antarctic ozone hole does break-up, the ozone-depleted air tends to drift out into nearby areas.
- ✓ Decreases in the ozone's level of up to 10% have been reported in new Zealand in the month following the break-up of the Antarctica ozone hole.

How does Ozone Hole get created?

- ✓ We all know that the Polar Regions get a much larger variation in sunlight than anywhere else and during the 3 months of winter spend most of time in the dark without solar radiation.
- ✓ Temperatures reduce around or below-80°C for much of the winter and the extremely low Antarctic temperatures cause cloud formation in the relatively "dry" stratosphere.
- ✓ These polar stratospheric clouds (PSCs) are composed of ice crystals that provide the surface for a multitude of reactions, many of which speed up the degradation of ozone molecules.
- ✓ A complex interplay of chemistry, dynamics, and radiation lead to conditions conducive to significant ozone loss in the Polar Regions.
- ✓ The sequence of events leading to the spring time depletion of ozone is initiated of the earth's orbit at about 23.5° causes the polar regions to experience continual darkness during their winter season.
- ✓ The air above the pole cools and a vortex is formed that isolates sets the stage for the rapid depletion of ozone by catalytic cycles. A catalytic cycle is a series of reactions in which a chemical family or a particular species is depleted, leaving the catalyst unaffected.

The odd-oxygen family is composed of ozone (O_3) and atomic oxygen (O). In the presence of a chlorine atom, the net result is the conversion of an oxygen atom and ozone molecule into two molecules of molecular oxygen (O_2).

Chlorofluorocarbon-bonds (CFCs) themselves are not involved in the catalytic process; upon reaching the stratosphere. They are subject to higher levels of ultraviolet radiation that decompose the CFCs and release atomic chlorine. The basic set of reactions that define the catalytic cycle involving chlorine and odd-oxygen appear below :

$Cl+O_3 \rightarrow ClO+O_2$

$ClO + O \rightarrow O_3$

Net result: $O_3+O \rightarrow 2O_2$

- ✓ Chlorine (Cl) is initially removed by reaction with ozone to form chlorine monoxide (ClO) in the first equation, but it is regenerated through reaction of CIO with any oxygen atom (O) in the second equation.
- ✓ The net result of the two reactions is the **depletion of ozone and atomic oxygen.**

The catalytic cycle involving chlorine and ozone was not discovered until 1973. The suspected cause of the depletion was catalytic cycles involving chlorine and nitrogen. Further studies described the multiphase process involving polar found to be involved in the extensive ozone loss.

Field studies in 1987, which involved flights from south America over the Antarctic continent, showed the role of chlorine monoxide (ClO) in the ozone depletion picture.

A clear anti-correlation between chlorine monoxide and ozone concentration- that is, an increase in chlorine monoxide correlates to a decrease in ozone- inside the polar vortex has been reported. Similar processes lead to depletion in the arctic, but to a lesser limits formation of PSCs.

The potential for significant depletion in the arctic does exist, however measurements taken from the microwave limb sounder (MLS) on the upper atmosphere research satellite (UARS) platform in 1992 show concentrations of chlorine monoxide in the arctic similar to those found in the Antarctic vortex. The break-up of the polar vortex following polar spring time leads to mixing of ozones and pulses to down to lower latitude regions.

Important summary of the Antarctic Ozone hole

⇒ Antarctica is surrounded by oceans on all sides. Its unique geographic location causes the clouds in the stratosphere to be really cold. The coldness causes the formation of polar stratospheric clouds which provide an ideal surface for production of ozone depleting chlorine compounds. These polar stratospheric clouds are relatively lesser in the Arctic.

⇒ As mid-may brings on the onset of winter, the Antarctic stratosphere cools and descends closer to the surface. The **Coriolis effect** (caused by the earth's rotation) sets up a strong westerly circulation around the south pole, forming an oblong vortex, which varies in size from year to year. Current theory holds that the vortex is like a semi-sealed reaction vessels with most of the Antarctic air staying trapped inside the vortex. As temperatures in the lower stratosphere cools below- 80°C, polar stratospheric clouds (PSCs) begin to form.

⇒ Most of the Antarctic chlorine ends up in reservoir compounds such as $ClONO_2$ or HCl. Reservoir compounds are so named because they hold the atmospheric chlorine in an inactive form but can react later, usually after a hit by ultraviolet radiation, and release reactive chlorine molecules. On the surface of the PSC crystals, nitrogen compounds are readily absorbed and chlorine reservoir compounds are converted to far more reactive compounds such as Cl2 and HOCl.

⇒ The small amounts of visible light during the Antarctic winter are sufficient to convert much of the atmospheric Cl2 to Clo :

- Cl_2+light→2Cl
- Cl+O_3→ClO+O2

⇒ Ordinarily much of the ClO would be captured by atmospheric NO_2 and returned to the $ClONO_2$ reservoir, but the polar clouds have absorbed most of the nitrogen compounds such as NO_2.

⇒ Spring brings an increase of ultraviolet light to the lower Antarctic stratosphere, providing the energy needed for the rapid catalytic breakdown of ozone by ClO and its dimer ClOOCl. Over 50% of the stratospheric ozone is destroyed by these two mechanisms, most of the damage occurring in the lower stratosphere.

⇒ Towards the end of spring (mid-December) the warm temperatures cause the vortex to break up; ozone-rich air from the surrounding area comes flooding in and masses of ozone-depleted air go wandering, temporarily lowering the ozone content in areas of south America and new Zealand by up to 10%.

⇒ One more important reason of that Antarctic Hole is bigger than Arctic Hole because **Earth's magnetic field** directs more positively charged solar wind particles to Earth's south pole. These are largely hydrogen, hydrogen oxidizes to water vapor, and water vapor both destroys ozone, and blocks one path of ozone production (not really important when UV-C is not available to make ozone anyway).

Major sources of stratospheric chlorine

- As much as 75-85% of the chlorine in the stratosphere comes from human activities. The remaining 15-20% comes almost totally from methyl chloride, most of that from natural sources and burning of biomass.
- Large, explosive volcanoes also contribute marginally to the same.
- The major sources of stratospheric chlorine and troposphere chlorine are quite varied (sea-spray, volcanoes, volatile organic compounds and so on). Most of the troposphere chlorine compounds never make it to the stratosphere.
- They are quickly decomposed by natural oxidans and the chlorine converted to water-soluble species, such as HCl, which get rained out of the atmosphere. Chlorofluorocarbons are vey non-reactive in the troposphere, with lifetimes ranging from 50-above 200 years and so they eventually make it up to the stratosphere.

How to control Acid Rain?

The best approach to combat acid rain is to reduce the amount of NO_X and SO_2 being released into the atmosphere. Fitting a catalytic converter a catalytic converter to a car can reduce the emission of NOx by up to 90%, but they very expensive, and cause more carbon dioxide to released, which contributes to the greenhouse effect. SO_2 emissions from power stations can be reduced before, during, or after combustion. In addition there are several methods to controls SO_2 and NO_x in the environment. Acid rain may be controlled by

- When fuel with low sulphur content (such as North Sea gas or oil) is burnt, not much sulphur dioxide will be formed. However, low sulphur fuels are more expensive because they are in greater demand and although high-sulphur fuels can be treated to reduce their sulphur content, it is very expensive
- The SO_2 created during combustion can be absorbed if an appropriate chemical (such as limestone) is present while the fuel burns.
- Once the fuel has been burned, the SO_2 can be removed from the exhaust gases. Most system spray a mixture of limestone and water onto the gases. This mixture reacts with the SO_2 to form gypsum, useful building materials
- Another option is not to burn fossil fuels, but to use alternative energy sources.

- All these methods for reducing acid gases are expensive, and have draw-backs, so have been passed to use them. The best way to reduce them is not to use as much energy in the first place. One can save energy by turning off-lights when you leave a room, avoiding short journeys by car, insulating the house properly and using electric and related appliances which use less energy.

Xeriscaping

Xeriscaping is also known as xerogardening. Xeriscaping refers to landscaping and gardening in ways that reduce or eliminate the need for supplemental water from irrigation. It is promoted in regions that do not have easily accessible, plentiful, or reliable supplies of fresh water, and is gaining acceptance in other areas as climate patterns shift. Plants whose natural requirements are appropriate to the local climate are emphasized, and care is taken to avoid losing water to evaporation and run-off. The specific plants used in Xeriscaping depend upon the climate.

Vermicompost

Vermicompost is the product or process of composting utilizing various species of worms, usually red wigglers, white worms, and earthworms to create a heterogeneous mixture of decomposing vegetable or food waste, bedding materials, and vermicast.

Benefits for Soil

- ★ Vermicast, similarly known as worm castings, worm humus or worm manure, is the end-product of the breakdown of organic matter by a species of earthworm.
- ★ Vermicompost is an excellent, nutrient-rich organic fertilizer and soil conditioner.
- ★ Vermicompost improved the physical make up of upper layers of soil, enriches soil with micro-organisms (adding enzymes such as phosphate and cellulose).
- ★ The microbial activity in worm castings is 10 to 20 times higher than in the soil and organic matter that the worm ingests, it also attracts deep-burrowing earthworms already present in the soil and the mucus present in vermicast improves water holding capacity

Benefits for Plant growth

- ★ Vermicompost enhances germination, plant growth, and crop yield and improves root growth and structure.
- ★ It enriches soil with micro-organisms (adding plant hormones such as auxins and gibberellic acid)

Economic Benefits:

- ★ Biowastes conversion reduces waste flow to landfills. Elimination of biowastes from the waste stream reduces contamination of other recyclables collected in a single bin (a common problem in communities practicing single-stream recycling.
- ★ The production also creates low-skill jobs at local level. Vermicompost has low capital investment and relatively simple technologies make vermicomposting practical for less-developed agricultural regions

Environmental Benefits:

- ★ Vermicompost helps to close the "metabolic gap" through recycling waste on-site. large systems often use temperature control and mechanized harvesting, however other equipment is relatively simple and does

not wear out quickly. Production reduces greenhouse gas emissions such as methane and nitric oxide (produced in landfills or incinerators when not composted or through methane harvest)

Disadvantages / Issues

★ Moisture, air circulation and compost quantity need regular monitoring otherwise the Vermicompost will smell like an old garbage. The quality of Vermicompost deteriorates in anaerobic environement.

★ Vermicompost can be carried out at relatively low temperatures (under 25 °C) only. It is vitally important to keep the temperature below 35 °C, otherwise the earthworms will be killed.

★ Vermicompost is time consuming. It can take many months, or even years, to build up a large working population of earthworms capable of vermicomposting significant quantities of waste. As well as this, earthworms (sometimes in large numbers) tend to escape during damp weather conditions or when food is in short supply.

Oncomouse

OncoMouse or Harvard mouse is a genetically modified laboratory mouse which carries a specific gene called an activated oncogene. The activated oncogene significantly increases the mouse's susceptibility to cancer, and thus makes the mouse suitable for cancer research. The rights to the invention are owned by DuPont. "OncoMouse" is a registered trademark.

Enviropig

Enviropig contains genes from mice and E coli bacteria which have been inserted into their DNA with absolute precision. Unlike normal pigs, Enviropigs have been designed to produce their own phytase. Enviropigs are able to absorb more phosphorous from its feed. Their wastes contained less of the potentially toxic substance and their meat is identical to cuts from a traditional Yorkshire pigs.

MON 809

MON 809 is an Insect Resistant maize under license from Monsanto Company. Small amounts of the introduced proteins, CryIA(b) and CP4 EPSPS are present in leaves, seeds and roots of line MON 809 but, not in the pollen. Hybrids derived from MON 809 are agronomically similar to their non-transgenic counterparts in terms of growth characteristics and resistance to non-Lepidopteran pests and produce similar yields in the absence of ECB. However, under heavy infestations of ECB, MON 809 hybrids out yield their non-transgenic counterparts by 10 - 15%. Hybrids derived from MON 809 are not tolerant to the concentrations of glyphosate herbicide that are typically used for weed control.

MON 810

MON 810 is a variety of genetically modified maize (corn) developed by Monsanto Company sold with the trade name YieldGard. It contains a gene from the bacterium Bacillus thuringiensis that expresses a toxin (Bt toxin) poisonous to some pest insects, such as the European Corn Borer. It was approved for use in the European Union in 1998, but later was banned in most countries.

MON 863

The genetically modified maize MON 863 was generated by transformation of Zea mays cell culture line AT824 (initiated from immature embryos of an inbred maize line AT) with a MluI restriction fragment from

plasmid PV-ZMIR13 using particle acceleration technology. The DNA fragment used for transformation carried two expression cassettes; a selectable marker gene nptII encoding neomycin phosphotransferase II and a trait gene encoding a variant Bacillus thuringiensis Cry3Bb1 insecticidal protein.The variant Cry3Bb1 protein expressed in MON 863 maize has seven amino acid differences from wild type Cry3Bb1 and was designed to enhance its expression in plants and insecticidal activity against corn rootworm. This protects the plant from corn rootworm. The major difference with MON 810 is that , MON 810 produces Cry1Ab toxin like Bt11 and Bt 176.

Amflora Potato

Amflora Potato is a GM Potato intended for industrial applications as potato starch which is better than the natural starch currently used. Natural potato starch is used for papermaking and other applications, and contains two constituent substances: amylopectin (80%), which is useful for industry, and amylose (20%) which often creates problems for industrial applications and therefore must be separated with chemical reactions that cost a lot of money. The Potato has been controversial in Europe.

Golden Rice

Golden rice is a variety of GM rice produced to biosynthesize beta-carotene, a precursor of pro-vitamin A in the edible parts of rice, to be used as a fortified food to be grown in areas where there is a shortage of dietary vitamin A. In 2005 a new variety called Golden Rice 2 was announced which produces up to 23 times more beta-carotene than the original variety of golden rice. However, due to significant intervention by environment activists, its not available for human consumption. Golden rice was created by transforming rice with two beta-carotene biosynthesis genes viz. psy (phytoene synthase) from **daffodil** (*Narcissus pseudonarcissus*) and crtl from the soil bacterium *Erwinia uredovora.* The International Rice Research Institute (IRRI) is currently coordinating the Golden Rice Network with other partners who have expertise in agriculture and nutrition to research and develop Golden Rice In 2011, IRRI announced that Helen Keller International, a leading global health organization that reduces blindness and prevents malnutrition worldwide, was joining their Golden Rice project to further develop and evaluate Golden Rice.

Vistive Gold

Vistive Gold is the trade name of GM Soyabean MON 87705, developed by Monsanto. MON 87705 was designed for as a replacement for hydrogenated oils and fats, which are high in trans-fatty acids. The decreased linolenic content allows MON 87705 to have favorable characteristics for deep frying and increasing the shelf life of foods.

Flavr Savr

Flavr Savr is a Genetically modified tomato, was the first commercially grown genetically engineered food to be granted a license for human consumption. It was first sold in 1994, and was only available for a few years before production ceased in 1997. It was developed by a company called Calgene , but mounting costs prevented the company from becoming profitable, and it was eventually acquired by Monsanto Company. The idea to develop Flavr Savr was to slow the ripening process of the tomato and thus prevent it from softening, while still allowing the tomato to retain its natural color and flavor.

GloFish fluorescent fish

The GloFish is a patented GM zebrafish with bright red, green, orange-yellow, blue, and purple fluorescent colors. It is one of the first genetically modified animals to become publicly available as a pet. The fish is originally the Zebrafish, a native of rivers in India and Bangladesh. A gene called green fluorescent protein (GFP), originally extracted from a jellyfish, that naturally produced bright green fluorescence was used to make them flourscent. The original idea was to develop a fish that could detect pollution by selectively fluorescing in the presence of environmental toxins.

Ice-minus bacteria

Ice-minus bacteria is a GM bacterium Pseudomonas syringae (P. syringae). The "ice-plus" protein found on the outer bacterial cell wall acts as the nucleating centers for ice crystals. This facilitates ice formation, hence the designation "ice-plus." The ice-minus variant of P. syringae is a mutant, lacking the gene responsible for ice-nucleating surface protein production. This lack of surface protein provides a less favorable environment for ice formation. Both strains of P. syringae occur naturally, but recombinant DNA technology has allowed for the synthetic removal or alteration of specific genes, enabling the creation of the ice-minus strain. A study has shown that its ice nucleating proteins may play an important part in causing ice crystals to form in clouds. If humans increase the frequency of bacteria lacking these proteins then it could potentially affect rainfall. P. syringae commonly inhabits plant surfaces, its ice nucleating nature incites frost development, freezing the buds of the plant and destroying the occurring crop. The introduction of an ice-minus strain of P. syringae to the surface of plants would incur competition between the strains. Should the ice-minus strain win out, the ice nucleate provided by P. syringae would no longer be present, lowering the level of frost development on plant surfaces at normal water freezing temperature (0oC). Even if the ice-minus strain does not win out, the amount of ice nucleate present from ice-plus P. syringae would be reduced due to competition. Decreased levels of frost generation at normal water freezing temperature would translate into a lowered quantity of crops lost due to frost damage, rendering higher crop yields overall. (wikipedia)

Onyx-015

Onyx-015 is a GM Virus trialled as a possible treatment for cancer. The E1B-55kDa gene has been deleted allowing the virus to selectively replicate in and lyse p53-deficient cancer cells.

