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SST 221, PRINCIPLES OF SEED TECHNOLOGY

GENETICALLY MODIFIED ORGANISMS

WHAT ARE GENETICALLY MODIFIED ORGANISMS?

• A genetically modified organism (GMO) is an organism whose genetic material has been altered using genetic engineering techniques.

• Organisms that have been genetically modified include micro-organisms such as bacteria and yeast, plants, fish, and mammals.

• Source of genetically modified foods, and are also widely used in scientific research and to produce useful goods other than food.

PRODUCTION OF GENETICALLY MODIFIED ORGANISMS

• Genetic modification involves the insertion or deletion of genes.

• When genes are inserted, they usually come from a different species, which is a form of horizontal gene transfer.

• In nature this can occur when exogenous DNA penetrates the cell membrane for any reason. • To do this artificially may require attaching the genes to a virus or just physically inserting the extra DNA into the nucleus of the intended host with a very small syringe, or with very small particles fired from a gene gun.

• Agrobacteriums ability to transfer genetic material to plants, or the ability of lentiviruses to transfer genes to animal cells are natural examples of gene transfer.

PRINCIPLE OBJECTIVE OF PRODUCTION

• The basic principle for producing a GMO was to add new genetic material into an organism's genome.

• This is called genetic engineering and was made possible through the discovery of DNA and the creation of the first recombinant DNA molecules by Paul Berg in 1972.

TRANSGENIC PLANTS

• Transgenic plants have been engineered for scientific research, to create new colors in flowers, and to create improved crops.

• In research, plants are engineered to help discover the functions of certain genes.

• One way to do this is to knock out the gene of interest and see what phenotype develops.

• Another strategy is to attach the gene to a strong promoter and see what happens when it is over expressed.

GM CROPS

• In agriculture, genetically engineered crops are created to possess several desirable traits, such as resistance to pests, herbicides, or harsh environmental conditions, improved product shelf life, increased nutritional value, or production of valuable goods such as drugs (pharming).

• Plants, including algae, jatropha, maize, and other plants have been genetically modified for use in producing fuel, known as biofuel.

MICROBES • Bacteria were the first organisms to be modified in the laboratory, due to their simple genetics.

• These organisms are now used for several purposes, and are particularly important in producing large amounts of pure human proteins for use in medicine.

• Genetically modified bacteria are used to produce the protein insulin to treat diabetes.

• Similar bacteria have been used to produce clotting factors to treat haemophilia, and human growth hormone to treat various forms of dwarfism.

MAMMALS • Ralph L. Brinster and Richard Palmiter developed the techniques responsible for transgenic mice, rats, rabbits, sheep, and pigs in the early 1980s.

• They established many of the first transgenic models of human disease, including the first carcinoma caused by a transgene.

• The process of genetically engineering animals is a slow, tedious, and expensive process. However, new technologies are making genetic modifications easier and more precise.

INTENDED PURPOSE FOR THE GENETIC MODIFICATION OF MAMMALS

• To research human diseases (for example, to develop animal models for these diseases).

• To produce industrial or consumer products (fibres for multiple uses.

• To produce products intended for human theraputic use (pharmacutical products or tissue for implantation).

• To enrich or enhance the animals' interactions with humans (hypo- allergenic pets).

• To enhance production or food quality traits (faster growing fish, pigs that digest food more efficiently). • To improve animal health (disease resistance).

FISH

• GM fish are used for scientific research and as pets, and are being considered for use as food and as aquatic pollution sensors.

• Genetically engineered fish are widely used in basic research in genetics and development. • Two species of fish, zebra fish and medaka, are most commonly modified because they have optically clear chorions (shells), rapidly develop, and the 1-cell embryo is easy to see and microinject with transgenic DNA.

• The GloFish is a patented brand of genetically modified (GM) fluorescent zebra fish with bright red, green, and orange fluorescent color.

• Although not originally developed for the ornamental fish trade, it became the first genetically modified animal to become publicly available as a pet when it was introduced for sale in 2003. They were quickly banned for sale in California on the grounds of ethical issues.

GENETIC ENGINEERING V/S TRADITIONAL BREEDING

• With traditional breeding, plants often exchange large, unregulated chunks of their genomes. • This can lead to both useful and unwanted traits in the offspring. Sometimes these unwanted traits can be unsafe.

• One example would be potato varieties made using conventional plant breeding that inadvertently produced excessive levels of naturally occuring glycoalkoloids.

• These glycoalkoloids cause cause gastrointestinal, circulatory, neurological and dermatological problems associated with alkaloid poisoning.

13. • Breeders sometimes have to cross many plants over multiple generations to produce the desired trait.

• GM techniques allow new traits to be introduced one at a time without complications from extra genes and extensive crossbreeding.

• GM techniques also allow traits from different organisms to be applied, such as pest resistance.

PROS OF GENETIC ENGINEERING

Production of Human Insulin:

• Patients suffering from diabetes are not capable of producing enough insulin. • So, there arises a need for such people to obtain insulin from external sources. • With the help of genetic engineering, human genes can be transferred into other mammals for the production of insulin. •

The mammals like sheep and goat are used as medium with human genes playing the role of 'software' or the 'brain' containing necessary genetic information for produce insulin.

Use in Gene Therapy:

• The GMOs like some viruses are used in gene therapy. • Gene therapy can be used in the treatment of various genetic disorders and diseases like sickle cell anemia, muscular dystrophy and cystic fibrosis. Creation of Neo-organs: • The unavailability of organs for transplants is a big problem today. • The creation of neo-organs in order to increase the supply of desired organs is possible by means of genetic engineering. • The regeneration of new tissues is carried out by the injection of a growth factor using a tissue injector. • Another procedure for creating new organs in which a scaffold made from biodegradable polymers is used to contain the plant cells. This scaffold is placed in a position where the new growth is expected. Eventually the scaffold breaks down or dissolves and a completely new organ is formed.

Usage in Agriculture:

• Genetically modified plants have many applications in the field of agriculture.

• Genetic modification or engineering is used for increasing the production of crops, pest control, weed management, etc.

• The genetically modified foods are also produced to make them more nutritive.

• For example, the incorporation of digestible iron in the genetically modified crops influences health in a positive way.

BENEFITS AT A GLANCE

• Genetic engineering when used on microorganisms help in the creation of new pharmaceuticals which cannot be made in any other way.

• Genetic engineering helps in the process of bio remediation which is the process of cleaning up waste and pollution with the help of living organisms.

• Genetic engineering has helped lower the overall usage of herbicide and pesticide.

• Genetic engineering has helped with the production of vaccines and other drugs in plants.

• Genetic engineering has helped produce quicker and more predictable way of generating new cultivars. Further, the cultivar properties are better known today than it was ever known before. Today, genetic engineering can produce sustainable agriculture.

18. • Genetic engineering has produced very useful genetically modified breeds which can tolerate factory farming without any suffering.

• In humans, genetic engineering is used to treat genetic disorders and cancer. It also helps in supplying new body parts.

• Although, this has not been done today, genetic engineering has the potential of creating new types of human beings with many advantageous traits.

• Genetic engineering is used in the field of mining to extract useful elements from the ones they are actually embedded into.

• Certain bacterial sequences are manipulated to transform waste into ethanol, so that it can be used as a fuel.

CONS OF GENETIC ENGINEERING

• Main argument made against activity of genetic modification is that it leads to unpredictable outcomes or side effects.

• Genetic modification is considered to be unnatural and doesn't fit in the context of natural ways like breeding/crossing the plants and animals for bringing out the best in them.

• Thus, the possibility of unpredictable alterations taking place in the genetic make-up of organisms is one of the biggest causes of worries among scientists regarding the whole issue of genetic modification.

• It is important to note that FDA has not approved consuming animals that are genetically modified. This stand taken by the FDA implies that they don't want these genetically organisms to become a part of the food chain.

Harmful Effects on Crops:

• The genetically modified crops which the farmers plant in their fields have the same genetic make-up. • Cross-pollination of such plants with other plants increases the risk of contamination. • The 'Bt' (*Bacillus thuringiensis*) genes present in the GM crops kill the insects like bees, ladybird beetles, butterflies, etc.

• Thus, helpful organisms too are affected along with pests.

GM Animals: • Genetic modification in animals is carried out for the production of pharmaceuticals, human proteins and in therapies.

• The activity of animal cloning leads to deformities at the time of birth and many of such animals die while they are still young. Genetic engineering is also used for creating organs by means of animals for implanting them in human beings. For example, pig's heart could be transplanted in a human, if he is facing the danger of heart failure. However, the pig's heart if infected with a disease, it might spread to the human beings.

• Also how exactly the modifications/alterations would affect the future generations of the species in questions. • Gambling with the fate of these innocent creatures and ultimately human beings (who consume these animals) is not at all worth the risk.

Risk of Misuse: • The risk of the information regarding these techniques falling into wrong hands should be considered while studying the pros and cons of genetic engineering.

• Mindless cloning of animals and plants for commercial purposes would definitely have adverse effects on the gene pool we have today.

• The process of genetic erosion might accelerate with increase in the number of genetically modified organisms.

Disruption of Natural Genetic Information:

• It is argued that in genetic engineering, the insertion of genes is done precisely in living cells.

• However, it cannot be decided where exactly in the DNA sequence, the gene is to be inserted.

• There is a risk of the disruption of gene expression and the genetic information present in the DNA.

Preliminary Stage of Research:

• Most of the research in the field of genetic engineering is in its preliminary stages.

• The tests are generally conducted on animals and very little of the research is reviewed by scientists.

• Moreover, the research methodology used by these companies is not reviewed by the FDA (Food and Drug Administration).

SOME FACTS • GM SEED IS TAKING OVER OUR NATURAL FOOD SUPPLY:

GM plants proven to be POISONOUS - killing insects, birds, butterflies, and destroying our Eco System and slowly killing animals.

• Scientists of FDA have reported that, "the processes of genetic engineering and traditional breeding are different and... they lead to different risks.

• GM FOOD CONTAMINATES; Common Garden Chemicals are also killing our BEES and causing deformed babies.

• The European Food Safety Authority has been studying the effects of these products and has uncovered a host of potential problems with their usage, especially in the developing bodies of children.

• Due to a disastrous crop of genetically modified cotton many Indian farmers face ruin, and choose instead to sell one of their kidneys or commit suicide.

• The Icelandic parliament sells the entire gene pool of its population to a private company which intends to turn over the data at a profit to the pharmaceutical industry and insurance companies. • MONSANTO, AVENTIS, DuPONT are three major companies working on GMO which are in question.

CONCLUSION TO PROTECT OUR HEALTH:

• Any food produced through genetic engineering should be banned until scientifically shown to be safe and safe for everyone.

• In the meantime, labeling should be required for any food that contains even one genetically engineered ingredient, or that has been produced using genetically modified organisms or enzymes.

• Full disclosure labelling will allow consumers to choose what they eat. It will also help scientists trace the source of health problems as well as the benefits arising from these foods.

THIS IS BECAUSE:

• The introduced gene may act differently when working within its new host.

• The original genetic intelligence of the host will be disrupted.

• The new combination of the host genes and the introduced gene will have unpredictable effects; and therefore;

• There is no way of knowing the overall, long-term effect of genetically engineered foods on the health of those who eat them.

HOW WE CAN BE SAFE

• Buy Organic - Certified organic products cannot intentionally include any GMO ingredients. • Look for "Non-GMO Project" verified seals.

• Avoid At-Risk Ingredients including Corn, Soybeans, Canola, Cottonseed.

• Buy Products Listed in non GMO shopping guides.