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Дзюбинська Х.А.

Additional Reading

for the Students of Biological and Technological Faculty

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Content

W H A T I S B I O T E C H N O L O G Y ?

There is little doubt that modern biology is the most diversified of all the natural sciences, exhibiting a bewildering array of subdisciplines: microbiology, plant and animal anatom, biochemistry, immunology, cellbiology, molecular biology, plant and animal physiology, morphogenesis, ecology, genetics and many others. The increasing diversity of modern biology has been derived primarily from the largely post-war introduction into biology of other scientific disciplines such as physics, chemistry.

Biotechnology is a collective noun for the application of biological organisms, systems or processes to manufacturing and service industries. The integrated use of biochemistry, microbiology and engineering sciences in order to achieve technological (industrial) application capabilities of microorganisms, cultured tissue cells. A technology using biological phenomena for copying and manufacturing various kinds of useful substances. The application of scientific and engineering principles to the processing of materials by biological agents to provide goods and

services. The science of the production processes based on the action of microorganisms and their active components and of production processes involving the use of cells and tissues from higher organisms. Medical technology, agriculture and traditional crop breeding are not generally regarded as biotechnology. Really no more than a name given to a set of techniques and processes. The use of living organisms and their components in agriculture, food and other industrial processes.

The application of our knowledge and understanding of biology to meet practical needs.,* to advance biotechnology for the public benefit, *to promote awareness, communication and collaboration in all fields of biotechnology , * to provide governmental and supranational bodies with information and informed opinions on biotechnology , * to promote public understanding of biotechnology.The EFB definition is applicable toboth ‘traditional or old’ and ‘new or modern’ biotechnology. Traditional biotechnology refers to the conventional techniques that have been used for many centuries to produce beer, wine, cheese and many other foods, while ‘new’ biotechnology embraces all methods of genetic modification by recombinant DNA and

cell .It is unfortunate that the term ‘biotechnology’ has become, in some quarters, a substitute for genetic modification or genetic engineering. Using the term biotechnology when describing trans-species genetic modifications was considered to be more friendly sounding and to arouse less anxiety. The term was then picked up by the media and by politicians, and subsequently found its way into government documents and legislation. Genetic modification has been used by mankind for over 10000 years to improve plants and animals by selective breeding. Only within 50 years this process used new methods, such as polyploidisation, mutagenesis and X-rays, to achieve changes in genetic composition. Genetic manipulation/modification/engineering is the modern method of selectively moving genes within the same species or between species, using modern molecular biology techniques.

I After reading the text – discuss it and answer the questions.

1 What is biotechnology?

2. When did it start to thrive and what other sciences is it connected with?

3. What branches of biotechnology do you know?

4 Is it diverse science? Explain your answer.
5. What is trans-species genetic modification?
6. What useful inventions of biotechnology can you name.

II. Find Ukrainian equivalents to English words:

DNA, cell, collaboration, molecular biology, application, to meet practical needs, diversified,subdiscipline, achieve capabilities, scientific disciplines, biochemistry, immunology, cellbiology, molecular biology.

Traditional and New Biotechnology [1]

Traditional Biotechnology

Traditional biotechnology refers to a number of ancient ways of using living organisms to make new products or modify existing ones. In its broadest definition, traditional biotechnology can be traced back to human's transition from hunter-gatherer to farmer. As farmers, humans collected wild plants and cultivated them and the best yielding strains were selected for growing the following seasons. As humans discovered more plant varieties and traits or characteristics, they gradually became adept at breeding specific plant varieties over

several years and sometimes generations, to obtain desired traits such as disease resistance, better taste and higher yield. With the domestication of animals, ancient farmers applied the same breeding techniques to obtain desired traits among animals over generations.

Centuries ago, people accidentally discovered how to make use of natural processes that occur all the time within living cells. Although they had no scientific explanation for the processes, they applied the results they saw to their domestic lives. They discovered, for example, that food matures in a way that changes its taste and content, and makes it less perishable. Hence, through a process later called fermentation, flour dough becomes leavened in the making of bread, grape juice becomes wine, and milk stored in bags made from camels' stomachs turns into cheese.

Through trial and error and later through advances in technology, people learned to control these processes and make large quantities of biotechnology products. Advances in science enabled the transfer of these mostly domestic techniques into industrial applications and the discovery of new techniques. Examples of traditional biotechnology techniques include selective breeding, hybridization and fermentation.

Important dates in traditional biotechnology.

Providing bread with leaven
Fermentation of juices to alcoholic beverages
Knowledge of vinegar formation from fermented juices
Manufacture of beer in Babylonia and Egypt
Wine manufacturing in the Roman Empire
Production of spirits of wine (ethanol)
Vinegar manufacturing industry
Discovery of the fermentation properties of yeast
Description of the lactic acid fermentation by Pasteur
Detection of fermentation enzymes in yeast by Buchner
Discovery of penicillin by Fleming
Discovery of many other antibiotics

Modern Biotechnology

Modern biotechnology refers to a number of techniques that involve the intentional manipulation of genes, cells and living tissue in a predictable and controlled manner to generate changes in the genetic make-up of an organism or produce new tissue. Examples of these techniques include: recombinant DNA techniques (DNA or genetic engineering), tissue culture and mutagenesis. Modern biotechnology began with the 1953 discovery of the structure of deoxyribonucleic acid (DNA) and the way genetic information is passed from generation to generation. This discovery was made possible by the discovery of genes (independent units that transmit traits from parents to

offspring) by Gregor Mendel. This was the transition from traditional to modern biotechnology. It became possible to produce desired changes in an organism through the direct manipulation of its genes in a controlled and less time-consuming fashion in comparison to traditional biotechnology techniques. These discoveries, opened up the possibilities for new applications of biotechnology which were unknown with traditional forms.

I Answer the following questions:

1. What two types of biotechnology do you know?
2. What does traditional (old) biotechnology deals with?
3. What does modern biotechnology deals with?
4. What traditional biotechnology techniques do you know?
5. What is fermentation?
6. What modern biotechnology techniques do you know?
7. When did modern biotechnology began?
8. Who is Gregor Mendel? What is his invention?

COLOUR CLASSIFICATION OF BIOTECHNOLOGY

Biotechnology is the use of living organisms, their parts or by-products in industrial applications. The term Biotechnology can refer to a wide range of applications from a vaccine to developing new sources of biofuel, genetic modification of crops, beer brewing and even anti-aging cosmetics.

The scope of Biotechnology in our world created a need to classify Biotech based on some common features or their final purpose. Below are some of the main areas of Biotechnology using a colour classification.

Red Biotechnology

Red Biotechnology (Biopharma) brings together all those Biotechnology uses connected to medicine and veterinary products. Red Biotechnology includes producing vaccines and antibiotics, developing new drugs, molecular diagnostics techniques, regenerative therapies and the development of genetic engineering to cure diseases through genetic manipulation.

White Biotechnology

White Biotechnology relates to industrial Biotech. White Biotechnology pays special attention to designing low resource-consuming processes and products, making them more energy efficient and less polluting than

traditional ones. An example of white Biotech is the use of microorganisms in chemical production, the design and production of new plastics/textiles and the development of new sustainable energy sources such as bio-fuels.

Yellow Biotechnology

Yellow Biotechnology, has been used to refer to the use of Biotechnology in food production, for example in making wine, cheese, and beer by fermentation

Grey Biotechnology

Grey Biotechnology refers to environmental applications, and is focused on the maintenance of biodiversity and the removal of pollutants/contaminants using microorganisms and plants to isolate and dispose of different substances such as heavy metals and hydrocarbons.

Green Biotechnology

Green Biotechnology is focused on agriculture. Green Biotechnological includes creating new plant varieties of agricultural interest, producing biofertilizers and biopesticides. This area of Biotech is based exclusively on transgenics (genetic modification) i.e. they have an extra gene or genes inserted into their DNA. The extra gene may come from the same species or from a different species.One of the interesting developments is plant varieties are able to act as bio-factories and produce

substances of medical, biomedical or industrial interest in quantities easy to be isolated and purified for example tobacco plants modified to grow Ebola vaccine.

Blue Biotechnology

Blue Biotechnology is based on the exploitation of marine resources to create products and applications of industrial interest. Taking into account that the sea presents the greatest biodiversity, there is potentially a huge range of sectors to benefit from the use of this kind of Biotechnology. One example is the use of wound dressings coated with Chitosan (Chitosan is a sugar that is typically derived from shrimp and crab shells).

I Answer the following questions:

1. What colours of biotechnology do you know?
2. What is red biotechnology?
3. What is blue biotechnology?
4. What is white biotechnology?
5. What is green biotechnology?
6. What is grey biotechnology?
7. What is yellow biotechnology?

II. Use Internet sources and prepare presentation on the topic "The most important colour in biotechnology"

TYPES OF BIOTECHNOLOGY[2]

1. Medical Biotechnology

Medical biotechnology is the use of living cells and other cell materials to better the health of humans. Primarily, it is used for finding cures as well as getting rid of diseases.Here, the technique is used to produce pharmaceutical drugs as well as other chemicals to combat diseases. It involves the study of bacteria, plant & animal cells to understand the way they function at a fundamental level. It heavily involves the study of DNA (Deoxyribonucleic acid) to get to know how to manipulate the genetic makeup of cells to increase the production of beneficial characteristics that humans might find useful, such as the production of insulin. The field usually leads to the development of new drugs and treatments, novel to the field. There are the following examples of medical biothecnology:

1. Vaccines

Vaccines are chemicals that stimulate the body's immune system to better fight pathogens when they attack the body. They achieve this by inserting weakened versions of the disease into the body's bloodstream. It causes the body to react as if it was under attack from the non-attenuated version of the disease. The body combats the weakened pathogens and, through the process, takes

note of the cell structure of the pathogens and has some cells that 'remember' the disease and store away the information within the body.

When the individual becomes exposed to the actual disease, the body of the individual immediately recognizes it and quickly forms a defense against it since it already has some information on it. This helps to heal quicker and less time being symptomatic. The weakened disease pathogens are extracted using biotechnological techniques such as growing the antigenic proteins in genetically engineered crops. An example is the development of an anti-lymphoma vaccine using genetically engineered tobacco plants

2. Antibiotics. Antibiotics combat pathogens for humans. Many plants are grown and genetically engineered to produce the antibodies.The method is more cost-effective than using cells or extracting these antibodies from animals as the plants can produce these antibodies in larger quantities.

2. Agricultural Biotechnology

Agricultural biotechnology focuses on developing genetically modified plants to increase crop yields. In some of the cases, the practice involves scientists identifying a characteristic, finding the gene that causes it, and then putting that gene within another plant so that it

gains that desirable characteristic, making it more durable or having it produce larger yields than it previously did. . There are the following examples of agricultural biotechnology:

1. **Pest Resistant Crops** Biotechnology has provided techniques for the creation of crops that have anti-pest characteristics naturally, making them very resistant to pests, as opposed to spraying them with pesticides.

An example of this would be the fungus *Bacillus thuringiensis* genes transferred to crops. The reason for this is that the fungus produces a protein (Bt), which is very effective against pests such as the European corn borer. The Bt protein is the desired characteristic scientist would like the plants to have, and for this reason, they transferred it to corn. The corn then produces the protein toxin naturally, lowering the cost of production by eliminating the cost of dusting the crop with pesticide

2. Plant and Animal Breeding. Selective breeding has a long history and this. practice involves choosing the animals with the most desirable characteristics to breed with each other so that the resulting offspring would also express these traits. Desirable characteristics included larger animals, animals more resistant to disease, and more domicile animals, to make the process of farming as

profitable as possible. This practice has been transferred to the molecular level with the same purpose. Different traits are selected among the animals, and once the genetic markers have been pointed out, animals and plants with those traits are selected and bred for those traits to be transferred.

Such information provides the basis for making informed decisions enhancing the capability of the scientists to predict the expression of those genes. An example is its use in flower production, where traits such as color and smell potency are enhanced.

3. Industrial Biotechnology

Industrial biotechnology is the application of biotechnology for industrial purposes that also include industrial fermentation. Applying the techniques of modern molecular biology, it improves efficiency and reduces the multifaceted environmental impacts of industrial processes including paper and pulp, chemical manufacturing, and textile. It includes the practice of using cells such as microorganisms, or components of cells like enzymes, to generate products in sectors that are industrially useful, such as food and feed, chemicals, detergents, paper and pulp, textiles, biofuels, and biogas. It is also actively advancing towards lowering greenhouse gas emissions by using renewable raw materials to

produce a variety of chemicals and fuels and moving away from a petrochemical-based economy. For example:

Biocatalysts. Biocatalysts have been developed by the industrial biotechnology companies such as enzymes, to synthesize chemicals. Enzymes are proteins produced by all organisms. The desired enzyme can be manufactured in commercial quantities using biotechnology.

Microorganisms Microorganisms find their use in chemical production for the design and manufacture of new plastics/textiles and the development of new sustainable energy sources such as biofuels.

4. Environmental Biotechnology

Environmental biotechnology is the technology used in waste treatment and pollution prevention that can more efficiently clean up many wastes compared to conventional Every organism ingests nutrients to live and produces byproducts as a result. But, different organisms need different types of nutrients. Some bacteria also thrive on the chemical components of waste products. For example environmental engineers introduce nutrients to stimulate the activity of bacteria that already exists in the soil at a waste site or add new bacteria to the soil. The bacteria help in digesting the waste right at the site, thereby turning it into harmless byproducts. After

consuming the waste materials, the bacteria either die off or return to their normal population levels in the environment. There are cases where the byproducts of the pollution-fighting microorganisms are themselves useful.

The example of environmental biotechnology is Bioremediation refers to the application of biotechnical methods which help in developing enzyme bioreactors that will not only pretreat some industrial and food waste components but also allow their efficient removal via sewage system without using solid waste disposal mechanisms.

I Answer the following questions:

1. In what way is biotechnology used in medical sphere?
2. What is DNA?
3. What is the mechanism of vaccines action? Are you for or against vaccination.?
4. What is the function of antibiotics?
5. What does agricultural biotechnology focuses on?
6. What is meant by pest resistant crops?
7. What is the aim of selective breeding?
8. In what industrial spheres is biotechnology used ?
9. What is biofuel?
10. In what way can pollution be prevented using environmental biotechnology?

What is agricultural biotechnology?

Biotechnology is any technique that uses living organisms or substances from these organisms to make or modify a product for a practical purpose . Biotechnology can be applied to all classes of organism - from viruses and bacteria to plants and animals - and it is becoming a major feature of modern medicine, agriculture and industry. Modern agricultural biotechnology includes a range of tools that scientists employ to understand and manipulate the genetic make-up of organisms for use in the production or processing of agricultural products. Some applications of biotechnology, such as fermentation and brewing, have been used for millennia. Other applications are newer but also well established. For example, micro-organisms have been used for decades as living factories for the production of life-saving antibiotics including penicillin, from the fungus Penicillium, and streptomycin from the bacterium

Streptomyces. Modern detergents rely on enzymes produced via biotechnology, hard cheese production largely relies on rennet produced by biotech yeast and human insulin for diabetics is now produced using biotechnology.

Biotechnology is used to address problems in all areas of agricultural production and processing. This includes plant breeding to raise and stabilize yields; to improve resistance to pests, diseases and abiotic stresses such as drought and cold. Biotechnology is used to develop low-cost disease-free planting materials for crops such as banana and potatoes. Biotechnology is used to speed up breeding programmes for plants, livestock and fish. Animal feeds are changed by biotechnology to improve animal nutrition and to reduce environmental waste. Biotechnology is used in disease diagnostics and for the production of vaccines against animal diseases.

I Answer the following questions:

8. What colours of biotechnology do you know?
9. What is red biotechnology?
10. What is blue biotechnology?
11. What is white biotechnology?
12. What is green biotechnology?
13. What is grey biotechnology?
14. What is yellow biotechnology?

Evolution of agricultural technologies over time?

Farmers and pastoralists have manipulated the genetic make-up of plants and animals since agriculture began more than 10 000 years ago. Farmers managed the process of domestication over millennia, through many cycles of selection of the best adapted individuals. This exploitation of the natural variation in biological organisms has given us the crops, plantation trees, farm animals and farmed fish of today, which often differ radically from their early ancestors.

Current agricultural research is focused on producing genetically engineered plants (transgenic plants). These are plants which contain one or more genes that have been artificially inserted instead of their acquiring them through the natural process of pollination. Modern genetics assists in improving the growth, health, vigor, and other qualities of agriculturally important mammals, poultry and fish The aim of modern breeders is the same as that of early farmers - to produce superior crops or animals. Conventional breeding, relying on the application of classic genetic principles based on the phenotype or physical characteristics of the organism concerned, has been very successful in introducing desirable traits into crop cultivars or livestock breeds from

domesticated or wild relatives or mutants . In a conventional cross, whereby each parent donates half the genetic make-up of the progeny, undesirable traits may be passed on along with the desirable ones, and these undesirable traits may then have to be eliminated through successive generations of breeding. With each generation, the progeny must be tested for its growth characteristics as well as its nutritional and processing traits. Many generations may be required before the desired combination of traits is found, and time s may be very long, especially for perennial crops such as trees and some species of livestock. Such phenotype-based selection is thus a slow, demanding process and is expensive in terms of both time and money. Biotechnology can make the application of conventional breeding methods more efficient.

Spontaneous mutations are the "natural" motor of evolution. Without mutations, there would be no rice, or maize or any other crop. Starting in the 1970s, the International Atomic Energy Agency sponsored research on mutation induction. Induced mutations are brought about by treating plant parts with chemical or physical mutagens and then selecting for desirable changes - in effect, to mimic spontaneous mutations and artificially broaden genetic diversity. Induced mutation resulted in

the introduction of new varieties of many crops such as rice, wheat, barley, apples, citrus, sugar cane and banana. Mutation has also tremendous economic impact on agriculture and food production, which is currently valued in billions of US dollars and millions of hectares of cultivated land.

Give equivalents of English words:

domesticated or wild relatives, mutants, genetically engineered plants, undesirable traits, conventional breeding, genetic diversity, tremendous economic impact, artificially inserted, pollination, ancestors, crop.

Translate the following sentences:

1. Mutations have tremendous economic effect in agriculture and food production.
2. Breeders want to produce superior crops and animals.
3. Scientists artificially insert certain genes into plants to make them better.
4. The search of desired traits in animals and plants takes a lot of time.
5. Genetics helps to improve the growth and yield of plants.

How can biotechnology be applied to agriculture?

Genes are the pieces of DNA code which regulate all biological processes in living organisms. The entire set of genetic information of an organism is present in every cell and is called the genome. The genetic material is structured in a similar way in different species, which makes it easier to identify potentially useful genes. Certain fragments of DNA that can be easily identified are used to 'flag' the position of a particular gene. They can be used to select individual plants or animals carrying beneficial genes and characteristics. Important traits such as fruit yield, wood quality, disease resistance, milk and meat production, or body fat can be traced this way. .

Plants can be obtained from small plant samples grown in test tubes. This is a more sophisticated form of planting. Another laboratory technique, in vitro selection, involves growing plant cells under adverse conditions to select resistant cells before growing the full plant. In conventional breeding half of an individual's genes come from each parent, whereas in genetic engineering one or several specially selected genes are added to the genetic material. Moreover, conventional plant breeding can only combine closely related plants. Genetic engineering permits the transfer of genes between organisms that are not normally able to cross breed. For example a gene from

a bacterium can be inserted into a plant cell to provide resistance to insects. Such a transfer produces organisms referred to as genetically modified (GM) or transgenic.

I Answer the following questions:

1. What is gene?
2. What is DNA
3. What did DNA used to flag?
4. What is in vitro selection?
5. Can conventional plant breeding combine different or only closely related plants
6. Can you give an example of transgenic transfer?

IS GENETICALLY MODIFIED FOOD SAFE TO EAT?

Foodstuffs made of genetically modified crops that are currently available (mainly maize, soybean, and oilseed rape) have been judged safe to eat. These conclusions are represented by International Council for Science (ICSU) and the World Health Organization (WHO).

However, the lack of evidence of negative effects does not mean that new genetically modified foods are without risk. Because of the possibility of long-term effects from genetically modified plants . Genetic engineering of plants could also offer some direct and indirect health benefits to consumers, for instance by improving nutritional quality or reducing pesticide use.

Scientists recommend that food safety Passessment should take place on a case-by-case basis before genetically modified food is brought to the market. In such assessments, foodstuffs derived from genetically modified plants are compared to their conventional counterparts, which are generally considered safe due to their long history of use. This comparison considers to what extent different foodstuffs can cause harmful effects or allergies and how much nutrients they contain.

Consumers may wish to select foods on the basis of how they are produced, because of religious, environmental, or health concerns. However, merely indicating whether a product is genetically modified or not, without providing any additional information, says nothing about its content nor about possible risks or benefits.

PROS AND CONS[3]

In the table below you will find some of the important advantages and disadvantages of genetic engineering. You will realize that each benefit has a negative aspect. Basically, by modifying the genes, we can improve a condition at the cost of another. The modification of a specimen and its later introduction to the environment can negatively impact the nature.

Pros

Faster Growth Rate Animals and plants can be genetically modified to promptly mature. For example, crops can be engineered to increase crop yield. There are crops being engineered to survive unfavorable conditions such as high heat or low light. This gives farmers the ability to expand beyond the traditional locations and use the empty lands for other purpose. Animals can also be genetically modified to improve production. Diary cows can be engineered to

produce more milk; sheep can grow wool faster; and animals bred for their meat can be engineered to grow bigger and faster (Pros and Cons of Genetic Engineering, 2014).

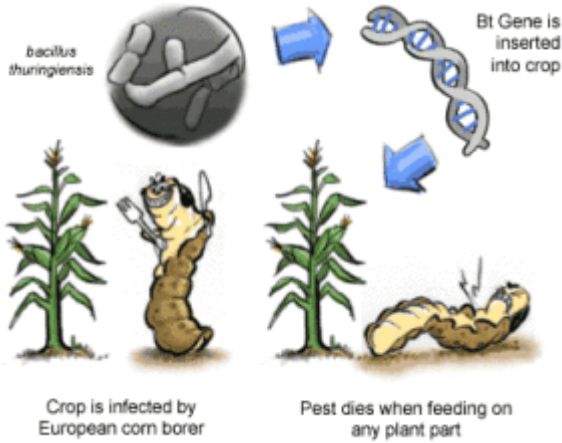
Cons

Less Nutritional Value Regarding the nutritional value of the products stems from the fact that some products can grow big and quickly at the cost of decreasing their nutritional value.

Pest-resistant and Extended Life This genetic modification is mainly executed in plants. The animal or plant ‘s genes are changed to make them resistant to pests and diseases. Plants being cultivated can have built in pest repellents which help reduce the need for harmful chemicals and other pesticides that cause damage to the water supply (Pros and Cons of Genetic Engineering, 2014).

Risky Pathogens Viruses and bacteria adapt to the environment. If a bacteria cannot get through the natural repellent of the genetically altered plant, there is a possibility that these viruses and bacteria will grow stronger and more resistant negatively affecting non

genetically engineered plants/animals.



Pest-resistant Crops.
Source:primalsciencehealth.wordpress.com

New Foods Currently, we can create new types of plants and animals by combining genes from different species. Scientists are taking a potato or soybean and giving the crop more nutrients to increase its value.

Anti GE Poster. Source: Cookingwithlittlebudy.com

Negative Side Effects The goal of genetic engineering is to solve an issue by Transferring genes to the organism that will help combat the problem. Sometimes, this can cause side effects. For example, you can modify a plant to need less water, but that would make it intolerant to direct sunlight (Pros and Cons of Genetic Engineering, 2014).

Unfavorable Diversity Genetically engineered species that reach the wild can have a negative impact on the domestic species. Since species that have been modified tend to be stronger, unmodified species would soon disappear because of the introduction of modified species. This would result in a decreased diversity.

I. Answer the following questions:

1. What are the most common genetically modified ?
2. What is DNA
3. What did DNA used to flag?
4. What is in vitro selection?
5. Can conventional plant breeding combine different or only closely related plants
6. Can you give an example of transgenic transfer?

What are the implications of GM-technologies for animals?[4]

Animal feeds frequently contain genetically modified crops and enzymes derived from genetically modified micro-organisms. There is general agreement that both modified DNA and proteins are rapidly broken down in the digestive system. It is unlikely that genes may transfer from plants to disease-causing bacteria through

the food chain. Nevertheless, scientists advise that genes which determine resistance to antibiotics that are critical for treating humans should not be used in genetically modified plants.

Until 2004, no genetically modified animals were used in commercial agriculture anywhere in the world, but several livestock and aquatic species were being studied. Genetically modified animals could have positive environmental impacts, for example through greater disease resistance and lower antibiotic usage. However, some genetic modifications could lead to more intensive livestock production and thus increased pollution.

International agreements

There are several international agreements that relate to the environmental aspects of genetically modified crops. The **Convention on Biological Diversity** is mainly concerned with the conservation and sustainable use of ecosystems but also with environmental effects of GMOs. A part of this convention is the **Cartagena Protocol on Biosafety**, which regulates the export and import of genetically modified crops. The **International Plant Protection Convention** was adopted to prevent the spread of pests affecting plants and plant products. It identified potential pest risks related to GMOs that may

need to be considered, such as the potential development of invasive species or effects on beneficial insects and birds.

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