BIOGENETICS IN SEEDS

Picture: Genetically modified crops from Waadt

Term Paper Biology
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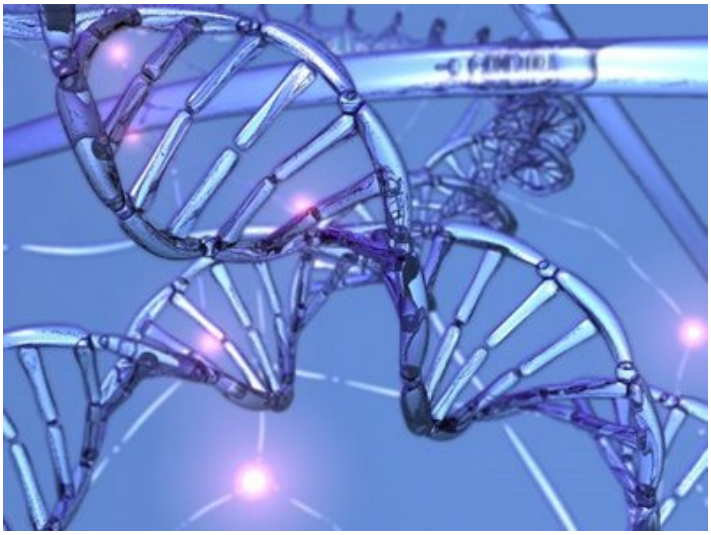


Preface

Motivation

Unfortunately, we were too late to write down our original idea „Biotechnology in Bt-corn“ first, so we had to come up with other topics. Each of us wanted to deal with different kind of domains in biogenetics, thus we decided to simply take „Biogenetics in seeds“ as our group interest. This would allow us to connect our interests and deepen them while we also try to differ them in many kind of ways, which will broaden or perspective and give our dossier a lot of variation.

What is especially interesting?

We think that this topic concerns everyone in the world and it's also interesting how green technology has changed and affected our lives and environment that much, without (most of) us even knowing. We also think that the development in agriculture techniques until now is very interesting and gives us many hints on how to treat our environment better, which is also another very important part.

Questions

As we occupied ourselves with our chosen topic, we also had lots of questions (as we read trough books and websites, we asked ourselves the following questions):

- What are the most important and common methods used in engineering technics? Why? (to simplify our topic we just describe one of those technics more closely)
- What are the advantages and disadvantages of this method?
- How did those methods affect the development of our agriculture?

Introduction

Recent events/scientific history

Biogenetic in seeds is a very current topic and will influence our future quite a bit.
Many organizations see this as a way to solve problems like the higher food demand due to the expanding world population and poor countries, which cannot afford to lose their crops. Also this has contributed a lot so far that the amount of food that can be grown on each acre of land has increased 10 times in the last 100 years.
In 2010, on more than 360 million acres modified crops were grown in 29 countries. Mainly poor farmers (90%) use this kind of seeds because of the increase in yields and the lower costs. Many European countries don't allow modified crops on the market, because they are afraid of dire effects. Although concerns were expressed about possible consequences, no such believed harm has been observed so far.

After 25 years of study about the safety of genetically modified crops, where the European Union has spent more than 425 million dollars into, the National Academy of Sciences and the British Royal Society (also other organizations) have come to the conclusion that crop modification by molecular methods does not more harm than crop modification by other methods.

Two years ago, John Dalli, the E.U. commissioner for consumer safety, accepted the genetically modified potato, whereon environmentalists have reacted with fury.
Still in 2012, BASF, the German chemical group, has given up to sell genetically modified products in Europe because of the lack of approval. This leaves a type of corn produced by Monsanto the only biotech crop grown in Europe.

Where/why is the chosen technique used?

To simplify our topic we introduce just one technique of many used in biogenetics in seeds: the biolistic gene transfer.
It injects cells with genetic information using a gene gun.

The gene gun was invented by John C Sanford, Ed Wolf, Nelson Allen at Cornell and Ted Klein of DuPont between 1983 and 1986.
In 1998, John O'Brien, a research assistant in the MRC's laboratory of Molecular Biology (LMB) could improve the accuracy, penetration was therefore increased, the DNA could be inserted into smaller targets and deeper tissues.

In his published protocol, he shows how the gene gun can be used to label single brain cells with dye, whose movement allows scientists to view interactions between living brain cells. It can also be used to transform almost any type of cell and is not limited to the genetic material of the nucleus. John O'Brien also predicts, that his further modified design could lead to more precise and better results in the clinical domain. (Able to use in animals and humans e.g. inject vaccines, without hurting the tissues)

The gene gun can also be used in biogenetics with seeds. Due to its good penetration and high accuracy, it's almost the easiest and most used technique to modify seeds, (especially used in crops).

Other methods

There are other techniques used in biogenetics.
The most common ones are:

Biological
- Gene transfer with Agrobacterium tumefaciens
- Transformation via viruses

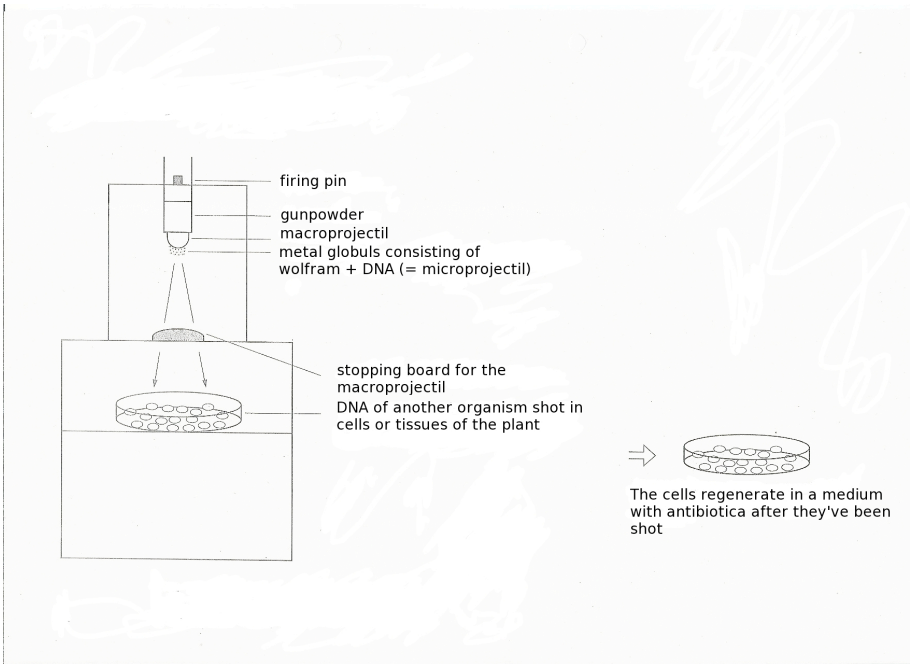
Physical
- Biolistic gene transfer
- Electroporation
- Microinjection

Chemical
- Protoplast method
- Antisense RNA

Method: Biolistic transfer (gene gun)

The biolistic gene transfer is one of the methods to get the DNA into the cell of a plant. Because of the thick and stable cell wall, which builds a barrier, scientists don't have many possibilities. One is with the protoplasts, which are cells without a cell wall, or the way to negotiate the plants cell wall.
The biolistic gene transfer works like this:
Tiny metal globules consisting of wolfram (tungsten) are covered with the DNA, which should get into the cells. The globules with the DNA are building the microprojectile**,** which are attached on a macroprojectile consisting of teflon. After it gets fired off, the macroprojectile has to stop at a stop-plate/board, but the microprojectile with the DNA bolt further to the plant cells. At that moment when they crash into the cell wall, the DNA gets pulled off and is able to get into the genome afterwards. To regenerate themselves, the treated cells are deposited into a medium filled with liquid antibiotics.

Scientists are still trying to improve the method of biolistic gene transfer. They constructed a new model. The DNA there is surrounded by a liquid drop and gets fired off like this. This works better because the macroprojectil, that makes the hole into the cell wall isn't afflicted anymore by the DNA. The DNA flies now, still in that drop, directly through the hole into the cell. That is possible because it is powered by a gas-pressure-pistol (gene gun).
The first biological tests showed very good results. They tested it in tobacco and the transfer gene was transferred by 1:1000. Another test was with wheat fibre, there the results were even better: 30:1000. But the science is still doing researches on the biolistic gene transfer, to improve the transfer rate and make it more precise. But it’s even harder than it seems. As already mentioned the majority of the Swiss and German population doesn’t like the thought of eating modified vegetables and fruits. Because of the political and ethical perspectives, companies (like BASF) have to do their work under complicated conditions.



Interview

1) What is your education?

I studied Agronomy. I worked with soil cultivation, plants' physiology and herbicides. Now I am working for Syngenta. I started as technical manager for crops and oilseed herbicides and since three weeks I am project leader for the Research & Development of crop seeds in Europe.

2) Do you have contact with genetic engineering?

At the beginning of my career my work was very close to genetic engineering. There were many ways open when I worked with herbicides, but now I am not really working in this field.

3) Are there any genetic engineering projects at Syngenta at the moment?

No, there aren't any commercial plans. Maybe there are some considerations, but no concrete plans.

4) Which techniques of genetic engineering are used with seeds?

Surely the transfer with the help of *Agrobacterium tumefaciens*, but also the mechanical method of biolistic gene transfer.

5) Which plants are genetically modified?

Mainly corn and rice. Corn is made resistant to the European Corn Borer and the Corn Rootworm. There is also corn, which is made herbicide resistant. Furthermore, wheat is genetically modified against several diseases but is not yet merchandised. There are many other plants, which are genetically modified like rape or rice.

6) What do you think are positive effects of genetic engineering on agriculture?

I think it offers new options for farmers. Probably there isn't a big difference for the consumer, only indirect because of the better quality of crops. But farmers could profit a lot by fighting against different diseases or making plants resistant to insects with the help of genetic engineering.

7) Are there any negative effects of genetic engineering?

There's one example with rape, where it is proved that a crossing with wild plants (Brassicaceae) exist. Especially with rape there could be grave natural consequences. For example deer eating a lot of rape sorts produced by crossing. These rapes contained a bittern, which inflated the deer until they died. I think there are not enough studies dealing with the problem of natural crossing of genetically modified plants and the possible consequences on the nature.

8) Many people are against genetic engineering because they think it is ethically not okay. How do you think about that?

There shouldn't be any boundless technology. There is need for an ethical barrier and scientists should be

controlled. When the aim is not to serve the farmers or the society genetic engineering shouldn't be allowed. You shouldn't forget to study the consequences on nature, but when there aren't any risks and everything is from the natural gene pool, why not? There is no need for a prohibition but for a regulation. There would be many possibilities to improve the quality and increase the quantity of the harvest. I think people should become aware that genetic engineering is just another new technology. Like computers earlier, genetic engineering now is a new upcoming technology, which is still developing.

9) What are the laws concerning genetic engineering in Switzerland?

   At the moment there's a moratorium. It isn't allowed to cultivate any genetically modified plants commercially. There are some exceptions with experiments under strict conditions. I think that there won't be a change of law before 2020 because the political environment isn't up to permit genetic engineering. This shows in the debate, which isn't scientific but emotional.

10) How is the law in other countries?

    In the EU there are two tolerated genetically modified sorts; one potato sort and one corn sort. In the USA there's a lot of genetic engineering. 95-99% of the plants are genetically modified; especially corn is nearly always grown genetically modified.

11) Do you see a chance for genetic engineering in Europe in the future?

    I think there is a demand for genetic engineering in Europe. It would broaden the possibilities for agriculture, for example it could help fighting against the corn rootworm causes by damaging the crop instead of doing this with insecticides.

12) Do you think that genetic engineering is the solution to the problem of the world's nutrition?

    I think it is one part of the solution. It needs many other parts: Plant's protection, herbicides, fungicides etc. We also have to solve the problem of global warming. Because of the global warming the occurrence of *fusarium* raises, a mould fungus which causes lots of damages to crops. This problem could also be solved by genetic engineering by making plants resistant against *fusarium*. So combining all possible efforts would be the best way for solving this problem.

Interview with Willy Rüegg (project leader for the Research & Development of crop seeds in Europe in the Syngenta), 03.04.12

Discussion

Disadvantages/dangers

In fact the transfer rate is lower than in the other gene transfer and the integration is coincidental. Also the fact that a different amount of DNA pieces can get into the one cell isn't really an advantage. That's why it's also very unstable and the added DNA is only active for a certain time and disappears after a specific time. Treated plants could pass down their modified gene to a wild plant and spread out. This could cause damages in nature. Most of the new technologies have not been fully developed, because there are not many long-term studies. There is also the possibility that this knowledge might get abused for other targets than for optimizing harvest and helping to solve the problem of worlds nutrition, like gene manipulation in humans for their own benefit.
Many people fear that modified plants could damage nature or themselves. Such concerns have been expressed, but none of those harms have been observed yet.

Advantages

The advantages of this method are that you are able to work with the whole cell and not just with protoplasts. Whole cells recover themselves better and regenerate faster to a whole plant. The improved resistance makes it possible to get a bigger harvest, this might be a chance to solve the problems of the world nutrition. The quality is improved, so a better taste and a growth of the size is as well guaranteed as the resistance against diseases, fungi and insects. The resistance against pest helps the poor farmers, so they can avoid the risk of loosing their harvest. And they are able to save money, because the modified plants don't need any pesticides. The whole method is much better for the environment and for nature.

Opinion

As we researched, we stumbled upon many tenuous facts and perspectives. We've already long thought about our topic and we were confident, that biogenetics in seeds is a sign of progress in science and will solve many problems. The longer we've occupied ourselves with this topic, the more we've also challenged our opinion, ethically and also ecologically.
Is it really okay to "play god" and change the genes, therefore disturb natural selection?
Are there really no harmful side effects?
What kind of future awaits us with our fast rising knowledge about technology?
Now, after intensive work with our topic, we've acquired quite some knowledge and we can say, that biogenetic in seeds might still be questionable in some ways but will, as we've seen in many numbers, be on a good way to solve many problems we face like hunger and poverty, as long as we don't lose our sight of our original goal (to help environment etc).

Summary

Biogenetics in seeds is a very current topic and something the world population relies on. Especially because of the fast rate the world's population is expanding, so the food demand is great. We hope to solve these kinds of problems with our modified seeds, which can resist most of the bad influences (bad weather, diseases etc.), grow fast and result in better quality. Also many poor farmers can profit from the seeds (loss will be reduced). Still, many countries in Europe don't approve of this method because they are afraid of dire effects. There might be consequences like the treated plant could pass down its modified DNA to a wild plant, which could damage nature. It might also be that the knowledge and technology could get abused. Some are scared, that the manipulated plant could affect the human body, but no such believed harm has been observed yet. There's still a lack of long term studies to fully develop the technology.
One of the methods used to manipulate the DNA of a plant is the biolistic gene transfer.
It's one of the most used methods. Tiny wolfram globules are covered with DNA. This combination works as a microprojectil, which is attached on a teflonic macroprojectil. When the globule is shot, the macroprojectil gets stopped at a stop-plate, while the microprojectil with the DNA bolts further and is able to pass the cell wall and get into the cell when they hit it.
Also this method needs more studies and improvement.
We believe that biogenetics in seeds is on its good way to solve many kinds of problems we face. Even though there are still many factors we don't know, we've seen numbers that show us, how biogenetic in seeds has helped us and spared many of us from poverty and hunger, also how it improved our medical skills.

Links/resources

http://www.chemie.tu-berlin.de/fileadmin/i10/Unterauftritte/PD.Dr.H.v.Doehren/Texte/BE/Sina_Liebezeit_Transgene_Pflanzen.pdf

http://www.mrc.ac.uk/Newspublications/News/MRC003469

http://www.biosicherheit.de/basisinfo/602.richtest-kanone.html

http://de.wikipedia.org/wiki/Genkanone

http://www.nytimes.com

Mr. Willy Rüegg

Schwerpunktfach Biologie Sheets: Biolistic gene transfer

Pictures:

http://scifi.pages.at/nominator/gen/

http://www.sueddeutsche.de/wissen/gruene-gentechnik-in-deutschland-aufruhr-im-genfeld-1.963865

http://testyourreasoningability.blogspot.com/2008/10/biogenetics-of-intelligence.html