Erasmus+ project “biotechnology in our life” 2015 - 2018

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Erasmus+

THE TEAM:

Koidula Gymnasium (Pärnu, EST)

Coornhert Lyceum (Haarlem, NLD)

IES JOSE DE RIBERA (Xativa, ESP)

Liceo Scientifico Statale Galilei Galileo (Verona, ITA)

St Neots Learning Partnership (St. Neots, GBR)

Öffentlich-stiftisches Gymnasium Bethel (Bielefeld, GER)

Univ. Bielefeld teutolab-biotechnology *(Bielefeld, GER)*

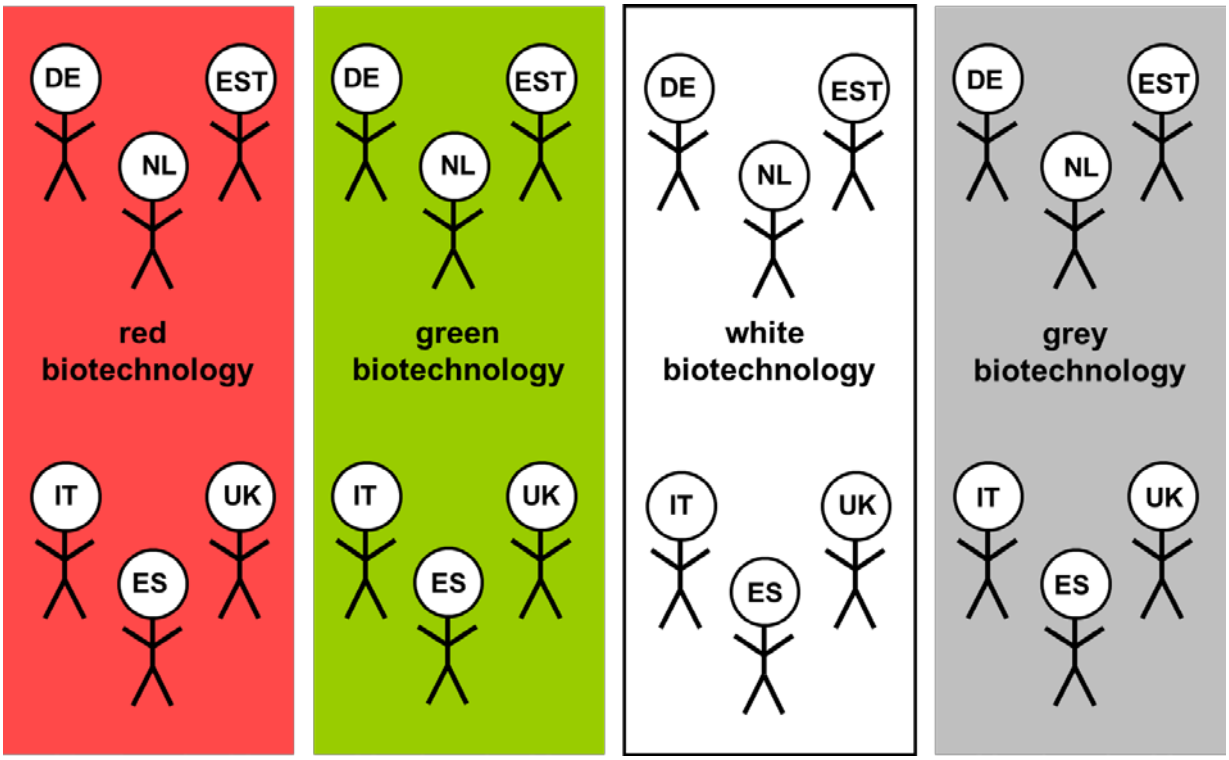
"Biotechnology in our life" is a project (August 2015 till August 2018) that strives for a compound structure between schools in Europe with science, companies, and politics.

Biotechnology, as the „use of biological processes for technical applications“ has both, a long history and an increasing prominence. For many years, living systems for technical appliances (brewing of beer, sewage clarification) have been used. The enormous potential of biotechnology has been recognized for only a few decades.

Regularly, new implementations and products are brought to the market. The awareness that, by transferring genetic material, interesting products can be "manufactured" in qualified production cells (e.g. human insulin, produced inside of bacteria), offers further possibilities. These genetic methods are equally admired as disregarded by the society.

The project aims at learning and experiencing the relevance of biotechnology in daily-life and to explore the potential of this research field for the future. The internationality (**Germany, The Netherlands, Spain, Italy, United Kingdom and Estonia**) of this project provides the chance to compare the nations' different experiences and bioethics perspectives.

24 international students aged between 15 and 18 participate the project and work in **four international teams with four different focusses**:



Each international team built three pairs. Each pair chose a topic they were interested in, made research and described their results in form of a poster, a presentation and an arcticle. The international students mainly worked virtually exchanging intermediate results on a special internet platform (eTwinning).

In addition the students meet at three **project meetings** in which they performed experiments, visited biotechnological companies and discussed their work and exchange their experiences. At the third meeting an exhibition took place.

1st meeting	independant/national team work transnational team work (virtual)	2nd meeting	independant/national team work transnational team work (virtual)	3rd meeting
07.10.2017 – 12.10.2017		03.02.2018 – 08.02.2018		10.03.2018 – 15.03.2018
Bielefeld Germany		**Haarlem** The Netherlands		**Pärnu** Estonia

This brochure provides an insight of the second year of this project.
In the **first part** of the brochure the respective host students report about the **transnational meetings**.
The articles in the **second part** of this brochure show the outcomings of the **students` work.**

Part I

Part II

Öffentlich-stiftisches Gymnasium Bethel, Bielefeld, Germany

Report from: Ani, Laura, Jonathan, Tom-Luka and Paul

The project "Biotechnology in our life" is an exchange between six European countries, England, Spain, the Netherlands, Estonia, Italy and Germany; from which three years in a row four students from each country participated. There were three meetings every year and this text is about the first meeting of the third year.

The project taught us about biotechnology, how it works, how it is applied and more backgrounds, as like ethical problems and more discussions. We visited some companies and heard many lectures about the economic and scientific sector of biotechnology.

From the 7th to the 12th of October the third meeting, the kick-off for the third and last year of the project, took place in Bielefeld in Germany. The twenty students from St. Neots, Xativa, Haarlem, Pärnu and Verona arrived on Saturday and stayed that day in their German host families. On the next we started at the university and met us all for the first time.

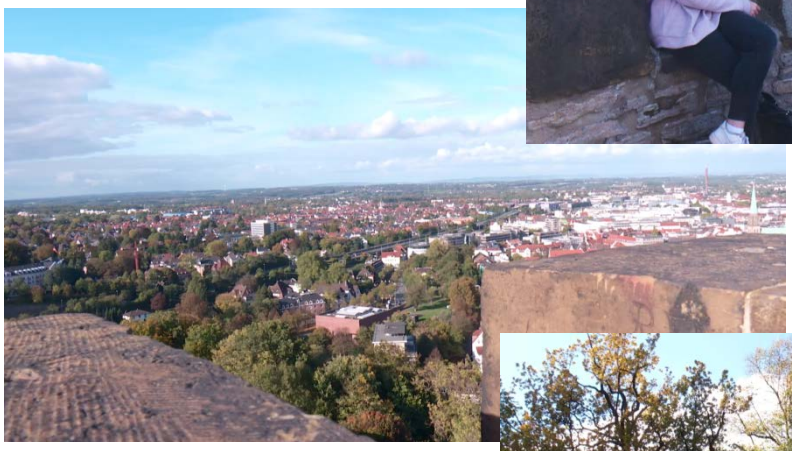
At first every student group from each country introduced themselves, the town they live in and their country. Afterwards a professor from the university of Bielefeld was holding the first lecture about biotechnology in general, a topic the most of us never really got in touch with, and where we find its applications in our lives, we also heard about the field of genetic engineering.

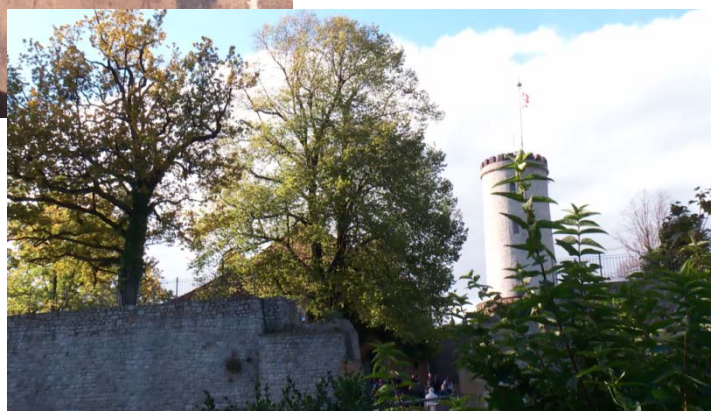
Before lunch we had the possibility to get to know each other with group activities: in international groups we had to solve various challenges and had to work in a team.

On the days we were in the university we got lunch there. In this time we had the possibility to again chat a bit and learn about the others.

After lunch we German students guided the others around the town and tried to show them the nicest parts of Bielefeld; we ended at the castle in the afternoon to climb the tower from where you have a great view over the city.

When we all were picked up it felt like we were no strangers any more.





The second day started with our teamwork. We all were divided into four groups with a student from every country and in this groups pairs of two have written an article about a biotechnological topic. So we were working on these in the morning.

After lunch we visited a company near to Bielefeld called “Evonik”. The site we went to researched on amino acids and produced them for the international market for animal food as nutritious substitutes.

We heard a lecture about the company and their work and we also saw the labs. In the end of the day we all were tired but happy.

On Tuesday the day started with another lecture about breeding of plants and how it developed over the time to the modern genetic engineering. The breeding of plants has a long history, it started more than 10000 years ago. The first prove of controlled breeding was 6000 years ago in Mexico with the development of maize. Around 1000 years ago cabbage was modified by selection since 1900 breeding by crossing has risen up and now the next developing stage is the genetic engineering which is basically the same like the selection but more controllable and more fast.

The conclusion was genetic engineering is one solution for problems like the growing population.

Afterwards we worked on with our research for our articles.

After another lunch in the university Mensa we had a guided tour around the CeBiTec, the Centre for Biology and Technology of the university Bielefeld and the university of applied sciences.

On Wednesday, our last day at the university, we heard a lecture about biological pest control and biotechnological aspects and possibilities in that topic. They tried to find a way to attract and kill pests on a sustainable way.

Afterwards we tried to identify orchids by excluding the DNA of it and compare it to other DNA samples of already known orchids. We used techniques like the PCR, which breaks up the DNA to multiplicate it to have comparable amounts of it.

One evening we went to a bowling centre. We had a very fun evening together, another experience putting us closer together as a group.

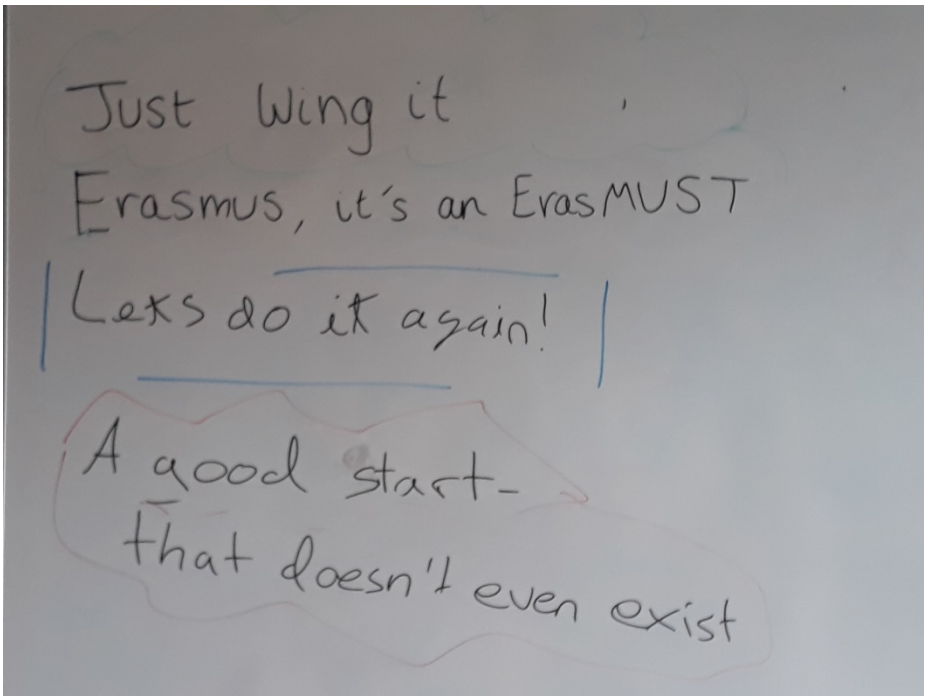
At the last evening we met in a restaurant. By now we all really liked eachother and became friends. It was hard to know that would have been the last evening together for three month.

On our last day together we were not in the university but in our school, where we showed them around and then worked on the articles. As a finish we had a panel discussion about genetically modified salmon. We all had to pretend to be an important person in an international discussion about the legalization of selling of GM salmon. It was very interesting and also confrontated us once more with the problems coming along with new technology and also took us to our borders of possibilities while speaking and discussing on a language we all learned from school.

In the afternoon and after another meal together the students left and went back to their each towns.

Not like them the memories stayed and we were all looking forward for the second time we would meet in Haarlem.

We learned very much about biotechnology that week but I think what is much more important we got to know new people and friends from all over Europe and that was the greatest goal of that week.



Coornhert Lyceum, Haarlem, the Netherlands

Report from: Lynn, Larissa, Sofie and Rijk

We started the week on Sunday. All the students had to come to the school by bike, which was an adventure. We were all looking forward to this day because we all wanted to see each other again and welcome the foreign students to our beautiful country and in particular our city, Haarlem. We started of the day by catching up a bit with all the students and than we had a short introduction speech from our teacher. After that we were ready to immediately start a practical work. This was a very cool practical work. We were going to make bioplastics!

We were all in international groups, which was a lot of fun because we could catch up and get to know each other a little bit better. To make the bioplastics we needed potatoes and some other "ingredients". We all thought it was quite funny that we were making plastic out of potatoes. During the practical work there were some steps in which we needed to wait for a couple of minutes. During our waiting time some people went to see the rehearsals for our school concert, this was a lot of fun.

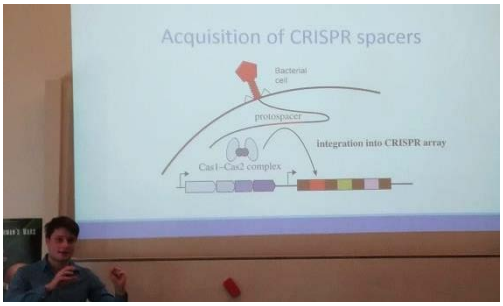
After the practical work we had lunch and we were then ready to go to the city centre of Haarlem, to give all the foreign students a tour of the city. We told something about the markets, we walked trough some typical Dutch streets and then walked along the canals. When we were done with the tour some groups went shopping or discovered the city a bit more.

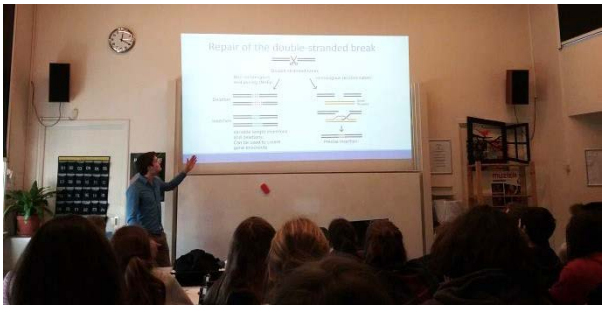
The second day of the program, Monday, we had planned an excursion to the Bioscience Park in Leiden.

In total we had about five readings and we visited a company called CHDR, Centre For Human Drug Research. The trip to Leiden was extremely interesting because we learned a lot about different types of companies and technologies. The best thing about Leiden was the reading and the visit at CHDR.

We got a tour through the building and we saw some of the techniques that are used for drug research. We believe that everyone had a good time in Leiden and we all learned new things about biotechnology. In the evening we went bowling with everybody, all the hosts came as well. We had a great time!

Tuesday started off with working on the article and poster! After this we had a lecture about CRISPR-Cas, witch is a method for modifying DNA. We believe that everybody thought that it was quite interesting.





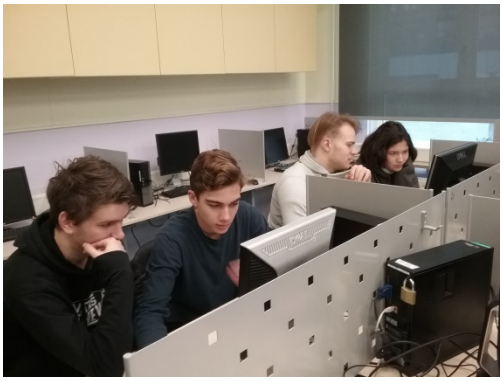
After the lecture we went to a pancake restaurant and had a delicious lunch! After our amazing lunch, we cycled to the beach. When arriving on the beach we all had fun in the very strong wind. To end the day, we went ice skating with all the hosts as well!!

Wednesday the 7th, the group visited Avantium in Amsterdam. We followed a lecture by Tom van Aken about renewable chemistry to avoid climate changes. After this lecture, we had a tour through the lab. It was very interesting because you could get a very clear view of working in a lab.

After lunch the group visited the science museum, NEMO, in Amsterdam. It was a fun and informative trip. The combination of fun and learning new stuff is the best. After visiting the museum, we were all invited to drink something on the roof of the museum with a beautiful view of Amsterdam.

After that the group was allowed to visit the city of Amsterdam till 7 PM because that was the time the group needed to be at the restaurant DE BEREN in Haarlem. The group had dinner together because it was the last evening.

On Thursday, we first worked on the article and the poster in our pairs.



After we worked on our articles and our posters we had lunch and the headmaster from the school gave us a short talk. We also went to see how our bio-plastic had turned out. It was so cool to see what we made! Later on we worked on the article and the poster again and we finished them! And than it was time to say goodbye :(

We all had a great time this week and we couldn't wait to see everyone again in Estonia!

Koidula Gymnasium, Pärnu, Estonia

Report from: Karin, Annabel, Theodor and Arlet

Sunday, 11 March

On the first day, we started with a lecture about all the educational facilities about biotechnology in Estonia given to us by geneticist Riin Tamm. Later we were presented with an introduction about Estonia with a short presentation and a trivia game. After a short break everyone was instructed to gather up in the city centre in front of Endla theatre, where we were tasked to tour around the city to find the city's landmarks.

During the game everybody had a chance to enjoy a walk and get more acquainted with the city. After a tiring walk we went to the Irish pub, where we had dinner. In the evening, one part of the group spent their free time by going bowling and the other part enjoyed the snowy weather of Estonia and went sledging.

Monday, 12 March

On Monday, we had a bus trip to Tartu, the university city of Estonia. There we visited a biotechnology company named Icosagen. The company produces recombinant antibodies and challenges recombinant proteins in mammalian cells.

Mart Ustav, the founder and CEO of Icosagen, gave us a presentation about the history of the company. After that, we headed to a science centre AHHAA, where we had free time to discover exhibits and get to know new things in a playful way. After that we had lunch in a cafeteria. The last thing at AHHAA was a science theatre, where we saw different experiments and got simple and understandable explanations for them.

We spent the evening and the night in a hostel named Hektor, where we also had dinner.

Tuesday, 13 March

On Tuesday we had breakfast at Hektor. After that we visited the University of Tartu Institute of Molecular and Cell Biology. There we had two lectures by the professors Ants Kurg and Andres Salumets. Andres Salumets gave an insight into the process of in vitro fertilisation and brought out some statistics about the situation in Estonia. Ants Kurg talked about the House of Romanov and the possible use of DNA in case of identifying unknown bodies.

After the lectures the foreign students took part of the Traveling Bioclass. The Traveling Bioclass shows students the basic work of lab workers and gives them a hands on experience. While the foreign students were in the Traveling Bioclass, the teachers got a tour to the Estonian Genome Center. In the evening we took a coach to Pärnu.

Wednesday, 14 March

On wednesday we finished preparing our presentations.

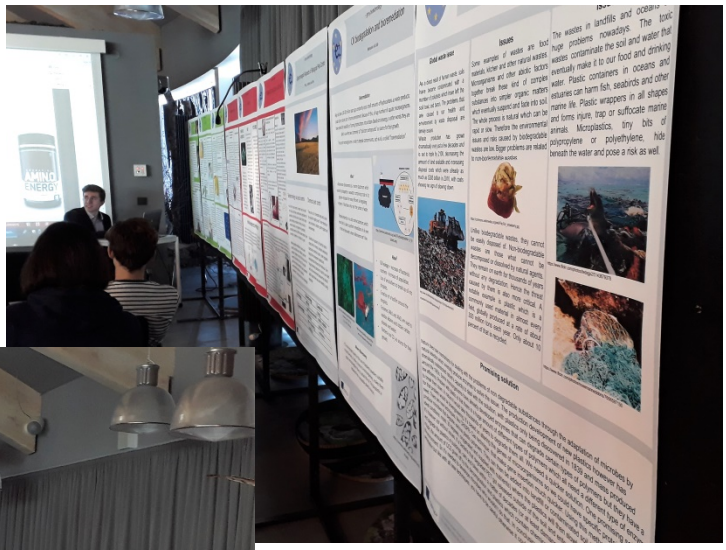
Later we had a workshop where we isolated bananas DNA. Firstly, the banana was smashed and some ethanol, washing-up liquid and hot water was added. Secondly, the solution was filtered to remove bigger banana chunks. We were able to see the DNA in the remaining solution. In the end of the workshop we played a game about the genetic diversity of species.

In the evening all of the students went to Estonia spa.

Thursday, 15 March

Thursday was the final day of our project, we finished it in Pernova nature house.

The graduation started with a speech by our towns deputy mayor. After the speech every pair showcased their work and answered all the questions the audience had.



When the presentation part was over there was a final speech by the project manager Maren and she also handed over the certificates of the project.

Then all of the students went to Hans Pub for the last meal together. After the meal everyone had their goodbyes and the project was over.

What is personalised medicine?

Personalised medicine is a way of treatment and care of patients, that tries to find each patient their own individual cure plan. The approach relies on information that has been found from human genome. But this is not the only aspect that should be looked at. A big role is also played by the surrounding environment and the person's lifestyle. Together these aspects give information that can help to find out some risks of developing diseases and discover illnesses earlier.

http://images.all-free-download.com/images/graphicthumb/pills_312257.jpg, (modified by Laura Marie Klatt)

It also provides a precise diagnosis, and determines the best way to help improve our health. Things like medicines, lifestyle changes and simple variations in diet can do that. There is hope that acknowledging people about their personal risk will help them feel more empowered to change their lifestyle.

How personalised medicine works in comparison to one-size-fits-all?

Unlike the one-size-fits-all medicine the personalised medicine tries to give the right medicine to the right patient. It maximizes the benefits of medical treatments while reducing side effects and costs. When doctors give their patients personalised medicine they do not have to try multiple medicines that probably will not work well enough. That can save important time as well as a lot of effort.

https://upload.wikimedia.org/wikipedia/commons/e/ee/Vacutainer_blood_bottles.jpg

With the help of a biomarker diagnostic medical decisions like the diagnosis, treatment or no treatment and the dose can be detected, to find the right therapy more quickly. Biomarkers are characteristics, that may be used to see how well the body responds to a treatment and can be detected for example out of blood draw, biopsy, gene sequencing, microscopic analysis or protein analysis.

Without personal medicine only some patients benefit from the one-size-fits-all medicine, some patients do not benefit and some maybe get adverse effects.

Advantages

People's average age is constantly growing. However, healthily lived years do not really rise, rather fall. This means less workers and more people in need of medical care. By continuing this way, there will not be this much resources left, to ensure the high quality medicine to everybody. A solution to it can be personalised medicine. Personalised medicine gives us a chance to increase the opportunity to prevent diseases. When a somebody has a predisposition to have for example diabetes, then he can focus on preventing it by changing his diet and doing more sport. Preventing diseases mean reduced healthcare costs and more healthy people, who are able to work and who have a better life quality.

If a person has a disease, then personalised medicine allows more quickly target right treatment for the patient, which raises probability of improved health outcomes. It is extremely essential if a patient has cancer and needs a very quick and precise treatment. This is a question between life and death. Better-targeted cure also helps to avoid adverse drug reactions. What actually shows that one medicine does not fit for everyone. So we should look at personalised medicine as an investment rather than an additional expense.

Disadvantages

We can see that personalised medicine has many advantages but it has also some disadvantages and ethic problems. When participants donate their blood samples to biobanks, they also have to share a lot of personal information, like details about their lifestyle, medical and family history. All this information is anonymized by using numbers and codes instead of names. But it may not guarantee complete privacy.

When biobanks do research to genes, they can uncover a person's genetic future – like having a great risk of developing Alzheimer's disease or any other untreatable condition, which the patient maybe did not want to know. Also staff and physician need to be prepared to know what to say when patients get this kind of statements. One of the risks is also that information from genome gets into third person's hand. For example when somebody applies for job and employer somehow has found out his genetic future – having a big risk for breast cancer – then employer might not want to employ him to prevent the following consequences.

Personalised medicine is still quite expensive. Because it is very costly to screen patients and to produce medicines for individuals or groups. Fortunately the cost has dropped dramatically so far and will probably keep falling.

Estonian Genome Center

Estonian Genome Center of the University of Tartu has created the biggest biobank in Estonia, which is also one of the most successful ones in Europe. Estonian Genome Center's main priorities are to improve population's health and introduce personalised medicine in Estonia. There are nearly 52,000 gene donors from 18 years to 104 years of age, which closely reflects the age, sex and geographical distribution of the Estonian population. This number makes about 5% of adults in Estonia. Collected data allows to do scientific researches. These reasearches help to understand, how genetic information and its mutations can affect individuals, their development, aging, health, and diseases. This valuable information can be used in personalised medicine.

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Autumn 2017 all of the 52,000 gene donors started to get their personal gene cards. This year, 2018, Estonian Genome Center's mission is to collect 100,000 new gene donor's blood tests. Extension of the Genome Center increases its value in science and in medicine. In the future every Estonian could have his own gene card and this can dramatically change our current medical system.

Sources: https://www.geenivaramu.ee/et/geenivaramust

https://theconversation.com/personalised-medicine-has-obvious-benefits-but-has-anyone-thought-about-the-issues-59158

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https://www.england.nhs.uk/wp-content/uploads/2016/09/improving-outcomes-personalised-medicine.pdf

http://phrma-docs.phrma.org/sites/default/files/pdf/chart_pack-value_of_personalized_medicine.pdf

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http://phrma-docs.phrma.org/sites/default/files/pdf/chart_pack-value_of_personalized_medicine.pdf

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Paul Ehrlich was the man who created the first modern antibiotic. In his experiments he noticed it was possible to create substances that can kill the bacteria which causes the disease but does not harm the other cells. He discovered an antibiotic that was the first effective medicinal treatment for syphilis, which is a sexually transmitted infection, caused by the bacterium Treponema pallidum subspecies pallidum. He used Benzathine benzylpenicillin, also known as benzathine penicillin G, for the treatment.

In 1928, by accident Alexander Fleming discovered the antibiotic Penicillin, that became one of the first medications to be effective against many bacterial infections caused by staphylococci and streptococci. This is a genus of coccus family that includes many pathogenic compounds that cause pus formation, especially in the skin and mucous membranes.

The first antibiotic was used by Selman Waksman in 1940, who discovered over 20 antibiotics. Antibiotic means “kill life’’, it’s called this way because antibiotics kill bacteria which causes a disease.

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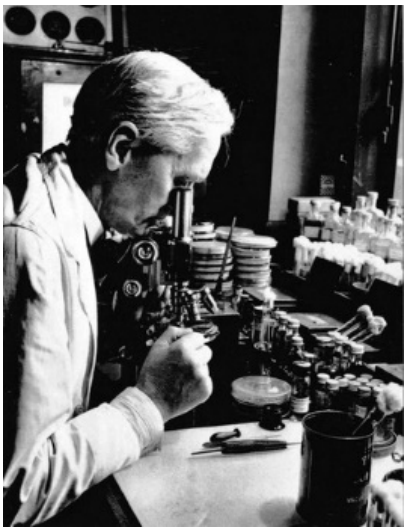

Antibiotics, also called antibacterials, are a type of antimicrobial drug used in the treatment and prevention of bacterial infections. They may either kill or inhibit the growth of bacteria. A limited number of antibiotics also have antiprotozoal activity.

Antibiotics are not effective against viruses such as the common cold, drugs which kill viruses are termed antiviral drugs or antivirals, rather than antibiotics.

Antibiotics are clinically approved ,but some of them can react allergies to some people. They are usually considered safe and well tolerated. However, some antibiotics have been associated with a wide extent of adverse side effects ranging from mild to very severe depending on the type of antibiotic used, the microbes targeted, and the individual patient.

Adverse effects range from fever and nausea to major allergic reactions, including photodermatitis and anaphylaxis.

Antibiotics are produced by fermentation. The process may take a few days to obtain an extractable amount of product. Antibiotic production is done by the batch process. Oxygen transport is the major concern An anti-biogram testis used to observe the amount of antimicrobial agent in the fermentation broth. A bioassay determines the activity unit of the bactericides. Antibiotics are commonly classified based on their mechanism of action, chemical structure, or spectrum of activity. Those that target the bacterial cell wall or the cell membrane or interfere with essential bacterial enzymes have bactericidal activities. Protein synthesis inhibitors are usually bacteriostatic. Further categorization is based on their target specificity. "Narrow-spectrum" antibiotics target specific types of bacteria, such as gram-negative or gram-positive, whereas broad-spectrum antibiotics affect a wide range of bacteria.

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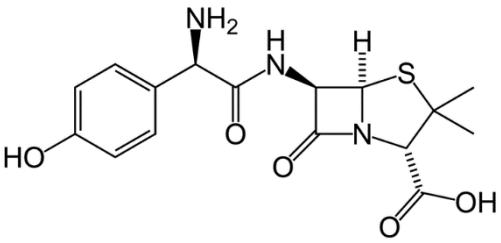
Amoxicillin is one of the most known antibiotics. Amoxicillin belongs to a group of drugs called the penicillins. They originate from a form of fungi called Penicillium fungi. They are used to treat infections caused by bacteria and to eliminate the bacteria.
Amoxicillin fights bacteria and stops them from growing by preventing them from forming cell walls. This kills the bacteria and eventually eradicates the infection. Amoxicillin and other antibiotics are not known to be effective against viral infections, such as colds and flu.



https://commons.wikimedia.org/wiki/File:Amoxicillin-2D-skeletal.png

Conditions that amoxicillin can treat include: bronchitis, ear infection, pneumonia, skin infections, urinary tract infections…
Like many forms of medication, amoxicillin can have unwanted side effects. Some of these are more common, and some are more severe. It is most important for doctors to check whether the patient is allergic to penicillin because an anaphylactic reaction can be fatal.
Signs and symptoms of an allergic reaction include: chest tightness, difficulty breathing, rash or hives, itchiness swelling of the face or throat.

PRENATAL DIAGNOSIS – MICROARRAY CGH

Worldwide, millions of individuals are affected by dominant or recessive genetic mutations. In order to avoid the transmission of severe pathogenic genetic variants and to enable early detection of genetic disorders, prenatal testing is offered.

https://pixabay.com/it/dita-mani-bambini-bambino-

There are many several prenatal techniques that can be used to discover to see whether there is a genetic disease or not.
Thanks to common screening procedures such as routine ultrasounds, blood tests and blood pressure measurement problems could be found among a large population.
Prenatal diagnosis is used to look weather there are genetic mutations or diseases or it could focus on pursuing additional detailed information once a particular problem has been found.

These are divided into two categories: Non-invasive or Invasive techniques

Non-invasive

Non-invasive procedures are used to detect general disease or deformations and don't have particular risk of abortions. The most popular ones are RH safe and prenatal safe.
Rh safe is a blood test that will be used to determine the blood type and Rh factor, which determines the compatibility with the mother and her growing fetus. The blood can be either Rh-positive or Rh-negative, if a mother is found to be Rh-negative, her body will produce antibodies that will affect any subsequent pregnancies. When there's an Rh incompatibility, most women will be given a shot of Rh-immune globulin.
Prenatal safe is a recent technique that takes the DNA of free fetal cells (cffDNA) that are circulating in a very little amount in the mother's blood. During pregnancy the placenta leaks baby's DNA into the mother's bloodstream. As a result, the mother's blood contains a mixture of baby's and mother's DNA. This technique could be very useful because it doesn't create any risk of abortion but nowadays there are many difficulties to found and isolate them because the levels in the blood is too low.

Invasive techniques:

Common diagnosis procedures include amniocentesis and chorionic villus sampling.
Amniocentesis is an invasive method that extract some amniotic fluid from the uterus and it can be done between the 14^{th} and 20^{th} weeks gestation
Chorionic villus sampling, take a sample of the chorionic villus and it can be done earlier (between 9 and 12 weeks gestation).

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The invasive techniques has 1% risk of causing abortion, but it's still recommended in particular to women over the age of 35 and women who have previously had premature babies or babies with a birth defect.

HOW CAN SCIENTISTS ANALYSIS THE FETAL DNA?

In order to analysis the fetal DNA several technologies have been invented and now are being developed. There are general or specific analysis that can use fast methods, so the result would be ready sooner, or slow methods which are very precise so microdeletions and micro mutations can be detected.

We can divide these techniques into:

- Traditional genetic ones: karyotyping
- Molecular genetic ones: Genetic screening such as microarray CGH and FISH

Now we want to examine what are microarrays and how do they work.

ARRAY CGH

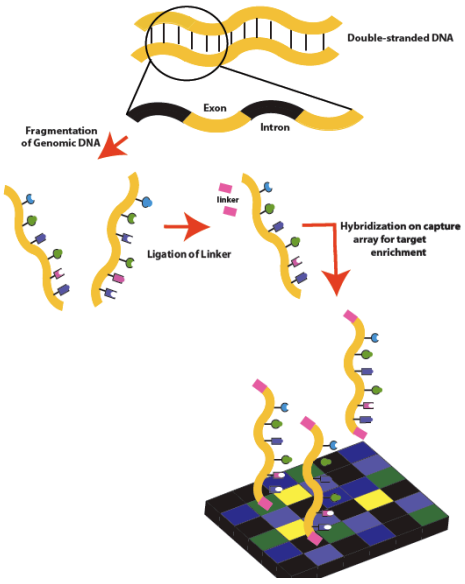
What is it?

Array CGH is a significant advance in technology that allows detection of chromosomes imbalances that are too small to be detected by looking down the microscope. Karyotyping is only as good as the resolution of a microscope and is not able to detect subtle chromosomes changes. These smaller alternations, often called submicroscopic alterations because they cannot be seen down the microscope, can still disrupt growth and development. These very small changes are often called microdeletions and micro-duplications. It compares the fetus DNA with a control DNA sample and identifies differences between the two sets of DNA. In this way deletions and duplications can be identified.

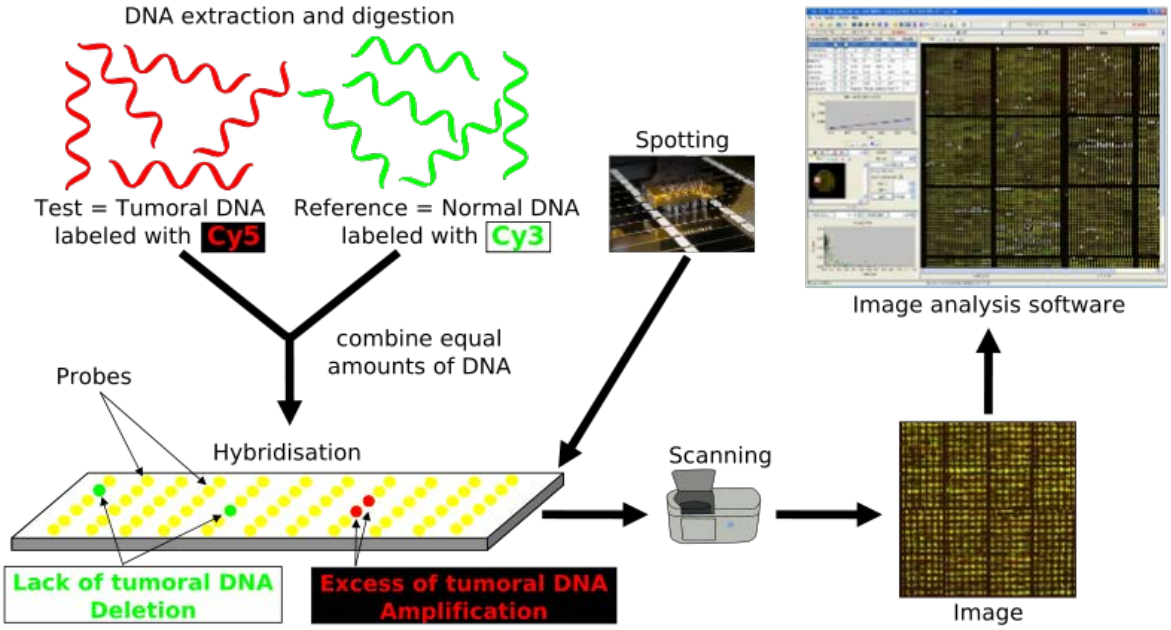
How does it work ?

A microarray works by exploiting the ability of a DNA molecule or strand to bind specifically to or hybridize to, another DNA molecule.

The microarray compromises tens of thousands of short sequences of DNA arranged in a precise grind on a glass slide called a chip. DNA from the patient is "digested" (chopped up into short lengths or fragments), then these fragments are labeled with a colored fluorescent dye. Reference DNA, from a person, or pool of people, with no genetic abnormalities, is labeled with a different colored fluorescent dye. The fluorescent dyes commonly used are red and green. Reference and patient samples are mixed together and applied to the chip and hybridization takes place- the fragments of DNA hybridize with their matching probes on the array. The chip is then scanned in a machine called a microarray scanner which measures the amount of red and green fluorescence on each probe. The microarray scanner, together with computer analytical software, calculates the ratio of the red to green fluorescent dyes to determine whether, for the piece of D



DNA represented by each probe. The patient sample has the correct amount of DNA (shown as yellow), too much DNA (a duplication) which would be shown by too much red, or too little DNA (a deletion) shown by too much green.



https://upload.wikimedia.org/wikipedia/commons/d/d2/Array-CGH_protocol.svg

CONCLUSION

ADVANTAGES:

- **Ability to explore all 46 chromosomes in a single test and to detect any DNA imbalance including extra or missing chromosomes and loss or gain of chromosomes material.**
- **It may avoid your child having to undergo many other tests in order to discover a reason for your child's difficulties.**
- **Helps to predict what to expect as your child gets older**
- **When a specific chromosomes imbalance is diagnosed, the parents (and other family members) can be tested to see if they are carriers of changes in their DNA that put them at risk of having more children with a chromosome change.**

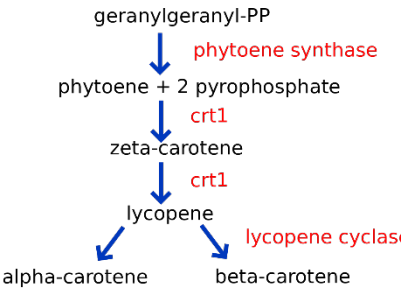
LIMITATIONS:

- **Balanced translocations and inversions (where chromosomes are inverted or reversed), will not be identified using array CGH.**
- **Genetic conditions are caused not only by chromosomes imbalances, but may also be caused by point(single base pair) changes, which it cannot detect these tiny changes.**
- **May identify chromosomes changes that are unrelated to your child's problems at the time of testing.**

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

What is Golden Rice?

Golden rice was developed to solve a big problem mostly in Asia or other places where there is a shortage of vitamin A. It is a type of rice that is genetically engineered. The difference between the white rice and the golden rice is the amount of vitamin A that is produced by the addition of three beta-carotene biosynthesis genes. There is also golden Rice 2 that is still in development now. It was announced in 2004 and this new type of golden rice produce 23 times more beta-carotene than the original golden rice did. Golden rice 2 is a combination of maize and rice. They use the phytoene synthase gene of the maize and the crt1 from the original golden rice. The phytoene synthase of the maize is important because it catalyzes the conversion of an important reaction to produce proteins.

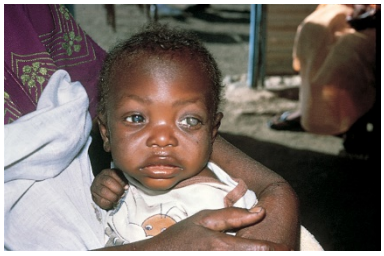


https://commons.wikimedia.org/wiki/File:Carotenoidsynthesis.svg

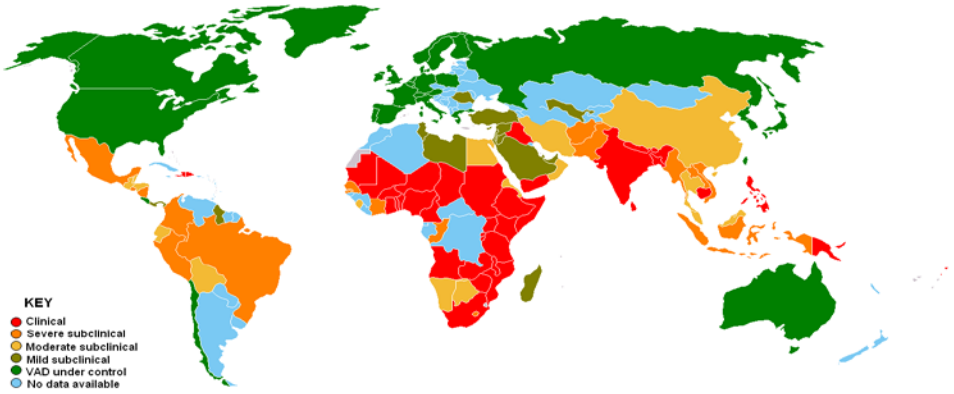
Why is Golden rice so important?

The development of the Golden rice is to decrease the deficiency of Vitamin A. This vitamin is very important for children. When you don´t have enough Vitamin A in your younger years you could be diagnosed with blindness, Xerophthalmia (your eyes can't produces tears that can lead to blindness) and even to death.

In 2005 there were 190 million children and 19 million pregnant woman diagnosed with VAD (Vitamin A deficiency). Each year millions of children and pregnant women die or become blind. Children who has a lack of Vitamin A in their diet are at a high risk for Xerophthalmia, the most common cause of childhood blindness. Also a lack of vitamin A can infect children way easier, and they can die of these common infections like flue or fever.



https://www.flickr.com/photos/communityeyehealth/5636914713

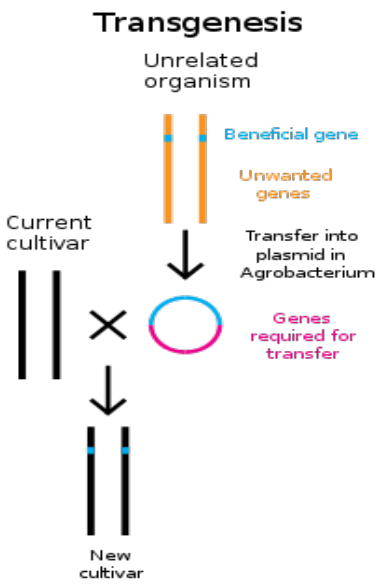


https://en.wikipedia.org/wiki/Golden_rice

**this map shows the degree of Vitamin A deficiency around the world*

How is the rice modified?

To produce and store beta-carotene the rice is genetically engineered with 3 genes. These included two genes from the daffodil plant (just a yellow flower) and the third from a bacterium (Erwinia Uredovora). This three will produce the vitamin A. These genes, along with promoters, are inserted into plasmids, small pieces of DNA. Plasmids are located in an agrobacteria (a plant microbe) that scientists use to ferry in the genes into the plant cells. They add the agrobacteria into a petri dish which contains rice embryos. When agrobacteria infect the embryos they also transfer the genes that encode the instruction for making beta-carotene. This transgenic rice needs to be crossed with local rice so it can be adapted to the local climate conditions.



https://commons.wikimedia.org/wiki/File:Breeding_transgenesis_cisgenesis.svg

History of the rice

1980 was the first time scientists were required to transform and express genes in plants. This was a real breakthrough in the biotechnology industry. In 1999 there was another great invention. They showed it was possible to reconstitute the carotenoid pathway which is active in leaves. Many people didn`t believe it was possible to modify plants at that time.

Profs Ingo Potrykus and Peter Beyer created the Golden rice in 2000. This product was still a prototype. The real Golden rice was planted in fields for the first time in 2004. The same team invented also Golden rice 2. This was all in the same year. But none of them is on the market.

https://commons.wikimedia.org/wiki/File:Team_Biofuels_with_Ingo_Potrykus_(3668815442).jpg

**The one in the middle with the cup in his hands is Profs Ingo Potrykus*

Problems with Golden Rice

The concept of Golden rice sounds maybe very attractive but it has a lot of downsides. Critics have raised concerns of using genetically engineered foods to combat vitamin deficiencies like vitamin A. One of the main problems with the original concept of golden rice that there wasn`t enough vitamin A in it. That's why golden rice 2 was developed. Greenpeace vehemently opposes the production and use of golden rice citing this GMO will encourage the development of more GMOs in the future.

Greenpeace says also that Non-GMO organic, traditional and conventional plants would be at a high risk of contamination by the Golden rice, if this GMO rice were released into the environment. Because this GMO will damage the fields. Since Golden Rice was first announced in 2000, Greenpeace has made a concerted effort to block its introduction. They produced misinformation and gone against the scientists of the golden rice. They also destroyed golden rice fields in the Philippines.

Because of this opposition of Greenpeace and many other environmentalist groups the golden rice, after 20 years of research, isn't produced yet.

Not everyone is negative about the golden rice. Two German economists have quantified the price of the opposition, in human health. Their study estimates that the delayed application of Golden Rice in India alone has cost 1,424,000 life years since 2002. Not only death is quantified but blindness as well.

Golden Rice is just one example. There are several other applications of GMO technology that could contribute to food security and reduce hunger and starvation.

https://commons.wikimedia.org/wiki/File:March_Against_Monsanto_Vancouver.jpg

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What is Bt-Corn?

Cultivation

Bt-Corn is corn (or maize) that has been genetically modified. Genetically modified organisms (GMOs) are organisms that have had their genes changed through the addition of genetic material from other organisms. The reasons for this usually are to improve the yield of the plant by altering it to become more resistant to pests, stronger to weather conditions or improving the quality of the plant.

Figure 1 – https://pixabay.com/nl/ma%C3%AFs-plantaardige-mais-2691398/

Usually pesticides are used in controlling pest numbers. However, there are many disadvantages to using pesticides. For example, there is direct harm to humans. They are toxins and can have neurological symptoms due to the exposure of pesticides. Also can result in an excess mortality rate from cardiovascular and respiratory disease because of the chemical contamination. Pesticides also result in negative impacts on the environment by contaminating the soil and waters. Also by contaminating insects and vegetation, this can also harm other organisms that eat them. Therefore, methods of controlling pests without using these harmful chemicals are always better alternatives. One example of this is BT-Corn.

The Bt-Corn was genetically modified which involved adding the Bt Delta Endotoxin into the plant. Bt Delta Endotoxin was selected because it is very successful and controlling the Lepidoptera larvae which kill (or damage) the plants making it unable to be sold to customers. The Bt Delta Endotoxin is harmless to humans, other mammals, fish and birds therefore is considered safe to introduce into the corn plant.

Figure 2 – https://pixabay.com/p-2615659/?no_redirect

Genetic modification works by adding a strand of DNA which codes for the particular trait that has been chosen to be added to a species of plant. The trait desired for corn was to be resistant to the larvae. The process used to insert the DNA (the Bt Delta Endotoxin) was by using a soil bacterium called Agrobacterium tumefaciens. This bacterium is used because it has a natural ability to do insert DNA into plant cells and cell genomes.

Figure 3 https://commons.wikimedia.org/wiki/File:Agrobacteriumgall.jpg

Use and impact

The farming of corn is greatly affected by these larvae which prevent a large amount of corn from being able to be sold. This results in: farmers earning little profit; land and energy being wasted; and food shortages. To overcome this problem, the larvae must be controlled, so, this is the reason why Bt-Corn was created. Bt-Corn has positively impacted lives in many ways such as reducing the use of pesticides which is more appealing to customers, saves money and also helps beneficial insects survive much better. It is recorded that, on average, farmers who adopt GM crops make more money in tougher times compared to those who do not. This impacts the farmers' lives positively as they have more money to afford their needs and luxuries.

The risks associated with Bt-Corn, like all GM crops, are that the modified genes can be transmitted to nearby crops through pollination and seeds. This contaminates other crops and, especially if the contaminated crops are labelled as organic, this can cause problems.

Bt-Corn controversy

Bt-engineered corn is among the first major commercial successes for agricultural biotechnology but people have many different opinions on GM crops. There is a big controversy surrounding GM Crops, largely due to how little we know about the long term effects. There is also a potential threat to species of butterflies and insects as toxicologists only focused on if they were safe for human consumption.

Monarch Butterflies

It has been reported by researchers at Cornell University that the pollen of Bt-Corn can kill monarch butterfly larvae.

John Losey and his team dusted milkweed leaves in the laboratory with pollen from Bt-Corn. Milkweed leaves are what monarch butterfly larvae mainly feed on. They fed the leaves to the caterpillars and after four days, only 56% of the caterpillars survived which is a high mortality rate

compared to non Bt-hybrids. The caterpillars that had survived were only half the weight of the control caterpillars.
Another one of the researchers was Linda S. Rayor (the Cornell instructor in entomology).
"Monarchs are considered to be a flagship species for conservation. This is a warning bell," says Rayor. "Monarchs themselves are not an endangered

species right now, but as their habitat is disrupted or destroyed, their migratory phenomena is becoming endangered." Although there is no harm to humans, other species need to be taken into account.

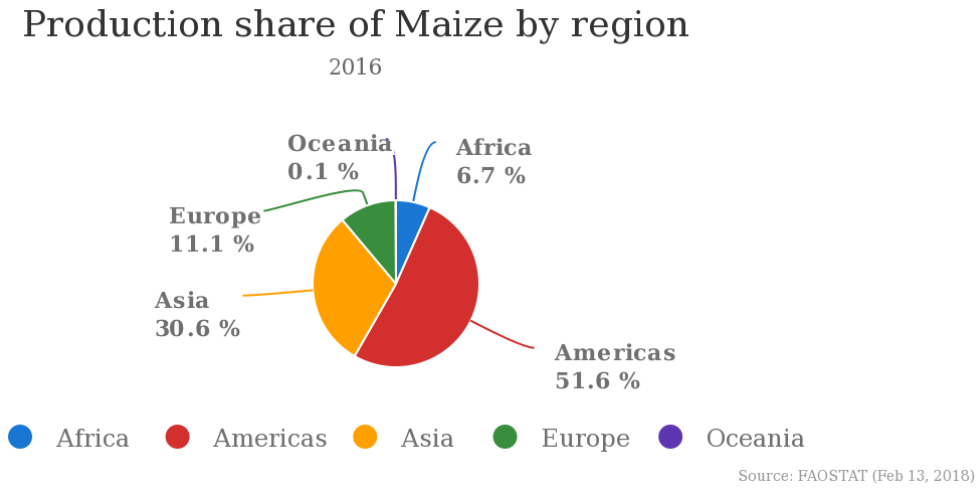
Conclusion

Overall, Bt-Corn is a great success and very beneficial for farmers in controlling the pests that reduce their crop yield and therefore profit. This would prevent food shortages and also result in a better life for farmers. However, the future of Bt-Corn and other GM crops should involve further research into reducing the impact on other species as well as humans. The BT-Corn could be modified further to decrease the negative impact on the monarch butterfly species.

Figure 4 –https://www.flickr.com/photos/scotnelson/14757676393

What are **GMOs**?

GMOs are genetically modified organisms, that are bred to have better traits compared to natural crops. Some of the traits could be drought resistance, pesticide resistance, more crop yield, more nutritional crops, resistance to pesticide killing poisons. These traits are usually taken from the genes of different fungi, bacteria, or even other plants.
One must extract the select genes from the donor organism and plant it in to the wanted plant DNA. Then it must undergo inspection from associations such as the **FDA** (food and drugs administration) and be given the seal of approval before the new GM plant is allowed to enter the market. Giving plants different properties is not a new concept. It has been done since hunter-gatherers started settling down and started mixing different variants of crops to increase results. The difference between the 'natural' way and the modern way is that the **randomness is mostly taken away from the formula**. To create a new type of GMO, it can be done in a few ways:
selective breeding: The ye olden ways of getting better crops. Crops are cross-bred and the crops with the best traits are planted for better yields.
advanced breeding: Breeders search in the plant genome specific traits and tag them. And they cross-breed those plants to yield better results.
GM plant breeding: Genes in a plant genome can be extracted and be inserted to other plants. That way breeders can easily get their desired traits in a plant.



Source: http://www.fao.org/

Why use GMOs?

Recently the demand for food has been greater than ever due to increasing population and the increase of quality of life. to create more food you need to either increase the farm land or increase the efficiency of farming. That is why GMOs have been on the gaze of many people. GMOs have the hope of increasing productivity of farmers, thus increasing the amount of food that can be farmed

per square unit of land. It is predicted that by 2050 the population of humans is expected to grow to c.a 10bln and by 2100 11bln according to a UN publication. Most of the population is concentrated to less developed areas of the world. One way to combat those solutions can be GMOs. Providing seeds that the specific area needs can increase yields.
In the US the average person consumes 15kg of maize related prducts annually. Due to the increasing population to suffice peoples' needs corn production must increase as well.

How **widespread** is corn?

Corn syrup, tortilla chips, sweeteners in soft drinks and baked goods. BT corn has increased popularity over the years.
In 1996 Bt-corn started gaining traction. In 2017 about **80% of the cultivated lands that grow corn,** have Bt-corn on them in the USA. US farmers grow corn on around 80 million acres annually. Most americans have been eating GM foods for the last 20 years.
It is expected that by 2020 the demand for corn is to be c.a 850mln metric tons. Bt-corn has shown to increase yields of crops by around 5%.

An **example** of a GM-corn

Bt-corn is a type of GM-corn. In the case of Bt-corn the donor organism is a naturally occurring soil bacteria *Bacillus thuringiensis*. The gene that was taken from the donor organism is one that kills **corn borers**, a parasite that eats corn and causes about 7-8% of the world corn to be inedible, in their larval state. The protein is highly selective, so it sould only affect the larvae. When the larvae consumes the crop with the Bt protein, it binds itself to the gut walls of the larvae and it stops feeding. Hours later the gut dissolves and the larvae dies to septicaemia due to the gut bacteria invading the organism. The *Bacillus thuringiensis* also carries diseases like *Aspergillus* and infects the crops when feeding, thus possibly spreading the disease on to humans.
Septicaemia - blood poisoning, especially that caused by bacteria or their toxins.
The implementation of this **DNA strand increased the yield of corn and made pesticides far less popular**. Decreasing the use of pesticides helps keep crops more safe for the consumers, because in most of the cases the pesticides linger in the yield that the end-consumer uses.
Bt has been in use since the 1960s and has been shown to be mostly safe for humans.

Why use Bt-corn?

Bt corn is a genetically modified variant of corn and it has been given properties to increase crop yield, help fight against competition, disease resistance etc.
GM corn offers distinct advantages over natural corn and has over the years increased yields per area unit. So it makes farming **more efficient**, require **fewer resources** and increases **profits**. GM corn can also be given better nutritional properties to people with a specific nutritional deficiency for example.

Bt-corn **Bt delta Endotoxin**

Bt-corn contains the Bt delta endotoxin. It was selected because it was very effective against the larvae of corn borers called ***Lepidoptera larvae***, who cause the most damage to maize. The **protein** is very selective and only targets the **gut of the larvae**. It binds to the gut wall and the insect stops feeding. Within hours the gut wall breaks down and the gut bacteria invade the organism. The insect dies of septicaemia due to the presence of the bacteria in the blood system. That is why it does not harm other insects such as beetles like other pesticides do. Although it specifically targets the corn eating larvae, there are many species and different species are more or less sensitive to the Bt delta endotoxin.
According to Monsanto…

What is **Monsanto**?

Monsanto is a public American multinational agrochemical and agricultural biotechnology corporation. Monsanto is the leading producer of Gm- seeds and many kinds of herbicide.
Monsanto once used to produce many now known harmful substances such as DDT, PCBs, Agent Orange and recombinant bovine growth hormone.
Its' business model of patenting their seeds has been lessening biodiversity and has the company has seen much controversy due to those business strategies.

History of Monsanto's controversy. Only selected the information that has seen much backlash

Monsanto was founded in 1901 as a chemical company. Their first products were artificial sweetener saccharin, caffeine and vanillin. In the 1935s they started manufacturing Polychlorinated biphenyl aka
PCBs thus expanding in to industrial chemicals.
In 1944 Monstanto started producing Dichlorodiphenyltrichloroethane aka DDT.
In 1977 Monsanto stopped producing PCBs and its' ban in the US followed 2 years later.
In 1983 Monsanto was the first to publish a paper on genetically modifying a plant.
In 1988 they did their first field tests of GM-plants.
1996 was the year when Monsanto purchased the company Agracetus that was the first to produce transgenic cotton, soybeans, peanuts and other crops.
In 1996 Monsanto also bought Dekalb, that marketed agricultural seeds, thus entering the corn seed business.
In the 20th century Monsanto changed face to a new "Monsanto" in 2000 when it spun-off its' agro-biotech subsidiary in to a new company.
Monsanto has had a history of producing harmful compunds and have pushed them in to the market with not enough research to back up the safety of the product. Monsanto has **lost their credibility in peoples' eyes.**

Why do people **oppose** consuming Bt-corn?

Studies have found that some variations of BT corn have caused damage to the digestion system of rats.
For example a study was conducted on a corn containing *Bacillus thuringiensis* genes producing **delta endotoxins** in the whole plant in order to give the plant insecticide properties. The studies purpose was to find the effects of the crop on male albino rats' gastrointestinal tract and the study found that

the corn **damaged various areas of the gastrointestinal tract**. Also vastly altered, or mutated specific cells of the jejunum in the intestines.

Also in 2012 'Moms across America' published a report that found that GM corn has way **less calcium and magnesium** compared to traditional corn. Magnesium and calcium are necessary for a human and even more so to a developing human.

The article also stated that GM corn has **glyphosate**, **formaldehyde** and **chloride levels** which are dangerous to animals and humans compared to traditional corn where such chemicals are mostly non-existent. The lack of various necessary minerals and metals may **cause health issues** down the line.

2012 Nutritional Analysis[1]
Comparison of GMO Corn versus Non-GMO Corn

	GMO Corn[2]	Non-GMO Corn[3]
Available Energy (ERGS)[4]	100	340,000
% Brix[5]	1	20
% Organic Matter	1.2	2.1
Phosphate ppm	3	44
Potassium ppm	7	113
Calcium ppm	14	6130
Magnesium ppm	2	113
Sodium ppm	5	0.2
pH	7.5	7.01
Cation Exchange Capacity	3	44
Base Saturation		
% K	0.7	9.2
% Mg	0.2	9.2
% Ca	5	62
% H	0	0
% Na	6.2	0.3
NO_3 ppm	2	4
NH_4 ppm	5	42
Sulfur ppm	3	42
Manganese ppm	2	14
Iron (Fe) ppm	2	14.3
Zinc ppm	2.3	14.3
Copper ppm	2.6	16
Cobalt ppm	0.2	1.5
Molybdenum ppm	0.2	1.5
Boron ppm	0.2	1.5
Selenium ppm	0.6	0.3
Carbon ppm	2	60
Chloride ppm	10	1
Anaerobic biology ppm	60	0
Chemical content ppm	60	0
Chlorides content ppm	60	0
Formaldehyde content ppm	200	0
Glyphosate content ppm	13	0
Positive Traits		
Aerobic biology %	1	100
Test Weight (lbs/bu)	57 – 58 lbs	61 – 62 lbs

[1] Field comparison of GMO vs. non-GMO next to each other.
[2] GMO/Roundup Ready for ten year.
[3] No Roundup Ready on the crop/soil for five years.
[4] ERGS equals energy giving off per gram per second.
[5] Brix is a quality measurement. The higher the number the more nutrition, energy and protein in the feed sample.

1

source: http://www.momsacrossamerica.com/tags/2012_corn_comparison

What Monsanto claims was that the gene specifically warded off insects, but the study disproved that statement.
Due to this Monsanto has been questioned by many voices. The discrepancy between what Monsanto says and how the corn behaves has put doubt in to the eyes of the people. People have been trying to stay away from GM plants due to those doubts.

Alongside Bt-corn its' **attackers evolve**.

Over the years these so called superweeds have risen on corn fields that are resistant to various herbicides.
For example **Roundup** is one of Monsantos' most popular herbicides and alongside it they have developed a corn type that is unaffected from glyphosate, the compound that is the bulk of Roundup. Many farmers nowadays are having a tough time dealing with weeds that have grown to become resistant to Roundup. This brings up the question if pouring such herbicides, pesticides etc is good in the long run.
The more such preventative measures we use, the more strains of weeds, insects may come up. Due to this farmers have grown weary and have become **dependant** on Roundup and Monsantos' seed because the weeds have grown only stronger and stronger. In the long run farmers become dependant on GM-seeds, because the pests have become immune to traditional pesticides. Increasing seed prices could be devastating for farmers that have become dependant on GM-products.

GMOs in **Europe**

The **European Commission** has laid out a legal framework to ensure that modern biotechnology, and more specifically modern GMOs, takes place in safe conditions.
The legal framework aims to protect human and animal health and the environment, put in procedures for risk assessment and authorisation of GMOs that are efficient, time-limited and transparent, ensure that all GMOs are labelled as such in order for consumers to make an informed choice and ensure the traceability of GMOs placed on the market (European commission).
Most GMOs have not been able to pass their standards and have been denied and some more acceptable GMOs have been on hold for over 10 years waiting for the approval of the EU. It has made **GMOs next to non-existent in Europe**. Only the Bt-corn has been able to pass their regulations and it has seen some use in **Spain**, but not much elsewhere and is only used as animal feed. The spanish farmers saw significant reductions in toxic mycotoxin levels when compared to traditional corn.
In 2010 the European Commission conducted a public survey about biotechnology and GMOs. The survey found that Europeans do not see the benefits of GMOs. 59% consider them to be unsafe or even harmful and are not in favour of developing GMOs and 70% say that GMOs are fundamentally unnatural. The study found that Europeans are overall accepting of biotechnology, but not in favour of GMOs.
In 2010, just **over half** of respondents from all the countries in the EU believe that biotechnology will have a **positive effect** on our way of life.

Patent discussion

Among the many contentious issues related to GMOs under public discussion, **legal issues** are in the spotlight.

There is debate as to how much **patent protection**, if any, should be granted to GMO companies, and whether the patent rights have been utilized rightfully against farmers. The court seems to be by and large standing with the companies.

an example for the questionability of the patent:

in the Philippines the BT corn was supposed to be an amazing opportunity for poor farmers. Unfortunately for these farmers they have to buy BT corn each year. BT corn is much more expensive and these farmers technique of farming is to keep old seeds. If they don't buy these seeds each year they can get into a lot of trouble.

Another huge legal problem with BT corn is cross contamination. This issue goes both ways. If one individual has BT corn and it pollinates another field than that field is now contaminated. Since there is a patent on those seeds those people with cross contaminated fields could get sued. Also an individual growing organic crops that has there filed contaminated now has a ruined field.

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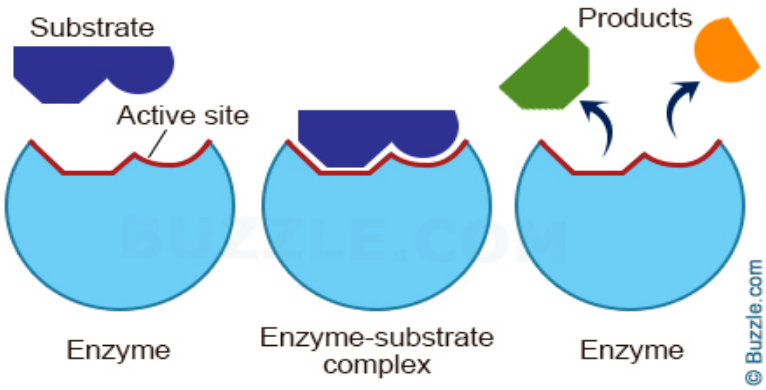
Enzymes in the food processing industry

Google defines an enzyme as "a substance produced by a living organism, which acts as a catalyst, to bring about a specific chemical reaction'' ; they are not used up in the chemical process. They are made of proteins and, more specifically, long chains of amino acids and have been used to produce cheese, yoghurt, bread, wine and beer for at least 8,000years. However, the people involved in manufacturing these goods were not aware of the existence of enzymes. Since the 1950s, enzyme technology has taken off and it is now the basis of the new industry called biotechnology.

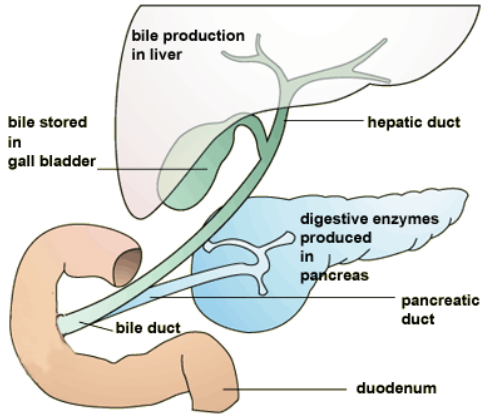


https://biochem80p.wordpress.com/tag/enzymes/

The process in which an enzyme breaks down a substance is simple: we can look at the lock-and-key model. Firstly, the substrate meets the enzyme and the two interlock much like a key fits a lock. They form an enzyme-substrate complex on the active site of the enzyme. The enzyme splits the substrate into several products. For example, in the stomach the protease breaks down proteins into smaller amino acids to be absorbed by the small intestine. The smaller products are more easily absorbed than larger molecules. For further detail, see the induced fit model, where the active sit is only slightly complementary and moulds itself around a substrate. This is continuously happening in your body.

Enzymes are involved in the food processes in our body: The stomach produces hydrochloric acid. This helps to begin digestion, and it kills many harmful microorganisms that might have been swallowed along with the food. The enzymes in the stomach work best in acidic conditions - in other words, at a low pH.

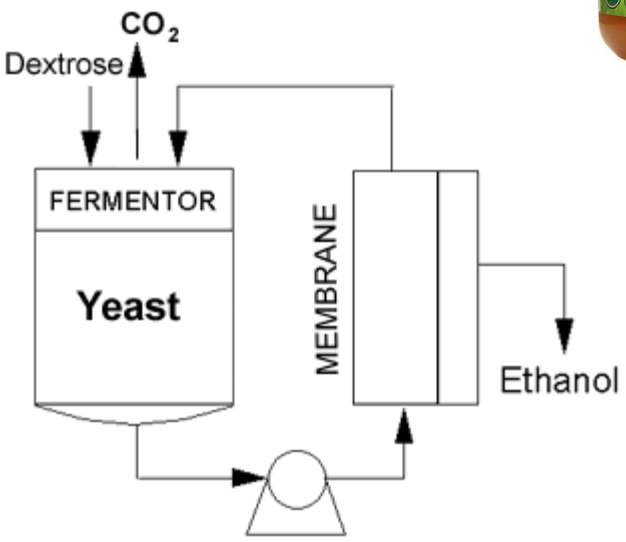
After the stomach, food travels to the small intestine. The enzymes in the small intestine work best in alkaline conditions, but the food is acidic after being in the stomach. A substance called bile neutralises the acid to provide the alkaline conditions needed in the small intestine. In industry therefore we have to be knowledgeable on these conditions.



http://www.bbc.co.uk/schools/gcsebitesize/science/add_aqa_pre_2011/enzymes/enzymes_and_digestion3.shtml

In industry, we need to mimic the bodial conditions in order to use enzymes for a specific function, whether it's a higher yield, or faster produce. For example, in the production of baby food we use enzymes. The enzymes are kept in a specific pH and at a certain temperature to allow them to break down the food, making it easier for a baby to swallow – with similar conditions to the body. We can see more industrial uses of enzymes in beer production.

http://faculty.fshn.illinois.edu/~mcheryan/ethanol.htm

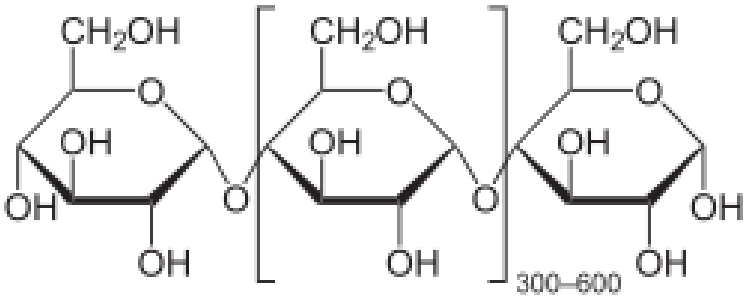


https://www.amazon.com/Earths-Best-Organic-Veggies-Potatoes/dp/B00FFJ3TJA?t

Enzymes are key in the production of beer through fermentation: starting with glucose, we can make beer. We can ferment glucose using yeast to produce ethanol and carbon dioxide. Enzymes in yeast cause this reaction, which is a fermentation reaction (due to the absence of oxygen). The fermentation works best in a warm solution, roughly 35 degrees celsius. This is similar to the temperature of the body – if the body however exceeds this temperature, the enzymes become denatured and their active sites can no longer fit substrates. This is a limitation of using enzymes, hence why we keep yeast in a dry cupboard, as oppose to a fridge or a considerably hotter location.

Other disadvantages of using enzymes obviously include the expensive costs to buy and extract pure forms, as impure mixtures from cells are ineffective and the difficulties in removing soluble enzymes from liquid products in solution, after they have catalysed the reaction – i.e. they could interfere with experimentation.

Enzymes, despite having these drawbacks have many positive features too: one enzyme molecule can catalyse 10 million reactions in a single second, furthermore this statistic stresses how effective they are at increasing the rate of chemical reactions. Secondly, the enzymes having the denaturing drawback can be beneficial because they work at lower temperatures, which saves money and energy. Enzymes can be 10,000times more efficient than ordinary catalysts too. The sheer speed at which they increase reactions can meet the quick demand for produce. We can see this is the production of polysaccharides using enzymes. We obtain these using starch.



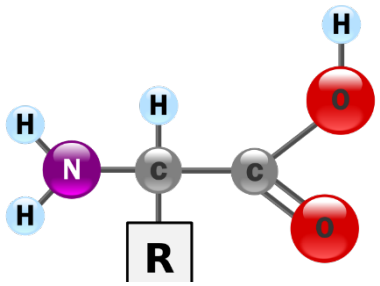
https://en.wikipedia.org/wiki/Starch

Starch is the most common insoluble storage carbohydrate in plants: starch is made up of two main components – amylose and amylopectin. Starch can be broken down into different monosaccharides and polysaccharides, which are sugary syrups. This include glucose, fructose, sucrose, maltose, maltotriose and raffinose. We use several different enzymes to get different syrups. These are then used in the food industry as a cheap replacement for sugar. It is easy to obtain all of these by breaking down starch with enzymes.
This is how enzymes are used in the food processing industry and the food processing industry, within our bodies.

What are amino-acids?

First of all, amino-acids are organic compounds containing both an amino group (NH_2) and a carboxyl group (COOH) connected by a CH group with a specific R compound connected to the carbon in the middle. The generic formula for an amino-acid is H_2N-CH-R-COOH.

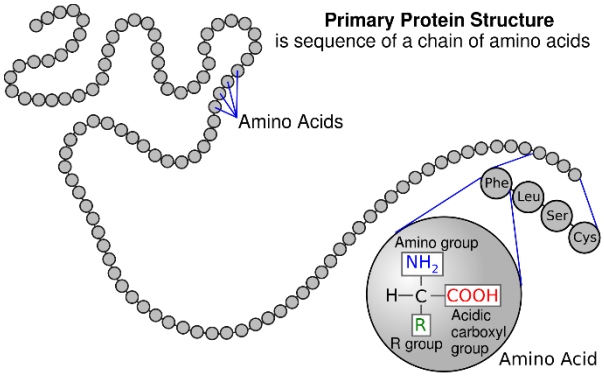
There are more than 500 amino-acids currently known, but only 20 of them appear in the human DNA as parts of the proteins. In fact, as they are the components of proteins, they are the second-largest compounds in human body.



https://commons.wikimedia.org/wiki/File:AminoAcidball.svg

The amino-acids differ from each other in the R group, which can be organic compounds alone or after a polymer chain. Based on the number of carbons in this chain, they are divided in classes using Greek alphabet letters.

As part of proteins, which make up cells and our whole body, the amino-acids are the most important basic components in our body and they are responsible for our metabolism in muscles, organs and the cells themselves. But they also have other functions: they are optimal for transportation or storage of nutrients, like water or fats, they can be oxidized to produce energy, or they can be used to synthesize other molecules used in our body, like neurotransmitters.



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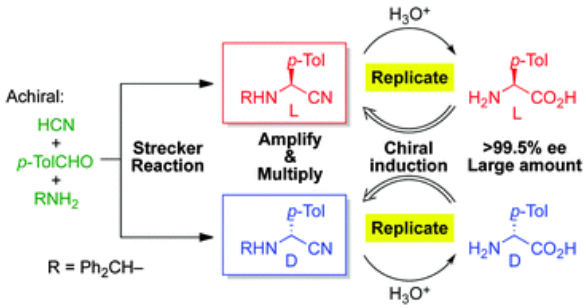
In fact, the best way to deliver amino-acids to our body is not by eating simple food, because the protein chains must be digested by the liver and it is a long and less effective way, but by eating pure amino-acids in integrators, because amino-acids get directly absorbed by our body and get in the circulation within 15 minutes.

Nine of the 20 amino-acids used in our proteins cannot be produced by our body, that is why we have to consume various types of food to integrate all of them. If special amino-acids are not available to our cells it could lead to metabolism diseases because some proteins are not produced anymore.

The first amino-acid has been discovered 1806 by the French chemists Louis-Nicolas Vauquelin and Pierre Jean Robiquet; the last one of the 20 common amino-acids has been discovered in 1935 by William Cumming Rose and he also discovered which are the essential amino-acids for the human body.

How does the chemical production work?

The chemical production usually uses the Strecker-amino-acid-synthesis, also known as Strecker synthesis, where aldehydes (RCHO), ammonia (NH_3) and hydrogen cyanide (HCN) react to form an α-amino-nitrile, which is subsequently hydrolysed to give the desired amino-acid.

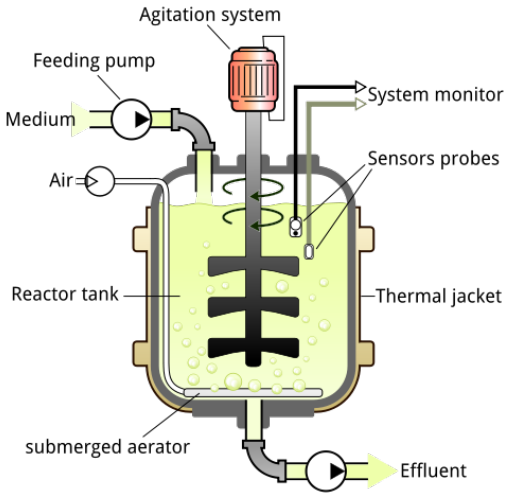


http://pubs.rsc.org/en/content/articlelanding/2016/cc/c6cc05544c#!divAbstract

How does the biotechnological production work?

Biotechnological production of amino-acids consists in a synthesis process that goes through bacteria cultures and fermentation. The first bacteria used for the culture were E. Coli but then C. Glutamicum was discovered for the production of glutamic acid and it replaced Coli in all the other fields of amino acid production.

First of all, to make the bacteria capable of producing an amino acid, genetic engineering is used to transfer a certain gene into the bacteria DNA. Then, the bacteria are cultivated in a bioreactor with a substrate where they can ferment and give us the amino acids as a product, which are then separated from the other stuff using different techniques.



https://commons.wikimedia.org/wiki/File:Bioreactor_principle.svg

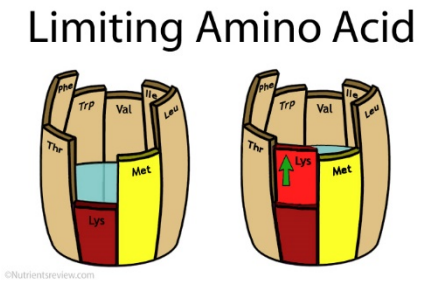
What are the differences between the two methods?

In the chemical production, some of the reagents are toxic and it has to be catalysed in a particular way, while the biotechnological way may be slower but does not have any problems, it is easier and much more sustainable because it works as a part of the environment even if it is artificial. In the chemical way you also have to still renovate reagents while the biotechnological process is continuous and can be carried over for a long time with a stable production.

What are they used for?

In first place, for the animals, essential amino-acids are used to feed them to increase the profit. In common animal food you have deficiency of some amino-acids, like Lysine, so by feeding them with these types of amino-acids you can control their health and meanwhile also increase the production with less food.

They are also used to treat nutrient deficiency or increase energy in the human patients. Some non-proteic amino-acids are instead produced and used in the pharmaceutical industry

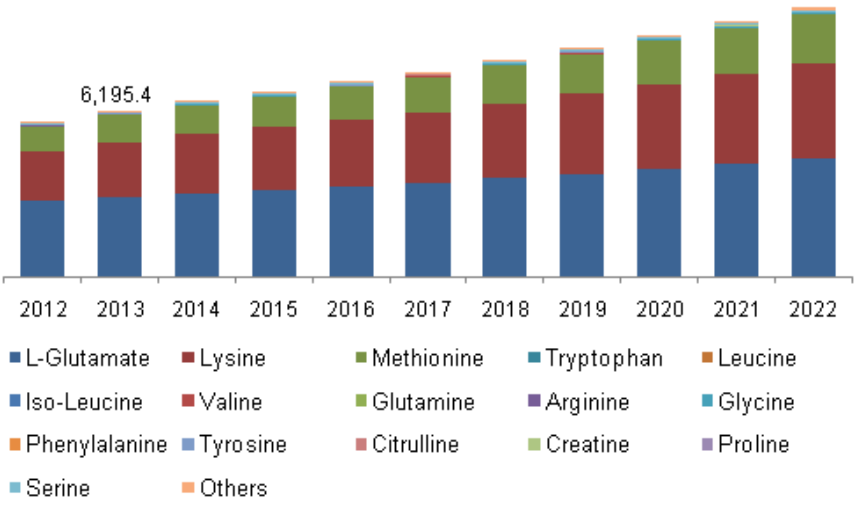


http://www.nutrientsreview.com/wp-content/uploads/2014/10/Limiting-Amino-

because they can be converted to neurotransmitters, like tryptophan.

Amino-acids in industry

The amino-acids industry is a field in development: in 2013 there were 6.19 million tons produced worldwide. The production is expected to grow continuously in the next years, especially for L-Glutamate, Lysine and also Methionine. There are various industries that are specialized in the amino-acids production: for instance Evonik Industries is a worldwide famous German company that uses biotechnological techniques to produce amino-acids for the animal food industry.



https://www.grandviewresearch.com/industry-analysis/amino-acids-market

In conclusion, amino-acids are one of the most important factors for life and we are not able to produce all of them by ourselves, so it is fundamental to have renewable and effective ways to produce them. The biotechnological way is by far the best method that can be utilized, because it uses natural instruments and it is quite self-sustainable. Manufactory is already using this method in the most part and research is also considered really important to further develop it in the best way possible. Biotechnology is already a big sector and it will grow faster than any other, as technology did in the past 20 years.

Company Profile – Janssen Pharmaceutical Companies

Photo by: Lynn Jakobs

Janssen is one of the biggest pharmaceutical companies in the world, specialized in vaccines and biopharmaceutical technologies. Its vaccines are sold in public and private markets worldwide. Janssen's core portfolio includes a vaccine against hepatitis B, a fully liquid vaccine against five important childhood diseases, and a virosome-adjuvanted vaccine against influenza. Janssen also sells the only oral anti-typhoid vaccine, an oral cholera vaccine and the only aluminium-free hepatitis A vaccine on the market.

History

Janssen was founded in 1953 by Dr. Paul Janssen in Belgium. He was a young doctor who wanted to save lives by developing better cure for diseases. Under the supervision of Dr. Paul Janssen they developed medication in different treatment areas.

Janssen joined the Johnson & Johnson-group in 1961. In 2011 all the pharmaceutical activities of Johnson & Johnson started to go by the name Janssen Pharmaceutical Companies. Joining Johnson & Johnson gave the opportunity to exchange knowledge and ideas with scientists around the world.

Johnson & Johnson

Johnson & Johnson is an American Multinational founded in 1886. The company is active in the pharmaceutical industry and medical and consumer products. The Johnson & Johnson-group consists of 265 companies in 60 countries and has about 128.000 employees worldwide.

https://upload.wikimedia.org/wikipedia/commons/thumb/e/e9/Johnson%26Johnson_Logo.svg/1000px-Johnson%26Johnson_Logo.svg.png

Products

Janssen has a wide variety of products in different therapeutic areas. They currently have 45 different medical products for cardiovascular & metabolism diseases. Janssen wants to eliminate the cardiovascular diseases and diabetes. Janssen wants to cure all the immune-meditated diseases around the world. Right now they have 16 products on the market to treat the diseases. They have 94 vaccines for infectious illnesses. Janssen wants to reduce the misery caused by neuropsychiatric diseases and pain conditions by providing 122 products against it. Janssen also provides 28 products to prolong and improve cancer patients' lives.

Technologies

Janssen has 12 research and development centres and 9 manufacturing sites in Europe, Africa and the Middle East.

Janssen has a broad development pipeline, with several Janssen products based on its unique PER.C6® production technology. The Company licenses this and other technologies to the biopharmaceutical industry. PER.C6® is a human cell line technology, it is good for manufacturing vaccines and monoclonal antibodies on a large-scale. It is especially good for manufacturing hard-to-grow viruses and by doing so it lowers the cost of the development of vaccines.

Janssen also uses its AdVac® production technology based on the development and production of gene carriers. It can be used together with PER.C6® technology to develop recombinant vaccines against life-threatening infectious diseases.

Sources

www.janssen.com

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Environmental problems

The problems that are caused to our health and environment by waste disposal are timely issues. Waste production has grown dramatically over just a few decades and is set to triple by 2100, decreasing the amount of land available and increasing disposal costs which were already as much as $205 billion in 2010.

Picture (1): landfill

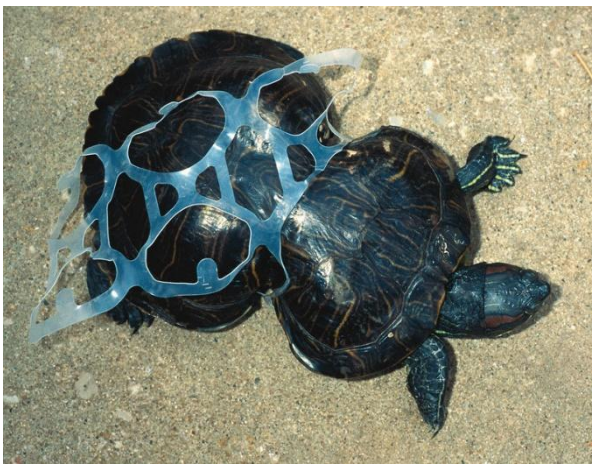
Normally in nature substances are in circulation. It's ensured by different living organisms like anim als and plants. Microorganisms have a huge part in that circle. They produce various enzymes to degrade organic compounds.Thanks to microbes for example dead organisms are decomposed. Everything that is in normal circulation and can be degraded by natural factors like microbes (e.g. bacteria, fungi and few more) and abiotic elements like temperature, UV, oxygen are called biodegradable wastes. Some examples of such wastes are food materials, kitchen wastes and other natural wastes.

Microorganisms and other abiotic factors together break down complex substances into simpler organic matters which eventually suspend and fade into soil. The whole process is natural which can be rapid or slow. Therefore the environmental issues and risks caused by biodegradable wastes are low. Bigger problems are related to non-biodegradable wastes. Unlike biodegradable wastes, they cannot be easily disposed of. Non-biodegradable wastes are those what cannot be decomposed or dissolved by natural agents. They remain on earth for thousands of years without any degradation. Hence the threat caused by them is also more critical. A notable example is the plastics which are a commonly used materials in almost every field, produced at a rate of about 300 million tons globally each year. Only about 10 percent of that is recycled.

To give these plastics a long lasting effect, improved quality plastics are being put to use (PET). This made them more temperature resistant and more durable even after use. Other examples are cans, metals, and chemicals for agricultural and industrial purposes. They are the main causes of air, water and soil pollution and diseases like cancer. As we become more technologically advanced, we produce materials that can withstand extreme temperatures, are durable and easy to use. Plastic bags, synthetics, plastic bottles, tin cans, and computer hardware- these are some of the things that make life easy for us.

But what we forget is that these advanced products do not break down naturally. When we dispose them in a garbage pile, the air, moisture, climate, or soil cannot break them down naturally to be dissolved with the surrounding land. They are not biodegradable. However natural waste and products break down easily when they are disposed as waste. Since non-biodegradable wastes are not eco-friendly, they need to be replaced. As a part of a development of alternatives, scientists have brought forward many ideas like biodegradable plastics. When we focus our science more on eco friendly materials we will have a greener future.

Wastes gathered in huge landfills on land and oceans cause a lot of environmental problems. The toxic wastes contaminate the soil and water that eventually make it to our food and drinking water. Plastic containers in oceans and estuaries can harm fish, seabirds and other marine life. Plastic wrappers in all shapes and forms insure, trap or suffocate marine animals. Microplastics, tiny bits of polypropylene or polyethylene, hide beneath the water and pose a risk as well.



Picture (2): turtle in plastic

Nature's defence systems

Nature does however have mechanisms for dealing with the problems of non degradable substances through the adaptation of bacteria by natural selection which now produce enzymes to solve the issue. The production development of new plastics however has dramatically outstretched nature's capacity to deal with the solution, with plastics only being discovered in 1839 and mass produced around the 1950s nature has not had the time to adapt and find a solution. New discoveries have been made however into how this process works which can probably be used to our advantage

picture (3): recycle

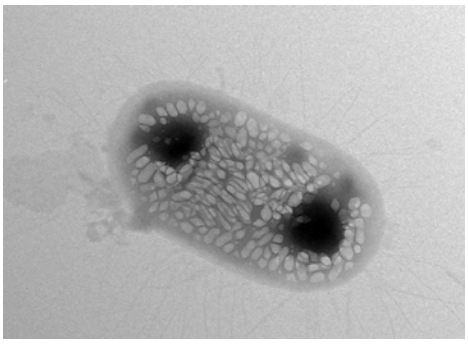
In 1975 a team of Japanese scientists discovered a strain of Flavobacterium living in the wastewater ponds next to the factory; while this should of been a natural occurrence these bacteria had developed an appetite for one type of nylon by-product which is used in the production of nylon 6 proving that nature can adapt to deal with the problem.This however is very limited because of a few problems:

The chain is only 6 carbons long (whereas polymers like PET are many thousands of carbons long and are very stable). The mutation that occurred produced an enzyme that was only just complementary to the substrate, so it has a long way to go before it is a viable solution to disposing of the large amount of plastic waste that we produce. There is a huge amount of different types of polymers which all need a different type of enzyme to break them down. Because of these reasons the development of natural enzymes does not seem to be a valid solution for the issue if it is to be solved within a few decades.This is the same for another type of bacteria which has been found to degrade PET, (again discovered by japanese scientists) although solves the first and partly the second issue it's still lacking a solution to the second problem as it has proven to be very slow and limited.

These issues could all be solved within a few thousand years by natural processes, however at the rate humanity is progressing new solutions need to be developed faster to meet the demand of our production; because of this the only solution that seems viable is bioengineering the bacteria/fungi to produce better enzymes to degrade the waste substances more efficiently or to develop new types of more biodegradable wastes (which is an undesirable trait if you want to have a bottle that any substance that contains water) so a new type of bioengineering needs to be used.

Bioengineering

Bioengineering bacteria to produce a different enzyme is done by the process of transformation were genetic material is inserted into the bacteria by using a bacteriophage virus or by weakening the cell membrane of the bacteria and allowing DNA to diffuse into the cell; this then will be translated by the host bacteria expressing the gene as a protein which is new or different.



Picture (4): genetically engineered E.Coli

What this means for soil remediation is that bacteria can be programed to create new enzymes which can break down our non degradable plastics into simple monomers that can be degraded by bacteria. Although we cannot find examples of this being used for the specific purpose of bioremediation, it is still in its early years and shows promise (especially with the development of new techniques for gene insertion (CRISPR-CAS being one great example) means that it can be done quicker and more efficiently making it a more of a viable solution in the near future.
They can then be added into landfill or contaminated soil (this has to be under ideal conditions; moist, 30 degrees, oxygenated and supplied with nutrients) where the plastics will then slowly be turned to soil/sludge.

It's however not without issues. If a bacteria that degraded PET got released outside of the soil and entered a city it would wreak havoc and degrade the plastics in buildings, cars and bikes within a matter of decades (or at least damage it beyond repair). Smaller problems include; the amount of CO2 given off by the decomposition and plastics which contain chemicals like chlorine (PVC) which can damage the environment.

In conclusion the waste problem in today's world is huge and it needs to be dealt with.There are two problems for what we need to find a solution for: firstly, we need to find alternative eco friendly materials that ensures minimal damage to the environment and secondly, we need to come up with good solutions for fast degradation for non-biodegradable materials.One solution for it is bioengineered microorganisms which can produce efficient enzymes that will degrade now non-degradable plastics. In that way we can help nature to deal with this problem by herself.

Picture sources:

1. *https://www.flickr.com/photos/cogdog/9090732482/in/photolist-eRjo3W-84aTYx-eRjoG1-84bdyg-7rg16S-84bbFg-84e1Cq-84aT4p-9tQiXH-84ejDA-84bgv6-84dZFA-84fpX5-84enWE-84dVQf-6hBZ7Y-84dUPJ-84bkEM-84fp8h-84cfHK-84fiU7-84fogS-84fqMQ-84esLw-84cpZV-qe1dsa-84cnx8-84fthy-84emBC-68STUB-84eiw3-6oUUjL-6P81Cj-nHTAe-nHTzK-nHTz1-nHTxR-eGv6jp-6wF7Zx-dS37Ki-bxDzsY-bpW1Uy-JqQp2-batm9X-8fxPeL-6tGj1z-ot4k7p-ga5Q9i-6oQLjF-otj1hb*
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All around the world crops are being destroyed by pests. When we hear pests we think of crops or other plants being damaged by rats, insects and weeds. Pests have negative effects on agriculture and on the economy because pests destroy 20% to 30% the worlds agricultural production, this is a big problem. Crops are lost to these factors:

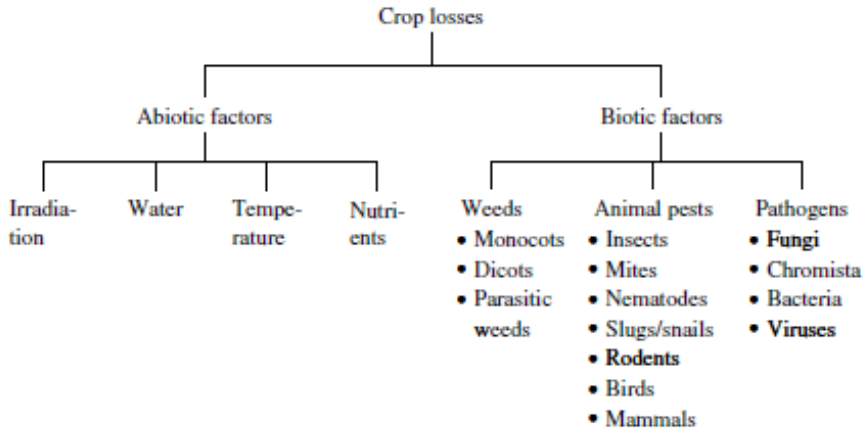


Fig. 1. Abiotic and biotic factors causing crop losses.

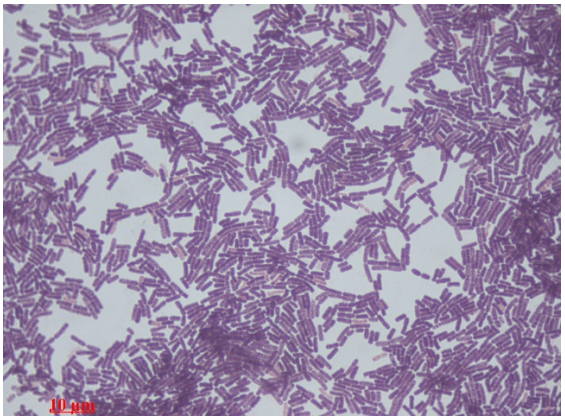
Chemical pest control

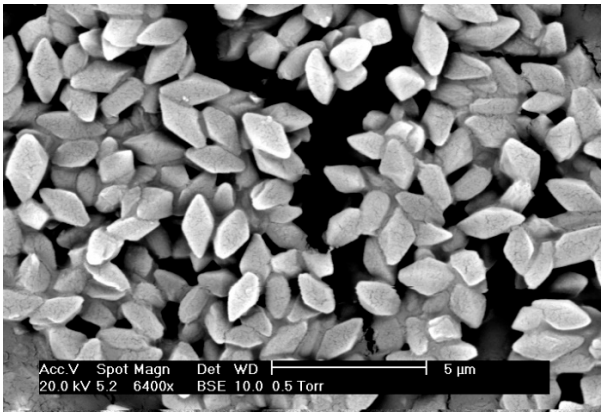
There are around 67000 different species that effect a lot of crops negatively. To find a solution for every crop with all of these different species is nearly impossible because there are so many. As a solution there are a lot of chemicals being used to prevent the crops from getting ruined. These chemicals are used as toxicants, sterilants, growth regulators and semiochemicals. Toxicants are supposed to kill pest that come in contact with the chemical, sterilants eliminate the reproductive potential of pests, growth regulators disrupt their development potential and semiochemicals influence their behaviour. Even though chemical pestcontrol is bad for your health and for the environment because they also kill useful insects there are some benefits to using chemicals. Using chemicals is very cheap and readily available.

Biotechnology as pest control

Biotechnology can also be used as pest control. It can improve crop insect resistance, it can enhance crop herbicide tolerance and facilitates the use of more environmentally sustainable farming practices. As a form of pest control, biotech can be used on crops so that they need fewer applications of pesticides. With this kind of pest control crops get genetically modified so they are toxic to certain insects. An organism is genetically modified when the DNA has been altered by the

insertion, deletion or a mutation of a gene. When genetic modification is used as pest control, we often insert a different gene from another organism. Most of the time the aim is to insert a new trait into the crop. This way the plant will create a resistance to pests, diseases, environmental conditions or chemical treatments. This will give the crop an advantage. Often the bacteria Bacillus thuringiensis is used, these bacteria produce a group of toxins called Cry toxins. When the gene of these bacteria are introduced into the crop, the crop is called a Bt crop and now produces the Cry toxin. The Cry toxin paralyzes the insects digestive system which causes their death.





Bacillus thuringiensis, https://id.wikipedia.org/wiki/Bacillus Cry Toxin, https://commons.wikimedia.org/wiki/File:Bt-toxin-crystals.jp

Other ways of biological pest control can be importation, augmentation or conservation. Importation introduces a pest's natural enemy to a region where they don't occur naturally. This method can very efficient but sometimes it can be dangerous because the newly introduced specie can become a pest itself.

Augmentation is a method that releases natural enemies that already occur in the area. This will boost the naturally occurring population in that area. This method is sometimes less efficient than importation but it is safer than that, because it doesn't disturb the biological system of the environment. There are two ways of augmentation either a big amount of "control agents" are released at once to rapidly decrease the pest or a small amount is released at intervals to keep the pest down to a low level.
Conservation is a method that keeps the already existing natural enemies in the area to target the pests. This method is very simple and cost-effective.

Advantages and Disadvantages
Some advantages of chemical pest control are is that the method is cheaper than the other methods and it is readily available. But to chemical pest control are a lot of disadvantages like the fact that the chemicals can be very poisonous not only to the pests but also to other animals and even to humans. The chemicals can be poisonous to the natural enemies of the pests which is bad because that way the enemies will not kill the pests and the population of pests will grow even faster. Another disadvantage is that the pests can become resistant to the chemical and that the pest control will not work.
Some advantages of the biotechnological methods are that these methods are more efficient than the other ones. The biotechnological ways are better for the environment because you do not need

the chemical pesticides anymore. There are some disadvantages to this method as well. One of them is that it is very expensive and quite hard to do. A lot of people are against this method because they do not think it is good to change the DNA of an organism.
Some advantages of the biological methods are that they are quite easy to do and have not a large influence on the environment. Some disadvantages of these methods are that they take a long time to plan and sometimes these methods aren't effective immediately.

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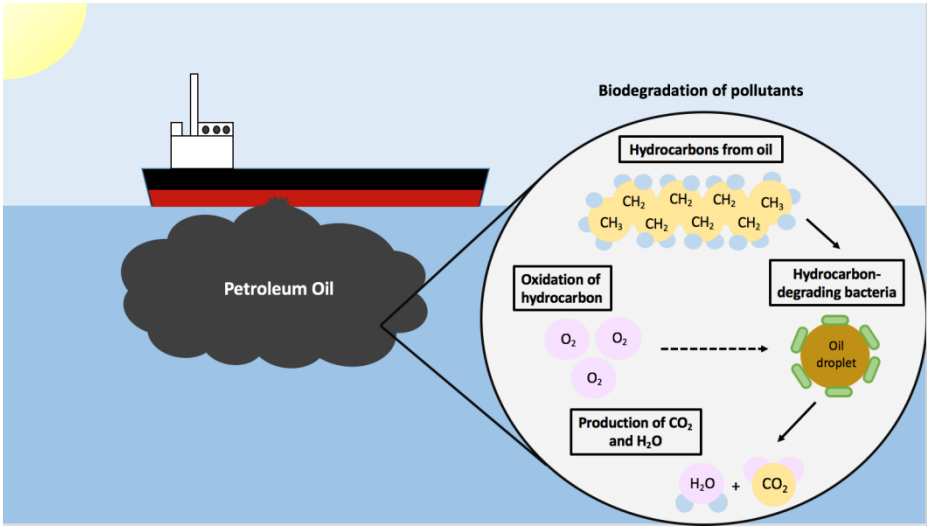
Oil spills are one of the most discussed environmental problems of our age: every year, due to the leak of petroleum in the sea, caused by oil tanker accidents, serious damages occur both to wildlife and to our environment.

Free image on: https://www.worldwildlife.org/stories/five-years-after-deepwater-horizon-spill

Many controversies have raised about which new technology performs the best result in oil remediation, but in recent years a new method involving the use of bacteria caught on.
Indeed petroleum hydrocarbons contained in crude oils are natural products derived from algae laid down 100-200 million years ago, that constantly input small amounts of aliphatic and aromatic hydrocarbons as waste products. Therefore we can say that crude oils are naturally a part of all marine environments. Because of this, a huge number of aquatic microorganisms have evolved the capability of turning hydrocarbons into carbon dioxide and energy; in other words they are able to use what we commonly call "pollutant compounds" as source for their growth. The use of microorganisms in order to degrade contaminants, such as oil, is called "bioremediation".
In particular, in order to find out more about these microorganisms' metabolism, biologists have analyzed two different bacteria: *Alcanivorax borkumensis* and *Oleispira antarctica.* Both of them are called hydrocarbonoclastic, which literally means "able to break hydrocarbons".

Alcanivorax borkumensis

Alcanivorax is a marine bacterium which naturally propagates in seawater containing crude oil. Its genome encodes for a wide spectrum of efficient oil-degrading enzymes that can be used in bioremediation of spills.
Not very much is known about the exact method used by *Alcanivorax* to biodegrade oil, but some hypothesis seem to be very close to the real mechanism. Oil leakage into aquatic environments causes an increase in phosphorus and nitrogen, natural nutrient of this bacterium. The increased nutrient availability causes *Alcanivorax* to grow faster and population to increase. Each bacteria forms a biosurfactant, an extra layer along the cell membrane. The substances that make up these layers can reduce the surface tension of water and have a function of emulsifiers, which help to break up oil into droplets. *Alcanivorax* creates a biofilm around oil droplets. In the end, two important enzymes (AlkB1 and AlkB2) are used to oxidize alkanes and obtain carbon dioxide and water, necessary for the bacteria's growth.



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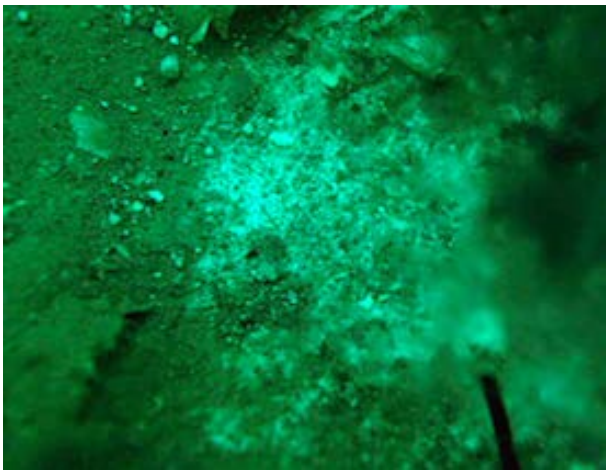
Alcanivorax's genome also codes for several defensive mechanisms. It flourishes almost only on or near to surface of water thanks to its mechanism of protection against UV radiation.

Oleispira Antarctica

Oleispira Antarctica is an aerobic marine bacterium and, just like *Alcanivorax,* has shown to play a significant role in biological removal of petroleum hydrocarbons from polluted waters.

Its name derives from the place where has been isolated for the first time: the Ross Sea in Antarctica. Indeed, *Oleispira* is a cold marine species, which means that is able to perform remediation of oil even in cold and deep water, where *Alcanivorax* can't live. Some gene clones belonging to *Oleispira* were found to be very common in samples obtained from deep underwater depths at the *Deepwater Horizon* oil spill in 2010.

This bacterium's metabolisms has shown to be very similar to *Alcanivorax*'s, but *Oleispira* can live in anaerobic conditions too, even if with some difficulties.



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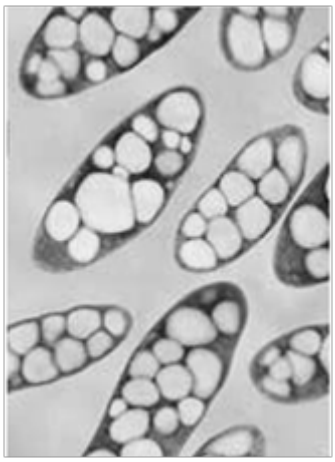
Minerv Biorecovery

As we said, hydrocarbonoclastic bacteria can survive only under specific oxygen and temperature conditions. Oil spills sometimes reach zones in the sea where bacteria can't live and because of this biologists tried to find out a way to create advantageous environments for them to grow.
Italian startup *Bio-on* developed a new project called *Minerv Biorecovery* which concerns the use of a special bioplastic able to eliminate, in natural ways, the pollution derived from hydrocarbons.
Minerv Biorecovery is a technique based on bioplastic (PHAs) powders, with a size of few microns, which form porous structure suitable to host bacteria. Bioplastic components act as nourishment for the colony and make it grow and strengthen to attack the oil. *Minerv Biorecovery* offers a home to microorganisms that are naturally present in the sea and help bioremediation process to get faster. This bioplastic is obtained from renewable plants sources and causes no problems in the food chain.



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In conclusion, oil spill are a major issue of our age and scientists are always looking for new technology to provide a solution. We know that a natural and sustainable way to solve this problem already exists, but certainly more in-depth studies and a higher interest by the press and the citizens would help research to gain support and progress more easily.

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