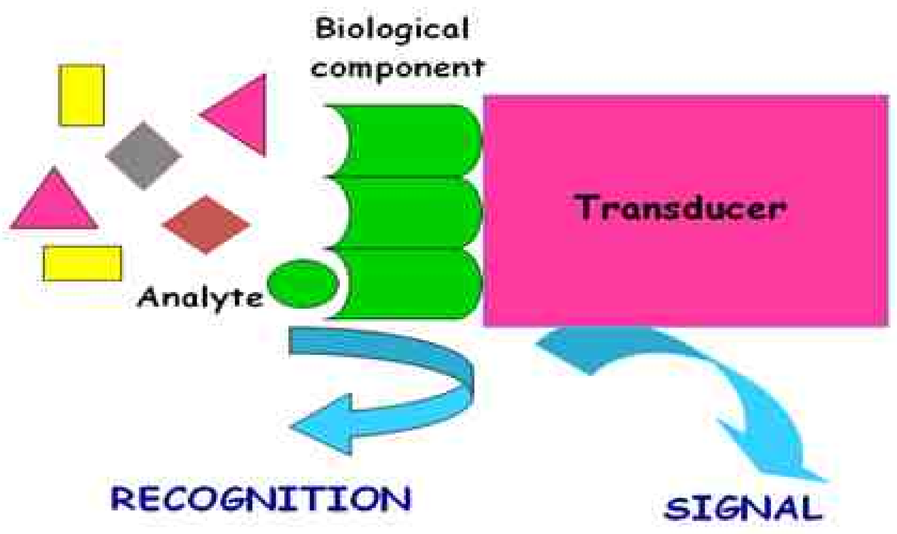
- red biotechnology -

Biosensors

Riccardo, Dan & Maria.

BIOSENSORS ARE AMAZING!!!

A biosensor is a device that uses specific biochemical reactions mediated by isolated enzymes, immunosystems, tissues, organelles or whole cells in order to detect chemical compounds usually by electrical, thermal or optical signals.

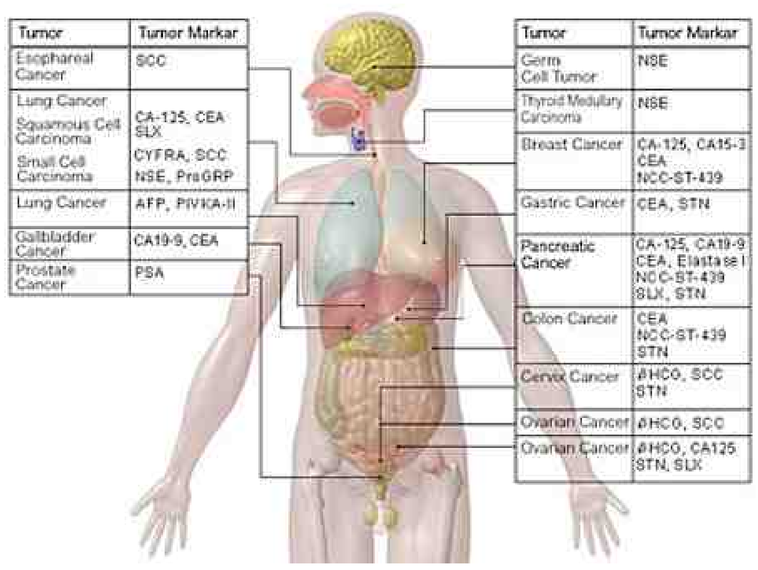


Biosensors are composed of two main parts: a biological component and a transducer.
The different types of transducers define the classification of biosensors; in fact we can differentiate electrochemical biosensors, optical biosensors, electronic biosensors, piezoelectric biosensors, gravimetric biosensors and pyroelectric biosensors

THEY CAN DETECT…

In order to detect the presence of an illness a biosensor need a biomarker: a measurable indicator of some biological state or condition, which in medicine is a substance that can be at abnormal levels in disease conditions.

The concept of biomarker is largely used in oncology: in fact, tumor cells usually produce tumor markers or stimulate normal cells to produce them in response of their presence.



Tumor	Tumor Markar
Esophareal Cancer	SCC
Lung Cancer Squamous Cell Carcinoma	CA-125, CEA SLX
Small Cell Carcinoma	CYFRA, SCC NSE, ProGRP
Lung Cancer	AFP, PIVKA-II
Gallbladder Cancer	CA19-9, CEA
Prostate Cancer	PSA

Tumor	Tumor Markar
Germ Cell Tumor	NSE
Thyroid Medullary Carcinoma	NSE
Breast Cancer	CA-125, CA15-3 CEA NCC-ST-439
Gastric Cancer	CEA, STN
Pancreatic Cancer	CA-125, CA19-9 CEA, Elastase I NCC-ST-439 SLX, STN
Colon Cancer	CEA NCC-ST-439 STN
Cervix Cancer	βHCG, SCC STN
Ovarian Cancer	βHCG, SCC
Ovarian Cancer	βHCG, CA125 STN, SLX

…MONITOR…

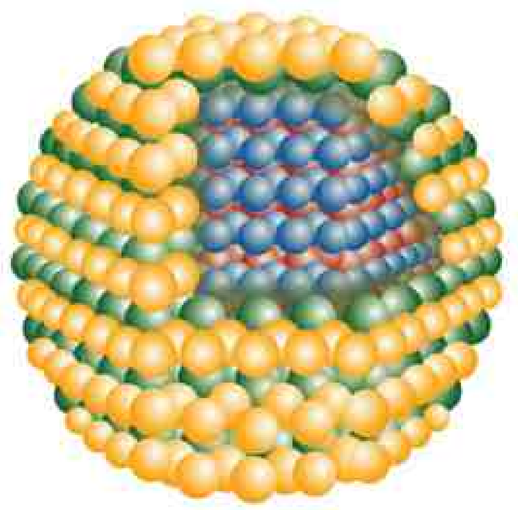
As well as for detecting the presence of a disease, biosensors are also used to control and monitor the evolution of pathologies that may aggravate at an uncertain moment, like diabetes or cancer.

For example, 70% of tumors can be cured but it is important to perform a correct follow-up in order to avoid a recurrence of the pathology, because some tumor cells may survive and start growing again even after many years.

…AND TREAT DISEASES!!

A special type of these biosensors are linked with therapeutic compounds, so that we can observe and treat an illness at the same time (theranostic approach).
An innovative approach in the use of biosensors is the quantum dots technology.

Quantum dots contain compounds operating as sensors and therapeutic agents; therefore, they represent the most developed example of theranostic agent.



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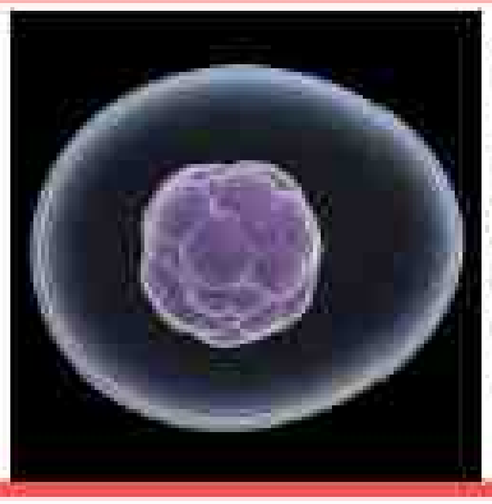
Stem cell biotechnology

Mairo Mitt and Dustin Schwederski

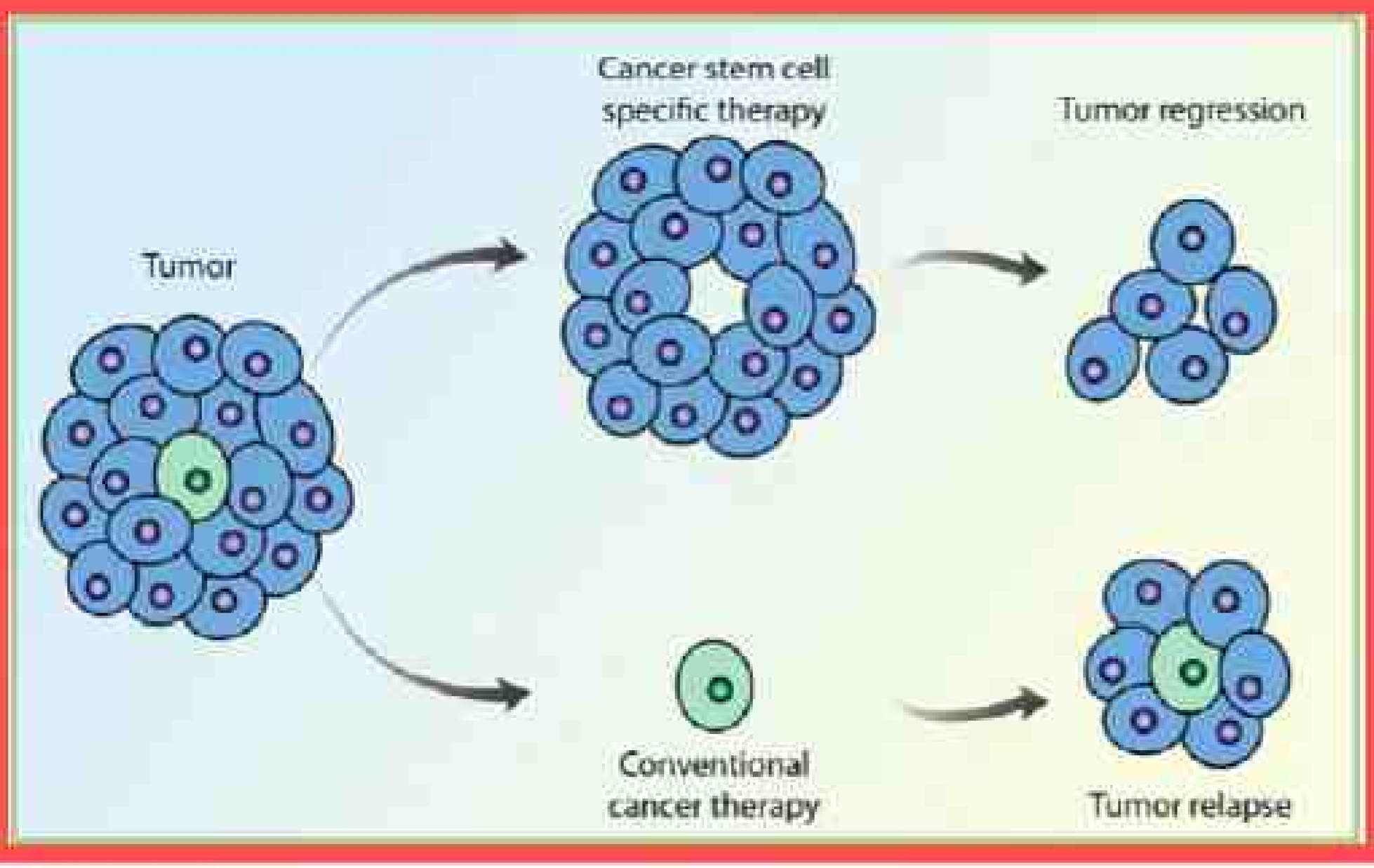
Stem cells are unspecialised cells that are characteristically of the same family type.

They retain the ability to divide throughout life and give rise to cells that can become highly specialized and take the place of cells that die.



Research has shown that FGF appears to play a major role in breast and prostate cancer, which is why the duo decided to focus on the protein's role.Fen Wang and Wallace McKeehan discovered the specific pathways FGF uses to activate stem cells or to keep them dormant. This discovery has major implications for future cancer therapies. It couldused to hold cancer at bay and stop it before it would be dangerous.

How can we cure Cancer and is it possible with embryonic stem cells?



Pros	Cons
•You can cure cancer •Dont damage other cells in body like the radiation curing	•A tumour can arise •It doesn`t work 100% of times •It is expenisve •It is difficult because you have to kill •It is illegal in the most countries

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Blood Glucose Biosensors

By Rachel, Fatma and Maarten

What are biosensors?

A biosensor is an analytical device that is used to detect a substance or compound, and can be defined as a 'compact analytical device or unit incorporating a biological or biologically derived sensitive recognition element integrated or associated with a physio-chemical transducer'.

Where are blood glucose biosensors used and why?

A prime example of blood glucose biosensors being used is the self-management of diabetes for adjusting medications, dietary regimes, and physical activity. Regular and frequent measurement of blood glucose may provide data for optimizing and/or changing patient treatment strategies.

Self-monitoring of blood glucose (SMBG) has been established as a valuable tool for the management of diabetes. The goal of SMBG is to help the patient achieve and maintain normal blood glucose concentrations in order to delay or prevent the progression of microvascular and macrovascular complications (stroke and coronary artery disease).

The findings of the Diabetes Control and Complications Trial (DCCT) and the United Kingdom Prospective Diabetes Study (UKPDS) showed that intensive control of elevated levels of blood glucose in patients with diabetes, decreases the frequency of complications and may reduce the occurrence and severity of large blood vessel disease.

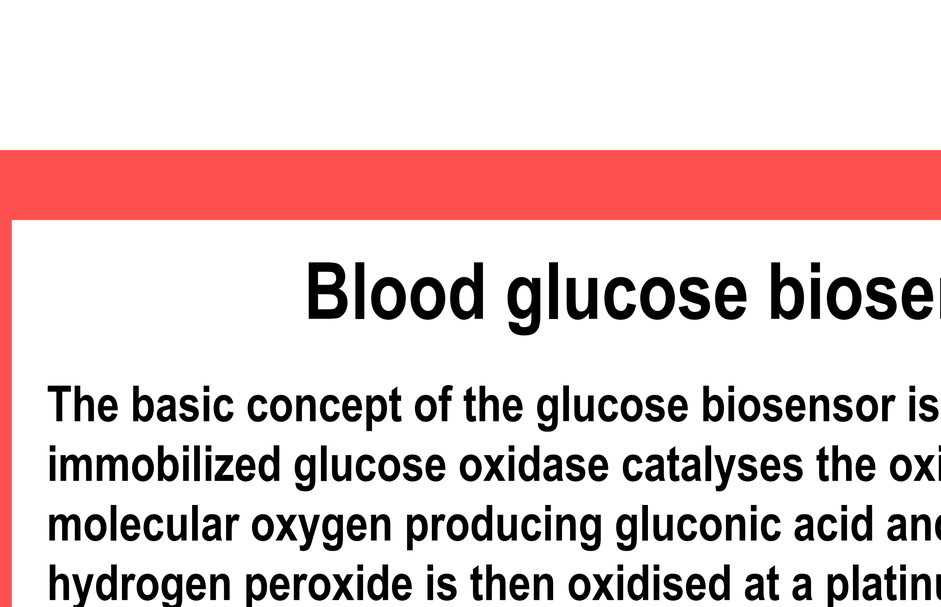
How do biosensors work?

There are three main parts of a biosensor:
(i)the biological recognition elements that differentiate the target molecules in the presence of various chemicals
(ii)a transducer that converts the bio recognition event into a measurable signal
(iii)a signal processing system that converts the signal into a readable form.

The molecular recognition elements include: receptors, enzymes, antibodies, nucleic acids, microorganisms and lectins.

Blood glucose biosensors

The basic concept of the glucose biosensor is based on the fact that the immobilized glucose oxidase catalyses the oxidation of β-D-glucose by molecular oxygen producing gluconic acid and hydrogen peroxide. The hydrogen peroxide is then oxidised at a platinum anode. The anode recognises the number of electron transfers that occur during oxidation. This electron flow is proportional to the number of glucose molecules present in the blood.



A small drop of blood is sufficient for the blood glucose biosensor to give an accurate reading of blood glucose levels.

Erasmus+

- green biotechnology -

Growing plants from meristems

By Matthew Williamson, Angelika Linder and Jade Taylor

What are meristematic cells?

Meristematic cells are a group of identical cells trapped in a constant state of cellular division.

For the most part, meristematic cells remain undifferentiated and continually undergo cell division by mitosis.

However, when exposed to certain conditions, they can develop into any specfic plant tissue.

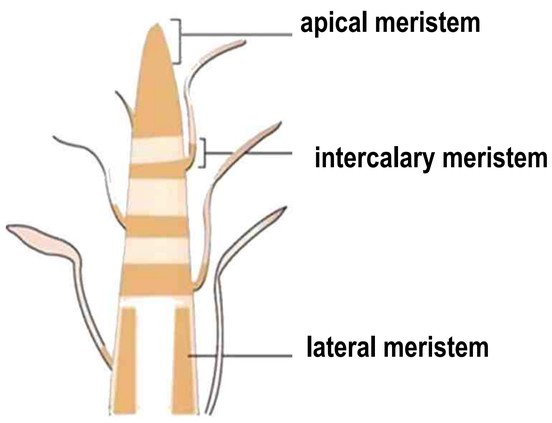
Where are they found?

There are three main types of meristematic tissue within plants.

•The apical type is found in the growing points of roots and shoots.

•The lateral type is located near the sides of the plant, usually in a cylinder.

•The intercalary type is found at the leaf base or at the base of internodes.



Growing plants from mertistematic tissue

Meristematic tissue is usually taken from the apical meristem. A small meristem-tip (often less than 1mm in length) is removed from the donor plant by sterile dissection under the microscope and transferred to a growth medium such as agar.

The conditions of the growth medium are regulated to allow differentiation of the tissue to take place. A shoot forms from the meristematic tissue followed by the subsequent development of root tissue. The plant will contiue to grow and be genetically identical to the parent plant.

Gene Banks

Gene Banks are a store of genetic material. Their aim is to preserve the gene pool of crop plants and their wild relatives thereby preserving the genetic basis of agriculture and horticulture.

The material in Gene Banks can exist in several forms and hence there are seed banks, tissue banks and pollen banks.
Seed and pollen banks are unable to store plants that reproduce asexually so tissue banks utilise meristematic cultures as a means of genetic storage of asexually-reproducing plants and those varieties that cannot produce seeds.

Cultivating plants from meristematic tissue offers a way of producing virus- free plants which is an added advantage of using this method to preserve plant species.

In Estonia they are ensuring the preservation of their plant material by a plant genetic resource collection and preservation programme. Plants grown from meristematic tissue are preserved in Gene Banks. EVIKA Gene Bank is one where food grain varieties are preserved *in vitro*.

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Genetically Modified Maize

Matteo Bianchini, Javier Navarro Sala, Andrea Jimenéz Gregorio

What is G.M.M.?

It is a genetically modified crop. Specific maize strains have been genetically engineered to express agriculturally-desirable traits

Example of trait number 1:

Resistance to herbicide

Maize resistant to glyphosate herbicides
Such as:

Killed:

broadleaf weeds and grasses

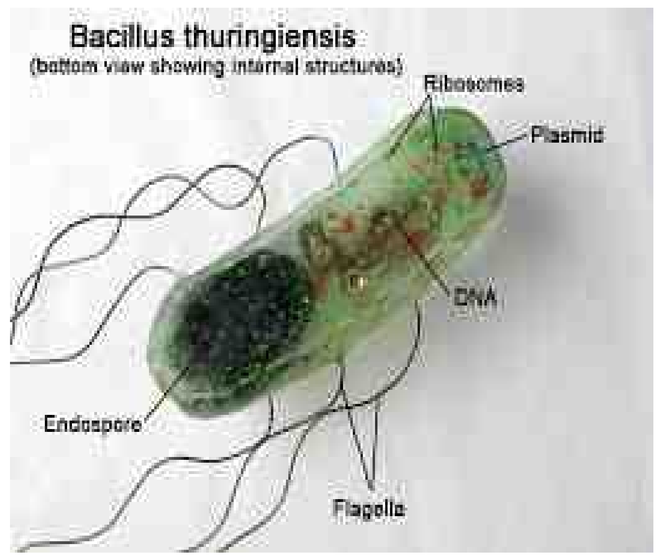
Not killed:

Modified maize

Example of trait number 2:

Production of insecticide

Maize modified to express
The Bt protein from the
Bacillus thuringiensis



-Insects eat this maize
-toxin activated in their gut
-paralysis and pores=Death

Affected insects:

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Golden Rice

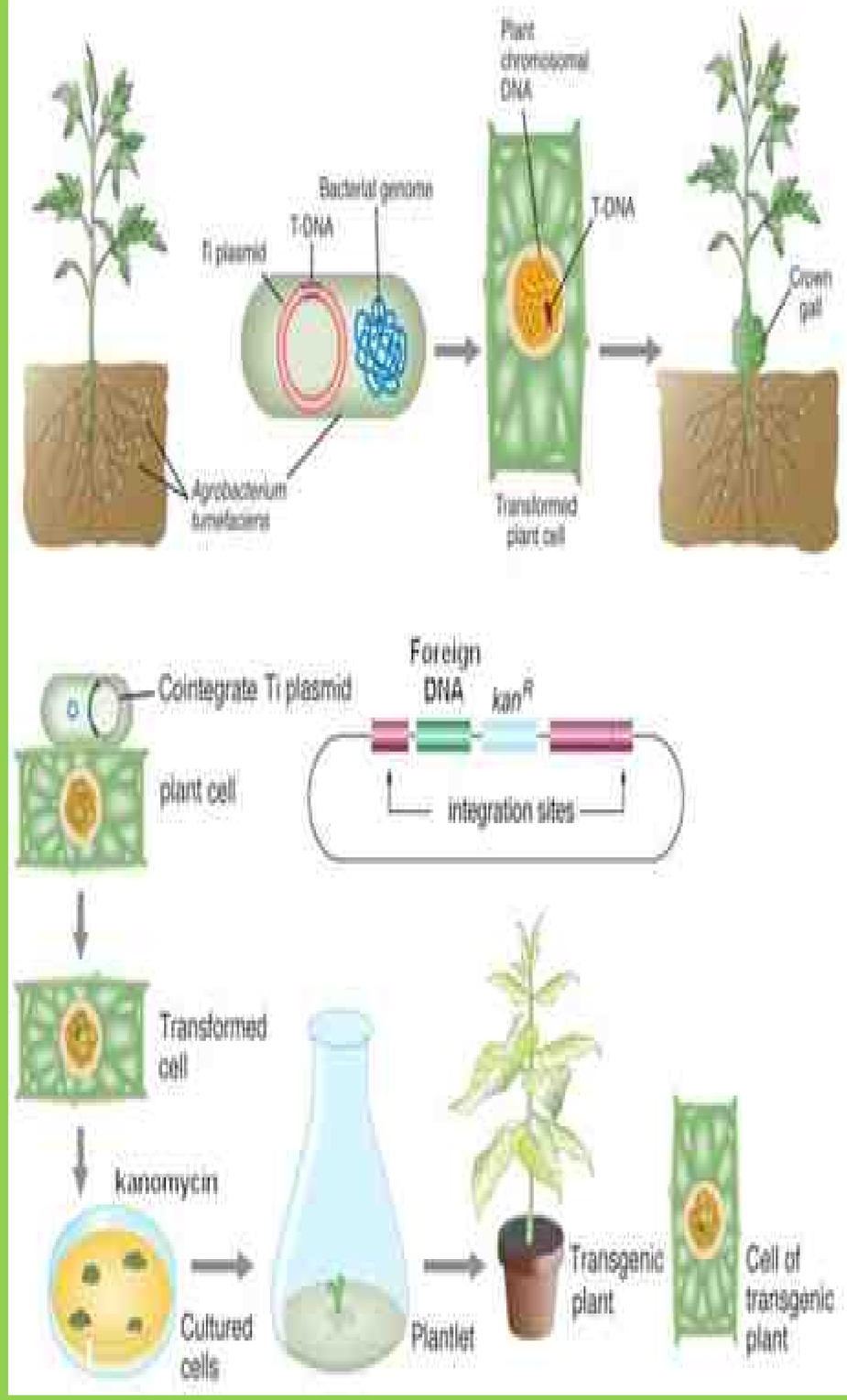
Ellis van Keulen and Swaantje Heinrichsdorf

According to UNICEF 1,5 million children per year die of a **vitamin A deficiency** and 500.000 children lose their sight!

Scientists came with a potential solution. Since 1997 they developed golden rice. Golden rice is a **genetically modified organism** also called a GMO. They put **carotene** in the rice and now it contains vitamin A.

Is golden rice the solution and why is it not already produced?

How it's made?



Pros	Cons
Golden rice can save people's life. Vitamin A in their normal diet can keep many children alive	Farmers are scared of the costs. But the companies provided access to the required technologies free of charge, for humanitarian purposes
They used carotene instead of pure vitamin A. Too much vitamin A can be dangerous but too much carotene is not harmful	People are scared but scientists believe that GMOs are digested just as normal plants. They contain amino acids that the human body can handle. That's the reason people are allowed to eat GMOs in Europe. But we don't know the effects in the long term yet
	There are some effects on our ecosystem: With GMOs we are going to lose species. Because even with buffer zones and isolation of GMOs on the field you can't stop that.
	Greenpeace claims that this project is used by the companies to get GMOs accepted ; a so called Trojan Horse!
	The project costs millions and Greenpeace is very angry about this! According to them it is not the solution.

So is this the solution?

The farmers don't want it. The people are scared of it! The governments are against it! It cost millions to develop it. But why not simply give vitamins? Or give people knowledge to produce vitamin A? Golden rice is an amazing idea and it really has potential to help people! But for now it's way too complicated! Maybe in the future, when people are more familiar with GMOs. But right now it's not the solution!

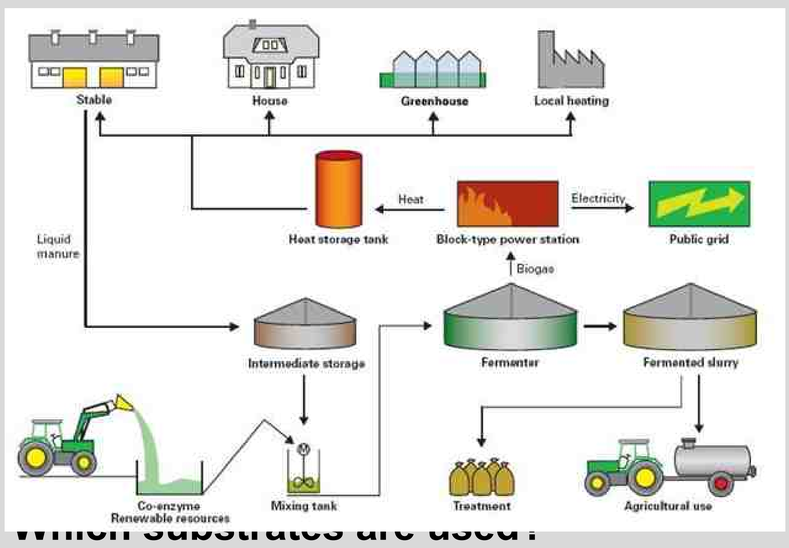
- white biotechnology -

Biogas

By Bendix and Merche

What is biogas?
Biogas is a renewable energy which doesn‘t the sun or wind
The energy comes from renewable resources
The production from biogas is earthpositive

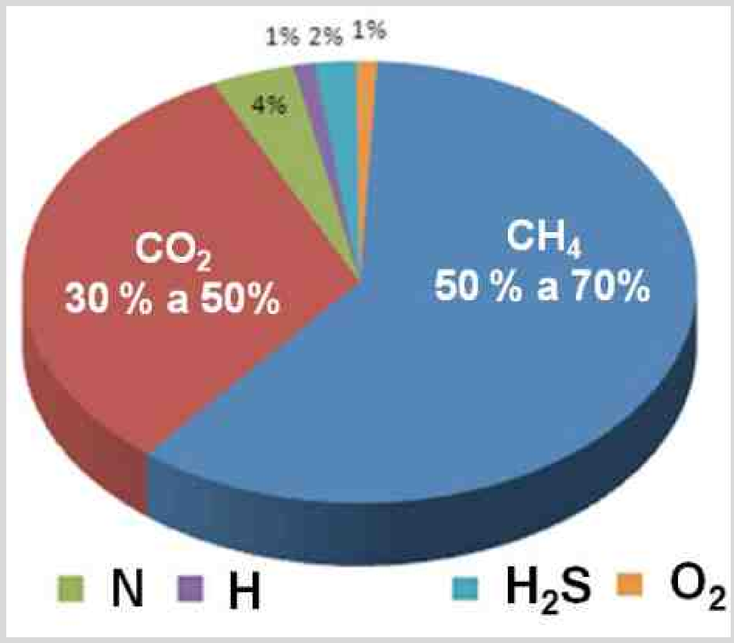
What is a biogas plant constructed?



Which substrates are used?
You can use corn, grass, sugar beet or animal waste

W
You can not really tell, because it is important to look at the equipment and place.

What are the components of biogas?



How does biogas develop?
It takes four steps:
The first stage is the hydrolysis.
Hydrolysis mean to break proteins, carbohydrates and lipiḍs in smaller things like glucose.
In the second phase (Acidogenese) the products of the hydrolysis are converted into low fat and carboxylic acids, and various other acids or alcohols, by acid-forming microorganisms.
In the third phase, the Acetogenese or vinegar-forming phase, the low fat and carboxylic acids are converted into acetate.
In the fourth and last phase the acetate is converted to methane and carbon dioxide.
Dividing acetic acid (acetoclastic)
(1) $CH3COO- + H + \rightarrow CH4 + CO2$
Hydrogen utilizing (hydrogenotroph):
(2) $CO2 + 4\ H2 \rightarrow CH4 + 2\ H2O$
(Exothermic reactions (heat is released))

Are there losses during the combustion of the methane?
In the combustion of methane, there are no relevant losses.
However, only 40% of the energy can be supplied as power to the grid.
The other 60% will released as heat.

What advantages and disadvantages are associated with biogas plants?
One disadvantage is the excessive application of remainders of fermentation as fertilizer on the fields.
One other disadvantage is the big plant from corn.
But a big advantage is that you can use electricity without wind and without sun.
One other advantage is that you can use organic waste.

Is the production of biogas sponsored by the state?
The German Renewable Energy Act (EEG) guarantees operators of biogas plants a fixed payment over the next 20 years. This has the positive effect that rate of return from the investments can be planned very detailed.

The following questions were answered by a biogas plant in Noth Germany:

How big is your plant and how many employees you employ?
The plant has an annual output of 700kW and is operated by an employee with 8 hours a day and a temporary worker.

Which substrates do you mainly use?
We use corn, GPS, sugar beets, grass and manure.

How do you use the waste heat generated during the combustion of methane?
10% of the waste heat is used for heating the fermenter and to keep the temperature of 38 °- 40 °. The remaining 90% goes to surrounding households that are supplied with heat all around the year.

What was the most important reason to open a biogas plant?
There is a real chance to earn money, because of the EEG. If this law did not exist, it would an unpredictable business.

How do you see biogas in the future?
The highlight was in the period between 2004-2009, so the new construction of biogas layers will decrease. Since the promised funds by the state decrease, more and more biogas plants will be opened within the next 10 years.

- White biotechnology -

FOOD FROM WASTE

Andri Kutsar, Silvia Costa

NAMASTE - EUROPE & INDIA

The European and Indian fruit and cereal processing industries generate several million tons per year of by-products that are mainly disposed of through landfills with a huge loss in terms of profit. Design novel strategies to turn citrus and wheat processing byproducts into food ingredients and products via sustainable processes was the main objective of the NAMASTE-EU project.

FRUIT SECTOR

In Europe the residue resulting from citrus processing is mainly constituted by peels and pulp, for an amount of by-product corresponding to about 50-60% of the original mass processed. A major part is applied for cattle feed or disposed of as waste.

India has a generation of a solid side stream (peels and kernels) from mango accounting for 40 to 60% of the original mass processed and a liquid waste (juice and wash water). Kernels are used to obtain mango kernel fat (mainly used for cosmetics), whereas dried peels are used for animal feeding or disposed as waste.

CEREAL SECTOR

The European Union is, by far, the main world producer of wheat and accounts for over 20% of the production while Indian production of rice accounts approximately 20% of the globally production.
The bulk of these grains are refined and used for food production, generating a wheat bran fraction, currently used predominantly as animal feed or disposed of as waste.

PHASE 1)	The first phase of the project was dedicated to identify and quantify the components (eventually new ingredients) of citrus and wheat processing by-products.
PHASE 2)	The second phase concerned the microbiological safety and stability of by-product raw materials.
PHASE 3)	The third phase included the pre-treatment of by-products and waste, recovery and production of natural molecules and the characterization of the ingredients obtained from wheat bran and citrus.
PHASE 4	The aim of the fourth phase was to design and develop at laboratory scale new food products from wheat bran and citrus by-products or natural compounds, by using different (bio)technological approaches.

CITRUS POMACE

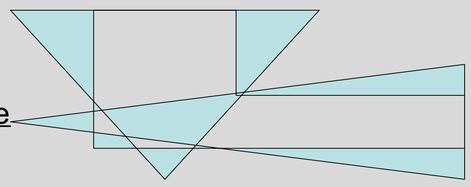
ORANGE AND LEMON

Citrus pomace is a by-product of juice extraction from the citrus fruits and has two principle components: rind and ‘rag’.

Aim: develop processes able to produce
- functional dietary fibres;
- polyphenols and carotenoids;
- clouding agent.

The extracts obtained from citrus peels lead to three prototypes:

(1)an orange juice enriched with citrus fibre,
(2)a polyphenol-rich fruit juice-based beverage
(3)a soft drink with the clouding agent.



Selected, produced at pilot scale and sent to Hungary (CCH) for a consumer’s acceptance test.

Several pre-treatment and operation conditions were evaluated in order to stabilize the raw materials prior to their processing. In particular, various trials were done to avoid citrus by-product colour and bitterness.

LAB SCALE FINAL PRODUCTS

1) several snacks from citrus by-products
2) a citrus-based monodose beverage
3) two citrus paste-based filled bakery products
4) two citrus-based instant desserts

WHEAT BRAN

Wheat bran is a by-product of the flour milling industry, currently used for the production of low-value products, like composts and livestock feed, and significant amounts are disposed in landfills as waste.

Bran is particularly rich in dietary fiber and contains significant quantities of starch, protein, vitamins, and minerals.
The presence of phenolic acids gives this fraction the potential to be exploited as a source of polymers and oligosaccharides with anti-oxidant properties for food use and also a potential substrate for the biotechnological production of vanillin.

Aim: convert and recover one or more of the following products
- Oligosaccharides with potential prebiotic activity from component arabinoxylans
- A bran product pre-fermented with carbohydrases and including probiotic agents
- Ferulic acid for bioconversion to bio-vanillin
- Enzyme-recalcitrant wheat bran fibre residues
- A peptide- / maltose-rich product suitable a growth / feed medium

LAB SCALE FINAL PRODUCT

1) a bakery product based on pre-fermented wheat bran

Both whole grains and fruit processing by-products represent a potentially valuable resource that can be developed into high value products. Particularly, citrus peels and their extracts have been reported to have potent health and preventive activities due to the abundance of flavonoids, while whole grains are rich in fibre and antioxidants, including trace minerals and phenolic compounds, which have been linked to disease prevention.

- white biotechnology -

Oestrogen in drinking water

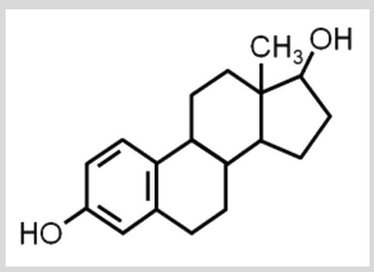
Alex Winter-Goodwin, Amy Dailet, George Lucas

What are hormones?

Hormones are proteins that are transported around the body by the blood and tissue fluids. They are substances that regulate our body‘s processes and our behaviour. For example, growth, mood and the menstrual cycles in women.

Examples of hormones include the sex hormones, testosterone and oestrogen and insulin, which maintains blood sugar levels.

The main hormone that affects drinking water is oestrogen because of its common use in contraceptive pills, patches, rings and injectables.



Oestrogen present in contraceptive pills

How does oestrogen enter drinking water?

Synthetic oestrogen is the main hormone that is used in female contraceptive pills. It works by preventing ovulation so no egg is released. Excess oestrogen is removed from the body in urine.

Since synthetic oestrogen is hard to breakdown it is not removed during the processing of waste water. Consequently, it enters the rivers and then our drinking water.

The concentration of synthetic oestrogen in rivers and drinking water is low and due to this low concentration, it is hard to measure. However, despite the low levels, it still affects us and river ecology.

The effects

On humans

By consuming oestrogen present in tap water, we are upsetting the natural balance of hormones in our bodies.
Increased oestrogen has been linked to poly-cyctic ovaires in women. Some experts belive the the presence of oestrogen in drinking water could be affecting men‘s sperm count. Testicular and prostate cancer could also be a consquence of overly high concentrations of oestrogen in the huamn body.

On river ecosystems

The presence of sytnthetic oestrogen in rivers can result in male fish developing female characteristics and changing sex. It can result in fish becoming sterile or having damaged sperm. Consequently, this affects fish populations in rivers and can have a very negative effect on river ecosystems.

Removing oestrogen from drinking water

Methods are available to remove oestrogen from drinking water such as ozonation, UV radiation, membrane filtration, reverse osmosis and activated charcoal adsorption. However, these methods are expensive and not commonly used in water treatment plants.

Laccase is an enzyme that is able to break down synthetic oestrogen.

The Bielefeld iGEM team are aiming to develop a biological filter using immobilised laccases to remove synthetic oestrogens and other aromatic compounds from municipal and industrial wastewater.

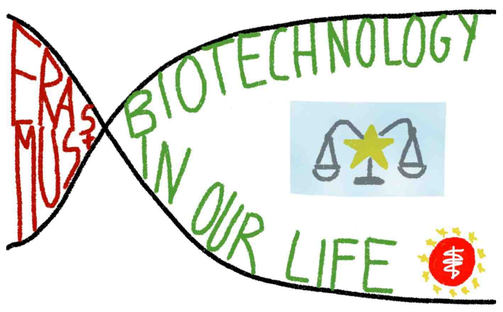
The students from Bielefeld used the genetic information in the turkey tail fungus to reprogram *E. coli* to produce the laccase they wanted. Several wastewater treatment specialists have expressed an interest in the new technology.

Laccase

Laccases

Laccases are copper-containing oxidase enzymes which can be found in many plants, fungi and microorganisms. They oxidise phenolic and non-phenolic compounds and therefore have useful applications such as the detoxification of industrial effluent, as a tool for medical diagnosis, as bioremediation agents to clean up herbicides, pesticides and certain explosives. The use of laccase-catalyzed oxidation to remove pharmaceutical and personal care products (PPCPs) has also been shown to have potential.

Erasmus+



- bioethics-

What do people think of biotechnology?

By Jordan Markham, Emma Hickling and Kees Westermann

Questionnaire

1. What country are you from and how old are you?
2. Do you know what biotechnology is?
   Biotechnology is the use of biological processes for things such as industry and medicine, specific examples include the usage of stem cells, genetic modifications of food and the production of antibiotics using micro-organisms.
3. Do you think biotechnology is a positive thing?
   Stem cells are cells in the body that can change their structure to perform a specialised role within the body, the only problem with this is that stem cells gathered from adults can't provide the same function as stem cells from the embryo as they do not have as wide a variety of differentiations. This means in order to help people effectively, most stem cells would need to come from embryos.
4. Do you believe that stem cell research is ethical?
5. Do you believe that stem cell research could be good for us?
6. Do you believe there are risks to using stem cells?
   Genetic modification of organisms involves altering the DNA of said organisms in a way that does not occur in nature, this means the process can be seen as quite unnatural despite having shown several benefits already.
7. Do you believe that it is ethical to genetically modify organisms?
8. Do you believe that genetically modifying organisms will be beneficial to people?
9. Do you believe there are risks to genetic modification of foods?
10. Do you have any further comments about Biotechnology?

We have put the questionnaire on a site called 'Servey Monkey', where people can make an account to make and answer surveys.

Bioethics is the study of the typically controversial issues emerging from new situations and possibilities brought about by advances in biology and medicine.
The field of bioethics has addressed a wide range of human inquiaries, from debates over the boundaries of life (abortion and euthanasia), to the allocation of scarce health care resources (organ donation), to the right to refuse medical care for religious reasons.

The scope of bioethics can expand with biotechnology, including cloning, gene therapy, life extension, human genetic engineering, astroethics and life in space, and manipulation of basic biology through altered DNA, XNA and proteins. These developments will affect future evolution, and may require new principles that address life at its core, such as biotic ethics that values life itself at its basic biological processes and structures, and seeks their propagation.

Bioethics

Laws and ethics concering GMOs in the EU and it‘s member states

Martin Sirg, Pilar Ferrer

What are GMOs?

A **genetically modified organism** is an organism whose **genetic material has been altered** using genetic engineering techniques. GMOs can have a both positive and a negative effect on humans, animals and the environment, that’s why The EU has introduced regulations and laws which manage the distribution and cultivation of GMOs. In addition to that, some countries in the EU have introduced extra laws and regulations concerning GMOs.

Positive sides of GMOs

Genetically modified organisms are used in biological and medical research, pharmaceutical drugs, experimental medicine and agriculture. Using GMOs in these fields, researchers are trying to **solve problems** that face humanity .

For example golden rice was created with the intention of bringing in vitamin A to the areas where the everyday food lacks vitamin A, which leads to the death of 670 000 children annually . So in this case golden rice could replace regular white rice which lacks vitamin A.

Negative sides of GMOs

Even though GM crops are made with good intentions, there are always negative sides to them. The biggest concern is that they can **alter the biological diversity of nature** by replacing non-GM crops completely. A good example of this comes from America where both growing and consuming GMOs is allowed: Most of the corn grown now is genetically modified, which is pesticide and herbicide resistant. Due to that insects and weeds have started to develop a resistance to the pesticides and herbicides.

Regulations In the EU

The EU has implemented numerous regulations concerning GMOs with the intentions to:

- Protect the environment and the health of humans and animals
- **Ensure clear labelling of GMOs** placed on the market in order to enable consumers as well as professionals (e.g. farmers, and food feed chain operators) to make an informed choice.
- Ensure the traceability of GMOs placed on the market
- Put in place procedures for **risk assessment** and authorization of GMOs that are efficient, time-limited and transparent.

Regulations In the EU member states

COUNTRIES FOR GMO

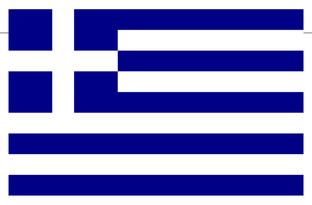
FINLAND

SPAIN

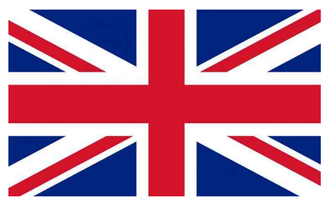
COUNTRIES AGAINST GMO

AUSTRIA

GERMANY



GREECE



UNITED KINGDOM

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