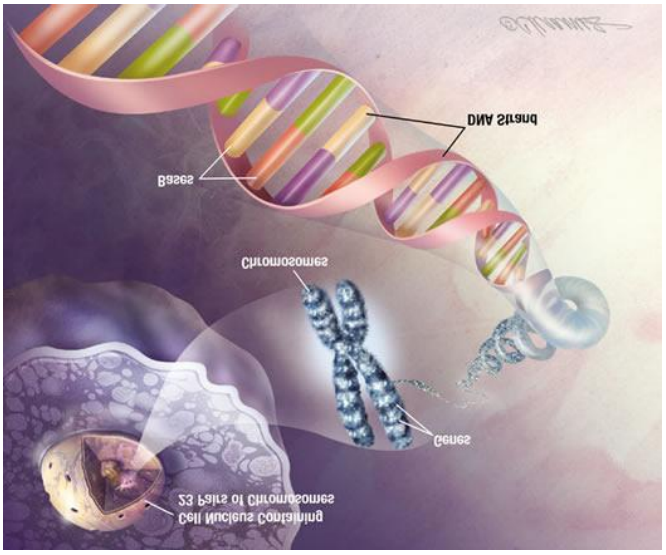
British Middle East Center
for Studies and Research

Genetics and Genetic Engineering



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What is genetic engineering?

Genetic engineering is the human altering of the genetic material of living cells to make them capable of producing new substances or performing new functions.

What is it GM?

The genetic modification is when scientists inserts or erase a gene, from food, animals. The major agricultural products can be broadly grouped into foods, fibers, fuels, and raw materials.

Agricultural genetic engineering

Golden rice

The golden rice is rice which has been genetically modified that contains more vitamin A. this is done by an element known as beta-carotene that is then converted into vitamin A once inside the body.

The genes which are implanted are three, two which are from the daffodils (narcissus pseudinarcissus **psy**) and one from a bacterium (erwinia uredovora **crt1**). The psy and the crt1 are transformed into the rice's nuclear genome and then placed under the control of an endosperm specific promoter, to ensure that they only express in the endosperm (which is the tissue that is produced in the seed around the fertilization time).

The reason why genetics engineering is used on the rice is because most third world countries eat and grow a lot of rice and eat an extremely limited diet which are lacking in the essential vitamins the body is in need of. A lack of vitamin A leads to becoming blind earlier in life. Therefore the GM golden rice will allow them to eat their rice but gain more vitamin A then the normal rice they eat. The genetic engineering will be needed as they are dealing lab based work.

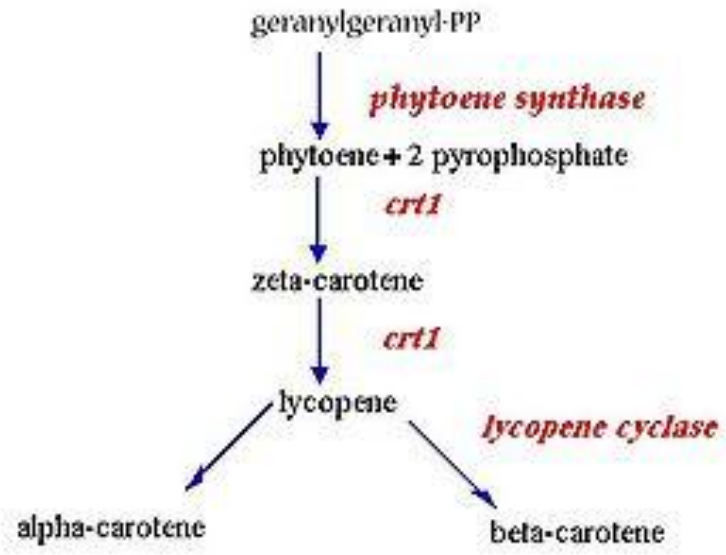
What do these genes do?

Golden rice was designed to produce beta carotene an ancestor of vitamin A in the part of the rice that people eat, is the endosperm. The rice normally does produce the beta-carotene in the form of carotenoid pigments however this happens in the leaves where it is used for photosynthesis, as the photosynthesis does not happen in the endosperm of the rice the carotenoid pigments is not needed there.

Golden rice was made by transforming rice with two beta carotene biosynthetic genes:

- psy (phytoene synthase) from daffodil (Narcissus pseudonarcissus)
- crt1 from the soil bacterium Erwinia uredovora.

current analysis has shown that the plant's endogenous enzymes process the lycopene to beta carotene in the endosperm which makes the rice yellow for which it is named.



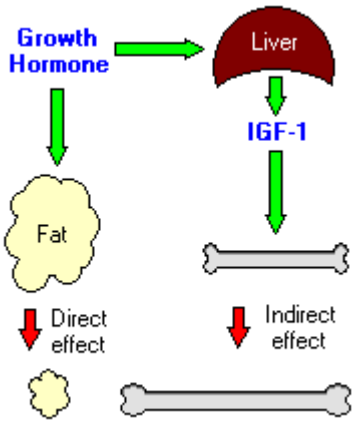
This is the carotenoid biosynthesis pathway in golden rice. In the endosperm of golden rice, the enzymes are expressed which is shown in red. These enzymes catalyze the biosynthesis of beta carotene from geranylgeranyl phosphate. So in the animal gut, beta carotene is assumed to be converted to retinal and then to retinol (vitamin A).

The method of production

The golden rice is made by inserting the beta-carotene into the endosperm of the rice. Rice plants have got enough vitamin A in their leaves however there is not any in the endosperm.

The plant tissue will be isolated and grown in a pure culture, this will then grow into a callus which are unspecialised cells once it gets to this stage the gene is inserted which is the narcissus pseudinarcissus **psy** and the erwinia uredovora **crt1**. Here after the callus will transform into plant cells with the gene, however they are not yet plants but is a blub of unspecialised cells, they are treated with plant regulatory hormones these are critical media components in determining the developments of the plant cells. Then it will produce formations of shoot and roots which will be a planet and a plant.

The golden colour in a indication of the concentration of the beta-catotene in the endosperm.



Medical genetic engineering

Growth hormone

The growth hormone is a protein (peptide) hormone which consists of 190 amino acids that is synthesized and secreted by cells called **somatotrophs** in the anterior pituitary. Its mainly in control of several physiologic process such as growth and metabolism. The growth hormone is a drug which is used for both humans and animals.

The gene which is used on the human growth hormone, are two. Growth hormone 1 (somatotropin) and growth hormone 2. they are both located in the q22-24 region of the chromosome 17 and are linked to the human chorionic somatomammotropin gene.

The reason why genetic engineering is used on the growth hormone is because there are some people who are incapable of producing somatotrophs, which means that their body is not developing as they should, this could be growth (height) or metabolic (weight). The drug could be introduced to dwarfs, under developing children or even people with eating disorders. The growth hormone will allow their body to develop normally or in a faster rate in order for them to get on with live easier.

The genetic engineering will be needed as they are dealing with lab based work, also there are many people who have a growth hormone disorder

<u>The method of production</u>

Firstly the growth hormone gene will be separated; this gene will be part of the DNA that is in the chromosome. It is then separated and copied in order for the scientist to have many of these growth hormones to work with. The DNA will then be planted into a bacterium's DNA by recombinant DNA technology a special enzyme used to cur open the plasmid and is removed from the bacteria cell. Once the plasmid ring is open the gene is inserted into it and the ring will close, at this stage the gene is inside the bacterial DNA plasmid. Then DNA is inserted back into the bacteria, by using a syringe needle and inserting the recombined plasmid through the cell membrane of the bacteria.

Nutrients will be given to the cells in order for them to grow and divide, so the growth hormone will grow and multiply. The bacteria will produce human growth hormones which are then collected and purified.
The growth hormones medicine is then given to people who are in need of it for example dwarfs, this should help them grow.

Task 2

Agricultural - Golden rice

Social considerations:-

The public generally have a positive view point on the GM golden rice, as it is saving millions of poor people in Africa and Asia from becoming blind early. However there is a minority who are against the aid as they believe that the food should not be modified, and instead help these countries in supplying different kind of diets. Some of the public think that this is making the underdeveloped countries more dependant in the richer countries. Although there are some considerations the rice is being introduced to most of Africa and Asia.

Some people who are against GM see that the golden rice is a method of making genetic engineering more widely accepted. These people believe that companies may go onto making other GM plants and crops in order to make profit.

Ethical considerations:-

There are a lot of organizations which have raised some concerns about GM food e.g. public interest groups, these concerns which are raised generally regard the human and animals health risk, environmental hazards and also health concerns.

Environmental concerns

The environmental concerns are that the crops will have a negative effect on the area, most people are considered and pollutions such as air pollution and water pollution. There are many people who are unaware of the effects which genetically modified crops and foods will have on environment, as this technology is something which is fairly new. Farmers fear that this will cause distractions in their areas and fields, which means that if this affects them their yield will decrease and therefore their profit will go down too.

Some part of the public also fear that the techniques which has been used in genetic modification are in accurate they feel that the scientist do not known much about DNA and are just doing things based on little knowledge, which is why many people are reluctant with the golden rice.

Health concerns

On of the major ethical concerns on GM foods is the health risk which may arise from them. People fear that it may cause new diseases and allergies, because the gene is extracted from one organism which has its allergic factors and is planted into the food, this means that the consumers who is allergic to that thing will be exposed to a risk of getting an allergic reaction with out knowing it. There are also concerns on this as it is believed that it may cause new allergies due to the genes being transferred between the organisms. The other major worry it the cause of a disease, this is because some of the GM crops and foods are modified using bacteria or a virus, this means that a disease my occur from it and also the crops may carry antibiotic resistance marker gene which would cause problems and complications if this is passed down to microbes which are causing disease and infections as it would make the individual how is affected serious ill as the antibiotic may not help.

For example: one of the genes used for the golden rice is a bacterium and the others are from a flower.

There is a mixture of right and wrong on this topic of GM golden rice. However more of these favor towards the right side and therefore there is not a major fuss on this, allowing scientist to produce more and provide to the places which are in need of them.

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Commercial considerations:-

Around 3.1 million is spent in making the golden rice each year. The process of making the golden rice is very lengthy and expensive because a lot of special equipments are used to insert the gene and also extract the genes.

The GM industries are creating concerns and worries for smaller businesses which are making profit out of their crops and foods, because in the GM industries that may be producing the same food however with benefits and they can make them faster. Therefore the smaller businesses are losing their profit making things difficult for them whereas the larger industries are making large profits

However due to the worries and complaints about genetic engineering the GM industries are facing difficulties in getting their products to the markets, this will cause a huge loss of profit for them. All of these GM industries have to make sure that they test their product before they release them into the markets as they may have faults,

this will again be very costly and if it turns out that the products are not suitable this will cause a huge disruption and debt for the company because they will not be able to make profit out of them.

Medical genetic engineering - Growth hormone

Social considerations: - and Ethical considerations: -

This type of genetic engineering doesn't raise many concerns within the public, as it is a medical treatment which enables people to grow. Most people agree that this is a good and valid reason for the use of GE. However there is a small minority who are against GE in any way. The concerns which arise from this are often:

- health concerns
- religious concerns
- Animal rights organizations

There are concerns on the health field because some people are allergic to animals, so for those people who are sensitive to animals would have an allergic reaction from this, although there is another alternative they may be afraid of it due to mutation of the bacteria or allergic reactions on this too, this would cause huge problems then. This is because some of these hormones are made using animal hormones.

This also raises major concerns for the animal right organizations, because the animals are killed to get their hormonal genes. They see this as animal cruelty; these people believe that the animals have rights (same rights as a human being is given) and should not be killed just to use their hormones in order to people or be used for scientific researches.

However new technology is allowing scientist to do the same job but using bacteria.

Within a society their will be many people who have different believes. Some people believe that the growth hormone is un-necessary because they believe that people should be happy with how God has created them and therefore are against all kinds of genetic engineering.

There is also a part of the society which have religious believes and are against animals being used for medical or genetically interventions, because some of the hormones which are created though GE are used from animals they would have an issue with this.

Many people are generally against GE intervention such as

- Cloning
- Manipulation of gene
- DNA modification

Commercial considerations: -

This is a drug which is used by the medical industries; the growth hormone can also be used for people who want to build more muscles. The drug is making profit in both fields, as it is being consumed by a wide range of individual people and industries.

Some people are against genetic engineering due to various reasons, this will interfere with the success of the industries and pharmaceuticals as this will hinder them from making profit out their production. Therefore people will not buy the products and if not many people are buying them, the marketing will stop asking for supplies which means that they will have a great decrease in the profit and may be in debts. It will be expensive for the pharmaceutical and other insulin production companies to produce growth hormones because highly equipped machines and special equipments are used; also the workers need to be trained to produce the insulin.

There are some people who are against the genetic engineering of growth hormone, mainly because often the process is used on animals and therefore the once which are labeled being from the animals people and will put people off buying the product, which means that there will be a profit loss on for must companies and pharmaceuticals which used animals.

However new technology and developments help scientist create the hormone using bacterium genes, for these industries and pharmaceuticals the cost of making the insulin works out to be much cheaper and they will be making a profit out of it as people who are against the animal testing's and cruelty will buy this growth hormone . Some times this hormone which are derived from bacteria can mutate, this may cause concerns and worries for patients who will be using the products and therefore will refuse to use the it, and this again will lead to a decrease in profit of the labs.

Reference

http://library.thinkquest.org/19037/agriculture2.html

http://members.tripod.com/c_rader0/gemod.htm

http://www.safe-food.org/-issue/ge.html

http://www.bionetonline.org/english/content/ff_cont3.htm

http://www.goldenrice.org/Content2-How/how1_sci.html

http://www.csa.com/discoveryguides/gmfood/overview.php

http://www.slideshare.net/sol777/golden-rice-potential-and-outlook