The fight against cancer trough gene technology

A closer look at a DNA-Chip

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Preface

Cancer still belongs to one of the biggest death causes in our present. The main reason why so many people are dying because of cancer are the wrong diagnosis which are leading to wrong treatments and severe side effects. Our motivation was to look for new treatments and ways to improve the diagnostics resulting a higher possibility to heal patients from cancer without harming them.
Gene technology isn't just a secure and harmless way to treat cancer patients, it is also a very new way of treatment and is experiencing a lot of progress. Therefore we can observe a lot of revolutionary changes which are made by the medical scientist who pin their hope on gene technology.
The results are amazing. Scientist have already found a way to diagnose exactly different cancer types by observing the activity of affected and non-affected tissue, using a gene chip. Another progress was made in the combat against cancer by genetically modifying bacterias in a way that the start to produce proteins which are destroying cancer cells or blocking the growth of their blood vessels.
It is amazing to see how the humanity is making progress in manipulating organisms by adding or taking away certain genes with the aim to make them helpful for the agricultre, industry or in our case medecin.
Although these progesses show us that it's possible to solve the problems to heal cancer without any further compications. But the questions are:

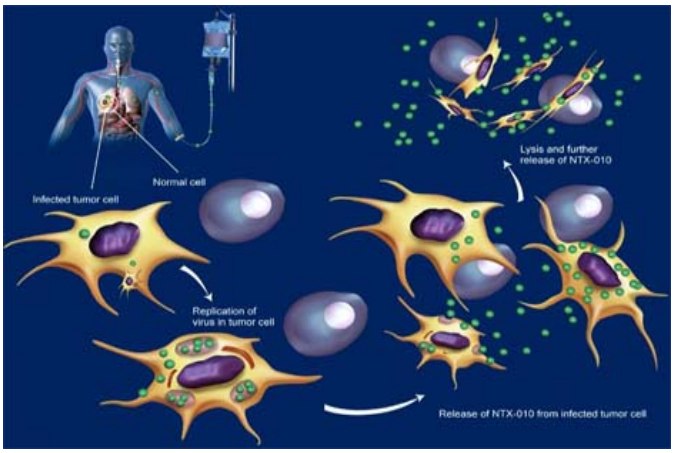
- We have hundereds of different cancer types and the revolutionary gene chip is just capable to prove one type and once. When will it be possible to use a universal genchip which can tell you the cancer type?
- The every genetical modified virus or bacteria can help successfully. Chance of a positive treatment is still not high enough. Will the science ever find a efficient medicament/treatment against cancer?

Introduction

Gentechnology was first done by the scientist Paul Berg (1972) by combining the DNA of the monkey virus and with that of the lambda virus. Sequently the scientist started to develop this area with the hope to have found the solution of several problems.
For example:
->Increasing productivity of animals (i.e. milk/wool production)
->Changeing the genetic make-up of bacterias in a way that they start to help the humans (i.e. producing insulin)
->Genetically modifying plants to advance them in a way the producers want (i.e.

resistance against herbicides, capable to bear chillness)

Now one of the bigger problems where genetechnology should help to get further is the combat against cancer.
Cancer is a class of diseases characterized by out-of-control cell growth. There are over 100 different types of cancer. Therefore we first need to examine the type after we treat the patient and that is practically impossible.
The result was that medecins had to treat the patient without the knowledge about the type, the strong side effects of the medicament and the high possibility of wrong treatment often caused a bigger damage than that it helped.
One treatment is the chemotherapy which can be used by many different types of cancer. But it can also be a very harmful solution, because cancer cells may grow and divide more rapidly than normal cells, many anticancer drugs are made to kill growing cells. But healthy cells also multiply quickly, and chemotherapy can also affect these cells, too. This damage to normal cells causes side effects.
The fast-growing, healthy cells most likely to be affected are **blood cells** forming in the bone marrow and cells in the digestive tract and reproductive system.



Another way to treat cancer happens with the help of **genetic engeneering**, by upgra-ding the efficiency of oncolytic viruses (=attacking cancer cells) or genetically modified herpes viruses with the objective to increase the production of specific proteins which inhibit the growth of blood vessels (needed for the growth of cancer)
The medical scientists are putting their hope into the genetic engeneering because these therapies don't have any strong side effects and the problem with wrong diagnosis caused by the absent knowledge of the cancer type is solved too. The revolutionary investigation of a gene chip which is capable to examine the type of cancer leads to more precise treatment and less mistakes.

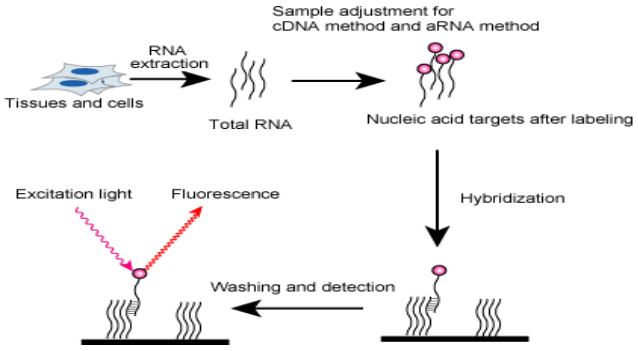
The DNA-chip

The size of a genechip (DNA-Chip or DNA-Microarray) is comparable to a coin. It`s a thin plate made out of glas. This plate contains many little chambers which are arranged in a grid. Such a chip contains up to 400`000 of these little reaction chambers. In each, a few million pieces of an exactly defined DNA sequnze are present. The computer gives you the information about the location of every single DNA sequence.
The use of a DNA-Chip is to analyze hundreds of genes at the same time. Therefore you can determine which genes of a certain tissue are

active at the moment. Comparing affected and non-affected tissue, show you their difference giving the informtion about the malfunction of the affected tissue.

Working process:

1.) You have to isolate then purify the DNA
2.) Now the DNA has to be marked with a special colour which reflects the light of the laser.
3.) Now the reaction chambers get filled with the purified DNA. This is mostly done by a pipetting robot.
4.) If in a chamber two complementairy base sequences meet they`ll bond together.
5.) Then you wash away the non-bonded DNA.
6.) Now light the chip with laser light. The marked DNA pieces will reflect the light and these reflections are the informations you can analyze afterwards.
7.) With the help of the reflection picture (Abb. 3) and the informations where you put the different DNA pieces in you can analyze the whole thing.



Analysis:

Trough the intensity of the reflected light it`s possible to see how many pieces bounded together in a specific chamber. If the light is bright many pieces bounded, therefore this DNA piece is very active in the test tissue. If the light is weak only a few pieces bounded. Acordingly if no reflection occurs the DNA piece present in the chamber isn`t active in the tested tissue.

An example out of real life is the one of the cancer institute of Heidelberg. They developed a chiptest for the papilloma virus thats a virus which ca cause cervical cancer. There are existing over a hundred different forms of the papilloma virus but only fifteen of them are really causing cancer.
What Heidelberg is doing is to prepare a chip with the DNA of the cancer causing virusses. So if a women is ifected by the papilloma virus the medcine do only have to take a cervic smear test, put it on the chip and after a few second he knows if the women is endangered to get cancer.

Interview

When did the reasearch for these gene chips start?

> I cant answer this question that easy. Because the DNA-chip insn`t a project we started at a certain time. It`s more a point in a longer process wich isn`t finished jet. If I had to give a starting point that would be the time we started to analyze the genetic expression of different cancer types.

Why exactly such a gene chip?

> As I said allredy we dont decided to invent a DNA-chip from one day to the other. We were analyzig the different cancer forms when this microary technique came up. Then we set us the goal to develop a DNA-cip for each known cancer form. The last one we finished was that one to check the papilloma virus for cervical cancer causing.

Could you explain the different steps of developement?

> First you have to decide what the precise application of the DNA-chip should be. Now lets take the example of the cervical cancer. In this case we had to develop a chip which can check if a patient which is infected of the papilloma virus is infected with a cervical cancer-causing one or not. Therefore we had to search all the genes which differ the cancer-causing virus from the rest. That the most difficult part because necessary to sequenze the whole genome of all known papilloma viruses an to compaire them. Afterwards you only have to extract all the relevant genes and put them into the chip. So our work wasn`t to develop the chip itselves but to find the relevant genes.

Will such chips belong to the routine in the near future?

> On a few areas the science has emerged the techniques so far that their test are that relable and precise they could bring them to the market. There is only one problem: The chips are very expensive and the DNA.chips wont come to the market very soon.

Is it possible to produce chips which have multiple functions?

> Basicaly it would be possible. But it would not be very meaningful because if you want to check a patient for breast cancer it is sensless to test him on the same time also for cervical cancer and pancreatic cancer.It only would make

sense if the chip tests two types which are really close together on fifficult to distiguish.

In which direction will the reaserch on the topic go in future?

I think that in future we`ll try to improve the tests in a way that we can`t only diagnose the disease but also diagnose the etiopathology. That would be a huge improvement.

The interview was made with Dr. J. Hoheisel from DKFZ Heidelberg.

Discussion

Will the medicament that I give to the patient be the right one?
Wich form of cancer has he?
Has he a tumor which is building metastases?

These questions are important if a doctor will treat a patient with medicaments and al these questions can be answerd by a gene chip.
So progress we would made if the gene chip really would come to the market would be extraordinaire. Because up to now the medics couldn`t answer these questions at all, or not as precise as needed.
But it`s still a long way up to the moment until the chips are developed so far, that they really can be used in praxis.
The scientists found out the system but thats not enough. Now the further research steps must be the developing of all the specialized chips for the different applications. But the science is on the way.
That are only a few examples of chips which are developed right now:

- Heidelberg --> for cervic cancer
- Massachusetts General Hospital --> breast cancer
- Hoffman-La Roche --> how fast a medicament will be decomposed

Advantages and disadvantages

	Advantages	Disadvantages / Dangers
Patients	• fast diagnose • precise diagnose • it`s cheaper if you the right treatment from the begining than as if you have to try several	

	things out • less adverse reactions	
Medics	• smaler possibility to give the wrong medicament • can react faster and more precise	• no chips for unusual diseases
Industry	• Can produce more spezific medicaments	• have to invent a chip for each disease
Science	• comprehension of cancer	

As we see in the table above there are much more advantages then disadvantages. So I think that this tecnique really could help to fight against cancer.

Summary

Gene technology is a really interesting topic and a science with huge opportunities. And that is also the case in reference to the the topic cancer. With the help of gene technology and it`s techniques many lives could be safed. One one hand through the diagnose possibilities and on the other hand through the modifying of oncolytic viruses.
In the area of diagnosis the science made big advances. They developped DNA-chips which can check a tissue in a few second. And tests are nearly that precisse and reliable as if they were made in a lab. Sadly up to now they are too expensive as they could been used in routine analysis. But the scientists are working on it. And whats the best on the DNA-chips is that tehy do not have any disadvantages apart from the costs.

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