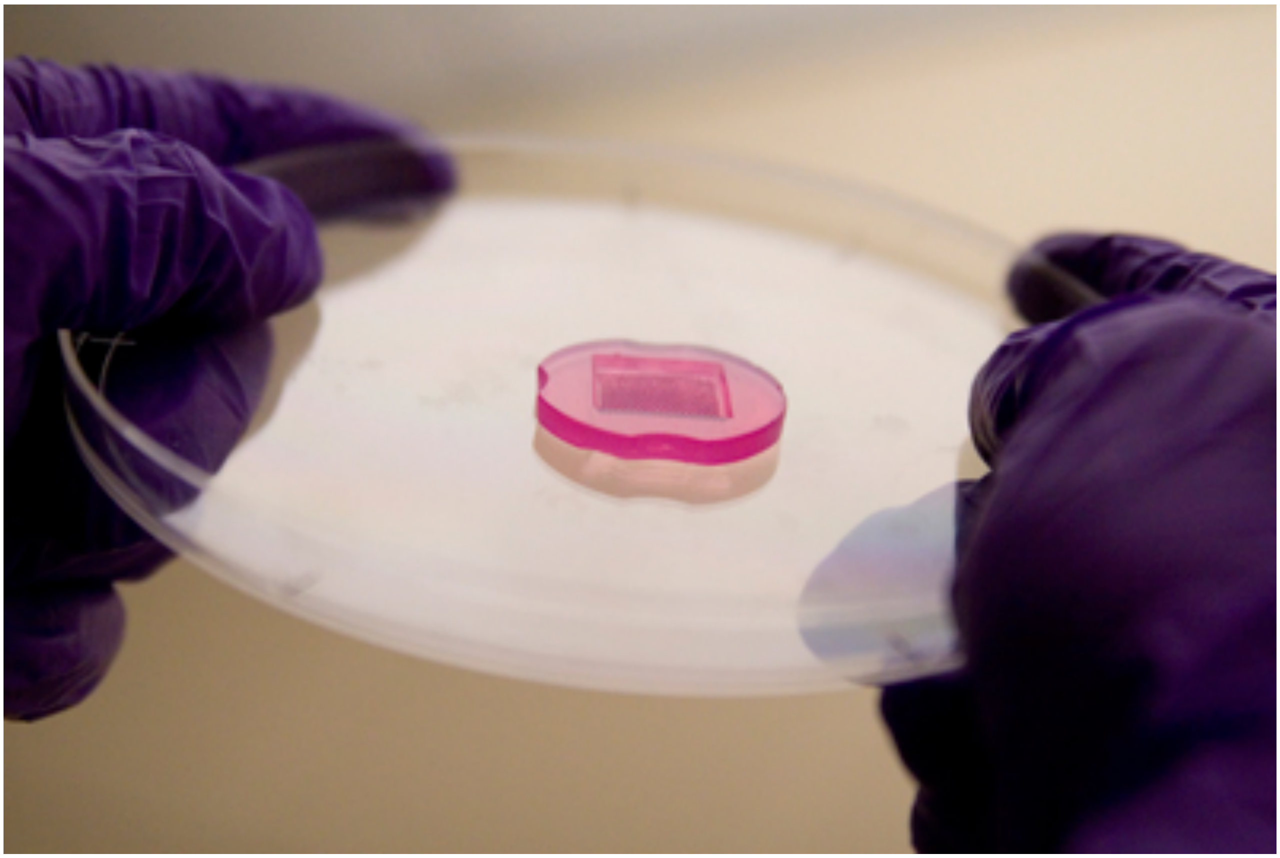
## Term Paper

# Fake skin



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# Preface

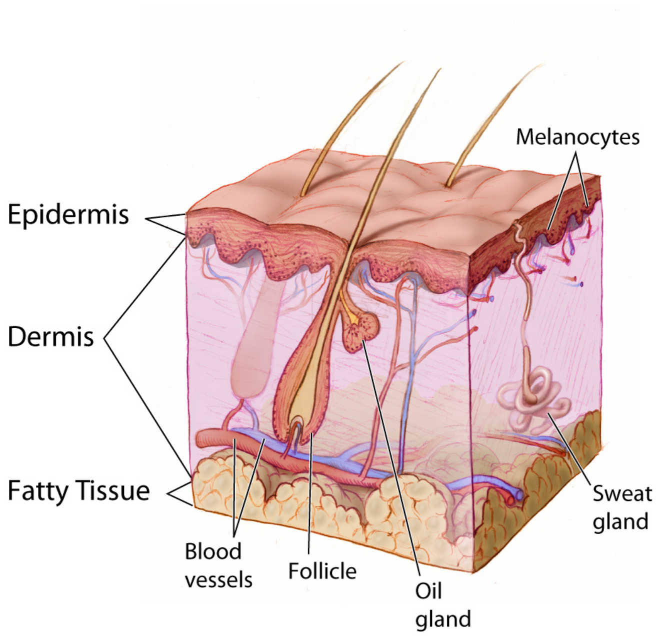
We chose “Fake Skin” as our topic because it was something very fascinating to all of us. The fact, that we are technologically able to successfully cultivate and implant artificial skin is very interesting.The skin is not only the largest organ on the human body, but also one of the most unique ones, due to its ability to heal very quickly and efficiently.

But what, if we suffer from a wound, which is too big to be healed by our skin itself? What if our skin suffered from a severe burn? Specialists are able to implant certain skin cells, that will regenerate the whole skin and heal large wounds. We have been searching for questions and answers all around this topic and have put up the following lead questions:

- How does the cultivation and usage of artificial skin work?
- What other benefits than healing wounds can we draw from artificial skin?
- What resources do we require to produce artificial skin?

# Introduction

Our skin is very robust and very sensitive at the same time. Since it protects our inner body from the environment, it has to endure quite a wide range of things. At the same time we have to be able to move without any difficulties, meaning that our skin has to be stretchable as well, giving it a certain weakness. For example a sharp object can cut through our skin. To get solve this problem our skin has developed so that it heals very quickly. Our skin consists of the following parts:




http://en.wikipedia.org/wiki/File:Anatomy_The_Skin_-_NCI_Visuals_Online.jpg

Our skin consists of the three main parts: The epidermis, the dermis and the fatty tissue. The epidermis renews itself every (~)30 days. The dermis is run through by blood vessels and is there to bond the epidermis to the body. Strictly seen, the fatty tissue (Hypodermis) isn't a part of the skin, but it attaches the skin to the body, and is run through by blood vessels. It consists of 50% body fat.

## An alternative to animal testing

Artificial skin is also a great alternative to animal testing. Any new cosmetics and drugs must be tested before they can be sold. Up to now in early stages of studies, animals have been used to test these products. This brings up ethical questions and moral difficulties. But now that skin can be produced in a lab, scientists can use it to test the products.

## Producing technique

There are several techniques to produce artificial skin. Synthetic skin is produced in a 3D cell culture. In a common petri dish a cell culture would stop growing after the cells get to near to each other, which is also known as confluence. It would stay in one layer, meaning it would be a two dimensional culture only. But exactly this 3rd dimension would be needed to produce a skin-like substance. Collagen is the most common protein in our skin. Luckily it is easy to extract, giving scientists the opportunity to use it for their 3D cell cultures. We are going to explain one common technique to grow a 3D cell culture, with a collagen sponge as a matrix.As a first step fibroblasts are injected into the collagen sponge. A fibroblast is a type of cell that plays a critical role in wound healing. After this first step, keratinocytes, which are the predominant cell type in the epidermis, the outermost layer of the skin, constituting 90% of the cells found there, are put on the top layer of the sponge, which is made by the fibroblasts.

# Interview

We had our interview with Peter Girling, founder of CELLnTEC®

**As I understand, the 3D cell culture involves a gel, which acts like scaffolding. Is this correct?**
3D cultures is a very broad term - it covers the full range of approaches from cells that self-assemble without the need for scaffolds (for example skin models), and also those which require a scaffold in which the cells are embedded (e.g. fibroblasts in collagen or another kind of gel).

**How does this gel affect the result, when testing the culture with drugs?**
Ideally, the scaffold itself doesn't have a significant effect. The change in cell behaviour should result mainly from the fact that the cells are in layers or clumps (depending on the kind of 3D model), and are thus surrounding each other. This changes how the drugs physically reach the cells, and also how the cells respond because they have many more connections with neighbouring cells.

**How realistic are your 3D cell cultures?**
3D cultures are definitely close to the in vivo situation than cells grown in 2D culture (a monolayer). This means that in some ways the 3D cultures will be very similar to the in vivo situation, however in every model there will always be many ways in which it is still quite different from a real tissue. The biggest difference is always the number of cell types - in vivo there are always many cell types present, in vitro it is mostly only one cell type, sometimes two.

**A big part of he cell cultures are stem cells. Do you think this will change some day?**
Stem cells are very important in the body, as they give rise to all the specialised cell types. This means they will always be important in vitro as well. The question will mostly be what is the best cell type for my test, for example should I test my drug on mesenchymal stem cells, or on the more specialised (differentiated) cells that those cells can develop into.

**How important can cell cultures become in regard to drug testing? Can it someday become as good as in vivo or will you always need a combination of both?**
In vivo tests will be required for a very long time. How long depends on what you are trying to test. For example simple toxicity tests can now be done quite reliably only using in vitro tests. However other more complicated tests (like reproductive or systemic toxicology) will only be possible once much more complicated in vitro models are reliable and easy to use.

**Are there permanent limits?**
There are no permanent limitations. Studies have shown that cells will construct very complex structures if they get the right environment. The challenge now is just to find the right environments.

**Can 3D cell culture help in growing organs? Or is this not the aim of 3D cell cultures?**
Growing organs is one application of 3D cultures. It will also be possible in the future, but will require more advances in the culture media to grow multiple cell types, and also the scaffolds to give the desired organ structure.

**Are 3D cell cultures still in the development stage?**
In vitro models have been constantly developed for 60 years. It will continue indefinitely.

# Summary

Our skin is unique and can't be exactly reproduced in the laboratory. But with our 3D cell structure technology we can make a very good replicate of the skin. But this replicate does not have blood vessels, sweat glands and hair follicles, which are important factors for our body.

With this skin we are able to do drug tests without hurting/killing animals, which is a big ethical problem nowadays. But, as always, this solution brings new problems: the stem cells that are used to make the fake sin are from aborted foetuses, which is another ethical problem.

There are several ways to produce the fake skin, but the most common way is the collagen sponge. With this sponge and the 3D cell structure we are able to create a our 3D fake skin.  There is also a possibility to produce the fake skin in the petri dish, when you mix the collagen and the fibroblasts, add them to a petri dish and add the keratinocytes on top of it.

Luckily, the collagen is quite easy to extract.

# Discussion

With our new 3D cell structure technology, we can produce a fake skin which is very similar to the real skin (epidermis).  The 3D technology enabled us to create complex layers and structures due to the three-dimensional space.

Even the fake skin looks quite similar to the real skin, it isn't. There are some details the scientists couldn't create. For example the hairs within the skin: they are very important for protection against light (UV & IR) and the temperature regulation of the body. The fake skin also doesn't have sweat glands, so you can't sweat through it, which can lead to heatstroke more often (body can't cool down at the fake skin parts). So the scientists have to find a way to create 3D cell culture grown hairs and sweat glands to make the fake skin better.

## Advantages

- Patients with big, burned areas, cauterization injuries or skin diseases (skin cancer) can get use of the fake skin to look more "normal" again
- The collagen used for the production is produced easily
- For drug tests you can use the fake skin instead of animals, this would eliminate the problem with the animal murders in the laboratories
- The drug testing on fake skin would even be faster, so the patients that may need the product can get it earlier

## Disadvantages

- There may be an ethical problem with the stem cells, because they are taken from aborted foetuses
- The body's immune system may reject the fake skin
- There are no blood vessels, sweat glands and hair cells included in the fake skin

# Glossary

- Transduction: the transfer of genetic material from one cell to another
- Fibroblast: a cell that contributes to the formation of connective tissue fibers.
- Keratinocytes: An epidermal cell that produces keratin.
- Melanocytes: a cell producing and containing melanin.
- In Vivo: As in real life

Word explanations: http://dictionary.reference.com

# References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