[youtube:http://www.youtube.com/watch?v=y4k55347ik0]

Keynote Speaker on stem cell research. Embryonic stem cells and adult stem cells - biotech company progress, stem cell investment, stem cell research results, should you invest in stem cell technology, stem cell organ repair and organ regeneration? Treatment using adult stem cells for people like the late Christopher Reeves, with recent spinal cord injuries - or stroke, or heart damage.

Comment by Dr Patrick Dixon following pharma keynote on stem cell research and science of ageing, health care, life expectancy, medical advances, pensions, retirement, lifestyles. (Read FREE SAMPLE of The Truth about Almost Everything - his latest book.)

"How AI Will Change Your Life - A Futurist's Guide to a Super-Smart World" - Patrick Dixon's latest book on AI is published in September 2024 by Profile Books. It contains 38 chapters on the impact of AI across different industries, government and our wider world, including the impact of AI on health care, Pharma, stem cell research and biotech innovation.

SEE ALSO more recent article on Future of Stem Cells in Organ Regeneration, Organ Repair and Health Care .

Every week there are new claims being made about embryonic stem cells and adult stem cells. What is the truth?

Scientific facts have often been lost in the media debate. The death of Superman hero Christopher Reeves has also focussed attention on stem cell research, and the urgent needs of those with spinal cord injury.

Here is a brief summary of important stem cell trends. You will also find on this site keynote presentations on stem cell research, speeches and powerpoint slides on the future of health care, the future of medicine, the future of the pharmaceutical industry , and the future of ageing - all of which are profoundly impacted by stem cell research.

Expect huge stem cell advances to treat disease and rebuild organs

There is no doubt that we are on the edge of a major stem cell breakthrough.

Stem cells will one day provide effective low-cost treatment for diabetes, some forms of blindness, heart attack, stroke, spinal cord damage and many other health problems.

Animal stem cell studies are already very promising and some clinical trials using stem cells have started (article written in September 2004).

As a physician and a futurist I have been monitoring the future of stem cells for over two decades and advise corporations on these issues, giving keynotes at their most important global events.

Exactly as I predicted back in 1993, stem cell investment, research effort, and treatment focus is moving rapidly *away* from embryonic stem cells (ethical and technical challenges) to adult stem cells which are turning out to be far easier to convert into different tissues than we thought.

I have met a number of leading researchers, and their progress in stem cell research is now astonishing. Over 2,000 new research papers on embryonic or adult stem cells are published in reputable scientific journals every year.

Stem cell technology is developing so fast that many stem cell scientists are unaware of important progress by others in their own or closely related fields.

They are unable to keep up.

The most interesting work is often unpublished, or waiting to be published.

There is also of course commercial and reputational rivalry, which can on occasions tempt scientists to downplay the significance of other people's results (or their claims).

Big questions to be answered on stem cells

What exactly are stem cells? Will stem cells deliver? Should you invest in biotech companies that are developing stem cell technology? What should physicians, health care professionals, planners and health departments expect? What will be the impact of stem cell treatments on the pharmaceutical industry? How expensive will stem cell treatments be? What about the ban on embryonic stem cell research in many nations? Do embryonic stem cell treatments have a future or will they be overtaken by adult stem cell technology?

What are stem cells - embryonic and adult stem cells

[youtube:http://www.youtube.com/watch?v=Ri10Y23QDSg]Stem cells are relatively primitive cells that have the ability to divide rapidly to produce more specialized cells.

Stem cells in the embryo are capable of huge variation in the kinds of tissues they make, reproduce rapidly and have attracted interest of researchers for decades.

However embryonic stem cells are hard to get hold of in humans - you need a supply of human embryos, which requires either breaking the law in some countries or applying for complex licenses in others.

But however they are sourced, there is another problem: embryonic stem cells are also hard to control, and hard to grow in a reliable way.

Embryonic stem cells have "minds" of their own, and embryonic stem cells are often unstable, producing unexpected results as they divide, or even cancerous growths.

Human embryonic stem cells usually cause an immune reaction when transplanted into people, which means cells used in treatment may be rapidly destroyed unless they are protected, perhaps by giving medication to suppress the immune system (which carries risks).

Therapeutic cloning as source of stem cells

One reason for intense interest in human cloning technology is so-called therapeutic cloning.

This involves combining an adult human cell with a human egg from which the nucleus has been removed.

The result is a human embryo which is dividing rapidly to try and become an identical twin of the cloned adult.

If implanted in the womb, such cloned embryos have the potential to be born normally as cloned babies, although there are many problems to overcome, including catastrophic malformations and premature ageing as seen in animals such as Dolly the sheep.

In theory, therapeutic cloning could allow scientists to take embryonic stem cells from the cloned embryo, throw the rest of the embryo away and use the stem cells to generate new tissue which is genetically identical to the person cloned.

In practice, this is a very expensive approach fraught with technical challenges as well as ethical questions and legal challenges.

Huge banks of embryonic stem cells - because of problems with tissue matching

An alternative is to try to create a vast tissue bank of tens of thousands of embryonic cells lines, by extracting stem cells from so many different human embryos that whoever needs treatment can be closely matched with the tissue type of an existing cell line.

But even if this is achieved, problems of control and cancer remain.

And again there are many ethical considerations with any science that uses human embryos, each of which is an early developing but complete potential human being, which is why so many countries have banned this work.

A great alternative to using embryonic stem cells

[youtube:http://www.youtube.com/watch?v=SKeorEMkFGY]Until recently it was taught in all medical schools that cells in the embryo were multipotent - able to give rise to every tissue - but by birth, this capacity was permanently lost.

That has been the reason why almost all research effort focused on embryonic stem cells until just a few years ago. But this was a major error, as I predicted over many years.

Indeed a moment's thought tells us how illogical it was to conclude that adult cells could not be persuaded to generate many different tissues.

Indeed we now see every day that many cells in children and adults have extraordinary capacity to generate or stimulate growth of a wide variety of tissues, if encouraged in the right way.

Take for example the work of Professor Jonathan Slack at Bath University who showed how adult human liver cells could be transformed relatively easily into insulin producing cells such as those found in the pancreas.

Or take the work of other scientists, using bone marrow cells to repair brain and spinal cord injuries in mice and rats, and now doing the same to repair heart muscle, brain, spinal cord and eyes in humans.

It was always obvious to me that adult cells were very adaptable

Why should any of this surprise us? Here are the facts that have always been well known about adult stem cells:

1. Almost all cells in your body contain your entire genome or book of life: enough information to make an entire copy of you, which is the basis of cloning technology.

2. So in theory, just about every cell can make any tissue you need.

3. The issue is that in most adult cells, almost every gene is turned off - the only issue is how to turn them back on again

4. If we take one of your skin cells and fuse it with an unfertilized human egg, the chemical bath inside a human egg activates all the silenced genes. The combined cell becomes so totipotent that it starts to make a new human being.

5. So we know that chemicals can restore a nucleus in a fixed-purpose adult cell, into a nucleus that behaves just like an egg.

6. It was not such a great step to imagine that scientists would experiment with different types of chemicals to activate just a few silenced genes, and perhaps at the same time silence some of the others?

And today this is quite routine. The first step is to make the cell nucleus regress to a less pre-determined state, and then push its genetic activity in one direction or another.

Impact of embryonic and adult stem cells on the future of medicine and health care

[youtube:http://www.youtube.com/watch?v=l-dpCiNgMqk]Stem cell therapy is not a conventional treatment using an external agent and so the normal 15 year development pipeline for new pharmaceutical products does not apply.

Indeed the gap between seeing promising stem cell results in animals and starting first human trials can be as short as 15 days.

Suppose you have a heart attack.

A cardiothoracic surgeon talks to you about using your own stem cells in an experimental treatment.

You agree.

A sample of bone marrow is taken from your hips, and processed using standard equipment found in most oncology centers for treating leukemia.

The result is a concentrated number of special bone marrow cells, which are then injected back into your own body - either into a vein in your arm, or perhaps direct into the heart itself.

The surgeon is returning your own unaltered stem cells back to you, to whom these cells legally belong.

This is not a new molecule requiring years of animal and clinical tests. Your own adult stem cells are available right now. No factory is involved - nor any pharmaceutical company sales team.

What is more, there are no ethical questions (unlike embryonic stem cells), no risk of tissue rejection, no risk of cancer.

Now we begin to see why research funds are moving so fast from embryonic stem cells to adult alternatives.

Repairing damaged retinas to restore sight

Harvard Medical School is another center of astonishing progress in adult stem cells. Their early trials showed partially restored sight in animals with retinal damage. Clinical trials have proceeded rapidly, around the world, using adult stem cells as a treatment to cure blindness caused by macular degeneration - old-age blindness and the commonest cause of sight-loss in America.

Twelve years ago, in 2008, when the first version of this article was published, I predicted that within a decde, people would be able to be treated routinely with their own stem cells in a clinic. And that is precisely what has happened.

Investment into embryonic stem cell research has collapsed

If you want further evidence of this switch in interest from embryonic to adult stem cells, look at the makers of Dolly the sheep.

The Rosslyn Institute in Scotland are pioneers in cloning technology.

They, along with others, campaigned successfully in UK Parliament for the legal right to use the same technology in human embryos (therapeutic cloning, not with the aim of clones being born).

But three years later, they had not even bothered to apply for a human cloning licence.

Why not? Because investors were worried about throwing money at speculative embryo research with massive ethical and reputational risks.

Newcastle University made headlines in August 2004 when granted the first licence to clone human embryos - but the real story was why it had taken so long to get a single research institute in the UK to actually get on and apply. Answer: medical research moved on and left the "therapeutic" human cloners behind.

Do stem cells really repair tissue - or just stimulate repair?

[youtube:http://www.youtube.com/watch?v=8F7_MIQ7kFg]For several years there has been a curious and very confusing debate in editorials of publications like the New England Journal of Medicine about whether adult stem cells actually regenerate tissue or not.

The debate centers on technical questions and semantics, rather than the reality of results.

Take for example heart repair.

We know that when bone marrow stem cells are released into the blood stream, they migrate into damaged heart tissue and when present, the heart is repaired.

It is hard to be certain what proportion of this remarkable process is due to stimulants or cytokines released locally by bone marrow cells, or is due to the bone marrow cells actually differentiating into heart tissue.

It remains a confusing picture, not least because in the lab, cells seem to change character profoundly, but in clinical trials it appears the effects of many stem cells are stimulatory.

Who cares?

As a clinician, I am delighted if injecting your bone marrow cells into your back means that you are walking around 3 months after a terrible injury to your spine instead of being in a wheelchair for the rest of your life.

I am not concerned very much with exactly how it all works, and nor will you be.

The future of stem cells

In summary, expect rapid progress in adult stem cells and slower, less intense work with embryonic stem cells.

Embryonic stem cell technology is already looking rather last-century, along with therapeutic cloning. Exactly as I predicted, we are in 2020 already able to produce a wide range of tissues using adult stem cells, with spectacular progress in tissue building and repair.

In some cases, these stem cells will be actually incorporated into the new repairs as differentiated cells, in other cases, they will be temporary assistants in local repair processes.

[youtube:http://www.youtube.com/watch?v=loXJAeQKZI0]We will also see some exciting new pharmaceutical products in the pipeline, which promise to do some of the same tricks without having to remove a single stem cell from the body. These drugs may, for example, activate bone marrow cells and encourage them to migrate to parts of the body where repairs are needed.

And along the way we will see a number of biotech companies fold, as a result of over-investment into embryonic stem cells, plus angst over ethics and image, without watching the radar screen closely enough, failing to see the onward march of adult stem cell technology.

Using embryos as a source of spare-part cells will always be far more controversial than using adult tissue, or perhaps cells from umbilical cord after birth, and investors will wish to reduce uneccessary risk, both to the projects they fund, and to their own organisations by association.

Despite this, we can expect embryonic stem cell research to continue in some countries, with the hope of scientific breakthroughs of various kinds.

Article first written in May 2004 and updated in February 2020