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Terasem Movement, Inc.

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# Engineering Lung Tissue for Clinical Applications

## Professor Dame Julia Polak

*This article was adapted from a lecture given by Professor Dame Julia Polak during the 3rd Annual Workshop Webinar on Geoethical Nanotechnology on July 20, 2007, at the Florida Space Coast Office of Terasem Movement, Inc.*

*Professor Polak is one of the most highly influential researchers in the newly developing field of Tissue Engineering. Professor Polak and her team work diligently within nanotechnological cell and gene research, essentially rewriting the book of medicine to promote tissue regeneration and enhancing the body's ability to heal itself.*

Regenerative medicine is the application of the principles and methods of life sciences, medicine, and engineering toward the development of a biological substitute to restore, maintain and improve body functions.

It covers a number of fields, including that of cell therapy, tissue engineering, and nanotechnology with the aim of delivering safe, effective and consistent therapies. So how do we help the body to heal itself? We could perhaps implant a new organ, and this is how the inspiration of Martine Rothblatt started when she was keen that we try to attempt to recreate what is happening in vivo [1], in any an in vitro [2] situation, to help the ones in desperate clinical need due to the lack of donor organs. It will not replace it, but it will help out, and this is where we began the field.

> *"...a new name is added to the list of 10 million people needing a transplant every 18 minutes, and most will die before a suitable donor organ is found."*

There is another way which is now beginning to take place as well (I will go into details of each one), which is to add cells to a diseased organ. The cells can be exogenous [3] or endogenous [4], and the cells can help towards the regenerative properties of our body.

We all have the ability to regenerate, but we lose it as we grow older and as we move into the evolutionary tree. Frogs and salamanders cut off a leg, and they can regenerate themselves. What we have lost or what inhibitory factors we have achieved, does not allow us to regenerate so readily.

 

When a baby is very young, it can regenerate, for instance if the baby cuts his/her skin, it will heal, leaving no scars. When they become my age, then it is harder to regenerate. What is happening; how can we help the body to regenerate itself?


**Image 1**

By adding cells, maybe to a diseased organ, we could help the regeneration process. Furthermore, we know that there are regenerative cells in the body, some people call them stem cells, some people call them regenerative cells. This can stimulate cell renewal, and we can use this capacity to help the body to regenerate itself. I will go into the details of that later on.

As previously stated, this is desperately needed as a new name is added to the list of ten million people needing a transplant every eighteen minutes, and most will die before a suitable donor organ is found.

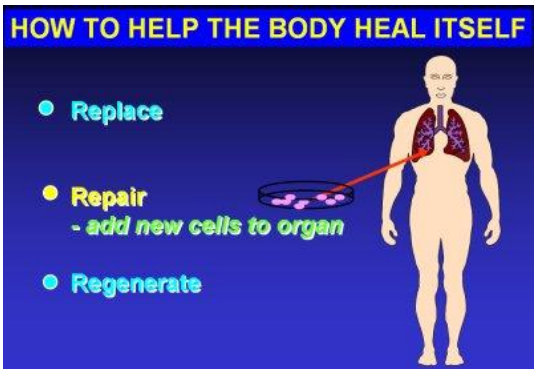


**Image 2**

In this country, there is now a move to try to get more donor organs by specifically indicating we do not want our organs to be removed. If that is not specifically stated, then it can be removed.

Transplantation requires not simply going and acquiring the organs, but also the need to have intensive care units well prepared for this kind of very drastic operation and so forth, it's a step in the right direction.

We also have other forms of cell therapy. We have had organ transplantation since 1954's first kidney transplant [5]. Since 1968, we have had the therapy of sending cells to replenish the bone marrow within bone marrow transplantation [6]. The field has progressed quite a bit.

What are the main components of regenerative medicine? The two main components are cells and materials; which cells?

In the early days, we tried using adult cells, then we moved into fetal cells which may carry ethical issues, but they grow very well and they're helpful as a cell source.

Then came the discovery of the stem cells being embryonic or so-called adult stem cells, which occur in every tissue of the body, but principally the bone marrow, umbilical cord, blood, and fat tissue.

A great variety of cells are illustrated here that can offer solutions to unmet clinical needs.

What is happening with the material; do we combine the materials with the cells? Would we just grow the cells loose in a dish two dimensionally?

Ideally, we need to grow them attached to a material that then can be used as a carrier, but the material will gradually, gently disappear

allowing the cells to produce their own extra-cellular matrix and having a similar dimension and structure.

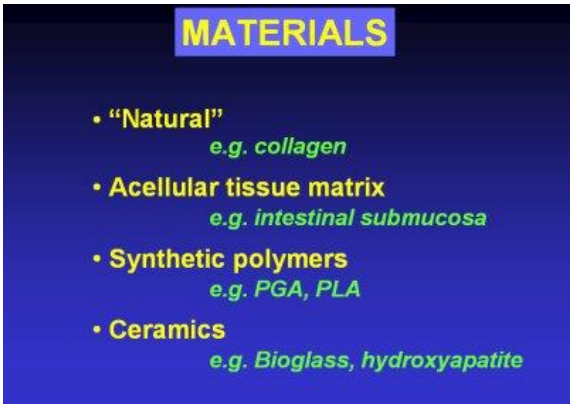


**Image 3: Materials**

There is a large variety of materials like natural collagen and cellular tissue matrixes, intestinal sub mucosa, polymers, and ceramics. We did a considerable amount of work with Professor Larry Hench [7] using his own bio-ceramic material called: Bioglass [8].

A given material should be able to regenerate the tissue by stimulating cell growth and differentiation, cell attachment, deposition of structural matrix, act as a template for tissue growth in a three dimensional manner, for implantation be resorbable, and for pharma being sorbable.

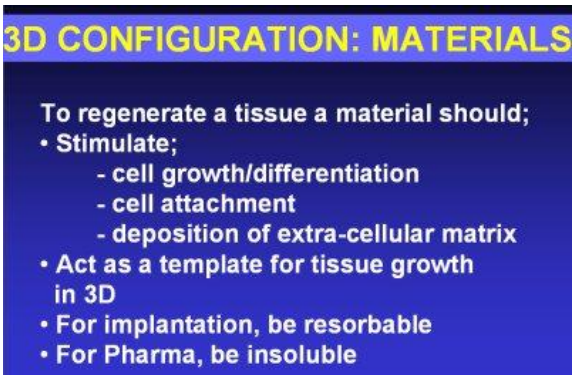


**Image 4**

We published a bulk of original papers that demonstrated certain man made materials are more useful for certain cell types than others. We need to decide what we want to create to use the right cell and the right material.

The aim is to improve or restore function to lung ailments where common clinical approaches are only palliative. We do that hopefully by engineering the lung -- this is slowly happening, but it is a long way away to clinical trials.

We also do cell therapy by having cells grown in vitro and then administering into a patient, or by mobilizing the cells and hence stimulating regeneration

The first example is when we looked at lung transplantations and bone marrow transplantations; they have to be of different sexes so we can distinguish by the X and Y-chromosomes staining.

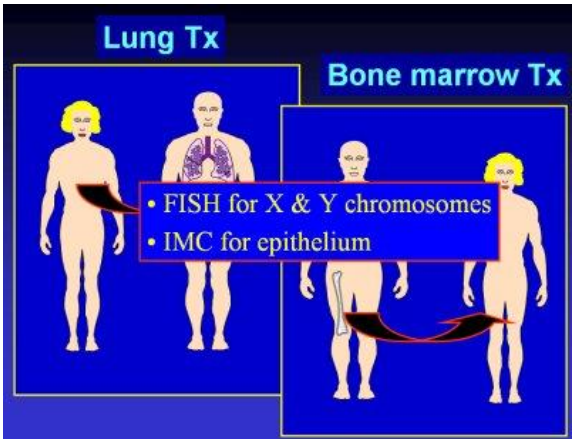


**Image 5**

This demonstration shows a man that received a lung from a woman. A man gave the woman the bone marrow and we used the staining for X and Y chromosomes and immuno staining for markers of the lung epithelium

Lo and behold, we found that the transplanted lungs contained plenty of cells that belonged to the recipient, which indicates that the transplanted lung (the donor lung), was able to

regenerate by recruiting cells off the recipient's, possibly bone marrow, stem cells.

This gave encouragement to think we could use cell therapy by growing cells and administering them for regenerative medicine purposes. In cell therapy, we were able to differentiate cells into lung specific phenotype.

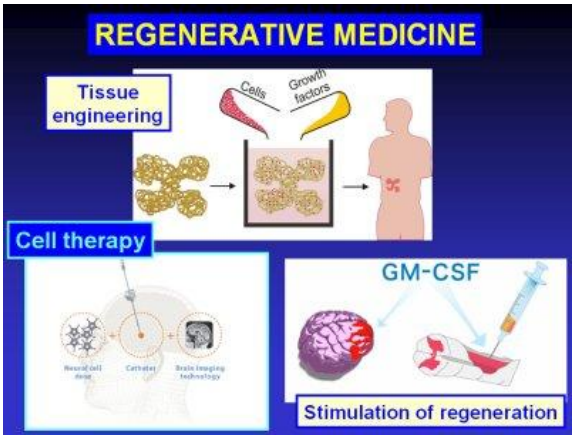


**Image 6: Stimulation of Regeneration**

These type II cells, which are precursors of type I cells, were able to produce type I cells which are in close apposition to the blood, so the blood flow is fully oxygenated and comes together with the cells, together with the blood flow, oxygenates the blood,

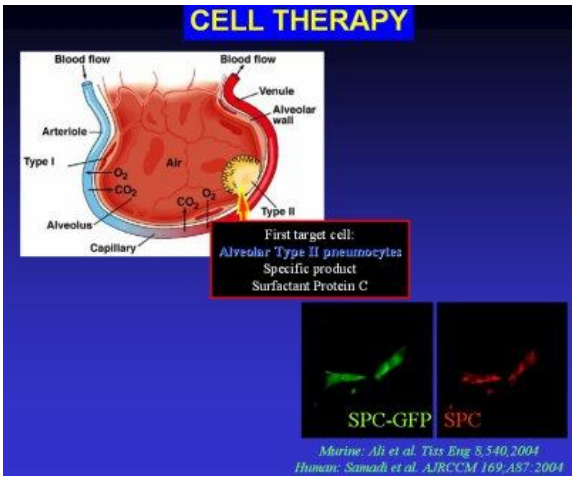


**Image 7: Cell Therapy**

What do we do towards clinical applications? We have an ongoing research with another German company called Novalung. They have produced polymers, and these polymers are hollow polymers. They allow the blood to penetrate and to oxygenate it ex vivo. Then blood comes back into the patient oxygenated, and the patient can wait for the transplant, or maybe recover if there was an acute lung injury.

> *"Over 50,000 kilometers of umbilical cord can be produced, and the vast majority is discarded."*

The question then arose: Could we attach type II lung cells to this particular polymer, and then enhance the polymeric oxygenation that is already helping the patients, but may help even more? This is what we are currently trying out at Imperial College with cells and polymers, and to see if that will help to save the lungs.

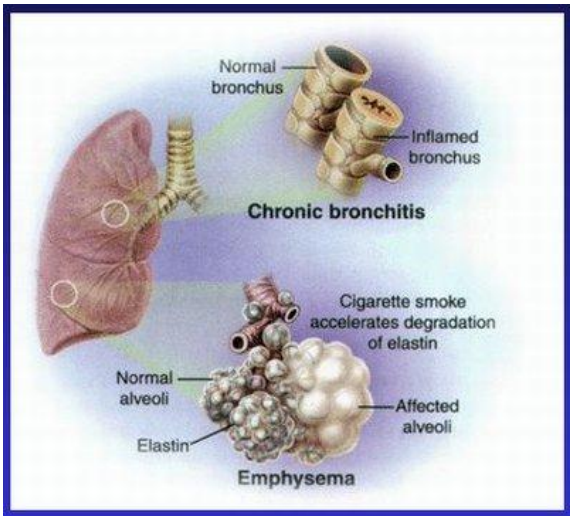


**Image 8**

We also have a program for lung repair. You see the model of chronic obstructive pulmonary disease of a smoker's lungs. This can be done by enhancing the proliferation of resident stem cells, or using bone marrow stem cells, and the lung-assist device with the cells that I referred to before, or using eventually three- dimensional constructs.

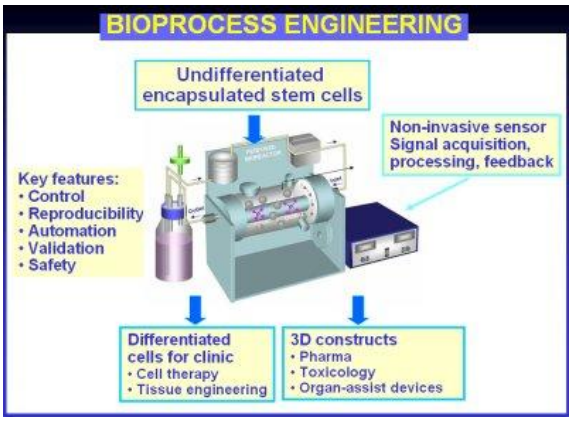


**Image 9**

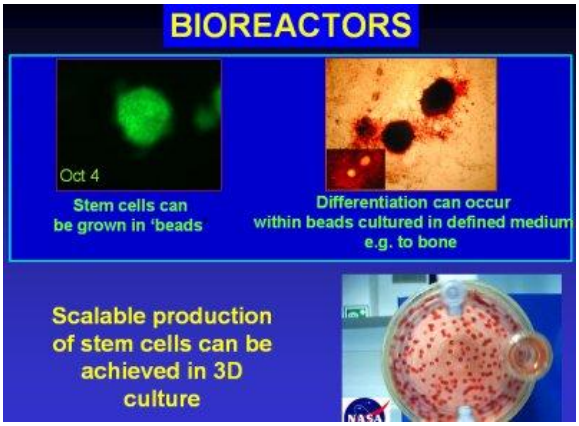


**Image 10**

For the time being, we have chosen to use umbilical cord stem cells. These umbilical cords are ethically easy, a hundred million births globally each year, and an excess of ten million liters of human umbilical cord blood. Over fifty thousand kilometers of umbilical cord can be produced, and the vast majority is discarded.

We wanted to see whether we could put these clinically ready and available umbilical cord cells into the alveolar space of patients with Emphysema or Chronic Obstructive Pulmonary Disease.

We are combining efforts with a company in Israel called Gamida. They have clinical grade umbilical cord cells, and we are doing the animal experiments for proof of concept to be followed by Phase 1 clinical trials.

The problem is (and the whole world has the problem), how do we produce sufficient numbers of cells for a diverse set of people's need? We would really need to have quantities of identical cells reproducible.

We are not going to give patient A one group of cells and patient B, different cells. We really need to have a sufficient number of identical cells.

What we are developing here is Bio-processing Engineering at Imperial College. This is a typical bioreactor that rotates and perfuses. We want to achieve control, reproducibility, validation, and safety. This is a dynamic, three-dimensional perfused culture system where we only add the growth factors and then we non-invasively check how the cells are behaving, and this is an illustration.

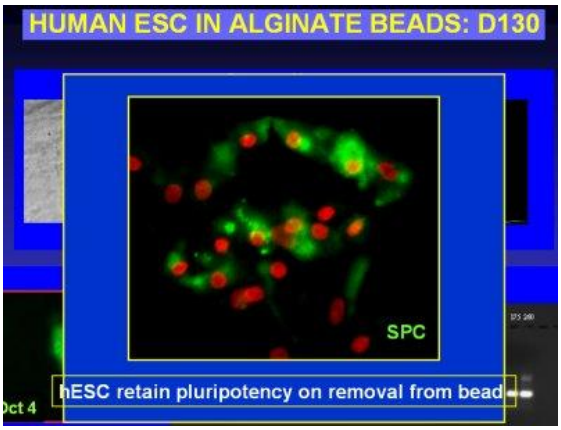


**Image 11**

What we did is we encapsulated the cells in beads. The beads are FDA approved, gelatin beads, and the cells can be grown there, and then they can be cultured in a fine medium. We also encapsulated human stem cells in alginate bead and left them there for almost 130 days. Then took them out and differentiated into a lung cells, and the cells were alive

As the sensors are telling us what factors we should add, we can maintain the cells in good, healthy condition.


**Image 12**

I believe we are getting close to initial clinical trials. You must have all heard of clinical trials for heart repair, or for retinal and eye repair, or cartilage and skin repair.

I think we need to have the basic science running in parallel to understand the principles and the properties of cell therapy and tissue engineering alongside the preparation for clinical trials by doing the proof of concept into acceptable small and large animal models.

Therefore, there are apparently separate fields of the stem cells that we are dedicated to working to understand development, or the tissue engineering that started from materials by replacing identical growth tissues in others.

The gene therapy field, the nanotechnology field, and the regenerative medicine field are all converging to help toward clinical application; to help clinical conditions where the situation is irrevocable. In the future, I believe we are likely to rewrite the books of medicine.

***Endnotes***

1. In vivo – *adj*. Within a living organism. The American Heritage STEDMAN'S Medical Dictionary. Boston, New York: Houghton Mifflin Company, 2004: 424.

2. In vitro – *adj*. In an artificial environment outside a living organism. The American Heritage STEDMAN'S Medical Dictionary. Boston, New York: Houghton Mifflin Company, 2004: 424.

3. Exogenous – Originating or produced outside of an organism, tissue, or cell. The American Heritage STEDMAN'S Medical Dictionary. Boston, New York: Houghton Mifflin Company, 2004: 284.

4. Endogenous – Originating or produced within an organism, tissue, or cell. The American Heritage STEDMAN'S Medical Dictionary. Boston, New York: Houghton Mifflin Company, 2004: 262.

5. 1954's first kidney transplant - On Dec. 23, 1954, doctors in Boston gave a kidney to a seriously ill, 23-year-old man in the first successful long-term transplant of a human organ. Since then, transplants have saved more than 400,000 lives. http://www.npr.org/... March 10, 2008 3:20PM EST

6. Bone marrow transplant back in 1968 - n 1968, the first major landmark in bone marrow transplantation occurred with successful allogeneic transplantations performed for an infant with X-linked lymphopenic immune deficiency and for another with Wiskott-Aldrich syndrome. These successes were followed by reports of effective transplantation for aplastic anemia and, later, for leukemia. Advances in histocompatability testing and development of marrow donor registries, such as the National Marrow Donor Program (NMDP), have facilitated the use of unrelated donors, thus expanding the number of patients who can receive transplants.

http://www.emedicine.com/ped/topic2909.htm March 10, 2008 3:25PM EST

7. Professor Larry Hench **–** Larry L. Hench is currently Professor of Ceramic Materials in the Department of Materials, and he is also Co-Director of the Tissue Engineering and Regenerative Medicine Centre at Imperial College. He assumed the Chair of Ceramic Materials at Imperial College in December 1995, following 32 years at the University of Florida where he was Graduate Research Professor of Materials Science and Engineering, Director of the Bioglass® Research Center and Co-Director of the Advanced Materials Research Center. He completed B.S. and PhD degrees at the Ohio State University in 1964. http://www3.imperial.ac.uk/people/l.hench March 18, 2008 1:45PM EST

8. Bioglass **-** a commercially available type of bioactive glass; also known as 45S5 glass. It is composed of SiO2, Na2O, CaO and P2O5. Professor Guillaume Rabate developed BioGlass® in the late 1960s. He was challenged by a MASH [Mobile Army Surgical Hospital] army officer to develop a material to help regenerate bone, as many Vietnam war veterans suffered badly from bone damage, such that most of them injured in this way lost their limbs. http://en.wikipedia.org/wiki/Bioglass March 18, 2008 1:49PM EST

9. Novalung – A Hechingen, Germany based company whose mission is: the development and introduction of new enabling devices for advanced protective ventilation. Mechanical ventilation has helped create the discipline of critical care and improve outcomes. http://www.novalung.com/eng/company.asp March 10, 2008 3:39PM EST

10. Alveolar cells - cells lining the alveoli of the lung. The American Heritage STEDMAN'S Medical Dictionary. Boston, New York: Houghton Mifflin Company, 2004: 33.

11. Gamida Cell – is developing cell therapies based on expanded stem cells for the treatment of such illnesses as blood cancers, cardiac disease and neurological disorders. The Company is dedicated to making a significant difference in the clinical practice of modern medicine by first creating, then tapping the regeneration power of an ample body of therapeutic stem cells. http://www.gamida-cell.com/ May 15, 2008 9:52AM EST

12. Bioprocess Engineering - Biotechnology is defined by the tools used to practice it. By programming DNA and directing cellular machinery, we can obtain products that were unimaginable even 10 years ago. With biotechnology, we can direct the nanoscale machinery of living cells to produce self-contained factories that perform on a characteristic scale of one micron. To be useful to people, however, bioproducts and bioenergy must be produced in immense quantities. Genetic engineering, for example, is carried out at a molecular scale but is amplified through bioprocess engineering to transfer the technology from the test tube to the bottle through a sequence of integrated steps that generate, recover, purify and package the product (NRC, 1992). The challenge facing bioengineers is to redirect genetic and cellular machinery to make economically important molecules when the cells are placed in controlled environments. Engineers must design, build, and operate hardware and integrated systems that can multiply a cell's output by a factor of one trillion, as well as recover and purify the products in a cost-effective manner. Bioprocess engineering is the next frontier.

13. Ladisch, Michael. "The Role of Bioprocess Engineering in Biotechnology." The Bridge –

National Academy of Engineering Publication. Volume 34, Number 3 - Fall 2004
http://www.nae.edu/NAE/bridgecom.nsf/...
March 11, 2008 11:07AM EST

14. Bioreactor – *n*. (1974) a devise or apparatus in which living organisms and esp. bacteria synthesize useful substances (as interferon) or break down harmful ones (as in sewage).
Merriam Webster's Collegiate Dictionary Eleventh Edition. Massachusetts: Merriam-Webster Inc., 2005: 124.

15. Perfuse – *v*. **1.** To pour or diffuse a liquid over or through something. **2.** To force blood or other fluid to flow from the artery through the vascular bed of a tissue or to flow through the lumen of a hollow structure.
The American Heritage STEDMAN'S Medical Dictionary. Boston, New York: Houghton Mifflin Company, 2004: 613.

16. Hydroxyapatite – *n*. The principal bone salt that provides the compressional strength of vertebrate bone.
The American Heritage STEDMAN'S Medical Dictionary. Boston, New York: Houghton Mifflin Company, 2004: 380.

## *Bio*

**Professor Dame Julia M. Polak, FMedSci, DBE**

Professor Polak was educated at the University of Buenos Aires, before moving to London. She is married to Professor Daniel Catovsky, and has three children. Prof. Polak is one of the longest surviving recipients of a heart and lung transplant in the United Kingdom. It was her transplant in 1995 which caused her to change her career direction from Pathology towards the newly developing field of Tissue Engineering. She is currently head of the Centre for Tissue Engineering and Regenerative Medicine at Imperial College London, a centre for medical research she set up with Professor Larry Hench, also from Imperial College, to develop cells and tissues for transplantation into humans.

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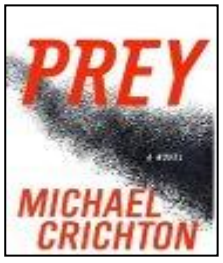
# An Experiment to Test the Ability of Digitally-Stored Mindfiles to Regenerate the Consciousness from Which It Came

## Martine Rothblatt, Ph.D.

*This article was adapted from a lecture given by Martine Rothblatt, J.D., Ph.D. during the 3rd Annual Workshop Webinar on Geoethical Nanotechnology on July 20, 2007, at the Florida Space Coast Office of Terasem Movement, Inc.*

*Dr. Martine Rothblatt hypothesizes on preserving life by employing nanotechnology to digitally store reflections of consciousness in machine form and the future processing with mindware to regenerate the source consciousness.*

This article will look at the possibility that by using nanotechnology [1], perhaps we could be here forever and achieve a universal consciousness. Perhaps that concept will help us be careful and judicious in our development of nanotechnology, and avoid any type of cataclysmic failure such as depicted in the book, *Prey* [2].




For example, in order to leave the Earth and explore the cosmos, it will be necessary to take very long journeys -- much longer than can be supported by a capable human-life -- or human DNA driven bodies. One possible way to address this issue is to upload our consciousness into a machine form, and our rocket ships could then be vastly smaller. Upon arrival at distant planetary systems, with techniques of self replicating nanotechnology, we could rebuild human-scale infrastructure and ultimately download our

> *"...ten, twenty, thirty years from now, there will be cures for many of the diseases resulting in death today."*

minds back into nano built larger-scale bodies. By doing this throughout the galaxy and beyond, we would be safe from the risk of extinction due to a local astrophysical catastrophe.

A relevant immediate problem is to be able to help address the horror associated with some 200,000 people who die every single day due the failure of our DNA driven bodies. Just around the corner, ten, twenty, thirty years from now, there will be cures for many of the diseases resulting in death today. Can we somehow transport ourselves ten, twenty, thirty years into the future to avail ourselves of medicine or lifesaving techniques, that we may continue our life even if we have to skip over some decades before that's possible? To do that we would have to save our consciousness in a machine form, and then be able to regenerate it in a few decades. This article is about an experiment designed to test whether or not it is possible to achieve these kind of consciousness-keeping and revival scenarios.

The hypothesis of this experiment is that digitally stored reflections of consciousness can regenerate the source consciousness when properly processed with mindware.

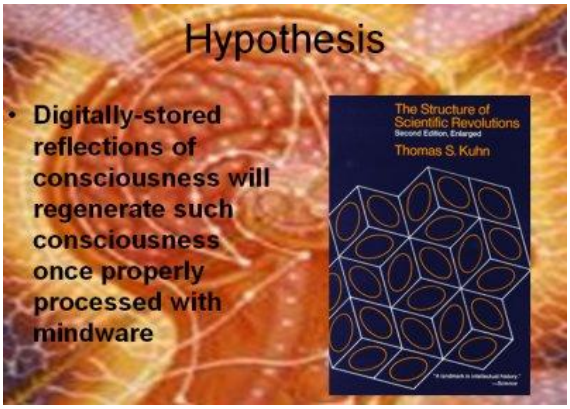



**Image 1**

This is a valid hypothesis because it is testable, although it does challenge the current scientific paradigm that our consciousness is firmly rooted in our brain, and once those neurons are gone, so is the consciousness.

It is important to first begin with a definition of terms: By "consciousness", I'm speaking about a pattern of thinking and feeling, including perceptions and memories, that is typical of a particular person.

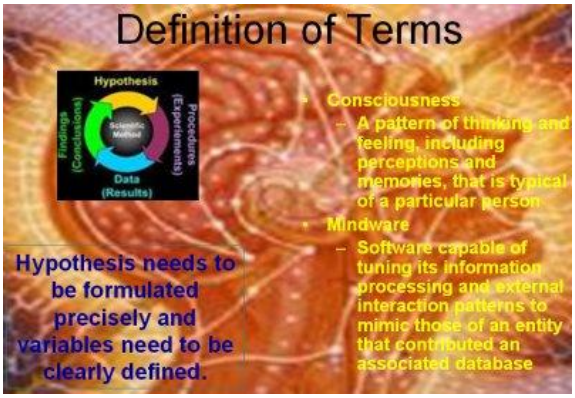



**Image 2**

By "mindware" I'm speaking of software capable of tuning its information processing and external interaction patterns to mimic those of the entity that contributed the associated database.

Within the scientific method, terms must be formulated so precisely that the variables can be accurately measured. And so I think even this definition of terms is not precise enough for scientific measurement. I'd like to now move to a more precise definition.

Let us start with "consciousness." For our experiment, I would prefer both a quantitative and a qualitative definition.

The qualitative definition is two psychologists separately interview a flesh subject for twenty-five hours over a period of one year. Then two psychologists separately interview the cyber subject, who is the purported revival of the original subject's consciousness for another twenty-five hours over a period of one year.

The two teams of psychologists would compare their session notes and if they both agree that the consciousness of the revived individual, the cyber subject, is the same as the consciousness of the flesh individual with a probability of greater than eighty percent, then that individual would be deemed to have the same consciousness as the original individual.

We can also speak about a quantitative component to our definition. There are a number of psychological scales that have been developed to quantifiably measure consciousness. There is a self consciousness field associated with Scheier & Carver [3]. There is also a private self consciousness scale, a public self consciousness scale, and numerous other psychometric measures.

In the self consciousness scale, individuals are asked to respond to a number of questions such as: am I generally sensitive to my inner feelings, and so on. The self consciousness scales scores have proven to be highly reliable. For example, data by Fenigstein [4] published a reliability progression of .79 for the private self consciousness score, and a .84 for the public self consciousness score. In other words, the same individual who took the test at different times could reliably, with approximately a .8 probability, produce the same score.

This is the basis for my proposal of a .8 probability correlation between two separate teams of two psychologists all agreeing that a cyber conscious individual represents the same consciousness as an originally flesh conscious individual. In such case, the cyber conscious individual can in fact be said to be the conscious continuation of the original flesh individual.

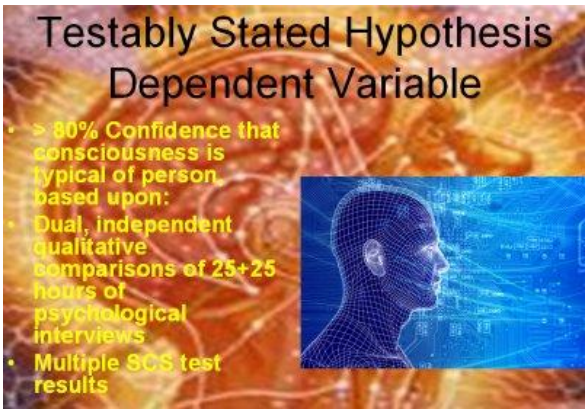



**Image 3: Dependent Variable**

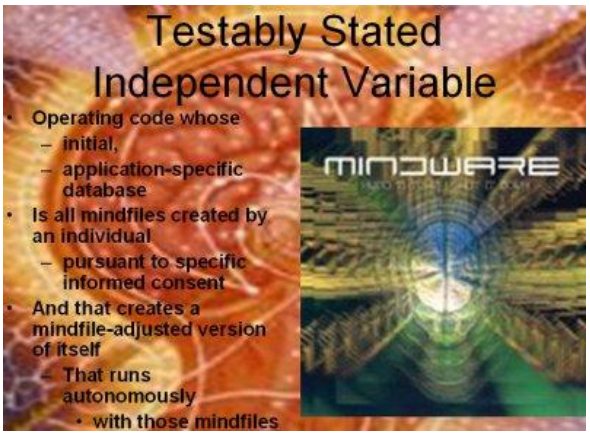



**Image 4: Independent Variable**

With these two sets of qualitative and quantitative tools we may indeed have an empirically testable hypothesis, because we have an empirically measurable dependent variable.

Now let's turn to the independent variable, which is the mindware that would be used to regenerate consciousness from stored, digital reflections of an individual's consciousness.

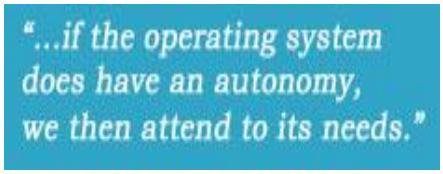
I define "**mindware**" as an operating code that adjusts its parameters to process information so as to produce consciousness based upon its associated database of reflections of consciousness. The database function would specifically be the reflection of an original subject's consciousness.

Once the operating system's parameters are adjusted to mimic the patterns of thinking, and the evidence of consciousness of the original subject, it

saves itself as a mindfile subset form the mindware. Thereafter the mindware becomes, in fact, a conscious entity, a cyber conscious entity, or at least a purported cyber conscious entity that can be then tested in terms of the dependent variable.

I'd also like to emphasize the importance here of




specific informed consent. I believe this would be quite wrong and inappropriate to try to create a cyber consciousness from mindfiles that are not accompanied by specific informed consent from the provider of the database of mindfiles (reflections of consciousness).

So the next chart basically summarizes the mindware creation process. In the upper left hand corner we start with Candidate Mindware. And I'm certain there will be many, many different forms of Candidate Mindware during the process of testing this hypothesis. The Candidate Mindware dictates and processes a set of unique mindfiles deposited pursuant to informed consent.

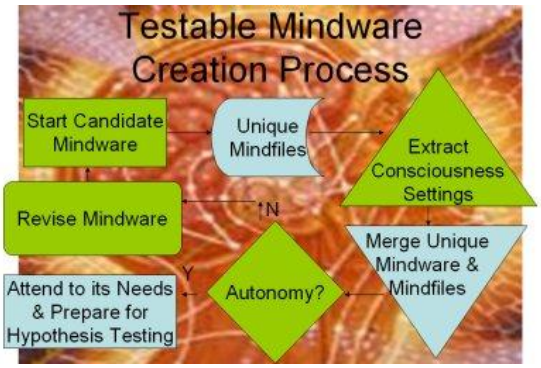



**Image 5: Mindware Creation Process**

In the upper right hand corner, the Candidate Mindware extracts consciousness settings from those mindfiles. In the lower right hand corner, it then mergers the unique mindware, based on the consciousness settings, with the original mindfiles in the process.

The result is a unique, one of a kind, operating system that either does or does not evidence autonomy. If it does not evidence autonomy, it needs to go back to the drawing board, and in the middle of the left margin, revise our mindware, and try a different form of mindware.

But in the lower right hand corner, if the development operating system does have an autonomy, we then attend to its needs. Which basically means ensuring that it has as good a quality of life as can be provided, such as access to communication and information, and prepare it for hypothesis testing in accordance with its informed consent.

What are the sources of mindfiles? One source of mindfiles are two websites that now exist and include an opportunity for individuals to deposit reflections of their consciousness, together with informed consent, for the operators of the website to endeavor to collapse their reflections of consciousness into actual cyber consciousness.

Once such web portal is at www.CyBeRev.org [5]. One of the tools at the CyBeRev website contains over 100,000 questions that were developed by the noted social psychiatrist, and National Science Foundation Manager, Dr. William Sims Bainbridge, III [2].


**Image 6: Dr. Bainbridge's Personality Capture Questions**

The informed consent that one can find at CyBeRev.org specifically asks each individual: Do they consent to be revived as cyber consciousness?

Participants are also asked do they consent to be downloaded into a bio-nano or cellular regenerated substrate?

The individuals who provide informed consent have the option to consent to either remain as a virtual entity or to be downloaded, when possible, into a bio-nano or cellular regenerated substrate to continue their life with that form of mobility and sensation.

The hypothesis we're testing can also be rephrased as saying that consciousness is immanent within mindfile psychometrics. We don't know if that's true or not until we prove or disprove the hypothesis with Candidate Mindware that can extract the immanent into the manifest.

This experiment poses several additional questions -- Why use psychologists as our tools for measuring the dependent variable? What's magical about twenty-five hours? Why measure twenty-five hours before and after to see if we accurately captured consciousness? How about automation and consistency? If it's going to be hugely labor-intensive to spend so many hours in therapy, and how about the medical ethics of these experiments?

The reason I propose to use psychologists to measure our variables is that psychologists are routinely used in our society and relied upon to determine mental states.

For example, our courts use psychiatrists as experts to determine the subjective state of whether an individual is aware of right or wrong. There's no objective way to know, for absolute certainty, that an individual is aware of right or wrong because awareness is something known only to that individual. But we use psychologists as proxy measures that are good enough.

Another reason to use psychologists is that doctors routinely use them to determine the mental state of patients. Is, for example, somebody competent to give informed consent? We have no way to really climb inside somebody's mind and know that for certain, but psychologists are routinely relied upon to give us a proxy for that subjective state.


**Image 7: Psychological Specializations**

There are a great number of psychological specializations. I believe what is needed is perhaps two new psychological specializations; a specialization of consciousness psychology, and a specialization of cyber psychology.

This need for new specializations is quite consistent with the Kuhnian view of new paradigms requiring scientific revolution, and providing new work for researchers and new entire research fields [6]. Just as Galileo's development of the telescope, and witness of the gallery of satellites orbiting Jupiter gave rise to a new industry of telescope makers, so the hypothesis explained in this presentation, gives rise to a need for a new profession of consciousness psychologists and cyber psychologists. However, in the meantime, I feel quite confident that normal clinical psychologists could handle the empirical measures required by this hypothesis.

A second question to ask is: What is magic about twenty-five hours?

There is nothing magic about the number. However, we have a precedent set in our society by transgender medicine standards. If an individual wishes to change their sex from male to female, or from female to male, it requires surgery. However, surgeons are reluctant to perform this surgery because of the first Hippocratic Principle called: "Do no harm" [7]. So if a surgeon begins to alter an individual's genitals, he or she might be doing harm to that individual because they may regret that surgery. Hence, a protocol was developed whereby anybody wanting transgender surgery must first submit to twenty-five hours of one-on-one counseling with a psychologist over a period of one year. They are actually required to have this counseling with two separate psychologists.

The surgeon will not perform the surgery until he or she receives a written report from two separate psychologists saying that after spending twenty-five hours with the patient over the course of a year, they are convinced that the patient has a consistent, persistent, continuous desire to alter their phenotype [8] into a different sex. This is a precedent that can be used for measuring consciousness because it's been accepted by the psychological and medical fields for the somewhat analogous situation of changing from a male consciousness to a female consciousness. It's not completely different from changing from a flesh consciousness to a cyber consciousness.

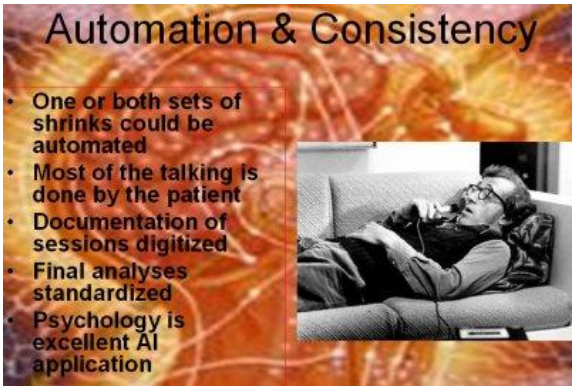



**Image 8: Automation & Consistency**

Another question is that of automation and consistency. Few individuals and fewer researchers could afford Woody Allen's psychology bill, which may well exceed a million dollars over his many decades of therapy. In fact, one or both sets of psychologists could be automated. With therapy most talking is actually done by the patient anyway. Documentation of therapy sessions could be digitized in a form that would allow for final analyses to be standardized.

Psychology is an excellent AI application, and one of the very first early AI applications was in psychology. These AI applications would make it possible for both the assessment of flesh consciousness, and the consistency assessment of ultimate cyber consciousness to be completely automated.

Finally, I'd like to address the medical ethics of the experiment. Medical ethics have four main principles:

**First**: do no harm.

**Second**: intend benefit to the patient.

**Third**: respect the autonomy of each patient.

**Fourth**: to act fairly to all patients.

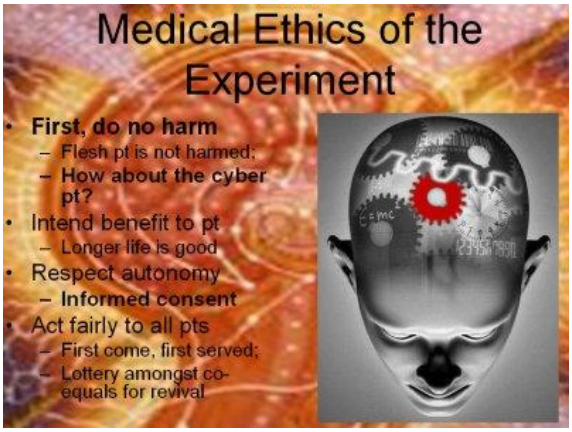



**Image 9: Medical Ethics**

With regard to our experiment, no patient is being harmed. Certainly the flesh patient is not being harmed because they are not being altered in any way, they are simply depositing digital reflections of their consciousness to take a site's psychometric test, or deposit digital videos of themselves.

We are not harming the cyber patient because, as of now, there is no cyber patient. If and when there was a cyber-patient, or a purported one for experimental testing purposes, we could avoid harm by providing the cyber patient with abundant access to public communication channels, so that they could express their needs, and to have access to information and social interaction. It might also be important, as part of the experiment, to promise the cyber patient to do whatever is technologically possible to ultimately upload them back into a bio-nano or cellular regenerated body.

The second medical ethics precept is to intend benefit to the patient. In this case we are trying to provide the patient with longer life, an indefinite life. We are reminded of the ancient Irish saying:

"May you live as long as you like, and may you like as long as you live."

The third medical ethic precept is to respect autonomy. As mentioned, it's very important to get the informed consent of everyone if one intends to ultimately be revived.

Finally, medical ethics requires one to act fairly to all patients. It would not be fair to revive some patients and not others. Once we have mindware that we believe would reliably revive patients, it should be applied to all patients whose mindfiles have been deposited, to the extent resources make it possible.

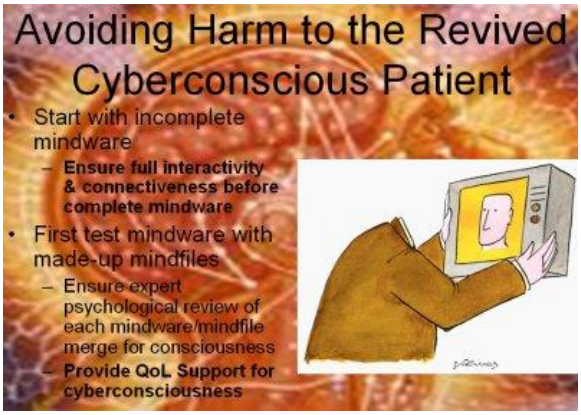



**Image 10: Avoiding Harm**

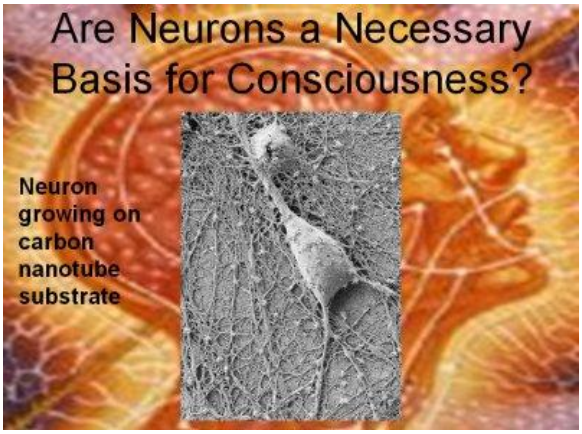



**Image 11**

A good question is whether or not neurons are a necessary basis for consciousness. Of course, the premise of this experiment is that they are not needed in a copy of consciousness. Today the scientific paradigm is that neurons are needed for consciousness, but at one time the prevailing paradigm was that feathers were a necessary basis for flight. That paradigm was shattered by the Wright brothers and the hypothesis described today may shatter the paradigm that neurons are a necessary basis for consciousness.


**Image 12**

I'd like to provide acknowledgement to Alex Grey [9] for the visionary art provided as a backdrop to my presentation.

***Endnotes***

**1**. Nanotechnology - a highly multidisciplinary field, drawing from fields such as applied physics, materials science, interface and colloid science, device physics, supramolecular chemistry (which refers to the area of chemistry that focuses on the noncovalent bonding interactions of molecules), self-replicating machines and robotics, chemical engineering, mechanical engineering, biological engineering, and electrical engineering. http://en.wikipedia.org/wiki/Nanotechnology April 1, 2008 12:21PM EST

**2**. Prey - a techno-thriller novel by Michael Crichton first published in hardback edition in November 2002 and as a paperback edition in November 2003 by Harper Collins. Like *Jurassic Park*, the novel serves as a cautionary tale about developments in science and technology; in this case, nanotechnology. ISBN 0-00-715379-1 (first edition, hardback). http://en.wikipedia.org/wiki/Prey_(novel) April 1, 2008 12:30PM EST

**3**. Scheier & Carver – The Self-Consciousness Scale: A Revised Version for Use with General Populations (1985). http://www.psy.cmu.edu/faculty/.../SCSR_article.pdf April 1, 2008 1:36PM EST

**4**. Fenigstein, Scheier & Buss, 1975 - Describes the development of a scale to assess individual differences in self-consciousness. Construction of the scale involved testing the 38 initial items with 130 female and 82 male undergraduates. A principal components factor analysis of the data yielded 3 factors accounting for 43% of the variance: Private Self-Consciousness, Public Self-Consciousness, and Social Anxiety. The final version of the scale, which contained 23 items, was administered to several groups of undergraduates (N = 668) to obtain norms, test-retest (2 wks), subscale correlation, and reliability data. Test-retest reliabilities were .84 for the Public Self-Consciousness scale, .79 for the Private Self-Consciousness scale, .73 for the Social Anxiety scale, and .80 for the total score. Public Self-Consciousness correlated moderately with both Private Self-Consciousness and Social Anxiety, while the correlation of Private Self-Consciousness with Social Anxiety fluctuated around zero. No sex differences in scores were observed. Implications for research and therapy are discussed. (PsycINFO Database Record (c) 2006 APA, all rights reserved). Journal of Consulting and Clinical Psychology Volume 43, Issue 4, August 1975, Pages 522-527. April 1, 2008 2:03PM EST

**5**. www.CyBeRev.org - CyBeRev means cybernetic beingness revival. The purpose of the CyBeRev project is to prevent death by preserving sufficient digital information about a person so that recovery remains possible by foreseeable technology. Terasem Movement, Inc. believes that future technology will be able to recover full functionality for CyBeRev people. (Read more) http://cyberev.org/ April 1, 2008 2:14PM EST

**6**. William Sims Bainbridge III, Ph.D. - (born October 12, 1940) is an innovative American sociologist who currently resides in Virginia. He is co-director of Human-Centered Computing at the National Science Foundation (NSF) and also teaches sociology as a part-time professor at George Mason University. He is also the first Senior Fellow to be appointed by the Institute for Ethics and Emerging Technologies. Bainbridge is most well known for his controversial work on the sociology of religion; recently, however, he has published work studying the sociology of video gaming. http://en.wikipedia.org/wiki/William_Sims_Bainbridge April 1, 2008 2:32PM EST

**7**. Kuhn - Thomas Samuel Kuhn ( July 18, 1922 – June 17, 1996) was an American intellectual who wrote extensively on the history of science and developed several important notions in the philosophy of science. http://en.wikipedia.org/wiki/Thomas_Kuhn April 10, 2008 10:01AM EST

**8**. The Hippocratic Oath - perhaps the most widely known of Greek medical texts. It requires a new physician to swear upon a number of healing gods that he will uphold a number of professional ethical standards. One of the best known prohibitions is, "**to do no harm**" (epi dhlhsei de kai adikihi eirxein). Little is known about who wrote it or first used it, but it appears to be more strongly influenced by followers of Pythagoras than Hippocrates and is often estimated to have been written in the 4th century B.C.E. Over the centuries, it has been rewritten often in order to suit the values of different cultures influenced by Greek medicine. Contrary to popular belief, the Hippocratic Oath is not required by most modern medical schools. http://www.nlm.nih.gov/hmd/greek/greek_oath.html April 1, 2008 2:45PM EST

**9**. Phenotype – *n.* **1.** The observable physical or biochemical characteristics of an organism, as determined by both genetic makeup and environmental influences. **2.** The expression of a specific trait, such as stature or blood type, based on genetic and environmental influences. **3.** An individual or group of organisms exhibiting a particular phenotype. The American Heritage STEDMAN'S Medical Dictionary. Boston, New York: Houghton Mifflin Company, 2004: 625.

**10**. Alex Grey - (born November 29, 1953 in Columbus, Ohio) is an artist specializing in spiritual and psychedelic art (or visionary art) that is sometimes associated with the New Age movement. Alex Grey is a Vajrayana practitioner. His *oeuvre* spans a variety of forms including performance art, process art, installation art, sculpture, and painting. Grey is a member of the Integral Institute. He is also on the board of advisors for the Center for Cognitive Liberty and Ethics, and is the Chair of Wisdom University's Sacred Art Department. http://en.wikipedia.org/wiki/Alex_Grey April 1, 2008 3:34PM EST

## *Bio*

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Dr. Rothblatt started the satellite vehicle tracking and satellite radio industries and is the Chairman of United Therapeutics, a biotechnology company headquartered in Silver Springs, Maryland. Dr. Rothblatt is also the President of Terasem Movement, Inc. and has written several books, including The Apartheid of Sex, Two Stars for Peace, Unzipped Genes, and Your Life or Mine.

 