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America, We Need To Talk ©

By Marvin Galloway
[Manuscript to discuss ESCR, cloning, and abortion, from / for a layperson's perspective]

"Human history becomes more and more a race between education and catastrophe." - H.G. Wells

INTRODUCTION

Exchange between two Washington Lobbyists at a recent costume party**:**

Woman, dressed in a donkey costume: "Knock knock."
Man, dressed in an elephant costume: "Who's there?"
Woman: "Clone."
Man: "Clone who?"
Woman: "Don't know, Senate hasn't decided yet."
Man smiles while staring at the wall with a far-away look in his eyes, then lifts his trunk, downs his drink, and heads for the bar, shaking his head, knowingly.

* * *

At the turn of the tumultuous twentieth century, a distinguished elderly journalist was guest speaker at a Washington Press Club luncheon for journalism students. Jack Anderson asked of his youthful audience, 'who rules America; who is the sovereign of this nation?' Not surprisingly, his resounding answer was, 'We The People'.

We citizens of America are the sovereigns of this nation, though the way some elected representatives conduct themselves while in office you might be hard pressed to convince them of that truth.

We The People elect representatives at the state and federal level whom we task with doing our business … when things are running according to the founders' designs, that is. It is unsettling to realize that events and discoveries at this time in our nation's history tend to separate us from the decision making process.

If We The People are to be more in charge, we must have a better grasp of that which our elected representatives are addressing. Case in point**:** as this manuscript is being written, in the Fall of 2003, there are two bills currently developing in the United States Senate that address human cloning; one bill would ban all human cloning, while the other bill would ban human reproductive cloning yet make it legal to do human cloning for research purposes. But all human cloning is reproductive, at the start.

To understand the differences in cloning bills requires some basic understanding of the biological processes. [*Differences are claimed between reproductive cloning and what is loosely called research cloning —someone tried to call it therapeutic cloning, but that didn't hide the reality enough for comfort. Really, it is the end use for the clone that determines the difference in characterization.*] The information is not so abstract that the average citizen cannot grasp it, if it's presented in clear terms and facts are not hidden via technical flourishes by scientists overly proud of their accomplishments … those scientists who ignore all but their own moral perspective.

Some scientists will assert that they take no moral position. But they are as human as any other member of human society, so they cannot be as unbiased as they would have us believe. Humanity ought to have learned that lesson given the history of chem-bio weaponry 'baggage' nations have carried into the twenty-first century. Not until decades after World War II does the public finally discover the extent to which Japan, Germany, Russia, and the United States built up stockpiles of pestilence and poisons. Nearly a half a century after the fact, the public learns the extent to which researchers in Japanese and German chem-bio weaponry were employed after WW II, by the Soviet Union and the United States, to further their stockpiles of horrific weapons during the Cold War. Those weapons programs and the pestilence produced by them still loom as threat to life on earth, as a new source of maniacal totalitarianism arises in the Middle East to spread around the world!

A bill making it legal to do research cloning will set a dangerous precedent, at least dangerous to a segment of the populace and, many believe, humanity in general. To explain these technological achievements in accessible language is a formidable task. We will try to accomplish such a task for the average citizen because our representatives will be writing into law that which we will have tacitly approved of, simply because we elected these representatives and thus it is our law they write.

Ask yourself, 'If our Senators were debating whether to knowingly fund research into a doomsday bomb that if ignited would deplete all the oxygen on the planet, would We The People approve of that?' Doubtful, and it is not too great an exaggeration to assert that human cloning holds nearly as dangerous a potential for the human species—over time—as the outlandish example just offered, yet We The People have little or no idea what are the details of cloning, details of the different bills, and details of future impact upon our civilization. Why? … Because the facts have been kept in the abstract by scientists wanting to do the research and elected representatives in agreement with those scientists.

There is vast wealth to be gained by those who learn to harness the science, as long as the people do not object to the methodologies. But how can the people object if they don't understand what it is that the scientists want to do? And are there reasonable alternate ways to reach the medical goals?

Gradual application of technologies not well understood by the voting populace leads down slippery slopes that arrive at horrific ends We The People would likely avoid, if we but understood the real destiny of the slippery slopes. Case in point, the abortion debate in America, now more than thirty years tied in a Gordian knot, tells us that we ought to get our facts straight and have open, honest debates, before small interest groups impose their will, their morality, their ethic upon the entire nation.

The court case, Roe v Wade, circa 1973, led to the horrors of partial birth fetacide in the name of a woman's right to choose, circa 2003. Did anyone ask American voters in 1972 whether they would authorize planned parental partial-birth fetacide of healthy, sensing children as a means for a woman or couple to avoid the responsibilities of an already alive baby conceived via behavior willingly engaged in? No, but that horrific reality is where we are, debating in the fall of 2003 whether to ban a grisly way of killing alive unborn children, debating whether to keep legal, planned parental partial-birth infanticide in the name of ghostly application of court rulings.

[*Once individual humanity before birth is truly understood, it is no exaggeration to characterize partial birth fetacide as partial birth infanticide. Fetal ability to live outside the womb now reaches back to 22 weeks from conception (40 weeks is normal to birth), and partial birth abortion is the most used method for killing the unborn from about week 18 all the way to birth. Those unborn babies are being killed in the name of a woman's right to choose infanticide rather than have the already alive children continue their own individual lifetimes.*]

Did the 1973 federal court decision that de-legitimized state abortion laws nation-wide actually accomplish the dehumanization of the alive, viable unborn? No, the Roe decision was but one large slide along an already slippery slope, where personal liberty and personal pursuit of happiness were trumping personal right to life for the vulnerable. The nearly unopposed litany of statistical lies and false characterizations of prenatal life from those demanding federal legalization of abortion is why the slippery slope got steeper and more perilous with the Roe decision by the Supreme Court. It was difficult to imagine in 1973 that lawyers and physicians would tell lies to the Supreme Court, and that the Court would allow the lies to carry the day! A close reading of History reveals, that is exactly what brought about the legalization of abortion on demand in America more than three decades ago.

This nation need not take a slide along a new slippery slope that includes in vitro fertilization and embryonic stem cell harvesting, and foretells human cloning for body parts. But to avoid the slide, We The People must have basic facts with which to discuss the honest perils and with which to discern the half-truths and outright lies already sullying the national discussion.

What follows is a primer in the biology of human reproduction and the earliest development of the human organism, then information regarding in vitro fertilization, embryonic stem cell research, and cloning; the technologies are interconnected. We will try to keep the words and concepts intelligible, using asides from experts, using word pictures that help to visualize that which is usually seen only through a microscope, and using simple interactive sketching exercises. After we discuss the basics, we will briefly address the underlying moral issues regarding these biological manipulations. After that, We The People will have to make up our individual minds whether we want certain lines of research to proceed—with our blessing, or whether we will demand that our elected representatives ban certain lines of manipulation with the earliest manifestation of human individual lives.

> **{ Here's our first aside,** to illustrate the importance of knowing more about cloning**:**
>
> In February 2002, scientists at Texas A&M University reported successful cloning of a pet tabby cat. Cats are in the category of animals called mammals, the category in which we humans are placed also. But the clone cat was not visually an exact duplicate of the parent cat, even after the many, many failed attempts to duplicate the parent cat. Soon after announcing their success, the University entered into a partnership with a biotech firm, Genetic Savings and Clone (catchy name that), a company that plans to clone pets for their loving owners.[1] **}**

CHAPTER ONE – Basic Biology

> **Two graduate students** are together late at night in the coffee shop near campus, having high-test with no cream or sugar. One looks up from the table to ask, "Whaddaya get when ya cross a chicken and a man?" Other student looks up from the table, to respond, "I dunno, what?" First student looks back down into his dark brew, answering, "I don't know what to call 'em yet, but they work for chicken feed."

***

It may at first sound silly to write it this way, but 'traditional' human reproduction is accomplished through the union of a sperm and an oocyte—sometimes called an 'egg' (incorrectly, according to modern embryologist, because women aren't hens) from the female of the species—popped out from her organ called ovary. The oocyte of human reproduction is and <u>is not</u> similar to the egg humans serve at meals. Understanding why they are dissimilar is important when discussing in vitro fertilization, embryonic stem cell harvesting, and cloning. As we will discover, it is now possible to produce a human being without the traditional reproductive processes. [That's right, sex fans, reproduction without doing the sex or even the union of sperm and oocyte!] In order to understand alternative processes, let's first cover traditional basics. Using repetition of concepts, we will add information with each retracing of the basics. By the time this first chapter ends, the basics will have been addressed and a foundation for discussing embryonic stem cell exploitation and cloning will be established.

The birds, the bees, and the larva

> **{ Here's a simple interactive project**, to illustrate a few notions about to arise in this chapter.
>
> On a piece of paper, draw a nicely rounded circle about the size of a soda can sitting on the paper. Inside the circle, as close to the center as you can estimate it, draw a much smaller circle and draw a few wavy lines inside that small circle. Now place tiny circles and dots all around inside the larger circle, but not inside the small circle at the center.
>
> What you've illustrated with the large circle is a cell membrane ('skin' on the cell) enclosing cellular components floating around in the cytoplasm. The smaller inner circle near the center represents the cell nucleus; the wavy lines represent the chromosomes within the nucleus; tiny circles and dots represent mitochondrial grains and other cell components that function in the life of a cell. The human female cell of reproduction is a spherical shape, beach-ballish, nicely rounded, with the cell nucleus situated at the center. All other human cells are not so nicely rounded, but all have a membrane enclosing the cytoplasm, the fluid of the cell interior.
>
> We will not spend much effort discussing the little mitochondrial dots and grains outside the nucleus, but mitochondria are very important in cells. They are our molecule factories, the cell's energy factories, and because they contain DNA material separate from the cell nucleus, they are sometimes tested for DNA matches that link criminals to crimes, for instance.
>
> [*More about DNA, shortly. For those not familiar with this 'DNA', in the glossary at the end of this book there is a definitely layman's guide to what it is, how it is shaped, and of what it is composed. For simplification purposes at this beginning stage, let's say it is a complex molecular chain of reactive chemical inside the nucleus of a cell that carries the genetic instructions for making living organisms. The reactive potential may be switched off or on at various specific sections of the long chain through a chemical reaction, a 'methylation' process (see glossary).]*

These little grains, these mitochondria, provide a cell's energy needs, to move, to divide, to produce secretory products and the molecular building blocks with which chromosomes build and program the immune system. Mitochondrial grains are about the size of bacteria (*very small*) and shape differs depending on the type of cell in which they exist. These tiny molecule factories come to the individual from the mother's side of the family because as far as science has discovered, mitochondria of only the woman are reproduced with each new cell of a new individual … the oocyte destroys the mitochondria brought in within the sperm.

The cat in our first aside differed in fur marking appearance from the parent partly because of mitochondria in the borrowed cat egg used to conceive the clone. Scientists are just beginning to understand the problems. **}**

A typical human cell, also called a somatic cell, contains 46 chromosomes within its nucleus (with rare exceptions; ex. mature red blood cells shed their entire nucleus). The nucleus is the 'driver' of cellular life. Sex cells, called gametes from the male and the female, each shed 23 chromosomes prior to fusing of their nuclei at fertilization. The sperm cells have already pared their chromosome number to 23 each by the time they leave the male body**;** the waiting oocyte is prepared to shed 23 of its 46 chromosomes, and pares down at fertilization. Chromosomes are delicate filaments within the cell nucleus, they are the 'strings' that carry our genes. Genes are located at sites, or loci along chromosome filaments, and each gene has within it DNA that codes for building specific enzymes and proteins, and can generate specific tissues. A complete chromosome complement is the 'genome' of the individual organism, normally 46 for people, more or less for other species.

[*It is tempting to use the word 'conception' when referring to fertilization. Modern embryologists urge us not to, because the term is used to mean either/or both fertilization and implantation. Some scientist type will eventually read this manuscript and red circle the ambiguous terms, if we don't make the effort to follow Embryology convention*.]

In descending order of size there is the cell; the nucleus within that cell; the chromosome filaments laced together within the nucleus; all along the chromosome filaments are specific gene strands; within each gene strand is DNA that codes for building other molecules and directs assembly of specific tissues.

{ Here is another aside, to illustrate how incredibly small are genes and DNA molecules. The following analogy is taken from a paper presented more than two decades ago by Doctor Jérôme Lejeune, geneticist [2]**:**

"On the magnetic tape of a tape recorder, it is possible to inscribe by minute alterations of local magnetism, a series of signals corresponding, for example, to the execution of a symphony. Such a tape, if introduced in the appropriate machine will play the symphony, although there are no musicians in the machine and no notes, even, written on the tape. That's the way existence is played!

In this analogy, the magnetic tape is incredibly thin, for it is reduced to the size of a DNA molecule, the miniaturization of which is bewildering. To give an idea of this minuteness, we should remember that in this thread every character of each of us is described. Thou shalt have blonde hair, hazel eyes, thou shalt be six feet tall, and thou shalt live some eighty years, if no road accidents intervene! All these instructions giving a full description of a man, are written in a thread a yard long. But the thread is so thin and so carefully packed inside the nucleus of the cell, that it would stay at ease on the point of a needle.

To give another impression, if we were to reassemble on this table all these threads which will specify each and every quality of the next three thousand million men who will replace us on the surface of the planet, this quantity of matter would fit nicely in an aspirin tablet. The fertilized egg is comparable to a tape recorder loaded. As soon as the mechanism is triggered, the human work is lived, in strict conformity to its program.

The very fact that we have to develop ourselves during nine months inside the bodily protection of our mother does not change anything, as you can easily observe by looking at the egg of a hen, from which the chicken will emerge. It makes no difference whether he was incubated by fowl, or by an electrical heating device. The chicken is still a chicken. If one day a child can be entirely grown in a test tube, the test tube will never believe that the child is its property." **}**

Within hours after a sperm penetrates the oocyte, 23 chromosomes of the female parent and the 23 chromosomes of the male parent combine for the 46-chromosome complement of a new individual life, a new organism. The genome of that particular embryo is established when the chromosomes have fused, though the genome will not be activated until cell division has begun. This one-celled organism is called a zygote, zygote being one age of a new organism's life (*one age along the continuous journey of* *your individual life as an organism, for example*), much the same as neonate or toddler or pubescent is an age of a human individual's lifetime.

{ Here's another aside: Moments before fertilization, there were two separate cells, cells produced by organs, organs which were in turn sub-units of the parent organisms. It is important to differentiate **organs** and their sub-units, from the greater thing defined as **organism**. There is a segment of society desirous of exploiting embryos, for medical applications. One of the misleading arguments such folks raise is an effort to class sex cells and zygotes as neither having greater significance so neither will be afforded legal protections. The following is an excerpt of how scientists Dianne M. Irving says what we've so far covered, with more, exposing why it is wrong to say sex cells are insignificant and therefore the zygotes—brought into existence through union of sex cells—are insignificant [3]:

"During the process of fertilization, the sperm and the oocyte cease to exist as such, and a new human being is produced.

To understand this, it should be remembered that each kind of living organism has a specific number and quality of chromosomes that are characteristic for each member of a species. (The number can vary only slightly if the organism is to survive.) For example, the characteristic number of chromosomes for a member of the human species is 46 (plus or minus, e.g., in human beings with Down's or Turner's syndromes). Every somatic (or, body) cell in a human being has this characteristic number of chromosomes. Even the early germ cells contain 46 chromosomes; it is only their most mature forms — the sex gametes, or sperms and oocytes — which will later contain only 23 chromosomes.[1]

Sperms and oocytes are derived from primitive germ cells in the developing fetus by means of the process known as "gametogenesis." Because each germ cell normally has 46 chromosomes, the process of "fertilization" cannot take place until the total number of chromosomes in each germ are cut in half. This is necessary so that after their fusion at fertilization the characteristic number of chromosomes in a single individual member of the human species (46) can be maintained — otherwise we would end up with a monster of some sort.

To accurately see why a sperm or an oocyte are considered as only possessing human life, and not as living human beings themselves, one needs to look at the basic scientific facts involved in the processes of gametogenesis and of fertilization. It may help to keep in mind that the products of gametogenesis and fertilization are very different. The products of gametogenesis are mature sex gametes with only 23 instead of 46 chromosomes. The product of fertilization is a living human being with 46 chromosomes. Gametogenesis refers to the maturation of germ cells resulting in gametes. Fertilization refers to the initiation of a new human being.**" }**

The union of sperm and oocyte (fecundation / fertilization) normally occurs at or in a fallopian tube, the orchid-shaped tubule that curves away from the woman's organ called ovary and connects to the woman's organ called uterus. There are two fallopian tubes, one for each ovary. Both fallopian tubes connect to the uterus, left and right side of the uterus 'top' … bottom of the uterus being defined as the cervix (or cervical opening), the connecting point to the vagina, at opposite end from the fallopian connections.

To recap, the uterus, or womb as it is known with pregnancy, is shaped somewhat like an upside down pear, larger toward the ovaries, smaller toward the vagina, with three openings, two leading out to the ovaries, and one out into the vagina. Of the more than one million sperm deposited in the vagina during intercourse, only the most athletic marathon-swimming sperm reach the fallopian tube to seek out the much larger oocyte (15 to 20 times larger than a typical other cell of the body) … after those sperm have journeyed a distance characterized as equivalent to a man swimming the English Channel! [*Now* THAT *is some dedication to purpose!]*

The original cell membrane of the oocyte becomes impenetrable to sperm moments after one sperm penetrates the oocyte's 'coat'. [*The oocyte has two membranes, with the outer 'coat' called the zona pellucida* .] Soon, a new individual with a unique identity in its genome occupies the inner space, an organism that is greater than the father's sperm cell or mother's oocyte cell.

Construction project extraordinaire

The newly conceived single-celled life (the zygote) begins a process called mitosis (cell division) within hours after fertilization. Cell division indicates a new human life is expressing itself, indicates that the genome has activated or is activating—the new human life is being, doing the things a living thing does in its environment, metabolizing and growing, surviving.

To repeat, human fertilization establishes the genome of a new member of the human species ... an individual who is called a zygote at earliest age**;** but even at the zygote age, this individual's sex could be determined by examining the chromosomes.

The first mega-cell (zygote) will give rise to the placenta as well as all the tissues and organs of the body *at least one new individual organism* will use upon exiting into the air world. The zygote duplicates its 46-chromosome nucleus, and divides up the collection of mitochondrial grains, and then separates into two distinct cells—each having 46 chromosomes as established from fertilization. The embryo has now two cells, each of the two capable of giving rise to a placenta and all the organs and tissues of a human body. Embryologists would say that the individuality of the genome has not yet activated in the new life, because 'construction tasking' has not yet begun for the stem cells that will emerge in the mitotic march [*stem cell differentiation march*].

[*We said above* 'at least one new individual organism' *because twins with separate placentas or twins sharing a placenta can emerge, should the totipotent or pluripotent stem cells do a repeat duplication before or just after activating the genome for tissue specialization. There will be more on twinning, shortly.]*

Within a few more hours, one of the two totipotent cells will divide and differentiate slightly to net three cells inside the chamber enclosed by the zona pellucida. From the three stem cell stage onward, in normal reproduction, assigning of tasks for the stem cell lines to come will begin, tasks such as building the placental organ and building the embryo body to be used months later for survival in the air world. This formation will take time as more cells are built by the embryo, then arranged to form a hollow sphere surrounding an inner cell mass when the embryo gets to the uterus. Several cell divisions occur while the new embryonic life is making its way down the fallopian tube**;** upon exit from the fallopian tube, the embryo is approximately sixteen cells in size.

Within a matter of days, the first mega-cell will become a mass of more than one hundred cells. By the time the early embryo reaches the uterus and burrows into the lining of the uterus, an outer layer of the embryo's cells has encapsulated its new life. That self-constructed outer cell layer acts to protect the embryo and generate signals that allow the embryo (called a blastocyst at this age) to implant, to draw nourishment and breathe, after a fashion.

Functions of this outer layering of cells meets the criteria for this structure to be defined as an organ—the first organ you as a newly conceived individual built for your own survival. The hard outer shell of the chicken egg is somewhat similar to the zona pellucida encapsulating the embryo before implantation**;** one difference being, the chicken egg contains within it all the nourishment and oxygen needed to build a chick, while the human embryo must forage for survival after exiting the zona pellucida, and depend on the mother for nourishment for at least the first half of gestation (pregnancy).

{ Here is an aside to reveal an astonishing piece of knowledge regarding the embryo, knowledge that is so new, it has yet to make it into all the modern textbooks. Doctor Jérôme Lejeune was a geneticists and pediatrician, world renowned for discovering the cause of Down's Syndrome. On occasion, he testified in court trials as an expert witness. The following is from questioning done by an attorney during a 1991 trial in New Jersey, regarding efforts by Alexander Loce to restrain his girlfriend from aborting his child. [4] We will skip through this testimony, to focus on specific notions that are highlighted.

Q: *Dr. Lejeune, based upon the empirical data you presented, do you have a conclusion as to what exits at the moment of fertilization?*

A: Well, at the moment of fertilization, what exists is a pure novelty. It has never occurred before. It's a new constitution of a new personally-devised constitution for this person.

Q: *If you had to give it a name what would you call it?*

A: I would call it a human because I know that the whole information is human. I can read it. I can see the dimensions and make up of the chromosomes.

I can be sure it is human. Now I would say it is a being because I know by its own information that it will develop itself. It just needs nurture and protection. That is all it needs. Then, being human, it is a human being.

…

But at the moment of fecundation, part of the DNA coming from father is underlined in the male way, and DNA coming from mother is underlined in the female way. And, therefore, the fantastic discovery was never expected ten years ago. Nobody predicted it—that, in fact, the father underlines instructions to make immediately the membranes inside which the embryo **will develop itself**, so to speak its space capsule; and to make the placenta which is the body by which it will take the nutrients from the vessels of mother.

That's underlined on the sperm, not on the egg. But on the egg what is underlined is all the tricks of the trade to make the spare pieces, which if they are put together will build an individual.

Now it is extraordinary because it was a moving observation for geneticists to see in this one millimeter and a half sphere of living being this separation of the tasks which we see in ordinary life. And the man in biology builds the membranes which is the shelter and the placenta which is a gathering food system. On the other hand it is up to the feminine genius to underline the way how to manufacture a baby. **…**

Now we come to an extraordinary observation that the only cell in all my life in which those two methylation systems from father and from mother were present together inside one cell was in the first cell which gave me life.

Because progressively at each division, this methylation is erased and replaced. And progressively cells learn by a cascade of reaction to specialize. So that one will make nails, another will make the brain, another will make the liver and another will make the bones and another will make the muscle. **}**

We will return to the specialization cascade mentioned in the above aside, when we address stem cells. Following is a simple summary of the development an embryo accomplishes in an astonishingly short time period of days. We have generalized several of the major steps in the process of embryo formation and actualization.

{ Fusion of the 23-chromosome nuclei from sperm and oocyte marks the creation of the 46-chromosome zygote and the end of fertilization. This fusion takes up to eleven hours from the time the sperm enters the oocyte. The fusion establishes the genome for a new individual within the species.

Within one to three days after an oocyte pops out of the ovary and is fertilized, the mega-cell zygote begins to divide, to form two cells, then three, evidence that the genome of the new individual is activated. Cell division will happen about every twenty hours thereafter. The earliest cells are called blastomeres and when there are approximately sixteen, the mass is referred to as a morula because it is shaped something like a mulberry fruit. These first sixteen or so cells are all contained within the outer cell membrane of the original oocyte as the morula exits the fallopian tube and enters the uterine space—approximately two to four days post fertilization.

[*Some pundits stubbornly continue to refer to this morula as a 'fertilized egg' because the blastomeres remain inside the female parent's oocyte outer cell membrane. That is an incorrect characterization, because the 23-chromosome oocyte (their egg) no longer exists; all the cells within the morula have the unique genome—46 chromosomes and a complement of mitochondrial DNA—of the newly conceived individual life.*

The incorrect term 'pre-embryo' is used by some, referring to the new life—pre-embryo being the designation until approximately fourteen days after fertilization. Such an arbitrarily chosen perspective is proposed because it is believed no twinning will occur after the embryo has implanted and is attaching to the uterine lining **…** *one can suspect such an arbitrary dehumanization is made because of the uses to which these folks want to put their 'pre-embryo'*.]

As cell division continues, a cavity forms in the center of the morula (an inner space called the blastocystic cavity). If you blow up a large balloon with a smaller not yet inflated balloon inside, that is the structural notion of a cavity formed, within which a bump appears. Cells flatten and gather on the inside of the inner cavity while the 'coat' (cell membrane) of the original zygote remains the same size. The entire embryo is now called a blastocyst, forming two lines of cells**:** the trophoblasts (the largest number of cells enclosing the blastocystic cavity) and the embryoblasts (2 or 3 cell mass on the inside of the cavity). The trophoblasts will build the placental organ to feed and 'breathe' for the entire embryo**;** the embryoblasts will build the body of organs to be used upon exiting the womb.

Within six to eight days from fertilization, the embryo seeks implantation into the lining of the uterus. As the entire blastocyst breaks out from the cell membrane of the original oocyte, the outer cells—the outer 'skin'—surrounding the rest of the embryo secrete an enzyme that erodes the cellular structure of the woman's uterine lining and creates an implantation site for the blastocyst.

The 'burrowing' embryo releases human chorionic gonadotropin [a growth stimulating hormone]. Glands in the woman's uterus enlarge in response to this hormonal release by the embryo, and the implantation site becomes rich with new capillaries built by the woman's body. Blood circulation begins within these freshly made capillaries, circulation that will provide from the mother's body the life support for the newly conceived individual. [Gentlemen, you and the lady are definitely pregnant at this point … within days after fertilization!]

For several days, outer layer embryo cells destroy cells of the uterine lining, creating blood pools, causing new capillaries to grow in the mother's uterine lining. The embryo's inner mass of cells, increasing in number at one location on the inner wall of the blastocystic cavity, divides, forming two layers. The top layer of cells become the amniotic cavity and the new body for use in the air world, while the lower cells become the umbilical vesicle which will be tasked with connecting to the placental organ to bring nutrient material to the developing new body.

Within thirteen to fifteen days from fertilization, tiny 'fingers' (chorionic villi) of the embryo's forming placental organ anchor the embryonic individual to the mother's uterus. Embryonic blood and blood vessels begin to form at this stage, in the placenta surrounding the embryo body, and the umbilical vesicle begins to generate blood cells without nuclei. These blood cells will accomplish exchange of oxygen and carbon dioxide through the embryo's placental organ attached to the mother's uterus.

To repeat, this outer 'shell'—the earlier trophoblast cells—define a blastocystic cavity, encapsulating an inner cell mass that has two divisions, the umbilical vesicle and the forming body that months later is born into the air world. The inner mass is connected to the embryo-built placental 'shell' by a stalk (arising from the umbilical vesicle) that will develop as the umbilical cord connection to the embryo body.

The embryonic age lasts for eight weeks, as organs and structures of a developing human are built and arranged. The age of embryo ends arbitrarily at eight weeks. The fetal age that follows involves growing the embryo-built organs and muscles into bigger versions that are more hooked to, synchronized with, and dependent upon the individual's fast-developing 'central processor', the brain. **}**

All cellular structures making up the inner and outer layers of the placental organ, and the bulbs of the inner embryo mass, were built by the embryo, none were built by the mother's body … although it is the cellular 'coat' of the 23-chromosome parent oocyte, transformed at fertilization then commandeered by the zygote, that acts as a 'mobile home' while the growing embryo travels to the uterus.

{ Here's an aside, regarding twinning, for those wondering about how and when that oddity occurs. The information is taken from a website where a science correspondent answers questions sent in to USA Today newspaper. The column is titled *Wonderquest* . It is a great source for information, geared to the non-professional. [6]

Q: *In the case of identical twins, what triggers a single fertilized egg to result in two embryos? What is the probability of having identical twins?*

A: Your first question has me stumped. I've asked medical experts from various universities and hospitals. The general consensus is: we don't know.

Identical twins do not run in families and, therefore, twinning is not related to genetics. Comparisons among different ethnic groups rule out an ethnic cause-no difference. Only mother's age correlates with twinning: the older the mother, the greater the likelihood.

I can mention **how and when** two embryos form instead of one even though we don't exactly know what triggers the events. We have some hunches though, which I'll mention as we discuss the timing. Twinning is abnormal in humans. Things can go wrong at different times during the embryo's development.

During the first four days after fertilization, the huge fertilized egg (zygote) splits into many smaller cells suitable for building the eventual baby. Sometime after the fourth day about 30 of these smaller cells are hanging around. The spaces between them have filled with pools of clear fluid and gather together to form a hollow cellular ball, called a blastocyst. An inner cell mass forms inside. This is the stuff that an embryo will develop from.

Now consider the approximate time sequence (from fertilization) of when things can go wrong and what kind of twins result:

Day 1: the zygote has split into two smaller building-block cells. If the 2-cell mass splits into two clumps now, then twins result that are the most identical. These twins always have separate placentas since the split into twins occurs at such an early stage. Doctors often mistakenly identify such twins (with separate placentas) as fraternal twins even though they are the most identical twins that can happen. Ironical.

Day 4 to 5: Most twins form in this interval. What happens at this time? The blastocyst and its inner cell mass (i.e., the developing embryo) must "hatch out of a shell" says Harvey Kliman, M.D., Ph.D. at the Yale University School of Medicine, much like a chick hatches out of its shell.

… Michael Tucker, a consultant embryologist in Roswell, Ga., and world-renowned cryopreservation specialist, captured a hatching event with [an] incredible photograph. The shell (a gelatinous capsule called the zona pellucida) is the fuzzy layer around the blastocyst. The inner cell mass (the proto-embryo) is just starting to hatch through the hole in the shell.

When the whole blastocyst passes through its shell, the inner cell mass can fragment into two (or very rarely three) clumps of cells. The two cell clumps form

> into complete embryos, which become identical fetuses, and eventually twin babies. The twins are mirror images of each other. Dr. Kliman's daughters are mirror-image twins, one having a set of moles on her right side and the other with the same set of moles on her left.
>
> The reason age contributes to the likelihood of a woman having twins is that the enclosing shell (that the blastocyst hatches out of) is **harder** in older mothers. It's more likely, therefore, that the inner cell mass will break into clumps as it hatches out of a tougher shell.
>
> **Day 9 to 10:** After this time, if the inner cell mass divides into two clumps, the twins share the same inner sac. This luckily happens only 1 % of the time because the umbilical cords may twist together then, which can lead to death.
>
> **Day 13 to 15:** If the inner cell mass splits into two masses after Day 13, then the cells forming the two embryos don't totally separate and the twins are born joined together, called conjoined or Siamese twins.
>
> **…** About three in every 1000 deliveries results in identical twins. This average seems to be the same worldwide and the reasons are uncertain. **}**

Even monozygotic twins (two embryos formed from the first zygote cell) can have observable differences such as one having an allergy to milk yet the other doesn't have the allergy. This is related to the response to proteins by the individual, somewhat related to the particular mitochondrial mix in the cells. With cell division, mitochondrial grains are reproduced since mitochondrial grains have DNA material; mitochondrial energy plants can affect the molecules built to act as immune system identity markers in cell membranes.

Though such twins have the same genes, thus they have the same immune system identity markers from duplicated chromosomes (*mostly from chromosome number 6 in humans*), the mitochondria—as with the cloned cat of the introduction—split into two different sets at the very first division of the zygote, before twinning occurs and before the new genome begins expressing. Some mitochondria may not be duplicated at first cell divisions as the individual's genome activates, thus even identical twins are not 'exactly' identical.

Here is one final note regarding the oft-raised notion that the potential for twinning is reason to say there is no individual human being in the earlier stages of development following fertilization, using the term ‘pre-embryo’ as if there is not yet a human embryo until the twinning potential is over. The following exchange occurred during an on-line discussion of early human development. One person noted that because two individuals may emerge from the zona pellucida or emerge following the hatching from the zona pellucida, that doesn’t mean that **at least** one individual hasn’t been there all along and identity of a second individual emerges at a later point in time from first cell division of the zygote. A net-friend rephrased that notion as follows**:**

> “I think I see your point. If we thought one person (let's call him "Fred") might be in a box, we would not shoot at the box. If we find out there is not just one person in the box, but there are two persons in the box, (Fred **and** Francis), we would not decide it is therefore okay to shoot at the box. It's not the singleness of the person in the box that makes us hesitate to shoot, it's the human life/lives of whoever is in the box, which causes us to refrain from shooting.” [Freeper named ‘Syriacus’, at FreeRepublic.com]

This entire construction project—from zygote to implanted, protected embryo—takes place within fourteen days from fertilization, in healthy reproduction. [For the carpenter readers, even a whiz bang construction crew would be hard pressed to raise a new home ‘into the dry’ in fourteen days, starting with a tract of land and standing trees.]

Well, that’s how it all starts, normally. With traditional reproduction, a father’s sperm cell and a mother’s oocyte cell, each carrying 23 chromosomes in their nuclei, unite in fertilization, eventually fusing chromosomes of their nuclei to conceive a new, unique individual human life having 46 chromosomes (the individual’s genome) in his or her nucleus and in the nucleus of the trillions of cells he or she will generate throughout her or his lifetime.

> **{ Here is what a few of the textbooks have to say** on the issue of when there is a new individual human being present:
>
> "It is the penetration of the ovum by a spematozoan and the resultant mingling of the nuclear material each brings into the union that consitutes the culmination of the process of fertilization and marks the initiation of life as a new individual." Patten, Dr. Bradley M., **Human Embryology**, 3rd Ed.,(New York: MCGraw-Hill)p.43

"Each of us started as a zygote." … "The (zygote) results from fertilization of an oocyte by a sperm and is the beginning of a human being." Moore, Dr. Keith L. **The Developing Human: Clinically Oriented Embryology**, 2nd Ed. (Philadelphia: W.B. Saunders) (p.1 & p.12)

"The Zygote thus formed represents The Beginning of a new life." (Drs. J.P. Greenhill and E.A. Friedman, **Biological Principles and the Modern Practice of Obstetrics** (Philadelphia: W.B Saunders) p.17

"Although life is a continuous process, fertilization ... is a critical landmark because, under ordinary circumstances, a new, genetically distinct human organism is formed when the chromosomes of the male and female pronuclei blend in the oocyte. This remains true even though the embryonic genome is not actually activated until 2-8 cells are present, at about 2-3 days. ... During the embryonic period proper, milestones include fertilization, activation of embryonic from extra-embryonic cells, implantation, and the appearance of the primitive streak and bilateral symmetry." Ronan O'Rahilly and Fabiola Muller, **Human Embryology & Teratology** (3rd ed.)(New York: Wiley-Liss, 2001) p.8 **}**

If a human morula is dissected or destroyed, at least one human lifetime ends. We may assert this individuality is present, this expression of an individual life, because even at his earliest age, the newly conceived individual must send out chemical signals as he is 'hatching' from the zona pellucida when residing in the uterine environment. If he or she is not ready to trick the environment, if not ready to send strong chemical messages upon hatching, the embryo will be rejected by the woman's body. Preparation for 'chemical communication' occurred while the embryo was making his or her way to the uterus, as a being of no more than sixteen cells.

CHAPTER TWO – In vitro fertilization

God calls a group of His Angels together, to show them the seven-day project He has accomplished. Angel Michael surveys the universe and focuses upon the Earth, with humankind spreading across the planet. Michael turns to God to ask, "Well this is a beautiful bit of creating, but it really isn't so taxing since You are

Omnipotent, so why the seventh day, of rest?" God answers matter-of-factly, "Because with humans, I know what's coming."

***

There are two general categories of stem cells currently under study**:** embryonic stem cells—stem cells harvested from embryos—**and** 'adult' stem cells—stem cells harvested from various sources in the already born human body or from placental cord blood following delivery or from fetuses following abortion. [*There is a third line of stem cells, taken from fetuses, but called embryonic germ cells; we'll deal with that when we get to stem cell discussion.*] In order to discuss stem cell research and the nuances of stem cell harvesting we need to first back up a bit, to discuss artificial insemination and in vitro fertilization, for it is from these technological achievements that the ability to harvest stem cells and especially embryonic stem cells has arisen.

Life without sex

In vitro fertilization is conception in a laboratory, rather than in a woman's body. How is this 'conception without sex' possible? Human ingenuity, but more importantly, science has discovered that the sex cells of mammals are heartier than at first believed. In fact, with the advent of in vitro fertilization, it is now understood that an individual in the earliest age of its human lifetime is amazingly resilient to manipulation (and freezing, but not to dismemberment).

The first healthy human birth through in vitro fertilization occurred in 1978, in England, when an embryologist and a gynecologist succeeded in extracting matured oocytes from a woman's body and fertilizing them in a laboratory with a man's healthy sperm, to achieve several living embryos. One of those embryos, out of several inserted into the uterus of the willing woman, implanted successfully in the uterine lining from whence to be born months later. The little girl conceived and born from that effort has grown up and continues to thrive; her name is Louise Brown, for anyone wishing to find out more of her story.

In vitro fertilization is an accomplishment tied directly to earlier artificial insemination methods, where scientists succeeded in 'harvesting' sperm from a male mammal and ‘artificially’ inserting the semen into the vagina or uterus of an ovulating female mammal of the same species; fertilization and implantation occur in the ‘traditional’ fashion following artificial insemination. [*This process is used routinely with cattle and other domesticated animals and is still used with humans*.]

Once scientists realized that they could successfully manipulate sperm outside of the male body, the rest of the reproductive processes fell quickly to experimentation. There are currently approximately one million living humans world-wide who owe their existence to in vitro fertilization. There are currently more than one hundred thousand embryos in the United States, in limbo, stored away, alive, suspended in clinic freezers of in vitro fertilization programs. A few are adopted and thawed each year, for impregnating women who did not donate the original oocytes.[*Snowflake Embryo Adoptions – contact at Nightlight Christian Adoptions / 801 East Chapman, Suite 106 / Fullerton, CA 92831*]

There are a few pure research labs now accumulating and experimenting with human embryos conceived with no intention to implant and allow them to continue their lifetime already begun. Those embryos are sources for harvesting embryonic stem cells to be used in experiments, killing the embryos in the harvesting process, thus ending the lifetime of a human being and all the human descendants that might follow from that individual life.

To put the above notions in a context**:** the flow of ‘reproductive’ technology is persistent, developing from artificial insemination, to in vitro fertilization, to harvesting cells and tissues from aborted fetuses, to harvesting stem cells from only-moments-before living embryos, to cloning of individual animals. But technologies do not always exist without restriction from the taboo structures of the society, the laws, the restraints.

[*Case in history* **:** *it is now known that the ancient Egyptians accessed electricity. They built primitive batteries and constructed wading pools stocked with electric eels, for the priestly class to use treating citizens with arthritis. But this technology was not shared openly with the general populace, in order to prevent the technological advances from disrupting the society’s well-defined hierarchy … and look how long the Egyptian civilization was able to thrive with that hierarchy!]*

To date, America has witnessed many examples of the ‘slippery slope’, but unchecked application of technologies and discoveries doesn’t always lead down a slippery slope. In America, to avoid slippery slopes the sovereigns must be in touch with advancements and the long-range implications, because exploitation of technology tends to corrupt checks and balances within the moral and legal taboo system of a society like ours. We'll explore that notion as we delved deeper into the technologies of stem cell exploitation and cloning.

> **{ Here's an aside**, to remind us what conception is. If you choose to read up on this subject at on-line sources, you will see the term 'zona pellucida' repeated, the cell membrane of the original oocyte that the embryo breaks out of in the uterus when seeking implantation. The following is an example as stated at one such excellent net source for pregnancy information. The description is accurate, whether the fertilization occurs in a woman's fallopian tube or in a well-lit lab.
>
> "Fertilization begins when a sperm penetrates an oocyte (an egg) and it ends with the creation of the zygote. The [*traditional*] fertilization process takes about 24 hours.
>
> A sperm can survive [*unsupported, in the wild, so to speak*] for up to 48 hours. … Only one sperm needs to bind with the protein receptors in the zona pellucida to trigger an enzyme reaction allowing the zona to be pierced. Penetration of the zona pellucida takes about twenty minutes.
>
> Within 11 hours following fertilization, the oocyte has extruded a polar body with its excess chromosomes [*the extra 23 female chromosomes not used in fusion*]. The fusion of the oocyte and sperm nuclei marks the creation of the zygote and the end of fertilization."[The Visible Embryo http://www.visembryo.com/baby/index.html] **}**

In vitro fertilization clinics were established to assist couples in having a child when their traditional conception efforts appear to be failing. There are many reasons why the traditional method may fail to conceive. We will focus upon the process used to assist in conceiving embryos in a laboratory, and then inserting them into the woman's uterus.

In order to prime the woman's ovaries, hormone injections are given, then the ovaries are observed via ultrasound imaging to see how many oocytes are about to pop from the ovaries. With the current technology, a needle probe is directed via ultrasound imaging through the muscular tissue of the vagina, into the lower pelvic cavity and over to the ovary to be harvested from. Several oocytes are usually extracted from the ovaries.

These oocytes are placed in or on a sterile platform (the famed petri dish), and then healthy, active sperm are introduced to the oocytes. [*Talk about your 'arranged dates'!*]

> **{ Here's an aside**, regarding clinical oocyte retrieval, lifted from the website of an in vitro fertilization clinic headquartered in New Jersey that enjoys an excellent success rate.[7]
>
> "The egg collection process (retrieval) is usually accomplished using the Ultrasound-Guided Trans-vaginal method. Other methods of retrieving oocytes that are rarely utilized in our practice but are sometimes necessary, include Laparoscopy or a Trans-Abdominal approach.
>
> The Ultrasound-Guided Trans-vaginal method of egg retrieval allows this procedure to be done in an out-patient setting. A vaginal ultrasound allows for visualization of both ovaries. A needle is inserted through the vaginal wall into the ovary. Each follicle is punctured individually and the fluid containing the egg is examined by the embryologist under the microscope until the egg is found. The duration of this procedure is usually less than 45 minutes." **}**

Some oocytes to which sperm are introduced in the lab will be fertilized and will change in appearance almost instantly. The change of appearance is caused by the oocyte transforming the zona pellucida (outer cell membrane) to make it into a sort of barrier, so that a second sperm may not then penetrate. To be even more in charge of fertilization, some clinics now needle inject a single selected sperm into the oocyte. [*Now THAT IS the ultimate in arranged unions!*]

The in vitro fertilization technician observes the embryos as they reside, alive, in the lab dish, watching them to see if the structure will take on the appearance of a mulberry fruit (the morula stage). If the embryo makes it to the morula stage, technicians don't wait much longer before implanting those active embryos into the target uterus.

A few in vitro fertilization clinics have become so able to carefully manage the embryos, they now assist the 'hatching' process, aiding the embryo in its break-out from the protective zona pellucida. This is quite an achievement because the embryo is much more fragile after it breaks out from the tougher protective capsule that was the original oocyte's cell membrane. Recalling the information about twinning, such 'assisted-in-hatching' embryos have better odds of achieving pregnancy but are problematic for fusing of embryos [*we'll address this oddity in the next chapter, d iscussing a human chimera*] resulting in conjoined twins from the IVF process.

> **{ Here's a second entry** from the website listed above. This is what clinics do with the embryos conceived in vitro.[7]
>
> **"**Embryo Transfer (ET) usually occurs seventy-two hours post-retrieval. The time of the transfer will be designated by the IVF staff. The embryo(s) that is(are) assessed to be developing normally will be considered for transfer. Although a recommendation (3-5 embryos) will be made regarding the number to transfer, the final decision resides with the couple and the physician. Transferring multiple embryos may result in the growth of more than one fetus. If you have extra embryos after the transfer, they will be cryopreserved if they have demonstrated appropriate development, unless you signed the consent to forgo cryopreservation [*freezing*].
>
> The method used for transferring embryos is similar to that of the mock transfer. You will need to drink fluids to fill your bladder before the actual transfer so that we may visualize the uterus by ultrasound during the transfer. ET is performed by inserting a small catheter through the cervical opening into the uterine cavity. The Embryo Transfer is usually a painless procedure. There is a recommended rest period after the transfer. You will be given specific instructions prior to the Transfer regarding your medications, future testing dates, and activity restrictions.**" }**

In February 1989, a very unusual case was argued before Judge W. Dale Young in Blount County, Tennessee. In that case, Junior L. Davis filed suit against his ex-wife, now Mary Sue Davis Stowe, over the custody of seven cryogenically frozen embryos that the two of them had created at a fertility clinic prior to their divorce. The following was offered by Dr. Jerome Lejeune (from court transcript), after giving extensive testimony as to why Embryologists and Geneticists hold as a fundamental principle that individual human life begins at fertilization**:**

> **"**When we come back to the early human beings in the concentration can, I think we have now the proof that there are not spare parts in which we could take at random, they are not experimental material that we could throw away after using it, they are not commodities we could freeze and defreeze at our own will, they are not property that we could exchange against anything. And if I understand well the present case and if I can say a word as geneticist, I would say: An early human being inside this suspended time which is the can cannot be the property of

anybody because it's the only one in the world to have the property of building himself. And I would say that science has a very simple conception of man; as soon as he has been conceived, a man is a man.**"**

Dr. Lejeune went on during his testimony to describe the effect upon the embryos held in such cold storage.

A.: **"**If we stop the process, if we slow down the movement of the molecules, we progressively come to a relative standstill, and when the embryo is frozen, these tiny human beings, they are very small, one millimeter and a half of a dimension, a sphere a millimeter and a half, you can put them in cannisters by the thousands. And then with the due connotation, the fact of putting inside a very chilly space, tiny human beings who are deprived of any liberty, of any movement, even they are deprived of time, (time is frozen for them), make them surviving, so to speak, in a suspended time, in a concentration can. It's not as hospitable and prepared to life as would be the secret temple which is inside the female body that is a womb which is by far much better equipped physiologically, chemically, and I would say intellectually than our best laboratories for the development of a new human being.

That is the reason why thinking about those things, I was deeply moved when you phoned to me, knowing that Madame, the mother, wanted to rescue babies from this concentration can. And to give to the baby--I would not use term baby, it is not perfectly accurate, not good English--would offer to those early human beings, her own flesh, the hospitality that she is the best in the world to give them.**"**

Dr. Lejeune described the freezing as suspending the embryos in time, slowing down their metabolism to such a degree that the embryos were in suspended animation but could be thawed carefully, to resume their normal cellular activities (in the deep cold, mitochondrial energy grains almost completely cease functioning). In the following exchange, notice how intention for the freezing appears to be the focus of the attorney's questioning, while he skillfully seeks to dehumanize the embryonic individuals using a term Dr. Lejeune has debunked in earlier testimony … 'pre-embryo'**:**

Q.: So that you can expect, therefore, by the rules of statistics if we freeze one hundred pre-embryos, and we come back to thaw them at any point, we know the odds are very, very high we'll only have seventy, seventy- five or eighty?
A.: Uh-huh (affirmative).
Q.: We knew that before we put them in the frigidaire?
A.: Yes.
Q.: Would you regard that as an intentional killing of embryos?

A.: No, but I would consider that it's making the embryo running a risk, and whether this risk was in the best interest of the embryo or not is an open question. I explain. When we do an intervention in a baby for a heart disease, in some intervention we know that around twenty percent of them will be killed by the intervention. And in this case the intervention is made only if we know if we don't operate the child will be killed by the disease at ninety-nine percent of probability. Then we say in the real interests of this patient the best for him is to operate even if the operation is still dangerous, the danger is much greater if we don't operate. That is a way you can make indeed some choices in medicine which are dangerous but which are, in fact, the best that you can do in the interest of this particular patient.

…

Q.: So in cryopreservation we know that we are going to kill ten, twenty, thirty percent of these early human beings merely so the woman has a better chance of getting pregnant?

A.: That would be one of the reservations that I would have, but I dislike you say you kill. It's not killing.

Q.: If we were to take the members, the individuals seated in the jury box and I were to have a room I could put them in where we would know that thirty percent of them would come out dead, would you not agree I would be guilty of murder?

A.: Well, it depends, sir, because if the room you were talking about were a shelter during a bombing time and if remaining in that room all of them will be dead, but in the shelter some of them will survive, even if thirty percent of them will be dead, you did well. So it depends on the reason why you did it.

…

Q.: You recognize the ethical and moral dilemma I'm raising, of course?

A.: No, I don't recognize it, sir.

Q.: You don't't?

A.: No, because you use the word killing. And if you take a embryo which has been frozen and you put him briskly at normal temperature so that he will die, you are killing the embryo. If you are freezing the embryo you are not trying to kill him, if I understand what you have in your mind is to help the embryo surviving so he could be implanted in the womb of the mother. So your technique is not good because you lose part of them, but you are not killing. And I would not say that my colleagues who are freezing embryos are killers. It's not true. Otherwise, maybe it's because I don't understand English, but I would not use the word kill. **}**

It is important to note that an in vitro fertilization technician will not seek to implant an embryo that has not proven it is developing, growing. The lab will not waste valuable assets in cryopreservation for such non-growing embryos, either. The embryo's cell division, even in a petri dish, is evidence that at least one individual human being has begun expressing its genome and is growing, living its individual life**.** It is also important to note that freezing of embryos not used in the implantation step is a practice aimed at preserving the individual life of the embryos; the freezing step is done to preserve the life of the embryos as best the lab can short of implantation. To view these tiny individuals in suspended animation as sources for stem cells by killing the embryo is a very different kettle of fish, sweeping aside their inalienable right to life, if you will. [*More about that later.*]

Under natural circumstances, with healthy human males and females, embryos are conceived fairly regularly during sexual behavior. It is estimated that approximately half the number of embryos conceived naturally fail to reach birth age or even to implant successfully. The reasons for this failure in reproduction are varied, from chromosome copying mistakes in early cell division, to hostile environment for the embryo. In vitro fertilization / implantation does raise the odds of successful reproduction in couples having problems with traditional means; the assisted method avoids several stages of peril during the first few days from introduction of sperm to the female host.

A slippery slope

It will not be long before scientists develop a useable artificial womb into which the in vitro embryo may be implanted and receive life support. Scientists have already harvested and grown uterine lining cells in the lab and implanted a human embryo into the matrix structure. We The People need to decide, before it's too late to turn back, whether our laws will extend value (embryos as humans, being) and therefore protect the embryo of in vitro fertilization even though it may never reside inside a human body for life support!

{ Here's an aside, regarding artificial wombs:

Men redundant? Now we don't need women either The Observer (UK) | 02/10/2002 | Robin McKie [13]

'Doctors are developing artificial wombs in which embryos can grow outside a woman's body. The work has been hailed as a breakthrough in treating the childless.

Scientists have created prototypes made out of cells extracted from women's bodies. Embryos successfully attached themselves to the walls of these laboratory wombs and began to grow. However, experiments had to be terminated after a few days to comply with in-vitro fertilisation (IVF) regulations.

'We hope to create complete artificial wombs using these techniques in a few years,' said Dr Hung-Ching Liu of Cornell University's Centre for Reproductive Medicine and Infertility. 'Women with damaged uteruses and wombs will be able to have babies for the first time.'

The pace of progress in the field has startled experts. Artificial wombs could end many women's childbirth problems - but they also raise major ethical headaches which will be debated at a major international conference titled 'The End of Natural Motherhood?' in Oklahoma next week.

'There are going to be real problems,' said organiser Dr Scott Gelfand, of Oklahoma State University. 'Some feminists even say artificial wombs mean men could eliminate women from the planet and still perpetuate our species. That's a bit alarmist. Nevertheless, this subject clearly raises strong feelings.'

Liu's work involves removing cells from the endometrium, the lining of the womb. 'We have learnt how to grow these cells in the laboratory using hormones and growth factors,' she said.

After this Liu and her colleagues grew layers of these cells on scaffolds of biodegradable material which had been modelled into shapes mirroring the interior of the uterus. The cells grew into tissue and the scaffold dissolved. Then nutrients and hormones such as oestrogen were added to the tissue.

'Finally, we took embryos left over from IVF programmes and put these into our laboratory engineered tissue. The embryos attached themselves to the walls of our prototype wombs and began to settle there.'

The experiments were halted after six days. However, Liu now plans to continue with this research and allow embryos to grow in the artificial wombs for 14 days, the maximum permitted by IVF legislation. 'We will then see if the embryos put down roots and veins into our artificial wombs' walls, and see if their cells differentiate into primitive organs and develop a primitive placenta.'

The immediate aim of this work is to help women whose damaged wombs prevent them from conceiving. An artificial womb would be made from their own endometrium cells, an embryo placed inside it, and allowed to settle and grow before the whole package is placed back in her body.

'The new womb would be made of the woman's own cells, so there would be no danger of organ rejection,' Liu added.

However, her research is currently limited by IVF legislation. 'The next stage will involve experiments with mice or dogs. If that works, we shall ask to take our work beyond the 14-day limit now imposed on such research.'

A different approach has been taken by Yoshinori Kuwabara at Juntendo University in Tokyo. His team has removed foetuses from goats and placed them in clear plastic tanks filled with amniotic fluid stabilised at body temperature. In this way, Kuwabara has kept goat foetuses alive and growing for up to 10 days by connecting their umbilical cords to machines that pump in nutrients and dispose of waste.

While Liu's work is aimed at helping those having difficulty conceiving, Kuwabara's is designed to help women who suffer miscarriages or very premature births. In this way Liu is extending the time an embryo can exist in a laboratory before being placed in a woman's body; Kuwabara is trying to give a foetus a safe home if expelled too early from its natural womb.

Crucially, both believe artificial wombs capable of sustaining a child for nine months will become reality in a few years.

'Essentially research is moving towards the same goal but from opposite directions,' UK fertility expert Dr Simon Fishel, of Park Hospital, Nottingham, said. 'Getting them to meet in the middle will not be easy, however. There are so many critical stages of pregnancy, and so many factors to get right. Nevertheless, this work is very exciting.'

It also has serious ethical implications, as Gelfand pointed out. 'For a start, there is the issue of abortion. A woman is usually allowed to have one on the grounds she wants to get rid of something alien inside her own body.

'At present, this means killing the foetus. But if artificial wombs are developed, the foetus could be placed in one, and the woman told she has to look after it once it has developed into a child.'

In addition, if combined with cloning technology, artificial wombs raise the prospect that gay couples could give 'birth' to their own children. 'This would no doubt horrify right-wingers, while the implications for abortion law might well please them,' he added.

Gelfand also warned that artificial wombs could have unexpected consequences for working women and health insurance. 'They would mean that women would no longer need maternity leave - which employers could become increasingly reluctant to give.

> 'It may also turn out that artificial wombs provide safer environments than natural wombs which can be invaded by drugs and alcohol from a mother's body. Health insurance companies could actually insist that women opt for the artificial way. 'Certainly, this is going to raise a lot of tricky problems.' **}**

As noted in the above article by Robin McKie, scientists in Japan have succeeded in removing a goat fetus from its mother, then removing it from support and protection of it's placental and amniotic sacs by placing it in an artificial chamber filled with amniotic fluid. At latest checking, they have sustained goat fetuses for up to seventeen weeks in their artificial womb! To be in opposition to such procedures is to be a 'right-winger', but is opposition to such manipulations really so radical? … Well, coupling artificial womb methodology to in vitro fertilization then stem cell exploitation would be ideal to such researchers since they would control the embryocide and feticide of lives coaxed into existence inside private confines of laboratories, IF laws do not establish the clear protection of earliest human existence along the individual lifetime continuum. [*We'll delve more deeply into that issue when we get to the ethics of these artificial procedures*.]

As is usually the case in reproductive science, scientists gear up to discover ways in assisting infertile women / couples. That's what spurred the quest to do artificial insemination, and then in vitro fertilization. Similar claims will no doubt be raised as a credible use for cloning techniques, somewhere. But the abuse potential is enormous … abuse especially if you consider the in vitro conception and farming of individual human embryos solely for the purposes of harvesting the stem cells to be at least objectionable, at most cannibalizing!

The will to live and grow

How tenacious are embryos? Well, if fertilization happens to occur before the ovum is moving along the fallopian tube pathway, there is the chance that the embryo will seek implantation somewhere other than the uterus (called an ectopic pregnancy). The new individual life may try to implant in the fallopian tube, or somewhere in the lower abdomen, or even in the tissues of a nearby organ! Usually, an ectopic pregnancy is surgically interrupted because of pain for the woman and the threat for tissue rupture with severe bleeding. The following article from the BBC News Online (Friday, 23 May, 2003) illustrates such a pregnancy … a child that beat the odds for implantation and succeeded all the way to assisted birth!

> **{ Miracle baby grew in liver** [9]
> A healthy baby has been born after developing in its mother's liver instead of in the womb.
>
> Reports from South Africa say Nhlahla, whose name means "luck" in Zulu, is only the fourth baby ever to survive such a pregnancy. In all, there have only been 14 documented cases of a child developing in this way. Nhlahla was born after specialists performed a difficult operation to deliver her on Tuesday.
>
> She had to be put on oxygen after her birth, where she weighed a healthy 2.8kg, but was breathing without aid by Thursday. Doctors said Nhlahla and her mother Ncise Cwayita, 20 - whose first baby was born normally - were both doing well. Liver specialist Professor Jack Krige, who helped deliver the baby, told a South African newspaper: "She is the real thing. She is truly a miracle baby."
>
> Risks
>
> When an egg is fertilised, it normally travels down the fallopian tube to the womb, where it implants and grows. But sometimes, the embryo implants in the fallopian tube, a standard ectopic pregnancy.
>
> In some cases - around one in 100,000 pregnancies - it falls out of the fallopian tube and can implant anywhere in the abdomen. In extremely rare cases, such as this one, the embryo attaches itself to the liver, a very rich source of blood. The baby is protected because it is within the placenta - but it does not have the usual protection of the womb - and is at more risk in the abdominal cavity. Most babies in extrauterine (out of the uterus) pregnancies die within a few weeks.
>
> Window
>
> In this case, doctors only discovered the baby was growing in the liver when they performed a scan this week. Her womb was found to be empty, even though her baby was due in a week.
>
> Ms Cwayita was transferred to the Groote Schuur Hospital in Cape Town. Dr Bruce Howard told the Cape Argus newspaper said: "We knew it was an extrauterine pregnancy but we didn't know it was in the liver until we started the operation on Tuesday morning." Doctors found a small "window" where the amniotic sac connected with the outside of the liver where they were able to go in

> to deliver the baby. Doctors had to leave the placenta and amniotic sac in the liver, because the mother's life would have been at risk. It is expected they will be absorbed back into her body.
>
> Professor James Walker, president of the British Ectopic Pregnancy Trust, told BBC News Online abdominal pregnancies could be very dangerous. "The mother is at a huge risk. One in 200 women die before we can do anything to help them. The main problem for the baby is that it is not protected by the muscular wall of the womb." **}**

Several things are illustrated with that pregnancy in a woman's liver tissues. First, it is the newly conceived life that directs the steps of its own growth and development, not the uterus of the mother. Second, and not so obvious, the newly conceived individual life must accomplish some tricky moves, to receive life support from a woman's body, even under normal circumstances, much more so when trying to implant in an organ not intended for gestation and birth. Why? … Because the newly conceived life is a foreign 'invader' to the woman's immune system, an invader her body will attack and try to eliminate if her system recognizes the invader.

It is a trick of chemical signaling by a separate entity (the new individual) that allows the embryonic individual to implant in the woman's body, because the tissues of the embryo and later the fetus are poisonous for the woman if the 'other' is not inside a separating membrane. This was illustrated tragically when a young woman in California (only 18 years old) used an abortifacient pill regimen, but her body failed to flush all the tissues of the dead embryo body (fetus) and the placental organ from her body; and she died of septic shock.

The woman in the BBC article was very fortunate since the placental tissue left behind from birth would be absorbed by the liver due to the liver's special regenerative abilities not found in other organs of the human body.

CHAPTER THREE – Stem cells and cascades

The Chimaera - or Chimera - was said to be made out of three different creatures: lion, goat and serpent. A savage beast, sprouting fire from its mouth, it devastated the land until it was killed by the hero Bellerophon who flew over it riding his winged horse Pegasus. This story, although apparently simple in its basic lines, is among the most ancient ones of occidental mythology and it hides some deep and still not exactly known meaning. [http://www.unifi.it/unifi/surfchem/solid/bardi/chimera/]

* * *

{ Here's an interactive exercise, to graphically illustrate what the stem cell cascade of specialization represents. The cascade runs from most generalized (having the greatest capacity to activate the DNA data) to most specialized (having the least capacity to activate the stored data; the DNA pattern remains throughout the lifetime, but has been deactivated except in multipotent stem cells). As one step from general to specific is taken, a 'switch' is turned off so the step is not repeated unless extra 'switches' for the task are active at some other gene.

With a pencil or pen and a piece of notebook paper, make the following drawing. Place a circle about the diameter of a soft drink can at the top of the page, to represent the zygote. Just below that large circle, draw a row of three circles each about the size of a quarter. Now, down another two or three inches from the row of three circles, draw a row of sixteen circles, each circle about the diameter of a dime. Go back to the large first circle and draw a line from the one circle to the circle on the left in the row of three, then another line from the top circle to the middle circle in the row of three**;** now draw a line from the middle circle in the row of three to the circle on the right in the row of three. Now draw lines from the circles in the row of three, to each circle in the row of sixteen, one line per circle in the row of sixteen.

To be more precise in the analogy, you would eventually need to draw a row with more than two hundred small circles in it, connected to a row above that one with fewer circles in it, because the stem cells of the early embryo eventually give rise to more than two hundred tissue lines within the human body.

In our drawing there is some confusion when trying to draw lines from the row of three to the row of sixteen. We've arranged the exercise that way, to illustrate a puzzle in embryonic stem cell exploitation. When harvesting stem cells from embryos—cells to be used in treating human disease in individuals older than the embryo or fetus—it is difficult to know which line of cells comes from which earlier pluripotent cells, and it is difficult to know whether a less specialized cell is captured when in fact a much more specialized stem cell is desired. A scientist wouldn't want to inadvertently extract embryonic stem cells destined to be teeth and implant those in a Parkinson's patient's brain, for obvious reasons. **}**

You existed briefly as a single mega cell called a zygote. Your first age in life was as a zygote. As you lived through your embryo age then into your fetal age, you built the tissues and organs you are using now as you live in the air world. Those organs and tissues were constructed by stem cells (those blastomeres in the morula, then those trophoblasts that went to building your placental organ and those embryoblasts that built your primitive body of organs which grew into the one you are using now).

There is an ordering to stem cells. Your first single cell (zygote) contained ALL the codes and messages, in 'un-played' form, that would be used to build your entire organismal structure as well as the first organ support structure (the placenta) that you used during your ages in mother's body then abandoned. The zygote is totipotent.

Recall if you will the phrasing by Dr. Jerome Lejeune: "Now we come to an extraordinary observation that the only cell in all my life in which those two methylation systems from father and from mother were present together inside one cell was in the first cell which gave me life." Dr. Lejeune is referring to the chemical cascading that follows as a zygote (a totipotential cell) undergoes cell division, mitosis. Again in Dr. Lejeune's words, "… progressively at each division, this methylation is erased and replaced. And progressively cells learn by a cascade of reaction to specialize."[4] And "And the very thing is that during this process, the expansion of the primary formula which is written in the early human being, nothing is learned but progressively a lot of things are forgotten. The first cell knew more than the three cell stage, and the three cell stage knew more than the morula … In the beginning it was written really not only what is the genetic message we can read in every cell, but it was written the way it should be read from one sequence to another one." [14]

The cell naming game progresses from totipotent, to pluripotent, to multipotent. With each progression, the cells that follow become more specialized, able to cascade into fewer and fewer of differing tissues, 'forgetting' a tiny bit as each step in the process is 'lived'.

[*The stem cells inside the blastocystic cavity are pluripotent cells, able to differentiate into the entire of the tissue and organ mul tipotent stem cell lines of your air -world body. Interestingly, even an adult has multipotent stem cells being produced inside the body. Journalists are calling them 'adult stem cells', but they're there throughout individual lifetime in embryo and fetal a ge and the ages to follow, there to act as 'spare parts', if you will. These cells may turn into several different needed tissues in an organ system; this is one of the topics we will be discussing shortly* .]

The totipotent cell divides, forming two totipotent cells, then one of those two divides to net three cells. Very early in mitosis, a change occurs, such that a last totipotent pair is produced. The next classifications of stem cells are pluripotent cells. With the tasking for placenta and the inner cell mass, the multipotent stem cells begin to have specific construction pathways they will follow as they in turn divide and give rise to more cells and eventually giving rise to more than two hundred tissue systems and organs (as with the differentiation of trophoblasts and embryoblasts before implantation).

Even as an early embryo only days old, the new individual life is growing and doing things to survive in its environment. The in vitro clinicians will observe the lab-conceived embryos for no more than three to five days from conception, then implant selected embryos that show they are actively growing, preparing to search out life support. Is this search by the embryo a 'conscious' effort, like a hungry person foraging for food? No, the individual has not built its brain that it will require in the air world, but it is a real effort to survive that is directed by the individual new life, it is an effort by a human individual at least equal to that which single-celled living things undertake. But it is so much more, a dialog even, between embryo and mother, that can last a lifetime for the mother, as we will see at the end of this chapter.

The cells forming the outer encapsulation of the embryo, the placental organ cells, are one class of embryonic stem cells. The cells building the embryo body inside the encapsulation are also embryonic stem cells. And these inner stem cells will give rise to all the OTHER organs of the developing body and the amniotic sac in which the baby 'floats'. But even the stem cells that form the sac are involved in the formation of the internal organs to be used upon exiting into the air world. The tissues that encapsulate some of the body's internal organs and line the gut derive from the cells that helped form the amniotic sac connected to the placental organ.

So, stem cells related to the placental organ and stem cells held within the inner cell sac of the blastocyst for the embryo body are involved in the construction project of the organism that lives in the air world. That’s important to note, because to date the disasters associated with embryonic stem cell harvesting and medical applications in humans have occurred due to inability to target and remove only the precise cells desired which will differentiate into the specific organ or tissue to treat the patient.

As mentioned before, there are sources for stem cells, other than living embryos. As you read this material, your body is busy creating new stem cells (called adult stem cells) for various tissue and organ classifications, to allow for repairs and renewal of organs and tissues vital to your survival. Adult stem cells are multipotent. Many of these adult stem cell lines are yielding treatment breakthroughs and are very effective since they come directly from the patient’s own body and are inserted back into the patient in a treatment regimen. Such stem cells taken from the patient for the patient’s treatment have what scientists call ‘histocompatibility’ … the recognition of tissue by the patient’s immune system which reads these stem cells as part of the patient, not foreign cells to be attacked.

There are stem cells in abundance to be harvested from cord blood left in the placenta and umbilicus of birthed infants. The trick of fooling the mother’s body into not reading the placenta as foreign tissue carries over to cord blood stem cells, also to a great degree sidestepping the tissue rejection problem **if** early immune system cells of the fetus can be isolated from the mix before using the cells with a needy patient. It is as if cord blood transferring the nutrients and gases to and from the growing baby is generalized, not well defined as from a specific member of the human family.

There are also stem cells harvested from aborted fetuses and the victim’s placental organ. The fetal tissue harvesting industry is now more than a billion dollar enterprise. We will not delve too deeply into that area of stem cell harvesting because of the sadness therein. But we ought not be naïve to assume that scientists are not actively pursuing fetal stem cells; the trick scientists want to achieve is targeted stem cell differentiation, as they direct the stem cell march into specific tissues and organs, a trick done routinely by the growing unborn child before being aborted and removed from the womb. That is what has given impetus to collecting embryonic germ cells (EG cells) of aborted fetuses, 'harvesting' from the reproductive organ region (*the gonadal ridge*) of the very young fetus.

Myth meets fact, a chimera

As a way to illustrate the 'plasticity' trick of early life, and to raise important points regarding the 'whys' of embryonic stem cell exploitation and cloning, let's look at a very rare example of human chimera, then we will look at examples of chimera experiments that have actually been done, mixing human and animal biological materials!

{ **The Mum Made of TWO Women** From BRIAN FLYNN in New York [10]

A MUM has stunned the medical world after tests showed she is made up of **TWO** women.
And even more incredibly she is **NOT** the biological mother of two of the children she conceived and had naturally.
Docs found the woman, named only as Jane, was formed from non-identical twin embryos who fused together in her own mother's womb.
Her blood and some of her organs are made up of her own cells — while other parts of her body "belong" to her unborn sister.

The amazing condition, which baffled doctors for two years, first came to light when Jane was given the bombshell news that two of her three sons did not share her DNA.
That meant they could not be hers — even though docs confirmed her husband was their father.

Finally Jane was diagnosed as a "chimera", a person made up of two distinct sets of DNA. There have been just 30 known cases, though this is the first described in detail.
Jane's bizarre story, reported in the New Scientist journal, began when she needed a kidney transplant.

Doctors in the US city of Boston did blood tests on her three sons to see if they might be donors.
Instead they found two of the boys could not be her own. Dr Margot Kruskall of the Beth Israel Deaconess Medical Center in Boston told how the results stumped her team and sparked a huge inquiry.
She said: "No-one could figure it out. One suggested Jane had secretly undergone fertility treatment using donated eggs. Another speculated she and her husband had got her sister to conceive with his sperm."

> The breakthrough came when tests on Jane's brother revealed the sons were all related to her family in some way or other.
> They then tested DNA from different parts of Jane's body, including the thyroid gland, mouth and hair — and were astonished to find they came from two different people.
>
> An examination of her ovaries led to the conclusion that she must be the result of embryonic twins who already had their own reproductive organs when they merged.
> *Cells from both twins existed in her ovaries side -by-side, meaning she could produce eggs with two different DNA fingerprints.*
>
> Dr Kruskall said the discovery meant there could be many more mums and dads who have no idea they are not their kids' biological parents. And she warned it could have implications in custody battles.
> Scientists also fear the number of chimeras will rise because increasingly common IVF treatment boosts the chances of conceiving twins. [The Sun, U.K.] **}**

The first thought that occurs to many reading the above articles is, 'what if Jane's children had been born through in vitro fertilization?' Can you imagine the conundrum lawyers could have constructed from the situation, upon learning there is different nuclear DNA and mitochondrial DNA in the children than the woman who bore those children? The in vitro clinic would face a formidable task, trying to prove the integrity of their services. And as legal appeals create legal precedent, imagine what the impact would be on criminal cases where nuclear DNA identification is used as evidence to convict or exonerate! It boggles the mind. How could a defense attorney or prosecutor ever explain enough basic biology and embryology for all the jurors to understand the possibilities? Without a jury of Embryologists, perhaps the prosecutor would present the biological facts and the defense attorney would then cite the exceptions. **…** Or worse, the defense attorney would cite the facts and try to confuse the jury, only to leave the poor prosecutor at a loss to explain why the differences didn't create reasonable doubt! But let's focus upon the 'when and how' for this human chimera formed from the embryo bodies generated by two individual genomes.

Our first clue to 'when' is the embryos with different genome identity existing side-by-side in Jane's mother's uterus, and the different nuclear DNA found in various tissues of Jane's body. Some tissue differentiation of the blastocyst stage had to have occurred in both embryos prior to fusing of the inner cell masses.

Because Jane emerged as one whole neonate, without two belly buttons, we surmise the 'how' to be**:** combining of Jane's DNA and her twins DNA likely occurred following the formation of two different morula then two separate blastocysts that oozed together shortly after hatching from separate zona pellucida that carried them to the mother's uterus **…** two 'hatchlings' combined into one blastocyst, with one placental organ sustaining one blastocystic cavity and one umbilical vesicle.

Using more technical terms that the reader now understands, Jane is the result of two different sets of pluripotent stem cells that mixed very early in development. Perhaps these differing pluripotent stem cells mixed because the twin embryo failed to develop its separate placental organ after hatching from a separate zona pellucida. **Or**, perhaps the twin's lifetime began when a second sperm fertilized the 'castoff polar body' Jane's mother's oocyte separated from the 46-chromosome start of the fertilization process. In other words, the polar body of the 'unused 23 chromosomes' of Jane's conception, may have been fertilized by a second sperm that managed to reach the inside of the zona pellucida at Jane's conception. During a more generalized methylation process of stem cell cascading, some tissue lines from one genome cancelled out a duplicate construction process in the twin genome, so that organs of differing genetic blueprints developed alongside each other. Because Jane has her oocytes and a twin's oocytes contained within her ovary—without the twin's genome being identified by Jane's immune system as 'not me'—we may surmise development allowed the directions on gene number 6 of both genomes to exist 'peacefully' in the construction of Jane's immune system … fusing of the inner cell masses happened before Jane's immune system was activated. Her twin's cells have histocompatibility with her immune system, so her immune system recognizes the twin's molecular marker identity as 'also me'.

A situation similar to Jane's can occur if one twin donates an organ such as a kidney to its sibling **…** if the immune systems are a close enough match, the organ will not be rejected by the receiver of the organ donation and anti-rejection drugs will not be needed. Such a close match is very rare unless the twins are identical—monozygotic. But in Jane's case, if she and her twin were identical, the twins would have emerged from a single first zygote and have identical chromosomes. Jane is the merging of separate and individual genomes from two zygotes because she has non-identical chromosomal DNA co-existing within her body. Jane's transplantation process occurred at Jane's earliest age in utero and involved many organ and tissue systems! Recall the words of Dr. Lejeune**:** "Because progressively at each division, this methylation is erased and replaced. And progressively cells learn by a cascade of reaction to specialize. So that one will make nails, another will make the brain, another will make the liver and another will make the bones and another will make the muscle."

What makes Jane a chimera is the evidence of two different genomes existing side-by-side in one functioning organism. At this point some will assert that 'because Jane is the reality of two different genomes, then before the two genomes thoroughly combined, there were no individuals in embryonic state, just embryonic stem cells.' We would direct them to the analogy of Fred and Francis, and reply that from the first division of cells by two separate zygotes in two separate zona pellucida, having two separate genomes from the same common father and mother, two individuals developed to the point where one was absorbed into the construction project for one vehicle of organs.' We would note also that, 'the two sets of pluripotent stem cells worked in competition and in concert during the entire embryonic age of Jane's embryo body construction.' Finally we would cite chimera individuals created through organ transplants. [*And if that didn't confuse them enough, we would suggest two or three college level Embryology textbooks, where this writer struggled through his balance of confusion.*]

Jane is solid evidence that two genomes were activated, that two organisms were living their genome program, but when the two got too close to each other early in the blastocyst age, their inner cell masses of pluripotent stem cells fused when the twin's placenta failed to develop, and one genome went on to dominate in the construction project while carrying her sister's injured life along with her, but without canceling the twin's genome completely because the combination occurred so early in the lifetimes of both, before an immune system was developed.

Remember that mitochondria we weren't going to spend much effort on? **…** Well, it was through the mitochondrial DNA that the sons were all matched to Jane's family tree, as per, "The breakthrough came when tests on Jane's brother revealed the sons were all related to her family in some way or other." The brother would have mitochondrial DNA from the same mother as Jane and the twin that was incorporated, so Jane's sons could be matched to their maternal grandmother's generation.

Beyond Jane, to Rabbit and Jane

Human tissue rejection is mostly related to the immune system built on instruction from chromosome #6 of the embryo's nucleus. Some scientists have decided to pursue a chimera approach to growing embryos using human genome (human 46-chromosome complement for a nucleus) and denucleated cow or a mouse or a rabbit ovum still containing the animal's mitochondria. The mixing has already begun in order to create material with which to study human stem cell cascading, and perhaps grow transplantable organs … the genome will be human while the DNA driving the mitochondria will be from another species. The following article excerpts should be enough to illustrate the direction some research is heading.

> {**Chinese Scientists Create First Human-Animal Embryo** by Sherrie Gossett For NewsMax.com Friday, Aug. 15, 2003 [11]
>
> Scientists in China have created the world's first embryonic chimeras, hybrid embryos that contain human and rabbit DNA, according to the Journal of Cell Research. **…**
>
> In the Chinese experiment, human nuclei was extracted from foreskin tissue and facial tissue from males and females ages 5-60. Samples were obtained from tissue discarded after surgery.
>
> The somatic nuclei were then transplanted ("nuclear transfer") into extracted New Zealand rabbit eggs and allowed to develop to the embryonic stage. The scientists report that the rabbit DNA successfully reprogrammed the human nuclei, causing it to multiply and develop into embryos that contained the human genome and the rabbit DNA [*rabbit mitochondria*].
>
> After several days of development, embryonic stem cells were obtained from the interior and put into frozen storage. Since the resultant stem cells were found to be encoded by the genome of the donor DNA [*the human donor*], the scientists hope that the research could be used to produce cells or tissues for human

autologous transplantation. [I*n this context, autologous means from the patient, back to the patient*] “Cells or tissue derived by this pathway would have nuclear DNA identical to the patient's and, therefore, would likely not be subject to immune rejection,” said the scientists. For this reason the scientists are hoping the research will lead to curative medical applications where tissue rejection has previously threatened the health of many patients.

The scientists say that the experiment proves that human and rabbit DNA can co-exist in a cell [*human nuclear DNA, rabbit mitochondrial DNA*], and that age might not be a factor for human compatibility with such future cell/tissue transplantation. Some uncertainties still exist, but the scientists report “it is possible that these cells will be recognized as ‘self’ when transplanted back into the same patient." In a previous interspecies nuclear transfer (NT) experiment, rabbit eggs successfully reprogrammed panda nuclei, but according to the report, this was the first successful experiment using human nuclei. **…**

In October 2000, the European Patent Office assured Greenpeace activists that it would never grant a patent on mixed-species embryos because they were considered an affront to "public order and morality." The activists were researching patents related to the human genome. A month later a researcher in Greenpeace's German office discovered that a patent had been already been granted for creation of a man-animal hybrid.

The patent stated it included a method for producing a non-human chimeric animal by the implantation into the animal of embryonic stem cells, including those from humans. **…**

An Australian company, Amrad, was granted the patent in 1999, which covers embryos containing cells from humans and from "mice, sheep, pigs, cattle, goats or fish." It was later sold to U.S. company Chemicon International, a provider of some of the basic material for the Chinese breakthrough. **…**

Douglas Melton, a cell biologist and cloning expert at Harvard University, called the work a major advance "because it offers a new system for exploring the mechanisms by which egg cells get adult cells to act in embryonic ways. That could provide deep insights into human development, wound healing and tissue regeneration," the Washington Post reported Thursday. The research is "extremely interesting, and I hope they pursue it," he said.

R. Alta Charo, an associate dean of law and professor of bioethics at the University of Wisconsin, told the Post, "Short of putting one of these embryos into a woman's body for development to term, I don't think this work harms anyone alive."

The experiments should force opponents of cloning research to specify where they would draw the line against the cloning of human embryos, she said.

The report of the rabbit-human embryo experiment appears in the August edition of the Journal of Cell Research, a peer-reviewed scientific publication of the Shanghai Institute of Cell Biology and the Chinese Academy of Sciences. **}**

There is a clue toward the end of the article as to why scientists are so focused upon embryonic stem cells: "… because it offers a new system for exploring the mechanisms by which egg cells get adult cells to act in embryonic ways." Ultimate goal? … To understand how embryos signal differentiation into specific tissues and organs, **so that the stem cells found in the adult may be de-differentiated and redirected to build tissues for the specific patient,** thereby producing autologous transplants so no anti-rejection medications would be necessary. The end goal is most ethical, but the means to accomplish the understanding of process is not. [We'll get into that more in the next chapter.]

The most immediate danger with the approach touted in the above article to generate human stem cells and perhaps human tissues and organs, using other animal eggs, is the likelihood of a viral disease that the host animal is resistant to, being passed to the human donor of the nuclear material who receives the cloned tissue back into their body. [Again, there are also major ethical issues to be addressed.]

A sideways step, to Jane and John

Such experiments with chimeras are not always received by fellow scientists as 'worthy'. Witness the following excerpt from a New Zealand newspaper, noting particularly the raising of the moral / ethical specter.

{ Creation of human 'she-males' angers IVF experts by Steve Connor [12]

An experiment that created human "chimeras" by merging male and female embryos in a test tube has been condemned as scientifically vacuous and ethically questionable by leading proponents of research into IVF [*in vitro fertilization*].

A team of privately funded researchers created the hermaphrodite chimeras- a mix of cells from two separate embryos - as part of a study into ways of treating inherited disorders but their colleagues in the field of reproductive medicine have strongly denounced the study.

The chimeric embryos, which contained both male and female cells growing side by side, were not allowed to live beyond six days after conception when they were still microscopic balls of cells. **…**

"It doesn't make any sense to me," said Alan Trounson, a leading authority in IVF research at Monash University in Melbourne, who publicly criticised the study when it was presented at the European Society of Human Reproduction and Embryology in Madrid.

"I think it's a flawed experiment. Unless you can be certain that you're doing good with something, you shouldn't do it at all. It is the Hippocratic principle of doing no harm," Professor Trounson told the meeting. "I think we've got to stand up and say we don't understand the point of this and we don't think it should proceed unless you have a much better reason. It is essentially trivial science that's unlikely to be useful. It's difficult to argue why it should be done to the public," added Professor Trounson.

The study was carried out at the Center for Human Reproduction in Chicago by a team led by Norbert Gleicher, the founder of the privately-funded institute, who is also a visiting professor of obstetrics and gynaecology at Yale University.

Professor Gleicher injected embryonic cells taken from male embryos into "high quality" female embryos that were about three-days old. Some of the chimeric embryos continued to develop apparently normally for three more days at which time the male cells had divided and spread throughout the female embryo. Professor Gleicher explained that he deliberately chose to insert male cells into a female embryo in order to make it easier to see whether the injected cells had managed to integrate into the recipient embryo, then he looked for the presence of the male Y chromosome.

He emphasised that he had approval from an in-house ethical committee and also took outside legal advice. He said the experiment would never be done on an embryo that he intended to implant into the womb. It was only conducted as part of an investigation into treating single-gene disorders, such as muscular dystrophy, by introducing healthy cells at an early stage of embryological development. **…**

"Normally you would do this with embryos of the same sex, but we did it with different ones as a model. Our primary purpose was to see if this was feasible and I think we have convincing evidence that the answer to that is yes," he said. **…**

However, other scientists were not convinced. Lyn Fraser, professor of reproductive biology at King's College London, said: "For me it's a non-starter. It's a biologically questionable approach. "There is no way you can ensure that so-

> called good cells would get to the organ in question. There is no guarantee it will work," she said. **…**
>
> Human chimeras can be created naturally when two embryos of siblings fuse spontaneously within the womb - an exceptionally rare event. [New Zealand Herald 3/07/2003] **}**

Since the sex of the individual may be discerned even at earliest embryo age in a petri dish, what the researcher did was use male and female embryonic stem cells to create what nature accomplished with Jane in the 'Two Mums' story. He targeted a living female at embryo age, injecting into her blastocystic cavity embryonic inner cell mass stem cells removed from a previously alive male individual at embryo age, then observed the mitotic dance! As stem cells of her turned on to begin building organs, the stem cells from him were turned off from that task. And while stem cells from him turned on to begin building perhaps muscle and bone, stem cells of her were turned off from that task. We've stated that it is the end use for the clone that determines the characterization of the methods; in this case it is the end use of the chimera that determines the 'ethical' status of the research.

The scientist in the above article 'emphasized that he had approval from an in-house ethical committee and also took outside legal advice.' Some ethicists, those! Is the public already clamoring for utilitarian exploitation of human life? While the nation awaited President Bush's decision (fall of 2001) regarding federal funding for embryonic stem cell research, it was proven during testimony before a Congressional Committee that there are scientists and Hollywood stars who believe human embryos should be afforded no more respect than a goldfish. The human embryo would become source for stem cells to be used in research on human diseases and to generate tissue lines for treating diseases of older individual humans. "Why wait, why hold off?" they would ask; "Science is already dissecting aborted fetuses, to harvest portions of their tiny bodies desired for research; sick and injured people need this technology," they would note. … And the world's morality would be further mutated into Hollywood's twisted vision of 'the good life', better living through human embryocide.

Astonishingly, this chimeric approach isn't a new slippery slope before us**:** for more than twenty years, mice containing human genes spliced into their genome have been residing in laboratories, being studied as they pass the human gene along to their offspring. Was that insertion of a portion of human DNA into a rodent's nucleus a wrong thing to do? Hardly, but it is a downward ethical leap to equate inserting a piece of DNA into a mouse genome, with terminating individual human lives, even chimeric human lives, in order to harvest body parts. If it has not already happened, soon human stem cells could be placed in mouse embryos, or human nuclei could be placed in a mouse egg, or mouse nuclei could be placed into a human oocyte. [*I wonder, would that create a manly mouse or a mousely man?*]

{ Here's an astonishing new insight regarding the interaction between the embryo / fetus and the mother, presented to a panel in 2000. Note in particular the role of stem cells addressed in the work presented by Dr. Salvatore Mancuso.

Pregnant Women "Inherit" Some Characteristics of Their Children
8-Sep-2000 -- ZENIT.org News Agency [19]

MILAN, SEP 5 (ZENIT.org). - Mothers undergo permanent changes during pregnancy, in which they "inherit" some characteristics of the child they carry and, through the child, also receive some characteristics of the father.

This is but one of the surprising discoveries to be presented at the congress entitled "At the Dawn of Human Life," organized by the Institute of Gynecology and Obstetrics of the Catholic University of Rome. The congress begins Sept. 6 in the Vatican, as part of the Jubilee of University Professors.

The child inherits half of his genetic patrimony from the mother. He also "hears" the outside world while in the womb, through the mother's body, a fact which substantially conditions the unborn child's life. Now, research indicates that the mother also undergoes long-term changes caused by the "person" of the child and, indirectly, also from her husband.

Professor Salvatore Mancuso, head of the gynecology institute, said: "We have proofs that beginning in the fifth week of gestation, in other words, when a woman realizes she is pregnant, an infinite number of messages pass from the embryo to the mother, through chemical substances like hormones, neurotransmitters, etc. Such information serves to adapt the mother's organism to the presence of the new being.

"Moreover, it has also been discovered that the embryo sends stem cells that, thanks to the mother's immune system tolerance, colonize the maternal medulla, and adhere to it. What is more, lymphocytes are born from here and remain with the woman for the rest of her life."

Mancuso continued: "From the fifth week there is clearly a passing of cells, but messages begin at conception. Even during the first phase of cellular subdivision, when the embryo is moving in the fallopian tubes, there are transmissions through contact with tissues touched by the moving embryo.

"Later, after implantation in the uterus, the dialogue is more intense through the blood and cells, and chemical substances enter the mother's bloodstream.

"Finally, the child's stem cells pass to the mother in great quantity, both at the moment of birth, whether spontaneous or Caesarean, as well as at the time of abortion, whether spontaneous or voluntary. These cells are implanted in the mother's medulla and produce lymphocytes, which have a common origin with the cells of the central nervous system; they have receptors for the neurotransmitters and can make messages pass that the maternal nervous system understands."

He added, "An astonishing area of research is opening up. This is information of enormous importance on the first phases of life."

When asked whether it was difficult to make rigid divisions of the phases of the embryo's development, Mancuso said, "It is a grave error to make distinctions between the embryo and pre-embryo. It is such an initial phase - one cannot of course speak of a central nervous system - but the messages the embryo sends to the mother express manifestations that are proper to the human species. The instruments used are highly specialized chemical substances and cells, such as stem cells.

"It should be remembered that if communication was lacking, the maternal organ would reject the embryo. The dialogue makes possible the perfect acceptance of an organism that is 50% foreign to the mother's genetic patrimony. In fact, these chemical substances, which express nutritional and metabolic needs of the embryo to the mother, cause an immune depression in her that facilitates the acceptance of the new being."

When asked how long the fetus' influence on the mother lasts, the professor answered**:** "Stem cells have been found in the mother even 30 years after the birth. It could be said, therefore, the pregnancy does not last the 40 canonical weeks, but the woman's entire life. … "This should be cause for reflection also in regard to the hypothesis of 'renting' a womb: In this case, the mother who carries the embryo accepts a being whose genetic patrimony is 100% foreign, and who will 'modify' her for the rest of her life. We have no idea of the long-term consequences of such operations.

> Regarding the transfer of the father's characteristics to the mother via the unborn child, Mancuso said, "These are areas that are yet to be explored. Of course it calls for reflection on a new way of understanding pregnancy. Also, a very close tie is undoubtedly created between man and woman, because the child has 50% of the father's genetic characteristics. Moreover, the hematopoietic [blood-producing] stem cells go to the medulla and produce offspring cells, lymphocytes and neurotransmitters with the capacity to dialogue with the maternal central nervous system. It is somewhat as though the 'thoughts' of the child pass to the mother, even many years after his birth." **}**

There is so much that is noteworthy in that article, it is hard to know where to begin! Think of it**:**

1) embryonic stem cells colonize the mother's medulla (*'medulla' refers to the inner portion of an organ; in this case the uterus or womb*);
2) the embryo carries on a dialogue with the mother's central nervous system and endocrine system (*glands and their secretions*);
3) some of the stem cells that colonize the uterus remain for the rest of the woman's lifetime, to message with her physiology (*the functioning of cells*);
4) because the embryonic stem cells remain alive within the mother's body, to effect her glandular systems, there may be feedback loops which should not be interrupted artificially because cancers may arise in her body related to disrupted feedback (note*: the body's endocrine system works through fundamentally a back-and-forth chemical signaling system between glands and organs and tissues; there are ongoing studies implicating abortion as a possible cause in some breast cancers*);
5) the messaging system between embryo and mother proves the embryo is an alive organism, a human organism that is working to survive;
6) since genetic aspects from the father (*via his 23 chromosomes in the 46-chromosome complement of the embryo*) remain within the mother's body for the rest of her life, the two really do become one flesh in her!

And finally there is this very disturbing potential: if scientists conceive hundreds of thousands or even millions of embryos for embryonic stem cell harvesting then tissue transplants into adult humans, what will be the effects of inserting chromosomal portions into the human family genome that have not been 'tested' through the stages of natural growth and development? Could scientists 'treat' us to extinction as a species?

Posing that alarm another way (as if contemplating our fictional 'oxygen bomb' in the introduction to this manuscript), nature has a built-in system for testing and discarding random genes—mutated genes—that may be bad for the long-term health of the species. It's called growth and development. Genes arise through randomness, but bad genes die out through reproductive selection and shortened lives, even shortened embryo lives (*bad genetic aspects are responsible for most miscarriages*). Additions to the species, via embryonic stem cells from beings no older than days, will not have been tested by the natural range of growth and development. Could scientists pass from their laboratories to the species 'genetic' time bombs?

It is now believed that 60 to 80 percent of conceptions do not reach birth age, because of *genetic anomalies*, errors in the genes or chromosome complement [27]. 'Nature' has a way of discarding badly shuffled genes or flawed DNA through growth and development, but what embryonic stem cell harvesting (whether from 'left-over embryos in IVF clinics or from specially created embryos using cloning) will do is extract the stem cells from the pre-implantation embryo and implant those cells in an adult patient **…** and thus bypass the growth and development process which would likely have discarded flawed genetic messages! It is also important to note that some genetic diseases don't even materialize until the adult organism reproduces or even until one or more generations later!

CHAPTER FOUR – Cloning

Two electricians, taking a break while wiring a new house:
First electrician – Did you read the paper this morning? … According to the newspaper, science can now clone any mammal. So what do you think they ought to clone first?
Second electrician – I'd like it to be me.
First – Why's that?
Second – So I can play golf while I work.

***

Well of course, if a clone of the electrician were born, there would be a matter of decades in age difference between the man and his clone. Surely the contractor would notice differences, and call the golf course to ask about that elderly guy playing from the senior tees! So why are scientists trying to do this DNA manipulation?

The term cloning can be used to describe more than one technique for working with biological materials. Only a few methodologies would fit the carelessly touted category of cloning an organism. Let's look at two methods of manipulating DNA that are not aimed at reproducing the organism.

PCR identification: Brainchild of Kary B. Mullis

One example of manipulating only the DNA happens when a crime lab wants to take a bit of tissue or saliva found at a crime scene and compare the DNA (unique genetic markers) of that evidence with a sample from a suspect. The lab makes 'shadow pattern' copies of the DNA using a process that mirrors exactly the patterns within the long, complex molecule that identifies the being from which the DNA originates. The lab is merely constructing a shadow of the DNA pattern. The process is PCR identification (*made famous during the O.J. Simpson trial and on television programs like CSI*). The technique works with sub-units of biological material that came from an organ of an organism. Since every cell an individual human makes during their lifetime has the same DNA pattern in the nucleus, only DNA of the suspect (not the whole suspect) need be manipulated to identify the pattern, as recorded in a shadow transferred onto paper by an 'imaging' molecule (a polymerase molecule). The imaging molecule binds to pieces of carefully, systematically separated DNA and carries data of these distinct pieces to a recording surface, creating a pattern much like the bar codes you see on articles in a grocery store.

The same identification method may be applied to the mitochondrial DNA, but the matching doesn't point as precise a finger since all mitochondria is inherited from the mother's side of the gene pool. Narrowing down the suspect list is all such mitochondrial identification accomplishes, pointing to a particular family tree, but not a particular individual within that family tree. PCR is the brilliant invention of Kary B. Mullis. He received a Nobel Prize for his brainchild and testified at the O.J. trial, to explain PCR . [Here's an Internet link**:** http://usitweb.shef.ac.uk/~mba97cmh/history/history.htm … and an Internet search engine request for PCR will yield even more on the subject.]

If the technician is replicating the actual molecule or only portions of the DNA molecular chain, instead of the just identifying the pattern of DNA, then it is actual cloning, said to be 'recombinant DNA' cloning. Going one step further, if replicating the entire organism, it is called 'research' cloning or 'therapeutic' cloning, or reproductive cloning.

Beings for sale or rent

We will avoid the complexity of DNA molecule cloning (recombinant DNA), where a section of DNA from a specific gene is attached to a loop that is inserted into a bacterium. Yeasts cells can be used also. The bacteria or yeast duplicate very rapidly, making perhaps billons of copies of the selected DNA section in a rather short period of time. This method is used when the specific function of a particular gene or piece of a gene is to be studied. Let's focus now upon the category of cloning which involves replicating of an individual organism.

Categories of organism cloning are reproductive cloning and therapeutic or 'research' cloning (there is a third category, called 'parthenogenesis', but it doesn't involve transferring the nucleus of a donor, so we will discuss that at the end of this section). These 'categories' all start with an 'in vitro' cloning of the entire organism, using a method called 'somatic cell nuclear transfer' (abbreviated as SCNT, and sometimes just NT). The word 'somatic' refers to the body (the soma). A typical well differentiated cell of the body (taken perhaps from the inner cheek cells or from bone marrow cells) has its nucleus removed then 'transferred', by injecting the somatic cell nucleus into an oocyte that has had the nucleus removed, or into a zygote that has had its nuclear core removed, or into a pluripotent stem cell of the early blastocyst that has had its nuclear core removed. [*There is one method that injects an entire somatic cell into the denucleated oocyte. Since the oocyte is 15 to 20 times larger than the other typical cells* *of the body, certain smaller cells may be treated then injected entirely into the oocyte.*] Once the transfer is accomplished, the resulting construct is stimulated with an electrical current or a chemical, and hopefully the newly constructed organism at single cell age begins mitosis (cell replication).

The first whole cloned higher mammal was Dolly the sheep. Roslin Institute of Scotland accomplished the feat, but it took 277 attempts before Dolly was born. [Dolly's conception and birth were reported in the following publication: *Nature,* **# 385,** pages 810-13, 1997]

{ Here's an aside, a sort of obituary regarding Dolly the clone:

"Celebrity Sheep Has Died at Age 6 [15]

Dolly, the first mammal to be cloned from adult DNA, was put down by lethal injection Feb. 14, 2003. Prior to her death, Dolly had been suffering from lung cancer and crippling arthritis. Although most Finn Dorset sheep live to be 11 to 12 years of age, postmortem examination of Dolly seemed to indicate that, other than her cancer and arthritis, she appeared to be quite normal. The unnamed sheep from which Dolly was cloned had died several years prior to her creation. Dolly was a mother to six lambs, bred the old-fashioned way." **}**

Dolly or any other animal created using somatic cell nuclear transfer technology is not truly identical to the donor. [*Remember the cat from the introduction?*] Only the clone's chromosomal or nuclear DNA is the same as the donor (*even that chromosomal pattern can be juggled slightly in reproduction, yielding different construction*). Some of the clone's genetic material come from the mitochondria in cytoplasm of the host ovum that had its nuclear material removed. Removing the nucleus from the ovum is called 'enucleation'. The ovum is said to be denucleated or enucleated, in case you see the term in a magazine article. Mitochondria contain their own short segments of DNA. Random changes (called mutations) in mitochondrial DNA are believed to play a role in the aging process of mammals.

Dolly's success proved that the genetic material from a specialized cell, such as an udder cell (where Dolly's DNA came from), could generate an entire new organism if only the nucleus were injected into the proper enucleated mother cell. [*Recalling the* *words of Dr. Lejeune, where he used the analogy of a magnetic tape filled with the pattern to reproduce a symphony, and the tape player needed to play the pattern … the denucleated ovum is the player and the injected donor nucleus material is the pattern for the symphony.*]

Before the success of Dolly, scientists believed that once a cell differentiated (became specialized as a liver cell, heart cell, udder cell, bladder cell, or any other type of cell), the change was permanent and unneeded genes in the cell would become inactive. Recall, if you will, the 'methylation' mentioned by Dr. Lejeune, where a methyl molecule at the end of a particular section of DNA is deactivated so as to make that particular gene 'silent'. The gene is not destroyed, merely deactivated by selection during the expression phase of building the organism. Some scientists believe that errors in the reprogramming process cause the high rates of death and deformity observed among animal clones (*errors in causing the nuclear chain, the entire DNA pattern, to 'remember' the way to build the organism*).

With reproductive cloning, the idea is to produce a close twin to the donor of the nucleus, giving life support to the embryo then the fetus, all the way to birth. Once the cloned embryo reaches a suitable age, it is transferred to the uterus of a female host where it continues to develop until birth.

With therapeutic cloning, the object will be to start an embryonic individual on the growth processes that yield pluripotent stem cells, then multipotent stem cells differentiating into the organs and tissues of the body that would exist in the air world in a matter of months. Stem cells are extracted from the embryo after it has built cells for 5 or 6 days. The embryo at this age is called a blastocyst. Therapeutic cloning will arrest the lifetime of the individual embryo, in order to harvest the desired multipotent stem cells for treating perhaps Parkinson's disease in the adult donating their somatic cell for the nucleus transfer. This of course ends the lifetime of the cloned embryo.

In typical double-speak style, some scientists and legislators prefer to use the term 'research cloning', though both reproductive cloning and research cloning start the same way, by 'conceiving' a new individual life. Which phrase is used for the methodology depends on whether the cloned embryo will live its short life in a lab and be dissected for stem cells, or whether it will be implanted in a host mother and allowed to continue its lifetime to birth. 'Research cloning' appears to better fit the work of those who conceive chimeras, such as a mix of the enucleated rabbit ovum and the nucleus from a human cell (the experiments mentioned in the previous chapter). The goal is pure research, trying to understand the molecular processes that cause the specialization changes from zygote to morula to blastocyst to fetus.

At this writing, a human being has yet to be proven born from the SCNT cloning process, but someone, somewhere, is no doubt trying! [A*n interesting Internet search of the Raelian religious cult will net discussion on 'reproductive cloning' efforts . Here's one:* http://www.cnn.com/2002/HEALTH/12/27/human.cloning/ **; Raelian leader says cloning first step to immortality** … *I wonder, do you suppose he's a golfer?*]

A tadpole was cloned in 1952. Following the success with frogs, the duplication of somatic cells (stem cells from animal embryos) in a tissue culture was accomplished (cell cloning). Then came the whole mammalian organism, Dolly, in 1997. Since Dolly, scientists have cloned several animals, including sheep, goats, cows, mice, pigs, cats, rabbits, a mule, and a gaur. All these clones were created using SCNT. Reproductive cloning for certain species such as monkeys, chickens, and dogs, have so far been unsuccessful. The process of stripping the nucleus from an ovum and replacing it with the nucleus of a donor cell is traumatic for the cell and the nucleus. Improvements in cloning technologies and deeper understanding of the early mitotic processes are needed before certain animals can be cloned successfully.

So what is driving the cloning frenzy? Reading the published debates, it appears that tissue rejection problems—when patients need transplants—is the force behind the research.

{ Here's an excerpt from an Internet published paper discussing cloning. The paper was prepared by congressional staffers, planning for debates on whole-organism or embryo cloning of humans, the scope of the Weldon-Stupak Human Cloning Ban legislation. [16] The paper, with illustrations, may be found at the following Internet link: http://www.house.gov/weldon/issues/clone_basics.htm/ **.**

Reasons for cloning

Some want to produce cloned children (so-called "reproductive cloning") because they want to replace a lost loved one, copy someone with desired genes, or to treat infertility. Indeed, Drs. Panos Zavos, Severino Antinori and Brigitte Boisselier are [sic] have claimed that they will produce the first cloned human early this year.

However, the cloned child would not be identical to the person who was cloned, that is the person who donated the nuclear material from a body cell. Though the cloned embryo, with the complete set of 46 chromosomes, would be the same as the donor, there are mitochondrial chromosomes from the female egg. The mitochondria are structures in the female egg outside of the nuclear DNA that contain some genetic material. These provide energy to the nucleus and therefore would effect the genetic development of the growing child. Therefore, a cloned child would not be completely genetically identical to the cloned person.

Moreover, personality is not determined by one's DNA but is significantly influenced by environment and individual choices. Creating cloned live-born human children necessarily begins by creating cloned human embryos, a process which some also propose as a way to create embryos for research purposes (so-called "therapeutic cloning").

Some scientists and biotech organizations want to create cloned embryos and use them for research or to derive stem cells, which would destroy the cloned embryo. Some of the more vocal advocates of this research are as follows: Dr. Rudolf Jaenisch of the Whitehead Institute in Massachussetts, Dr. Tomas Okarma who is the President of Geron a major embryo stem cell research company, Dr. Michael West who is the President of Advanced Cell Technology, MA which has begun experiments to clone human embryos, as well as the national Biotechnology Industry Organization (BIO), and Dr. Michael Soules, who is President of the American Society for Reproductive Medicine.

Creating the cloned embryo for research is a type of reproduction, since the cloned embryo is biologically new human life. It is therefore scientifically misleading to call cloning for research purposes "therapeutic " as distinct from "reproductive" cloning.

…

There are no models in animal cloning in which scientists derived stem cells to cure the animals. The prospect of creating clinical treatments from stem cells derived from cloned embryos is completely speculative.

Some tout “research cloning” as necessary for embryo stem cell research, because creating <u>stem cell based tissues from your own clone</u> would not have the same tissue rejection problems as from tissues created from embryo stem cells with someone else's genetic makeup. <u>This is fiction</u>.

Rejection Problem: It is false to say that cloning solves the transplant rejection problem. Each embryo clone would still contain mitochondrial DNA from the egg donor; the clone is NOT an exact genetic copy of the nucleus donor, and its antigens would therefore provoke immune rejection when transplanted. There would still be the problem of immunological rejection that cloning is said to be indispensable for solving. [*Remember the not e about 'histocompatibility', in a previous chapter?*]

Reprogramming Problem: Some argue that "therapeutic cloning" must be performed to research reprogramming errors, in order to better develop tissues using embryo and adult stem cells. The argument is that once we understand reprogramming errors, we can take a body cell and reprogram the cells to become stem cells. At best this research is decades away [with] no animal work to suggest whether this is even doable. Other currently pursued lines of research to solve the rejection problem are more promising. **}**

Parthenogenesis, girls and boys the hard way

{ Let's begin with an excerpt from an Internet encyclopedia entry [18]**:**

Parthenogenesis (pärthenojen´esis) [Gr.,=virgin birth], in biology, a form of reproduction in which the ovum develops into a new individual without fertilization. Natural parthenogenesis has been observed in many lower animals, especially insects, e.g., the aphid. In many social insects, such as the honeybee and the ant, the unfertilized eggs give rise to the male drones and the fertilized eggs to the female workers and queens. The phenomenon of parthenogenesis was discovered in the 18th cent. by Charles Bonnet. In 1900, Jacques Loeb accomplished the first clear case of artificial parthenogenesis when he pricked unfertilized frog eggs with a needle and found that in some cases normal embryonic development ensued. Artificial parthenogenesis has since been achieved in almost all major groups of animals, although it usually results in incomplete and abnormal development. Numerous mechanical and chemical agents have been used to stimulate unfertilized eggs. In 1936, Gregory Pincus induced parthenogenesis in mammalian (rabbit) eggs by temperature change and chemical agents. **…** The phenomenon is rarer among plants (where it is called parthenocarpy) than among animals. **}**

In the first chapter, when we described the oocyte preparing for fertilization, we noted that the human oocyte has the typical 46 chromosomes of any other somatic cell, prior to arrival of the sperm. When a sperm cell penetrates the outer coat (the zona pellucida), the oocyte finishes dividing 46 chromosomes in half, with 23 chromosomes being pushed aside in a 'polar body' and the other 23 chromosomes fusing with the 23 chromosomes brought in by the sperm cell, to conceive a new genome for an individual human life. With parthenogenesis, the scientist captures an oocyte before it divides its 46 chromosomes. Using a chemical or electrical stimulus, the scientist causes the oocyte to begin cell division (mitosis), forming an embryo, called a parthenote.

If such an individual could be brought to term—born—she still would not be an exact duplicate of the woman from whom the oocyte was taken, because gene shuffling occurs in gametes (primitive sex cells) as they are being formed in the fetal body. [*This 'shuffling' during gametogenesis helps to account for the vast diversity within a species*.] Scientists are hard at work trying to devise a way to construct a male version of this trick. The idea would be to use the 23-chromosome complements from two sperm, fusing the two complements—to net 46 chromosomes—then injecting the nuclear mass into a donor oocyte that had been denucleated.

Why this difficult trick to derive male parthenotes? Because the scientists want to produce tissues from embryos closely matched to the person to be treated. Chromosomes of any particular parthenote would be tissue compatible with only the individual donating the gamete(s), so the same trick of tissue compatibility would be necessary if treating a male using the stem cells harvested from the resulting embryo. [*And as culture changes, there is of course the issue of a being with two fathers, a s genetic parents. If homosexual marriage catches on* **…** *well, families?*]

This parthenogenic trick is not a new development with mammals. As far back as 1983, Elizabeth J. Robertson demonstrated that stem cells removed from parthenogenic mouse embryos could form tissues such as nerve and muscle. In 2001, Advanced Cell Technologies reported creating parthenotes that developed to what appeared to be the blastocyst stage, but none contained the inner cell mass from which the air-world body develops. We'll take a look at their work in the next chapter.

Fiction and facts

Cloning of whole organisms is still a science in its infancy. The popular movie, ***Jurassic Park*** , was a fictional speculation on cloning extinct animals … extinct for millions of years! Cloning technologies will have to reach tremendous insights into constructing from scratch the DNA molecular chain, before such fancies can be achieved,

if readable DNA can be found in a fossil. But science is hard at work trying to save endangered species, and even trying to clone a wooly Mammoth using DNA found in the cells of frozen carcasses, and then injected into the denucleated egg of an elephant. The cloned embryo will be placed back into the elephant—if she'll allow it—to give life support until birth.

{The possibilities for successful cloning of species other than humans are measurably important in saving endangered animals. The following is an excerpt from a whimsical article related to real science [17]**:**

Cloning Could Make Champion Gelding a Dad
Associated Press ^ | Fri, Jun 06, 2003 | MICHAEL GORMLEY

There's a not so funny side to the thoroughbred who could win The Triple Crown.

Unlike Secretariat and other superstar sires, Funny Cide is a gelding. That means he can't reproduce, costing his owners millions of dollars in stud fees and ending a champion's lineage.

But a scientist who recent [sic] helped clone a racing mule believes Funny Cide could probably buck the odds right now.

"I feel quite confident that technically it can be done. It will be a natural extension now that we've cloned the mule," said Dirk Vanderwall, assistant professor in the Department of Animal and Veterinary Science at the University of Idaho. "It is extremely likely that, yes, we can clone an individual animal like Funny Cide."

Vanderwall and two other scientists are responsible for the May 4 birth of Idaho Gem, the first clone from the horse family. Vanderwall said scientific scuttlebutt is that two cloned horses, one in Texas and another in Paris, will be born soon. Sheep, cows, pigs, cats and rodents have already been cloned.

A clone, however, doesn't mean an exact double. Environmental factors and even the gene expression" in a cloned animal can make an offspring different from the "founder," he said. But Idaho Gem so far isn't showing any physical problems or anything other than the racing spirit of its champion founder, Taz the mule.

"From the moment of birth, (Idaho Gem's) just been very healthy and vigorous and continues to be," Vanderwall said Friday. **}**

CHAPTER FIVE – Stem cells and controversy

As the story was told, King Minos, the ancient king of Crete, succeeded in defeating the pirate bands plundering his Mediterranean Sea. Minos believed the sea god, Poseidon, aided him against the pirates, so Minos planned a celebration and sacrifice to Poseidon. The sea god sent a most worthy sacrifice, a magnificent white bull, swimming to Minos out of the sea. Old King Minos was so fond of the magnificent beast, he decided to sacrifice another bull from his royal herd and save the white bull as a prized possession. Failure to use the most worthy sacrifice properly and selfish keeping of the gift angered Poseidon. He cast a spell upon Queen Pasiphae, wife of Minos, causing her to become enthralled with the white bull. In her twisted love for the beast, she enlisted the help of an inventor, to make a fake cow so that she might mate with the bull. Pasiphae was successful; she conceived and bore the cruel Minotaur, a creature with a man's body but a bull's head.

[*Not long after the above synopsis of the Minotaur myth was typed into the outline of this manuscript, the author read an article regarding the private company, Advanced Cell Technologies, which is actually injecting the nucleus from human somatic cells into de-nucleated cow eggs. The resulting alive embryos prove that mammalian mitosis marches onward. Could the mythical Minotaur be a reality in our future?*]

* * *

Not long ago, during National Public Radio's 'Morning Edition', reporter Joe Palca interviewed ethicist Ron Green, a supporter of destructive embryonic stem cell research. When asked if the special creation of stem cell lines from 'extra' embryos of IVF clinics might lead to creating specific embryos for spare parts/organs, Green opined that it was probably not going to happen, that we could probably pass a law banning such a practice.

Joe Palca also interviewed R. Alta Charo, a professor of Law and Ethics at the University of Wisconsin. Professor Charo found the practice of anonymous donors of oocytes and sperm a method preferable to using 'left over' embryos of IVF clinics for producing embryonic stem cells … she favored conceiving embryos specifically for harvesting, feeling somehow 'anonymous' conception would remove the practice from ethical barriers. Charo noted that this way, "scientists could avoid altogether the possible emotional attachments parents might feel toward the children they had created but not implanted." That was a most chilling revelation, coming from a professor of Law and Ethics! … She can acknowledge that the parents have conceived children, yet she sees nothing amiss in using these children for experimentation.

The Professor Charo mentioned above is the same Professor Charo who saw no ethical or moral problems in mixing a human nucleus and rabbit de-nucleated egg to create chimeric embryos for research! It is such 'blurred ethics' at major research institutions that are at the heart of corroded societal taboos and the dehumanization of the earliest ages in individual human lifetimes. It is a quantum leap away from ethics to go from placing human adult stem cells in other animal embryos and watching the results, to the creation of a minotauresque being. The cow remains a cow if only human adult stem cells are placed in its embryo to develop for tissue research (a xenotransplant– *an action in which an organ or tissue is transferred from one animal to another of a different species*). But to try and create likely severely handicapped humans using a denucleated cow egg? Yes, America, we need to talk about these things! Is it more ethical to create a severely handicapped being from whom scientists will remove body parts for research?

To prepare for the discussion that follows, let's do a quick review of embryonic development and stem cells**:**

> The fusion of nuclei from father and mother brings into being the genome for at least one new individual human life. The first cell of a new individual is called a zygote. The zygote is a totipotent cell; it will give rise to the placental organ used to accomplish life support and also will give rise to stem cells that build the body the individual will use upon exiting into the air world.
>
> By the time the growing embryo reaches the uterus, the sixteen or so stem cells, called a morula, quickly generate cells to raise the total to more than one hundred cells, differentiating into mostly trophoblast stem cells (*directed toward constructing the placenta and related tissues and membranes*) and very few pluripotent stem cells, called embryoblasts. The entire collection of stem cells is called a blastocyst (*the preimplantation embryo consisting of a sphere of cells with an outer cell layer, a fluid-filled cavity, and a cluster of cells on the interior that is the inner cell mass—the embryo body*).
>
> As the embryo 'hatches' from the zona pellucida that has encased the increasing cell mass on the journey to the uterus, stem cells are increasing the blastocystic cavity surrounding a few (2 or 3) pluripotent stem cells—embryoblasts that will

be tasked with building the amniotic sac and embryo body which develops into the body of organs and tissues for use when the new individual exits the womb into the air world.

Within 5 to 6 days from fertilization, embryoblast stem cells form a ‘bump’ (inner cell mass) on the interior of the blastocystic cavity; the ‘bump’ has two aspects, the embryo body and umbilical vesicle. The umbilical vesicle begins immediately to produce blood cells (*within about a week after fertilization, normally*). As the embryo body develops, the pluripotent stem cells differentiate into multipotent stem cells tasked to build specific organs and tissue systems. Researchers target these embryonic stem cells for harvesting and exploitation because the cells have specialized somewhat, but not so much as to lose their desired plasticity for many pathways to building organs and tissues.

The embryo age of the new individual ends at eight weeks and the fetal age begins. [*Embryo age ends rather arbitrarily at eight weeks, for legal purposes, but biologically, many tissue lines have yet to be instituted. It is 3 months from fertilization before all the systems of the baby have been formed.*]

From the fetal age onward, the human individual’s existence is characterized by growth and specialization of the organs and tissues built during the embryo age. There are construction sites within a fetus that continue to have less differentiated stem cells (pluripotent stem cells) even during the fetal age. One of these sites is the gonadal ridge from which sex organs and the gametes arise in the individual. Stem cells are harvested from the gonadal ridge of the early fetus (approximately five to nine weeks of age) when these hapless beings are aborted. These stem cells are believed capable of giving rise to the three main tissues lines of the body.

It is the dream of medical science, perhaps even the ‘holy grail’, to find a ready source of tissues that can be profitably manipulated to cure human injury and diseases, without causing tissue rejection or death due to unwanted side effects in the patient being treated.

During an Internet discussion on abortion, the following was posted regarding the 1981 Senate Judiciary Subcommittee hearings on the question, "When does human life begin?" Appearing before the Committee to speak on behalf of the scientific community was a group of internationally known geneticists and biologists, all saying the same thing, namely, that life begins at conception—and they told their story with a glaring absence of opposing testimony. Of the 57 people who testified, only one was wishy-washy about conception being the beginning of individual human lifetime … from a philosophical standpoint, not a scientific one. Here are a few notable responses to the Committee**:**

> Dr. Micheline M. Mathews-Roth, Harvard medical School, cited references from medical textbooks and more than 20 Embryology texts, that human life begins at conception.
>
> Dr. Richard V. Jaynes offered, "To say that the beginning of human life cannot be determined scientifically is utterly ridiculous."
>
> Dr. Alfred Bongiovanni, University of Pennsylvania School of Medicine, asserted confidently, "I am no more prepared to say that these early stages represent an incomplete human being than I would be to say that the child prior to the dramatic effects of puberty ... is not a human being."
>
> Geneticist, Dr. Jerome Lejeune, told the Senators, "To accept the fact that after fertilization has taken place a new human has come into being is no longer a matter of taste or opinion, it is plain experimental evidence."
>
> Dr. Hymie Gordon, Chairman of the Department of Genetics at Mayo Clinic, offered, "By all the criteria of modern molecular biology, life is present from the moment of conception."
>
> Dr. McCarthy de Mere, medical doctor and law professor at the University of Tennessee, stated, "The exact moment of the beginning of personhood and of the human body is at the moment of conception."
>
> Dr. Landrum Shettles, to some the father of In Vitro Fertilization, noted, "Conception confers life and makes that life one of a kind." And on the Supreme Court Roe v. Wade ruling which sought to establish ambiguity, he noted, "To deny a truth [about when life begins] should not be made a basis for legalizing abortion."

In a previous chapter, we noted that there are two main sources for human stem cells: 1) embryos, and 2) developed human beings beyond the embryo stage. Hopefully, the reader has reached the conclusion (as supported by the sciences of Embryology and Genetics) that even at the earliest embryonic age, as soon as mitosis is evidenced, there is an individual human lifetime up and running.

Controversy over stem cell exploitation and cloning has a simple dividing line, if the reader applies the standard of ‘first, do no harm’ … meaning, ‘first, don’t harm one individual human being in order to treat another human being.’ This standard is at the heart of more than two thousand years of medical science. If coupled with a second notion, namely, ‘no individual or society has the right to own another individual human being’, it is easy to decide whether harvesting the body parts of early human individuals is ethical or not. It is also not so difficult to decide whether creating human-animal chimeras is ethical.

No matter how strange may be the chimera created from injecting a human nucleus into a denucleated animal egg, that chimera is of the human genome, not the other animal’s genome. Such a perhaps grossly handicapped individual is no less an individual member of the human species.

Consider the following string of questions:

> Is it permissible to purposely conceive a handicapped individual who will not be born (raised in a lab not a living host), or if born will be unlikely to survive?
> Is it permissible to target purposely-handicapped individuals for harvesting of body parts (*the stem cells of such an embryo are in fact that individual’s body parts*)?
> Is it permissible to conceive an individual then raise that individual in an artificial womb, in order to dissect him or her for useful tissues and organs used to treat other individuals?
> Is it permissible to abort alive, unborn babies with the intention to harvest their useful body parts?
> Is it permissible to harvest tissues from babies who were naturally miscarried, not purposely aborted, or from individuals dead due to unintended consequences, such as an accident or heart attack?

Applying the two fundamental principles of ‘first, do no harm’ and ‘no one may own another individual’, the only question that may have a ‘yes’ answer is the last one. It is the only category for which helping flows from not intentionally harming another.

Relying upon the above two notions as a measuring rod for ‘ethical’, let’s take a look at recent articles that discuss stem cells. First, three articles regarding stem cell work that would not be unethical according to our ‘measuring rod’**:**

> **{ UNR researcher's stem-cell work lauded** / Elaine Goodman / Reno Gazette-Journal / October 22nd, 2001 [20]
>
> It sounds like a science fiction novel but researcher Esmail Zanjani’s experiments at the University of Nevada, Reno are real. Zanjani injects human stem cells into sheep fetuses. The sheep grow up to have human cells growing throughout their bodies. The proportion of human cells is small, and the sheep don’t show any outward human characteristics. The experiments could lead to ways to treat genetic diseases while a child is still in the womb. The research might also produce hybrid human-animal organs for transplant into humans, with less chance

of rejection than a purely animal organ. And Zanjani's sheep give researchers a unique way to study stem cell behavior.

Most other stem cell research involves putting animal stem cells back in the same species of animal, or studying human stem cells in laboratory dishes. Zanjani's work looks at how human stem cells behave inside an animal. "This is one of the best models that exists today," said Dr. John Wagner, a stem cell researcher at the University of Minnesota. "It was a very helpful breakthrough. Wagner and other stem cell researchers across the country send Zanjani stem cells to test in his sheep. Before Zanjani's sheep, stem cell researchers were limited to testing their cells in mice, Wagner said.

So far, Zanjani has used human bone marrow or umbilical cord blood stem cells in his research. Those stem cells don't involve the destruction of an embryo. Now that President Bush has lifted a ban on federal funding for embryonic stem cell research, Zanjani expects he'll test those cells in his sheep, too. Zanjani said he'll need to get approval from the National Institutes of Health, which funds much of his research, before he works on embryonic stem cells in his laboratory. "In a couple of years, we'll know a lot more than we know now," he said.

Zanjani has worked with sheep since the 1960s. The 61-year-old scientist has a sheep poster and toy sheep throughout his cluttered office at the Veteran Affairs Medical Center in Reno. Zanjani tried working with goats for awhile, but that didn't last long. "They ate my papers," he said.

A native of Iran, Zanjani earned his doctorate in experimental hematology at New York University and has been a professor in the University of Nevada School of Medicine in Reno since 1987. Sheep work well in Zanjani's research because their development closely mirrors that of humans.

Zanjani injects sheep fetuses with cells from human bone marrow or umbilical cord blood. The cells are injected before the animal's immune system develops, so they're not rejected as foreign. Zanjani studies the sheep after they are born and grown up to see whether the human cells survive. Usually, human cells can be detected throughout the animal's body. Zanjani is hoping his research will lead to procedures to cure genetic diseases while a child is still in the womb.

Stem cells have been implanted into human fetuses to correct genetic immunodeficiency. Further study could lead to treatment in the womb of other genetic diseases, such as sickle cell anemia, Zanjani said.

But scientists still have much to learn about stem cells. For example, umbilical cord stem cells have been used to successfully treat leukemia. But the amount of cord blood is so small, researchers are looking for ways to multiply the cells in the laboratory before injecting them into patients. "The more stem cells you give, the better the outcome (for the patient)," said Wagner of the University of Minnesota.

Researchers need to know if the stem cells grown in the lab work as well as the ones straight from the umbilical cord. Zanjani's sheep system lets scientists such as Wagner treat stem cells in different ways and test them in a living animal.

Another possible application of Zanjani's work is xenotransplantation, the transfer of an animal organ into a human. For example, doctors might be able to remove stem cells from a patient with liver disease, inject them into a fetal pig and transplant the newly grown pig-human liver into the patient. The hybrid liver, with human cells matching the patient's genes, would have less chance of rejection than a purely animal organ. "It would certainly be better than giving them a pig liver with no human portion," Zanjani said. While some researchers sing the praises of embryonic stem cells and their potential to become any cell type in the body, Zanjani prefers the umbilical cord cells. He calls embryonic stem cells "untamed beasts."

Unless treated in a special way, the embryonic cells will grow unchecked when injected into an animal's body, essentially becoming cancer cells, Zanjani said. "Embryonic stem cells cannot be used as they are," Zanjani said. "You have to instruct them to do something." Yet Zanjani is pleased that President Bush decided to lift the ban on federal funding for embryonic stem cell research.

Only by studying the different types of stem cells will scientists be able to determine which ones have the most potential, Zanjani said. But Zanjani hopes that lifting the ban on federal funding for embryonic stem cell research won't drain money from studies on other types of stem cells. "It will be a major, major shame if they divert a large portion of the funds to one at the expense of the other," he said.

* * *

Blood could generate body repair kit / 19:00 26 November 03 / Andy Coghlan for Newscientist.com [21]

A small company in London, UK, claims to have developed a technique that overturns scientific dogma and could revolutionise medicine. It says it can turn ordinary blood into cells capable of regenerating damaged or diseased tissues. This could transform the treatment of everything from heart disease to Parkinson's.

If the company, TriStem, really can do what it says, there would be no need to bother with conventional stem cells, currently one of the hottest fields of research. But its astounding claims have been met with bemusement and disbelief by mainstream researchers.

TriStem has been claiming for years that it can take a half a litre of anyone's blood, extract the white blood cells and make them revert to a "stem-cell-like" state within hours. The cells can be turned into beating heart cells for mending hearts, nerve cells for restoring brains and so on.

The company has now finally provided proof that at least some of its claims might be true. In collaboration with independent researchers in the US, the company has used its technique to turn white blood cells into the blood-generating stem cells found in bone marrow.

When injected into mice, these cells migrated to the bone marrow and generated nearly all the different types of human blood cells, the team will report in the January edition of *Current Medical Research and Opinion* (vol 20, p 87), a peer-reviewed journal.

Proof required

"I would be extremely sceptical of these findings and would need more proof," says stem cell expert Evan Snyder of the Burnham Institute in La Jolla, California, whose response is typical of many scientists **New Scientist** contacted. "I was extremely sceptical," says team member Tim McCaffrey, a cardiovascular researcher at George Washington University in Washington DC, who was asked to evaluate TriStem's claims. "They did it in front of my eyes with my own blood," he says. "It's stunning."

Even if replacing bone marrow is all TriStem's method can achieve, it is still significant. Tens of thousands of people need bone marrow transplants each year. In some cases, doctors already extract stem cells from the blood instead of transplanting bone marrow itself. A donor is given growth factors that make their marrow stem cells proliferate and spill over into the blood, but the procedure takes several days. TriStem's method might make it possible to obtain vast numbers of blood stem cells in a fraction of the time. "What's radical is the speed and ease with which it works," McCaffrey says.

Much, much more

But the company claims it can do much, much more. Ilham Abuljadayel, the founder of TriStem, says that by adapting standard culturing methods she has managed to turn white blood cells into heart, nerve, bone, cartilage, smooth muscle, liver and pancreatic cells. TriStem has not yet published results proving all these claims. Since the company has worked only with human cells, it cannot perform what is regarded as the "gold standard" test of stem cells' versatility: inserting them into an embryo to show they can form all the different tissues. But if TriStem's method really can produce a wide range of cells, its potential is huge.

For starters, it would avoid the ethical issues associated with embryonic stem cells, the most versatile kind of stem cell. TriStem's method would also make it easy to treat individuals with their own cells, avoiding any problems with immune rejection. The only way to obtain ESCs that match a patient's own tissues would be therapeutic cloning, yet to be achieved with human cells. The adult stem cells found in various tissues in the body could also solve both these problems. But there is still much debate about their versatility, and even if some are capable of forming just about any cell type, they are scarce. Extracting and multiplying them is difficult and time-consuming.

In addition, TriStem's claims challenge the scientific dogma that specialised cells cannot revert back to an unspecialised state or be converted from one type to another. Other groups also claim that they can "transdifferentiate" cells (**New Scientist** print edition, 12 October 2002). But none can do so as swiftly and easily as TriStem

Killer antibody

Its "miracle" hinges on an antibody manufactured by DakoCytomation of Denmark that is normally used to detect abnormal brain cells. In the early 1990s, while working as a consultant immunologist, Abuljadayel tried to use the antibody to kill leukaemia cells. Instead of dying, the cells altered form and flourished. Abuljadayel says the antibody binds to a receptor on the cell surface. But how the antibody triggers "retrodifferentiation", if indeed it does, remains to be established. To avoid arguments about whether the cells produced are genuine stem cells, she calls them "stem-cell-like cells". Abuljadayel applied for a patent on retrodifferentiation in 1994, and in 1999 founded TriStem with the help of her husband, Ghazi Dhoot, then an investment banker. The company has long struggled to convince mainstream scientists that its system works.

Like TriStem, McCaffrey encourages sceptics to try the procedure themselves before condemning it. "I don't think there's voodoo involved, but until a number of people do it, other scientists have every right to be cautious," he says.
For many researchers, alarm bells ring loudest over the failure of TriStem to get such groundbreaking results published in a leading journal. They also ask why Abuljadayel has had no permanent academic position.

Gross mortality

Then there is the question of whether TriStem really has achieved retrodifferentiation. Alexander Medvinsky at the Institute of Stem Cell Research in Edinburgh thinks the antibody might simply kill ordinary white blood cells, leaving stem cells behind. But McCaffrey rejects this, saying that tests show the white blood cells remain alive. "There is no gross mortality, and the numbers surviving are of the order of 90 to 95 per cent."

Not all researchers are as sceptical. "The results reported here are impressive," says Bob Lanza, chief scientific officer of Advanced Cell Technology of

Massachusetts. "If successfully repeated, this process could have broad clinical potential."

TriStem is sufficiently confident that its method works to start human trials. Earlier in November it received permission to carry out a clinical trial of its technology for creating stem cells from blood. Senior government research collaborators in the country hosting the trial have asked for the location to be kept secret for now. The method will be used to treat a dozen patients with aplastic anaemia, a condition in which people have a severe lack of bone marrow. Abuljadayel plans to treat the patients with blood stem cells derived from tissue-matched donors. "Within a week, we should find if the cells have taken," she says, adding that any improvements in the patients' condition should be immediately noticeable.

* * *

Ultimate stem cell discovered / 19:00 23 January 02 / Sylvia Pagán Westphal, Boston, for Newscientist.com [22]

A stem cell has been found in adults that can turn into every single tissue in the body. It might turn out to be the most important cell ever discovered.

Until now, only stem cells from early embryos were thought to have such properties. If the finding is confirmed, it will mean cells from your own body could one day be turned into all sorts of perfectly matched replacement tissues and even organs. If so, there would be no need to resort to therapeutic cloning - cloning people to get matching stem cells from the resulting embryos. Nor would you have to genetically engineer embryonic stem cells (ESCs) to create a "one cell fits all" line that does not trigger immune rejection. The discovery of such versatile adult stem cells will also fan the debate about whether embryonic stem cell research is justified.

"The work is very exciting," says Ihor Lemischka of Princeton University. "They can differentiate into pretty much everything that an embryonic stem cell can differentiate into."

Remarkable findings

The cells were found in the bone marrow of adults by Catherine Verfaillie at the University of Minnesota. Extraordinary claims require extraordinary proof, and though the team has so far published little, a patent application seen by New Scientist shows the team has carried out extensive experiments. These confirm that the cells - dubbed multipotent adult progenitor cells, or MAPCs [*pronounced ‘map seas’*] - have the same potential as ESCs. "It's very dramatic, the kinds of observations [Verfaillie] is reporting," says Irving Weissman of Stanford University. "The findings, if reproducible, are remarkable."

At least two other labs claim to have found similar cells in mice, and one biotech company, MorphoGen Pharmaceuticals of San Diego, says it has found them in skin and muscle as well as human bone marrow. But Verfaillie's team appears to be the first to carry out the key experiments needed to back up the claim that these adult stem cells are as versatile as ESCs.

Verfaillie extracted the MAPCs from the bone marrow of mice, rats and humans in a series of stages. Cells that do not carry certain surface markers, or do not grow under certain conditions, are gradually eliminated, leaving a population rich in MAPCs. Verfaillie says her lab has reliably isolated the cells from about 70 per cent of the 100 or so human volunteers who donated marrow samples.

Indefinite growth

The cells seem to grow indefinitely in culture, like ESCs. Some cell lines have been growing for almost two years and have kept their characteristics, with no signs of ageing, she says.

Given the right conditions, MAPCs can turn into a myriad of tissue types: muscle, cartilage, bone, liver and different types of neurons and brain cells. Crucially, using a technique called retroviral marking, Verfaillie has shown that the descendants of a single cell can turn into all these different cell types - a key experiment in proving that MAPCs are truly versatile. Also, Verfaillie's group has done the tests that are perhaps the gold standard in assessing a cell's plasticity. She placed single MAPCs from mice into very early mouse embryos, when they are just a ball of cells. Analyses of mice born after the experiment reveal that a single MAPC can contribute to all the body's tissues.

MAPCs have many of the properties of ESCs, but they are not identical. Unlike ESCs, for example, they do not seem to form cancerous masses if you inject them into adults. This would obviously be highly desirable if confirmed. "The data looks very good, it's very hard to find any flaws," says Lemischka. But it still has to be independently confirmed by other groups, he adds.

Fundamental questions

Meanwhile, there are some fundamental questions that must be answered, experts say. One is whether MAPCs really form functioning cells. Stem cells that differentiate may express markers characteristic of many different cell types, says Freda Miller of McGill University. But simply detecting markers for, say, neural tissue does not prove that a stem cell really has become a working neuron.

Verfaillie's findings also raise questions about the nature of stem cells. Her team thinks that MAPCs are rare cells present in the bone marrow that can be fished out through a series of enriching steps. But others think the selection process actually creates the MAPCs. "I don't think there is 'a cell' that is lurking there that can do this. I think that Catherine has found a way to produce a cell that can behave this way," says Neil Theise of New York University Medical School. **}**

In the first article, Dr. Zanjani mentioned President Bush lifting the ban on federally funded embryonic stem cell research. The research for which federal funding will be available involves embryonic stem cell lines created prior to the President's ruling. His ruling establishes controls that prevent federal funding to create new cell lines, thereby banning federal funding for future embryocide.

In the second and third articles, the 'gold standard' is mentioned, by which stem cells are tested for their placticity. In the third article, the MAPCs were isolated from mice and injected into mice embryos, proving their ability to differentiate into the actual tissues and organs of the mouse. In the second article, the 'gold standard' would not be applied. Since the blood-generated stem cells were from human blood, testing on human subjects is happening already, because the blood-born cells are isolated from the patient into whom the cells will be re-injected—remember 'autologous'?

Now, let's take a look at an article reporting efforts at 'therapeutic cloning' that don't measure up to our standard axioms, our ethics measuring rod.

{ The First Human Cloned Embryo / November 24, 2001 / Scientific American by Jose B. Cibelli, Robert P. Lanza, and Michael D. West, with Carol Ezzell [23]

"THEY WERE SUCH TINY DOTS, YET THEY HELD SUCH immense promise. After months of trying, on October 13, 2001, we came into our laboratory at Advanced Cell Technology to see under the microscope what we'd been striving for—little balls of dividing cells not even visible to the naked eye. **…**

With a little luck, we hoped to coax the early embryos to divide into hollow spheres of 100 or so cells called blastocysts. We intended to isolate human stem cells from the blastocysts to serve as the starter stock for growing replacement nerve, muscle and other tissues that might one day be used to treat patients with a variety of diseases. Unfortunately, only one of the embryos progressed to the six-cell stage, at which point it stopped dividing. **…**

WE LAUNCHED OUR ATTEMPT to create a cloned human embryo in early 2001. We began by consulting our ethics advisory board, a panel of independent ethicists, lawyers, fertility specialists and counselors that we had assembled **…" }**

The scientists consulted with an ethics advisory panel of their choosing, before jumping into 'therapeutic cloning'. The panel gave their okay, knowing fully what was intended. The article goes on to describe how women were recruited to willingly provide anonymous donor oocytes, how skin cells from anonymous donors were used for the DNA source to inject into the denucleated oocytes, how the researchers turned to trying parthenogenesis when their SCNT efforts failed to create more than a six-celled embryo. [*Perhaps it means nothing, but th is particular human cloning experiment began in earnest, July of 2001.*] The parthenogenic effort yielded what appeared to be human embryos at the blastocyst stage, but they lacked an inner cell mass from which to harvest stem cells.

One can take the scientists at their word, that they were trying this manipulation of early human life in order to discover sources for tissues that could be used to treat the maladies of our fellow sojourners. They mean well, but their means to this therapy are an affront to the sanctity of individual human lives, tiny lives these scientists sought to bring into existence along a lifetime however shortened, as sources for body parts to treat older individual humans.

Will it stop with failure after failure? Well, to quote the closing sentences of the article, "Meanwhile we are continuing our therapeutic cloning experiments to generate cloned or parthenogenetically produced human embryos that will yield stem cells. Scientists have only begun to tap this important resource." And **THAT** is why We The People need to talk, America. We need to talk amongst ourselves and talk to our elected representatives.

Every human being alive today started their individual life at the time of their conception, and they continue along an individual journey in their body until someone ends it or natural event ends it ... individual human life begins at conception. Whether it happens in a woman's fallopian tube or a well-lit laboratory, conception is the start of at least one individual lifetime. Harvesting stem cells from human embryos or fetuses, to be used for treating or searching for treatments for the illnesses of older individual human beings, is no less cannibalism than if the patient were served extracted embryonic stem cells on chocolates, for a cure.

CONCLUSION

In the introduction, we raised the issue of 'slippery slope'. This issue has also arisen during discussions and debates by The President's Council on Bioethics, regarding embryonic stem cell exploitation and cloning. To formulate conclusions regarding these bio-technological issues, we will do well to heed the subtle alarm raised by Dr. Charles Krauthammer, a member of the committee for The President's Council.

April 25, 2002, during a session discussing ethics of cloning in biomedical research, Dr. Krauthammer made the following important observations regarding one of the other panel member's plea that the nation allow science to 'roll', to explore all avenues of human cellular development, harvesting stem cells from any human embryos, whether derived from 'leftover' IVF clinic procedures or created anew with cloning technology. The Chairman of the committee, Dr. Leon Kass, had listed four categories of opinion regarding the research and the status of the human embryo: the first being total disregard for the human embryo, granting that life no more significance than a glob of cells, and four being total regard for the human embryo as a member of equal value to any other human individual because the human embryo is a living member of the human race. The text may be found beginning on page 17 of the transcript for the afternoon session [24] (http://bioethicsprint.bioethics.gov/transcripts/apro2/apr25session4.html)**:**

> **DR. KRAUTHAMMER:** "Mike [Michael S. Gazzaniga, Ph.D., *another of the members on the panel*] says and I think if I have the quote correctly, those not trained in science don't understand that what we need to do is let science roll.
>
> Well, we let science roll in the 20th century. We got eugenics. We got the Tuskegee experiment. [*The Tuskegee experiment was an unethical study of a sexually transmitted disease, where black persons in particular, presenting with the disease, were studied rather than treated, as a means to understand how the disease effects the human nervous system and human anatomy and physiology. The study was extremely dehumanizing for the persons presenting with the disease and in fact 'sacrificed' the infected individuals as a means to study the particulars.*] We had such horrors in mid-century that we needed the Nuremburg

Code [*following revelation of medical atrocities, experiments on imprisoned human subjects, committed during the Nazi's reign over Germany and Europe*]. Humanity hadn't had to write it before, but it had to write it after. So I'm a little skeptical about letting science roll. Scientists are one of the great resources in any society. They do the science, but they don't own the science. And the reason that we're here is because we don't have a guild system in this society, we have a democracy. We don't say to automakers you know how to make cars, therefore you will determine what safety standards will be in cars. No, it's the non-experts, it's the lawyers and the Congress who decide what are going to be the safety requirements in cars and that is imposed on the experts who make the cars and that's how we do it in a democracy and that's why we have this council to advise the President and the country on what restrictions might or might not be applied on what is undoubtedly a wonderful enterprise.

But we don't have a guild system in which all the rules are made internally, not in a democracy.

The reason I'm against research cloning is not because of the reasons underlying position 4 which is somehow attributing a worth to the blastocyst equal or at least comparable to that of a human, but out of a prudential consideration as to what happens if we don't. [*Here comes the 'slippery slope'* **…**]

The first slippery slope and I think an argument that in and of itself would be enough for a person to oppose research of cloning is that I think there can't be any doubt that if we sanction an industry -- and it will become an industry -- for the creation of cloned embryos, it is absolutely inevitable that we will begin to see those embryos implanted and we will have the moral horror of having a cloned embryo in gestation which under penalty of law would have to be destroyed and that is a moral certainty that I think is intolerable. But as I wrote in my piece in The New Republic [*Dr. Krauthammer is perhaps better known for his formidable journalistic talents* **…**], that is a little bit too easy. I think it would be reason enough to prudentially oppose research cloning, but let's assume, put it aside. I think there are other reasons and the reasons are that once you start on this, once you start rolling along this road, it will lead us to places where I think that we don't want to go. I may be wrong, obviously nobody knows exactly how we will end up or where this will take us, but I think a prudent society needs to make choices based on past history and some understanding of human nature.

The problem, Daniel [Daniel W. Foster, M.D., *another member of the panel*], is not that the research might fail. The danger is that it might succeed wonderfully and we will then have scientists say as we just heard, give me three more weeks with this embryo. Why not have a fetus where the organs are developed and use them for transplantation rather than have a Rube Goldberg system of growing it into a blastocyst, teasing out stem cells, tweaking them into developing into cell lines? Why not let nature produce with that wonderful machine a fetus and let's strip it apart for its parts? Most of us would say today that is unconscionable.

Well, I suspect that if we live in a society where we do this kind of stuff at an earlier level, for a decade or two or three, it will be less unconscionable.

In the end, I think the major issue here is that we are crossing a new barrier with research cloning and that is the creation of embryos solely for their use and I'm afraid that once you do that and we create an industry in which this will be the business of that industry, embryo creation, that we will so desensitize ourselves to the use or misuse of this entity that we will end up doing things that we don't want to do and don't want a society to do.

I think that prudential argument is one on which we can argue about well, what are the likelihoods of these things happening, but I think we ought to be realistic, that once you start on that road, we will be, as a society, far less able to resist the temptations that today seem obvious that we ought to resist, but tomorrow, probably won't."

CHAIRMAN KASS: "Jim Wilson?"

DR. WILSON (James Q. Wilson, Ph.D.)**:** "I've listened for years to Charles and read Charles for years without, I think, disagreeing with a single word he's uttered until today. And my problem is with the slippery slope argument. The slippery slope argument which we hear much of in the literature although it's rarely defined, is kind of a warning sign that's put up on a highway, don't go any further or unknown bad things will happen to you. But rarely is it carried out to show that if you walk past that sign, these unknown, soon-to-be-named bad things will, in fact, happen to you. The slippery slope argument here does have a name as what's going to happen to us if we permit the use of somatic cell transfer for the purposes of creating clones for biomedical research. It is inevitable that we will soon have cloning to make babies and perhaps cloning to produce from fetal organs parts to be used by human beings and after that God knows, perhaps organs taken from babies."

…

"Now you might be able to say that sliding down that slope is inevitable in the case of cloning because there will be such a huge financial demand for the benefits of cloning that any form of cloning, however benign in original intention, will lead to the worse forms of cloning to satisfy that demand. But from all the scientific testimony I've heard so far, there isn't this huge financial demand and there isn't because nobody has found yet the exact techniques that competent, but ordinary physicians can use to cure these diseases, so that I want us to back away from the prudential or this particular prudential argument because I don't think it's correct unless Charles is in a position to show that the slope is so slippery, so covered with banana oil, that one step past the warning line we have now drawn on the pavement will bring us down into chaos."

DR. KRAUTHAMMER: "Well, let me give you a recent and empirical example of that slope. The country had a debate on stem cells about a year ago [*2001*] and

> the major argument by the proponents of stem cell research –and I was one of them—was that we are using discarded embryos, everybody understood that, and we were going to bring a benefit from something that would otherwise bring no good. The understanding was, in fact, Senator Frist made the presentation on the floor of the Senate and he established conditions under which he would support stem cell research, the regulations that we ought to institute in support of that research and among them he listed very emphatically that the research would not be done with embryos created for the purpose of using for stem cells. That was what he said.
>
> Now and here we are a year later and we're arguing over a technique of cloning which can only be done in a manner in which an embryo is created in order to destroy [it]. So within a year, what we have is the ground shifting on this debate on precisely a point that a year ago we had been assured would be excluded by regulation and by law."

Dr. Krauthammer has represented the slippery slope most effectively! Those in favor of exploiting 'extra' embryos at IVF clinics and in favor of cloning new embryonic lives as nothing more than globs of cells are understandably against the argument, but the entire matter revolves around 'what is the embryo'? As we return to the transcript, please note how the moral perspective of each panel member frames their perception of the human embryo, and how they go to great lengths to avoid expressing their actual perspective on the embryo, to instead focus upon the uses for this human life**:**

> **CHAIRMAN KASS:** "Janet [*Dr. Janet Rowley*], did you want to comment?"
>
> **DR. ROWLEY (**Janet D. Rowley, M.D., D.Sc**): …** "I would like to respond to the discussion that Leon framed as we began this session and my points of view are certainly influenced substantially by my view that we are really, we have the potential of being on the threshold of some major biological discoveries that will be of enormous importance, but I qualify that with the same statement I made when we began this discussion in January, that this is a hope and at the present time we have no idea as to how much that hope will actually be successful and that was reiterated and confirmed again by both speakers this morning, that these are very, very, very early days and the promise that many of us see in this kind of research may -- I think it's not fair to say that the promise will not be realized, but I think that it is fair to say that the promise may take a very long time. And I just want to point out that we began the war on cancer in 1970 with the notion that it was all going to be over in 10 or 20 years and we're far from it. We're far from it because we're dealing with very complex systems in cells about which we are woefully ignorant, but I think the part of the research that will be permitted by going ahead with cloning and some of the aspects of experiments with somatic nuclear cell transfer will enlighten us so much that we'll be able to see better how

to expand on these in the future. And I would only echo our morning speakers by saying that I think that to ban this kind of research which has the potential for therapy would be a great tragedy."

CHAIRMAN KASS: "Michael Sandel?"

PROF. SANDEL (Michael J. Sandel, D.Phil.**):** "I just wanted to pick up on the last small uncharacteristic slip Charles where he slipped back into the polemical action description to use Professor Outka's phrase of what cloning for biomedical research is. I thought following Paul's and Leon's corrective which Outka accepted, we agreed that there are two possible action descriptions for both of these practices. By both, I mean creation of embryos for reproductive purposes and creation of embryos for purposes of medical research, a charitable description and an uncharitable one. The charitable description in each case describes the action in terms of the end it's aimed at. So in the case of embryos created for reproduction we point by the description to the end. Likewise, in the case of cloning for biomedical research, the end there is the creation of an embryo for the sake of promoting the curing of disease. There is an uncharitable description available equally to both and if we want to compare them, compare the moral status of these practices, we should use either the charitable descriptions of each or the uncharitable descriptions of each. The uncharitable descriptions in each case doesn't refer to the end being aimed at, but instead to the foreseeable, though undesirable effect.

So it would be fair to say that with Charles and with Outka's paper that in the case of creating an embryo for the sake of biomedical research to describe that as creating an embryo in order to destroy it, but only in the same sense that we should describe creation of embryos for reproduction purposes as the creation of embryos in order to discard the inevitable extras that will accompany the practice of IVF. So both activities admit of charitable and uncharitable descriptions and if we're going to compare their moral status, we should compare them either under one description, the things they aim at or under the other description, the foreseeable, but undesirable side effects that accompany both."

DR. KRAUTHAMMER: "Michael, I'm surprised that you also made an uncharacteristic slip when you said the inevitable destruction of the embryos in IVF because you know, as I know, we could, in principle, establish an IVF clinic tomorrow in which you assign only a single embryo to a woman. So you would thereby have a process of IVF where you have no inevitable, indeed, indeed no discarded embryos.

On the other hand, in cloning, it is absolutely inevitable that that embryo, because it will be disassembled, will be destroyed."

> **PROF. SANDEL:** "Well, if the practice of creating embryos for reproductive purposes involved no spares, no extras, then it would have a different moral status and character from the practice we currently have."

Please note that Professor Sandel affirms in oblique fashion a notion we've touched on, that 'the end use for the individual embryo will be allowed to define the nature of that individual life and the moral status of the practiced utilization of that individual life!' Such a perspective shows how dehumanizing beliefs regarding the embryonic life totally dominate the utilitarian perspective. Dr. Kass put this in perspective for his 'ethics' panel:

> **CHAIRMAN KASS:** "The slippery slope, to call something a slippery slope argument is already to put it in a category where you can abstract it and then say you like those arguments or you don't. Rather, it seems to me, it's worth thinking about, not in general in the light of other examples, but to think about it in the context of the particular thing we are talking about.
>
> I think I might have said once before that the reason that arguments about continuity of action are so appropriate in the area that we are here talking about is because development is itself a continuum and the value of the thing being developed, never mind morally, but biologically, increases with development and if it should turn out that tissues down the road are really more valuable for the treatment of the same patients we now want, the argument that's now being made for doing it will be very hard to resist.
>
> The real essence of the slippery slope argument is not a prediction, an empirical prediction. It is a question of the logic of justification and it's very important how you somehow justify what you're doing here because if, as in this area, the continuity of development and the continuity of research offers such great promise, you might, without even knowing it, be countenancing the next sort of stages and in the end you will wind up as Bertrand Russell said about pragmatism. 'It's like a warm bath. It warms up so imperceptibly you don't know when to scream.' **…**

So, what IS the human embryo? Well, the staff working with the committee cited above did the grunt work, defining and establishing the limits with which the committee would work. Included at the end of this manuscript, in an appendix, is an authorized copy of a working paper the staff prepared regarding terminology. Upon reading the excellent descriptions by the staff regarding just what is the human embryo, one cannot explain why some members of the President's Council on Bioethics continued to dehumanize the individual human embryo … unless it is solely an effort to support the desire to exploit these individual human lives suspended in IVF clinic freezers and created in well-lit laboratories via cloning technology, regardless of the moral or ethical status of the lives to be exploited. Before closing this manuscript, please visit the well-written explanation prepared by the Council Staff. It will serve as summary of the information covered in this manuscript, and clarify the ethical perspective one ought to use when contemplating the harvesting and cannibalizing of individual human lives at their embryo age.

We will close with the opening remarks offered by Dr. Leon Kass, as he prepared the panel for discussion of the 'Public Policy Options' regarding human cloning [25] (http://bioethicsprint.bioethics.gov/transcripts/jun02/june20session2.html) **:**

CHAIRMAN KASS: "Could we start to reassemble, please?

All right. This is the Council's, believe it or not, human cloning session 11, public policy options, the first of two sessions on public policy in which with no absolutely firm boundaries between them, we want first to have a general discussion of the strengths and weaknesses of available policy options, and then especially in the afternoon gradually move toward the policy recommendations that we might put forward.

I'd like to say a little bit by way of introduction to this because I think this is a difficult and vexing subject, but a very important one, and especially in the spirit of the conversation that we've just heard, one that is in some ways more important than the cloning issue itself.

It's very hard to tell when one is in the middle of a historical situation what it really means and whether it has the kind of signal importance that some of us think it does. One would like to think not that we have the authority over this matter, but one would like to think that one would try to think about this matter in such a way that 15 or 20 years down the road one doesn't look back and say, you know, we treated something as trivial which turned out to be massively important," or conversely, we turned out to treat something which was really quite trivial as if it was of world historical significance.

I mean, I have my own hunches about this. I don't know that they're shared, but I think it's at least important to be mindful of the question that this could be something very important.

Cloning, if it works, as we have already seen, would be a new mode of human procreation, and it might also serve as a kind of precedent for selecting in advance the genetic make-up of children. So it is something in itself and something that belongs to something larger than itself.

Cloning for biomedical research, if it works, is a powerful tool for understanding and treatment of human disease, but it also is an instance of the production of new embryonic life solely for use and necessary destruction.

And if it were legislatively provided for, this would not be just permitted as it now is, but it would be officially endorsed by U.S. law. So that is something to be reckoned with.

Also, this debate about cloning is a new instance of at least some tension in the longstanding, tacit, social contract between science and technology, society and politics, on the other. It is a social contract with a moral foundation, a foundation in which scientists and researchers are encouraged to pursue the truth, but in the service of the goods of the society that contract necessarily being stressed or tested, when the things that technology and science proposed to do or want to do might come in conflict, in fact, with the values or norms of the society.

And ordinarily we, at least in this country, have allowed these things to go along without too much attention. This now comes to be a test not just about the question of cloning, but how this community will, in fact, deal with those questions when we have goods in conflict, and whether there can be democratic self-governance about these matters or whether there should be or can be democratic self-governance about these matters.

So I want to suggest to you that although it looks like a small, little question, there are lots of things just in the penumbra of this that I think are quit important.

Second, I think we've all seen why this is so hard. We have in our previous meetings taken up the questions of the ethical issues of cloning to produce children and the ethical issues of cloning for biomedical research independently of one another, and that makes perfectly good sense because the moral issues that are raised there are, indeed, quite different.

And in fact, a sign that they're different is people can be opposed to the one and be in favor of the other, and people who might be opposed to both will differ as to which they think is worse.

It might, therefore, seem sensible to disaggregate these two forms or these two uses of cloning and develop independent public policies for each, and I think if anybody has thought about this a little while sees that it's virtually impossible. It's very difficult, if not impossible, to do so.

And the reason is simple. I'm just stating the obvious, but this is to at least make it clear why we are having such a hard time. The reason is simple because both of these activities of cloning begin in the same way with the initial act of cloning by somatic cell nuclear transfer that produces the cloned embryo, and therefore, it's difficult, perhaps impossible, to craft the policy that deals with one, but does not tacitly, and usually explicitly, affect the other.

A thoroughgoing attempt to prevent cloning to produce children by banning the first step would obviously prevent cloning for biomedical research. An attempt to promote cloning by biomedical research might well have consequences for cloning to produce children. An attempt to prevent cloning to produce children at the step of the transfer of a cloned embryo to initiate a pregnancy would tacitly approve the creation of the cloned embryos for research.

And imposing penalties on implantation while sanctioning creation, a policy that banned only transfer to the uterus, would then require that the cloned embryos be destroyed at risk of federal prosecution.

So these things are, alas, mixed up together, and as the conversation has already showed, even if one tried to craft policy through statutory language, the difficulty of doing this is enormous. Let's say you wanted to make a particular act illegal. You have to precisely define what act is proscribed.

And when I first started on this subject, I thought it very simple. It shall be unlawful to attempt to clone a human being. But it's simple to say and vexing to specify.

The question that is contested is: what do you mean by a human being? Does it mean a child or adult, or does it also mean the human embryo as a human being understood at that stage of development?

And the definition of cloning is, therefore, impossible to specify unless you've specified that in advance, and attempting to clone, if you want to say, "You shall not attempt to clone," that could either mean blocking somatic cell nuclear transfer itself or the transfer of the resulting cloned embryo to a woman..

Now, there would be a way of disentangling these two things or at least having them separate if, in fact, it was done as the British, in fact, did it or as some of the other nations have done it, namely, they have a general policy on embryo research which governs everything or they have a general policy on assisted reproduction and embryo research.

And then the cloning question fits in in some way. We don't have that, and that makes our situation here, I think, terribly difficult.

Just a couple of other things and then I think we can move to the discussion. It's perfectly clear from the conversations we've had, especially on the ethics of cloning for biomedical research, that we have a clash of competing goods and interests, and it's also clear from the discussion bearing on the question is this research necessary.

This notion of necessity came up in the previous discussion, and it is important to the moral analysis. There's a dispute even on that question because we do not have full knowledge about the science so that we proceed in this discussion as almost everybody does whenever they do public policy under the veil of ignorance, sometimes more, sometimes less, but always with the kind of uncertainty about the future.

What that means is when one moves from the discussion of ethics where one could sit in one's armchair and construct one's hypotheses to the realm of policy, one really has to move from the realm of principle to the realm of prudence, which is not to say uninformed by the moral analysis, but can't simply be settled by it.

And this means really thinking about the ends that we're seeking, thinking about selecting the fitting means always in the light of the circumstances, a very complicated task always, and especially when the best simply might be different from the best possible here and now. That might be the situation in which we find ourselves.

And I would at least like to suggest that the ethical analysis that we've been engaged in is certainly pertinent here, but it has now to consider all kinds of other things that are related to the complexity of what happens if you actually try to give voice to your ethical intuitions at the level of public policy, given the difficulties of drafting, given the competing goods and the like.

There is a question, I think, that will lurk beneath the surface of this discussion, which is who bears the burden of proof and persuasion in these kinds of matters. Is it the proponents who are proposing that we cross certain kinds of moral boundaries or is it the people who want to say no, when in a country, by and large, freedom is the rule? You have to do more than sort of say certain kinds of things might happen, but you have to show that they might likely happen and the costs to the common good are sufficiently great before you restrict people and even put them in jail.

I mean, these are important things, I think, to keep in mind.

Let me just introduce the specific proposals that we can consider. Then I would open the discussion either on the general matters and then gradually move to -- I'll go wherever you'd like, but we have, if you think about it, one has, thinking now just about human cloning, and we've got, let's say, Cloning 1 and Cloning 2. I mean cloning to produce children and cloning for biomedical research.

There are two large categories, allow and forbid, and under each category, there are two possibilities: allow without regulation or allow with regulation; forbid for now, forbid permanently." **…**

Someone will eventually write legislation to address these issues. Even if We The People do nothing, say nothing, and wait upon our elected representatives to offer some leadership, the essence of what we believe regarding individual human embryos will be stamped upon America for all History to inspect. I suspect we have historical lessons upon which to draw, if we will do so. Currently, in vitro fertilization methodology assumes that parents own the embryonic individual lives they bring into being. That perspective will be easily transferred to in vitro cloning creation of human embryos. But does a clinic or individual have the intrinsic right to own another individual human life? If these ethicists actually want our opinion, then **America, We Need To Talk!**

***

GLOSSARY

Allogeneic stem-cell transplantation – the transplantation of tissues from genetically different donors

Androgenesis – a term that one may encounter when reading articles on cloning and parthenogenesis; it refers to the forming of a 46-chromosome nuclear mass fusing the 23 chromosomes from two separate 23-chromosome male gametes (sperm), with the goal to create an embryo having two male parents (*trust me, with the political environment of homosexuality issues, you will see this term if you're paying attention; Advanced Cell Technologies and other labs are currently researching this 'option' for generating 'therapeutic' clones, and who knows, perhaps even alternate lifestyle families*)

Asexual reproduction – The term "asexual reproduction" means reproduction not initiated by the union of oocyte and sperm. [http://bioethicsprint.bioethics.gov/background/workpaper2.html]

Autologous – meaning, from the same organism (see xenotransplant)

Biologically related children – Children are "biologically related" to the individuals who are the sources of their genetic endowment, in the case of sexual reproduction, to one man and one woman who are the sources of sperm and egg (the "biological" parents),

in the case of cloning, to the source of the donor nucleus.
[http://bioethicsprint.bioethics.gov/background/workpaper2.html]

Blastocyst – An early stage in the development of mammalian embryos, when the embryo is a spherical body comprising an inner cell mass that will become the fetus and an outer ring of cells that will become part of the placenta.
[http://bioethicsprint.bioethics.gov/background/workpaper2.html]

Chromosomes – Structures inside the nucleus of a cell, made up of long pieces of DNA coated with specialized cell proteins, duplicated at each cell division (22 pairs plus two X if female; 22 pairs plus an X and a Y, if male). Chromosomes thus transmit the genes of the organism from one generation to the next (ex: sperm with 22 chromosomes plus a Y chromosome and an oocyte with 23 chromosomes—for a male to be conceived—make 23 pairs at reproductive fusion, thus 46 chromosomes).

Cloning – *"Reproductive" cloning* -- 1) Obtaining a human or animal egg cell and removing its DNA. 2) Inserting a nucleus or a cell from a donor human or animal in order to produce a reconstructed egg that is genetically very similar to the donor. 3) Implanting the reconstructed egg in a uterus and delivering the resulting baby or newborn animal.
"Research" cloning -- 1) Obtaining a human or animal egg cell and removing its DNA. 2) Inserting a nucleus or a cell from a donor human or animal to produce a reconstructed egg that is genetically very similar to the donor. 3a) In some cases, termed "therapeutic" cloning or "cell replacement through nuclear transfer" (CRNT), the next steps include growing the reconstructed egg to the 100-200 cell embryo (blastocyst) stage, then taking the embryo apart to isolate and preserve "individualized" stem cells for immediate or future use in cell transplantation therapies. 3b) In other cases, the next steps comprise various scientific experiments designed to better understand the earliest stages of human embryonic development.
Gene (molecular) cloning -- Using carrier pieces of DNA (called vectors) to isolate and characterize DNA segments coding for proteins.
"Human cloning" -- The term 'human cloning' means the asexual reproduction of a new human organism that is genetically virtually identical to an already existing, or previously existing, human being. Operationally, it is currently accomplished by introducing the nuclear material of a human somatic cell into an oocyte whose own nuclear material has been removed or inactivated, to produce a living organism -- at whatever stage of development -- that has a human (or predominantly human) genetic constitution.
[http://bioethicsprint.bioethics.gov/background/workpaper2.html]

DNA – In most organisms the genetic code is carried by very long molecules called deoxyribonucleic acid (DNA). These long duplex molecules are tightly packaged and form part of the genes, which in turn form the chromosomes. DNA molecules also run functions of mitochondrial grains within the cell cytoplasm. Information is transcribed from DNA to RNA, from which the information is then acted upon to from proteins (RNA, ribonucleic acid; in this instance a copying molecule and action molecule; the notion is like a stamp pad, where the original DNA molecule directs the image carved onto the stamp pad plate—the RNA—yet the DNA molecule remains out of the stamping action).

DNA is a polymer (a chemical compound formed from small molecules). In natural state, DNA exists as the form of a spiral or coiled spring, or perhaps more like a very long spiral-twisted ladder, with step treads that are paired reactive molecules binding across the gap between the side rails.

There are four different base reactive molecules, thymine (T), adenine (A), cytosine (C) and guanine (G) (bound by chemical bond to make the treads in our ladder analogy), and the sequence in which they are arranged determines the genotype and characteristics of the organism. The bases can form complementary pairs (at one side of a single step in our long-ladder analogy), thymine binding with adenine and cytosine with guanine. The genetic code is formed by triplets of bases, called codons; each triplet encodes for an amino acid, the building blocks of proteins.

The human genome contains approximately $3X10^9$ bases (that's a three followed by 9 zeros, or three billion **…** a number so large, only Bill Gates and legislators could hope to comprehend it). Large sections of the DNA sequence are common to many organisms; some sequences are shared by related groups of organisms; small sections are unique to the individual.

Codons are 'words' of the DNA message, and the arrangement of words express the directions of form and function for the organism. [*This description —with author asides — is based upon data presented by Dr Ruth McNerney, lecturer at the London School Of Hygiene and Tropical Medicine; Dr. McNe rney has posted an excellent explanation of PCR, found at* http://www.lshtm.ac.uk/pmbu/staff/rmcnerney/homepage/basicstext.html]

Chemical DNA was first discovered in 1869, but its role in genetics was not proven until 1943. In 1953, James Watson and Francis Crick, using x-ray photographs by Rosalind Franklin, determined the structure consisted of two matching chains of chemical bases wrapped around each other in a double helix.

Egg – the roundish reproductive body produced by females of birds and reptiles, consisting of ovum and its complement of albumen, jelly, membranes, and egg case (shell, according to species; reptiles form a leathery shell, while birds form a harder shell) [Random House Dictionary Of The English Language, 2^{nd} Ed.]

Embryo – 1. An organism in the early stages of development. 2. In humans, the developing organism from conception until approximately the end of the second month; developing stages from this time to birth are commonly designated as fetal. [http://bioethicsprint.bioethics.gov/background/workpaper2.html]

Epigenetic modification – Turning genes encoded by chromosomal DNA on and off during cell differentiation through changes in a) DNA methylation, b) the assembly of histone proteins into nucleosomes, and c) remodeling of chromosome-associated proteins such as linker histones. [http://bioethicsprint.bioethics.gov/background/workpaper2.html]

Epigenetic reprogramming – The process of removing epigenetic modifications of chromosomal DNA, so that genes whose expression was turned off during embryonic development and cell differentiation become active again. Epigenetic reprogramming of the donor cell DNA is believed to be an essential process in generating live offspring through "reproductive" cloning using adult donor cells and nuclei. [http://bioethicsprint.bioethics.gov/background/workpaper2.html]

Fecundation – the same as fertilization; in his quoted texts, Dr. Jerome Lejeune used the word because his native language was French and the English term fertilization is ‘fecundation’ in the French vernacular

Gametogenesis – the word refers to the maturing of germs cells (not bacteria germs, but human reproductive sex cells); the term ‘maturing’ is somewhat misleading since this process begins in the fetal age, with female gametes preparing for the far-off event of fertilization when they will so late in maturing shed half of their 46 chromosomes active during the ‘maturation’ process; male gametes accomplish the paring down from 46 to 23 chromosomes while still in the male body; for more, search out the word ‘meiosis’ in a good encyclopedia

Gestation – the period of intrauterine fetal development (as noted in this manuscript, that ‘intrauterine’ realm will soon be achievable without the continuous life support from a mother’s body!) [Taber’s Cyclopedic Medical Dictionary, 11th Ed]

MAPCs – (pronounced ‘map seas’) multipotent adult progenitor cells, perhaps the promethean stem cell of all adult stem cells, able to differentiate into nearly every tissue line of the human body

Medulla – inner or central portion of an organ, in contrast to the outer portion or cortex [Taber’s Cyclopedic Medical Dictionary, 11th Ed]

Methylation – a methyl molecule is formed with one carbon atom and three hydrogen atoms (written as CH_3 in Chemistry); reactive potential is governed by how many ‘H’ atoms are attached to the ‘C’ atom; the word ‘methylation’ in the text refers to a hydrogen atom being replaced with a methyl molecule on a DNA portion, acting as a switch to ‘turn off’ (or ‘silence’, in Dr. Lejeune’s analogy of a magnetic tape and the music information) that portion of the DNA that was, prior to methylation, in the ‘on’ mode for chemical reactions

Mitosis – the action whereby a cell duplicates its chromosomal count and mitochondrial grains, then divides to form a duplicate of itself, literally making its twin (a clone) of itself; during gestation, the organism has cells duplicating, but becoming slightly more specialized as the organ systems are constructed, so the mitosis cascade during gestation is not exact duplication because developmental abilities are ‘turned off’ selectively as stem cells differentiate in their duplication (see methylation)

Organ – in biological terms, a grouping of tissues into a distinct structure, as a heart or kidney, that performs a specialized task [Random House Dictionary Of The English Language, 2nd Ed.]

Organism – **1.** a form of life composed of mutually interdependent parts that maintain various vital processes. **2.** any life form considered as an entity [Random House Dictionary Of The English Language, 2nd Ed.] (Author's added note: a being constructed from sub-units called organs, functioning as an integrated whole)

Parthenogenesis – a form of reproduction in which the ovum (oocyte in humans, though it seems odd to refer to human parthenogenesis) develops into a new individual without fertilization

PCR – polymerase chain reaction

Placenta – in mammals, the placenta is the first organ built by the embryo, functioning to protect but also generate signals from the embryo to his or her surroundings, then as the placental organ develops, it acquires nourishment and 'breathes' for the embryo then the growing baby or babies; this organ for survival in the water world is cast off at birth into the air world

Polymer – a chemical compound formed by union of small molecules and usually consisting of repeating structural units [The Merriam-Webster Dictionary © 1994]

Xenotransplant – an operation in which an organ or tissue is transferred from one animal to another of a different species.

APPENDIX

(http://bioethicsprint.bioethics.gov/background/workpaper5.html)

This staff working paper was discussed at the Council's February 2002 meeting. It was prepared by staff solely to aid discussion, and does not represent the official views of the Council or of the United States Government. [26]

Staff Working Paper
On Terminology

Introduction: The Importance of Careful Use of Names
There is a great deal of confusion about the terms used in discussing human cloning. There is honest disagreement about what names should be used, and there are also

attempts to select and use terms in order to gain advantage for a particular moral or policy position. It is terribly important to try to be accurate and fair in the matter of language. Choice of names can decisively affect the way questions are posed, and hence how answers are given. Efforts to win the moral argument by Orwellian use of speech must be resisted. The issue is not a matter of semantics; it is a matter of trying to call things by their right names, of trying to fit speech to fact as best one can. We should not only stipulate the meanings we intend by our use of terms; we should also choose terms that most accurately convey the descriptive reality of the matter at hand. If this is well done, the moral argument can then proceed on the merits, without distortion by linguistic sloppiness or chicanery.

Many of the terms that appear in the cloning debate are confusing or are used in a confused manner. There are difficulties concerning the terms that seek to name the *activity* or *activities* involved: cloning, asexual reproduction, reproductive cloning, research cloning, therapeutic cloning, somatic cell nuclear transfer (or nuclear transplantation), nuclear transfer for stem cell research, nuclear transfer for regenerative medicine. There are difficulties concerning the terms that seek to name the *"product"* or *"products"* of the activities: cell, activated cell, clump of cells, reconstituted (or reconstructed) egg, zygote, embryo, human embryo, blastocyst, potential human being, human being, clone, person. And there are difficulties concerning the terms that seek to describe the *relation* between the "product" and the person whose somatic cell nucleus was transferred to produce "it": genetic copy, replica, genetically virtually identical, non-contemporary twin, clone.

Let us try to sort out the terms by beginning with the nature of the *activity* or the *deed* done in the activity of cloning. As a prelude to doing so, some general observations will be helpful. Although all aspects of an activity or action are relevant to understanding its full human meaning, when describing a deed we do well to distinguish WHAT it is from both HOW it is done and WHY it is done. The act itself (WHAT) may be accomplished by a variety of means or techniques (HOW), and it may be undertaken for a variety of motives or purposes (WHY). To be sure, there is disagreement about the degree to which the motives or purposes of the agent are to be reckoned in the description of the act itself. For example, do the different motives make an act of "mercy-killing" different AS AN ACT from murdering a person or killing a murderer or killing someone in self-defense? Or are they all equally acts of homicide (killing of a human being) whose MORAL meaning we can then proceed to debate, if we wish, by attending not only to the act itself but also to the agent's motive and purpose? (See Meilaender comment on "Distinguishing Motive and Intention.") Though we do not wish to beg this question, the very existence of this disagreement suggests that we do well not to ignore the naked act itself, since it may well have a meaning independent of what moved the agent.

To illustrate: in vitro fertilization (IVF: the extra-corporeal -- *in vitro* = in glass -- merging of egg and sperm, creating a zygote that is the beginning stage of a new living being) is the WHAT. It is an act of "fertilization," of making fertile, of making the egg cell ready and able to develop into the human organism. This fertilization may be accomplished in at least two ways (HOW): by merely mixing egg and sperm, allowing the sperm to find and penetrate the egg, or by the technique of injecting individual sperm directly into the egg (a technique known as ICSI, intracytoplasmic sperm injection). And it may be done for the (proximate) purpose (WHY) of initiating a pregnancy, in turn for the (ultimate) purpose of providing a child for an infertile couple; or it may be done for the (proximate) purpose of providing living human embryos for basic research on normal and abnormal embryological development, in turn for the (ultimate) purposes of understanding human development or of discovering cures for diseases and producing tissues for regenerative medicine. Though the technique used or the purposes served may differ, in the crucial respect the act remains the same and bears a common intrinsic meaning: a human zygote, the first stage of a new human being, is intentionally produced outside the body with technical assistance.

As it happens, this fact is more or less accurately reflected in the descriptive terminology used for IVF. Interestingly enough, unlike the situation with cloning, no one distinguishes between "reproductive IVF" and "therapeutic IVF" or "research IVF," naming the activity or deed after the motive or purpose of the agent. This may reflect the accidental fact that IVF was initiated solely (or mainly) by people who were interested in using it to produce live-born children for infertile couples; the research use of "spare" embryos created by IVF came only later. But it happens that this common name is also descriptively apt: the deed is fertilization of egg by sperm, creating a living human zygote, the first stage of the development of a new human being.

It should be noted that, although we began by trying to describe the deed rather than the product of the deed, the two aspects merged necessarily. The meaning of the act of "fertilization" falls forward onto the nature of the "object" that fertilization creates: the fertilized egg or zygote or earliest embryo.**1** (By contrast, there is nothing in the name of the technique, "intracytoplasmic sperm injection," that even hints at the immediate result or goal of the intended injection.) Similar attention to the nature of the product may turn out to be indispensable for a proper characterization of the activity of cloning.

Cloning: Toward an Appropriate Terminology

Though much of the terminological confusion and controversy concerns the way to describe the different kinds of cloning practices that are envisioned, the term "cloning" itself is not without its own ambiguities. A "clone" (noun, from the Greek klon, "twig") refers to a group of genetically identical molecules, cells, or organisms descended from a single common ancestor, as well as to any one of the one or more individual organisms that have descended asexually from a common ancestor. "To clone" (verb) is to duplicate or create a genetic duplicate(s) of a molecule, cell, or individual organism. The replication of DNA fragments in the laboratory is called "DNA cloning." The propagation of single-cell lines in tissue culture is sometimes referred to as "cell cloning." Asexual propagations of bacteria or of plants by means of cuttings are instances of organismal cloning. Cloning of higher organisms is more complex: all cloning of vertebrate organisms must begin at the embryonic stages. Contrary to what some people imagine, cloning of amphibians or mammals (including human beings) is not the "Xeroxing" of an adult organism.

In the sense relevant here, "cloning" is a mode of asexual reproduction (parthenogenesis is another), the creation of a new individual not by the chance union of egg and sperm (from female and male individuals, the parents), but the creation of a new individual by some form of replication of the genetic make-up of a single individual. (The essence of sexual reproduction is not bodily intercourse but the fusion of male and female germ cells; thus IVF, though it takes place outside the body, is-biologically speaking-a form of sexual reproduction.) The WHAT of cloning is the activity of producing a clone, an individual or group of individuals genetically the same as the precursor that is being "replicated."2

In much of the current public discussion, we encounter a distinction between "reproductive" cloning and "therapeutic" cloning. The distinction is based entirely on the differing goals (the WHY) of the cloners: in the first case, the goal is the production of a cloned baby, in the second case, the development of treatments for diseases (suffered not by the clone, but by others). Both these terms have been criticized by partisans of several sides of the debate, and for understandable reasons.

Some object to the term "reproductive" cloning used as a term of distinction, because they argue that ALL cloning is reproductive: all cloning intends and issues in the creation of a living human embryo, a creature that is a new human being in the (its) earliest stage of development or "reproduction." (This is a descriptive, not a normative point; it does not necessarily imply that such a being is fully human or "one of us," hence deserving of the moral and social protection accorded "persons.") The fact that only some of these embryonic cloned humans are wanted for baby-making purposes does not, in the view of these critics, alter this fact about their being.

Others object to the term "therapeutic" cloning for related reasons. The act of cloning may be undertaken with healing motives. But it is not itself an act of healing, nor does it issue in or effect a treatment or a cure (compare, in this respect, what used to be called "therapeutic abortion," an abortion undertaken in cases in which pregnancy was life-threatening to the pregnant woman and where abortion was therefore intended to save the woman's life). The prospective beneficiaries of any acts of cloning are, at the moment, purely hypothetical. And if medical treatments do eventually result, the embryonic clone produced in the process will never be the beneficiary of any therapy. On the contrary, this sort of cloning actually sacrifices the being that results from the act of cloning.

To avoid the misleading implications of calling any cloning "therapeutic," we might prefer the term "research" cloning, again indicating the purpose of the activity. Yet others find fault with this replacement. Because it appears to be a deliberate substitution for "therapeutic" cloning, it seems to imply that the scientists have abandoned the pursuit of medical cure in favor of research (as an end in itself). Believing that creating embryos just for research would seem to be less justifiable than creating them with healing motives, these critics want to avoid the impression that scientists want to experiment on new life just to satisfy their curiosity. (The same argument applies with equal force against the term "experimental cloning.")

Some proponents of "therapeutic" cloning-the use of quotation marks are intended only to indicate that there is dispute over whether this term is apt-also now complain about the term, but not about the adjective. Though they originally coined and used the term, they now want to shed the term "cloning," fearing that the opprobrium of the latter will weigh against the activity itself. Cloning, they insist, should be reserved for the activity that creates live-born cloned babies; it should not apply to the initial act that starts the process, which they would rather call "somatic cell nuclear transfer" or "nuclear transplantation." While not inaccurate, such a substitution is, as the sequel suggests, also problematic.

To escape from the bad connotations of "cloning," and to stay closer to scientific terminology, scientists now seem to prefer the term human "somatic cell nuclear transfer" (SCNT) as the name for the activity they support. But accurate though it may be as a description of the technique that is used to produce the embryonic clone (HOW), it does not touch the nature of the deed itself (WHAT). The WHAT is "the creation of a living-human-zygote (or embryo) that is genetically virtually identical to the donor organism," a fact or meaning not captured in the name for the HOW, the transfer of a somatic cell nucleus (into an unfertilized egg whose own nucleus has been removed or inactivated). This reduction of act to its mechanism is roughly analogous to describing walking as "sequential alternate leg advancement" (SALA). In fact, it is not even as good as this, for, as a name, SCNT is not a fully accurate description even of the technique itself. Not only does it make no reference to the intended and direct result of the deed of nuclear transfer. It also omits mention of the fact that the recipient of the transferred nucleus is an EGG (rather than another kind of) cell, which then can be made to behave as if it were a zygote produced by fertilization. The further amendments, "somatic cell nuclear transfer for stem cell research" or "nuclear transplantation for regenerative medicine" only compound the difficulty, mixing in the purpose of the activity (WHY) with its technique (HOW), thus further obscuring the immediate meaning (the WHAT) of the act itself, the creation of a living human embryo of a certain type, i.e., cloned.

There is a further difficulty with these expressions. All these descriptions of the activities that the scientists wish to pursue omit all reference not only to cloning but also to embryos (and human embryos). Indeed, some are insisting that the immediate product of somatic cell nuclear transfer is not an "embryo" but rather "an activated cell," and that the subsequent stages of development should not be called embryos but "clumps of cells" or "activated cells."

Once again, we see how the meaning of the act, and hence its proper name and description, falls forward onto the nature of the product. We come then at the question of names from a consideration of the outcome.

The initial product of SCNT is, to be sure, a cell. But it is no ordinary cell. It is a cell that resembles and can be made to act like a fertilized egg, a cell that not only has the full complement of chromosomes but, unlike a somatic cell, is capable of developing into a new organism. In other words, it is a zygote or a zygote-like being. It is, to be sure, not just a cell but an active cell, or, at least, it can be activated, say by electric shocking. But to name it "activated cell" is much too vague to describe the activity of which it is capable. For once stimulated, the activity of this "cell" produced by SCNT is nothing other than human embryological development, initiated and directed by the cell itself. The processes of cellular growth, chromosomal replication, cell division, and (ultimately) differentiation into the tissues and organs of the organism are coordinated processes under the governance of the immanent plan for such development encoded in the cell's genetic material. In other words, the "cell" is an organism in its germinal stage, and its activities are those of an integrated and self-developing whole.

For the same reason, it is inaccurate to describe the next few stages of this developing being as "clumps of cells." Yes, there will be 2, then 4, then 8 cells "clumped" together, and the 100-200 cell spherical stage called the blastocyst may be externally described as a "ball of cells" or a "clump of cells." But this ball or clump is not just a heap or an aggregate; it is a primordial and unfolding whole that functions as a whole and that is in the process of developing into a mature whole being, if nothing interferes (and if it is implanted). It is, in short, an embryo. That it can be interfered with to prevent it from reaching that maturity does not alter our assessment of what it is, here and now, any more than the eating of a sprouting acorn by a squirrel denies that the acorn is a nascent or embryonic oak tree.

The fact of the matter seems to be this: the product of somatic cell nuclear transfer is a living (one-celled) human embryo. The immediate intention of transferring the nucleus is precisely to produce just such a being: one that is alive (rather than non-living), one that is human (rather than non-human or animal), and one that is an embryo, a developing being capable of unfolding into an articulated organismic whole (rather than just a somatic cell capable only of replication into more of the same cell type). This is the intended product of SCNT, whether the motive or purpose is baby-making with the embryo or scientific research to be conducted on the embryo. Also, the blastocyst that develops from this one-celled embryo will be the same being, whether it is then transferred to a woman's uterus to begin a pregnancy or it is used as a source of stem cells for research and possible therapy for others.

The name "SCNT" also omits one further, crucial, and indeed essential aspect of this activity and this product. The human embryo thus produced will be a clone: a genetic copy (rather, a near copy) of the individual that was the source of the transferred nucleus, hence an embryonic clone of the donor. There is, to be sure, much discussion about how close the genetic relation is between donor and embryonic clone, and what that bodes for the phenotypic identity of the clone. The environment in which the donor came to be and lives surely differs from the one in which the cloned embryo may develop (if it does develop). There may be imprinting differences in gene expression early on that may affect the degree of genetic identity. There is also the matter of the mitochondrial genes, some 13 or so genes out of a total of some 30,000, which are inherited from the female source of the egg (the clone would be genetically identical only in those cases in which the same woman donated both egg and somatic cell nucleus, to produce an embryonic clone of herself). Yet the goal in this process is in fact an embryo or child that is genetically virtually identical to the donor; otherwise there would be no reason to create the embryo by SCNT rather than by ordinary IVF.

This analysis leads to the following conclusion regarding the terms most descriptive of the facts of the matter:

WHAT: The term "human cloning" means the asexual production of a new human organism-at whatever stage of development-that is genetically virtually identical to an already existing or previously existing human being.

HOW: It is currently accomplished by introducing the nuclear material of a human somatic cell into an oocyte whose own nucleus has been removed or inactivated, to produce a living organism that has a human genetic constitution virtually identical to the donor of the somatic cell.

WHY: This same activity may be undertaken for purposes of baby-making or for purposes of scientific and medical investigation and use.

Human "reproductive" cloning and human "therapeutic"/"research" cloning should now be understood to mean the following:

1. "Reproductive" cloning: Creation of a living cloned human embryo, produced for the (proximate) purpose of initiating a pregnancy that will issue in a child who will be a genetic (near-)twin of a previously existing individual, with the ultimate goal of satisfying one or another parental desire to have such a child.

2. "Therapeutic"/"Research" cloning: Creation of a living cloned human embryo, produced for the (proximate) purpose of using it in research or for extracting its stem cells, with the ultimate goals of gaining scientific knowledge of normal and abnormal development and of developing cures for human diseases.

What Does This Mean for the Council's Work?
Where does this linguistic analysis leave us? One possibility is to adopt the dominant terminology ("reproductive" and "therapeutic" or "research"), given that we have little hope of changing the current usage. We could make perfectly clear what these terms mean in our hands, so that there will be no ambiguity. At the same time, our analysis might serve to chasten people regarding the power and pitfalls of the terminology, including the ones we are adopting. The analysis would also alert people to the danger of euphemism and misleading speech.

A second possibility is to attempt a better way of describing these matters, perhaps even coining some new terms. No one should underestimate the difficulty of the task, or exaggerate the chances that our terms, even if better, could gain currency. But the invitation is open to anyone who would like to make a proposal.

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1. Though not needed for present purposes, a more careful analysis of the WHAT of this activity would distinguish between the activity itself and the product that results from it.

Unlike non-productive activities, for example dancing ("How can we know the dancer from the dance?"), the work (activity) of making and producing issues in separable objects or works (products). Although shoemaking completes itself in the production of a shoe, the shoe as RESULT is distinct from the ACTIVITY of shoemaking. Similarly, though fertilization is an activity that is intelligible only as issuing in a fertilized egg, the now-fertile egg as RESULT or PRODUCT stands apart from the deed of IVF.

2. Although cloning, like fertilization, is responsible for bringing forth a new organism, the activities are named in very different ways, yet in each case emphasizing the inner intention of the activity. "Fertilization" describes the activity in terms of the capacitation of the egg, as a result of which development begins. "Cloning" describes the activity in terms of the relation between the progenitor and the product. In cloning by somatic cell nuclear transfer, the egg, though it is activated as if it were fertilized, is not cloned; cloned rather is the donor from whom the nucleus was taken; and the resulting organism (at all stages of development) is a clone of the donor. The name of the activity, "cloning," even more than "in vitro fertilization," refers to the *product* of the activity, an identical (or near-identical) thing.

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