INSTITUTE FOR THEOLOGICAL ENCOUNTER WITH SCIENCE AND TECHNOLOGY

BULLETIN

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During Lent I propose that, while thinking of fasting and repentance, we also look to the future. The primary reason for that, of course, is that the future can still be modified, while the past cannot. Let me make one suggestion in the light of the future.

Last September, at our meeting (on *Neuroscience*) at Our Lady of the Snows, I made a modest proposal toward the end of the discussion. In editing the material from that meeting, I have been thinking about the recommendation I made. I think it is a more important suggestion than I knew when I made it last fall.

I proposed that ITEST work to form a national or international, loose-knit, quasi-religious, ecumenical group to work with patients with cancer or neurodegenerative diseases. The cost of the care for an aging population with such diseases will be astronomical. The quality of care probably will suffer as well. We can help those patients afflicted with these diseases live at home with those who love them. It would be more compatible with their inherent dignity than the way we now warehouse them.

St. Paul said that the most important thing was love and in his epistles John kept emphasizing "Love one another as I have loved you." Home and familiar surroundings may be the best medicine for the sufferers. It may also be more cost-effective. In a few years, the insurance companies will not be able to pay for all those living with these diseases.

I proposed some loose-knit organization of people caring for other people. They could help the care givers by cutting grass, shoveling snow, raking leaves, going to the grocery, doing chores around the house and so on. Almost everyone could help by taking such chores on themselves. Some, with specialized training, could help to care for the patients. We could at least help the care givers take care of their loved ones with Parkinson's or Alzheimer's disease. This would help fulfill the Lord's word: "what you did for these, the least of my brethren, you did also for me." Work to make the world a better place. Have a blessed Lent. God bless you all.

Robert Brungs, S.J.

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ANNOUNCEMENTS

1. *Globalization in the 21st Century: Christian Challenges.* We finally have our complement of essayists for this workshop at Our Lady of the Snows Shrine, Belleville, Illinois, September 26-28, 2003. If you are planning to attend, please send in your registration as soon as possible because space is limited at the Shrine hotel. Most of our stateside members have already received the invitational brochure listing the essayists and the titles of their papers, but we will repeat the information here for those who missed it.

Dr. Jeffrey Arnett, an independent scholar affiliated with the Department of Human Development at the University of Maryland, *Citizens of the World: Young People and Globalization*; Dr. Robert J. Collier, Head of the Animal Sciences Department at the University of Arizona, *Science in the Global Village*; Dr. Jean Robert Leguey-Feilleux, Professor of Political Science at Saint Louis University, *Political Implications of Globalization*; Dr. Edward J. O'Boyle, Senior Research Associate affiliated with Mayo Research Institute, West Monroe, Louisiana, *Norms for Evaluating Economic Globalization* and Fr. Stephen Rowntree, SJ, Loyola University, New Orleans, Louisiana, *Close Encounters: Religions in the Global Village - Conflict/Consensus, Conversation.*

"The dignity of the human person is clearly at stake in the process of globalization. The scientific community has been 'globalizing' for many years and may have numerous lessons to teach us. Science has experienced few of the problems associated with the rise and fall of other cultures or the major aspects of other cultures. This is only a part of the story." *(from the description of the workshop)* Join us in discovering "the rest of the story." How do the upheavals in the Middle East and around the world affect our thinking in this area? How do we harmonize our Christian principles with secular values of globalization? As we address these and other pertinent questions, we promise a stimulating yet relaxing weekend amid the natural beauty of the grounds at the Shrine.

2. Some of you will be receiving a third and final membership renewal notice for calendar year 2003. If you have not yet renewed, you may still do so. Those who have not renewed since 2000 will be dropped from the active membership list. If you have received renewal notices, you have not yet renewed. We have been sending the quarterly *Bulletin* to all members and non-members alike on our list, via e-mail or hard copy, via the US Post Office. Beginning January 1, 2004 dues-paid members in 2002 and 2003 will receive the quarterly *Bulletin*. Only dues-paid members for 2004 will receive other membership materials (books of Proceedings and occasional papers). If you pay by credit card, please remember that we can accept ONLY MasterCard or Visa. We are sorry, but that's all that we are permitted to honor.

3. Call for articles, commentaries and reflections for future issues of the *ITEST Bulletin*: The articles may be submitted on floppy disks, CD's, e-mail attachment(no viruses, please) or hard copy. We accept WORD, WordPerfect 5.1 (DOS version), WordPerfect for Windows or plain text. Once the members of the editorial board decide that the article will be published they will notify the author(s) regarding the particular issue in which the article will appear. Manuscripts will not be returned.

4. Please notify us if you have any further suggestions or comments on Fr. Brungs' editorial on the first page of this bulletin. Would you care to help promote a similar program in your area of the country? It would be very difficult to pursue this on a national level -- the local level would be ideal. Are there groups already established which you could join? Let us know if there are functioning groups that are successful. We could pool information and either "plug into" existing situations or use these as models for organizing new ones in our area. What does this project have to do with the goals and aims of ITEST? We welcome your feedback.

5. The ITEST Board of Trustees will hold its quarterly meeting on May 29, 2003 at Jesuit Hall, St Louis, Missouri. If you have any concerns you would like the Board to address, please contact the ITEST office via e-mail or phone and the staff will relay these concerns to the Board for discussion. We will be deciding the topic for the Fall of 2004. What about a meeting on *Computers, Artificial Intelligence and Virtual Reality*?

6. Check our web site at *http://ITEST.slu.edu* - then to Current Items of Interest for more detailed information on our September workshop on globalization.

7. The deaths of Robert Bertram and Bishop James Hoffman have highlighted an unpleasant fact: we are all getting older. The membership has been decreasing a bit (this will accelerate even more in the future) because of the deaths of our older members. We have to continue recruiting younger people for ITEST. This is a task for the whole membership. It is necessary for you to enlist apostolically-minded people for ITEST. The office will gladly provide you with material but the enlisting of membership is everyone's privilege. One last thing: we do need candidates for Director of ITEST. Father Brungs would really like to retire to Chairman of the Board status. Any suggestions?

OBITUARY OF ROBERT W. BERTRAM

Robert Brungs, SJ

This is one of the hardest tasks I have had since John Matschiner and I founded ITEST some thirty five years ago -- the obituary of a long-time friend and brother in Christ. Even though I could probably assign the task to someone else, it is my duty and my honor to do so.

Bob, a Lutheran Pastor and theology professor, was born on March 27, 1921 in Fort Wayne, Indiana. He died after a long illness on March 13th, two weeks before his 82nd birthday. That is the span of his life. It does not begin to span his deeds during that life.

Bob was educated in Lutheran parochial school and college in Fort Wayne. He earned his theology degree at Concordia Seminary in Saint Louis in 1946 and married the love of his life, Ethelda Koch, that same year. He received an MA in psychiatric social work in 1948. He received his PhD in 1964 from the University of Chicago. His doctoral mentors were Paul Tillich and Jaroslav Pelikan. In 1951 Bob was ordained as a pastor in the Lutheran Church, Missouri Synod.

In 1963 Bob accepted a call to teach at his alma mater, Concordia Seminary in St. Louis. Though fully engaged as teacher at the seminary, two new venues opened for him after 1963. He became a major voice in international theological conversations and internally in the "Kirchenkampf" brewing for years in the Lutheran Church, Missouri Synod. It was in 1974 that a "seminary-in-exile" (Christ Seminary - Seminex) came into being. Bob was a major architect of Seminex's internal governance and also its interpreter to the church and the secular world. He also taught at Lutheran School of Theology at Chicago, commuting weekly from St. Louis for eight years.

The above is a skeletal look at Bob Bertram and a few of his accomplishments. It would be easy to fill the entire page with merely a list of the theological and ecclesiastical commissions to which he belonged and to which he gave his guidance. But that listing would in no way exhaust Bob's gift to the church and to Jesus Christ whom he loved. Let me rather put the listing of those activities aside to concentrate more on the man.

Bob and I met over 30 years ago and developed a friendship which from my side had few equals. Bob was a consummate lover of people, starting from and working out of a never-ending love of his wife Ethelda. Bob wore his vast knowledge lightly -- at least with me. I must admit that we did not have deep philosophical or theological conversations about the Trinity. Rather, our private conversations tended more to the eschatalogical aspects of Christ. In conversation we tended to look ahead to the future we both knew awaited us.

In these conversations the lover who was Bob Bertram made himself evident. I guess he felt enough at ease with me to say things I can't imagine he would say to many. I do not want to intrude on that relationship except to say it was more often than not cast in the language of the One Flesh of Scripture. I don't know its present state but a couple of years ago Bob was writing on marriage as the two-in-one-flesh of Genesis. As I say, I don't know the present state of the book he was writing, but I hope some other lover finished it.

His humor was subtle but even when it was not it was designed to make a point in a very funny way. If I may I will add one item from what Bob called his "anecdotage." He told the assembled group toward the end of a particularly seeminly endless session that the Chairman of some Lutheran assembly once made the remark: It's not that everything has not been said. It is that not everyone has said it." Needless to say, while it got a huge laugh, the story made some point or other -- which is now lost in my memory.

Bob was the Vice-Director of ITEST for approximately 30 years. It is a job something like and something unlike the job of the Vice President of the United States. Bob was much more important to ITEST than the Vice President seems to be to the country. Bob was very active in setting the topics for many meetings and getting speakers for those meeting from his extensive association with highly educated people.

More than that, he acted as moderator for almost all the ITEST conferences and workshops. This task he performed with more than consummate grace, affability, humor and just good solid scholarship. I can remember many of his teaching moments and point them out in the Proceedings of the ITEST meetings. Along with Fr. Don Keefe, Bob spoke in complete sentences and his words rarely needed editing. What a gift to an editor!

Finally, let me say to Bob: what a joy to have known you. Thanks for stretching me out and for discussing the eschaton with me. Thank you for giving yourself to ITEST and to all who knew you. God's blessing, Bob.

OBITUARY OF BISHOP JAMES HOFFMAN

Robert Brungs, S.J.

Another death also occurred since the Winter *ITEST Bulletin* was published. Bishop James Hoffman, bishop of Toledo, Ohio died at the age of 71. His death was unexpected and affected the ITEST community greatly.

Bishop Hoffman was quite interested in the faith/science apostolate and was a member of ITEST for at least twenty-five years. More than just being a member, Bishop Hoffman was a very generous contributor to our work. I first met the Bishop when he was a member of the Bishops' Committee on Science, Technology and Human Values and I was a consultant.

Perhaps Bishop Hoffman's main interest (certainly it was one of his main interests) was the apostolic work of the laity. We will reprint (with permission) the obituary from *Initiatives*, the publication of the National Center for the Laity, PO Box 291102, Chicago, IL 60629.

Bishop James Hoffman (1932-2003)

"Hoffman became bishop of Toledo in 1981 and about that time assumed the chair of the U. S. Bishops Committee on the Laity. He was proud of many formation programs around the country and particularly in Toledo "for people who wish to serve as pastoral associates, lectors, catechists, Eucharisitic ministers and myriad other services within the parish." However, Hoffman -- who in his younger days was involved with the Young Christian Students and the Christian Family Movement -- was concerned that since Vatican II "the official Church effort has been to form and shape lay leaders and ministers for work inside the Church rather than in the secular world." The overemphasis on internal ministry has "perhaps by default disvalued the crucial work of lay women and men in the world. It is my personal conviction...that we need to attend to the vision of Vatican II relative to the lay apostolate and to provide support and encouragement for those who spend their lives in the crucial secular professions, be it politics, communications, science or whatever." Hoffman expressed the wish that official Church agencies take cues from the National Center for the Laity's *Chicago Declaration of Christian Concern* and show "greater sensitivity...to the importance of the lay vocation in the world."

Hoffman -- a pastor, an educator, a person of prayer, a civic leader, a friend to the poor and a great supporter of the laity -- is mourned not only in Toledo but in many other communities around the country.

CHRISTIANITY AND MODERN SCIENCE

Rudolf B. Brun

[*Professor Rudolph Brun teaches in the Department of Biology at Texas Christian University in Fort Worth, Texas. Professor Brun studied theology as well under Hans Urs von Balthasar in Europe. He writes this article both for inclusion in this issue of the Bulletin and for Readings on Faith and Science -- II. The latter work will most probably be put on the ITEST web site by the end of this year. Your responses to this article and the others in this issue are welcome.*]

Thesis: Creation reflects the Trinitarian existence of God.

Abstract: God is Trinitarian existence, unity in the diversity of Father, Son, and Holy Spirit. The eternal Word of God creates creation that is not God. Modern science discovered that novelty emerges from the unification of elements that were previously unified. The ontological structure of created existence is united diversity. It is the reflection of the Trinitarian existence of God in the "otherness" of creation.

Incarnation, the fundamental mystery of Christianity.

The gospel of John opens with the introduction to the central mystery of Christianity: "In the beginning was the Word, and the Word was with God, and the Word was God. All things came to be through him, and without him nothing came to be" (Jan. 1,1-3). John's gospel opens with the paradox that Christ is simultaneously the creator and creation.[1] Through incarnation the originator of all that is, the infinite God, becomes coexistent with the created finite world.[2]

Christ does not pretend to be creation but *is* creation. "For in him were created all things, in heaven and earth,[....] All things were created for him and through him" (Col, 1, 15-16). In Christ created reality, the finite, is taken up into the infinite, into the eternity of the creator. Christianity therefore understands Christ to be the person in which the infinite, the finite eternity and time intersect.[3] This is the reason why in Christ creation is open to the creator.

The mystery of incarnation therefore illuminates the mystery of creation. It allows a glimpse into how God almighty, who *is* existence, can create from what does not exist. God brings forth creation from nothingness; from what is essentially not God. The Word of God *that is* God creates creation *that is not* God.

Incarnation, the paradox of how God can be God in the absolute otherness of a human being, is at the center of Christian faith. How this is possible we cannot understand. We may understand, however, that the paradox is rooted in the almightiness of God. From incarnation a light shines that illuminates why the presence of God in the world does not destroy the world but affirms it. Faith can understand the message that the almighty Word of God does not hold on to its divinity; it departs from God to create the world.

The deep structure of creation

Incarnation therefore is God's divine gift of itself to creation. Because God is eternal his gift of the Word is given to creation from all eternity. It is only for us who are in time that incarnation is an event in history. The gift of the Word of God to the otherness of creation is, however, the center of all creation. It is the pivotal event in which the eternal act of God to create and save becomes concrete in time. Therefore it is in Christ that creation finds its goal, meaning and purpose for all time, past, present and future.

Christianity reveals that the nature of Nature is the Word of God given away to the absolute otherness of God.[4] Creation is a loving gift, a gift really given -- no strings attached. The gift is his creative Word, the Son of God who is God. This is why created existence cannot find the principle of its being. We can only wonder why it is that synthesis is the existence giving principle. "It is in virtue of unity that beings are beings."[5] The universe emerges through sequential synthesis. The creative process brings forth novelty by integrating elements that are integrated unities themselves. It is integration of diversity into unity that brings forth new existence. This is why all created reality exists as united diversity. It is the watermark imprinted on all that is the mark of the Triune Word of God in the otherness of creation.

It is through this gift of the Word of God to *what-it-is-not* God that creation is creative. Holy Scripture, therefore, is not the only Word of God, creation is too! Because there is the Bible and the Book of Nature there is biblical and natural theology. As Galileo already argued, both are revelations of God and therefore cannot contradict each other.[6]

The view from science

Ever since Darwin, however, Christianity and science seem to do just that -- be in conflict with one another. Christianity understands the world to be God's handy work. Darwin showed instead that all forms of life, including human beings, are the result of natural history, of evolution, not of supernatural intervention(s). Robert Chambers (and others before him) had already suggested that organisms were brought forth by nature. For Chambers, the Creator had created the world in such away that natural law was capable of bringing forth not only the physical inorganic world but also plants and animals. He argued that this was a much grander view of the power of the creator than supernatural interventions by special creations.[7]

Darwin not only made a convincing case for evolution but also suggested the mechanism by which nature could bring forth new forms of life. He discovered that chance variations between individuals of a species provided the substrate for natural selection. Only the best adapted individuals to the ever changing environments would survive. Survival of the fittest was nature's way to bring forth new forms of life. Darwin's argument that plants and animals evolved by natural selection working on events that happened by chance deeply upset Christianity. How could creation fulfill God's plan if nature worked by happenstance? How could human beings be created in the image of God if they had come higgledy-piggledy into the world? For most pious people Darwin had thrown out the creator from creation. They understood that Darwin had replaced God's guiding hand in the world with blind chance events. Human beings were not special creations anymore but produced by accidental variations, natural, (and sexual) selection.[8]

There were, however, some Christian theologians that welcomed Darwin's view. Among them was the Russian philosopher and theologian Vladimir Solovyev. In his lectures on "Godmanhood" he writes: "Why are the labours and efforts necessary in the life of the world, why must nature experience the pains of birth, and why, before it can generate the perfect and eternal organism, must it produce so many ugly, monstrous broods which are unable to endure the struggle of existence and perish without a trace? Why does God leave nature to reach her goals so slowly and by such ill means? Why in general, is the realization of divine idea in the world a gradual and complex process, and not a single, simple act? The full answer to this question is contained in one word, which expresses something without which neither God nor nature can be conceived; the word is *freedom*."[9]

Neither Solovyev nor Darwin could have known that matter as well as life, had also evolved. Fred Hoyle, the British mathematician and astronomer, suggested in the mid twentieth century that atoms evolve in stars. Today we know that the nuclear furnaces in the center of stars synthesize increasingly complex, heavier and heavier atoms.[10] The "raw materials" to do that, hydrogen, helium and some lithium, originated in the original explosion of the big bang.

It was Albert Einstein who correctly suggested that matter emerges from frozen energy. The fundamental particles that constitute all matter formed after the universe had cooled sufficiently. This allowed the primordial plasma of energy and matter to form.[11] Some of these particles emerged within fractions of a second. The first might have been the carriers of a unified primordial force. It was perhaps "a quantum-gravity" that then split into two forces: gravity and an "electro-nuclear" force. The "electro-nuclear" force (carried by X-particles) split into the electro-weak force (carried by Z-particles) and the strong force (carried by gluons). About one million years after the original explosion the universe had sufficiently cooled to allow light to emerge (carried by photons). The electro-weak force had split into the weak force (involved in radioactive decay) and the electro-magnetic force.

Why these "details?" Because the forces that organize the universe are a result of the natural evolutionary process not of supernatural intervention. The Descartian view that the world works like a machine, thanks to God-given natural laws, is out of date. God is not the supreme watchmaker who designed creation to work like a wound-up watch. Deism, even in a Christian disguise, is dead. Rather, Christianity knows that creation has its roots in a far deeper ground in the Triune God himself. Creation *is* the Word of God that departs from God into the "otherness" of creation.

Can modern science shed a light into this foundation of creation? I think the answer is "yes." Already Teilhard de Chardin saw that the world emerges through sequential syntheses from the integration of elements that were synthesized before.[12] Today we know this more precisely for example, the atoms listed in the Periodic Chart really are the result of sequential integrative events. We also know that from the increasingly heavier atoms to the appearance of complex molecules and to the first forms of life, it is always synthesis (of what was previously synthesized) that brings forth novelty.

This can perhaps best be demonstrated by dissecting complex entities into their constitutive parts. By sequential disassembling of complex unities into their elements, one actually is traveling back in time. Take any animal or plant and analyze its parts. The further down into the details one chooses to go, the further back one goes into past events. For example, cells are older than any tissues, parts of cells, (organelles) are older than cells, molecules are older than the organelles they form, the DNA molecules are older than the chromosomes, and the carbon atoms in the DNA are older than the DNA they (help) to form. And what is the source of the carbon atoms? They originated in the stars that formed from matter that froze even earlier from the energy released in the original explosion.

Teleology?

Traveling back in time by sequential dissection of complexity into its elements might generate the illusion that the forward moving process was directed toward a predetermined end. Similar to a "simple" fertilized egg that reaches the complexity of the adult, so the universe might have started from simple beginnings to a predetermined complex end. The fallacy here is to project the way organisms develop to the way the universe came into existence. In organisms there is a (genetic) program that guides plant and animal development to a predetermined end. There is no such program that guides the universe from its beginning to a predetermined goal. Rather, cosmogenesis is a probabilistic process. Each event in cosmic history happens within a space of other possible events. The process is essentially open-ended and therefore undetermined (stochastic). In short, cosmogenesis is the result of a genuine historical process. This is because those events that really happen out of the panoply of those that could also have happen bring forth new reality, new existence statistically. This is why the future is undetermined and open, not an extrapolation of the determined closed past. Thanks to the presence of the energy released in the original explosion, nature is capable of bringing elements together that it has synthesized before. This is why all complexity is constructed from elements that are complex unities themselves. Cosmogenesis is not teleological (predetermined) but teleomorphic (probabilistic complexification).

Cosmogenesis is the result of a self-similar, non-linear process. Self-similar because it is always the unification of parts that brings forth the new. The process is non-linear because the new has qualities that its elements (in isolation) do not have. For example, hydrogen and oxygen are gases but water (H_2O) is liquid. Furthermore, the integration of atoms into molecules brings forth entities essentially different from the atoms they integrate.

We have not yet generated life from molecules. It is, however, just a matter of time before we will be able to do what nature did on earth around four billion years ago.

Modern insights into molecular genetics quite strongly suggest that synthesis was also the engine that brought forth new forms of life. Genes became integrated into genetic programs. These control the development of the fertilized eggs into adults. New plants and animals seem to have emerged thanks to the duplication, variation, and integration of primordial genomes into new genetic programs.[13]

We do not yet know how the genetic program evolved that brought forth humans. We do know, however, that we are an outcome of the universal creative process of nature. We also know that roughly forty to seventy thousand years ago *Homo sapiens* (modern humans) brought forth representational art: bison, horses, mammoths and deer, skillfully painted on the walls of caves. Self-consciousness had emerged and with it the discovery of the difference between the "I" and the "not I." It is thanks to this space between the subjective "me" and the objective "not-me," nature that allows me to recognize the world as other. Self-consciousness creates the space for the understanding that I am a part of something that I am not.

Humans discover nature, but in this discovery nature also finds itself. Through self-consciousness humans and nature come to themselves. The discovery of nature within the human mind has deep consequences. Because the root of human subjectivity reaches into the objectivity of nature, we can find out how nature works. This is why we can write equations that describe the laws of nature. This is also the reason why there is art. It is the continuation of the creativity of nature at the level of the human mind.

We are that part of nature in which nature reaches the capacity to recognize itself. In this recognition nature comes to the understanding that it is not the source of itself. It is the understanding that its own existence is anchored in transcendent otherness. It is the wonder about the nature of being; the fundamental mystery of why there is anything rather than nothing.

In the depth of all human beings therefore dwells the wonder of this existence-giving "otherness." It is the root of deep-truth all human beings share, the source of beauty in nature and art, the source of humble, pious, and moral existence and the foundation of true religion.

Christianity reveals that this transcendent source of all existence is the Word of God in the otherness of creation.

Conclusion

Christian revelation opens an insight into this mysterious nature of nature. "For in him were created all things in heaven and on Earth.... all things were created through him and for him" (Col. 1, 16). This is why Christians know that Christ, the Word of God, is the foundation of creation.

The fundamental dogma of Christianity is that God the creator is love. Out of this love God sent his Word into *what-is-not* God. Because of this gift of God's Word to creation, nature becomes creative. Through the creative principle of the Word of God in the "otherness" of nature, creation reaches the point in which it discovers itself. Nature discovers itself through the emergence of human self-consciousness. Here the universe, the macrocosm, comes to itself in the microcosm of the human mind. This is why human beings represent nature, not just as empty icons but concretely. Through the human mind, nature is open unto itself. In this openness nature becomes aware of its transcendent origin.

Because human beings represent nature, their relationship with the Creator is critical for all creation. Critical, because we may accept or reject the loving relationship offered by God to creation through us. This why Saint Paul writes: "For creation awaits with eager expectation the revelation of the children of God" (Rm. 8: 19).

There is no reason for Christianity to shun science. To the contrary, the discoveries modern science has made about creation make it even more reasonable to believe.

Endnotes

1 Nicholas of Cusa, *On Learned Ignorance*. A Translation by Jasper Hopkins, The Arthur J. Banning Press 1985, Book III, chapter 2, pp. 128-130.

2 Maurice Blondel, *Lettres Philosophiques: Lettre a Abbé J. Wehrle 11 juillet 1904*, pp. 227-235. Aubier. Edition Montaigne, Paris 1961 229.

3 Xavier Tilliette: "Le Christ des Philosophes, Du Maitre de sagesse au divin Témoin." *Culture et verité*, Paris 1993, p. 39.

4 Hegel, *Philosophy of Nature*; Edited and translated

by M. J. Petry, London, George Allen and Unwin London, New York 1970, § 246, § 247, § 248.

5 Plotinus: *The Enneads; Nine Tractate*." Faber and Faber, London, 1956, p. 614.

6 Pope John Paul II: "To the Reverend John V. Coyne, S.J." In: *John Paul II on Science and Religion*. R. J. Russell et al. The University of Notre Dame Press, 1990.

7 From the book: *The Growth of Biological Thought, Diversity, Evolution, and Inheritance* by Ernst Mayr, The Belknap Press, Harvard University Press 1982, p. 382.

8 Charles Darwin: *The Descent of Man*. Murray, London, 1871.

9 Vladimir Solovyev, *Lectures on Godmanhood*. London: Dobson, 1948, p. 178-179.

10 For an overview and mechanism of synthesis see: William Fowler: "The Quest for the Origin of the Elements." *Science*, vol. 226 23 November 1984.

11 See for example: William J. Broad: "In a Lab on Long Island, a Visit to the Big Bang." *New York Times*, January 14, 2003.

12 Teilhard de Chardin: *The Human Phenomenon*. Brighton [UK]; Portland, OR. Sussex, Academic Press, 1999.

13 Scott Gilbert: *Developmental Biology* 7th edition. Sinauer, Sunderland, MA 2003.

SIX MAGIC NUMBERS IN PHYSICS

Thomas P. Sheahen

[Dr. Sheahen, a frequent contributor to the ITEST Bulletin, graduated with his PhD from MIT in 1966. Since then he has been in academia, government service and business. He currently resides in Deer Park, Mayland, in the far western part of the state.]

Was the universe designed and created intelligently, or did it all just happen randomly? Were the basic laws underlying all science just dumb luck, or do they serve some purpose?

For most people, their introduction to physics deals with Newton's laws, energy, momentum, sound, light and *maybe* a little atomic physics. Quantum Mechanics opens up an almost mystical wonderland of strange phenomena, and leads various people off into philosophical speculation of one kind or another.

One very essential fact is that everything we deal with is made of atoms -- every cell in every body, every neuron in the brain, and so forth. Through the use of intellect, we are able to discern order in nature, and that order is rooted in mathematical laws that govern the behavior of atoms. The "advance" of science is the discovery of patterns and regularities that display order. To "study" science means to inquire into the organized body of knowledge about order.

In basic physics, we learn about certain numerical values, like the temperature at which water boils, the speed of light, the charge on the electron, the acceleration of gravity, and many more. Each of these *physical constants* has some dimensions, or units, like meters per second or miles per hour. Only a few of these are worth memorizing, since their numerical values change whenever the units change.

Dimensionless Numbers

However, it is possible to construct *dimensionless ratios* by comparing two numbers that have the same dimensional units. For example, the speed of sound (C_s) and the speed of light (C_L) both are measured in the dimensions of meters/second, and so their ratio is a pure number without any dimensions at all. (No matter what units you use, C_L/C_s = 875,000). Another dimensionless number is the ratio of the mass of the proton divided by the mass of the electron: M_p/m_e = 1836. There is a very long list of dimensionless numbers that can be constructed this way. You might think all these numbers are of no special significance, just a coincidence. For most of them, you would be right.

However, here's what is really interesting: There are six very special dimensionless numbers which, if their numerical values had been different by even very small percentages, the universe as we know it today could never have come to be. These numbers pertain to the basic forces that govern the universe, the size and time scale of the universe, and the structure of everything. They appear in physics at a very rudimentary level. Coincidences? Actually, they reveal the exquisite *engineering* that went into giving us the universe we live in.

The British Royal Astronomer Martin Rees has written a book, *Just Six Numbers*[1], that devotes one chapter apiece to explaining the significance of each of these very special numbers. Here I follow Rees' descriptions, but there is only space enough to synopsize very briefly the key interesting facts about each.

Let's examine each of these numbers in turn:

The Special Numbers

1. *Ratio of the Electromagnetic Force to the Gravitational Force*: Gravity is a *lot* weaker than electromagnetism. It may not feel like it when you fall out of a tree and hit the ground, but it is. The extremely weak force of gravity only builds up to real strength when a *lot* of mass is present, such as in a planet. In stars and galaxies, there is so much mass that the force of gravity dominates.

However, both gravity and electromagnetism vary in strength via an "inverse square" law. As electric charges get farther away from each other (distance r), the force between them diminishes; similarly, as planetary bodies get farther away, the force diminishes; The "inverse square" law says both kinds of forces fall off as $1/r^2$. Consequently, a ratio can be formed of the strength of the two forces, and the $1/r^2$ dependence cancels out.

The ratio of the electromagnetic force to the gravitational force is about 10^{36} (= 1 with 36 zeroes). Martin Rees' book denotes this ratio by the letter *N*.

The extreme weakness of gravity is what gives the universe enough time to "get its act together." If gravity were stronger, gases would coalesce into much smaller stars much more quickly, and those stars would burn out more rapidly -- in about 10 thousand years instead of 10 billion years. The formation of planets takes longer than that, and the development of life longer still. If gravity were stronger, stars wouldn't last for enough time for us to be here.

2. *Efficiency of the Strong interaction, E*: Inside a star hydrogen is "burned" by nuclear fusion into helium. The interactions between protons and neutrons are governed by the *Strong Force*. As hydrogen nuclei combine, a certain amount of mass is converted into energy, according to the famous formula $E = mc^2$. The amount of mass converted is $E = 0.007$ (= 7/10 of one percent). Some of that energy is released as starlight, some energy is carried away by neutrinos streaming outward, but most sticks around the star as heat, and regulates the speed at which burning takes place and hydrogen is used up.

Now, what's interesting is that if this conversion efficiency were $E = .008$, the early protons from the Big Bang would have combined too quickly, and stars would not even have formed. If $E = .006$, protons would not bind to neutrons, and thus there would be no stellar process to produce helium. Either way, no stars as we know them.

Moreover, another process taking place inside stars produces carbon by the combination of three helium nuclei. A chance combination of three things is much too rare to depend on to produce much of anything, but it seems there is a "resonance" -- a very precise matching of energy levels -- that allows this process to happen, forming carbon from helium. Without the fine-tuning of the strength of the *Strong Force,* that resonance would vanish. Needless to say, without carbon, again no biology as we know it. The value of E has to be quite close to 0.007.

3. *Cosmic Density*: For centuries astronomers have looked at stars, but only in the 20th century was it discovered that the stars cluster together in galaxies. By the late 20th century, it became clear that the rotating motions within galaxies would cause them to fly apart, *unless* there is a lot of additional unseen mass out there exerting the gravitational pull necessary to hold things together. This unseen mass is termed *Dark Matter*. This idea is fully accepted by astrophysicists, because it is based upon a very sound theoretical basis. Our current understanding is that we see very little of the mass in the universe; about *90%* of the mass is actually dark. It is probable that most of this mass is neutrinos, but other contestants have not been ruled out.

What is important, though, is that the universe has some average density, customarily denoted by ρ. If we take all that can be seen and spread it out uniformly over all space, that density seems to be about $\rho = 0.1$ atoms/m^3; and if we add interstellar dust, it becomes $\rho = 0.2$ atoms/m^3. The presence of dark matter runs it up to around $\rho = 2$ atoms/m^3.

If the density exceeded 5 atoms/m^3, the strength of gravitational attraction would be so great as to pull everything back together again in a giant collapse. That is called the "critical density." The ratio of the *actual* density to the *critical* density is denoted by Ω and is another of the six special numbers.

It is not difficult to do calculations to show the importance of the density ratio. Starting off from the Big Bang, the expansion of the universe can be traced in space and time, depending on various choices for the parameter Ω. Basically, the computational process diverges, that is, it runs off wildly. If the *actual* density were slightly lower than the *critical* density ($\Omega < 1$), expansion would proceed rapidly, and density would become lower still; in that case, stars and galaxies would never form, and the universe would simply fly apart. If the density were slightly high ($\Omega > 1$), gravity would halt expansion, the universe would re-collapse, and there would be insufficient time for stellar evolution. The range of permissible values of Ω is very narrow -- and sure enough, we're in that range. The actual expansion rate of the universe is an observable, measurable quantity, known as the *Hubble Constant.* We observe that, in over 10 billion years, Ω has stayed remarkably close to one. For that to be true today, it must have been the case that at one second after the Big Bang, $\Omega = 1$ had to hold within one part in 10^{15}. It is plausible to argue that Ω has to be *exactly* one, for reasons not yet discovered.

4. *Smoothness and Ripples*: Any theory of cosmology has to match the observations from astronomy. One problem is that the observable universe is certainly non-uniform. If one imagines a "Big Bang" followed by expansion, at first it would be plausible to suppose that the expansion proceeded uniformly; in which case, there would be no particular reason for stars and galaxies to coalesce.

The most convincing observational evidence we have that a big bang did occur is the *Cosmic Background Radiation,* which shows that the universe is filled with radiation corresponding to a temperature of about 3 °K (2.7 °K to be precise). That radiation, leftover from a very hot Big Bang about 14 billion years ago, was first discovered in *1963,* and seemed to be coming uniformly from all directions. However, in recent years, the NASA *Cosmic Background Experiment* (COBE) showed that there were small fluctuations ("ripples") in this radiation, and those irregularities are enough to trigger the formation of galaxies: denser regions led to galaxies, and sparser regions led to voids. The magnitude of the initial fluctuations are very small: about one part in 10^5 (1/100,000). But slight density fluctuations are magnified over time, such that stars and galaxies coalesce.

Separately, the gravitational "binding energy" of a galaxy, divided by the energy of its rest mass ($E = mc^2$) is denoted by Q, and is about 10^{-5}. This number Q provides an estimate of the size of "ripples" in the density of space. The fact that it comes out about the same as the "ripples" in cosmic background radiation confirms the relation between the two -- the primordial fluctuations of radiation density probably led to the observed density variations across intergalactic space.

Since $Q \approx 10^{-5}$, it means that gravity is weak in a galaxy (or in a cluster of galaxies), so Newton's laws are applicable. That in turn allows machine computations to be done on an expanding universe subject to its own gravity; the results simulate how gravitation leads to clusters of galaxies. The numerical outcome is statistical, of course, but not in disagreement with what is observed.

However, if Q were significantly smaller than 10^{-5}, galaxies would coalesce much slower and looser, star formation would be much slower, and the heavy elements formed in a supernova would easily go away, so that planets could not condense around stars. If Q were significantly larger than 10^{-5} (large ripples), very large galaxies would coalesce quickly and collapse into black holes. Stars (if any) would be so close-packed that they could not have planets. Either way, Q has to be close to 10^{-5} or else no planets form, and once again, we're not here.

5. *The Cosmological Constant*, λ: When Einstein first proposed the General Theory of Relativity, he introduced a term (λ) known as the *Cosmological Constant,* whose role was to provide a balancing force that opposed gravity and kept everything from collapsing. It was to represent a force even weaker than gravity, one that would only have effects on a galactic scale, undetectable on our planetary scale. This force created a "cosmic repulsion." This factor λ didn't enhance the beauty of Einstein's equations, and he was unhappy with it. It became unnecessary several years later when the universe was observed to be expanding. So theorists set $\lambda = 0$, and put it aside. Some years later Einstein called it his "greatest blunder."

Many decades later, λ is making a comeback. There is reason to believe that there may be energy-fluctuations in a vacuum, and there are irregularities in the observed primordial background radiation. Recent astronomical observations of red-shifts from distant supernovae tell how fast they are receding, and hence give a measure of the expansion rate.

But still λ must be a very small number. If $\lambda = 0$, then the expansion of the universe is decelerating. On the other hand, with a finite λ there would be an anti-gravity effect that actually accelerates the expansion. Thus, the fine-tuning of λ affects the predictions of the long-term future of the universe.

6. *Dimensionality*, D: The sixth number that Rees takes note of is the dimensionality of space, denoted by D. This equals 3, and thanks to the theory of relativity, the space-time continuum is taken as 4-dimensional. The connection of *time* to the 3 *space* dimensions is easy to do mathematically, by associating an imaginary number with time; and the equations of physics take on a sym-

metry and beauty when this is done. However, in human thoughts and human language, the connection has never been successfully made.

Nevertheless, it is easy to show that a universe having 2 or 4 (or more) spatial dimensions doesn't work. The electromagnetic and gravitational forces only fall off as $1/r^2$ in a system having 3 spatial dimensions. That means that atoms wouldn't form, and the orbits of planets would be unstable, if there were other than 3 spatial dimensions. In fact, Martin Rees has some kind words to say (p. 136) about William Paley, a theologian-scientist circa 1800 who first stressed the importance of this dimensional requirement. Again, the significance is that we wouldn't be here unless $D = 3$.

In the relatively new physics research category of *String Theory*, quarks are treated as excitations upon a string, and the whole theory takes place in a manifold of extra spatial dimensions (usually 10), most of which are "compactified" or "rolled up." The mathematics is sound, but the links to ordinary language are awkward and contrived, and so the non-specialist listener is often mystified by presentations attempting to explain string theory. For example, the analog of a membrane (familiar to us as a 2-dimensional surface) is termed a "d-brane" in higher dimensions, and quantum gravity is then said to project downward from higher dimensions to become the gravity that we observe in the real universe. It's very difficult to form an image of what this means.

It is important to note here only that string theory does not predict any changes in 3-dimensional physics. Electromagnetism and gravity do not change. For everyday purposes, the sixth number has the single value $D = 3$.

What Does It All Mean?

So what are we to make of these remarkably fine-tuned numbers? Are they all just coincidences, even the one (Ω that must be precise to the 15^{th} decimal place? A lot of people would call this very clear evidence for design -- the numbers seem to point out clearly that the Creator of the universe was awfully smart, thought way ahead, and had perfect control. Of course, the phrase "thought way ahead" gives an image of God acting *within* time, rather than being exempt from time and simply *present* to all times; but that's another story entirely. Still, the impact of the numbers is to inspire in mankind both awe and humility.

It must be noted that the phrase "intelligent design" has been blurred by confusion and politics, and is often (erroneously) associated with creationism. Recognizing this distortion, we need a new phrase to convey the idea that God's comprehension and creativity runs all the way from mathematics to mankind.

We know that God has a habit of never *forcing* anyone to believe in Him. There is a "bail out" path for those who insist that our universe must be due just to random chance alone. That bail-out route requires the notion of a "Multiverse."

The idea is as follows: in the "Multiverse", there are an infinite number of universes, and most of them are uninteresting, just random chaos. All the others (except ours) are going nowhere fast. This way, we just so happen to be in the only universe that could accommodate us. With an infinite number of possibilities, *of course*, one would turn out just right.

Just one thing, though: It is impossible for us to detect or observe any of those other universes in any way. There is absolutely no connection between our universe and all those others. If you can agree with the "Multiverse" idea, then you can accept that our universe was just dumb luck, the one-in-a-gazillion event that led to something meaningful.

This is the point where a lot of scientists part company. In particular, Martin Rees, author of *Just Six Numbers* whom I have quoted so extensively above, prefers the idea of a "Multiverse." I find this surprising, since on page 68 in the same book he writes: "A 'bad' theory, in this sense, is one that is so flexible that it can be adjusted to account for any data."

I prefer this approach: Many centuries ago, scientists adopted a principle that has become known as "Occam's Razor." You limit your theories to the simplest possible combination of hypotheses that can explain the *observed data*. That's how *real* science is done. You don't think up extraneous stuff that is unobservable and call that "science." In fact, you really can't call yourself a scientist if you don't accept this basic principle of thinking and reasoning known as "Occam's Razor."

Thus, there is quite a high price to be paid if you want to believe in the "Multiverse" and say that all these very precise dimensionless numbers have no significance -- you have to abandon a basic cornerstone of science! How can anyone go for the "Multiverse" and still call himself or herself a scientist? *Cognitive Dissonance* is the only way I can describe that behavior, and I certainly can't explain it. My view is a very harsh one: the "Multiverse" is the last refuge of the atheist who is so totally committed to his position that he will give up everything else to hold onto it.

For the rest of us, the message that stands out from the exceptional precision of the dimensionless ratios is that our universe was designed by an intelligence far superior to our own, who wanted things to come out in a very special way, and wanted us to be here eventually. But the "eventually" that involves *us* is not the end of the road. The *really* interesting question is: "What's next?"

Endnotes

1. M. Rees, *Just Six Numbers*, (Basic Books: 2000)

HUMAN EMBRYONIC STEM CELL RESEARCH: ETHICS IN THE FACE OF UNCERTAINTY

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Too often the opposing positions in the stem cell and cloning debate are presented in terms of the obviousness of their assertions made. Considering the complex nature of these controversial issues challenging our society, the reality is much less clear and certain. Therefore, the question addressed in this essay is: how might we best respond to the challenge of human embryonic stem cell research in the face of the uncertainties that pervade this issue?

Uncertainty is present in all aspects of this issue: scientific, medical, moral, religious and political. This essay begins with the areas of uncertainty that are perhaps most surprising and, hence, most vexing for those engaged in this public debate -- the scientific and the medical.

In order to appreciate more fully the scientific and medical uncertainties within stem cell research, it is helpful to put the science of the stem cell debate within a larger context of the current advances in molecular and cellular research. Stem cells are only one part of the rapidly expanding arena of molecular biology research. This arena includes such topics as genetic therapies, genomics, pharmacology, proteomics, and various types of cellular and tissue research.[1] All of these research trajectories offer tremendous potential for advancing our scientific knowledge as well as the possibility of leading to new and exciting medical therapies and products. A couple of examples may help give a sense of the scope of these possibilities.

Much has been written both in academic journals and the popular press about the promise of human gene therapy. Until recently there has been little concrete evidence of the fulfillment of that promise, and, instead, some tragic and troubling research tragedy has occurred.[2] However, the latest results of some clinical trials employing gene therapies to treat immune system disorders indicate that the promise might be at least partially satisfied.[3]

In these clinical experiments, the researchers added a functioning gene to the cells of individuals who were diseased because of a genetic defect. The drawbacks to this approach include the problem of not being able to control where the new gene incorporates into a cell's DNA, and the problem of the mutated gene remaining in the cells. In the near future, researchers hope to address these problems by directly replacing or repairing the diseased genes.[4]

If the disease to be treated results from flaws in a region of DNA much larger than a single nucleotide or even a single gene, then researchers may try to employ artificial chromosomes to address the situation. In addition to a larger genetic carrying capacity, human artificial chromosomes would also have the advantages of maintaining a more stable number of the copies of a gene within a cell along with better control of long--term gene expression.[5] Using these genetic technologies to target both small and large genetic mutations, the physicians of the future may have much greater success in treating the genetic causes of many diseases.

However, if these genetic technologies can be used successfully to treat disease, might not they also be used to change the genetic constitution of a human being in order to alter that individual's physical or behavioral characteristics? Considering the fact that human beings share over 98% of their genetic sequence with chimpanzees, the question arises: would changing an individual's genetic constitution to include DNA sequences previously foreign to a human being change the nature of that individual? Is there an amount or kind of alteration that would result in that individual no longer being human?

These examples from human genetic engineering have been used to show that the ethical challenges generated by cutting edge biotechnologies are very much the same as those raised by human stem cell research. An example from stem cell research will help to demonstrate this point.

In an experiment designed to investigate the emergence of reservoirs of neural stem cells in the developing fetal brain, Evan Snyder and Curt Freed directed research whereby cells from a neural stem cell line derived from a human fetal cadaver were implanted into the developing brain of a fetal bonnet monkey at approximately 12-13 weeks of gestation. After sacrificing the fetal monkey four weeks later, Freed and Snyder found that the human neural stem cells had migrated and incorporated into the fetal monkey brain.[6]

Though it was not the stated purpose of the experiment, these results pose serious questions about the uniqueness or significance of human nature. If human beings are considerably interchangeable with other animals on a cellular and/or genetic level, then how might that reality affect our concepts of our selves? If we now have the ability to interchange genes, or cells, or even tissues and organs with other animals, then at what point does an addition of non-human parts make a human being something or someone else? Already researchers add human DNA and human cells to animals. In light of these realities, one could try to frame the question of human nature in terms of percentages of human DNA, cells, or genes expressed in a given animal. This approach, I would argue, is not likely to succeed because such quantification cannot encompass the complexity and richness found in our concepts of human nature.

The above experiment with human neural stem cells in fetal monkey brains is particularly relevant to these questions about human nature because arguments are often presented that focus on the human brain as the physiological basis for what makes human beings special or unique. If cells from humans and other animals can be mixed early in development and still form a functioning brain, then does it -- will it -- should it matter what percentage of a brain is made up of human cells? Perhaps, instead, research will indicate that the timing of a genetic or cellular manipulation during organismal development is more important than the amount of material inserted? Whatever the case may be, brain experiments mixing cells from different species will certainly add to the challenges scientific research is raising to our commonly held concepts of what it means to be human, and what makes humans special -- if anything.

In light of these challenges, and the troubling ramifications they may have for our moral frameworks and ethical reasoning due to their unsettling effects on our beliefs and concepts about human nature and human value, one could easily ask why it is that such research is being done at all? In order to answer this question well, at least a cursory understanding of stem cell research is required.

First of all, what are stem cells? The concept of stem cells is used to help explain how it is that a multicellular organism, such as a human being, can begin as a single cell and yet develop into a complex creature made of trillions of cells, that come in thousands of different types, which form hundreds of different tissues and organs, that provide the physiological basis for all our abilities and characteristics. In addition, many of the cells we require to function die during the course of a lifetime and need to be replaced. Stem cells are the source of these replacement cells. Hence, stem cells are considered to be special cells that can multiply to create and replace the many cells of our bodies, and at the same time replace themselves so that we continue to have some stem cells throughout our lives.[7]

From this understanding of stem cells one can easily project several important goals for research using these amazing cells. Often these goals are grouped into three categories: basic research in human development, safer and more specific drug development, and therapies to repair or replace damaged tissues and organs.[8] The basic research is obviously significant because scientists want to understand better how human beings develop from a single cellular structure to the complex structure of an adult body. In addition, since stem cells function to replace the cells we lose in daily life, basic stem cell research may help answer questions about disease, injury, and aging.

The goal of safer and more specific drug development is one that might be less obvious to the public at large. The idea here is to use stem cells from different individuals to grow cells, tissues, or perhaps even organs. Then instead of, or in addition to, testing drugs on animals or generic human cell lines which may not represent accurately or precisely the reactions of a target human tissue, the cells or tissues grown from different individuals can be tested for the efficacy and toxicity of various drugs. From such research, companies might get a much better idea of which individuals would benefit more from which drugs, and which individuals should avoid which drugs, even before clinical trials with human subjects are begun.

Eventually, the goal of this research is to develop products and therapies that would allow physicians to more directly, efficiently and effectively replace and repair the cells, tissues, and organs of an individual that may have been damaged or destroyed. This medical approach is now being promoted as "regenerative medicine."[9] In the public debate surrounding the stem cell issue, it is most often this goal of using stem cell research to regenerate tissues and organs that receives the greatest attention. Some additional distinctions concerning different types of stem cell research will help to clarify why this is the case.

The distinction most often used in the current stem cell debate is between "embryonic" and "adult" stem cells. "Adult" stem cells is something of a misnomer, since they are found in various tissues from the time of fetal development until death. "Embryonic" stem cells are those derived from the inner cell mass of a "blastocyst." "Blastocyst" is the term for a certain stage of human organismal development that is within the broader eight week period of embryonic development. The blastocyst is a hollow sphere of cells with a cluster of cells inside. The embryonic stem cells are derived from this inner cluster, and are obtained by breaking open and thus destroying the blastocyst. Since the procurement of embryonic stem cells results in the destruction of embryos, this process is highly contentious in our society where many hold the position that human lives deserve protection from destruction for research purposes even, or especially, during this early stage of development.

If obtaining human embryonic stem cells is so controversial, then why would anyone want to do it? The answer to this question requires our returning to the above description of stem cells and human development. Since it is known that the human body begins development with the fertilization of an egg with a sperm, it can be concluded that all the different cells of an individual had their beginning in a single fertilized egg. Similarly, scientific evidence indicates that all the different cells of our adult bodies arise from some of the cells in the inner cell mass of the blastocyst. Using this information, researchers conclude that these embryonic stem cells must be able to make any human cells or tissues one might need for research or therapy. Therefore, some researchers wish to use these embryonic stem cells to recapitulate what goes on during normal and/or abnormal human development.

Basically, then, the public debate concerning human embryonic stem cells revolves around weighing the good of doing this scientific research, with the primary goal of medical benefit, against the harms involved in doing research on human embryos. Having listed the benefits of this research above, I now turn briefly to the harms involved.

The most obvious, and probably the most broadly contentious, harm cited in the public debate is the destruction of the human embryo. This issue becomes exacerbated when proposals are made for intentionally creating human embryos, either by *in vitro* fertilization or by nuclear transfer techniques (cloning), in order to destroy them for their embryonic stem cells. At issue here is the value -- moral, legal, social, etc. -- societies are to acknowledge in or give to human embryos. The different arguments made concerning the value of human embryos range from claiming that they should be treated basically the same as any piece of human tissue to claiming that they should be treated basically the same as any human person. Since much has already been written across this broad spectrum, I wish to address only one aspect of the debate that highlights the uncertainty involved in this issue -- the ambiguities encountered in this debate concerning the term "embryo."

In order to support the claim that human embryos should not have protections similar to those held by human subjects in general, it is often argued that the relatively high rate of embryo loss in early pregnancy (with some estimates at 50%[10]) indicates that embryos should receive a lesser moral and legal status than human subjects in general.[11] Otherwise, it is asked, why do not societies and cultures encourage the ritual mourning of the loss of these embryos, and why do they not advocate for greater medical interventions to save these human lives? Prescinding from an analysis of differing traditions concerning the appropriate response to death early in human development, one can, instead, evaluate the importance of this argument by focusing on the ambiguity, or even equivocation, inherent in this argument with respect to the use of the term "embryo."

When arguing about the ethical status of a human embryo, the underlying reality about which one is arguing can be described as that stage of human development we all transited on our way to our current stage of human development, whatever that may be. In other words, we are discussing human embryos in the context of what we ourselves once were. This context is not the same as the scientific one that undergirds the statistics about human embryo losses in early pregnancy. Such statistics might readily include abnormal growths, such as complete hydatidiform moles.[12]

Though hydatidiform moles may have characteristics similar to embryos as described above, these growths are not developing along the trajectory of a human organism. Rather, these growths are disorganized in their development to the extent that they may require surgical removal in order to prevent them from becoming life threatening cancers. The question then arises: in light of the possibility of non-embryonic pregnancies, how many of these pregnancy losses are actually human embryos of the type of which we envision in our ethical debates? Once again, it appears that we are confronted with significant uncertainty. Since our scientific conceptualizations of an embryo may not match the embryo conceptualizations employed in our ethical analyses, the relevance of the argument regarding the percentages of embryos lost in pregnancy may be only minimal at best with respect to the human embryo research debate.

This problem of uncertainty in arguing about the ethical status of embryos fits within the larger context of uncertainty about human nature described earlier in this essay. It is not surprising that there is difficulty in defining the beginnings of human life, if it is indeed becoming more difficult to define human life itself due to our rapidly increasing scientific information. From this larger context, these uncertainties in the definition and understanding of embryos and human life may help to explain the impasse currently experienced in the human embryo research debates. If different, and even contrary, understandings of the beginnings of human life are being used in this public debate, then without extensive clarifications resolution of this contentious issue may be improbable, if not impossible. And if we cannot reach resolution on the status of the human embryo, how will we as a society address the coming dilemmas surrounding our concepts of human life or human nature?

I have argued elsewhere that the answers to these profound questions will require a revitalization of the philosophical anthropologies that undergird our ethical systems as well as our concepts of health, disease and human nature.[13] This revitalization will likely entail broad interdisciplinary and intercultural dialogue, and, hence, some length of time. Still, as our society currently wrestles with these more fundamental questions, one needs to inquire what our society is doing now to address the debate concerning human embryonic research in spite of the contentiousness and uncertainty surrounding this issue?

In one sense, this dilemma is not new for us, for as a society we have already decided that, in light of past abuses such as the research performed on African--Americans or the mentally disabled, it is sometimes best to limit what science and technology can do in order to better serve what is good for society.[14] In light of the harms caused to people in the name of scientific or medical progress, our society, and others around the world, have created guidelines and agencies to protect human research subjects from undue risks and harms.[15] This protection of human research subjects is an ongoing process, with new revelations and investigations regularly being reported by government commissions and by the media.[16] The controversies surrounding human embryo research not only involve the debate over the status of human embryos, but also include other human subject issues such as the procurement of human eggs in large numbers as might be required by nuclear transfer research and technology.[17] From within this current context of protections from undue research risk and harm, how is our current system of public ethical reflection responding to the human embryo research predicament?

One response to this contentious social issue has been for various organizations to gather panels of experts to investigate, analyze and evaluate the issue with the goal of generating recommendations for actions to be undertaken by governmental and/or other agencies. In general, the arguments and recommendations formulated by these expert panels have been reflective of or employed by many who are engaged in the broader public debate, especially with regard to legislation that has been or is to being addressed on both the state and national levels. The arguments that have been made in support of human embryo research often fall into two primary categories, referred to here as arguments from "need" and "number."[18] A brief analysis of these arguments will reveal the uncertainties inherent in them, and, consequently, their insufficiency to serve as justifications for pursuing this socially contentious research.

Addressing the argument of the *need* for human embryo research, it is important to recall that, as was observed in the beginning of this essay, the diseases suggested as likely targets for human embryonic stem cell research are also being targeted by researchers using other approaches, such as genetic therapies, drug development and adult stem cells. It may well be the case that for many patients the treatments for their illnesses may come more quickly from research avenues other than human embryonic stem cell research, and that these alternative treatments may even be better than any treatment derived from human embryonic stem cell research.

In response to this uncertainty as to what line of research might yet prove most successful in meeting the medical needs of people afflicted with severe or fatal diseases, proponents of human embryo research have argued that all scientifically sound lines of research should be pursued simultaneously, so that we have the best chance of discovering what will work as soon as possible. From a scientific perspective, this approach makes the most sense. In science, when there is uncertainty, one does all the research indicated to gain the desired knowledge and understanding. However, as was observed above, what is best for science is not always best for a society and its members. Some lines of research may be restricted or banned regardless of their scientific appeal in order to protect the well being of a society. Research that is as controversial and contentious as human embryo research must have reasons to justify its pursuit that are as ethically compelling as the harms it creates.

At this point in the debate, human embryo research proponents often turn to the second argument cited above and emphasize the incredible *number* of people who could potentially benefit from such research. These proponents can point to the uncertainty inherent in all this biological research and argue that no society should deny all these people who suffer from severe and fatal diseases the potential benefits of this research, even if the research is controversial and contentious within a given society. Associating this research with the substantial societal value of medical healing gives this argument significance.

There is, however, a fundamental flaw in this argument that undermines its power and claim. The flaw in this argument lies in its assumption of a direct correlation between scientific or medical advance and medical benefit for those who need it. The realities of health care systems both in our own society and around the world argue against this assumption. With respect to health care in the United States, we need to acknowledge that, even if treatments from human embryonic stem cell research are the first to be proven successful, many if not most people who need these treatments will not get them.

Evidence of the accuracy of this bleak assessment of our health care system is found in the December 2001 report of the President's Cancer Panel. Though great strides have been made in cancer research during the past three decades of our war on cancer, the Panel concludes, "In short, our health care system is broken, and it is failing people with cancer and those at risk for cancer -- all of us."[19] Worldwide the situation is much more bleak, considering that millions of children die each year from a lack of clean water, not to mention inadequate access to minimal health care technology.[20] Therefore, just because many people in the world might tragically share a devastating disease, such as diabetes or Parkinson's, one cannot conclude that this tragedy will be resolved by breakthroughs in research. The greater tragedy is that only a relative few will enjoy the benefits of many of our medical research advances. The argument from *number* does not fit our social reality.

At this juncture, it is critical that the arguments from uncertainty presented above be applied precisely. These arguments have been made to call attention to the flaws in the reasoning often presented in support of human embryonic research. These arguments do not argue against the pursuit of medical advances *per se*. These argument do, however, place scientific and medical research in the larger context of the good of societies in general. The National Bioethics Advisory Commission acknowledged the importance of this context and the consequent requirement for greater justification than normal in pursuing scientific research that is socially contentious.[21] Therefore, if the justification for proceeding with the destruction of human embryos for research rests even in part on these claims of *need* and *number*, then this justification is flawed and requires rethinking.

The evidence and analysis put forward in this essay attest to the pervasiveness of *uncertainty* in all of the aspects of the human embryo research issue. This uncertainty, it has been argued, even undermines the proposals for pursuing this research put forth by some of the expert panels commissioned to address this issue.

How then should society proceed? The arguments of this essay suggest two responses that could be implemented immediately within the current circumstances of our society. First, in recognition of the need for research into stem cell biology in order to understand better its promises and perils for future societal decisions, governmental support should be increased for stem cell research using animal models and non-embryonic human stem cells. This response would achieve scientific progress without raising especially contentious social and ethical concerns.

Second, in recognition of the vast numbers of people, within our own nation and around the world, who suffer from severe and lethal diseases or injuries, the findings and recommendations for improving health care proposed by expert groups such as the President's Cancer Panel and the World Health Organization should receive at least the same level of attention and action as has been expended on human embryo research.

Endnotes

1 The National Center for Biotechnology Information has websites that provide an overview of many of these technologies and internet links to other resources explaining these technologies. See both *http://www.nebi.nlm.nih.gov/About/primer/index.html*, and http://www.nebi.nlm.nih.gov/About/outreach/index.html.

2 See, Somia N, Verma IM, "Gene therapy: trials and

tribulations," *Nat Rev Genet*. 2000 Nov;1(2):91-9; and Teichler Zallen D, "US gene therapy in crisis," *Trends Genet*. 2000 Jun;16(6):272-5.

3 Rosen FS, "Successful gene therapy for severe combined immunodeficiency," *NEngl J Med*. 2002 Apr 18;346(16):1241-3; and Hacein-Bey-Abina S, Le Deist F, Carlier F, Bouneaud C, Hue C, De Villartay JP, Thrasher AJ, Wulffraat N, Sorensen R, Dupuis-Girod S, Fischer A, Davies EG, Kuis W, Leiva L, Cavazzana-Calvo M, "Sustained correction of X-linked severe combined immunodeficiency by ex vivo gene therapy," *NEngl J Med*. 2002 Apr 18;346(16):1185-93.

4 Gene replacement could involve techniques known as homologous recombination while gene repair could be done using techniques that correct a mutation by replacing the single letter (nucleotide) that is misspelled in the DNA. For example, see Richardson PD, Augustin LB, Kren BT, Steer CJ, "Gene repair and transposon-mediated gene therapy," *Stem Cells*. 2002 Mar;20(2):105-18.

5 Willard, HF, "Artificial chromosomes coming to life," *Science* 2000, 290:1308-9.

6 Ourednik V, Ourednik J, Flax JD, Zawada WM, Hutt C, Yang C, Park KI, Kim SU, Sidman RL, Freed CR, Snyder EY, "Segregation of human neural stem cells in the developing primate forebrain," *Science*. 2001 Sep 7;293(5536):1820-4

7 For background on stem cell biology and the perspective of the National Research Council committee on stem cell research see their report, "Stem Cells and the Future of Regenerative Medicine" which can be found online at http://www-.nap.edu/books/0309076307/html/.

8 See the NIH stem cell primer webpage, http://www4.od.nih.gov/stemcell/figure5jpg.

9 "Stem Cells and the Future of Regenerative Medicine," note 7.

10 For more on miscarriage and its causes see the March of Dimes website at http://www.modimes.org/HealthLibrary/334_592.htm.

11 For two examples of this type of argument see *American Journal of Bioethics* 2(1) 2002, Jeffrey Spike, "Bush and Stem Cell Research: An Ethically Confused Policy," p. 45, and Robert Baker, "Stem Cell Rhetoric and the Pragmatics of Naming," p. 53.

12 For more on molar pregnancies see http://www.modimes.org/HealthLibrary/334_591.htm.

13 "Philosophical Anthropologies and the HGP," in Controlling Our Destinies: The Human Genome Project from Historical, Philosophical Social and Ethical Perspectives, edited by Phillip R. Sloan; Notre Dame University Press, 2000.

14 Adil E. Shamoo and Joan L. O'Sullivan, "The Ethics of Research on the Mentally Disabled," in *Health Care Ethics: Critical Issues for the 21st Century*, eds. John F. Monagle and David C. Thomasma, Gaithersburg, MD: Aspen Publishers, Inc., 1998.

15 Guidelines for protecting human research subjects are found in such reports as the World Medical Association's "Declaration of Helsinki," and the U.S. "Protection of Human Subjects," *Code of Federal Regulations* 45 CFR 46, revised March 8, 1983. As well as RAC, OPRR, etc.

16 Examples of current events include the Virginia Governor's apology for forced sterilizations (http://www.governor.state.va.us/Press_Policy/Releases/May2002/May0202.htm), and recent Navy bioweapon exposures reports (http://www.cbsnews.com/stories/2002/05/24/national/main510079.shtml).

17 Andrew Pollack, "Use of Cloning to Tailor Treatment Has Big Hurdles, Including Cost," *New York Times* (December 18, 2001).

18 Though many examples of these basic arguments can be found in the transcripts of Congressional and state legislature hearings, one can find the arguments from need and number clearly stated in the following documents from three of the highest profile expert panels assembled to date: American Association for the Advancement of Science and the Institute for Civil Society report, "Stem Cell Research and Applications: Monitoring the Frontiers of Biomedical Research" (*http://www.aaas.org/spp/dspp/sfrl/projects/stem/report.pdf*) National Bioethics Advisory Commission report, "Ethical Issues in Human Stem Cell Research, September 1999" (*http://bioethics.Georgetown.edu/nbac/pubs.html*) and the National Research Council and Institute of Medicine report: "Stem Cells and the Future of Regenerative Medicine (2002)" (*http://books.nap.edu/books/0309076307/html/R1.html*).

19 President's Cancer Panel report (Dec. 2001), "Voices of a Broken System: Real People, Real Problems," p. 2 (http://deainfo.nci.nih.gov/ADVISORY/pcp/video-summary.htm).

20 World Health Organization, "Children's Environmental Health" (http://www.who.int/peh/ceh/index.htm).

21 NBAC report, note 18, p. 52-3.

CATHOLIC CHURCH GRANT FOR ADULT STEM CELL RESEARCH

Catholic News Headlines from Church Resources
cathnews@churchresources.com.au
25 March 2003

The Catholic Archdiocese of Sydney is pleased to announce that a $50,000 grant made available on 9 April 2002 by Archbishop Pell to support adult stem cell research has been awarded to a research team at Griffith University, led by Professor Alan Mackay-Sim.

Professor Mackay-Sim's team is conducting research into the development of therapies to utilize stem cells extracted from patients' nasal lining to replace those lost to disease. The Selection Committee concluded that this project is of first-class scientific merit, markedly original, and has good long-term therapeutic possibilities.

Archbishop Pell said he was delighted that the grant will be used to support adult stem cell research in an under-recognized area.

"This is an Australian project of genuine excellence, Australian science at its best, and I warmly congratulate Professor Mackay-Sim and his colleagues on winning this grant," Dr Pell said.

Professor Mackay-Sim said that this grant will fund research into the use of olfactory stem cells in treating Parkinson's disease.

"Potentially these cells could be taken from a patient's own nose, grown in the laboratory and transplanted into the same patient. This obviates the ethical and technical problems raised by transplanting cells from other people or from embryos," Professor Mackay-Sim said.

The selection Committee consisting of Dr. Bernadette Tobin of the Plunkett Centre for Ethics in Health Care (Chair), Dr. Peter McCullagh [long-time ITEST member and contributor, ed.], Honorary Research Associate, Faculty of Veterinary Science, University of Sydney, and Associate Professor Colin Thomson, Consultant in Health Ethics, National Health and Medical Research Council, considered four applications for the grant and was unanimous in recommending it be awarded to the Griffith University project.