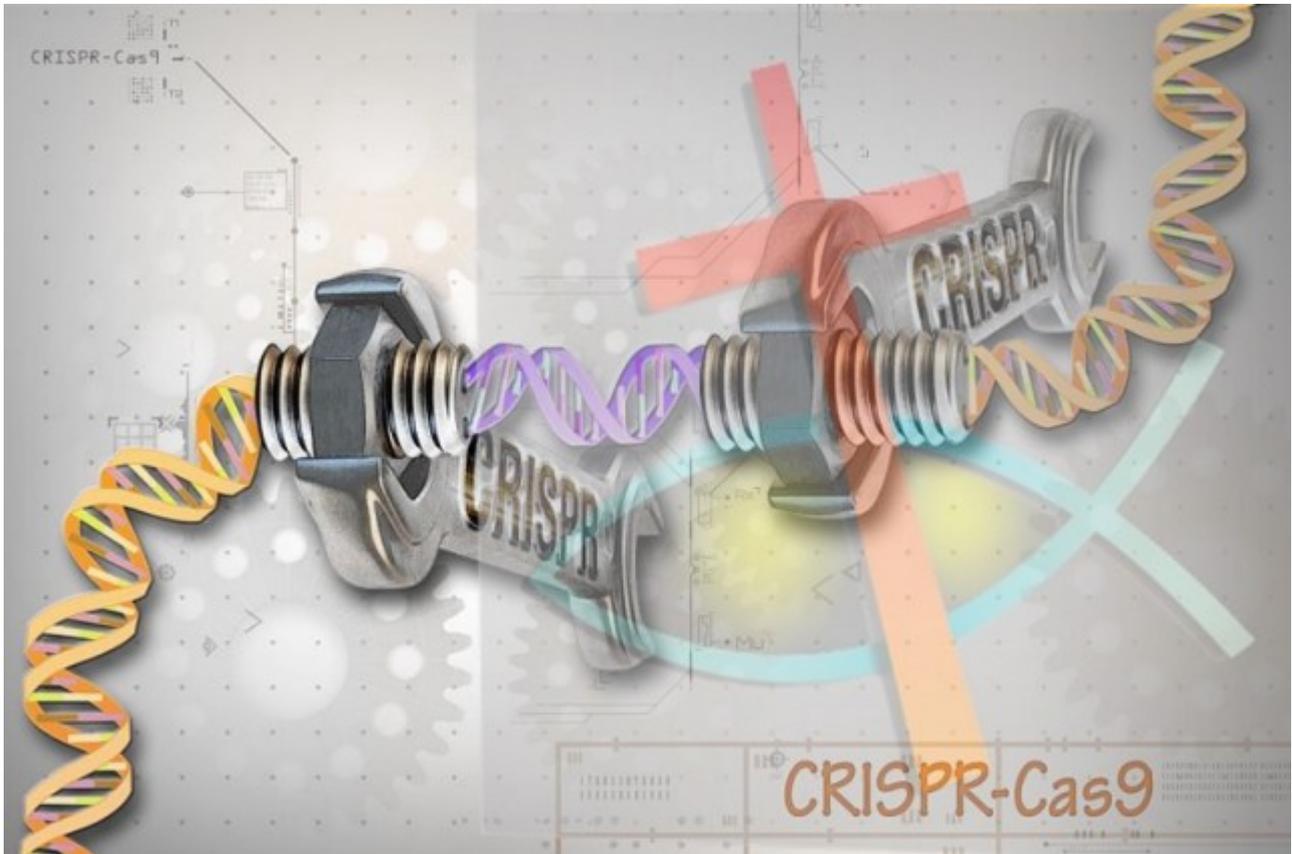


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CRISPR gene modification diagram (from [Wikimedia Commons](#)) + Christian Symbol

*“There is a fundamental difference between religion, which is based on authority, and science, which is based on observation and reason. **Science will win because it works.**”* [emphasis added]

—Stephen Hawking. ABC Interview, 2010

*“Pure insight and logic, whatever they might do ideally, are not the only things that produce our creeds.”*

—William James, [The Will to Believe](#)

## SECTION 1: A Look Back and Ahead

In ESSAYS 1-7 I've shown that (or done my best to do so for open minds):

the Catholic Church is not the enemy of science and, indeed, was the midwife of science for Western civilization;

the Catholic dogma, *Creatio ex Nihilo*, God created the universe from nothing, is totally in accord with **settled** cosmological science;

logic and rational inquiry have some limitations and exceptions; also, science, which employs several modes of rational inquiry, requires both theory and reproducible empirical validation; science can neither disprove nor prove the existence of a Trinitarian God; there is no conflict between Catholic Teaching and the science of common descent (evolution) provided we acknowledge that the human soul is uniquely bestowed by God at the moment of conception; moreover, there are several theories produced to explain how evolution occurs;

cognitive science explains how the brain works but does not tell us what is consciousness or a soul; philosophers disagree generally about "the hard problem of consciousness;" what Catholic teaching says about the soul is not challenged by scientific findings or philosophical conjectures;

miracles have occurred and will occur; although such events are outside the realm of scientific inquiry, they are validated empirically and by faith.

In this Essay I put the question, "Does science tell us how to live, how to be good Catholics?" I answer "No!" Science answers questions about "how" the world works (or does so to an extent). It does NOT give answers to "why" or "should" questions. On the other hand, materialists say that science does tell us how to live. These evangelists of scientism propose that science explains everything one needs to know about the world. The best of these arguments has been given by the physicist Sean Carroll in his apologia for scientism, "The Big Picture." I've rebutted his theses in a post. ["Sean Carroll's 'The Big Picture' Reviewed: Why 'Poetic Naturalism' is an Oxymoron,"](#) so there's no need to repeat my arguments here.

Just as science and technology do not tell us what our moral or religious beliefs should be, so our Catholic faith can not help us to judge what is good or bad science. Catholic teaching can, however, tell us what to do with science.

There are several issues where Catholic teaching might intersect science, or perhaps I should say, the consequences of technology, among which are the following: .

judging the truth of scientific theories as they apply to human conduct or Catholic Dogma;  
the right to life (abortion and euthanasia);  
genetic modification of human beings—designer babies.

Let's discuss the first in the list above: should the Church judge the truth of scientific theories?

## SECTION 2: Should the Church Meddle in Science?

### 2.1 THE GALILEO AFFAIR

In 1633 the Catholic Church made a big mistake: it convicted Galileo of heresy for advocating the Copernican theory, that the earth revolved around the sun. That is a bald statement of a much more complicated situation, as I've said in [ESSAY 1: The Catholic Church, Midwife and Nursemaid to Science, Section 4.1](#). Galileo was convicted not so much for advocating the Copernican hypothesis, but for saying that Bible erred in its picture of the world. The Galileo affair has been used as a cudgel against the Catholic Church, as an argument that the Church opposes science. But, as George Sim Johnston puts it:

*"The Galileo affair is the one stock argument used to show that science and Catholic dogma are antagonistic. While Galileo's eventual condemnation was certainly unjust, a close look at the facts puts to rout almost every aspect of the reigning Galileo legend."*

—George Sim Johnston, "[The Galileo Affair](#)"

Summarizing Johnston's arguments, one can say that both Galileo and some Church officials were at fault, that it was a different time with different concerns—high officials in the Church, initially sympathetic to Galileo, were defending orthodoxy against the onslaught of the Reformation.

Galileo was condemned not for his advocacy of the Copernican theory per se, but for his advocacy that Scripture was to be interpreted loosely (even though St. Augustine had also argued for a non-literal interpretation of Genesis). And Galileo's science was not entirely correct: he proposed circular orbits for the planets and an incorrect theory of tides. All this is dealt with at greater length in the article linked above. Nevertheless, this one piece of history has been the cannon used in the war of materialists against the Church to support their perceived conflict between the Church and Science.

In 1979 Pope St. John Paul II asked the Pontifical Academy of Sciences to make an in-depth study of the affair. Commenting on their report in 1992, he said, as an apology, explaining what had happened:

*"Thanks to his intuition as a brilliant physicist and by relying on different arguments, Galileo, who practically invented the experimental method, understood why only the sun could function as the centre of the world, as it was then known, that is to say, as a planetary system. The error of the theologians of the time, when they maintained the centrality of the Earth, was to think that our understanding of the physical world's structure was, in some way, imposed by the literal sense of Sacred Scripture...."*

—Pope St. John Paul II, "[Address to Pontifical Academy of Sciences](#)", as quoted in L'Osservatore Romano N. 44 (1264) – November 4, 1992

## **2.2 CARDINAL SCHONBRUN AND INTELLIGENT DESIGN**

Clearly the Church not make judgments on scientific matters when the science itself is not settled, Church dignitaries should carefully consider whether it is necessary that they support

one of several contending interpretations. Cardinal Schonbrun caused much controversy by publishing an essay in the New York Times, "[Finding Design in Nature](#)", that seemed to support the theory of Intelligent Design as opposed to the neo-Darwinian mechanism of evolution. The essay was criticized by a number of Catholic scientists, including the then director of the Vatican Observatory, and by the physicist, Stephen Barr, in an [article in First Things](#). Cardinal Schonbrun enlarged on his position in a [later article in First Things](#) and explained that he was not necessarily supporting Intelligent Design theory, but that God guided all events, including evolution, and that our universe is not the product of chance. I certainly agree with that opinion.

### 2.3 POPE FRANCIS AND ANTHROPIC GLOBAL WARMING (AGW)

I'm very much afraid that Pope Francis has repeated the mistake made by Cardinal Schonbrun, by taking an official Church position for the truth and perils of Anthropic Global Warming. In his Encyclical *Laudato Si* and in [statements from the Pontifical Academies of Science and Social Science](#) there are judgments and statements that are contentious, that are not held by all scientists. For example, it is not the case that polar ice and Himalayan snow are decreasing (they continually melt, but the net amount is not decreasing due to global warming—see [evidence from satellite images](#).)

As I said above, I don't propose in this essay to debate extensively the merits of AGW. (See "[Scientific Integrity: Lessons from Climategate](#)," "[Laudato Si on the Science of Global Warming](#).") On the other hand, it is essential that two points be made:

**First, it is not true that a "97% consensus" of scientists support the AGW / Climate Change proposition.** See, for example [the 97% myth](#). And in any case, scientific theories and propositions are not judged by majority vote, but by empirical confirmation. Before the Michelson-Morley experiment a majority of scientists believed in the ether as the medium for propagation of electromagnetic waves; afterwards, not many.

Second, the extent of data massaging ("fudging") revealed in the Climategate excerpts and of fiddled [temperature data from Paraguayan weather stations](#) should cause one to regard reported temperature increases with more than usual skepticism.

Accordingly, global warming caused by human production of CO<sub>2</sub> is by no means a settled

scientific issue. For a fuller account see Andrew Montford's ["The Unintended Consequences of Climate Change Policy"](#).

#### **2.4 LEMAITRE & POPE PIUS XII: THE BIG BANG AS THEOLOGY; WHY THE CHURCH SHOULDN'T JUDGE SCIENCE**

Pope Pius XII wanted to use the Big Bang theory of Abbe LeMaitre as evidence in a proof for God, supported by the Church. (See [here](#).) Abbe LeMaitre dissuaded him from doing so by arguing that scientific theories are tentative, subject to change, and that certainly isn't a property one should expect of a religious truth. After his conversation with Abbe LeMaitre, Pope Pius XII evidently agreed. He made no further proposals about the Big Bang as part of Catholic theology.

The Dogma and Doctrine of the Church are handed down from God as eternal truths, whereas theories and fundamental principles of science can change, supplanted by new theories and new empirical evidence. (I hope the latter has been evident from the previous Essays.)

Accordingly, for Church officials to make a judgment about scientific matters—settled or unsettled—is to presume knowledge and authority for which they are not qualified. And such judgments oppose the notion of Dogma and Doctrine justified by Revelation and Tradition, rather than by empirical validation.

### **SECTION 3: What Biology and Catholic Teaching Tell Us about the Sanctity of Life**

*"Human life is sacred because from its beginning it involves the creative action of God and it remains for ever in a special relationship with the Creator, who is its sole end. God alone is the Lord of life from its beginning until its end: no one can under any circumstance claim for himself the right directly to destroy an innocent human being."*

Catholic Catechism, 2258

### **3.1 EMBRYOLOGY: HUMAN DEVELOPMENT IS CONTINUOUS FROM CONCEPTION TO BIRTH**

Embryology tells us that the development of the human from conception to birth is continuous; there are no sharp changes, no sudden metamorphosis, caterpillar to butterfly.

Thus the full humanity is present in the 8 cell blastopod as well as in baby emerging from the birth canal. There is a fine [Youtube depiction](#) of this continuous development by Alexander Tsiaras. Here is the video.

The Princeton philosopher, Peter Singer, recognizes that there is no logical distinction between the child *in utero*, unborn, and the infant, the child which has emerged from the birth canal. Thus it is as permissible to kill an unwanted child after it is born as before:

***“ ‘Newborn human babies have no sense of their own existence over time. So killing a newborn baby is never equivalent to killing a person, that is, a being who wants to go on living [emphasis added]...Sometimes, perhaps because the baby has a serious disability, parents think it better that their newborn infant should die. Many doctors will accept their wishes, to the extent of not giving the baby life-supporting medical treatment. That will often ensure that the baby dies...My view is different from this... I believe it should be possible to carry out that decision, not only by withholding or withdrawing life support — which can lead to the baby dying slowly from dehydration or from an infection — but also by taking active steps to end the baby’s life swiftly and humanely.’ ...More recently, in an April interview with WND’s Aaron Klein, [Mr. Singer](#) said bluntly: ‘I don’t want my health insurance premiums to be higher so that infants who can experience zero quality of life can have expensive treatments.’ ”***[emphasis added]

—Peter Singer, as [quoted in the Washington Times](#)

### 3.2 WHEN IS HUMAN; WHO IS HUMAN

*“We use terms like “zygote” and “fetus” — and for that matter “adolescent” and “adult” — to describe human beings at different stages of development. **A fertilized human egg is simply a human being at its first stage.** [emphasis added]... But certain individuals like to use these terms as though they describe entirely different creatures, not stages of the same creature. They do this to disguise what they actually believe, which may also be stated quite simply: that some human lives are worth less than others.”*

—Peter Christofferson, comment on [“The Banality of Evil, Redux: Do Planned Parenthood Officials Sin?”](#)

Some abortion proponents attempt to justify killing the unborn by denying the humanity of an embryo or fetus; they use the following arguments:

A fetus is not human until it totally emerges from the birth canal (a presumed justification for partial-birth abortion);

Before some arbitrary time mark, say 24 weeks after conception, it is permissible to abort a fetus;

Since self-awareness is a prime criterion for being human, it is permissible to abort an embryo or fetus before it is self-aware.

All these assertions deny a fundamental article of Catholic Faith, that life begins at the instant of conception and that the Holy Spirit endows that life with a soul. Moreover, these arguments are not justified by any sort of scientific evidence.

### 3.3 PARTIAL BIRTH ABORTION IS IRRATIONAL

In a 1999 debate on partial birth abortion, Senator Rick Santorum showed that Senator Barbara Boxer’s defense for this cruel act was irrational. (See [here](#) for a full account of the debate.)

Senator Boxer: *“The baby is born when the baby is outside the mother’s body”*

Senator Santorum tried to get a more specific answer by asking whether if only a toe was inside the birth canal, or a foot, or ??, would the baby then be subject to abortion:

Senator Santorum: *“But, again, what you are suggesting is if the baby’s toe is inside the mother, you can, in fact, kill that baby.”*

Senator Boxer vehemently denied that, but would not specify how much of the baby’s body had to be in the birth canal to justify partial birth abortion. Her assertion that the baby had to be outside the mother’s body in order to qualify as a human being defies common sense, as was made obvious by Senator Santorum’s questioning. And this is the problem with partial birth abortion: it defines human status in a totally arbitrary way.

### **3.4 TIME LIMITS TO ALLOW ABORTION ARE ARBITRARY**

In many states an arbitrary time after conception is set for abortions to be allowed: before that time abortion is legal; afterwards, not. Most recently the Ohio State Legislature passed a 20 week abortion limit.

Some interesting questions occur, naive though they may be. First, how do you determine (without drastic invasions of privacy) when conception occurs? Turning aside from that issue, we can ask if a fetus at 19 weeks, 6 days, 23 hours, and 59 minutes after conception is non-human, i.e. legally eligible for abortion, then why is a fetus 20 weeks, and one minute after conception human, not to be aborted? What happens during those two minutes that changes the fetus from non-human to human? I should hope it’s clear that any time marker to legalize abortion is arbitrary, without any rational basis.

### **3.5 THERE IS NO SHARP POINT AT WHICH A HUMAN IS SELF-AWARE**

The third of the comments above asserted that an embryo or fetus would not be human because it would not be self-aware and, therefore, could be aborted without qualms. Really? If we're deeply asleep, do we then become non-human, zombies? What about people in deep comas from which they later awake? Are they non-human while in coma and then become human again when they recover?

With respect to self-awareness in infants, it does not suddenly occur when the baby emerges from the birth canal. Studies by an Emory University psychologist, Phillippe Rochat, suggest that there are [five levels of self-awareness from infancy to early childhood](#). Rochat asserts that even immediately after birth, babies have passed beyond the initial stage (total confusion):

*“It appears that immediately after birth, infants are capable of demonstrating already a sense of their own body as a differentiated entity: an entity among other entities in the environment (Level 1).”*

—Phillipe Rochat, [Five levels of self-awareness as they unfold early in life](#)

And if this awareness is present immediately after birth, should it not also be present before birth? And if the development of consciousness is a continuous process, when is it that not one smidgeon of self-awareness is present? Remember, the brain is present as a partially developed organ some 5 weeks after conception.

### **3.6 ALLOWING ABORTION HAS WIDER MORAL CONSEQUENCES**

In one of my blog posts, [The Banality of Evil, Redux](#), I compared the Nazi genocide of Jews to the Planned Parenthood abortion industry:

*“The Nazis did not regard Jews as humans, nor, evidently, do Planned Parenthood doctors regard unborn babies as human.”*

Once it is admitted that a person “no matter how small” can be classified as non-human, then there are no limits:

*“Assuming as a principle that humans can be selectively classified as unworthy of life—as elderly, as disabled, as unborn, as ethnically impure, as mentally challenged—violates that which is, or should be, written in the conscience of every man.”*

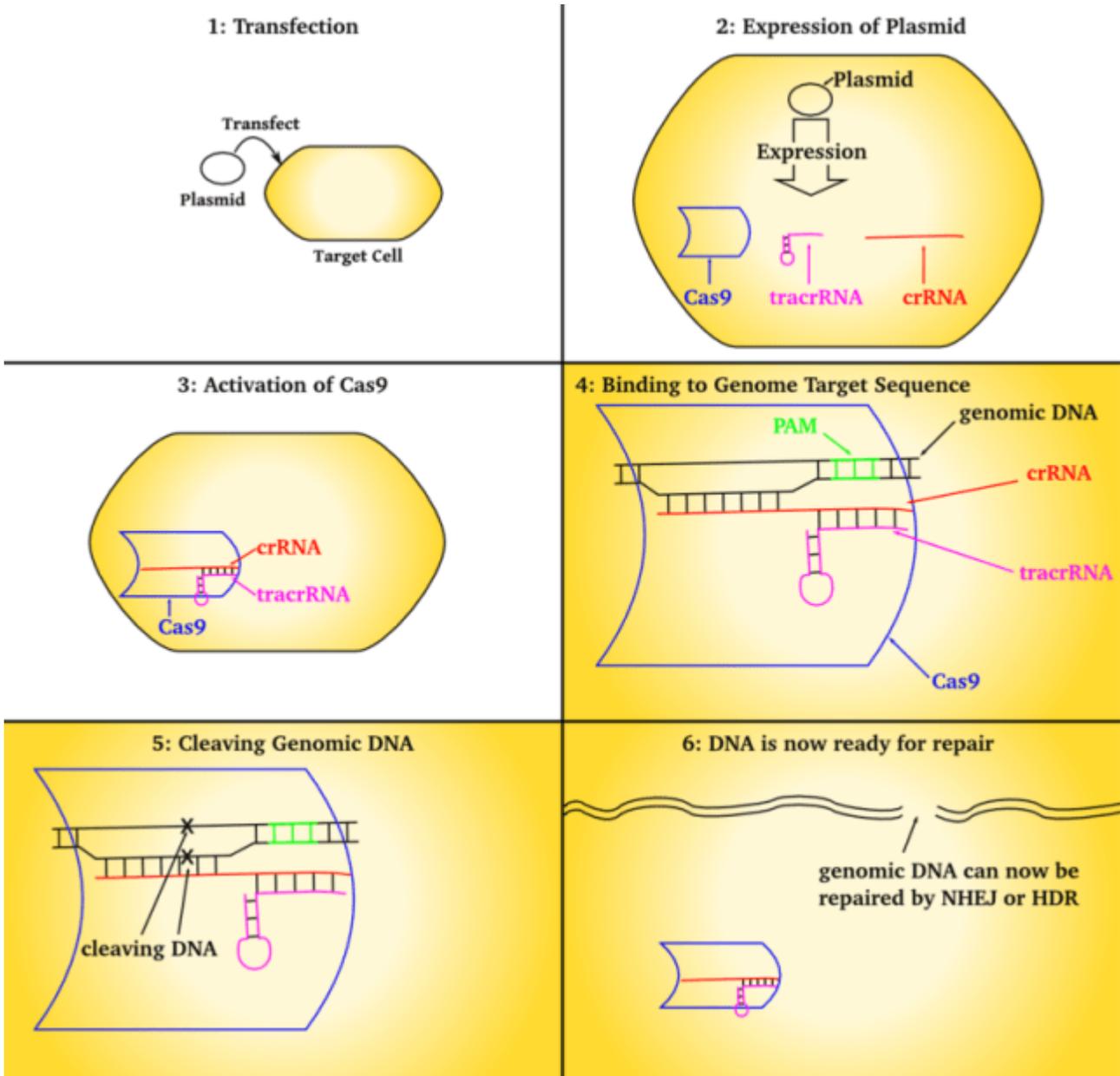
Since Roe vs Wade there has been a decline in sexual morality, a rise in fatherless families and, generally, all that contributes to bad times. Whether there is a causal relation as some contend can be debated. (See [The Myth about Abortion and Crime](#) and [Does Abortion Really Reduce Crime](#).) So where does that leave us? That no good, and possibly evil, can come from abortion.

Let’s turn to another issue, where science has made advances that have to be checked, reined in by ethics and moral teaching, genetic modification of humans.

## SECTION 4: Genetic Modification of Humans—Designer Babies

### 4.1 CRISPr/Cas9 GENE EDITING

Designer babies? Yes, that possibility looms ahead of us. CRISPR/Cas9 gene editing of human embryos is reported in an [issue of Protein and Cell](#).and in the [MIT Technology Review](#). The molecular biology involved in this gene editing is illustrated in the diagram below:



How CRISPR gene modification works  
 from [Wikimedia Commons](#)

RNA is introduced into a plasmid, with a protein complexing agent, Cas9, which procedure enables the RNA to snip genomic DNA at a predetermined site, into which alternative

genomic material can be introduced. For a more extended discussion, see the Science Background section, or these neat YouTube videos, [here](#) and [here or this article](#).

So, could we have beautiful, NCAA champions, children who get 1600 SAT scores? And if we could, should we? Let's see first what science-fiction says (which has predicted many changes in our life) and then what Catholic Teaching tells us.

#### **4.2 GENETIC ENGINEERING DYSTOPIAS OF SCIENCE FICTION**

Nancy Kress's Hugo Award winning novella, [Beggars in Spain](#), dealt with the societal and moral issues of genetic engineering in 1995, before the advent of the CRISPR/Cas9 technique. The title comes from a character's question, one of the genetically engineered elite, "what do the productive members of society owe to the unproductive members who have nothing to offer except need"? These unproductive members are presumably "the Beggars in Spain," whence the title. I won't spoil the novel's conclusion (it's actually a trilogy), except to note that it's surprising. But I will note that there ensues a class war, or perhaps I should say a race war, the "normals"—genetically unmodified—against the super-humans, those endowed with ability because their parents were able to afford the expensive genetic modification procedures

Aldous Huxley, in his novel [Brave New World](#), had a somewhat different approach. In his "brave new world," babies came from bottles, not the wombs of mothers; they were sleep indoctrinated to be happy in their pre-ordained caste—alpha, beta, gamma, delta, epsilon:

*"Alpha children wear grey. They work much harder than we do, because they're so frightfully clever. I'm awfully glad I'm a Beta, because I don't work so hard... And Epsilons are still worse. They're too stupid to be able to read or write. Besides they wear black, which is such a beastly colour. I'm so glad I'm a Beta."*

—Aldous Huxley, [Brave New World](#), Chapter 2.

And the hero in Brave New World commits suicide because he cannot find anything in that world worth living for.

Both Nancy Kress and Aldous Huxley show how a world managed by pre-ordained ability and oriented towards material satisfaction is, ultimately, not a satisfactory world in which to live. There is a particularly moving episode in Beggars in Spain, in which a genetically engineered dog, a luxury curiosity that can speak—frightened beyond its ken—jumps off a penthouse patio. But neither Kress nor Huxley address the most important question: is there an absolute, intrinsic moral prohibition against genetically modifying humans as if they were only animals. So, that's where we go next.

#### 4.3 CATHOLIC TEACHING AND GENETIC ENGINEERING

The substance of Catholic teaching on genetic engineering is given in the document, [Charter for Health Care Workers, Pontifical Council for Pastoral Assistance](#), and from works footnoted in that document, as quoted below:

*“In moral evaluation a distinction must be made between strictly <therapeutic> manipulation, which aims to cure illnesses caused by genetic or chromosome anomalies (genetic therapy), from manipulation <altering> the human genetic patrimony. A curative intervention, which is also called ‘genetic surgery,’ ‘will be considered desirable in principle, provided its purpose is the real promotion of the personal well-being of the individual, without damaging his integrity or worsening his condition of life.’...On the other hand, interventions which are not directly curative, the purpose of which is **“the production of human beings selected according to sex or other predetermined qualities,”** [emphasis added] which change the genotype of the individual and of the human species, “are contrary to the personal dignity of the human being, to his integrity and to his identity. Therefore they can be in no way justified on the pretext that they will produce some beneficial results for humanity in the future,’... **‘no social or scientific usefulness and no ideological purpose***

***could ever justify an intervention on the human genome unless it be therapeutic, that is its finality must be the natural development of the human being.*** [emphasis added] “

This charter does indeed provide guidance, but is it sufficient for every situation?

Let's first agree that the conditions for which genetic treatment might be used to remedy or cure a disease are carefully defined. For example, there are a number of diseases which are genetic in origin: Huntington's chorea (Woody Guthrie's disease), hemophilia, sickle cell anemia, susceptibility to breast cancer, to mention just a few. Should we conclude that God allows us to alter these defects, to enable us to live better lives? Suppose genetic therapy had been available to correct the childhood condition of Bl. Hermann Contractus, who was the author of the prayer Salve Regina (Hail Holy Queen) and who supposedly suffered from cleft palate and spinal defects. Had these defects been corrected would we then have had that prayer?

Now let's go to the borderline situations. What about diseases that may disable a person, or make him more liable to die, conditions which are secondary causes of disease: obesity (as a precondition for circulatory problems), depression (as a precondition for addiction or suicide)? What about babies with Down's syndrome? What do the prescriptions laid out by the Charter tell us here? Would genetic manipulation to avoid such problems be treatment or enhancement?

The situation is clear in other respects; genetic manipulation to get 180 IQ, 7 ft basketball players is not to be done (if it be possible). Pope St. John Paul II made this abundantly clear in his address to the World Medical Association, as quoted in the encyclical *Donum Vitae*

*“Each human person, in his absolutely unique singularity, is constituted not only by his*

*spirit, but by his body as well. Thus, in the body and through the body, one touches the person himself in his concrete reality. To respect the dignity of man consequently amounts to safeguarding this identity of the man 'copore et anima unus' [body and soul one thing]...It is on the basis of this anthropological vision that one is to find the fundamental criteria for decision-making in the case of procedures which are not strictly therapeutic, as, for example, those aimed at the improvement of the human biological condition"*

—Pope St. John Paul II, Address to the World Medical Association, as quoted in [Donum Vitae](#)

And this says it all. That which preserves the dignity and uniqueness of the human being as God has intended, is that which is to be allowed. Constructing a designed class of superhumans will not bring happiness to the world, as [Brave New World](#) and [Beggars in Spain](#) demonstrate. And the final question (to which I don't know the answer), is there a slippery slope in genetic engineering on which we can't control our descent? If we can replace the gene that causes Huntington's chorea, will we then be content not to engineer the superman or superwoman?

Perhaps the answer is to find a gene for holiness. As C.S. Lewis put it, the next evolutionary advance will not be in physical or mental improvement, but to be sons of God:

*"...I should expect the next stage in Evolution not to be a stage in Evolution at all: I should expect that Evolution itself as a method of producing change will be superseded. And finally, I should not be surprised if, when the thing happened, very few people notice it ....it is a change that goes off in a totally different direction—a change from being creatures of God to being sons of God... the first instance appeared in Palestine two thousand years ago."*

—C.S. Lewis, [Mere Christianity](#).

## SECTION 5: Summing up—The Questions Science Doesn't Answer

*“Knowledge of physical science will not console me for ignorance of morality in time of affliction, but knowledge of morality will always console me for ignorance of physical science.”*

—Blaise Pascal, “Pensees,” #23

### 5.1 WHAT ARE THE QUESTIONS THAT SCIENCE DOESN'T ANSWER?

Here are some questions (among many) that should be answered before this big one is addressed: “Does science tell us how to live?”

Can knowledge of the human genome enable one to make moral choices about abortion, genetic modification of embryos, euthanasia?

If we [know that a nun meditating](#) on the Seven Last Words of Christ has greater activity in her frontal lobe and less in her temporal lobe, does that tell us more about Christ's salvific agony on the Cross?

Is our delight in the lovely musical waterfalls of [Bach's Contrapunctus 9](#) (Art of the Fugue) achieved by knowing that there are octave jumps, 2 to 1 frequency changes, at the beginning of each [glissando](#)?

Does our understanding of the formula  $E=mc^2$  help us to decide on the morality of atom bombing a terrorist country?

Clearly, the answers to each of these questions is a resounding NO!

The scientific method will tell us whether scientific theories are “true” or “false”, that is to say, whether they are confirmed by empirical tests, whether they are in harmony with the general framework of science, and, lastly, but not so important, whether they are elegant and

beautiful. That is the only kind of value judgment that science can make. It can't be a basis for judgments about what Socrates would call "the good," what is beautiful, what is just, what is kind. Indeed, science can't tell us why science itself works.

## **5.2 SCIENCE DOES NOT GIVE ETERNAL TRUTHS**

When a scientist says we should put all our trust in what science tells us about the world, he displays an ignorance of the history and philosophy of science.

SCIENCE CHANGES: Theories and principles that at one time held sway are superseded by new theories needed to explain newly discovered phenomena—e.g. Caloric theory as a heat substance, disproved by Rumford's cannon boring experiments; quantum theory to explain the Ultra-violet Catastrophe and specific heat anomalies; special relativity to explain the absence of ether drift observed in the Michelson-Morley experiments; (see [Essay 2](#), for more). It is the height of intellectual arrogance to believe that present day theories in physics are the last word.

REDUCTIONISM DOESN'T WORK: Complicated and chaotic phenomena like weather, liquid turbulence, biological processes, cannot be explained starting from the most fundamental equations and principles, such as Schrodinger's equation, General Relativity field equations, the Standard Model. Phenomenological equations and generalizations are necessary to make predictions from observations (see "[Tipping the Sacred Cow of Science...](#)"). Such phenomena have to be analyzed as emergent properties of complex interacting entities.

THERE ARE CONCEPTUAL INCONSISTENCIES IN PHYSICS—I'm not talking here about the fundamental equations, but rather the qualitative concepts underlying such equations, the interpretations that we put on the fundamental theories. I'll discuss the three most important of these tensions below.

### **The Second Law of Thermodynamics and time reversibility<sup>1</sup>.**

This Law, dealing with entropy as "Time's Arrow," has to do with transitions from an ordered

state to a disordered state, from an ice cube melting to liquid water, from a drop of food coloring put into water, from Humpty Dumpty falling and breaking his yolk, and on and on. A video illustrating the dropped food coloring is shown below, but reversed (going backwards in time) so you see the ink coming together to form a drop.

Here's the puzzling feature in this: according to the fundamental laws of physics governing molecular behavior, this time reversal process should be as likely as what happens when the drop is put into water. These laws—Newtonian physics, relativity, quantum mechanics—are all symmetric with respect to time reversal, replacing  $t$  (the symbol for time) by  $-t$ , in the equations. Which is to say, that the solutions you get going backwards in time are as valid as the ones going forward. But that isn't the way the world works.

In short, the Second Law of Thermodynamics cannot be derived from fundamental physical theories. It is empirically based, but even without a theoretical justification it will be more likely to be valid two centuries from now than any other theory or principle current now (as Einstein said). A more complete account of thermodynamics and The Second Law is given in the Science Background appendix for this web-book.

### **Quantum Mechanics and Relativity—spouses that get along, but disagree on fundamentals.<sup>2</sup>**

Quantum mechanics and relativity are each great theories, confirmed experimentally down to lots of decimal places.<sup>3</sup> Sadly, the fundamental concepts on which the theories are based and their interpretations do not harmonize. This is not to say that special relativity cannot be incorporated into quantum mechanics. Dirac gave his important relativistic quantum equation that predicted electron spin and positrons. Quantum field theory is a formulation of quantum mechanics that takes special relativity into account in order to analyze radiation and fundamental particles.

Nevertheless, if you examine the qualitative ideas underlying relativity and quantum

mechanics, trying to see what concepts are taken to be real and operational, you will find that the theories disagree. Relativity takes the dynamical variables of Newtonian mechanics—position, momentum, energy, time—to be well defined for a given reference frame. These dynamical variables also enter into the equations of quantum mechanics, but there is a difference: Heisenberg Uncertainty Principle tells us that for pairs of so-called [“conjugate variables”](#) (e.g., position and velocity; energy and time; angular momentum and orientation) you cannot determine simultaneously precise values for both members of the pair. (See this [Youtube video](#) for a nice qualitative explanation.)

If both quantum mechanics and relativity give good results, even though they are based on different assumptions, where do the two theories conflict or disagree? The answer is in the domain where distances are very small (which means quantum restrictions have to be taken into account) and where mass/energy density is very high (so that relativity/gravitation enters). And this domain is that which was present shortly after “The Big Bang,” creation from a discontinuity, occurred.

Theories of quantum gravity, theories combining quantum mechanics and general relativity have been proposed to account for gravitational effects at times shortly after the “Big Bang.” However, since the energetics involved are so large, the theories do not seem to be susceptible to experimental tests. However, recently a “tabletop” experiment has been proposed to see if quantum gravity entities, “gravitons,” do exist and undergo quantum effects. See [this article](#) for a description of the proposed experiment and also a nice account of the problems in testing combinations of quantum and relativity theories.

String theories (I use the plural because there are different brands and marks of these) have been proposed to unify quantum and relativity theories. The problem with these proposals is that they are not susceptible to experimental tests and are overly parametrized, so that any possible test might be satisfied. Peter Woit has written an extended critique of string theory, [“Not Even Wrong.”](#) that shows why it is not good science. (The title comes from Pauli’s

remark about a physics paper he was refereeing: "it's so bad it's not even wrong.")

### **The "hard problem" of consciousness.**

In ESSAY 6, "[Can Computers Have a Soul?](#)" I gave a brief review of what scientists and philosophers had to say about "consciousness," self-awareness, what Aquinas might have termed "the intellective-soul." Their opinions run the gamut from materialists, who claim the brain is just a meat computer, to the new "[Mysterians](#)," philosophers who believe that consciousness is a phenomenon that can never be understood scientifically because we are limited in our understanding. I'll repeat the conclusion I gave at the end of that essay:

*"So, what's the verdict? It seems the jury is hung. No argument presented has been strong enough to convince the others. My own judgment is inclined to that of the New Mysterians. It is a view that is compatible with religious belief, and the belief that at the top of a conscious scale is the consciousness of the Trinitarian God, in which all of Plato's and St. Augustine's ideal forms reside."*

### **The "Veiled Reality" of quantum mechanics**

*Anyone who tells you they understand quantum mechanics is a liar."*

—attributed to Richard Feynman (in one form or another), Nobel Prize winner for work in quantum electrodynamics.

Quantum mechanics is peculiar (in more ways than one)! The theory yields extremely accurate predictions and has not been proven incorrect in any experiments thus far. Nevertheless (as per Feynman's quote) it is not intelligible in terms of every-day experience. The mathematical formalism is elegant, and there is not a problem at the next stage: letting physical quantities stand in for the mathematical variables. The difficulty is at a higher level: the interpretation of measurements in terms of qualitative models that correspond to

our intuitive view of what the world is like.

I've discussed strange quantum phenomena—[entanglement](#), [observation creates reality](#)—in an ebook, [The Quantum Catholic](#), and in several blog posts: "[Does Quantum Mechanics speak to Catholic teaching](#)," "[Quantum Divine Action via God Berkeleyan Observer](#)," "[Quantum Mechanics and the Real Presence](#)." I'll summarize some of the conclusions philosophers have drawn from quantum strangeness:

With respect to **entanglement**, the long distance instantaneous correlation of properties between entangled particles, the philosopher Michael Redhead argues that entanglement and non-locality yield an "indeterministic", a "holistic non-separability" interpretation of quantum mechanics, such that

*"[this interpretation] allows 'room' for divine action on particular occasions...Holism is an anti-reductionist thesis that shows how every element of the universe has for its ground of being the totality of the whole, which pantheists would want to identify with God."*

—Michael Redhead, "The Tangled Story of Non-locality in Quantum Mechanics" in "[Scientific Perspectives on Divine Action: Quantum Mechanics](#)"

As Bernard d'Espagnat, French physicist/philosopher, winner of the Templeton Prize, has put it so aptly, there is a "**veiled reality**" underlying quantum mechanics, a reality that science cannot penetrate:

*"There must exist, beyond mere appearances ... a '**veiled reality**' [emphasis added] that science does not describe but only glimpses uncertainly. In turn, contrary to those who claim that matter is the only reality, the possibility that other means, including spirituality, may also provide a window on ultimate reality cannot be ruled out, even by cogent scientific arguments."*

—Bernard d'Espagnat, as quoted in "[The New Scientist](#)"

### 5.3 THE SUMMING UP

I've shown (to my satisfaction and, I very much hope, to the reader's) that science can not tell us how to live, to choose the good and avoid the evil. Moreover, I have demonstrated that, despite the claims of materialists, science does not and cannot give us a "Theory of Everything" to provide total understanding of how our world works, from the universe itself

down to the ultimate particle.

Even if we focus only on quantum mechanics we find mysteries that support for our belief in God as Creator and Sustainer:

The “veiled reality” underlying quantum mechanics strongly suggests that science, per se, can not reveal all that can be known of God.

Entanglement makes a deterministic view of the world unlikely and allows freedom for Divine Action.

The “Measurement Problem” yields a justification for a Berkeleyan view of reality, with God the “ultimate observer” sustaining the universe.

The materialist will answer that the ancient limitations to our human power set forth in Scripture have been overcome:

*Who hath measured the waters in the hollow of his hand, and meted out heaven with the span, and comprehended the dust of the earth in a measure, and weighed the mountains in scales, and the hills in a balance?*

—Isaiah 40:12 (KJV)

And indeed all these can be done by science. But those are only material things, and material things are not all there is to life.

## REFERENCES

<sup>1</sup>See the article “[Thermodynamic Asymmetry in Time](#)” for a fuller account of the tension between the Second Law of Thermodynamics and the principle of time reversibility.

<sup>2</sup>See the articles “[How/Why Quantum Mechanics and Relativity Are Incompatible](#)” and “[Where do General Relativity and Quantum Mechanics contradict each other](#)” for a more extended

discussion.

<sup>3</sup>Also, see Essay 2, [“How We Believe, How Science Works”](#) and [“Wrinkles in Space-How Science Works”](#) , articles giving experimental evidence for relativity. Many web articles discuss experimental verifications of quantum theory: do a web search “experimental verification of quantum mechanics” and you’ll find a garden to pick from.