A PLACE FOR RELIGION IN SCIENCE?

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As Director of the Columbia Center for the Study of Science and Religion I am often asked, what is "Science and Religion?"

Is it, or can it become, a real field? Or is it just a phrase, no more than a trivial coupling, clever but sterile? It's easy to think of such couplings: "Chinese and Latin" is not a field, even though both deal in matters of syntax, grammar and meaning. "Math and Music" is not a field either, even though both deal in the harmonious relationships among symbols.

"Science and Religion" both deal with explanations and underlying mechanisms, but if one can say "so what?" to either of the first two pairs, why not say it about this third? Are the shared attributes of science and religion rich enough to outweigh their manifold intellectual, emotional and intentional differences?

I say yes. I think it not because of my religion—I came very late to life as an observant Jew, and I am acutely aware of the partial nature of my observances—but because of my science. From the 1960s through the 1990s my field was one whose name—molecular biology—now stands as a model of a field with a well-defined agenda. But until the 1950s the notion of coupling the study of molecules—specific structures assembled from specific atoms—with the study of any aspect of life itself was as novel as the notion today of science and religion being, or becoming, a field, whether scientific religion, or religious science.

Until then, molecules were nature, and biology was mystery. The factors of inheritance?: totally mysterious. The way in which a body and brain emerged

from the descendants of a single fertilized egg cell?: totally mysterious. The way in which living and dead are different?: totally mysterious.

There were many founders of this new field whom I know well, and of those Jim Watson is the one I know best. His really important book was not the self-serving memoir "The Double Helix," but the earlier, 1965 single-author textbook, *The Molecular Biology of the Gene*. In it he made the case that DNA resolved all these mysteries and many others; he pretty much single-handedly gave my generation of scientists the idea that any mystery could be understood through a proper manipulation of the proper molecules.

Not that I am saying, nor does he claim even today, that all mystery has been resolved, only that its resolution may be best sought in the chemistry of the molecules of the living world. I am saying that science and religion invite a comparison to molecules and biology, but with the addition of moral norms.

Why do we ask what is right? How do we know which answer to believe? What difference can any answer make, in the span of a necessarily mortal life? Those non-scientific questions did not then appear, nor do they now appear, to be mysteries that may yet be resolved by molecular biology. Rather, they seem to emerge in most of us in what is a wholly unscientific but necessary way; in their absence a person will be freed from the necessity to ponder them, at great risk to one and all. Molecular biology must nevertheless continue to ignore these matters of moral norms, which leaves science with a gap that bothers many molecular biologists and others who cannot see why these questions of norms are not being acknowledged.

Any current issue of molecular biology or any other science, placed in the context of moral norms, is therefore no longer simply a problem in science, but rather, it becomes a problem in science and religion. There are two ways for this to happen: either it becomes a problem in religious science, or in scientific religion. The latter seems to me much less interesting than the former. A good example of scientific religion would be the futile attempt to pin religious meaning and purpose on the facts and evidence of natural selection, even though the mechanism of natural selection is demonstrably devoid of moral content.

Religious science on the other hand is simply what happens when one introduces the notion of moral norms to any current scientific agenda, and sees how that agenda might change. Neither compulsion nor certainty are embedded in the choice to expand the agenda in this way. One may turn away from one's science for guidance, not because molecular biology still knows too little, nor because of religious dogma, but simply because molecular biology cannot

approach these questions at all, even to ask them. And in turning elsewhere one might reasonably be interested in the remarkable emergence in all cultures at all times of systems of thought and insight that address precisely these questions, systems we call religions.

Here are four examples of what I am talking about. All four deal with the same mystery, the same underlying question that Watson and his mentors were no less driven by than we are today: "What is life?" This question is of course also the name of a book written more than two decades before Watson's text, and a decade before his discovery of the elegant natural solution to the problem of inheritance, the informationally redundant, self-replicating, double helix of DNA.

Writing during WWII in double Dublin exile from physics and from Germany, the great German physicist Erwin Schrödinger turned his attention to the mystery at the heart of pre-molecular biology, the nature of the gene. He intuited the necessity for a molecule that had the stability of a crystal, and the textual content of something entirely non-repetitive, coining the name "aperiodic crystal" for the gene, an oxymoron that precisely captures DNA's actual properties.

In my four brief case studies, science and religion emerge in different roles but in each case the story could not be told at all without a component of norms and values introduced from outside the scientific system at hand, and in each case this component of "Right and Wrong" has a recognizably religious aspect. The four are:

- What is life if we can design recombinant DNAs?
- What is life if we can design clones of a person
- What is life if we can make a commodity of an animal?
- What is life if we can make a commodity of a person?

Only the first and second examples are intertwined in my own career as a lab scientist, and I'll discuss them together. The third and fourth are aspects of my current work as the director of the CSSR.

The national debate about cloning, that is, whether or not it is right to insert the nucleus of a person's tissue cell into a woman's egg, is about to become irrelevant for American science. American scientists seem to have forfeited their chance to convince our government to contribute to this next generation of rational therapies. It was not always this way. As Nicholas Wade points

out (*New York Times*, February 15, 2004, section 4, page 12),

> This outcome contrasts with the last big ethical issue posed by new biological research, the invention in 1975 of recombinant DNA. . . . On that occasion, after a fierce and often bitter discussion, biomedical researchers were allowed to go ahead with the new technique under rules drawn up by their patron agency, the National Institutes of Health.

I am the person who brought about this first process, as a young scientist teaching a course in tumor virus biology under Watson's directorship at Cold Spring Harbor in the early 1970s. I learned from one of Stanford biochemist Paul Berg's students in my summer course that Berg was about to construct a novel recombinant DNA that included the cancer-causing gene of the monkey tumor virus SV40. This experimental protocol seemed in principle to be capable of generating a molecule with an possible risk of emerging as a novel source of human tumors. That was worrisome. It was a worry that could be dealt with by experimentation in dishes and in animals, so I called Berg in California and asked him if he were worried too.

He wasn't. But nor was he able to answer my worry, so he did the right thing and helped the National Institutes of Health to set up the necessary experiments. My call also led to the Asilomar conferences from which the voluntary moratorium on recombinant DNA work emerged, which led to the formation of the Recombinant DNA Advisory Committee or RAC, a model of bioethics at work to this day.

But neither the call nor the outcome has been accepted as a model. In his new biography of Jim Watson, Victor McElheny gives his narration of this incident the heading "Robert Pollack Has a Fit," and as Wade notes, from that time until now, for more than three decades, there have been no reports of any scientist, in any field, precipitating a voluntary moratorium on any line of active basic research in order to establish a regulated system of approval for further work.

It seems to me time once again to step outside of ordinary science, to invite a voluntary private as well as public moratorium and period of reflection, in order to gain regulated government support for therapeutic cloning, that is, the production of human stem cells through the fertilization of a human egg and the recovery of early stem cells, as Korean scientists have shown ought to be pos-

sible.

The technology of therapeutic cloning would have no focus other than the clinical needs of one person at a time. In this technology, an egg cell donated by a woman—not a new embryo, but a cell with no full human genome and no chance of becoming a person—would have its nucleus removed and a nucleus from a patient put in its place. The egg cell's remaining material—its cytoplasm—would reorganize the genes of the patient's genome, so that the donor's genes would recapitulate each embryonic stem-cell stage their ancestral cells went through soon after the earlier formation of the fertilized egg that would become the recipient. The egg cell cytoplasm would be using the donor's nucleus to spin off a population of stem cells, each with the capacity to differentiate in as many ways as a doctor might want, and each also specifically marked on their surfaces with the molecules found only on the cells of the donor.

Nor is that all: if the donor of the nucleus were the victim of a mutational disease like Huntington's disease, the genomic lesion first could be repaired by genetic engineering of donated cells from any tissue—blood or skin, say—and then the genetically repaired nucleus could be transferred into the egg cytoplasm. In this way a person might be given a set of appropriately differentiating cells that were otherwise genetically his or her own, only freed from the mutation and therefore able to reconstitute the normal function that the inherited disease had foreclosed.

One more advantage: the genetic engineering of the donor's nuclear genome need not be solely to repair an inherited mutation. We know, for instance, that the immune cells of persons who inherit the otherwise unremarkable absence of the cell-surface protein CKR5 cannot be infected by HIV. Such people are rare; they can be identified as remarkably resistant to AIDS even when they engage in repeated high-risk behavior. One might therefore expect that nuclei donated by any HIV-infected person, if genetically engineered to remove the gene for the CKR5 receptor and then passaged through egg cytoplasm, would produce new cells for the AIDS patient's immune system that might re-establish a healthy immune system despite the virus's presence, and even perhaps allow for his or her survival and long-term recovery.

Engineered this way or simply taken from a tissue, differentiated cells from therapeutic clones should not be rejected by the immune system when they are used to treat the donor's own illness; instead, they have the better chance to become a new form of medicine, a tissue replacement treatment designed solely for the one person who donates the nucleus.

At first sight it seems too late for revisiting the recombinant-DNA precedent, as the President has already issued a ban on federal support for any manipulation of a human egg cell except to fertilize it with donor sperm for fertilization by donor sperm, and then only so that the resulting pre-embryo may be placed in a woman's uterus so that it may have a chance to become a baby. I think it is not too late to reopen the issue, but it must first be restated in a way that allows honest and open reconsideration of the larger context, including conflicting ideas of what is morally right.

The President's position is understandable when seen through the lens of his publicly acknowledged, deeply held religious convictions. It is odd that no one—not the President, nor the press, nor the many corporate and university ethicists, scientists and doctors who have spoken out in the past few years—has seemed comfortable admitting the matter of personal religious belief to the discussion of these two decisions.

The reason given by the President for turning away from this technology was the anxiety that if placed in a woman's body for the requisite nine months, a reoriented human genome in a donor egg cytoplasm might be born as either a clonal copy of the donor of that nucleus, or a genetically engineered one.

Here the President seemed to be on very strong ground: a cloned human would be a terrible experiment, performed on a person for his or her entire life, with no chance of that person withdrawing from the experiment if it does not go well. The process is of absolutely no clinical utility, and would create a situation little different from slavery. The person emerging from an experiment in which a therapeutic clone were placed in a woman's body and carried to term, would be the object of fascinated attention—if not the property—of the scientists and doctors who initiated his or her novel genome, and their funders. Their interest in that child would be in its experiences as an experiment, an interest hardly based on love; parental consent would merely legitimize a degree of disinterested ownership over another person from birth through death.

Cloning a person does not serve the purpose of medicine, that is, to alleviate or cure the suffering of a person already here among us. The creation of any cloned child with a changed genome would be in addition a Promethean grasp at the human germ line, but even cloning a person without genetic manipulation would convert kinship and childhood into commodities. As a friend once said to make me, think again about performing a particularly seductive experiment: if it isn't worth doing, it isn't worth doing well.

But the well-founded anxiety that therapeutic cloning might be misused to

create a cloned child—and I share this anxiety with a clear majority of polled citizens—is no reason to turn away from the new technology of therapeutic cloning. Between the therapeutic clonal cell line and the cloned person stands a formidable barrier, one that I am sure makes this second technology both feasible and safe. That barrier, all but invisible in the discourse on cloning but no less solid for that, is a woman's body.

Human eggs—the sole source of that brilliant cytoplasm that can send a human genome down the paths of differentiation into all the different cells of the body—are the product of women's bodies. Human embryos and fetuses and newborns are also the products of women's bodies. No potential person can become a person outside of a woman's body. And, in our country at this time, a Supreme Court precedent exists for the notion that a woman, but not her fetus, is a person under the law and therefore subject to both the freedoms and the responsibilities of the law. This law establishes the right of a woman to the use and control of her own body, up to and including her right to end the life of a fetus within her so long as that fetus could not survive outside her body.

In the Federal government's current view, a woman who exercises her right to abort her fetus is making a profound religious error, yet it remains her right. Acknowledging the existence of this current reality, one that lies wholly outside the science of the matter, may actually help in an unexpected way to establish a path for federally supported therapeutic cloning, that is, properly regulated transfer of tissue nuclei into eggs for therapeutic purposes.

Consider what would follow if legislation now being discussed were passed into law, and carrying a human clone to term were made illegal. It is clear the President supports such a law and, given what I have just said, so do I. But how could such a law be enforced except under the aegis and with the full endorsement of the current law, that holds a woman responsible for the decisions she makes concerning the initiation and termination of her pregnancies?

Such a law would oblige "Pro-choice" and "Pro-life" activists each to face the odd necessity of accepting a portion of the other side's argument, in order to retain the merit of their own. From a pro-life position, it would be necessary to acknowledge that a law forbidding the carrying of clones to term could be enforceable on a woman only in the context of every woman having the complete right to choose her actions in this matter; from a pro-choice position it would be necessary to acknowledge that such a new law set a limit on the range of a woman's legal choices. Were such legislation to become the law, then women would be held properly responsible and accountable to assure that a

therapeutic clone would not become a person. Under those circumstances, each therapeutic clone would have only one function: the amelioration of suffering of the donor of its initial nucleus.

If the government would only accept what such a law would confirm—the full legal responsibility of women in this country for that part of their lives that men cannot replicate but only control—it would be able to work with scientists to issue a strong call for therapeutic cloning from donor eggs, coupled with an equally strong sanction against the implantation of any experimentally modified human embryos into a woman's body. But because such a ruling would be binding only on women—there is no other place to find a uterus—it would first require the government to accept that a woman is fully responsible for her body at all times, and that a pregnant woman but not the fetus within her has the legal standing of a person in law.

Today, unwilling or unable to do this, the NIH has instead issued only a strong condemnation of future therapeutic cloning, as if the availability of a woman's body once the egg had been given its nucleus, could be taken entirely for granted. It is insulting if not illegal to give women so little credit and so little power that it becomes necessary indirectly to protect them from this potential misuse of their bodies by forbidding therapeutic cloning, a technology that begins with a woman's egg but not her uterus, and might conceivably end with a new, safe, secular technology of healing.

There is always time to begin to do better. Consider a woman suffering from AIDS, who is neither eligible for federal medical insurance nor able to work at a job that would provide her with private insurance. How elegant it would be—and how clearly different from current policies concerning such women—if the first therapeutic cloning were done for her, using her own eggs and their own nuclei, creating for her a CKR5-deleted, HIV-resistant immune system at no cost to her, simply because she is a fellow-citizen facing death, and because this might offer her a chance to live.

My third example of religion having a place in the practice of good science, deals with the definition of life in the Bible. Assume for the moment that this definition has some binding utility for you, as it still does today for observant Jews; you will see that it does have a bearing on what we all eat. In Genesis 9, 3-5, Noah and his children get an unexpectedly precise anatomical definition of life soon after the Flood recedes:

> Every creature that lives shall be yours to eat; as with the green grasses, I give you all these. You must not, however, eat flesh with its life-blood in it. For your own life-blood I will require a reckoning: I will require it of every beast; of man too, will I require a reckoning for human life, of every man for his fellow man. Whoever sheds the blood of man, by man shall his blood be shed; for in His image did G-d make man.

That is, the life of an animal, or a person, is in the blood. The blood of an animal must be removed before one can eat it for the same reason the blood of a person must not be shed at all: the blood is the life, and the life of man and beast belongs to G-d. This passage and many other inform a highly evolved set of rules for the slaughter of animals for food in a properly respectful, or kosher, way. In particular, it is the reason that no animal or bird that eats blood, can possibly be fit for kosher slaughter: kosher animals are all ruminants, grass-eaters.

The problem is that while a cow converts water, grass and straw into beef and other body parts, slaughter does not return the unusable parts of a cow to grass. Rather, the skin, bones, organs and blood present a problem. They cannot be left around, they pollute, and they cost a lot to bury or burn. The solution that has been available for many decades, and one used by slaughterhouses worldwide, is to bake this offal until it is dry, grind it into a powder, and then — no kidding—feed it to chickens and other animals, including cows.

Given these facts, the first presumption one would make is that kosher beef comes from animals segregated from dried blood because, after all, once they eat blood they are no different in sacred terms from a dog or a vulture. Imagine my surprise to find that in this country kosher beef comes from cows slaughtered without regard for what they have eaten. There are of course grass-fed cows; there is a serious and growing environmentalist movement to return ruminants to their natural diet. But again I was surprised to learn from the organization that certifies kosher slaughterers that one cannot find, in this country, kosher meat that has come from a grass-fed cow.

Well and good; why is this a problem that exemplifies the field of science and religion? Simply this: the shape-shifting infectious protein that is responsible for mad-cow disease is transmitted from cow to cow precisely, and only, when a cow is obliged to eat the dried remains of another cow, and when that first cow was infected with the agent. Some number of cows fed this way will

become the source—the only source—of the human degenerative disease for which there is no cure, the human variant of mad-cow disease.

In the UK a decade ago, the response to a hundred or so cases of human mad-cow disease was to incinerate essentially all British cattle and start over, strictly forbidding the feeding of blood to cows. A few years ago a test was developed that could flag the presence of the mad-cow agent in the blood of a cow before it showed any symptoms of the disease. In Japan every cow is tested before slaughter, at a cost of $30 per cow for a million cows each year. In the EU the rule is the same, at a total cost ten times higher. In our country today though, only 20,000 cows, or one cow in 10,000, is tested annually.

What to do? Avoid beef, but that does not speak to the religious aspect of this problem, in which one has an obligation to the larger community as well as to oneself. Lobby for testing of every animal? Of course. But again, in the largest terms the issue is plainly one that perfectly exemplifies the field of science and religion: in this case a religious position and a scientific one are perfectly aligned, and it is the political will to act along that alignment, that is missing.

Finally, a few words on the Human Genome and the idea of Race. DNA is a chemical of great informational density, a text of great importance. But any person's genome—his or her complement of two copies of each of about 30,000 genes, one copy of each from each parent—is no more the complete statement of that person's life and character, than a canonical text is the complete statement of a living religion. Everything interesting in both cases, is the product of interpretation and interaction. Anyone who knows or is an identical twin also knows each twin of a pair to be unique, despite the presence of another person with the same canonical text in each cell.

Genetic differences among us nevertheless do account for many differences between one person and another. From any one person to another, unrelated one, the chances are that there will be more than one difference in any gene studied, as unrelated genomes differ by as much as one letter in a thousand. Imagine a text with that many variations from copy to copy having in any sense one canonical version. So, there can be no biological data to support the racist notion of oneself as a member of a genetically privileged group.

Instead, all that makes us human in a biological sense is that despite these differences the six billion different human genomes are all in principle capable of coming together with each other through sperm and egg to make another generation of people. The biology of us makes us truly all equal. More to the point, the history of our species' DNA tells us that we are all the descendants of

Africans. The evidence for this comes from many quarters, but DNA evidence is most interesting: because Africa is the first home of us all, people who are the least dispersed descendants of the original people—today's Africans—have the greatest genetic diversity of all human subpopulations.

The rest of us are in a sense tribal offshoots, each the product of a migration that carrying away only a fraction of the genetic richness of our species, which still remains where it began, in Africa. The irony of universal African patrimony only makes the core American racism more stupid, though not less dangerous, than any other dehumanization: only some of us are African-Americans, but all of us are American-Africans. Many corporations, and the NIH, have declared an interest in examining human DNAs for evidence of Race, in order to tailor drug delivery to different genetic constituencies. The science behind this may be open for discussion on its merits, but in the larger context it would be morally as well as scientifically wrong to seek the data in racial categories.

Race is not a biological but a negative category, defining what the racist is not. As a negative category, Race is an idea that resists scientific elaboration, but it is a powerful idea nevertheless, and here is where once again religion may inform science. The question that emerges when one is applied to the other is the one I began with: from where do ideas emerge, and in particular, from where does our sense of what is right and wrong emerge? Clearly ideas cannot emerge from DNA.

There are about three billion letters in the human genome. But there about a million-fold more synaptic connections in a human brain at birth than there are letters in any human cell's canonical text. These synaptic connections—the basis of all mental activity later in life—cannot have all been specifically encoded by our genomes. At birth some are not functional, nor are many stable or specific; synaptic connections harden into circuits only later.

So that is the answer: our brains become minds—our reflexes become deeds—solely by social interaction. Our DNA encodes, in other words, a Learning Machine. What these genes encode, is the capacity of synaptic connections to be stabilized by use, through the activation and repression of genes in nerve cells. The Learning Machine starts up at birth at the latest, activated by initial input signals from the organs of perception. This is the mechanism by which the mind slowly emerges from the brain, through imitation of the minds of those people with whom the infant interacts. Experiences of the first two years, before language, lay down much of the stable circuitry of the thinking brain.

Even after these formative years, the mature brain forever retains plasticity.

in its circuits, and it never loses the capacity to link past with present experience by familiarity of synaptic pattern. Synaptic connections are made and broken throughout life; these are experienced variously as sensation, perception, memory, repression and—for my argument's sake, most important—ongoing teaching and learning.

The learning machine requires adequate social interaction from birth on; absent that, sociopathic disasters ensue. Racism one of these disasters. Whoever is cast as in the negative category of the Other by adults when they interact with their children, will become the Other to those children. When Race is learned in this way, it is a biological event, but only in that the synaptic wiring of associations in the brain of the child will have mimicked those in the brain of the adult. This form of inheritance is not through DNA, but it can be as stable, and as long-lasting, as genetic inheritance. But we must be clear: it is social, not genetic.

The Racist thinks of everyone in the Other category as if they were genetically identical clones: "all you people look alike to me." The irony of thinking of the Other this way is more perfect in the American case than any other. Here the Other is likely to be a descendant of Africans, who are today genetically the most genetically diverse of all people. It is the Racists who—thinking alike despite all facts—form a clone; not a genetic clone, but a social one.

Here is why religious science is an important idea: absent a constant attention to moral norms, any social clone will be at risk of punishing innocent people, whether inadvertently as in the scientific study of race, or intentionally as in the many manifestations of racism itself. We need to have both norms and genetics present in any serious discussion of Race.

The learning machine can change. What is needed is the will to change the way we raise our kids. The resources for change would then not be found in any science as science is construed today, but in a larger notion of science that accepted the existence of moral norms and obligations. DNA did not cause the problem of Racism and DNA will not save us from it; new insights into teaching and learning—the essence of science and religion when they are aligned as they are here—may just do the trick.