Institute For Theological Encounter With Science and Technology
Volume 50 - #4 Fall 2019 Bulletin

ADVENIAT REGNUM TUUM…

The Promise and Peril of Genetic Engineering

May "thy kingdom come," a line from the Pater Noster! Although my study of Latin unfortunately extended only to the end of my sophomore year in high school, that phrase struck me forcefully as I thought about the opening message for this final 2019 issue of the ITEST bulletin.

In Advent, which is almost upon us, we often think of it, and rightly so, as a time of waiting-- not the impatient waiting in line often experienced at the supermarket-- but an anticipatory waiting for good news, like Santa Claus. Much better than Santa, the Incarnate Word in the form of a child at Christmas will be here "in the flesh" as we recall every year without fail.

Thy Kingdom come! Without stretching the analogy too much, we must ask what meaning we convey when we use that phrase. What does that mean---"Thy Kingdom come"-- when applied to the promising and perilous world of rapidly advancing biotechnology, and for this issue, specifically CRISPR? Whose kingdom will be advanced? The Kingdom of God, or the Kingdom of Folly? What kind of "incarnation" will the biotechnologies bring to the world? Curing of genetic diseases relatively disappointing until now? Assuredly! People suffering from genetic diseases such as sickle cell anemia, Duchenne muscular dystrophy, and certain forms of blindness will undoubtedly benefit. But will the "peril" also be manifest in "designer babies?"

In the main feature in this issue, Jesuit Father Kevin FitzGerald addresses the discovery and development of CRISPR and its importance to medical advance. He challenges us to assume a sense of responsibility—yes, all ITEST members and Christians globally-- to become involved in the direction this technology will take in the Kingdom. He writes, "After participating in two meetings which both addressed this issue, [genetic engineering] I thought this article might best serve to stimulate discussion among the ITEST community. My hope is that it would both enliven the community from within, and also encourage outreach to other groups that might further stimulate the expansion of the ITEST community and its gifts."

During this coming season of ADVENT as we "look forward with longing," let us remember that the Promise of Isaiah fulfilled in the Incarnation in Jesus, brings about anew the Kingdom of God in our hearts. Should not the presence of CRISPR technology shout a warning to researchers to use this God-given ability to bring about a corresponding renewal "in and of the body" to the Kingdom of God? At the same time, we

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In This Issue...

recognize the shadow part of the "promise" – the "peril" – the temptation to race headlong into a future without patiently "waiting," testing and weighing the implications of CRISPR biotechnology for the future of the human race.

In any event, as Father Brungs, our founder would often say, "We have Jesus' promise: 'I am with you always until the end of the world'." Mt. 28:20.

Sincerely in Christ,

S. M. Postiglione, RSM

Marianne Postiglione, RSM
Editor: ITEST Bulletin

A Blessed Advent!

Announcements

Faith and Science in Catholic Schools

Take a look at how faith and science are integrated in Catholic school classrooms!

ITEST has partnered with WCAT Radio to produce a series on the integration of faith and science in the Catholic school classroom. We are well on our way in uploading teacher interviews, and there will be many more to come. You can listen to the interviews here: https://faithscience.org/catholicschools/

Please reach out to friends who teach in Catholic schools to ask them to be interviewed to contribute to our collection.

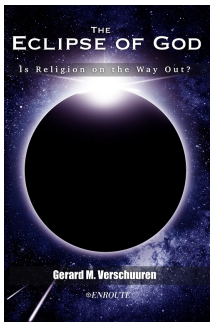
Faith-Science 2020

Faith-Science 2020 is an ITEST initiative that seeks to frame the faith-science conversations that will occur in the third decade of the third millennium. To participate in the planning process, register today at https://faithscience.org/membership-information/

New Book

We are happy to introduce Gerard Verschuuren's book *The Eclipse of God: Is Religion on the Way Out?*

This book was specifically written for all those who feel lost in a world dominated by ideologies that obscure God. It is hard to pinpoint one particular cause of how we feel in such Godforsaken times and places, but science is likely one of the main perpetrators, as some scientists use their scientific "authority" to churn out, with the speed of light, books that promote opinions and views that go far beyond their scientific expertise, and that rob people of any religious beliefs they might have. These prolific writers are inundating the book market, magazines, and the internet with their message that a state of conflict exists between science and religion, and that science holds the winning hand. They loudly broadcast through the megaphones of our society their anti-religious propaganda: (1) Since there was a Big Bang, there is no creation. (2) Because there is only matter, there can be no spirit. (3) There is no purpose in life, for randomness is all there is. (4) There is no God, only a god-gene. (5) Neurons are in complete charge, so the mind is an illusion. (6) Everything is relative, for objective truth just does not exist. (7) Morality is only a matter of personal opinions and preferences. (8) All in all, God is dead.



If you wonder how you and your religious faith could ever survive in such an environment, this is the right book for you. Find the book at http://enroutebooksandmedia.com/eclipseofgod/

Institute for Theological Encounter with Science and Technology
Cardinal Rigali Center • 20 Archbishop May Drive • St. Louis, Missouri 63119 • USA
314.792.7220 • www.faithscience.org • E-mail: ITESTfaithscience@gmail.com

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Human Genome Editing: Where We are Now, and How We can Find our Way Forward.

Kevin T. FitzGerald, S.J., Ph.D.

Occasionally a new medical technology that has received a great deal of attention in the mass media actually lives up to its promise and its peril. Human genome editing (e.g. CRISPR technology) appears to be well on its way to doing just that.

The concept of genome editing is similar to the familiar practice of text editing that many undertake when using word processing software programs. This idea of editing DNA has been pursued since the 1970 identification and characterization of a bacterial enzyme that could cut any organism's DNA at specific target sites.[1] Over the next 40 years, good progress was made in research labs to expand the scope and the power of scientists' ability to edit the genomes of various organisms, including human beings. This progress was time-consuming and expensive, requiring advanced equipment and skilled researchers. Then in 2012, Jennifer Doudna and Emmanuelle Charpentier reported an advance in genome editing using a bacterial enzyme complex called "clustered regularly interspaced short palindromic repeats" (CRISPR) along with "CRISPR-associated protein 9" or Cas-9.[2]

CRISPR -- Clustered Regularly Interspaced Short Palindromic Repeats

Cas9 – enzyme which acts as molecular scissors is attached to the RNA (a molecule that can locate and read the genetic information contained in the DNA)

The CRISPR-Cas9 advance was remarkable for three reasons. First, was a significant improvement in both the accuracy and the efficacy of gene edit targeting. The improvement meant that researchers could achieve both a higher percentage of successful gene edits along with a lower percentage of undesired "off-target" edits that may create harms more significant than the benefits from the intended edit. The second advantage of the CRISPR-Cas9 technology was significantly lower costs in using this system. This second advantage, along with the third improvement—much less technical skill and resources required—has resulted in the availability of online do-it-yourself CRISPR kits that anyone can purchase for under $200, to perform simple gene editing experiments at home or in school.[3]

Even with these remarkable improvements, it remains crucial to remember that the facts that undesirable off-target edits still occur even in the best gene editing systems, and that desired edits only affect some of the targeted cells, severely limits the current medical applications of this technology because treating patients requires very high standards of safety and efficacy. So, for now, gene editing is limited to treatments where only a small percentage of target cells need to be successfully edited and where any cells that get an undesired edit can either be selected out (because the targeted cells are being treated outside the body, i.e. *ex vivo)* or will likely cause a harm that is less significant than the desired treatment benefit, e.g. causing a tumor versus saving the patient's life. Currently there are only a few dozen registered CRISPR gene editing clinical trials ongoing in the world, with most of those in China.[4] However, the number of gene editing trials and treatments will likely increase rapidly as improvements in gene editing technology continue at an amazing pace. For example, in October, 2019, another leap forward in CRISPR technology accuracy and versatility was announced. It is called "Prime Editing CRISPR," and will once again expand the possibilities of gene editing treatments.[5]

Currently there are only a few dozen registered CRISPR gene editing clinical trials ongoing in the world...

The most controversial, and, hence, widely reported, recent event in CRISPR gene editing was the announcement by Dr. He Jiankui, of the Southern University of Science and Technology in China, that he had

Continues on page 4

used CRISPR technology to alter the genomes of twin female embryos to make them resistant to HIV, had implanted both embryos in their mother's uterus, and that the twin girls had been born—apparently healthy.[6] This announcement was widely reported because of the global outrage that was expressed within the scientific and healthcare communities regarding the numerous ethical and scientific violations this human experimentation involved. Dr. He's project was both dangerous and medically unnecessary, since there already are medical interventions that can prevent the transmission of HIV from an infected parent to the fetus. In addition, Dr. He appears to have violated standard ethical review procedures and may not have adequately consented the couples he recruited for this experiment. Finally, preliminary analysis indicates that the CRISPR treatment may not have worked as intended, significantly undermining Dr. He's claims of success on any level.[7]

Adding to the concern raised by Dr. He's debacle, China has several other public CRISPR clinical trials underway, though they only involve treating specific cells in adults resulting in genome changes that will not get passed along to subsequent generations. However, these clinical trials are also raising concerns due to a lack of rigorous oversight and long term follow up of treated patients.[8] Since China is currently leading the way in the number of active CRISPR clinical trials, there is substantial anxiety among CRISPR scientists and medical researchers that disasters in China could severely impact the ability of researchers to do clinical trials in the EU and the US, where clinical trials are just ramping up. Hence, there continues to be an outcry from EU and US researchers and bioethicists for extensive public engagement to both prepare the public for what may be ahead in terms of both the promise and peril of CRISPR treatments, and to obtain the insights, hopes and fears of the public regarding the possible medical use of human genome editing.

It is in our loving and caring relationships that we become fully who we are, and who God desires us to be.

Interestingly, despite this extensive current outcry, and the fact that the call for public engagement regarding CRISPR has been around for years now,[9] real public engagement is still sorely lacking. Two logistical issues may be hampering the pursuit of a substantive, global community engagement. First, there do not seem to be any global organizations currently sufficiently motivated to undertake such an effort, and, second, motivation may be hindered by a lack of infrastructure and experience to undertake such a project. Therefore, also interestingly, this situation may be an opportunity for global faith-based organizations, such as the Catholic Church with its global healthcare activity, to help lead the way in engaging the public and ensuring that the engagement effort is focused on determining what is best for all patients, especially those whose voices are not often heard.

For Christian faith-based healthcare organizations, community engagement is intrinsic to healthcare activity as it fosters the two key goals Jesus had for those he healed. First is the physiological healing a person needs. Physiological healing is often required in order to achieve the more important second goal—to reunite the person with that person's community. That healing of any estrangement reestablishes the most fundamental and life-giving aspect of each and every human being—loving and caring relationships with others in one's family and community. It is in our loving and caring relationships that we become fully who we are, and who God desires us to be.

Perhaps this fundamental truth of the importance of a person's relationship to a community is one impetus behind the global outrage that arose in response to Dr. He's human experimentation. Even if his motives were solely to provide the infants with an added protection against acquiring HIV, his lack of proper engagement with the global community threatens to estrange these girls from society and forever taint their lives with the fact that they were improperly used in human experimentation and created differently than everyone else. Even if Dr. He had been entirely successful in his technological attempt to edit the girls' genomes, he still caused this potential estrangement for these girls.

Continues on page 5

In response to the current turmoil surrounding human genome editing, the question arises: is there a way faith-based institutions, such as ITEST, can readily use their community outreach experience and expertise to engage the global public regarding the use of human genome editing in healthcare? Considering the enormous potential genome editing has for changing medical treatments, and our concepts of human nature, might not faith-based healthcare and educational institutions actually be obligated to get involved in this global community outreach, and, perhaps, even take the lead? For instance, faith-based organizations could work together to network globally to pursue a variety of public engagement events, and to promote greater community reflection, regarding how we all might work together to integrate genome editing technology into healthcare in a manner that will provide the greatest benefits to all, and avoid as many harmful incidents as possible. Then, even if gene editing technology does not live up to its promise, and proves to be more harmful than good, people around the world will still benefit because we will have fostered a system for global engagement that will have already brought people closer together, increased our understanding of each other's hopes and fears, and provided a platform for facing together the challenges the future will bring to us all, both technological and humanistic.

[1] Smith HO and Wilcox KW, "A restriction enzyme from Hemophilus influenzae I. Purification and general properties," Journal of Molecular Biology, 51 (2): 379-91, (July 1970).

[2] Doudna

[3] One example of such a kit can be found on Amazon at https://www.amazon.com/DIY-Bacterial-Genome-Engineering-CRISPR/dp/B071ZXW1TW (accessed Nov 7, 2019).

[4] www.clinicaltrials.gov (accessed Nov 7, 2019). For more information regarding U.S. efforts see https://commonfund.nih.gov/editing

[5] Anzalone, A. et al. Search-and-replace genome editing without double-strand breaks or donor DNA. Nature https://doi.org/10.1038/s41586-019-1711-4 (2019).

[6] "First CRISPR babies: 6 questions that remain," by David Cyranoski, Nature, 11/30/2018.

[7] "The CRISPR Baby Scandal Gets Worse by the Day," by Ed Yong, Atlantic, 12/3/2018.

[8] "Chinese Gene-Editing Experiment Loses Track of Patients, Alarming Technology's Inventors," by Preetika Rana and Wenxin Fan, Wall Street Journal, online Dec. 28, 2018, 6:00 a.m. ET.

[9] "CRISPR: What Potential? What Peril? Who Decides?" Health Care Ethics USA, Winter 2017, Vol. 25, No. 1.

Kevin T. FitzGerald, S.J., Ph.D., is the John A. Creighton University Professor, and chair of the Department of Medical Humanities in the School of Medicine, at Creighton University. He received a Ph.D. in molecular genetics, and a Ph.D. in bioethics, from Georgetown University. His research efforts focus on the utilization of reflection in medical education, on the investigation of abnormal gene expression in cancer, and on ethical issues in biomedical research and medical genomics. He has published educational, scientific, and ethical articles in peer-reviewed journals, books, and in the popular press.

Fr. FitzGerald has given presentations nationally and internationally, and has often been interviewed by the news media, on such topics as human genetic engineering, cloning, stem cell research, and personalized medicine. He is a founding member of Do No Harm, a member of the ethics committee for the March of Dimes, and a member of the Genetic Alliance IRB. In addition, he currently chairs the Ethics Advisory Council for the Geisinger Health System MyCode biobank project, which includes a Return of Results process for exome sequencing of project participants.

In addition, Fr. FitzGerald has been a Corresponding Member of the Pontifical Academy for Life since 2005, and a Consultor to the Pontifical Council for Culture since 2014. He is currently on the ITEST Board of Directors.

From Y2K and Beyond

(ITEST Bulletin, Winter 2000 Volume 31, No.1)

(The Editors chose these messages from Father Robert Brungs, S.J., Founder of ITEST, as a look back at his concern-- almost two decades ago-- of the importance of "the body" in our salvation. Given the current advances in the bio-technologies, (such as CRISPR, the topic of this issue) it appears that, Father Brungs' reflections could be read as "Fall, 2019, Volume 50 No. 4".

Y2K has come and gone and doesn't seem to have registered an impact on our computers. I can't quite decide whether to welcome you into the Third Millennium or the New Year, 2000. It's probably best that I not make a decision beyond reminding you that the calendar date represents little else than the conventional way we calculate it. It is simply a mental construct, with or without a foundation in reality.

It might be appropriate, in the light of expectations coming from biology, to ask what we can do in the coming years. One thing we can do is meet the challenges and opportunities presented to the Faith with Christian dignity. The problems and promises are vast and essentially unpredictable, though, we know, they will partake of the generally utilitarian view of the human so prevalent in our society at present. It will do us little good to sit on the sidelines and say: "It wasn't like this in the past."

One thing we can do is both purify and extend our understanding of the human being, especially of "the body," if we can speak thus. In the long history of Christianity there seems to be this movement; in the early centuries the key issue was the nature of God. Who is God? The Christological and Trinitarian dogmas resulted from this turmoil. Then, over an extended period, there were (and there still are) arguments on the nature of the church and the sacraments. Though those issues are still not settled between the traditions, we are entering into the new questions of *who and what are we***?**

ITEST's contribution to this discussion has been an ongoing, on and off, anthropological discussion, especially on the body. *The body will be the pivot on which the argument will turn.* We are aware that we cannot define the person solely in terms of the body, but our physical nature is much more important than has been generally recognized in the Church. We are promised that in the final Kingdom of Christ, He will transfigure our bodies into copies of His own glorified body. We wait for the transfiguration in faith. But what will it be? We really have no idea. Still, we must work toward an understanding of this mystery, knowing that even our best answers may be wildly off the mark.

From **"Everything is Done 'In the Body'"** Fr. Robert Brungs, S.J., Fall 2000, Volume 31, No. 4

"We are all searchers of the Truth. We can never say that we have arrived at our destination, which is the Truth until we see him face to face…

Gregory of Nyssa uses an image of a spiral: seeing Him we will begin to know Him, and knowing Him better, we will love Him more, and loving Him more, we will know Him better –in an ascending spiral forever. What a breathtaking thought! But we will know Him as a human being with a body – always with a body—as we are bodied. His body and ours in a never-ending dance of love! Our bodies will know Him better and love Him more – and His body will be in union with ours.

One thing is clear: the body is more important to our salvation than we usually credit. Every deed we do as human is done in the body—good or evil. Every thought we think, every dream we have has its origin in the body. We cannot serve God nor love Him apart from the body. I won't impute to you the thoughts in my mind, but I must continually remind myself how important to my salvation the body is. Maybe I should just end these wanderings with a salute to the body…Until the future, then, I salute all you bodied persons and look forward with you to a stunning future. God be with you."

YouTube Presentations on CRISPR

(The editors decided to expand the information contained in written articles/essays in journals and magazines, by including oral lectures and discussions appearing on YouTube. You will see a short description of the lecture followed by the title of the presentation on YouTube).

How CRISPR Lets Us Edit Our DNA

A TED talk by Jennifer Doudna (November 12, 2015)

Jennifer Doudna, biochemist and co-inventor of CRISPR, a promising genetic technology whose aim is to cure certain genetic diseases, discusses in this 2015 video, the basics of CRISPR-Cas9. Early on, she shares credit with her co-inventor, Emmanuelle Charpentier, geneticist and director at the Max Planck Institute in Berlin for developing the protocol together.

Careful teacher that she is, Doudna tells the viewer what CRISPR *is,* what it can *do* and where *we are today* with the technology. However, she has also called for a global discussion on the use of the technology considering ethical and societal implications. Highly recommended by teachers and students alike who have studied this TED presentation and submitted comments, they reassure the viewers that by careful listening they can understand the basics of CRISPR in a comfortable 15 minutes and 53 seconds.

Find this talk at https://www.youtube.com/watch?v=TdBAHexVYzc

Dr. Jennifer A. Doudna runs a research laboratory and institute at UC Berkeley and is a leading expert on protein-RNA biochemistry, CRISPR biology, and genome engineering.

Bibliography/Resources

A Crack in Creation: Gene Editing and the Unthinkable Power to Control Evolution Jennifer A. Doudna and Samuel H. Sternberg, Mariner books edition, 2018, Houghton Mifflin Harcourt, 2017 Boston, New York, pp.281.

"The cheapest, simplest, most effective way of manipulating DNA ever known, CRISPR may well give us the cure to HIV, genetic diseases, and some cancers. Yet even the tiniest changes to DNA could have myriad, unforeseeable consequences-to say nothing of the implications of intentionally mutating embryos to create 'better' humans." (from the publisher)

Jennifer A. Doudna, Ph.D.

CRISPR Biology and Biotechnology: The Future of Genome Editing

A talk delivered at the Science History Institute (November 17, 2018) **b**y Jennifer Doudna

In this lecture, accompanied by excellent graphic slides, Professor Doudna, before examining CRISPR, describes the basics of the DNA molecule, as prelude to teaching about CRISPR. Her interest in science began to grow after reading a book her father had given her titled, *The Double Helix,* when she was still quite young. Her interest continued to grow throughout her college years leading her to the study of science even though, as she notes, at one point she received a "C" in chemistry.

Again, students and teachers alike have highly recommended this presentation as a refresher or as an introduction to the workings of CRISPR-Cas9 and its implications for the future.

Find this talk at https://www.youtube.com/watch?v=mO0xFBQox-Q

From the Editor: In this issue of the ITEST Bulletin, Volume 50, No. 4, we will devote the entire issue to the question of CRISPR. However, rather than publishing a limited selection of essays and articles, we have chosen to offer an abstract of each article giving the reader a choice to access the link in order to read the entire article, or to note the link and read the entire article later.

CRISPR Enters Human Clinical Trials

Tina Hesman Saey

This article deals with a relatively new stage of CRISPR protocol, "entering human clinical trials" for various diseases such as sickle cell anemia, cystic fibrosis and Leber congenital amaurosis 10, an inherited type of blindness. According to Ronald Conlon, a geneticist at Case Western Reserve University in Cleveland, conventional gene therapies have not always been successful, and in fact, have often suffered "severe setbacks," such as a patients developing cancer.

Have this obstacle and other ethical considerations been overcome by the more promising CRISPR? Many researchers agree with that opinion. Clinical trials on humans are relatively new, but the outlook is promising. Alan Regenberg, a bioethicist at Johns Hopkins Berman Institute of Bioethics, notes that the CRISPR therapies will not lead to changes that can be inherited, thus making it safer than conventional genetic editing; however, he warns that scientists must proceed with caution.

Clinical trials proceed at institutes like the University of Pennsylvania where two people with recurring cancers have received CRISPR/Cas9 therapy. The university has not yet announced the outcome of these trials.

For the entire article, go to https://www.sciencenews.org/article/crispr-gene-editor-first-human-clinical-trials

Tina Hesman Saey is a geneticist turned science writer, a Fulbright Scholar and an honors graduate from University of Nebraska where she did research on tobacco plants and ethanol producing bacteria. After earning a Ph.D. from Washington University in St. Louis, she went on to secure a journalism degree, making her ultimately suitable to write with authority on science topics for science journals and the St. Louis Post-Dispatch. Saey currently is senior writer for Science News.

> "As long as the genetic code for a particular trait is known, scientists can use CRISPR to insert, edit, or delete the associated gene in virtually any living plant's or animal's genome….Practically overnight we have found ourselves on the cusp of a new age in genetic engineering and biological mastery—a revolutionary era in which the possibilities are limited only by our collective imagination." p. xiii
>
> Jennifer Doudna, *A Crack in Creation: Gene Editing and the Unthinkable Power to Control Evolution* (co-author Samuel H. Sternberg) Mariner Books, Boston, New York, 2018.

(Of all the articles reviewed by the editors for this issue, none have been more strongly opposed to the use of CRISPR-Cas9 than the author, Rebecca Taylor. In the interest of fairness, the editors have decided to include this article from the National Catholic Register as worthy of consideration regardless of the reader's stance on genetic editing in human beings.)

Immoral Uses of Biotechnology – Even with Good Intentions – are Evil

February 6, 2017

by Rebecca Taylor, clinical laboratory specialist in molecular biology

View her blog at http://www.marymeetsdolly.com/

"Should Christians face unethical uses of biotechnology with despair and resignation or with hope and determination?" The answer in this essay is, "a little bit of both" except when involving the use of human embryos. Taylor cites an experiment by Frederik Lanner, a developmental biologist in Sweden who intentionally modified otherwise healthy IVF embryos, using the CRISPR genetic editing tool, to deliberately halt their development. He and others claim that eventually destroying the edited human embryos "…is critical to understanding human development, which, in turn will shed light on infertility and disease."

Although some of the noted scientists connected closely with genetic editing therapies have called for a moratorium on any editing of human embryos, for fear that it will lead to "…the creation of genetically modified children," others have traveled to various countries to perform these experiments without government oversight or, might we say, safety assurances.

Another genetic editing therapy concerns "mitochondrial replacement" which seeks to eliminate the transmission of genetic disease through the mitochondria we inherit solely from our mothers. Because of the risks of transplanting the nucleus of one cell into another to make a new organism, (remember "cloning?") researchers are concerned about the health of the resulting children. Yet the research goes on.

Taylor reports on a number of other experiments that should cause Christians to despair, mainly since the integrity of human life is completely disregarded especially where the final end of the human embryo is death not life.

Yet, not is all doom and gloom. Taylor recommends prayer above all, and contacting local representatives on such issues to assist in "steering funding away from unethical research."

To view the entire article, go to http://www.ncregister.com/daily-news/immoral-uses-of-biotechnology-even-with-good-intentions-are-nevertheless-ev

> "I do think that the study of natural science is so glorious a school for the mind, that with the laws impressed on all these things by the Creator, and the wonderful unity and stability of matter, and the forces of matter, there cannot be a better school for the education of the mind."
>
> Michael Faraday (1791-1867)

Can the Thought of Teilhard de Chardin Carry Us Past Current Contentious Discussions of Gene Editing Technologies?

By Maria Sulekova, Ph.D. and Kevin T. FitzGerald, S.J.

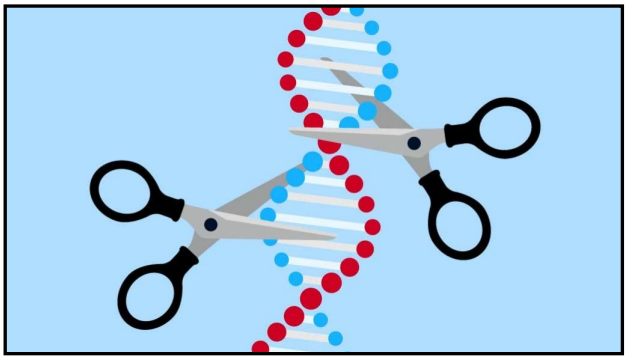
from *Cambridge Quarterly of Healthcare Ethics (2018), 0, 1-14*

***Abstract**: The advent of CRISPR-Cas9 technology has increased attention, and contention, regarding the use and regulation of genome editing technologies. Public discussions continue to give evidence of this debate falling back into the previous polarized positions of technological enthusiasts versus those who are more cautious in their approach. One response to this contentious relapse could be to view this promising and problematic new technology from a radically different perspective that embraces both the excitement of this technological advance and the prudence necessary to use it well. The thought of Teilhard de Chardin provides this desired perspective, and some insights that may help carry forward public discussions to achieve widely accepted uses and regulations.*

> *"In the CRISPR debate, there is currently a call for constructive dialogue and alternative approaches. Employing different types of frameworks capable of considering both enthusiastic and cautious approaches regarding the use of gene editing is required. We believe that Teilhard de Chardin's perspective represents a valuable contribution to the effort to find inclusive frameworks."*
>
> (p. 12 from the title above)

This paper addresses the fundamental outlook on the field, as contrasted to a specific technology. In addition to the abstract, we reflect on the paper as a whole. Indeed, enthusiasts of CRISPR abound and their work, is not only waiting in the wings, but has appeared full-blown on the stage. Browse the shelves of book stores like Barnes and Noble to see magazine racks filled with magazines containing articles such as "Latest scientific cures with CRISPR – the Miracle Tool" and others. Yet, many other scientists, researchers and science writers urge caution. Remember the issue of cloning human beings, IVF controversy and others that raised public awareness about medical-moral ethics and values? "But whose values are they?" Father Brungs founding director of ITEST often asked. "Are these values allied with faith (Judeo-Christian) or the values of the secular world?"

The authors of this article tackle those question from the perspective of Teilhard de Chardin, Jesuit, author and paleontologist who died in 1955, but whose influence on religious/scientific thought is still very current. In a nutshell, "Teilhard aimed at a metaphysic of evolution, holding that it was a process converging toward final unity that he called the Omega point." (Encyclopedia Britannica)



After a detailed examination of CRISPR in relation to Teilhard's thought, the authors conclude, "In the context of the CRISPR debate, the crucial task will be to decide what goal(s) we are willing to pursue as individuals, as societies, and as a species when we speak about the use of gene editing. Teilhard does not provide that specific answer, not having had knowledge of the genetic technology, but he can provide a better way to think about how we might find that answer."

Repairing the Future

by Anna Groves

Discover Magazine, May 2019

A research Team in Oregon hopes gene editing technology will put an end to inherited diseases.

The research using gene editing on human embryos has raised voices of concern from scientists around the world. However, at the Oregon Health and Science University (OHSU), the staff say that their research represented by CRISPR-Cas-9 signifies the first steps toward repairing a genetic mutation in patients with diseases such as cystic fibrosis, sickle cell anemia and Huntington's.

Professor Shoukhrat Mitalipov at OHSU says that human clinical trials for such procedures are at least 5 to 10 years away given the safety precautions involved. In addition to obvious ethical challenges for such experimentation, there are legal challenges.

> "To answer the question 'To be or not to be?' we cannot turn to a science book."
>
> Stanley L. Jaki
>
> *The Limits of Limitless Science.*

The National Academies of Science and Medicine (NAS) met in 2017 to prepare guidelines for allowing gene editing passed on to future generations. They stipulated: that the edit should happen only "in the absence of reasonable alternatives." However, in November 2018 Chinese scientist, He Jiankui used the CRISPR-Cas9 protocol to experiment on twins *in vitro* to increase resistance to HIV even though the protocol was not yet proven and did not adhere to the guidelines. Medical professionals consider HIV preventable and treatable.

Meanwhile, the Oregon staff is working to correct a mutation in a gene (MYBPC3) which causes hypertrophic cardiomyopathy (HCM), a thickening of the muscle around the heart often found in young apparently healthy athletes who die suddenly after engaging in vigorous exercise.

Early intervention is paramount in treating such diseases with the CRISPR-Cas9 package, "before any damage is done," notes Dr. Mitalipov, "even in the embryo." However, some unexpected outcomes may ensue. In an experiment at OHSU using CRISPR-Cas9 to replace a defective gene with a functioning one on a patient with HMC, the results were different from what the researchers expected. Although Mitalipov claimed success, other scientists who tried to replicate the experiment criticized the results. For a detailed explanation please access the article at the link provided below.

Legal hurdles still exist surrounding the question of research on embryos. Private funding supports the work of OHSU and other labs like it, but the ethical question remains: Are human beings properly the "products" of a three person (technician, egg and sperm) assisted "union" in a test tube? The National Institutes of Health provides no funding for "research in which a human embryo is intentionally created or modified to include a heritable genetic modification."

Anna Groves, who holds a Ph.D. in Plant Biology, serves as Associate Director of *Discover.*

> "Anybody who has been seriously engaged in scientific work of any kind realizes that over the entrance to the gates of the temple of science are written the words: 'Ye must have faith.'"
>
> ~ Max Planck

New CRISPR Tool Turns on Genes

Tina Hesman Saey
January 20, 2018
Molecular editor treats mice's diseases without cutting DNA.

This new tool, CRISPR-Cas9 molecular scissors acts as a highlighter for genetic instruction, according to the author, Tina Hesman Saey, Senior Writer at *Science News* magazine.

This technique, she explains, has worked well in mice with type 1 diabetes, kidney injury and Duchenne muscular dystrophy. In addition, this tool could be used to turn on dormant genes or to reinvigorate genes that grow sluggish with age.

Charles Gersbach, a biomedical engineer at Duke University, notes that this capability, used to improve the health of the animal (and eventually the human being when clinical trials are approved), is a "great advance."

However, researchers have found that CRISPR gene activators are sometimes too big to fit into the viruses that deliver the tools to cells. To overcome that hurdle, Juan Carlos Izpisua Belmonte of the Salk Institute for Biological Studies in La Jolla, Calif and colleagues shrank the tool, using guide RNAs shorter than the usual length. This "short leash" proved successful in delivering the package to the correct target.

Other experimentation has occurred involving mice with a muscle-wasting disease that mimics Duchenne muscular dystrophy. Using the same technique mentioned above -- by turning on dormant or other genes – mice treated with this protocol had more muscle mass in their hind legs than untreated mice did. A caveat: Saey warns that, although useful for research, the safety of this technology must be demonstrated before therapy can be used in people.

Subscribers to *Science News* may go to this link to view the entire article:

https://www.sciencenews.org/article/crisprcas9-can-reverse-multiple-diseases-mice

Will Better 'Babies' Become a Moral Must-Do?

Tina Hesman Saey
March 18, 2017

"Do parents have a moral obligation to make 'better` babies through genetic engineering?" The author, Tina Hesman Saey opens her short essay on designer babies quoting from the 2017 World Conference of Science Journalists in San Francisco. Attendees explored the question of the rapid advance of genetic engineering noting that experiments have already occurred in human embryos to fix mutations that cause heart and blood disorders. The tool was CRISPR-Cas9, the genetic "scissors" used to remove a defective gene and to replace it with a "healthy" gene.

Many people agree that using CRISPR-Cas9 to cure genetic diseases is quite proper and laudatory, but "meddling with characteristics that have nothing to do with health" is *verboten.* In this situation, creating "designer babies" is anathema.

Yet, time marches on and what was once "should we do it?" – create designer babies—morphs into "we must do it" as a moral obligation for the betterment of our children. Is this coming in the near future? Some ethicists emphatically say "yes!"

Julian Savulescu, an ethicist at the University of Oxford supports the view noting that employing genetic editing techniques to their children is no different from vaccinating them or giving them medicine when they are ill.

However an opponent emerges in the thinking of retired bioethicist, Ronald Green of Dartmouth College. Although he fully supports genetic editing for curing diseases such as sickle cell anemia and cystic fibrosis, he categorically opposes creating a class of "genobility," as Green calls it. Parents who want to use CRISPR-Cas9 to produce a child who may be taller, with blond hair and blue eyes, and oh, yes, superior intelligence, may in the end be disappointed in "the work of their hands" along with that of the researcher in the lab.

Other researchers say that "designer babies" are very far in the future and are not worthy of serious discussion at this point. However, with the rapid advance of science and technology, "far in the future" may be just around the corner.

Subscribers to *Science News* may go to this link to view the entire article:

https://www.sciencenews.org/blog/science-the-public/ethics-gene-editing-babies-crispr

First Opinion from STATnews.com

"Before heritable genome editing, we need slow science and dialogue 'within and across nations'"

By Francoise Baylis, author of *Altered Inheritance: CRISPR and the Ethics of Human Genome Editing,* (Harvard University Press, September 2019).

The quote by the author and university research professor Baylis at Dalhousie University in Halifax, Nova Scotia, succinctly covers the main points of his essay on CRISPR.

His caveat above all is to proceed slowly with this genetic tool especially when experimenting with "heritable genome editing." That means germline editing which would affect any future "issue" (those born in the future) from the patient treated. Baylis approached other scientists involved in some way with the discovery of CRISPR, asking them to speak out on the necessity of slowing down this kind of research, especially that of germ line editing given questions of safety and other "accidents" resulting from insufficiently tested procedures. According to the author, Emmanuelle Charpentier and Feng Zhang agreed to support his efforts, but Jennifer Doudna, the other CRISPR pioneer, "expressly declined to participate in this initiative."

Baylis was asking simply that there be a moratorium on heritable genome editing emphasizing "…the importance of dialogue within and across nations, and the need for broad societal consensus on the appropriateness of altering the human genome for a particular purpose before any such research could proceed."

The author arrived at his conclusion: the need for careful collaboration with other researchers on the question of heritable genome editing. His decision rested mainly on the reaction to the work of rogue Chinese biophysicist, He Jiankui. He created gene-edited twins (*in vitro*) with the aim to "knock out" the gene leading to the HIV virus. However, that experiment, completed without a nod to scientists who were taking the "slow path" in genetic editing on human beings, raised the hackles of researchers around the world. Such an experiment placed the onus squarely on He's back generally worldwide, not because the scientists envied his "success" but because the protocol did not meet the accepted standards for such experiments.

> "I believe God did intend, in giving us intelligence, to give us the opportunity to investigate and appreciate the wonders of His creation. He is not threatened by our scientific adventures."
>
> Francis Collins, physician-geneticist, Director of National Institutes of Health in Bethesda, Maryland, led the Human Genome Project.

In the feature article of this issue, Father Kevin FitzGerald echoes the stance of Baylis in calling for public involvement, in this case, from Christian not-for-profit entities, like ITEST, in addressing the implications of heritable gene-editing. Baylis in his book *Altered Inheritance*, strongly urges moving from "public education," important in itself, "…to public engagement, and then to public empowerment."

The author admits that, used wisely, CRISPR-Cas9, can be an effective tool in curing certain diseases such as sickle cell anemia, cystic fibrosis, Duchenne muscular dystrophy, among others, but he advises caution. He notes, "It is a call for all of us to take collective responsibility for the biological and social future of humankind as we think carefully about what kind of world we want to live in, and how genome editing technology might help us build that world."

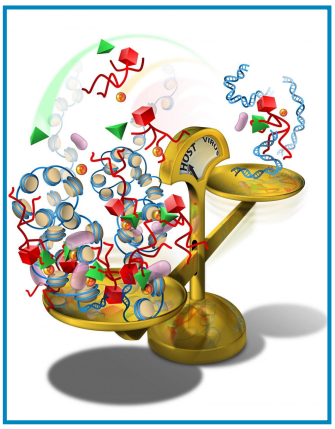
Sound familiar? It appears to echo the concern around "*in vitro"* fertilization and cloning of human beings in the 80s and 90s.

To view the entire article, please click on the link below.

https://www.statnews.com/2019/09/23/genome-editing-slow-science-dialogue/

The editors highly recommend "Bioethics News" a newsletter published by the Bioethics Observatory at the Catholic University of Valencia. Their objective is to present "specialized topical reports and news with ethical implications based on the latest research findings."

CRISPR-Cas9 Causes More Damage in the Genome than Thought



"At present CRISPR-Cas9 produce[s] off-target effects and the CRISPR-Cas9 editing system causes more damage in the cellular DNA than previously believed." This is not detected by standard tests, according to a study published in *Nature Biotechnology." (Bioethics News)*

Further, one of the authors of the study, Allan Bradley, notes that "This is the first systematic assessment of unexpected events resulting from CRISPR-Cas9 editing in therapeutically relevant cells, and we found that changes in the DNA have been seriously underestimated."

For the entire article, go to the following link.

http://bioethicsobservatory.org/2018/10/crispr-off-target-effects/28097

Chinese Scientists Try to Cure One Man's HIV with CRISPR

WIRED Magazine

September 11, 2019

A patient diagnosed with HIV-AIDS and leukemia was treated in 2017 with the gene-editing tool, CRISPR. The plan was to destroy the man's bone marrow then insert the new stem cells donated by a healthy man.

However, before inserting the new cells, the doctors edited them with CRISPR to cripple a gene CCR5 "without which HIV can't infiltrate cells." The procedure worked but only partially; the patient is in complete remission from his leukemia since the procedure, but still not cured of HIV-AIDS. A small percentage of the cells continue to carry the CCR5 mutation.

The test shows that "The safety profile appears to be acceptable," according to Carl June, pioneering cancer researcher. At the same time, he cautioned that the study was too limited in scope (only a single patient) to provide definitive and long term data.

To access the entire article, go to https://www.wired.com/story/chinese-scientists-try-to-cure-one-mans-hiv-with-crispr/.

> "It's interesting when you read the life of Christ how much of his time he spent healing the sick. There must have been a reason for that—he was modelling for us what it is we are intended to do by following his path."
>
> *Francis Collins, physician-geneticist, Director of National Institutes of Health in Bethesda, Maryland, led the Human Genome Project.*

The CRISPR Antidote

By Eric Betz

Discover Magazine, December 2017

Science tells us that a bacteria's natural defense system against viruses is called CRISPR-Cas9. In 2011 biochemist Jennifer Doudna and French microbiologist Emmanuelle Charpentier suspected that they could try to engineer CRISPR to act as an editing tool, snipping out a diseased or target gene and inserting a new healthy one.

Other labs jumped on the bandwagon and experimented with a relatively good success score. "CRISPR-Cas9 lets you find the right spot," according to Joseph Bondy-Denomy, a microbiologist at the University of California, San Francisco (UCSF). "That's a big deal."

However, that "big deal" encountered some problems when used in complex clinical trials where more mutations can occur. In May, 2017 a group of ophthalmologists used CRISPR to fix a blindness-causing gene in mice. Their report of the results published in *Nature Methods* demonstrated that the roaming Cas9 scissors or snipping tool, after doing its "target duty", often went roaming around in other areas of the DNA snipping other genes that resembled the target gene; labelled "off-target." The disappointed ophthalmologists wrote that, although CRISPR fixed the blindness-causing disease in mice, researchers found "hundreds of unintended genetic mutations in the treated mice."

How does one rein in a genetic tool bent on roaming around unguided on a long leash? Provide a shorter leash. A scientist did just that and devised an anti-CRISPR antidote. Bondy-Denomy, the UCSF microbiologist found a natural way to provide an "off-switch" which prevents CRISPR from roaming, hence curbing the CRISPR tool's "wanton ways" of producing unintended mutations in the animals – and eventually in human beings.

For more detail on the process Bondy-Denomy used in the experiment go to

http://discovermagazine.com/2017/dec/the-crispr-antidote

Doctors Try CRISPR Gene Editing for Cancer, a First in the U.S.

The Associated Press
November 6, 2019

One hurdle has been crossed using the genetic tool, CRISPR, to fight cancer in a recent experiment reported by the study leader, Dr. Edward Stadtmauer of the University of Pennsylvania in Philadelphia. Thus far, the safety of the experiment is no longer a problem, but yet to be tested is the survival of the patients involved.

The procedure involved deleting three genes that "might have been hindering these cells' ability to attack the disease, and adding a new, fourth feature to help them do the job."

Of the three patients tested, one patient's cancer worsened and another remained stable. One patient has sarcoma and the other two have multiple myeloma, a blood cancer. It is too soon, reports the doctors, to ascertain if the third patient will worsen or improve since it is too recent to tell. The plan is to treat 15 more patients, assess safety and see how it works.

Although Chinese scientists have tried this treatment with cancer patients, this is the first to take place outside China. It took more than two years to obtain permission and approval from the U.S. government regulators to try it.

The American Society of Hematology released these early results. More detailed information will be given at the annual conference in December.

For more details, go to the following link.

http://www.texarkanagazette.com/news/features/story/2019/nov/13/doctors-try-crispr-gene-editing-cancer-attempt-first-us/803829/

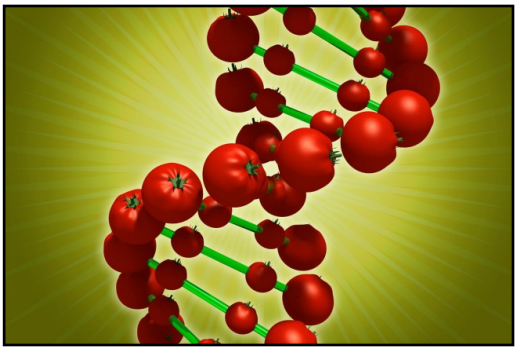
A New Green Revolution:
Scientists Are Using CRISPR to Re-domesticate Fruits and Vegetables

By Jonathon Keats

Discover Magazine

Although many of the articles reporting on the use of CRISPR as a genetic tool relate to the eventual curing of certain diseases in human beings, the research by plant geneticists has not been lacking.

As reported in the October 2019 issue of the monthly magazine, *Eating Well,* Monsanto's groundbreaking work on Bacillus thuringiensis (Bt) corn in the 1970s and 1980s enabled farmers who used this Genetically Modified Organism (GMO) to rely less and less on herbicides damaging to the environment. Unfortunately for some, Monsanto took another road, rather than pursuing and developing the Bt technology further, they devised the herbicide, Roundup, a "blockbuster" herbicide effective in weed control. Some soil scientists worry that Roundup Ready seeds may have unforeseen consequences on the environment.



How are scientists today "re-domesticating" certain fruits and vegetables? They have selected the vegetable of choice, the tomato (which of course is a fruit to those "in the know.") One such scientist, plant biologist, Joyce Van Eck at Boyce Thompson Institute in New York "envisions an alternative approach to cultivation." Rather than standing by and letting Mother Nature or accidents take their course, Van Eck has stepped in with other scientists and introduced the use of CRISPR-Cas9 to introduce commercially attractive traits in the wild twiggy branched tomato such as better color, flavor, nutritional value, smaller compact plants and drought resistance.

Other labs around the world are jumping on the CRISPR bandwagon and have arrived at promising results. For instance, plant physiologist Lazaro E. Pereira Peres reported in *Nature Biotechnology,* that he had successfully controlled branch length and improved fruit size and yield in the wild tomato while retaining drought resistance in the wild tomato plants.

Scientists predict that in the future CRISPR-Cas9 genetic editing of fruits and vegetables will be a vital factor in feeding the world as climate change and other environmental factors bring about change in 21st century living.

For more information on this article please click on the following link

https://www.discovermagazine.com/health/a-new-green-revolution-scientists-are-using-crispr-to-re-domesticate-fruits-and-vegetables

"Reading Scripture, it's impossible to escape the notion that God takes food seriously. Manna in the desert, the many banquets! The bread of life! One can make a case that Scripture uses food as symbolic of our humanity. Conviviality is the virtue that take place in the presence of food and drink. Wine! The glad heart! 'They have no wine'. We might contemplate why food is symbolic of us and how it is a part of our rallying around the Lord who has already rallied around us."

Fr. Robert Brungs, S.J. "Science and Politics of Food." 2000