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Dignitatis Personae Complexio: Human Genetic Engineering and the Catholic Church

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Member of the World Health Organization

It was not accidental that the great Harvard geneticist George Church gave his 2012 book on "how synthetic biology will reinvent nature and ourselves" the bold title *Regenesis*. Although we may differ in our understanding of how life on earth sprung into being, it will be increasingly clear to everyone that recent advances in the life sciences are giving our species a growing ability to remake all of life, including our own. Even those believing the original genesis a divine act must now grapple with the awesome human power of regenesis.

But although we may suddenly possess powers we have long attributed to our various gods, deploying them unguided by a positive values framework would be a recipe for disaster. To make sure our most sacred values guide the application of our most powerful technologies, we all must come together as never before to set standards for how best to proceed. The Catholic Church has an essential role to play in this process.

The genetics revolution was not spun out of whole cloth when Watson, Crick, Franklin, and Wilkins identified the double helix structure of DNA in 1953. Hundreds of years of prior research across multiple fields, much of it sponsored by the Church, had made this breakthrough possible. Many of the great researchers who laid the groundwork for the field of genetics were themselves priests, the Augustinian monk Gregor Mendel foremost among them.

Along the way, new discoveries compounded as the rate of innovation escalated. Once we understood that the book of life was written in the Gs, As, Ts, and Cs of DNA, advances in genome sequencing made reading the code of life possible. The development of genome editing tools like CRISPR showed that the code of life could be edited. Now rapid advances in synthetic biology are making it possible to create new life from biological building blocks. This ongoing genetic revolution is showing us that the source code of life is an increasingly readable, writable, and hackable form of information technology.

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Whether someone believes human beings are single cell organisms gone wild over billion years of evolution or the result of a divine plan, the idea of hacking our biology should be cause for concern. However far our science has come, our understanding of the immense complexity of our own biology remains relatively minimal. In spite of these legitimate and highly warranted concerns, however, it would also be wrong to deny ourselves the tremendous benefits of life-affirming technologies in the name of questionable ideas about what is and is not natural.

Early humans lived as our simian relatives do today, in constant fear of predation, disease, and starvation. Harnessing fire, building tools, and developing agriculture, medicine, and cities were hallmarks of our struggle to tame the ravages of unadulterated nature. Lots of terrible things, from disease to drought, are perfectly natural but we fight to mitigate their effects because we feel saving the lives of our fellow humans is a good thing to do. Genetic technologies will help us do that more effectively as we transition from the current world of generalized medicine based on population averages to the coming world of precision medicine where treatments will be tailored to each person's individual biology.

To make this transition possible, most of us will soon have our whole genomes sequenced as part of our standard healthcare. Our ensuing greater understanding of how each of us functions on a molecular level will make amazing new treatments possible to treat Cancer and various genetic disorders. Researchers will utilize massive and forever growing data pools of genetic and life information to increasingly crack the code of our complex biology. Our increasing ability to read and comprehend the code of our lives will then quickly move us from our world of precision medicine toward our coming reality of predictive medicine, healthcare, health, and life.

Parents will be told before taking their newborns home from the hospital that their children have, for example, a greater than average chance of later developing early onset familial Alzheimer's or, perhaps, a hereditary form of breast cancer. Although most new parents would today recoil from that type of probabilistic information, future parents will feel differently because it will empower them to help their children live healthier lives. This new appreciation for probabilistic genetic information will extend far beyond healthcare.

There's a reason we don't call it the disease genome or the healthcare genome but the human genome. Our genetic code serves as a blueprint for much of what we have the potential to be. Massive genetic and life databases won't just tell us about our disease risks but also give us imperfectly predictive information about the genetic components of our most intimate human traits. Parents at the hospital

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might also be told, for example, their newborn has a greater than average chance of exceling at abstract math, physics, or sprinting, or that their child is more likely than other children to be highly empathic or, alternately, a psychopath.

Because environmental and other factors still play a very important role, this won't mean kids with these increased potentials will be destined for pre-determined outcomes. But the importance of nurture hardly renders nature irrelevant. As we learn to look under the hood of what it means to be a human, parenting, personhood, and potential will come to be seen as being more influenced by genetics than currently the case.

The most profound application of genetic technologies will be in transforming the way we make babies and the nature of the babies we make. Our biology, by definition, is buggy, generating an incessant flow of variation. Just as some babies are born with seemingly advantageous mutations, around 2 percent of all babies are born with harmful genetic abnormalities. Some of these lead to painful, early deaths. For decades, increasing numbers of prospective parents have been using in vitro fertilization (IVF), a process in which eggs are surgically extracted from the mother then fertilized with the father's sperm before being re-implanted into the womb. Some higher risk parents have then used pre-implantation genetic testing (PGT) to screen the fertilized eggs for genetic and chromosomal disorders to help determine which to implant.

Because nature's "error rate" is constant but technology's tends to decrease, there seems little doubt that IVF plus embryo screening will over time come to be seen by many as a safer way to conceive than inside the female body through sex. Although people will initially choose to avail themselves of these technologies out of concern for the health of their future children, the implications of this transformation will extend far beyond health. In jurisdictions where it is legal, prospective parents will be able to know much more about the range of genetic potentials for each embryo before making the decision about which to implant. Many will likely choose to optimize the health and longevity of their potential offspring when making these choices, but the optionality will go further. Height and the genetic components of traits like IQ and personality style will be among the many potential considerations.

Although the mathematics of choice will be limited because human females tend to produce a relatively small number of eggs (the average women has only around 15 eggs extracted during IVF while the average male ejaculation contains hundreds of millions of sperm cells), the availability of human eggs will likely increase dramatically due to advances in stem cell technologies. Skin cells, for

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example, could be extracted from the potential mother then induced into stem cells which could then be induced into egg precursor cells and then eggs. Rather than having just a few eggs, a prospective mother could through this process produce many thousands. These thousands of fertilized eggs could be incubated for around five days before a few cells could be extracted from each and then sequenced. Having thousands of viable, natural embryos from which to choose would fundamentally transform the process of baby-making from what some call randomness and others divine grace toward a more conscious human decision.

Once parents select which among their pre-implanted embryos they would like to implant, genome editing tools far more precise than today's CRISPR will increasingly be used to edit a small number of genes either to eliminate a serious risk, like a potentially deadly genetic mutation spread across all available embryos, or to provide a potential benefit such as conferring immunity to a range of deadly viruses. We humans who once sat in the back seat of our evolutionary car will increasingly take our hand at the wheel.

For those of us who believe that fighting disease, optimizing human health and longevity, and preventing the premature death of children and dementia among the elderly are desirable goals, these technologies will be an enormous benefit. But we will all need to recognize that these powerful and highly beneficial technologies come accompanied by serious risks.

As in many areas, our tools making change possible are far more advanced than our understanding of the systems we seek to change. If some people have access to powerful genetic technologies and others do not, we run the risk of dangerously bifurcating our species into genetic haves and have nots. If we don't recognize that genetic diversity is the foundation of our collective resilience, we could threaten our survival by blindly chasing social norms in our reproductive decisions. There is no good or bad in evolution, only sets of traits that are better or worse suited to a given environment. When conditions change, what were once the most advantageous attributes can become the new liabilities.

With the science advancing so rapidly and so much at stake, it might be convenient if our species could just hit a pause button giving us more time to reflect. Unfortunately, we don't have that option. With more humans existing, educated, and networked than ever before and multiple scientific revolutions folding into and empowering each other, our science is advancing exponentially. Today's science fiction is rapidly becoming tomorrow's science. Our diversity within and between societies paired to incessant competition is driving us forward relentlessly. We can

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no more stop revolutionary science than we can prevent the earth from revolving around our sun.

But to prevent the promise of the genetic revolution from transforming into a dystopian nightmare we can – and must – work to ensure our best ethical frameworks are applied to every stage of our decision-making. As a champion of one of the world's great moral traditions, the Catholic Church has a special responsibility in this process.

For centuries, the Church has been perceived as both a champion and a foe of science. The same Church that supported Gregor Mendel fought to silence Galileo. Over the course of the past century, however, the Church has made a concerted effort to reconcile science and faith. In 1936, Pope Pius XI established the Pontifical Academy of Sciences, confirming the Church's commitment to promoting scientific progress. More recently, the Church began accepting evolution as being "more than a hypothesis".

As the Church has increasingly recognized the value of science, it has strongly supported the integration of ethical frameworks into decision-making about how science and technology should be applied. This support has helped democratize beneficial technologies like advanced agriculture and internet access and helped limit the proliferation of harmful technologies like nuclear, chemical, and biological weapons. The 2008 Vatican guidance on bioethics, *Dignitas Personae,* wisely labelled science "an invaluable service to the integral good of the life and dignity of every human being".

But the Church's laudable efforts to promote the ethical application of science have, in the view of many observers, been undermined by its adherence to rigid rules that arguably have inflicted tremendous harm on many of the people it aspired to help. Positions against condom use, stem cell research, IVF, and pre-implantation genetic testing find support from some Catholic principles but seem to violate others by perpetuating avoidable and unnecessary suffering and limiting some prospective parents' ability to bring life into the world.

Hard and fast of rules may be easy to communicate across a vast global organization spanning continents and cultures, but adhering to them with inflexible rigidity makes the necessary balancing of costs and benefits impossible. For most of the complex issues surrounding the application of genetic technologies, taking an extreme position at one end of the spectrum or another tends to inflict unnecessary harm.

In light of its principles, it is understandable the Church would want, for example, to oppose indiscriminate sexual promiscuity and promote healthy marriage. But if

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a blanket prohibition on condom use is the means to this end, what happens when a married man in a poor village contracts HIV from a blood transfusion? Does the Church expect him to never make love with his wife again or to potentially infect her? Is the Church living up to its principles by making it impossible for him and his wife to use IVF and embryo screening as one way of having a baby while avoiding unprotected sex? Although the Church's conception of sex as sacred can be life-affirming, many in the health care community are deeply concerned that its fervent opposition to condom use has contributed to increasing the number of deaths from AIDS and other sexually transmitted diseases, especially in Sub-Saharan Africa.

Similarly, by opposing major categories of critical stem cell research, the Church may be championing, in the words of the *Dignitas Personae*, "the unconditional respect that is morally due to the human being", but it is potentially condemning some people to death from genetic disorders that might otherwise have been cured or avoided? By asserting a blanket opposition to IVF and pre-implantation genetic testing, the Church may be supporting the position that "the procreation of a human person be brought about as the fruit of the conjugal act specific to the love between spouses", but also making it impossible for a certain set of loving spouses to have children of their own or obliging them to risk having children with avoidable and sometimes deadly genetic diseases. Even our best values can inflict unnecessary harm when applied absolutely regardless of the context.

Because life is complicated, our morality often lies more in the struggle to apply our most sacred values in challenging situations than in our strict adherence to absolute rules. The Catholic Church, which establishes many rules for its followers, has demonstrated an impressive willingness to change course over time. The same Church whose doctrines once seemingly justified murderous crusades, inquisitions, holy wars, and colonizations has now evolved doctrines that boldly champion peace and human rights.

Other concepts, like just war, also demonstrate potential room for flexibility. Unlike the Quakers and Jains who oppose all violence, the Catholic Church still maintains elements of a proportionate just war doctrine that does not, for good reason, completely reject the use of force. Hitler represented an unmitigated evil that needed to be defeated by all necessary means. But if force can be used in a just war context to fight for a greater good, would it not stand to reason that stem cell research and condom use that can prevent terrible suffering and save people's lives should also be subject to the same cosmic cost-benefit analysis?

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This kind of focus on how best to realize core values in a complex world of trade-offs will be even more essential when facing the tough decisions that lie ahead as the genetics revolution unfolds. *Dignitas Personae* wisely supported the possibility of using gene therapies to correct genetic diseases in humans while expressing significant caution about the heritable genetic manipulation of future children as "an unjust domination of man over man".

If a hypothetical person were dying from a dominant genetic disorder, Church teaching would likely accommodate gene therapy designed to alter the person's genetics to cure the disease. If the same deadly genetic disease were to be diagnosed not in a living person but in a fetus inside a mother's womb, Church doctrine could also potentially accommodate fetal gene therapy to fix the harmful mutation before the child was born. In each of these scenarios, the gene edit would conceivably fix the problem without passing the alterations to future generations. Editing this same gene earlier in the process, however, could remove the threat of this deadly disease forever. This could be done by genome editing the sperm or egg that combined to form the embryo (if the mutation is not *de novo* and comes from one of the parents) or by editing the early-stage pre-implanted embryo. In technical terms, this is called crossing the germline because genetic alterations of these sex cells would pass to future generations.

Crossing the human germline with gene edits is a very big deal. He Jiankui, the Chinese biophysicist who secretly edited the genomes of embryos that became two Chinese girls born in October 2018 was rightly condemned and sentenced to a three-year prison term. The World Health Organization international advisory committee on human genome editing (on which I serve) has stated unequivocally that that no genome editing of human embryos designed to be implanted and taken to term should be permitted at this time because the science is not yet sufficiently mature. Given the very rapid progress being made in genetic technologies, however, there will soon come a time when this type of intervention can be done accurately and safely. When that happens, the moral calculus for many people will likely shift and the Church will face an even greater challenge in defending absolute rules.

Efforts to distinguish genetic interventions for therapeutic reasons from interventions designed to provide enhancements will be a case in point. Although it is tempting to follow a "therapy good, enhancement bad" standard, this approach will likely not stand up well under scrutiny. What, for example, happens if a future deadly virus is wiping out humanity and the only way we believe we can save our species is by engineering in our next generations a resistance to all viral

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infections? What happens if earth's environment becomes too hostile to support our current biology due to climate change or some other transformation? How would we draw a clear line between therapy and enhancement when we can't define the parameters of what is and is not normal and the world around us is constantly changing?

UNESCO asserted in a 1997 declaration that "the human genome must be preserved as common heritage of humanity". This position is extremely difficult to defend. Because our genomes are constantly changing across generations, the only way to truly preserve our genomes "as common heritage of humanity" would be to ban sexual reproduction and solely clone ourselves to reproduce. Once we accept that our genomes are constantly changing and creating new mutations as we procreate, believe it right to fight deadly genetic diseases and save people's lives using genetic technologies, and witness the increased efficacy of both somatic and germline interventions, it will be extremely difficult to draw such a clear moral line between heritable and non-heritable genome editing.

Accepting that it could be justifiable in some cases to edit a pre-implanted embryo to prevent a deadly disease, however, does not mean we must blindly support all germline human genome editing for any reason. Among the excellent reports issued by national science academies following the announcement of the Chinese CRISPR baby fiasco, the German Bioethics Council stood out for its significance. As historical heirs to the monstrous misapplication of genetic "science" by the Nazis, the post-War Germans have been extremely thoughtful and careful in regulating and restricting any technologies raising the faintest hint of eugenics.

It was therefore highly notable when the May 2019 report of the German council outlined an ethical framework for evaluating whether heritable changes to a human genome could be justified. In direct contradiction of the Council of Europe's Oviedo principles, the German council asserted that their ethical analysis "does not lead to any categorical inviolability of the human germline". They then described specific applications of heritable human genetic engineering, such as when both prospective parents have cystic fibrosis, where "no categorical reasons for prohibiting such interventions can be derived from the application of ethical concepts". That these highly responsible German ethicists are open to considering the possibility of a limited range of justifiable heritable edits to humans does not mean that everyone else must be. It does, however and at very least, suggest that the path of virtue does not necessarily lay at either extreme of unbounded permissibility or ultimate restriction.

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That none of these issues are easy is the essential point. The deep complexity of these life and death matters demands that we all be guided by our best values. As clear as they may be, absolute, unrestricted, and unlimited bans on the application of human genetic technologies, would very likely inflict the same type of harm on the most vulnerable among us as has the absolute ban on condom use. Just as supporting a transhumanist genetic free-for-all would cause unnecessary suffering, so too does a blanket ban on technologies that have such a great potential to save lives. To realize our collective best potential, we must both define *and* seek to realize our core values within the complexity of our real world where there are always costs, benefits, and tradeoffs. Truly championing our best values requires that we wrestle with this complexity.

To its credit, the Catholic Church appears to have subtly recognized this possibility. The *Dignitas Personae* asserts:

> Because the risks connected to any genetic manipulation are considerable and as yet not fully controllable, *in the present state of research*, it is not morally permissible to act in a way that may cause possible harm to the resulting progeny. In the hypothesis of gene therapy on the embryo, it needs to be added that this only takes place in the context of *in vitro* fertilization and thus runs up against all the ethical objections to such procedures. For these reasons, therefore, it must be stated that, *in its current state*, germ line cell therapy in all its forms is morally illicit.

The words “as yet”, “in the present state of research”, and “in its current state” together demonstrate a remarkable signaling by the Church that there could come a time when the potential benefits of limited heritable genetic manipulation might outweigh the considerable costs. This recognition that the life-saving benefits of the genetics revolution will be realized not in the abstract world of moral absolutes but rather the complex world of trade-offs has the potential to place the Catholic Church where it must be – at the center of an interactive global dialogue on how our powerful new tools can best be applied in service of our humanity.

We don’t have a moment to lose. As Harvard biologist E.O. Wilson has asserted, “We have paleolithic emotions; medieval institutions; and god-like technology”. While our technologies are advancing exponentially, our common understanding of what’s happening and at stake is only moving forward linearly, and our badly needed regulatory infrastructures is only inching forward glacially. To progress safely and together, we must urgently address this dangerous misalignment.

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It is easy to imagine how our species might abuse the god-like powers we are inevitably assuming. We could crash ecosystems with our gene drives, reduce our diversity and resilience through narrow embryo selection, pigeon-hole people to fulfill pre-determined societal roles, engage in genetic arms races, commoditize our future children, and destroy our common humanity in countless other ways. We can also imagine beautiful scenarios where we cure deadly genetic diseases, give years of healthy life to our parents and grandparents and help the most vulnerable among us live more empowered and healthy lives. The difference between these two scenarios is us.

Because our most powerful technologies will impact all of us in such deep and fundamental ways, we must each be educated about what is happening and empowered to help determine the best collective way forward. We need a comprehensive, transparent, inclusive, open, and informed species-wide dialogue on the future of human genetic engineering.

As a global community of over a billion people, the Catholic Church could be a critical catalyst of this process. The tremendous educational capacities of the Church which are used primarily to engage Catholics, can also help others of all faiths and traditions in open and inclusive dialogues helping develop norms that can guide national and global regulations. The Church, however, will not be in a position to play this constructive role if it positions itself solely as an enforcer of rigid and absolute rules in the name of an ultimately indefensible clarity.

To help lead a global conversation about the best way forward, the Church must be open to it. It must enter the ethical conversation about real-world trade-offs in the name of highest principles. It must champion the complexity of the human dignity, the *complexio dignitatis personae.*

Our human species is today at a crossroads, a moment of regenesis. The opportunities and challenges before us are like none other we have ever faced. The consequences of our decisions are existential. The Catholic Church has a critical role to play fostering respect for human life, a focus on what is sacred, and a global process promoting human dignity in our complex world. Is it willing to do so?