DIGNITAS

a publication of THE CENTER FOR BIOETHICS & HUMAN DIGNITY • VOLUME 16 • NO 4 • WINTER 2009

FROM IPODS TO IHUMANS: WHAT WILL NANOTECHNOLOGY DO TO US?[1]

BY DÓNAL P. O'MATHÚNA, PHD

My interest in nanotechnology grew out of conversations with scientists developing medical diagnostic devices at our university, Dublin City University. The term came up more and more in relation to the development of smaller and smaller lab-on-a-chip devices. While many exciting ideas were being proposed, I raised questions about the ethical implications of some of these devices. Many agreed they knew little about the potential hazards of the nanomaterials they were manufacturing or using. Yet universities and governments around the world are investing heavily in nanotechnology for its economic return. All sorts of useful devices are being developed, but others want to use nanotechnology to enhance people all the way to the posthuman – a new species with capabilities far beyond those of humans.

Those raising serious concerns about nanotechnology are sometimes accused of focusing too much on science fiction. Curiously, science fiction was one of the few places with a cautionary message about nanotechnology. I was drawn to examine why this might be the case, and whether science fiction offered a helpful way to raise ethical issues about nanotechnology (and other bioethical issues). Out of this developed my book *Nanoethics*. Written for a general audience, it introduces the science behind nanotechnology and the main ethical issues involved. Clearly informed by my Christian beliefs, these are presented in a way that hopefully will resonate with a wide audience. Human nature, with its potential and its flaws, is frequently examined by science fiction, which thereby provides a helpful signpost towards the true source of hope and redemption which some seek in technology.

Nanotechnology gets its name from the prefix 'nano', which refers to one billionth of a unit. Nanotechnology focuses on the nanometer (nm) scale, which is usually 1-100 nm. Most atoms are smaller than this range, while bacteria and cells are larger. Within the nanoscale fall large molecules, particular biological molecules like proteins and DNA, with many viruses right at the 100 nm limit. Nanotechnology focuses on understanding, manipulating, and manufacturing items in the nanoscale range.

A brief history of the development of nanotechnology is given in my book, and more detailed accounts are available.[2] Much of the vision for nanotechnology can be traced back to a talk given by Richard Feynman in 1959. He later won the 1965 Noble Prize in Physics, though not for work in nanotechnology. Feynman discussed how it should be possible to write the entire Encyclopedia Britannica on the head of a pin. He challenged physicists to develop the necessary methods, which were available a few decades later. Feynman also envisioned building surgical devices that could be injected into the body, guided to the source of health problems, and conduct repairs.

Science fiction picked up on this idea in the movie *Fantastic Voyage* (1966). The submarine that travelled through the patient's bloodstream was made through fictional methods, not nanotechnology. This exemplifies a complex interdependence between science and science fiction, as Feynman was clearly influenced by earlier science fiction. Nanobots have become a staple in science fiction, and some ethical concerns have been raised about these. However, this has also led to criticisms that nanoethics is overly concerned about the distant future. In my book, I develop a general distinction between "futuristic nanotechnology" and "normal nanotechnology." The former needs to be examined, but the latter is more pressing because nano-enabled products are on the market already.

Many recent developments in personal electronic devices, like the iPod, can be traced to nanotechnology. Other applications include sports equipment that is stronger and lighter, antibacterial coatings, and 'self-cleaning' windows. Carbon nanotubes are one group of nanoparticles that is attracting much interest. These hollow tubes are made from carbon atoms and are just a few nanometers wide. They have very distinct electrical and magnetic properties, and are unusually strong. They are expected to lead to a new generation of strong, but light, materials for car bodies and space-craft. They can be used in fabrics which are able to convert friction from body movement into stored electrical energy. This could power GPS systems, laptops, and other electronics for hikers or soldiers.

An important ethical issue is how decisions are being made about the types of products to be enabled by nanotechnology. While some parts of the world get smaller, faster iPods, others have no food, clean water, or basic healthcare. The life expectancy in some countries is half of that in the U.S. and Europe. Many deaths occur from "neglected diseases" which have received little or no research in recent decades.

The reasons for this situation are complex and multi-faceted. Solutions will not be simple. But at this point, many of the issues are not even being addressed. Some are claiming that even in bioethics there exists a "first-world bias."[3] The ethical issues of concern to poorer nations and communities rarely feature on the bioethics agenda. Ultimately this is an issue of justice, something Christians should be very concerned about. The problem here is not nanotechnology itself, but

CONTINUED ON PAGE 4

from the director's desk

BY PAIGE C. CUNNINGHAM, JD
Executive Director

Enhancement. Beyond therapy. "Better than well." Superhuman. What do these phrases intimate? A futuristic sci-fi scenario? A much needed leap forward in biomedicine? Or, merely a description of the current state of affairs? These phrases suggest a reality that is both 'now' and 'not yet.' We are all familiar with the controversy over the use of steroids in athletic competition. We may not be as familiar with personalized genomics. One element that ties these two examples together is the moral reflection that should attach to each. But, all too often, moral reflection comes after the fact, after the scandal, after the cosmetic surgery gone awry.

As we absorb the scientific discoveries and technological innovations of this biotech century, it is exceedingly urgent that we grapple with the moral questions they raise. Should we chase after the goals of living longer and working smarter, boosting our brainpower and physical performance to boundless heights? Can we discern which of these developments genuinely respect our human dignity as they remedy our human frailty? Our investigation must go further. Even if these innovations are individually unobjectionable, they could have a collective impact that we ought to consider.

These considerations were at the heart of our recent summer conference, "Beyond Therapy: Exploring Enhancement and Human Futures." I was pleased to participate in the proceedings with our high-caliber, diverse array of speakers. Collectively, they unpacked serious questions about genomics and race, living humanly in a digitized world, regenerative medicine, physicians and other "endangered species," and the pursuit of superhealth. Dr. William Hurlbut (former member of the President's Council on Bioethics) opened our deliberations with considerations on embodiment and human dignity. Amy Laura Hall explored the troubling area of "mommy mistakes and the rhetoric of shame." Read Schuchardt took us behind the camera to scrutinize Hollywood's angle. A new feature was the opportunity to listen in as three scholars engaged each other in closing reflections on our possible human futures.

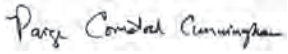
In reflection on the rich discussion of enhancement and human futures, I have been thinking about my own uneasy relationship with technology. While not precisely *bio*technology, there are communication technologies that re-shape how I live my day. My time seems to dribble away, spent on the demands of the alluring chime announcing "you've got mail,"desultory wandering around the Internet, and on and on. Whether in pursuit of the latest technology that promises efficiency, productivity, and cutting-edge information, or biomedicine that suggests youth, health, and energy, one outcome is the same: a continual raising of the bar of expectations and aspirations. Will it stop? Or, will we contrive to raise it to ever greater heights, until we "build us a city and a tower, whose top may reach unto heaven"?

Allow me to propose one theme to ponder. Alyssa Henning, a doctoral student in Jewish Bioethics, suggests a value common to all Jewish denominations: *Shabbat*, or Sabbath. This day of rest is more than a 24-hour interlude every seven days. Sabbath recalls the biblical account of creation. The text reminds us of the great creative act which brought the universe into being, God's perfect satisfaction with the fruit of his work, and his response. When God completed his work and contemplated all that he had made, "behold, it was very good." And then, God rested "from all his work which he had made."

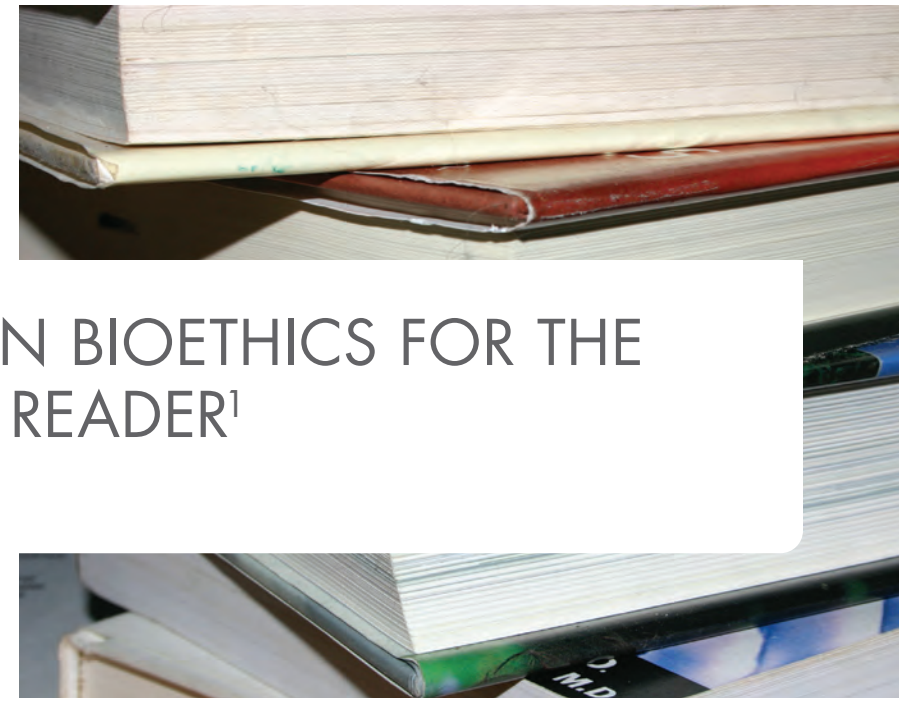
Could we learn a bioethics lesson from the richness of this account? First, every development in biomedicine or biotechnology springs from gifted, creative powers. Unlike God, we do not create *ex nihilo*, and we do not create perfectly. Yet, we have capacities for astounding inventiveness. As the pace of our inventiveness increases, the generations of biotechnology compress. Rather than a span of five centuries between Copernicus' heliocentric revolution and the arrival of Apollo 11 on the moon, mere decades separate the birth of Louise Brown, the first test tube baby, from the birth of Hannah Strege, the first "Snowflake" baby born as the result of embryo adoption.

Second, we can contemplate all that humankind has made, and say that much of it is good. Honesty demands that we also admit the poisonous fruit of our labors.

Finally, could we periodically rest from all that we have made? God's seventh day invites us to pause, to contemplate creation, and to enjoy completion. We would do well to be content with our human limitations, and grateful to the One who designed us this way. Gratitude and contentment are the remedy for what truly needs to be enhanced: our souls.



THE CENTER FOR BIOETHICS & HUMAN DIGNITY
2065 HALF DAY ROAD | DEERFIELD, IL 60015 USA
V 847.317.8180 | F 847.317.8101
INFO@CBHD.ORG | WWW.CBHD.ORG



TOP 5 BOOKS IN BIOETHICS FOR THE CHRISTIAN LAY READER[1]

BY PAIGE C. CUNNINGHAM, JD

I often am asked the question of what books would help an individual to quickly access the basic issues of bioethics. The books below are some of my top recommendations, particularly for those looking for Christian introductory material. Each of these books reflects an evangelical perspective or a viewpoint that is within the Judeo-Christian Hippocratic tradition.

Joni Eareckson Tada and Nigel Cameron. *How to Be a Christian in a Brave New World* (Grand Rapids: Zondervan, 2006). Two pioneers in defending the dignity of all human beings challenge the church to understand and care about the efforts to remake humanity through robotics, human harvesting, and designer babies. Who better than Joni Eareckson Tada to talk about using exotic technologies to heal human bodies? The volume weaves personal narratives throughout the bioethical discussions.

Chuck Colson and Nigel Cameron, eds. *Human Dignity in the Biotech Century: A Christian Vision for Public Policy* (Downers Grove: InterVarsity Press, 2004). This collection gathers essays from top bioethics thinkers and activists. Pick among topics such as learning from our mistakes, new technology, genetics, and transhumanism. Get ready for the science fiction realities of the 21st century, and get involved!

John Kilner and C. Ben Mitchell. *Does God Need our Help? Cloning, Assisted Suicide, and Other Challenges in Bioethics* (Wheaton: Tyndale, 2003). Designed like a field guide, this handy book covers the bases in an easy-to-understand format. The authors present the major secular ethical frameworks, contrasting them with biblical perspectives. Finally, Kilner and Mitchell sort out the promising developments from the morally dubious.

Gilbert Meilaender. *Bioethics: A Primer for Christians* (Grand Rapids: Eerdmans, 2004). For the reader wanting to dig a bit deeper into the ethical questions, Meilaender—a former member of the President's Council on Bioethics—lays out the theological framework. From prenatal screening and the distinction between procreation and reproduction on to organ donation and refusal of treatment, this volume elucidates and elaborates. A "must have" for pastors, teachers, lay leaders, and thoughtful Christians.

Robert George and Christopher Tollefsen. *Embryo: A Defense of Human Life* (Doubleday, 2008). If you have ever wanted to defend the value of a human embryo without using the Bible, this is the one for you. Making the complex simple, the authors offer a compelling case for the embryo from the perspective of systematic biology and ethical reasoning.

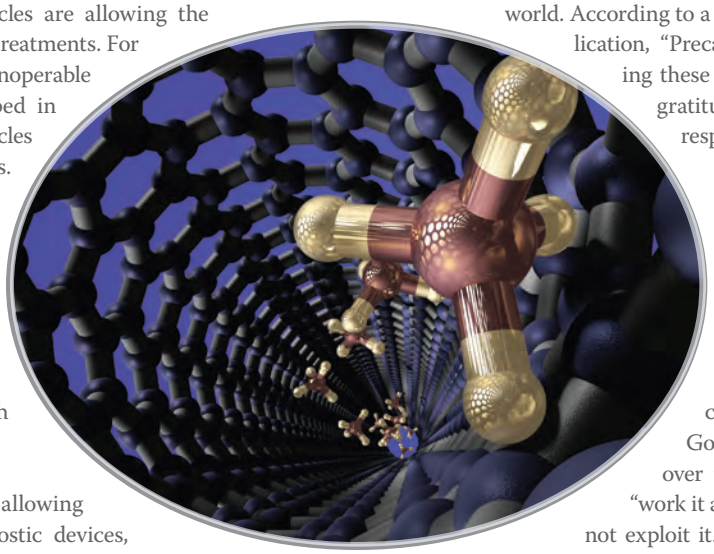
1 Adapted from a piece entitled "My Top 5 Books on Life Ethics" that originally appeared in *Christianity Today*, November 2009, 68. Also available electronically at http://www.christianitytoday.com/ct/2009/november/18.68.html.

Continued from page 1

the question is whether it will contribute to potential solutions. We should be involved enough to know where our public resources are going, and who they will benefit.

Meanwhile, medicine and pharma are planning to take advantage of the unique biological properties of nanoparticles. Nanoparticles go where other chemicals cannot, which brings hope for new drugs and drug delivery devices. According to researchers, a 'rule of thumb' for nanoparticles is that those with diameters less than 100 nm can enter cells, less than 40 nm can enter the cell nucleus, and those less than 35 nm can pass through the blood-brain barrier.[4]

Nanotechnology can construct drugs for certain diseases that only enter the cells impacted by the disease. Existing drugs can be modified to make their delivery more precise. That way they are less likely to have side effects. Also, more of the drug will be used for what it is designed to do, and might therefore be more effective and require lower doses. Nanoparticles are allowing the development of completely new treatments. For example, an approach to treating inoperable brain tumors has been developed in Germany. Magnetic nanoparticles are injected into the tumors. When the patient is exposed to a magnetic field (as done in an MRI), the nanoparticles vibrate, generating a localized increase in temperature which selectively kills the cancer cells. Early results are showing successful treatment of such tumors.



In addition, nanotechnology is allowing the development of new diagnostic devices, such as lab-on-a-chip technology. Small implants are being developed so that drugs can be delivered more specifically and monitored carefully. Devices are being developed where the biological marker is monitored and the drug or hormone released to keep levels within the normal range. New types of cochlear implants are being developed that allow improved hearing, while other implants are allowing the blind to see, literally.

However, the pervasive reach of nanoparticles also raises concerns about their potential side-effects, and whether enough is being done to investigate them. Nanotechnology is receiving huge investment, led by the U.S. federal agency, the National Nanotechnology Initiative (NNI). Its budget for 2010 is $1.64 billion. The expected return is also massive, with an anticipated global market of $1-3 trillion by 2015. However, only a relatively small proportion of the research funding is being targeted at environmental, health, and safety (EHS) research. In the 2010 NNI budget, EHS research received $88 million (5.4 percent). This funding allocation is based on a 2008 NNI Strategy which the National Research Council at the National Academy of Sciences strongly criticized for substantially overestimating the EHS research already under way.[5]

To date, little is known about the potential risks of most nanoparticles and nano-enabled products. Carbon nanotubes account for 80 percent of the nanomanufacturing sector. Five hundred tons of carbon nanotubes were produced globally in 2008, and it is anticipated that millions of tons will be produced annually in the near future. In a 2009 toxicity review, no research was found on human exposure to carbon nanotubes.[6] The review could locate only 21 animal and tissue studies, with most showing statistically significant damage in the groups exposed to the nanoparticles compared to the control groups. Although the experimental details differed significantly from natural exposure methods, the reviewers concluded that if carbon nanotubes get into the body, they will cause damage.

We should learn from past mistakes. Many are calling for a precautionary approach to the development of nanotechnology. The European Commission has developed a Code of Conduct for nanotechnologists which gives priority to the "precautionary principle."[7] While somewhat controversial, historical investigations have shown that a precautionary approach could have averted at least some of the damage from past environmental disasters. However, the values supporting the precautionary principle conflict with many of those in our market-driven world. According to a World Health Organization publication, "Precaution gives priority to protecting these vulnerable systems and requires gratitude, empathy, restraint, humility, respect and compassion."[8]

These values are completely compatible with Christianity, yet can conflict with an unrelenting drive for profit and progress. This tension needs to be acknowledged and grappled with, both by scientists and bioethicists. As Christians, we know that God has given humanity dominion over the world. But we were told to "work it and take care of it" (Genesis 2:15), not exploit it. The implications for nanotechnology need to be examined.

No area points to the urgency of this evaluation more than human enhancement. CBHD's recent summer conference on the ethics of enhancement was thus very timely. Some want to use nanotechnology to profoundly change humanity, to rebuild the human body, giving us the iHuman. One posthuman website asks: "What if your body could regenerate healthier, fresher skin and substitute worn out tendons, ligaments and joints with replaceable ones? What if your body was as sleek, as sexy, and felt as comfortable as your new automobile?"[9]

The analogy with the car is, for some, to be taken literally. One mainstream nanotechnology textbook states:

> The brain is a very elaborate machine, but it is just a machine that obeys the rules of chemistry and physics. There is no reason that such a machine will not eventually be built in a laboratory or later even in a mass-production assembly line. The bionanotechnological principles presented in this book allow [us] to envision ways to make such complex machines.[10]

This is not just an off-the-wall perspective. Mainstream scientists, not just posthumanist philosophers, are claiming we can use technology to defeat aging and death. In a standard nanotechnology textbook it is claimed that nanotechnology "is considered poised to revolutionize the world as we know it, and transform us into something better."[11] Note

that they want to transform *us*, not just science or the environment. The goal is a perfect human body that will not decay.

The Future of Humanity Institute at Oxford University is a leading promoter of posthumanism. Its director, Nick Bostrom, defines a posthuman as,

> A being that has at least one posthuman capacity. By a posthuman capacity, I mean a general central capacity greatly exceeding the maximum attainable by any current human being without recourse to new technological means.[12]

He claims that we should be able to live healthy for about 1000 years. Aubrey de Grey, founder and Chief Science Officer of the SENS Foundation (SENS stands for Strategies for Engineered Negligible Senescence), claims the first person who will live for 200 years is already alive. Technology will allow us to keep going. Bostrom also looks to cognitive and emotional enhancement. The ethical justification offered for this vision is an ethical principle that much of the Western world has already accepted. "Providing they are not significantly harming others, people who live in a liberal, democratic society are free to pursue whatever lifestyle they choose."[13]

Nanotechnology visionaries and posthuman philosophers often forget the nature of human nature even as they pursue a new human nature. Here is where science fiction provides important reminders of the truths that Scripture articulates. Classics like Mary Shelley's *Frankenstein*, H. G. Wells' *Time Machine*, Aldous Huxley's *Brave New World*, C. S. Lewis' *Cosmic Trilogy*, or modern movies like *GATTACA* and *The Island*, point to underlying problems with manipulating humans. Science fiction typically claims that technological enhancement does not go hand-in-hand with human progress. Attempts to control our evolution typically lead to further degeneration and conflict. I believe this is because authors of literature often have a better grasp of fallen human nature than those who are overly enamored by our capacity for technological developments.

Nathaniel Hawthorne's 1843 short story, *The Birth-Mark*, is also insightful here.[14] A brilliant scientist is married to a beautiful wife who is perfect in every way but one: she has a birth-mark on her cheek. He works tirelessly to develop a cure and to convince her that she needs the birth-mark removed. Eventually, he makes the needed cure. She drinks it. The birth-mark fades. She dies.

The story captures the lack of gratitude which so easily arises in the endless pursuit of perfection. Although our lives are not perfect, we have been given very much. In spite of all we have, our world encourages us to look at what we do not have - yet. Many would encourage us to look to medicine and technology to attain that perfection. Technology can do much good when directed at developing new treatments for diseases, better water purification methods, more environmentally friendly agriculture, etc. But when perfection in this world becomes the goal, we run the risk of becoming less grateful for what we have and less tolerant of those who are less than perfect. When those values predominate, terrible tragedies often occur as we see in fiction and in history.

Values underlie scientific and technological developments. Humility is one that is easily neglected. Literature has always reminded science of its limits, going back at least to Icarus and Daedalus. Literature can remind us that science and technology are good when put to good use addressing important and legitimate needs. But the very success of these enterprises can become a temptation to overstep the boundaries of science and pursue illegitimate ends. We must be concerned about the visions of futuristic nanotechnology when they seek after inappropriate if not unattainable ends. And at the same time, we must address the pressing ethical issues that normal nanotechnology presents today.

---

1 This essay is a condensed version of a talk given in Belfast, Northern Ireland on January 18, 2010 as part of the Christians in Science Ireland lecture series. The complete text of the presentation is available, along with others, at http://bioethicsireland.ie/nanoethics/. The bioethical issues raised by nanotechnology are examined in more detail, with a comprehensive bibliography, in my *Nanoethics: Big Ethical Issues with Small Technology* (Continuum, 2009).

2 Steven A. Edwards, *The Nanotech Pioneers: Where Are They Taking Us?* (Weinheim: WILEY-VCH, 2006).

3 Stuart Rennie and Bavon Mupenda, "Living Apart Together: Reflections on Bioethics, Global Inequality and Social Justice," *Philosophy, Ethics, and Humanities in Medicine* 3 (December 2008): 25.

4 Kenneth A. Dawson, Anna Salvati and Iseult Lynch, "Nanoparticles Reconstruct Lipids," *Nature Nanotechnology* 4 (February 2009): 84-85.

5 National Research Council, *Review of Federal Strategy for Nanotechnology-Related Environmental, Health, and Safety Research* (Washington, DC: National Academy of Sciences Press, 2008).

6 Ash Genaidy, Thabet Tolaymat, Reynold Sequeira, Magda Rinder and Dion Dionysiou, "Health Effects of Exposure to Carbon Nanofibers: Systematic Review, Critical Appraisal, Meta Analysis and Research to Practice Perspectives," *Science of the Total Environment* 407 (2009): 3686-3701.

7 European Commission, *Code of Conduct for Responsible Nanosciences and Nanotechnologies Research* (2008) ftp://ftp.cordis.europa.eu/pub/fp7/docs/nanocode-recommendation.pdf (accessed 20 April 2010).

8 Ted Schettler and Carolyn Raffensperger, "Why is a Precautionary Approach Needed?' in *The Precautionary Principle: Protecting Public Health, the Environment and the Future of our Children*, edited by Marco Martuzzi and Joel A. Tickner (Copenhagen: World Health Organization, 2004), 66.

9 Primo Posthuman. http://www.natasha.cc/primo.htm (accessed 20 April 2010).

10 Ehud Gazit, *Plenty of Room for Biology at the Bottom: An Introduction to Bionanotechnology* (London: Imperial College Press, 2007), 126.

11 Geoffrey Ozin, André Arsenault and Ludovico Cademartiri, Nanochemistry: A Chemical Approach to Nanomaterials, 2nd edition (New York: Springer-Verlag, 2009), x.

12 Nick Bostrom, "Why I Want to be a Posthuman When I Grow Up," in *Medical Enhancement and Posthumanity*, edited by Bert Gordijn and Ruth Chadwick (Berlin: Springer, 2008), 108.

13 Nick Bostrom and Rebecca Roache, "Ethical Issues in Human Enhancement," in *New Waves in Applied Ethics*, edited by Jesper Ryberg, et al. (New York: Palgrave Macmillan, 2007), 125.

14 Nathaniel Hawthorne, "The Birth-Mark," in *Being Human*, edited by The President's Council on Bioethics (Washington, DC: President's Council on Bioethics, 2003), 5-20.

G12 COUNTRY REGULATIONS OF ASSISTED REPRODUCTIVE TECHNOLOGIES

The United States notably has little federal or state regulations pertaining to the assisted reproductive technology (ART) industry. This is in contrast to other developed nations, which provide more extensive regulations on the use of ART and in many cases restrict its use for certain ends, such as reproductive cloning. While some of these regulations may not be ideal, they are steps taken to ensure the health and safety of women utilizing ART and the children resulting from these technologies, as well as the ethical use of ART by all participants. The respective regulations of the Group of Twelve (G12) countries are summarized below, including key laws, prohibitions, and policies. The G12 consists of members of the Group of Ten (G10), the wealthiest members of the International Monetary Fund, with the addition of Spain and Australia. This group was chosen since the G12 is composed of industrially advanced countries suitable for comparison with the U.S.

Australia

Australia regulates ART at both the federal and state level, with the states providing the most regulation. The key federal law is the *Prohibition of Human Cloning for Reproduction and the Regulation of Human Embryo Research Amendment Act 2006*. This law prohibits reproductive cloning and allows states to either permit or prohibit research cloning. Research cloning is permitted in Victoria, New South Wales, Tasmania, Queensland, South Australia and the Australian Capital Territory. Additionally, this law prohibits germline modification and the commercial trading of human eggs, sperm or embryos.

The National Health and Medical Research Council publishes *Ethical Guidelines on the Use of Assisted Reproductive Technology in Clinical Practice and Research*. These general guidelines must be followed for ART centers to be accredited by the Reproductive Technology Accreditation Committee. These guidelines encourage limiting the number of embryos created to those needed during the course of treatment, strict recording of the outcomes of ART, and the prohibition of non-medical sex selection and commercial surrogacy. Non-commercial or altruistic surrogacy is permitted by some Australian states.

Belgium

Belgium's key laws pertaining to ART are the *Law on Research into Embryos In Vitro* 2002 and the *Law on Medically Assisted Reproduction and the Disposition of Supernumerary Embryos and Gametes* 2007. These laws prohibit reproductive cloning, the creation of embryos for research purposes, non-medical sex selection or treatment for eugenic purposes, and the creation of chimeras or hybrid embryos.

As of 2003, ART is completely covered by Belgium's national health plan. This insurance provides up to 6 cycles of ART for women under the age of 42. Women over 42 years are ineligible for coverage. This coverage comes with strict limits on the number of embryos transferred per cycle, limiting the number of embryos transferred to a maximum of 2 for women under the age of 36 and a maximum of three for women under the age of 40.

Canada

Canada's *Assisted Human Reproduction Act* (2004) created the Assisted Human Reproduction Agency of Canada (AHRA) responsible for administering and enforcing the AHR act and its regulations. This Act prohibits reproductive and research cloning, the creation of IVF embryos for purposes other than reproduction or reproduction research, non-medical sex selection, germline modification, the creation of a chimera or hybrid embryo, commercial surrogacy, and the commercial trading of human eggs, sperm and embryos. This Act also establishes a series of principles related to ART including the provision that "the health and well-being of children born through the application of assisted human reproductive technologies must be given priority in all decisions respecting their use" and that "the health and well-being of women must be protected in the application of these technologies." These principles also discourage discrimination against persons seeking to use ART on the basis of their sexual orientation or marital status and they discourage the use of ART for commercial ends due to its exploitative nature.

France

France's key laws include the *Bioethics Law No. 2004-800* (2004) and the *Law on the Donation and Use of Elements and Products of the Human Body, Medically Assisted Procreation, and Prenatal Diagnosis, No. 94-654* (1994). The *Bioethics Law* created the French Biomedicine Agency, responsible for licensing and regulating ART centers. These laws prohibit reproductive and research cloning, the creation of embryos for research purposes, germline modification, and non-medical sex selection. Surrogacy is also prohibited. In France, preimplantation genetic diagnosis is allowed only when a parent or close relative has a serious genetic disease and also for HLA tissue matching. France's national health plan provides complete coverage for ART to heterosexual couples who are of reproductive age and are married or have lived together for two years.

Germany

Germany's key laws and guidelines pertaining to ART include the *Federal Embryo Protection Law 1990*, the *Adoption Brokerage Law 2006*, and the *Guideline of the German Federal Medical Chamber 2006*. These laws prohibit research and reproductive cloning, gamete donation, the creation of hybrid embryos, the cryopreservation of fertilized eggs, sex-selection (with the exception of sperm sorting for the prevention of a few sex-lined genetic disorders), preimplantation genetic diagnosis, and all forms of surrogacy. Only three eggs can be fertilized and transferred in one reproductive cycle.

Italy

In Italy, ART is regulated under the *Medically Assisted Procreation Law* (2004). This law prohibits research and reproductive cloning, the manipulation of embryos, the use of donated eggs or sperm for ART, and the cryopreservation of embryos (with the exception of severe injury/illness preventing embryo transfer). A maximum of three eggs can be fertilized and transferred per reproductive cycle. Sex-selection is only permitted through sperm sorting for sex-lined genetic diseases. All forms of surrogacy are prohibited. The use of preimplantation genetic diagnosis for the selection of embryos is generally prohibited, but has been allowed through the courts on a case-by case basis. Genetic testing for non-medical purposes is prohibited. The use of ART is restricted to stable heterosexual couples who live together, are of reproductive age, are over the age of 18, have documented infertility, and have been first provided the opportunity for adoption.

Japan

In Japan, the only law related to ART is the *Law Concerning Regulation Relating to Human Cloning Techniques and Other Similar Techniques* (June 2001). This law prohibits reproductive cloning, germline modification, and the transfer of human/animal hybrid embryos to either a human or animal. Research cloning is permitted in Japan. Other ART activities are regulated by voluntary guidelines produced by the Japan Society of Obstetrics and Gynecology.

Netherlands

The Netherlands's key laws on ART are the *Act Containing*

Rules Relating to the Use of Gamete and Embryos (Embryos Act) (July 1, 2002) and the *Commercial Surrogacy Act* (November 1, 1993). The *Embryos Act* prohibits the creation of embryos for research purposes, allowing an embryo to develop outside the human body for longer than 14 days, reproductive cloning, germline modification, the creation of human/animal hybrid embryos, non-medical sex selection, and commercial donation of gametes or embryos for reproductive or research purposes. The *Commercial Surrogacy Act* prohibits commercial and professionally arranged surrogacy. In the Netherlands, preimplantation genetic diagnosis is permitted only for serious genetic disease at one facility, although the government has recently allowed testing for certain hereditary cancers and is considering offering testing for a wider range of conditions in the future.

Spain

In Spain, key laws pertaining to ART are the *Law on Assisted Human Reproduction Techniques, No. 14/2006* (May 27, 2006) and the *Biomedicine Law 14/2007* (July 3, 2007). The National Commission on Human Reproductive Assistance is Spain's ART advisory committee. The above laws prohibit reproductive cloning, the transfer of more than three embryos per reproductive cycle, the creation of embryos for purposes other than reproduction, germline modification, non-medical sex selection, and the use of preimplantation genetic diagnosis for non-medical purposes. Surrogacy is not recognized in Spain. The commercial donation of gametes is allowed for assisted reproduction and research, although only 6 children can be born from the same donor.

Sweden

In Sweden, key laws regulating ART are the *Act on Ethics Review of Research Involving Humans, Law No. 460* (2003), and the *Genetic Integrity Act, Law No. 351* (2006). Sweden provides financial coverage for ART to couples who are married or are in a stable relationship. Reproductive cloning, surrogacy, germline modification, and the use of preimplantation genetic diagnosis for social purposes are prohibited. Preimplantation genetic diagnosis is permitted for disease and for HLA matching (only after approval by the Board of Health and Welfare). Sweden allows only one embryo (two in older women) to be transferred per reproductive cycle. Embryos can be cryopreserved for up to five years.

Switzerland

Switzerland's key laws regulating ART include the *Federal Law on Medically Assisted Reproduction* (1998), the *Federal Act on Research Involving Embryonic Stem Cells* (2003), and the *Federal Law on Medically Assisted Reproduction* (2004). Prohibited practices include reproductive and research cloning, egg and embryo donation for ART, creating an embryo for research purposes, creating a hybrid embryo, germline modification, preimplantation genetic diagnosis, non-medical sex-selection, and surrogacy. Switzerland limits the number of embryos transferred per reproductive cycle to three and requires cryopreserved gametes and embryos to be destroyed after five years.

United Kingdom

The United Kingdom's laws on ART include the *Surrogacy Arrangement Act (*1985), the *Human Embryology & Fertilisation Act (1990),* and the *Human Reproductive Cloning Act*. These laws prohibit reproductive cloning, the transfer of a non-human embryo to a woman or a human embryo into an animal, allowing embryos to develop outside of the human body for fourteen days, germline modification, non-medical sex selection, and commercial surrogacy arrangements. The *Human Embryology and Fertilisation Act* established the Human Fertilisation and Embryology Authority (HFEA) responsible for licensing fertility clinics and regulating the use of donor gametes, assisted fertilization, preimplantation genetic diagnosis, the storage of gametes and reproductive tissue, and research using human embryos. The HFEA limits the number of embryos transferred per reproductive cycle to 1-2 embryos for women under the age of 40. A maximum of three embryos can be transferred to women over 40. The HFEA also prohibits commercial egg and sperm donation.

United States

The only federal legislation passed pertaining to ART is the *Fertility Clinic Success Rate and Certification Act of 1992* establishing the reporting of pregnancy success rates to the Centers for Disease Control and Prevention for publication. Regulation of ART varies at the state level. Seven states have legislation that prohibit human cloning for both reproductive and research purposes, while eight states ban reproductive cloning. Other states prohibit commercial surrogacy or regulate surrogacy agreements. Several states require private insurance coverage of ART and regulate the donation of sperm, eggs, and embryos. Only Pennsylvania extensively regulates and monitors ART clinics and activities.

(Compiled from the following resources and in direct consultation with the following international laws)

American Society for Reproductive Medicine. "IFFS Surveillance 2007." *Fertility and Sterility* 87 (2007): S1-S67.

Americans United for Life. *Defending Life 2010: A State by State Legal Guide.* Chicago: Americans United for Life, 2010.

Australia, Parliament of Australia. *Prohibition of Human Cloning for Reproduction and the Regulation of Human Embryo Research Amendment Act 2006* No. 172, 2006.

Australia. National Health and Medical Research Council. *Ethical Guidelines on the Use of Assisted Reproductive Technology in Clinical Practice and Research.* Australian Government (2007).

Canada, Minister of Justice. *Assisted Human Reproduction Act, Statues of Canada* 2004, c.2.

Belgium, Chamber of Representatives. *Law on Medically Assisted Reproduction and the Disposition of Supernumerary Embryos and Gametes* 2007. *Relatif à la Procréation Médicalement Assistée et à la Destination des Embryons Surnuméraires et des Gamétes.* DOC 51 2567/005.*

Belgium, Chamber of Representatives. *Law on Research into Embryos In Vitro* 2002. *Relatif à la Recherche Sur les Embryons In Vitro.* DOC 50 2182/001.*

BioPolicy Wiki. http://www.biopolicywiki.org/index.php?title=Main_Page (accessed April 1, 2010).

Germany. German Federal Medical Chamber. *Guideline of the German Federal Medical Chamber 2006. (Muster-)Richtlinie zur Durchführung der Assistierten Reproduktion 2006.**

Germany. Bundesrat. *Adoption Brokerage Law 2006. Gesetz über die Vermittlung der Annahme als Kind und uber das Verbot der Vermittlung von Ersatzmüttern 2006.* http://www.bundesjustizamt.de/nn_257850/SharedDocs/Publikationen/BZAA/AdVermiG,templateId=raw,property=publicationFile.pdf/AdVermiG.pdf (accessed April 9, 2010). *

Germany. Bunderstag. *Act for the Protection of Embryos 1990. Gesetz zum Schutz von Embryonen 1990.* http://www.bmj.bund.de/files/-/1147/ESchG%20englisch.pdf (accessed April 9, 2010).

Hayes, Richard. "An Emerging Consensus: Human Biotechnology Policies Around the World." November 6th, 2008. http://www.geneticsandsociety.org/article.php?id=4358 (accessed April 1, 2010).

Health Canada. "Assisted Human Reproduction Internationally." October 1, 2004. http://www.hc-sc.gc.ca/hl-vs/reprod/hc-sc/general/international-eng.php#Ita (accessed April 1, 2010).

Italy. Italian Parliament. "Medically Assisted Procreation Law/ Norme in material di procreazione medicalmente assistita." *Official Gazette/Gazetta Ufficiale 24*, February 24, 2004.*

Kindregan, Charles P., Jr. Assisted Reproductive Technology: A Lawyer's Guide to Emerging Law and Science. Chicago: American Bar Association, 2006.

National Conference of State Legislatures. "Human Cloning Laws." January 2008. http://www.ncsl.org/issuesresearch/health/humancloninglaws/tabid/14284/default.aspx (accessed April 1, 2010).

Netherlands. *Act Containing Rules Relating to the Use of Gamete and Embryos (Embryos Act)* June 20, 2002. http://english.minvws.nl/en/folders/ibe/2002/introduction-embryo-act.asp (accessed April 9, 2010).

Spain. Cortes Generales. *Law on Assisted Human Reproduction Techniques, No. 12/2006. Ley 14/2006, de 26 de mayo, Sobre Téchnicas de Reproducción Humana Asistida.* BOE 126: 19947-19956.*

Spain. Cortes Generales. *Biomedicine Law 14/2007. Ley 14/2007, de 3 de Julio, de Investigación Biomédica.* BOE 159: 28826-28848.*

Sweden. *Act on Ethics Review of Research Involving Humans, Law No. 460 (2003). Law (2003: 460) om etikprövning av forskning som avser människor. Svenska författningssamling* 2003: 460.*

Sweden. *Genetic Integrity Act, Law No. 351* (2006). *Law (2006: 351) om genetisk integritet m.m. Svenska författningssamling* 2006: 351.*

Switzerland. The Federal Assembly of the Swiss Confederation. *Federal Law on Medically Assisted Reproduction* (1998). *Bundesgesetz über die medizinisch unterstützte Fortpflanzung.* SR 810.11.*

United Kingdom. United Kingdom Parliament. *Human Fertilisation and Embryology Act 1990,* c. 37.

United Kingdom. United Kingdom Parliament. *Human Fertilisation and Embryology Act 2008*, c. 22.

United Kingdom. United Kingdom Parliament. *Human Reproductive Cloning Act 2001*, c.23.

United Kingdom. United Kingdom Parliament. *Surrogacy Arrangements Act 1985*, c. 49.

United States. U.S. Congress. *Fertiliy Clinic Success Rate and Certification Act of* 1992, 42 U.S.C., §263a-1 (2005).

*Google Translate was used to verify the content of these laws discussed in secondary sources.

updates & activities

CENTER UPDATE

In January 2010, CBHD continued its tradition of sponsoring strategic networking gatherings in Washington, D.C. Our March 2009 networking dinner featured contrasting presentations from Nigel M. de S. Cameron, PhD and Kevin FitzGerald, PhD, PhD regarding the future of biotechnology and the ethics involved. The dinner and lecture brought together a variety of congressional staffers, leaders of key policy organizations, and other DC insiders. Our most recent event featured a presentation from Dean Clancy, former executive director of the President's Council on Bioethics, evaluating the impact of past and future councils on bioethics. The lively discussion that ensued brought wide participation from the packed-in attendees.

CONFERENCE AUDIO

The following conference proceedings are or will be available for sale in MP3 CD format. Please contact customer service online, info@cbhd.org or by 847.317.8180 to place an order.

2009, Global Bioethics: Emerging Challenges Facing Human Dignity ($25)
The contemporary bioethical landscape is marked by two realities: the increasingly sophisticated issues presented by the emerging scientific and technological innovations forcing the expansion beyond traditional bioethical categories, as well as a global context in which these issues bypass borders and national governance. At the core of these two realities are the challenges these present to the fundamental notion of human dignity in a globalized world.

2010, Beyond Therapy: Exploring Enhancement and Human Futures (*Available September 15, 2010*)
A decade into the biotech century, scientific discoveries and technological innovations are transforming the nature of biomedicine and revolutionizing the expectations for biotechnology. A new medicine that moves beyond therapy to enhancement presents both opportunities and perils. *Beyond Therapy: Exploring Enhancement and Human Futures* probes these possibilities. What do these imply for the future of our individual and common humanity?

STAFF

PAIGE CUNNINGHAM, JD:

- Interviewed by:
  - *Christianity Today* regarding "Should Christian Doctor's Leave the AMA?" in December 2009.
  - *The Technology Show* on the intersection of bioethics, technology, and theology in December 2009.
  - *Moody Radio* about general bioethics questions in January 2010.
  - *St. Louis Post Dispatch* for perspectives on embryo adoption in January 2010.

HANS MADUEME, MD, PHD CANDIDATE:

- Invited speaker on bioethics at Village Church of Barrington, Barrington, IL (3 week series), in December 2009.
- Began working as adjunct faculty at Trinity Graduate School in January 2010.

KIRSTEN RIGGAN, MA:

- Guest lectured at George Fox University on preimplantation genetic diagnosis in March 2010.

FELLOWS

DENNIS HOLLINGER

- Published *The Meaning of Sex: Christian Ethics and the Moral Life*. Grand Rapids: Baker, 2009.

GREGORY RUTECKI

- Published "'Give me children or I'll die!' Is it time to consider the uterus as a non-vital organ transplant?" *Ethics & Medicine* 2009; 25: 177-186.

DÓNAL O'MATHÚNA

- Appointed the chair of CBHD's Academy of Fellows
- Published Nanoethics: Big Ethical Issues with Small Technology. London: Continuum, 2009.

ON THE CBHD BOOKSHELF

For those interested in knowing what books the Center staff have been reading. In this particular listing, we have chosen to highlight novels with bioethical themes as core aspects of the books. After each novel we have listed the relevant themes that are raised. Please let us know what books you are reading that we should add to our bookshelves

- Atwood, Margaret. *Oryx and Crake. New York: Random House, 2003.*
  (Core Issue: Genetic Engineering)
- Cook, Robin. *Crisis. New York: Penguin Books, 2006.*
  (Core Issues: Boutique Medicine, Medical Malpractice)
- Crichton, Michael. *Next. New York: HarperCollins, 2006.*
  (Core Issues: Genetic Engineering, Human-Animal Hybrids, Gene Patents)
- Gibson, William. *Neuromancer. New York: Ace Books, 1984.*
  (Core Issues: Transhumanism, Artificial Intelligence, Human Enhancement, Cyborgs)
- Mosley, Walter. *Futureland: Nine Stories of an Imminent World. New York: Warner Books, 2001.*
  (Core Issues: Bio-Terrorism, Human Enhancement, Technological Disparity, Neuropharmacology)
- Picoult, Jodi. *My Sister's Keeper. New York: Washington Square Press, 2004 (Film Version 2009).*
  (Core Issues: Savior Siblings, Medical Emancipation, Pre-implantation Genetic Diagnosis)
- Powers, Richard. *Galatea 2.2. New York: Picador, 1995.*
  (Core Issues: Neuroscience, Artificial Intelligence)