Human genome editing technologies in the center of current transhumanistic discourse on human enhancement

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HUMAN GENOME EDITING TECHNOLOGIES IN THE CENTER OF CURRENT TRANSHUMANISTIC DISCOURSE ON HUMAN ENHANCEMENT

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Abstract

The article deals with certain challenges connected with the progress of human enhancement technologies, where genome editing technologies form part of them. Today, the idea of human enhancement is the subject of considerable debate among various streams of transhumanist thinkers. The author rejects pessimistic and dystopian views on human enhancement technologies that see these technologies as one of the main risks for modern civilization, and instead defends the opposite view. It is claimed that although such technologies continue to be relatively poorly defined, they do and will belong to the 'good side' of current (future) technological progress. Namely, in the context of pragmatic and moderate transhumanism, human enhancement is primarily viewed as a way of improving the quality of human and social life. The article mainly refers to human genetic enhancement, noting that the invention of CRISPR/Cas9 technology about 10 years ago paved the way for a revolution in gene research and gene therapy. Before the emergence of CRISPR/Cas9 technology, bioethical discussions had mostly concentrated on classical bioethical dilemmas (autonomy, privacy, etc.). Yet, the situation has changed radically in the last 3 years when the first practical misuses of CRISPR-Cas 9 technology (the He Jiankui affair) in germline genome editing were reported. Although the author agrees with views calling for more scientific and broader social control of germline genome editing, strong support is given for the claims made by moderate and pragmatic transhumanists that modern democratic societies must ensure that objective and unbiased assessments of the benefits/risks of all types of human enhancement technologies are retained.

Key words: *human enhancement, genome editing technology, bioethics, moral entrepreneurship, CRISPR-Cas 9 technology, He Jiankui affair.*

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Introduction

Overly critical views on the transhumanist discourse can often be found today. It seems the aversion to transhumanism is firmly linked to the threats before the current and regarding the future progress of human enhancement technologies. In the thinking of various social groups, one frequently encounters deeply rooted, considerably pessimistic, even dystopian views on the whole future of technological progress, not simply the specific technology of human enhancement. These pessimistic and dystopian views sometimes even lead to technophobia, *i.e.*, a hate of technology that rises above a reasonable consideration of the possible negative effects of technological progress. They tend to present technology as one of the main risks for modern civilization. In these views, newly emerging technologies are accompanied with metaphors like "Brave new world", "Frankenstein's science", "playing God", etc. Not just ordinary people, but even scientists, experts, and the media are inclined to such a negative standpoint on these technologies.

In this contribution, the opposite view is defended. The basic assumption is that there is needed to overcome the (unproductive) disqualifications proposed in modern transhumanistic discourse. Namely, if technological progress is seen not simply as something that develops with a deterministic logic of its own, but as something that depends considerably on the overall social context, such kinds of technophobia can be shown to be unfounded. A look back at history reveals that many earlier fears about technology proved to be exaggerated. The resistance to new technologies gradually disappeared when they in the meantime became widely accepted in society. After the new technologies became established, there was no longer a need to repeatedly keep finding a new consensus on their acceptance.

Today, the controversial debates concerning transhumanism must be put on the right track. Unlike the simplified disqualifications found in transhumanist discourse, it is better to understand transhumanism as an effort for ensuring human development and social well-being on the grounds of technological progress. The philosophy of transhumanism has advanced greatly ever since Julien Huxley first uttered that word (Huxley 1968). Today, transhumanist discourse is increasingly exploring the boundless positive possibilities of technological progress for generations of people now and in the future. The opinions of the frontrunners of transhumanism are far from an uncritical presentation of technological progress. They also stress possible misuses of the newly emerging technologies and pay substantial respect for individual safety, freedom, privacy, etc. (Newton 2019). As Nick Bostrom, a leading representative of transhumanism, wrote in his article Transhumanist Values: "Transhumanism advocates the well-being of all sentience, whether in artificial intellects, humans, and non-human animals (including extraterrestrial species, if there are any)" (Bostrom 2005, 4).

The world-renowned German philosopher Stefan Lorenz Sorgner also defends the realistic and pragmatic concept of transhumanism. Instead of far-flung future technological hype, he presents the role of technological progress primarily as a means of gradually contributing to the social welfare of society. In this sense, his transhumanism has nothing together with disreputable thinking such as the idea that human beings may become immortal, etc. For him, the idea of immortality functions in the best case as a rhetorical metaphor. In all of his most recent books, instead of the idea of the immortality of human beings he places in the forefront the idea of the happiness of human beings on the planet (Sorgner 2022; Sorgner 2021; Sorgner 2016).

The thinking of certain leading transhumanists today makes it hard to agree with the critics of transhumanism who declare that this philosophy is in the best case a pseudo-scientific ideology oriented to making baseless speculations about a distant future. The worst tendency in the discussions on transhumanism is insisting on fixed ideological statements, which have remained notwithstanding the open dialogue. This is also the case with discussions regarding the progress of human genome editing technologies. These technologies give the option of radically changing the (biological and social) conditions of human beings and their lives. Such possibilities options are not just projections relating to distant future societies, but already appear today. Therefore, while considering the issues of human genome editing technologies it is necessary to take more holistic views into account. In this contribution, some aspects of human genome editing technologies are highlighted, as connected with broader questions concerning the role of newly emerging technologies in current human enhancement processes.

Role of Newly Converging Technologies in Enabling the Shift to Human Enhancement

One of the main ideas behind the pragmatic idea of transhumanism is that strategic interventions using newly emerging technologies into both our reproductive capacity and nature's selection processes will permit us to direct the course of human evolution. Newly emerging technologies have started to show their dominance over spontaneous biological processes and are finally overtaking biology as the science of life. These processes of the "technization of nature" are best seen in current genetic engineering research (Endy *et al*. 2014; Calvert 2010).

Genetic engineering no longer relies on ad hoc technological procedures. Instead, it is transforming into a systematically pursued undertaking where the operations of biological systems can be described in a standardized form with the use of technology; namely, a precondition for making them measurable, comparable, exchangeable, etc. Yet, human genome editing technology does function in this way. For example, the relative ease of applying the latest ground-breaking technology – CRISPR-Cas9 technology – means that it can be quickly incorporated using the equipment, skill sets, practices, and routines of a wide variety of research groups, in turn opening up fresh experimental possibilities. Finally, the biggest expectation concerning the entire field of genetic engineering ever since the 1980s has been that the rearrangement of organic life will entail routine and standardized procedures. Drew Endy, a leading synthetic biologist, described it this way: "Biotechnology remains complex because we have not so far made it simple" (Endy 2005, 451). The processes of technicization are responsible for the nostalgic image of the biological world and for nature slowly disappearing. While throughout humankind's long intellectual history the main idea about nature was that it conceals its secrets from human view, it seems that today nature no longer has any secrets. Nature has largely been reduced to matter that can and must be technically manipulated in manifold ways. Modern biogenetics and biomedicine can claim the most merit for this new conception of nature. Contrary to the outdated belief that altering the genes of a human amounts to 'a violation of its essence' (as constantly complained by conservative bioethicists), genetic research and therapy are no longer understood as an unnatural intervention in the fixed essence of human beings. Accordingly, they are not just part of evolution, but one of the engines driving it. Stefan Sorgner claims that there is "... a close connection between transhumanism and two assumptions, *i.e.* evolutionary (naturalistic) thinking and belief in technological progress" (Sorgner 2021, 84).

Today, several potentially valuable applications for current and future society are emerging as the newly emerging technologies become unified, *i.e.*, biotechnology, nanotechnology, information technology, and cognitive technology. These applications cover practically every area of human life. We are living in a time of more intense processes aimed at unifying scientific and technological knowledge – the crucial factors in encouraging human enhancement. To describe these processes of merging newly emerging technologies, the umbrella term "converging technologies" is often used. The first and most comprehensive elaboration of the concept of converging technologies was provided about 20 years ago by William S. Bainbridge and Mihail C. Roco (Bainbridge and Roco 2002). Rogers Hollingsworth has dealt extensively with the converging technologies concept and claims that today they are in the development phase, which requires the building of a strong common scientific-technological core made up of shared theoretical frameworks plus a common stock of models and mechanisms that integrates a broad range of domains normally analyzed by different scientific disciplines and technological areas (Hollingsworth 2006).

The initial conceptualization of the converging technologies concept was followed by rapid progress and its operationalization. Today, these processes may best be described as a combination of enabling scientific discoveries (genetics, nanoscience), techniques (informatics, gene splicing), and advances in associated tools (computing power, robotics) that is strongly accelerating the basic science involved and leading to practical technological applications across a breathtaking range of subjects, from human health through to material science (for more, see Fuller 2012). The convergence of various disciplinary fields is especially important for genomic science and technology that support several types of genomic therapy. For instance, today it is extremely important to integrate genomic data into electronic health records, *i.e.*, to combine the knowledge of all scientific fields to allow researchers to improve the clinical impact of the genomic data, demonstrate their utility, and make it accessible for clinical decision support tools (Venner *et al*. 2021). In genomic sciences dealing with extending the healthy lifespan of human beings, strong processes involving the cross-fertilization of scientific disciplines have also been noticed. Namely, in the context of transhumanism and human enhancement, prolonging the human lifespan is no longer simply a purely theoretical topic. It is becoming a practical question related to the further interconnectedness of scientific and technological areas where synthetic biology, nanotechnology, and micro-fabrication, along with advanced computational, modeling, and visualization capabilities, can ultimately be enlisted to solve the problem of degenerative ageing and how to extend the healthy lifespan of humans (Stambler 2019).

The concept of converging technologies refers to the radically new possibilities that are opening up for modern societies. While in many centuries in the past small-scale convergences were underway in scientific and technological development, the current trans-disciplinary convergences are radically altering the character of modern science and technology. These trends towards the unification of scientific and technological knowledge hold huge implications for the current and future social life of humans. They are sometimes described in hyperbolic terms. Kurt Kurzweil is a well-known transhumanist thinker who seems to advocate that such ideas of converging all spheres of life are the most provocative. He assumes that already in the near future an evolutionary process in which the union of all entities of the world (not only scientific knowledge) will occur. At this point of singularity, the knowledge and skills embedded in our brains will be combined with the vastly superior capacity, speed, and knowledge-sharing ability of our own creations. As he states: "Just as a black hole in space dramatically alters the patterns of matter and energy accelerating toward its event horizon, the impending singularity in our future is increasingly transforming every aspect of human life" (Kurzweil 2005, 7).

Idea of Human Enhancement Supported by a Pragmatic and Moderate Transhumanist Discourse

In contrast to conservative bioethicists who seek to guarantee the permanence of human life and the fixed human essence as it is broadly recognized today, even moderate transhumanist thinkers support the proactive stance taken by innovation-oriented individuals. Their overriding maxim is that the future must be made by active and innovative human activity, which in itself assumes that, regardless of how normal and successful an activity may be, there are always better ways of achieving the same ends, if not better versions of the same ends. Steve Fuller and Veronika Lipinska invented the concept of "moral entrepreneurship" to describe this proactive stance that people adopt (Fuller and Lipinska 2014). According to Fuller and Lipinska, the proponents of moral entrepreneurship are future-oriented innovators who are leading the way into the unknown territory of technological progress. Their purpose is not to do only pure research with the intention to understand the ways in which human and other living systems will develop in the future. Their purpose is instead chiefly to produce new types of human enhancements in an evolutionary way. The crucial message of arguments claiming that we need "moral entrepreneurship" is that future-oriented innovators should be free to use their creative efforts to contribute to social welfare on the grounds of redesigning the biological conditions of humans, but without interfering with the rights possessed by someone else.

In the context of pragmatic and moderate transhumanism, human enhancement is mostly seen as a way of improving human and social life. It seems that this variant of transhumanist thinking is consistent with the fundamental assumptions made in bioethics literature more generally. For example, both mainstream bioethics and transhumanists encourage conceiving of the self within a framework of choice and agency, and explicitly or implicitly claim that more choices and more capabilities are obviously improving the quality of human and social life (see, *e.g*. Hall 2019). Finally, even Francis Fukuyama, one of the fiercest opponents of transhumanism, acknowledges the use of cognitive enhancement, claiming that "...a society with higher average intelligence may be wealthier, insofar as productivity correlates with intelligence" (Fukuyama 2002, 97).

It is sometimes difficult to talk about technologies dedicated to human enhancement as a specific type of newly emerging technology. Potentially, any newly emerging technology that allows individuals to make themselves better regarding human beings' species-typical functioning could be labelled human enhancement technology. Advances made in the broad spectrum of newly emerging technologies are creating the possibility of improving or enhancing many human capabilities beyond what up until recently were considered 'average' or 'normal'.

Extremely promising fields of enquiry when it comes to human enhancement technologies are genetic enhancement, morphological enhancement, cyborg enhancement, and pharmacological enhancement. Namely, technological progress typically refers to one of six categories of enhancements: cognitive, affective, moral, physical, cosmetic, longevity. (Longevity enhancements are interventions that prolong a human's lifespan) (Newton 2019; Sorgner 2018; Savulescu *et al*. 2011).

In recent times, especially genetic human enhancement has led to many bioethical questions being raised. The big reason for this is that such enhancement has taken a huge step further. According to Stefan Sorgner, CRISPR/Cas9 technology could make it easier for people to develop in a carbon-based way, *i.e.*, they could become organic trans- or posthumans where the posthuman either still belongs to the human species, but has at least one characteristic which goes beyond the limits of current human capacities, or can become a representative of a new species (Sorgner 2021).

Although (bioethical) debates on the social role of human enhancement technologies are constantly underway, these technologies remain relatively poorly defined by experts. The main reason is that no strict demarcation exists between human enhancement and medical therapy that could guide research inquiries made in these fields. As concerns genetic enhancement, the line between medical treatment and enhancement is extremely complicated. Another problem is that it is changing rapidly over time. Past development of human genome editing technology and its use in medical therapy shows that it holds the capacity to alter the scope very quickly of what is considered normal. The use of medical treatment for longevity enhancements is such a case. Since, on one hand, the processes of ageing have proven to be a "disease of the cells" (De Grey and Rae 2008, 12) and, on the other, the progress of biomedicine is acquiring the capability to manipulate what is happening inside cells, and thus tackling disease by resetting the cellular clock raises the important question of whether it makes sense to strictly distinguish therapy from enhancement. The processes of biological ageing must namely be addressed at the level of the cell, and the molecules that constitute it, in genes, in both the nucleus and the mitochondria, as well as through epigenetic modulation. For example, Alzheimer's disease research may have 'side effects' for efforts to enhance cognition.

Elizabeth Parish describes an even more trivial case to show how difficult it is to draw a strict dividing line between human enhancement and medical therapy: how to define the function of antibiotics? Does the fact they are effective just long enough to fight off a pathogen mean that they belong to medical therapy, or do they belong to enhancement if such treatment amounts to building a super body with abilities that the natural body does not possess? Elizabeth Parish concludes that an unambiguous answer here is impossible (Parrish 2019).

It is expected that the further progress of various forms of gene therapies oriented to techniques of inserting or deleting genes will make the distinction between gene therapy and gene enhancement even more difficult. This is especially true in a situation where gene therapy will be able to address a complex genetic disease, *i.e.*, diseases, caused by many genes, not just one.

The very simple cases presented above reveal the difficulties in defining a strict dividing line between medical treatment and human enhancement. These are extraordinarily complex, knowledge-intensive and controversial topics that pose a challenge for all bioethicists and transhumanist thinkers. Genome enhancement appears not only at the crossroads of different theoretical views, but also at the intersection of very different social interests. For instance, if these technologies permit more genes that cause undesirable conditions or characteristics in humans to be identified, societal pressure could then increase to eliminate those conditions or characteristics. This approach could shrink the category of 'normal' species functioning and broaden what is considered to be a deleterious mutation. Some former normal human variants could thereby be recategorized as pathological.

This means that in the context of current debates on the further progress of human enhancement technologies it is vital to follow pragmatism and pluralism. On the one hand, we can avoid, in this manner, a total ban of many gene therapies that promise to heal various diseases and, on the other hand, we can also avoid a laissez-faire approach. We need more realism and fewer ideological statements while assessing genomic enhancement. When genomic therapy in biomedicine also opens the way to enhancement interventions, a bioethical assessment based on empirical data and not simply moral and ideological disqualifications will be needed.

The Need to Encourage an Open and Critical Intellectual Discussion on All Types of Human Genome Editing Technologies

In the last 10 years, the progress made by human genome editing technology has meant human organisms can be transformed by direct manipulation of genomes within a broad range of applications. The invention of CRISPR/Cas9 technology about 10 years ago paved the way for a revolution in gene therapy. Put simply, CRISPR-Cas9 works as a type of molecular scissors that can selectively trim away unwanted parts of the (human) genome and replace them with new stretches of deoxyribonucleic acid (DNA) (Tyagia *et al*. 2020). In recent times, this revolutionary genome editing technology has become extremely popular in biomedicine.

Before the invention of CRISPR-Cas 9 technology, biomedical gene therapy had a longer history based on genetic recombination. This type of gene therapy can correct deleterious genetic mutations that cause various diseases by inserting multiple copies of the nonmutated version of the gene either directly into the body (in vivo) or into stem cells that are subsequently infused into the body (ex vivo). With genetic recombination, the nonmutated copies of the gene are usually carried into human cells by a 'vector' (modified viruses or plasmids as delivery vehicles) that is able to facilitate the transport of the genetic material into the patient's cells (Keeler *et al*. 2017). A big problem with this therapy is that the behaviour of added genes inserted into the human body is not always predictable. These genes cause many 'off-target' effects, what may bring several negative consequences for patient health. At some point, this growth even ended abruptly following the death of a young boy called Jesse Gelsinger, a patient who was receiving an experimental therapy in 1999 (Mukherjee 2016).

The discovery of CRISPR-Cas9 technology made it immediately apparent that this technology is far more accurate and precise than the older genetic intervention technologies, that its editing power can be assessed in ways not possible with genetic recombination, and that it can be applied at any stage of human development. CRISPR-Cas9 technology has opened up new dimensions with respect to the accessibility and the scope of therapeutic applications.

Still, the great expectations regarding the potential of human genome editing technology have been accompanied by growing awareness about its risks. The main concerns refer to human germline editing. Since such editing creates changes that can be passed on to future generations and the implications of these heritable changes have not been tested in practice, this approach is presently not safe enough to justify its use in medical therapy.

Before CRISPR/Cas9 technology emerged, bioethical discussions connected with human genome editing were mostly concentrated on ethical arguments known as "principilism" (Bauman 2016). Here, the ethical dilemmas have generally been restricted to the questions of autonomy (one cannot experiment on another individual unless that person has agreed to be experimented upon), beneficence, and non-maleficence (the possibility of harming a person must be lower than the possibility of helping the person), etc. The reason for this is that the somatic genome editing therapies developed over decades were based on longstanding experimental and clinical research practices and healthcare. The difference between somatic and germline genome editing was first introduced in A Report on the Social and Ethical Issues of Genetic Engineering with Human Beings prepared by U.S. President's Commission for the Study of Ethical Problems in Medicine (Splicing Life, 1982). In this report, the difference was described in the following way: mutations that occur in somatic cells only affect the progeny of that mutant cell, which means that the effects of such mutations are restricted to the individual in whom they occur. In germ cells, however, mutations result in the altered DNA being transmitted to all cells—somatic and germinal—of an offspring. [2]

For example, French W. Anderson, the leading scientific advocate of gene therapy in 1980, differentiated three types of genetic engineering of future generations: therapy on somatic cells for treating genetic disease, the enhancement of simple characteristics of human beings (*e.g.*, height), and eugenics to improve complex human traits. Anderson saw somatic gene therapy as ethically acceptable whereas enhancement and eugenics were not (Anderson 1985).

The situation has changed radical in the last few years when the first practical misuses of CRISPR technology in germline editing were reported (Martin *et al*. 2020; Turkmendang and Martin 2021). Namely, the hardly controversial and speculative bioethical debates on germline human genome editing at the time of the rise of genetic recombination completely changed following the announcement of the birth of the first gene-edited babies in China. The scientific and wider social community was shocked when biophysicist He Jiankui from China announced the birth of twin babies whose genes he had modified with the gene editing technique. He had used CRISPR in an attempt to make a specific change in the DNA (CCR5 gene) of the human embryos. By so doing, He Jiankui had hoped that HIV would be unable to infect the white blood cells of the babies born from the embryos. The edited version of the CCR5 gene

[2] As stated by many authors, the distinctions made between somatic and germline editing might still be too approximate. It is worth noting that the effects of heritable changes only occur when the modified cells are used to establish a pregnancy that is carried to term. Thus, a distinction has been made between germline genome editing (GGE), which may only affect in vitro embryos in research activity, and heritable genome editing (HGE), which is used in reproductive medicine (Almeida and Ranische 2022) .

might be passed down to those babies' children (if any) and down through the generations (for more, see: He Jiankui 2018; Sand *et al*. 2019).

Although an independent investigation of the He Jiankui affair is still pending due to a lack of information (Meyer 2022; Greely 2019), it has provoked an extremely strong response from most leading genetic scientists, bioethicists, and international institutions around the world. While aspects of the opinions of the actors involved vary, they have generally joined in the call to ban clinical uses of human germline editing.

The birth of the first gene-edited babies is certainly connected with the threat of a new type of eugenics. Since germline editions can be inherited by future generations, their effect on future human life is unpredictable. Still, even though about 30 nations currently have legislation that directly or indirectly bans all clinical uses of germline editing, it is hard to expect that all of the actors involved will be able to fully agree on the bioethical positions on human germline editing.

It is interesting that some critics of human genome editing contend that the real change in the germline modification discourse already came with the new technique of mitochondrial replacement therapy that is used to avoid inherited mitochondrial disease. The UK was the first jurisdiction in the world to legally permit the technique of mitochondrial replacement therapy before the controversial "He Jiankui affair".[3]

Moreover, there are different views on how to cope with the issue of the extreme conditions of human life. People are suited for life on earth, but not for the extreme conditions in outer space. Therefore, each future imaginary provides a wide range of arguments for what and how to do with such extreme situations. For example, even serious scientists,

[3] The report of Nuffield Council on Bioethics maintains that there are no categorical reasons to prohibit some kinds of research in germline genome editing (Nuffield Councl of Bioethics 2018). By emphasizing the value of procreative freedom, the report stresses that in some cases human genome editing might be the only option for couples to conceive genetically-related, healthy offspring. In the UK, the Human Fertilisation and Embryology (Mitochondrial Donation) Regulations permit genetic modification to enable the conception of children without the mitochondrial disease. It assesses that, compared to nuclear DNA, making changes to mitochondrial DNA is relatively insignificant in the makeup of human genes.

including some working with NASA, have started to ask whether humans can be genetically enhanced for space travel or the possible colonization of other planets. They will need a powerful immune system to protect them from possible deadly new pathogens, etc. Georg Church, the world-renowned genetic scientist who cofounded Harvard Medical School's Consortium for Space Genetics, is promoting the further exploration of human health in space as well. He has identified around 40 genes that might be advantageous for long-term spaceflight (and would also benefit those who stay behind) (Pontin 2018).

It is legitimate to ask whether people should still be human beings or new creatures. Taking account of the complexity of the current situation in germline genome editing, it would be intellectually and socially unproductive to entirely halt any more of such research activities, let alone further intellectual discussions on this topic. A difference does exist between research and clinical application. Many historical cases in the field of biosciences suggest that it is pointless to impose categorical bans on any kind of newly emerging technology. In the current atmosphere of a strict ban of germline genome editing, calls for the measured analysis of all the (positive and negative) implications of all kinds of human genome editing approaches are not always heard. Finally, the next generation of personalized medicine is accompanied by many expectations that it will be based just on gene therapy, whether targeting the germline or somatic cells. The issue of whether to permit (or not) the further progress of any kind of emerging technology must be resolved following a proper assessment of the risks and benefits. Namely, when the benefits are found to outweigh the risks scientists (or physicians) must determine whether to continue, modify, or immediately stop the continuing progress of technology. All new technologies should not be analyzed simply in terms of their risks, but also in terms of the opportunities they provide. New governance experiments and settings are hence needed in order to foster a rational discourse on the further development of all kinds of human genome editing technologies. Here, it will also be necessary to re-define the function of expert knowledge and its role in risk assessment in the intermediary space between cognitive and practical values. If we wish to prevent the complex relations between values and technologies, among different values, and the competing interpretations of values from leading to ever more conflicts about new and emerging technologies, we must find new ways to foster a rational discourse on these technologies and the relevant values.

Conclusion

The main aim of the discussion was to address the issue of human genome editing as it relates to the recent progress made by human enhancement technologies. In modern transhumanist discourse, much attention is paid to the issue of human enhancement as supported by the progress of newly emerging technologies. Today, a number of potentially valuable applications are emerging from the processes of unifying newly emerging technologies, *i.e.*, biotechnology, nanotechnology, information technology, and cognitive technology. The convergence of various disciplinary fields is especially important in human genomic technology related to genomic therapy and genetic enhancement. In the article, some cases of the converging of technology were presented. Human enhancement as supported by transhumanist thinkers was shown to still be relatively poorly defined. The prime reason for this is that no strict demarcation between human enhancement and medical therapy exists that could guide research inquiries in these fields. This issue becomes extremely complicated when it comes to genetic enhancement. The discussion included a presentation of certain bioethical implications of the current rapid progress being made by human genome editing technologies. The invention of CRISPR/Cas9 technology some 10 years ago opened the door for a revolution in gene therapy. While before the emergence of CRISPR/Cas9 technology bioethical discussions were generally concentrated on classical questions, the invention of CRISPR/Cas 9 technology and the practical (mis)use of this technology in the context of germline genome editing are creating totally new bioethical dilemmas. When taking account of the complexity of the present situation with germline genome editing, it was argued that it would be intellectually and socially unproductive to entirely halt further research into various types of human genome editing. It is vital to keep in mind the maxim of moderate and pragmatic transhumanists who claim that in modern democratic societies, and despite the contested future of scientific-technological progress, pluralistic views and public discussions of the benefits and risks of any newly emerging technology (including germline genome editing technology) must not be stifled.

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