Open Journal of Philosophy, 2023, 13, 681-695
https://www.scirp.org/journal/ojpp
ISSN Online: 2163-9442
ISSN Print: 2163-9434

Would the Convergence of Nanotechnology, Biotechnology, Information Technology and Cognitive Science Be a Springboard for Transhumanism and Posthumanism?

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How to cite this paper: Sawadogo, J., & Simpore, J. (2023). Would the Convergence of Nanotechnology, Biotechnology, Information Technology and Cognitive Science Be a Springboard for Transhumanism and Posthumanism? *Open Journal of Philosophy, 13,* 681-695.
https://doi.org/10.4236/ojpp.2023.134043

Received: August 5, 2023
Accepted: October 23, 2023
Published: October 26, 2023

Abstract

Nanotechnologies, biotechnologies, information technologies and cognitive sciences (NBIC) have gradually gained traction in the United States of America (USA), subsequently expanding to Europe, and are now proliferating worldwide. Scientists are trying with more success to remove the causes of death by "repairing" humans, or even by "increasing" their physical and cognitive capacities. NBICs not only can help researchers promote "one health" by improving environmental conditions, human and animal health, but also, they can lead humanity towards transhumanism through eugenics. Thanks to the principle of totality, the intentional modification of the human body for therapeutic purposes through surgery has always been seen as a source of medical progress. But how far can the living human body be modified at will? Gilbert Hottois and Jean-François Mattei have deciphered transhumanism to question its alleged "humanism" and study its impact on our humanity. Today, science has gone further thanks to the possibilities offered by converging NBIC technologies and especially with the advent of human genome editing! The objective of this article is to highlight the hopes and fears of *Homo sapiens* following the applications of NBICs, and to propose ethical reflections on the invading transhumanist and posthumanist doctrines that tend to become spiritual movements, even religions. A summary study, based on a scientific bibliography, linked to NBICs and including ethical aspects, will present the ethical issues of the convergence of nanotechnologies, biotechnologies, information technologies and cognitive sciences, which could become a springboard for transhumanism and posthumanism.

Keywords

Biotechnology, Nanotechnologies, NBICs, Artificial Intelligence, Human Enhancement, Transhumanism, Posthumanism

1. Introduction

In the United States, at the end of 2001, the so-called "*converging technologies*": "neotechnologies" began to emerge as a result of recommendations from the National Science Foundation (Börner et al., 2020). The North American perspective saw the convergence of these technologies as an extraordinary opportunity to enhance human capabilities for human development. Certainly, these converging technologies are relevant in the field of human, animal, educational, environmental and social health with positive consequences, but also with possible challenges, risks and deviations. Thus, the development of these converging technologies and their integration may have social, ethical and legal implications.

Nanotechnologies, biotechnologies, computer science and cognitive sciences (NBIC) constitute a vast multidisciplinary scientific field, receiving funding from several institutions for scientific research since discoveries and innovations are increasingly motivating donors (Giesen, 2018). Theorists and adepts of transhumanism, who dream of humans who can be both "repaired" and "improved" (Khushf, 2004; Tomkins, 2014), are constantly imagining how to bring together the NBICs (Khushf, 2007) in order to boost the physical capacities and cognitive faculties of *Homo sapiens*, and forever eliminate their diseases, infirmities, handicaps, suffering and ageing (Koch, 2010). The ultimate goal would be to provide humans with the elixir of immortality! Transhumanists are based on the convergence of NBICs, which are technologies that are progressing exponentially. According to their hypothesis, when the evolution of these technologies reaches the computing power of the human brain, progress will come up against a critical point: the "singularity". Once the singularity is reached, artificial intelligence (AI) will be infinitely more powerful than all human intelligence combined. From that point on, AI will confiscate technological progress and rule humans as it pleases, leading *Homo sapiens* directly into the era of post humanism (Kurzweil, 2005). The objective of this article case is to highlight the hopes and fears of *Homo sapiens* following the applications of NBICs, and to propose ethical reflections on the invading trans-humanist and post humanist doctrines that tend to become spiritual movements, even religions. From this point of view, it is evident that the issue surrounding the utilization of NBICs holds a global significance, as no individual will be able to evade their dominant influence. Therefore, consequently, we find in this research the importance of global bioethics, as advocated by authors such as (Macpherson, 2007; Mattei, 2012; Ten Have, 2022; Richie, 2022; Tong, 2022).

2. Methodology

A literature review was conducted in English and/or French using PubMed, Google Scholar, Science Direct and Web of Science databases. Documents from WHO, FAO and UNESCO were also used. The main search terms used were: "biotechnology", "nanotechnologies", "NBICs", "converging technology", "transhumanism", "post humanism", "Human Enhancement". The data was exported into the Endnote software and duplicates were removed. The second level of selection consisted of reading the abstracts of eligible articles and eliminating those without an abstract or presenting irrelevant data. Finally, a review of the full texts allowed the final selection of 52 articles for this study.

3. Applied NBICS: Hopes and Fears of *Homo sapiens*

3.1. Biotechnologies: Hopes, Fears and Fantasies of *Homo sapiens*

Definition of Biotechnology: The concept of "biotechnologies" is not a univocal term because it covers a wide range of technological concepts (Kilbane 2nd, 2016). The term derives from three ancient Greek words: *bios* (life); *technè* (technology, production) and *logos* (science).

Nowadays, there are several definitions of biotechnology. The word "biotechnology" was first used in 1919 by Karl Ereky, a Hungarian Engineer. For him, Biotechnology makes it possible to manufacture products using living organisms based on raw materials. According to the Organization for Economic Cooperation and Development (OECD), biotechnology is defined as "the application of science and technology to both living organisms and their parts, products and molecules in order to modify living and non-living materials used in the production of knowledge, goods and services" (OECD, 1999). As for the Cartagena Protocol on Biosafety to the Convention on Biological Diversity of 29 January 2000, biotechnology is defined as any technological application that uses biological systems, living organisms, or derivatives thereof, to produce or modify products or processes for specific uses. For the Food and Agriculture Organization of the United Nations (FAO), biotechnology is "the use of biological processes or living organisms for the production of materials and services beneficial to humanity (Zaid et al., 2001). Biotechnology therefore involves the mastery of techniques aimed at increasing the economic value of plants and animals. Finally, according to (Gupta et al., 2016), biotechnology is "any technology applied to living organisms to make them more useful to humans". From this perspective, the application of modern biotechnology is based on the use of technologies such as tissue culture, genomics, marker-assisted selection, diagnostics and genetic engineering. In short, biotechnology is a multidisciplinary field where science and technology coexist. Certainly, modern biotechnology represents an enormous development potential for the 21st century people. However, the potential applications they offer in the agro-pastoral, biomedical and industrial fields raise both hopes and fears as there is no certainty of zero risk in the use of its products (Bielecka & Mohammadi, 2014).

Hopes, fears and fantasies of Homo sapiens: As described by scientists, the general public, the civil society and the international media, modern biotechnology has many applications in various fields today. Currently, we are talking more about green biotechnology (agriculture), blue biotechnology (seas and oceans), red biotechnology (health), white biotechnology (industry), grey biotechnology (ecosystem and environment), brown biotechnology (arid and desert soils), gold biotechnology (bioinformatics), black biotechnology (bioterrorism and biological warfare), violet biotechnology (biosafety) and yellow biotechnology (food industries). Here, we will only focus on red biotechnology, although from a *"one health"* perspective, there is an integrated approach to health that emphasizes the interactions between animals, humans and their environment.

Modern biotechnology is primarily based on the recombinant DNA technology for gene therapy and industrial production. In this sense, it is possible, for example, to modify DNA or cellular RNA by mutagenesis, or to carry out cell fusions of different taxonomic families in order to obtain the synthesis of a targeted product. These unconventional genetic engineering techniques easily overcome all physiological barriers to natural regeneration or genetic recombination. The aspects below can be mentioned in the sector of health:

- *The production of health knowledge:* DNA sequencing, genes drive and the Clustered Regularly Interspaced Short Palindromic Repeats/Cas9 gene editing technique have led to an unprecedented revolution in human medicine. Certainly, the Human Genome Organization (HUGO) sequencing project and Organoids have helped establish the link between genetics and many pathologies by identifying mutated genetic biomarkers and potential therapeutic targets against which drugs can be developed or genotherapy applied.
- *The production of new innovative medicines for health:* Through genetic engineering—the CRISPR Cas9 technique—humans can now produce increasingly targeted and specific biomedicines. Thus, new generations of treatments derived from living organisms are currently under development, especially innovative therapy medicinal products such as gene therapy, cell therapy and tissue engineering.
- *The production of health services:* Genetic engineering nowadays makes it possible to design experimental models *in vitro* or *in vivo* for preclinical research on new therapeutic molecules.

On the one hand, *Homo sapiens* bases its hopes on the enormous potential of biotechnology because it can improve its living conditions on earth. And yet, *Homo sapiens* is worried, perplexed and anxious because with modern biotechnologies, humans have a double-edged knife in their hands. Man can build but he can also demolish. If these same revolutionary biotechnological techniques fall into the hands of unethical, unconscious and megalomaniacal researchers, they will develop tailor-made babies, Genetically Modified Organisms (GMOs) (Rose & Brown, 2019), cloned humans and cyborgs.

Certainly, the whole range of successes in the health field mentioned above was made possible thanks to biotechnologies applied in the therapeutic, pharmacological and diagnostic fields. This biotechnological push shall be correlated with the rapid growth of nanobiotechnologies, nanomedicines and nanosciences.

3.2. Nanobiotechnologies: Hopes, Fears and Fantasies of *Homo sapiens*

Nanobiotechnology is the marriage between biotechnology and nanotechnology. It is the manipulation of matter at the molecular level. Nanotechnologies appeared in the 1980s with the invention of the scanning tunnel microscope, which allows atoms to be moved individually. In this sense, they allow the creation of chemical species at nanometer scale (One nanometer is equivalent to one billionth of a meter: 10^{-9} m).

Thanks to the NBICs, humans will be able to repair their organs on nanometric scales: modify genes; "control" epigenetics; repair cells and tissues; model cell metabolism; create artificial organs; develop surgical robotics; put in electronic implants; treat genetic pathologies, using nano-implants and nanomotors. Thus, nanobiotechnology offers and will offer in the future: a more personalized and preventive medicine capable of decoding gene signals; more effective and less invasive care against cancers (Roco, 2003a; Roco, 2003b). All this is made possible by the new possibilities of selectively treating diseased cells; nanobiotechnologies, especially nanomedicines, provide *Homo sapiens* with the possibility to improve its life by innovating today's medical practices. Thanks to the NBICs, yesterday's science fiction will become medical-reality; it now seems that science has caught up with science fiction (Lecellier, 2011). These include biomaterials for the manufacture of artificial skin (Lee et al., 2023); nanocapsules and lasers for targeted chemotherapy to fight tumors (Moawad et al., 2023); nanoparticles, nanorobots that are injected directly into the tumor and are capable of selectively killing tumor cells; addressing mechanisms that allow proteins to be directed to their target receptors.

According to (De Jong & Borm, 2008), nanoparticles can open the door to a multitude of therapeutic opportunities. However, they also carry risks. These nanoparticles are not limited by traditional body barriers. They infiltrate into the cell nucleus and can interact with nuclear DNA. These risks must be assessed before their use on a large scale. From there, researchers themselves are raising questions: how does the human body react to these nanoparticles? What will be the impact of the release of these nanoparticles on the environment? (Yadi et al., 2018) These questions form the basis of concerns and perplexity about the use of nanobiotechnology results.

Information technologies (computer science) and cognitive sciences (brain sciences; artificial intelligence): Hopes and Fears of Homo sapiens

NBICs have induced gigantic technological tidal waves and their impetuous shockwaves of innovation are still expanding exponentially. These absolutely colossal computing powers allow what was unimaginable a few decades ago; understanding the modelling of living beings.

Thus, according to Curbatov and Marie (Curbatov & Marie, 2016), "the interaction between nanotechnologies and information technologies is a synergy in both recursive directions that is mutually reinforced: the power of processors enhances data exchange and processing, which in turn impacts the development of nanostructures". For Oleg, not only are information technologies used for computer simulation nano-objects, but there is nowadays a wide use of nanotechnology to create powerful computing and communication devices based on biological and neurological systems. In addition, information technologies are also used for modelling biological systems. Nowadays, thanks to increasingly powerful computers such as hexaflop, the modelling, analysis and decoding of genes and their expression are carried out with ease in major molecular biology and molecular genetics laboratories. And it has become possible to interface human cells, including neurons, with electronic components (Bouton, 2019).

Cognitive sciences, which aim at studying and understanding how the brain works, could help to overcome neurodegenerative diseases. The progress of nanomedicine is most remarkable: after cochlear implants for the treatment of deaf children, surgical robotics, artificial retinas and hearts, researchers are now placing implants in the brain to treat neurodegenerative diseases such as Alzheimer's and Parkinson's diseases. These types of therapies can help restore and improve cognitive abilities.

If these NBIC processes are now used for therapeutic purposes primarily, they could be used to boost human physical and mental capacities. Exoskeletons appear in factories, hospitals and even in some armies. Advances in neurotechnology make it possible to control video games through thought or improve mental capacities to fight against the occurrence of neurodegenerative diseases. Advances in synthetic biology, such as the Crispr-Cas9 method, make it possible to carry out interventions of unprecedented precision on the human genome at a lower cost. The cursor moves gradually: the purpose is no longer just caring for or repairing Man, but "increasing" him, extending the deadline for his death, and finally, "building" a more powerful individual: a cyborg.

This perspective raises enormous anthropological, ethical, bioethical and deontological issues.

4. Applied NBICs: Anthropological and Ethical Challenges

Anthropological and ethical challenges can be well highlighted within the framework of bioethical reflection. Gradually, through the care for the sick person, surgery, and genetic manipulation, researchers are moving the cursor as mentioned above; and without ethics, they would probably achieve through new forms of eugenics, the goals that transhumanism and posthumanism set for themselves (Mattei, 2012).

"Since biotechnologies, nanotechnologies and information sciences have converged, new perspectives for the transformation of living beings have emerged. The corresponding ethical questioning is specified in terms of benefit/risk balance, but also in terms of the goals pursued, the relationship to living beings and to life. This questioning takes into account today's technoscientific mentality and the analysis of a complex living being, both robust and vulnerable" (Magnin, 2018).

Developing countries like Rwanda, Uganda, South Africa, Ethiopia, Tanzania, and other countries in Sub-Saharan Africa have already embraced NBIC technologies by using drones to deliver on time blood products, vaccines and emergency medical equipment (Amukele, 2022; Griffith et al., 2023; McCall, 2019; Nisingizwe et al., 2022); by developing electronic algorithms for clinical decision support and digital platforms for ambulatory pediatric patients (Tan et al., 2023) and by instituting online training for the development of health professionals (Byungura et al., 2022; Bälter et al., 2022). Digital technologies have already demonstrated their effectiveness in responding to the internal challenges of large African cities, by improving the quality of public services through the digitization of "cadastres" (land registries), the real-time management of public transport; by increasing the security of sites and people through video surveillance; by promoting the provision of new services to users within the framework of e-governance, which saves time and reduces the burden on public services (Ndaguba et al., 2023; Ogbodo et al., 2022).

4.1. Biotechnology: The Other Side of the Coin

The described positive aspects of biotechnology also have a dark and risky side. The first downside is that biotechnology can foster new forms of eugenics. According to Aubert-Marson (2009), eugenics is "the science of race improvement, which is by no means confined to questions of judicious unions, but which, particularly in the case of man, is concerned with all the influences likely to give the best endowed races a greater chance of prevailing over the less good races" (Aubert-Marson, 2009). A better knowledge of genetics and molecular biology offers scientists under the leadership of public authorities the opportunity to set up systems for the selection of individuals and, even worse, for the genetic transformation of *Homo sapiens*. Hence the need to maintain the "bridge" mentioned by (Bingham, 1972) between ethical values and biotechnological advances. The philosopher Dominique Folscheid says there is "eugenics as soon as a third party intervenes in the choice of another's origin, with a view to conducting negative or positive selection (Magnin, 2018). Indeed, this possibility is given to States that take the ethical responsibility in the place of citizens to practice this modern, *"soft"* and silent eugenics. In this sense, Hans Jonas had highlighted this problem of our responsibility towards future generations (Vahanian, 1991). The technical assistance of almost 350,000 conceptions of children, every year, by *in vitro* fertilization, that is, 0.3% of the 130 million babies born in the world (Calhaz-Jorge et al., 2017), constitutes an anthropological phenomenology. And therefore, a relevant question arises: what kind of "person" do we want in our modern societies? (De La Rochebrochard, 2018).

Indeed, beyond the controlled technology of procreation, old anthropological questions must be asked again, especially since each technological advance calls for another step towards the unknown. Jacques Testart, the French biologist who allowed the birth of the first test-tube baby in France in 1982, admits that he and his team had not been very concerned about ethical issues; and that's where the problem lies. Their only concern was to help infertile couples have children (Testart, 1995). "I was a field biologist. I had no contact with the humanities." Having become aware of the challenges of scientific advances, he is now an enlightened critic of science. The problem (Bansal et al., 2021) is neither medical nor technical, but societal, and therefore fundamentally anthropological. It is a problem of human society that often overshadows the actual anthropological, philosophical and ethical issues. As Jean-François Bouvet says, are children conceived in a tailor-made manner (Jordan, 2020) human persons, having their end in themselves, or are they considered as objects to be manipulated?

What is the meaning of human procreation in "Le Meilleur des mondes" *[Brave New World]* finally achieved? (Huxley, 1932). Does the word "procreate" still mean the fact of committing oneself to someone else, or recognizing and receiving a host and offering hospitality to a newcomer? Scientific techniques are breaking down and redefining the concepts of parenthood, paternity and maternity; which is also an anthropological issue. States are called upon to respond positively to new desires or fantasies, as underlined by the Director of the European Centre for Law and Justice (Steffann et al., 2005): the desire to have a child with a dead person; the mother's desire to be the "father" of the child; the request for a presumption of maternity for the "mother's wife"; the desire to be the "mothers" of the same child... Jacques Cohen, head of an American laboratory, and one of the pioneers in human procreation, joyfully spoke of "the wonderful future that embryo sorting will allow" (Cohen, 1988).

The debate, in its anthropological and ethical dimensions, seems to have been confiscated in advance, with the complicity of the public media, which are challenging the anthropological foundations of our living together (Flavigny, 2019).

4.2. Nanobiotechnologies: A Double-Edged "Weapon"

No one can question the effectiveness and performance of nanobiotechnologies in diagnosis and therapy. But a "means" remains a means and from an ethical point of view, only the final intention in the use of this technical instrument will determine its ethical aspects (Le Méné, 2016).

Should we therefore abandon the search for and detection of the risks of hereditary genetic diseases? Certainly, no! But at the same time, research should be developed on the means of therapy for these detected diseases and not use these research tools as the justification of insidious eugenics! The precautionary principle should require researchers and technicians not to develop certain means of investigation that would substantially transform Man. Should nanobiotechnologies, through their hyperinformativity, make Man lose their ontological and anthropological identity? (Hottois, 2014)

4.3. Information Technology and Cognitive Sciences: A Simple Tool?

Artificial intelligence (AI) can have potential side effects in humans whose impact can be more or less considerable as: AI addiction, loss of jobs, discrimination, violation of privacy, cyberattacks, false information, hacking of drones, planes, self-driving cars and large-scale blackmail (Shoss & Ciarlante, 2022; Granulo et al., 2019). To avoid the negative side effects of AI, it is important to remember that the use of AI should be done responsibly; according to ethical and deontological standards in order to guarantee the safe and effective use of this technology. Governments and businesses must work together to develop regulations and ethical standards for the use of AI. Users should also be aware of the potential risks associated with using AI and take steps to protect their privacy and security. Ethical issues regarding AI systems relate to all stages of the life cycle of these systems, understood here as ranging from research, design and development to deployment and use, and including maintenance, operation, commercialization, financing, monitoring and evaluation, validation, end of use, decommissioning and dismantling (UNESCO, 2021b).

There is no doubt that the computer age and the mastery of artificial intelligence have made it possible to "repair" the human body, replace certain organs and perform tissue transplants. But from "repair" to the improvement and increase of human capacities, the dream of transhumanists can lead to abuses that ignore ethical and deontological values. Several authors have recently alerted public opinion to these anthropological and ethical challenges (Testart, 2018). Jacques Testart and Agnès Rousseaux have stigmatized the "suicidal promises" of transhumanism (Testart, 2018). Talking about the "body of transhumans", Pruski asks the question: What Demarks the Metamorphosis of Human Individuals to Posthuman Entities? (Pruski, 2019); Olivier Rey is urging for a serious consideration of the ideas of transhumanism to find the true anthropological answers of our time (Rey, 2018b).

Nowadays, the human body is being repaired, restored and improved. But tomorrow technological progress will irreversibly redesign Man as he is already presented in science fiction films: a superman (the augmented Man), more powerful and more intelligent (Mendz & Cook, 2021). Possible abuses are already fueling the ethical debate.

"Transhumanism considers Man as a technological project". From this perspective, transhumanists do not see any reason why the work should not start from the design stage. But if a child is a product, why not include additional functions in him/her? Transhumanism seeks to be in "synergy" with information technologies to achieve its goals" (Rey, 2018a).

Transhumanists by their theories thus consider artificial intelligence as a simple "computing power"; which is typical of their approach on the basis of which they say that if the power of computers continues to grow, computers will become more intelligent than humans....” (Mariani, 2018).

This perspective of using technological convergence to promote eugenics and “Augmented Humans” differs, on the one hand from that of UNESCO, which stipulates in its objectives that “Artificial Intelligence (AI) has the potential to address some of the biggest challenges in education today, innovate teaching and learning practices, and ultimately accelerate the progress towards the Sustainable Development Goals” (SDG4), (UNESCO, 2021a). And on the other, that of the WHO which advocates that “Artificial Intelligence (AI) holds great promise for improving the delivery of healthcare and medicine worldwide, but only if ethics and human rights are put at the heart of its design, deployment” (WHO, 2021).

Of course, converging technologies could contribute enormously to the development of humankind and its environment if and only if, in their application, they are governed by ethics, legal norms and wisdom. However, two fundamental pitfalls are inescapable. On the one hand, there is a global disparity in the development and utilization of NBICs between the North and South; this ethically unjustified inequity compromises the global solidarity so strongly advocated by international political bodies. The question arises: how can the development gap between the affluent countries of the G7, G8, G20, BRICS... and the rest of the developing world be bridged? On the other hand, it is crucial to emphasize the peril to humanity posed by the unethical utilization of NBICs, given their potentially disastrous and unpredictably consequences. On the contrary, from the standpoint of global bioethics, which advocates “one health”, humanity has a greater opportunity for qualitative survival by prioritizing the well-being of its living environment. What is required is a moral compass that fosters “the unity of humanity, solidarity, equality, openness to differences and an emphasis on what human beings have in common” (Richie, 2022). This would go further than the mirages of transhumanist projects.

5. Conclusion

The ideology of transhumanism is not only the improvement, augmentation or enhancement of the human being, but also its overcoming by modern and advanced technologies that also imply a control of life and death. Under these conditions, what would become of “Man”, the “*Anthropos*” with all his rationality, his freedom and his desire to live? For the benefit of future generations, NBICs must promote convergences of nanotechnologies, biotechnologies, information technologies and cognitive sciences that respect not only the dignity of the human person and human development, but also, from the perspective of global bioethics, the conditions of “One health” for the survival of planet Earth itself.

This article has highlighted the objectively beneficial aspects of NBICs in the medical field for the well-being and better life of human being. Enlightened and conscientious scientists will be able to take into account the anthropological and ethical implications of their research, thus respecting the principles of precaution and prudence. On the other hand, it was noted that these scientific and biotechnological advances could be a springboard, through utilitarian conceptions of bioethics (cost/benefit; pleasure for the greatest number; social utility/private right, etc.), to achieve the goals of transhumanism and posthumanism. The convergence of NBICs can lead to a threat to humanism inherited from philosophical wisdom, which considers Man/Woman as a subject, and never as a means or a useful object!

No matter what precautions researchers take, they will never achieve zero risk in their modern biotechnology research. But whoever risks nothing, has nothing. You still have to know how to risk by not setting foot where you are not sure. Between lures, misfortunes, fears and anxieties, human being thinks and builds his future! But with the NBICs applied, today with fear, one must ask oneself: *"Homo sapiens, quo vadis"?*

Author Contributions

Joseph Sawadogo = ***JoS***; *Jacques Simpore* = ***JaS***.

Study concept and design: JoS and JaS.

Drafting of the manuscript: JoS and JaS.

Critical revision of the manuscript for important intellectual content: JoS and JaS.

Study supervision: JoS and JaS.

Acknowledgements

We thank the Professor-researchers du Centre de Recherche Biomoléculaire Pietro Annigoni (CERBA) du Burkina Faso et de l'Université Saint Thomas d'Aquin (USTA) for their support. The authors especially thank Dr. Abdoul Karim OUATTARA for the translation of the article into English.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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Abbreviations and Acronyms

AI	Artificial Intelligence
CRISPR-Cas9	Clustered Regularly Interspaced Short Palindromic Repeats-associated protein 9
DNA	Deoxyribonucleic acid
FAO	Food and Agriculture Organization
GMOs	Genetically Modified Organisms
HUGO	Human Genome Organization
NBIC	Nanotechnologies, biotechnologies, information technologies and cognitive sciences
OECD	Organization for Economic Cooperation and Development
RNA	Ribonucleic acid
SDG4	Sustainable Development Goals
UNESCO	United Nations Educational, Scientific and Cultural Organization
WHO	World Health Organization