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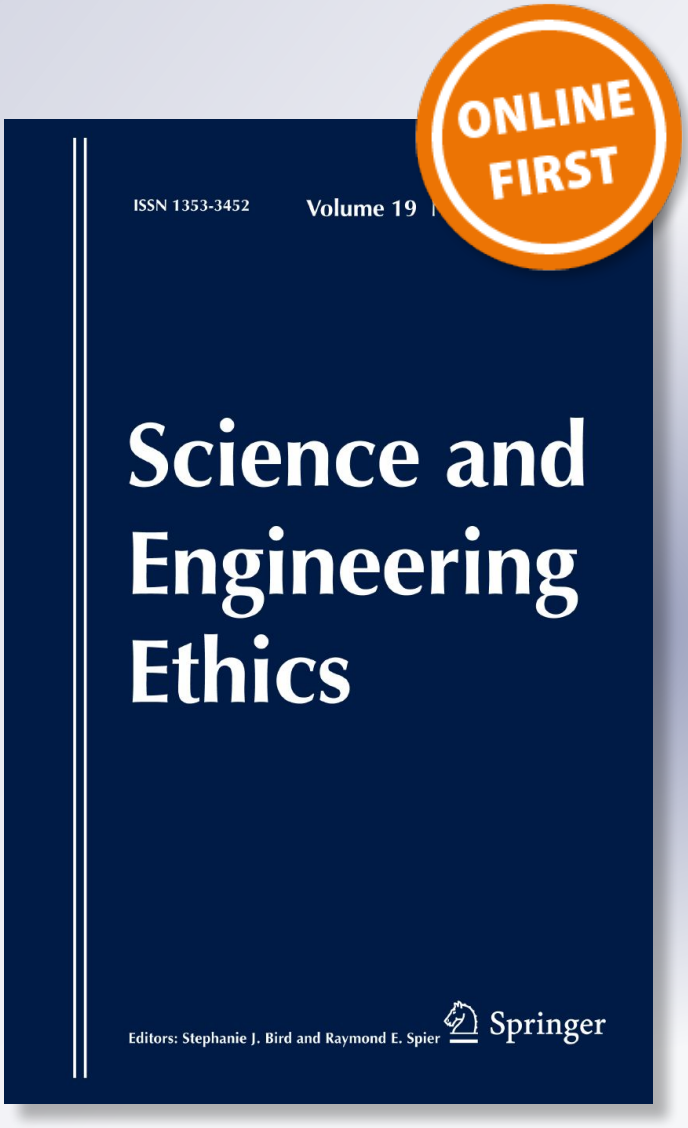

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ORIGINAL PAPER

The Conception of Synthetic Entities from a Personalist Perspective

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Abstract Synthetic biology opens up the possibility of producing new entities not found in nature, whose classification as organisms or machines has been debated. In this paper we are focusing on the delimitation of the moral value of synthetic products, in order to establish the ethically right way to behave towards them. In order to do so, we use personalism as our ethical framework. First, we examine how we can distinguish between organisms and machines. Next, we discuss whether the products of synthetic biology can be considered organisms at all and assess what their moral value is and how should we behave towards them. Finally, we discuss the hypothetical case of synthetic humans.

Keywords Synthetic biology · Bioethics · Personalism · Moral value · Moral status

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Introduction

Although synthetic biology is a promising discipline that could lead to many useful applications in different fields, it is not exempt from bioethical issues, one of which is the need to determine the moral status of the products of this discipline. Until now, the boundary between organisms and machines was clearly delimited. However, because synthetic biology opens up the possibility of producing new entities not found in nature, whose membership in one of these two groups is not evident, this boundary is becoming blurred, raising concerns about their moral status (Deplazes and Huppenbauer 2009; Basl and Sandler 2013; Holm and Powell 2013; Nicholson 2013).

Since this is a rapidly-growing discipline, it is imperative to establish the moral status of synthetic products, in order to make clear from the outset the treatment that these will merit. In this paper, this issue is addressed using personalism as our ethical framework.

Personalism is a philosophy that was born in Europe during the first half of the twentieth century, and is characterized by placing the person at the center of its reflection and conceptual structure. Leading philosophers in this field include Mounier, Maritain, Nédoncelle, Scheler, Von Hildebrand, Stein, Buber, Wojtyla, Guardini, Marcel, Marías and Zubiri. In the field of bioethics, the main representative of personalism is Elio Sgreccia (Burgos 2012). According to personalism, the value of the person is above that of other beings, and the human person is the point of reference and measurement of what is lawful and unlawful. It is a moderate anthropocentrism, which "reserves for man the role of steward, thereby charging him with a serious responsibility" (Sgreccia 2012, p. 98).

For our analysis, the principles developed by Sgreccia (2012) have been used: (1) *protecting the life and genetic identity of every human individual*: human physical integrity and the genetic heritage must be maintained, unless it compromises the life of the individual; (2) *the therapeutic principle*: it is permissible to carry out a genetic intervention, even if it is invasive, on the living subject when it is necessary to correct a defect or treat an otherwise incurable disease; (3) *protecting the ecosystem and the environment*: humans must protect the environment and cannot treat other living organisms as mere instruments; (4) *the ontological and axiological difference between man and other living beings*: there is a profound difference between humans and other living beings; and (5) *the competence of the community*: scientists must keep communities aware of relevant advances in order to make it possible to develop a well-informed public opinion, which has to be taken into account by governments in decision-making processes. Principles 3 and 4 are the most relevant to our study.

The principle of *protecting the ecosystem and the environment* states that humans are not only beneficiaries but also stewards of the created world and, in particular, of other living creatures. This function of stewards (not owners) forces us to recognize that "the existence of other living beings is not exhausted in being an instrument" (p. 322). Thus, organisms cannot be treated as mere means. This viewpoint is also reflected in the encyclical letter *Laudato Si*, in which one of the central concepts is

the recognition of the value proper to each creature (Pope Francis 2015). Although this document is not considered personalist per se, its concept of person and the importance given to it coincide with personalism, and it quotes authors such as Paul Ricoeur, Romano Guardini and Thomas Aquinas. It states that, "Because all creatures are connected, each must be cherished with love and respect, for all of us as living creatures are dependent on one another" (p. 30), and that "it would also be mistaken to view other living beings as mere objects subjected to arbitrary human domination" (p. 60), later affirming that "our 'dominion' over the universe should be understood more properly in the sense of responsible stewardship" (p. 87). Furthermore, nature and ecosystems as a whole must also be respected and taken care of. "[M]an can easily recognize that the attitude of care is the most appropriate to interact with ecosystems […] given his rational condition, only he is able to perceive of its value" (Pastor 2016).

Regarding the principle of *the ontological and axiological difference between man and other living beings*, it is worth noting that this view is shared by several different philosophical and ethical frameworks. Jaworska and Tannenbaum (2013) explain that "[i]t is usually taken for granted that all adult cognitively unimpaired human beings have FMS" (full moral status, which the highest degree of moral status). This is consistent with the principle of *the ontological and axiological difference between man and other living beings*, although personalism differs from some other views in that it recognize the same moral status in all human beings, regardless their cognitive capacities or stage of development. This conception of man arises from the recognition of a full dignity in every human being (Spaemann 2000).

As mentioned above, synthetic biology seems to blur the boundaries between organisms and machines, raising concerns about the moral status of synthetic entities. To understand this, it is necessary to clarify the different types of synthetic products that result from the different branches of synthetic biology (Deplazes 2009). One first approach is bioengineering, which aims to apply engineering principles to biology, thus transforming biotechnology into an engineering discipline. BioBricks are a good example of this approach. They are genetic parts of a defined structure and function and fulfill the engineering principles of standardization, decoupling and abstraction (Endy 2005). Secondly, synthetic genomics consists of the chemical synthesis of a minimal genome (a genome containing the fundamental genes of life) in order to constitute a "chassis genome" to which other genes with specific functions can be attached. Researchers of the J. Craig Venter Institute synthesized a very simple bacterial genome and successfully introduced it into a bacterium whose DNA had been destroyed (Gibson et al. 2010). This experience is a milestone in Synthetic Biology history, since it approximates to the synbio ideal of creating life. A third approach is the production of protocells, simple forms of life produced totally from scratch, using nonliving materials as raw ingredients. These chemical systems would be capable of reproducing themselves, as well as adapting and evolving (Rasmussen et al. 2009). However, until now only structures showing some life-like behaviours have been achieved (Rasmussen et al. 2016). Protocells are expected to increase our understanding of the essence of life, particularly about its origin (Ma and Feng 2015). Finally, unnatural molecular

biology consists of the design and construction of artificial genomes with new types of nucleic acids (i.e., xeno-nucleic acids) or by changing the universal genetic code (Schmidt et al. 2017).

In order to establish the ethically appropriate way to behave towards synthetic entities, three questions must be answered: What is it meant by moral status? Can the products of synthetic biology be considered organisms at all? And if so, what is the moral status of synthetic organisms and how should they be treated?

What is it Meant by Moral Status?

Certainly, it is not simple to answer this question, since the concept of moral status itself is not clearly defined. Furthermore, there is a plethora of theories regarding the moral status of different organisms, focusing mainly on animals (Cavalieri and Singer 1994; Regan 2001; Regan and Singer 1998; Rollin 2006; Rowlands 2009; Ryder 2000; Singer 2006), and a consensus is far from being reached. Discussions revolve around having or not having moral status, or placing the moral status of some organisms above that of others, usually sentient over non-sentient organisms (Jaworska and Tannenbaum 2013), despite the fact that sentience is a concept difficult to define.

From the principle of *protecting the ecosystem and the environment*, moral status could be defined as the quality of an entity that implies that its treatment as a mere medium by a moral agent (person) has negative moral implications. The problem with this definition is that it is unable to give a reason for the supremacy of the person over other living beings. Therefore, by virtue of *the ontological and axiological difference between man and other living beings*, different categories should be established for them. With this aim, moral status and moral value are two concepts that can be distinguished. Moral status appears to be superior to moral value (Steinbock 2009), so we suggest reserving it for persons. Thus, moral status can be understood as the moral implications arising from human dignity, and moral value as the quality of an entity that implies that its treatment as a mere medium by a moral agent (person) has negative moral implications. Accordingly, all organisms have a moral value, but so too do other entities, such as natural species, ecosystems, the environment or human corpses.

One question that might arise is whether all non-human organisms have the same moral value. The principle of *protection of the ecosystem and the environment* does not differentiate between different organisms (not even among these and the environment). Rather, they are valuable in the same degree. However, does it mean that all non-human living beings should be treated in the same way? This would not be consistent with our principle. So, to act as responsible "stewards" of the created world, and in particular, of other living creatures, as established by the principle, the diverse interests of the different organisms must be taken into account. Thus, although different organisms can be said to have the same moral value, their interests may differ, and may morally matter to different degrees. The consequences triggered by actions for the interests of the different organisms are often given by the features of the organism itself (sentience, interests, emotions, consciousness,

etc.). Thus, in spite of the lack of specific determinations regarding the moral status (or value, according to our terminology) of organisms, legislations and guidelines usually govern the use of organisms to satisfy human purposes (for example, in industrial farming and experimentation) based on the features and interests of these organisms. Bacteria, plants and mammals are not treated with the same care, since by virtue of their different characteristics, they have different requirements.

It may happen that human interests are contrary to the interests of other organisms, as often occurs in scientific research. Given the principle of *the ontological and axiological difference between man and other living beings*, human interests morally matter more than the interests of any other being, and thus prevail when deciding a course of action. Therefore, it is ethically appropriate to act in order to accomplish human interests, even if it means frustrating the interests of another organism, provided that such human interests are morally appropriate in themselves.

Can the Products of Synthetic Biology be Considered Organisms at All?

In order to answer this question, it is necessary to define the concept of life, since this is what primarily distinguishes organisms from non-organisms. Sgreccia (2012) states that:

> there is a finality throughout the world of living things […]. In inanimate realities, the purpose or end is something external; it does not reside in the thing but rather in the mind of the planner. […] On the contrary, the purpose is immanent within animate realities (p. 81).

Historically, several authors have elaborated different lists of criteria which define what life is. Koshland (2002) puts forward what he call "The seven pillars of life": (1) program, which in Earth is the DNA; (2) improvisation, which is the capacity of organisms to change their program in order to adapt to their environment by a process of mutation plus selection; (3) compartmentalization or confinement of organisms to a limited volume by means of a membrane or skin; (4) energy, since organisms are metabolizing systems; (5) regeneration, in order to compensate the thermodynamic losses. Reproduction is one of these pillars; (6) adaptability, which is part of the program and involves those behavioral responses that allow survival in quickly changing environments; and (7) seclusion, which is the specificity of enzymes and DNA and RNA interactions.

Ganti (2003) proposes "the principles of life" as being necessary and sufficient for life, are: (1) units of life lose their properties if they are subdivided; (2) units of life perform metabolism; (3) units of life must be inherently stable in spite of environmental changes; (4) units of life contain an informational subsystem necessary for them, to function; and (5) units of life have their processes regulated and controlled. According to this author, growth, reproduction, the capacity for evolution and mortality are potential but not absolute life criteria, which means that all of them together are crucial for populating the planet but not strictly necessary for life.

Another well-known theory to describe life is the theory of Autopoiesis. According to this model, organisms are "homeostatic systems that have their own organization as the critical fundamental variable that they actively maintain constant" (Maturana 1975). The concept of autopoiesis has been recently reformulated in order to provide a clearer and more precise definition, easier to apply in practice. According to this new definition, a system is autopoietic if and only if:

1. It is a network of physical and chemical processes.
2. This network chemically produces a subset of the components which are parts of the network.
3. This subset of components, by means of relations among its members and with the components of its surroundings, generates the conditions necessary to maintain the components of the network in physical proximity, collectively forming a spatially discrete individual unit over time. (Razeto-Barry 2012).

The different synthetic biology approaches address different features of living organisms (such as metabolism, genetic programme, or the interaction with the environment) in order to obtain new life forms (Deplazes-Zemp 2012). Nonetheless, while synthetic biologists modify these features, they do not eliminate them. If the entity still keeps these features, it does not matter in what measure they are artificially modified, the entity will still be an organism.

Few authors have approached this issue in the specific field of synthetic biology. Deplazes and Huppenbauer (2009) compare organisms and machines as opposite ends representing the living and the non-living worlds, and find that these entities differ in four properties: composition (organic material vs. inorganic material), origin (uncertain vs. clearly defined), development (change vs. permanence) and purpose (own purposes vs. external, i.e. human, purposes).

These authors position the products of bioengineering, synthetic genomics and protocell synthetic biology, somewhere between these ends according to four features that they identify as being distinctive of each one. Table 1 summarizes how synthetic products resemble organisms or machines according to these criteria.

Deplazes and Huppenbauer (2009) explain that, when positioning synthetic biology products as either machines or organisms, it is more important to focus on their purpose than on their origin. They argue that, when naming them as living machines or as synthetic organisms, the noun refers to the purpose of the entity (human vs. own, respectively), while the descriptive adjective refers to their origin (uncertain vs. clearly defined, respectively). They continue their argument by explaining that, given that the noun is more important, i.e. vital, than the adjective for the categorization of the entities, then their purpose predominates over their origin as a classification criterion. The authors therefore conclude that those entities whose purpose is external (human) are better positioned as machines, thereby avoiding discussions about their instrumentalization.

However, it is debatable that by concerning ourselves with the way in which humans refer to these entities, it can be deduced where they are better positioned. Additionally, understanding the term *purpose* as something exclusively human or inherent to the organism is inaccurate, since these two purposes need not be

Table 1 Comparison of synthetic biology products with organisms and machines. Retrieved from Deplazes and Huppenbauer (2009)

	Machines	Bioengineering products	Chassis organisms	Synthetic cells	Organisms
Composition	++	−−	−−	−−	−−
Origin	++	−	−+	++	−−
Development	++	−	−−	−−	−−
Purpose	++	++	+	−	−−

++ indicates that the feature is machine-like, while −− indicates that it is organism-like. Between these ends, + indicates that the feature is not absolutely machine-like, but more similar to a machine than to an organism; − indicates that the feature is not exactly organism-like, but more similar to an organism than to a machine; −+ indicates that the feature is right in the middle of the two ends

mutually exclusive. Actually, the situation that an entity is designed and constructed in order to fulfill human purposes does not mean that it does not serve its own ends.

Nicholson (2013) also considers *purpose* as the most important dissimilarity between organisms and machines, but he understands the term as ultimate *telos*. For Nicholson, organisms are *intrinsically* purposive systems, while machines are *extrinsically* purposive systems. An organism "acts on its own behalf, towards its own ends. Its telos is internal, arising from within, and it ultimately serves no purpose other than to maintain its own organization" (p. 671). Furthermore, the internal organizational dynamics of organisms are characterized by the phenomena of self-formation, self-preservation, self-reproduction and self-restitution. In contrast, a machine "operates towards an end that is external to itself. Its *telos* is imposed from the outside and it is of use or value to an agent other than itself. A machine does not serve its own interests but those of its maker or user" (p. 671). Its construction, assembly and maintenance require an external agent. Therefore, according to this author, if synthetic products are *intrinsically* purposive systems, then they are organisms, regardless their artificial origin, which is consistent with the vision of Sgreccia (2012).

Although there are different definitions of life, synthetic biology does not eliminate any of the features proposed as defining life. Consequently, synthetic biology products must be considered as organisms, regardless of their natural or artificial origin and the human purposes involved in their design and production, and can be called synthetic organisms. The *Mycoplasma capricolum* cell containing the genome of Mycoplasma mycoides, synthesized by researchers at the J. Craig Venter Institute (Gibson et al. 2010), serves as an example of these kinds of organisms.

What is the Moral Value of Synthetic Organisms and How Should They be Treated?

Having established that at least some synthetic biology products are organisms and not machines or anything intermediate, their moral value must be discussed and their interests taken into account in order to preserve them as far as possible, safeguarding the principle of *protection of the ecosystem and the environment*.

Apart from this principle, the moral implications of the relationship of the human being with other living beings and with the environment have not been addressed from personalism, much less with respect to synthetic organisms.

Expounding this issue goes beyond our objectives. However, it would be very valuable if this area of research could be developed and studied in more depth from a personalistic philosophy. Pending this, we propose to review the contributions of several authors in this field, and to contrast the validity of their claims from a personalistic point of view. Since it has already been stated that our position is moderate anthropocentrism, common anthropocentrism or biocentrism in general will not be discussed. Instead, the focus of our work is on the specific case of synthetic organisms, although this will inevitably lead us to dialogue with the frameworks of reference of the different authors.

Attfield (2012) discusses the bearing of biocentrism on the production of artificial life. He uses the term "moral standing" of organisms, meaning "they warrant moral attention or consideration for their own sake" (p. 2). From this perspective, all living creatures have moral standing because they have a good of their own and, therefore, "their flourishing or attaining their good is intrinsically valuable" (p. 2). The author argues that, guided by the principle of beneficence, humans should avoid inflicting harm and injury (where there is no good reason to do so) on any kind of organism, even if they are non-sentient. From this perspective, synthetic organisms are also bearers of moral standing.

However, he finds a problem in defining what constitutes the harm (and the flourishing) of synthetic organisms, since there is no point of reference for distinguishing whether their lives are going well or badly. To resolve this question, he presents some arguments. First, synthetic organisms would be bearers of most of the central characteristics of life (metabolism, growth, homeostasis, reproduction, self-organization and/or goal-orientedness). If some of these characteristics are harmed in some way in a synthetic organism, then its flourishing can be said to be impaired. Secondly, observation can also help us to determine the good for these organisms. Later, the author talks about the quality of life of synthetic organisms, which could be wronged (by comparison with that of creatures of familiar kinds) if the genetic modifications led to consequences such as a lack of sentience or a creature that seldom moves.

> For example, meat producers might wish to produce such a creature to continue producing meat while avoiding charges of causing pain and suffering to sentient creatures. […] So we could intelligibly talk of their quality of life being a deterioration from that of familiar creatures; and this could form the basis of an ethical objection to generating them (p. 8).

This perspective exceeds the obligations towards non-human organisms prescribed by personalism. The principle of *protection of the ecosystem and the environment* obliges us to preserve the biodiversity and the environment and not to interfere with the interests of non-human organisms if it is not necessary to satisfy some human interest (provided that it is morally correct). Thus, from our perspective, one must take into account the interests of the organism as it is, and the consideration of how much better a life it could have lived if it were not synthetic has no moral relevance.

Bedau and Larson (2013) use environmental ethics as a framework to draw conclusions about the intrinsic value of synthetic organisms. Following Sandler (2012), they distinguish three kinds of intrinsic values: intrinsic subjective value, which depends on someone's opinion; intrinsic objective value, which something possesses in and of itself; and inherent worth, which is possessed by virtue of something having a good of its own, having its own interests, purposes or biological needs. With regard to intrinsic subjective values, the authors explain that synthetic organisms can have these, since these values depend on people's opinion. However, they point out that, due to this subjectivity, the ethical implications of having this kind of value are not to be considered. Regarding intrinsic objective values, they argue that synthetic organisms have those properties that are objectively valuable, such as self-regulation, stability, self-organization or spontaneity, and thus they also possess this kind of value. At this point, they discuss whether the fact that synthetic organisms do not have a natural evolutionary history interferes with the possibility of their having an intrinsic objective value. They provide two reasons to argue that this is not the case. Firstly, directed evolution and evolutionary design of experiments, which mimic adaptive Darwinian evolution, are processes that are used to produce some synthetic organisms, suggesting that "synthetic life-forms could have the intrinsic objective value (if any) that comes from the wisdom of nature" (p. 79). Secondly, if a synthetic organism, once produced, was released into the environment, it could adapt, mutate and evolve. Finally, with regard to inherent worth, the authors conclude that this is also present in synthetic organisms, since they have interests derived from their biological needs in the same way that natural organisms do.

Their conclusions are correct according to their terminology. However, it is necessary to make a point on the consequences derived from the recognition of these intrinsic values.

Sgreccia (2012) states that:

> The attribution of intrinsic value to non-human entities has led to an extension of the boundaries of the moral community beyond the unique category of human beings. This broadening can be considered essentially correct so long as it is interpreted as the need to establish moral duties for man not only toward other human beings, but also toward natural entities. Conversely, matters become remarkably problematic and even unacceptable from both the philosophical and scientific standpoints with the affirmation that all natural entities possess the same moral value (p. 97).

Therefore, from a personalist point of view, the recognition of these values would not lead us to equate their moral value with that of humans, which is consistent with our distinction between moral value and moral status.

Douglas et al. (2013) state that what matters when defining the moral status of an organism is the non-genealogical properties that they possess, such as mental capacities. They define moral status as a special value "typically attributed to beings in virtue of the mental capacities they or normal members of their species possess" (p. 692), such as capacities for consciousness, experiencing pleasure and pain, self-consciousness or rationality. Baertschi (2012) also uses the term moral status, and

advocates that some organisms have it and some do not on the basis of their intrinsic properties. The author defines the moral status of an organism as having "a peculiar value grounded in some of his intrinsic properties" (p. 5), what forces moral agents to have moral obligations towards them, so that they cannot be treated in just any way we please. According to these views, the artificial origin of synthetic organisms would have no impact on their moral status. Synthetic organisms would have moral status if their intrinsic properties were valuable.

From our ethical framework, these non-genealogical or intrinsic properties are relevant, as they will directly determine the interests of the organism. However, these views fail to fulfill the principle of *the ontological and axiological difference between man and other living beings*. By applying the same criteria to humans and animals, the most vulnerable human beings, such as embryos, are left unprotected. Furthermore, this conception of moral status leads to conclusions that are contrary to the principle of *protecting the ecosystem and the environment*, according to which no living organism can be treated as a mere instrument.

Basl and Sandler (2013) argue that even non-sentient organisms have a good on their own, since they are teleologically organized according to the etiological account of teleology, which implies that the goal-directedness of entities is derived from the selection process from which they result. Therefore, they argue, synthetic organisms also have a good of their own. However, they explain that this does not mean they have moral status, since for an entity to have moral status, it must have interests and these interests must be morally relevant. A counterintuitive consequence seems to arise from their argument. They state that if the etiological account of teleology is accepted, then that artifacts also have a good of their own has to be recognized, since they are also teleologically organized.

From our perspective, and in line with Nicholson (2013), what matters when defining the nature of an entity is its intrinsic purposiveness, i.e. its self-maintaining organization, which differs from the broader term of goal-directedness advocated by Basl and Sandler (2013).

Finally, Preston (2013) argues that the intrinsic value of synthetic organisms is diminished relative to that of naturally occurring organisms. The author presents three arguments to defend this view. First of all, the situation that the teleological organization of synthetic organisms is connected to the designer's intentions implies that their good is not entirely their own. Second, in the case of synthetic organisms, the "artifactual final cause" (attributable to the designer) is prior to the "organismal final cause" (attributable to the organism's autonomous functioning). Finally, the condition that synthetic organisms are organisms is an incidental attribute to the intended purpose, which is the essential attribute.

However, these arguments are questionable. First, as Nicholson argues, even if the synthetic organism serves the interests of its maker or user, it would do so only to some extent; its ultimate purpose will still be to maintain its own organization (Nicholson 2013). Second, in the current state of synthetic biology, the technique works on preexisting organisms. Even Venter's artificial bacteria required inserting the synthetic genome into a natural DNA damaged bacterium (Gibson et al. 2010). Finally, synthetic biologists design their studies on the basis that they are going to

work on organisms, and taking into account the special features of these organisms is critical to achieve successful outcomes (Porcar and Peretó 2016).

From a personalist perspective, there are no grounds on which to argue a difference of value among natural organisms and synthetic ones. Nevertheless, it should be clarified that, although respect for them is prescribed by the principle of *protection of the ecosystem and the environment*, this only obliges us to protect the interests of each specific individual, and not the synthetic species in general, which would not be part of the ecosystems and environment that must be preserved. In fact, it will usually be the case that natural biodiversity and ecosystems must be preserved from the interaction with synthetic organisms in order to safeguard their conservation.

It is therefore necessary to address those features of synthetic organisms that determine their interests, in order to define what their interests would be, whether these interests morally matter, and whether the intended use for them could harm those interests. Having made these concretizations, it can be determined how these organisms must be treated.

Although existing laws and guidelines can be useful to guide the ethically acceptable treatment of organisms, preserving their interests as far as possible, it could be the case that the rules or principles established cannot be extrapolated to organisms that are not included among those for which the rule applies. This limitation might be more notable in the case of synthetic biology, since unknown organisms or existing organisms with novel features (and perhaps different interests) can appear. For this reason, it is necessary to anticipate these situations, determine the interests of synthetic organisms before producing them, consider them in the context of their intended use, and establish the necessary measures to preserve their interests as far as possible.

The Special Case of Synthetic Humans

When discussing the moral consideration owed to synthetic organisms, an aspect of special interest is the hypothetical case of synthetic humans.

For the time being, synthetic biology has mainly focused on microorganisms. Nevertheless, the possibility of applying synthetic biology to humans has already been mentioned by leading representatives in this field. Thus, Drew Endy has suggested that it offers the possibility of skipping evolution by designing our own offspring (Specter 2009), while George Church has written that it could be used to obtain virus-proof humans or bring Neanderthals back to life (Church and Regis 2012). There are two main options when considering the use of synthetic biology techniques to modify the human genome: using it with the aim of *improving* humans; or to develop what has been called *subhumans*, humanoid organisms that would serve purposes such as being sources of transplantable tissues and organs, experimental subjects or crash test dummies, and to neutralize landmines (Newman 2012).

The bioethical study of synthetic biology must take into account the possibilities contemplated above, in order to prevent an unethical scenario. The principle of

protecting the life and genetic identity of every human individual advocates that the human genetic heritage must not be touched. Thus, both the modification of the genetic composition of human populations in order to promote the reproduction of more desirable traits and any type of meiogenic practice, i.e. the production of humanoid organisms to be used by humans, are rejected from consideration as ethically acceptable options.

This special case alerts us to the risk of viewing synthetic organisms as machines. Using the term machine to label synthetic organisms is not only incorrect but also dangerous. If synthetic organisms are deemed machines, then no moral considerations are necessary when dealing with them. Thus, in the case that subhumans are obtained, their interests would not be taken into account and they could be used as a mere means to serve the purposes of normal humans. However, as it has been argued, they would not be machines, but organisms. Moreover, regardless of the changes made to their genome, they would still be humans. Consequently, the term subhuman is unwarranted, and both its meaning and its underlying objectives are contrary to human dignity.

In this regard, Douglas et al. (2013) state that:

> if synthetic biologists did manage to construct a human embryo entirely from scratch, and this developed into a human person, that person would, intuitively, be entitled to the same rights and privileges as another person, despite her curious origin. What matters, again, is not origin, but mental capacity (p. 695).

From a personalist perspective, the same criteria are not applied when sepeaking of human beings or non-human beings, as prescribed by the principle of the ontological and axiological difference between man and other living beings. A synthetic human would "be entitled to the same rights and privileges as another person" by virtue of their dignity, not of their mental capacity.

Conclusions

Among the ethical issues that arise from the emerging field of synthetic biology, the need to define the moral status of its products is a key to ensure that both research and applications derived from this discipline are carried out in an ethically acceptable way. Given the artificial origin and the human intervention involved in the production of synthetic entities, their classification as living beings or machines is debated. Here, this issue is addressed from a personalist framework, which provides us with principles to conduct a bioethical analysis of the topic. The most relevant principle here is the principle of *protection of the ecosystem and the environment*, which states that man is not only the beneficiary but also the steward of the world and, in particular, of other living creatures.

In this essay, the concepts of moral status, meaning the moral implications arising from human dignity, and moral value, meaning the quality of an entity that implies that its treatment as a mere means by a moral agent (a person) has negative

moral implications, are distinguished. According to this terminology, only humans have moral status, while all organisms have moral value.

Therefore, in order to determine if synthetic entities have moral value, the question of whether they are organisms or machines must be addressed. On the basis of their immanent purpose, it is concluded that those synthetic entities that retain self-formation, self-preservation, self-reproduction and self-restitution are organisms, regardless their origin and the human purposes involved in their production.

Thus, given that all organisms have goals, and that, from a personalist point of view, all living beings are intrinsically valuable, their goals must be taken into account. By comparing the contributions of other authors in this field from the standpoint of personalism, some additional conclusions are derived. First, considerations about the possibly wronged flourishing of synthetic organisms because of their design have no moral relevance from our point of view. Secondly, the characteristics of synthetic organisms must be observed in order to determine their requirements and preserve them as far as possible. Thirdly, an important comment is the case that there is not a moral duty to safeguard the conservation of synthetic species, since they are not part of the biodiversity that must be protected. Finally, the primacy of the person must be always observed, taking into account that, from our ethical framework, human interests prevail over the interests of non-human living organisms.

Furthermore, using the term "machine" to describe synthetic organisms is perilous. While today the only synthetic organisms that can be produced are microorganisms, whose requirements have no impact at the moral level for their manipulation, this could change when more complex organisms are produced. Naming them properly from the beginning would ensure that the interests of more complex synthetic organisms are respected in the future. Finally, it is argued that synthetic humans must not be invented under any set of circumstances, and that the term *subhuman* is both unwarranted and contrary to human dignity.

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