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Reassembling the Organ™

A sympoietic perspective on life evaluation in xenotransplantation practice

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Introduction

Amidst the difficulties of contemporaneity, namely in the context of ecological crises and social injustices, the American philosopher Donna Haraway rejects any easy escape. She addresses complexities and challenges of present times discarding idealized futures as plausible solutions: she calls for *staying with the trouble* (2016).[1] In a fight against both tendencies of sitting without trying, as the world we live in is unalterable, and placing extreme faith in solving any modern issue relying on technology, Haraway argues we must start to consider other scenarios.

The first step toward this goal is orienting ourselves toward reality as a *more-than-human* event, in which the present moment of destructiveness is a consequence of the mixture of different spatialities and temporalities, livings and meanings. A revolution in the perception and representation of reality that in Haraway's vision implies a different way of inhabiting it. In fact, recognizing the complexity and inseparability among all living and non-living entities dethrones the privileged position of humans, also on the ethical-political plane. This translates into acknowledging and addressing those places and subjects where the always *becoming-in-relation-with* is tangled with injustice and violence.

That's why making ourselves present and *response-able*[2] for those situated and individual experiences of struggle (staying with the trouble, indeed) becomes a solution: learning to live

[1] Haraway D. J. (2016) Staying with the trouble. Making kin in the Chthulucene. Duke university press.Durham and London. p.1.

[2] Key term in Haraway's philosophy, emphasizing the capacity and obligation to respond ethically and thoughtfully to the interconnected world we live in.

with and alongside other species is mutually beneficial in several ways. In summary, according to Haraway, if humans were to recognize their entanglement with other earthly beings and systems, to stay present and attentive to the ongoing struggles working their ways through them creatively and responsively, they could foster relationships able to help all parties thrive in a shared world.

Continuing this line of thought, the historian and technoscience studies scholar Michelle Murphy (2018) reflects on the necessity of reimagining how we manage with and relate to collectivity. She rejects the idea of population as a conceptual framework that in the face of contemporary environmental and social violence points to human density as the issue. This idea translates itself in the construction of a web of infrastructures, laws and technologies that, instead of reordering unjust power relationships, promote solutions centered on managerial policy control and fundamentally deeming individual lives as expendable. As Murphy asserts, being against the problem of population not only necessitates developing concepts and practices of *becoming-with-the-many* differently, but also requires the adoption of a different approach resisting the biopolitical impulse encapsulated in the equation "some must die so that others can live."[3]

The will to exit this vision requires to become aware of the consequences of its violence and to transform accordingly the many obsolete and exploitative epistemic habits embedded in how sciences problematize humans and nonhuman lives. Despite the lack of a unified and undisputed theory of life within sciences, concepts such as gene, organism, species and ecosystem have become so entrenched they seem to exist in the world itself, in place of being recognized as materializations of specific historical contingencies. These fixed categories are the knowledge tools used to give a representation of the world and, therefore, the foundations of those

[3] Murphy M. *Against population towards alterlife*. In Haraway D. J, Clarke A. E. (2018) *Making kin not population*. University of Chicago Press. USA. p.112.

technoscientific practices that impose an uneven distribution of life chances. That's why Haraway and Murphy call for alternative decolonial ways of theorizing life acknowledging the ongoing violence and creating futurities in the aftermath.

In answering this call, this research attempts to abandon the well-established biological categories and practices that perpetuate exploitation and inequality in contemporary technoscience and on which Western society places enormous and unquestioned trust. More precisely, the aim is to adopt a perspective able to look at life beyond its individualistic and hierarchical conceptions; a specific view on life capable of recognizing that every living being emerges through ongoing and reciprocal relationships with other living and non-living entities. This perspective, which Haraway defines as *sympoietic*, challenges the engineered residues in technoscientific practices that too often calculate which lives are worth living. This results in questioning a view that relies on damage-based research on a domain of beings already confined in hostile worlds.

The following study draws the attention on the humbleness of the "right-here," emphasizing the situated experiences taking place in the biotechnological and medical fields where systematic inequalities vividly impact animal individualities. Thus, looking through a broader symbiotic perspective, we are willing to analyze how, in specific practices, certain lives are defined in comparison to others as "not worth living, lives considered better not to have been born, lives not worth supporting, unproductive lives, ignorable and killable."[4]

Having this analytical framework in mind, our research aims at focusing on a specific and situated practice seeking to highlight the individual experiences (both human and nonhuman) connected to it and the related consequences. More precisely, the following paragraphs will

[4] Cit. Ibidem. p.122.

analyze the current state of xenotransplantation and how this shapes and evaluates the individualities living by and for this practice. The analysis will be conducted relying on a sympoietic perspective willing to avoid the risk of evaluating those lives on their sacrificability. Xenotransplantation is the biotechnological and medical practice of transplanting organs from genetically modified animals into humans with severe medical conditions. The choice to draw a research on this specific activity it's been driven by two main factors. On one hand, it stems from the narrative that portrays xenotransplantation as a procedure according to which life is ostensibly prioritized. As a matter of fact, it aims at saving numerous human lives by addressing the increasing deaths due to the global critical shortage of organ donors, yet still imposing death on animal lives. On the other hand, it is linked to the recent developments of this practice, which make it a potential standard procedure in the near future, as evidenced by the increasing market interest in companies driving research in this field.

The latest advancements in biotechnological and medical research including practices such as cloning and gene editing, along with a better understanding of infection control, have created space for the possibility of harvesting organs from animals; a procedure that now exclusively relies on selected breeds of swine. Xenotransplantation, unlike the already established use of pig valves to repair human hearts, involves extensive genetic modification of the animals. This latter procedure, combined with breeding them solely to the purpose of harvesting their organs, raises serious ethical issues. Moreover, significant concerns have been raised among public opinion due to the breaking of boundaries between species, which threatens the sense of identity and causes cultural shock.

In accordance with the framework adopted by Murphy and Haraway, this research is focusing on how xenotransplantation concretizes itself in the bodies and ontological experiences of both pig "donors" and human recipients in recent cases of such surgeries. In this context, *staying*

with the trouble of this dynamic goes beyond the transplantation operation itself. It involves making present what happens in farms for genetically modified pigs, which are emerging and multiplying globally, and understanding how this dynamic reshapes the identity of individual recipients.

We will be focusing on the specific narratives and practices mobilized in those places and by those relationships through which the recent cases of xenotransplantation on living patients have materialized. In January 2022, the first notable case occurred in Baltimore, where a genetically engineered pig heart was transplanted into David Bennett Sr., a 57-year-old man with end-stage heart failure. This case served as the foundation for this research. However, during this study, two additional cases of xenotransplants in living patients were documented: a heart transplant in September 2023 on Lauren Faucette, who died six weeks later, and a kidney transplant in March 2023 on Richard Slayman, who passed away two months after the surgery. These cases confirm the skyrocketing velocity at which this practice is developing and highlight the need for reflection on its implications.

In doing so, this research aims at going beyond an ethical debate on whether this practice should continue based on human or animal welfare. It addresses the concept of what it means to be alive, which lies at the foundation of this practice. That's the reason behind the choice of the alternative perspective of sympoiesis to explore both the complex interlocking of events, subjects and representations that constitute xenotransplantation, and the idea of living itself connected to this practice. The ultimate goal is to provide a richer and more nuanced comprehension of what it means to be alive in and through the different contexts of this biotechnological and medical procedure. We seek to engage deeply with current structures of power and epistemic habits that perpetuate violence and inequality. We aim at highlighting, alongside the lives saved by xenotransplantation, those that are voluntarily sacrificed for this

purpose. In fact, this practice sits on the category of species which justifies calculations made on living beings in which animal individualities are inevitably accounted as killable.

Our hope is that, by challenging the notion of life typically upheld in the discussion of this practice, it would be possible to recognize the inherent worth of all lives. Thus, fostering a more just representation of xenotransplantation. A one that considers the broader social and ecological impacts of its work and requires acknowledging the reality that human well-being often comes at the expense of those deemed expendable.

In order to fully develop the analysis within this framework, the research will focus on re-centering the framing of the complex and composed reality of xenotransplantation around the concrete and symbolic entity of the organ, which is central to how this practice operates and constructs itself. More precisely, in the first chapter *Something New Under the Skin*, we will start by examining how biology envisions living beings, and which biotechnological and medical practices this vision justifies. From there, we will explore how this order can change by reconsidering the fundamental characteristics of the living according to the sympoietic perspective. Achieved through the integration of different anthropological, biological and philosophical studies, this different approach will allow us to move beyond a world of fixed categories. Hence, revolutionizing the concept of "organism" in the recognition of the organ itself as a symbiotic living entity: an unexpected presence in the usual universe depicted by biology capable to re-evaluate the dynamics of xenotransplantation when placed at the center of this research.

By applying this alternative perspective to the work of one of the companies active in this field, in *How to Functionalize a Pig* we will analyze how in xenotransplantation the organ is designed as a product around which a set of practices are developed to functionalize it for use in surgeries.

A goal reached inside the laboratory through the modifications of the animal body, but most importantly, by the industrialization of all those life-affirming activities that characterize each existence.

The sympoietic perspective applied on what biology defines as an organ also highlights the semiotic and symbolic character on which xenotransplantation operates. That's why, in *Accepting the Intruder*, we will examine how, starting from the metaphor of the immune system that science mobilizes through this practice as a biopolitical exercise of identity definition, not only the animal's experience, but also that of the recipient is shaped based on the different representations of the transplantable organ.

In conclusion, we will attempt to overcome the recognized limitations in the practices and narratives of xenotransplantation through a different framework that can emphasize the sympoietic reality of the world we inhabit and, especially, of the life that emerges within it. The hope is that, by analyzing xenotransplantation as it's been described so far, we can foster a more just and equal technoscientific thought capable of taking responsibility for the lives on which the well-being of others is violently imposed. This is the only way we can place science and technology on our side in answering the following questions: " What must be cut and what must be tied if multispecies flourishing on earth, including human and other-than-human beings in kinship, are to have a chance?"[5]

[5] Cit. Haraway D. J. (2016) *Staying with the trouble. Making kin in the Chthulucene*. Duke university press, Durham

1. Something new under the skin

According to the FDA, in 2021 ten patients died each day in the United States while on the waiting list to receive life-saving vital organs for transplant.[6] The severity of this situation is not solely attributable to the fallacy of medical policies in the USA, rather to a global issue tied to the increasing demand for human organs for clinical transplantation, surpassing the actual supply. Some estimates suggest that in recent years the number of available human organs for transplantation has equaled as little as 5% of the required number and future scenarios predict a worsening situation.[7] This current biomedical issue is the driving force behind the growing importance of xenotransplantation, the process of grafting or transplanting organs and tissues between members of different species. This method would provide a plentiful source of organs without relying on human donors. Contrary to common belief, xenografts are not primarily obtained from species genetically similar to human recipients, such as nonhuman primates, instead biomedical research has identified pigs as the best sources. The main reasons include the large availability and appropriate size of the species to provide functioning organs for adults, but most importantly the possibility of being genetically engineered and bred with relative ease.[8]

Even from these few pieces of information, it is clear why the public debate on the subject is sharply divided between those who advocate for the practice, considering it salvation for a

[6] "Xenotransplantation" in U.S. Food and Drug Administration official site https://www.fda.gov/vaccines-blood-biologics/xenotransplantation.
[7] Caschalo M, Platt J. (2008) *Challenges and potentials of xenotransplantation.*Clinical Immunology (Third Edition), Mosby. USA.
[8] Ibidem.

significant number of patients whose survival depends on transplant operations, and those who denounce the lack of ethics, highlighting the cost of this success falling on the lives of thousands of nonhuman animals. Moreover, hesitations arise also about the possibilities of xenozoonosis, the increasingly accepted hybridization between human and nonhuman animals and the extensive use of biotechnology in medical practices. Amidst all these questions, it seems overlooked that xenotransplantation is not a possible future reality, but a phenomenon already present and ultimately deciding the (way of) living and dying for many human, nonhuman and more-than-human beings. While still considered a cutting-edge procedure, the practice of transplanting organs or tissues from animals to humans has a long history. Many research cases have advanced interventions in this field since the early 20th century. Though involving various methods and different organs, their effectiveness has generally been measured by the recipient's survival duration post-transplant. In 1983, a widely known case involved the transplantation of a baboon heart into an infant known as Baby Fae (died 20 days later).[9] Currently, in most cases, more complex transplants occur in patients declared brain-dead or artificially kept alive.[10] However, in January 2021, xenotransplantation achieved a new and celebrated milestone. In Baltimore, after an eight-hour operation, David Bennett Sr, a 57-year-old man with a life-threatening heart condition, received a heart from a genetically modified pig. Despite the patient passing away two months after the operation, the event was met with jubilation within the scientific community.[11]

In all the reasoning concerning the practice of xenotransplantation, as in this case, life is seemingly at the center of the frame, yet the discussion revolves around who has the legitimacy

[9] Cooper D, Hara H, Banks C.A, Cleveland D. and Iwase H. (2019), The "Baby Fae" baboon heart transplant—Potential cause of rejection. Xenotransplantation, 26: e12511. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6717028/.

[10] This choice is dictated by regulations governing the introduction of new medical and pharmacological practices with the aim of reducing and preventing potential risks. Therefore, the procedure varies depending on the country and the current legislation in place.

[11] Rabin R. C. *In a First, Man Receives a Heart from a Genetically Altered Pig.* The New York Tames. January 10, 2022.

to live and how. At the foundation of it, the adoption of a state perspective that reduces living beings to populations without acknowledging how the experiences of living and dying are always individual and situated.[12] Besides, xenotransplantation, within its multitude of temporalities, spatialities, entities and narratives, determines how humans and nonhumans live based on a specific concept of life that is scientifically accepted and politically applied. While not questioning the validity of these beliefs, as demonstrated by Bruno Latour,[13] it would be a mistake to consider this scientific idea of life as a mere *matter of fact,* without recognizing the collection of narratives, power relations and subjects that composed and continually co-produce it. In the words of Donna Haraway:

> It matters what matters we use to think other matters with; it matters what stories we tell to tell other stories with; it matters what knots knot knots, what thoughts think thoughts, what descriptions describe descriptions, what ties tie ties. It matters what stories make worlds, what worlds make stories.[14]

That's the intent of this research, to use and put in relation biological, semiotic, medical and anthropological views to broaden up the perspectives governing Western belief systems regarding the living. The goal is not to define what is life, but to propose an interpretative framework that defines who lives and what it means to be alive without looking at the mere biological phenomenon, but also acknowledging how the individual experience of living

[12] cf. Murphy M. *Against population towards alterlife*. In Haraway D. J, Clarke A. E. (2018) *Making kin not population.* University of Chicago Press. USA. p.103-112.

[13]Bruno Latour throughout all his work challenges the conventional view of scientific ideas as isolated entities of objective truth, proposing instead that they are social constructions arising from complex negotiations among various actors and interests. For an in-depth exploration see: Latour B. (1993). We have never been modern. Harvard University Press Cambridge, Massachusetts. p. 1-10.

[14] Cit. Haraway D. J. (2016) *Staying with the trouble. Making kin in the Chtulucene*. Duke university press.Durham and London. p.12.

simultaneously shapes and is shaped by the political choices and moral economies of contemporary society.[15] Like playing with a kaleidoscope by examining the concept of living through diverse disciplines' lenses and simultaneously attempting to shift perspectives on how we consider and value the experience of life, we seek to transcend the anthropocentric view which hinders our ability to be present in the "here" and "now" of nonhuman individualities entailed by xenotransplantation. Our aim, then, is not to categorize this practice as inherently good or evil, but to make us capable of thinking and being present in its delineations about who lives and dies and, most importantly, how.

1.1 Introducing sympoiesis

What is Life? Besides being the question from which it seems necessary to start to reconsider the concept of living, it is also the title of the groundbreaking text published in 1944 by the quantum physicist Erwin Schrödinger. The book marks the beginning of a new biological approach grounded in physics and chemistry, aiming to answer that initial question; the molecular biologism field.[16] The fascination of this book lay in treating the gene not as an abstract unit, but as a concrete physical substance, advancing hypotheses about its molecular structure that signified a revolution in the approach to genetics.

Schrodinger was the first to suggest that the gene could be viewed as an information carrier whose physical structure corresponds to a succession of elements in a hereditary code script. Few decades later this path of research achieved the discovery of the DNA structure and the unraveling of the genetic code. Advancing to ever microscopic levels in their exploration of

[15] Fassin, D. (2009). *Another Politics of Life is Possible*. Theory, Culture & Society. p.48.

[16] Capra F, Luisi P. (2014) *The system's view of life, a unifying vision*. Cambridge University Press. p. 61.

biological life, molecular biologists found that the characteristics of all living organisms, from bacteria to humans, were encoded in their chromosomes in the same chemical substance using the same code script. The link between genes and biological traits seemed compellingly simple: biologists had discovered the alphabet of a truly universal language of life.

The subsequent advancement in research demonstrated a consistent discrepancy between this theoretical framework and the biological reality, making "evident that the primacy of the gene as the core explanatory concept of biological structure and function is more a feature of the twentieth century than it will be of the twenty-first."[17] Even though Schrodinger's field of study did not define life successfully, the way it directed its research and its subsequent development has deeply influenced the way of evaluating and relating to the living by the technoscientific society. Moved by the most faithful Cartesian reductionism, the philosophical certainty in the possibility of understanding all aspects of complex structures by reducing them to their smallest constituent parts, the genetics field signifies a very specific way of framing the living. The gene became the map of life itself through a perspective that considers the whole not as the sum of the parts, but rather of the parts summarizing the whole.

Donna Haraway is a severe critic of this concept, reflecting on how this idea of *life itself* could be ensnared in fetishism, akin to the Marxist sense where things are mistakenly perceived as generators of value without considering the human and nonhuman relationships that compose them.[18] Similarly the genes, the minimal unit of genetics study, are imagined without tropes, neglecting the liveliness of *bodies-in-the-making*.[19] Rejecting static and essential identities, Haraway promotes bodies constructed, altered and influenced by social, cultural, technological

[17] cit. Keller E.F. (2000) *The Century of the Gene*. Harvard University Press. Cambridge. p. 9.
[18] v. Haraway D. J. (1996) Modest_witness@Second_Millenium. FemaleMan_Meets_OncoMouse. Routledge. New York, London. p. 141.
[19] ibidem p. 141-147.

and biological forces.[20] In conclusion, the belief that life in itself could be a legitimate object of scientific scrutiny is not just an interpretative problem, as it has proven incapable of fully explaining biological complexity. Instead, reducing life to information is what allowed its instrumentalization with the developments of biotechnologies as clear examples. The criticism being put forward does not aim at a generalized demonization regarding the technoscientific society's utilization of specific knowledge about life. Many undeniably positive outcomes, particularly in the medical field, have emerged. However, what is under critique is the underlying vision of life that serves as the foundation for technoscientific practices and narratives. This vision is severely reductive because the methods used to evaluate and frame living entities in response to the question *what is life* do not take into consideration life as an emergent property within the complexity of reality. That's why Haraway calls for an alternative approach that looks at the interactions of specific material-semiotic bodies, considering "complex, dynamic, responsive, situated, historical systems"[21] and looking at the ecological assemblages between living and non-living entities through which life emerges. Haraway develops this idea through the work of biologist Lynn Margulis, known for her theory of *symbiogenesis*, which emphasizes the interconnectedness and collaborative nature of life processes. From this the term *sympoiesis*,[22] in which Haraway expands Margulis's ideas, describing the collective, collaborative, and relational aspects of living systems and knowledge production. The intent of sympoiesis framework is to extend the horizon of research beyond the preexisting bounded units defined by biology such as cells, molecules, genes, organisms,

[20] The concept is extensively developed within the idea of the cyborg, conceiving the body as a fluid and contextual entity permeated by technologies and interconnections, incorporating a plurality of influences and relationships. For in-depth analysis Haraway D. (2016) *A Cyborg Manifesto, science technology and socialist-feminism in the late twentieth century*. University of Minnesota Press. p. 52-68.

[21] Cit. Haraway D (2016). *Staying with the trouble. Making Kin in the Chthulucene.* Duke university press, Durham and London. p.58.

[22] For more in depth analysis: Haraway D (2016). *Staying with the trouble. Making Kin in the Chthulucene.* Duke university press, Durham and London. P. 58-70.

viruses, ecosystems, etc. Haraway refuses to consider any of these entities used in technoscience as a self-sufficient instrument of knowledge because incapable of describing the historically specific, and always multi-species, lively economies of troping that composed the reality.

Applying the sympoietic perspective on the xenotransplantation means framing nonhuman entities involved in these dynamics differently compared to the mechanistic and speciesist gaze which reduces them to resources of "pieces" for the pharmaceutical and medical industry. Moreover, reconsidering who and what lives in xenotransplantation, questioning the identities usually defined as living by technoscience and exploring their ways of becoming in symbiosis, is a way to morally and politically engage with this practice. Specifically, the aim is to examine, through the lens of sympoiesis, the multispecies relationships between humans and nonhumans that can be forcefully and violently assembled by this practice. Thus, this research proposes to observe the dynamics of xenotransplantation using an unconventional perspective from which to develop its reflections. In the biotechnological and biomedical practice in analysis, we will see how life-in-the-making emerges through constitutive relationships between quasi-collective/quasi-individual partners, starting from the entity that best embodies this form of entanglement: the transplanted organ. Besides, it is the evaluation, design and development of every individual organ that defines and directs the phenomenological experience of life for each animal "donor" involved. Alike, it is on the transplanted organ that medical, technological and biotechnological knowledge and practices operate, reshaping the physical and political boundaries of human and nonhuman identities.

Nevertheless, approaching the organ from a sympoietic perspective entails not only shifting the point of view on xenotransplantation, but also challenging the boundaries of traditionally considered individualities and rethinking the very idea of the organ as an anatomical unit limited to a specific function within the organism. That's why, before highlighting and developing the

consequences on social and political debate due to this change of perspective, it is necessary to define more clearly if, and how, it's possible to expand the concept of organ.

1.2 Rethink the organism

Usually perceived strictly in line with its definition as "a collection of tissues that structurally form a functional unit specialized to perform a particular function,"[23] the organ is narrated and then used by technoscience as a piece of a mechanism necessary for the functioning of a larger project. This conception is strictly related to the scientific belief of an underlying order to life as precedently seen in genetics theory. The French biologist and epidemiologist Jean-Jacques Kupiec strongly criticizes this belief because it falls into the trap of methodological essentialism. The belief that the inherent and definitive characteristics of knowledge objects, the essence, precedes existence itself, postulating an imaginary and illusionary order. In opposition, in his work *The Anarchic Conception of the Living*[24](2021), he opens up the spectrum and possibilities of life, basing his perspective entirely on the notion that the primary characteristic of the living is variability.[25] A theory that results in questioning functionality as a prerequisite for the existence of entities in the development of the complexity of reality. At the origin of this primary variability in living organisms, Kupiec places the global instability of both the genome and the gene. The consequence is that cells differentiate through collectively regulated random variations: they can change state spontaneously without instructions but stabilize in states that allow interaction with their neighbors. Getting back to the foundational theory of genetics, if Schrodinger conceptualized a molecular order expressed in the genetic

[23] Cit Widmaier E P; Raff H; Strang, KT. (2014). Vander's Human Physiology (12th ed.). McGraw-Hill Higher Education.
[24]The original title of the work is "Et si le vivant était anarchique," and as it has not yet been translated into English, the reference is to the Italian version titled "La concezione anarchica del vivente" (2021) by Eleuthera.
[25] cit Kupiec J. (2021) *La concezione anarchica del vivente*. Eleuthera. Milano. p. 14.

information and contained in the DNA that comes first and disclose the existence. By contrast, at the emergence of life Kupiec imagines an anarchic society in which every member is free, but limited by the presence of other individuals, adapting itself to its society and optimizing the available resources.[26] The direct consequence of this anarchic theory of the living is to imagine the organism not as a centralized whole where each part is dedicated to its proper functioning, but as a set of self-managing communities resulting from interactions between its parts and the environment. Therefore, every living system is not defined in itself by any predefined purpose in forming that defined cell, tissue, organ, organism, etc, but rather to live for itself, cooperating due to the constraints imposed by the environment in which it is situated. In other words, the parts of an organism do not obey a central power, but each part differentiates *here and now* due to its local and immediate dependence.[27]

In essence, biology is limited by the belief that material processes cannot produce anything on their own without a principle of order and purpose; a certainty that Haraway, as Kupiec, strongly opposes. To reach this conclusion in *The Anarchic Conception of the Living*, the French biologist, as in sympoietic approach, recontextualizes the defined entities that are at the foundation of scientific knowledge, highlighting their fluidity. Among these ones, the concept of species is the most reconsidered by Kupiec.

If positing variability as a foundational characteristic of the living in the field of genetics is an innovative idea, it is the opposite in the context of evolution. It is well known that in Darwin's foundational text *On the Origin of the Species* (1859) the fundamental ideas conveyed are that all organisms have descended with modifications from a common ancestor and that natural selection is the mechanism of evolution. Such descent with modifications is what continuously

[26] The opposition between the two societies is employed by Kupiec himself. For an in depth analysis: Kupiec J. (2021) *La concezione anarchica del vivente*. Eleuthera. Milano. p. 22-26.
[27] ibidem p. 177.

creates differences among individuals, forming the basis of the natural selection process: once again, variability emerges as a fundamental characteristic. As just explained, the reason behind these modifications among the set of individuals sharing a common ancestor in Kupiec lies in variation as a basic characteristic of living beings, even at the cellular level. In other words, in his vision there is no division between *ontogenesis*, cell differentiation, and *phylogenesis,* species differentiation, because linked by a causal chain that ties these phenomena. Thus, the idea that individuals of a species never vary in their specific characteristics and, therefore, have absolute constancy in nature is incorrect. Rather, what generates similarities is the result of a genealogical connection, a set of individuals sharing a common ancestor. However, this genealogical descent is not built from unchanged reproductions, but from *descent with modifications* that continuously create differences among individuals: species constantly vary.[28] The term *species*, then, identifies groups of individuals that resemble each other, but there is no statutory grouping.

The central point for Kupiec is the incessant *flow of life*[29] from which species are arbitrarily extrapolated at an instant "t" in the history of life through criteria of our choice, grouping living beings and giving them a name.[30] The conclusion reached by Kupiec is very interesting because it retains that, even if always considered distinct primary entities, species and individuals are secondary ones extrapolated from the *flow of life* based on the image that we have of ourselves. As stated by Kupiec:

> In biology, it is imagined that the adult individual is the center and purpose of biology itself. When we look at the developing embryo, our idea is that each of the cells does not exist for itself hic et

[28] ibidem p. 157.
[29] For Kupiec, the flow of life is the primary entity of the living, coinciding with the flow of generations composed of genealogical lines. For an in-depth analysis: Kupiec J. (2021) *La concezione anarchica del vivente*. Eleuthera. Milano. p. 214.
[30] Ivi.

> nunc, here and now, but exists in view of a future project, which is the adult, the totality that is ourselves. [...] The theory that I propose, on the other hand, is that cells exist initially for themselves, reacting to their local conditions of existence, here and now. It is through the social relations between cells that an individual is constructed.[31]

That's why Kupiec's anarchic theory of the living breaks with methodological essentialism in conceiving life and refers to it as a *flow of life*, a dynamic emerging from material relationships that makes us clear how we can redefine the entities to refer to in the complexity of *life-in-the-making*. In fact, Kupiec's theory highlights the anthropocentric nature of defining individuals and species, urging us to recognize the arbitrariness of these classifications. However, it also raises the question of how to consider the experience of life and death as always individual and contextualized.

This arbitrariness highlighted by Kupiec in the definition of the entities within the *flow of life*, is not only a limit in interpretative terms, but also in moral and political ones. As demonstrated by the interrogatives arising about xenotransplantation dynamics, the world as framed by those entities defined in technoscience imply simplifications that leave broad areas in shadow. As Latour asserts in *We Have Never Been Modern* (1993), a confusion arises from the complexity of a world where a clear distinction between "natural" and "cultural" entities as defined by sciences is impossible, because, as just seen, they are always arbitrary.[32] Latour, to resolve this confusion generated by a reality inhabited by more and more strident hybrids, precisely proposes placing these entities themself at the center of the frame.[33] Conflicting with the narratives of Western interpretation, hybrids are monsters to science because impossible to be

[31] My translation. Excerpt from an interview for *Il tascabile*. See Cinini G. *La vita non è scritta da nessuna parte.* Il Tascabile. November 11, 2021. https://www.iltascabile.com/scienze/kupiec-concezione-anarchica-vivente/ .
[32] Latour B. (1993). We have never been modern. Harvard University Press Cambridge, Massachusetts.p. 1-3.
[33] Ibidem p. 24-25.

interpreted according to the nature/culture dualism, revealing how none of these labels exists and then, the arbitrariness of every interpretative framework.

Forced to exist, genetically modified and subsequently transplanted, whether it be a lung, a kidney, a heart or a liver, the xenografted organ is effectively a monstrous entity in Latourian terms. Because of this, even though abandoning rhetoric that assesses who deserves to live and who deserves to die, and making us present and responsible for the dynamics of violence and oppression on the animals upon which this practice is based, the difficulty in ethically and politically interpreting this dynamic in its complexity persists. As proposed by Latour, by placing the transplanted organ at the center of our research, we are able to get rid of the limits of the usual narratives surrounding medical and technological practices on the living and look more in depth. In fact, xenotransplantation is not only connected to violence against nonhuman individuals, but also to the modification, redesign and compromise of those physical-semiotic entanglements from which every form of life emerges. The concretization of xenotransplant's narratives and practices not only decides on bodies but organizes and appropriates specific ways of making sympoiesis. Infusing new significance to the concept of organ to shed light on this aspect, however, implies the need to look at it beyond its defined functionality in the organism, observing, instead, how the emergence by and through the symbiotic assemblages characterized this entity within the *flow of life*.

1.3 Living organs

Kupiec asserts that life is a global property, arising from collective interactions; true not only for the simple cell but for any other macroscopic form of life.[34] That of a large mammal, for example, represents the organized, integrated interaction of heart, kidneys, lungs, brain, arteries

[34] Like the non-localization of life, the emergent property of life is an idea that is implicit in Kupiec's work.

and veins. These organs form a network, composed of diverse tissues and specialized organelles. In turn, each tissue and organelle represents a network comprised of various types of cells. In summary, life is inherently tied to physical and is fundamentally an emergent property. This quality doesn't exist in isolation within individual components, but comes into being only when these components are assembled together. Besides, where is life localized in a cell, a plant or a dog? Is there a particular reaction, a specific magical spot, where we can affix a label and say: here is life? In contrast to reductionism, life is a characteristic that cannot be simplified or reduced to its individual parts. This characteristic of every living being is at the base of the most common questions about xenotransplantation: on one hand, the survival of the recipient seems to depend on the notion that organs like the kidney, liver, or heart are essentially mechanical components, thereby justifying their use from animal sources. On the other hand, there exists a fear surrounding this overt hybridization, considering it an "unnatural" act. This leads us to ponder whether implanting a pig's kidney into a human, for example, could imply the creation of something fundamentally distinct from a human. These questions persist in the limitations of reducing individual organs to their assigned functions and portraying the organism as a mere collection of gears. Giving up on this interpretation by taking a sympoietic perspective and looking at the organism as a set of physical and semiotic entanglements, we can overcome this confusion. Indeed, by shifting away from the idea of the organ as a resolved entity tasked with the compliance to a bigger project, what remains is not a casual set of tissues and nerves.

Making reference to the work of the two Chilean biologists Humberto Maturana and Francisco Varela[35] looking at the majority of what we call organs it is possible to recognize not only a *structure*, the physical properties of its components and their actual relationships which allows

[35]Initially conceived in the late 1960s by Maturana, the theory was later developed by his student Varela. For this reason, when referring to this theory, both names are mentioned.

its activity, but also an *organization* of this system. In the theory of Maturana and Varela the presence of this second feature in a system is what defined it as a living one. In fact, while the *structure* can (and must) change continually during the lifetime of an organism, the *organization* is what allows it to change while remaining itself;[36] consequently "when the organization changes, it spells the end of that lifetime."[37] Thus, according to their theory, the key feature defining a living system is its ability to preserve its identity by undergoing *structural* changes through its *organization*. While *structure* is physical or molecular, *organization* is conceptual or logical and crucially self-produced.[38] That's why the term they coined for this theory is *Autopoiesis*, where *auto* means *self*, referring to the autonomy of self-organizing systems and poiesis (which shares the same Greek root as the word *poetry*) means *making.*[39] This doesn't imply that living beings create life by themselves, but rather that we can recognize a living system in its ability to distinguish and maintain its own individuality. As Varela (1992) puts it,

> An autopoietic system is organized (defined as unity) as a network of processes of production (synthesis and destruction) of components such that these components: continuously regenerate and realize the network that produces them, and constitute the system as a distinguishable unity in the domain in which they exist. The autopoietic mechanism will maintain itself as a distinct unity as long as its basic concatenation of processes is kept intact in the face of perturbations and will disappear when confronted with perturbations that go beyond a certain viable range, which depends on the specific system considered.[40]

[36]David Russell & Lloyd Fell. *An introduction to "Maturana's" biology*. Unknown. p. 5
[37] Ibidem p. 6.
[38] Ivi.
[39] Here, the translation provided is that of Capra and Luisi (2014). The term is actually broader and describes the process through which something that was not there can come into existence, the action that leads from non-being to being.
[40] Cit. Varela F. J. (1992) *Autopoiesis and biology of intentionality*. In Mc Mullin B. (ed) Proceedings of the workshop *Autopoiesis and perception*. Dublin City University. p. 2.

For example, looking at the microscopic level, the cell is an autopoietic unit because its main function is to maintain its own individuality despite the myriad chemical transformations taking place in it. This seemingly contradictory relationship between change and constancy is explained by the fact that the cell regenerates from within the components that are consumed. This occurs at the expense of nutrients and energy flowing inside the cell, forming an energetically and materially open system to the environment, but operationally closed.[41] These characteristics which define the cell as an autopoietic entity can be recognized equally in every living being, even if with substantial differences between them, like a tree or an elephant. This distinction sets these living entities apart from other equally complex or emergent systems that we should not consider alive, such as a computer or a mineral.[42]

In the autopoietic theory, the conservation of the identity of each biological unit is central, as opposed to the conservation of a population or the genetic material running through a particular lineage. This differs from the perspectives of population genetics and sociobiology, which have focused on gene pools and species behavior overlooking how the majority of organs could also be recognized as living elements. The vision of Maturana and Varela makes it easier to frame the fact that the majority of living systems are composed of many other living beings, each maintaining its specific individuality. Adopting the harawayan sympoietic approaching this research implies preferring the entanglements and connections through which individual lives (admitted that they can be defined in advance) *become-with*. Otherwise, the reflection of Maturana and Varela is useful for recognizing entities in the flow of life that are not based on an anthropocentric and arbitrary perspective, but rather stem from the specific relationship created between the autopoietic unit and its surroundings. In fact, the way to adapt to its

[41] Capra F, Luisi P (2014). *The system's view of life, a unifying vision*. Cambridge University Press. p.174.
[42] Ibidem p. 171.

surroundings by a defined system establishes a clear difference between a living and nonliving one. In the words of Capra and Luisi (2014),

> If you kick a stone, it will react to the kick according to a linear chain of cause and effect, and its behavior can be calculated by applying the basic laws of Newtonian mechanics. If you kick a dog, the dog will respond with structural changes according to its own nature and nonlinear pattern of organization; the resulting behavior is generally unpredictable.[43]

As it keeps interacting with its environment, a living system undergoes a sequence of structural changes, and over time it forms its own individual pathway, defined by Marurana and Varela as *structural coupling*. Thus, the response of that specific dog would depend both on its *structure*, which determines what it's capable of (barking, running, biting, etc) and simultaneously on its previous interaction with its environment. In other words, its history. Thus, an organism exists only in its connection with its medium and that connection is actually its history of interaction, which will continue as long as the organism can maintain its organization, then it ceases.

Although the autopoietic theory is not fully resolved in this description, what mentioned until now already offers an alternative way to frame organs, beyond its functionality defined by biology. Symbiotically looking at human and non-human subjects as emergent phenomena of collective action and interaction, the organ surface as a living entity participating in *life-in-the-making*. A new entity capable of imprint an entire new meaning to the practice of xenotransplantation. For example, thinking at the recent milestone achieved by the practice in

[43] Capra F, Luisi P (2014). *The system's view of life, a unifying vision*. Cambridge University Press p. 176.

the case of David Bennet Sr where the heart of a genetically modified pig kept him alive for two months following the operation, let's reconsider the cardiac organ as just discussed.

As well known, the heart holds significant cultural importance in Western societies, stemming from its symbolic ties to emotions, particularly love. Rooted in religious, artistic, and linguistic expressions, the heart has become an iconic representation of human affection and spiritual depth. Its role as a central cultural emblem is a far cry from the functional reading provided by biology, but that is not what we refer to when defining it a living being. Rather, it involves recognizing how the cardiac organ, despite having characteristics assimilable to other living entities, is not considered as such based on the perspectives of modern biology and medicine. This, as stated by Kupiec, is due in part to the arbitrary process of identifying and recognizing individuals within the *flow of life*. Instead, according to the theory of Maturana and Varela the heart can be classified among the living entities. Quoting Capra and Luisi (2014):

> Life is a factory that makes itself from within. Thus, an organ like the heart can be seen as an autopoietic system, as it is capable of self-sustainment through a series of processes that regenerate all components within its own boundary. On the other hand, this complex autopoietic system is composed of smaller autopoietic units, down to the single cells of various kinds, and the entire human being can also be seen as an autopoietic system.[44]

Moreover as in every other autopoietic entity also in the heart life occurs within an operationally closed system, meaning it is not defined by its surroundings but interacts with what is around, creating its own environment through the need to sustain and reproduce itself. So, we realize that the cardiac organ aligns entirely with the fundamental characteristics that autopoiesis

[44] Capra F, Luisi P (2014). *The system's view of life, a unifying vision*. Cambridge University Press p.273.

establishes in defining a system as living. Otherwise, the intention of these statements is not to spark a debate about the idea of a living organ as an epistemic truth or a scientifically rigorous concept. Instead, the goal is to apply a sympoietic perspective to xenotransplantation, acknowledging the transplanted organ as a catalyst for new reflections in the social and political discourse surrounding it. However, it is important to recognize that adopting this approach as defined thus far is not simply a flight of fancy.

Returning to the example of the transplanted heart in the case under consideration, it is possible to address some of the numerous criticisms that could be raised against the assertion of a living heart.[45] For example, highly specialized tissue-defined structure and the lack of autonomous growth are characteristics that should not be considered in evaluating the feasibility of the claim. As we have seen in Kupiec's anarchic interpretation, every entity is *in-the-making* and focusing on the specialized functionality of an organ is a perspective merely dictated by an anthropocentric and arbitrary perception. One might argue that the heart, like any organ, depends on the organism for its existence. However, as seen in *sympoietic* and autopoietic theory most living systems *become-with* other living entities, autopoietic subunits which, although dependent, maintain their own individuality. The same can be said for the cells that make up the human body, for instance. This assertion also stems from the inability to extend the concept of ecology even within organisms, where similarly there is a balance and exchange of nutrients and resources among their composing entities. In this sense stating that the heart cannot live outside the organism would be like claiming that coral cannot live outside water. The absence of reproductive capacity in the heart can also be dismissed, the perspective we are applying to the organ focuses on how life emerges through and with the heart, not if it has the

[45] The functioning and structure of cardiac organs can vary significantly among different species. Given the impossibility of analyzing individual cases, the discussion is limited to the species considered in the practice of xenotransplantation, which is the focus of this text.

potential to perpetuate life in the next generation. The most critical point is undoubtedly the lack of an autonomous response to external stimuli. This idea is based on the notion that the heart, like the entire body, is entirely dependent on the autonomous nervous system that acts to maintain the internal environment. Despite its veracity, this view is interestingly challenged within the medical field itself. For example, cardiologists Arden and Armour conducted studies on the link between neurological and cardiac diseases, demonstrating that the heart's nervous system functions as a processing center, not only in concert with the brain but also independently of it. This specific field of study, known as neurocardiology, affirms that "the heart possesses its own little brain, capable of complex computational analysis on its own*"* to maintain its own balance and respond to occurrences in the environment.[46]

1.4 Ends and means in life

Framing the organ as a living entity, as discussed in the preceding pages, and symbiotically present within the dynamics of xenotransplantation is not intended to romanticize bodies or fall into sterile forms of new materialism. Rather, what motivates us to explore this concept is its potential to reveal "stories (and theories) that are just big enough to gather up the complexities and keep the edges open and greedy for surprising new and old connections."[47] In this context, reflecting on a living organ within the practices and knowledge surrounding xenotransplantation implies a departure from the mechanistic worldview. Unlike how

[46] In addition to what has already been stated, some studies on neurocardiology demonstrated that taking simultaneously an electrocardiogram and an electroencephalogram during the arising of an emotion in a subject seems to start in the heart and not in the brain. The development of these studies could decide upon the fact that the human capacity of emotional response depends on an autonomous cardiac capacity of feeling. For a more in-depth analysis: Candia-Rivera D & Catrambone V, Thayer JF, Gentili C, Valenza G (2022). Cardiac sympathetic-vagal activity initiates a functional brain-body response to endothelial arousal. National Academy of Sciences (USA).

[47] Cit. Haraway D (2016). *Staying with the trouble. Making Kin in the Chthulucene.* Duke University Press, Durham and London. p.101.

technological and medical sciences typically conceptualize and approach organ modification and transplantation as mechanical procedures, viewing organs as living presences acknowledges their profound implications for how life emerges and takes shape; how individuals experience it or even lack the capacity to do so. Embracing the perspective of organs as living presences does not entail simply adding more nonhuman entities to consider alongside the deceased in biotechnological practices; as Federica Timeto (2020) reminds us,

> Counting nonhumans is, all in all, an easy operation. Enumeration ensures a common plane of coexistence, allowing us to imagine a foundation underlying nominal groupings. [...] Making them matter is much more complicated: mattering always takes place within connections that demand and make possible a response, not just a mere calculation or classification. Allowing animals to respond, therefore, rather than giving them (our) voice.[48]

Placing the living organ at the core of this alternative interpretation aims to align with this intention and infuse new significance into the typically considered exploited individualities in xenografting. Primarily, this perspective positions itself as anti-speciesist, as it prompts us to reflect beyond the human/animal dichotomy. The organ, as presented thus far, actively engages in symbiotic relationships, revealing itself not only as necessary for its mechanical function within the organism, but also as an active element within the ecology through which lives take shape uniquely and specifically. This viewpoint expands the focus beyond the identification of the "animality" imposed on nonhumans on which is based their exploitation in xenotransplants realization. Developing the idea of an organ that must be alive to be transplanted shifts attention to a more intimate plane than species identity: the construction and definition of one's own self.

[48] My translation from Timeto F. M. (2020). *Bestiario Haraway. Per un femminismo multispecie.* Mimesis, Italia. p. 23.

There are numerous accounts of people directly or indirectly affected by xenografting practices, recounting the process of reconstructing and reconsidering their own identity following the operation. A process much more political than the avoidance of possible chemical rejections. A transplanted pulsating heart, whether it be a liver, kidney or lung, is not merely an insignificant presence; rather, it serves as evidence of a living "donor" with its own history and way of living. This implies the awareness that it is not just "an" animal, an individual of a species, that dies, but a specific and situated individuality. At the same time, this resignification of the organism, no longer passive to the experience of life and to self-identification, also allows us to reflect on the myriad forms of activities aimed at regenerating and maintaining life itself. Activities typically overlooked in acknowledging the ways in which humans and other-than-humans are interwoven in forming politically charged realities.

Before delving into these reflections that our perspective casts on the dynamics of xenotransplantation, it is essential to consider another aspect that the notion of the organ as a living presence allows us to focus on. In fact, if xenotransplantation is proposed as a salvation for a large number of (human) lives, we must make *matter* "who can be born and who is forced to, who dies and who is killed, who survives and who disappears"[49] in the concretization of this practice. Making these individualities *matter*, as defined in the aims of this research, does not mean approaching their exploitation with a demographic perspective that reduces them to a population, but rather highlighting their always individual and situated experience. To achieve this goal and bring alternative elements to the debate on this topic, it is useful to position our focus where xenotransplantation operates and reasons: the transplanted organ. Every individual and specific organ in the dynamic of xenotransplantation is imbued with a speciesist vision, designed, modified and utilized within this framework with significant and concrete

[49] Cit. Ivi.

consequences on the life experience of the animals forcedly involved in this dynamic. However, placing the organ at the center of the frame not as a mere component but as a living entity within a nonhuman organism, allows us to understand that in the dynamics of xenotransplantation there is not only the exploitation of animal individualities, but also a further step, namely, the humanization of nonhumans. If life is sympoietic rather than individual, then examining the living organ means recognizing how biotechnological and medical practices in this context operate on the physical and semiotic entanglements, modifying and redirecting them for purposes that are solely anthropocentric. To understand this dynamic, this research will not only reframe the transplanted organ by limiting itself to the narratives, practices or knowledge that develop around it, but will consider its concrete presence first and foremost. Indeed, it is through the organ's physical structure and semiotic significance that solutions and problems of xenotransplantation are implied. Moreover, it is through its situated presence that we can relate human and nonhuman entities before, after and during the transplant operation, each time in a new and different way.

The transplanted organ transcends mere narrative; its properties and unique characteristics shape studies, projects and research practices across various fields, technologies and biotechnologies, influencing every individual experience related to these dynamics. All these converging elements make the transplanted organ the perfect entity to simultaneously understand the anthropocentric gaze imposed on nonhumans and the consequences on them that go beyond death, imposing purposes and meanings that are always and invariably alien to them. In conclusion, in the following pages, through the framework taken into account to look at the living and placing the organ at the core of the analysis, we will analyze how in xenotransplantation the reravelings of the idea of organism is also the unraveling of animal phenomenological experience, how the estimation of the organ is also the devaluation of animal

individualities. In this practice the disruption of existing symbiotic assemblages signifies the creation of new connections and opportunities for others to remain alive. The question is at what and at whom expense and, then, on what ground we ought to prioritize advocating for some form of shared life and no others.

Considering the organ as an unexpected living entity against the common idea of organism does not mean giving voice to this presence through an invented subjectivity. The challenge is precisely to make it *matter*, avoiding an imperialistic and orientalist approach to what is other-than-human, thinking that it should be represented because it is incapable of doing so itself. At the same time, it would be wrong to think that we can overcome or erase ontological differences between human and nonhuman entities. This concept is aptly illustrated by Radhika Govindrjan in her multispecies ethnography research in India's Central Himalayas. There, she explores the creation of physical and meaningful relations between animals and humans, focusing on situated relationships between *those* nonhumans and *those* humans. Govindrajan reminds us that any multispecies relationship must be viewed as constituting a partial connection between beings who enter into their relations as unpredictable, unknowable, and unequal. In her words,

> The elision of the difference between diverse beings, even if motivated by a desire to challenge human exceptionalism and the untenable boundary between nature and culture, often ends up reinforcing the domination of the human by drawing the other-than-human into the ambit of human experience while creating a false veneer of equality. Given these dangers, it is important for us to remember that the other-than-human, as Stuart McLean (2016)[50] puts it, remains an

[50] McLean, S. (2016). *Nature. Theorizing the contemporary*. Cultural Anthropology website, January 21. https:// culanth .org /fieldsights /789 - nature.

'intimate stranger,' a 'force that can never be exhaustively encompassed by human intentionalities and understandings.[51]

With these considerations in mind, the challenge of examining the organ in the dynamics of xenotransplantation without reverting to traditional scientific interpretations becomes even more daunting. This is especially true if we have emphasized the importance of not solely relying on narratives surrounding the organ but also considering its situated presence. After all, even though we have defined it as living, what new insights could it provide us by examining its physical structure, which has nevertheless remained unchanged?

The American anthropologist Eduardo Kohn poses himself a similar problem in his *How Forests Think (2013)*, to which he responds with a mode of looking at nonhumans that we have not thoroughly considered until now. Fundamentally, Kohn asserts that nonhuman living entities have ontologically unique properties associated with their constitutively semiotic nature, which are, to a certain extent, knowable to us. As partly emerged in the autopoietic theory presented earlier, even the simplest living beings differ markedly from objects or artifacts as they possess their own logic; or in Kohn's words, their semiotic meaning. According to Kohn, the frequent error of social sciences expanding to consider the nonhumans is to interpret them according to a form of reductionism that leaves concepts like agency and representation unexamined. This leads to a form of dualism in which humans and nonhumans acquire mixtures of thinglike and humanlike properties.[52] Instead, all living beings, being such, express forms of agencies that do not depend on our interpretation. In considering the nonhuman, to Kohn,

[51] Govindrajan R (2018). *Animal intimacies, interspecies relatedness in India's central Himalayas.* University of Chicago press. p. 25.
[52] Kohn E. (2013). *How forests think: toward anthropology beyond human*. University of California Press p.91.

> telos, representation, intentionality, and selfhood still need to be accounted for and because the way such processes emerge and operate beyond the human is not theorized, Latourian science studies are forced to fall back on humanlike forms of representation and intentionality as operative in the world beyond the human. These are then applied, if only metaphorically, to entities otherwise understood only in their secondness. This approach to nonhuman agency overlooks the fact that some nonhumans, namely, those that are alive, are selves. As selves, they are not just represented, but they also represent. And they can do so without having to 'speak.' Nor do they need a 'spokesperson'[53] because representation exceeds the symbolic, and it therefore exceeds human speech.[54]

Thus, in Kohn's perspective, just as humans portray nonhuman beings in various culturally, historically, and linguistically distinct ways, influencing our connections with them, it is equally crucial to recognize that these beings represent us, holding profound significance. Eduardo Kohn emphasizes that the world beyond humans isn't devoid of meaning until we attribute meaning to it because the interpretation of the world is not exclusive to us. Instead, we should perceive other species as active participants in creating meaningful worlds. This perspective, also central to Govindrajan's research, implies that nonhumans actively craft narratives about the world they inhabit and their relationship with it.[55]

Eduardo Kohn's proposition to interpret nonhuman perspectives is intricately tied to the notion within the Runa population that every living being holds a unique perception of the world. Expanding on this idea through a comprehensive four-year field study in the indigenous

[53] Referred to: Latour B. (2004) *How to Talk About the Body? TheNormative Dimension of Science Studies*. in Body & Society. SAGE Publications. London, Thousand Oaks and New Delhi. p. 62-70.
[54] Kohn E. (2013). *How forests think: toward anthropology beyond human*. University of California Press p. 92.
[55] Ibidem p. 20.

Amazon of Ecuador, Kohn integrates the local concept of a "thinking" forest with the semiotic theories of Peirce. This synthesis forms the foundation of his approach, premised on the belief that life is inherently semiotic, implying that semiotic aspects can be applied to all biological processes. To explain this theory, Kohn takes the example of the giant anteater, which has the ability to feed on ants thanks to its specific tongue and snouts that can capture certain features of the environment. The physical structure of this animal unmistakably reveals a bodily interpretation of its surroundings, even in the absence of consciousness, as part of the evolutionary adaptation that shaped the meaning expressed by its body signs. From a semiotic point of view, the increasing accuracy that the giant anteater has come to represent about its surroundings implies two important consequences: the sign, to be something that stands for something else, must be related to a somebody; that's why we can identify a self in the giant anteater.[56] The second consequence is that this self becomes through a dialog with the environment that occurs in the development of a lineage over time: the giant anteater selectively *remembers* its own form and *forgets* the ones of the ancestor that didn't fit appropriately with the surroundings.[57] As Kohn explains, in this semiotic idea, what differentiates a living being from a snowflake, for instance, is that even if both are defined by the interaction with the environment, only the first one has a lineage that selectively remembers its previous fits in the world. Looking closely, Kohn's interpretation is highly relatable to the theory of autopoiesis and allows us to understand deeply what it means to have a conception of the environment in nonhuman or even consciousness-lacking entities. As Kohn writes, “although semiosis is embodied, it always involves something more than bodies; something absent: a semiotically mediated future environment. A guess that is expressed through the body of what the future

[56] Ibidem p. 75.
[57] Ibidem p. 76.

will hold."[58] A living sign is an expectation of regularity, something that has not yet come to exist but will likely come to be. They are the products of an expectation, of a highly embodied *guess* at what the future will hold. The same dynamic is organized and implemented in xenotransplantation. To ensure that the organ of the animal "donor" can continue to live in the recipient's body through surgical, genetic, and pharmacological practices, an attempt is made to ensure that the environment that the organ has envisioned in its structure continues to exist. Although the biomedical assertion is that "the body accepts the organ,"[59] it is rather the *embodied guess* that defines the need for an environment capable of sustaining that life.

Life forms, whether human or nonhuman, because they are intrinsically semiotic, exhibit what Peirce calls a *scientific intelligence*. By *scientific*, he does not mean an intelligence that is human, conscious, or even rational but simply capable of learning by experience. This is another way of saying that selves think. Such thinking need not happen within the life of a single skin-bound organism because biological lineages also think: they too, over the generations, can grow to learn by experience about the world around them, and as such, demonstrate a *scientific intelligence*. If selves are thoughts and the logic through which they interact is semiotic, then relation is representation. This concept aligns with the famous Jakob von Uexküll's idea of *Umwelt,*[60]illustrating that each organism has a unique perceptual world. Taking the example of a tick, von Uexküll would emphasize that its *Umwelt* is limited to sensations of warmth, smell, and touch on the skin of a host animal. This highlights how organisms, like ticks, navigate their environments with specific sensory perspectives, shaping their subjective experiences and interactions.[61] Ticks do not distinguish among many kinds of mammals; in their structural

[58] Ivi.

[59] Medical jargon referring to the absence of cases of rejection or other complications following the grafting of the transplanted organ.

[60] Usually translated as *Lifeworld,* in the work of von Uexküll refers to the subjective and unique perceptual world experienced by an organism.

[61] Ginn F. (2014). *Jakob von Uexküll, Beyond Bubbles: On Umwelt and Biophilosophy*. Science as Culture, 23:1. p. 132.

perception of the world, they are capable of confusion. Even if it is also a limitation, this confusion is fundamental for its survival because it is through this kind of *forgetting* of the totality of reality that it is capable of noticing differences. In conclusion, selves, not things, qualify as agents. Selves are the product of a specific relational dynamic that involves absence, future, and growth, as well as the ability for confusion.

In the majority of cases these fundamental characteristics are not recognized to the nonhumans and more-than-humans by those scientific knowledge tools typically used, which consider *life in itself.* The consequence of this reduction that technoscience applies to the living is that the world becomes disenchanted, in the sense of literally meaningless. Ends become displaced to a human realm that becomes ever smaller and more detached from the mundane world as this vision of science expands to encompass more domains.[62] This results in modern forms of knowledge and ways of manipulating the nonhuman world characterized by a mechanistic view. As already highlighted with the geneticist approach to life, the failure to recognize ends means the potential objectification of the living. Selves are transformed into machines, and therefore means to achieve ends that are, by definition and design, external to them. The perspective that technoscientific society imposes on the living transforms it into a machine, bracketing out the ends that are intrinsic to its being, seizing the opportunity of interpreting and defining its purpose. A dynamic of which xenotransplantation undoubtedly represents one of the ultimate expressions. What is obscured in technoscientific narratives and practices is that ends are not located somewhere outside the world but constantly flourish in it. They are intrinsic to the realm of life. Living beings *guess* at and thus create futures to which they shape themselves. Unlike machines, living beings emerge complex instead of being built from parts by someone bracketed out of the picture. The world, the living Earth, is always making itself, and we are

[62] For a more in-depth analysis: Kohn E. (2013). *How forests think: toward anthropology beyond human*. University of California Press p.89-92.

part of that process, both made by the world and part of its continuous making. In short, we are participants in its ongoing story. Life is a process of becoming, and therefore, at the foundation of the following pages, we must keep clear and emphasize what it means to be alive based on what has been discussed so far, for whoever that *who* we are considering. Being alive means *becoming-with* in multispecies relationalities and still having one's own desires, one's own memories, goals, and sentience. Ultimately, through the words of Bird-Rose (2011) "we can say that life has desires, and we can talk about what these desires are: life desires complexity, life wants to join, create, experiment, do more."[63]

Reflecting on xenotransplantation with *response-ability* means rejecting the calculation of lives worth living and biopolitical frameworks that focus on beings already confined in hostile worlds.[64] Instead, it is crucial to look at individual animal experiences, focusing on those aspects that we have recognized as characterizing a real and, above all, meaningful life.

What needs to *matter* then is not only the consequences of xenografting on other animals, but also the forms of violence and exploitation inherent in which the practice of xenotransplantation arises. As for example Govindrajan emphasizes, the challenge that confronts critical feminist kinship studies is not just to highlight the multispecies relationship through which reality comes to life, but also to expose and undermine the circuits of race, gender, and species difference and violence within which it takes shape. As the ecological and multispecies ethnographer Deborah Bird-Rose remind us in her text *Wild Dog Dreaming* (2011), interests are mutual, and while they are not indistinguishable, "they are situated within the larger dance of life which involves life and death, self and other, us and them."[65] Against such a system of entangled interests and

[63] Cit. Bird Rose D. (2011). *Wild Dog Dreaming. Love and extinction.* University of Virginia press. p. 49.
[64] Murphy M. *Against population, towards alterlife*. In Clarke E, Haraway D, (2018). *Making kin not population*. Prickly paradigm press, Chicago. p. 122.
[65] Cit. Bird Rose D. (2011). *Wild Dog Dreaming. Love and extinction.* University of Virginia press. p. 27.

accountability, we can juxtapose indifference as one of the many terrible consequences of thinking that there is a solid boundary between animals and humans. That's why putting the transplanted organ at the center of the frame must not be an excuse to put the human somewhere else, doing something else when it comes to killing and using nonhuman animals. The "culling" and "management" of herds, the "euthanization" of laboratory animals are all practices that xenotransplantation perpetuates and especially through which perpetuates itself.[66]

That's why we are going to develop our research precisely from where and how the organ is brought to life. The genetically modified and subsequently transplanted organ takes shape inside a mechanistic view of the living that materializes on bodies through biotechnological practices and valorizes them according to market laws. Making the transplanted organ *matter* in observing what would seem to be exclusively a medical practice has much to say about how connected it actually is with the industrial production and consumption of nonhuman living beings. Artificial insemination on a massive scale, more and more audacious manipulations of the genome, the reduction of the animal to production and overactive reproduction (hormones, genetic crossbreeding, cloning, and so on) for consumption are all entangled in the promise, contained in xenotransplantation, of human well-being. Connections that, for the most part, are hard to make between biomedical practices and the industrialized manufacture of corpses. Species, ecosystems, habitats, relationships and connections that sustain the web of life on Earth become "collateral casualties" in the rush for consumption. Then, if the initial question was about what life is at stake when we talk about xenotransplantation, it is fundamental that these lives (and deaths) also take space, be connected to medical practices and become visible in these processes. In conclusion, developing the insight that the organ is alive is also relevant because it is at the heart of the apparently insoluble distance between human and nonhuman. Therefore,

[66] Ivi.

in the next pages, we will leverage its unusual perspective to try to answer the questions Bird Rose invites us to consider: “How shall we see the eyes, the relationships, the companionship, the connections, the crossovers that connect their deaths with our lives? How shall we engage our imagination so as to reach into these death places?”[67]

[67] Cit. Ibidem. p. 28.

2. How to functionalize a pig

Searching on YouTube, it's not difficult to see extracts of real xenotransplantation surgeries. In all cases the harvested organ is pulled out by the nurse from inside an isothermal box, appearing in good shape and substantially like a human one. In the operating theater, surrounded by surgeons, lies the human recipient on whom the transplanted entity will be connected to the veins and the nervous system before being revitalized through electric stimulation. Throughout the entire procedure, the presence of the animal "donor" remains invisible. As inside the operating room, the absence of nonhuman life occurs in the complex interrelation of industrial, biotechnological, medical narratives and practices that shaped the formation of every single organ, both in thought and concrete reality. Making *matters* the animal individualities that in xenotransplantation live and die means looking at the connections that precede the sterilized room and the operating table; especially where this practice leaves a shadowy area.

Every living entity, as we have defined it, emerges always in relation to a set of physical, semiotic and social relationships; in this case, this holds true simultaneously for the organ to be transplanted as well as for the animal individual to which it belongs. Moreover, talking of living individualities, whatever they may be, means talking of specific moments in time and space, in situated relations of powers and bodies. The most recent and discussed cases of xenotransplantation surgeries, including the already mentioned David Bennett Sr. case, were

all performed by the University of Maryland School of Medicine[68] through the xenografted organs supplied by Revivicor. This company is a specific division of the United Therapeutics Corporation, one of the biggest and most avant-garde in the development of biotechnology components for medical needs. Revivicor is specialized in farming and cloning genetically modified pigs designed for research and development in the field of xenotransplantation. That's why to recognize what kind of nonhuman lives are lived and created in the dynamic of xenotransplantation we have to look at the industrial, political and medical intentions overlapping in the plants of Revivicor. The intent is not to focus on this reality to develop a critique of specific actors or practices; rather, it is to analyze one of the many hotspots of hostility in a world where any living being can escape entanglements with capitalist, speciesist or racist forms of violence.[69] For this reason, to make these lives matter, we firstly have the duty to highlight the speciesism that xenotransplantation perpetuates and is based on, putting under analysis especially where this dynamic takes shape on and through animal bodies. Weitzenfeld (2014) addresses speciesism as,

> an ideology that naturalizes and rationalizes the present unequal political-economic relationships based upon competition and exploitation of animal others that are upheld by the state. Speciesism, accordingly, is not the source but the symptom of oppression that lies in hierarchical material relationships whereby power and capital-fiscal, social, cultural and spiritual are accumulated through the exploitation of animals. Speciesism is not mere prejudice but a composite of interspecies injustices within material institutions, discursive regimes and embodied affects. Speciesism is a complex of material institutions that systematically, non-criminally sacrifice the

[68] In 2022-2023 alone, under the guidance of Professor Muhammad M. Mohiuddin, considered one of the world's foremost experts on xenotransplantation, the University of Maryland has performed the first three transplants in medical history from pigs to living human patients, with surprising results.

[69] Murphy M. *Against population, towards alterlife*. In Clarke E, Haraway D. J. (2018). *Making kin not population*. Prickly paradigm press, Chicago, p.121.

> lives and interests of animals as well as cultural discourses and narratives, speech and stories that circulate misrepresentations of animal others as inferiors and proper objects of sacrifice.[70]

The material and discursive relations transmitted through human and animal bodies co-create this reality and the employment of nonhuman animals in medical and pharmacological intentions is a central point of it. This especially emerges in the new roles that non human species obtained under the threat of infectious disease in the wake of the late nineteenth-century. As carefully analyzed by the historian of science Robert Kirk (2017), in this period the laboratory became the new biopolitical space in which biomedical sciences and the pharmaceutical industry defined their authority and legitimacy as protectors of global health until the contemporary era.[71] It is at this moment that the *laboratory animal* was "invented" as a specific form of life created for, within and by scientific medicine. A life that could be killed without consequence because existing within a space of indistinction between the categories of human and nonhuman. A living organism that finds its end in "being simultaneously similar enough to humans so as to suffer in their stead yet different enough for humanity to allow them to do so."[72]

In the laboratory, animal life undergoes a transformation in significance that transcends mere selection and breeding of specific species for experimentation. Typically viewed as holistic entities with individuality and personality, animals become what sociologist of science Michael Lynch terms *analytical animals* in this setting.[73] They are reduced to abstracted versions of their

[70] Cit. Weitzenfeld A, Weitzenfeld M. *An overview of anthropocentrism, humanism and speciesism*. In Nocella A J, Sorenson J, Socha K, and Matsuoka A (2014). *Defining critical animal studies. An intersectional social justice approach for liberation, defining critical animal studies*. Peter Lang Publishing, Inc. (New York). p. 20.

[71] Kirk R. G. W. *The Birth of the Laboratory Animal: Biopolitics, Animal Experimentation, and Animal Wellbeing*. In Chrulew M, Wadiwel D. J. (2017). *Foucault and Animals*. Brill, Leiden and Boston. p. 195.

[72] Ibidem p. 199.

[73] Lynch, M. E. (1988). *Sacrifice and the Transformation of the Animal Body into a Scientific Object: Laboratory Culture and Ritual Practice in the Neurosciences*. Social Studies of Science, 18(2) p. 269.

natural selves, repositories of data and mathematical knowledge that go beyond their immediate material presence. Lynch identifies the pivotal moment of this transformation in the "sacrifice" of animals, a term denoting not their destruction for scientific or medical progress, but rather the ritualistic process through which their bodies and interpretive significance are transformed into vessels of generalized knowledge.[74] In the practice of xenografting this knowledge materializes itself symbolically and physically in the transplantable organ, an entity that defines the animals inserted in this practice as always and necessarily marked for death.

With the understanding that xenotransplantation is proposed as a means of defending and maintaining life, we aim to further develop our research in the following pages to explore the type of life it pertains to and, consequently, the existence it shapes for the animal individuals involved in this practice. The posed question is not whether the perspectives of life reserved for the pigs raised and genetically modified in xenotransplantation are “human,” but rather what idea of life this practice proposes and at whose expense. Previously questioning the mechanistic and functional idea of the living organism, we have already focused on what kind of life biotechnological and medical practice refers to and which forms of life and experiences connected to these are overlooked. Among them, the transplantable organ, a central entity in the interweaving of the dynamics to which the possibility of such medical operation is connected. A centrality that is fundamental to be developed in order to reach with response-ability those animal individualities entangled in xenotransplantation, but first to understand how technoscience frames these lives to permit their death.

[74] Ibidem p. 274-280.

2.1 Producing organs™

Although in public debates about xenotransplantation there is a greater emphasis on the shocking breaking of the division between human and nonhuman bodies, in medical research, biotechnological programming as well as in industrial production, everything revolves around the (making of) transplantable organ. As clearly expressed by the United Therapeutics Company statement, the focus of its research is to expand the availability of transplantable organs through the creation of standardized products.[75] Even though the research is still far from replacing allografts in all cases, there are two products already available: the UKidney™ and the UHeart™.[76] Still in a development stage and not saleable in any jurisdiction, the explicit intent is to make them available on the market as soon as possible.

Any organ as a patented product is profoundly interesting because it is the definitive incarnation of the consequence of reducing the living organism to *life itself* in the neoliberal era. The organ™ is a *modest witness*[77] to the technoscientific events that embody it, especially the "employment" of nonhuman lives in its creation. What this viewpoint makes clear is how nonhuman individual experiences are not considered in any of the phases and relations that make up the possibility of xenografting. As Timeto emphasizes,

> if the slaughterhouse disassembles the animal into the cultural object "meat," the laboratory into the cultural object "data," a process that takes place even before in the phase of selection and

[75] United therapeutics in September 2023 published an official document on its website highlighting the recent milestones in xenotransplantation and the future attempts. For a more in-depth analysis: https://ir.unither.com/press-releases/2023/09-22-2023-191510052

[76] Actually United Therapeutics is working also on the UTHYMOKIDNEY™ project: a xenokidney from a pig with a single genetic edit, together with tissue from the same pig's thymus. The use of the pig's thymus tissue is intended to condition the recipient human's immune system to "recognize" the kidney and reduce the likelihood of rejection.

[77] Haraway proposes the idea of the modest witness as opposed to the notion of neutral and universal knowledge. The modest witness is an entity that disseminates and generates knowledge starting from its own physical and social positioning, which is always and necessarily partial. For a more in-depth analysis: Haraway D. J. (1996) *Modest_witness@Second_Millenium. FemaleMan_Meets_OncoMouse*. Routledge. New York, London. p. 1-3.

breeding, which continues beyond the laboratory itself through the circulation and use of the obtained data.[78]

In the dynamics of xenotransplantation, these two forms of animal dismemberment overlap in the creation of the cultural object "organ." With these assumptions, it would be reductive to develop research by merely enumerating the nonhuman lives that die on this practice and even less to consider the idea of an animal "sacrifice" necessary for a greater good. Rather, it is necessary to start precisely from the awareness that the nonhuman individual experience has no place amidst the entanglements of "nature," technology and politics that form the organ™.

The development of research and practices around the organ as a standardized and reproducible entity is not dictated solely by surgical or biotechnological needs. Focusing on the mechanical component "organ," while omitting the living being that it composes, is also a will to redefine the animal as a subordinate entity to humans.

In this respect, xenotransplantation is a tool of that biopolitical regime that Hailey Singer (2017) defines as *pharmaco-carnism*. Here, *pharmaco* stands for the transformation of social behaviors or bodily conditions into ailments that require pharmaceutical treatment or enhancement, in other words the bio-molecular surveillance and control of the bodies. While *carnism* defines the psychological framework and defense mechanism, theorized by social psychologist Melanie Joy,[79] which "individuals use to deny, justify and rationalize industries, habits of thought and practices that turn animals into objects who experience life as a form of grinding pain up until the point of death."[80] The consequence is that of maintaining by rendering invisible extensive forms of physical violence against animals. For this reason, if transplantation is a well-

[78] My translation from Timeto F. (2020). *Bestiario Haraway. Per un femminismo multispecie*. Mimesis, Italia. p.94.
[79] For a more in-depth analysis: Melanie J. (2010). *Why We Love Dogs, Eat Pigs and Wear Cows: An Introduction to Carnism*. San Francisco: Conari Press.
[80] Singer H. (2017). *The pharmaco-carnist regime: some notes on an era*. The lifted brow. p. 2.

established and generally accepted practice opposed to the recent surge in using animal components, this is still an automatic extension of a trend inherent in the imposition of medical-pharmaceutical sciences. In xenotransplantation the symbolic and physical harvesting of organs from animals it's a significant part of the ritual reiterations that produce certain species as raw materials for human use, with their bodies bound and penetrated by exchange value.

This institutionalized violence is not only a form of constant redefinition of the biopolitical order but, as in carnism, a way of not making animal life present in the concretization of xenotransplantation. Just as the cultural creation of the concept of "meat" makes the death of animal life absent, the same applies to deferring every aspect on which xenotransplantation is based to the "organ" object, becoming an *absent referent* as well. As Carol J. Adams (2010) explains, the idea of "meat," and thus that of "organ," precedes and enables the death of animals, which are transformed into dead bodies before even concretizing it: "the *absent referent* permits us to forget about the animal as an independent entity; it also enables us to resist efforts to make animals present."[81] This is possible, as we have seen, also because the concept of "organ" refers to a mechanistic view of reality that culturally allows us in a transplanted heart or liver to not conjure dead dismembered animals, but only a physical function. Based on this belief, the concretization of xenografting is designed from laboratory to farm and up to the operating theater. To summarize, xenotransplantation emerges as a "bio-techno-eco-political arrangement"[82] that arises from the material overlap of animal agriculture and the pharmaceutical industry with the consequence of inserting the death-marked bodies of animals in the market as indispensable requirements for human health.

[81] Cit. Adams C. J. (2010). *The sexual politics of meat, a feminist vegetarian critical theory*. Continuum, London and New York. p. 66.

[82] Cit. Singer H. (2017). *The pharmaco-carnist regime: some notes on an era*. The lifted brow. p. 2.

By placing the organ™ at the center of the perspective, it allows us to focus on what has been said so far, but considering it within the *sympoietic* perspective we have decided to adopt, further expand our horizons. Having previously defined life as an always emerging, interdependent, and symbiotic event among living and non-living entities, we have thus recognized how, in this perspective, an organ can be considered an alive component of a life because it forms and defines itself in a specific manner with its environment. From this, a sympoietic vision of the organism emerges that imposes us a reflection: while on one hand, xenotransplantation foresees and necessitates the death of the nonhuman individuality, on the other hand, the organ™ is always necessarily produced by and co-producer of an animal life. Although this consideration may seem implicit, it is exactly the omission of this aspect that allows xenotransplantation. In the latter, animal life becomes an object to be ordered, ranked, aggregated and molded to economic and political ends thanks to its reduction to the anonymous facticity of bare life[83], a life reduced to mere biological persistence.

Under the gaze of contemporary technoscience, the animal organism becomes only a laboring system, "structured by a hierarchical division of labor and an energetic system fueled by sugars and obeying the laws of thermodynamics. For us, the living world has become a command, control, communication, intelligence system (C'I in military terms) in an environment that demands strategies of flexible accumulation."[84] However, there is no "mere biological persistence" that does not imply a set of physical and semiotic relations and indeed express forms of agency and will. Therefore, although marked by death, it is crucial to investigate how,

[83] Concept introduced by Giorgio Agamben signifying life that has been exposed to what he terms the structure of exception that constitutes contemporary biopower. Bare life refers then to a conception of life in which the sheer biological fact of life is given priority over the way a life is lived, by which Agamben means its possibilities and potentialities. For a more in-depth analysis: Agamben G. (1998). *Homo Sacer: sovereign power and bare life*. Stanford University Press.

[84] Cit Haraway D. J. (1996) *Modest_witness@Second_Millenium. FemaleMan_Meets_OncoMouse*. Routledge. New York, London. p. 97.

and at which expense, in xenotransplantation animal lives are symbolically and concretely inserted into the serial production of organs.

2.2 Clones, hybrids and cyborgs

On the official website of Revivicor, on the "history" page, a red timeline connects a series of foundational events of the company.[85] The first step dates back to 1996, when the company collaborated with the Roslin Institute "to establish the world's first cloned mammal," alongside the black and white photo of Dolly. The famous Scottish sheep, due to her assisted creation from technologically altered cells, has always symbolized the viability of an entirely new form of existence, which redefined the limits of biology. Despite that, as Sarah Franklin argues in her research "Dolly Mixtures" (2007),

> Dolly is an animal whose making belongs to a long tradition of innovation in the management of life itself as both an economic and national resource, she is a classic mixture of agricultural, scientific, medical, commercial and industrial ambitions. Hence, while she is very much a late-twentieth-century animal in terms of the precise molecular technologies necessary to her creation, the feat of producing her viability belongs to a long tradition of reshaping animal bodies, crisscrossing cell lines and redesigning animal germ plasm in the interests of both capital accumulation and national or imperial expansion.[86]

Revivicor is linked to this same tradition and has been developing its possibilities through research: in 2000, it proudly produced "the world's first cloned pig." One year later, it

[85] Revivicor official site; accessed April,2024 https://www.revivicor.com/ .
[86] Franklin S. (2007). *Dolly mixtures, the remaking of genealogy*. Duke University Press, Durham and London. p. 5.

established "the world's first alpha-gal knockout pigs"; the GalSafe™ lineage progenitors. Specifically, this involved the production in series of genetically modified pigs engineered to lack a specific molecule called *alpha-gal* found in the cells of most mammals but not in humans. By modifying the pig's genome and deactivating the gene responsible for producing the *alpha-gal* molecule, Revivicor produced pigs that do not express this molecule in their cells, potentially making them safer for human consumption and reducing the risk of triggering allergic reactions in susceptible individuals. Simultaneously, the potential applications in xenotransplantation become clear. Hence, in 2011, Revivicor came under the aegis of United Therapeutics with the intent to "create an unlimited supply of manufactured organs for transplantation." In 2021, the company celebrated the first kidney transplant from a pig into the body of a recently deceased human maintained on artificial support using the UKidney™. In 2022, a heart from a Revivicor pig was clinically used, establishing a new record for the longest surviving recipient of a xenotransplantation product with the David Bennett Sr case.

In addition to the incredible short span of time for the realization of the possibility of using cloned animals in transplant practice since the Dolly case, from this summary emerges how genetic appropriation coincides with the formation of carefully standardized laboratory animals. Genetically modified pigs are entities in which those concepts of species, genome, organism, etc, that biology puts at its foundation and defines as "natural," are redesigned by industrial and experimental ends. They represent hybrids in Latourian terms: living beings that defy interpretation within the conventional framework of human versus nonhuman because they do not neatly fit into the dichotomy of natural versus social at first.[87]

Knockout pigs are clearly a product of biotechnology, a practice that by definition "involves the use of living organisms, or parts of living organisms, to provide new methods of production,

[87] Latour B. (1993). *We have never been modern.* Harvard University Press Cambridge, Massachusetts. p. 10-12.

make new products and find new ways to improve our quality of life."[88] As described by NPR[89] after a visit to the laboratory of Revivicor, the pigs that born here are all cloned embryos. In the labs, it all begins with gene editing by a scientist delicately piercing the egg with a tiny pipette under a microscope to suction out the DNA, later the edited pig skin cells are injected inside the eggs' outer membrane. Finally, the scientists zap the combination of cells with two electric shocks to fuse the edited cells with the emptied eggs and then initiate cell division to create an embryo. What is produced is a knockout pig, an animal with 10 genetic modifications to support organ functioning in the human body. Six human genes are added to the pig genome to facilitate immune acceptance of the organ, while four genes are knocked out: three that contribute to porcine organ rejection in humans and one that cause organ growth beyond human size.[90]

The consequences of these types of modifications have been widely criticized and perhaps one of the scholars who has most acutely developed their aspects is Zipporah Weisberg, denouncing how biotechnology can signify an *ontological collapse* for animal individualities. With this term, she indicates " the conflict between what an animal is in its distorted form as a biogenetic commodity and what it is or could be in its undisturbed form as a subject-of-meaningful-life."[91]

The modalities and timing of biotechnological research dictated by capitalist order often result in forms of physical and psychological suffering beyond our comprehension. Genetically modified animals, specifically, often suffer from deformities, impairments, and devastating diseases that result from the violent alteration of their fundamental genetic makeup necessary for surgical purposes. Alongside these issues, Weisberg considers the *ontological collapse*

[88] Definition of biotechnology by The Canadian Biotechnology Strategy (CBS), reported in Weisberg Z. (2014). *Biotechnology as End Game: Ontological and Ethical Collapse in the 'Biotech Century'*. Springer, Canada. p. 41.
[89] Stein R. *How genetically modified pigs could end the shortage of organs for transplants.* NPR. February 29, 2024. https://www.npr.org/sections/health-shots/2024/02/29/1231699834/genetically-modified-pigs-organs-human-transplant
[90] United therapeutics statement published in September 2023 about developments in xenotransplantation: https://ir.unither.com/press-releases/2023/09-22-2023-191510052
[91] Cit. Weisberg Z (2014). *Biotechnology as End Game: Ontological and Ethical Collapse in the 'Biotech Century*'. Springer, Canada. p. 46.

experienced by animal individuals, their simultaneous dematerialization in the form of data and computerizable and modifiable codes, and their being reduced to mere materiality, raw matter for mass production. This reality strongly emerges in the internal opposition within the dynamics of xenotransplantation: on one side, knockout pigs come into being in all their materiality in laboratories and farms, on the other, the same biotechnological and surgical dynamics that require their birth operate at the level of data, designing those hybrid entities named UKidney™ and UHeart™.

Developing the idea of the organ as a living entity that comes into being with and through the single knockout pig, shows an ontological collapse occurring also at an additional level. Haraway, in considering a broader entity than that of the animal subject, introduces the concept of holobiont[92], a strange cognitive element framed "like knots of diverse intra-active relatings in dynamic complex systems."[93] A multi- or semi-individuality entity that here materializes in the organ™-knockout-pig: a natural-cultural assemblage designed by the networks of technoscience with the sole intent of xenotransplantation and still clearly alive. The organ™-knockout-pig is forged within that historical cultural tradition that not only reshapes the animals' bodies but also generates animal life as a definition of biopower and capital accumulation; and thus closely kinshipped to Dolly. The organ™-knockout-pig is life that does not exist outside the medical intent of transplantation, nor outside the laboratory-farm of Revivicor in Virginia, because it exists only in the interaction between machines and people. More precisely, between the computerized information of the genetically modified organ and the research in the surgical field, between the biotechnological practices and the FDA policies for the development of new

[92] Haraway proposes the holobiont within the sympoietic interpretative framework, thus opposing a knowledge based on the idea of individuality. The holobiont is substantially a reality composed of multiple players symbiont to each other. For a more in-depth analysis: Haraway D (2016). Staying with the trouble. Making Kin in the Chthulucene. Duke university press, Durham and London. p. 58-67.

[93] Haraway D (2016). *Staying with the trouble. Making Kin in the Chthulucene*. Duke university press, Durham and London. p. 60.

therapies, between the increasing demand for transplant organs and the many animal lives used for scientific research. The organ™-knockout-pig is an undeniably living entity that has been conceived based on the concepts of *species*, *organism*, and *organ*, but that goes beyond each of these "natural" units because it is shaped by the interplay of biological, technological and social relations. In conclusion, the organ™-knockout-pig is, in all respects, using another Harawayan conception, a cyborg.[94]

Three boundary collapses enable the emergence of what we term "cyborgs," beings that are neither purely organic nor purely artificial. These collapses occur between human and machine, between physical and non-physical realms or matter and information, and most importantly, between human and animal.[95] All these conditions coexist in the holobiont in analysis, which emerges through organic and mechanical intricacies. The relationship between bodies and technologies in the case of animal lives in scientific research or intensive farming is often conceptualized as a connection of the organism to the machine as its extension. Many examples abound, such as cows connected to mechanical milking machines, artificial insemination in farms, monkeys fitted with neuroprosthetic devices to study brain function and so forth. However, changing perspective and looking at the organ™-knockout-pig as defined so far, what emerges is how in the mass production of transplant organs, the animal organism and the machine are conflated.

In the theory of Kupiec life emerges in the organism as a spontaneous cooperation of cells, tissues and organs creating their own "society" and optimizing the available resources, alike through the work of Maturana and Varela comes to light the relevance of the autopoietic work

[94] Developed in depth in "A Cyborg Manifesto," Haraway refers to those hybrid beings that blur the boundaries between human and machine, nature, and culture as entities that challenge traditional notions of identity, boundaries, and categorizations. For a more in-depth analysis: Haraway D. (2016) *A Cyborg Manifesto, science technology and socialist-feminism in the late twentieth century*. University of Minnesota Press.

[95] My translation from Timeto F. (2020). *Bestiario Haraway. Per un femminismo multispecie.* Mimesis, Italia. p. 105.

of each living. Then, what looms in the mass production of transplant organs through the breeding of genetically modified pigs is the technoscientific intent to functionalize the symbiotic and spontaneous emergence of life. In the holobiont in question, the animal subject becomes another tool of the command, control, communication system, which programs and genetically shapes the living for the development and maintenance of the organ™. A reality that becomes even clearer in the awareness of Revivicor's expressed intent to harvest three organs (heart, liver, and kidneys) from each raised pig in the future.[96]

Life rendered as information, as data, is what allows the objectification and exploitation of individual living entities, but in its realization the commodification that occurs is not only that of genetic resources, the functional units of heredity, or even just of the "pieces" into which animal life is disassembled. Added to this is the commodification through programming and functionalization of those organizing and maintenance activities that are inherent to every living being. Symbiotic relationships, which allows the ability to grow, specialize, relate, regenerate, etc., is where life emerges. After all, it is the set of these vital relationships that create the organ™ as well as that signify the existence of every knockout pig, although already designed and modified by biotechnologies. If the organism in the Cartesian view closely resembles a machine, in contemporary technoscience its functionality becomes standardized and part of the production chain for xenotransplantation realization. More precisely, in this dynamic Descartes's argument becomes a self-fulfilling prophecy through the insertion of animal individualities in the assembly production of the transplantable organ. A procedure that goes beyond the functionalization of the animal's body, requiring the removal of every attribute of subjectivity from the animal to be reduced in a mechanized resource for surgery’s supplies. In the anthropocentric view the animal organ is an extracted part of a well functioning machine,

[96] Stein R. *How genetically modified pigs could end the shortage of organs for transplants.* NPR. February 29, 2024. https://www.npr.org/sections/health-shots/2024/02/29/1231699834/genetically-modified-pigs-organs-human-transplant

not a symbiotic component of that emergent living system called pig and that's why it can be employed as a medical resource.

In conclusion, if the intention was to look at animal lives in the practice of xenotransplantation, expanding the perspective on individual entities reveals that, despite being marked by death, animal life is actually widely considered fundamental within the industrialized process that produces the organ™, even if mechanized at the extreme. Otherwise it is only through the process of integration into this assembly production and annihilation of animal subjectivity that the animal organ can be accepted in the anthropocentric view. The organ™ in this sense does not break down the barriers between human and animal, but only makes these boundaries clearer.

2.3 Standardization as commodification

In the NPR article during the visit to the nursery barn where the baby pigs are moved when they're old enough to be weaned from their mothers, the Revivicor farming representative, besides describing the pigs as very smart and interactive animals, also emphasizes that each one has its own personality. Indeed, he adds, "some of them are grouchy. Some of them are very friendly. Some like to be scratched behind their ears. Others on their back or on their tails."[97] Despite being a casual exchange, the tender attention given to the subject sharply contrasts with Revivicor's symbolic and concrete effort to standardize animal life. The production of organs as certified products and the breeding of a lineage of knockout pigs imply, above all, the standardization of the animal body. It represents an overarching effort to align the anatomy and physiology of animals as closely as possible with the industrial objectives defined within the

[97] Ivi.

realm of xenotransplantation. This trend is embodied in the physical structure of every knockout pig: deliberate selection of their muscle density engineered to reduce the risk of internal organ damage; genetic imposition preventing them from growing beyond a certain size to ensure their organs match to those of fully grown human recipients and the eradication of immunological barriers to streamline transplantation and enhance compatibility between "donor" organs and recipients. Essentially, the complex interplay between biotechnological advancements and the commodification of *life itself* leads to the relentless pursuit of standardization of structural traits, viewing living organisms not only as sources of biological materials but also as customizable entities tailored to meet the demands of industrial production.

At the same time, this standardization through the programming and functionalization of the body, when viewed through the sympoietic lenses, implies another form of control over individualities, one that involves the reduction of variability. As Franklin reflects, this intent emerges exemplary in the significant effort invested by technoscience in the implementation of cloning practices. Sexual reproduction, opposed to replication, results in greater variability and complexity in new life forms. Sex enhances mixture because it maximizes adaptive capacity or fitness through variation. Mix, in this context, adds flexibility; the ability to change.[98] It is precisely on these terms that Revivicor opted for cloning as a more efficient, less costly, and less risky form of reproduction in industrial terms. Otherwise, it is exactly in the aspect of variability that the biologist Kupiec identifies the fundamental characteristic of living beings. In its vision variability is what constitutes real and individual life experience in the here and now, defined by the relationships in which it emerges. In fact, as elucidated by the work of Kohn, Maturana and Varela previously developed, the term "variability" actually signifies that entire physical-semiotic processes upon which living entities rely and create their own

[98] Franklin S. (2007). *Dolly mixtures, the remaking of genealogy*. Duke University Press, Durham and London. p.20

specificity in relation to their surroundings. That's why in the standardization required by the practice of xenotransplantation, the aim is not only a control in terms of measures, dimensions or functions, but rather a staunch opposition to peculiarity and specificity. All these correspond to those characteristics that Kohn in *How Forests Think* (2013) described as expressions of ends and means inherent in each living for itself.

Weisberg, in his severe critique of biotechnologies, highlights how in this practice there is a conflict between what an animal is in its "distorted form as a biogenetic commodity and what it is or could be in its undisturbed form as a subject-of-meaningful-life."[99] However, in the standardization applied by technoscience on animal life the issue goes beyond an opposition between body and subjectivity. In fact, the knockout pig, although substantially modified in its genetic composition, is able to be present to its own existence unlike other tremendous conditions imposed by biotechnologies on animal lives to which Weisberg refers.[100] Rather, the imposition of xenotransplantation on animal individualities is manifested in the fact that the subjective meanings and purposes emerging in and through the embodied reality of each animal are valued and used based on industrial intentions. This is evident in the implicit practice in biotechnology of redirecting, or eradicating when non-functional, those processes through which the individual experience of life symbiotically emerges.

For instance, let's delve into the aspect of the organism's growth in knockout pigs. Growth stands as a fundamental property of living beings, facilitating the continuous emergence of life within the symbiotically complex system of the organism. Specifically, growth coincides with the multiplication and specialization of cells during the embryonic phase, culminating in the

[99] Cit. Weisberg Z (2014). *Biotechnology as End Game: Ontological and Ethical Collapse in the 'Biotech Century'*. Springer, Canada. p.46.

[100] Above all, the example of brain-machine interfaces is perhaps the most relevant. These biotechnological practices allow for the manipulation of the brain activity of a given animal by another animal or by humans, thereby expropriating its embodied consciousness.For a more in-depth analysis: Weisberg Z. (2014). *Biotechnology as End Game: Ontological and Ethical Collapse in the 'Biotech Century*'. Springer, Canada. p.44.

formation of tissues, organs and intricate systems. In the adult organism, this process persists, enabling the regeneration of damaged tissues and the healing of wounds. Cells reproduce to replace those lost due to injury or natural wear and tear, simultaneously allowing organisms to adapt to fluctuations in their surrounding environment. However, in the mutations imposed by Revivicor, their focus on the organ exclusively results in its design mirroring the size of a human adult. Consequently, the growth gene is deactivated, leading to the stunted development of the pigs. The intricate and dynamic actions of living organisms, as manifested in growth, self-repair and self-adaptation, are stripped of significance by technoscientific practices. They are reduced within the framework of serial production to mere increments in size.

Taking into account the example just described and returning to the holobiont organ™-knockout-pig, situated symbiotically within the emergence of life between multi- or semi-individualities and even between living and non-living entities, we encounter yet another form of ontological collapse. Indeed, in this context, both the organ and the pig are alive within the sympoietic relationships that connect and unify them in an active process of mutual self-definition; a process that is far from merely mechanical.

As clearly articulated by Kohn, emergent life is never random but expresses choices, traces forms of organization and possesses its own forms of agency. That's why there is an inherent sense to life that is not only ignored by technoscience but also redirected for its own ends. Specifically, if each individual living entity developed its own structural-semiotic way of being alive, then in the holobiont organ™-knockout-pig, many dynamics that would otherwise emerge in specific and peculiar ways are instead manipulated, restructured, and augmented in the realization of xenotransplantation. Processes such as growth, reproduction, adaptation to the environment, energy transformation are dismantled and reorganized/standardized through methods of reversal, switching, imitation and transfer, ultimately allowing them to be

repurposed and redirected. In conclusion, the speciesist violence inherent in this manipulation cannot be quantified solely by the physical or psychological suffering of the animal, as it represents a form of degradation of the physical-semiotic actions and relations through which life communicates its existence. It is a process of emptying these expressions of meaning by technoscience, neatly arranging them on its workbench as ready-to-use tools.

From what has been discussed so far, it is reasonable to assert that the practice of xenotransplantation, in its relationship with animal life, not only deprives it of its own purpose and meaning but rather redirects it towards the objectives and methods of mass production, thereby industrializing it. This does not merely involve reducing organisms to machinery, but also entails the elimination of those sympoietic elements that allow a particular form of life to be unique and inserting what is useful to its ends into a carefully designed process. Animal lives become appendages and resources for human ends. The organ™ is brought to life for human use in mass production and thus the sympoietic emergences through which life comes into being are sidelined. Reproduction is stripped of its potentialities of mixing and variability, development is carefully calibrated in terms of functionality, adaptation to the environment is considered solely in the potential rejection of the organ by the human recipient, and so forth. In short, even though all these processes are considered according to animal welfare laws, the individual pig becomes a mere container for organ supplies and the meaning of its life completely sidelined. A reality expressed also in the inability of these lives to take place outside the laboratory, primarily due to modifications that render them unable to interact with an environment other than that of the laboratory-farm aimed at their exploitation in the pharmaco-carnist regime.

In summary, once animal life is inserted into the dynamics of xenotransplantation, it is necessarily marked by death, but at the same time, the individual experience of life is far from devalued. Rather, congruent with the speciesist ideology on which xenotransplantation is based, life, along with the animal body, becomes a precious object for the accumulation of capital, a resource of “labor" in the mass production process of transplant organs. By placing this latter entity at the center, it is possible to see how the forms of speciesist violence imposed on animal individuals in xenotransplantation go beyond those typically criticized in the debate on zoological use in scientific research or medical practices. The breeding of knockout pigs in the Revivicor's facilities is perfectly in line with the FDA policies on animal welfare; even the critique by Zipporah Weisberg, while fundamental, considers the ontological collapse that occurs between the animal subject and its own body without truly considering that the experience of life goes far beyond the individual. Therefore, looking through a broader, symbiotic perspective and thus beyond individuality, allows us to see how value is assigned and how the living is shaped in the realization of xenotransplantation.

As it should be clearer now, the interplay between medical, biotechnological, and neoliberal productive relations exclusively converge around the organ as a standardized product, with significant consequences for animal lives. Firstly, bringing to life animal cyborgs: the pigs are transformed into a technical force and become functionalized for the assembly production of the organ™. The organism is reconfirmed as a machine by technoscience, not only in the relationships that regulate and shape it, but rather in its functionality designed from the outside, resulting in the body where animal subjectivity expresses itself as merely a part of mass production. At the same time, the birthing of these entities, inconceivable according to the laws of "nature," implies further violence on the experience of the living. Life, which is always emergent, self-referential and fundamentally life-affirming, is emptied of such ends in

xenotransplantation. The means inherent in life itself are enlisted in the service of the ends of medical practices. Animal life in its individual positioning is effectively industrialized, a consequence made possible by the anthropocentric cosmos in which the body and the animal are always devoid of a political subjectivity, entities marginalized and excluded from public discourse and decision-making processes.

The critique that this research brings to this practice and its normalization goes beyond denouncing the use of animals as resources for their body parts within a mechanistic worldview, nor does it merely emphasize how the animal phenomenological experience is distorted in biotechnological practice, as the response would always be that of necessary sacrifice for a greater good. Instead, this research aims to emphasize that in the practice of xenotransplantation, animal life is not “consecrated” to the higher cause of medical progress, but rather stripped of its inherent meaning and, as a result, induced to exist. Animal individuality becomes a commodity in xenotransplantation, reinforcing speciesism and its material consequences. This practice also reaffirms animal bodies as raw materials for advancing medical scientific knowledge within the pharmaco-carnist regime.

Despite the severe condition of speciesist violence on nonhuman entities that has been analyzed, it would be wrong to suggest that animal individualities do not demonstrate a form of agency in response to the practice of xenotransplantation in their very existence, in their here and now; even just corporally. This form of *resistance through existence* clearly doesn't need a spokesperson, which is not the intention of this research, which rather proposes a critique of biotechnological and medical practices going beyond arguments revolving on the physical or psychological suffering of animals, as is the case with many of Weisberg's arguments, in the end. Also because these technoscientific practices are already striving to "solve" these ethical obstacles by functionalizing the animal body for industrial purposes, genetically eradicating

any perception of the animal's pain, for example, or altering its perception through technology; let's think of the cows in the intensive farming with VR for reproduce "natural" environments. What could be our response at this point? The one we have attempted to provide is placing the emergent sympoietic nature of existence at the center of reflection, focusing on the organ as an embedded living being in the context of xenotransplantation. On the other hand, in these pages, we have developed this perspective only about the animal lives for which xenotransplantation is responsible. Conversely, the animal organ survives its "donor" and, as we will demonstrate in the following pages, is capable of infusing new meanings even into the human individuals who live after the transplantation. In the following chapter, The aim is to highlight which assemblages of different kinds of xenotransplantation produce, with the intention of tracing connections broad enough to make us aware and *response-able* to the many animal individualities that are born and die in facilities like Revivicor's.

3. Accepting the intruder

In 2004, the Italian artist and designer Elio Caccavale initiated an experimental project called *Utility Pets* to draw attention to the ethical implications of xenotransplantation. As he explains in the article *A pig saved my life* (2010), the project was influenced by the real-life experience of a man who received a modified pig's liver for seven hours as a temporary "bridge" until a human one became available for a transplant. As a result of this event, a picture of Wilbur (the pig) appeared inside the house of the recipient and thanksgiving services in its honour were held at the christian churches of the city.[101] Starting from this story Caccavale decided to participate in the social and ethical debate surrounding xenotransplantation, envisioning a future where organ recipients would develop a close relationship with the pig donors taking them at home. In this imagined scenario Caccavale provocatively pondered the necessity of new objects to ensure a good quality life for the pig while living in the home with its owner's family until the day of organ replacement. Among the products, a *comforter*: "a psychological product made from the snout of a pig, which helps people come to terms with the contradictory feelings generated by this complex situation."[102]

Despite its ironic approach, the project invites the spectator to reflect on how human well-being extensively relies upon animal individualities. Simultaneously highlights how the "success" of xenotransplantation can't be reduced to a mere mechanical procedure of connection between nerves, tissues and veins. Like every form of medical practice, the procedures that are employed

[101] Caccavale E. *A pig saved my life.* In Giovanni A. (2010). Antennae: The Journal of Nature in Visual Culture 12. p.27.
[102] Cit. Ibidem p.30.

are multiple and vary depending on the dimension in which they are addressed, whether it's a consultation room, a surgical theatre or a private space.[103] For this reason, contrary to what one might think, the assimilation of that extraneous entity that is an animal's organ doesn't occur only through the chemical rearrangement of the immune system, but also through a process that is both intimate and individual as well as collective and political. The transplantation of an animal organ is a composed and heterogeneous procedure operated not only within the recipient's body but also within the shared cultural context that defines what is *self* and *identity*. It is a procedure carried out not by the sole medical staff, but by the entire symbolic and material network around the recipient, including public debate, cultural media and, not least, its kin. All these diffuse realities and stakeholders collectively participate in the production and re-production of the cultural and material authority of biomedicine, which has the power of plasmate bodies and the individual experiences of illnesses, cure and death.

As previously observed, this authority in the practice of xenotransplantation concretized itself long before and in different places than the operating theatre through the designing and breeding of genetically modified animals, known as knockout pigs. These animals are nurtured for laboratory purposes and only within that controlled biopolitical and physical space they can exist. In fact, the building of this practice around the organ as a patented product rely on the alteration of pigs' genome and consequently on the modification of their structure and immune system. That's why a life for the "donor" pigs outside a sterilized environment and side by side their recipient as imagined by Caccavale would be impossible. Otherwise, the imposed segregation of these animals in the laboratory is not only a consequence of their health risk due

[103] This concept is clearly expressed in the seminal studies by Annemarie Mol on atherosclerosis, focusing on how the disease is enacted in different medical practices. For a more in-depth analysis: Mol A. (2002). *The body multiple: ontology in medical practice*. Duke University Press, Durham and London.

to their genetic alterations, but also a necessary division to confirm and reinforce their speciesist exploitation.

The varying degrees of proximity and distance between human and pig species throughout history have been continuously recalibrated and reorganized both physically and symbolically. In a historical perspective, they share thousands of years of common history and only recently domesticated pigs have moved from backyard pigsties to biomedical laboratories.[104] This growing separation from domestic spaces has coincided with the increasing scientific interest in their phenotypic and genotypic features similarities, which are prerequisites for the use of swines in medical research. Since the early 20th century, veterinary and biomedical experiments exchanging biological material through cloning, grafting and transplantation, have signified unprecedented proximity in this relationship. The subsequent creation of transgenic, hybrid and chimeric animals, as the systematic attempt to "humanize" the pig to make its organs acceptable for the human immune system, speaks not only of a constant redefinition of the concepts of species and organisms, but more generally of the *self*.

This aspect emerges prominently in the case of xenotransplantation, especially when examined in its situated and individual concretization. Indeed, the practice is constructed around the potential hazard of non-integration by the recipient; in medical terms, *rejection*. This risk occurs at the biological level with the immunological response of the recipient's organism "against" the xenograft, but also at a psychological and social level, where there may be resistance to the medical practice itself. Studies in medical anthropology have highlighted how each patient experiences their body, disease, and treatment in ways that may differ from medical perspectives. The practice of care received by the patient itself is experienced with multiplicity

[104] Folker M. P, Svendsen M. N, Koch L. *Lifeworlds of the pig: towards a cartography of porcine/human entanglements. A proposed case study of the Danish pig between the production of meat and medicine*. In Holmberg T. (2009). *Investigating human/animal relations in science, culture and work*. Uppsala Universitet.

in its emotional, physical, and conceptual dimensions, varying depending on moments and situations.[105] For this reason, to determine the success of xenotransplantation becomes necessary a continuous definition and redefinition of the concept of *self* and *other* through the shaping of both bodies and narratives.

In this process of resignification, the organ itself also requires a particular transformation. Indeed, once harvested from the animal "donor," this entity remains perilously between being a "gift" and a salvation for the recipient, yet also a dangerous and problematic presence in the definition of its human identity. That's why, in the next pages, we will extend our research by placing the element of the organ and the sympoietic framework at the center of our analysis once again. This time, we aim to emphasize how technoscientific knowledge and practices, based on an individualistic vision, shape not only the bodies and life experiences of animals but also those of human recipients. A reflection justified also by the desire to propose an alternative narrative of this practice that, while perhaps incapable of fully reconciling the "contradictory feelings generated by this complex situation," could nonetheless bring to the forefront the significance of animal individualities and the ways in which they are made fundamental to the realization of this practice.

3.1 Defense systems

Transplanting biological materials between the same or different species is based on the concepts of extrusion and intrusion, identity and extraneity, acceptance and rejection. It is not a coincidence that this practice was developed during the 19th century simultaneously with the

[105] For a more in depth analysis: Mol A. (2002). *The body multiple: ontology in medical practice*. Duke University Press, Durham and London. p. 29-52.

scientific “discovery” of the immune system. While the first demonstrations that exposure to a pathogen could lead to immunity were being carried out, early attempts at skin grafts and organ transplants often failed due to rejection; failures that provided critical insights into the body's “defense” mechanisms. Surgeons and scientists observed that transplanted tissues were often attacked and destroyed by the recipient's body, leading them to hypothesize the existence of a system responsible for this reaction, what is now known as the immune system. From that moment on, biological and medical sciences, already built around the concept of individuality, found the ultimate proof of this ideal in that complex network of organs, proteins and white blood cells.

The sign became the thing itself and the idea of that tangible delimitation of a biological individuality became a polymorph and powerful object of faith, knowledge and practice in the Western idea of identity. In her early work *The Biopolitics of Postmodern Bodies* (1991) Haraway reflected precisely upon this point on this terms:

> My thesis is that the immune system is an elaborate icon for principal systems of symbolic and material ‘difference’ in late capitalism. Pre-eminently a twentieth-century object, the immune system is a map drawn to guide recognition and misrecognition of self and other in the dialectics of western biopolitics. That is, the immune system is a plan for meaningful action to construct and maintain the boundaries for what may count as self and others in the crucial realm of the normal and the pathological. [106]

For this reason the immune system and its manipulation is a subject of primary importance in research and practice within the contemporaneous nation-state order. This focus helps define

[106] Cit. Haraway D. J. *The Biopolitics of Postmodern Bodies: Determinations of Self in Immune System Discourse.* In: Haraway D. J. (1991) *Simians, Cyborgs, and Women. The Reinvention of Nature.* New York: Routledge. p. 204.

and constantly re-define fixed entities like race, gender, and species, which are foundational to the knowledge and practices of power. As the writer Evelyn Tsitas (2013) highlights this reasoning on the concept of identity through the definition and challenging of the biological body take place also through cultural production. In recent years human identity has been imagined and represented through every kind of more or less fantastic bodily transformation as genetic manipulation, transpecies organ implantation or zoonotic viruses contagion.[107] Hybrids, chimeric and monstrous entities have become fundamental to reflect upon the definition of human self, making it coincide with immunological and physical perimeter.

Xenotransplantation is clearly a product and a tool of this biopolitical exercise. Proof of this, as we have seen, is the narrative and practical way through which animal organs are harvested with the intent of perpetrating the *anthropological machine*[108] and maintaining the exploitation of nonhuman species. Although, even if the medical and public debate promote through this practice the theme of immunological barrier as a militaristic metaphors in which the body is represented as an "embattled self," in the concretization of it this substantial preoccupation about defined identities is lacking. The risk of overcoming species boundaries disappears when nonhuman bodies are mobilized within anthropocentric hierarchies of values and power.[109]

Inside the laboratories of Revivicor, the creation of the organ™ is made possible through what might be called an assembly production process. This involves harnessing the spontaneous and symbiotically emerging characteristics present in every organism. As we have seen with many

[107] Tsitas E. (2013). *Monsters manufactured: the human animal hybrid in science fiction and Donna Haraway's "A Cyborg Manifesto."* Unpublished Ph.D. thesis, RMIT University, Melbourne. p. 7.

[108] Giorgio Agamben uses this term as a metaphor to describe the processes through which Western culture constructs human identity by devaluing animal identity. This biopolitical exercise dehumanizes and marginalizes those who do not fit neatly into the constructed category of the human, including non-human animals and humans perceived as less "fitting." For a more in-depth analysis: Agamben G. (2003). *The Open: Man and Animal.* Stanford Univ Press, UK.

[109] Timeto F. *Deadly contagions, vital contagions. Interspecies relationships in the new pandemic age.* In Cudworth E, McKie R. E, Turgoose D. (2022). *Feminist Animal Studies. Theories, Practices, Politics*. Routledge, London and New York. p. 101-102.

sympoietic activities such as growth, reproduction or the ability to respond to trauma, the same occurs within the symbiotic relationships and activities that constitute an organism's immune response. Besides, the ability to functionalize the pig's immune system to make the transplantable organ capable of living both inside the animal and human organism is what makes it a functional and highly valuable product in the market. Therefore, in the design of the organ™, there is no room for any militarized defense of individualities to maintain, rather an immense work of mixture and modifications of those immunological "barriers."

Each transplantable heart, liver or kidney comes to life inside a genetically modified pig. As extensively explained in the case of the knockout-pigs nurtured in the Revivicor facilities, these genetic alterations are not about dismantling the pig's immune defenses. Instead, they focus on creating a new molecular order based on both animal and human genetic elements, while eliminating certain potentially problematic components (such as the alpha-gal protein).

In the case of Revivicor's Uheart™ and UKidney™, these mixtures and modifications occur not only genetically but also through extensive experiments of xenotransplantation into baboons. This species, with its significant genetic similarity to humans, allows for continuous adjustments to the genetic modifications to ensure the safety of the organ™ at the moment of the actual operation. The human recipient itself is part of this process of exchange and mixture, undergoing pharmacological therapies involving antibodies, which are often derived from rabbits. In conclusion, in the fabrication of the transplantable organ, the immune system is not framed as a barrier of defense of the self. Rather, it is seen as an element characterized by mutability and interconnectedness.

The conception of the immune system employed in the production of the organ™ is very similar to the alternative theory about immunity of the Nobel prize winner Niels K. Jerne. In this opposed framing the immune system is understood as a dynamic network with an extraordinary

ability to recognize and respond to antigens, the substances that trigger immune responses.[110] Rather than viewing it as reacting to external threats, Jerne proposes that it operates through a process of *internal mirroring*. According to his theory, the immune system consists of interconnected units that recognize and interact with each other within the system itself. Each of these components, like a piece in a puzzle, contributes to the formation of a self-referential network. So, when the immune system encounters external antigens, it responds based on whether these antigens match those already present in its internal "library" of antibodies. More precisely, in this theory the amino acid sequences of immunoglobulins, which are proteins produced by the immune system to fight antigens, share structural similarities with all potential antigens. This means that the immune system contains "internal images" representing the environment.

Similarly to this conception of the immunological network, the organ™ is functionalized through the creation of a shared and mixed "library" of antibodies between animals and humans, primarily through the genetic modification of pigs. This framing goes beyond the idea of the body as an embattled self, revealing how the immune system also emerges in constant flux and adaptation with surrounding conditions, demonstrating its sympoietic nature. In essence, as the Lithuan scholar Audronė Žukauskaitė underlines, in Jerne's theory "the distinction between *self* and *other* can be conceptualized only from the observer's point of view."[111]

Haraway, recognizing as well how the idea of immunity is more deeply political than it is medical and that when applied in biological contexts is, itself, a metaphor, reflects on Jerne's theory, proposing it as an alternative to framing reality outside the categories of self and

[110] The presentation of Jerne's theory that follows is based on the summary and explanation proposed by Žukauskaitė. For a more in-depth analysis, Žukauskaitė A. (2022). *Sympoiesis, Autopoiesis and immunity: how to coexist with nonhuman others?* University of Lodz, Poland. p. 388-389.

[111] Cit. Žukauskaitė A. (2022). *Sympoiesis, autopoiesis and immunity: how to coexist with nonhuman others?* University of Lodz, Poland.

identity. In her vision, immunity should be viewed as a dynamic boundary, constantly negotiated and redefined in response to encounters with otherness. In this sense, Revivicor's organ™, in its immunological formation built in relations with humans, nonhumans and machines is an expression of this. Underlining once again that "bodies as objects of knowledge are material-semiotic generative nodes. Their boundaries materialize in social interaction; 'objects' like bodies do not pre-exist as such."[112] However, one might think that xenotransplantation, like many other practices involving forms of hybridization or genetic manipulation, could signify a concrete revolution in the dualistic vision of reality.

While it is true that the implantation of organs from genetically altered animals into the human body creates living entities that clash with the biological definition of individuality as a well-defined entity inscribed within the body itself, it would be a mistake to celebrate this practice as liberatory with respect to those limiting and oppressive fixed identities. As Weisberg reflects, there is a danger in romanticizing biotechnology's role in "queering" and "transgressing" boundaries between humans, other animals and techniques.[113] Proof of this is the ways in which the bodies and experiences of laboratory pigs are shaped in the production of transplant organs in which the redefinition of selves rarely emerges as a practice of liberation. Rather, in most cases, it presents itself as a form of reinforced exploitation that primarily impacts animal bodies. Some posthumanist positions express enthusiasm for the supposed transformative power of biotechnology in challenging traditional identities on a symbolic and discursive level. However, this enthusiasm often overlooks the individual and situated experiences of violence, especially the animal ones. Like the deliberate intent of Revivicor of altering and exploiting the inherent

[112] Cit. Haraway D. J. *The Biopolitics of Postmodern Bodies: Determinations of Self in Immune System Discourse*. In: Haraway D. J. (1991) *Simians, Cyborgs, and Women. The Reinvention of Nature.* New York: Routledge. p.208.
[113] Weisberg Z. (2014). *Biotechnology as End Game: Ontological and Ethical Collapse in the 'Biotech Century'.* Springer (Canada). p. 49.

characteristics of pigs to align them seamlessly with technological systems, effectively erasing any distinction between the animals and the machinery they interact with.

Lastly, returning to Haraway's cyborg metaphor and her proposal to view the immune system as a potential image of exchange and mixture rather than conflict, we must be cautious not to project this possibility onto xenotransplantation. Indeed, even though the immunological features of each transplantable organ are the result of a network of multispecies connections, the biotechnological practice that enables it is rooted in an approach to living beings as coded texts and engineered communication systems, focusing on genes while neglecting the ontological experiences of individual animals. Precisely for this reason, each transplantable organ, although marketed as a patented product, is always an experimental process, inherently impossible to be fully modelled due to the complex and specific sympoietic emergence of it. A reality underscored by the unexpected outcomes of every recent case of xenograft operation.

In summary, the creation of hybrids and cyborgs through xenotransplantation does not offer a liberatory vision, it rather reinforces the narcissistic view that human beings occupy a special and unique metaphysical status. To attempt to use this practice for promoting more sustainable narratives, we must first understand why the exploitation of animal life in the production of the organ™ is silenced and mystified so that such an alien entity can be accepted in the eyes of the recipient and in the general cultural perception. Indeed, in order to avoid intimate and collective forms of rejection, the practice of xenotransplantation also acts on meanings, assigning radically new ones compared to traditional medical and biotechnological approaches to both the animal individuality and the idea of the organ itself. In short, why does the creation of narratives that, as in the case of the immune system, constitute the collective construction of organismal boundaries can profoundly influence the recipient's perception of life, illness and mortality?

3.2 “Will I oink?”

The experience of xenotransplantation for each recipient begins long before the surgery. In all known cases of this cutting-edge procedure on a living patient, there is a very serious, typically terminal, and particularly advanced medical condition for which an organ transplant would be the only solution. Once patients are approved for a transplant and placed on the official waiting list, they must undergo a comprehensive and invasive series of tests, which can take up to a month to complete. Some patients need to undergo "corrective" surgery as the lifelong intake of powerful immunosuppressants requires the body to be free of infections before, during and after the transplant. Additionally, extensive psychological evaluations are typically part of the assessment process to determine if a patient can manage the wait for a transplant and make the necessary psychological and social adjustments. In cases where potential recipients would face death due to their position on the waiting list, few American hospitals equipped with the right technologies and medical staff have the capacity of proposing this avant-garde procedure.

Whether the patient survives the operation or not, the practice of xenotransplantation does not end in the operating room. Instead, it extends into the personal lives of the recipient and their loved ones, and more importantly, into the public sphere through a narrative of the procedure that is anything but random.

In 1992, contemporary French philosopher Jean-Luc Nancy underwent a heart transplant, an experience he recounted in *The Intruder* (2008), a sort of philosophical autobiography in which he reflects upon the ontological trauma that signifies the operation in the perception of self. Actually, this text goes beyond recounting his own experience, creating a metaphor upon his medical condition that has much more to do with the sociopolitical phenomenon of accepting the stranger. In any case, in Nancy’s book it is the organ that is put at the center of his reflection, which is described, indeed, as an *intruder*. A presence that, in his experience, must be

recognized in its intrusion and extraneity to be accepted and integrated, otherwise the risk that its unwelcome arrival will continue to manifest itself in some way. [114]

As we will see, this reality is true for every transplant patient and is even more central in the case of an *intruder* of animal origin. This process of extrusion and acceptance doesn't rely upon the only recipient, but of the entire *network* in which it is embedded. This term is not referred only to the direct personal relationship that intercourse around the recipient as could be the medical staff or its loved ones, but rather of all those subjects that collaborate in the public rehearsal and performance of medical-scientific authority. A concept that Nancy expresses in this term:

> No doubt this [the transplant] can only happen if I want it, along with several others. "Several others": those who are close to me, but also the doctors, and, finally, myself, now doubled or multiplied more than ever before. Always for different motives, this whole world has to agree, in unison, to believe that prolonging my life is worth the effort. It isn't hard to picture the complexity of this strange group, intervening thus in the most sensitive part of "me." Let's pass over those who are close and pass over my-"self."[115]

This collective dimension that Nancy describes is particularly important in the process of signifying a practice that presents itself as a way of saving human lives amidst expressions of anxiety and public alarm about the surgical-genetic mixture between humans and animals. To achieve this goal without questioning the identity divisions on which the anthropocentric order is based, the subjects and relationships that comprise xenotransplantation, in fact, undertake a dynamic and collective re-framing of the transplanted organ.

[114] Nancy J. (2008). *The intruder.* In Nancy J. *Corpus.* Fordham University Press, New York. p.161.
[115] Cit. Nancy J. (2008). *The intruder.* In Nancy J. *Corpus.* Fordham University Press, New York. p.163.

It is particularly interesting that Western culture, despite being characterized by a surge of interest in conceptualizing the body as an embattled self upon which identities can be inscribed, leaves the organic internal components of it largely uninterrogated, except through the mechanistic lens.[116] This Cartesian vision of the world forms the foundation of technoscience and thus the creation of the organ™, but it is also what creates a "yuk" reaction to people when this entity pulsates inside a human recipient. In fact, this reaction stems from an implosion between the ideas of the organism as a set of gears, the body as the seat of identity, and the metaphysical superiority of humans over animals.[117]

In the famous text *Purity and danger* (1994), the anthropologist Mary Douglas reflects around the idea that dirt and impurity are not inherent qualities of objects or substances but are determined by cultural contexts and social structures. Dirt is defined as *matter out of place*, meaning that substances or objects become dirty or polluting when they are found in contexts where they do not belong according to the societal classification system. When something disrupts these categories, it is often seen as impure or dangerous. In the same way, the organ, framed through the technoscience lens as a component in the functionalizable and divisible machine that is the organism, becomes *matter out of place* in the construction of personal identity in xenotransplantation. A symptom of this is the widespread fear that the recipient might adopt animal characteristics or behaviors, with David Bennett Sr.'s ironic question, "Will I oink?" being a humorous example.[118] This general fear that the presence of an animal organ might irreparably dehumanize a person is not due to public ignorance but is a consequence of

[116] Birke L, Michael M. (1998). *The Heart of the matter: animal bodies, ethics, and species boundaries*. The Whitehorse Press, Cambridge UK. p.247.

[117] Birke. L. (2005) *Meddling with Medusa: on genetic manipulation, art and animals*. Springer-Verlag London Limited. p.113.

[118] The quote refers to the first comment that David Bennett Sr. reportedly made when the operation was proposed to him. For a more in-depth analysis, Rabin R. C. *In a First, Man Receives a Heart from a Genetically Altered Pig*. The New York Times. January 10, 2022. https://www.nytimes.com/2022/01/10/health/heart-transplant-pig-bennett.html

the mechanistic and speciesist foundations upon which scientific knowledge and practices are based.

In his study *Ordering Hope* (1998), through the analysis of interviews, scientific publications and newspaper articles related to xenotransplantation, Nick Brown highlights how the representations mobilized can not only re-narrate the practice itself but also re-signify the ideas of "organ" and "animal" according to necessity. For example, one of the ways the fear of dehumanization is alleviated is through the instrumentalization of the scientific concept of immunological identity. The transplanted organ is presented as an entity that, before the operation, is "humanized" through genetic manipulation, thereby "losing" any worrisome aspect of animality.[119] As we have seen, while it is true that some genetic components of the pig are eliminated and others of the human genome are added in the knockout pig, this identity-based reading proposed by scientific authorities is an instrumental interpretation of the reality of the practice. Nonetheless, this semi-scientific reading of the transplantable organ still represents a problem in the individual and intimate experience of the recipients and their kin.

In her anthropological research about allotransplantation experiences Lesley Sharp (1995) describes the reconstruction of personal identity for organ recipients as an extremely complex process. In this there is a great effort by the specialists in preventing patients from any form of psychological identification with their donors.[120] As highlighted in her research the practice of transplantation dictates a strict disposition about the disposable information on the organ donor that the recipient is allowed to get, opposed to what Sharp describes as a sincere need of many recipients to get "closer" to its donor in order to build a new identity after the shocking experience of the transplant. As the medical anthropologist explains, "after surgery, recipients

[119] Birke L, Michael M. (1998). *The Heart of the matter: animal bodies, ethics, and species boundaries*. The Whitehorse Press, Cambridge UK. p. 254.

[120] Sharp, L. A. (1995). *Organ transplantation as a transformative experience: anthropological insights into the restructuring of the self*. Medical Anthropology Quarterly. p.368.

may no longer feel that they are whole persons; integrating the donor as part of the self gives rise to a permanent sense of being renewed or healed and contributes to a sense of wholeness."[121] This dynamic is not unfamiliar to xenotransplant patients: CNN reports that Lawrence Faucette, the second ever living patient of pig' heart transplant, as soon as he recovered from the operation asked for a T-shirt that said "Just call me Wilbur," referencing the pig in E.B. White's beloved novel "Charlotte's Web." Moreover, when doctors had to clear fluid from around his heart, he asked to have a pig drawn on the bandage.[122] Differently from any kind of pathological response, Sharp specifies that these symbolic embellishments on the self should be viewed as "natural responses to unnatural circumstances."[123]

For this reason, in the public and hospitalized representation of xenotransplantation, the individual animals on which the industrial production of transplantable organs falls are presented to the recipients and the public with an entirely new significance. As the sociologists Birke and Michael (1998) reflect, especially in the narrative of public media, pigs acquire completely new roles compared to those assigned to them by biotechnology:

> Pigs, as organ donors, seem not only to have agency, but to be saviors (they could save lives). They are, moreover, financial speculators (heading for market). [...] Even though it is clear from the reports that these animals have been created by scientists, they also become animals who actively participate in the research enterprise. The living animal is thus tacitly represented as exercising agency, even if its body and components are not. "Granting" such agency to pig donors, however implicitly, relies on the notion of consent that is central to human organ transplantation. No organ can be transplanted from a human body unless that person (or one of their relatives) has

[121] Cit. Ibidem. p.372.

[122] Christensen J. *More people need transplants than there are organ donors. Pigs might be a solution.* CNN. 9 May 2024. *https://edition.cnn.com/2024/01/30/health/pig-organ-transplant-xenotransplantation/index.html*

[123] Cit. Sharp, L. A. (1995). *Organ transplantation as a transformative experience: anthropological insights into the restructuring of the self*. Medical Anthropology Quarterly. p. 372.

> consented. Clearly, the pigs do not, and cannot, consent to being used for these purposes. But, by articulating phrases that imply agency, the media reports come close to implying that the pigs themselves are in agreement.[124]

This description of animal individualities intersects with that typically proposed by the medical staff to the individual patient, defining the received organ as a *gift*. If not explicitly depicted as willing, this rhetoric creates a misleading idea of sacrifice for human well-being around the deaths of these animals. A representation that, just as it happens for millions of pigs each year in the meat industry, conceals the methods and practices of exploitation primarily inflicted on the bodies upon which these realities are based.

In summary, the organ™ continues to be shaped even after implantation in the human body through various layers of representation, differing based on the situation and the stakeholders involved and often creating incoherent or conflicting narratives. In the surgical proposal of the operation to the patient, for instance, the organ is merely a muscle that, through advancements in medical technology, is capable of pulsating in another body. However, immediately after the surgery, the same entity transforms into a gift, from which, in any case, the scientific authority reassures us that all aspects of "animality" have been purged.

This constant assembly and reassembly of significations is fundamental to the dynamic process of extrusion/intrusion which, according to Nancy, allows the acceptance of what is alien. In this context, however, it is not only useful for the acceptance of the animal organ but also for that of the practice of xenotransplantation itself.

The research into harvesting organs from animals to implant in human patients affected by terminal conditions and the subsequent hospitalization of this procedure is not easily accepted

[124] Birke L, Michael M. (1998). *The Heart of the matter: animal bodies, ethics, and species boundaries*. The Whitehorse Press, Cambridge UK. p.257.

or justified socially. For this reason, as Brown reflects, the various representations, though starkly contrasting between those put forward by scientists in the Revivicor laboratories and those of the families of recipients in the intimacy of their homes, are necessary to depict the practice as a *bearer of hope*.[125]

As clearly expressed in every scientific article, public news, interview with doctors and recipients and publications by biotechnological companies, this *hope* is explicitly that of saving lives that would otherwise be lost through the technoscientific procedure. This hopeful mission through which xenotransplantation is presented is what justifies and normalizes the killing of animals and the use of their internal components, but also, the experimentation of such an invasive and still-developing practice on living human patients.

Contrary to what one might think, xenotransplantation, in its current state, has never guaranteed a life span longer than a few months. Even though it is undeniable that compared to certain death, it is a preferable opportunity, what emerges from the experiences of patients undergoing this procedure is precisely the sense of participating in the advancement of the practice. As stated by Richard Slayman, first kidney recipient from a pig: "I saw it not only as a way to help me, but a way to provide hope for the thousands of people who need a transplant to survive."[126] All patients who have undergone the procedure did so knowing the improbability of returning to a "normal" life, but with a strong sense of contributing to the improvement of the practice. That's why patients are frequently described as "heroes" who, unlike the pigs, voluntarily undergo the operation, nurturing the hope that one day no one will have to endure the same difficulties related to organ shortages. The media also strongly emphasize this point, mentioning the possibility that one day sick children will no longer have to die waiting for organs, thereby

[125] Brown, N. (1998). *Ordering Hope: Representations of Xenotransplantation - An Actor/ Actant Network Theory Account.* Unpublished Ph.D. thesis, University of Lancaster, Lancaster, United Kingdom. p. 162.
[126] Cit. Unknown. *First-ever transplant of pig kidney to patient a success*. The Harvard Gazette, 21 March 2024. https://news.harvard.edu/gazette/story/2024/03/first-ever-transplant-of-pig-kidney-to-patient-a-success/

consolidating and legitimizing the practice through its moral elevation. However, there is currently no evidence that this procedure could be viable for children in the future. As it is rarely mentioned that xenotransplantation is heavily questioned in the medical debate due to the significant risks it entails, particularly the potential for zoonosis.

In conclusion, the representation of xenotransplantation as a bearer of hope relies on the implicit idea that this practice is an indisputable, if not natural, phase in the ever-advancing progress of the medical-sciences. This framing makes xenotransplantation ethically unquestionable because, in the general conception, scientific progress is always its own arbiter. This is evidenced by the fact that in the narratives used to describe xenotransplantation the possibility of alternative ways to address the problem of organ shortages is never mentioned. More importantly, there is no space in these representations for any form of problematization or justification of that industrialization of animal bodies and lives on which the practice is based.

3.3 Regenerative and hybrid labor

As noted by Nancy, each operation of (xeno)transplantation results from the intertwinement of a personal contingency with that of technological history. Even so, it is necessary to position this event within a much wider frame that considers the socio-economic dimensions in which both these contingencies occur. The organ™ is undoubtedly a *modest witness* to specific forms of speciesist exploitation justified and perpetuated by various identitarian narratives, but it also represents a peculiar way in which the life sciences create forms of economic value. Looking at the individual and situated experience of xenotransplantation, we have extensively discussed the Revivicor company, which, along with eGenesis, is one of the most significant players in xenotransplantation research involving genetically modified pigs. However, broadening the

perspective, Revivicor is just one of the 6,600 private companies in the field of biotechnologies for diagnostic and therapeutic solutions that operated in America in 2022.[127]

These numbers, combined with the increasing speed in standardizing xenografting in the medical field, reflect a growing interest in the contemporary economy's use of "latent value incumbent in biological products and processes to capture new growth and welfare benefits for citizens and nations."[128] In other words, this reflects the development of a new market branch called *bioeconomy*. This branch responds to the ever-growing demand for innovation in the life sciences, which, according to sociologists Melinda Cooper and Catherine Waldby (2014), cannot be reduced to the commercialization of biomedical knowledge and productivity. In fact, it is characterized by newly defined contractual rights over living beings and their bodies, driving value production through biotechnological innovation.[129]

Cooper and Waldby highlight how while the mainstream discourse about biotechnology market focuses on the cognitive and technical skills of researchers, engineers, project coordinators and others, it neglects the significant labor performed by a broad range of subjects. Specifically, those individuals that perform what the two sociologists define as *clinical labor*.[130] A term that encompasses various productive activities at the expense of the subjects employed in biotechnological innovation, such as participating in clinical research trials, donating bodily materials and tissue samples for research or reproductive purposes, performing gestational surrogacy and sharing valuable bio-information. Forms of participation that conventional theories of labor, bioethics and innovation don't acknowledge in its embodied and visceral

[127] Vuleta B. *Biotechnology Statistics: Employment, Usage, and Benefits.* Seed Scientific, 22 October 2021. https://seedscientific.com/biotechnology-statistics/

[128] Cit. OECD (2006). *Scoping document: The bioeconomy to 2030: Designing a policy agenda, June.* In Hilgartner S. (2007). *Making the bioeconomy measurable: politics of an emerging anticipatory machinery*. Department of Science & Technology Studies, Cornell University, USA.

[129] Cooper M, Waldby C. (2014). *Clinical labor: Tissue donors and research subjects in the global bioeconomy*. Duke University Press. p. 3.

[130] Ibidem. p.7.

risks.[131] In summary, Cooper and Waldby underlines how research subjects and tissue donors constitute the *clinical laborers* of the global bio-economies, performing *services in the self*: risky, embodied forms of labor critical to the overall bioeconomic enterprises.

Xenotransplantation is a prime example of practices driven by bioeconomic forces, particularly as a generator of value in medical-technology innovation that relies on the in vivo biology of different subjects, especially pigs. Surprisingly, despite Cooper and Waldby recognize how every form of embodied risky labor is unevenly distributed within societies, capitalizing on asymmetries and hierarchies within and across categories of class, gender, and ethnicity, that of species is not considered in their analysis. Consequently, their framework overlooks the critical labor performed by animal individualities in the development of biotechnology. Despite this, the work of the two sociologists is fundamental in considering a perspective that allows us to narrate xenotransplantation differently. A perspective that can highlight its symbiotic dynamics and finally make the animal individualities on which the survival of human recipients depends *matter*.

In their book *Clinical Labor* (2014), Cooper and Waldby develop their reflections starting from the role of reproductive activity. This feminized work has always been excluded from any form of market relations, but in the contemporary neoliberal order, it has become a form of economic labor in key sectors of the bioeconomy.[132] For example, through artificial reproductive technologies (ART), which rely on the extraction of certain biological materials such as oocytes from the female human body. At the same time, however, Cooper and Waldby, drawing from feminist thought, which has long been at the forefront in recognizing undervalued and unwaged work, reflect on the difference between reproductive and regenerative labor. The conclusion they reach is that it is not the products of reproductive labor that are valuable, but the ability of

[131] Ibidem. p.32.
[132] Ibidem. p.33.

living tissues themselves to regenerate, thereby providing “inexhaustible” reserves of resources.[133] This kind of physiological labor is perceived as a gift of nature rather than a process of embodied production in the organization of the bioeconomy.

The production of the organ™ in Revivicor's facilities is precisely based on this point. The transplantable organ possesses its commercial value not only in its dimension and composition that enables it to be transplanted into a human organism, but especially in its self-regenerative capabilities. These characteristics are the real market value of the organ as a patented product, even though in the narratives surrounding xenotransplantation they are portrayed as a *gift of life*. A concept that propagates the idea of progress in the medical-scientific field as exclusively dependent on the knowledge of tireless scientists and the relentless advancement of available technologies, while rendering the role of the countless animal individualities, forcibly placed at the service of the technoscientific process, invisible. In this specific case, those of the knockout pigs, on which falls the embodied risk of generating and "donating" transplantable organs. At the same time, as extensively demonstrated by this research, the use of animal life in the dynamics of xenotransplantation is much more problematic than that. In fact, the regenerative capabilities of the organ can be recognized only as inherent characteristics of the organ as a living entity: these characteristics do not exist in themselves, but only thanks to their symbiotic emergence within the organisms of the knockout pigs. These are subjects whose entire biological activity is put at the service of the organ™ product, and whose regenerative capacities are nothing but a consequence of that set of symbiotic activities through which life emerges. All the life-affirming activities, as we have seen, become forms of labor in xenotransplantation, being mechanized, extracted, enhanced or removed and therefore definitively beyond the concept of *clinical labor* offered by Cooper and Waldby.

[133] Ibidem. p.114.

The political theorist Alyssa Battistoni similarly reflects on how to give political space to these symbiotic activities which, when inserted into bioeconomic dynamics, automatically become forms of labor. For this reason, Battistoni categorically rejects the concept of natural capital, in which they have always been placed by political-economic thought. As she writes in her article *Bringing In the Work of Nature* (2016):

> Natural capital, like biocapital, is not just dependent on, but constituted by, reproduction, regeneration and renewal: the organisms and ecosystems that provide ecosystem services are valuable not as products in the form of raw material for commodity production but for their ability to continually generate a biosphere capable of supporting life.[134]

Thus, Battistoni proposes the concept of *hybrid labor*, in which the "work of nature" is framed as collective and distributed between humans and nonhumans in its capacity to reproduce, regenerate and renew.[135] This concept highlights the intersection and interdependence of human labor with ecological and technological systems. A form of labor that, although not previously defined in these terms, was already expressed in the perspective of the transplantable organ as we have defined it so far.

In this research, we have focused on how each organ is an entity that exists and lives always and necessarily in relation to an individual and situated subject. This makes it far from being a mere cog within an organism and rather an expression of the sympoietic emergence of every living being. In the specific case of the organ™ produced by Revivicor, it is situated within animal individualities that are shaped and exploited according to relationships and modalities driven by the intertwining of specific economic relations, animal welfare policies

[134] Battistoni A. (2016). *Bringing in the work of nature: from natural capital to hybrid labor*. Sage publications. p. 15.
[135] Ibidem. p. 2.

and medical and biotechnological knowledge and practices. That's why, the holobiont organ™-knockout-pig, within this network of physical and semiotic connections, truly performs forms of *hybrid labor,* primarily in its capacity to regenerate, grow, develop, heal, and so on.

Viewing the practice of xenotransplantation as supported by forms of *hybrid labor* ensures that these sympoietic life-affirming activities are recognized, moving beyond the opposition between intrinsic and instrumental value in the political debate around "nature." In the words of Battistoni, "naming nature's productive activity *labor* rather than *capital* recognizes the already-economic status of nature while asserting that it is also-political. It offers a way of thinking about nonhuman activity in terms of a political economy that rests less heavily on ontological categories." [136]

Framing this dynamic in such a way opens a debate on how and which ecologies are mobilized in the integration of humans, nonhumans and technologies, thus actively questioning appropriate social relationships of compensation, care and value. This way of looking at xenotransplantation and biotechnological practices in general, means thinking about individualities with solidarity, as *hybrid labor* recognizes a "shared position and a linked fate."[137] This admission does not necessitate a complete upheaval of those fixed categories upon which technoscience relies, nor does it impose overcoming nature–society dualism by dissolving all boundaries between *self* and *other*.

This does not mean that the proposal is to accept and promote speciesist, racist or sexist practices and narratives. On the contrary, thinking about the world we live in, according to *hybrid labor,* precisely highlights our interdependence with nonhuman entities and the ways through which this occurs, while not implying absolute equality between all beings or the

[136] Ibidem p. 17.
[137] Ibidem. p.18.

absence of power differentials. While *hybrid labor* recognizes the emergence of life as sympoietic, at the same time, Haraway herself clarifies that "symbiosis is not a synonym for 'mutually beneficial.'"[138] This implies that multispecies collaborations might also be damaging, poisonous or contagious.

After all, re-narrating and re-signifying the practice of xenotransplantation as the product of a labor shared and (unequally) distributed between human and nonhuman subjects, instead of celebrating animal sacrifice for human well-being and thus hiding the treatments animals are subjected to in laboratories, means exactly to *staying with the trouble*. What we advocate through a different narrative of these practices is being present in these dynamics with the consequence of assuming responsibility for the living and dying that occurs in the transplantation of an organ from a pig to a human. It means at least asking ourselves what kinds of life (and death) experiences we are imposing on individuals in the realization of this practice.

Lastly, the concept of *labor* draws on commodified status as a basis for asserting collective power against economic logic, and so it is with *hybrid labor*, demanding justice within the multispecies relationship, ensuring it is not only an instrumental relationship. This does not mean that we should think of multispecies relationships only in these terms, but to add a critical dimension to them. Labor touches on questions of use, value and production that are undeniably central to the contemporary neoliberal approach to nonhuman entities in technoscience and beyond. In short, the hope in proposing the concept of *hybrid labor* is to finally contemplate "what kind of world we want to reproduce together, towards ends determined collectively rather than by the owners of capital."[139]

[138]Cit. Haraway D. J. (2016). *Staying with the trouble. Making Kin in the Chthulucene.* Duke university press, Durham and London. p.60.

[139] Cit. Battistoni A. (2016). *Bringing in the work of nature: from natural capital to hybrid labor*. Sage publications. p.20.

The analysis of the actual or possible narratives and representations of xenotransplantation doesn't mean discussing something separate from the reality of the practice. Recalling Latour's reflection, the construction of rhetoric around a specific scientific practice is always an expression of the social contexts and power interests that compose it. This is why they have the capacity to concretely redefine the relationships and subjects involved. Haraway also acknowledges this in her critique of the immune system as a metaphor for identity, recognizing how it is always dependent on the socio-political relationships in which it is embedded, and as such, constantly reassembled. As we have seen, the direct consequence is the instrumentalization of the immune system in xenotransplantation and the consequent production of the organ™ as an entity that challenges all the fixed categories utilized by biopolitics. Although the immune system is an actual reality in its organic material components, its "function" as an identity tool in the practice of xenotransplantation is bent and instrumentalized to correspond to the hopeful promise of this practice.

Similarly, transplantable organ in this practice moves between the cracks of concepts like species, organism and self, continually shifting through the times and spaces of xenotransplantation, becoming and remaining a collection of images: a gear, a set of computerized data, a product, a medical tool, an intruder, and finally a gift. Each of these representations does not merely involve discourse around the transplantable organ but also defines, for instance, what the genetic component of a knockout pig should be, thus determining its way of existing in the world, and, more importantly, how, at what age and with what physical dimensions it will die.

The proposal for an alternative way of framing the dynamics of xenotransplantation is based precisely on this awareness and is put forward without any presumption of determining

whether this practice is essentially right or wrong. Instead, framing the transplantable organ as a product of *hybrid labor* in which medical knowledge and technological advancement undoubtedly play a crucial role, but that cannot succeed without the sympoietic emergence of life from each individual pig, shifts the focus to the embodied risk these animals endure and the ways in which their lives are harnessed to serve the technoscientific industry. Moreover, highlighting the *hybrid labor* underlying xenotransplantation brings to light the concrete and symbolic place known as the "laboratory," where life sciences practices and knowledge are created and applied, but which in mainstream narratives remains unproblematized and uninvestigated, especially in its ethical component. Indeed, centering the narrative on the *hybrid labor* that enables a given practice means illustrating how scientific progress, understood as eternal modernization, is a process that always depends on specific socio-economic relationships that are, therefore, always questionable.

In essence, the doubt that *hybrid labor* introduces is that even if the goals of xenotransplantation are just, the methods through which it is realized might be subject to criticism. Thus, the aim of this research with this proposal is not to revolutionize the practice but to offer the opportunity to form an opinion by making the situated human and nonhuman individualities that live in and through xenotransplantation *matters*.

This was precisely the intent that led us to focus on the situated experience of the knockout pigs that live and die in Revivicor's facilities. Although in the previous pages we have tried to give equal weight to the experiences of recipients and their loved ones, it could be said that these pages lack the voice of those who live xenotransplantation as their only chance of survival while anxiously awaiting a human organ that would never arrive in time. Similarly, the opinions and perceptions related to patients Bennett, Faucette and Slayman are certainly partial, as they were gathered from indirect interviews. In other words, it could be argued

that analyzing the representations currently used to justify and perpetuate the practice of xenotransplantation, and even proposing an alternative, in this way means ignoring the fact that such narratives and practices are mobilized to address an extremely difficult reality: death.

While acknowledging the truth of these omissions, the purpose of this research lies exactly in the desire to give meaning and make present the deaths that occur within the domain of this practice. *Staying with the trouble* of xenotransplantation certainly means recognizing how the narratives mobilized are sometimes justifiably violent and contradictory in the face of the difficulty of narrating death due to the medical institutions' inability to address the shortage of transplant organs. More importantly, however, it means recognizing the fact that in the current framing, while the human deaths for which the practice is responsible are given meaning, the same is not true for the numerous animal individualities that die without will for those same lives. After all, if the success and development of this practice currently rely on the sacrifice of the patients, even though the framing of *hybrid labor* may not (perhaps) "come to terms with the contradictory feelings generated by this complex situation"[140] for the recipients, it would at least be able to make them fully aware of their choice by understanding the reality in which they are deciding to participate in its entirety.

[140] Cit. Caccavale E. *A pig saved my life* . In Giovanni A. (2010). Antennae: The Journal of Nature in Visual Culture 12. p. 30.

Conclusion

Although in these pages xenotransplantation appears as a well-established practice, the reality is that it still has major steps to take before being available to the general public. Farms for genetically modified pigs, like those of Revivicor, are multiplying and financial investments in this practice are constantly increasing, demonstrating significant interest in this field of research. However, no country has yet approved the possibility of clinical trials for this practice, which is fundamental for it to become a standardized procedure.

The primary reason behind this hesitancy is the many doubts and hazards related to the implementation of it. Besides the risk of severe immunological responses to the animal organ, which remains unresolved despite genetic alterations in pigs, the main concern is the danger of endogenous retroviruses. A notable example of the devastating impact of these porcine viruses is the swine flu epidemic in 2009, which resulted in the deaths of approximately a quarter of a million people.[141] In xenotransplantation, there is a concrete risk that some of these viruses could go undetected before the graft, potentially leading to disastrous epidemics. Apparently, the cause of death of David Bennett Sr. himself was attributed to one of these porcine retrovirus.[142] Considering that some of these diseases may spread from the recipient across a community, they pose a significant danger to public health.[143]

[141] Rollin B. E. (2020). *Ethical and societal issues occasioned by xenotransplantation.* Animals: an open access journal from MDPI, 10(9), 1695. p.3.
[142] Christensen J. *More people need transplants than there are organ donors. Pigs might be a solution.* CNN. 9 May 2024. *https://edition.cnn.com/2024/01/30/health/pig-organ-transplant-xenotransplantation/index.html*
[143] Ivi.

All this makes the future of xenotransplantation unpredictable. The only certainty in the field is that even with the implementation of comprehensive health and social policies to maximize the number of human donors, it would still be impossible to meet the current demand for organs. This is because, even in the best-case scenario, less than 1% of volunteers would die in a manner that makes their organs viable for transplantation.[144]

Some retain that xenotransplantation could be a *bridge practice*, a relatively short-term solution while waiting for new and safer practices that are still under research. Like the use of 3D-printing technologies to assemble multiple cell types, growth factors and biomaterials to produce bioartificial organs, on which there are ongoing studies.[145]

In all this medical-scientific debate concerning the value of xenotransplantation, there is a significant absence of critical reasoning around what kind of life and which lives are valued in this practice; especially given its aim to save as many as possible. Moving beyond an approach that merely calculates the lives xenotransplantation is or could be responsible for, this research has highlighted how the transplantation of animal organs is based on an uneven distribution of life chances. Namely, how the interplay of medical practices, technological innovations, political visions and cultural meanings that composes the xenotransplantation systematically imposes forms of violence on some lives connected to it. This inequity is evident not only in the relegation of certain beings to exploitative dimensions but also in the consideration and valuation of only certain aspects of living.

As made clear through the sympoietic lens employed in this study, this hierarchical and exploitative organization of living beings is generated by the biological categories that technoscience places at its foundation. A truth that becomes apparent if recognized how

[144] Ivi.

[145] Rogers K. *When we'll be able to 3D-print organs and who will be able to afford them.* CNN, 10 March 2023. https://edition.cnn.com/2022/06/10/health/3d-printed-organs-bioprinting-life-itself-wellness-scn/index.html

xenotransplantation operates in a cosmos that revolves around the organ, an entity whose definition and representation are continuously renegotiated, consequently justifying different and new forms of violence each time.

As clarified by this study, the cooperation of technologies and life sciences endlessly mobilized in our contemporaneity with practices such as genetic engineering or cloning, stems from a vision that reduces life to its minimal components while ignoring its emergent and interdependent properties. This type of reductionism is an expression of the neoliberal era, characterized by the normalization of the commodification of living beings and their components with the bio-economy as the ultimate example.

The framework of knowledge and theories around which xenotransplantation is designed clearly relates to this. Inside and outside of Revivicor's facilities, the realization of this practice revolves around the idea of life as data and the ability to utilize it. In fact, it is the genetic data that enables the creation of knockout pigs and again the collection of data from transplantation experiments on primates and brain-dead human patients that allows for their perfection. Even the involvement of recipients is dictated by data, both physically through the definition of times and modalities of the anti-rejection therapies and psychologically in their willingness to risk death by undergoing the operation in order to advance the research through the gathering of more information. All this focus on data in the practice of xenotransplantation leads to the belief that an organic component can be mass-produced according to precise and measured parameters, resulting in the idea of transplantable organs as patented products.

As clearly underlined by the consequences of our research, this erroneous conviction is anything but innocuous. In failing to recognize how organisms form in specific and situated relationships of complexities and interdependencies, it allows for a command-control operation on the living

aimed at the functionalization of life according to industrial rhythms and interests. Obviously, this form of exploitation mainly impacts those lives that technoscience defines and redefines as expendable through the biological categories and public narratives it mobilizes.

In the case of xenotransplantation these lives are always, and inevitably, those of animals, who bear the most significant burden of this dynamic driven by both medical research and market interests. A process that results in what Weisberg defines as an *ontological collapse* in their individual experience of life, a split between what they would naturally seek and what their altered bodies allow them to do, due to induced genetic modifications and the procedures they undergo. However, in these pages, we have also focused on how the essence of their existence is further overridden by human-defined purposes and constraints in the exploitation of all those symbiotic and life-affirming activities that define every living subject. By recognizing life as an event emerging in a dynamic and interdependent relationship with its surroundings, we have also seen how each living being is not a mere collection of disconnected elements. Rather, there is an emergent organization within it. These web of relations and actions, including growth, immune response, adaptation to the environment, energy transformation and more, are those that characterize the existence of each living being. So, in the case of knockout pigs, exactly these processes are co-opted into the assembly production of the organ™, through a strict functionalization aligned with the goals of xenotransplantation. A consequence of the marginalization of the individual experiences of animals in technoscientific vision, and thus of their struggle.

Starting from this awareness, our proposal to re-narrate the relationship and the activities that compose xenotransplantation and other biotechnological practices under the concept of *hybrid labor* could represent a viable alternative to hold them accountable for the struggles they generate and for those who experience them. After all, these practices are fundamentally based

on the unproblematic appropriation of those symbiotic activities extensively described earlier, which can be summarized and represented in the idea of *regenerative labor*. As in our case in which it is essentially this kind of labor that enables the organ to function in both a human and a pig's body, thus defining its true market value as a patented product.

While it's challenging to define in this context the best ways to propose a perspective that recognizes labor as equally and collaboratively human, nonhuman and technological, this research has clearly showed how in the development of technoscientific practices, not only policies play a role, but also public opinion and therefore the media represent a fundamental aspect. After all, the willingness to discuss *hybrid labor* in the context of biotechnology means acknowledging all those individuals who structurally, based on social categories of race, gender and species, bear the embodied risks and sufferings of it. In essence, it's a reflection that aims to at least juxtapose the "successes" of technoscience with the structural violence they are based on, with the intention of making them *respons-able* for this as much as possible.

This reasoning brings us back to the sympoietic vision of life and its consequences on the ethical-political plane. In analyzing xenotransplantation, we have focused on how certain lives are prioritized at the expense of others and the impact this has on individual experiences. However, this research also addresses which aspects of life are entirely overlooked in this practice and by biotechnology in general.

Life sciences and related disciplines undeniably apply a standardizing gaze to livings and their material and immaterial components without considering variability as a fundamental characteristic of being alive, as emphasized by Kupiec. More precisely, what emerges in this research is how the self-logics, forms of organization and agency that constitute the uniqueness of each living being are substantially ignored by technoscience. As each individual living entity

develops its own structural-semiotic way of being alive, in biotechnology this specificity is manipulated, restructured and augmented for specific uses. There is essentially a nullification of any expression of life's uniqueness. This opposition to the variability and complexity of life goes beyond biological conceptions, manifesting violently on bodies not only through their standardization but also by excluding the ends inherent to their activities. As exemplified in Revivicor's designs, reproduction is stripped of its potential for mixing and variability, development is meticulously calibrated in terms of functionality and adaptation to the environment is considered solely in terms of potential organ rejection by the human recipient.

In essence, what is absent in the way technoscience approaches life is the recognition of its intrinsic forms of telos, representation, intentionality and agency. These characteristics, as we have extensively demonstrated in considering some organs as alive, are inherent in all biological processes, even nonhuman ones and even in entities without consciousness. Yet, in the technoscientific employment of living beings, these characteristics remain completely sidelined. We want to conclude, therefore, with an invitation to open up a reflection on the general use of life in contemporary society, primarily through research on biotechnologies and their various applications, from the medical field to agriculture. This research should look at where life is put at the service of humans, aiming to highlight what omissions have been made, what ends have been imposed, and, most importantly, the consequences on those individual beings that usually do not enter the frame. After all, it is these violent omissions that allow for the perpetuation of the *anthropological machine,* in which the origins of speciesist exploitation and the environmental crisis we are currently facing can be traced.

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