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# **Mapping the Ethics of Animal Research: The Moral Relationship between Humans and Animals, the Ethics of Animal Research, and the Future Alternatives**

**Siwat Varnakomola<sup>1</sup>**

<sup>1</sup>King's College London (2022)

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## Abstract

Over the past few years, the debate on animal research has once again received much attention from scholars across fields of study. Previous studies have extensively discussed when and how it is morally acceptable to use animals in research. Nevertheless, no consensus has been reached until today. Therefore, this study will engage in this conversation by calling into question whether animals do possess moral status and on what conditions using them in research is morally justified. The main objective of this study is twofold. First, it attempts to set out the moral relationship between humans and animals providing an overall evaluation of the animals' moral status and explaining how this moral landscape has evolved overtimes. Second, it aims to outline some of the extant and future alternatives which could fully replace most animal research and testing nowadays. Recognising the moral status of animals, this study argues that animal research is morally justified only when, first, it greatly benefits both humans and animals that it can preclude great suffering or death in a huge number of humans and animals. Second, there are no alternatives that can completely replace using animals in research. If animal research is inevitable, the 3Rs principles – *replacement, reduction, refinement* – must be applied accordingly. Despite the potential criticisms, the article maintains that using animals in research should remain an option, but it must be the last resort when no alternatives can fully replace them.

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**Keywords:** animal research, the moral status of animals, the ethics of animal research, alternatives to animal research, social morality.

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## Introduction

For decades, animal research<sup>1</sup> has germinated in many countries across the world, and it has raised moral and ethical concerns among people. Thanks to the protests against animal experiments throughout the twentieth century, the 3Rs principles have been developed: *replacement* (replacing 'sentient' animals with painless or do-no-harm alternatives), *reduction* (reducing the number of animals used in research as much as possible), and *refinement* (minimising pain, suffering, and distress in all procedures). Nowadays, the 3Rs principles serve as fundamental justification for animal research globally (Sneddon et al., 2017; DeGrazia & Beauchamp, 2019; Zemanova, 2020). Against this backdrop, using animals<sup>2</sup> in research remains controversial. Much of the extant literature still debates over the conditions in which using animals in research is morally justified. Certain scholars contend that animal research is morally permissible in some cases, most importantly, when there are no alternatives (Fenton, 2019; Kabene & Baadel, 2019; Martin, 2022). Contrarily, others disagree by arguing that animal research is morally unacceptable in all cases and that allowing using animals in research would lead to detrimental consequences to the future of animals across the world (Regan, 1986; Akhtar, 2015; Healey, 2020).

In this regard, this article contributes to this conversation by calling into question whether animals do have moral status and what conditions permit the use of animals in research considering the currently available alternatives. The aim is two-pronged. First, it attempts to map out the moral relationship between humans and animals providing a critical overview of the moral status of animals and to explain how this status has evolved over time. This article emphasises that animals do possess moral status since they can express moral reasons in the form of emotions as will be discussed later. Second, it aims to outline certain existing and future alternatives which could fully replace the use of animals in most research and testing. The article maintains that there are two useful approaches to analyse the conditions in which the use of animals in research is morally justified. The first approach is utilitarianism, an ideology in Western ethics. Another approach is non-abolitionist Buddhist ethics, an ideology in Eastern ethics. Both approaches agree that animal research is permissible only if it greatly benefits humans and animals while using animals in research that merely generates economic benefits is not morally justified. This will be discussed in the third part.

Recognising the moral status of animals, this article argues that animal research is morally justified only if, first, it greatly benefits both humans' and animals' interests that it can prevent great suffering or death in a huge number of humans and animals. Second, no alternatives can fully replace using animals in research. Most importantly, if it is inevitable to use animals in research – *there are no alternatives* – then applying the 3Rs principles is a must. By this, the article strongly supports that animal research producing trivial benefits or mere economic benefits such as toxicity testing in cosmetic industry or weaponry research is *not* morally justified thanks to the existing alternatives.

The article admits that some people might disagree with the main argument since it still permits using animals in research in certain cases. However, on the one hand, the fact remains that using animals in research should still be an option, but it must be the last resort when no alternatives can fully replace using them. On the other hand, completely prohibiting animal research in all cases may preclude any future innovative projects that would considerably advance the future of animals and humankind.

In building this argument, the article will proceed in five parts. The first part will outline the background of animal research in Western society. The next part will discuss whether animals do have moral status or value as well as represent the moral relationship between humans and animals by putting forward a case of Danish research monkeys. Using the development of the SARS-Cov-2 vaccine as an example, the third part will then analyse the conditions in which animal research is morally acceptable. The fourth part will unpack the 3Rs principles and outline other existing alternatives by using organ-on-chips (OOC) and computer modelling as examples. This part will end by providing recommendations to encourage fully replacing animals in research. The last part concludes that using animals in research that substantially benefits humans and animals' interests when there are no alternatives is morally acceptable, meanwhile using them in research generating sole economic or trivial benefits is morally unjustified.

### **A brief history of animal research in Western society**

The history of using animals in scientific research can be traced back to the seventeenth and eighteenth centuries. During this period, animals were considered solely as biological ‘resources’ to be exploited to serve the interests of humans (Rollin, 2009; Koch & Svensen, 2015; Monsó et al., 2018). They were widely used in experiments by scientists and researchers since they offer important biomedical knowledge, which was essential to scientific advancement to benefit humankind during that time (Franco, 2013; DeGrazia, 2015). William Harvey, for instance, published *Exercitatio Anatomica de Motu Cordis et Sanguinis in Animalibus* in 1628 which “provided the most accurate description of blood circulation and heart function of his time” (Franco, 2013, p. 243). Similarly, the physiologist Stephen Hales developed the first measurement of pressure in blood vessels in the eighteenth century and invented the forceps— an instrument used in medical treatment, especially for the delivery of babies (Eknoyan, 2016).

The nineteenth century saw a more moral and ethical consideration among people over using animals in research, indicating a growing recognition of animals’ moral status as seen from an increasing number of antivivisection movements<sup>3</sup> such as the movement in Britain (Regan, 1986; DeGrazia, 2015). Moreover, thanks to the demands for animal welfare against animal experimentation, there was the world’s first legislation which regulates the widespread animal experiments called the 1876 Cruelty to Animals Act which established a system requiring licences for experimentation on animals (Finn & Stark, 2015). In the United States (US), due to the dissatisfaction of widespread outrage that pets such as dogs, cats, rabbits were stolen and were sold to research laboratories, the Animal Welfare Act became law in 1966 but it still excluded farm animals, rats, and mice, which were widely used in research the most (DeGrazia, 2015). As well, there were the US federal laws to protect animals in experimentation such as the 1985 Health Research Extension Act (Rollin, 2009). Despite the continuing protests, the number of animal experiments kept rising throughout the twentieth century.

Fortunately, a moral and ethical framework was developed in the late 1950s. This has become a dominant guiding principle to conduct animal research until today (2022 A.D.). Having been developed by William Russell and Rex Burch in 1959, the 3Rs principles – *replacement*, *reduction*, and *refinement* – have been universally adopted by scientists and researchers to justify the use of animals in their research in addition to the harm-benefit analysis (Brønstad & Sandøe, 2019; Hubrecht & Carter, 2019). Replacement refers to replacing animals with do-no-harm alternatives. Reduction refers to lowering the number of animals used in research as much as possible, while refinement refers to refining all procedures conducted during research to minimise animals’ suffering (Sneddon et al., 2017; Zemanova, 2020). Despite the criticisms for their inadequacies and a call for reinvigoration (Strech & Dirnagl, 2019; Blattner, 2019; DeGrazia & Beauchamp, 2019; Martin, 2022), these principles clearly reflect the global trends towards the prioritisation over animal welfare nowadays.

### **Debates over animals’ moral status, and the shifting moral landscape in the relationship between humans and animals.**

Drawing from the aforementioned background, animals are not initially considered as moral subjects and how we treat to them does not have a moral importance (Rollin, 2009; Koch & Svensen, 2015; Monsó et al., 2018).

However, from the nineteenth century onward witnessed a shift in the moral landscape between humans and animals to consider moral and ethical concerns in how humans treat animals. Until today, there is a consensus among scientists that animals are considered as moral subjects, but a little disagreement remains on whether they are moral agents<sup>4</sup>. This section will take a step back to answer the question of whether animals have moral status, or whether it is only humans that possess such status. A key purpose of this is to set the stage before moving to the next part which will discuss the conditions when animal research is morally justified.

There are many ways to identify the moral status or value of animals. One way is to examine if animals are moral subjects so that they can possess moral status even if they are not moral agents. One of the most influential works on this is Rowlands (2012). In his book, *Can Animals Be Moral?* He strongly argues that animals can be moral subjects even if they fail to be moral agents. Like individuals, whether animals can be moral subjects depends on the fact that they can act or can be motivated to act based on moral reasons. Rowlands (2012) proposes that the moral reasons of animals appear in the form of *emotions*. These involve happiness, joy, love, sadness, anger, etc. This led him along with several scholars like Rollin (2009) and Monsó et al. (2018) conclude that animals are moral subjects since they can act or can be motivated to act by their moral reasons which are full range of emotions. Therefore, sentient animals have moral status, and they are beings to whom moral agents can have obligations. A plethora of extant studies supports this claim (Nyika, 2009; Potts, 2009; Rollin, 2009; Rowlands, 2012; Koch & Svensen, 2015; Monsó et al., 2018; Andrianova, 2021; Martin, 2022).

One of them is the case of *Mila, the saviour beluga* cited in Potts (2009). Mila was the beluga housed at the aquarium in China. It was the moment when Yang Yun, the Chinese diver who was participating in the diving contest at that aquarium, had her legs paralysed during the contest. She felt scared. Unexpectedly, Mila came out of nowhere to help her. Mila held her legs with her jawbone and brought her back to the surface. This case backs Rowlands's argument well. Saving Yang Yun's life, Mila the beluga seems to act morally in this case. Her behaviour demonstrates that there is evidence of concern for the paralysed diver, and she seems motivated to behave based on this concern. This means that Mila understood that the diver needed help, so she decided to help the diver whose leg was paralyzed. Hence, Mila appears to be a moral subject since she can behave based on her moral reasons in the form of emotions. Nevertheless, she fails to be a moral agent because she does not have responsibility or obligation to help the diver, meaning that Mila could choose to ignore the diver. Instead, she is a sentient being to whom moral agents could have obligations.

The second way is to evaluate whether animals possess either intrinsic or extrinsic value or both. There are two primary types of value: *Intrinsic value* and *Extrinsic value*. The former can be defined as an internal property of something and defines its existence. When we say something has intrinsic value, it means that such a thing is valuable 'in itself' or 'in its own right'. (Regan, 1986; Zimmerman & Bradley, 2019). This implies that we, humans, are obliged to consider their well-being and not to impose suffering on them, or at least not with inadequate justification. In addition, Westacott (2019) explains that the intrinsic value can be characterised as

‘for someone else’s sake’ because people sometimes bequest their own happiness for the sake of either other people in the wider society or for other things, to name a few, arts, spirituality, or religion. Those are the things which make they feel cherished by someone for their own sake. In contrast, the extrinsic value can be defined as instrumental value since it values things as a means to some ends (Zimmerman & Bradley, 2019; Westacott, 2019). This suggests that animals can be used to achieve certain ends for the humans’ sake. Taken together, recent studies confirm animals possess both values (Monsó et al., 2018; Schlote, 2018; Andrianova, 2021). This is because, on the one hand, animals can act on its own and they can express permission or objection in accordance with their needs through their body languages. On the other hand, animals can be used by someone as a means of achieving that one’s or someone else’s needs/objectives as seen in using animals in research.

All things considered, it seems clear that animals *do have* moral status whether they are valued intrinsically or extrinsically. Although they fail to be moral agents as they have no moral obligations, they all are moral subjects which can act or can be triggered to act based on their emotions as moral reasons. Drawing upon this consideration, the following paragraphs will investigate the moral relationship between humans and animals to show the shift in animals’ moral status from being biological resources only serving humans’ interests to moral subjects possessing a claim to life for their own needs.

As the first part has shown, the moral landscape of animals started to shift from the nineteenth century onward. Humans began to rethink and alter the ways in which they treated animals based on the consideration of animals as moral subjects. Among other scholars, Koch and Svensen (2015) provide the clearest illustration reflecting this shift. Studying the moral relationship between the researchers and capuchin monkeys in Danish biomedical research, they employ Giorgio Agamben’s concept of ‘bare life’ (*zoe*) and ‘quantified life’ (*bios*) to demonstrate the dynamic of the moral landscape in using non-human primates for research in Danish biomedical laboratories<sup>5</sup>. Initially, the dominant moral logic for using monkeys in research is that monkeys are regarded as a ‘pure *zoe*’ which means that they are used only to serve human interests and have no moral importance or, in the language of value, have a pure extrinsic value – only for contributing to humans’ quantified *bios* life. To illustrate, an enormous number of monkeys were killed for the purpose of polio research around the 1950s. Their lives in the laboratory, for captured monkeys, were so desperate that their housing and husbandry were bad for their own lives. Considering the following description:

“The monkeys were placed in the basement of the lab in individual cages, physically isolating the monkey bodies from each other. The smallest and oldest cages were 0.7 x 0.7 x 0.85m. The monkeys were used for experiments several times a week. They were *forcefully* (emphasis added) pushed towards the injection needle, and subjected to the effects of experiments, observation, and various kinds of testing. And after hours or days of recuperation, they would relieve similar or new experiments involving prolonged muscular and neurological spasms, depression, or other undesirable effects.” (Koch & Svensen, 2015, p. 376)

This demonstrates that the monkeys are considered as pure *zoe* and that researchers have no obligations to treat the monkeys morally since their bodies are sacrificed only to achieve the objectives of the research. Yet, this consideration of monkeys as pure *zoe* cannot prevent the researchers' consciousness from becoming emotionally affected by what they did to the monkeys because they cannot turn a blind eye when monkeys experience sufferings. Furthermore, it appears that the researchers respect the lives of those monkeys and that the procedures they do to the monkeys should not be too painful. One of them admitted that "it is difficult to throw off the discomfort of letting them sit in the cages. They got good food and service but could not jump around as in a zoo" (Koch & Svensen, 2015, p. 377). Another researcher stated that "they had our respect and compassion; it should not be too painful for them." (Koch & Svensen, 2015, p. 377). His statement poses a moral consideration here. It implies that the researcher recognised moral importance of the monkeys and felt that they were emotionally connected to him – they can experience pain and suffering like humans. Therefore, this made him feel obliged to treat the monkeys in a more moral way. By this, the monkeys' status slips from being a pure *zoe* to be exploited for humans' sake to more *bios*, which hinders humans from exploiting the monkeys fully because of the moral relationship they feel obliged to.

Linking to the wider conversation, this reconceptualised moral relationship between humans and animals has not only laid the foundation for humans to establish a more moral and ethical approach to animal research, but also given rise to a prolonging debate on what conditions morally justify using animals in research. This will be assessed in the following part.

### **Discrepancies over the conditions when animal research is morally justified**

As discussed earlier, there seems to be no consensus among scholars on when animal research is morally permissible. In essence, this long-lasting debate reflects three competing views. Regardless of the existing alternatives, the first view permits animal research in all cases. Another view justifies animal research when there are no alternatives, and the research output greatly benefits both humans and animals in some ways (Fenton, 2019; Kabene & Baadel, 2019; Martin, 2022). The last view suggests a complete abolition of using animals in research in all cases (Regan, 1986; Akhtar, 2015; Healey, 2020). Considering the shifting animals' moral status above, the first view is no longer considered as morally and ethically acceptable among all people because not only does it obsolete, but it also disregards the alternatives to replace using animals in research. Therefore, the ongoing debate concentrates on two latter views. Pondering both views thoroughly, this article maintains the second view. Although both views are regarded as morally justified, allowing using animals in research that provides great benefits to humans and animals when there are no alternatives seems more advantageous than entirely abolishing it.

Over the past few years, the proposal to totally prohibit animal research in all cases has been challenged by several studies (Fenton, 2019; Kabene & Baadel, 2019; Andrianova, 2021; Martin, 2022). Recognising the intrinsic value of animals, the former justifies by stressing that animals have absolute claim to their life. Humans therefore have no rights to deprive of this claim. Although admitting that this justification is true, it

could be criticised in two ways. First, certain animals like mammals can provide consent<sup>6</sup>. For example, Schlote (2018) and Andrianova (2021) illustrate how mammals can express either permission or objection through their body languages. In this regard, using animals in research could be justified when animals express consent in some ways. This idea is heavily influenced by Donovan (1990) arguing from a feminist perspective that how human treat animals must be based on the emotional conversation between them. Second, a complete abolition of animal research would preclude any future advantageous projects that may substantially benefit both humans and animals, for example, when the research output can prevent great suffering or death in an enormous number of humans and animals as will be seen in the case of developing the SARS-Cov-2 vaccine<sup>7</sup>. Martin (2022) supports this by arguing that a total abolition of animal research would be ethically problematic as it seems to preclude any potential advantages to animals.

To elaborate the second point, two approaches seem useful to suggest the conditions permitting animal research – the utilitarianism and the non-abolitionist Buddhist ethics. First employed by Singer (1975) to study animal rights, utilitarianism admits that sentient beings are both equally considered by “counting everyone’s comparable interests equally in its directive to maximise utility or net welfare” (DeGrazia, 2015, p. 691). Similarly, Graham and Prescott (2015) argue that cost-benefit or harm-benefit analysis is deeply embedded in ethics in animal research guided by utilitarianism. Therefore, utilitarianism may allow using animals in research if it offers great benefits for humans and animals, or as long as expected interests outweigh the costs, and there are no alternatives that offer a ‘better’ cost-benefit ratio. In line with other scholars (Singer, 1975; DeGrazia, 2015; Koch & Svensen, 2015; Kabene & Baadel, 2019), this led Rollin (2009) concluded that embracing the utilitarian benefit argument could end up with the fact that animal research is only morally justifiable when it contributes to a greater good than harm. Importantly, this does not mean utilitarianism would justify ‘all’ research that simply produces more good than harm. Rather, research producing only trivial benefits like mere economic necessity is not morally acceptable (Kabene & Baadel, 2019).

Likewise, Buddhist ethics follows a similar logic. Buddhism stresses that deliberately imposing any harms to any sentient beings is unacceptable in the first place because it is considered as conducting bad *karma*<sup>8</sup>. This may leave the doer encounter undesirable consequences. However, it still follows the utilitarian harm-benefit calculation contending that animal research remains morally permissible when the research brings about greater benefits than harm to animals as Fenton (2019, p. 112) precisely noted that “it [animal research] is permissible when the research or test offers a possible benefit to the animal research or test subject that is otherwise unavailable, and *the possible benefit is greater than the cost to the subject*”. By this, using animals in research that generates considerable benefits to animals or test subjects, according to Buddhism, is morally justified, whereas the research that does more harm than good to them is morally unacceptable. In line with the utilitarianism, this means Buddhism does regard using animals in research producing merely trivial benefits as morally unjustified because only economic necessity is not sufficient to give grounds for animal research.



Taken together, it should be clear that using animals in research or testing to achieve mere economic and trivial benefits is morally unjustified. In contrast, it is morally acceptable only if (1) it greatly benefits both humans' and animals' interests that it can prevent great suffering or death in a huge number of humans and animals, and (2) no alternatives can fully replace using animals in research. A good example elaborating this argument is the case of developing the SARS-Cov-2 vaccine as will be discussed in the following paragraphs.

It is undeniable that the outbreak of coronavirus (COVID-19) since 2019 has impacted all species leading to a great suffering and death in both humans and animals across the world. In response, scientists have been developing the vaccine to prevent humans and animals from getting infected. A large number of animals have been used in numerous biomedical research to develop the vaccine (Deb et al., 2020; Iserson, 2021; Schwedhelm et al., 2021). For example, in Germany, Schwedhelm et al. (2021) indicate that over seven millions of animals have been used in the laboratories over a year and five months since the beginning of the pandemic as seen in figure 1. Using the 3Rs as fundamental ethical principles to conduct research, the justification is two-pronged. On the one hand, animals provide us with focal details regarding the COVID symptoms, and how the virus works. Also, their models offer a new scientific knowledge on how safe and effective different types of the SARS-Cov-2 vaccine are such as the effectiveness of the mRNA vaccine (NIAID Now, 2021). On the other hand, no alternatives seem to fully replace the use of animals in such research (Deb et al., 2020; Iserson, 2021; Schwedhelm et al., 2021). These contributions of laboratory animals are behind the success of Pfizer and Moderna in producing the mRNA vaccine which was claimed to prevent over 90 percent of all the SARS-Cov-2 infections (NIAID Now, 2021). Moreover, their role in biomedical research will also determine the success of the Russian Carnivac-Cov vaccine, which is invented particularly for animals like dogs, cats, etc. to generate the antibodies preventing them from getting infected by the SARS-Cov-2 (Chavda et al., 2021; Rozenbaum, 2021).

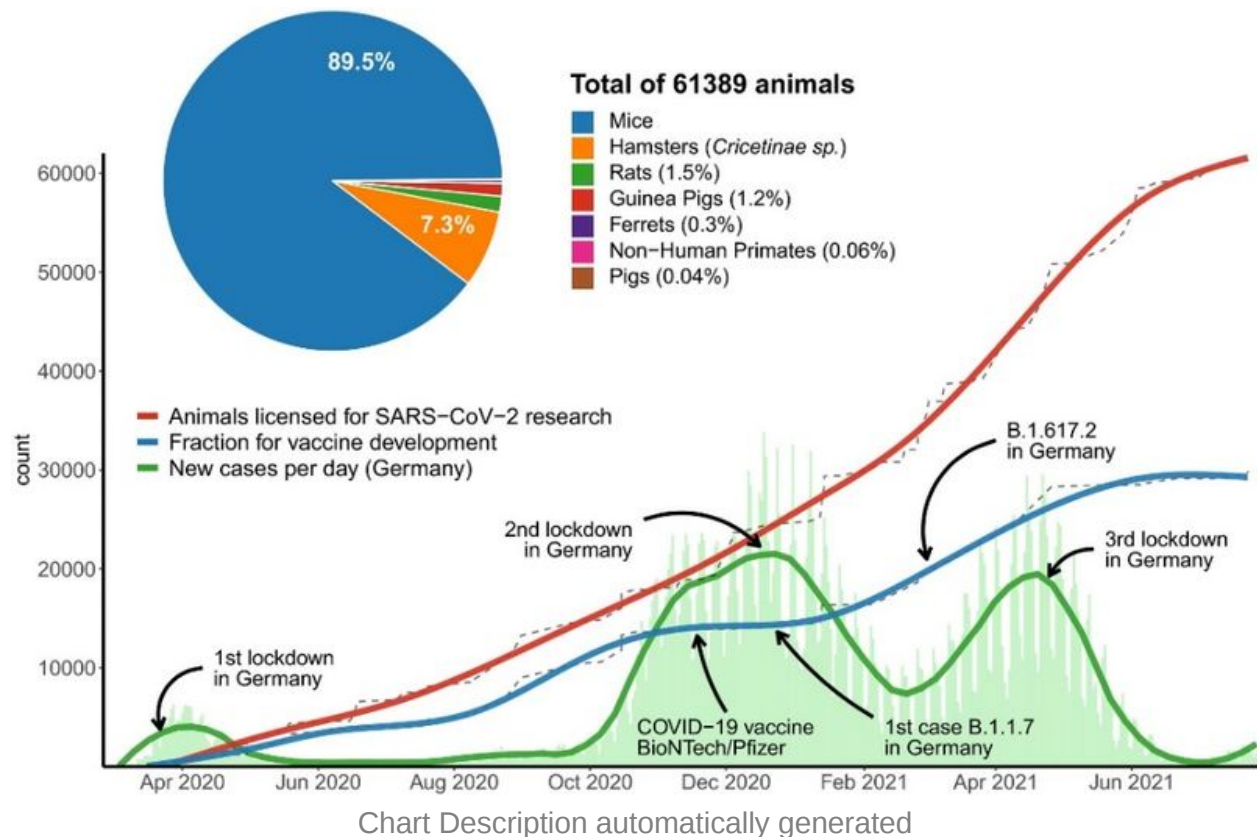


Figure 1. The number of animals used to research the SARS-Cov-2 vaccine in Germany between April 2020 and June 2021 from Schwedhelm et al., 2021, p. 2.

According to our thesis, this seems morally justifiable. Firstly, the development of the SARS-Cov-2 vaccine is for preventing great suffering and death of humans and animals, signifying that it provides great benefits to both entities. Secondly, while there are no alternatives that can completely replace the use of animals in such research, the principles of 3Rs are employed as a guiding moral and ethical principles to justify using them in the research. Unsurprisingly, the development of the SARS-Cov-2 vaccine has triggered another wave of advancing further alternatives to completely replace the animal research (Deb et al., 2020; Iserson, 2021). This links to the wider debate of the inadequacies of 3Rs principles and the growing efforts to reinvigorate them to better protect the animal rights in the research. This will be discussed in the following section.

### The 3Rs principles and other alternatives

To compromise both biomedical research community's interests and its ethical concerns, the 3Rs principles were developed by Russell and Burch in 1959 to provide an ethical guiding framework for acting 'more humane' (or less evil) in animal research. Up to the present, they remain dominant ethical principles that every researcher strongly embraces to justify all cases of animal research. As mentioned earlier, the 3Rs consist of *replacement* – replace animals used in research with any alternatives, *reduction* – reduce a number of animals

used in research, and *refinement* – refine the techniques to minimise the suffering, pain, and distress in animals as low as possible (Sneddon et al., 2017; Zemanova, 2020). These principles have been implemented in legislation in countries across the world, for instance, in European countries. This section will evaluate whether the implementation of 3Rs principles in animal research is successful and will then outline the alternatives to replace using animals in research.

Animal research in Europe is abided by a common directive implemented in different national legislations that are designed to enforce widely accepted ethical standards (Brønstad & Sandøe, 2019). The EU directive 2010/63 article I uses the language of 3Rs, stating that “this Directive establishes measures for the protection of animals used for scientific or educational purposes. To that end, it lays down rules on the following: (a) the replacement and reduction of the use of animals in procedures and the refinement of the breeding, accommodation, care, and use of animals of procedures” (European Union, 2010, p. 38). Brønstad & Sandøe (2019) interviewed a group of researchers in four northern European countries in order to study how ethical guidance given by the 3Rs interacts or competes with other considerations in research including planned animal use. They argue that although the implementation of the 3Rs is successful among those researchers since they do address values and work in conformity with the 3Rs, there are some practical issues in adapting the *reduction* and *refinement* principle. The concern of the former is that using a miniscule number of animals was insufficient to provide reliable data and was considered as unethical animal use. Importantly, it is essential to include an adequate number of animals to ensure the statistical impact and justify the animal use in the research. Meanwhile, the latter encounters the concern that treating animals well to avoid stress may make researchers collect the data on a slant. These findings of their study shed light on the increasing debate over the inadequacies of the 3Rs principles in protecting animal rights as follows.

Although universally accepted, some scholars suggest that the 3Rs principles seem insufficient to justify the use of animals in research. Therefore, they need to be reinvigorated or developed further (Strech & Dirnagl, 2019; Blattner, 2019; DeGrazia & Beauchamp, 2019; Walker & Eggel, 2020; Martin, 2022). Criticising that the principles focus heavily on animal welfare and seem to ignore the aspect of scientific value, making the principles inadequate to justify the use of animals in research, Strech and Dirnagl (2019, p. 1) argue that these principles need to be expanded into 6Rs principles, which further include “robustness, registration, and reporting,” in order to adequately justify the usage of animals in research. Similarly, Blattner (2019) suggests that the hierarchy within 3Rs principles must be re-arranged, with the replacement placed on the top to emphasise the need to find alternatives to replace the animals used in research as soon as possible. DeGrazia and Beauchamp (2019) criticises that the 3Rs principles provide an ethical framework to justify the use of animals only in scientific research. Hence, they fail to recognise several focal aspects of animal welfare outside the scientific procedures such as housing, transport, and companionship. Taken together, all scholars agree that the 3Rs principles are fundamental to justify the use of animals in research even though they suggest that the principles themselves need to be revised or further developed.

Apart from the 3Rs principles, nowadays, there are many available alternatives that could replace using animals in most research. To name a few, these involve the organ-on-chips (OOC), computer modelling, human tissue models, human blood derivatives, using human *volunteers*, stem cells, 3Ds images, etc. Notwithstanding, this article will investigate only the first two alternatives since they have gained prominence among researchers and scientists for the past few years. Even though they cannot replace all animal experiments up to now, they still serve as ethical and preferred choices for researchers to the use of animals in research (Cheluvappa et al., 2017; Kabene & Baadel, 2019; Wu et al., 2020; Low et al., 2021).

The first example is the organ-on-chips (OOC) which was first developed by the Wyss Institute at Harvard University. Utilising computer microchip manufacturing methods, scientists at the institute have developed chips that mock the structure and function of human organs and organ systems (See Also Wu, et al. 2020; Low et al., 2021). The first of these was the lung-on-a-chip, “a clear, thumb drive-size device with two channels: an air-filled upper channel lined with human alveolar epithelial cells, and a lower channel lined with blood vessel cells and a white blood cell-containing solution flowing through” (Kwon, 2017). These microchip organs could replace animal studies by replicating human physiology, diseases, and drug responses more accurately than crude animal experiments do (GlobalData Healthcare, 2018). Additionally, Low et al. (2021) indicate that the OOC not only provides accurate details disease pathophysiology and human organ function but also precisely anticipate the effectiveness of drugs in humans.

Another example lies in computer modelling which is “a wide range of sophisticated computer models that simulate human biology and the progression of developing diseases” (*Alternatives to Animal Testing*, 2019). Currently, Human biology and pathophysiological simulations can be displayed by utilising innovative computer modelling software. Studies show that computer modelling help improve drug development for patients (Passini et al., 2018), precisely predicting the ways that new drugs will react in the human body, and after all replacing the use of animals in exploratory research and many standard drug tests (Cheluvappa et al., 2017; *Alternatives to Animal Testing*, 2019). Cheluvappa et al. (2017) illustrate on how the QSAR Toolbox, a software that supports chemical hazard evaluation, has been widely employed by researchers to reduce their dependence on animal research. Similarly, studying the animal research in British cosmetic industry, Kabene and Baadel (2019) indicate that computer modelling provides more accurate details for medical and cosmetics tests than animal experiments.

Thanks to the technological advancement and success of many alternatives nowadays, it could be argued that although the future scientific advancement of alternatives in animal research is unpredictable, the existing alternatives could replace *almost* all animal research considering the success in applying these alternatives in research across fields of study. To support those alternatives, governments of all countries should support and invest more in technological advancements and implement more stringent regulations that restrict animal research, experiment and testing where other alternatives are available and accessible. If it is inevitable to use

animals in research, then applying 3Rs principles, together with guaranteeing the animals' housing condition which should reach the basic needs of the animals, is a must.

## **Conclusion**

It is indisputable that the conversation over the 'right' ethics of animal research remains contentious up to the present. The article sets out to establish a comprehensive overview of the ethics of using animals in research nowadays and to evaluate the existing and future alternatives that may replace animal research completely. This article has examined the evolving moral landscape between humans and animals since the seventeenth century as well as reflected on the prolonging discrepancies over when and how animal research is morally justified. The article has also proposed a wide range of alternatives that could replace animal research fully in the future.

Recognising the animals as moral subjects, this article has argued that animal research is morally permissible only when (1) it greatly benefits both humans and animals that it can prevent great suffering or death in a huge number of humans and animals, and (2) no alternatives can fully replace using them in research as shown in the case of developing the SARS-Cov-2 vaccine. When animal research is inevitable, the 3Rs principles must be employed accordingly. Thanks to the alternatives available nowadays, using animals in research generating trivial benefits or mere economic benefits such as toxicity testing in cosmetic industry and weaponry research is no longer morally justified. To continue encouraging the development of future alternatives, the article has suggested that the government should play a leading role in financially supporting the projects and raise awareness among people to place greater prominence on the animals' moral status.

Due to the limited spaces, it seems far from possible to investigate this topic with further depth and invite readers to engage in a longer conversation especially on the question of the consent of animals as well as the burgeoning debate on the reinvigoration of the 3Rs principles. These would be compelling subjects for future research to address. Finally, the article is valuable to the wider society to establish better understandings of the moral relationship between humans and animals, and the ethics of using animals in research considering various alternatives nowadays. Appreciating this moral landscape is quintessential for us, humans, as it will determine how we treat to animals, and how humans and animals can prosper together in our one world.

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## Footnotes

1. This article will define the term “animal research” as animal usage in order to (1) seek new knowledge of biological processes and function, biomedical, or veterinary knowledge, which promotes human and animal health, and (2) test chemical substances and products’ toxicity on animals for ensuring consumers’ safety. ↵
2. Throughout this article, the term “animal (s)” will refer to all non-human animals which possess both a certain level of consciousness and the ability to express emotions. ↵

3. The pro-animal rights movement that strongly holds that animals and humans are similar to each other. [↵](#)
4. The moral agents are all beings that have moral and ethical responsibilities or obligations and certainly have moral status. For now, only humans are regarded as moral agents (DeGrazia, 2015). [↵](#)
5. However, using nonhuman primates for research is no longer morally accepted in the Danish research community as the monkeys are regarded as moral subjects possessing a claim to their life (Koch & Svensen, 2015). [↵](#)
6. This article defines ‘consent’ as the ability to permit or to allow. However, not all animals can express consent, and researchers admit that it seems difficult to measure animals’ consent and to prove that animals provide ‘true’ consent (Schlote, 2018; Andrianova, 2021). This could be an interesting issue that future research should deal with. [↵](#)
7. Another case is when the output can reinforce the animals’ resilience to the repercussions of the changing climate such as helping them adapt to a harsh environment easier. [↵](#)
8. *Karma* is the Sanskrit word that means action. Bad *karma* means a sum of the doer’s actions that would bring unpleasant consequences back to the doer, whereas good *karma* is the opposite. [↵](#)