

Creating chimeras for organs is legal in Switzerland

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Switzerland has very detailed laws regulating the use of animals in agriculture, entertainment and science. There are also many Swiss laws governing the genetic modification of animals, protecting human embryos, and criminalising the creation of human/animal chimeras or hybrids. Despite all these regulations, the creation of an animal embryo that will develop a human organ using induced pluripotent stem cells and the subsequent birth of the resulting chimera would actually be permitted by current legislation. While this might appear to be an unhappy accident due to insufficient scientific foresight, I argue here that this loophole should not be closed, as the creation of human organs inside animals will probably be possible within 10 years, and Swiss laws would currently enable the use of this process to save human lives through this allogenic or autologous organ source.

Introduction

Switzerland is famous for taking the rights of non-human lifeforms seriously. In fact, some would argue that the country has gone too far in this direction, and the government received some ridicule for the statement in 2008 that plants should also be treated with respect [1]. Swiss laws governing research with animals, interference with human embryos, and the creation of human/animals hybrids or chimeras are also quite strict. However, recent scientific advances in regenerative technology create a loophole in the Swiss law that would actually allow the addition of human genetic material to an animal embryo, the implantation of this embryo in an animal mother, and the subsequent birth of a human/animal chimera. While it might be surprising both that the law allows this and that anyone would want to do it, there is actually a very good reason for doing so.

Recent discoveries by Japanese scientists suggest that it will soon be possible to grow a human organ inside a pig [2]. The advantage of this new 'chimera organ' technology is that human organs created by adding induced pluripotent stem cells containing the recipient's own DNA to pig embryos which are then gestated and birthed by pigs will not trigger the usual immune response that occurs when a pig or human organ is transplanted into a human. Ironically, a «tailored» human organ grown inside a pig is less likely to be rejected than one grown inside another human. Even if this autologous organ creation proves too expensive and time-consuming, allogenic organs created using a series of several hundred IPS cell lines should enable a

vastly important new source of organs that are less likely to be rejected. It is likely that within 10–20 years, anyone in need of an organ will be able to use this technology to grow a new one inside a pig (or a primate if necessary). Fortunately (or unfortunately depending on your perspective), Switzerland will not have to change the law for this technology to be put into use. This seems implausible, so it is necessary to examine the relevant laws and explain why this is the case.

Animal protection law

Perhaps the most obvious objection to this idea is that there are strict protections for animals in Switzerland. Research using animals is heavily regulated and criminal sanctions apply in some cases. However, while there are very specific protections in place, it is not obvious that they would apply in this specific case. The creation of chimera organs will not constitute research once the technology is perfected (which could happen outside Switzerland). The 2005 Animal Protection law states in Article 3c that an animal experiment is:

Any measure in which a live animal is used with the aim of

1. *testing a scientific assumption,*
2. *observing the effect of a particular measure in the animal,*
3. *testing a substance,*
4. *obtaining or testing cells, organs or bodily fluids, except when this is in the context of agricultural production, diagnostic or curative operations on the animal or for determining the health status of animal populations,*
5. *obtaining or replicating organisms alien to the species in question,*
6. *teaching or training.*

Using pigs to grow human organs would not be covered by any of these criteria once the technology was proven and validated. While organs would be removed from the animals, they would be killed first, and so would not meet the primary criterion. Furthermore, genetic modification of animals is not governed by this law. (Article 11 of the law also requires that anyone conducting research with or looking after animals requires a cantonal license, and that the Federal Council «shall define

the criteria for weighing the strain on the animals against the benefits for research in the production».)

Animal protection ordinance

The 2008 animal protection ordinance provides more specific guidance than the 2005 law. It states that «Licences for the production of genetically modified animals using approved methods shall be granted if: a. only approved methods of gene technology are used; b. the animals are not genetically modified for impermissible purposes.»

The use of IPS cells is not prohibited, and «impermissible purposes» remain undefined. While some would argue that creating human organs inside animals is clearly an impermissible purpose, many others would argue that doing so in order to save human lives is clearly permissible. The same ordinance confirms that chimeras would not be «lab animals» as defined by the law because they are not to be used in experiments. Taken together, the 2005 and 2008 laws would not prevent the use of chimeras for organ creation, although they would probably prevent research to develop any such technology.

Law regulating GM animals

In addition to the aforementioned animal protection law, there is a law specifically regulating the use (but not the creation) of genetically modified animals («Loi sur le génie génétique», 2003). Article 8 states that

L'intégrité des organismes vivants doit être respectée dans toute modification du patrimoine génétique d'un animal ou d'un végétal. Elle n'est pas respectée, notamment lorsque cette modification porte gravement atteinte à des propriétés, des fonctions ou des mœurs caractéristiques d'une espèce sans que des intérêts dignes de protection prépondérants le justifient.

However, this would not necessarily rule out the creation of chimera animals and their sacrifice to save human lives, as «la santé de l'être humain» and «un bénéfice notable pour la société, sur le plan économique, social ou écologique» are both noted as interests worthy of protection. The same law regulates the effect of GM organisms on the environment, but given that the risk of zoonoses (new viruses that cross the species barrier) would be much lower for human organs created inside pigs than for pig organs used for transplant, it is unlikely that this would pose a problem.

Article 119 of the Constitution

If animal protection laws do not stop the creation of chimera organs, surely another law must? Article 119

of the Swiss constitution concerns gene technology and reproductive medicine; one might hope that it would prevent the creation of human organs inside animals. It states that

a. all forms of cloning and interference with the genetic material of human reproductive cells and embryos are unlawful.

b. non-human reproductive and genetic material may neither be introduced into nor combined with human reproductive material.

Neither of these provisions would prevent the creation of a chimera using IPS cells. Doing so does not involve cloning or any human reproductive cells; nor does it involve the combination of non-human reproductive material and human reproductive material. It does involve the combination of human genetic material and non-human reproductive material, but this is the only thing that the law does not prohibit.

Law on assisted reproduction

The 1998 legislation governing assisted reproduction specifically aims to prevent the creation of any hybrids or chimeras. Article 36 is entitled «Cloning, chimera and hybrid formation» and states that: «Any person who creates a clone, a chimera or a hybrid shall be liable to a term of imprisonment [...] The same penalty shall apply to any person who transfers a chimera or a hybrid to a woman or to an animal.» This unequivocal statement appears to make it clear that anyone creating a human organ inside an animal would go to jail. However, the definitions of chimera and hybrid are key here:

chimera formation means the fusion of totipotent cells from two or more genetically different embryos. Embryonic cells are totipotent if they are capable of developing into any type of specialised cell [...] hybrid formation means causing a non-human sperm cell to penetrate into a human ovum, or a human sperm cell into a non-human ovum.

These definitions of chimera and hybrid both exclude the addition of IPS cells to an animal embryo; IPS cells are not «from an embryo». Because of the focus on embryos and embryonic stem cells, the Swiss laws create a loophole that would allow the creation of human organs inside animals.

Law on organ transplantation

Finally, although the creation of chimera organs inside hybrid animals would appear to be permitted by current Swiss law, one remaining hurdle is the 2004 law on organ transplantation. Article 43 states that «Any

person who wishes to transplant organs, tissues or cells of animal origin or transplant products obtained therefrom into humans shall require authorisation from the Federal Office.» The criteria for authorisation are as follows:

Authorisation shall be granted for a clinical trial if:

- a) risk of infection for the population can be excluded with a high degree of probability;*
- b) a therapeutic benefit can be expected;*
- c) the necessary technical and operative requirements have been fulfilled;*
- d) suitable quality assurance system is in place.*

Authorisation shall be granted for standard treatment if:

- a) a risk of infection for the population can be excluded;*
- b) therapeutic benefit has been demonstrated;*
- c) the requirements stipulated in paragraph 2 letters c and d have been fulfilled.*

Again, however, the transplantation of chimera organs into humans could meet all of these criteria. Risk of infection is expected to be lower than for normal xenotransplantations, and a therapeutic benefit is expected. The other two requirements are technicalities. If clinical trials were successful, all the criteria for «standard treatment» would then be met, paving the way for clinical use of this new biotechnology.

Conclusion

Many people will be horrified that the relatively conservative Swiss laws on animal protection, genetic modification, and human reproduction would allow the creation of pigs with entire human organs inside them,

and the slaughter of these pigs in order to save human lives. The same people will probably insist that the law will be changed immediately. However, would Swiss people really want to let people die rather than use pigs to create new organs for them? One Swiss person dies every week while waiting for an organ, and this technology could save 500 lives per decade in Switzerland alone. Given Switzerland's historic poor organ donation rates, it would be better to leave the law as it currently stands and take advantage of this revolutionary technology once it is fully developed. In the meantime, there should probably be a public debate on the issues raised in this paper.

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