Cloning Centering at Egoism

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§1. Introduction

Cloning research caught a great deal of attention when Dolly the sheep was born (§4). While some fear surrounded the attainment (§§14-15), Wilmut's research itself has grown well, providing a less vicious manner to gain ES cells (§12).

In this article, we review the progress of cloning research along with the concern of medical circles about its application to reproductive cloning, that is to say, making replicas of human beings (§§16-21).

Note that all the content is ascribed to the author alone, not to Musashino University.

§2. Hypertrophy of Ego

In the story of Hegel, an *ego,* or a *self-consciousness,* makes an appearance to universalize itself, denying *the others*[1]. This might be incomprehensible without knowing Fichte, who wrote another story of the *absolute ego* struggling for the return to itself, overcoming the obstacles of both human and nonhuman beings[2], which is why the ego comes to exclude the others.

Hegel himself reconciled this, as it were, *hypertrophy of ego* with the others at a level of the *absolutive knowledge,* according to which the conflict between ego and the others should be resolved when they know each other at a higher level of ethics.

But possibly, Hegel's philosophy is one thing, and our age is another. In our age, similar hypertrophy of ego appears to feed itself, disguised with scientific discovery. As such, we shall straightforwardly take up *cloning research,* a hot spot of modern biotechnology, which is our concern below.

§3. Cloning as an Issue

On a level of consciousness, hypertrophy of ego would be frustrated in face of reality[3]. On a material level, however, the same hypertrophy might realize itself with the help of modern technology, namely *cloning.*

This is why cloning becomes our concern. Nevertheless, most of us do not know what cloning is in the first place. Thus, we want to clarify it with the help of history, which means we approach it by tracing the history of cloning back to its origin (§§4-12). And

then, we refer to criticism against cloning research inside medical circles (§§13-16). Finally, through the consideration of surrogate mothering, we come to the point of modern hypertrophy of ego, namely the "Baby Factory" Case (§19).

§4. Dolly the Sheep

What is cloning? This question is probably concerned with history. In terms of history, let us clarify the concept of cloning, first.

Regarding this question, what comes into our mind is probably *Dolly the sheep.* In 1997, when British biologist Ian Wilmut (1944-) and his team published "Viable offspring derived from fetal and adult mammalian cells" in Nature, cloning research caught a great deal of attention.

(1) Wilmut's cloned lamb (left) with its surrogate mother (right)[4].

This was, however, already a culmination of this field. To see the concept of cloning in a more fundamental way, we must set back the watch a little bit further.

§5. Plant Cloning

According to Fischbach et al.[5], people had the idea of cloning as early as 1970s, long before Wilmut's team succeeded in cloning mammals.

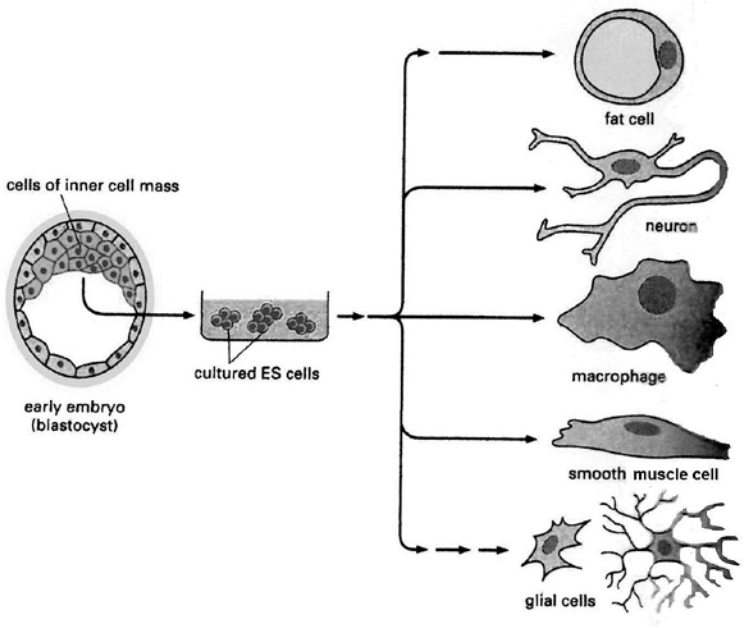
Herbert John Webber (1865-1946) is said to have coined the word "clone." He made it in order to describe the *vegetative propagation,* a kind of *asexual reproduction*[6]. We can say, therefore, cloning was originally devised for *vegetation:* reproduction of potatoes from their *tubers,* for example. You may also hear Frederick Steward (1904-1993) cloned a carrot from somatic cells of its root alone in 1958[7].

§6. Reversibility

The beginning of cloning research was all about vegetation. How did it move on to animal cloning like Wilmut's research, then?

One point which interested researchers at that time was that cloned plants, such as tubers of potatoes and roots of carrots, showed phenomena of *reversibility of differentiation*[8]. *Differentiation* is a key stage of *development*[9], which can be displayed as follows:

(2) Differentiation and ES cell (Alberts et al. 2003, p.724)



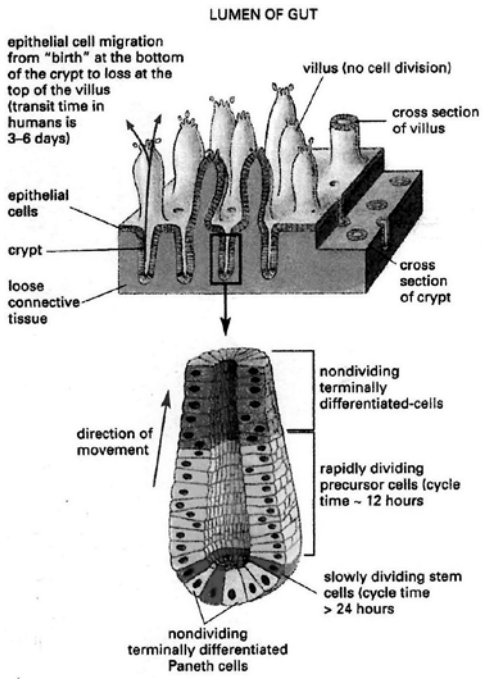
On the right side, you can find the "fat cell," the "neuron," the "macrophage," the "smooth muscle cell," and the "glial cells." They are all *differentiated* from one primitive cell[10], which we see in early stages of an embryo[11] like the *two-cell stage,* the *four-cell stage,* etc.[12] This process of differentiation plays a key role in the development of living things but was long considered *irreversible.* Cloning research overturned that very idea[13].

§7. Stem Cell

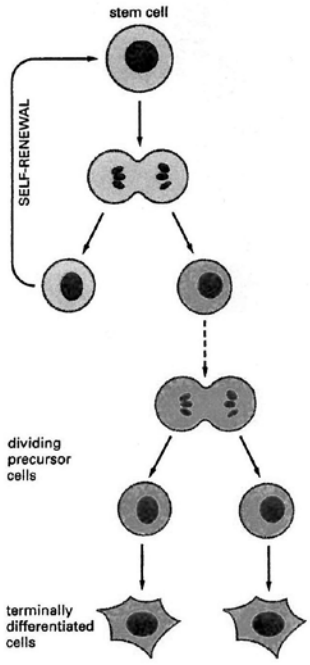
The differentiation was long considered irreversible. It was plant cloning that overturned that fixed idea for the first time[14]. Regarding this, researchers started working on animal cloning as a matter of course.

On the other hand, there were phenomena known to the researchers at that time, which we find in the name of *"stem cells"* research, currently. See the following figure[15]: Here we see the *lining of the small intestine* on the left side (*Fig.* (3)), where the moving cells referred to as "slowly dividing stem cells" can be find. They move upward to be the "nondividing terminally differentiated-cells," which are called the "epithelial cells" in the upper figure.

(3) *The Lining of the Small Intestine*
(Alberts et al. 2003, p.722)



(4) *Stem Cell and Precursor Cell*
(Alberts et al. 2003, p.721)



Those moving cells draw a circle, as the figure on the right side shows (see "SELF-RENEWAL" in *Fig.* (4)). This circulation means they can repeat the differentiation all over again, which is nothing but phenomena of reversibility.

These phenomena are not surprising, if we reflect on life protection, because such parts as the *lining of the small intestine* and the *skin* are always exposed to quite hostile conditions, so that they must have developed a certain strategy to replace their constituents (cells) one after another constantly[16]. It is shown in *Fig.* (4) clearly, according to which the lining of the small intestine has a group of cells always ready for the replacement. While not needed, they repeat a circular process ("SELF-RENEWAL"). Yet once needed, they turn into "precursor cells," taking the place of the damaged cells[17]. It is exactly these cells that researchers called *"stem cells."*

§8. Totipotency and Pluripotency

Stem cells are literally natural when we think about life protection, but even so, a huge surprise. For they are very akin to animal cloning, while a subtle difference alienates one from the other. Three levels of reversibility make us realize it: *totipotency, pluripotency,* and *multipotency.*

Stem cells of the small intestine we saw above (§7) are *multipotent* at most; they cannot differentiate into *every* cell type[18].

The next level is *pluripotency*. This level is the one that the *ES cells*[19] and the *iPS cells*[20] display. The pluripotency is capacity "to form any of the three germ layers (endoderm, mesoderm, ectoderm) that compose over 200 different cell types found in the body, excluding the placenta"[21].

"[E]xcluding the placenta" might be fatal lack: ES cells and iPS cells cannot compose the placenta. And it was this lack that prevented researchers from animal cloning. However, Wimult's team finally got over it to make a "totipotent" cell. *Totipotency* is capacity to "give rise to all the 220 cell types in the embryo plus the extra-embryonic tissues necessary to form the placenta and yolk sac that together allow for the development of the fetus"[22]. With totipotency, Wilmut's cell was able to develop into a whole individual, which was nothing but a breakthrough.

§9. ES cells and Regenerative Medicine

Let us take here a detour for a moment, since key terms which are no less crucial than cloning have appeared: the ES cell and the iPS cell. They will tell us medically critical ideas like *regenerative medicine, epigenetics* and *therapeutic cloning*.

Let us take up the ES cell, first. The *ES cell* (*embryonic stem cell*)[23] is a mass from the polarized end of the cavity inside the *blastocyst,* the stage corresponding to the *blastula* of a sea urchin or a frog[24]. As we glanced in *Fig.* (2), it practically meets the demand of regenerative medicine[25].

Think about a *diabetic* patient, for example. His *B cell in Islet of Langerhans* does not function well to secrete *insulin*. But if the alternative B cell were provided, like the "fat cell," the "neuron," etc. in *Fig.* (2), it would drastically help the patient's treatment for sure. In this sense, the ES cell was expected to help regenerative medicine.

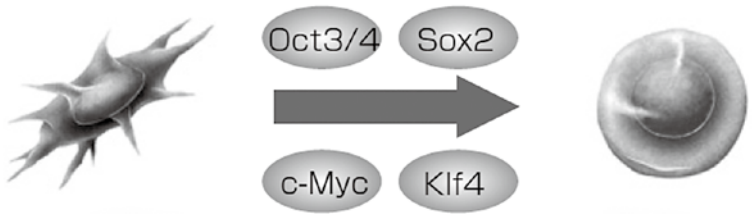
§10. iPS cell

ES cells were promising in the field of regenerative medicine but had a problem. The material they are taken from was a blastula, part of a *fertilized egg* or an *embryo*[26]. This means: we destroy a *life* when we get ES cells.

This drawback drove the stem cell research to the next level and finally, Yamanaka Shinya (1962-) invented *iPS cells* (*induced pluripotent cells*) in 2006[27].

Yamanaka's iPS cell is made by introducing into a somatic cell[28] the four transcription factors[29]: *Oct 3/4, Sox2, c-My,* and *Klf4*.

(5) *Induction of the iPS cell* (Yamanaka 2009)



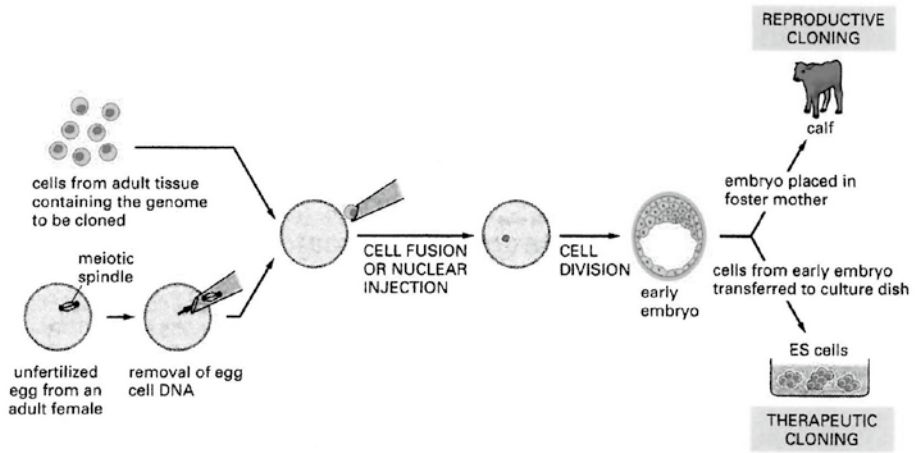
This method was a big discovery, because it told us the *epigenetic*[30] factors to repeat the differentiation all over again. On his merits, Yamanaka was awarded the *Novel Prize in Physiology or Medicine in 2012* (Novel, 2012).

§11. Is Totipotency Truly Required?

The modern stem cell research culminated in Yamanaka's iPS cell, meeting the demand of regenerative medicine[31]. Then, what about cloning?

In §8, we saw the cloned cell is superior to the iPS cell in its totipotency. But now we know the demand of regenerative medicine, in terms of which the cloned cell no longer keeps the superiority because, considering the pressing need of medical care, the cell to be provided need not be totipotent any longer. Pluripotency suffices. The totipotency the cloned cell has boasted appears no longer necessary. This is why we come to a parting of ways in cloning research:

(6) *Animal Cloning* (Alberts et al. 2003, p.725)



This figure shows a parting of ways. See the fork on the rightmost side. “THERAPEUTIC CLONING,” the lower course, is cloning research which leads to regenerative medicine, aiming at the provision of ES cells only. In contrast, “REPRODUCTVE CLONING,” the upper course, is very much cloning research we have seen above as Dolly the sheep[32].

§12. Therapeutic Cloning is Not Sinful

Let us take a closer look at therapeutic cloning, remembering the vicious characteristic of ES cells[33].

The vicious characteristic of ES cells is that they violate life at the stage of the fertilized egg, which drove Yamanaka to the invention of the iPS cell. But take a closer look at therapeutic cloning, the lower course of *Fig.* (6), where we see the therapeutic cloning not violating life though it makes use of the ES cell. This is simply because therapeutic cloning avoids fertilization by removing the egg cell DNA in advance. Instead of fertilization, therapeutic cloning adopts the so-called *nuclear transplantation*. It proceeds this way: first, the nucleus of an unfertilized egg cell, which is haploid (n), is sucked out, then a nucleus, which is diploid (2n), of a cell taken out of a tissue of an adult individual is introduced into the genetically vacant place of the egg cell, and finally, the egg cell with another nucleus is allowed to develop in culture[34].

Leaving the question of removal of the egg cell DNA aside, this procedure of nuclear transplantation is considered to be much better than the one we saw above[35] in that it does not sacrifice the fertilized egg. This is because the ES cell obtained by nuclear transplantation is basically not the result of sexual intercourse leading to fertilization.

§13. A Parting of Ways

This is how cloning research can reach the level of the iPS cell in providing unvicious ES cells. These unvicious ES cells are literally unvicious because they are gained from unfertilized egg, not violating any lives. The unfertilized egg grows to be a blastocyst[36] replicating DNA of the original cell taken out of a tissue of an adult individual. But here we see something sensitive: the blastocyst is, at any rate, a *replica.* So the question is how to use the replica.

In the case where cloning researchers use the blastocyst only with the intention of gaining ES cells, any problems will not occur. By contrast, in the case where they use the blastocyst *as it is,* a problem will loom up: the notorious reproductive cloning gets empowered.

In fact, these two cases correspond to the lower course of *Fig.* (6) on the rightmost side and its upper course respectively. Therefore, the problem is whether or not researchers can abstain from taking the upper course: reproductive cloning by making use of the blastocyst *as it is.*

§14. Refusal by the United Nations

If cloning researchers are tempted to use the cloned blastocyst as it is, the notorious reproductive cloning gets empowered. It is this temptation that the circles of physicians or biologists have long feared.

The United Nations was the first to point out this risk. The best-known is *"United Nations Declaration on Human Cloning"* (UN 2005), which had the form of recalling *Article 11* of *"Universal Declaration on the Human Genome and Human Rights"* (UN 1997), which was originally concerned with the problem of human genome research[37]:

(7) Practices which are contrary to human dignity, such as reproductive cloning of human beings, shall not be permitted. States and competent international organizations are invited to co-operate in identifying such practices and in taking, at national or international level, the measures necessary to ensure that the principles set out in this Declaration are respected. (UN 1997, Article 11)

It is noteworthy that this declaration was made as early as 1997, when the success of Wilmut's team appeared[38].

§15. Discussions of AMA

The declaration of the UN was followed by *"AMA's 1999 CEJA Report." AMA* is the acronym for the *American Medical Association,* the authority of physicians in the United States. Its document at *CEJA*[39] in 1999 provided more persuasive discussions on reproductive cloning:

(8) *The Four Logical Reasons to Ban the Reproductive Cloning*
Reason 1: The Lack of Confidence (AMA 1999, pp.4-5 "A")[40]
The application of reproductive cloning is still far from safe. If the problem is sorely infertility of the couple, it can be settled by surrogate mothering in most cases.

Reason 2: Psychological Pressure (AMA 1999, p.5 "B")
The cloned baby is, if realized, expected to suffer man-made misfortunes. For example, a baseball star's clone-child is destined to live up to his father's expectation. Is it truly happiness of the child?

Reason 3: The Possibility of Social Disorder (AMA 1999, pp.5-6 "C")
Even surrogate mothering provoked social controversies like the *Baby M case*[41]. Consequently,

cloning must bring about much larger disorder in society. Not only legal disputes but also the collapse of human nature is expectable. Our society might be full of gay couples having their child by cloning, for example. Is it truly sound for our society?

Reason 4: The Specter of Eugenics (AMA 1999, p.6 "D")
In connection with *Reason 2,* cloning probably involves some discrimination on the level of genetic characters (phenotypes). But who on earth decides the superior characters? Cloning would skew the sound, impartial gene selection in nature, reducing the genetic diversity, which has protected us from the threat of nature.

§16. Reproductive Cloning and Surrogate Mothering

These arguments of AMA's are in themselves persuasive. What comes to our mind is, however, that these criticisms, directed to reproductive cloning originally, are the ones we often see in debates on *surrogate mothering* as well.

In fact, AMA referred to surrogate mothering in course of argument. See *Reason 1* and *Reason 3,* for example: "If the problem is sorely infertility of the couple, it can be settled by surrogate mothering in most cases." (*Reason 1*), "Even surrogate mothering provoked social controversies like the Baby M case." (*Reason 3*). These sentences implicitly or explicitly refer to surrogate mothering, which is true of *Reason 2* and *Reason 4* as well.

Based on these, we would like to take up surrogate mothering as well in the following, which will be useful to foresee the potential threat of reproductive cloning.

§17. Two Types of Surrogate Mothering

What is surrogate mothering? To answer this, two types of surrogate mothering should be considered: *traditional surrogacy* and *gestational surrogacy*[42].

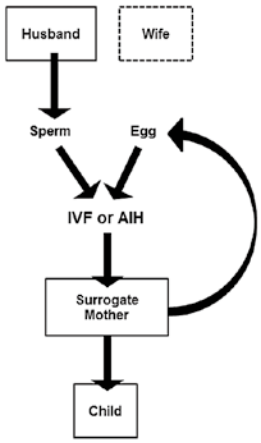
When surrogate mothering is chosen, a problem basically lies in the *wife's* side: she simply cannot get pregnant with her own genitalia[43]. That makes the couple rely on a *surrogate mother,* a substitute for the *wife.* Then, they have two otions[44]:
Let me explain *AIH* (*Artificial Insemination with Husband's Semen*) in the middle of *Fig.* (9) first. This is basically not concerned with surrogate mothering. AIH is more simple infertility treatment, that is, it is mostly applied to the case where the wife still *can* get pregnant. In that case, trouble is solved simply by injecting the husband's semen into the wife's genitalia. This is AIH.

AIH is not considered a main option for surrogate mothering even if it appears in *Fig.* (9). For, as mentioned above, in case of surrogate mothering, the wife is supposed to be infertile,

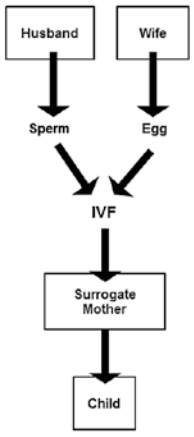
which is not the case AIH mainly handles. Thus, given that physicians are forced to apply AIH, the husband's semen is to be injected into a surrogate mother, not into the wife. This actually led to legal troubles, such as the Baby M[45]. But troubles of this kind (namely the genetic separation of the wife from the baby) have been settled with the invention of IVF.

IVF (*in-vitro fertilization*) was invented by R.G. Edwards (1925-) in 1978[46]. It was

(9) *Traditional Surrogacy*



(10) *Gestational Surrogacy*



originally aiming at overcoming the low success rate of AIH. But it also enabled the infertile wife to take part in surrogate mothering, that is, she can provide *her own* egg thanks to IVF, as *Fig.* (10) shows, which gave birth to gestational surrogacy.

§18. The Same Root

We quickly reviewed surrogate mothering. Although gestational surrogacy apparently provided some solution, there still remains an enigma.

Why do people stick to genetic liaison that way? The infertile wife was so pleased with the invention of IVF, since she was able to provide her own egg, getting back genetic liaison. The difference between not providing her own egg and providing one, in other words, not keeping genetic liaison and keeping it, is huge.

Humans emotionally attach themselves to the descendants having genetic linkage. They stick to it as long as there is an enigmatic desire to leave the existence to posterity.

After all, whether surrogate mothering or reproductive cloning, biotechnology of this kind could be attributed to this desire, namely desire to leave the existence with genetic liaison. Surrogate mothering represents its positive side. Reproductive cloning represents its negative side. But the root of the two appears the same.

§19. The “Baby Factory” case

The same root could be found concerning reproductive cloning and surrogate mothering. To see that, in other words, to see the potential threat of reproductive cloning, we would like to take up a weird case brought about by a rich Japanese: the *“Baby Factory”* case.

This case occurred in 2013[47]. Mitsutoki Shigeta, a 24-year-old son of Yasumitsu Shigeta, the founder of Japanese mobile phone distributor Hikari Tsushin[48], is alleged to beget 16 babies[49], making use of Thai commercial surrogacy. Japan Times reports:

(11) “As soon as [the first surrogate mothers] got pregnant, [Mitsutoshi Shigeta] requested more. He said he wanted 10 to 15 babies a year, and that he wanted to continue the baby-making process until he’s dead,” said Mariam Kukunashvili, founder of the New Life clinic, which is based in Thailand and six other countries. He also inquired about equipment to freeze his sperm to have sufficient supply when he’s older, she said in a telephone interview from Mexico. […] As for Shigeta’s motives, Kukunashvili said he told the clinic’s manager that “he wanted to win elections and could use his big family for voting,” and that “the best thing I can do for the world is to leave many children.” (Japan Times, 2014 Aug.23).

The Thai media called this also the “serial surrogacy” case (Japan Times, 2014 Sep.2). And the Japanese man[50] himself was investigated by Interpol for *human trafficking* and *child exploitation* (Japan Times, 2014 Aug.23).

§20 Reappearance of Hypertrophy of Ego

The desire for making replicas of him/herself is possibly rooted in any person. The Japanese man’s case lights up this dark side of human lust very well. He said that “he wanted 10 to 15 babies a year,” and that “he wanted to continue the baby-making process until he’s dead.”[51] Isn’t this what we saw before? That is, *hypertrophy of ego.*

The Japanese man also said that “he wanted to win elections and could use his big family for voting,” and that “the best thing I can do for the world is to leave many children.” This mindset seems to instantiate crystallization of hypertrophy of ego as we saw it at the beginning of the present article.

§21 Cloning centering at Egoism

What drove the Japanese man is not sexual desire, but lust for universalization of the self,

in other words, hypertrophy of ego.

Pure motivation to universalize the self stays unvicious as long as it is in harmony with humanity, which was also the strategy of Hegel and Fichte. However, mixed up with biotechnology alone without ethics, the same motivation continue to inflate itself to lead to the case like "Baby Factory."

What was missing in the case of the Japanese man was of course ethical education. But it is principally avoidable. And to make matters worse, outside legal system, one can easily indulge in desire as the Japanese man had it. Then, what if reproductive cloning steps into the picture. Given the lack of sexual desire and the advantage over surrogate mothering, people like the Japanese man would definitely prefer reproductive cloning.

This is how reproductive cloning is expected to take the place of commercial surrogacy, if realized.

§22 Conclusion

Naturally, as AMA pointed out, even reproductive cloning cannot provide a human replica in a complete way:

> (12) [A]s observed in monozygotic twins[52], having identical genes does not result in two indistinguishable individuals. A clone must – because of the different environment and circumstances [⋯] – be a different person from the person from whom he or she was cloned. [Besides, monozygotic twins] may be more similar than clones since most [monozygotic] twins are conceived and nurtured in the same environment in utero and often during childhood. Since environment has a profound influence on development, human clones likely would be different in terms of personality and other characteristics. (AMA 1999, p.2)

Making a replica by reproductive cloning is principally in vain, as even monozygotic twins, which are more "cloned" than a cloned individual, can*not* be completely *indistinguishable,* because their later lives eventually determine their characteristics.

Nevertheless, for people like the Japanese man, cloning would remain attractive. Ethically unrefined ego would drive them from commercial surrogacy further to reproductive cloning.

Here, the problem lies of course in ethics. We should discuss not only the vicious hypertrophy of ego, but also the enigmatic desire to leave the existence to posterity in itself. For that purpose, the arguments provided by the medical circles, such as the UN and AMA, are not persuasive yet. We must go into human mentality in much deeper ways.

[1] "The self-consciousness is, at the beginning, an existence simply for itself, which maintains its identity only by excluding the others from its consciousness." The text is: "Das Selbstbewusstsein ist zunächst einfaches Für-sich-sein, [und ist] sich-selbst-gleich durch das Ausschließen alles andern aus sich" (Hegel 1807, 143).

[2] This story comes from the following three principles:

According to *the first principle,* the ego posits itself in an ultimate way: "Das Ich setzt ursprünglich schlechthin sein eigenes Sein." (Fichte 1794, 98)

According to *the second principle,* as we empirically admit "A is not equal to non-A" with absolute certainty, so we convincingly posit a nonego against our own ego: "So gewiss das unbedingte Zugestehen der absoluten Gewissheit des Satzes : − A nicht = A unter den Tatsachen des empirischen Bewusstseins vorkommt : so gewiss wird dem Ich schlechthin entgegengesetzt ein Nicht-Ich." (Fichte 1794, 104)

According to *the third principle,* the ego posits, against its own reducible form, a similarly reducible nonego inwardly: "Ich setzte im Ich dem teilbaren Ich ein teilbares Nicht-Ich entgegen." (Fichte 1794, 110)

Thus, the absolute ego posited in the first principle is destined to struggle with nonegos, finding them outer obstacles. Hegel inherited this course of argument from Fichte.

[3] The second principle of Fichte indicates it (see note 2 above). Freud also described it in the name of *Pcpt.-Cs.* (cf. Kaneko 2016b, §8).

[4] The picture from Wilmut's original paper (Wilmut et al. 1997, p.812). The difference of their colors clearly shows that the genetic information of the surrogate mother did not affect the cloned lamb. According to Bartlett (2014), the left one is the well-known *Dolly*.

[5] See "3. Historical Overview of Vertebrate Cloning" of Fischbach et al. (2015).

[6] See the explanation of Fischbach et al. (2015) and that of Kawashima et al. (2006, p.76).

[7] See the explanation of Shiokawa et al. (2007, pp.104-105).

[8] Tubers of potatoes are differentiated cells, and so are roots of carrots. Thus, growing up into adult plants, they provide evidence of the reversibility of differentiation.

[9] See the explanation of Shiokawa et al. (2007, pp.104-105).

[10] At present, we do not take the ES cell on the left side into consideration. The ES cell is treated in §9 below.

[11] We can call the fertilized egg which began to develop an "embryo" (Kawashima et al. 2006, p.92f.). In case of humans, the embryo is also called a "fetus" shortly before the birth (Kawashima et al. 2006, p.101).

[12] See the explanation of Kawashima et al. (2006, pp.96-97).

[13] See the explanation of Shiokawa et al. (2007, p.93) and that of Asashima et al. (2013, p.163).

[14] See §5 above.

[15] We use the example of the lining of the small intestine, but originally, the stem cell was discovered in *bone marrow* by James Till (1931-) and Ernest McCulloch (1926-2011) in 1960s (Fischbach et al. 2015, Module1). See also the explanation of Alberts et al. (2003, p.722).

[16] See the explanation of Albert et al. (2003, pp.721f.).

[17] See the explanation of Alberts et al. (2003, p.721).

[18] See the explanation of Fischbach et al. (2015, Module1, Glossary).

[19] See §9 below.

[20] See §10 below.

[21] See the explanation of Fischbach et al. (2015, Module1, Glossary).

[22] See the explanation of Fischbach et al. (2015, Module1, Glossary).

[23] They are found by Martin Evans in 1981. Afterward, James Thompson made Human ES cells in 1998 (Yamanaka 2009, p.67).

[24] See the descriptions of Fischbach et al. (2015, Module1), Kawashima et al. (2006, pp.92-93, pp.96-99, p.101) and Shiokawa et al. (2007, p.116).

[25] See the explanation of Shiokawa et al. (2007, p.116) and that of Hamai et al. (2013, p.178).

[26] See note 11 above.

[27] See the series of his researches (Yamanaka et al. 2006; Yamanaka et al. 2007; Yamanaka 2009).

[28] According to Yamanaka, *mouse embryonic/adult fibroblast* (Yamanaka et al. 2006) and *human dermal fibroblast* (Yamanaka et al. 2007) were used. A *fibroblast* is a cell of the dermis (cf. Sakai & Hashimoto 2015, pp.90-91, p.241).

[29] Normally, transcription factors mean regulatory proteins, which are explained by Jacob & Monod's operon theory (cf. Asashima et al. 2013, p.113; Kaneko 2016b, §13).

[30] *Epigenetics* could be defined as the field to study chain reactions of regulatory proteins and genes in terms of operon theory (Fischbach et al. 2015, Glossary; Kaneko 2015, §13).

[31] In fact, Yamanaka (2009, pp.68-70) talks about the application of iPS cells to the treatment of diabetic patients though he calls the attention to the fact that the iPS cell research has not put this treatment into practice yet.

[32] See §4 above.

[33] See §10 again.

[34] See the explanation of Alberts et al. (2003, p.725).

[35] See the first paragraph of §10.

[36] The "early embryo" in *Fig.* (7). See also that in *Fig.* (2).

[37] As for the human genome, see also the historical research of Kaneko (2016a, pp.1044-1046).

[38] See §4 above.

[39] The acronym for "the Council on Ethical and Judicial Affairs."

[40] Each heading is made by Kaneko.

[41] The case occurred in New Jersey, the United States, in the 1980s. The intended surrogate mother, Mary Beth Whitehead, contracted with the intended father, William Stern, to gestate his (and his infertile wife's) baby. However, soon after birth, Whitehead changed his mind not to return the baby simply because she loves it. This is why a lawsuit was filed. The first trial supported the Sterns mainly on account of the contract and Whitehead's emotional instability. The second trial conversely supported Whitehead, accusing commercial surrogacy. The third trial, however, supported the Sterns, considering the best interest of the child. See the

explanation of Tong (2015, sec.4).

[42] As for the following discussion, see the article of Tong (2015, sec.2).

[43] As is well known, genitalia are a complex organ constituted of, in the female case, a *vagina*, a *uterus*, an *ovary* and *uterine tubes* (Sakai & Hashimoto 2012, pp.210-211). As for the fertilization, see the illustration by Asashima et al. (2013, p.159).

[44] See the figures by Hamai et al. (2013, p.79).

[45] See note 41 above.

[46] On his merits, Edwards was awarded the *Novel Prize in Physiology and Medicine in 2010* (Novel 2010).

[47] "[T]he first baby was born in June 2013" (Japan Times 2014 Aug.23).

[48] According to The Japan Times (2014 Sep.2).

[49] According to The Japan Times (2014 Aug.23).

[50] In the following, taking the credit of Shigeta's into consideration, we refer to him merely as "the Japanese man."

[51] See (11) above.

[52] Interestingly enough, the famous experiment in 1902 of the two-celled salamander embryo by Hans Spemann (1869-1941) is regarded as a predecessor of cloning and an artificial creation of monozygotic twins (Fischbach et al. 2015).

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