



On Cloning: Advocating History of Biology in the Public Interest *

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Abstract. Cloning – the process of creating a cell, tissue line or even a complete organism from a single cell – or the strands that led to the cloning of a mammal, Dolly, are not new. Yet the media coverage of Dolly's inception raised a range of reactions from fear or moral repulsion, to cautious optimism. The implications for controlling human reproduction were clearly in the forefront, though many issues about animals emerged as well. On topics of public interest such as cloning, historians of biology have the opportunity to make a unique contribution. Such debates are often aired as if they have no precedents, either in biology or in the ethical, moral, and social concerns arising in the public arena. The technology leading to Dolly draws on strands of research going back to the 1890s, and the cycle of public response has been repeated often in the past century. What can we learn from examining these events historically, and how can we – or should we even try – to inform public opinion? I think we should try and will outline briefly some of the ways that can work.

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Introducing the concept of cloning in 1903, Herbert John Webber wrote that “clons [sic] are groups of plants that are propagated by the use of any form of vegetative parts such as bulbs, tubers, cuttings, grafts etc. and are simply parts of the same individual.”¹ Two years later, Charles Louis Pollard suggested “*clone* (plural *clones*) as the correct form of the word.”² By the 1920s, the term covered a range of types of asexually reproducing genetic copies. Trees sending up runners, worms dividing into smaller worms, populations of genetically identical bacteria, cells dividing into tissue: all are clones. Clearly, then, cloning is not new. Even though using somatic cell nuclear transfer in “higher” mammals is new, this was a logical next step in ongoing productive research. So why did Dolly arouse such passions? Why should we,

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¹ Webber, 1903, p. 501.

² Pollard, 1905, p. 88.

as historians of biology, care about cloning? What do we have to contribute to understanding this scientific development and the responses?

We can outline different research threads leading to Dolly and ask what was new in each case. Placing discussion about cloning in the context of these diverse earlier advances reveals that nothing about Dolly was the result of fundamentally new science. Nor should anything seem scientifically shocking about a cloned sheep, even one resulting from somatic cell nuclear transfer. For, in fact, the scientific threads were already there and available to be woven together. Yet the public response ranged from initial repulsion to growing endorsement. Historians of biology have an important role to play in understanding these reactions.

The most important research threads in developmental biology leading to cloning include, first, the discovery of artificial fertilization and the ability to stimulate development in selected cases. Second came the ability to recombine tissue through grafting and transplantation, leading naturally to the third thread, nuclear transplantation. Fourth was cell line and gene cloning. Next came recombinant DNA techniques of the 1970s. Finally, advances in reproductive technologies provide an important context within which these other advances have gained significance. Two lines of research – in development and genetics and in reproductive technology – provide the warp and woof of the modern cloning fabric.

Artificial Parthenogenesis

Historically, the first research thread leading to experimental cloning involved laboratory stimulation of development through artificial fertilization. From “natural” reproduction in aspen trees or sea anemones, for example, it is a short step to carrying out some forms of cloning, but there has to be an interest in intervening. By the turn of the 20th century, researchers had that interest and enough knowledge about fertilization and the fundamentals of inheritance and development to begin experimenting.³ Jacques Loeb’s artificial parthenogenesis of sea urchin eggs in the 1890s showed that fertilization is not necessary to make larval urchins.⁴ Loeb altered the water’s salt content to stimulate cell division and, as historian Philip Pauly has shown, produced an exciting sense of controlling or engineering life.⁵ This introduced questions about whether the male is necessary, whether reproduction has to be sexual, and how far science might be able to take us through biological engineering. Newspapers trumpeted the story of “creation of life” and reporters saw

³ Wilson, 1896.

⁴ Loeb, 1899, pp. 135–138.

⁵ Pauly, 1987, especially chapter 5.

parallels to "immaculate conception" in the laboratory. Though some invoked Frankenstein scenarios, the interest remained largely positive. Science might unlock the "secrets of life" and in the golden progressive era of science and engineering, that seemed good.

Transplantation

Second came experimental manipulation of development. Hans Spemann and Ross Harrison transplanted tissue from one organism to another, producing hybrids that developed according to the mixed inherited pattern. They worked with somatic tissue, but Spemann suggested a "fantastic experiment" using nuclear transplantation to produce a clone from embryonic or even adult cells.⁶ Obviously, the cell must not end up with two nuclei, so the procedure begins with enucleation of the host cell. The process is not easy to carry out effectively and Spemann did not do so, but he did make clear that such a step would not be surprising scientifically. The concept is straightforward and just requires technical facility. That this transplantation research was embraced as a positive advance is reflected in Spemann's Nobel Prize and Ross Harrison's almost having received one. News coverage of transplantation focused on possibilities for medical applications and reflected a wider enthusiasm for scientific and technical achievement.

Cell Line and Gene Cloning

A third line of development began in the 1950s and 1960s with the routine development of cloned cell lines.⁷ Gene cloning followed, and we have developed progressively faster, more accurate, and more efficient laboratory methods for producing cell line and gene clones, using machines and microbial "factories" as appropriate. Gene cloning is now routine, with undergraduates happily reporting successful cloning from the research laboratories where they work in increasing numbers. With cell line and gene cloning part of normal operating procedures, we recombine genetic material without much concern, and have forgotten the calls for caution about "playing God" that such research initially evoked. Though historians have examined aspects of this cloning in the context of recombinant DNA techniques, genetics, molecular biology, and biotechnology, there is much room for further study of this work in its own right.

⁶ Spemann, 1938; Hamburger, 1988; Harrison, 1907, pp. 239–281; Maienschein, 1991.

⁷ Bergmann, 1959, pp. 648–649; Vogt, 1959, pp. 1257–1270.

Nuclear Transplantation

In 1957, Robert Briggs and T.J. King successfully transplanted nuclei in *Xenopus laevis*. In the 1960s, John Gurdon expanded the range of techniques and cells (including differentiated frog somatic cells) that could be cloned this way. The work proved technically difficult, yielding a low success rate. Yet it took only one to prove that there is no natural barrier to laboratory production of such hybrids, quickly labeled "clones" and heralded as advances in both the popular and scientific presses. Briggs/King and Gurdon therefore added an important thread of possibilities. How different can the individuals be and still allow successful nuclear transplantation and cloning? What would the most extreme genetic hybrids look like? To what extent was this sort of nuclear transplantation different in kind from the tissue transplantation of Spemann and Harrison? These experimental embryologists of the 1950s and 60s expanded the range of the imaginable.

Biology textbooks suggested that it was probably just a matter of time before we moved beyond frogs to being able to transplant nuclei from one embryo into another in higher mammals and probably even humans. While skeptics thought there might be natural barriers to this because of the complexities of development, others thought we were well on our way. As James Watson, John Tooze, and David Jurtz wrote in *Recombinant DNA: A Short Course*, "In the immediate future there is little likelihood of nuclear transplantations being attempted with any other mammalian species" or even much beyond frogs. Yet, "If the efficiency and reproducibility can be improved, the method may, however, find a place in animal breeding. In theory it could be attempted with human eggs and embryonic cells, but for what reason? There is no practical application."⁸ That was 1983. It is worth exploring why so many biologists felt so certain about what could be done and yet wondered whether we would want to.

Recombinant DNA

Recombinant DNA may well have been the most startlingly new research thread, challenging basic assumptions about the inherited genetic foundations for development. Whereas transplanting tissue or entire nuclei to create new hybrids brought challenges to assumptions about the nature and stability of individuals and species, there still seemed to be limits as to how far we could manipulate across the differences and yield viable results.

The 1970s brought demonstrations that we could go quite far. Transplanting pieces of DNA from animals into bacteria successfully crossed wide

⁸ Watson, Tooze and Kurtz, 1983, pp. 207–208.

boundaries. Furthermore, the process created not just one isolated hybrid, but also a reproducing lineage of hybrids thereafter. As one columnist reflected shortly after the announcement about Dolly, with gene splicing "society confronted a far more radical biological breakthrough a quarter-century ago and has emerged none the worse for it."⁹

The scientific community reacted to gene splicing by calling for more thought and a moratorium on research with human DNA and on processes judged to pose a biological or physical threat for humans. Worry, public outcries and calls for legislation, testing, relaxing of worries in the face of evidence that the threat was less than feared, and eventual acceptance and even enthusiasm: this cycle of reaction to recombinant DNA research is typical.¹⁰ One commentator noted later that "With the prospect of human cloning becoming less unthinkable by the day, it seems almost quaint that a mere decade ago people were up in arms over the perils of spraying strawberries with bacteria genetically altered to prevent frost."¹¹ Although the European public has been considerably less sanguine about the safety of genetic engineering, demand and opportunity have nonetheless led us on, especially when the costs of continuing research seem modest and the benefits enticing. Bioethicists have taken up discussion of these issues, often pronouncing with great confidence on the social implications of the molecular research. Historians have much to add.

Reproductive Technology

Drawing on these earlier threads of research could almost have led researchers to a cloned Dolly without further advances. The earlier steps could provide an enucleated host cell with sufficient nutrients for growth and differentiation, and a donor nucleus. They included the process to combine the two and artificially initiate cell division and differentiation. In principle, we can even do all this work in a simple glass dish. So far, however, in mammals the dividing cell must be implanted into a uterus. The last important thread of research necessary before we get to Dolly, therefore, lies with reproductive technology. We still need living wombs available as incubators, and we have them because of advances in reproductive technologies and agriculture. Implantation techniques were not new with Dolly, of course, but this step is essential for the process to work. Furthermore, the promises and limitations of reproductive technology provide the social climate of expectations and possibilities in which reactions to Dolly have evolved.

⁹ Boffey, 1997.

¹⁰ Goodfield, 1977; Wade, 1979.

¹¹ Johnson, 1997.

Human reproductive technologies have exploded since the birth of Louise Brown as the first "test tube baby" in 1978 in Britain.¹² Much of the burgeoning bioethics literature has focused on reproductive issues, featuring hopes or dismays concerning an advanced genetic engineering that can combine the preferred set of cloned genes and have them nurtured by the "best" possible mother – sometimes a third party surrogate. There is heated discussion about reproductive rights, responsibilities, and concerns about unequal social distribution of the "goods" provided by fertility clinics that are not covered by standard insurance in many societies. Reproductive research began in agricultural contexts, of course, and it is not surprising that Dolly appeared there. But the implications for human reproduction concern us most, and discussion of cloning inevitably takes place in the context of human reproductive fears and hopes.

Designing Dolly

To produce Dolly, Ian Wilmut and his team wove together these various established research threads.¹³ None was new with Dolly, not even their combination, though the exact details of the technique for fusing the new cell into the host and provoking cell division incorporated original twists. Two years earlier, in 1995, Wilmut's Roslin Institute had already produced Megan and Morag, genetic copies from cells cultured from a nine-day old sheep embryo – and hence a similar type of clone.¹⁴

One detail was new with Dolly, of course, in technical fact if not in theory. It was this final innovation that most jolted people's imaginations, stimulated the excited flow of journalists' ink and electrons, and provoked controversy. That the nucleus came from an adult somatic rather than embryonic cell was not sufficiently radical scientifically that it should have evoked such strong reactions. Yet this strand of the story attracted the most public attention. The prospects for apparently cloning oneself, of having children who are twins of the parents: that generational oddity caused the confusion. Of course, even this possibility is not really new since we can freeze human embryos and keep them for a generation before implanting them. But collectively, we had not really thought about that. The child is not supposed to be the brother of the man.

Partly this conception resulted from the packaging of the story. Initial scientific reports in *Nature* made it clear what techniques had been used and

¹² Edwards, 1980; Andrews, 1999.

¹³ Wilmut, Schnieke, McWhir, Kind and Campbell, 1997, pp. 810–813.

¹⁴ Campbell, McWhir, Ritchie and Wilmut, 1996, pp. 64–66.

what Wilmut's team had accomplished. Yet Gina Kolata's lead story in the *New York Times* the next day provoked all the reactions we would expect: the dreaded achievement, the suggestion that science now has no limits or as biologist Lee Silver eagerly put it: only a day before he had written that adult cell cloning impossible, and now "all of science fiction is true." There came a shudder of excitement about what more we might accomplish, concern about the genie out of the bottle, references to opportunities to clone Jesus, and Wilmut's own reflection that "It would be desperately sad if people started using this sort of technology with people."¹⁵

A week later, Kolata and Michael Specter referred to cloning as "A New Creation" and wrote that "People have been obsessed with the possibility of building humans for centuries, even before Mary Shelley wrote 'Frankenstein' in 1818. Still, so few legitimate researchers actually thought it was possible to create an identical genetic copy of an adult animal that Dr. Wilmut may well have been the only man trying to do it, a contrast with the fiery competition that has become the hallmark of modern molecular biology." She told the story in terms of creating life, creating genetic copies, producing identical offspring, and human manipulation of the "most forbidden – and tantalizing – doors of modern life."¹⁶ Her presentation was calculated to elicit the range of responses from abhorrence of scientists' hubris in even presuming to try such research to the admiration of the heroism of the modest, religious Wilmut for unlocking secrets to better life. Her subsequent book shows the dangers of journalistic enthusiasm.¹⁷ We will benefit from turning the historian's careful scholarship and attention to detail to the story of this science – and to the telling of the story. We can also gain from perspective on past reactions.

Reactions to Dolly

Sure enough, fears did come immediately. One commentator noted that Dolly brought together "the sheep joke," a "sex joke," and the "clone joke." He saw this as revealing "how much cloning appalls us, unnerves us, disgusts, horrifies and revolts us, precisely because it engages our deepest concerns about personhood, identity, life and sex. And if horror and disgust are too strong (not for me), there is no doubt that the possibility of perfect doubling disconcerts us, and suggests we are in the presence of the uncanny, however loosely we may want to understand that term."¹⁸ Concerns about assaults on

¹⁵ Kolata, February 23, 1997; Wilmut, 1998; Wilmut, Campbell, and Tudge, 2000.

¹⁶ Kolata, March 3, 1997; Kolata, 1998.

¹⁷ Kolata, 1998.

¹⁸ Miller, 1998, pp. 78–87, quotation p. 81.

human autonomy because of presumed precise genetic doubling does disturb people, though cloning produces less perfect doubles than normal identical twinning. Others worry about "playing God" and ask "what is natural," but we have faced such questions before with recombinant DNA research, and historians can reflect on why we thought that we had at least partial answers.

This initial "yuk" response then gave way to a sense of opportunity and even demand for this technology. Within a few months of Wilmut's announcement, newspaper stories and fertility literature began suggesting prospects for improved human reproduction through cloning. Economics and business publications pointed to practical possibilities and urged investment rather than ethical fussing.¹⁹ Furthermore, as researchers at the Roslin Institute showed by adding a human gene to the sheep Polly, it is even possible to enhance the normal genetic makeup.²⁰ Perhaps we can do better than nature herself. By December 1997, one writer had already admitted that "Although initial reactions were universally against all human cloning, there have been whispers that such cloning may one day have a place in giving infertile couples genetic offspring."²¹ On August 16, 2000, the British government introduced legislation to allow scientific research on human cloned embryonic cells, though not (yet) full scale cloning of persons.²² Interest continues, despite technical obstacles and safety concerns.

This growing public acceptance of a strong genetic determinism with its hope for predictability and control is apparently reinforced by the eager promises of the Human Genome Project and an attendant public demand for genetic engineering and reproductive choice. Who wants to suffer the problems of "normal" reproduction, enthusiasts urge, when we could do it so much "better" and avoid the heartache when things so often go wrong. While scholars fret about genomics as the new eugenics and remind us of past abuses, many people are eager for help from any available reproductive technology.²³ A recent glance at the techno-future cited philosopher of science Philip Kitcher's observation that "There's a group of parents who will say to themselves: 'The old ways of giving birth were risky and we're not going to take those risks.'" For those parents, the most advanced genetic technologies are no longer an intriguing or worrisome option but an expectation and even a responsibility.²⁴ Cloning pioneer John Gurdon and Alan Colman

¹⁹ Steinfels, 1997.

²⁰ Schneike, Kind, A. J. Ritchie, Mycock, Scott, M. Ritchie, Wilmut, Colman, and Campbell, 1997, pp. 2130–2133.

²¹ Pennisi, 1997, pp. 2038–2039.

²² Hawkes, 2000; Masood, 1999, p. 4; Abbott, 1999, p. 103.

²³ Proctor, 1992, pp. 57–93; Paul, 1995; Kolata, December 2, 1997.

²⁴ Jones, 2000, p. 80; Kitcher 1997.

have reflected on "The future of cloning" and concluded that cloning may offer some therapeutic advantages. While obstacles remain, they feel that "Belated sober reflection revealed that few of these [initial] moral arguments were sound."²⁵

Of course, people may not believe that human cloning will really happen, though it is beginning to seem more likely that at least someone will try. When it does, and we are forced to confront what human cloning means, only then are we likely to experience another communal shudder. What we learn from history is that after that shudder is likely to come cautious acceptance.

So historians of biology have important reflections to make about cloning. Here is opportunity to carry out our scholarly study of a scientific development and reactions, as they play out in our political and social context. There is also opportunity to step forward to illuminate public discussion and media presentation of this science, to show that this is not radically new science. Nor is the cycle of reactions from yuk to tolerance to enthusiasm to reflective concern new or atypical. This science does not justify rushing to pass federal prohibitions nor exaggerating risks to stifle public discussion or scientific exploration. Instead, we historians of biology can help inform a reflective public discussion of the nature of scientific discovery and application. We do not need for all of us to take on such roles, but at least some can – and should. There is a role for what is, in effect, history of science in the public interest.

²⁵ Gurdon and Colman, 1999, pp. 743–746.

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