

# Embryonic human persons

Talking Point on morality and human embryo research

Robert P. George & Patrick Lee

If, as we believe, human embryos are human beings who deserve the same basic respect we accord to human beings at later developmental stages, then research that involves deliberately dismembering embryonic humans in order to use their cells for the benefit of others is inherently wrong. Just as harvesting the organs of a living child for the benefit of others is immoral and illegal, so 'disaggregating' embryonic human beings would also be immoral and should be illegal—of course governments should therefore not fund such procedures. In this article, we provide some of the evidence that human embryos are indeed human beings and, as such, deserve a level of respect that is incompatible with treating them as disposable research material. We also consider two recent objections to our position.

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In sexual reproduction, conception occurs when a sperm cell unites with an oocyte, the two cease to be, and their constituents successfully enter into the makeup of a new and distinct organism, which is called a zygote in its original one-celled stage. This new organism begins to grow by the normal process of differentiated cell division into an embryo, dividing into two cells, then four, eight and so on, although some divisions are asynchronous. Its cells constitute a human organism, for they form a stable body and act together in a coordinated manner, which contributes to regular,

predictable and determinate development toward the mature stage of a human being. That is, from the zygote stage onward, the human embryo has within it all of the internal information needed—including chiefly its genetic and epigenetic constitution—and the active disposition to develop itself to the mature stage of a human organism. As long as the embryo is reasonably healthy and is not denied or deprived of a suitable environment and adequate nutrition, it will actively develop itself along the species-specific trajectory of development. This means that the embryo has the same nature—in other words, it is the same kind of entity—from fertilization onward; there is only a difference in degree of maturation, not in kind, between any of the stages from embryo, to fetus, infant and so on. What exists in the early stages of development is not a mere bundle of homogeneous cells. Scientific evidence shows that already at the two-cell stage, and even more so at the four-cell stage and thereafter, there is a difference in the internal structure of the embryonic cells; although they have the same DNA, each has a distinct pattern of gene expression (Memili & First, 2000; Thompson *et al*, 1998; Zernika-Goetz, 2003; Zimmerman & Schultz, 1994; Santo & Dean, 2004).

The human embryo is the same individual as the human organism at subsequent stages of development. The evidence for this is the genetic and epigenetic composition of this being—that is, the embryo's molecular composition is such that he or she has the internal resources to develop actively himself or herself to the next mature stage—and the typical embryo's regular, predictable and observable behaviour—that is, the embryo's actual progression through an internally coordinated and complex sequence of development to his or her mature stage.

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It is important to note that embryological evidence shows that the human embryo is a whole, although obviously immature, human being; it is not a mere part. This is a crucial point: human tissues or human cells, whether body cells or gametes, are indeed human—that is, genetically human—but are not whole human organisms. Neither of these has the active disposition to develop itself to the mature stage of a human being. By contrast, the human embryo, from fertilization onward, is fully programmed to actively develop himself or herself to the next mature stage along the path of human development.

One objection against this position is based on a comparison of human embryos to somatic cells, given that producing humans by cloning is a possibility. Ronald Bailey, a science writer for *Reason* magazine, observes that each cell in the human body possesses the entire DNA code, but that each has become specialized as a muscle or skin cell, for example, by most of that code being turned off. During cloning, previously deactivated parts of the genome are reactivated. Bailey therefore argues that if human embryos are human beings with moral worth because of their potential to become adult humans, the same must be said of somatic cells, which is absurd (Bailey, 2001).

However, Bailey's argument is based on a false analogy. The somatic cell is something from which a new organism can be generated; it is certainly not, however, a

distinct organism. A human embryo, by contrast, is already a distinct, self-developing and complete human organism.

Moreover, the type of ‘potentiality’ possessed by somatic cells differs profoundly from the potentiality of the embryo. A somatic cell has a potential only in the sense that something can be done to it so that its constituents—its DNA molecules—enter into a distinct whole human organism, which is a human being, a person. In the case of the embryo, by contrast, he or she is already actively—indeed dynamically—developing himself or herself to the further stages of maturity of the human being he or she already is.

**...somatic cells, in the context of cloning, are not analogous to embryos, but to gametes whose union results in the generation of an embryo in the case of ordinary sexual reproduction**

True, the whole genetic code is present in each somatic cell. However, this point fails to show that its potentiality is the same as that of a human embryo. When the nucleus of a somatic cell is inserted into an enucleated ovum and given an electric stimulus, this is not merely the placing of the somatic cell into an environment hospitable to its continuing maturation and development. Rather, it generates a wholly distinct, self-integrating and entirely new organism—it generates an embryo. The entity—the embryo—brought into being by this process is radically different from the constituents that entered into its generation.

Recently, Agata Sagan and Peter Singer of Princeton University (Princeton, NJ, USA) have attempted to rescue Bailey’s argument. They insist that the enucleated ovum, or ovular cytoplasm, is indeed only an environment and so the fusion of a stem cell with it does not produce a new entity. For, they contend, if the nucleus of a stem cell were transferred to a different egg with different cytoplasm, this would not result—in their judgment—in a different embryo (Sagan & Singer, 2007). They conclude—comparing embryos to stem cells rather than to somatic cells, as Bailey did—that “it would seem that if the human embryo has moral standing and is entitled to protection in virtue of what it

can become, then the same must be true of human embryonic stem cells” (Sagan & Singer, 2007).

The question is whether the ovular cytoplasm is merely a suitable environment, which allows an already existing organism—the somatic cell or stem cell—to develop capacities already within it, as Bailey, Sagan and Singer claim, or, on the contrary, whether it is a cause or co-cause that produces a substantial change resulting in the coming to be of a new organism, the embryo—which is our view.

Notice, first, that a new organism might be generated by the interaction of two causes, although it is possible that the same organism could have been generated by two different co-causes. Prior to the splitting of a flat worm, for example, there is a single flat worm; however, any number of mechanical forces might produce two flat worms, and could thus be the cause of the coming to be of new substances. Therefore, the fact—if it is a fact, and that is not clear—that the same embryo could be produced by cloning with this or that enucleated ovum does not show that the enucleated ovum is a mere environment.

Moreover, during the transformation of a stem cell into a whole organism, when it is fused with the ovular cytoplasm, it is obvious that the cytoplasm is more than just a suitable environment, and that the change is a coming to be of a new organism, for two reasons. First, the stem cell was not a whole organism before this fusion; it functioned together with the other parts of a larger organism for the survival and flourishing of that organism, not of itself. After the fusion, there is a new and complete—that is, whole—organism, not a mere part. Second, something that qualifies as ‘merely environmental’ does not enter into an organism and modify its internal parts resulting in an entity with a new developmental trajectory. However, the ovular cytoplasm does just that in regard to the nucleus placed within it. The cytoplasm, or factors in the cytoplasm, reprogramme the nucleus fused with it. The crucial and decisive fact that undermines the effort of Sagan and Singer to rescue Bailey’s argument is that factors of the cytoplasm change the epigenetic state of what was hitherto a somatic cell or stem cell. These factors modify the genes in various ways—for example, subtracting methyl groups from key molecules in the DNA of the cell—so that it becomes de-differentiated, which is to say, it ceases to be a somatic cell or a stem cell—and part of a

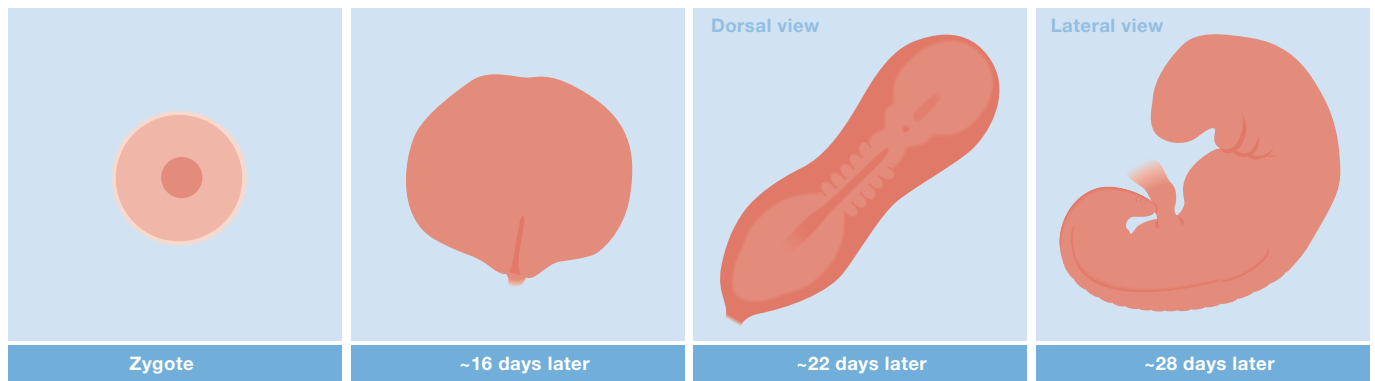
larger organism—and a new whole organism is produced: an embryo.

Thus, somatic cells, in the context of cloning, are not analogous to embryos, but to gametes, the union of which results in the generation of an embryo in the case of ordinary sexual reproduction. You and I were never either a sperm cell or an ovum. Nor would a person who was brought into being by cloning have been once a somatic cell. To destroy an ovum or a skin cell, the constituents of which might have been used to generate a new and distinct human organism, is not to destroy a new and distinct human organism—for no such organism exists or ever existed. However, to destroy a human embryo is precisely to destroy a new, distinct and complete human organism, an embryonic human being.

Others have denied that human embryos are human beings, arguing that human beings come to be only gradually: human embryos are therefore on their way to becoming, but are not yet, human beings. This objection was advanced by Michael Sandel at Harvard University (Cambridge, MA, USA) in his book *The Case Against Perfection* (Sandel, 2007). According to Sandel, human organisms come to be gradually rather than at a determinate time, and a human organism is not fully present until some time after the embryonic stage. He states that this idea defeats the pro-human-embryo argument, which he recounts as follows: “the development of the embryo from the zygote stage on through the embryonic, fetal and infant stages is continuous, without any abrupt changes in direction of growth; therefore, one can conclude that there is no change in identity during that time, and, since a human infant is a human organism, so is a human zygote” (Sandel, 2007).

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Sandel contends that this argument commits what philosophers know as the sorites fallacy; it illicitly assumes that one can never produce a radical change by the addition of several small changes. For example, suppose one reasoned as follows about grains of sand: “[w]e can never get



a heap of sand from adding grains of sand to each other. For if I add just one grain to another that will not make a heap, and if I add another, that also will not produce a heap, since a tiny addition cannot change a few grains of sand into a heap. But the same point will be true for each grain of sand added, therefore I can never arrive at a heap of sand, by the repeated addition of a grain of sand to others.” That is the sorites fallacy (Sandel, 2007).

According to Sandel, the pro-human-embryo argument is therefore fallacious. From the fact that one cannot designate an instant or moment in which there is a radical change in the developmental process from a human embryo to a mature human being, it does not follow that there is no significant and radical difference between them. Consequently, Sandel argues, it does not follow that a human embryo is a human being. Rather, just as adding grains of sand to each other gradually produces something radically different, namely, a heap of sand, the process of development of the embryo and fetus in the womb gradually produces a human organism—but only gradually, not all at once.

Contrary to what Sandel assumes, however, the argument we presented above does not begin merely from the continuity of embryonic development. Sandel is of course right that the sorites fallacy is a fallacy—but he is mistaken in thinking that the basic pro-human-embryo argument commits it. The argument is not that an adult must be the same individual who was once an embryo simply because there is no significant difference between any two adjacent stages in the development from embryo to adult. Rather, the argument is that the adult is identical to the embryo he

or she once was because there are no essential differences in the kind of being one is between any two stages—whether the two stages are adjacent to each other or not—in the development of a human individual from embryo to fetus, infant, child, adolescent and adult. There are of course several significant differences between an embryo, an infant and an adult—such as size and degree of development. But there is no difference in the kind—that is, there is no difference in the fundamental nature of the entity—between any two stages of the developing living being—whether those stages are adjacent to each other or are several months apart in his or her life cycle.

**Whether a new human organism exists is a question to which the answer must be either yes or no—there is no in between**

Again, the human embryo, from fertilization forward, develops in a single direction by an internally directed process: the developmental trajectory of this entity is determined from within, not by extrinsic factors, and always toward the same mature state, from the earliest stage of embryonic development onward. This means that the embryo has the same nature—it is the same kind of entity, a whole human organism—from fertilization forward; there is only a difference in degree of maturation between any of the stages in the development of the living being.

The alternative, gradualist position proposed by Sandel is untenable in light of modern embryology. He claims that becoming a human organism is a gradual process, and so it is arbitrary where in that process

one locates the beginning of a fully fledged human being. The entire process would include the maturation of the gametes, their moving toward each other, the penetration of the oocyte by the sperm, the intermingling of their nuclei, the emergence of the zygote, its growing by differentiated cell division, its implantation in the mother’s uterus and so on. This whole continuous process, according to Sandel, is the gradual coming to be of a human organism.

As we will show, this position implicitly presupposes that human beings are processes, not entities that persist throughout various changes. However, first, even if human beings were processes, this position would be untenable. Second, human beings are in fact not processes but are persisting substances.

There are two views of human beings, or indeed of all living beings. The temporal-parts view—also known as four-dimensionalism or perdurantism—defines a human being or any organism as a process or series of events, similar to a song or a football game. By this view, the human being is not wholly present at each time that it exists. Rather, just as the human being has spatial parts, ‘Smith-on-Monday’ and ‘Smith-on-Tuesday’ are only parts of the whole Smith, who is a process or series of events, spread out over, for example, 70 or 80 years.

According to the second view of human beings—the one we believe is far more sound—a human being is wholly present at each moment that he or she exists. It is literally true that you, the whole you, is currently reading this article, even though changes are going on within you. It is not only a temporal part of you, ‘you-on-Friday-afternoon’. This second view is called endurantism or three-dimensionalism.

Now, if a human being is a thing that exists as a whole at each moment that it exists, then it cannot at any time be only partly present—at every moment that it exists, it exists as a whole, even if it is immature and is still undergoing improvement or development. However, if someone holds that a human being comes to be gradually, then he or she is committed also to the position that during this coming to be the human being is not wholly present but only partly present. Thus, the position on human embryos proposed by Sandel and others presupposes the temporal-parts view of human beings—that a human organism is a process.

We will argue that we are not processes; that is, that the temporal-parts view of human beings is unsound. However, the first point we make is that even if we were processes, Sandel's position would be untenable. If we were processes, it would perhaps be vague exactly when the processes we were began. Still, in the case of human organisms, that vagueness would not extend far, and any doubts about whether the human organism as a distinctive process had begun would certainly be ended by the time of fertilization. As an analogy, the First World War was in fact a process or a series of events, rather than a persisting substance. Yet, although it might be unclear at what precise moment it began, it was certainly underway in September 1914 at the Battle of the Marne, when the armed conflict among the main participants had begun.

It is often said that fertilization is not a 'moment' but a process that takes approximately 24 hours. It is true that one cannot determine to the millisecond exactly when fertilization begins. Nevertheless, the beginning of fertilization certainly does signal a fundamentally new type of process. In other words, one might deny—against what we argue below—that at fertilization the human being comes to be, as a whole, all at once—yet one would be forced by the sheer weight of the facts of human embryology to concede that fertilization initiates a wholly new and distinct developmental trajectory. Before fertilization, hundreds of millions of sperm exist with a behavioural trajectory toward an oocyte, and an oocyte with a behavioural trajectory toward a sperm. Once a sperm and an oocyte successfully unite, there is a single, internally organized development toward an ever more complex and organized multicellular organism, indeed, toward the mature stage of a human

organism. This point is true independently of whether one interprets the organism as a persisting substance or as a process.

Notwithstanding, it is a mistake to view the human organism as a process or as an entity that includes temporal parts and whose beginning is indeterminate. One serious problem with the process or temporal-parts view is that, in the end, it cannot make sense of how we explain processes. True, we can explain some processes by referring to other processes that occurred earlier but, in the end, the processes are explained by reference to something that persists. Processes are extended in time and often composed of smaller processes or events, and what needs to be explained with respect to such sets or series is precisely their regular and ordered sequence. However, what ultimately explains such order and regularity in sequences of processes extended in time is an entity of some sort that persists through time.

For example, we must affirm the existence of animals as entities that persist through long stretches of time, in order to account for the complex processes of growing, perceiving, reacting to stimuli, crawling, walking, running and so on. The actions initiated and sustained by animals—including actions such as chasing prey, eating meals and mating—are complex actions that take time. To suppose that there are only events or processes strung together in various ways is to lose sight of the fact that an action and its structure is explained by the kind of entity that produced and sustained it throughout a period of time. A dog will chase a rabbit, whereas a horse will not. This is partly because a dog is a carnivore and a horse is a herbivore. However, this is most reasonably interpreted as a dog being a certain type of entity—that is, an enduring source of predictable actions and reactions, a persisting centre of actions and reactions, which include chasing rabbits. Thus, organisms are not mere processes; rather, they are entities that persist through time (Lee & George, 2008).

**The difference between a being that deserves full moral respect and a being that does not [...] cannot consist only of the fact that, while both have some feature, one has more of it than the other...**

Thus, when the human organism comes to be, it must come to be as a whole, and therefore all at once—although, of course, once it comes into being, it will grow and proceed through various developmental phases toward maturity. Many changes precede this substantial coming to be, changes that dispose the future constituents of the substance more and more to that substantial change. The mutual approach and union of the sperm and the oocyte is a gradual process that results in the coming to be of a new organism. However, the organism itself does not exist until that process is completed. Before the completion of this process, it is not correct to say that the new organism partly exists. In fact, when it does come into existence, it comes into existence as a whole organism—although at an immature stage.

Of course, some realities do have indeterminate beginnings, but they are distinct from the kind of reality an organism is, including a human organism. We suggest that the only way something can have an indeterminate beginning is if it is an aggregate composed of simpler entities, a quality or a quantity.

The famous example of the ship of Theseus illustrates the case of aggregates, by which we mean a group of substantial entities united in some manner, as opposed to a single although complex substantial entity. As each board is replaced in the ship, one might ask whether or not this is the same ship. The answer is that at many stages there just is no fact of the matter; at many stages the answer is indeterminate. This, however, is because the ship is not a natural unitary substance, but is actually an aggregate composed of simpler distinct entities arranged in a certain manner by human beings for a certain use. Whether we choose to call a group of boards, canvas and nails a ship is a conventional issue, not always determined one way or the other by the reality. We have this same type of indeterminacy with respect to heaps of sand—because these are aggregates, it is arbitrary where we draw the line between sand that constitutes a heap and sand that does not. Here the indeterminateness seems to be located in our concepts or classifications. Qualities—or, more specifically, the intensities of qualities—and quantities also have indeterminate beginnings. However, higher organisms are neither mere aggregates of simpler entities, nor qualities or quantities.



It is therefore incorrect to claim, as Sandel and others do, that the transition from sperm and oocyte to zygote, multi-celled embryo, fetus and so on is all on a continuum. On the contrary, after the sperm and the oocyte cease to be and their constituents contribute to the formation of a new organism, what exists is a distinct whole, with its own internal organizing principle. In other words, what exists is a distinct centre of actions and reactions, with a determinately distinct developmental trajectory. Whether a new human organism exists is a question to which the answer must be either yes or no—there is no in between. If a human organism exists, then he or she exists as a whole and not just partly, and this is true for all the times that he or she exists. Embryos are whole human beings, at the early stage of their maturation. The term ‘embryo’, similar to the terms ‘infant’ and ‘adolescent’, refers to a determinate and enduring organism at a particular stage of development. Just as you and I once were infants, so too you and I once were embryos. Each of us came into being as an embryo, and developed by an internally directed and gapless process from the embryonic into and through the fetal, infant, child and adolescent stages, and into adulthood with our determinateness and unity fully intact.

Some grant that the human embryo is a human organism, but deny that this means it is a being deserving of full moral respect. They claim that in order to have dignity and a right to life, a human being must have additional characteristics such as self-awareness. Often this view is expressed along the following lines: “[w]hile human embryos are human organisms, they are not persons, and it is persons who deserve full moral respect, not necessarily human organisms.”

We believe that this view, which relegates some living human beings to the status of ‘non-persons’, is profoundly mistaken. It is clear that one need not be actually or immediately conscious, reasoning, deliberating or making choices, in order to be a human being who deserves full moral respect, for plainly people who are asleep or in reversible comas deserve such respect. Thus, if one denies that human beings are intrinsically valuable by virtue of what they are, one requires an additional attribute, which must be a capacity of some type and, obviously, a capacity for certain mental functions.

Of course, human beings in the embryonic, fetal and early infant stages cannot yet exercise mental functions characteristically carried out by most human beings at later stages of maturity. Still, they have in radical—that is, root form—these very capacities. Precisely by virtue of the kind of entity they are, they are, from the beginning, actively developing themselves to the stages at which these capacities will—if all goes well—be immediately exercisable. Although, similar to infants, they have not yet developed themselves to the stage at which they are self-aware, it is clear that they are rational animal organisms. Having a rational nature is, in the words of Jeff McMahan at Rutgers University (New Brunswick, NJ, USA) a “status-conferring intrinsic property”. The argument is not that every member of the human species should be accorded full moral respect because the more mature members of the species have a status-conferring intrinsic property, as McMahan mistakenly interprets the nature-of-the-kind argument. Instead, we contend that each member of the human species has a rational nature.

It is obvious in practical deliberation that one’s own well-being and fulfilment—such as one’s own health and understanding—is worth pursuing and promoting. It is also obvious that the well-being and fulfilment of others is worth pursuing or at least respecting. However, the well-being and fulfilment of others is worthy of respect even at times when they are unconscious—when they are asleep, comatose or at any time that they exist, including those times during which they are developing to the stage at which they will be actually exercising the basic natural capacity for agency. We contend that these other entities are bearers of rights—their fulfilment is worthy of pursuit and respect, they should not be intentionally harmed, and they should be treated as we would have others treat us—because of the kind of entity they are, namely a creature with a rational nature, not in virtue of certain accidental characteristics such as age, size, location or stage of development. Briefly, we can advance two arguments to show that the substantial nature of the individual, and not accidental characteristics, should be recognized as the basis for having dignity and basic rights.

First, the developing human being does not reach a level of maturity at which he or she performs a type of mental act that other animals do not perform—even animals

such as dogs and cats—until at least several months after birth. A 6-week-old baby cannot immediately perform characteristically human mental functions. However, if full moral respect were due only to those who have immediately exercisable capacities for characteristically human mental functions, it would follow that 6-week-old infants do not deserve full moral respect—some philosophers have actually claimed that infants do not deserve the moral respect of basic human rights (Singer, 1995). Thus, if human embryos might legitimately be destroyed to advance biomedical science, then it follows logically that, subject to parental approval, the body parts of human infants should be fair game for scientific experimentation.

**...human beings are intrinsically valuable in the way that allows us to ascribe to them equality and basic rights in virtue of what they are...**

Second, one might at first think that there are two types of capacity for consciousness or other mental functions: an immediately exercisable capacity for consciousness; and another, basic natural capacity that requires time and internal development in the organism before it can be actualized. One has this basic natural capacity for consciousness from the time that one comes to be—a human being has this capacity or potentiality from the embryonic stage forward by virtue of the fact that he or she has a disposition to actively develop to the stage where he or she will be conscious.

However, in reality, there is just one capacity for consciousness and just one capacity for each distinct type of living act. What is referred to as ‘the immediately exercisable capacity’ for consciousness is the development of that single capacity. A capacity such as that for consciousness is a power to perform a specific type of action. The capacity develops and comes closer to being the performance of that action, with the development of the constitution of the organism; however, in a living being, the transition from the basic natural capacity to perform an action characteristic of living beings on the one hand, to the performance of that action on the other hand, is just the development of the basic power that the organism has from its beginning. The capacity for consciousness is gradually developed or brought towards

maturation, through gestation, childhood, adolescence and so on.

Proponents of an immediately exercisable capacity for mental functions as a criterion for having dignity and a right to life do not select one property or feature rather than another as a criterion for dignity and rights. Instead, they select a certain degree of a property. However, such a selection is inevitably arbitrary. For why should the *n*th degree of that property qualify one as having rights? Why not the *n*th+1 degree or the *n*th+2 degrees and so on? The difference between a being that deserves full moral respect and a being that does not—and might therefore legitimately be killed to benefit others—cannot consist only of the fact that, while both have some feature, one has more of it than the other—one has some arbitrarily selected degree of the development of some feature or property, whereas the other does not. This conclusion would follow no matter which of the acquired qualities proposed as qualifying some human beings or human beings at some developmental stages for full respect were selected.

The criterion we propose—that of a creature being an individual with a rational nature—does not suffer from this problem of arbitrariness. There is a radical difference between individuals with a rational nature and other entities, and that difference is morally relevant—rational creatures, at all times that they exist, should be treated as we would have others treat us.

It follows that it cannot be the case that some human beings and not others are intrinsically valuable, by virtue of a certain degree of development. Rather, human beings are intrinsically valuable in the way that allows

us to ascribe to them equality and basic rights in virtue of what they are; and all human beings are intrinsically valuable.

As human beings are intrinsically valuable and deserve full moral respect in virtue of what they are, it follows that they are intrinsically and equally valuable from the point at which they come into being. Even in the embryonic stage of our lives, each of us was a human being and, as such, worthy of concern and protection. Embryonic human beings, whether brought into existence by the union of gametes, somatic-cell nuclear transfer or other cloning technologies, should be accorded the respect given to human beings in other developmental stages. Their right to life should be acknowledged and respected.

REFERENCES

Bailey R (2001) Are stem cells babies? *Reason*, July 11. www.reason.com  
 Lee P, George RP (2008) *Body-Self Dualism in Contemporary Ethics and Politics*. Cambridge, UK: Cambridge University Press  
 Memili E, First NL (2000) Zygotic and embryonic gene expression in cow: a review of timing and mechanisms of early gene expression as compared with other species. *Zygote* **8**: 87–93  
 Sagan A, Singer P (2007) The moral status of stem cells. *Metaphilosophy* **38**: 264–284  
 Sandel M (2007) *The Case Against Perfection*. Cambridge, MA, USA: Belknap Press of Harvard University  
 Santo F, Dean W (2004) Epigenetic reprogramming during early development in mammals. *Soc Reprod Fertil* **127**: 543–651  
 Singer P (1995) Killing babies is not always wrong. *The Spectator*, 16 September, pp 20–22  
 Thompson EM, Legouy E, Renard JP (1998) Mouse embryos do not wait for the MBT: chromatin and RNA polymerase remodeling in genome activation at the onset of development. *Development* **124**: 4615–4625  
 Zernika-Goetz M (2003) Patterning of the embryo: the first spatial decisions in the mouse. *Development* **129**: 815–529

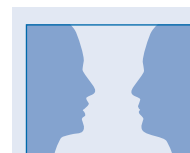
Zimmerman JW, Schultz RM (1994) Analysis of gene expression in the preimplantation mouse embryo: use of mRNA differential display. *Proc Natl Acad Sci USA* **91**: 5456–5460



Patrick Lee (right) is John N. and Jamie D. McAleer Professor of Bioethics and Director of the Institute of Bioethics at the Franciscan University of Steubenville (OH, USA).

Robert P. George is McCormick Professor of Jurisprudence and Director of the James Madison Program in American Ideals and Institutions at Princeton University (NJ, USA), and a member of the United States President's Council on Bioethics and the United Nations Educational, Scientific and Cultural Organization World Commission on the Ethics of Scientific Knowledge and Technology. E-mail: rgeorge@princeton.edu

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For more discussion on this topic, see also Baldwin T (2007) Morality and human embryo research. This issue p299. doi:10.1038/embor.2009.37  
 Douglas T, Savulescu J (2009) Destroying unwanted embryos in research. This issue p307. doi:10.1038/embor.2009.54