

JOHN BRYANT AND MARY GUDGIN
**Attitudes amongst young adults to use
of embryonic stem cells in research
and therapy: comparison of
evangelical Christian students with
non-Christian students**

The various attitudes towards the use of early embryos for the generation of embryonic stem cells are surveyed, with a focus on the positions held within different segments of the Christian community. This discussion is further informed by the results of a survey carried out in Exeter, UK, to compare the views of a group of evangelical students with those of a matched control group professing no religious faith. It is concluded that religious belief is a key element influencing the attitudes of young adults towards the use of early embryos.

Keywords: embryonic stem cell; bioethics; evangelical student; embryology; medical technology.

Introduction

Stem cells¹ are cells defined by two clear properties. First, their populations are self-maintaining, so that when a stem cell divides, at least one of the daughter cells is also a stem cell. Secondly, they have the potential to develop into the different cell types that are found in the body. Thus any daughter cell arising by cell division from a stem cell, which does not itself become a stem cell, is destined to give rise, by further divisions and by differentiation, to one or more types of mature, functional cell. During post-fertilisation development, stem cells are first seen in the early embryo. At the blastocyst stage of embryonic development, which in humans occurs a few days after the completion of fertilisation, the embryo consists of a hollow ball, the outer layer of which is known as the trophectoderm from which, if a pregnancy is established, the placenta will be derived. Into the hollow ball protrudes a compact mass of cells, the inner cell mass, and from these the embryo proper and thence the fetus and eventually the baby will be formed. It is immediately obvious that although the cells of the inner cell mass have lost the potential to form the placenta, they retain the developmental potential to form all the different types of cell that

1 A fuller account of stem cells, written for a non-specialist readership, may be found in Bryant, J.A. *Stem Cells*, Bioethics Briefings N0 5. Centre for Bioscience, Higher Education Academy (2006). Available online at <http://www.bioscience.heacademy.ac.uk/ftp/Resources/ethicsbrief5.pdf>

occur in the mammalian body. They are thus described as *pluripotent*. However, this population is relatively short-lived because, if a pregnancy is established, these cells soon give rise to the three tissue layers of the embryo, namely the endoderm, mesoderm and ectoderm which themselves go on to form particular tissues and organs as the embryo develops. In terms of self-renewal then, the cells of the inner cell mass are much more time-limited than adult stem cells (see below) but are nevertheless known as *embryonic stem cells* (ES cells).

Stem cells also exist in the post-embryonic phases of life when specific stem cell populations are responsible for replenishment and repair of particular tissues. The most well-known population of these 'adult'² stem cells is that in the bone marrow from which all types of blood cell are ultimately derived.

Both types of stem cell have been suggested as possible agents of regenerative medicine, that is, in the repair of tissues and organs damaged by trauma or disease. However, ES cells, because of their very much wider potential in nature, are usually regarded as likely to be of greater usefulness. The use of ES cells in regenerative medicine would involve the growth of embryos *in vitro* to the blastocyst stage, the removal of the inner cell mass and the culture of those cells in conditions that allow them to retain their self-renewing, pluripotent nature. This had first been achieved with mouse ES cells in 1981³ and for humans in 1998⁴. However, maintenance in culture is not enough if the cells are to be used in regenerative medicine: it needs to be possible to induce the formation of different cell types from the cultured ES cells and this has now been achieved to a limited extent with human ES cells⁵.

There was thus in the late 1990s/early 2000s an impetus for increased research on ES cells. However, in the United Kingdom a change of law was needed in order that such research could proceed freely. The Human Fertilisation and Embryology (HFE) Act (1990) permitted research on embryos, under the regulatory powers of the HFE Authority (HFEA), provided that the research was related to human reproduction and fertility. The Act also allowed the creation of embryos *in vitro* specifically for research but in practice nearly all embryos used in research are 'spare', surplus to the requirements of IVF treatment. Use of human embryos as sources of stem cells was outside the provisions of the HFE Act but the Act was amended by Parliament in 2001 to permit, under licence from the HFEA, use of embryos for research on medical conditions as well as on reproduction and fertility. The amendment thus permit-

2 Although widely used, the term *adult stem cells* is a misnomer because these populations are established during fetal growth; *post-embryonic stem cells* is the more accurate term.

3 Evans, M. and Kaufman, M.H. 'Establishment in culture of pluripotential stem cells from mouse embryos', *Nature* (1981) 292, 154-156.

4 Thomson, J.A., Itskovitz-Eldor, J., Shapiro, S.S., Waknitz, M.A., Swiergiel, J.J., Marshall, V.S. & Jones J.M. 'Embryonic stem cell lines derived from human blastocysts', *Science* (1998) 282, 1145-1147.

5 Odorico, J.S., Kaufman, D.S. & Thomson, J.A. 'Multilineage differentiation from human embryonic stem cell lines', *Stem Cells* (2001) 19, 193-204.

ted the use of blastocysts as sources of stem cells. This change was in general welcomed by the biomedical research community, by patient support groups and by medical charities. The change in the terms of the Act also allowed the establishment of a national stem cell bank; this was opened in May 2004.⁶

Although the change in the terms of the Act was widely supported, it did have its opponents; those opponents also made their views known when the stem cell bank was opened.⁷ The grounds for opposition were that the removal of stem cells destroyed an early human embryo which is regarded by some as deserving the same status in ethical thinking as a fully-formed human being. Philosophical discussions of this view are presented by Borge and Evers⁸, Devolder⁹ and Steinbock¹⁰. Here it simply needs to be stated firstly that this view is based on the supposition that human personhood is attained at 'conception'. The latter term is in fact ambiguous and needs some clarification. Its original meaning must have been the establishment of a pregnancy since nothing was known about fertilisation and the early human embryo; some still use it in this sense. However, today most use it to mean [the completion of] fertilisation and hence the formation of an embryo. The latter use is certainly that usually adopted by those proposing that the early embryo possesses full human personhood. Secondly, this view of the early embryo leads to the conclusion that ending the life of an embryo to obtain stem cells is equivalent to ending the life of a fully formed human. This position is one of a range encountered in discussions by Christians of the moral status of the early embryo, as clearly reviewed by Jones.¹¹ It is the position formally adopted by the Roman Catholic church¹² and by many, perhaps the majority of conservative protestant or evangelical Christians, in so far as may be judged by much of the writing on the topic from within that constituency, exemplified by several authors.¹³

Despite the pronouncements from church authorities or the literature emanating from those taking this very conservative position on the early embryo, there are writers from within both the Roman Catholic and evangelical protestant traditions who have challenged it. The work of two Roman Catholic scholars, Thomas Shannon and James Walter, on this topic¹⁴ has been reviewed by

6 <http://news.bbc.co.uk/1/hi/health/3725935.stm> (last accessed on 11/10/2006)

7 Odorico et al. *op. cit.*, (5).

8 Borge, O.J. & Evers, K. 'Aspects on properties, use and ethical considerations of embryonic stem cells – a short review', *Cytotechnology* (2003) 41, 59-68.

9 Devolder, K. 'Human embryonic stem cell research: why the discarded-created-distinction cannot be based on the potentiality argument', *Bioethics* (2005) 19, 167-186.

10 Steinbock, B. 'The morality of killing human embryos', *Journal of Law, Medicine and Ethics* (2005) 34, 26-34.

11 Jones, D.G. 'Responses to the human embryo and embryonic stem cells: scientific and theological assessments', *Science and Christian Belief* (2005) 17, 199-222.

12 Pope John Paul II *The Gospel of Life*, Papal Encyclical, 1995.

13 Hui, E.C. *At the Beginning of Life: Dilemmas in Theological Bioethics*, Downers Grove, IL: Inter-Varsity Press (2002); Taylor, P. *For What it is Worth*, London: CARE (2002); <http://www.cbhd.org/resources/stemcells/index.html> (last accessed on 11/10/2006).

14 Shannon, T.A. & Walter, J.J. *The New Genetic Medicine*, Lanham, MD: Rowman and Littlefield (2003).

Jones,¹⁵ while amongst evangelical Christian authors, Jones himself,¹⁶ Bryant and Searle¹⁷ and Berry¹⁸ exemplify those who do not ascribe full personhood to the early embryo. So, within both the Roman Catholic and evangelical protestant constituencies, there are those who depart from the received orthodoxy, whether the latter is official or just perceived.

It is clear then that, while generalisations can be made about the views held on early human embryos within particular Christian traditions, it cannot be assumed that all who belong to those traditions adhere to those views. For example, the support for ES cell research by USA Democratic presidential candidate, the Roman Catholic John Kerry in 2004 was contrary to the teaching of his church. There is also recent evidence suggesting that within the evangelical Christian constituency in the USA there are some who do not hold the very conservative view on the status of the early embryo outlined above and who thus support research on ES cells.¹⁹ There are however no quantitative data on this, although 'fundamentalist' pastors have been surveyed in the USA on their attitudes to cloning.²⁰ That survey was based on answers to two open-ended questions presented via the Internet with an invitation to reply. In respect of the present paper, views on therapeutic cloning, involving the creation of embryos in order to use the ES cells, are the most relevant. The majority of the pastors opposed this, and in some replies the status of the early embryo was mentioned as a factor. Nevertheless, a small minority approved of (or at least did not oppose) therapeutic cloning, indicating a more liberal view of the early embryo.

In the UK, a MORI poll of just over 2000 adults (upwards from 15 years old) was carried out in 2003²¹ It was based on respondents' selecting from three statements the one that most closely described their own view of the use of human embryos in medical research. About 70% of the respondents approved of the use of human embryos for research but at the other end of the spectrum just under 19% agreed that '*the use of human embryos for medical research is never acceptable*'. Respondents were not asked to give reasons for their answers, so it is not known whether any were influenced by religion.²² It is therefore of interest to know whether profession of a religious faith, in partic-

15 Jones, D.G. *op. cit.*, (11).

16 *ibid.*

17 Bryant, J. & Searle, J. *Life in Our Hands*, Leicester: Inter-Varsity Press (2004).

18 Berry, A.C. *Beginnings: Christian Views of the Early Embryo*, London: Christian Medical Fellowship (1993).

19 Thirteen/WNET New York, Innovation Survey (2004): <http://www.pbs.org/wnet/innovation/resources5.html> (last accessed on 09/10/2006).

20 Weasel, L.H. & Jensen, E. 'Language and value in the human cloning debate: a web-based survey of scientists and Christian fundamentalist pastors', *New Genetics and Society* (2005) 24, 1-14.

21 <http://www.mori.com/polls/2003/amrc.shtml> (last accessed on 11/10/2006).

22 However, the figure of 19% is higher than the percentage of UK citizens who profess to be practising Roman Catholics, evangelical protestants or muslims (the teachings of Islam are also conservative in respect of the early human embryo), again indicating that factors other than religion may play a role in this debate.

ular, profession of a conservative protestant faith, is correlated with particular views on embryonic stem cells. A subsidiary question then arises: How far do the views of those who write about this topic from a conservative standpoint represent the wider membership of that tradition?

Methods

Our survey, carried out in late 2004 and early 2005, focused on students. This provided a clearly defined sub-group within the chosen constituency (evangelical Christians) and facilitated matching in respect of age range (19-22) and level of education (working for a degree-level qualification) with a 'control' group who professed no religious faith. The evangelical Christian students surveyed all attended a student group organised by St Leonard's Church, Exeter, a conservative evangelical Anglican church.²³ Only those who described themselves as Christians in the sense of having a personal faith in Jesus Christ were included in the survey. The non-religious group surveyed were students belonging to various sports clubs in the Athletic Union at the University of Exeter; any sportsmen or women who professed a religious faith were excluded from the survey. Views were obtained by administration of a questionnaire which respondents were asked to complete without discussion with their peers. Questionnaires were handed personally to all members within each of the defined experimental groups and were completed in the presence of the researcher; there were no non-respondents. Respondents were not remunerated. The questionnaire was answered anonymously and all originals were destroyed after collation of the data. Prior to answering the questionnaire, all respondents were informed of the function of the questionnaire within the research project and were given a brief background paper explaining adult, embryonic and cord-blood stem cells and therapeutic cloning.

The questionnaire took the form of a series of statements to which the students were asked to respond on a five-point Likert scale.²⁴ Data from questionnaires such as these are, strictly speaking, non-parametric. However, Johnson and Creech²⁵ and Hopkin²⁶ have shown very clearly that, provided certain conditions are met in respect of sample size and of number of possible responses on the Likert scale, statistical analysis using methods developed for parametric data gives a reliable indication of statistical significance. The methods used here and the patterns of data obtained meet the requirements for use of simple parametric statistical analysis. This was done using the Sta-

23 <http://www.stleonardsexeter.org.uk> (Last accessed on 11/10/2006).

24 Likert, R. *A technique for Measurement of Attitudes*, New York: Columbia University Press (1932).

25 Johnson, D.R. & Creech, J.C. 'Ordinal measures in multiple indicator models: a simulation study of categorization error', *American Sociological Review* (1983) 48, 398-407.

26 Hopkins, W.G. *A New View of Statistics*, pub. online at <http://www.sportsci.org/resource/stats/> (last accessed on 11/10/2006).

tistical Package for the Social Sciences (SPSS) software package. The statistical analysis, employing the t-test (not assuming equal variance), was performed on the raw data, but for presentation as histograms (Figs 1-5) the data were converted into percentages.

Results

The focus here is on attitudes to the use of embryonic stem cells, including those derived via 'therapeutic cloning'. The key statements in the questionnaire that form the basis for this analysis were:

- I approve of the use of early human embryos as a source of stem cells
- I approve of further research on human embryos in order to understand the potential of embryonic stem cells in medical treatment
- I approve of the HFEA's decision to allow therapeutic cloning of embryos as a source of human embryonic stem cells for medical research²⁷

Possible responses went from 'I strongly agree' to 'I strongly disagree.'

In addition to these main questions, two further questions were asked in order to ascertain the respondents 'background' attitudes to embryos and fetuses:

- At what stage do you consider a fetus/embryo to be a human person?
 1. At birth
 2. At viability (c.22 weeks)
 3. At initiation of the central nervous system (3 – 4 weeks)²⁸
 4. At implantation (c.7 days)
 5. At the completion of fertilisation
- What is your view on abortion (termination of an established pregnancy)?
 1. Should be available on demand
 - 2
 - 3
 - 4
 5. Unacceptable in all circumstances

The three primary questions revealed very clear and significant differences between the evangelical Christian students and the non-Christian students. Figures 1 to 3 show the responses to each statement as percentages of the total number of respondents in each category. Percentages were used here because the number of Christian respondents (n = 84) was different from the number of non-Christian respondents (n = 91). Thus, the majority of Christian students

²⁷ Therapeutic cloning was defined in order to ensure that the term was understood.

²⁸ Note that although the primitive streak gives the earliest sign that a central nervous system (CNS) will be formed it cannot be taken as the actual initiation of the CNS.

disapproved or strongly disapproved of the use of early embryos as a source of stem cells, of further research on human embryonic stem cells and of the HFEA's decision to permit therapeutic cloning. By contrast, the majority of the non-Christian students approved or strongly approved of these activities. Statistical analysis of the raw data indicated that these differences between the two groups were significant at $p < 0.01$.

Dealing now with the two ancillary questions, again there were clear differences between the two groups. Amongst the evangelical Christian students, 61% ascribed human personhood to the very early embryo at the completion of fertilisation although 20% were of the opinion that personhood was attained at *c.*3-4 weeks (corresponding to the appearance of the CNS) (Figure 4). Responses from non-Christians were more variable but only a small minority ascribed personhood to the early embryo either before or after implantation. The modal answer for this group was that personhood is attained at *c.*22 weeks (at which time a prematurely born baby, given appropriate medical support, has a chance of survival). However, 14% of this group believed that only at birth did a fetus/baby become a human person. As before, the difference between Christians and non-Christians was highly significant ($p < 0.01$).

Responses to the question on abortion were for both groups more spread than answers to other questions (Figure 5). However, it was clear that Christian students were in general opposed to abortion, with 25% declaring it to be unacceptable under all circumstances. Nevertheless, 6% of Christian respondents believed that abortion should be available on demand. The percentage holding this view amongst non-Christian students was 32% and in general, this group was permissive in its attitudes to abortion, although just one non-Christian respondent believed that it was unacceptable under all circumstances. As with the previous data, the difference between the two groups was significant at $p < 0.01$.

The data thus show strong links between attitudes to embryonic stem cells, views about the attainment of human personhood and attitudes to abortion. This becomes even more apparent when correlations are calculated by comparing, for each respondent, the answers to each question. The examples shown in Table 1 indicate that disapproval of abortion is strongly correlated with ascribing human personhood to early, pre-implantation embryos. This in turn, as would be expected, is linked with disapproval of the use of human embryonic cells. Conversely, respondents who have a liberal attitude to abortion are very unlikely to ascribe human personhood to the pre-implantation embryo and in turn are very likely to approve of the use of human stem cells.

Although the questionnaires were completed anonymously, respondents were asked to indicate gender. This facilitated the comparison within each group of the views of male and female respondents. The data are summarised as the means of the Lickert scale responses to the five questions presented above (Table 2). Responses of men and women showed no major differences although the following trends may be discerned:

- Amongst Christians, where overall there was clear disapproval of the use of ES cells and of therapeutic cloning, women tended to be even more opposed to these developments than men
- Women were in general likely to ascribe human personhood to the embryo/fetus at an earlier stage than men
- Christian women, although expressing in general a disapproval of abortion, were less disapproving than Christian men

Discussion

The data presented here provide clear evidence for very marked differences of opinion between evangelical Christian and non-Christian students on ES cells, therapeutic cloning, the status of the early embryo and on abortion.

First, are these data, based on samples, true indicators of the views of the constituencies they are taken to represent? A broader follow-up survey, looking at attitudes within a wider range of religious groups, showed that the sample of non-Christian students surveyed here (drawn from university sports clubs) did reflect the views of non-religious students in general and that other evangelical Christian students, outside of the group that met at St Leonard's Church, expressed similar opinions to those presented here.²⁹

Secondly, breakdown of the data by both religion and gender showed that gender had a small affect, particularly amongst Christians. Gender was also a minor factor amongst Americans surveyed for attitudes to ES cell technology in which, although over 70% of the total population expressed approval, women were slightly less approving than men.³⁰ In the data presented here, by far the major factor affecting attitudes to ES cells and associated topics was religion, with non-Christians being much more permissive on all the issues than evangelical Christians. A similar conclusion was reached by Turnpenny³¹ in a broader but less focused survey in which the data revealed '*an association between religion and antipathy towards research with early human embryos*'. The attitudes towards the early embryo that the evangelical Christian students presented here are also similar to those that surfaced in a much smaller study of 'fundamentalist' pastors in the USA³² and are consistent with opinions of a number of authors, writing on this topic from within the conservative Christian constituency.³³

How then is this position arrived at? Some insight into this question is provided by the observed correlations between the answers to the different questions. For both groups of respondents, the answers are grouped as a linked

29 J.A. Bryant, G. Cook and J.P.S. Evans, unpublished data.

30 Berry *op. cit.*, (18).

31 Turnpenny, L. MSc dissertation, University of Bath, UK (2006).

32 Thirteen/WNET *op. cit.*, (19).

33 Pope John Paul II *op. cit.*, (12); Hui *op. cit.*, (13); Taylor *op. cit.*, (13).

'package'. For the non-Christian students, a permissive attitude towards abortion is correlated with not assigning human personhood to the early embryo, which in turn is correlated with a positive attitude to stem cell research including therapeutic cloning. For the evangelical Christians, a much less liberal attitude to abortion is linked with assigning human personhood to the early human embryo and this leads to the disapproval of the use of human ES cells. Thus, although these students had received no direct Christian teaching on the human embryo or on ES cells, their attitudes to these issues were likely to have been driven by previous teaching on abortion.

Attitudes to abortion stem from the idea that all human life, including life in the womb, is sacred. However, as the conservative Christian ethicist and theologian Richard Hays writes, *'The Bible contains no texts about abortion.'*³⁴ Nevertheless, the lack of specific biblical prohibition of abortion does not mean that it is a permitted practice. There are many possibilities open to twenty-first century humans which, inevitably, are not mentioned in the Bible but that does not mean that they are permissible. Thus, in respect of abortion, Hays is of the opinion that such an idea would not have occurred in the communities of the Old or New Testament. Life was regarded as being in God's hands and a child was a precious gift from God. Hays also suggests that the unborn child, as the very weakest member of the community, deserves all the care we bestow on our neighbour. He concludes that *'the cumulative case becomes weighted heavily against abortion'*³⁵ and points out that even as early as the first century, teachings on Christian discipleship prohibited abortion. Nevertheless, he also concedes that sometimes abortion is the lesser of two wrongs; in such circumstances, abortion should be permitted. Such a position is taken by many evangelical Christians, including many of those in this survey. The modal response (Fig. 5) approximately conforms to Hays's position, although it is noted that 36% of the replies from Christians indicated a more permissive attitude while 25% believed that abortion was always unacceptable.

If abortion is regarded as usually unacceptable, can it be argued from there that it is equally unacceptable to end the life of a very early embryo, for example in order to extract stem cells? The strong correlation in this survey between attitudes to the two events suggests that certainly the respondents to the questionnaire made this connection. It is also a linkage that has been made by a number of writers,³⁶ at least two of whom³⁷ extend to the pre-implantation embryo Hays's argument about caring for the weakest of our neighbours. Further, several authors cite Psalm 139: 13-16 and Jer.1: 5 in support of their view, and it is very likely that this argument is widely accepted amongst evangelical

34 Hays, R.B. *The Moral Vision of the New Testament*, Edinburgh: T & T Clark (1997) pp.446ff.

35 *ibid.*, p. 456.

36 Jones, D.G. *op. cit.*, (11); Pope John Paul II *op. cit.*, (12); Hui *op. cit.*, (13); Taylor *op. cit.*, (13).

37 Taylor *op. cit.*, (13); O' Mathúna, D.P. 'Cloning and stem cell research: wrong motives on both sides of the Atlantic', pub. online at http://www.cbhd.org/resources/stemcells/omathuna_fall-2000.htm (last accessed on 11/10/2006).

Christians. However, other authors from within the evangelical constituency have argued, as Hays does in respect of abortion, that to use such verses in this way is to misapply them by extrapolating them to situations for which they were not intended³⁸ (although it must again be noted that that lack of specific biblical texts does not necessarily imply permission). These latter authors tend to place great emphasis on the biological fate of the early embryo (including the high 'wastage' rate in nature), stating that there is a major difference in the developmental potential of an early embryo prior to implantation into the wall of the uterus and a post-implantation embryo/fetus.³⁹ This leads to a rejection of the view that the early embryo possesses full human personhood and to a breakage of the perceived moral linkage between the life of the early embryo and the life of a fetus growing in the womb. For such authors it is not inconsistent to hold a relatively non-permissive view on abortion but to approve of medical technologies involving the use of embryonic stem cells. Nevertheless, that does not lead to a trivial or cavalier attitude to the early human embryo: use of embryos should be directed only to the relief of human suffering.⁴⁰ Indeed, amongst those who do not ascribe personhood to the early embryo and who place emphasis on the biology, there are some who are concerned that even their use to relieve human suffering may be going too far in the direction of making early embryos mere commodities. This concern, mentioned briefly by Bryant and Searle,⁴¹ is discussed at length by the Roman Catholic biologist/theologian, Deane-Drummond⁴² and leads to a more ambivalent position on the use of ES cells in medical therapy.

Conclusions

In the survey discussed here, non-Christian students expressed approval of medical technologies involving ES cells, broadly in line with wider population surveys carried out in the UK by MORI in 2003⁴³ and in the USA by the public broadcasting station Thirteen/WNET New York in 2004.⁴⁴ The evangelical Christian students by contrast expressed disapproval of these technologies. Such disapproval represents one end of a spectrum of views held amongst Christians⁴⁵ and is likely to reflect the majority view amongst evangelical Christians (although no other quantitative data are available for direct comparison). Nevertheless, there are evangelical Christians who hold much less

38 Jones, D.G. *op. cit.*, (11); Bryant and Searle *op. cit.*, (17); Jones, D.G. *Designers of the Future*. Oxford: Monarch Books (2005).

39 Taylor *op. cit.*, (13); O' Mathúna *op. cit.*, (37); Jones, D.G. *op. cit.*, (11); Bryant and Searle *op. cit.*, (17).

40 Jones, D.G. *op. cit.*, (11, 38).

41 Bryant and Searle *op. cit.*, (17).

42 Deane-Drummond, C.E. *The Ethics of Nature*, Oxford: Blackwell (2004), pp. 124ff.

43 Weasel & Jensen *op. cit.*, (20).

44 Thirteen/WNET *op. cit.*, (19).

45 see Jones, D.G. *op. cit.*, (11).

conservative views of the early embryo and who may therefore have more permissive attitudes to medical technologies involving ES cells.

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Table 1. Correlations between answers to pairs of questions

Questions compared	Correlation coefficient	Significance
Q4 and Q5	0.88	p < 0.01
Q4 and Q2	0.89	p < 0.01

Key: Q2: Further research on human embryos for ES cells
 Q4: Attainment of personhood during embryonic/fetal development
 Q5: Abortion

Table 2. Responses to questions analysed by gender

Question No.	Mean Score			
	non-Xn Female n = 34	non-Xn male n = 57	Xn female n = 49	Xn male n = 35
1	2.32	2.21	3.96	3.57
2	2.09	2.12	3.82	3.51
3	2.06	2.07	3.88	3.51
4	2.59	2.39	4.16	4.09
5	2.15	2.04	3.57	3.86

Key: Q1: Use of embryonic stem cells
 Q2: Further research on human embryos for ES cells
 Q3: Therapeutic cloning
 Q4: Attainment of personhood during embryonic/fetal development
 Q5: Abortion

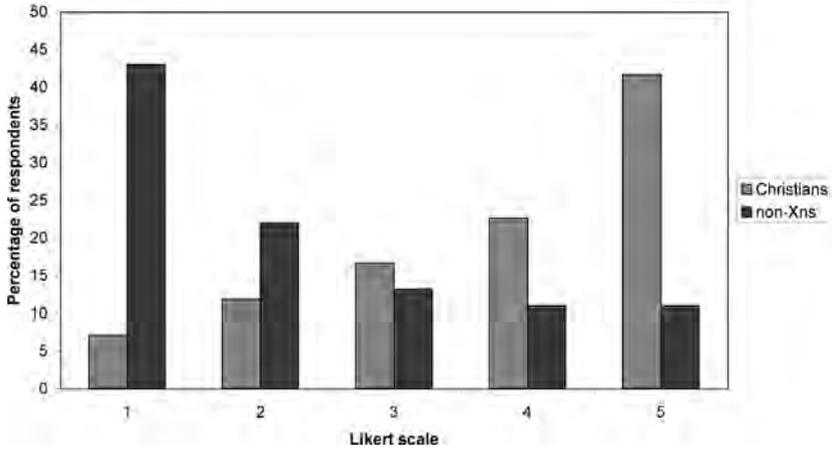


Figure 1. Responses of non-Christian and evangelical Christian students to the statement ‘I approve of the use of early human embryos as a source of stem cells.’ On the 5-point Likert scale used to elicit responses, 1 = strongly agree, 5 = strongly disagree.

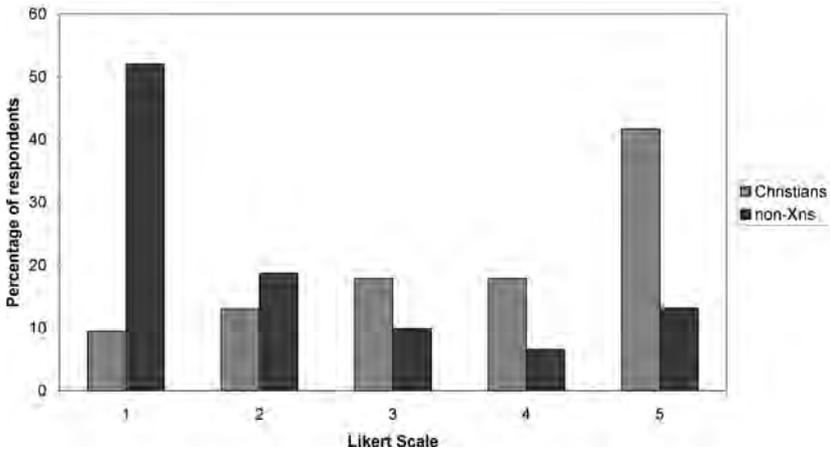


Figure 2. Responses of non-Christian and evangelical Christian students to the statement ‘I approve of further research on human embryos in order to understand the potential of embryonic stem cells in medical treatment.’ On the 5-point Likert scale used to elicit responses, 1 = strongly agree, 5 = strongly disagree.

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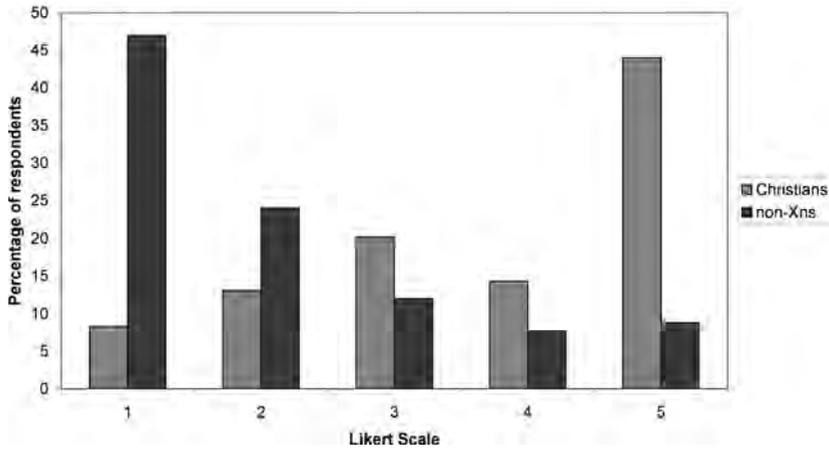


Figure 3. Responses of non-Christian and evangelical Christian students to the statement 'I approve of the HFEA's decision to allow therapeutic cloning of embryos as a source of human embryonic stem cells for medical research.' On the 5-point Likert scale used to elicit responses, 1 = strongly agree, 5 = strongly disagree.

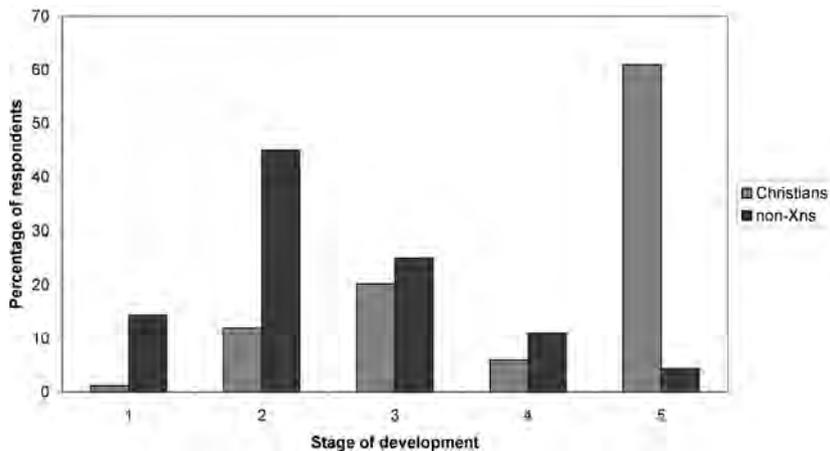


Figure 4. Views of non-Christian and evangelical Christian students as to when an embryo/fetus attains human personhood. On the 5-point scale, 1= At birth, 5 = At the completion of fertilisation (for further details see text).

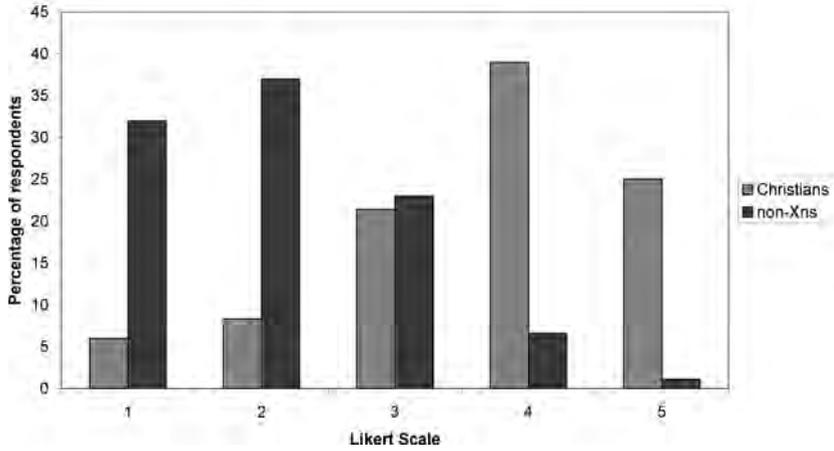


Figure 5. Views of non-Christian and evangelical Christian students on abortion. On the 5-point scale, 1 = Should be available on demand, 5 = Unacceptable in all circumstances.

Appendix

Briefing paper on stem cells, assuming no previous knowledge or scientific expertise

Stem cells, (unlike most cells in the body, which are specialised for a certain function) have the ability to develop into many different types of cells and renew themselves indefinitely. Stem cells therefore have great potential for use medically as they can replace diseased or damaged cells with healthy functioning ones. Extensive research is under way in this area because it is believed that stem cells could relieve much suffering from illness and disease, such as Parkinson's, various genetic disorders and diabetes.

There are two main sources of stem cells, those from an *embryo* and those from an *adult* (adult in this case refers to any person from birth onwards). The *placenta* and *umbilical cord* also contain stem cells but the full potential of these as sources of stem cells is not yet clear. However they have been used to cure 'faulty' bone marrow in a sibling of a newborn baby, by obtaining stem cells from the baby's umbilical cord.

Stem cells found within an embryo, before it implants into the womb lining, are the most versatile source of stem cells, as with the right growth factors these cells can potentially develop into *all* the types of cell found in the human body (as would naturally occur in pre-natal development). The main source of embryonic stem cells used for research is from spare embryos from *in vitro* fertilisation (IVF) that are no longer needed for fertility treatment. Another source of embryonic stem cells is from creating embryos specifically for research purposes. One approach to this is known as *therapeutic cloning*. This is when an egg cell (oocyte) has its nucleus removed and replaced with a nucleus from a normal adult cell from a patient. The egg cell with its new nucleus is stimulated to divide as if it were an embryo. Its development is halted by the removal of the stem cells and the embryo is never implanted in the womb. The removed embryonic stem cells would therefore be immunologically identical to the original patient and could be used to heal them without the risk of rejection. Therapeutic cloning has been legal in Britain since 2001 because of a change in the HFE Act. However the Human Fertilisation and Embryology Authority (HFEA), which makes sure that any research involving human embryos is properly regulated, only granted on 11 August 2004 the first licence (to researchers at the University of Newcastle) to perform the cloning of human embryos.

Stem cells extracted from the adult body are also being employed in research as they too can differentiate into different cell types but, unlike embryonic stem cells, they cannot develop into all the cell types in the body, making their potential more limited. However some adult stem cells are easier to obtain, for example from bone marrow which contains stem cells which give rise to the various cells in blood.