

# THE CHIMPANZEE GENOME AND THE CHRISTIAN VIEW OF HUMANITY

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*The publication of the chimpanzee genome has thrown attention again on theological issues surrounding evolution and God's interaction with the world. A group of New Zealand scientists has published below a statement concerning the impact of this research on the Christian view of humanity. It is published here in order to stimulate serious debate—in science, philosophy and theology—on our understanding of human origins. Some initial responses follow the statement.*

There's this story about the bishop's wife who was told of Darwin's theory of human descent from apes. She responded, "Let's hope that it isn't true—or, if it is, that it won't become generally known". Genetic science has shown that humans and chimpanzees have a common ancestor. We must openly consider some of the implications of this conclusion for Christian thought.

The technique of 'genome sequencing' works out the order of the four chemical letters that embody the genetic

information of DNA. The sequences of the human and chimp genomes are now available.<sup>1</sup> This work has provided fascinating insights into how genomes are put together.

Amazingly, half of our genome has been assembled stepwise by the addition of pieces of parasitic DNA. These parasites are known as 'jumping genes' (or, more formally, 'mobile elements'). The DNA in our 46 chromosomes contains a zoo of 3 million such segments of parasitic DNA.

Some of these parasitic elements are the DNA of retroviruses, distantly related to the AIDS virus. Others are known as 'long interspersed elements'. These have vigorously colonised the DNA of mammals using two genes of their own. The members of a third group ('short interspersed elements') possess no genes of their own but hijack the enzymes of other parasites in order to copy-and-paste themselves into new DNA sites.<sup>2</sup>

These parasites insert themselves into DNA at preferred sites, but this can

occur randomly in the genome. They are still at it. One in every 200 babies has inherited a new parasitic element. One in every 1000 patients with a newly arising genetic disease has succumbed to a misdirected parasite that has disrupted an important gene.<sup>3</sup>

Some viruses that cause cancer also splice themselves at random sites into peoples' DNA. When a particular piece of viral DNA occurs at the same point in the DNA of all the cells in a cancer, those cells are known to be descendants of the one cell in which the unique viral insertion occurred.<sup>4</sup> In the same way, the presence of a particular parasitic element, inserted in the same place in the DNA of two or more species of animal, shows that those species are descendants of the one creature in which the unique insertion occurred.

DNA sequencing has shown that we share myriad individual parasitic elements with other primate species such as chimps and gorillas. We are products of

We and other primates have generated new genes by copy-and-paste processes. These new genes have been copied (randomly) into our chromosomes, with the essential co-operation of enzymes contributed by parasites.<sup>9</sup> Other parasitic elements that were added to primate DNA as 'junk' have been co-opted to contribute to the structure of our genes.<sup>10</sup>

The study of parasitic DNA has elucidated striking aspects of our biology. There are also fascinating implications for Christian faith. The presence of shared parasites in different species demonstrates that we have evolved. Religious attempts to base faith in God by denying that evolution has occurred are untenable. Such attacks on evolutionary science are futile.

The colonisation of our DNA by parasitic elements is not an integral part of our life cycle or body plan. We conclude that random events have structured our DNA. To some people, the operation of chance rules God out

('chance') generates novelty. The consistent, rational lawfulness of nature ('necessity') provides boundaries to that novelty so that change is limited (constrained) in particular directions. This delicate balance between randomness and lawfulness is consistent with a Creator's plan. Chance is an aspect of creation.<sup>12</sup>

Evolution is a wondrously fruitful process that has generated the breathtaking diversity of life because of the potentiality conferred upon it by its Creator. Analogously, powerful computer programs solve problems by randomly generating possible solutions and then selecting between them.<sup>13</sup> Fittingly, they are called 'genetic algorithms'. The rationality of evolution is consistent with the conclusion that humanity is a purposed outcome.

Of course, not everyone sees this. To one physicist (Stephen Weinberg, an atheist), cosmic history is pointless; to another (John Polkinghorne, a Christian), it is rich and fruitful because the

## God values his creation so much that it is given

the one lineage in which these mobile elements colonised primate DNA. Our place in the ape family has been mapped out by investigating which species has which parasite.<sup>5</sup> Parasitic sequences are 'fingerprints' that establish evolutionary relationships.

It is stunning to view large segments of DNA from different species showing the same randomly generated array of parasites.<sup>6</sup> Unique patterns of parasites also act as specific fingerprints to show how, during primate history, large segments of DNA have been copied-and-pasted to generate complex gene families.<sup>7</sup>

Many of these parasites have been domesticated. Primates (including us) have co-opted genes that were originally added to primate DNA as part of invading viruses. Such viral genes usually decay away, but several that entered primate DNA in distant ancestors now have a job to do in the development of the placenta.<sup>8</sup>

as the Creator of the process.

Such randomness reflects the underlying consistent patterns by which nature operates. It reflects lawful behaviour. We rightly speak of the laws of probability, or the science of statistics. Probabilistic (chance) events are consistent with the law-giving rationality of the Creator.

God does not control the events of nature with a vice-like grip. He is not a master puppeteer. A clockwork universe, devoid of chance events, would be a static structure in which nothing could develop. There could be no freedom, no newness, no novelty. God values his creation so much that it is given the freedom to change, to generate a history, to follow an independent course within the limits that God maintains.<sup>11</sup>

Randomness cannot then undermine faith in God as Creator. Indeed, there is an exquisite balance between 'chance' and 'necessity' in evolution. Randomness

faithfulness of God provides an exciting vision of hope.<sup>14</sup> To one French biologist (Jacques Monod, an atheist), evolution is merely a tale told by an idiot; to another (Teilhard de Chardin, a mystic Christian), it is a grand epic leading to an exhilarating climax.<sup>15</sup> To one evolutionary scientist (Richard Dawkins, an atheist), no intelligent person can speak of cosmic purpose; to another (Simon Conway Morris, a Christian), it is there for all who will take off their dark glasses.<sup>16</sup>

There is a probabilistic texture to the world. The materialist notes this randomness and assumes that evolution is meaningless. The Christian observes the same randomness and perceives a grand design in the story. Small wonder that modern science was incubated in a Christian environment.<sup>17</sup> Only people who believed in a faithful, good and purposive creator God would have valued material nature enough to probe its structure.

The very processes that have contributed to our evolution and provided new genes also cause diseases. The trial-and-error processes of genetics produce suffering. Why should God create through such an insanely slow and brutal process as evolution?

The scientist Peter Medawar said that such questions are those that children ask.<sup>18</sup> This does not mean that such questions are juvenile or trivial. Rather, they address ultimate issues that cannot be answered by science. They presuppose that we need to address a person for personal answers. But of course we cannot interrogate God as we would like.

We can make the general observation that anything of value is achieved through travail. Running a race, climbing a mountain, passing an exam, or creating a spectacularly complex, fertile and beautiful biosphere all demand time and pain. At the heart of the Bible story is the conviction that God has paid dearly for his commitment to his creation.

The Christian physical scientist C.A. Coulson observed the suffering in nature. He concluded that all of nature is obedient to the supreme law of sacrifice. The spectacular diversity of life could only come about at the cost of ongoing death. This law of sacrifice—life from death—seems to be embedded in the deep structure of reality.

At the start of the Christian faith is the suffering of a gory Roman gibbet. God himself in a person called Jesus of Nazareth experienced utter abandonment on a cross so that he could renew creation and reconcile humanity to himself. The death of Jesus is the chief exemplification of the sacrificial law of the universe, the time when God entered creation to remove evil and its attendant suffering by the sacrifice of himself.<sup>19</sup>

A young medical geneticist called Francis Collins turned from atheism to commitment to Jesus Christ as he saw the faith of his patients in the face of suffering. Now as the Director of the

human genome project, he sees in the human genome, parasites and all, the work of God.<sup>20</sup>

The primate geneticist Achilles Dugaiczuk has surveyed the myriad random events by which genetic parasites have colonised our genome. He concludes that evolution may be based on the repeatable, “but it is also based on the unique, which is at the outer edge of science”.<sup>21</sup>

Unique events in our genetic history have made us what we are now. A pattern of unique events in the random confusion of human history—God appearing among us as a peasant carpenter who died on a cross and, according to eyewitnesses, returned to life—seems totally consistent with this view of reality. Our genetic, biological history is necessary but not sufficient to describe our humanity. We are social, relational creatures. God has involved himself personally in history, and has shared our suffering that he might redeem and transform us.

# the freedom to change, to generate a history.

## RESPONSES

Case asked some local scientists and theologians for their initial responses to this article and the genome research. Please add your thought to the discussion by emailing [case@newcollege.unsw.edu.au](mailto:case@newcollege.unsw.edu.au).

### Peter Barry

*Emeritus Professor of Medical Science, University of New South Wales, Sydney*  
I think that this is an important and excellent article and that the Christian church has to face up to what is happening in genetics research. As Christians we should have nothing to fear from a search for truth.

### Barry Newman

*Lecturer in Science Education (retired), University of New South Wales, Sydney.*  
The article is too assertive for my liking and should have used words such as “strongly suggests” rather than “proves”. There is a character to the article which suggests “truth by assertion”. It is not

written by theologians and this unfortunately manifests itself at certain points. There is a tendency to let evolutionary theory lead the way theologically and so there are distortions of the nature of God.

Nonetheless, the matter needs to be brought out into the open. We can only help one another by having the matters dealt with openly with various reactions and debate. Matters such as randomness/ chance/probability and the sovereignty of God have probably not been addressed as well as they might be and the article might promote some decent thinking in the area.

Evangelicals need to push for better understanding of the biblical material.

In the end, it is not evolutionary theory that is at issue but how to properly handle the biblical text. No one is well served if we continue to hide a better understanding of Genesis 1-11 from others out of consideration for their feelings or beliefs.

### Andrew Sloane

*Lecturer in Old Testament and Christian Thought, Morling College, Sydney.*

The issue of biological evolution and its relation to Christian belief in God as creator just won't seem to go away. The views expressed in this paper will disturb and anger some within the Church; others will be unfazed. As someone with an interest in the intersections between

Christian faith, intellectual inquiry and the world in which we live at times I find the defensive response to evolutionary biology and the great efforts some will go to in order to defend Christian faith against the 'attacks' of science, quite frankly, irritating. I find it irritating for a number of reasons.

## *Why have we allowed this to be conceived of as a threat to our faith in God as Creator?*

First, when we think about God and creation there are very much more important matters for our consideration than questions of the mechanisms our sovereign Creator used (and uses) to bring creatures into existence. Issues such as whether we are acting as responsible representatives of God in the world, preserving its rich diversity and ensuring that its bounty is available for all humans to enjoy, not just an elite few. Or enabling people to recognise God's goodness and glory as reflected in the world and, through the message of the gospel, come to glorify him and serve him in his world which is, after all, his due. It seems to me that we ought not to allow this (in my mind fruitless) debate to distract us from these crucial concerns. That is not, of course, to decry intellectual engagement with the world, including understanding its history and considering how that relates to our faith. Nor is it to say that this is not an important issue for Christians with an interest in science to explore.

This brings me to my second irritation. Why have we allowed this to be conceived of as a threat to our faith in God as Creator? Why do some within the Church still seem to have such an impoverished view of God as Creator that they think he cannot use the rich and complex processes of biological evolution to achieve his purposes? Surely by now we realise that the text of Scripture is concerned with calling us to glorify God and engage responsibly in his world rather than giving us information about procedures that would be beyond

our ability to fully grasp, let alone control (see Job 38–41). If this new research on gene sequencing is sound (a matter beyond my technical expertise) what are its implications for Christian faith? None whatsoever as far as I can see. It may strengthen the case for evolutionary mechanisms for God's

creation of humans and other species. That doesn't dissolve the essential mystery of God's creative work, it doesn't mean that we are to glorify him any less (or more). It may mean we understand that aspect of the world a little better. ©

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**Graham O'Brien is a molecular geneticist who is training for the ministry. He is a member of the Inter-Church Bioethics Council.**

**Cris Print is a molecular biologist with a particular interest in bioinformatics. He is also Associate Professor in the Department of Molecular Medicine and Pathology, University of Auckland.**

**Andrew Shelling is a molecular biologist who lectures in Reproductive Science at the University of Auckland. He is currently President of the Human Genetics Society of Australasia (NZ Branch).**

**The authors are grateful for advice from Paul Wraight who has taught physics at the University of Aberdeen, New Zealand. He is currently writing a book on cosmology and God.**

### ENDNOTES

- 1 For a general review on the primate genome, see Enard W and Paabo S (2004). Comparative primate genomics. *Annu Rev Genomics Hum Genet* 5, 351; for an anticipation of the chimp genome see Gagneux P (2004). A Pan-omic view: insights into hominoid evolution through the chimpanzee genome. *Trends Ecol Evol* 19, 571; for the latest update on the human genome, see International Human Genome Sequencing Consortium (2004). Finishing the euchromatic sequence of the human genome. *Nature* 431, 931.
- 2 Kazazian HH (2004). Mobile elements: drivers of genome evolution. *Science* 303, 1626.
- 3 Long and short interspersed elements (LINE-1 elements; Alu and SVA elements respectively) still cause genetic disease. See Ostertag EM and Kazazian HH (2001). Biology of mammalian L1 retrotransposons. *Annu Rev Genet* 35, 501; Deininger PL and Batzer MA (1999). Alu repeats and human disease. *Molec Genet Metab* 67, 183; Ostertag EM, Goodier JL, Zhang Y and Kazazian HH (2003). SVA

elements are nonautonomous retrotransposons that cause disease in humans. *Am J Hum Genet* 73, 1444.

- 4 These include leukaemia, hepatitis and papilloma viruses. See for example from recent tumour virus literature Tsukasaki K, Koeffler P and Tomonaga M (2000). Human T-lymphotropic virus type I infection. *Best Pract Res Clin Haematol* 13, 321; Ng IO-L, Guan XY, Poon RT-P et al (2003). Determination of the molecular relationship between multiple tumour nodules in hepatocellular carcinoma differentiates multicentric origin from intrahepatic metastasis. *J Pathol* 199, 345.
- 5 Primate evolution is reviewed by Schmitz J, Roos C and Zischler H (2005). Primate phylogeny: molecular evidence from retrotransposons. *Cytogenet Genome Res* 108, 26. Two major studies placing humans in their family context are Salem A-H, Ray DA, Xing J et al (2003). Alu elements and hominid phylogenetics. *Proc Natl Acad Sci USA* 100, 12787; Xing J, Salem A-H, Hedges DJ et al (2003). Comprehensive analysis of two AluYd subfamilies. *J Mol Evol* 57 suppl. 1, S76. Relationships of species belonging to the New World monkeys also have been strikingly elucidated: Roos C, Schmitz J and Zischler H (2004). Primate jumping genes elucidate strepsirrhine phylogeny. *Proc Natl Acad Sci USA* 101, 10650.

Interestingly, techniques that compare the sequences of multiple, distantly related mammalian species reveal the presence of very ancient parasitic inserts that have almost faded away from the genetic record. These identify common ancestors near the base of the mammalian tree. See Blanchette M, Green ED, Miller W and Haussler D (2004). Reconstructing large regions of an ancestral mammalian genome in silico. *Genome Res* 14, 2412.

- 6 Often little is made in published studies of these shared arrays of common parasites. Scientists have reasons for studying them other than merely using them as demonstrations of evolution. But they do indeed constitute stunning evidence that we and the chimps (and Old World primates and beyond) are derived from the same ancestor. See the patterns of shared parasites in Shibuya K, Kudoh J, Obayashi I et al (2004). Comparative genomics of the keratin-associated protein (KAP) gene clusters in human, chimpanzee, and baboon. *Mammalian Genome* 15, 179; Kouprina N, Pavlicek A, Mochida GH et al (2004). Accelerated evolution of the *ASPM* gene controlling brains size begins prior to human brain expansion. *PLoS Biol* 2, 653; Pavlicek A, Noskov VN, Kouprina N et al (2004). Evolution of the tumor suppressor *BRCA1* locus in primates: implications for cancer predisposition. *Hum Molec Genet* 13, 2737.

7 Sawai H, Kawamoto Y, Takahata N and Satta Y (2004). Evolutionary relationships of major histocompatibility complex class I genes in simian primates. *Genetics* 166, 1897; Kulski JK, Anzai T, Shiina T and Inoko H (2004). Rhesus macaque class I duplcon structures, organisation and evolution within the alpha block of the major histocompatibility complex. *Molec Biol Evol* 21, 2079.

- 8 For a review, see Gifford R and Tristem M (2004). The evolution, distribution and diversity of endogenous retroviruses. *Virus Genes* 26, 291.

- The HERV-FRD retrovirus is possessed by all simians and therefore entered the primate germline in an ancestor of the simians. Blaise S, de Parseval N, Benit L and Heidmann T (2003). Genomewide screening for fusogenic human endogenous retrovirus envelopes identifies syncytin 2, a gene conserved on primate evolution. *Proc Natl Acad Sci USA* 100, 13013.
- The ERV3 retrovirus is possessed by all Old World primates, and therefore entered primate DNA in an ancestor of this group. Herve CA, Forrest G, Lower R et al (2004). Conservation and loss of the ERV3 open reading frame in primates. *Genomics* 83, 940. Of note is the fact that the *env* gene is truncated by a 'stop' mutation at the same point in all species tested (baboon, macaque, orang, gibbon, chimp, human). The same mutation could not be expected to have occurred independently in all six species; rather these species have all inherited the mutation from the one individual in which the mutation

uniquely occurred.

- The HERV-W retrovirus integrated in an ape ancestor. Mallet F, Bouton O, Prudhomme S *et al* (2004). The endogenous locus ERVWE1 is a bona fide gene involved in hominoid placentation physiology. *Proc Natl Acad Sci USA* 101, 1731; Bonnaud B, Bouton O, Oriol G *et al* (2004). Evidence of selection on the domesticated ERVWE1 env retroviral element involved in placentation. *Mol Biol Evol* 21, 1895. This particular retrovirus has undergone a 12-base deletion (present in all species that possess it) that enhances its ability to induce cell fusion. This is another striking marker of common ancestry. Prudhomme S, Oriol G and Mallet F (2004). A retroviral promoter and a cellular enhancer define a bipartite element which controls env ERVWE1 placentation expression. *J Virol* 78, 12157.
- 9 The co-operating parasites are called LINES and their 'reverse transcriptase' enzyme has copied-and-pasted primate genes. An enzyme that acts in the brain arose in an ancestor of the apes when its gene was copied and pasted into a new site. Burki F and Kaessmann H (2004). Birth and adaptive evolution of a hominoid gene that supports high neurotransmitter flux. *Nature Genet* 36, 1061. Another example of the phenomenon of gene birth by retrotransposition is: Betran E, Wang W, Jin L and Long M (2002). Evolution of the phosphoglycerate mutase processed gene in human and chimpanzee revealing the origin of a new primate gene. *Mol Biol Evol* 19, 654.
- Early indications are that hundreds of genes have been duplicated courtesy of obliging LINE-1 elements. See Emerson JJ, Kaessmann H, Bertran E and Long M (2004). Extensive gene traffic on the mammalian X chromosome. *Science* 303, 537; Wang PJ (2004). X chromosomes, retrogenes and their role in male reproduction. *Trends Endocrin Metab* 15, 79.
- 10 This has been shown repeatedly for the short elements known as Alu elements. For general reviews, see Jasinska A and Krzyzosiak WJ (2004). Repetitive sequences that shape the human transcriptome. *FEBS Lett* 567, 136; Shedlock AM, Takahashi K and Okada N (2004). SINEs of speciation: tracking lineages with retrotransposons. *Trends Ecol Evol* 19, 545.

For two striking examples where old parasites are now part of chimp and human genes see, Courseaux A and Nahon JL (2001). Birth of two chimeric genes in the *Hominidae* lineage. *Science* 291, 1293; Singer SS, Mannel DN, Hehlhans T *et al* (2004). From 'junk' to gene: *curriculum vitae* of a primate receptor isoform gene. *J Mol Biol* 341, 883.

11 It is out of respect for the given independence of the world that its evolution must take place through the interplay of chance and necessity. Perhaps God must work this way "out of respect for the beloved". Polkinghorne J (1986) *One World*. (London: SPCK), p. 81. The author was Professor of Mathematical Physics at Cambridge before he shocked everyone by resigning to become an Anglican priest.

12 An understanding stressed by scientists of the highest calibre who possess biblical faith. A God who is both loving and faithful bestows on his creation the twin gifts of freedom and reliability. See Polkinghorne J (1983). *The Way the World Is* (London: SPCK), p. 11f; and Polkinghorne J. (1994). *Science and Christian Belief* (London: SPCK), pp. 76-77.

To Robert Boyd, the rationality of God is expressed "within the cosmos and alike in what seems chaos"; God works as much in randomness as order; see Berry RJ ed (1991). *Real Science Real Faith* (Eastbourne: Monarch), p. 68.

Ted Burge writes, "order is essential, together with chance, in the evolution of the universe." Burge T (2002). What else does physics tell us about God? *Science and Christian Belief* 14, 79. The latter authors were professors of physics at London University.

- 13 Rolston H (1999). *Genes, Genesis and God* (Cambridge: CUP). Genetic algorithms are "search algorithms based on the mechanics of natural selection and natural genetics". Genetic problem-solving then is not blind. "It is remarkably like what some of the smartest scientists are doing" (pp. 34-37). "Computer scientists solve problems with genetic algorithms, patterned after natural selection, using random variation and retention of the best surviving solutions" (p. 169). The author is Distinguished Professor of Philosophy, Colorado State University.
- 14 Polkinghorne J (1996). *Beyond Science*.

(Cambridge: CUP), ch. 7; see also his more popular 1994 book, *Quarks, Chaos and Christianity*. (London: SPCK), ch. 7.

15 See Polkinghorne J, *One World*, p. 43.

16 Conway Morris S (2003). *Life's Solution: Inevitable humans in a Lonely Universe*. (Cambridge: CUP). The author is Professor of Geology at Cambridge, Fellow of the Royal Society, and the leading authority of the fossils of the Burgess Shale.

17 Russell CA (1985). *Cross-currents*. (Leicester: IVP); Kaiser C (1991). *Creation and the History of Science*. (London: Marshall Pickering); Alexander D (2001). *Rebuilding the Matrix*. (Oxford: Lion).

18 Berry RJ (1986). What to believe about miracles. *Nature* 322, 321.

19 Coulson CA (1958). Science and Christian Belief. (London and Glasgow: Fontana), pp. 132-135. The author, one of the great British physical scientists of the twentieth century, states "For evolution, the story of man, traced for us by the scientist, is seen as the travail of God's energy, creating man in His own image. No wonder it is shot through with pain and sacrifice and blood...For creation, and Nature and man, these are not what God did, or even what God does, but what He is. The only interpretation that will do justice to them is in terms of love and sacrifice, linking them all together in the bond of God's Being."

Rolston states that "The way of history too, like that of nature, only more so, is a *via dolorosa*. Since the beginning, the myriad creatures have been giving up their lives as a ransom for many. In that sense, Jesus is not the exception to the natural order, but a chief exemplification of it." The essential theme of Christianity and Judaism is that suffering love is divine (pp. 306-307).

20 Collins F (1999). The human genome project: tool of atheistic reductionism or embodiment of the Christian mandate to heal? *Science and Christian Belief* 11, 99; see also his comments in News (2000). World leaders heap praise on human genome landmark. *Nature* 405, 983.

21 Gibbons R, Dugaiczky LJ, Girke T *et al* (2004). Distinguishing humans from great apes with AluYb8 repeats.

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