Human genomics and the Image of God

Graeme Finlay

The God of the Bible is also the God of the genome. He can be worshiped in the cathedral or in the laboratory. His creation is majestic, awesome, intricate, and beautiful – and it cannot be at war with itself.[1]

Francis Collins, Head of the Human Genome Project

Summary

The DNA we have inherited is the current edition of a text that has been transmitted to us through innumerable generations of ancestors. Unique markers in our DNA show that our ancestors were shared not only with other people, but (progressively further back in time) with other apes, primates and mammals. Our DNA tells a story that describes our biological origins during mammalian evolution, but that is not sufficient to account for our origins as persons. We are formed as persons only as we hear and assimilate stories transmitted in our families and communities. Christians believe that the story that is essential to the development of a fulfilled humanity is that which relates God's redeeming action in Jesus Christ.

Judaeo-Christian ethics have always been motivated by the biblical concept that humanity is created in the 'image and likeness' of God (Gen. 1:26-28). This recognition that each person somehow reflects the nature of God and so has an inalienable dignity and value, has motivated compassion and social reform down the centuries.

And yet the essential meaning of the concept of the 'image of God' is to some extent ambiguous. People have often identified particular features of humanness (such as creativity, rationality or the moral sense) as being central to the meaning. But such understandings are too narrow.

The intended meaning of this biblical term must be inferred from its originating socio-religious context. The kings of the ancient Near East set up statues of themselves, identified as their 'image and likeness', in order to assert their authority over their domains.[2] The Bible thus indicates that, alone of all creatures, human beings have been made for God, have been appointed to serve God and are accountable to God. We are creatures with a calling to care for each other and for the wider creation. One implication of this commission is that care for creation must be seen an ethical imperative. Biblically, our response to the environmental crisis cannot reduce to enlightened self-interest. It is a divinely given mandate.[3]

All this presupposes that we have the potential to know and live in relationship with our Creator and that our behaviour should reflect His love and goodness. It follows that to be estranged from God is to be unfulfilled – and may well lead us to assuage our longings by frenetic involvement in other pursuits.[4]

It is clear that any description of ourselves as bearers of God's 'image and likeness' encompasses the totality of our personhood. But this is necessarily an *embodied* personhood. We are biological creatures. The mental capacities that are unique to us as human beings, such as our capacity to engage in scientific reasoning, aesthetics, moral deliberation and religious devotion, are embedded in our biology and therefore in our genetic substrate. And our genes themselves have taken shape through the material process of biological evolution.

About the Author

Since 1980, Graeme Finlay has been involved in cancer research in the Auckland Cancer Society Research Centre, New Zealand, the largest laboratory of its kind in the southern hemisphere. From 2000 he has also been Senior Lecturer in Scientific Pathology, University of Auckland. Dr Finlay writes and lectures widely on the subject of science and faith.

Our stories

To describe ourselves as human beings, we must attend to two types of story. Firstly, there is a *scientific* or *genetic* story that narrates our biological history. The study of our genome has told us

- that we are an evolved species;
- where we are located in the primate and mammal family trees;
- how genes have appeared and decayed during the development of our species.

Further, the study of our genome is *in principle* entitled to tell us

- how our genome gives rise to our biological features;
- how our genes function to enable the development of our mental faculties (such as our scientific, aesthetic, and religious capacities);
- how our genes influence our behaviour.

Despite the heady advances of genetics, humility is in order. Scientific understanding of the role of much of the genome is in its infancy. The proportion of our DNA that codes for proteins is 1.2% of

1 Collins, F.S. *The Language of God,* New York: Free Press (2006), p.211.
2 Hess, R.S. 'Genesis 1-2 and recent studies of ancient texts', *Science and Christian Belief* (1995) 7, 141-149.
3 Spencer, N. and White, R. *Christianity, Climate Change and Sustainable Living,* London: SPCK (2007), pp.83-86.
4 McGrath, A, ed. *The New Lion Handbook Christian Belief,* Oxford: Lion (2006), pp. 74, 76, 78.

the whole. Regulatory functions have been assigned to an additional few per cent of our DNA. Much of the remainder was once dismissed as 'junk', but there is increasing evidence that the 'junk' DNA has novel functions that are as yet unknown.[5] Genome science has much to learn.[6]

Rolston reminds us that physics and chemistry are the same anywhere in the universe, but that biology (or 'natural history') is a story peculiar to Earth. This story becomes 'memorable, cumulative and transmissible' in the genes of living organisms. But the story of humanity is not written in genes only. We must also give account of the cultural history that has developed out of genetic history. The genetic phase of the story could never anticipate how the cultural phase would unfold. We dare not commit the 'genetic fallacy' that presumes to explain culture in terms of genetics.[7]

So in addition to the genetic story, we possess a *personal* story. It follows that the study of our genome cannot tell us

- how our personal environment (relationships, cultures and stories) forms us as people;
- why cultures have developed in the particular directions we see today;
- whether our beliefs about purpose, the ultimate nature of reality and God are true;
- whether our behaviours are right.

We must take both the scientific and the personal stories seriously. The former is a precondition of the latter, but it can be known and interpreted only through the latter. It is only persons, who have been formed by the stories told in very particular societies, who will wonder about their biological origins and who will be equipped with the critical realist world-view that allows them to pursue the appropriate academic disciplines. There is strong evidence that this world-view arose from the monotheistic faith of the Bible.[8]

The genetic story

The DNA that is packed into our cells (our genome) embodies the genetic instructions required for our physical development. It resembles a written text in that it contains a linear sequence of chemical 'letters' (designated 'A', 'C', 'G' and 'T') that spell out this genetic information. Our complement of DNA contains two sets of instructions, each comprising 3 billion chemical 'letters'. It has aptly been called our instruction book.

Our DNA embodies the information that we have inherited from countless generations of ancestors. It is modified in every generation through which it is transmitted and so the particular version that each one of us has received is a record of our history. For example, a boy inherits his Y chromosome from his father, who had inherited it from his father. That boy and his brothers share any mutations that occurred in the Y chromosomal DNA of their father. They and their male cousins share any mutations that arose in the Y chromosome of their grandfather. Our genome is a history book that tells the story of our genealogy.

The order of the chemical 'letters' in our DNA (the sequence) has been determined by the Human Genome Project.[9] The genomes of several other species have also been sequenced. Of particular importance are those of the chimpanzee, our closest living relative,[10] and of the rhesus macaque, a more distant relative (an Old World Monkey), that has played an important role in medical research.[11] A comparison of our genome sequence with those of other species has allowed geneticists to catalogue the differences that exist between genomes and so reveal the genetic basis of our biological nature.[12]

- Much of our DNA can be aligned directly with that of other species. When this is done, human DNA is found to differ from chimp DNA in only 1% of the 'letters', and from macaque DNA in 6%. However, there are extensive regions where the DNA cannot be aligned because new material has been inserted into, or old material deleted from, the genome of one species. When these are taken into account, the human and chimp genomes differ by 5% and the human and macaque genomes by at least 10%.
- This high degree of genetic similarity indicates that the proteins of humans and chimps will also be very similar. Indeed 20-30% of the proteins encoded in our genome are identical to the corresponding protein of chimps. Of the proteins that do differ between these species, only 2 amino acids on average are changed in each protein. About 10% of our proteins are identical with their macaque equivalents.
- New genes have appeared since the human and chimp lineages branched out from their common ancestor. We possess several hundred genes that are not found in chimps. Most of these have arisen through the duplication of pre-existing genes, followed by divergence of the genetic information present in each copy.
- Some old genes have been disabled on the human lineage since the time of the common ancestor. Several hundred genes that remain active in chimps are disabled in our genome and cannot direct the production of a protein because they have acquired inactivating mutations. Loss of genes has provided us with more delicate cheek muscles, has made us less hairy, has reduced the acuteness of our sense of smell and has altered our susceptibility to malaria. The active form of the *CASP12* gene is currently disappearing from the human gene pool. This gene may compromise responses to some bacterial infections, and its active form survives only in a minority of people.
- Biological differences between humans and chimps will also reflect changes in gene regulation. A gene that encodes the same protein in each species will have widely different effects if in one of these species it is expressed more actively, or at different times, or in different tissues. The brains of humans and chimps appear to show fewer differences in gene expression than do other organs. Most of the differences identified represent increased expression in humans.
- Half our genome has arisen from the activities of genetic parasites or 'jumping genes'. These are segments of DNA that colonise genomes and propagate themselves by copying-and-pasting themselves into new sites in the DNA.[13] More than three million of these genetic parasites have accumulated in our DNA, of which over 99% are shared by humans and chimps. This is testimony to the vast shared history from which we and chimps have arisen. The order in which each parasite has been added to primate DNA has provided an unambiguous outline of primate evolution (Figure 1).[14] During evolutionary history, parasitic additions to our genomes have provided raw material from which new genetic function has arisen. This includes both regulatory and protein-coding function.[15] Several thousand inserted parasitic units are unique to humans (and a comparable number to chimps) and may have contributed to the biological differences between the two species.

5 Pheasant, M. and Mattick, J.S. 'Raising the estimate of functional human sequences', *Genome Res*. (2007) 17, 1245-1253.
6 McGrath op. cit. [4]
7 Rolston, H. III. Genes, *Genesis and God,* Cambridge: CUP (1999), pp. 50-53; 154-159.
8 Trigg, R. 'A Christian Basis for Science', *Science and Christian Belief* (2003) 15, 3-15.
9 International Human Genome Sequencing Consortium. 'Initial sequencing and analysis of the human genome', *Nature* (2001) 409, 860-921.
10 The Chimpanzee Sequencing and Analysis Consortium. 'Initial sequence of the chimpanzee genome and comparison with the human genome', *Nature* (2005) 437, 69-87.
11 Rhesus Macaque Genome Sequencing and Analysis Consortium. 'Evolutionary and biomedical insights from the rhesus macaque genome', *Science* (2007) 316, 222 -233.
12 Kehrer-Sawatzki, H. and Cooper, D.N. 'Understanding the recent evolution of the human genome: insights from human-chimpanzee genome comparisons', *Hum. Mutat*. (2007) 28, 99-130.
13 Jurka, J., Kapitonov, V.V., Kohany, O. and Jurka, M.V. 'Repetitive sequences in complex genomes: structure and evolution', *Annu.Rev. Genomics Hum.Genet*. (2007) 8, 241-259.
14 Ray, D.A. 'SINEs of progress: mobile element applications to molecular ecology', *Molecular Ecology* (2007) 16, 19-33; Salem, A.-H., Ray, D.A., Xing, J. et al. 'Alu elements and hominid phylogenetics', *Proc. Natl. Acad. Sci. U.S.A*. (2003) 100, 12787-12791.
15 Volff, J.-N. 'Turning junk into gold: domestication of transposable elements and the creation of new genes in eukaryotes', *BioEssays* (2006) 28, 913-922.

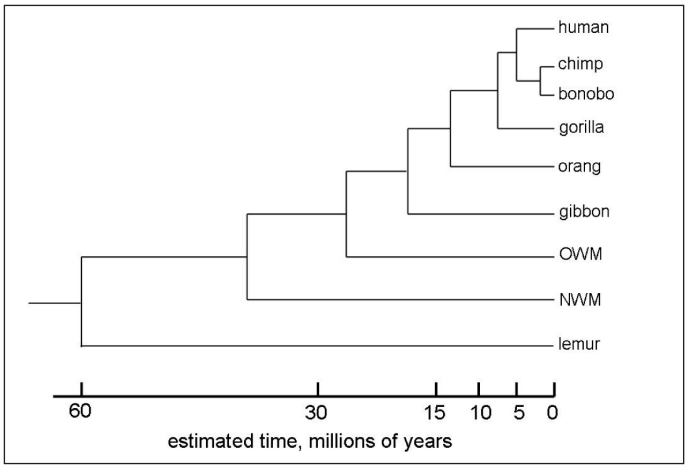

Figure 1. A simplified outline of the primate family tree, derived from the order in which 'jumping genes' have accumulated in primate genomes. For example, a particular 'jumping gene' that is present in the genomes of the great apes arose in the DNA of a great ape ancestor.[16] OWM: Old World Monkeys. NWM: New World monkeys.

Ancient classes of 'jumping genes' in our DNA are present in the genomes of all mammals. The study of their distribution is yielding a detailed map of our place in mammalian history (Figure 2).[17] For example, we primates form a grouping with the flying lemurs, tree shrews, rabbits and rodents called Euarchontoglires. The evolutionary scheme so generated is compatible with that derived from the distribution of rare mutations in genes.[18] And the study of chromosomes (cytogenetics) has demonstrated that the particular shape of our chromosome set can be cut-and-pasted to generate that of a great ape ancestor, or of a primate ancestor or of an ancestor of all placental mammals.[19] The genetic story that is embodied in our DNA provides a coherent account of how progenitor genomes have been transformed into human genomes by familiar (natural) and random genetic mechanisms.

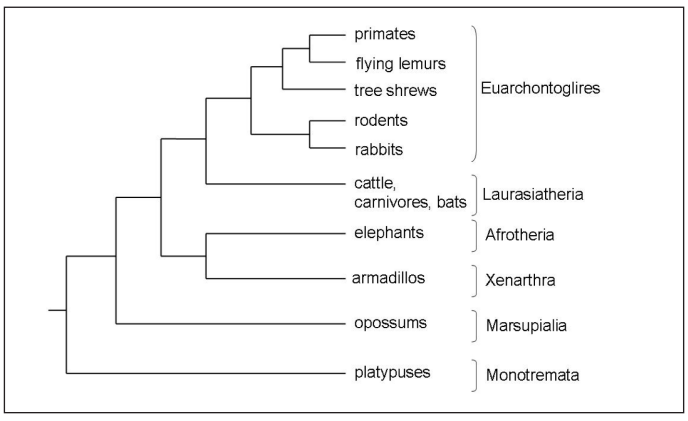

Figure 2. A simplified outline of the mammalian family tree, derived from the distribution of 'jumping genes', rare mutations in genes, and from the progressive remodelling of chromosome sets. The Euarchontoglires group has been expanded to show the five orders that constitute it. There is no attempt to indicate timescale.[20]

One must expect that our DNA has been formed also by events that preceded the origins of mammals. However, the specific genetic markers arising from such ancient DNA rearrangements and 'jumping gene' insertions have been eroded beyond recognition. Nevertheless the story told by our DNA is epic. Each 'jumping gene' fossil that we share with opossums originally inserted into the DNA of a common progenitor that scampered around under the feet of dinosaurs. Each insert that we share with elephants predated the plate tectonic separation of the land masses Laurasia and Gondwana. And each insert that we share with dogs predated the asteroid impact that ended the dinosaur era.

Genomes are not static, ordered assemblages of genes, but are continuously modified. Comparisons with the genomes of related species reveal how segments of DNA are added, lost, or rearranged. Such comparisons document the rise and fall of gene families and the origins of the tendencies to various genetic diseases. Our DNA has inscribed within its sequence a record of its assembly by myriad invading genetic parasites. They have modified and expanded it and contributed numerous functional components. We are at least partly what our parasites have made us.

Given that the development of our genome can be described comprehensively in molecular terms (at least through most of mammalian history), does that leave room for us to think of ourselves as creatures made in the image of God? Genetic evolution has led to a uniquely complex cultural evolution.[21] We humans alone reflect on our past and our future, and our origins and our destiny. We live in complex societies and are nurtured in diverse cultures that have been shaped by the contingencies of human history. Christian theologians have emphasised the fact that the directedness and character of our lives – including those of sociobiologists – come from stories.

The personal story

The genetic story has the potential to describe the origins of the unique potentialities of the highly versatile ('cognitively fluid') human brain – a brain capable of engaging in the pursuits of science, art, and religion. Van Huyssteen has written, 'the cognitive fluidity of our minds allowed for the possibility of powerful metaphors and analogies, without which science, art and religion could not exist'. The genetic story that underlies this capacity is necessary but not sufficient to account for our humanity and culture, because the evolution of the genome cannot explain 'the particular paths that human culture will take through rational knowledge, moral awareness, aesthetic appreciation, and our religious disposition.'[22]

Superimposed on our genetic story are the vitally important narrative stories, transmitted in human communities, that direct our lives along certain trajectories. They form our self-identity, our character and the intentionality that motivates and orientates our lives, our values and our ethics.

Significantly, we are 'story-making creatures'. Birch and Rasmussen have written, 'It is through story that people create their own plot lines and establish the framework in which they presently live, and will live in the future'.[23] It is stories, arising in the contingent happenings of human lives, that 'become recipes for structuring experience itself, for laying down routes into memory and, finally, for guiding one's life.' [24]

There are no exceptions here: from the most militant materialist to the most meditative mystic, the orientation of our lives is formed by stories. The human stories imbibed during our upbringing are foundational for our knowledge of the world. They enable us to become aware of ourselves as human, as rational beings, as people with a history and as the inheritors of a genetic story.

Some writers committed to a materialistic understanding of life dismiss the 'religious' story because it is purportedly based on scriptures that are invested with 'authority'. They promote the scientific story as being superior because it is based on empirical data. However,

16 Salem, Ray, Xing et al. *op. cit.,* (14).

17 Nishihara, H., Hasegawa, M. and Okada, N. 'Pegasoferae, an unexpected mammalian clade revealed by tracking ancient retroposon insertions', *Proc. Natl. Acad. Sci. U.S.A.* (2006) 103, 9929-34.

18 Janecka, J.E., Miller, W., Pringle, T.H. et al. 'Molecular and genomic data identify the closest living relatives of primates', *Science* (2007) 318, 792-794.

19 Ferguson-Smith, M.A. and Trifonov, V. 'Mammalian karyotype evolution', *Nature Reviews Genetics* (2007) 8, 950-962.

20 see footnotes 17 – 19.

21 Varki, A. and Altheide, T.K. 'Comparing the human and chimpanzee genomes: searching for needles in a haystack', *Genome Res.* (2005) 15, 1746-1756.

22 Van Huyssteen, J.W. *Alone in the World? Human Uniqueness in Science and Theology,* Grand Rapids and Cambridge: Eerdmans (2006), pp. 214-215, 312-313.

23 Birch, B.C. and Rasmussen, L.L. *Bible and Ethics and the Christian Life,* Minneapolis: Augsburg (1989), p. 127

24 *ibid.,* p. 106.

the authority of the biblical stories for Christian faith arises from the way in which they have been found to describe and interpret events in empirical human history authentically. The genetic story reconstructed from DNA sequences and the Christian story arising from the concrete events of human history thus bear the same kind of authority. These are stories that make cogent sense of vast bodies of experience.

The genetic story to which scientists restrict themselves makes sense of DNA sequences with their myriad inserted markers and so describes the biological origin of the *human animal*. The narrative stories told in human communities are needed to form the *human person*. The biblical story makes sense of Israel's experience of God, of the history of Jesus, and of our own lives, and so enables us to understand ourselves as creatures made in the 'image and likeness of God'.

Israel told the story of how God rescued them from Egypt, and so came 'to see itself as a people on a journey, an adventure. Its ethics become the virtues necessary to sustain Israel on the road. … Story is the fundamental means of talking about and listening to God, the only human means available to us that is complex and engaging enough to make comprehensible what it means to be with God.'[25]

Similarly, the Church is a story-telling community. It arises from the details of God living in a particular man, proclaiming a particular ethic, dying a particular death and rising in a particular way. 'The Christian claim is bound to this particular story, since it understands that the way of God is paradigmatically present in the way of Jesus as a way of life, and is carried on among those who strive to make this life their own.'[26]

So it is that the Christian church did not begin with metaphysical speculation but with stories about Jesus and those whose lives were caught up in his life. These stories enable us to see meaning and significance in our lives. 'The little story I call my life is given cosmic, eternal significance as it is caught up within God's larger account of history.' Hauerwas and Willimon conclude that true freedom arises in our being linked to a true story. The Christian community knows the story that tells how the risen Christ returned to his disciples in forgiveness; and so expects his continued presence, forgiveness and blessing.[27]

We may approach reality around us as 'nature' and appropriately investigate the effect of our evolutionary past on phenomena such as 'altruism' and socially disruptive behaviour. But such starkly minimalist scientific parlance is inadequate to describe human morality. Regardless of how our genome influences our behaviour, human ethics transcends genetics. It is when we view reality as 'creation' (a perspective arising from the biblical story) that we may recognise the moral dimension to our lives in terms of *agape* 'love' (of the kind revealed by God) or of 'sin' (that is, action incompatible with the nature of God).[28]

The virtuous life is not genetically specified. It is not common sense, or self-evident to any rational person of good will. It does not reduce to simple ethical prescriptions and formulations. 'Our character is the result of our sustained attention to the world that gives a coherence to our intentionality. Such attention is formed and given content by the stories through which we have learned to form the story of our lives.'[29]

Hauerwas has said, 'The moral life is not simply a matter of decision governed by publicly defensible principles and rules; we can only act in the world we see, a seeing partially determined by the kind of beings we have become through the stories we have learned and embodied in our life plan'. Stories and metaphors enable us to interpret the world 'by providing the narrative accounts that give our lives coherence. Ethical principles and rules are only shorthand reminders needed for moral education and explanation: 'their moral significance is contained in stories.'[30]

Integrating our stories

Religious people sometimes reject the storied nature of our biological origins, opting instead for an approach to genetics that denies the story told in our DNA. Similarly, there have always been people who deny the storied nature of the Gospel of Jesus. From the second century Gnostics onwards, they have removed Jesus from his historical and Jewish background. But any scholarship, no matter how erudite, that is built upon false premises, is doomed to failure.[31] A historical approach to the data of both biology and of the Gospels is consistent, compatible with a critically realist scientific perspective and intellectually satisfying.

Both primate genomics and the biblical accounts of Israel and of Jesus are powerful stories. But we will be intellectually schizophrenic if we keep them in separate boxes. Christians believe that the most satisfying world-view integrates these accounts as different phases of the *same* story. The history of life as inscribed in DNA is but our discovery of an epic story that God has written. Science fills in the details of our biological history that God has created. Ancient Hebrew (Isa.65-66) and Christian (2 Pet.3:13; Rev.21:1) interpreters of history take up this same story to describe how God intends to transform an uncompleted creation into one that is perfect.

This uncompleted story addresses a deep irony. Only one product of evolution has been designated 'the image and likeness of God', and this creature has been guilty of continuous and barely mitigated savagery. As an unrivalled product of the evolutionary story, we 'image' God in a very provisional way. This mystery is resolved when we encounter the climax of the Old Testament story, Jesus Christ, who is described as the exact likeness of God (Col.1:15). The death and resurrection of Christ provides the hermeneutic key by which history may be understood. These events in turn point to the climax of the New Testament story. God will confer Christ's perfect likeness on sinful humanity, and transform people into the very likeness of Christ (1 Cor. 15:49).

The reality of our humanity is not called into question by the fact that our genome is wholly inconvertible into that of other primates by known genetic mechanisms. Nor can the genome-behaviour link (the insights of sociobiology) affect our moral personhood. The people we are and the way we live our lives are formed by the stories we value. In a fragmented world on a dying planet, there is no greater need than to listen attentively to the story of Jesus.

25 Hauerwas, S. and Willimon, W.H. *Resident Aliens,* Nashville: Abingdon Press (1989), pp. 54-55.
26 Birch and Rasmussen *op. cit.,* (23), pp. 106-107, 125.
27 Hauerwas and Willimon *op. cit.,* (25), pp. 55, 67, 68.
28 Messer, N. *Selfish Genes and Christian Ethics,* London: SCM Press (2007), pp.106, 111-113, 128, 164f, 184, 192, 195.
29 Hauerwas, S. *Vision and Virtue,* Notre Dame: University of Notre Dame Press (1981), pp. 68-77.
30 *ibid.*
31 Wright, N.T. *Scripture and the Authority of God,* London: SPCK (2005).

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